surface of the external pterygoid plate and to the grooved surface of the tuberosity of the palate bone, and by a second slip from the outer surface of the tuberosities of the palate and superior maxillary bones; its fibres pass downward, outward, and backward, to be inserted, by a strong, tendinous lamina, into the lower and back part of the inner side of the ramus and angle of the lower jaw, as high as the dental foramen.

Relations.—By its *external surface*, with the ramus of the lower jaw, from which it is separated, at its upper part, by the External pterygoid, the internal lateral ligament, the internal maxillary artery, the dental vessels and nerves, and the lingual nerve, and a process of the parotid gland. By its *internal surface*, with the Tensor palati, being separated from the Superior constrictor of the pharynx by a cellular interval.

Nerves.—These muscles are supplied by the inferior maxillary nerve.

Actions.—The Temporal and Masseter and Internal pterygoid raise the lower jaw against the upper with great force. The superficial portion of the Masseter assists the External pterygoid in drawing the lower jaw forward upon the upper, the jaw being drawn back again by the deep fibres of the Masseter and posterior fibres of the Temporal. The External pterygoid muscles are the direct agents in the trituration of the food, drawing the lower jaw directly forward, so as to make the lower teeth project beyond the upper. If the muscle of one side acts, the corresponding side of the jaw is drawn forward, and, the other condyle remaining fixed, the symphysis deviates to the opposite side. The alternation of these movements on the two sides produces trituration.

Surface Form.—The outline of the muscles of the head and face cannot be traced on the surface of the body, except in the case of two of the masticatory muscles. Those of the head are thin, so that the outline of the bone is perceptible beneath them. Those in the face are small, covered by soft skin, and often by a considerable layer of fat, so that their outline is concealed, but they serve to round off and smooth prominent borders and to fill up what would be otherwise unsightly angular depressions. Thus, the Orbicularis palpebrarum rounds off the prominent margin of the orbit, and the Pyramidalis nasi fills in the sharp depression beneath the glabella, and thus softens and tones down the abrupt depression which is seen on the unclothed bone. In like manner, the labial muscles, converging to the lips and assisted by the superimposed fat, fill in the sunken hollow of the lower part of the face. Although the muscles of the face are usually described as arising from the bones and inserted into the nose, lips, and corners of the mouth, they have fibres inserted into the skin of the face along their whole extent, so that almost every point of the skin of the face has its muscular fibre to move it; hence it is that when in action the facial muscles produce alterations in the skin-surface, giving rise to the formation of various folds or wrinkles, or otherwise altering the relative position of parts, so as to produce the varied expressions with which the face is endowed; hence these muscles are termed the "muscles of expression." The only two muscles in this region which greatly influence surface form are the Masseter and the Temporal. The Masseter is a quadrilateral muscle, which imparts fulness to the hinder part of the cheek. When the muscle is firmly contracted, as when the teeth are clenched, its outline is plainly visible; the anterior border forms a prominent vertical ridge, behind which is a considerable fulness, especially marked at the lower part of the muscle; this fulness is entirely lost when the mouth is opened and the muscle no longer in a state of contraction. The Temporal muscle is fan-shaped, and fills the Temporal fossa, substituting for it a somewhat convex form, the anterior part of which, on account of the absence of hair over the temple, is more marked than the posterior, and stands out in strong relief when the muscle is in a state of contraction.

MUSCLES AND FASCIÆ OF THE NECK.

The muscles of the neck may be arranged into groups corresponding with the region in which they are situated.

These groups are nine in number:

1. Superficial cervical region.
2. Depressors of the Os Hyoides and Larynx.
3. Elevators of the Os Hyoides and Larynx.
4. Muscles of the Tongue.
5. Muscles of the Pharynx.
6. Muscles of the Soft Palate.
7. Muscles of the Anterior Vertebral Region.
8. Muscles of the Lateral Vertebral Region.
9. Muscles of the Larynx.

The muscles contained in each of these groups are the following:

1. *Superficial Region.*
   - Platysma myoides.
   - Sterno-cleido-mastoid.

Infra-hyoid Region.

2. *Depressors of the Os hyoides and Larynx.*
   - Sterno-hyoid.
   - Sterno-thyroid.
   - Thyro-hyoid.
   - Omo-hyoid.

Supra-hyoid Region.

3. *Elevators of the Os hyoides and Larynx.*
   - Digastric.
   - Stylo-hyoid.
   - Mylo-hyoid.
   - Genio-hyoid.

Lingual Region.

4. *Muscles of the Tongue.*
   - Genio-hyo-glossus.
   - Hyo-glossus.
   - Chondro-glossus.
   - Stylo-glossus.
   - Palato-glossus.

5. *Muscles of the Pharynx.*
   - Inferior constrictor.
   - Middle constrictor.
   - Superior constrictor.
   - Stylo-pharyngeus.
   - Palato-pharyngeus.

6. *Muscles of the Soft Palate.*
   - Levator palati.
   - Tensor palati.
   - Azygos uvulæ.
   - Palato-glossus.
   - Palato-pharyngeus.
   - Salpingo-pharyngeus.

7. *Muscles of the Anterior Vertebral Region.*
   - Rectus capitis anticus major.
   - Rectus capitis anticus minor.
   - Rectus capitis lateralis.
   - Longus colli.

8. *Muscles of the Lateral Vertebral Region.*
   - Scalenus anticus.
   - Scalenus medius.
   - Scalenus posticus.

9. *Muscles of the Larynx.*
   - Included in the description of the Larynx.

1. Superficial Cervical Region.

Platysma myoides. Sterno-cleido-mastoid.

Dissection.—A block having been placed at the back of the neck, and the face turned to the side opposite that to be dissected, so as to place the parts upon the stretch, make two transverse incisions: one from the chin, along the margin of the lower jaw, to the mastoid process, and the other along the upper border of the clavicle. Connect these by an oblique incision made in the course of the Sterno-mastoid muscle, from the mastoid process to the sternum; the two flaps of integument having been removed in the direction shown in Fig. 194, the superficial fascia will be exposed.

The **Superficial Cervical Fascia** is a thin, aponeurotic lamina which is hardly demonstrable as a separate membrane. Beneath it is found the Platysma myoides muscle.

The **Platysma myoides** (Fig. 195) is a broad, thin plane of muscular fibres placed immediately beneath the superficial fascia on each side of the neck. It arises by thin, fibrous bands from the fascia covering the upper part of the Pectoral and Deltoid muscles; its fibres pass over the clavicle and proceed obliquely upward and inward along the side of the neck. The anterior fibres interlace, below and behind the symphysis menti, with the fibres of the muscle of the opposite side; the posterior fibres pass over the lower jaw, some of them being attached to the bone below the external oblique line, others passing on to be inserted into the skin and subcutaneous tissue of the lower part of the face, many of these fibres blending with the muscles about the angle and lower part of the mouth. Sometimes fibres can be traced to the Zygomatic muscles or to the margin of the Orbicularis oris. Beneath the Platysma the external jugular vein may be seen descending from the angle of the jaw to the clavicle.

Surgical Anatomy.—It is essential to remember the direction of the fibres of the Platysma in connection with the operation of bleeding from the external jugular vein; for if the point of the lancet is introduced in the direction of the muscular fibres, the orifice made will be filled up by the contraction of the muscle, and blood will not flow; but if the incision is made across the course of the fibres, they will retract and expose the orifice in the vein, and so allow the flow of blood.

Relations.—By its *external surface*, with the integument, to which it is united more closely below than above; by its *internal surface*, with the Pectoralis major and Deltoid, and with the clavicle. In the *neck*, with the external and anterior jugular veins, the deep cervical fascia, the superficial branches of the cervical plexus, the Sterno-mastoid, Sterno-hyoid, Omo-hyoid, and Digastric muscles; behind the Sterno-mastoid muscle it covers in the posterior triangle of the neck. On the *face* it is in relation with the parotid gland, the facial artery and vein, and the Masseter and Buccinator muscles.

Action.—The Platysma myoides produces a slight wrinkling of the surface of the skin of the neck, in an oblique direction, when the entire muscle is brought into action. Its anterior portion, the thickest part of the muscle, depresses the lower jaw; it also serves to draw down the lower lip and angle of the mouth on each side, being one of the chief agents in the expression of melancholy.

The **Deep cervical fascia** lies under cover of the Platysma myoides muscle and constitutes a complete investment for the neck. It also forms a sheath for the carotid vessels, and, in addition, is prolonged deeply in the shape of certain processes or lamellæ, which come into close relation with the structures situated in front of the vertebral column.

The investing portion of the fascia is attached behind to the ligamentum nuchæ and to the spine of the seventh cervical vertebra. Along this line it splits to enclose the Trapezius muscle, at the anterior border of which the two enclosing lamellæ unite and form a strong membrane, which extends forward so as to roof in the posterior triangle of the neck. Along the hinder edge of the Sterno-mastoid this membrane again divides to enclose this muscle, at the anterior edge of which it once more forms a single lamella, which roofs in the anterior triangle of the neck, and, reaching forward to the middle line, is continuous with the corresponding part from the opposite side of the neck. In the middle line of the neck it is attached to the symphysis menti and body of the hyoid bone.

Above, the fascia is attached to the superior curved line of the occiput, to the mastoid process of the temporal, and to the whole length of the body of the jaw. Opposite the angle of the jaw the fascia is very strong, and binds the anterior edge of the Sterno-mastoid firmly to that bone. Between the jaw and the mastoid process it ensheaths the parotid gland—the layer which covers the gland extending upward under the name of the parotid fascia to be fixed to the zygomatic arch. From the layer which passes under the parotid a strong band, *the stylo-mandibular ligament*, reaches from the styloid process to the angle of the jaw.

Below, the fascia is attached to the acromion process, the clavicle, and manubrium sterni. Some little distance above the last, however, it splits into two layers, superficial and deep. The former is attached to the anterior border of the manubrium, the latter to its posterior border and to the interclavicular ligament. Between these two layers is a slit-like interval, the *suprasternal space*, or *space of Burns*. It contains a small quantity of areolar tissue, and sometimes a lymphatic gland; the lower portions of the anterior jugular veins and their transverse connecting branch; and also the sternal heads of the Sterno-mastoid muscles.

The fascia which lines the deep aspect of the Sterno-mastoid gives off certain important processes, viz.: (1) A process to envelop the tendon of the Omo-hyoid, and bind it down to the sternum and first costal cartilage. (2) A strong sheath, the carotid sheath, for the large vessels of the neck, enclosed within which are the carotid artery, internal jugular vein, the vagus, and descendens hypoglossi nerves. (3) The prevertebral fascia, which extends inward behind the carotid vessels, where it assists in forming their sheath, and passes in front of the prevertebral muscles. It thus forms the posterior limit of a fibrous compartment which contains

the larynx and trachea, the thyroid gland, and the pharynx and œsophagus. The prevertebral fascia is fixed above to the base of the skull, while below it is continued into the thorax in front of the Longus colli muscles. Parallel to the carotid vessels and along their inner aspect it gives off a thin lamina, the *bucco-pharyngeal fascia*, which closely invests the constrictor muscles of the pharynx, and is continued forward from the Superior constrictor on to the Buccinator. It is attached to the prevertebral layer by loose connective tissue only, and thus an easily distended space, the *retro-pharyngeal space*, is found between them. This space is limited above by the base of the skull, while below it extends behind the

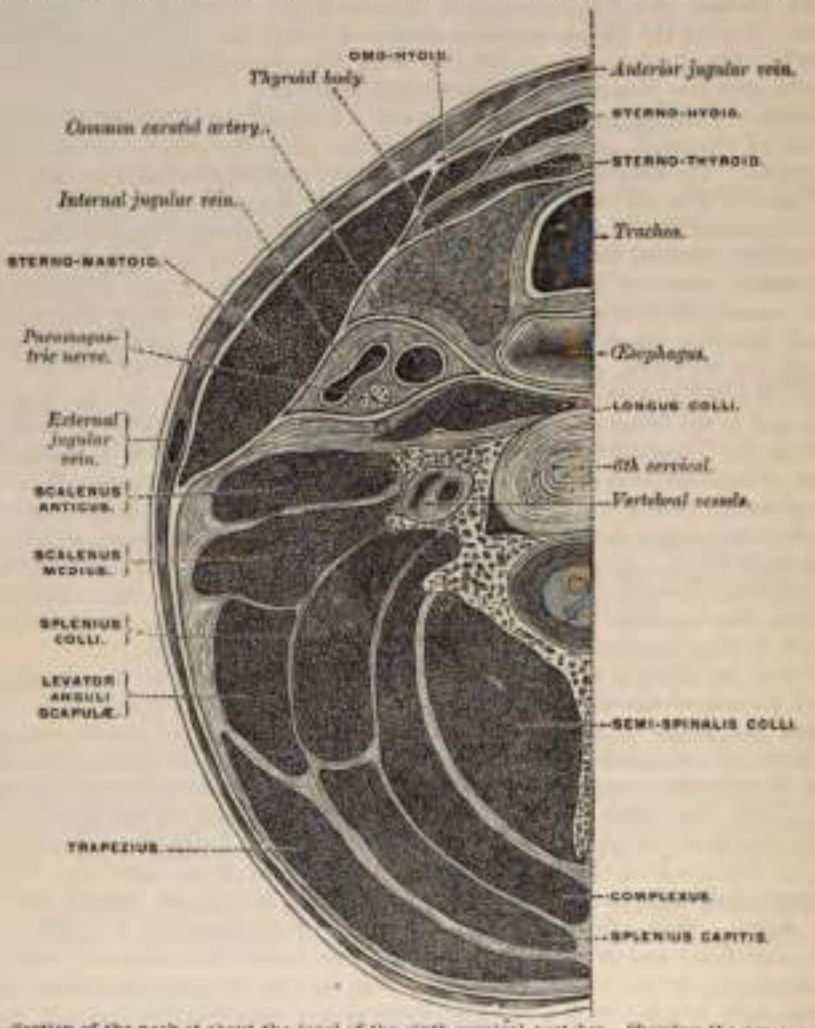


FIG. 201.—Section of the neck at about the level of the sixth cervical vertebra. Showing the arrangement of the deep cervical fascia.

œsophagus into the thorax, where it is continued into the posterior mediastinum. The prevertebral fascia is prolonged downward and outward behind the carotid vessels and in front of the Scaleni muscles, and forms a sheath for the brachial nerves and subclavian vessels in the posterior triangle of the neck, and, continued under the clavicle as the axillary sheath, is attached to the deep surface of the costo-coracoid membrane. Immediately above the clavicle an areolar space exists between the investing layer and the sheath of the subclavian vessels, and in it are found the lower part of the external jugular vein, the descending clavicular nerves, the suprascapular and transversalis colli vessels, and the posterior belly of the

Omo-hyoid muscle. This space extends downward behind the clavicle, and is limited below by the fusion of the costo-coracoid membrane with the anterior wall of the axillary sheath. (4) The pre-tracheal fascia, which extends inward in front of the carotid vessels, and assists in forming the carotid sheath. It is farther continued behind the depressor muscles of the hyoid bone, and, after enveloping the thyroid body, is prolonged in front of the trachea to meet the corresponding layer of the opposite side. Above, it is fixed to the hyoid bone, while below it is carried downward in front of the trachea and large vessels at the root of the neck, and ultimately blends with the fibrous pericardium.

Surgical Anatomy.—The cervical fascia is of considerable importance from a surgical point of view. As will be seen from the foregoing description, it may be divided into three layers: (1) A superficial layer; (2) a layer passing in front of the trachea, and forming with the superficial layer a sheath for the depressors of the hyoid bone; (3) a prevertebral layer passing in front of the bodies of the cervical vertebræ, and forming with the second layer a space in which are contained the trachea, œsophagus, etc. The superficial layer forms a complete investment for the neck. It is attached behind to the ligamentum nuchæ and the spine of the seventh cervical vertebra; above it is attached to the external occipital protuberance, to the superior curved line of the occiput, to the mastoid process, to the zygoma and the lower jaw; below it is attached to the manubrium sterni, the clavicle, the acromion process, and the spine of the scapula; in front it blends with the fascia of the opposite side. This layer would oppose the extension of abscesses or new growths toward the surface, and pus forming beneath it would have a tendency to extend laterally. If it is in the posterior triangle, it might extend backward under the Trapezius, forward under the Sterno-mastoid, or downward under the clavicle for some distance, until stopped by the junction of the cervical fascia to the Costo-coracoid membrane. If the pus is contained in the anterior triangle, it might find its way into the anterior mediastinum, being situated in front of the layer of fascia which passes down into the thorax to become continuous with the pericardium; but owing to the lesser density and thickness of the fascia in this situation it more frequently finds its way through it and points above the sternum. The second layer of fascia is connected above with the hyoid bone. It passes down beneath the depressors and in front of the thyroid body and trachea to become continuous with the fibrous layer of the pericardium. Laterally it invests the great vessels of the neck and is connected with the superficial layer beneath the Sterno-mastoid. Pus forming beneath this layer would in all probability find its way into the posterior mediastinum. The third layer (the prevertebral fascia) is connected above to the base of the skull. Pus forming beneath this layer, in cases, for instance, of caries of the bodies of the cervical vertebræ, might extend toward the posterior and lateral part of the neck and point in this situation, or might perforate this layer of fascia and the pharyngeal fascia and point into the pharynx (retro-pharyngeal abscess).

In cases of cut throat the cervical fascia is of considerable importance. When the wound involves only the superficial layer the injury is usually trivial, the only special danger being injury to the external jugular vein, and the only special complication being diffuse cellulitis. But where the second of the two layers has been opened up, important structures may have been injured, which may lead to serious results.

It may be worth while mentioning that in Burns's space is contained the sternal head of origin of the Sterno-mastoid muscle, so that this space is opened in division of this tendon. The anterior jugular vein is also contained in the same space.

The **Sterno-mastoid** or **Sterno-cleido-mastoid** (Fig. 202) is a large, thick muscle, which passes obliquely across the side of the neck, being enclosed between the two layers of the deep cervical fascia. It is thick and narrow at its central part, but is broader and thinner at each extremity. It arises, by two heads, from the sternum and clavicle. The *sternal portion* is a rounded fasciculus, tendinous in front, fleshy behind, which arises from the upper and anterior part of the first piece of the sternum, and is directed upward, outward, and backward. The *clavicular portion* arises from the inner third of the superior border and anterior surface of the clavicle, being composed of fleshy and aponeurotic fibres; it is directed almost vertically upward. These two portions are separated from one another, at their origin, by a triangular cellular interval, but become gradually blended, below the middle of the neck, into a thick, rounded muscle, which is inserted, by a strong tendon, into the outer surface of the mastoid process, from its apex to its superior border, and by a thin aponeurosis into the outer half of the superior curved line of the occipital bone. The Sterno-mastoid varies much in its extent of attachment to the clavicle: in one case the clavicular may be as narrow as the sternal portion; in another, as much as three inches in breadth. When the clavicular

origin is broad, it is occasionally subdivided into numerous slips separated by narrow intervals. More rarely, the corresponding margins of the Sterno-mastoid and Trapezius have been found in contact. In the application of a ligature to the third part of the subclavian artery it will be necessary, where the muscles come close together, to divide a portion of one or of both.

This muscle divides the quadrilateral space at the side of the neck into two triangles, an anterior and a posterior. The boundaries of the *anterior triangle* are, in front, the median line of the neck; above, the lower border of the body of the jaw, and an imaginary line drawn from the angle of the jaw to the mastoid

Fig. 302.—Muscles of the neck and boundaries of the triangles.

process; behind, the anterior border of the Sterno-mastoid muscle. The apex of the triangle is at the upper border of the sternum. The boundaries of the *posterior triangle* are, in front, the posterior border of the Sterno-mastoid; below, the middle third of the clavicle; behind, the anterior margin of the Trapezius.[1] The apex corresponds with the meeting of the Sterno-mastoid and Trapezius on the occipital bone.

Relations.—By its *superficial surface*, with the integument and Platysma, from which it is separated by the external jugular vein, the superficial branches of the cervical plexus, and the anterior layer of the deep cervical fascia. By its *deep surface* it is in relation with the Sterno-clavicular articulation; a process of the deep cervical fascia; the Sterno-hyoid, Sterno-thyroid, Omo-hyoid, posterior belly of the Digastric, Levator anguli scapulæ, Splenius and Scaleni muscles; common carotid artery, internal and anterior jugular veins, commencement of the internal and external carotid arteries, the occipital, subclavian, transversalis colli, and suprascapular arteries and veins; the phrenic, pneumogastric, hypoglossal, descendens and communicans hypoglossi nerves; the spinal accessory nerve, which

[1] The anatomy of these triangles will be more exactly described with that of the vessels of the neck.

pierces its upper third; the cervical plexus, parts of the thyroid and parotid glands, and deep lymphatic glands.

Nerves.—The Platysma myoides is supplied by the facial nerve; the Sterno-cleido-mastoid, by the spinal accessory and deep branches of the cervical plexus.

Actions.—When only one Sterno-mastoid muscle acts, it draws the head toward the shoulder of the same side, assisted by the Splenius and the Obliquus capitis inferior of the opposite side. At the same time it rotates the head so as to carry the face toward the opposite side. If the head is fixed, the two muscles assist in elevating the thorax in forced inspiration.

Surface Form.—The anterior edge of the muscle forms a very prominent ridge beneath the skin, which it is important to notice, as it forms a guide to the surgeon in making the necessary incisions for ligature of the common carotid artery and for œsophagotomy.

Surgical Anatomy.—The relations of the sternal and clavicular parts of the Sterno-mastoid should be carefully examined, as the surgeon is sometimes required to divide one or both portions of the muscles in *wry-neck*. One variety of this distortion is produced by spasmodic contraction or rigidity of the Sterno-mastoid; the head being carried down toward the shoulder of the same side, and the face turned to the opposite side and fixed in that position. When there is permanent shortening, subcutaneous division of the muscle is resorted to by some surgeons. This is performed by introducing a tenotomy knife beneath it, close to its origin, and dividing it from behind forward whilst the muscle is put well upon the stretch. There is seldom any difficulty in dividing the sternal portion by making a puncture on the inner side of the tendon, and then pushing a blunt tenotome behind it, and cutting forward. In dividing the clavicular portion care must be taken to avoid wounding the external jugular vein, which runs parallel with the posterior border of the muscle in this situation, or the anterior jugular vein, which crosses beneath it. If the external jugular vein lies near the muscle, it is safer to make the first puncture at the outer side of the tendon, and introduce a blunt tenotome from without inward. Many surgeons prefer dividing the muscle by the open method. An incision is made over either origin of the muscle, the tendon is exposed, a director is passed underneath it, and it is then divided. With care and attention to asepsis this plan of treatment is devoid of risk, and in this way the accidental division of the vessels can be avoided. Some of the fibres of the Sterno-mastoid muscle are occasionally torn during birth, especially in breech presentations; this is accompanied by hemorrhage and formation of a swelling within the substance of the muscle. This by some is believed to be one of the causes of wry-neck, the scar tissue which is formed contracting and shortening the muscle.

2. Infra-hyoid Region (Figs. 202, 203).

DEPRESSORS OF THE OS HYOIDES AND LARYNX.

Sterno-hyoid.	Thyro-hyoid.
Sterno-thyroid.	Omo-hyoid.

Dissection.—The muscles in this region may be exposed by removing the deep fascia from the front of the neck. In order to see the entire extent of the Omo-hyoid it is necessary to divide the Sterno-mastoid at its centre, and turn its ends aside, and to detach the Trapezius from the clavicle and scapula. This, however, should not be done until the Trapezius has been dissected.

The **Sterno-hyoid** is a thin, narrow, ribbon-like muscle, which arises from the inner extremity of the clavicle, the posterior sterno-clavicular ligament, and the upper and posterior part of the first piece of the sternum; passing upward and inward, it is inserted, by short, tendinous fibres, into the lower border of the body of the os hyoides. This muscle is separated, below, from its fellow by a considerable interval; but the two muscles come into contact with one another in the middle of their course, and from this upward lie side by side. It sometimes presents, immediately above its origin, a transverse tendinous intersection, like those in the Rectus abdominis.

Relations.—By its *superficial surface*, below, with the sternum, the sternal end of the clavicle, and the Sterno-mastoid; and above, with the Platysma and deep cervical fascia; by its *deep surface*, with the Sterno-thyroid, Crico-thyroid, and Thyro-hyoid muscles, the thyroid gland, the superior thyroid vessels, the thyroid cartilage, the crico-thyroid and thyro-hyoid membranes.

The **Sterno-thyroid** is situated beneath the preceding muscle, but is shorter and wider than it. It arises from the posterior surface of the first bone of the sternum,

below the origin of the Sterno-hyoid, and from the edge of the cartilage of the first rib, occasionally of the second rib also, and is inserted into the oblique line on the side of the ala of the thyroid cartilage. This muscle is in close contact with its fellow at the lower part of the neck, and is occasionally traversed by a transverse or oblique tendinous intersection, like those in the Rectus abdominis.

Relations.—By its *anterior surface*, with the Sterno-hyoid, Omo-hyoid, and Sterno-mastoid; by its *posterior surface*, from below upward, with the trachea, vena innominata, common carotid (and on the right side the arteria innominata), the thyroid gland and its vessels, and the lower part of the larynx and pharynx. The inferior thyroid vein lies along its inner border, a relation which it is important to remember in the operation of tracheotomy. On the left side the deep surface of the muscle is in relation to the œsophagus.

The **Thyro-hyoid** is a small, quadrilateral muscle appearing like a continuation of the Sterno-thyroid. It arises from the oblique line on the side of the thyroid cartilage, and passes vertically upward to be inserted into the lower border of the body and greater cornu of the hyoid bone.

Relations.—By its *external surface*, with the Sterno-hyoid and Omo-hyoid muscles; by its *internal surface*, with the thyroid cartilage, the thyro-hyoid membrane, and the superior laryngeal vessels and nerve.

The **Omo-hyoid** passes across the side of the neck, from the scapula to the

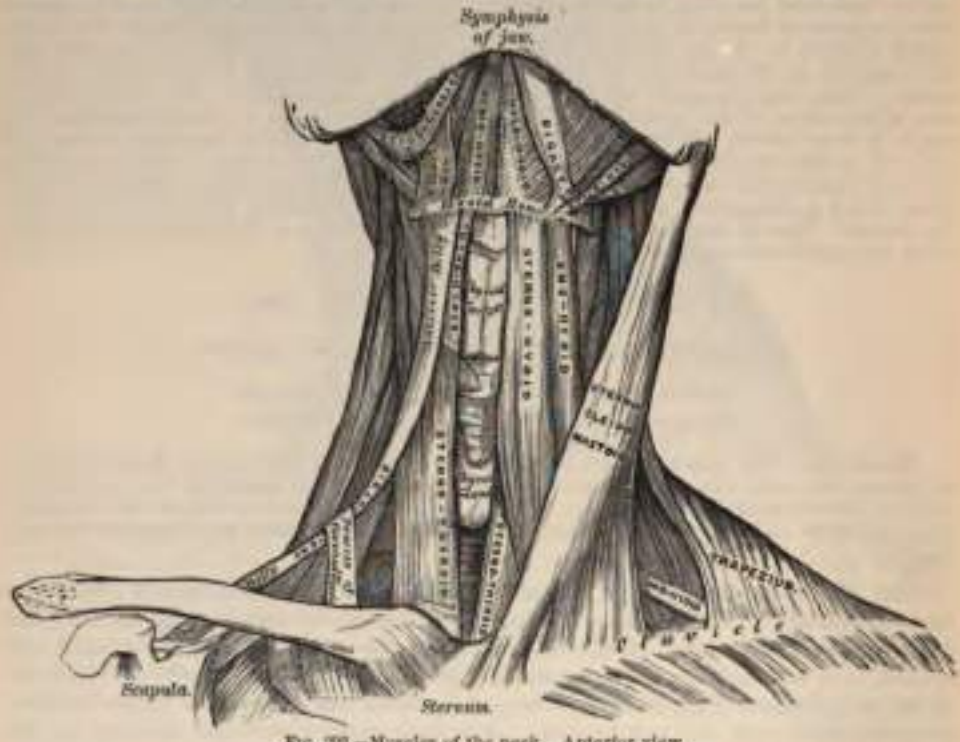


FIG. 98.—Muscles of the neck. Anterior view.

hyoid bone. It consists of two fleshy bellies, united by a central tendon. It arises from the upper border of the scapula, and occasionally from the transverse ligament which crosses the suprascapular notch, its extent of attachment to the scapula varying from a few lines to an inch. From this origin the posterior belly forms a flat, narrow fasciculus, which inclines forward and slightly upward across the lower part of the neck, behind the Sterno-mastoid muscle, where it becomes tendinous; it then changes its direction, forming an obtuse angle, and terminates in the anterior belly, which passes almost vertically upward, close to the outer border of the Sterno-hyoid, to be inserted into the lower border of the body of the

os hyoides, just external to the insertion of the Sterno-hyoid. The central tendon of this muscle, which varies much in length and form, is held in position by a process of the deep cervical fascia, which includes it in a sheath. This process is prolonged down, to be attached to the clavicle and first rib. It is by this means that the angular form of the muscle is maintained.

This muscle subdivides each of the two large triangles at the side of the neck into two smaller triangles; the two posterior ones being the *posterior superior* or *occipital*, and the *posterior inferior* or *subclavian*; the two anterior, the *anterior superior* or *superior carotid*, and the *anterior inferior* or *inferior carotid triangles*.

Relations.—By its *superficial surface*, with the Trapezius, the Sterno-mastoid, deep cervical fascia, Platysma, and integument; by its *deep surface*, with the Scaleni muscles, phrenic nerve, lower cervical nerves, which go to form the brachial plexus, the suprascapular vessels and nerve, sheath of the common carotid artery and internal jugular vein, the Sterno-thyroid and Thyro-hyoid muscles.

Nerves.—The Thyro-hyoid is supplied by the hypoglossal; the other muscles of this group by branches from the loop of communication between the descendens and communicans hypoglossi.

Actions.—These muscles depress the larynx and hyoid bone, after they have been drawn up with the pharynx in the act of deglutition. The Omo-hyoid muscles not only depress the hyoid bone, but carry it backward and to one or the other side. It is concerned especially in prolonged inspiratory efforts; for by tensing the lower part of the cervical fascia it lessens the inward suction of the soft parts, which would otherwise compress the great vessels and the apices of the lungs. The Thyro-hyoid may act as an elevator of the thyroid cartilage when the hyoid bone ascends, drawing upward the thyroid cartilage, behind the os hyoides. The Sterno-thyroid acts as a depressor of the thyroid cartilage.

3. Supra-hyoid Region (Figs. 202, 203).

ELEVATORS OF THE OS HYOIDES—DEPRESSORS OF THE LOWER JAW.

Digastric.	Mylo-hyoid.
Stylo-hyoid.	Genio-hyoid.

Dissection.—To dissect these muscles a block should be placed beneath the back of the neck, and the head drawn backward and retained in that position. On the removal of the deep fascia the muscles are at once exposed.

The **Digastric** consists of two fleshy bellies united by an intermediate, rounded tendon. It is a small muscle, situated below the side of the body of the lower jaw, and extending, in a curved form, from the side of the head to the symphysis of the jaw. The *posterior belly*, longer than the anterior, arises from the digastric groove on the inner side of the mastoid process of the temporal bone, and passes downward, forward, and inward. The *anterior belly* arises from a depression on the inner side of the lower border of the jaw, close to the symphysis, and passes downward and backward. The two bellies terminate in the central tendon which perforates the Stylo-hyoid, and is held in connection with the side of the body and the greater cornu of the hyoid bone by a fibrous loop, lined by a synovial membrane. A broad aponeurotic layer is given off from the tendon of the Digastric on each side, which is attached to the body and great cornu of the hyoid bone: this is termed the *supra-hyoid aponeurosis*. It forms a strong layer of fascia between the anterior portion of the two muscles, and a firm investment for the other muscles of the supra-hyoid region which lie deeper.

The Digastric muscle divides the anterior superior triangle of the neck into two smaller triangles; the upper, or *submaxillary*, being bounded, above, by the lower border of the body of the jaw, and a line drawn from its angle to the mastoid process; below, by the posterior belly of the Digastric and the Stylo-hyoid muscles; in front, by the middle line of the neck and the anterior belly of the Digastric, the lower or *superior carotid triangle* being bounded above by the posterior belly of the Digastric, behind by the Sterno-mastoid, below by the Omo-hyoid.

Relations.—By its *superficial surface* with the mastoid process, the Platysma, Sterno-mastoid, part of the Splenius, Trachelo-mastoid, and Stylo-hyoid muscles, and the parotid gland. By its *deep surface*, the anterior belly lies on the Mylo-hyoid; the posterior belly on the Stylo-glossus, Stylo-pharyngeus, and Hyo-glossus muscles, the external carotid artery and its occipital, lingual, facial, and ascending pharyngeal branches, the internal carotid artery, internal jugular vein, and hypoglossal nerve.

The **Stylo-hyoid** is a small, slender muscle, lying in front of, and above, the posterior belly of the Digastric. It arises from the back and outer surface of the styloid process, near the base; and, passing downward and forward, is inserted into the body of the hyoid bone, just at its junction with the greater cornu, and immediately above the Omo-hyoid. This muscle is perforated, near its insertion, by the tendon of the Digastric.

Relations.—By its *superficial surface* above with the parotid gland and deep cervical fascia; below it is superficial, being situated immediately beneath the deep cervical fascia. By its *deep surface*, with the posterior belly of the Digastric, the external carotid artery, with its lingual and facial branches, the Hyo-glossus muscle, and the hypoglossal nerve.

The Stylo-hyoid Ligament.—In connection with the Stylo-hyoid muscle may be described a ligamentous band, the *Stylo-hyoid ligament*. It is a fibrous cord, often containing a little cartilage in its centre, which continues the styloid process down to the hyoid bone, being attached to the tip of the former and the small cornu of the latter. It is often more or less ossified, and in many animals forms a distinct bone, the *epihyal*.

The anterior belly of the Digastric should be removed, in order to expose the next muscle.

The **Mylo-hyoid** is a flat, triangular muscle, situated immediately beneath the anterior belly of the Digastric, and forming, with its fellow of the opposite side, a muscular floor for the cavity of the mouth. It arises from the whole length of the mylo-hyoid ridge of the lower jaw, extending from the symphysis in front to the last molar tooth behind. The posterior fibres pass inward and slightly downward, to be inserted into the body of the os hyoides. The middle and anterior fibres are inserted into a median fibrous raphé, extending from the symphysis of the lower jaw to the hyoid bone, where they join at an angle with the fibres of the opposite muscle. The median raphé is sometimes wanting; the muscular fibres of the two sides are then directly continuous with one another.

Relations.—By its *cutaneous* or *under surface*, with the Platysma, the anterior belly of the Digastric, the supra-hyoid aponeurosis, the submaxillary gland, submental vessels, and mylo-hyoid vessels and nerve; by its *deep* or *superior surface*, with the Genio-hyoid, part of the Hyo-glossus and Stylo-glossus muscles, the hypoglossal and lingual nerves, the submaxillary ganglion, the sublingual gland, the deep portion of the submaxillary gland, and Wharton's duct; the sublingual and ranine vessels, and the buccal mucous membrane.

Dissection.—The Mylo-hyoid should now be removed, in order to expose the muscles which lie beneath; this is effected by reflecting it from its attachments to the hyoid bone and jaw, and separating it by a vertical incision from its fellow of the opposite side.

The **Genio-hyoid** is a narrow, slender muscle, situated immediately beneath[1] the inner border of the preceding. It arises from the inferior genial tubercle on the inner side of the symphysis of the jaw, and passes downward and backward, to be inserted into the anterior surface of the body of the os hyoides. This muscle lies in close contact with its fellow of the opposite side, and increases slightly in breadth as it descends.

Relations.—It is covered by the Mylo-hyoid, and lies along the lower border of the Genio-hyo-glossus.

Nerves.—The Digastric is supplied: its anterior belly, by the mylo-hyoid branch

[1] This refers to the depth of the muscles from the skin in the order of dissection. In the erect position of the body each of these muscles lies above the preceding.

of the inferior dental; its posterior belly, by the facial; the Stylo-hyoid, by the facial; the Mylo-hyoid, by the mylo-hyoid branch of the inferior dental; the Genio-hyoid, by the hypoglossal.

Actions.—This group of muscles performs two very important actions. They raise the hyoid bone, and with it the base of the tongue, during the act of deglutition; or, when the hyoid bone is fixed by its depressors and those of the larynx, they depress the lower jaw. During the first act of deglutition, when the mass is being driven from the mouth into the pharynx, the hyoid bone, and with it the tongue, is carried upward and forward by the anterior belly of the Digastric, the Mylo-hyoid, and Genio-hyoid muscles. In the second act, when the mass is passing through the pharynx, the direct elevation of the hyoid bone takes place by the combined action of all the muscles; and after the food has passed the hyoid bone is carried upward and backward by the posterior belly of the Digastric and Stylo-hyoid muscles, which assist in preventing the return of the morsel into the mouth.

4. Lingual Region.

Genio-hyo-glossus.	Stylo-glossus.
Hyo-glossus.	Palato-glossus.
Chondro-glossus.	

Dissection.—After completing the dissection of the preceding muscles, saw through the lower jaw just external to the symphysis. Then draw the tongue forward, and attach it, by a stitch, to the nose; when its muscles, which are thus put on the stretch, may be examined.

The **Genio-hyo-glossus** has received its name from its triple attachment to the jaw, hyoid bone, and tongue, but it would be better named the *Genio-glossus*,

Fig. 204.—Muscles of the tongue. Left side.

since its attachment to the hyoid bone is very slight or altogether absent. It is a flat, triangular muscle, placed vertically on either side of the middle line, its apex

corresponding with its point of attachment to the lower jaw, its base with its insertion into the tongue and hyoid bone. It arises by a short tendon from the superior genial tubercle on the inner side of the symphysis of the jaw, immediately above the Genio-hyoid; from this point the muscle spreads out in a fan-like form, a few of the inferior fibres passing downward, to be attached by a thin aponeurosis into the upper part of the body of the hyoid bone, a few fibres passing between the Hyo-glossus and Chondro-glossus to blend with the Constrictor muscles of the pharynx; the middle fibres passing backward, and the superior ones upward and forward, to enter the whole length of the under surface of the tongue, from the base to the apex. The two muscles lie on either side of the median plane; behind, they are quite distinct from each other, and are separated at their insertion into the under surface of the tongue by a tendinous raphé, which extends through the middle of the organ; in front, the two muscles are more or less blended: distinct fasciculi are to be seen passing off from one muscle, crossing the middle line, and intersecting with bundles of fibres derived from the muscle on the other side (Fig. 205).

Relations.—By its *internal surface* it is in contact with its fellow of the opposite side; by its *external surface*, with the Inferior lingualis, the Hyo-glossus, the lingual artery and hypoglossal nerve, the lingual nerve, and sublingual gland; by its *upper border*, with the mucous membrane of the floor of the mouth (frænum linguæ); by its *lower border*, with the Genio-hyoid.

Fig. 205.—Muscles of the tongue from below. (From a preparation in the Museum of the Royal College of Surgeons of England.)

The **Hyo-glossus** is a thin, flat, quadrilateral muscle which arises from the side of the body and whole length of the greater cornu of the hyoid bone, and passes almost vertically upward to enter the side of the tongue, between the Stylo-glossus and Lingualis. Those fibres of this muscle which arise from the body are directed upward and backward, overlapping those arising from the greater cornu, which are directed upward and forward.

Relations.—By its *external surface*, with the Digastric, the Stylo-hyoid, Stylo-glossus, and Mylo-hyoid muscles, the submaxillary ganglion, the lingual and hypoglossal nerves, Wharton's duct, the ranine vein, the sublingual gland, and the deep portion of the submaxillary gland. By its *deep surface*, with the Stylo-hyoid ligament, the Genio-hyo-glossus, Lingualis, and Middle constrictor, the lingual vessels, and the glosso-pharyngeal nerve.

The **Chondro-glossus** is a distinct muscular slip, though it is sometimes described as a part of the Hyo-glossus, from which, however, it is separated by the fibres of the Genio-hyo-glossus, which pass to the side of the pharynx. It is about three-quarters to an inch in length, and arises from the inner side and base of the lesser cornu and contiguous portion of the body of the hyoid bone, and passes directly upward to blend with the intrinsic muscular fibres of the tongue, between the Hyo-glossus and Genio-hyo-glossus. A small slip of muscular fibre is occasionally found, arising from the cartilago triticea in the thyro-hyoid ligament, and passing upward and forward to enter the tongue with the hindermost fibres of the Hyo-glossus.

The **Stylo-glossus**, the shortest and smallest of the three styloid muscles, arises from the anterior and outer side of the styloid process, near its apex, and from the

stylo-mandibular ligament, to which its fibres, in most cases, are attached by a thin aponeurosis. Passing downward and forward between the internal and external carotid arteries, and becoming nearly horizontal in its direction, it divides upon the side of the tongue into two portions: one longitudinal, which enters the side of the tongue near its dorsal surface, blending with the fibres of the Lingualis in front of the Hyo-glossus; the other oblique, which overlaps the Hyo-glossus muscle and decussates with its fibres.

Relations.—By its *external surface*, from above downward, with the parotid gland, the Internal pterygoid muscle, the lingual nerve, and the mucous membrane of the mouth; by its *internal surface*, with the tonsil, the Superior constrictor, and the Hyo-glossus muscle.

The **Palato-glossus**, or **Constrictor isthmi faucium**, although it is one of the muscles of the tongue, serving to draw its base upward during the act of deglutition, is more nearly associated with the soft palate, both in its situation and function; it will consequently be described with that group of muscles.

Nerves.—The Palato-glossus is probably innervated by the spinal accessory nerve, through the pharyngeal plexus; the remaining muscles of this group, by the hypoglossal.

Muscular Substance of Tongue.—The muscular fibres of the tongue run in various directions. These fibres are divided into two sets—Extrinsic and Intrinsic. The extrinsic muscles of the tongue are those which have their origin external, and only their terminal fibres contained in the substance of the organ. They are: the Stylo-glossus, the Hyo-glossus, the Palato-glossus, the Genio-hyo-glossus, and part of the Superior constrictor of the pharynx (Pharyngeo-glossus). The intrinsic are those which are contained entirely within the tongue, and form the greater part of its muscular structure.

The tongue consists of symmetrical halves separated from each other in the middle line by a fibrous septum. Each half is composed of muscular fibres arranged in various directions, containing much interposed fat, and supplied by vessels and nerves.

FIG. 206.—Muscles on the dorsum of the tongue.

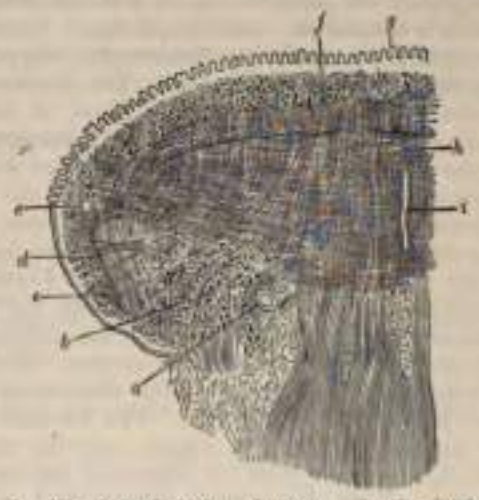


FIG. 207.—Coronal section of tongue, showing intrinsic muscles. (Altered from Krause.) *a*, lingual artery; *b*, Inferior lingualis, cut through; *c*, fibres of Hyo-glossus; *d*, oblique fibres of Stylo-glossus; *e*, insertion of Transverse linguals; *f*, Superior lingualis; *g*, papillæ to tongue; *h*, vertical fibres of Genio-hyo-glossus intersecting Transverse linguals; *i*, septum.

To demonstrate the various fibres of the tongue, the organ should be subjected to prolonged boiling, in order to soften the connective tissue; the dis-

section may then be commenced from the dorsum (Fig. 206). Immediately beneath the mucous membrane is a submucous, fibrous layer, into which the muscular fibres which terminate on the surface of the tongue are inserted. Upon removing this, with the mucous membrane, the first stratum of muscular fibres is exposed. This belongs to the group of intrinsic muscles, and has been named the *Superior lingualis* (*m. longitudinalis superior*). It consists of a thin layer of oblique and longitudinal fibres which arise from the submucous fibrous layer, close to the Epiglottis, and from the fibrous septum, and pass forward and outward to the edges of the tongue. Between its fibres pass some vertical fibres derived from the Genio-hyo-glossus and from the vertical intrinsic muscle, which will be described later on. Beneath this layer is the second stratum of muscular fibres, derived principally from the extrinsic muscles. In front it is formed by the fibres derived from the Stylo-glossus, running along the side of the tongue, and sending one set of fibres over the dorsum which runs obliquely forward and inward to the middle line, and another set of fibres, seen at a later period of the dissection, on to the under surface of the sides of the anterior part of the tongue, which run forward and inward, between the fibres of the Hyo-glossus, to the middle line. Behind this layer of fibres, derived from the Stylo-glossus, are fibres derived from the Hyo-glossus, assisted by some few fibres of the Palato-glossus. The Hyo-glossus, entering the side of the under surface of the tongue, between the Stylo-glossus and Inferior lingualis, passes round its margin and spreads out into a layer on the dorsum, which occupies the middle third of the organ, and runs almost transversely inward to the septum. It is reinforced by some fibres from the Palato-glossus; other fibres of this muscle pass more deeply and intermingle with the next layer. The posterior part of the second layer of the muscular fibres of the tongue is derived from those fibres of the Hyo-glossus which arise from the lesser cornu of the hyoid bone, and are here described as a separate muscle—the Chondro-glossus. The fibres of this muscle are arranged in a fan-shaped manner, and spread out over the posterior third of the tongue. Beneath this layer is the great mass of the intrinsic muscles of the tongue, intersected at right angles by the terminal fibres of one of the extrinsic muscles—the Genio-hyo-glossus. This portion of the tongue is paler in color and softer in texture than that already described, and is sometimes designated the medullary portion in contradistinction to the firmer superficial part, which is termed the cortical portion. It consists largely of transverse fibres, the *Transverse lingualis* (*m. transversus linguæ*), and of vertical fibres, the *Vertical lingualis* (*m. verticalis linguæ*). The Transverse lingualis forms the largest portion of the third layer of muscular fibres of the tongue. The fibres arise from the median septum, and pass outward to be inserted into the submucous fibrous layer at the sides of the tongue. Intermingled with these transverse intrinsic fibres are transverse extrinsic fibres derived from the Palato-glossus and the Superior constrictor of the pharynx. These transverse extrinsic fibres, however, run in the opposite direction, passing inward toward the septum. Intersecting the transverse fibres are a large number of vertical fibres derived partly from the Genio-hyo-glossus and partly from intrinsic fibres, the Vertical lingualis. The fibres derived from the Genio-hyo-glossus enter the under surface of the tongue on each side of the median septum from base to apex. They ascend in a radiating manner to the dorsum, being inserted into the submucous fibrous layer covering the tongue on each side of the middle line. The Vertical lingualis is found only at the borders of the fore part of the tongue, external to the fibres of the Genio-hyo-glossus. Its fibres extend from the upper to the under surface of the organ, decussating with the fibres of the other muscles, and especially with the Transverse lingualis. The fourth layer of muscular fibres of the tongue consists partly of extrinsic fibres derived from the Stylo-glossus, and partly of intrinsic fibres, the *Inferior lingualis* (*m. longitudinalis inferior*). At the sides of the under surface of the organ are some fibres derived from the Stylo-glossus, which, as it runs forward at the side of the tongue, gives off fibres which, passing forward and inward between the fibres of the Hyo-glossus, form an inferior oblique stratum which joins in front with the

anterior fibres of the Inferior lingualis. The Inferior lingualis is a longitudinal band, situated on the under surface of the tongue, and extending from the base to the apex of the organ. Behind, some of its fibres are connected with the body of the hyoid bone. It lies between the Hyo-glossus and the Genio-hyo-glossus, and in front of the Hyo-glossus it gets into relation with the Stylo-glossus, with the fibres of which it blends. It is in relation by its under surface with the ranine artery.

Surgical Anatomy.—The fibrous septum which exists between the two halves of the tongue is very complete, so that the anastomosis between the two lingual arteries is not very free, a fact often illustrated by injecting one-half of the tongue with colored size, while the other half is left uninjected or is injected with size of a different color.

This is a point of considerable importance in connection with removal of one-half of the tongue for cancer, an operation which is now frequently resorted to when the disease is strictly confined to one side of the tongue. If the mucous membrane is divided longitudinally exactly in the middle line, the tongue can be split into halves along the median raphe without any appreciable hæmorrhage, and the diseased half can then be removed.

Actions.—The movements of the tongue, although numerous and complicated, may be understood by carefully considering the direction of the fibres of its muscles. The *Genio-hyo-glossi* muscles, by means of their posterior fibres, draw the base of the tongue forward, so as to protrude the apex from the mouth. The anterior fibres draw the tongue back into the mouth. The whole length of these two muscles, acting along the middle line of the tongue, draw it downward, so as to make it concave from side to side, forming a channel along which fluids may pass toward the pharynx, as in sucking. The *Hyo-glossi* muscles depress the tongue and draw down its sides, so as to render it convex from side to side. The *Stylo-glossi* muscles draw the tongue upward and backward. The *Palato-glossi* muscles draw the base of the tongue upward. With regard to the intrinsic muscles, both the Superior and Inferior linguales tend to shorten the tongue, but the former, in addition, turn the tip and sides upward so as to render the dorsum concave, while the latter pull the tip downward and cause the dorsum to become convex. The Transverse lingualis narrows and elongates the tongue, and the Vertical lingualis flattens and broadens it. The complex arrangement of the muscular fibres of the tongue, and the various directions in which they run, give to this organ the power of assuming the various forms necessary for the enunciation of the different consonantal sounds; and Dr. Macalister states that "there is reason to believe that the musculature of the tongue varies in different races owing to the hereditary practice and habitual use of certain motions required for enunciating the several vernacular languages."

5. Pharyngeal Region.

Inferior constrictor.	Superior constrictor.
Middle constrictor.	Stylo-pharyngeus.
Palato-pharyngeus. }	(See next section.)
Salpingo-pharyngeus. }	

Dissection (*Fig.* 208).—In order to examine the muscles of the pharynx, cut through the trachea and œsophagus just above the sternum, and draw them upward by dividing the loose areolar tissue connecting the pharynx with the front of the vertebral column. The parts being drawn well forward, apply the edge of the saw immediately behind the styloid processes, and saw the base of the skull through from below upward. The pharynx and mouth should then be stuffed with tow, in order to distend its cavity and render the muscles tense and easier of dissection.

The **Inferior constrictor,** the most superficial and thickest of the three constrictors, arises from the sides of the cricoid and thyroid cartilages. To the cricoid cartilage it is attached in the interval between the Crico-thyroid muscle in front and the articular facet for the thyroid cartilage behind. To the thyroid cartilage it is attached to the oblique line on the side of the great ala, the cartilaginous surface behind it, nearly as far as its posterior border, and to the inferior cornu. From these attachments the fibres spread backward and inward, to be inserted into the fibrous raphe in the posterior median line of the pharynx.

The inferior fibres are horizontal, and continuous with the fibres of the œsophagus: the rest ascend, increasing in obliquity, and overlap the Middle constrictor.

Relations.—It is covered by a thin membrane which surrounds the entire pharynx (bucco-pharyngeal fascia). *Behind*, it is in relation with the vertebral column and the prevertebral fascia and muscles; *laterally*, with the thyroid gland, the common carotid artery, and the Sterno-thyroid muscle; by its *internal surface*, with the Middle constrictor, the Stylo-pharyngeus, Palato-pharyngeus, the fibrous coat and mucous membrane of the pharynx. The internal laryngeal nerve and the laryngeal branch of the Superior Thyroid artery pass near the upper border, and the inferior, or recurrent laryngeal nerve, and the laryngeal branch of the Inferior Thyroid artery, beneath the lower border of this muscle, previous to their entering the larynx.

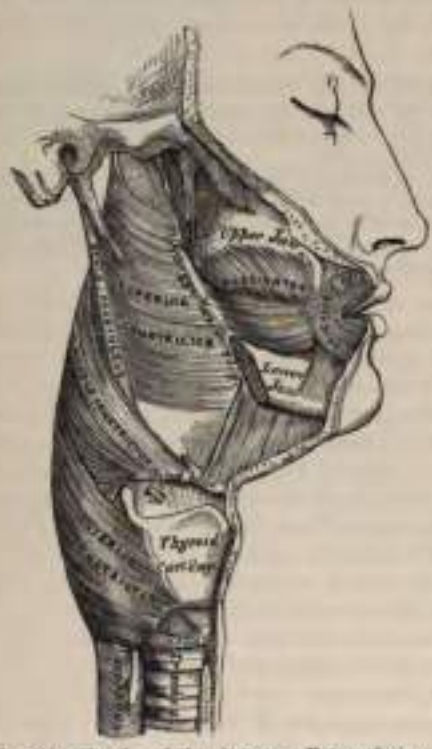


FIG. 208.—Muscles of the pharynx. External view.

The **Middle constrictor** is a flattened, fan-shaped muscle, smaller than the preceding. It arises from the whole length of the upper border of the greater cornu of the hyoid bone, from the lesser cornu, and from the stylo-hyoid ligament. The fibres diverge from their origin, the lower ones descending beneath the Inferior constrictor, the middle fibres passing transversely, and the upper fibres ascending and overlapping the Superior constrictor. The muscle is inserted into the posterior median fibrous raphé, blending in the middle line with the one of the opposite side.

Relations.—This muscle is separated from the Superior constrictor by the glosso-pharyngeal nerve and the Stylo-pharyngeus muscle and Stylo-hyoid ligament; and from the Inferior constrictor by the superior laryngeal nerve. *Behind*, it lies on the vertebral column, the Longus colli, and the Rectus capitis anticus major. *On each side* it is in relation with the carotid vessels, the pharyngeal plexus, and some lymphatic glands. Near its origin it is covered by the Hyo-glossus, from which it is separated by the lingual vessels. It lies upon the Superior constrictor, the Stylo-pharyngeus, the Palato-pharyngeus, the fibrous coat, and the mucous membrane of the pharynx.

The **Superior Constrictor** is a quadrilateral muscle, thinner and paler than the other constrictors, and situated at the upper part of the pharynx. It arises from the lower third of the posterior margin of the internal pterygoid plate and its hamular process, from the contiguous portion of the palate bone and the reflected tendon of the Tensor palati muscle, from the pterygo-maxillary ligament, from the alveolar process above the posterior extremity of the mylo-hyoid ridge, and by a few fibres from the side of the tongue. From these points the fibres curve backward, to be inserted into the median raphe, being also prolonged by means of a fibrous aponeurosis to the pharyngeal spine on the basilar process of the occipital bone. The superior fibres arch beneath the Levator palati and the Eustachian tube, the interval between the upper border of the muscle and the basilar process being deficient in muscular fibres and closed by the pharyngeal aponeurosis. This interval is known as the *sinus of Morgagni*.

Relations.—By its *outer surface*, with the prevertebral fascia and muscles, the vertebral column, the internal carotid and ascending pharyngeal arteries, the

internal jugular vein and pharyngeal venous plexus, the glosso-pharyngeal, pneumogastric, spinal accessory, hypoglossal, lingual, and sympathetic nerves, the Middle constrictor and Internal pterygoid muscles, the Styloid process, the Stylo-hyoid ligament, and the Stylo-pharyngeus. By its *internal surface*, with the Palato-pharyngeus, the tonsil, the fibrous coat and mucous membrane of the pharynx.

The **Stylo-pharyngeus** is a long, slender muscle, round above, broad and thin below. It arises from the inner side of the base of the styloid process, passes downward along the side of the pharynx between the Superior and Middle constrictors, and spreads out beneath the mucous membrane, where some of its fibres are lost in the Constrictor muscles; and others, joining with the Palato-pharyngeus, are inserted into the posterior border of the thyroid cartilage. The glosso-pharyngeal nerve runs on the outer side of this muscle, and crosses over it in passing forward to the tongue.

Relations.—*Externally*, with the Stylo-glossus muscle, the parotid gland, the external carotid artery, and the Middle constrictor; *internally*, with the internal carotid, the internal jugular vein, the Superior constrictor, Palato-pharyngeus, and mucous membrane.

Nerves.—The Constrictors are supplied by branches from the pharyngeal plexus, the Stylo-pharyngeus by the glosso-pharyngeal nerve, and the Inferior constrictor by an additional branch from the external laryngeal nerve and by the recurrent laryngeal.

Actions.—When deglutition is about to be performed, the pharynx is drawn upward and dilated in different directions, to receive the morsel propelled into it from the mouth. The Stylo-pharyngei, which are much farther removed from one another at their origin than at their insertion, draw the sides of the pharynx upward and outward, and so increase its transverse diameter, its breadth in the antero-posterior direction being increased by the larynx and tongue being carried forward in their ascent. As soon as the morsel is received in the pharynx, the Elevator muscles relax, the bag descends, and the Constrictors contract upon the morsel, and convey it gradually downward into the œsophagus. Besides its action in deglutition, the pharynx also exerts an important influence in the modulation of the voice, especially in the production of the higher tones.

6. Palatal Region.

Levator palati.	Palato-glossus.
Tensor palati.	Palato-pharyngeus.
Azygos uvulæ.	Salpingo-pharyngeus.

Dissection (Fig. 209).—Lay open the pharynx from behind by a vertical incision extending from its upper to its lower part, and partially divide the occipital attachment by a transverse incision on each side of the vertical one; the posterior surface of the soft palate is then exposed. Having fixed the uvula so as to make it tense, the mucous membrane and glands should be carefully removed from the posterior surface of the soft palate, and the muscles of this part are at once exposed.

The **Levator palati** is a long, thick, rounded muscle, placed on the outer side of the posterior nares. It arises from the under surface of the apex of the petrous portion of the temporal bone, and from the inner surface of the cartilaginous portion of the Eustachian tube; after passing into the pharynx, above the upper concave margin of the Superior constrictor, it passes obliquely downward and inward, its fibres spreading out in the soft palate as far as the middle line, where they blend with those of the opposite side.

Relations.—*Externally*, with the Tensor palati and Superior constrictor and Eustachian tube; *internally*, with the mucous membrane of the pharynx; *posteriorly*, with the posterior fasciculus of the Palato-pharyngeus, the Azygos uvulæ, and the mucous lining of the soft palate.

The **Circumflexus** or **Tensor palati** is a broad, thin, ribbon-like muscle, placed on the outer side of the Levator palati, and consisting of a vertical and a horizontal

portion. The vertical portion arises by a flat lamella from the scaphoid fossa at the base of the internal pterygoid plate; from the spine of the sphenoid and the outer side of the cartilaginous portion of the Eustachian tube: descending vertically between the internal pterygoid plate and the inner surface of the Internal pterygoid muscle, it terminates in a tendon, which winds round the hamular process, being retained in this situation by some of the fibres of origin of the Internal pterygoid muscle. Between the hamular process and the tendon is a small bursa. The tendon or horizontal portion then passes horizontally inward, and is inserted into a broad aponeurosis, the *palatine aponeurosis*, and into the transverse ridge on the horizontal portion of the palate bone.

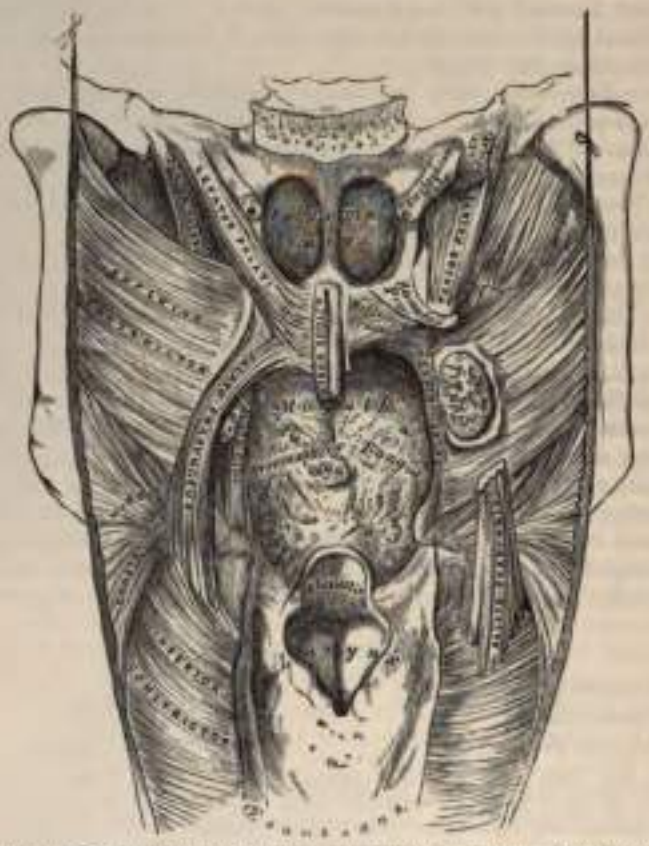


Fig. 209.—Muscles of the soft palate, the pharynx being laid open from behind.

Relations.—*Externally*, with the Internal pterygoid; *internally*, with the Levator palati, from which it is separated by the Eustachian tube and Superior constrictor, and with the internal pterygoid plate. In the soft palate its tendon and the palatine aponeurosis are anterior to those of the Levator palati, being covered by the Palato-glossus and the mucous membrane.

Palatine Aponeurosis.—Attached to the posterior border of the hard palate is a thin, firm, fibrous lamella which supports the muscles and gives strength to the soft palate. It is thicker above than below, where it becomes very thin and difficult to define. Laterally, it is continuous with the pharyngeal aponeurosis.

The **Azygos uvulæ** is not a single muscle, as would be inferred from its name, but a pair of narrow cylindrical fleshy fasciculi placed on either side of the median line of the soft palate. Each muscle arises from the posterior nasal spine of the palate bone and from the contiguous tendinous aponeurosis of the soft palate, and descends to be inserted into the uvula.

Relations.—*Anteriorly*, with the tendinous expansion of the Levatores palati; *behind*, with the posterior fasciculus of the Palato-pharyngeus and the mucous membrane.

The two next muscles are exposed by removing the mucous membrane from the pillars of the fauces throughout nearly their whole extent.

The **Palato-glossus (Constrictor isthmi faucium)** is a small fleshy fasciculus, narrower in the middle than at either extremity, forming, with the mucous membrane covering its surface, the anterior pillar of the soft palate. It arises from the anterior surface of the soft palate on each side of the uvula, and, passing downward, forward, and outward in front of the tonsil, is inserted into the side of the tongue, some of its fibres spreading over the dorsum, and others passing deeply into the substance of the organ to intermingle with the Transversus linguæ. In the soft palate the fibres of this muscle are continuous with those of the muscle of the opposite side.

The **Palato-pharyngeus** is a long, fleshy fasciculus, narrower in the middle than at either extremity, forming, with the mucous membrane covering its surface, the posterior pillar of the soft palate. It is separated from the Palato-glossus by an angular interval, in which the tonsil is lodged. It arises from the soft palate by an expanded fasciculus, which is divided into two parts by the Levator palati and Azygos uvulæ. The *posterior fasciculus* lies in contact with the mucous membrane, and also joins with the corresponding muscle in the middle line; the *anterior fasciculus*, the thicker, lies in the soft palate between the Levator and Tensor, and joins in the middle line the corresponding part of the opposite muscle. Passing outward and downward behind the tonsil, the Palato-pharyngeus joins the Stylo-pharyngeus, and is inserted with that muscle into the posterior border of the thyroid cartilage, some of its fibres being lost on the side of the pharynx, and others passing across the middle line posteriorly to decussate with the muscle of the opposite side.

Relations.—In the soft palate its *posterior surface* is covered by mucous membrane, from which it is separated by a layer of palatine glands. By its *anterior surface* it is in relation with the Tensor palati. Where it forms the posterior pillar of the fauces it is covered by mucous membrane, excepting on its outer surface. In the *pharynx* it lies between the mucous membrane and the Constrictor muscles.

The Salpingo-pharyngeus.—This muscle arises from the inferior part of the Eustachian tube near its orifice; it passes downward and blends with the posterior fasciculus of the Palato-pharyngeus.

In a dissection of the soft palate from its posterior or nasal surface to its anterior or oral surface, the muscles would be exposed in the following order: viz. the posterior fasciculus of the Palato-pharyngeus, covered over by the mucous membrane reflected from the floor of the nasal fossæ; the Azygos uvulæ; the Levator palati; the anterior fasciculus of the Palato-pharyngeus; the aponeurosis of the Tensor palati, and the Palato-glossus covered over by a reflection from the oral mucous membrane.

Nerves.—The Tensor palati is supplied by a branch from the otic ganglion; the remaining muscles of this group are in all probability supplied by the internal branch of the spinal accessory, whose fibres are distributed along with certain branches of the pneumogastric through the pharyngeal plexus.[1] It is possible, however, that the Levator palati may be supplied by the facial through the Petrosal branch of the Vidian.

Actions.—During the *first stage* of deglutition the morsel of food is driven back into the fauces by the pressure of the tongue against the hard palate, the base of the tongue being, at the same time, retracted, and the larynx raised with the pharynx, and carried forward under it. During the *second stage* the entrance to the larynx is closed, not, as was formerly supposed, by the folding backward

[1] *Journal of Anatomy and Physiology*, vol. xxiii., p. 523.

of the epiglottis over it, but, as Anderson Stuart has shown, by the drawing forward of the arytenoid cartilages toward the cushion of the epiglottis—a movement produced by the contraction of the external thyro-arytenoid, the arytenoid, and aryteno-epiglottidean muscles.

The morsel of food after leaving the tongue passes on to the posterior or laryngeal surface of the epiglottis, and glides along this for a certain distance;[1] then the Palato-glossi muscles, the constrictors of the fauces, contract behind the food; the soft palate is slightly raised by the Levator palati, and made tense by the Tensor palati; and the Palato-pharyngei, by their contraction, pull the pharynx upward over the morsel of food, and at the same time come nearly together, the uvula filling up the slight interval between them. By these means the food is prevented passing into the upper part of the pharynx or the posterior nares; at the same time the latter muscles form an inclined plane, directed obliquely downward and backward, along the under surface of which the morsel descends into the lower part of the pharynx. The Salpingo-pharyngeus raises the upper and lateral part of the pharynx—*i. e.* that part which is above the point where the Stylo-pharyngeus is attached to the pharynx.

Surgical Anatomy.—The muscles of the soft palate should be carefully dissected, the relations they bear to the surrounding parts especially examined, and their action attentively studied upon the dead subject, as the surgeon is required to divide one or more of these muscles in the operation of staphylorraphy. Sir W. Fergusson was the first to show that in the congenital deficiency called *cleft palate* the edges of the fissure are forcibly separated by the action of the Levatores palati and Palato-pharyngei muscles, producing very considerable impediment to the healing process after the performance of the operation for uniting their margins by adhesion; he, consequently, recommended the division of these muscles as one of the most important steps in the operation. This he effected by an incision made with a curved knife introduced behind the soft palate. The incision is to be halfway between the hamular process and Eustachian tube, and perpendicular to a line drawn between them. This incision perfectly accomplishes the division of the Levator palati. The Palato-pharyngeus may be divided by cutting across the posterior pillar of the soft palate, just below the tonsil, with a pair of blunt-pointed curved scissors; and the anterior pillar may be divided also. To divide the Levator palati the plan recommended by Mr. Pollock is to be greatly preferred. The soft palate being put upon the stretch, a double-edged knife is passed through it just on the inner side of the hamular process and above the line of the Levator palati. The handle being now alternately raised and depressed, a sweeping cut is made along the posterior surface of the soft palate, and the knife withdrawn, leaving only a small opening in the mucous membrane on the anterior surface. If this operation is performed on the dead body and the parts afterward dissected, the Levator palati will be found completely divided. In the present day, however, this division of the muscles, as part of the operation of staphylorraphy, is not so much insisted upon. All tension is prevented by making longitudinal incisions on either side, parallel to the cleft and just internal to the hamular process, in such a position as to avoid the posterior palatine artery.

7. Anterior Vertebral Region.

Rectus capitis anticus major.	Rectus capitis lateralis.
Rectus capitis anticus minor.	Longus colli.

The **Rectus capitis anticus major** (Fig. 210), broad and thick above, narrow below, appears like a continuation upward of the Scalenus anticus. It arises by four tendinous slips from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ, and ascends, converging toward its fellow of the opposite side, to be inserted into the basilar process of the occipital bone.

Relations.—By its *anterior surface*, with the pharynx, the sympathetic nerve, and the sheath enclosing the internal and common carotid artery, internal jugular vein, and pneumogastric nerve; by its *posterior surface*, with the Longus colli, the Rectus capitis anticus minor, and the upper cervical vertebræ.

The **Rectus capitis anticus minor** is a short, flat muscle, situated immediately behind the upper part of the preceding. It arises from the anterior surface of the lateral mass of the atlas and from the root of its transverse process, and, passing

[1] Walton (quoted by A. Stuart) maintains that the epiglottis is not essential to the deglutition even of liquids.

obliquely upward and inward, is inserted into the basilar process immediately behind the preceding muscle.

Relations.—By its *anterior surface*, with the Rectus capitis anticus major; by its *posterior surface*, with the front of the occipito-atlantal articulation.

The **Rectus capitis lateralis** is a short, flat muscle, which arises from the upper surface of the transverse process of the atlas, and is inserted into the under surface of the jugular process of the occipital bone.

Relations.—By its *anterior surface*, with the internal jugular vein; by its *posterior surface*, with the vertebral artery. On its *outer side* lies the occipital artery; on its *inner side*, the suboccipital nerve.

FIG. 218.—The prevertebral muscles.

The **Longus colli** is a long, flat muscle, situated on the anterior surface of the spine, between the atlas and the third dorsal vertebra. It is broad in the middle, narrow and pointed at each extremity, and consists of three portions: a superior oblique, an inferior oblique, and a vertical portion. The *superior oblique portion* arises from the anterior tubercles of the transverse processes of the third, fourth, and fifth cervical vertebræ, and, ascending obliquely inward, is inserted by a narrow tendon into the tubercle on the anterior arch of the atlas. The *inferior oblique portion*, the smallest part of the muscle, arises from the front of the bodies of the first two or three dorsal vertebræ, and, ascending obliquely outward, is inserted into the anterior tubercles of the transverse processes of the fifth and sixth cervical vertebræ. The *vertical portion* lies directly on the front of the spine; it arises, below, from the front of the bodies of the upper three dorsal and lower three cervical vertebræ, and is inserted above into the front of the bodies of the second, third, and fourth cervical vertebræ above.

Relations.—By its *anterior surface*, with the prevertebral fascia, the pharynx, the œsophagus, sympathetic nerve, the sheath of the great vessels of the neck, the inferior thyroid artery, and recurrent laryngeal nerve; by its *posterior surface*, with the cervical and dorsal portions of the spine. Its *inner border* is separated from the opposite muscle by a considerable interval below, but they approach each other above.

8. Lateral Vertebral Region.

Scalenus anticus. Scalenus medius.
Scalenus posticus.

The **Scalenus anticus** is a conical-shaped muscle, situated deeply at the side of the neck, behind the Sterno-mastoid. It arises from the anterior tubercles of the

FIG. 211.—Muscles of the neck. (From a preparation in the Museum of the Royal College of Surgeons of England.)

transverse processes of the third, fourth, fifth, and sixth cervical vertebræ, and, descending almost vertically, is inserted by a narrow, flat tendon into the Scalene

tubercle on the inner border and upper surface of the first rib. The lower part of this muscle separates the subclavian artery and vein, the latter being in front, and the former, with the brachial plexus, behind.

Relations.—*In front*, with the clavicle, the Subclavius, Sterno-mastoid, and Omo-hyoid muscles, the transversalis colli, the suprascapular and ascending cervical arteries, the subclavian vein, and the phrenic nerve; by its *posterior surface*, with the Scalenus medius, pleura, the subclavian artery, and brachial plexus of nerves. It is separated from the Longus colli, on the inner side, by the vertebral artery. On the anterior tubercles of the transverse processes of the cervical vertebræ, between the attachments of the Scalenus anticus and Longus colli, lies the ascending cervical branch of the inferior thyroid artery.

The **Scalenus medius**, the largest and longest of the three Scaleni, arises from the posterior tubercles of the transverse processes of the lower six cervical vertebræ, and, descending along the side of the vertebral column, is inserted by a broad attachment into the upper surface of the first rib, behind the groove for the subclavian artery, as far back as the tubercle. It is separated from the Scalenus anticus by a subclavian artery below and the cervical nerves above. The posterior thoracic, or nerve of Bell, is formed in the substance of the Scalenus medius and emerges from it. The nerve to the Rhomboids also pierces it.

Relations.—By its *anterior surface*, with the Sterno-mastoid; it is crossed by the clavicle, the Omo-hyoid muscle, subclavian artery, and the cervical nerves. To its *outer side* is the Levator anguli scapulæ and the Scalenus posticus muscle.

The **Scalenus posticus**, the smallest of the three Scaleni, arises, by two or three separate tendons, from the posterior tubercles of the transverse processes of the lower two or three cervical vertebræ, and, diminishing as it descends, is inserted by a thin tendon into the outer surface of the second rib, behind the attachment of the Serratus magnus. This is the most deeply placed of the three Scaleni, and is occasionally blended with the Scalenus medius.

Nerves.—The Rectus capitis anticus major and minor and the Rectus lateralis are supplied by the first cervical nerve, and from the loop formed between it and the second; the Longus colli and Scaleni, by branches from the anterior divisions of the lower cervical nerves (fifth, sixth, seventh, and eighth) before they form the brachial plexus. The Scalenus medius also receives a filament from the deep external branches of the cervical plexus.

Actions.—The Rectus anticus major and minor are the direct antagonists of the muscles at the back of the neck, serving to restore the head to its natural position after it has been drawn backward. These muscles also serve to flex the head, and, from their obliquity, rotate it, so as to turn the face to one or the other side. The Longus colli flexes and slightly rotates the cervical portion of the spine. The Scaleni muscles, when they take their fixed point from above, elevate the first and second ribs, and are, therefore, inspiratory muscles. When they take their fixed point from below, they bend the spinal column to one or the other side. If the muscles of both sides act, lateral movement is prevented, but the spine is slightly flexed. The Rectus lateralis, acting on one side, bends the head laterally.

Surface Form.—The muscles in the neck, with the exception of the Platysma myoides, are invested by the deep cervical fascia, which softens down their form, and is of considerable importance in connection with deep cervical abscesses and tumors, modifying the direction of their growth and causing them to extend laterally instead of toward the surface. The *Platysma myoides* does not influence surface form except it is in action, when it produces wrinkling of the skin of the neck, which is thrown into oblique ridges parallel with the fasciculi of the muscle. Sometimes this contraction takes place suddenly and repeatedly as a sort of spasmodic twitching, the result of a nervous habit. The *Sterno-cleido-mastoid* is the most important muscle of the neck as regards its surface form. If the muscle is put into action by drawing the chin downward and to the opposite shoulder, its surface form will be plainly outlined. The sternal origin will stand out as a sharply-defined ridge, while the clavicular origin will present a flatter and not so prominent an outline. The fleshy middle portion will appear as an oblique roll or elevation, with a thick rounded anterior border gradually becoming less marked above. On the opposite side—*i. e.* on the side to which the head is turned—the outline is lost, its place being occupied by an oblique groove in the integument. When the muscle is at rest its anterior border is still

visible, forming an oblique rounded ridge, terminating below in the sharp outline of the sternal head. The posterior border of the muscle does not show above the clavicular head. The anterior border is defined by drawing a line from the tip of the mastoid process to the sterno-clavicular joint. It is an important surface-marking in the operation of ligature of the common carotid artery and some other operations. Between the sternal and clavicular heads is a slight depression, most marked when the muscle is in action. This is bounded below by the prominent sternal extremity of the clavicle. Between the sternal origins of the two muscles is a V-shaped space, the *suprasternal notch*, more pronounced below, and becoming toned down above, where the Sterno-hyoid and Sterno-thyroid muscles, lying upon the trachea, become more prominent. Above the hyoid bone, in the middle line, the anterior belly of the *Digastric* to a certain extent influences surface form. It corresponds to a line drawn from the symphysis of the lower jaw to the side of the body of the hyoid bone, and renders this part of the hyo-mental region convex. In the posterior triangle of the neck, the posterior belly of the *Omo-hyoid*, when in action, forms a conspicuous object, especially in thin necks, presenting a cord-like form running across this region, almost parallel with, and a little above, the clavicle.

MUSCLES AND FASCIÆ OF THE TRUNK.

The muscles of the Trunk may be arranged in four groups, corresponding with the region in which they are situated.

I. The Back.
II. The Thorax.
III. The Abdomen.
IV. The Perinæum.

I. MUSCLES OF THE BACK.

The muscles of the Back are very numerous, and may be subdivided into five layers:

First Layer.

Trapezius.
Latissimus dorsi.

Second Layer.

Levator anguli scapulæ.
Rhomboideus minor.
Rhomboideus major.

Third Layer.

Serratus posticus superior.
Serratus posticus inferior.
Splenius capitis.
Splenius colli.

Fourth Layer.

Sacral and Lumbar Regions.

Erector spinæ.

Dorsal Region.

Ilio-costalis.
Musculus accessorius ad ilio-costalem.
Longissimus dorsi.
Spinalis dorsi.

Cervical Region.

Cervicalis ascendens.
Transversalis cervicis.
Trachelo-mastoid.
Complexus.
Biventer cervicis.
Spinalis colli.

Fifth Layer.

Semispinalis dorsi.
Semispinalis colli.
Multifidus spinæ.
Rotatores spinæ.
Supraspinales.
Interspinales.
Extensor coccygis.
Intertransversales.
Rectus capitis posticus major.
Rectus capitis posticus minor.
Obliquus capitis inferior.
Obliquus capitis superior.

First Layer.

Trapezius. Latissimus dorsi.

Dissection (Fig. 212).—Place the body in a prone position, with the arms extended over the sides of the table, and the chest and abdomen supported by several blocks, so as to render the muscles tense. Then make an incision along the middle line of the back from the occipital protuberance to the coccyx. Make a transverse incision from the upper end of this to

the mastoid process, and a third incision from its lower end, along the crest of the ilium to about its middle. This large intervening space should, for convenience of dissection, be subdivided by a fourth incision, extending obliquely from the spinous process of the last dorsal vertebra, upward and outward, to the acromion process. This incision corresponds with the lower border of the Trapezius muscle. The flaps of integument are then to be removed in the direction shown in the figure.

FIG. 212.—Dissection of the muscles of the back.

The **superficial fascia** is exposed upon removing the skin from the back. It forms a layer of considerable thickness and strength, in which a quantity of granular pinkish fat is contained. It is continuous with the superficial fascia in other parts of the body. The **deep fascia** is a dense fibrous layer attached to the occipital bone, the spines of the vertebræ, the crest of the ilium, and the spine of the scapula. It covers over the superficial muscles, forming sheaths for them, and in the neck forms the posterior part of the deep cervical fascia; in the thorax it is continuous with the deep fascia of the axilla and chest, and in the abdomen with that covering the abdominal muscles.

The **Trapezius** (Fig. 213) is a broad, flat, triangular muscle, placed immediately beneath the skin and fascia, and covering the upper and back part of the neck and shoulders. It arises from the external occipital protuberance and the inner third of the superior curved line of the occipital bone; from the ligamentum nuchæ, the spinous process of the seventh cervical, and those of all the dorsal vertebræ; and from the corresponding portion of the supraspinous ligament. From this origin the superior fibres proceed downward and outward, the inferior ones upward and outward, and the middle fibres horizontally, and are inserted, the superior ones into the outer third of the posterior border of the clavicle; the middle fibres into the inner margin of the acromion process, and into the superior lip of the posterior border or crest of the spine of the scapula; the inferior fibres converge near the scapula, and terminate in a triangular aponeurosis, which glides over a smooth surface at the inner extremity of the spine, to be inserted into a tubercle at the outer part of this smooth surface. The Trapezius is fleshy in the greater part of its extent, but tendinous at its origin and insertion. At its occipital origin it is connected to the bone by a thin fibrous lamina, firmly adherent to the skin, and wanting the lustrous, shining appearance of aponeuroses. At its origin from the spines of the vertebræ it is connected to the bones by means of a broad semi-elliptical aponeurosis, which occupies the space between the sixth cervical and the third dorsal vertebræ, and forms, with the aponeurosis of the opposite muscle, a tendinous ellipse. The rest of the muscle arises by numerous short tendinous fibres. If the Trapezius is dissected on both sides, the two muscles resemble a trapezium or diamond-shaped quadrangle; two angles corresponding to the shoulders; a third to the occipital protuberance; and the fourth to the spinous process of the last dorsal vertebra.

The clavicular insertion of this muscle varies as to the extent of its attachment; it sometimes advances as far as the middle of the clavicle, and may even become blended with the posterior edge of the Sterno-mastoid or overlap it. This should be borne in mind in the operation for tying the third part of the subclavian artery.

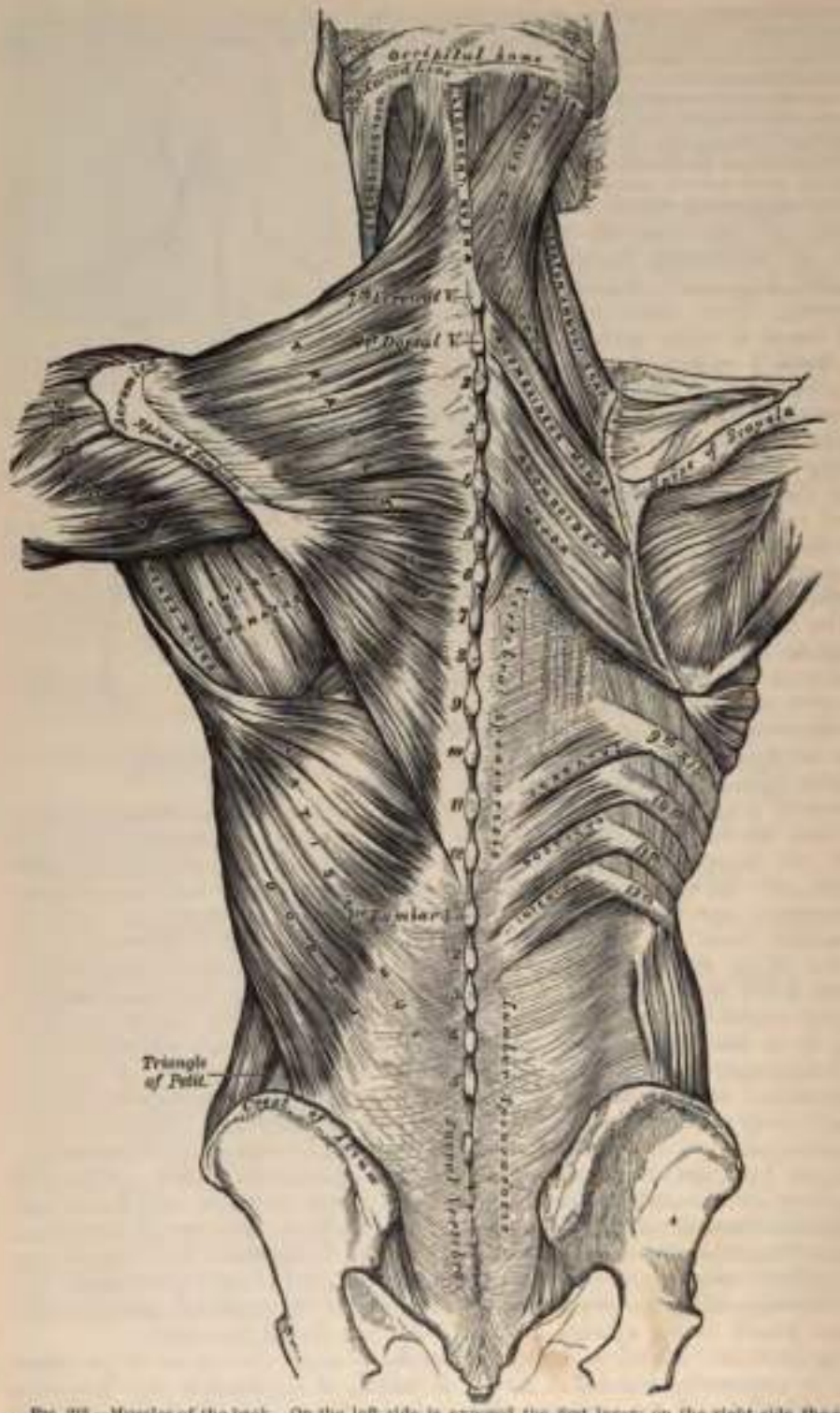


FIG. 215.—Muscles of the back. On the left side is exposed the first layer; on the right side, the second layer and part of the third.

Relations.—By its *superficial surface*, with the integument; by its *deep surface*, in the neck, with the Complexus, Splenius, Lævator anguli scapulæ, and

Rhomboideus minor; in the back, with the Rhomboideus major, Supraspinatus, Infraspinatus, and Vertebral aponeurosis (which separates it from the prolongations of the Erector spinæ), and the Latissimus dorsi. The spinal accessory nerve and the superficial cervical artery and branches from the third and fourth cervical nerves pass beneath the anterior border of this muscle. The anterior margin of its cervical portion forms the posterior boundary of the posterior triangle of the neck, the other boundaries being the Sterno-mastoid in front and the clavicle below.

The **Ligamentum nuchæ** (Fig. 213) is a fibrous membrane, which, in the neck, represents the supraspinous and interspinous ligaments of the lower vertebræ. It extends from the external occipital protuberance to the spinous process of the seventh cervical vertebra. From its anterior border a fibrous lamina is given off, which is attached to the external occipital crest, the posterior tubercle of the atlas, and the spinous process of each of the cervical vertebræ, so as to form a septum between the muscles on each side of the neck. In man it is merely the rudiment of an important elastic ligament, which, in some of the lower animals, serves to sustain the weight of the head.

The **Latissimus dorsi** is a broad flat muscle which covers the lumbar and the lower half of the dorsal regions, and is gradually contracted into a narrow fasciculus at its insertion into the humerus. It arises by tendinous fibres from the spinous processes of the six inferior dorsal vertebræ and from the posterior layer of the lumbar fascia (see page 342), by which it is attached to the spines of the lumbar and sacral vertebræ and to the supraspinous ligament. It also arises from the external lip of the crest of the ilium, behind the origin of the External oblique, and by fleshy digitations from the three or four lower ribs, which are interposed between similar processes of the External oblique muscle (Fig. 218, page 358). From this extensive origin the fibres pass in different directions, the upper ones horizontally, the middle obliquely upward, and the lower vertically upward, so as to converge and form a thick fasciculus, which crosses the inferior angle of the scapula, and occasionally receives a few fibres from it. The muscle then curves around the lower border of the Teres major, and is twisted upon itself, so that the superior fibres become at first posterior and then inferior, and the vertical fibres at first anterior and then superior. It then terminates in a short quadrilateral tendon, about three inches in length, which, passing in front of the tendon of the Teres major, is inserted into the bottom of the bicipital groove of the humerus, its insertion extending higher on the humerus than that of the tendon of the Pectoralis major. The lower border of the tendon of this muscle is united with that of the Teres major, the surfaces of the two being separated by a bursa; another bursa is sometimes interposed between the muscle and the inferior angle of the scapula. This muscle at its insertion gives off an expansion to the deep fascia of the arm.

A muscular slip, *axillary arch*, varying from 3 to 4 inches in length, and from ¼ to ½ of an inch in breadth, occasionally arises from the upper edge of the Latissimus dorsi about the middle of the posterior fold of the axilla, and crosses the axilla in front of the axillary vessels and nerves, to join the under surface of the tendon of the Pectoralis major, the Coraco-brachialis, or the fascia over the Biceps. The position of this abnormal slip is a point of interest in its relation to the axillary artery, as it crosses the vessel just above the spot usually selected for the application of a ligature, and may mislead the surgeon during the operation. It may be easily recognized by the transverse direction of its fibres. Dr. Struther found it, in 8 out of 105 subjects, occurring seven times on both sides.

There is usually a fibrous slip which passes from the lower border of the tendon of the Latissimus dorsi, near its insertion, to the long head of the Triceps. This is occasionally muscular, and is the representative of the *Dorso-epitrochlearis* muscle of apes.

Relations.—Its *superficial surface* is subcutaneous, excepting at its upper part, where it is covered by the Trapezius, and at its insertion, where its tendon is crossed by the axillary vessels and the brachial plexus of nerves. By its *deep surface* it is in relation with the Lumbar fascia, the Serratus posticus inferior, the lower external intercostal muscles and ribs, inferior angle of the scapula, Rhomboideus major, Infraspinatus, and Teres major. Its outer margin is

separated below from the External oblique by a small triangular interval, the triangle of Petit; and another triangular interval exists between its upper border and the margin of the Trapezius, in which the Rhomboideus major muscle is exposed.

Nerves.—The Trapezius is supplied by the spinal accessory, and by branches from the anterior divisions of the third and fourth cervical nerves: the Latissimus dorsi, by the middle or long subscapular nerve.

Second Layer.

Levator anguli scapulæ. Rhomboideus minor.
Rhomboideus major.

Dissection.—The Trapezius must be removed, in order to expose the next layer; to effect this, detach the muscle from its attachment to the clavicle and spine of the scapula, and turn it back toward the spine.

The **Levator anguli scapulæ** is situated at the back part and side of the neck. It arises by tendinous slips from the transverse process of the atlas, and from the posterior tubercles of the transverse process of the second, third, and fourth cervical vertebræ; these, becoming fleshy, are united so as to form a flat muscle, which, passing downward and backward, is inserted into the posterior border of the scapula, between the superior angle and the triangular smooth surface at the root of the spine.

Relations.—By its *superficial surface*, with the integument, Trapezius, and Sterno-mastoid; by its *deep surface*, with the Splenius colli, Transversalis cervicis, Cervicalis ascendens, and Serratus posticus superior muscles, and with the posterior scapular artery and the nerve to the Rhomboids.

The **Rhomboideus minor** arises from the ligamentum nuchæ and spinous processes of the seventh cervical and first dorsal vertebræ. Passing downward and outward, it is inserted into the margin of the triangular smooth surface at the root of the spine of the scapula. This small muscle is usually separated from the Rhomboideus major by a slight cellular interval.

Relations.—By its *superficial (posterior) surface*, with the Trapezius; by its *deep surface*, with the same structures as the Rhomboideus major.

The **Rhomboideus major** is situated immediately below the preceding, the adjacent margins of the two being occasionally united. It arises by tendinous fibres from the spinous processes of the four or five upper dorsal vertebræ and the supraspinous ligament, and is inserted into a narrow tendinous arch attached above to the lower part of the triangular surface at the root of the spine; below, to the inferior angle, the arch being connected to the border of the scapula by a thin membrane. When the arch extends, as it occasionally does, but a short distance, the muscular fibres are inserted into the scapula itself.

Relations.—By its *superficial (posterior) surface*, with the Latissimus dorsi; by its *deep (anterior) surface*, with the Serratus posticus superior, posterior scapular artery, the vertebral aponeurosis which separates it from the prolongations from the Erector spinæ, the Intercostal muscles, and ribs.

Nerves.—The Rhomboid muscles are supplied by branches from the anterior division of the fifth cervical nerve; the Levator anguli scapulæ, by the anterior division of the third and fourth cervical nerves, and frequently by a branch from the nerve to the Rhomboids.

Actions.—The movements effected by the preceding muscles are numerous, as may be conceived from their extensive attachment. The whole of the Trapezius when in action retracts the scapula and braces back the shoulder; if the head is fixed, the upper part of the *Trapezius* will elevate the point of the shoulder, as in supporting weights; when the lower fibres are brought into action, they assist in depressing the bone. The middle and lower fibres of the muscle rotate the scapula, causing elevation of the acromion process. If the shoulders are fixed, both

Trapezii, acting together, will draw the head directly backward; or if only one acts, the head is drawn to the corresponding side.

The *Latissimus dorsi*, when it acts upon the humerus, depresses it, draws it backward, adducts, and at the same time rotates it inward. It is the muscle which is principally employed in giving a downward blow, as in felling a tree or in sabre practice. If the arm is fixed, the muscle may act in various ways upon the trunk; thus, it may raise the lower ribs and assist in forcible inspiration; or, if both arms are fixed, the two muscles may assist the Abdominal and great Pectoral muscles in suspending and drawing the whole trunk forward, as in climbing or walking on crutches.

The *Levator anguli scapulæ* raises the superior angle of the scapula, assisting the Trapezius in bearing weights or in shrugging the shoulders. If the shoulder be fixed, the Levator anguli scapulæ inclines the neck to the corresponding side and rotates it in the same direction. The Rhomboid muscles carry the inferior angle backward and upward, thus producing a slight rotation of the scapula upon the side of the chest, the Rhomboideus major acting especially on the lower angle of the scapula through the tendinous arch by which it is inserted. The Rhomboid muscles, acting together with the middle and inferior fibres of the Trapezius, will draw the scapula directly backward toward the spine.

Third Layer.

Serratus posticus superior. Serratus posticus inferior.

Splenius { Splenius capitis. / Splenius colli.

Dissection.—To bring into view the third layer of muscles, remove the whole of the second, together with the Latissimus dorsi, by cutting through the Levator anguli scapulæ and Rhomboid muscles near their origin, and reflecting them downward, and by dividing the Latissimus dorsi in the middle by a vertical incision carried from its upper to its lower part, and reflecting the two halves of the muscle.

The **Serratus posticus superior** is a thin, flat, quadrilateral muscle situated at the upper and back part of the thorax. It arises by a thin and broad aponeurosis from the ligamentum nuchæ, and from the spinous processes of the last cervical and two or three upper dorsal vertebræ and from the supraspinous ligament. Inclining downward and outward, it becomes muscular, and is inserted, by four fleshy digitations into the upper borders of the second, third, fourth, and fifth ribs, a little beyond their angles.

Relations.—By its *superficial surface*, with the Trapezius, Rhomboidei, and Levator anguli scapulæ; by its *deep surface*, with the Splenius and the vertebral aponeurosis, which separates it from the prolongations of the Erector spinæ, and with the Intercostal muscles and ribs.

The **Serratus posticus inferior** is situated at the junction of the dorsal and lumbar regions; it is of an irregularly quadrilateral form, broader than the preceding, and separated from it by a considerable interval. It arises by a thin aponeurosis from the spinous processes of the last two dorsal and two or three upper lumbar vertebræ, and from the supraspinous ligaments. Passing obliquely upward and outward, it becomes fleshy, and divides into four flat digitations, which are inserted into the lower borders of the four lower ribs, a little beyond their angles. The thin aponeurosis of origin is intimately blended with the lumbar fascia.

Relations.—By its *superficial surface*, with the Latissimus dorsi. By its *deep surface*, with the Erector spinæ, ribs, and Intercostal muscles. Its upper margin is continuous with the vertebral aponeurosis.

The *Vertebral aponeurosis* is a thin, fibrous lamina, extending along the whole length of the back part of the thoracic region, serving to bind down the long Extensor muscles of the back which support the spine and head, and separate them from those muscles which connect the spine to the upper extremity. It consists of longitudinal and transverse fibres blended together, forming a thin lamella, which is attached in the median line to the spinous processes of the dorsal vertebræ; ex-

ternally, to the angles of the ribs; and below, to the upper border of the Serratus posticus inferior and a portion of the lumbar fascia, which gives origin to the Latissimus dorsi; above, it passes beneath the Serratus posticus superior and the Splenius, and blends with the deep fascia of the neck.

The *Lumbar fascia* or *aponeurosis* (Fig. 213), which may be regarded as the posterior aponeurosis of the Transversalis abdominis muscle, consists of three laminæ, which are attached as follows: the posterior layer, to the spinæ of the lumbar and sacral vertebræ and their supraspinous ligaments; the middle, to the tips of the transverse processes of the lumbar vertebræ and their intertransverse ligaments; the anterior, to the roots of the lumbar transverse processes. The posterior layer is continued above as the vertebral aponeurosis, while inferiorily it is fixed to the outer lip of the iliac crest. With this layer are blended the aponeurotic origin of the Serratus posticus inferior and part of that of the Latissimus dorsi. The middle layer is attached above to the last rib, and below to the iliac crest; the anterior layer is fixed below to the ilio-lumbar ligament and iliac crest; while above it is thickened to form the external arcuate ligament of the diaphragm, and stretches from the tip of the last rib to the transverse process of the first or second lumbar vertebra. These three layers, together with the vertebral column, enclose two spaces, the posterior of which is occupied by the Erector spinæ muscle, and the anterior by the Quadratus lumborum.

Now detach the Serratus posticus superior from its origin, and turn it outward, when the Splenius muscle will be brought into view.

The **Splenius** is situated at the back of the neck and upper part of the dorsal region. At its origin it is a single muscle, narrow, and pointed in form; but it soon becomes broader, and divides into two portions, which have separate insertions. It arises, by tendinous fibres, from the lower half of the ligamentum nuchæ, from the spinous processes of the last cervical and of the six upper dorsal vertebræ, and from the supraspinous ligament. From this origin the fleshy fibres proceed obliquely upward and outward, forming a broad flat muscle, which divides as it ascends into two portions, the Splenius capitis and Splenius colli.

The **Splenius capitis** is inserted into the mastoid process of the temporal bone, and into the rough surface on the occipital bone just beneath the superior curved line.

The **Splenius colli** is inserted, by tendinous fasciculi, into the posterior tubercles of the transverse processes of the two or three upper cervical vertebræ.

The Splenius is separated from its fellow of the opposite side by a triangular interval, in which is seen the Complexus.

Relations.—By its *superficial surface*, with the Trapezius, from which it is separated below by the Rhomboidei and the Serratus posticus superior. It is covered at its insertion by the Sterno-mastoid, and at the lower and back part of the neck by the Levator anguli scapulæ; by its *deep surface*, with the Spinalis dorsi, Longissimus dorsi, Semispinalis colli, Complexus, Trachelo-mastoid, and Transversalis cervicis.

Nerves.—The Splenius is supplied from the external branches of the posterior divisions of the cervical nerves; the Serratus posticus superior is supplied by the external branches of the posterior divisions of the upper dorsal nerves; the Serratus posticus inferior by the external branches of the posterior divisions of the lower dorsal nerves.

Actions.—The Serrati are respiratory muscles. The Serratus posticus superior elevates the ribs; it is therefore an inspiratory muscle; while the Serratus inferior draws the lower ribs downward and backward, and thus elongates the thorax. It also fixes the lower ribs, thus aiding the downward action of the diaphragm and resisting the tendency which it has to draw the lower ribs upward and forward. It must therefore be regarded as a muscle of inspiration. This muscle is also probably a tensor of the vertebral aponeurosis. The Splenii muscles of the two sides, acting together, draw the head directly backward, assisting the Trapezius

and Complexus; acting separately, they draw the head to one or the other side, and slightly rotate it, turning the face to the same side. They also assist in supporting the head in the erect position.

Fourth Layer.

I. Erector spinæ.

a. Outer Column.	*b. Middle Column.*
Ilio-costalis.	Longissimus dorsi.
Musculus accessorius.	Transversalis cervicis.
Cervicalis ascendens.	Trachelo-mastoid.

c. Inner Column.

Spinalis dorsi.

II. Complexus.

Dissection.—To expose the muscles of the fourth layer, remove entirely the Serrati and the vertebral and lumbar fasciæ. Then detach the Splenius by separating its attachment to the spinous processes and reflecting it outward.

The **Erector spinæ** (Fig. 214) and its prolongations in the dorsal and cervical regions fill up the vertebral groove on each side of the spine. It is covered in the lumbar region by the lumbar fascia; in the dorsal region, by the Serrati muscles and the vertebral aponeurosis; and in the cervical region, by a layer of cervical fascia continued beneath the Trapezius and the Splenius. This large muscular and tendinous mass varies in size and structure at different parts of the spine. In the sacral region the Erector spinæ is narrow and pointed, and its origin chiefly tendinous in structure. In the lumbar region the muscle becomes enlarged, and forms a large fleshy mass. In the dorsal region it subdivides into two parts, which gradually diminish in size as they ascend to be inserted into the vertebræ and ribs.

The Erector spinæ arises from the anterior surface of a very broad and thick tendon, which is attached, internally, to the spines of the sacrum, to the spinous processes of the lumbar and the eleventh and twelfth dorsal vertebræ, and the supraspinous ligament; externally, to the back part of the inner lip of the crest of the ilium, and to the series of eminences on the posterior part of the sacrum, which represents the transverse processes, where it blends with the great sacro-sciatic and posterior sacro-iliac ligaments. Some of its fibres are continuous with the fibres of origin of the Gluteus maximus. The muscular fibres form a single large fleshy mass, bounded in front by the transverse processes of the lumbar vertebræ and by the middle lamella of the lumbar fascia. Opposite the last rib it divides into two parts, the Ilio-costalis and the Longissimus dorsi; the Spinalis dorsi is given off from the latter in the upper dorsal region.

The **Ilio-costalis** (*Sacro-lumbalis*), the external portion of the Erector spinæ, is inserted, generally, by six or seven flattened tendons into the inferior borders of the angles of the six or seven lower ribs. The number of the tendons of this muscle is, however, very variable, and therefore the number of ribs into which it is inserted. Frequently it is found to possess nine or ten tendons, and sometimes as many tendons as there are ribs, and is then inserted into the angles of all the ribs. If this muscle is reflected outward, it will be seen to be reinforced by a series of muscular slips which arise from the angles of the ribs; by means of these the Ilio-costalis is continued upward to the upper ribs and cervical portion of the spine. The accessory portions form two additional muscles, the Musculus accessorius and the Cervicalis ascendens.

The **Musculus accessorius ad ilio-costalem** arises, by separate flattened tendons, from the upper borders of the angles of the six lower ribs: these become muscular, and are finally inserted, by separate tendons, into the upper borders of the angles

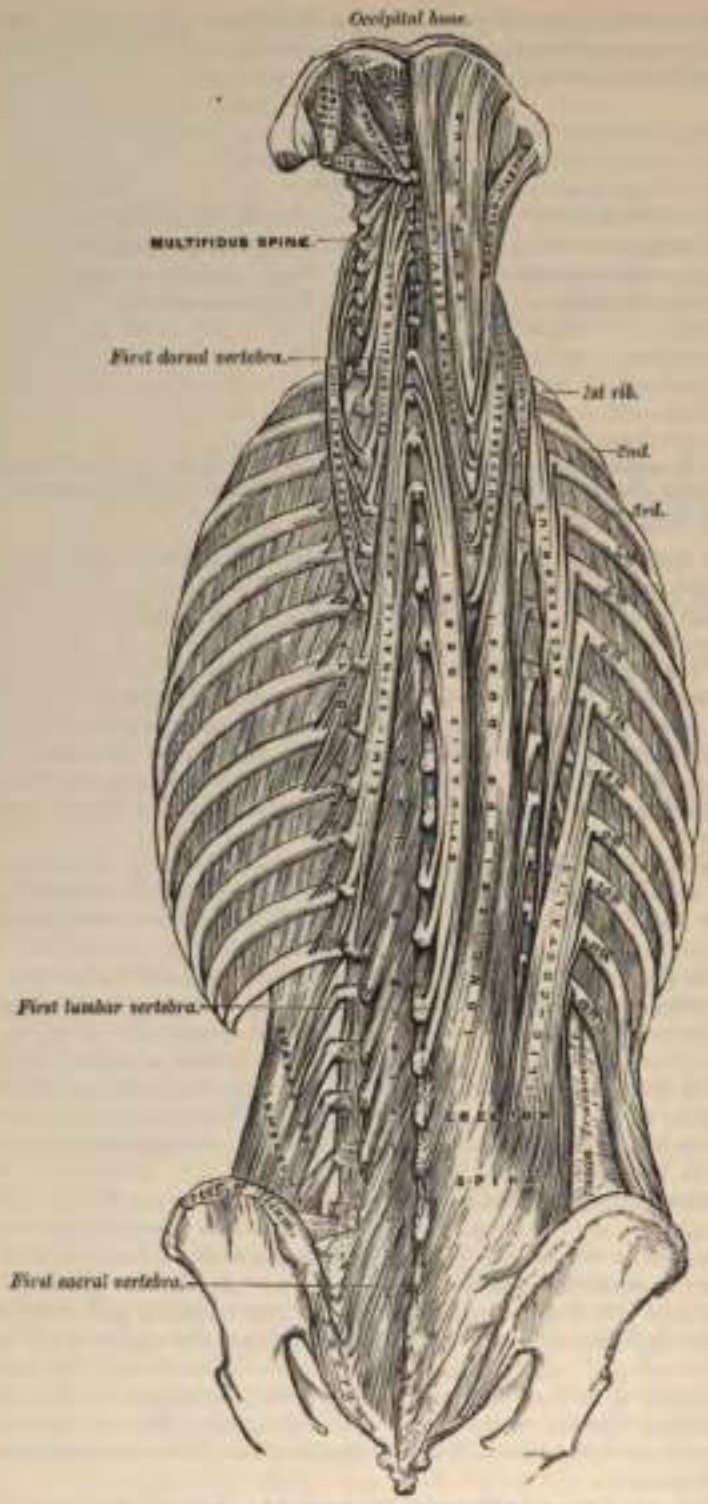


FIG. 214.—Muscles of the back. Deep layers.

of the six upper ribs and into the back of the transverse process of the seventh cervical vertebra.

The **Cervicalis ascendens**[1] is the continuation of the Accessorius upward into the neck; it is situated on the inner side of the tendons of the Accessorius, arising from the angles of the four or five upper ribs, and is inserted by a series of slender tendons into the posterior tubercles of the transverse processes of the fourth, fifth, and sixth cervical vertebræ.

The **Longissimus dorsi** is the middle and largest portion of the Erector spinæ. In the lumbar region, where it is as yet blended with the Ilio-costalis, some of the fibres are attached to the whole length of the posterior surface of the transverse processes and the accessory processes of the lumbar vertebræ, and to the middle layer of the lumbar fascia. In the dorsal region, the Longissimus dorsi is inserted, by long thin tendons, into the tips of the transverse processes of all the dorsal vertebræ, and into from seven to eleven of the lower ribs between their tubercles and angles. This muscle is continued upward to the cranium and cervical portion of the spine by means of two additional muscles, the Transversalis cervicis and Trachelo-mastoid.

The **Transversalis cervicis** or **colli**, placed on the inner side of the Longissimus dorsi, arises by long thin tendons from the summits of the transverse processes of the six upper dorsal vertebræ, and is inserted by similar tendons into the posterior tubercles of the transverse processes of the cervical vertebræ, from the second to the sixth inclusive.

The **Trachelo-mastoid** lies on the inner side of the preceding, between it and the Complexus muscle. It arises, by tendons, from the transverse processes of the five or six upper dorsal vertebræ, and the articular processes of the three or four lower cervical. The fibres form a small muscle, which ascends to be inserted into the posterior margin of the mastoid process, beneath the Splenius and Sterno-mastoid muscles. This small muscle is almost always crossed by a tendinous intersection near its insertion into the mastoid process.[2]

The **Spinalis dorsi** connects the spinous processes of the upper lumbar and the dorsal vertebræ together by a series of muscular and tendinous slips which are intimately blended with the Longissimus dorsi. It is situated at the inner side of the Longissimus dorsi, arising, by three or four tendons, from the spinous processes of the first two lumbar and the last two dorsal vertebræ: these, uniting, form a small muscle, which is inserted, by separate tendons, into the spinous processes of the dorsal vertebræ, the number varying from four to eight. It is intimately united with the Semispinalis dorsi, which lies beneath it.

The **Spinalis colli** is a small muscle, connecting together the spinous processes of the cervical vertebræ, and analogous to the Spinalis dorsi in the dorsal region. It varies considerably in its size and in its extent of attachment to the vertebræ, not only in different bodies, but on the two sides of the same body. It usually arises by fleshy or tendinous slips, varying from two to four in number, from the spinous processes of the fifth, sixth, and seventh cervical vertebræ, and occasionally from the first and second dorsal, and is inserted into the spinous process of the axis, and occasionally into the spinous processes of the two vertebræ below it. This muscle was found absent in five cases out of twenty-four.

Relations.—The Erector spinæ and its prolongations are bound down to the vertebræ and ribs in the lumbar and dorsal regions by the lumbar fascia and the vertebral aponeurosis. The inner part of these muscles covers the muscles of the fifth layer. In the neck they are in relation, by their *superficial surface*, with the Trapezius and Splenius; by their *deep surface*, with the Semispinalis dorsi et colli and the Recti and Obliqui.

The **Complexus** is a broad thick muscle, situated at the upper and back part of the neck, beneath the Splenius, and internal to the Transversalis cervicis and

[1] This muscle is sometimes called "Cervicalis descendens." The student should remember that these long muscles take their fixed point from above or from below, according to circumstances.

[2] These two muscles (Transversalis cervicis and Trachelo-mastoid) are sometimes described as one, having a common origin, but dividing above at their insertion. The Trachelo-mastoid is then termed the *Transversalis capitis*.

Trachelo-mastoid. It arises, by a series of tendons, from the tips of the transverse processes of the upper six or seven dorsal and the last cervical vertebræ, and from the articular processes of the three cervical above this. The tendons, uniting, form a broad muscle, which passes obliquely upward and inward, and is inserted into the innermost depression between the two curved lines of the occipital bone. This muscle, about its middle, is traversed by a transverse tendinous intersection. The *Biventer cervicis* is a small fasciculus, situated on the inner side of the preceding, and in the majority of cases blended with it; it has received its name from having a tendon intervening between two fleshy bellies. It is sometimes described as a part of the Complexus. It arises by from two to four tendinous slips, from the transverse processes of as many of the upper dorsal vertebræ, and is inserted, on the inner side of the Complexus, into the superior curved line of the occipital bone.

Relations.—The Complexus is covered by the Splenius and the Trapezius. It lies on the Rectus capitis posticus major and minor, the Obliquus capitis superior and inferior, and on the Semispinalis colli, from which it is separated by the profunda cervicis artery, the princeps cervicis artery, and branches of the posterior primary divisions of the cervical nerves. The Biventer cervicis is separated from its fellow of the opposite side by the ligamentum nuchæ.

Fifth Layer.

Semispinalis dorsi.	Extensor coccygis.
Semispinalis colli.	Intertransversales.
Multifidus spinæ.	Rectus capitis posticus major.
Rotatores spinæ.	Rectus capitis posticus minor.
Supraspinales.	Obliquus capitis inferior.
Interspinales.	Obliquus capitis superior.

Dissection.—Remove the muscles of the preceding layer by dividing and turning aside the Complexus; then detach the Spinalis and Longissimus dorsi from their attachments, divide the Erector spinæ at its connection below to the sacral and lumbar spines, and turn it outward. The muscles filling up the interval between the spinous and transverse processes are then exposed.

The **Semispinalis dorsi** (Fig. 214) consists of thin, narrow, fleshy fasciculi interposed between tendons of considerable length. It arises by a series of small tendons from the transverse processes of the lower dorsal vertebræ, from the tenth or eleventh to the fifth or sixth; and is inserted, by five or six tendons, into the spinous processes of the upper four dorsal and lower two cervical vertebræ.

The **Semispinalis colli,** thicker than the preceding, arises by a series of tendinous and fleshy fibres from the transverse processes of the upper five or six dorsal vertebræ, and is inserted into the spinous processes of four cervical vertebræ, from the axis to the fifth cervical. The fasciculus connected with the axis is the largest, and chiefly muscular in structure.

Relations.—By their *superficial surface*, from below upward, with the Spinalis dorsi, Longissimus dorsi, Splenius, Complexus, the profunda cervicis artery, the princeps cervicis artery, and the internal branches of the posterior divisions of the first, second, and third cervical nerves; by their *deep surface*, with the Multifidus spinæ.

The **Multifidus spinæ** consists of a number of fleshy and tendinous fasciculi which fill up the groove on either side of the spinous processes of the vertebræ, from the sacrum to the axis. In the sacral region these fasciculi arise from the back of the sacrum, as low as the fourth sacral foramen, and from the aponeurosis of origin of the Erector spinæ; from the inner surface of the posterior superior spine of the ilium and posterior sacro-iliac ligaments; in the lumbar regions, from the articular processes; in the dorsal region, from the transverse processes; and in the cervical region, from the articular processes of the three or four lower vertebræ. Each fasciculus, passing obliquely upward and inward, is inserted into the whole length of the spinous process of one of the vertebræ above. These fasciculi vary in length: the most superficial, the longest, pass from one vertebra to the

third or fourth above; those next in order pass from one vertebra to the second or third above; whilst the deepest connect two contiguous vertebræ.

Relations.—By its *superficial surface*, with the Longissimus dorsi, Spinalis dorsi, Semispinalis dorsi, and Semispinalis colli; by its *deep surface*, with the laminæ and spinous processes of the vertebræ, and with the Rotatores spinæ in the dorsal region.

The **Rotatores spinæ** are found only in the dorsal region of the spine, beneath the Multifidus spinæ; they are eleven in number on each side. Each muscle is small and somewhat quadrilateral in form; it arises from the upper and back part of the transverse process, and is inserted into the lower border and outer surface of the lamina of the vertebra above, the fibres extending as far inward as the root of the spinous process. The first is found between the first and second dorsal; the last, between the eleventh and twelfth. Sometimes the number of these muscles is diminished by the absence of one or more from the upper or lower end.

The **Supraspinales** consist of a series of fleshy bands which lie on the spinous processes in the cervical region of the spine.

The **Interspinales** are short muscular fasciculi, placed in pairs between the spinous processes of the contiguous vertebræ, one on each side of the interspinous ligament. In the *cervical region* they are most distinct, and consist of six pairs, the first being situated between the axis and third vertebra, and the last between the last cervical and the first dorsal. They are small narrow bundles, attached, above and below, to the apices of the spinous processes. In the *dorsal region* they are found between the first and second vertebræ, and occasionally between the second and third; and below, between the eleventh and twelfth. In the *lumbar region* there are four pairs of these muscles in the intervals between the five lumbar vertebræ. There is also occasionally one in the interspinous space, between the last dorsal and first lumbar, and between the fifth lumbar and the sacrum.

The **Extensor coccygis** is a slender muscular fasciculus, occasionally present, which extends over the lower part of the posterior surface of the sacrum and coccyx. It arises by tendinous fibres from the last bone of the sacrum or first piece of the coccyx, and passes downward to be inserted into the lower part of the coccyx. It is a rudiment of the Extensor muscle of the caudal vertebræ of the lower animals.

The **Intertransversales** are small muscles placed between the transverse processes of the vertebræ. In the *cervical region* they are most developed, consisting of rounded muscular and tendinous fasciculi, which are placed in pairs, passing between the anterior and the posterior tubercles of the transverse processes of two contiguous vertebræ, separated from one another by the anterior division of the cervical nerve, which lies in the groove between them. In this region there are seven pairs of these muscles, the first pair being between the atlas and axis, and the last pair between the seventh cervical and first dorsal vertebræ. In the *dorsal region* they are least developed, consisting chiefly of rounded tendinous cords in the intertransverse spaces of the upper dorsal vertebræ; but between the transverse processes of the lower three dorsal vertebræ, and between the transverse processes of the last dorsal and the first lumbar, they are muscular in structure. In the *lumbar region* they are arranged in pairs, on either side of the spine, one set occupying the entire interspace between the transverse processes of the lumbar vertebræ, the *intertransversales laterales*; the other set, *intertransversales mediales*, passing from the accessory process of one vertebra to the mammillary process of the next.

The **Rectus capitis posticus major** arises by a pointed tendinous origin from the spinous process of the axis, and, becoming broader as it ascends, is inserted into the inferior curved line of the occipital bone and the surface of bone immediately below it. As the muscles of the two sides pass upward and outward, they leave between them a triangular space, in which are seen the Recti capitis postici minores muscles.

Relations.—By its *superficial surface*, with the Complexus, and, at its insertion, with the Superior oblique; by its *deep surface*, with part of the Rectus capitis posticus minor, the posterior arch of the atlas, the posterior occipito-atlantal ligament, and part of the occipital bone.

The **Rectus capitis posticus minor**, the smallest of the four muscles in this region, is of a triangular shape; it arises by a narrow pointed tendon from the tubercle on the posterior arch of the atlas, and, becoming broader as it ascends, is inserted into the rough surface beneath the inferior curved line, nearly as far as the foramen magnum, nearer to the middle line than the preceding.

Relations.—By its *superficial surface*, with the Complexus and the Rectus capitis posticus major; by its *deep surface*, with the posterior occipito-atlantal ligament.

The **Obliquus capitis inferior**, the larger of the two Oblique muscles, arises from the apex of the spinous process of the axis, and passes outward and slightly upward, to be inserted into the lower and back part of the transverse process of the atlas.

Relations.—By its *superficial surface*, with the Complexus and with the posterior division of the second cervical nerve, which crosses it; by its *deep surface*, with the vertebral artery and posterior atlanto-axial ligament.

The **Obliquus capitis superior**, narrow below, wide and expanded above, arises by tendinous fibres from the upper surface of the transverse process of the atlas, joining with the insertion of the preceding, and, passing obliquely upward and inward, is inserted into the occipital bone, between the two curved lines, external to the Complexus.

Relations.—By its *superficial surface*, with the Complexus and Trachelo-mastoid and occipital artery. By its *deep surface*, with the posterior occipito-atlantal ligament.

The Suboccipital Triangle.—Between the two oblique muscles and the Rectus capitis posticus major a triangular interval exists, the *suboccipital triangle*. This triangle is bounded, above and internally, by the Rectus capitis posticus major; above and externally, by the Obliquus capitis superior; below and externally, by the Obliquus capitis inferior. It is covered in by a layer of dense fibro-fatty tissue, situated beneath the Complexus muscle. The floor is formed by the posterior occipito-atlantal ligament and the posterior arch of the atlas. It contains the vertebral artery, as it runs in a deep groove on the upper surface of the posterior arch of the atlas, and the posterior division of the suboccipital nerve.

Nerves.—The third, fourth, and fifth layers of the muscles of the back are supplied by the posterior primary divisions of the spinal nerves.

Actions.—When both the Spinales dorsi contract, they extend the dorsal region of the spine; when only one muscle contracts, it helps to bend the dorsal portion of the spine to one side. The Erector spinæ, comprising the Ilio-costalis and the Longissimus dorsi with their accessory muscles, serves, as its name implies, to maintain the spine in the erect posture; it also serves to bend the trunk backward when it is required to counterbalance the influence of any weight at the front of the body, as, for instance, when a heavy weight is suspended from the neck, or when there is any great abdominal distension, as in pregnancy or dropsy; the peculiar gait under such circumstances depends upon the spine being drawn backward by the counterbalancing action of the Erector spinæ muscles. The muscles which form the continuation of the Erector spinæ upward steady the head and neck, and fix them in the upright position. If the Ilio-costalis and Longissimus dorsi of one side act, they serve to draw down the chest and spine to the corresponding side. The Cervicales ascendens, taking their fixed points from the cervical vertebræ, elevate those ribs to which they are attached; taking their fixed points from the ribs, both muscles help to extend the neck; while one muscle bends the neck to its own side. The Transversalis cervicis, when both muscles act, taking their fixed point from below, bend the neck backward. The Trachelo-mastoid, when both muscles act, taking their fixed point from below, bend the head backward; while, if only one muscle acts, the face is turned to the side on which the muscle is acting, and then the head is bent to the shoulder. The two Recti

muscles draw the head backward. The Rectus capitis posticus major, owing to its obliquity, rotates the cranium, with the atlas, round the odontoid process, turning the face to the same side. The Multifidus spinæ acts successively upon the different parts of the spine; thus, the sacrum furnishes a fixed point from which the fasciculi of this muscle act upon the lumbar region; these then become the fixed points for the fasciculi moving the dorsal region, and so on throughout the entire length of the spine; it is by the successive contraction and relaxation of the separate fasciculi of this and other muscles that the spine preserves the erect posture without the fatigue that would necessarily have been produced had this position been maintained by the action of a single muscle. The Multifidus spinæ, besides preserving the erect position of the spine, serves to rotate it, so that the front of the trunk is turned to the side opposite to that from which the muscle acts, this muscle being assisted in its action by the Obliquus externus abdominis. The Complexi draw the head directly backward: if one muscle acts, it draws the head to one side, and rotates it so that the face is turned to the opposite side. The Superior oblique draws the head backward, and, from the obliquity in the direction of its fibres, will slightly rotate the cranium, turning the face to the opposite side. The Obliquus capitis inferior rotates the atlas, and with it the cranium, round the odontoid process, turning the face to the same side. The Semispinales, when the muscles of the two sides act together, help to extend the spine; when the muscles of one side only act, they rotate the dorsal and cervical parts of the spine, turning the body to the opposite side. The Supraspinales and Interspinales by approximating the spinous processes help to extend the spine. The Intertransversales approximate the transverse processes, and help to bend the spine to one side. The Rotatores spinæ assist the Multifidus spinæ to rotate the spine, so that the front of the trunk is turned to the side opposite to that from which the muscle acts.

Surface Forms.—The surface forms produced by the muscles of the back are numerous and difficult to analyze unless they are considered in systematic order. The most superficial layer, consisting of large strata of muscular substance, influences to a certain extent the surface form, and at the same time reveals the forms of the layers beneath. The *Trapezius* at the upper part of the back, and in the neck, covers over and softens down the outline of the underlying muscles. Its anterior border forms the posterior boundary of the posterior triangle of the neck. It forms a slight undulating ridge which passes downward and forward from the occiput to the junction of the middle and outer third of the clavicle. The tendinous ellipse formed by a part of the origin of the two muscles at the back of the neck is always to be seen as an oval depression, more marked when the muscle is in action. A slight dimple on the skin opposite the interval between the spinous processes of the third and fourth dorsal vertebræ marks the triangular aponeurosis by which the inferior fibres are inserted into the root of the spine of the scapula. From this point the inferior border of the muscle may be traced as an undulating ridge to the spinous process of the twelfth dorsal vertebra. In like manner, the *Latissimus dorsi* softens down and modulates the underlying structures at the lower part of the back and lower part of the side of the chest. In this way it modulates the outline of the Erector spinæ; of the Serratus posticus inferior, which is sometimes to be discerned through it, and is sometimes entirely obscured by it; of part of the Serratus magnus and Superior oblique, which it covers; and of the convex oblique ridges formed by the ribs with the intervening intercostal spaces. The anterior border of the muscle is the only part which gives a distinct surface form. This border may be traced, when the muscle is in action, as a rounded edge, starting from the crest of the ilium, and passing obliquely forward and upward to the posterior border of the axilla, where it combines with the Teres major in forming a thick rounded fold, the posterior boundary of the axillary space. The muscles in the second layer influence to a very considerable extent the surface form of the back of the neck and upper part of the trunk. The *Levator anguli scapulæ* reveals itself as a prominent divergent line, running downward and outward, from the transverse processes of the upper cervical vertebræ to the angle of the scapula, covered over and toned down by the overlying Trapezius. The *Rhomboidei* produce, when in action, a vertical eminence between the vertebral border of the scapula and the spinal furrow, varying in intensity according to the condition of contraction or relaxation of the Trapezius muscle, by which they are for the most part covered. The lowermost part of the Rhomboideus major is uncovered by the Trapezius, and forms on the surface an oblique ridge running upward and inward from the inferior angle of the scapula. Of the muscles of the third layer of the back, the *Serratus posticus superior* does not in any way influence surface form. The *Serratus posticus inferior*, when in strong action, may occasionally be revealed as an elevation beneath the Latissimus dorsi. The *Splenii* by their divergence serve to broaden out the upper part of the back of the neck and produce a

local fulness in this situation, but do not otherwise influence surface form. Beneath all these muscles those of the fourth layer—the *Erector spinæ* and its continuations—influence the surface form in a decided manner. In the loins, the Erector spinæ, bound down by the lumbar fascia, forms a rounded vertical eminence, which determines the depth of the spinal furrow, and which below tapers to a point on the posterior surface of the sacrum and becomes lost there. In the back it forms a flattened plane which gradually becomes lost. In the neck the only part of this group of muscles which influences surface form is the *Trachelo-mastoid*, which produces a short convergent line across the upper part of the posterior triangle of the neck, appearing from under cover of the posterior border of the Sterno-mastoid and being lost below beneath the Trapezius.

2. MUSCLES AND FASCIÆ OF THE THORAX.

The muscles belonging exclusively to this region are few in number. They are the

Intercostales externi.	Triangularis sterni.
Intercostales interni.	Levatores costarum.
Infracostales.	Diaphragm.

Intercostal Fasciæ.—A thin but firm layer of fascia covers the outer surface of the External intercostal and the inner surface of the Internal intercostal muscles; and a third layer, the middle intercostal fascia, more delicate, is interposed between the two planes of muscular fibres. These are the intercostal fasciæ; they are best marked in those situations where the muscular fibres are deficient, as between the External intercostal muscles and sternum, in front, and between the Internal intercostals and spine, behind.

The **Intercostal muscles** (*Fig.* 230) are two thin planes of muscular and tendinous fibres, placed one over the other, filling up the intercostal spaces, and being directed obliquely between the margins of the adjacent ribs. They have received the name "external" and "internal" from the position they bear to one another. The tendinous fibres are longer and more numerous than the muscular; hence the walls of the intercostal spaces possess very considerable strength, to which the crossing of the muscular fibres materially contributes.

The **External Intercostals** are eleven in number on each side. They extend from the tubercles of the ribs, behind, to the commencement of the cartilages of the ribs, in front, where they terminate in a thin membrane, the anterior intercostal membrane, which is continued forward to the sternum. They arise from the lower border of each rib, and are inserted into the upper border of the rib below. In the two lowest spaces they extend to the end of the cartilages, and in the upper two or three spaces they do not quite extend to the ends of the ribs. Their fibres are directed obliquely downward and forward, in a similar direction with those of the External oblique muscle of the abdomen. They are thicker than the Internal intercostals.

Relations.—By their *outer surface*, with the muscles which immediately invest the chest—viz. the Pectoralis major and minor, Serratus magnus, and Rhomboideus major, Serratus posticus superior and inferior, Scalenus posticus, Ilio-costalis, Longissimus dorsi, Cervicalis ascendens, Transversalis cervicis, Levatores costarum, Obliquus externus abdominis, and the Latissimus dorsi; by their *internal surface*, with the middle intercostal fascia, which separates them from the intercostal vessels and nerve and the Internal intercostal muscles, and, behind, from the pleura.

The **Internal Intercostals** are also eleven in number on each side. They commence anteriorly at the sternum, in the interspaces between the cartilages of the true ribs, and from the anterior extremities of the cartilages of the false ribs, and extend backward as far as the angles of the ribs, whence they are continued to the vertebral column by a thin aponeurosis, the posterior intercostal membrane. They arise from the ridge on the inner surface of each rib, as well as from the corresponding costal cartilage, and are inserted into the upper border of the rib below. Their fibres are directed obliquely downward and backward, passing in the opposite direction to the fibres of the External intercostal muscle.

Relations.—By their *external surface*, with the intercostal vessels and nerves and the External intercostal muscles; near the sternum, with the anterior inter-

costal membrane and the Pectoralis major. By their *internal surface*, with the pleura costalis, Triangularis sterni, and Diaphragm.

The **Infracostales (subcostales)** consist of muscular and aponeurotic fasciculi, which vary in number and length: they are placed on the inner surface of the ribs, where the Internal intercostal muscles cease; they arise from the inner surface of one rib, and are inserted into the inner surface of the first, second, or third rib below. Their direction is most usually oblique, like the Internal intercostals. They are most frequent between the lower ribs.

The **Triangularis sterni** (Fig. 215) is a thin plane of muscular and tendinous fibres, situated upon the inner wall of the front of the chest. It arises from the lower third of the posterior surface of the sternum, from the posterior surface of the ensiform cartilage, and from the sternal ends of the costal cartilages of the three

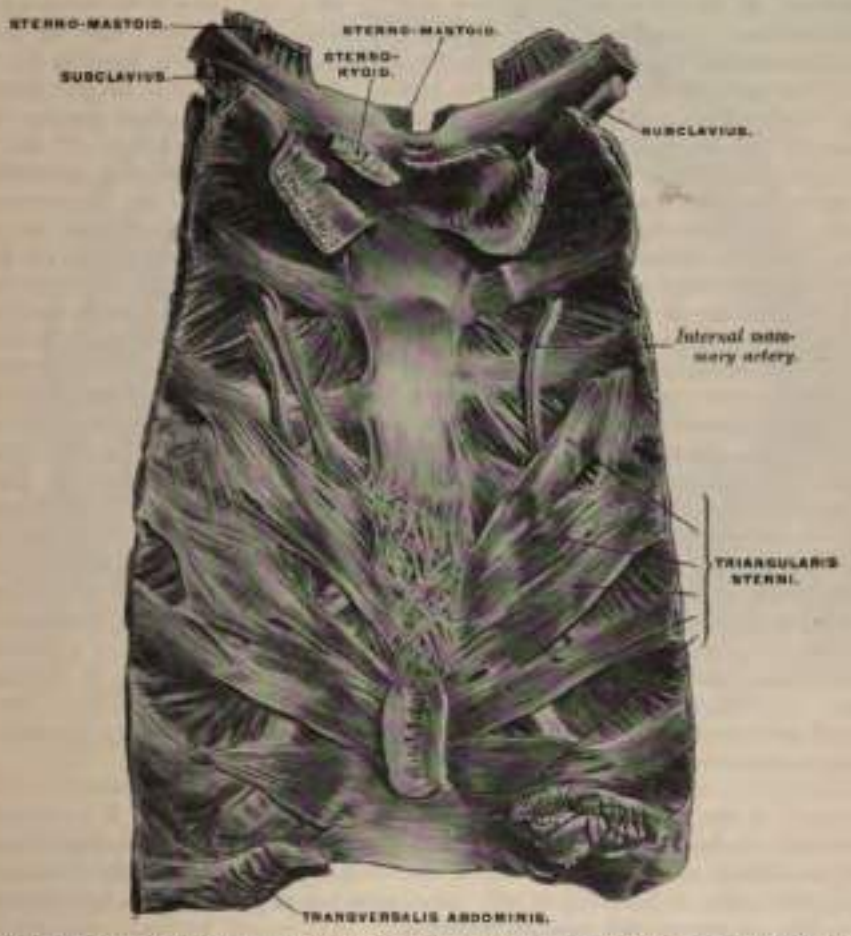


FIG. 215.—Posterior surface of sternum and costal cartilages, showing Triangularis sterni muscle. (From a preparation in the Museum of the Royal College of Surgeons of England.)

or four lower true ribs. Its fibres diverge upward and outward, to be inserted by digitations into the lower border and inner surfaces of the costal cartilages of the second, third, fourth, fifth, and sixth ribs. The lowest fibres of this muscle are horizontal in their direction, and are continuous with those of the Transversalis; those which succeed are oblique, whilst the superior fibres are almost vertical. This muscle varies much in its attachment, not only in different bodies, but on opposite sides of the same body.

Relations.—*In front*, with the sternum, ensiform cartilage, costal cartilages,

Internal intercostal muscles, and internal mammary vessels; *behind*, with the pleura, pericardium, and anterior mediastinum.

The **Levatores Costarum** (Fig. 214), twelve in number on each side, are small tendinous and fleshy bundles which arise from the extremities of the transverse processes of the seventh cervical and eleven upper dorsal vertebræ, and, passing obliquely downward and outward, are inserted into the upper border of the rib below them, between the tubercle and the angle. The Inferior levatores divide into two fasciculi, one of which is inserted as above described; the other fasciculus passes down to the second rib below its origin; thus, each of the lower ribs receives fibres from the transverse processes of two vertebræ.

Nerves.—The muscles of this group are supplied by the intercostal nerves.

The **Diaphragm** (*διάφραγμα, a partition wall*) (Fig. 216) is a thin, musculofibrous septum, consisting of muscular fibres externally, which arise from the circumference of the thoracic cavity and pass upward and inward to converge to a central tendon. It is placed obliquely at the junction of the upper with the middle third of the trunk, and, separating the thorax from the abdomen, forming the floor of the former cavity and the roof of the latter. It is elliptical, its longest diameter being from side to side, somewhat fan-shaped, the broad elliptical portion being horizontal, the narrow part, the *crura*, which represents the handle of the fan, vertical, and joined at right angles to the former. It is from this circumstance that some anatomists describe it as consisting of two portions, the upper or great muscle of the Diaphragm, and the lower or lesser muscle. It arises from the whole of the internal circumference of the thorax, being attached, in front, by fleshy fibres to the ensiform cartilage; on either side, to the inner surface of the cartilages and bony portions of the six or seven inferior ribs, interdigitating with the Transversalis; and behind, to two aponeurotic arches, named the *ligamentum arcuatum externum et internum*, and by the crura, to the lumbar vertebræ. The fibres from these sources vary in length: those arising from the ensiform appendix are very short and occasionally aponeurotic; those from the ligamenta arcuata, and more especially those from the cartilages of the ribs at the side of the chest, are longer, describe well-marked curves as they ascend, and finally converge to be inserted into the circumference of the central tendon. Between the sides of the muscular slip from the ensiform appendix and the cartilages of the adjoining ribs the fibres of the Diaphragm are deficient, the interval being filled by areolar tissue, covered on the thoracic side by the pleuræ; on the abdominal, by the peritoneum. This is, consequently, a weak point, and a portion of the contents of the abdomen may protrude into the chest, forming phrenic or diaphragmatic hernia, or a collection of pus in the mediastinum may descend through it, so as to point at the epigastrium. A triangular gap is sometimes seen between the fibres springing from the internal and those arising from the external arcuate ligament. When it exists, the kidney is separated from the pleura only by fatty and areolar tissue.

The *ligamentum arcuatum internum* is a tendinous arch, thrown across the upper part of the Psoas magnus muscle, on each side of the spine. It is connected, by one end, to the outer side of the body of the first or second lumbar vertebra, being continuous with the outer side of the tendon of the corresponding crus; and, by the other end, to the front of the transverse process of the first, and sometimes also to that of the second, lumbar vertebra.

The *ligamentum arcuatum externum* is the thickened upper margin of the anterior lamella of the lumbar fascia; it arches across the upper part of the Quadratus lumborum, being attached, by one extremity, to the front of the transverse process of the first lumbar vertebra, and, by the other, to the apex and lower margin of the last rib.

The Crura.—The Diaphragm is connected to the spine by two *crura* or *pillars*, which are situated on the bodies of the lumbar vertebræ, on each side of the aorta. The crura, at their origin, are tendinous in structure; the right crus, larger and longer than the left, arising from the anterior surface of the bodies and intervertebral substances of the three or four upper lumbar vertebræ; the left, from

the two upper; both blending with the anterior common ligament of the spine. These tendinous portions of the crura pass forward and inward, and gradually converge to meet in the middle line, forming an arch, beneath which passes the aorta, vena azygos major, and thoracic duct. From this tendinous arch muscular fibres arise, which diverge, the outermost portion being directed upward and outward to the central tendon; the innermost decussating in front of the aorta, and then diverging, so as to surround the œsophagus before ending in the central tendon. The fibres derived from the right crus are the most numerous and pass in front of those derived from the left.

The *Central* or *Cordiform Tendon* of the Diaphragm is a thin but strong tendinous aponeurosis, situated at the centre of the vault formed by the muscle,

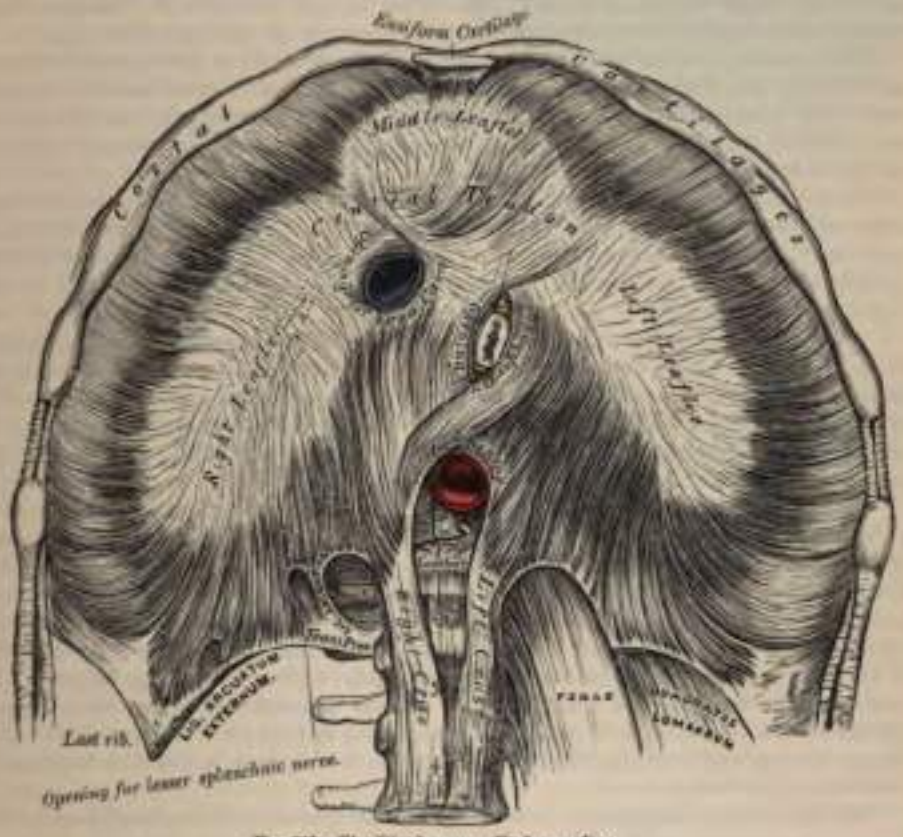


FIG. 216.—The Diaphragm. Under surface.

immediately below the pericardium, with which it is partly blended. It is shaped somewhat like a trefoil leaf, consisting of three divisions, or leaflets, separated from one another by slight indentations. The right leaflet is the largest; the middle one, directed toward the ensiform cartilage, the next in size; and the left, the smallest. In structure, the tendon is composed of several planes of fibres which intersect one another at various angles, and unite into straight or curved bundles—an arrangement which affords it additional strength.

The *Openings* connected with the Diaphragm are three large and several smaller apertures. The former are the aortic, the œsophageal, and the opening for the vena cava.

The *aortic opening* is the lowest and the most posterior of the three large apertures connected with this muscle, being at the level of the first lumbar vertebra. It is situated slightly to the left of the middle line, immediately in front of the bodies of the vertebræ; and is, therefore, *behind* the Diaphragm, not

in it. It is an osseo-aponeurotic aperture, formed by a tendinous arch thrown across the front of the bodies of the vertebræ, from the crus on one side to that on the other, and transmits the aorta, vena azygos major, and thoracic duct. Sometimes the vena azygos major is transmitted upward through the right crus. Occasionally some tendinous fibres are prolonged across the bodies of the vertebræ from the inner part of the lower end of the crura, passing behind the aorta, and thus converting the opening into a fibrous ring.

The *œsophageal opening* is situated at the level of the tenth dorsal vertebra; it is elliptical in form, muscular in structure, and, formed by the decussating fibres of the two crura, is placed above, and, at the same time, anterior, and a little to the left of the preceding. It transmits the œsophagus and pneumogastric nerves and some small œsophageal arteries. The anterior margin of this aperture is occasionally tendinous, being formed by the margin of the central tendon.

The *opening for the vena cava* (*foramen quadratum*) is the highest, about on the level of the disc between the eighth and ninth dorsal vertebræ; it is quadrilateral in form, tendinous in structure, and placed at the junction of the right and middle leaflets of the central tendon, its margins being adherent to the wall of the inferior vena cava.

The *right crus* transmits the greater and lesser splanchnic nerves of the right side; the *left crus* transmits the greater and lesser splanchnic nerves of the left side, and the vena azygos minor. The ganglia ted cords of the sympathetic usually enter the abdominal cavity by passing behind the internal arcuate ligaments.

The *Serous Membranes* in relation with the Diaphragm are four in number: three lining its upper or thoracic surface; one, its abdominal. The three serous membranes on its upper surface are the pleura on either side and the serous layer of the pericardium, which covers the middle portion of the tendinous centre. The serous membrane covering its under surface is a portion of the general peritoneal membrane of the abdominal cavity.

The Diaphragm is arched, being convex toward the chest and concave to the abdomen. The *right portion* forms a complete arch from before backward, being accurately moulded over the convex surface of the liver, and having resting upon it the concave base of the right lung. The *left portion* is arched from before backward in a similar manner; but the arch is narrower in front, being encroached upon by the pericardium, and lower than the right, at its summit, by about three-quarters of an inch. It supports the base of the left lung, and covers the great end of the stomach, the spleen, and left kidney. At its circumference the Diaphragm is higher in the mesial line of the body than at either side; but in the middle of the thorax the central portion, which supports the heart, is on a lower level than the two lateral portions.

Nerves.—The Diaphragm is supplied by the phrenic nerves and lower intercostal nerves and phrenic plexus of the sympathetic.

Actions.—The Intercostals are the chief agents in the movement of the ribs in ordinary respiration. When the first rib is elevated and fixed by the Scaleni, the External intercostals raise the other ribs, especially their fore part, and so increase the capacity of the chest from before backward; at the same time they evert their lower borders, and so enlarge the thoracic cavity transversely. The Internal intercostals, at the side of the thorax, depress the ribs and invert their lower borders, and so diminish the thoracic cavity; but at the fore part of the chest these muscles assist the External intercostals in raising the cartilages.[1] The Levatores

[1] The view of the action of the Intercostal muscles given in the text is that which is taught by Hutchinson (*Cyc. of Anat. and Phys.*, art. "Thorax"), and is usually adopted in our schools. It is, however, much disputed. Hamberger believed that the External intercostals act as elevators of the ribs, or muscles of inspiration, while the Internal act in expiration. Haller taught that both sets of muscles act in common—viz. as muscles of inspiration—and this view is adopted by many of the best anatomists of the Continent, and appears supported by many observations made on the human subject under various conditions of disease, and on living animals after the muscles have been exposed under chloroform. The reader may consult an interesting paper by Dr. Cleland in the *Journal of Anat. and*

costarum assist the External intercostals in raising the ribs. The Triangularis sterni draws down the costal cartilages; it is therefore an expiratory muscle.

The Diaphragm is the principal muscle of inspiration. When in a condition of rest the muscle presents a domed surface, concave toward the abdomen; and consists of a circumferential muscular and a central tendinous part. When the muscular fibres contract, they become less arched, or nearly straight, and thus cause the central tendon to descend, and in consequence the level of the chest-wall is lowered, the vertical diameter of the chest being proportionally increased. In this descent the different parts of the tendon move unequally. The left leaflet descends to the greatest extent; the right to a less extent, on account of the liver; and the central leaflet the least, because of its connection to the pericardium. In descending the diaphragm presses on the abdominal viscera, and so to a certain extent causes a projection of the abdominal wall; but in consequence of these viscera not yielding completely, the central tendon becomes a fixed point, and enables the circumferential muscular fibres to act *from* it, and so elevate the lower ribs and expand the lower part of the thoracic cavity; and Duchenne has shown that the Diaphragm has the power of elevating the ribs, to which it is attached, by its contraction, if the abdominal viscera are *in situ*, but that if these organs are removed, this power is lost. When at the end of inspiration the Diaphragm relaxes, the thoracic walls return to their natural position in consequence of their elastic reaction and of the elasticity and weight of the displaced viscera.[1]

In all expulsive acts the Diaphragm is called into action, to give additional power to each expulsive effort. Thus, before sneezing, coughing, laughing, and crying, before vomiting, previous to the expulsion of the urine and fæces, or of the fœtus from the womb, a deep inspiration takes place.

The height of the Diaphragm is constantly varying during respiration, the muscle being carried upward or downward from the average level; its height also varies according to the degree of distension of the stomach and intestines, and the size of the liver. After a forced expiration, the right arch is on a level, in front, with the fourth costal cartilage; at the side, with the fifth, sixth, and seventh ribs; and behind, with the eighth rib, the left arch being usually from one to two ribs' breadth below the level of the right one. In a forced inspiration, it descends from one to two inches; its slope would then be represented by a line drawn from the ensiform cartilage toward the tenth rib.

Muscles of Inspiration and Expiration.—The muscles which assist the action of the Diaphragm in ordinary tranquil inspiration are the Intercostals and the Levatores costarum, as above stated, and the Scaleni. When the need for more forcible action exists, the shoulders and the base of the scapula are fixed, and then the powerful muscles of forced inspiration come into play; the chief of these are the Trapezius, the Pectoralis minor, the Serratus posticus superior and inferior, and the Rhomboidei. The lower fibres of the Serratus magnus may possibly assist slightly in dilating the chest by raising and everting the ribs. The Sterno-mastoid also, when the head is fixed, assists in forced inspiration by drawing up the sternum and by fixing the clavicle, and thus affording a fixed point for the action of the muscles of the chest. The Ilio-costalis and Quadratus lumborum assist in forced inspiration by fixing the last rib (see page 367).

The ordinary action of expiration is hardly effected by muscular force, but results from a return of the walls of the thorax to a condition of rest, owing to their own elasticity and to that of the lungs. Forced expiratory actions are

Phys. No. II., May, 1867, p. 209, "On the Hutchinsonian Theory of the Action of the Intercostal Muscles," who refers also to Henle, Luschka, Budge, and Baumler, *Observations on the Action of the Intercostal Muscles*, Erlangen, 1860. (In *New Syd. Soc.'s Year-Book for* 1861, p. 69.) Dr. W. W. Keen has come to the conclusion, from experiments made upon a criminal executed by hanging, that the External intercostals are muscles of expiration, as they pulled the ribs down, while the Internal intercostals pulled the ribs up and are muscles of inspiration (*Trans. Coll. Phys. Philadelphia*, Third Series, vol. I., 1875, p. 97).

[1] For a detailed description of the general relations of the Diaphragm, and its action, refer to Dr. Gibson's *Medical Anatomy*.

performed mainly by the flat muscles (Obliqui and Transversalis) of the abdomen, assisted also by the Rectus. Other muscles of forced expiration are the Internal intercostals and Triangularis sterni (as above mentioned).

3. MUSCLES OF THE ABDOMEN.

The muscles of the abdomen may be divided into two groups: 1. The superficial muscles of the abdomen; 2. The deep muscles of the abdomen.

1. Superficial Muscles.

The Muscles in this region are, the

Obliquus Externus.	Transversalis.
Obliquus Internus.	Rectus.
	Pyramidalis.

3. Dissection of inguinal hernia.

FIG. 217.—Dissection of abdomen.

Dissection (Fig. 217).—To dissect the abdominal muscles, make a vertical incision from the ensiform cartilage to the symphysis pubis; a second incision from the umbilicus obliquely upward and outward to the outer surface of the chest, as high as the lower border of the fifth or sixth rib; and a third, commencing midway between the umbilicus and pubes, transversely outward to the anterior superior iliac spine, and along the crest of the ilium as far as its posterior third. Then reflect the three flaps included between these incisions from within outward, in the lines of direction of the muscular fibres. If necessary, the abdominal muscles may be made tense by inflating the peritoneal cavity through the umbilicus.

The **Superficial fascia** of the abdomen consists, over the greater part of the abdominal wall, of a single layer of fascia, which contains a variable amount of fat; but as this layer approaches the groin it is easily divisible into two layers, between which are found the superficial vessels and nerves and the superficial inguinal lymphatic glands. The superficial layer (*fascia of Camper*) is thick, areolar in texture, containing adipose tissue in its meshes, the quantity of which varies in different subjects. Below it passes over Poupart's ligament, and is continuous with the outer layer of the superficial fascia of the thigh. In the male this fascia is continued over the penis and outer surface of the cord to the scrotum, where it helps to form the dartos. As it passes to the scrotum it changes its character, becoming thin, destitute of adipose tissue, and of a pale reddish color, and in the scrotum it acquires some involuntary muscular fibres. From the scrotum it may be traced backward to be continuous with the superficial fascia of the perinæum. In the female this fascia is continued into the labia majora. The deeper layer (*fascia of Scarpa*) is thinner and more membranous in character than the superficial layer. In the middle line it is intimately adherent to the linea alba and to the symphysis pubis, and is prolonged on to the dorsum of the penis, forming the suspensory ligament; above, it is continuous with the superficial fascia over the rest of the trunk; below, it blends with the fascia lata of the thigh a little below Poupart's ligament; and below and internally it is continued over the penis and spermatic cord to the scrotum, where it helps to form the dartos. From the scrotum it may be traced backward to be continuous with the deep layer of the superficial fascia of the perinæum. In the female it is continued into the labia majora.

The **External** or **Descending Oblique muscle** (Fig. 218) is situated on the side and fore part of the abdomen; being the largest and the most superficial of the three flat muscles in this region. It is broad, thin, and irregularly quadrilateral, its muscular portion occupying the side, its aponeurosis the anterior wall, of the

abdomen. It arises, by eight fleshy digitations, from the external surface and lower borders of the eight inferior ribs; these digitations are arranged in an oblique line running downward and backward; the upper ones being attached close to the cartilages of the corresponding ribs; the lowest, to the apex of the cartilage of the last rib; the intermediate ones, to the ribs at some distance from their cartilages. The five superior serrations increase in size from above downward, and are received between corresponding processes of the Serratus magnus; the three lower ones diminish in size from above downward, receiving between them corresponding processes from the Latissimus dorsi. From these attachments, the fleshy fibres proceed in various directions. Those from the lowest ribs pass nearly vertically downward, to be inserted into the anterior half of the outer lip of the crest of the ilium; the middle and upper fibres, directed downward and forward, terminate in an aponeurosis, opposite a line drawn from the prominence of the ninth costal cartilage to the anterior superior spinous process of the ilium.

The **Aponeurosis of the External Oblique** is a thin, but strong membranous aponeurosis, the fibres of which are directed obliquely downward and inward. It is joined with that of the opposite muscle along the median line, covers the whole of the front of the abdomen; above, it is connected with the lower border of the Pectoralis major; below, its fibres are closely aggregated together, and extend obliquely across from the anterior superior spine of the ilium to the spine of the os pubis and the lines ilio-pectinea. In the median line it interlaces with the aponeurosis of the opposite muscle, forming the linea alba, which extends from the ensiform cartilage to the symphysis pubis.

That portion of the aponeurosis which extends between the anterior superior spine of the ilium and the spine of the os pubis is a broad band, folded inward, and continuous below with the fascia lata; it is called *Poupart's ligament*. The portion which is reflected from Poupart's ligament at the spine of the os pubis along the pectineal line is called *Gimbernat's ligament*. From the point of attachment of the latter to the pectineal line, a few fibres pass upward and inward, behind the inner pillar of the ring, to the linea alba. They diverge as they ascend, and form a thin, triangular, fibrous layer, which is called the *triangular fascia of the abdomen*.

In the aponeurosis of the External oblique, immediately above the crest of the os pubis, is a triangular opening, the *external abdominal ring*, formed by a separation of the fibres of the aponeurosis in this situation.

Relations.—By its *external surface*, with the superficial fascia, superficial epigastric and circumflex iliac vessels, and some cutaneous nerves; by its *internal surface*, with the Internal oblique, the lower part of the eight inferior ribs, and Intercostal muscles, the Cremaster, the spermatic cord in the male, and round ligament in the female. Its *posterior border*, extending from the last rib to the crest of the ilium, is fleshy throughout and free; it is occasionally overlapped by the Latissimus dorsi, though generally a triangular interval exists between the two muscles near the crest of the ilium, in which is seen a portion of the internal oblique. This triangle, *Petit's triangle*, is therefore bounded in front by the External oblique, behind by the Latissimus dorsi, below by the crest of the ilium, while its floor is formed by the Internal oblique (Fig. 213).

The following parts of the aponeurosis of the External oblique muscle require to be further described: viz., the external abdominal ring, the intercolumnar fibres and fascia, Poupart's ligament, Gimbernat's ligament, and the triangular fascia of the abdomen.

The External Abdominal Ring.—Just above and to the outer side of the crest of the os pubis an interval is seen in the aponeurosis of the External oblique, called the *External Abdominal Ring*. The aperture is oblique in direction, somewhat triangular in form, and corresponds with the course of the fibres of the aponeurosis. It usually measures from base to apex about an inch, and transversely about half an inch. It is bounded below by the crest of the os pubis; above, by a series of curved fibres, the *intercolumnar*, which pass across

the upper angle of the ring, so as to increase its strength; and on each side, by the margins of the opening in the aponeurosis, which are called the columns or pillars of the ring.

The external pillar, which is at the same time inferior from the obliquity of its direction, is the stronger: it is formed by that portion of Poupart's ligament which is inserted into the spine of the os pubis; it is curved so as to form a kind of groove, upon which the spermatic cord rests. The internal or superior pillar

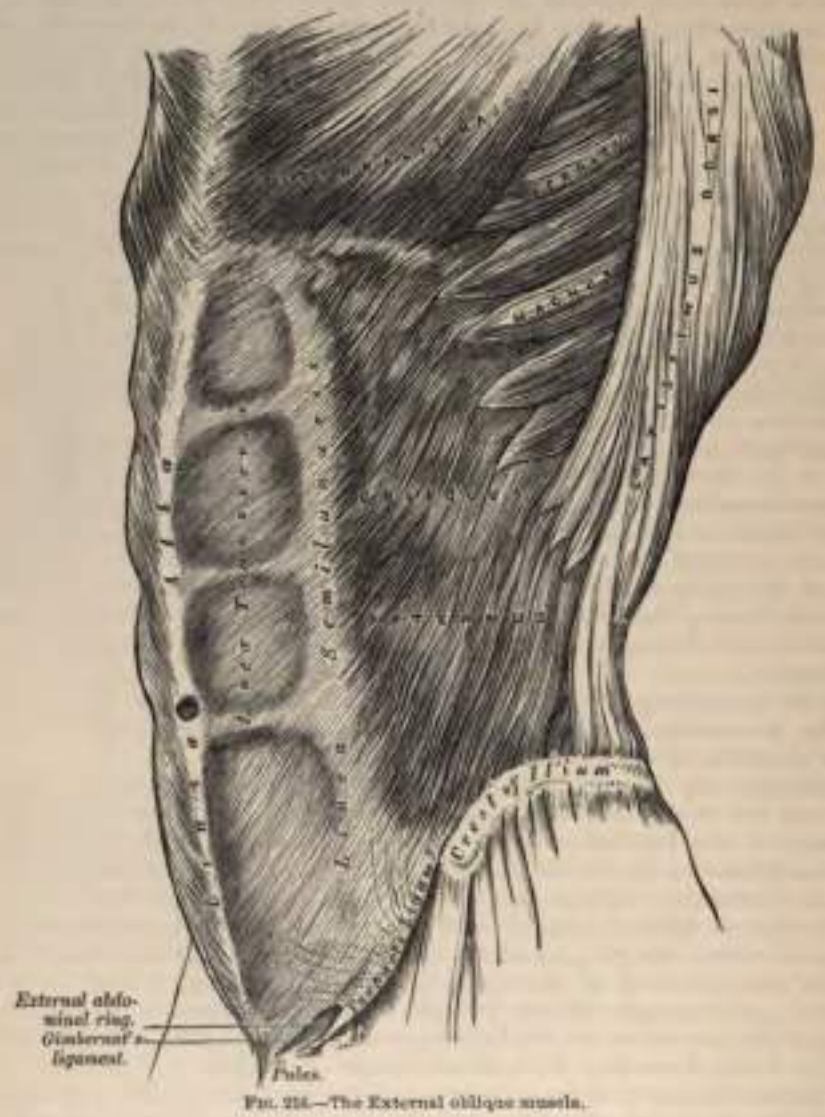


FIG. 258.—The External oblique muscle.

is a broad, thin, flat band which is attached to the front of the symphysis pubis, interlacing with its fellow of the opposite side, that of the right side being superficial.

The external abdominal ring gives passage to the spermatic cord in the male, and round ligament in the female; it is much larger in men than in women, on account of the large size of the spermatic cord, and hence the greater frequency of inguinal hernia in men.

The **intercolumnar fibres** are a series of curved tendinous fibres, which arch

across the lower part of the aponeurosis of the External oblique. They have received their name from stretching across between the two pillars of the external ring, describing a curve with the convexity downward. They are much thicker and stronger at the outer margin of the external ring, where they are connected to the outer third of Poupart's ligament, than internally, where they are inserted into the linea alba. They are more strongly developed in the male than in the female. The intercolumnar fibres increase the strength of the lower part of the aponeurosis, and prevent the divergence of the pillars from one another.

These intercolumnar fibres as they pass across the external abdominal ring are themselves connected together by delicate fibrous tissue, thus forming a fascia, which as it is attached to the pillars of the ring covers it in, and is called the *intercolumnar fascia*. This **intercolumnar fascia** is continued down as a tubular prolongation around the outer surface of the cord and testis, and encloses them in a distinct sheath; hence it is also called the external spermatic fascia.

The sac of an inguinal hernia, in passing through the external abdominal ring, receives an investment from the intercolumnar fascia.

If the finger is introduced a short distance into the external abdominal ring and the limb is then extended and rotated outward, the aponeurosis of the External oblique, together with the iliac portion of the fascia lata, will be felt to become tense, and the external ring much contracted; if the limb is on the contrary flexed upon the pelvis and rotated inward, this aponeurosis will become lax and the external abdominal ring sufficiently enlarged to admit the finger with comparative ease: hence the patient should always be put in the latter position when the taxis is applied for the reduction of an inguinal hernia in order that the abdominal walls may be relaxed as much as possible.

Poupart's ligament, or the **crural arch,** is the lower border of the aponeurosis of the External oblique muscle, and extends from the anterior superior spine of the ilium to the pubic spine. From this latter point it is reflected outward to be attached to the pectineal line for about half an inch, forming Gimbernat's ligament. Its general direction is curved downward toward the thigh, where it is continuous with the fascia lata. Its outer half is rounded and oblique in direction. Its inner half gradually widens at its attachment to the os pubis, is more horizontal in direction, and lies beneath the spermatic cord.

Nearly the whole of the space included between the crural arch and the innominate bone is filled in by the parts which descend from the abdomen into the thigh. These will be referred to again on a subsequent page.

Gimbernat's ligament is that part of the aponeurosis of the External oblique muscle which is reflected upward and outward from the spine of the os pubis to be inserted into the pectineal line. It is about half an inch in length, larger in the male than in the female, almost horizontal in direction in the erect posture, and of a triangular form with the base directed outward. Its base, or outer margin, is concave, thin, and sharp, and lies in contact with the crural sheath, forming the inner boundary of the femoral ring. Its apex corresponds to the spine of the os pubis. Its posterior margin is attached to the pectineal line, and is continuous with the pubic portion of the fascia lata. Its anterior margin is continuous with Poupart's ligament. Its surfaces are directed upward and downward.

The **triangular fascia** of the abdomen is a layer of tendinous fibres of a triangular shape, which is attached by its apex to the pectineal line, where it is continuous with Gimbernat's ligament. It passes inward beneath the spermatic cord, and expands into a somewhat fan-shaped fascia, lying behind the inner pillar of the external abdominal ring, and in front of the conjoined tendon, and interlaces with the ligament of the other side at the linea alba.

Ligament of Cooper.—This is a strong ligamentous band, which was first described by Sir Astley Cooper. Its extends upward and backward from the base of Gimbernat's ligament along the ilio-pectineal line, to which it is attached. It is strengthened by the fascia transversalis, by the pectineal aponeurosis, and by a

lateral expansion from the lower attachment of the linea alba (adminiculum lineæ albæ).

Dissection.—Detach the External oblique by dividing it across, just in front of its attachment to the ribs, as far as its posterior border, and separate it below from the crest of the ilium as far as the anterior superior spine; then separate the muscle carefully from the Internal oblique, which lies beneath, and turn it toward the opposite side.

The **Internal** or **Ascending oblique muscle** (Fig. 219), thinner and smaller than the preceding, beneath which it lies, is of an irregularly quadrilateral form,

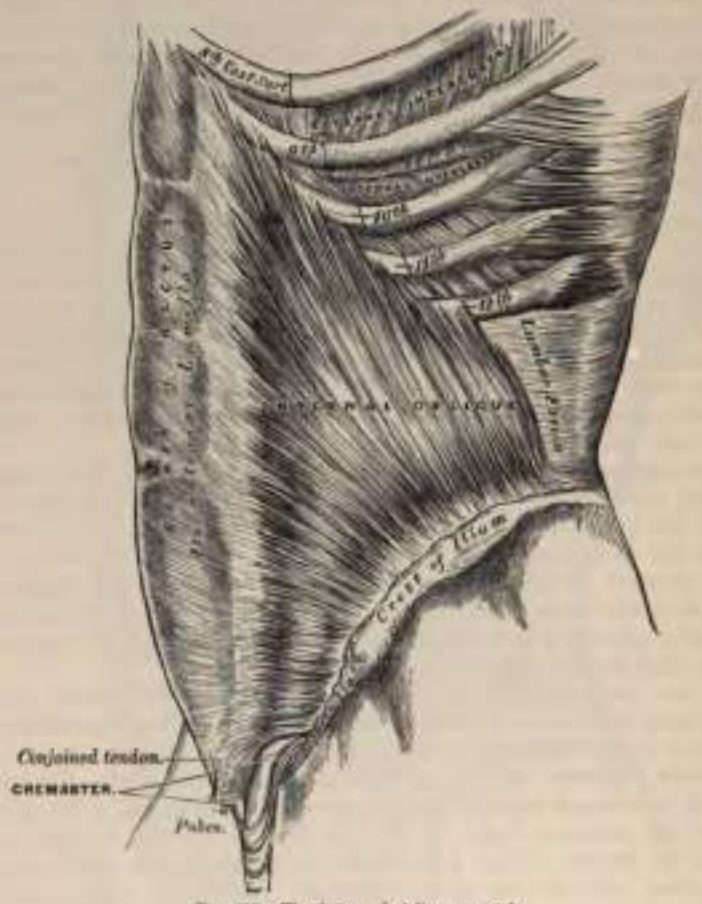


FIG. 219.—The internal oblique muscle.

and situated at the side and fore part of the abdomen. It arises, by fleshy fibres, from the outer half of Poupart's ligament, being attached to the groove on its upper surface; from the anterior two-thirds of the middle lip of the crest of the ilium, and from the posterior lamella of the lumbar fascia. From this origin the fibres diverge: those from Poupart's ligament, few in number and paler in color than the rest, arch downward and inward across the spermatic cord in the male and the round ligament in the female, and, becoming tendinous, are inserted, conjointly with those of the Transversalis, into the crest of the os pubis and pectineal line, to the extent of half an inch, forming what is known as the conjoined tendon of the Internal oblique and Transversalis; those from the anterior third of the iliac origin are horizontal in their direction, and, becoming tendinous along the lower fourth of the linea semilunaris, pass in front of the Rectus muscle to be inserted into the linea alba; those which arise from the middle third of the origin from the crest of the ilium pass obliquely upward and inward, and terminate in an aponeurosis

which divides at the outer border of the Rectus muscle into two lamellæ, which are continued forward, in front and behind this muscle, to the linea alba, the posterior lamella being also connected to the cartilages of the seventh, eighth, and ninth ribs; the most posterior fibres pass almost vertically upward, to be inserted into the lower borders of the cartilages of the three lower ribs, being continuous with the Internal intercostal muscles.

The conjoined tendon of the Internal oblique and Transversalis is inserted into the crest of the os pubis and pectineal line, immediately behind the external abdominal ring, serving to protect what would otherwise be a weak point in the abdominal wall. Sometimes this tendon is insufficient to resist the pressure from within, and is carried forward in front of the protrusion through the external ring, forming one of the coverings of direct inguinal hernia; or the hernia forces its way through the fibres of the conjoined tendon. The conjoined tendon is sometimes divided into an outer and an inner portion—the former being termed the *ligament of Hesselbach*; the latter, the *ligament of Henle*.

The aponeurosis of the Internal oblique is continued forward to the middle line of the abdomen, where it joins with the aponeurosis of the opposite muscle at the linea alba, and extends from the margin of the thorax to the os pubis. At the outer margin of the Rectus muscle this aponeurosis, for the upper three-fourths of its extent, divides into two lamellæ, which pass, one in front and the other behind the muscle, enclosing it in a kind of sheath, and reuniting on its inner border at the linea alba; the anterior layer is blended with the aponeurosis of the External oblique muscle; the posterior layer with that of the Transversalis. Along the lower fourth the aponeurosis passes altogether in front of the Rectus without any separation. Where the aponeurosis ceases to split, and passes altogether in front of the Rectus muscle, a deficiency is left in the sheath of the muscle behind; this is marked above by a sharp lunated margin having its concavity downward. This is known as the *semilunar fold of Douglas*.

Relations.—By its *external surface*, with the External oblique, Latissimus dorsi, spermatic cord, and external ring; by its *internal surface*, with the Transversalis muscle, the lower intercostal vessels and nerves, the ilio-hypogastric and the ilio-inguinal nerves. Near Poupart's ligament it lies on the fascia transversalis, internal ring, and spermatic cord. Its lower border forms the upper boundary of the inguinal canal.

The **Cremaster muscle** is a thin, muscular layer, composed of a number of fasciculi which arise from the inner part of Poupart's ligament, where its fibres are continuous with those of the Internal oblique and also occasionally with the Transversalis. It passes along the outer side of the spermatic cord, descends with it through the external abdominal ring upon the front and sides of the cord, and forms a series of loops which differ in thickness and length in different subjects. Those at the upper part of the cord are exceedingly short, but they become in succession longer and longer, the longest reaching down as low as the testicle, where a few are inserted into the tunica vaginalis. These loops are united together by areolar tissue, and form a thin covering over the cord and testis, the *fascia cremasterica*. The fibres ascend along the inner side of the cord, and are inserted by a small pointed tendon into the crest of the os pubis and front of the sheath of the Rectus muscle.

It will be observed that the origin and insertion of the Cremaster is precisely similar to that of the lower fibres of the Internal oblique. This fact affords an easy explanation of the manner in which the testicle and cord are invested by this muscle. At an early period of fœtal life the testis is placed at the lower and back part of the abdominal cavity, but during its descent toward the scrotum, which takes place before birth, it passes beneath the arched fibres of the Internal oblique. In its passage beneath this muscle some fibres are derived from its lower part which accompany the testicle and cord into the scrotum. It occasionally happens that the loops of the Cremaster surround the cord, some lying behind as well as in

front. It is probable that under these circumstances the testis, in its descent, passed through instead of beneath the fibres of the Internal oblique.

In the descent of an oblique inguinal hernia, which takes the same course as the spermatic cord, the Cremaster muscle forms one of its coverings. This muscle becomes largely developed in cases of hydrocele and large old scrotal hernia. The Cremaster muscle is found only in the male, but almost constantly in the female a few muscular fibres may be seen on the surface of the round ligament, which correspond to this muscle, and in cases of oblique inguinal hernia in the female a considerable amount of muscular fibre may be found covering the sac.

Dissection.—Detach the Internal oblique in order to expose the Transversalis beneath. This may be effected by dividing the muscle, above, at its attachment to the ribs; below, at its connection with Poupart's ligament and the crest of the ilium; and behind, by a vertical incision extending from the last rib to the crest of the ilium. The muscle should previously be made tense by drawing upon it with the fingers of the left hand, and if its division is carefully effected, the cellular interval between it and the Transversalis, as well as the direction of the fibres of the latter muscle, will afford a clear guide to their separation; along the crest of the ilium the circumflex iliac vessels are interposed between them, and form an important guide in separating them. The muscle should then be thrown inward toward the linea alba.

The **Transversalis muscle** (Fig. 220), so called from the direction of its fibres, is the most internal flat muscle of the abdomen, being placed immediately beneath the Internal oblique. It arises by fleshy fibres from the outer third of Poupart's ligament; from the inner lip of the crest of the ilium for its anterior three-fourths; from the inner surface of the cartilages of the six lower ribs, interdigitating with the Diaphragm; and from the lumbar fascia, which may be regarded as the posterior aponeurosis of the muscle. (See page 342.) The muscle terminates in front in a broad aponeurosis, the lower fibres of which curve downward and inward, and are inserted, together with those of the Internal oblique, into the lower part of the linea alba, the crest of the os pubis and pectineal line forming what is known as the conjoined tendon of the Internal oblique and Transversalis. Throughout the rest of its extent the aponeurosis passes horizontally inward, and is inserted into the linea alba, its upper three-fourths passing behind the Rectus muscle, blending with the posterior lamella of the Internal oblique; its lower fourth passing in front of the Rectus.

Relations.—By its *external surface*, with the Internal oblique, the lower intercostal nerves, and the inner surface of the cartilages of the lower ribs; by its *internal surface*, with the fascia transversalis, which separates it from the peritoneum. Its lower border forms the upper boundary of the inguinal canal.

Dissection.—To expose the Rectus muscle, open its sheath by a vertical incision extending from the margin of the thorax to the os pubis, and then reflect the two portions from the surface of the muscle, which is easily done, excepting at the lineæ transversæ, where so close an adhesion exists that the greatest care is requisite in separating them. Now raise the outer edge of the muscle, in order to examine the posterior layer of the sheath. By dividing the muscle in the centre, and turning its lower part downward, the point where the posterior wall of the sheath terminates in a thin curved margin will be seen.

The **Rectus abdominis** is a long flat muscle, which extends along the whole length of the front of the abdomen, being separated from its fellow of the opposite side by the linea alba. It is much broader, but thinner, above than below, and arises by two tendons, the external or larger being attached to the crest of the os pubis, the internal, smaller portion interlacing with its fellow of the opposite side, and being connected with the ligaments covering the front of the symphysis pubis. The fibres ascend, and the muscle is inserted by three portions of unequal size into the cartilages of the fifth, sixth, and seventh ribs. The upper portion, attached principally to the cartilage of the fifth rib, usually has some fibres of insertion into the anterior extremity of the rib itself. Some fibres are occasionally connected with the costo-xiphoid ligaments and side of the ensiform cartilage.

The Rectus muscle is traversed by tendinous intersections, three in number.

which have received the name of *lineæ transversæ*. One of these is usually situated opposite the umbilicus, and two above that point; of the latter, one corresponds to the extremity of the ensiform cartilage, and the other to the interval between the ensiform cartilage and the umbilicus. These intersections pass transversely or obliquely across the muscle in a zigzag course; they rarely extend completely through its substance, sometimes pass only halfway across

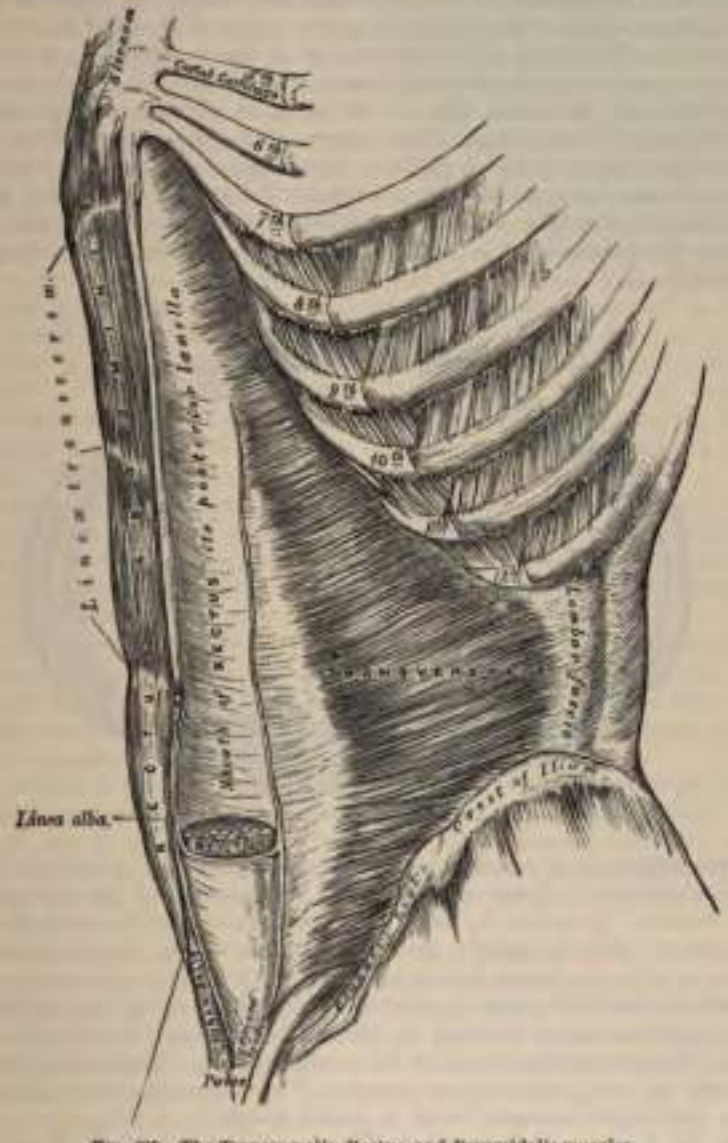


FIG. 220.—The Transversalis, Rectus, and Pyramidalis muscles.

it, and are intimately adherent in front to the sheath in which the muscle is enclosed. Sometimes one or two additional lines may be seen, one usually below the umbilicus; the position of the other, when it exists, is variable. These additional lines are for the most part incomplete.

The Rectus is enclosed in a sheath (Fig. 221) formed by the aponeuroses of the Oblique and Transversalis muscles, which are arranged in the following manner. When the aponeurosis of the Internal oblique arrives at the outer margin of the Rectus, it divides into two lamellæ, one of which passes in front of the Rectus,

blending with the aponeurosis of the External oblique; the other, behind it, blending with the aponeurosis of the Transversalis; and these, joining again at its inner border, are inserted into the linea alba. This arrangement of the aponeuroses exists along the upper three-fourths of the muscle: at the commencement of the lower fourth, the posterior wall of the sheath terminates in a thin curved margin, the *semilunar fold of Douglas*, the concavity of which looks downward toward the pubes; the aponeuroses of all three muscles passing in front of the Rectus without any separation. The extremities of the fold of Douglas descend as pillars to the os pubis. The inner pillar is attached to the symphysis pubis; the outer pillar, which is named by Braune the ligament of Hesselbach, passes downward as a distinct band on the inner side of the internal abdominal ring, and there its fibres divide into two sets, internal and external; the internal fibres are attached to the ascending ramus of the os pubis and the pectineal fascia; the external ones pass to the Psoas fascia, to the deep surface of Poupart's ligament, and to the tendon of the Transversalis on the outer side of the ring. The Rectus muscle, in the situation where its sheath is deficient, is separated from the peritoneum by the transversalis fascia.

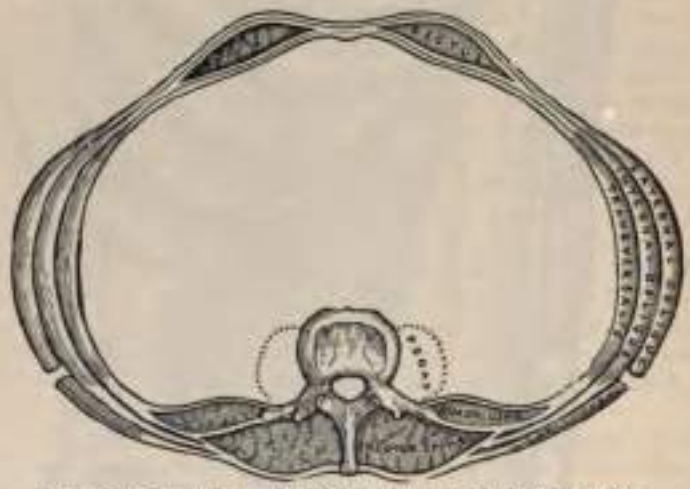


FIG. 221.—A transverse section of the abdomen in the lumbar region.

The **Pyramidalis** is a small muscle, triangular in shape, placed at the lower part of the abdomen, in front of the Rectus, and contained in the same sheath with that muscle. It arises by tendinous fibres from the front of the os pubis and the anterior pubic ligament; the fleshy portion of the muscle passes upward, diminishing in size as it ascends, and terminates by a pointed extremity, which is inserted into the linea alba, midway between the umbilicus and the os pubis. This muscle is sometimes found wanting on one or both sides; the lower end of the Rectus then becomes proportionately increased in size. Occasionally it has been found double on one side, or the muscles of the two sides are of unequal size. Sometimes its length exceeds what is stated above.

Besides the Rectus and Pyramidalis muscles, the sheath of the Rectus contains the superior and deep epigastric arteries, the terminations of the lumbar arteries and of the lower intercostal arteries and nerves.

Nerves.—The abdominal muscles are supplied by the lower intercostal nerves. The Transversalis and Internal oblique also receive filaments from the hypogastric branch of the ilio-hypogastric and sometimes from the ilio-inguinal. The Cremaster is supplied by the genital branch of the Genito-crural.

In the description of the abdominal muscles mention has frequently been made of the linea albæ, lineæ semilunares, and lineæ transversæ; when the dissection of the muscles is completed these structures should be examined.

The **linea alba** is a tendinous raphé seen along the middle line of the abdomen, extending from the ensiform cartilage to the symphysis pubis, to which it is attached. It is placed between the inner borders of the Recti muscles, and is formed by the blending of the aponeuroses of the Obliqui and Transversales muscles. It is narrow below, corresponding to the narrow interval existing between the Recti; but broader above, as these muscles diverge from one another in their ascent, becoming of considerable breadth after great distension of the abdomen from pregnancy or ascites. It presents numerous apertures for the passage of vessels and nerves: the largest of these is the umbilicus, which in the fœtus transmits the umbilical vessels, but in the adult is obliterated, the cicatrix being stronger than the neighboring parts; hence umbilical hernia occurs in the adult *near* the umbilicus, whilst in the fœtus it occurs *at* the umbilicus. The linea alba is in relation, in front, with the integument, to which it is adherent, especially at the umbilicus; behind, it is separated from the peritoneum by the transversalis fascia; and below, by the urachus, and the bladder when that organ is distended.

The **lineæ semilunares** are two curved tendinous lines placed one on each side of the linea alba. Each corresponds with the outer border of the Rectus muscle, extends from the cartilage of the ninth rib to the pubic spine, and is formed by the aponeurosis of the Internal oblique at its point of division to enclose the Rectus, where it is reinforced in front by the External oblique and behind by the Transversalis.

The **lineæ transversæ** are narrow transverse lines which intersect the Recti muscles, as already mentioned; they connect the lineæ semilunares with the linea alba.

Actions.—The abdominal muscles perform a threefold action:

When the pelvis and thorax are fixed, they compress the abdominal viscera, by constricting the cavity of the abdomen, in which action they are materially assisted by the descent of the diaphragm. By these means the fœtus is expelled from the uterus, the fæces from the rectum, the urine from the bladder, and the contents of the stomach in vomiting.

If the pelvis and spine are fixed, these muscles compress the lower part of the thorax, materially assisting expiration. If the pelvis alone is fixed, the thorax is bent directly forward when the muscles of both sides act, or to either side when those of the two sides act alternately, rotation of the trunk at the same time taking place to the opposite side.

If the thorax is fixed, these muscles, acting together, draw the pelvis upward, as in climbing; or, acting singly, they draw the pelvis upward, and bend the vertebral column to one side or the other. The Recti muscles, acting from below, depress the thorax, and consequently flex the vertebral column; when acting from above, they flex the pelvis upon the vertebral column. The Pyramidales are tensors of the linea alba.

The **fascia transversalis** is a thin aponeurotic membrane which lies between the inner surface of the Transversalis muscle and the extra-peritoneal fat. It forms part of the general layer of fascia which lines the interior of the abdominal and pelvic cavities, and is directly continuous with the iliac and pelvic fasciæ. In the inguinal region the transversalis fascia is thick and dense in structure, and joined by fibres from the aponeurosis of the Transversalis muscle, but it becomes thin and cellular as it ascends to the Diaphragm, and blends with the fascia covering this muscle. In front, it unites across the middle line with the fascia on the opposite side of the body, and behind it becomes lost in the fat which covers the posterior surfaces of the kidneys. Below, it has the following attachments: posteriorly, it is connected to the whole length of the crest of the ilium, between the attachments of the Transversalis and Iliacus muscles; between the anterior superior spine of the ilium and the femoral vessels it is connected to the posterior margin of Poupart's ligament, and is there continuous with the iliac fascia. Internal to the femoral vessels it is thin and attached to the os pubis and pectineal line, behind the conjoined tendon, with which it is united; and, corresponding to the point where the femoral vessels pass into the thigh, this fascia descends in

front of them, forming the anterior wall of the crural sheath. Beneath Poupart's ligament it is strengthened by a band of fibrous tissue, which is only loosely connected to Poupart's ligament, and is specialized as the *deep crural arch*. The spermatic cord in the male and the round ligament in the female pass through this fascia; the point where they pass through is called the *internal abdominal ring*. This opening is not visible externally, owing to a prolongation of the transversalis fascia on these structures, forming the *infundibuliform fascia*.

The **internal** or **deep abdominal ring** is situated in the transversalis fascia, midway between the anterior superior spine of the ilium and the symphysis pubis, and about half an inch above Poupart's ligament. It is of an oval form, the extremities of the oval directed upward and downward, varies in size in different subjects, and is much larger in the male than in the female. It is bounded, above and externally, by the arched fibres of the Transversalis; below and internally, by the deep epigastric vessels. It transmits the spermatic cord in the male and the round ligament in the female. From its circumference a thin funnel-shaped membrane, the *infundibuliform fascia*, is continued round the cord and testis, enclosing them in a distinct pouch.

When the sac of an oblique inguinal hernia passes through the internal or deep abdominal ring, the infundibuliform process of the transversalis fascia forms one of its coverings.

The **inguinal** or **spermatic canal** contains the spermatic cord in the male and the round ligament in the female. It is an oblique canal about an inch and a half in length, directed downward and inward, and placed parallel to and a little above Poupart's ligament. It commences above at the internal or deep abdominal ring, which is the point where the cord enters the spermatic canal, and terminates below at the external ring. It is bounded in front by the integument and superficial fascia, by the aponeurosis of the External oblique throughout its whole length, and by the Internal oblique for its outer third; behind, by the triangular fascia, the conjoined tendon of the Internal oblique and Transversalis, transversalis fascia, and the subperitoneal fat and peritoneum; above, by the arched fibres of the Internal oblique and Transversalis; below, by Gimbernat's ligament, and by the union of the fascia transversalis with Poupart's ligament. The deep epigastric artery passes upward and inward behind the canal lying close to the inner side of the internal abdominal ring. The interval between this artery and the outer edge of the Rectus is named Hesselbach's triangle, the base of which is formed by Poupart's ligament.

That form of protrusion in which the intestine follows the course of the spermatic cord along the spermatic canal is called oblique inguinal hernia.

The Deep Crural Arch.—Curving over the vessels, just at the point where they become femoral, on the abdominal side of Poupart's ligament and loosely connected with it, is a thickened band of fibres called the deep crural arch. It is apparently a thickening of the fascia transversalis, joining externally to the centre of Poupart's ligament, and arching across the front of the crural sheath to be inserted by a broad attachment into the spine of the os pubis and ilio-pectineal line, behind the conjoined tendon. In some subjects this structure is not very prominently marked, and not infrequently it is altogether wanting.

Surface Form.—The only two muscles of this group which have any considerable influence on surface form are the External oblique and Rectus muscles of the abdomen. With regard to the External oblique, the upper digitations of its origin from the ribs are well marked, intermingled with the serrations of the Serratus magnus; the lower digitations are not visible, being covered by the thick border of the Latissimus dorsi. Its attachment to the crest of the ilium, in conjunction with the Internal oblique, forms a thick oblique roll, which determines the iliac furrow. Sometimes on the front of the lateral region of the abdomen an undulating outline marks the spot where the muscular fibres terminate and the aponeurosis commences. The outer border of the Rectus is defined by the *linea semilunaris*, which may be exactly defined by putting the muscle into action. It corresponds with a curved line, with its convexity outward, drawn from the end of the cartilage of the ninth rib to the spine of the os pubis, so that the centre of the line, at or near the umbilicus, is three inches from the median line. The

inner border of the Rectus corresponds to the *linea alba*, marked on the surface of the body by a groove, the *abdominal furrow*, which extends from the infrasternal fossa to, or to a little below, the umbilicus, where it gradually becomes lost. The surface of the Rectus presents three transverse furrows, the *lineæ transversæ*. The upper two of these, one opposite or a little below the tip of the ensiform cartilage, and another, midway between this point and the umbilicus, are usually well marked; the third, opposite the umbilicus, is not so distinct. The umbilicus, situated in the linea alba, varies very much in position as regards its height. It is always situated above a zone drawn round the body opposite the highest point of the crest of the ilium, generally being about three-quarters of an inch to an inch above this line. It generally corresponds, therefore, to the fibro-cartilage between the third and fourth lumbar vertebræ.

2. Deep Muscles of the Abdomen.

Psoas magnus.	Iliacus.
Psoas parvus.	Quadratus lumborum.

The Psoas magnus, the Psoas parvus, and the Iliacus muscles, with the fascia covering them, will be described with the Muscles of the Lower Extremity.

The Fascia covering the Quadratus Lumborum.—This is the most anterior of the three layers of the lumbar fascia. It is a thin layer of fascia, which, passing over the anterior surface of the Quadratus lumborum, is attached, internally, to the bases of the transverse processes of the lumbar vertebræ; below, to the ilio-lumbar ligament; and above, to the apex and lower border of the last rib.

The portion of this fascia which extends from the transverse process of the first lumbar vertebra to the apex and lower border of the last rib constitutes the ligamentum arcuatum externum.

The **Quadratus lumborum** (Fig. 214, page 344) is situated in the lumbar region. It is irregularly quadrilateral in shape, and broader below than above. It arises by aponeurotic fibres from the ilio-lumbar ligament and the adjacent portion of the crest of the ilium for about two inches, and is inserted into the lower border of the last rib for about half its length, and by four small tendons, into the apices of the transverse processes of the four upper lumbar vertebræ. Occasionally a second portion of this muscle is found situated in front of the preceding. This arises from the upper borders of the transverse processes of three or four of the lower lumbar vertebræ, and is inserted into the lower margin of the last rib. The Quadratus lumborum is contained in a sheath formed by the anterior and middle lamellæ of the lumbar fasciæ.

Relations.—Its *anterior surface* (or rather the fascia which covers its anterior surface) is in relation with the colon, the kidney, the Psoas muscle, and the Diaphragm. Between the fascia and the muscle are the last dorsal, ilio-hypogastric, and ilio-inguinal nerves. Its *posterior surface* is in relation with the middle lamella of the lumbar fascia, which separates it from the Erector spinæ. The Quadratus lumborum extends, however, beyond the outer border of the Erector spinæ.

Nerve-supply.—The anterior branches of the last dorsal and first lumbar nerves; sometimes also a branch from the second lumbar nerve.

Actions.—The Quadratus lumborum draws down the last rib, and acts as a muscle of inspiration by helping to fix the origin of the Diaphragm. If the thorax and spine are fixed, it may act upon the pelvis, raising it toward its own side when only one muscle is put in action; and when both muscles act together, either from below or above, they flex the trunk.

IV. MUSCLES OF THE PELVIC OUTLET.

The muscles of this region are situated at the pelvic outlet in the ischio-rectal region and the perinæum. They include the following:

I. Muscles of the ischio-rectal region.

II. Muscles of the perinæum: A. In the Male; B. In the Female.

I. Muscles of the Ischio-rectal Region.

Corrugator cutis ani. — Internal sphincter ani.
External sphincter ani. — Levator ani.
Coccygeus.

The Corrugator Cutis Ani.—Around the anus is a thin stratum of involuntary muscular fibre, which radiates from the orifice. Internally, the fibres fade off into the submucous tissue, while externally they blend with the true skin. By its contraction it raises the skin into ridges around the margin of the anus.

The **External sphincter ani** is a thin, flat plane of muscular fibres, elliptical in shape and intimately adherent to the integument surrounding the margin of the anus. It measures about three or four inches in length from its anterior to its posterior extremity, being about an inch in breadth opposite the anus. It arises from the tip and back of the coccyx by a narrow tendinous band, and from the superficial fascia in front of that bone; and is inserted into the central tendinous point of the perinæum, joining with the Transversus perinæi, the Levator ani, and the Accelerator urinæ. Like other sphincter muscles, it consists of two planes of muscular fibre, which surround the margin of the anus and join in a commissure in front and behind, some fibres crossing from side to side in front and behind the anus.

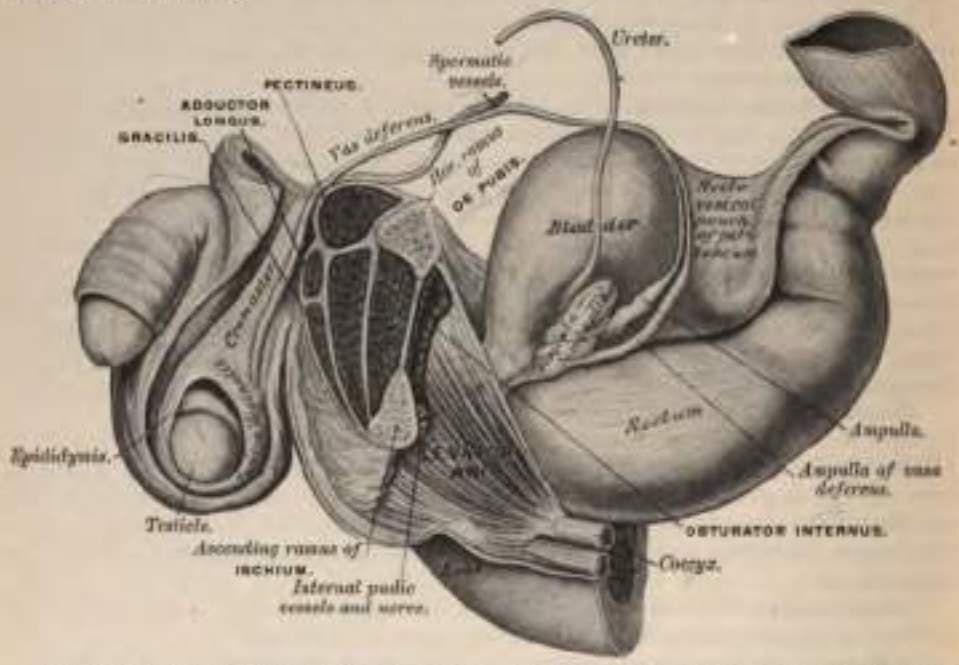


Fig. 222.—Side view of pelvis, showing Levator ani. (From a preparation in the Museum of the Royal College of Surgeons.)

Nerve-supply.—A branch from the anterior division of the fourth sacral and the inferior hæmorrhoidal branch of the internal pudic.

Actions.—The action of this muscle is peculiar: 1. It is, like other muscles, always in a state of tonic contraction, and having no antagonistic muscle, it keeps the anal orifice closed. 2. It can be put into a condition of greater contraction under the influence of the will, so as to occlude more firmly the anal aperture in expiratory efforts unconnected with defecation. 3. Taking its fixed point at the coccyx, it helps to fix the central point of the perinæum, so that the Accelerator urinæ may act from this fixed point.

The **Internal sphincter ani** is a muscular ring which surrounds the lower

extremity of the rectum for about an inch, its inferior border being contiguous to, but quite separate from, the External sphincter. This muscle is about two lines in thickness, and is formed by an aggregation of the involuntary circular fibres of the intestine. It is paler in color and less coarse in texture than the External sphincter.

Actions.—Its action is entirely involuntary. It helps the External sphincter to occlude the anal aperture.

The **Levator ani** (Fig. 222) is a broad, thin muscle, situated on each side of the pelvis. It is attached to the inner surface of the sides of the true pelvis, and descending, unites with its fellow of the opposite side to form the floor of the pelvic cavity. It supports the viscera in this cavity and surrounds the various structures which pass through it. It arises, in front, from the posterior surface of the body of the os pubis on the outer side of the symphysis; posteriorly, from the inner surface of the spine of the ischium; and between these two points, from the angle of division between the obturator and recto-vesical layers of the pelvic fascia at their under part. The fibres pass downward to the middle line of the floor of the pelvis, and are inserted, the most posterior into the sides of the apex of the coccyx; those placed more anteriorly unite with the muscles of the opposite side in a median fibrous raphé, which extends between the coccyx and the margin of the anus. The middle fibres, which form the larger portion of the muscle, are inserted into the side of the rectum, blending with the fibres of the Sphincter muscles; lastly, the anterior fibres, the longest, descend upon the side of the prostate gland to unite beneath it with the muscle of the opposite side, blending with the fibres of the External sphincter and Transversus perinæi muscles at the central tendinous point of the perinæum.

The anterior portion is occasionally separated from the rest of the muscle by connective tissue. From this circumstance, as well as from its peculiar relation with the prostate gland, descending by its side, and surrounding it as in a sling, it has been described by Santorini and others as a distinct muscle, under the name of Levator prostatæ. In the female, the anterior fibres of the Levator ani descend upon the side of the vagina.

Relations.—By its *inner* or *pelvic surface*, with the recto-vesical fascia, which separates it from the viscera of the pelvis and from the peritoneum. By its *outer* or *perineal surface*, it forms the inner boundary of the ischio-rectal fossa, and is covered by a thin layer of fascia, the *ischio-rectal* or *anal fascia*, given off from the obturator fascia. Its *posterior border* is free and separated from the Coccygeus muscle by a cellular interspace. Its *anterior border* is separated from the muscle of the opposite side by a triangular space, through which the urethra, and in the female the vagina, passes from the pelvis.

Nerve-supply.—A branch from the anterior division of the fourth sacral nerve and a branch from the pudic nerve, which is sometimes derived from the perineal, sometimes from the inferior hæmorrhoidal division.

Actions.—This muscle supports the lower end of the rectum and vagina, and also the bladder during the efforts of expulsion. It elevates and inverts the lower end of the rectum after it has been protruded and everted during the expulsion of the fæces. It is also a muscle of forced expiration.

The **Coccygeus** is situated behind and parallel with the preceding. It is a triangular plane of muscular and tendinous fibres, arising, by its apex, from the spine of the ischium and lesser sacro-sciatic ligament, and inserted, by its base, into the margin of the coccyx and into the side of the lower piece of the sacrum. It assists the Levator ani and Pyriformis in closing in the back part of the outlet of the pelvis.

Relations.—By its *inner* or *pelvic surface*, with the rectum. By its *external surface*, with the lesser sacro-sciatic ligament. The *lower border* is in relation with the posterior border of the Levator ani, but separated from it by a cellular interval: its *upper border* is in relation with the lower border of the Pyriformis, but separated from it by the sciatic and internal pudic vessels and nerve.

Nerve-supply.—A branch from the fourth and fifth sacral nerves.

Action.—The Coccygei muscles raise and support the coccyx, after it has been pressed backward during defecation or parturition.

II. A. Muscles and Fasciæ of the Perinæum in the Male.

Transversus perinæi.	Erector penis.
Accelerator urinæ.	Compressor urethræ.

Superficial Fascia.—The superficial fascia of the perinæum consists of two layers, superficial and deep, as in other regions of the body.

The *superficial layer* is thick, loose, areolar in texture, and contains much adipose tissue in its meshes, the amount of which varies in different subjects. In front, it is continuous with the dartos of the scrotum; behind, it is continuous with the subcutaneous areolar tissue surrounding the anus; and, on either side, with the same fascia on the inner side of the thighs. This layer should be carefully removed after it has been examined, when the deep layer will be exposed.

The *deep layer of superficial fascia* (Fascia of Colles) is thin, aponeurotic in structure, and of considerable strength, serving to bind down the muscles of the root of the penis. It is continuous, in front, with the dartos of the scrotum; on either side it is firmly attached to the margins of the rami of the os pubis and ischium, external to the crus penis, and as far back as the tuberosity of the ischium; posteriorly, it curves down behind the Transversus perinæi muscles to join

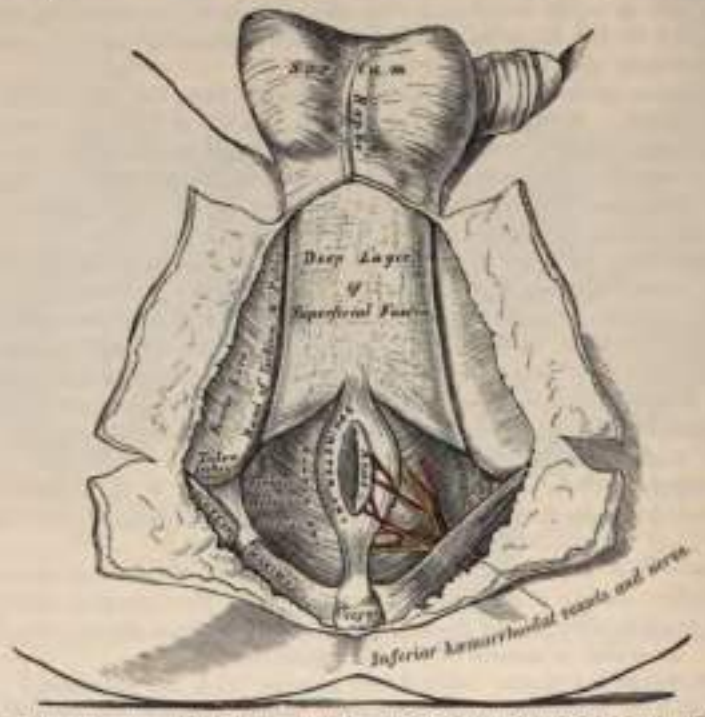


Fig. 225.—The perinæum. The integument and superficial layer of superficial fascia reflected.

the lower margin of the triangular ligament. This fascia not only covers the muscles in this region, but sends upward a vertical septum from its deep surface, which separates the back part of the subjacent space into two, the septum being incomplete in front.

The Central Tendinous Point of the Perinæum.—This is a fibrous point in the middle line of the perinæum, between the urethra and the rectum, being about half an inch in front of the anus. At this point four muscles converge and are attached: viz., the External sphincter ani, the Accelerator urinæ, and the two

Transversus perinæi; so that by the contraction of these muscles, which extend in opposite directions, it serves as a fixed point of support.

The **Transversus perinæi** is a narrow muscular slip, which passes more or less transversely across the back part of the perineal space. It arises by a small tendon from the inner and fore part of the tuberosity of the ischium, and, passing inward, is inserted into the central tendinous point of the perinæum, joining in this situation

FIG. 224.—The muscles attached to the front of the pelvis. (From a preparation in the Museum of the Royal College of Surgeons of England.)

with the muscle of the opposite side, the External sphincter ani behind, and the Accelerator urinæ in front.

Nerve-supply.—The perineal branch of the internal pudic.

Actions.—By their contraction they serve to fix the central tendinous point of the perinæum.

The **Accelerator urinæ** (*Ejaculator seminis*, or *Bulbo-cavernosus*) is placed in the middle line of the perinæum, immediately in front of the anus. It consists of two symmetrical halves, united along the median line by a tendinous raphé. It arises from the central tendon of the perinæum, and from the median raphé in front. From this point its fibres diverge like the plumes of a pen; the most

posterior form a thin layer, which is lost on the anterior surface of the triangular ligament; the middle fibres encircle the bulb and adjacent parts of the corpus spongiosum, and join with the fibres of the opposite side, on the upper part of the corpus spongiosum, in a strong aponeurosis; the anterior fibres, the longest and most distinct, spread out over the sides of the corpus cavernosum, to be inserted partly into that body, anterior to the Erector penis, occasionally extending to the os pubis; partly terminating in a tendinous expansion, which covers the dorsal vessels of the penis. The latter fibres are best seen by dividing the muscle longitudinally, and dissecting it outward from the surface of the urethra.

Action.—This muscle serves to empty the canal of the urethra, after the bladder has expelled its contents; during the greater part of the act of micturition its fibres are relaxed, and it only comes into action at the end of the process. The middle fibres are supposed, by Krause, to assist in the erection of the corpus

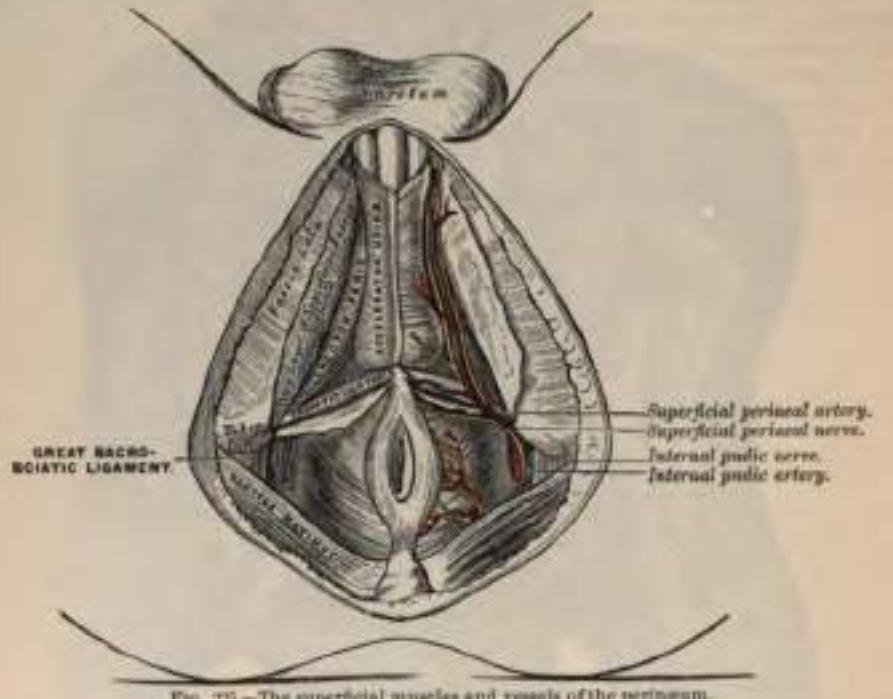


FIG. 225.—The superficial muscles and vessels of the perinæum.

spongiosum, by compressing the erectile tissue of the bulb. The anterior fibres, according to Tyrrel, also contribute to the erection of the penis, as they are inserted into, and continuous with, the fascia of the penis, compressing the dorsal vein during the contraction of the muscle.

The **Erector penis** (*Ischio-cavernosus*) covers part of the crus penis. It is an elongated muscle, broader in the middle than at either extremity, and situated on either side of the lateral boundary of the perinæum. It arises by tendinous and fleshy fibres from the inner surface of the tuberosity of the ischium, behind the crus penis, from the surface of the crus, and from the adjacent portion of the ramus of the ischium. From these points fleshy fibres succeed, which end in an aponeurosis which is inserted into the sides and under surface of the crus penis.

Nerve-supply.—The perineal branch of the internal pudic.

Actions.—It compresses the crus penis and retards the return of the blood through the veins, and thus serves to maintain the organ erect.

Between the muscles just examined a triangular space exists, bounded internally by the Accelerator urinæ, externally by the Erector penis, and behind

by the Transversus perinæi. The floor of this space is formed by the triangular ligament of the urethra (deep perineal fascia), and running from behind forward in it are the superficial perineal vessels and nerves, the long pudendal nerve; the transverse perineal artery coursing along the posterior boundary of the space on the Transversus perinæi muscle.

The **Triangular Ligament** (*Deep perineal fascia*) is stretched almost horizontally across the pubic arch, so as to close in the front part of the outlet of the pelvis. It consists of two dense membranous laminæ, which are united along their posterior borders, but are separated in front by intervening structures. The superficial of these two layers, the *inferior layer of the triangular ligament*, is triangular in shape, about an inch and a half in depth. Its apex is directed forward, and is separated from the subpubic ligament by an oval opening for the transmission of the dorsal vein of the penis. Its lateral margins are attached on each side to the rami of the ischium and os pubis, above the crura penis. Its base is directed toward the rectum, and connected to the central tendinous point of the perinæum. It is continuous with the deep layer of the superficial fascia behind the Transversus perinæi muscle, and with a thin fascia which covers the cutaneous surface of the Levator ani muscle (*anal* or *ischio-rectal* fascia).

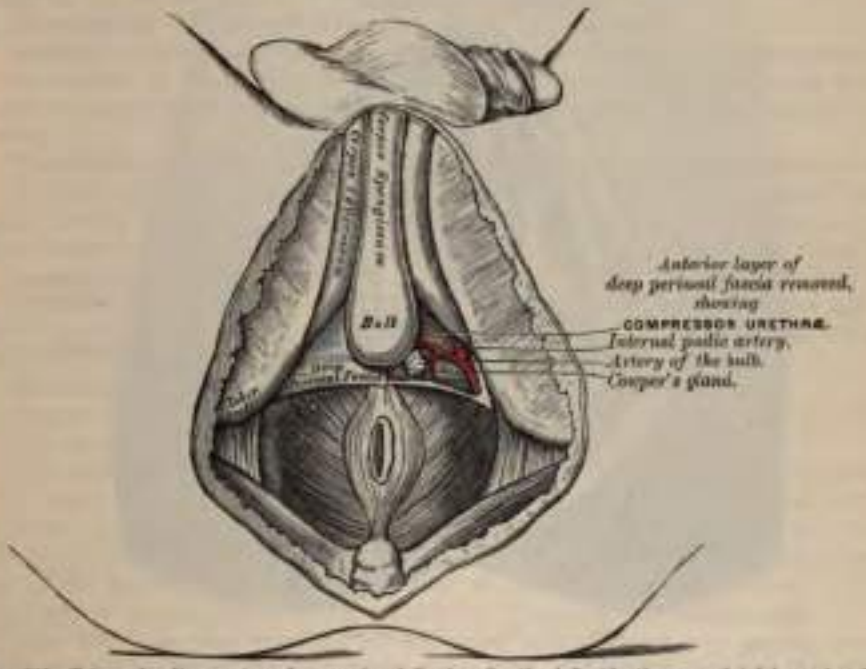


FIG. 236.—Triangular ligament or deep perineal fascia. On the left side the superficial layer has been removed.

This layer of the triangular ligament is perforated, about an inch below the symphysis pubis, by the urethra, the aperture for which is circular in form and about three or four lines in diameter; by the arteries to the bulb and the ducts of Cowper's glands close to the urethral orifice; by the arteries to the corpora cavernosa—one on each side, close to the pubic arch and about halfway along the attached margin of the ligament; by the dorsal arteries and nerves of the penis near the apex of the ligament. Its base is also perforated by the superficial perineal vessels and nerves, while between its apex and the subpubic ligament the dorsal vein of the penis passes upward into the pelvis.

If this superficial or inferior layer of the triangular ligament is detached on either side, the following structures will be seen between it and the deeper layer: the dorsal vein of the penis; the membranous portion of the urethra, and the

Compressor urethræ muscle; Cowper's glands and their ducts; the pudic vessels and dorsal nerve of the penis; the artery and nerve of the bulb, and a plexus of veins.

The deep layer of the ligament (*superior layer of the triangular ligament*) is derived from the obturator fascia and stretches across the pubic arch. If the obturator fascia is traced inward after covering the Obturator internus muscle, it will be found to be attached by some of its deeper or anterior fibres to the inner margin of the ischio-pubic ramus, while its superficial or posterior fibres pass over this attachment to become the superior layer of the triangular ligament. Behind, this layer of the fascia is continuous with the inferior layer and with the fascia of Colles, and in front it is separated from the apex of the prostate gland through the intervention of a prolongation of the recto-vesical fascia. It is pierced by the urethra, or rather consists of two halves which are separated in the middle line by the urethra passing between them.

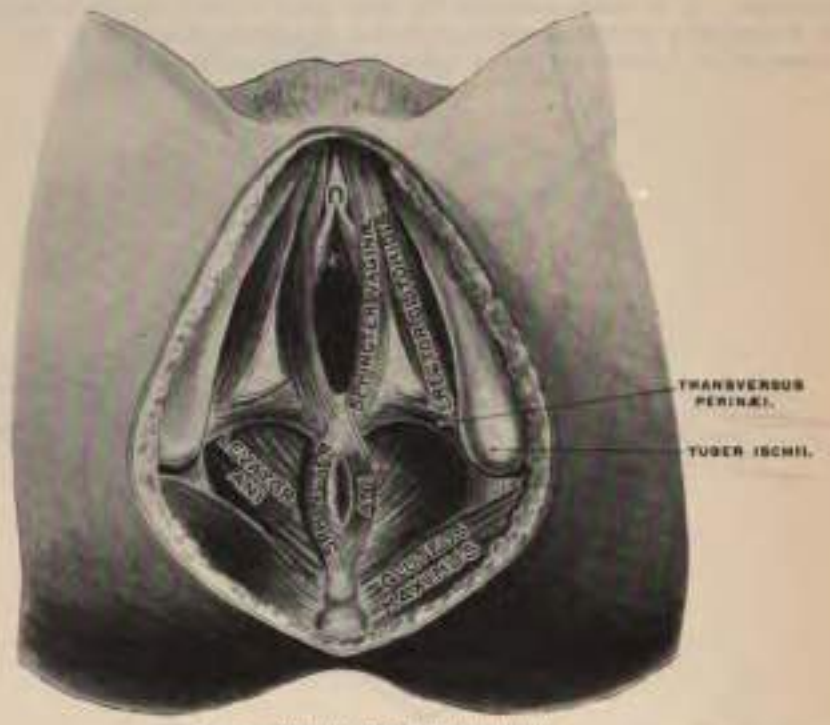


FIG. 227.—Muscles of the female perinæum.

The **Compressor urethræ** (*Constrictor urethræ*) surrounds the whole length of the membranous portion of the urethra, and is contained between the two layers of the triangular ligament. It arises, by aponeurotic fibres, from the junction of the rami of the os pubis and ischium, to the extent of half or three-quarters of an inch: each segment of the muscle passes inward, and divides into two fasciculi, which surround the urethra from the prostate gland behind to the bulbous portion of the urethra in front; and unite, at the upper and lower surfaces of this tube, with the muscle of the opposite side by means of a tendinous raphé.

Nerve-supply.—The perineal branch of the internal pudic.

Actions.—The muscles of both sides act together as a sphincter, compressing the membranous portion of the urethra. During the transmission of fluids they, like the Acceleratores urinæ, are relaxed, and come into action only at the end of the process, to eject the last drops of the fluid.

II. B. Muscles of the Perinæum in the Female (Fig. 227).

Transversus perinæi.	Erector clitoridis.
Sphincter vaginæ.	Compressor urethræ.

The **Transversus perinæi** in the **female** is a narrow muscular slip, which passes more or less transversely across the back part of the perineal space. It arises by a small tendon from the inner and fore part of the tuberosity of the ischium, and, passing inward, is inserted into the central point of the perinæum, joining in this situation with the muscle of the opposite side, the External sphincter ani behind, and the Sphincter vaginæ in front.

Nerve-supply.—The perineal branch of the internal pudic.

Actions.—By their contraction they serve to fix the central tendinous point of the perinæum.

The **Sphincter vaginæ** surrounds the orifice of the vagina, and is analogous to the Accelerator urinæ in the male. It is attached posteriorly to the central tendinous point of the perinæum, where it blends with the External sphincter ani. Its fibres pass forward on each side of the vagina, to be inserted into the corpora cavernosa of the clitoris, a fasciculus crossing over the body of the organ so as to compress the dorsal vein.

Nerve-supply.—The perineal branch of the internal pudic.

Actions.—It diminishes the orifice of the vagina. The anterior fibres contribute to the erection of the clitoris, as they are inserted into and are continuous with the fascia of the clitoris; compressing the dorsal vein during the contraction of the muscle.

The **Erector clitoridis** resembles the Erector penis in the male, but is smaller than it. It covers the unattached part of the crus clitoridis. It is an elongated muscle, broader at the middle than at either extremity, and situated on either side of the lateral boundary of the perinæum. It arises by tendinous and fleshy fibres from the inner surface of the tuberosity of the ischium, behind the crus clitoridis from the surface of the crus, and from the adjacent portion of the ramus of the ischium. From these points fleshy fibres succeed, which end in an aponeurosis, which is inserted into the sides and under surface of the crus clitoridis.

Nerve-supply.—The perineal branch of the internal pudic.

Actions.—It compresses the crus clitoridis and retards the return of blood through the veins, and thus serves to maintain the organ erect.

The **triangular ligament** (*deep perineal fascia*) in the female is not so strong as in the male. It is attached to the pubic arch, its apex being connected with the subpubic ligament. It is divided in the middle line by the aperture of the vagina, with the external coat of which it becomes blended, and in front of this is perforated by the urethra. Its posterior border is continuous, as in the male, with the deep layer of the superficial fascia around the Transversus perinæi muscle.

Like the triangular ligament in the male, it consists of two layers, between which are to be found the following structures: the dorsal vein of the clitoris, a portion of the urethra and the Compressor urethræ muscle, the glands of Bartholin and their ducts; the pudic vessels and the dorsal nerve of the clitoris; the arteries of the bulbi vestibuli, and a plexus of veins.

The **Compressor urethræ** (*Constrictor urethræ*) arises on each side from the margin of the descending ramus of the os pubis. The fibres, passing inward, divide into two sets: those of the fore part of the muscle are directed across the subpubic arch in front of the urethra to blend with the muscular fibres of the opposite side; while those of the hinder and larger part pass inward to blend with the wall of the vagina behind the urethra.

Nerve-supply.—The perineal branch of the internal pudic.

MUSCLES AND FASCIÆ OF THE UPPER EXTREMITY.

The Muscles of the Upper Extremity are divisible into groups, corresponding with the different regions of the limb.

I. Of the Thoracic Region.

1. *Anterior Thoracic Region.*

Pectoralis major. Pectoralis minor.
Subclavius.

2. *Lateral Thoracic Region.*

Serratus magnus.

II. Of the Shoulder and Arm.

3. *Acromial Region.*

Deltoid.

4. *Anterior Scapular Region.*

Subscapularis.

5. *Posterior Scapular Region.*

Supraspinatus. Teres minor.
Infraspinatus. Teres major.

6. *Anterior Humeral Region.*

Coraco-brachialis. Biceps.
Brachialis anticus.

7. *Posterior Humeral Region.*

Triceps. Subanconeus.

III. Of the Forearm.

8. *Anterior Radio-Ulnar Region.*

Superficial Layer.
- Pronator radii teres.
- Flexor carpi radialis.
- Palmaris longus.
- Flexor carpi ulnaris.
- Flexor sublimis digitorum.

Deep Layer.
- Flexor profundus digitorum.
- Flexor longus pollicis.
- Pronator quadratus.

9. *Radial Region.*

Supinator longus.
Extensor carpi radialis longior.
Extensor carpi radialis brevior.

10. *Posterior Radio-Ulnar Region.*

Superficial Layer.
- Extensor communis digitorum.
- Extensor minimi digiti.
- Extensor carpi ulnaris.
- Anconeus.

Deep Layer.
- Supinator brevis.
- Extensor ossis metacarpi pollicis.
- Extensor brevis pollicis.
- Extensor longus pollicis.
- Extensor indicis.

IV. Of the Hand.

11. *Radial Region.*

Abductor pollicis.
Flexor ossis metacarpi pollicis (Opponens pollicis).
Flexor brevis pollicis.
Adductor obliquus pollicis.
Adductor transversus pollicis.

12. *Ulnar Region.*

Palmaris brevis.
Abductor minimi digiti.
Flexor brevis minimi digiti.
Flexor ossis metacarpi minimi digiti (Opponens minimi digiti).

13. *Middle Palmar Region.*

Lumbricales.
Interossei palmares.
Interossei dorsales.

Dissection of Pectoral Region and Axilla (Fig. 228).—The arm being drawn away from the side nearly at right angles with the trunk and rotated outward, make a vertical incision through the integument in the median line of the chest, from the upper to the lower part of the sternum; a second incision along the lower border of the Pectoral muscle, from the ensiform cartilage to the inner side of the axilla; a third, from the sternum along the clavicle, as far as its centre; and a fourth, from the middle of the clavicle obliquely downward, along the interspace between the Pectoral and Deltoid muscles, as low as the fold of the armpit. The flap of integument is then to be dissected off in the direction indicated in the figure, but not entirely removed, as it should be replaced on completing the dissection. If a transverse incision is now made from the lower end of the sternum to the side of the chest, as far as the posterior fold of the armpit, and the integument reflected outward, the axillary space will be more completely exposed.

I. Muscles and Fasciæ of the Thoracic Region.

1. *Anterior Thoracic Region.*

Pectoralis major. Pectoralis minor.

Subclavius.

The **superficial fascia** of the thoracic region is a loose cellulo-fibrous layer enclosing masses of fat in its spaces. It is continuous with the superficial fascia of the neck and upper extremity above, and of the abdomen below. Opposite the mamma it divides into two layers, one of which passes in front, the other behind, that gland; and from both of these layers numerous septa pass into its substance, supporting its various lobes: from the anterior layer fibrous processes pass forward to the integument and nipple. These processes were called by Sir A. Cooper the *ligamenta suspensoria*, from the support they afford to the gland in this situation.

The **deep fascia** of the thoracic region is a thin aponeurotic lamina, covering the surface of the great Pectoral muscle, and sending numerous prolongations

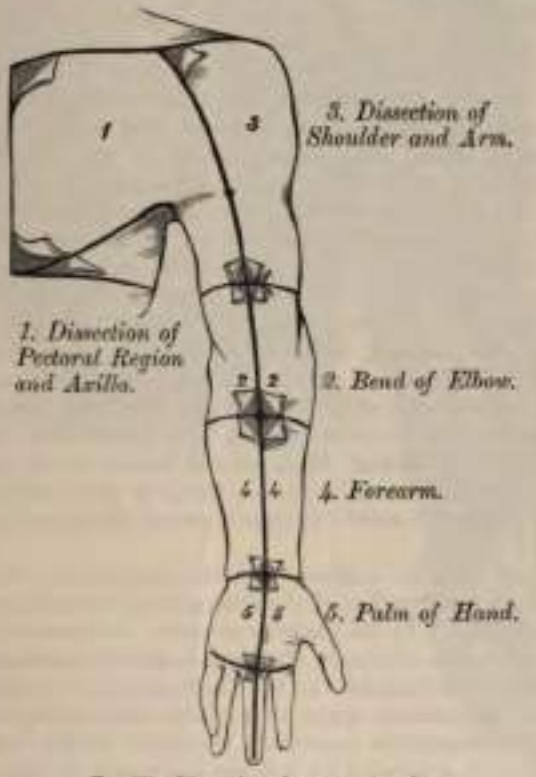


FIG. 228.—Dissection of upper extremity.

between its fasciculi: it is attached, in the middle line, to the front of the sternum, and above to the clavicle; externally and below it becomes continuous with the fascia over the shoulder, axilla, and thorax. It is very thin over the upper part of the muscle, thicker in the interval between the Pectoralis major and Latissimus dorsi, where it closes in the axillary space, and divides at the outer margin of the latter muscle into two layers, one of which passes in front and the other behind it; these proceed as far as the spinous processes of the dorsal vertebræ, to which they are attached. As the fascia leaves the lower edge of the Pectoralis major to pass across the floor of the axilla it sends a layer upward under cover of the muscle: this lamina splits to envelop the Pectoralis minor, at the upper edge of which it becomes continuous with the costo-coracoid membrane. The hollow of the armpit, seen when the arm is abducted, is mainly produced by the traction of this

fascia on the axillary floor, and hence it is sometimes named the *suspensory ligament* of the axilla. At the lower part of the thoracic region this fascia is well developed, and is continuous with the fibrous sheath of the Recti muscles.

The **Pectoralis major** (Fig. 229) is a broad, thick, triangular muscle, situated at the upper and fore part of the chest, in front of the axilla. It arises from the anterior surface of the sternal half of the clavicle; from half the breadth of the anterior surface of the sternum, as low down as the attachment of the cartilage of the sixth or seventh rib; this portion of its origin consists of aponeurotic fibres, which intersect with those of the opposite muscle; it also arises from the cartilages of all the true ribs, with the exception, frequently, of the first or of the seventh, or both; and from the aponeurosis of the External oblique muscle of the abdomen. The fibres from this extensive origin converge toward its insertion, giving to the muscle a radiated appearance. Those fibres which arise from the clavicle pass obliquely outward and downward, and are usually separated from the rest by a cellular interval: those from the lower part of the sternum, and the cartilages of the lower true ribs, pass upward and outward, whilst the middle fibres pass horizontally. They all terminate in a flat tendon, about two inches broad, which is inserted into the outer bicipital ridge of the humerus. This tendon consists of two laminæ, placed one in front of the other, and usually blended together below. The anterior, the thicker, receives the clavicular and upper half of the sternal portion of the muscle; and its fibres are inserted in the same order as that in which they arise; that is to say, the outermost fibres of origin from the clavicle are inserted at the uppermost part of the tendon; the upper fibres of origin from the sternum pass down to the lowermost part of this anterior lamina of the tendon and extend as low as the tendon of the Deltoid and join with it. The posterior lamina of the tendon receives the attachment of the lower half of the sternal portion and the deeper part of the muscle from the costal cartilages. These deep fibres, and particularly those from the lower costal cartilages, ascend the higher, turning backward successively behind the superficial and upper ones, so that the tendon appears to be twisted. The posterior lamina reaches higher on the humerus than the anterior one, and from it an expansion is given off which covers the bicipital groove and blends with the capsule of the shoulder-joint. From the deepest fibres of this lamina at its insertion an expansion is given off which lines the bicipital groove of the humerus, while from the lower border of the tendon a third expansion passes downward to the fascia of the arm.

Relations.—By its *anterior surface*, with the integument, the superficial fascia, the Platysma, some of the branches of the descending cervical nerves, the mammary gland, and the deep fascia; by its *posterior surface:* its *thoracic portion*, with the sternum, the ribs and costal cartilages, the costo-coracoid membrane, the Subclavius, Pectoralis minor, Serratus magnus, and the Intercostals; its *axillary portion* forms the anterior wall of the axillary space, and covers the axillary vessels and nerves, the Biceps and Coraco-brachialis muscles. Its *upper border* lies parallel with the Deltoid, from which it is separated by a slight interspace in which lie the cephalic vein and humeral branch of the acromial thoracic artery. Its *lower border* forms the anterior margin of the axilla, being at first separated from the Latissimus dorsi by a considerable interval; but both muscles gradually converge toward the outer part of the space.

Dissection.—Detach the Pectoralis major by dividing the muscle along its attachment to the clavicle, and by making a vertical incision through its substance a little external to its line of attachment to the sternum and costal cartilages. The muscle should then be reflected outward, and its tendon carefully examined. The Pectoralis minor is now exposed, and immediately above it, in the interval between its upper border and the clavicle, a strong fascia, the *costo-coracoid membrane*.

The **costo-coracoid membrane** is a strong fascia, situated under cover of the clavicular portion of the Pectoralis major muscle. It occupies the interval between the Pectoralis minor and Subclavius muscles, and protects the axillary vessels and

nerves. Traced upward, it splits to enclose the Subclavius muscle, and its two layers are attached to the clavicle, one in front of and the other behind the muscle; the latter layer fuses with the deep cervical fascia and with the sheath of the axillary vessels. Internally, it blends with the fascia covering the first two inter-

FIG. 229.—Muscles of the chest and front of the arm. Superficial view.

costal spaces, and is attached also to the first rib internal to the origin of the Subclavius muscle. Externally it is very thick and dense, and is attached to the coracoid process. The portion extending from its attachment to the first rib to the coracoid process is often whiter and denser than the rest; this is sometimes called the *costo-coracoid ligament*. Below, it is thin, and at the upper border of the Pectoralis minor it splits into two layers to invest the muscle; from the lower border of the Pectoralis minor it is continued downward to join the axillary fascia, and outward to join the fascia over the short head of the Biceps. The costo-coracoid membrane is pierced by the cephalic vein, the acromial thoracic artery and vein, superior thoracic artery, and anterior thoracic nerves.

The **Pectoralis minor** (Fig. 230) is a thin, flat, triangular muscle, situated at the upper part of the thorax, beneath the Pectoralis major. It arises by three

tendinous digitations from the upper margin and outer surface of the third, fourth, and fifth ribs, near their cartilages, and from the aponeurosis covering the Intercostal muscles; the fibres pass upward and outward, and converge to form a flat tendon, which is inserted into the inner border and upper surface of the coracoid process of the scapula.

Relations.—By its *anterior surface*, with the Pectoralis major and the thoracic

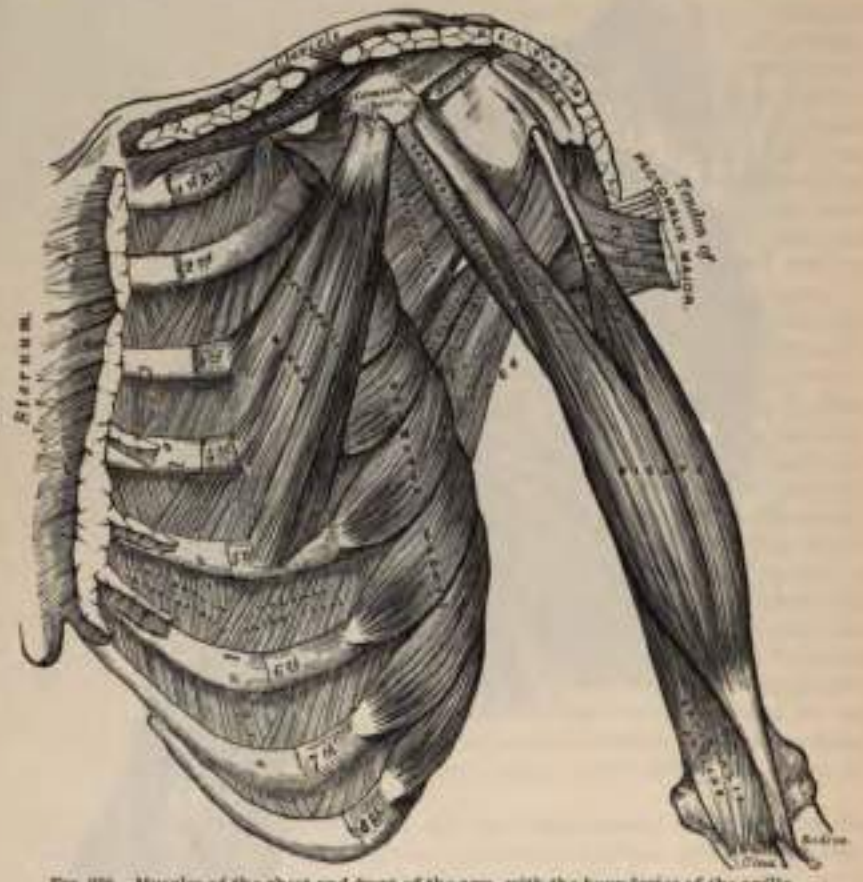


FIG. 230.—Muscles of the chest and front of the arm, with the boundaries of the axilla.

branches of the acromial thoracic artery. By its *posterior surface*, with the ribs, Intercostal muscles, Serratus magnus, the axillary space, and the axillary vessels and brachial plexus of nerves. Its upper border is separated from the clavicle by a triangular interval, broad internally, narrow externally, which is occupied by the costo-coracoid membrane. In this space is the first part of the axillary vessels and nerves. Running parallel to the lower border of the muscle is the long thoracic artery.

The costo-coracoid membrane should now be removed, when the Subclavius muscle will be seen.

The **Subclavius** is a small triangular muscle, placed in the interval between the clavicle and the first rib. It arises by a short, thick tendon from the first rib and its cartilage at their junction, in front of the rhomboid ligament; the fleshy fibres proceed obliquely upward and outward, to be inserted into a deep groove on the under surface of the clavicle.

Relations.—By its *upper surface*, with the clavicle. By its *deep surface* it is separated from the first rib by the subclavian vessels and brachial plexus of nerves. Its *anterior surface* is separated from the Pectoralis major by the costo-coracoid

membrane, which, with the clavicle, forms an osseo-fibrous sheath in which the muscle is enclosed.

If the costal attachment of the Pectoralis minor is divided across, and the muscle reflected outward, the axillary vessels and nerves are brought fully into view, and should be examined.

Nerves.—The Pectoral muscles are supplied by the anterior thoracic nerves; the Pectoralis major through these nerves receives filaments from all the spinal nerves entering into the formation of the brachial plexus; the Pectoralis minor receives its fibres from the eighth cervical and first dorsal nerves. The Subclavius is supplied by a filament from the fifth cervical nerve.

Actions.—If the arm has been raised by the Deltoid, the Pectoralis major will, conjointly with the Latissimus dorsi and Teres major, depress it to the side of the chest. If acting alone, it adducts and draws forward the arm, bringing it across the front of the chest, and at the same time rotates it inward. The Pectoralis minor depresses the point of the shoulder, drawing the scapula downward and inward to the thorax, and throwing the inferior angle backward. The Subclavius depresses the shoulder, drawing the clavicle downward and forward. When the arms are fixed, all three muscles act upon the ribs, drawing them upward and expanding the chest, and thus becoming very important agents in forced inspiration. Asthmatic patients always assume an attitude which fixes the shoulders, so that all these muscles may be brought into action to assist in dilating the cavity of the chest.

FIG. 231.—Serratus magnus. (From a preparation in the Museum of the Royal College of Surgeons of England.)

2. Lateral Thoracic Region.

Serratus magnus.

The **Serratus magnus** (Fig. 231) is a thin, irregularly quadrilateral muscle, situated between the ribs and the scapula at the upper and lateral part of the chest. It arises by nine digitations or slips from the outer surface and upper border of the eight upper ribs (the second rib giving origin to two slips), and from the aponeurosis covering the corresponding intercostal muscles. From this extensive attachment the fibres pass backward, closely applied to the chest-wall, and reach the vertebral border of the scapula, and are inserted into its ventral aspect in the following manner. The upper two digitations—*i. e.*, the one from the first rib and the higher, of the two from the second rib—converge to be inserted into a triangular area on the ventral aspect of the superior angle. The next two digitations spread out to form a thin triangular sheet, the base of which is directed backward and is inserted into nearly the whole length of the ventral aspect of the vertebral border. The lower five digitations converge, as they pass backward from the ribs, to form a fan-shaped structure, the apex of which is inserted, partly by muscular and partly by tendinous fibres, into a triangular impression on the ventral aspect of the inferior angle. The lower four slips interdigitate at their origin with the upper five slips of the External oblique muscle of the abdomen.

Relations.—This muscle is partly covered, in front, by the Pectoral muscles; behind, by the Subscapularis. The axillary vessels and nerves lie upon its upper part, while its *deep surface* rests upon the ribs and intercostal muscles.

Nerve.—The Serratus magnus is supplied by the posterior thoracic nerve, which is derived from the fifth, sixth, and generally the seventh cervical nerves.

Actions.—The Serratus magnus, as a whole, carries the scapula forward, and at the same time raises the vertebral border of the bone. It is therefore concerned in the action of pushing. Its lower and stronger fibres move forward the lower angle and assist the Trapezius in rotating the bone round an axis through its centre, and thus assists this muscle in raising the acromion and supporting weights upon the shoulder. It is also an assistant to the Deltoid in raising the arm, inasmuch as during the action of this latter muscle it fixes the scapula and so steadies the glenoid cavity on which the head of the humerus rotates. After the Deltoid has raised the arm to a right angle with the trunk, the Serratus magnus and the Trapezius, by rotating the scapula, raise the arm into an almost vertical position. It is possible that when the shoulders are fixed the lower fibres of the Serratus magnus may assist in raising and everting the ribs; but it is not the important inspiratory muscle which it was formerly believed to be.

Surgical Anatomy.—When the muscle is paralysed, the vertebral border, and especially the lower angle of the scapula, leaves the ribs and stands out prominently on the surface, giving a peculiar "winged" appearance to the back. The patient is unable to raise the arm, and an attempt to do so is followed by a further projection of the lower angle of the scapula from the back of the thorax.

Dissection.—After completing the dissection of the axilla, if the muscles of the back have been dissected, the upper extremity should be separated from the trunk. Saw through the clavicle at its centre, and then cut through the muscles which connect the scapula and arm with the trunk, viz.: the Pectoralis minor in front, Serratus magnus at the side, and the Levator anguli scapulæ, the Rhomboids, Trapezius, and Latissimus dorsi behind. These muscles should be cleaned and traced to their respective insertions. Then make an incision through the integument, commencing at the outer third of the clavicle, and extending along the margin of that bone, the acromion process, and spine of the scapula; the integument should be dissected from above downward and outward, when the fascia covering the Deltoid is exposed (Fig. 228, No. 3).

II. MUSCLES AND FASCIÆ OF THE SHOULDER AND ARM

The **superficial fascia** of the upper extremity is a thin cellulo-fibrous layer, containing the superficial veins and lymphatics, and the cutaneous nerves. It is most distinct in front of the elbow, and contains very large superficial veins and nerves; in the hand it is hardly demonstrable, the integument being closely adherent to the deep fascia by dense fibrous bands. Small subcutaneous bursæ are found in this fascia over the acromion, the olecranon, and the knuckles. The deep fascia of the upper extremity comprises the aponeurosis of the shoulder, arm, and forearm, the anterior and posterior annular ligaments of the carpus, and the palmar fascia. These will be considered in the description of the muscles of the several regions.

3. Acromial Region.

Deltoid.

The **deep fascia** covering the Deltoid (deltoid aponeurosis) is a fibrous layer which covers the outer surface of the muscle, thick and strong behind, where it is continuous with the infraspinatus fascia, thinner over the rest of its extent. It sends down numerous prolongations between the fasciculi of the muscle. In front, it is continuous with the fascia covering the great Pectoral muscle; behind, with that covering the Infraspinatus; above, it is attached to the clavicle, the acromion, and spine of the scapula; below, it is continuous with the deep fascia of the arm.

The **Deltoid** (Fig. 229) is a large, thick, triangular muscle, which gives the rounded outline to the shoulder, and has received its name from its resemblance to the Greek letter Δ reversed. It surrounds the shoulder-joint in the greater part of its extent, covering it on its outer side, and in front and behind. It arises from

the outer third of the anterior border and upper surface of the clavicle; from the outer margin and upper surface of the acromion process, and from the lower lip of the posterior border of the spine of the scapula, as far back as the triangular surface at its inner end. From this extensive origin the fibres converge toward their insertion, the middle passing vertically, the anterior obliquely, backward, the posterior obliquely forward; they unite to form a thick tendon, which is inserted into a rough triangular prominence on the middle of the outer side of the shaft of the humerus. At its insertion the muscle gives off an expansion to the deep fascia of the arm. This muscle is remarkably coarse in texture, and the arrangement of its muscular fibres is somewhat peculiar; the central portion of the muscle—that is to say, the part arising from the acromion process—consists of oblique fibres, which arise in a bipenniform manner from the sides of tendinous intersections, generally four in number, which are attached above to the acromion process and pass downward parallel to one another in the substance of the muscle. The oblique muscular fibres thus formed are inserted into similar tendinous intersections, generally three in number, which pass upward from the insertion of the muscle into the humerus and alternate with the descending septa. The portions of the muscle which arise from the clavicle and spine of the scapula are not arranged in this manner, but pass from their origin above, to be inserted into the margins of the inferior tendon.

Relations.—By its *superficial surface*, with the integument, the superficial and deep fasciæ, Platysma, and supra-acromial nerves. Its *deep surface* is separated from the head of the humerus by a large sacculated synovial bursa, and covers the coracoid process, coraco-acromial ligament, Pectoralis minor, Coraco-brachialis, both heads of the Biceps, the tendon of the Pectoralis major, the insertions of the Supraspinatus, Infraspinatus, and Teres minor, the scapular and external heads of the Triceps, the circumflex vessels and nerve, and the humerus. Its *anterior border* is separated at its upper part from the Pectoralis major by a cellular interspace, which lodges the cephalic vein and humeral branch of the acromial thoracic artery; lower down the two muscles are in close contact. Its *posterior border* rests on the Infraspinatus and Triceps muscles.

Nerves.—The Deltoid is supplied by the fifth and sixth cervical through the circumflex nerve.

Actions.—The Deltoid raises the arm directly from the side, so as to bring it at right angles with the trunk. Its anterior fibres, assisted by the Pectoralis major, draw the arm forward; and its posterior fibres, aided by the Teres major and Latissimus dorsi, draw it backward.

Surgical Anatomy.—The Deltoid is very liable to atrophy, and when in this condition simulates dislocation of the shoulder-joint, as there is flattening of the shoulder and apparent prominence of the acromion process; upon examination, however, it will be found that the relative position of the great tuberosity of the humerus to the acromion and coracoid process is unchanged. Atrophy of the Deltoid may be due to disuse or loss of trophic influence, either from injury to the circumflex nerve or cord lesions, as in infantile paralysis.

Dissection.—Divide the Deltoid across, near its upper part, by an incision carried along the margin of the clavicle, the acromion process and spine of the scapula, and reflect it downward, when the structures under cover of it will be seen.

4. Anterior Scapular Region.

Subscapularis.

The **subscapular fascia** is a thin membrane attached to the entire circumference of the subscapular fossa, and affording attachment by its inner surface to some of the fibres of the Subscapularis muscle: when this is removed, the Subscapularis muscle is exposed.

The **Subscapularis** (Fig. 230) is a large triangular muscle which fills up the subscapular fossa, arising from its internal two-thirds, with the exception of a narrow margin along the posterior border, and the surfaces at the superior and inferior angles which afford attachment to the Serratus magnus: it also arises from

the lower two-thirds of the groove on the axillary border of the bone. Some fibres arise from tendinous laminæ, which intersect the muscle, and are attached to ridges on the bone; and others from an aponeurosis, which separates the muscle from the Teres major and the long head of the Triceps. The fibres pass outward, and, gradually converging, terminate in a tendon, which is inserted into the lesser tuberosity of the humerus. Those fibres which arise from the axillary border of the scapula are inserted into the neck of the humerus to the extent of an inch below the tuberosity. The tendon of the muscle is in close contact with the anterior part of the capsular ligament of the shoulder-joint, and glides over a large bursa, which separates it from the base of the coracoid process. This bursa communicates with the cavity of the joint by an aperture in the capsular ligament.

Relations.—Its *anterior surface* forms a considerable part of the posterior wall of the axilla, and is in relation with the Serratus magnus, Coraco-brachialis, and Biceps, the axillary vessels and brachial plexus of nerves, and the subscapular vessels and nerves. By its *posterior surface*, with the scapula and the capsular ligament of the shoulder-joint. Its *lower border* is contiguous with the Teres major and Latissimus dorsi.

Nerves.—It is supplied by the fifth and sixth cervical nerves through the upper and lower subscapular nerves.

Actions.—The Subscapularis rotates the head of the humerus inward; when the arm is raised, it draws the humerus forward and downward. It is a powerful defence to the front of the shoulder-joint, preventing displacement of the head of the bone.

5. Posterior Scapular Region (Fig. 232).

Supraspinatus.	Teres minor.
Infraspinatus.	Teres major.

Dissection.—To expose these muscles, and to examine their mode of insertion into the humerus, detach the Deltoid and Trapezius from their attachment to the spine of the scapula and acromion process. Remove the clavicle by dividing the ligaments connecting it with the coracoid process, and separate it at its articulation with the scapula: divide the acromion process near its root with a saw. The fragments being removed, the tendons of the posterior Scapular muscles will be fully exposed, and can be examined. A block should be placed beneath the shoulder-joint, so as to make the muscles tense.

The **Supraspinous fascia** is a thick and dense membranous layer, which completes the osseo-fibrous case in which the Supraspinatus muscle is contained, affording attachment, by its inner surface, to some of the fibres of the muscle. It is thick internally, but thinner externally under the coraco-acromial ligament. When this fascia is removed, the Supraspinatus muscle is exposed.

The **Supraspinatus muscle** occupies the whole of the supraspinous fossa, arising from its internal two-thirds and from the strong fascia which covers its surface. The muscular fibres converge to a tendon which passes across the upper part of the capsular ligament of the shoulder-joint, to which it is intimately adherent, and is inserted into the highest of the three facets on the great tuberosity of the humerus.

Relations.—By its *upper surface*, with the Trapezius, the clavicle, the acromion, the coraco-acromial ligament, and the Deltoid; by its *under surface*, with the scapula, the suprascapular vessels and nerve, and upper part of the shoulder-joint.

The **Infraspinous fascia** is a dense fibrous membrane, covering in the Infraspinatus muscle and attached to the circumference of the infraspinous fossa; it affords attachment, by its inner surface, to some fibres of that muscle. At the point where the Infraspinatus commences to be covered by the Deltoid, this fascia divides into two layers: one layer passes over the Deltoid muscle, helping to form the Deltoid fascia already described; the other passes beneath the Deltoid to the shoulder-joint.

The **Infraspinatus** is a thick, triangular muscle, which occupies the chief part of the infraspinous fossa, arising by fleshy fibres from its internal two-thirds, and

by tendinous fibres from the ridges on its surface: it also arises from a strong fascia which covers it externally, and separates it from the Teres major and minor. The fibres converge to a tendon which glides over the external border of the spine of the scapula, and, passing across the posterior part of the capsular ligament of the shoulder-joint, is inserted into the middle facet on the great tuberosity of the humerus. The tendon of this muscle is occasionally separated from the spine of the scapula by a synovial bursa which communicates with the synovial cavity of the shoulder-joint.

Relations.—By its *posterior surface*, with the Deltoid, the Trapezius, Latissimus dorsi, and the integument; by its *anterior surface*, with the scapula, from which

FIG. 282.—Muscles on the dorsum of the Scapula and the Triceps.

it is separated by the suprascapular and dorsalis scapulæ vessels, and with the capsular ligament of the shoulder-joint. Its *lower border* is in contact with the Teres minor, occasionally united with it, and with the Teres major.

The **Teres minor** is a narrow, elongated muscle, which arises from the dorsal surface of the axillary border of the scapula for the upper two-thirds of its extent, and from two aponeurotic laminæ, one of which separates this muscle from the Infraspinatus, the other from the Teres major; its fibres pass obliquely upward and outward, and terminate in a tendon which is inserted into the lowest of the three facets on the great tuberosity of the humerus, and, by fleshy fibres, into the humerus immediately below it. The tendon of this muscle passes across the posterior part of the capsular ligament of the shoulder-joint.

Relations.—By its *posterior surface*, with the Deltoid and the integument; by its *anterior surface*, with the scapula and dorsal branch of the subscapular artery, the long head of the Triceps, and the shoulder-joint; by its *upper border*, with the Infraspinatus; by its *lower border*, with the Teres major, from which it is separated anteriorly by the long head of the Triceps.

The **Teres major** is a thick but somewhat flattened muscle, which arises from the oval surface on the dorsal aspect of the inferior angle of the scapula, and from the fibrous septa interposed between it and the Teres minor and Infraspinatus; the fibres are directed upward and outward, and terminate in a flat tendon, about two inches in length, which is inserted into the inner bicipital ridge of the humerus. The tendon of this muscle, at its insertion into the humerus, lies behind that of the Latissimus dorsi, from which it is separated by a synovial bursa, the two tendons being, however, united along their lower borders for a short distance.

Relations.—By its *posterior surface*, with the Latissimus dorsi below, and the long head of the Triceps above. By its *anterior surface*, with the Subscapularis, Latissimus dorsi, Coraco-brachialis, short head of the Biceps, the axillary vessels, and brachial plexus of nerves. Its *upper border* is at first in relation with the Teres minor, from which it is afterward separated by the long head of the Triceps. Its *lower border* forms, in conjunction with the Latissimus dorsi, part of the posterior boundary of the axilla. The Latissimus dorsi at first covers the origin of the Teres major, then wraps itself obliquely round its lower border, so that its tendon ultimately comes to lie in front of that of the Teres major.

Nerves.—The Supra- and Infra-spinatus muscles are supplied by the fifth and sixth cervical nerves through the suprascapular nerve; the Teres minor, by the fifth cervical, through the circumflex; and the Teres major, by the fifth and sixth cervical, through the lower subscapular.

Actions.—The Supraspinatus assists the Deltoid in raising the arm from the side, and fixes the head of the humerus in the glenoid cavity. The Infraspinatus and Teres minor rotate the head of the humerus outward: when the arm is raised, they assist in retaining it in that position and carrying it backward. One of the most important uses of these three muscles is the great protection they afford to the shoulder-joint, the Supraspinatus supporting it above, and preventing displacement of the head of the humerus upward, while the Infraspinatus and Teres minor protect it behind, and prevent dislocation backward. The Teres major assists the Latissimus dorsi in drawing the humerus downward and backward, when previously raised, and rotating it inward; when the arm is fixed, it may assist the Pectoral and Latissimus dorsi muscles in drawing the trunk forward.

THE ARM.

6. Anterior Humeral Region (Fig. 230).

Coraco-brachialis. Biceps. Brachialis anticus.

Dissection.—The arm being placed on the table, with the front surface uppermost, make a vertical incision through the integument along the middle line, from the outer extremity of the anterior fold of the axilla to about two inches below the elbow-joint, where it should be joined by a transverse incision, extending from the inner to the outer side of the forearm; the two flaps being reflected on either side, the fascia should be examined (Fig. 228).

The **deep fascia** of the arm is continuous with that covering the Deltoid and the great Pectoral muscles, by means of which it is attached, above, to the clavicle, acromion, and spine of the scapula; it forms a thin, loose, membranous sheath investing the muscles of the arm, sending down septa between them, and composed of fibres disposed in a circular or spiral direction, and connected together by vertical and oblique fibres. It differs in thickness at different parts, being thin over the Biceps, but thicker where it covers the Triceps, and over the condyles of the humerus; it is strengthened by fibrous aponeuroses, derived from the Pectoralis major and Latissimus dorsi on the inner side, and from the Deltoid externally. On either side it gives off a strong *intermuscular septum*, which is attached to the supracondylar ridge and condyle of the humerus. These septa serve to separate the muscles of the anterior from those of the posterior brachial region. The external intermuscular septum extends from the lower part of the anterior bicipital ridge, along the external supracondylar ridge, to the outer condyle; it is blended with the tendon of the Deltoid, gives attachment to the Triceps behind, to the Brachialis anticus, Supinator longus, and Extensor carpi radialis longior, in front, and is

perforated by the musculo-spiral nerve and superior profunda artery. The internal intermuscular septum, thicker than the preceding, extends from the lower part of the posterior lip of the bicipital groove below the Teres major, along the internal supra-condylar ridge to the inner condyle; it is blended with the tendon of the Coraco-brachialis, and affords attachment to the Triceps behind, and the Brachialis anticus in front. It is perforated by the ulnar nerve and the inferior profunda and anastomotic arteries. At the elbow the deep fascia is attached to all the prominent points round the joint—viz. the condyles of the humerus and the olecranon process of the ulna—and is continuous with the deep fascia of the forearm. Just below the middle of the arm, on its inner side, in front of the internal intermuscular septum, is an oval opening in the deep fascia which transmits the basilic vein and some lymphatic vessels. On the removal of this fascia the muscles, vessels, and nerves of the anterior humeral region are exposed.

The **Coraco-brachialis**, the smallest of the three muscles in this region, is situated at the upper and inner part of the arm. It arises by fleshy fibres from the apex of the coracoid process, in common with the short head of the Biceps, and from the intermuscular septum between the two muscles; the fibres pass downward, backward, and a little outward, to be inserted by means of a flat tendon into an impression at the middle of the inner surface and internal border of the shaft of the humerus between the origins of the Triceps and Brachialis anticus. It is perforated by the musculo-cutaneous nerve. The inner border of the muscle forms a guide to the position of the brachial artery in tying the vessel in the upper part of its course.

Relations.—By its *anterior surface*, with the Pectoralis major above, and at its insertion with the brachial vessels and median nerve which cross it; by its *posterior surface*, with the tendons of the Subscapularis, Latissimus dorsi, and Teres major, the inner head of the Triceps, the humerus, and the anterior circumflex vessels; by its *inner border*, with the brachial artery, and the median and musculo-cutaneous nerves; by its *outer border*, with the short head of the Biceps and Brachialis anticus.

The **Biceps** (*Biceps flexor cubiti*) is a long fusiform muscle, occuping the whole of the anterior surface of the arm, and divided above into two portions or heads, from which circumstance it has received its name. The short head arises by a thick flattened tendon from the apex of the coracoid process, in common with the Coraco-brachialis. The long head arises from the upper margin of the glenoid cavity, and is continuous with the glenoid ligament. This tendon arches over the head of the humerus, being enclosed in a special sheath of the synovial membrane of the shoulder-joint; it then passes through an opening in the capsular ligament at its attachment to the humerus, and descends in the bicipital groove, in which it is retained by a fibrous prolongation from the tendon of the Pectoralis major. Each tendon is succeeded by an elongated muscular belly, and the two bellies, although closely applied to each other, can readily be separated until within about three inches of the elbow-joint. Here they end in a flattened tendon, which is inserted into the back part of the tuberosity of the radius, a synovial bursa being interposed between the tendon and the front of the tuberosity. As the tendon of the muscle approaches the radius it becomes twisted upon itself, so that its anterior surface becomes external and is applied to the tuberosity of the radius at its insertion: opposite the bend of the elbow the tendon gives off, from its inner side, a broad aponeurosis, the *bicipital fascia* (*semilunar fascia*), which passes obliquely downward and inward across the brachial artery, and is continuous with the deep fascia of the forearm (Fig. 229). The inner border of this muscle forms a guide to the position of the vessel in tying the brachial artery in the middle of the arm.[1]

[1] A third head to the Biceps is occasionally found (Theile says as often as once in eight or nine subjects), arising at the upper and inner part of the Brachialis anticus, with the fibres of which it is continuous, and inserted into the bicipital fascia and inner side of the tendon of the Biceps. In most cases this additional slip passes behind the brachial artery in its course down the arm. Occasionally the third head consists of two slips which pass down, one in front, the other behind the artery, concealing the vessel in the lower half of the arm.

Relations.—Its *anterior surface* is overlapped above by the Pectoralis major and Deltoid; in the rest of its extent it is covered by the superficial and deep fasciæ and the integument. Its *posterior surface* rests above on the shoulder-joint and upper part of the humerus; below it rests on the Brachialis anticus, with the musculo-cutaneous nerve intervening between the two, and on the Supinator brevis. Its *inner border* is in relation with the Coraco-brachialis, and overlaps the brachial vessels and median nerve; its *outer border*, with the Deltoid and Supinator longus.

The **Brachialis anticus** is a broad muscle, which covers the elbow-joint and the lower half of the front of the humerus. It is somewhat compressed from before backward, and is broader in the middle than at either extremity. It arises from the lower half of the outer and inner surfaces of the shaft of the humerus, and commences above at the insertion of the Deltoid, which it embraces by two angular processes. Its origin extends below, to within an inch of the margin of the articular surface, and is limited on each side by the external and internal borders of the shaft of the humerus. It also arises from the intermuscular septa on each side, but more extensively from the inner than the outer, from which it is separated below by the Supinator longus and Extensor carpi radialis longior. Its fibres converge to a thick tendon, which is inserted into a rough depression on the anterior surface of the coronoid process of the ulna, being received into an interval between two fleshy slips of the Flexor profundus digitorum.

Relations.—By its *anterior surface*, with the Biceps, the brachial vessels, musculo-cutaneous, and median nerves; by its *posterior surface*, with the humerus and front of the elbow-joint; by its *inner border*, with the Triceps, ulnar nerve, and Pronator radii teres, from which it is separated by the intermuscular septum; by its *outer border*, with the musculo-spiral nerve, radial recurrent artery, the Supinator longus, and Extensor carpi radialis longior.

Nerves.—The muscles of this group are supplied by the musculo-cutaneous nerve. The Brachialis anticus usually receives an additional filament from the musculo-spiral. The Coraco-brachialis receives its supply primarily from the seventh cervical, the Biceps and Brachialis anticus from the fifth and sixth cervical nerves.

Actions.—The Coraco-brachialis draws the humerus forward and inward, and at the same time assists in elevating it toward the scapula. The Biceps is a flexor of the forearm; it is also a powerful supinator, and serves to render tense the deep fascia of the forearm by means of the broad aponeurosis given off from its tendon. The Brachialis anticus is a flexor of the forearm, and forms an important defence to the elbow-joint. When the forearm is fixed, the Biceps and Brachialis anticus flex the arm upon the forearm, as is seen in efforts of climbing.

7. Posterior Humeral Region.

Triceps. Subanconeus.

The **Triceps** (*Triceps extensor cubiti*) (Fig. 232) is situated on the back of the arm, extending the entire length of the posterior surface of the humerus. It is of large size, and divided above into three parts; hence its name. These three portions have been named (1) the middle, scapular, or long head; (2) the external, or long humeral; and (3) the internal, or short humeral head.

The *middle* or *scapular head* arises, by a flattened tendon, from a rough triangular depression on the scapula, immediately below the glenoid cavity, being blended at its upper part with the capsular ligament; the muscular fibres pass downward between the two other portions of the muscle, and join with them in the common tendon of insertion.

The *external head* arises from the posterior surface of the shaft of the humerus, between the insertion of the Teres minor and the upper part of the musculo-spiral groove; from the external border of the humerus and the external intermuscular

septum: the fibres from this origin converge toward the common tendon of insertion.

The *internal head* arises from the posterior surface of the shaft of the humerus, below the groove for the musculo-spiral nerve; commencing above, narrow and pointed, below the insertion of the Teres major, and extending to within an inch of the trochlear surface: it also arises from the internal border of the humerus, and from the back of the whole length of the internal and lower part of the external intermuscular septa. The fibres of this portion of the muscle are directed, some downward to the olecranon, whilst others converge to the common tendon of insertion.

The *common tendon* of the Triceps commences about the middle of the back part of the muscle: it consists of two aponeurotic laminæ, one of which is subcutaneous and covers the posterior surface of the muscle for the lower half of its extent; the other is more deeply seated in the substance of the muscle: after receiving the attachment of the muscular fibres, they join together above the elbow, and are inserted, for the most part, into the back part of the upper surface of the olecranon process; a band of fibres is, however, continued downward, on the outer side, over the Anconeus, to blend with the deep fascia of the forearm. A small bursa, occasionally multilocular, is situated on the front part of this surface, beneath the tendon.

The long head of the Triceps descends between the Teres minor and Teres major, dividing the triangular space between these two muscles and the humerus into two smaller spaces, one triangular, the other quadrangular (Fig. 232). The triangular space contains the dorsalis scapulæ vessels; it is bounded by the Teres minor above, the Teres major below, and the scapular head of the Triceps externally: the quadrangular space transmits the posterior circumflex vessels and the circumflex nerve; it is bounded by the Teres minor above, the Teres major below, the scapular head of the Triceps internally, and the humerus externally.

Relations.—By its *posterior surface*, with the Deltoid above: in the rest of its extent it is subcutaneous; by its *anterior surface*, with the humerus, musculo-spiral nerve, superior profunda vessels, and back part of the elbow-joint. Its *middle* or *long head* is in relation, behind, with the Deltoid and Teres minor; in front, with the Subscapularis, Latissimus dorsi, and Teres major.

The **Subanconeus** is a name given to a few fibres from the under surface of the lower part of the Triceps muscle, which are inserted into the posterior ligament of the elbow-joint. By some authors it is regarded as the analogue of the Subcrureus in the lower limb, but it is not a separate muscle.

Nerves.—The Triceps is supplied by the seventh and eighth cervical nerves through the musculo-spiral nerve.

Actions.—The Triceps is the great extensor muscle of the forearm, serving, when the forearm is flexed, to extend the elbow-joint. It is the direct antagonist of the Biceps and Brachialis anticus. When the arm is extended the long head of the muscle may assist the Teres major and Latissimus dorsi in drawing the humerus backward and in adducting it to the thorax. The long head of the Triceps protects the under part of the shoulder-joint, and prevents displacement of the head of the humerus downward and backward. The Subanconeus draws up the posterior ligament during extension of the forearm.

Surgical Anatomy.—The existence of the band of fibres from the Triceps to the fascia of the forearm is of importance in excision of the elbow, and should always be carefully preserved from injury by the operator, as by means of these fibres the patient is enabled to extend the forearm, a movement which would otherwise mainly be accomplished by gravity; that is to say, allowing the forearm to drop from its own weight.

III. MUSCLES AND FASCIÆ OF THE FOREARM.

Dissection.—To dissect the forearm, place the limb in the position indicated in Fig. 228; make a vertical incision along the middle line from the elbow to the wrist, and a transverse incision at the extremity of this; the superficial structures being removed, the deep fascia of the forearm is exposed.

The **deep fascia** of the forearm, continuous above with that enclosing the arm, is a dense, highly glistening aponeurotic investment, which forms a general sheath enclosing the muscles in this region; it is attached, behind, to the olecranon and posterior border of the ulna, and gives off from its inner surface numerous intermuscular septa, which enclose each muscle separately. Below, it is continuous in front with the anterior annular ligament, and forms a sheath for the tendon of the Palmaris longus muscle, which passes over the annular ligament to be inserted into the palmar fascia. Behind, near the wrist-joint, it becomes much thickened by the addition of many transverse fibres, and forms the posterior annular ligament. It consists of circular and oblique fibres, connected together by numerous vertical fibres. It is much thicker on the dorsal than on the palmar surface, and at the lower than at the upper part of the forearm, and is strengthened above by tendinous fibres derived from the Brachialis anticus and Biceps in front, and from the Triceps behind. Its deep surface gives origin to muscular fibres, especially at the upper part of the inner and outer sides of the forearm, and forms the boundaries of a series of conical-shaped cavities, in which the muscles are contained. Besides the vertical septa separating each muscle, transverse septa are given off both on the anterior and posterior surfaces of the forearm, separating the deep from the superficial layer of muscles. Numerous apertures exist in the fascia for the passage of vessels and nerves; one of these, of large size, situated at the front of the elbow, serves for the passage of a communicating branch between the superficial and deep veins.

The muscles of the forearm may be subdivided into groups corresponding to the region they occupy. One group occupies the inner and anterior aspect of the forearm, and comprises the Flexor and Pronator muscles. Another group occupies its outer side, and a third its posterior aspect. The two latter groups include all the Extensor and Supinator muscles.

8. Anterior Radio-ulnar Region.

The muscles in this region are divided for convenience of description into two groups or layers, superficial and deep.

Superficial Layer.

Pronator radii teres.	Flexor carpi ulnaris.
Flexor carpi radialis.	Flexor sublimis digitorum.
Palmaris longus.	

These muscles take origin from the internal condyle of the humerus by a common tendon.

The **Pronator radii teres** arises by two heads. One, the larger and more superficial, arises from the humerus, immediately above the internal condyle, and from the tendon common to the origin of the other muscles; also from the fascia of the forearm and intermuscular septum between it and the Flexor carpi radialis. The other head is a thin fasciculus which arises from the inner side of the coronoid process of the ulna, joining the preceding at an acute angle. Between the two heads the median nerve enters the forearm. The muscle passes obliquely across the forearm from the inner to the outer side, and terminates in a flat tendon, which turns over the outer margin of the radius, and is inserted into a rough impression at the middle of the outer surface of the shaft of that bone.

Relations.—By its *anterior surface*, throughout the greater part of its extent, with the deep fascia; at its insertion it is crossed by the radial vessels and nerve, and covered by the Supinator longus; by its *posterior surface*, with the Brachialis anticus, Flexor sublimis digitorum, the median nerve, and ulnar artery, the small or deep head being interposed between the two latter structures. Its *outer border* forms the inner boundary of a triangular space in which are placed the brachial artery, median nerve, and tendon of the Biceps muscle. Its *inner border* is in contact with the Flexor carpi radialis.

Surgical Anatomy.—This muscle, when suddenly brought into very active use, as in the game of lawn tennis, is apt to be strained, producing slight swelling, tenderness, and pain on putting the muscle into action. This is known as "lawn-tennis arm."

The **Flexor carpi radialis** lies on the inner side of the preceding muscle. It arises from the internal condyle by the common tendon, from the fascia of the forearm, and from the intermuscular septa between it and the Pronator radii teres, on the outside, the Palmaris longus internally, and the Flexor sublimis digitorum beneath. Slender and aponeurotic in structure at its commencement, it increases in size, and terminates in a tendon which forms rather more than the lower half of its length. This tendon passes through a canal on the outer side of the annular ligament, runs through a groove in the os trapezium (which is converted into a canal by a fibrous sheath, and lined by a synovial membrane), and is inserted into the base of the metacarpal bone of the index finger, and by a slip into the base of the metacarpal bone of the middle finger. The radial artery lies between the tendon of this muscle and the Supinator longus, and may easily be tied in this situation.

Fig. 233.—Front of the left forearm: superficial muscles.

Relations.—By its *superficial surface*, with the deep fascia and the integument; by its *deep surface*, with the Flexor sublimis digitorum, Flexor longus pollicis, and wrist-joint; by its *outer border*, with the Pronator radii teres and the radial vessels; by its *inner border*, with the palmaris longus above and the median nerve below.

The **Palmaris longus** is a slender, fusiform muscle lying on the inner side of the preceding. It arises from the inner condyle of the humerus by the common tendon, from the deep fascia, and the intermuscular septa between it and the adjacent muscles. It terminates in a slender flattened tendon, which passes over the upper part of the annular ligament, to end in the central part of the palmar fascia and lower part of the annular ligament, frequently sending a tendinous slip to the short muscles of the thumb. This muscle is often absent, and is subject to very considerable variations: it may be tendinous above and muscular below; or it may be muscular in the centre, with a tendon above and below; or it may present two muscular bundles with a central tendon; or finally it may consist simply of a mere tendinous band.

Relations.—By its *superficial surface*, with the deep fascia. By its *deep surface*, with the Flexor sublimis digitorum. *Internally*, with the Flexor carpi ulnaris. *Externally*, with the Flexor carpi radialis. The median nerve lies close to the tendon, just above the wrist, on its inner and posterior side.

The **Flexor carpi ulnaris** lies along the ulnar side of the forearm. It arises by two heads, connected by a tendinous arch, beneath which pass the ulnar nerve and posterior ulnar recurrent artery. One head arises from the inner condyle of the humerus by the common tendon; the other from the inner margin of the olecranon and from the upper two-thirds of the posterior border of the ulna by an aponeurosis, common

to it and the Extensor carpi ulnaris and Flexor profundus digitorum; and from the intermuscular septum between it and the Flexor sublimis digitorum. The fibres terminate in a tendon which occupies the anterior part of the lower half of the muscle, and is inserted into the pisiform bone, and is prolonged from this to the fifth metacarpal and unciform bones, by the piso-metacarpal and piso-uncinate ligaments: it is also attached by a few fibres to the annular ligament. The ulnar artery lies on the outer side of the tendon of this muscle, in the lower two-thirds of the forearm, the tendon forming a guide in tying the vessel in this situation.

Relations.—By its *superficial surface*, with the deep fascia, with which it is intimately connected for a considerable extent; by its *deep surface*, with the Flexor sublimis digitorum, the Flexor profundus digitorum, the Pronator quadratus, and the ulnar vessels and nerve; by its *outer* or *radial border*, with the Palmaris longus above and the ulnar vessels and nerve below.

The **Flexor sublimis digitorum (perforatus)** is placed beneath the preceding muscles, which therefore must be removed in order to bring its attachment into view. It is the largest of the muscles of the superficial layer, and arises by three heads. One head arises from the internal condyle of the humerus by the common tendon, from the internal lateral ligament of the elbow-joint, and from the intermuscular septum common to it and the preceding muscles. The second head arises from the inner side of the coronoid process of the ulna, above the ulnar origin of the Pronator radii teres (Fig. 100, p. 151). The third head arises from the oblique line of the radius, extending from the tubercle to the insertion of the Pronator radii teres. The fibres pass vertically downward, forming a broad and thick muscle, which speedily divides into two planes of muscular fibres, superficial and deep: the superficial plane divides into two parts which end in tendons for the middle and ring fingers; the deep plane also divides into two parts, which end in tendons for the index and little fingers, but previously to having done so, it gives off a muscular slip, which joins that part of the superficial plane which is intended for the ring finger. As the four tendons thus formed pass beneath the annular ligament into the palm of the hand, they are arranged in pairs, the superficial pair corresponding to the middle and ring fingers, the deep pair to the index and little fingers. The tendons diverge from one another as they pass onward. Opposite the bases of the first phalanges each tendon divides into two slips, to allow of the passage of the corresponding tendon of the Flexor profundus digitorum; the two portions of the tendon then unite and form a grooved channel for the reception of the accompanying deep flexor tendon. Finally they subdivide a second time, to be inserted into the sides of the second phalanges about their middle. After leaving the palm, these tendons, accompanied by the deep flexor tendons, lie in osseo-aponeurotic canals (Fig. 234). These canals are formed by strong fibrous bands, which arch across the tendons, and are attached on each side to the margins of the phalanges. Opposite the middle of the proximal and second phalanges the sheath is very strong, and the fibres pass transversely; but opposite the joints it is much thinner, and the fibres pass obliquely. Each sheath is lined by a synovial membrane, which is reflected on the contained tendons.

Relations.—In the forearm, by its *superficial surface*, with the deep fascia and all the preceding superficial muscles; by its *deep surface*, with the Flexor profundus digitorum, Flexor longus pollicis, the ulnar vessels and nerve, and the median nerve. In the hand its tendons are in relation, *in front*, with the palmar fascia, superficial palmar arch, and the branches of the median nerve; *behind*, with the tendons of the deep Flexor and the Lumbricales.

Deep Layer.

Flexor profundus digitorum. Flexor longus pollicis.
Pronator quadratus.

Dissection.—Divide each of the superficial muscles at its centre, and turn either end aside; the deep layer of muscles, together with the median nerve and ulnar vessels, will then be exposed.

The **Flexor profundus digitorum (perforans)** (Fig. 234) is situated on the ulnar side of the forearm, immediately beneath the superficial Flexors. It arises from the upper three-fourths of the anterior and inner surfaces of the shaft of the ulna, embracing the insertion of the Brachialis anticus above, and extending, below, to within a short distance of the Pronator quadratus. It also arises from a depression on the inner side of the coronoid process; by an aponeurosis from the upper three-fourths of the posterior border of the ulna, in common with the Flexor and Extensor carpi ulnaris; and from the ulnar half of the interosseous membrane. The fibres form a fleshy belly of considerable size, which divides into four tendons: these pass under the annular ligament beneath the tendons of the Flexor sublimis digitorum. Opposite the first phalanges the tendons pass through the openings in the two slips of the tendons of the Flexor sublimis digitorum, and are finally inserted into the bases of the last phalanges. The portion of the muscle for the index finger is usually distinct throughout, but the tendons for the three inner fingers are connected together by cellular tissue and tendinous slips as far as the palm of the hand. The tendons of this muscle and those of the Flexor sublimis digitorum, whilst contained in the osseo-aponeurotic canals of the fingers, are invested in a synovial sheath, and are connected to each other and to the phalanges by slender tendinous filaments, called *vincula accessoria tendinum*. One of these connects the deep tendon to the bone before it passes through the superficial tendon; a second connects the two tendons together, after the deep tendons have passed through; and a third connects the deep tendon to the head of the second phalanx. This last consists largely of yellow elastic tissue, and may assist in drawing down the tendon after flexion of the finger.[1]

Four small muscles, the Lumbricales, are connected with the tendons of the Flexor profundus in the palm. They will be described with the muscles in that region.

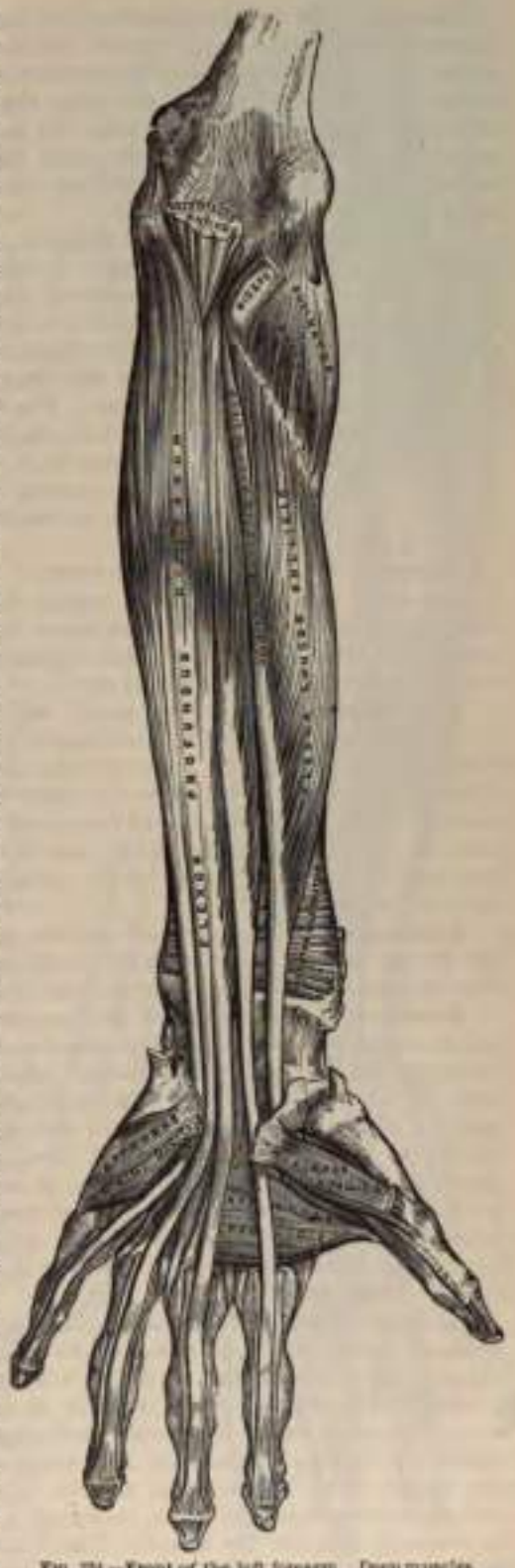


FIG. 234.—Front of the left forearm. Deep muscles.

[1] Marshall, *Brit. and For. Med.-Chir. Rev.*, 1853.

Relations.—By its *superficial surface*, in the forearm, with the Flexor sublimis digitorum, the Flexor carpi ulnaris, the ulnar vessels and nerve, and the median nerve; and in the hand, with the tendons of the superficial Flexor; by its *deep surface*, in the forearm, with the ulna, the interosseous membrane, the Pronator quadratus; and in the hand, with the interossei, Adductor pollicis, and deep palmar arch; by its *ulnar border*, with the Flexor carpi ulnaris; by its *radial border*, with the Flexor longus pollicis, the anterior interosseous vessels and nerve being interposed.

The **Flexor longus pollicis** is situated on the radial side of the forearm, lying on the same plane as the preceding. It arises from the grooved anterior surface of the shaft of the radius, commencing above, immediately below the tuberosity and oblique line, and extending below to within a short distance of the Pronator quadratus. It also arises from the adjacent part of the interosseous membrane, and generally by a fleshy slip from the inner border of the coronoid process or from the internal condyle of the humerus. The fibres pass downward, and terminate in a flattened tendon which passes beneath the annular ligament, is then lodged in the interspace between the outer head of the Flexor brevis pollicis and the Adductor obliquus pollicis, and, entering an osseo-aponeurotic canal similar to those for the other flexor tendons, is inserted into the base of the last phalanx of the thumb.

Relations.—By its *superficial surface*, with the Flexor sublimis digitorum, Flexor carpi radialis, Supinator longus, and radial vessels; by its *deep surface*, with the radius, interosseous membrane, and Pronator quadratus; by its *ulnar border*, with the Flexor profundus digitorum, from which it is separated by the anterior interosseous vessels and nerve.

The **Pronator quadratus** is a small, flat, quadrilateral muscle, extending transversely across the front of the radius and ulna, above their carpal extremities. It arises from the oblique or pronator ridge on the lower part of the anterior surface of the shaft of the ulna; from the lower fourth of the anterior surface and the anterior border of the ulna; and from a strong aponeurosis which covers the inner third of the muscle. The fibres pass outward and slightly downward, to be inserted into the lower fourth of the anterior surface and anterior border of the shaft of the radius.

Relations.—By its *superficial surface*, with the Flexor profundus digitorum, the Flexor longus pollicis, Flexor carpi radialis, and the radial vessels; by its *deep surface*, with the radius, ulna, and interosseous membrane.

Nerves.—All the muscles of the superficial layer are supplied by the median nerve, excepting the Flexor carpi ulnaris, which is supplied by the ulnar. The Pronator radii teres and the Flexor carpi radialis derive their supply primarily from the sixth cervical; the Palmaris longus from the eighth cervical; the Flexor sublimis digitorum from the seventh and eighth cervical and first dorsal, and the Flexor carpi ulnaris from the eighth cervical and first dorsal nerves. Of the deep layer, the Flexor profundus digitorum is supplied by the eighth cervical and first dorsal through the ulnar and anterior interosseous branch of the median. The remaining two muscles, Flexor longus pollicis and Pronator quadratus, are also supplied by the eighth cervical and first dorsal through the anterior interosseous branch of the median.

Actions.—These muscles act upon the forearm, the wrist, and hand. The Pronator radii teres helps to rotate the radius upon the ulna, rendering the hand prone: when the radius is fixed it assists the other muscles in flexing the forearm. The Flexor carpi radialis is one of the flexors of the wrist; when acting alone it flexes the wrist, inclining it to the radial side. It can also assist in pronating the forearm and hand, and, by continuing its action, to bend the elbow. The Flexor carpi ulnaris is one of the flexors of the wrist: when acting alone it flexes the wrist, inclining it to the ulnar side, and, by continuing to contract, it bends the elbow. The Palmaris longus is a tensor of the palmar fascia. It also assists in flexing the wrist and elbow. The Flexor sublimis

digitorum flexes first the middle and then the approximal phalanx. It assists in flexing the wrist and elbow. The Flexor profundus digitorum is one of the flexors of the phalanges. After the Flexor sublimis has bent the second phalanx, the Flexor profundus flexes the terminal one, but it cannot do so until after the contraction of the superficial muscle. It also assists in flexing the wrist. The Flexor longus pollicis is a flexor of the phalanges of the thumb. When the thumb is fixed it also assists in flexing the wrist. The Pronator quadratus helps to rotate the radius upon the ulna, rendering the hand prone.

9. Radial Region (Fig. 235).

Supinator longus.
Extensor carpi radialis longior.
Extensor carpi radialis brevior.

Dissection.—Divide the integument in the same manner as in the dissection of the anterior brachial region, and, after having examined the cutaneous vessels and nerves and deep fascia, remove all these structures. The muscles will then be exposed. The removal of the fascia will be considerably facilitated by detaching it from below upward. Great care should be taken to avoid cutting across the tendons of the muscles of the thumb, which cross obliquely the larger tendons running down the back of the radius.

The **Supinator longus** (brachio-radialis) is the most superficial muscle on the radial side of the forearm; it is fleshy for the upper two-thirds of its extent, tendinous below. It arises from the upper two-thirds of the external supracondylar ridge of the humerus, and from the external intermuscular septum, being limited above by the musculo-spiral groove. The fibres terminate above the middle of the forearm in a flat tendon, which is inserted into the outer side of the base of the styloid process of the radius.

Relations.—By its *superficial surface*, with the integument and fascia for the greater part of its extent; near its insertion it is crossed by the Extensor ossis metacarpi pollicis and the Extensor brevis pollicis; by its *deep surface*, with the humerus, the Extensor carpi radialis longior and brevior, the insertion of the Pronator radii teres, and the Supinator brevis;

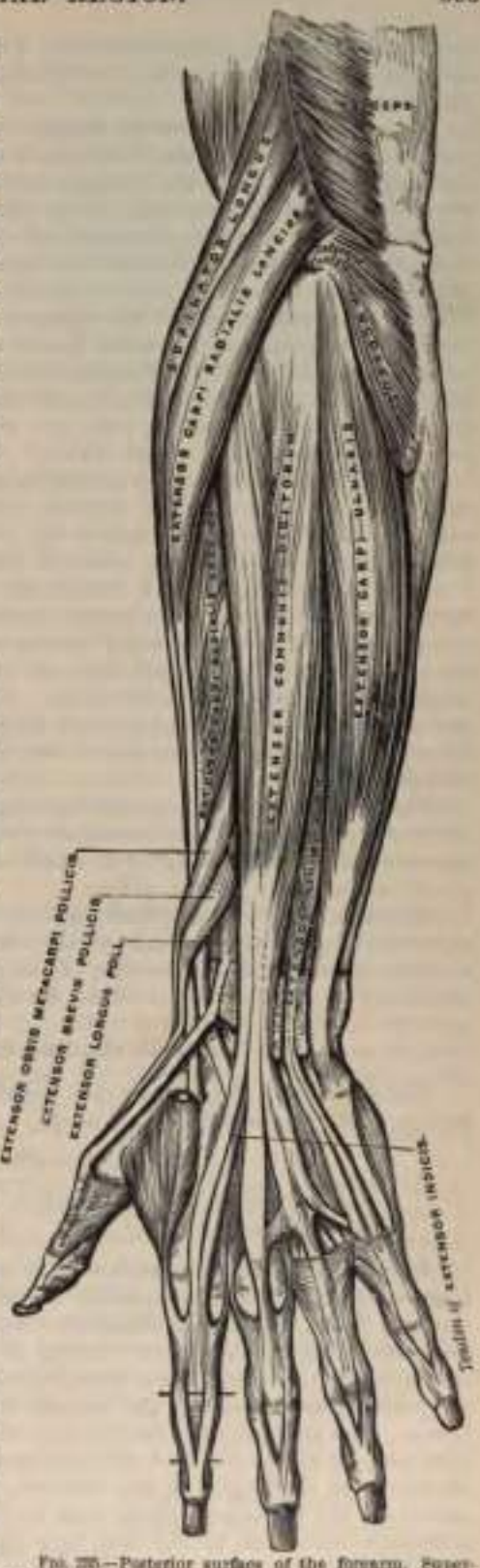


FIG. 235.—Posterior surface of the forearm. Superficial muscles.

by its *inner border*, above the elbow, with the Brachialis anticus, the musculo-spiral nerve, and radial recurrent artery; and in the forearm with the radial vessels and nerve.

The **Extensor carpi radialis longior** is placed partly beneath the preceding muscle. It arises from the lower third of the external supracondylar ridge of the humerus, and from the external intermuscular septum by a few fibres from the common tendon of origin of the Extensor muscles of the forearm. The fibres terminate at the upper third of the forearm in a flat tendon, which runs along the outer border of the radius, beneath the extensor tendons of the thumb; it then passes through a groove common to it and the Extensor carpi radialis brevior, immediately behind the styloid process, and is inserted into the base of the metacarpal bone of the index finger, on its radial side.

Relations.—By its *superficial surface*, with the Supinator longus and fascia of the forearm; its *outer side* is crossed obliquely by the extensor tendons of the thumb; by its *deep surface*, with the elbow-joint, the Extensor carpi radialis brevior, and back part of the wrist.

The **Extensor carpi radialis brevior** is shorter, as its name implies, and thicker than the preceding muscle, beneath which it is placed. It arises from the external condyle of the humerus by a tendon common to it and the three following muscles; from the external lateral ligament of the elbow-joint, from a strong aponeurosis which covers its surface, and from the intermuscular septa between it and the adjacent muscles. The fibres terminate about the middle of the forearm in a flat tendon which is closely connected with that of the preceding muscle, and accompanies it to the wrist, lying in the same groove on the posterior surface of the radius; it passes beneath the extensor tendons of the thumb, then beneath the annular ligament, and, diverging somewhat from its fellow, is inserted into the base of the metacarpal bone of the middle finger, on its radial side.

The tendons of the two preceding muscles pass through the same compartment of the annular ligament, and are lubricated by a single synovial membrane, but are separated from each other by a small vertical ridge of bone as they lie in the groove at the back of the radius.

Relations.—By its *superficial surface*, with the Extensor carpi radialis longior, and with the Extensor muscles of the thumb which cross it; by its *deep surface*, with the Supinator brevis, tendon of the Pronator radii teres, radius, and wrist-joint; by its *ulnar border*, with the Extensor communis digitorum.

10. Posterior Radio-ulnar Region (Fig. 235).

The muscles in this region are divided for purposes of description into two groups or layers, superficial and deep.

Superficial Layer.

Extensor communis digitorum.	Extensor carpi ulnaris.
Extensor minimi digiti.	Anconeus.

The **Extensor communis digitorum** is situated at the back part of the forearm. It arises from the external condyle of the humerus by the common tendon, from the deep fascia, and the intermuscular septa between it and the adjacent muscles. Just below the middle of the forearm it divides into three fleshy masses, from which tendons proceed; these pass, together with the Extensor indicis, through a separate compartment of the annular ligament, lubricated by a synovial membrane. The tendons then diverge, the innermost one dividing into two; and all, after passing across the back of the hand, are inserted into the second and third phalanges of the fingers in the following manner: the outermost tendon, accompanied by the Extensor indicis, goes to the index finger; the second tendon is sometimes connected to the first by a thin transverse band, and receives a slip from the third tendon; it goes to the middle finger; the third tendon gives off

the slip to the second, and receives a very considerable part of the fourth tendon; the fourth, or innermost tendon, divides into two parts: one goes to join the third tendon, the other, reinforced by the Extensor minimi digiti, goes to the little finger. Each tendon opposite the metacarpo-phalangeal articulation becomes narrow and thickened, and gives off a thin fasciculus upon each side of the joint, which blends with the lateral ligaments and serves as the posterior ligament; after having passed the joint it spreads out into a broad aponeurosis, which covers the whole of the dorsal surface of the first phalanx, being reinforced, in this situation, by the tendons of the Interossei and Lumbricales. Opposite the first phalangeal joint this aponeurosis divides into three slips, a middle and two lateral: the former is inserted into the base of the second phalanx; and the two lateral, which are continued onward along the sides of the second phalanx, unite by their contiguous margins, and are inserted into the dorsal surface of the last phalanx. As the tendons cross the phalangeal joints they furnish them with posterior ligaments.

Relations.—By its *superficial surface*, with the fascia of the forearm and hand, the posterior annular ligament, and integument; by its *deep surface*, with the Supinator brevis, the Extensor muscles of the thumb and index finger, the posterior interosseous vessels and nerve, the wrist-joint, carpus, metacarpus, and phalanges; by its *radial border*, with the Extensor carpi radialis brevior; by its *ulnar border*, with the Extensor minimi digiti and Extensor carpi ulnaris.

The **Extensor minimi digiti** is a slender muscle placed on the inner side of the Extensor communis, with which it is generally connected. It arises from the common tendon by a thin, tendinous slip, and from the intermuscular septa between it and the adjacent muscles. Its tendon runs through a separate compartment in the annular ligament behind the inferior radio-ulnar joint, then divides into two as it crosses the hand, the outermost division being joined by the slip from the innermost tendon of the common extensor. The two slips thus formed spread into a broad aponeurosis, which after receiving a slip from the Abductor minimi digiti is inserted into the second and third phalanges. The tendon is situated on the ulnar side of, and somewhat more superficial than, the common extensor.

The **Extensor carpi ulnaris** is the most superficial muscle on the ulnar side of the forearm. It arises from the external condyle of the humerus by the common tendon; by an aponeurosis from the posterior border of the ulna in common with the Flexor carpi ulnaris and the Flexor profundus digitorum; and from the deep fascia of the forearm. This muscle terminates in a tendon which runs through a groove behind the styloid process of the ulna, passes through a separate compartment in the annular ligament, and is inserted into the prominent tubercle on the ulnar side of the base of the metacarpal bone of the little finger.

Relations.—By its *superficial surface*, with the deep fascia of the forearm; by its *deep surface*, with the ulna and the muscles of the deep layer.

The **Anconeus** is a small triangular muscle placed behind and below the elbow-joint, and appears to be a continuation of the external portion of the Triceps. It arises by a separate tendon from the back part of the outer condyle of the humerus, and is inserted into the side of the olecranon and upper fourth of the posterior surface of the shaft of the ulna; its fibres diverge from their origin, the upper ones being directed transversely, the lower obliquely inward.

Relations.—By its *superficial surface*, with a strong fascia derived from the Triceps; by its *deep surface*, with the elbow-joint, the orbicular ligament, the ulna, and a small portion of the Supinator brevis.

Deep Layer (Fig. 237).

Supinator brevis.
Extensor ossis metacarpi pollicis.
Extensor brevis pollicis.
Extensor longus pollicis.
Extensor indicis.

The **Supinator brevis** (Fig. 236) is a broad muscle, of hollow cylindrical form, curved round the upper third of the radius. It consists of two distinct planes of muscular fibres, between which lies the posterior interosseous nerve. The two planes arise in common: the superficial one by tendinous, and the deeper by muscular, fibres from the external condyle of the humerus; from the external lateral ligament of the elbow-joint and the orbicular ligament of the radius; from the ridge on the ulna, which runs obliquely downward from the posterior extremity of the lesser sigmoid cavity; from the triangular depression in front of it; and from a tendinous expansion which covers the surface of the muscle. The superficial fibres surround the upper part of

FIG. 236.—Supinator brevis. (From a preparation in the Museum of the Royal College of Surgeons of England.)

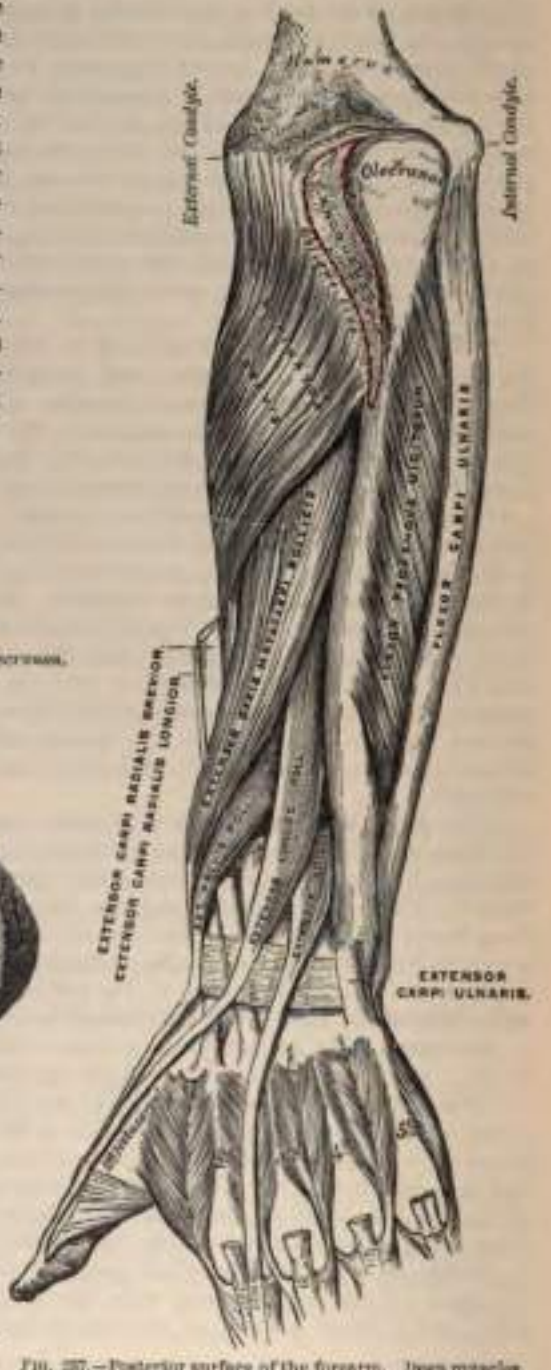


FIG. 237.—Posterior surface of the forearm. Deep muscles.

the radius, and are inserted into the outer edge of the bicipital tuberosity and to the oblique line of the radius, as low down as the insertion of the Pronator radii teres. The upper fibres of the deeper plane form a sling-like fasciculus, which encircles the neck of the radius above the tuberosity and is

attached to the back part of its inner surface: the greater part of this portion of the muscle is inserted into the posterior and external surface of the shaft, midway between the oblique line and the head of the bone. Between the insertion of the two planes the posterior interosseous nerve lies on the shaft of the bone.

Relations.—By its *superficial surface*, with the superficial Extensor and Supinator muscles, and the radial vessels and nerve; by its *deep surface*, with the elbow-joint, the interosseous membrane, and the radius.

The **Extensor ossis metacarpi pollicis** is the most external and the largest of the deep extensor muscles: it lies immediately below the Supinator brevis, with which it is sometimes united. It arises from the outer part of the posterior surface of the shaft of the ulna below the insertion of the Anconeus, from the interosseous membrane, and from the middle third of the posterior surface of the shaft of the radius. Passing obliquely downward and outward, it terminates in a tendon which runs through a groove on the outer side of the styloid process of the radius, accompanied by the tendon of the Extensor brevis pollicis, and is inserted into the base of the metacarpal bone of the thumb. It occasionally gives off two slips near its insertion—one to the Trapezium, and the other to blend with the origin of the Abductor pollicis.

Relations.—By its *superficial surface*, with the Extensor communis digitorum, Extensor minimi digiti, and fascia of the forearm, and with the branches of the posterior interosseous artery and nerve which cross it; by its *deep surface*, with the ulna, interosseous membrane, radius, the tendons of the Extensor carpi radialis longior and brevior, which it crosses obliquely, and, at the outer side of the wrist, with the radial vessels; by its *upper border*, with the Supinator brevis; by its *lower border*, with the Extensor brevis pollicis.

The **Extensor brevis pollicis** (*Extensor primi internodii pollicis*), the smallest muscle of this group, lies on the inner side of the preceding. It arises from the posterior surface of the shaft of the radius, below the Extensor ossis metacarpi pollicis, and from the interosseous membrane. Its direction is similar to that of the Extensor ossis metacarpi pollicis, its tendon passing through the same groove on the outer side of the styloid process, to be inserted into the base of the first phalanx of the thumb.

Relations.—The same as those of the Extensor ossis metacarpi pollicis.

The **Extensor longus pollicis** (*Extensor secundi internodii pollicis*) is much larger than the preceding muscle, the origin of which it partly covers in. It arises from the outer part of the posterior surface of the shaft of the ulna, below the origin of the Extensor ossis metacarpi pollicis, and from the interosseous membrane. It terminates in a tendon which passes through a separate compartment in the annular ligament, lying in a narrow, oblique groove at the back part of the lower end of the radius. It then crosses obliquely the tendons of the Extensor carpi radialis longior and brevior, being separated from the other extensor tendons of the thumb by a triangular interval, in which the radial artery is found, and is finally inserted into the base of the last phalanx of the thumb.

Relations.—By its *superficial surface*, with the same parts as the Extensor ossis metacarpi pollicis; by its *deep surface*, with the ulna, interosseous membrane, the posterior interosseous nerve, radius, the wrist, the radial vessels, and metacarpal bone of the thumb.

The **Extensor indicis** is a narrow, elongated muscle placed on the inner side of, and parallel with, the preceding. It arises from the posterior surface of the shaft of the ulna, below the origin of the Extensor longus pollicis and from the interosseous membrane. Its tendon passes with the Extensor communis digitorum through the same canal in the annular ligament, and subsequently joins the tendon of the Extensor communis which belongs to the index finger, opposite the lower end of the corresponding metacarpal bone, lying to the ulnar side of the tendon from the common Extensor.

Relations.—The relations are similar to those of the preceding muscles.

Nerves.—The Supinator longus is supplied by the sixth, the Extensor carpi

radialis longior by the sixth and seventh, and the Anconeus by the seventh and eighth cervical nerves, all through the musculo-spiral nerve; the remaining muscles of the radial and posterior brachial region are supplied through the posterior interosseous nerve, the Supinator brevis being supplied by the sixth cervical, the Extensor carpi radialis brevior by the sixth and seventh cervical, and all the other muscles by the seventh cervical.

Actions.—The muscles of the radial and posterior brachial regions, which comprise all the extensor and supinator muscles, act upon the forearm, wrist, and hand; they are the direct antagonists of the pronator and flexor muscles. The Anconeus assists the Triceps in extending the forearm. The chief action of the Supinator longus is that of a flexor of the elbow-joint, but in addition to this it may act both as a supinator or a pronator; that is to say, if the forearm is forcibly pronated it will act as a supinator, and bring the bones into a position midway between supination and pronation; and, *vice versâ*, if the arm is forcibly supinated, it will act as a pronator, and bring the bones into the same position, midway between supination and pronation. The action of the muscle is therefore to throw the forearm and hand into the position they naturally occupy when placed across the chest. The Supinator brevis is a supinator; that is to say, when the radius has been carried across the ulna in pronation and the back of the hand is directed forward, this muscle carries the radius back again to its normal position on the outer side of the ulna, and the palm of the hand is again directed forward. The Extensor carpi radialis longior extends the wrist and abducts the hand. It may also assist in bending the elbow-joint; at all events, it serves to fix or steady this articulation. The Extensor carpi radialis brevior assists the Extensor carpi radialis longior in extending the wrist, and may also act slightly as an abductor of the hand. The Extensor carpi ulnaris helps to extend the hand, but when acting alone inclines it toward the ulnar side; by its continued action it extends the elbow-joint. The Extensor communis digitorum extends the phalanges, then the wrist, and finally the elbow. It acts principally on the proximal phalanges, the middle and terminal phalanges being extended by the Interossei and Lumbricales. It has also a tendency to separate the fingers as it extends them. The Extensor minimi digiti extends similarly the little finger, and by its continued action it assists in extending the wrist. It is owing to this muscle that the little finger can be extended or pointed whilst the others are flexed. The chief action of the Extensor ossis metacarpi pollicis is to carry the thumb outward and backward from the palm of the hand, and hence it has been called the *abductor pollicis longus*. By its continued action it helps to extend and abduct the wrist. The Extensor brevis pollicis extends the proximal phalanx of the thumb. By its continued action it helps to extend and abduct the wrist. The Extensor longus pollicis extends the terminal phalanx of the thumb. By its continued action it helps to extend and abduct the wrist. The Extensor indicis extends the index finger, and by its continued action assists in extending the wrist. It is owing to this muscle that the index finger can be extended or pointed while the others are flexed.

Surgical Anatomy.—The tendons of the Extensor muscles of the thumb are liable to become strained and their sheaths inflamed after excessive exercise, producing a sausage-shaped swelling along the course of the tendon, and giving a peculiar creaking sensation to the finger when the muscle acts. In consequence of its often being caused by such movements as wringing clothes, it is known as "washerwoman's sprain."

IV. MUSCLES AND FASCIÆ OF THE HAND.

The **Muscles of the Hand** are subdivided into three groups: 1. Those of the thumb, which occupy the radial side and produce the *thenar* eminence; 2. Those of the little finger, which occupy the ulnar side and give rise to the *hypothenar* eminence; 3. Those in the middle of the palm and within the interosseous spaces.

Dissection (Fig. 228).—Make a transverse incision across the front of the wrist, and a second across the heads of the metacarpal bones: connect the two by a vertical incision in the middle line, and continue it through the centre of the middle finger. The anterior and posterior annular ligaments and the palmar fascia should then be dissected.

FIG. 228.—Transverse section through the wrist, showing the annular ligaments and the canals for the passage of the tendons.

The **Anterior Annular Ligament** is a strong, fibrous band which arches over the carpus, converting the deep groove on the front of the carpal bones into a canal, beneath which pass the flexor tendons of the fingers. It is attached, internally, to the pisiform bone and the hook of the unciform bone, and externally to the tuberosity of the scaphoid and, to the inner part of the anterior surface and the ridge on the trapezium. It is continuous, above, with the deep fascia of the forearm, of which it may be regarded as a thickened portion, and, below, with the palmar fascia. It is crossed by the ulnar vessels and nerve and the cutaneous branches of the median and ulnar nerves. At its outer extremity is the tendon of the Flexor carpi radialis, which lies in the groove on the trapezium between the attachments of the annular ligament to the bone. It has inserted into its anterior surface a part of the tendon of the Palmaris longus and part of the tendon of the Flexor carpi ulnaris, and has arising from it, below, the small

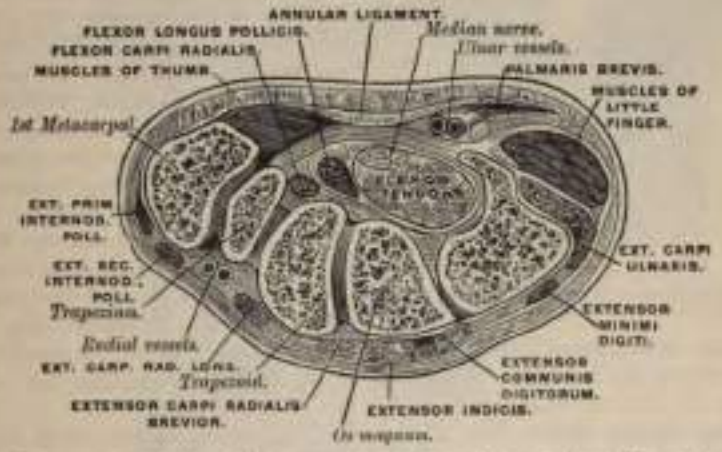


FIG. 229.—Transverse section through the carpus, showing the relative positions of the tendons, vessels and nerves. (Henle.)

muscles of the thumb and little finger. Beneath it pass the tendons of the Flexor sublimis and profundus digitorum, the Flexor longus pollicis, and the median nerve.

The Synovial Membranes of the Flexor Tendons at the Wrist.—There are two synovial membranes which enclose all the tendons as they pass beneath this ligament—one for the Flexor sublimis and profundus digitorum, the other for the Flexor longus pollicis. They extend up into the forearm for about an inch above the annular ligament, and downward about halfway along the metacarpal bone, where they terminate in a blind diverticulum around each pair of tendons, with the exception of that of the thumb and those of the little finger—in these two digits the diverticulum is continued on, and communicates with the synovial sheath of the tendons in the fingers. In the other three fingers the synovial sheath of the

tendons begins as a blind pouch without communication with the large synovial sac (Fig. 240).

Surgical Anatomy.—This arrangement of the synovial sheaths explains the fact that thecal abscess in the thumb and little finger is liable to be followed by abscesses in the forearm, from extension of the inflammation along the continuous synovial sheaths. Ganglion is apt to occur in this situation, constituting "compound palmar ganglion"; it presents an hour-glass outline, with a swelling in front of the wrist and in the palm of the hand, and a constriction corresponding to the annular ligament between the two. The fluid can be forced from the one swelling to the other under the ligament.

The **Posterior Annular Ligament** is a strong fibrous band extending obliquely downward and inward across the back of the wrist, and consisting of the deep fascia of the back of the forearm, strengthened by the addition of some transverse fibres. It binds down the extensor tendons in their passage to the fingers, being attached, internally, to the styloid process of the ulna, the cuneiform and pisiform bones; externally, to the margin of the radius; and, in its passage across the wrist, to the elevated ridges on the posterior surface of the radius. It presents six compartments for the passage of tendons, each of which is lined by a separate synovial membrane. These are, from without inward—1. On the outer side of the styloid process, for the tendons of the Extensor ossis metacarpi and Extensor brevis pollicis; 2. Behind the styloid process, for the tendons of the Extensor carpi radialis longior and brevior; 3. About the middle of the posterior surface of the radius, for the tendon of the Extensor longus pollicis; 4. To the inner side of the latter, for the tendons of the Extensor communis digitorum and Extensor indicis; 5. Opposite the interval between the radius and ulna, for the Extensor minimi digiti; 6. Grooving the back of the ulna, for the tendon of the Extensor carpi ulnaris. The synovial membranes lining these sheaths are usually very extensive, reaching from above the annular ligament, down upon the tendons for a variable distance on the back of the hand.

Fig. 240.—Diagram showing the arrangement of the synovial sheaths of the palm and fingers.

The **deep palmar fascia** (Fig. 241) forms a common sheath which invests the muscles of the hand. It consists of a central and two lateral portions.

The *central portion* occupies the middle of the palm, is triangular in shape, of great strength and thickness, and binds down the tendons and protects the vessels and nerves in this situation. It is narrow above, where it is attached to the lower margin of the annular ligament, and receives the expanded tendon of the Palmaris longus muscle. Below, it is broad and expanded, and divides into four slips for the four fingers. Each slip gives off superficial fibres, which are inserted into the skin of the palm and finger, those to the palm joining the skin at the furrow corresponding to the metacarpo-phalangeal articulation, and those to the fingers passing into the skin at the transverse fold at the base of the fingers. The deeper part of each slip subdivides into two processes, which are inserted into the lateral margins of the anterior (glenoid) ligament of the metacarpo-phalangeal joint. From the sides of these processes offsets are sent backward, to be attached to the borders of the lateral surfaces of

the metacarpal bones at their distal extremities. By this arrangement short channels are formed on the front of the lower ends of the metacarpal bones, through which the flexor tendons pass. Dr. W. W. Keen describes a fifth slip as frequently found passing to the thumb. The intervals left in the fascia between the four fibrous slips transmit the digital vessels and nerves and the tendons of the Lumbricales. At the points of division of the palmar fascia into the slips above mentioned numerous strong, transverse fibres bind the separate processes together. The palmar fascia is intimately adherent to the integument by dense fibro-areolar tissue, forming the superficial palmar fascia, and gives origin by its inner margin to the Palmaris brevis: it covers the superficial palmar arch, the

FIG. 341.—Palmar fascia. (From a preparation in the Museum of the Royal College of Surgeons of England.)

tendons of the flexor muscles, and the branches of the median and ulnar nerves, and on each side it gives off a vertical septum, which is continuous with the interosseous aponeurosis and separates the lateral from the middle palmar group of muscles.

The *lateral portions* of the palmar fascia are thin, fibrous layers, which cover, on the radial side, the muscles of the ball of the thumb, and, on the ulnar side, the muscles of the little finger; they are continuous with the dorsal fascia, and in the palm with the central portion of the palmar fascia.

The **Superficial Transverse Ligament of the Fingers** is a thin, fibrous band which stretches across the roots of the four fingers, and is closely attached to the skin of the clefts, and internally to the fifth metacarpal bone, forming a sort of rudimentary web. Beneath it the digital vessels and nerves pass onward to their destination.

Surgical Anatomy.—The palmar fascia is liable to undergo contraction, producing a very inconvenient deformity known as "Dupuytren's contraction." The ring and little fingers are most frequently implicated, but the middle, the index, and the thumb may be involved. The proximal phalanx is drawn down and cannot be straightened, and the two distal phalanges become similarly flexed as the disease advances.

2. Radial Region (Figs. 242, 243).

Abductor pollicis.
Opponens (Flexor ossis metacarpi) pollicis.
Flexor brevis pollicis.
Abductor obliquus pollicis.
Adductor transversus pollicis.

The **Abductor pollicis** is a thin, flat muscle, placed immediately beneath the integument. It arises from the annular ligament, the tuberosity of the scaphoid, and the ridge of the trapezium, frequently by two distinct slips; and, passing outward and downward, is inserted by a thin, flat tendon into the radial side of the base of the first phalanx of the thumb, sending a slip to join the tendon of the Extensor longus pollicis.

Relations.—By its *superficial surface*, with the palmar fascia and superficialis volæ artery, which frequently perforates it. By its *deep surface*, with the Opponens pollicis, from which it is separated by a thin aponeurosis. Its *inner border* is separated from the Flexor brevis pollicis by a narrow cellular interval.

The **Opponens pollicis** (*Flexor ossis metacarpi pollicis*) is a small, triangular muscle, placed beneath the preceding. It arises from the palmar surface of the ridge on the trapezium and from the annular ligament, passes downward and outward, and is inserted into the whole length of the metacarpal bone of the thumb on its radial side.

Relations.—By its *superficial surface*, with the Abductor and Flexor brevis pollicis. By its *deep surface*, with the trapezio-metacarpal articulation. By its *inner border*, with the Adductor obliquus pollicis.

The **Flexor brevis pollicis** consists of two portions, outer and inner. The outer and more superficial portion arises from the outer two-thirds of the lower border of the annular ligament, and passes along the outer side of the tendon of the Flexor longus pollicis; and, becoming tendinous, has a sesamoid bone developed in its tendon, and is inserted into the outer side of the base of the first phalanx of the thumb. The inner and deeper portion of the muscle is very small, and arises from the ulnar side of the first metacarpal bone beneath the Adductor obliquus pollicis, and is inserted into the inner side of the base of the first phalanx with this muscle.

Relations.—By its *superficial surface*, with the palmar fascia. By its *deep surface*, with the tendon of the Flexor longus pollicis. By its *external surface*, with the Opponens pollicis. *Behind*, with the Adductor obliquus pollicis.

The **Adductor obliquus pollicis** arises by several slips from the os magnum, the bases of the second and third metacarpal bones, the anterior carpal ligaments, and the sheath of the tendon of the Flexor carpi radialis. From this origin the greater number of fibres pass obliquely downward and converge to a tendon, which, uniting with the tendons of the deeper portion of the Flexor brevis pollicis and the Adductor transversus, is inserted into the inner side of the base of the first phalanx of the thumb, a sesamoid bone being developed in the tendon of insertion. A considerable fasciculus, however, passes more obliquely outward beneath the tendon of the long flexor to join the superficial portion of the short flexor and the Abductor pollicis.[1]

[1] This muscle was formerly described as the deep portion of the Flexor brevis pollicis.

Relations.—By its *superficial surface*, with the Flexor longus pollicis and the outer head of the Flexor brevis pollicis. Its *deep surface* is in relation with the deep palmar arch, which passes between the two adductors.

The **Adductor transversus pollicis** (Fig. 242) is the most deeply seated of this group of muscles. It is of a triangular form, arising, by its broad base, from the lower two-thirds of the metacarpal bone of the middle finger on its palmar surface; the fibres, proceeding outward, converge, to be inserted, with the inner part of the Flexor brevis pollicis, and the Adductor obliquus pollicis, into the ulnar side of the base of the first phalanx of the thumb. From the common tendon of insertion a slip is prolonged to the Extensor longus pollicis.

Relations.—By its *superficial surface*, with the Adductor obliquus pollicis, the tendons of the Flexor profundus, and the Lumbricales. Its *deep surface* covers the first two interosseous spaces, from which it is separated by a strong aponeurosis.

Three of these muscles of the thumb, the Abductor, the Adductor transversus, and the Flexor brevis pollicis, at their insertions give off fibrous expansions which

FIG. 242.—Muscles of thumb. (From a preparation in the Museum of the Royal College of Surgeons of England.)

join the tendon of the Extensor longus pollicis. This permits of flexion of the proximal phalanx and extension of the terminal phalanx at the same time. These expansions, originally figured by Albinus, have been more recently described by M. Duchenne (*Physiologie des Mouvements*).

Nerves.—The Abductor, Opponens, and outer head of the Flexor brevis pollicis are supplied by the sixth cervical through the median nerve; the inner head of the Flexor brevis, and the Adductors, by the eighth cervical through the ulnar nerve.

Actions.—The actions of the muscles of the thumb are almost sufficiently indicated by their names. This segment of the hand is provided with three extensors—an extensor of the metacarpal bone, an extensor of the first, and an extensor of the second phalanx; these occupy the dorsal surface of the forearm and hand.

There are also three flexors on the palmar surface—a flexor of the metacarpal bone, a flexor of the proximal, and a flexor of the terminal phalanx; there is also an Abductor and two Adductors. The Abductor pollicis moves the metacarpal bone of the thumb outward; that is, away from the index finger. The Flexor ossis metacarpi pollicis flexes the metacarpal bone—that is, draws it inward over the palm—and at the same time rotates the bone, so as to turn the ball of the thumb toward the fingers, thus producing the movement of opposition. The Flexor brevis pollicis flexes and adducts the proximal phalanx of the thumb. The Adductores pollicis move the metacarpal bone of the thumb inward; that is, toward the index finger. These muscles give to the thumb its extensive range of motion. It will be noticed, however, that in consequence of the position of the first metacarpal bone, these movements differ from the corresponding movements of the metacarpal bones of the other fingers. Thus extension of the thumb more nearly corresponds to the motion of abduction in the other fingers, and flexion to adduction.

12. Ulnar Region (Fig. 243).

Palmaris brevis.

Abductor minimi digiti. Flexor brevis minimi digiti.

Opponens (Flexor ossis metacarpi) minimi digiti.

The **Palmaris brevis** is a thin quadrilateral muscle placed beneath the integument on the ulnar side of the hand. It arises by tendinous fasciculi from the annular ligament and palmar fascia; the fleshy fibres pass inward, to be inserted into the skin on the inner border of the palm of the hand.

Relations.—By its *superficial surface*, with the integument, to which it is intimately adherent, especially by its inner extremity; by its *deep surface*, with the inner portion of the palmar fascia, which separates it from the ulnar vessels and nerve, and from the muscles of the ulnar side of the hand.

The **Abductor minimi digiti** is situated on the ulnar border of the palm of the hand. It arises from the pisiform bone and from the tendon of the Flexor carpi ulnaris, and terminates in a flat tendon, which divides into two slips; one is inserted into the ulnar side of the base of the first phalanx of the little finger. The other slip is inserted into the ulnar border of the aponeurosis of the Extensor minimi digiti.

Relations.—By its *superficial surface*, with the inner portion of the palmar fascia and the Palmaris brevis; by its *deep surface*, with the Flexor ossis metacarpi minimi digiti; by its *outer border*, with the Flexor brevis minimi digiti.

The **Flexor brevis minimi digiti** lies on the same plane as the preceding muscle, on its radial side. It arises from the convex aspect of the hook of the unciform bone and anterior surface of the annular ligament, and is inserted into the inner side of the base of the first phalanx of the little finger. It is separated from the Abductor at its origin by the deep branches of the ulnar artery and nerve. This muscle is sometimes wanting; the Abductor is then, usually, of large size.

Relations.—By its *superficial surface*, with the internal portion of the palmar fascia and the Palmaris brevis; by its *deep surface*, with the Opponens. The deep branch of the ulnar artery and the corresponding branch of the ulnar nerve pass between the Abductor and Flexor brevis minimi digiti muscles.

The **Opponens (Flexor ossis metacarpi) minimi digiti** (Fig. 234) is of a triangular form, and placed immediately beneath the preceding muscles. It arises from the convexity of the hook of the unciform bone and contiguous portion of the annular ligament; its fibres pass downward and inward, to be inserted into the whole length of the metacarpal bone of the little finger, along its ulnar margin.

Relations.—By its *superficial surface*, with the Flexor brevis and Abductor minimi digiti; by its *deep surface*, with the Interossei muscles in the fourth metacarpal space, the metacarpal bone, and the Flexor tendons of the little finger.

Nerves.—All the muscles of this group are supplied by the eighth cervical nerve through the ulnar nerve.

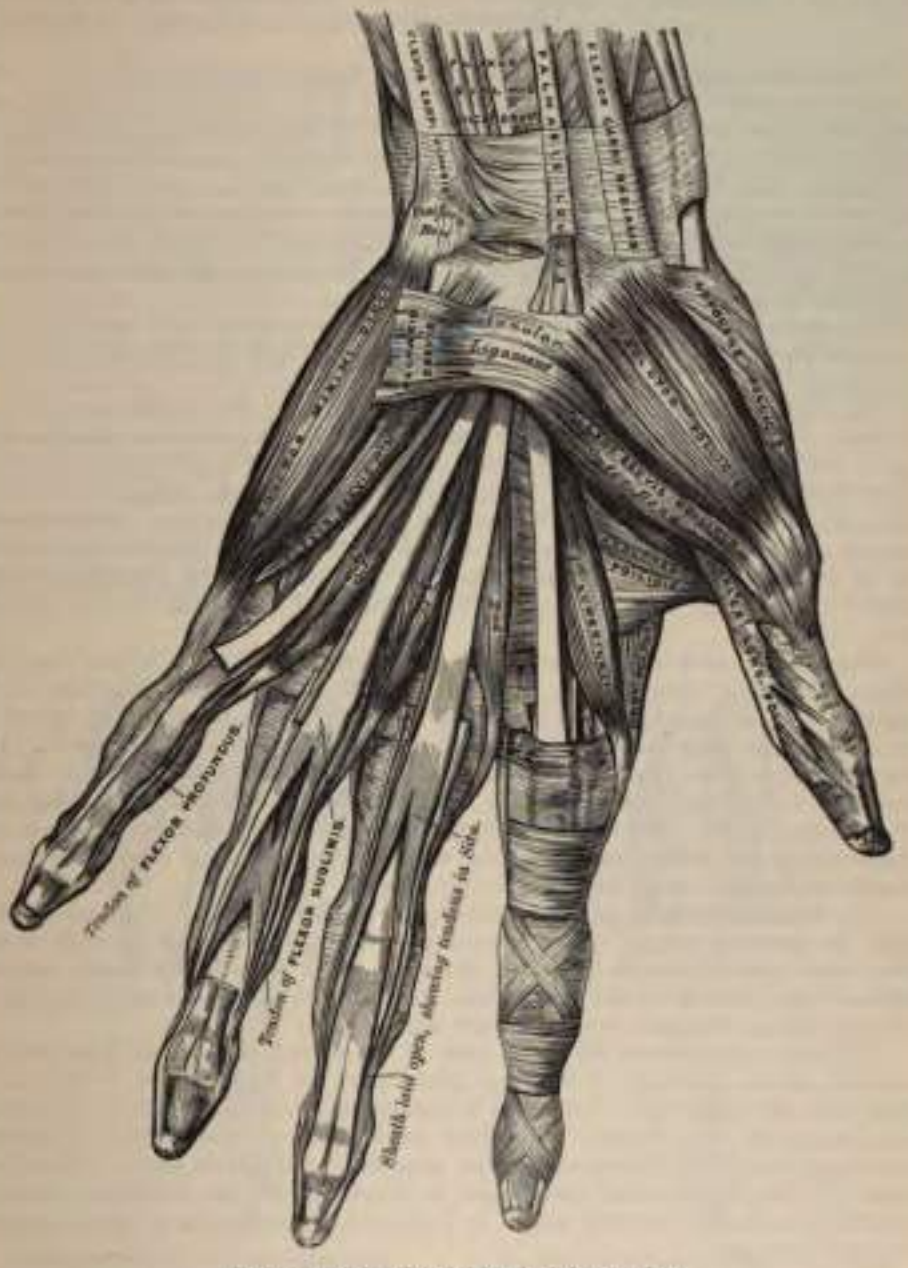


FIG. 383.—Muscles of the left hand. Palmar surface.

Actions.—The Abductor minimi digiti abducts the little finger from the middle line of the hand. It corresponds to a dorsal interosseous muscle. It also assists in flexing the proximal phalanx. The Flexor brevis minimi digiti abducts the little finger from the middle line of the hand. It also assists in flexing the proximal phalanx. The Opponens minimi digiti draws forward the fifth metacarpal bone, so as to deepen the hollow of the palm. The Palmaris brevis corrugates the skin on the inner side of the palm of the hand.

13. Middle Palmar Region.

Lumbricales. Interossei dorsales.
Interossei palmares.

The **Lumbricales** (Fig. 243) are four small fleshy fasciculi, accessories to the deep Flexor muscle. They arise from the tendons of the deep Flexor: the first and second, from the radial side and palmar surface of the tendons of the index and middle fingers respectively; the third, from the contiguous sides of the tendons of the middle and ring fingers; and the fourth, from the contiguous sides of the tendons of the ring and little fingers. They pass to the radial side of the corresponding fingers, and opposite the metacarpo-phalangeal articulation each tendon is inserted into the tendinous expansion of the Extensor communis digitorum, covering the dorsal aspect of each finger.

The **Interossei muscles** (Figs. 244, 245) are so named from occupying the intervals between the metacarpal bones, and are divided into two sets, a dorsal and palmar.

The **Dorsal interossei** are four in number, larger than the palmar, and occupy the intervals between the metacarpal bones. They are bipenniform muscles, arising by two heads from the adjacent sides of the metacarpal bones, but more extensively from the metacarpal bone of the finger into which the muscle is inserted. They are inserted into the bases of the first phalanges and into the aponeurosis of the common Extensor tendon. Between the double origin of each of these muscles is a narrow triangular interval, through the first of which passes the radial artery; through the other three passes a perforating branch from the deep palmar arch.

The *First dorsal interosseous muscle*, or *Abductor indicis*, is larger than the others. It is flat, triangular in form, and arises by two heads, separated by a fibrous arch, for the passage of the radial artery from the dorsum to the palm of the hand. The outer head arises from the upper half of the ulnar border of the first metacarpal bone; the inner head, from almost the entire length of the radial border of the second metacarpal bone; the tendon is inserted into the radial side of the index finger. The *second* and *third dorsal interossei* are inserted into the middle finger, the former into its radial, the latter into its ulnar side. The *fourth* is inserted into the ulnar side of the ring finger.

The **Palmar interossei**, three in number, are smaller than the Dorsal, and placed upon the palmar surface of the metacarpal bones, rather than between them. They arise from the entire length of the metacarpal bone of one finger, and are inserted into the side of the base of the first phalanx and aponeurotic expansion of the common extensor tendon of the same finger.

The *first* arises from the ulnar side of the second metacarpal bone, and is inserted into the same side of the first phalanx of the index finger. The *second* arises from the radial side of the fourth metacarpal bone, and is inserted into the same side of the ring finger. The *third* arises from the radial side of the fifth metacarpal bone, and is inserted into the same side of the little finger. From this account it may be seen that each finger is provided with two Interossei muscles, with the exception of the little finger, in which the Abductor muscle takes the place of one of the pair.

Nerves.—The two outer Lumbricales are supplied by the sixth cervical nerve, through the third and fourth digital branches of the median nerve: the two inner Lumbricales and all the Interossei are supplied by the eighth cervical nerve, through the deep palmar branch of the ulnar nerve. Brooks states that the third lumbrical received a twig from the median in twelve out of twenty-one cases.

Actions.—The Palmar interossei muscles adduct the fingers to an imaginary line drawn longitudinally through the centre of the middle finger; and the Dorsal interossei abduct the fingers from that line. In addition to this, the Interossei, in

conjunction with the Lumbricales, *flex the first phalanges* at the metacarpo-phalangeal joints, and extend the second and third phalanges in consequence of their insertion into the expansion of the extensor tendons. The Extensor communis digitorum is believed to act almost entirely on the first phalanges.

SURFACE FORM OF THE UPPER EXTREMITY.

The *Pectoralis major* largely influences surface form and conceals a considerable part of the thoracic wall in front. Its sternal origin presents a festooned border which bounds and determines the width of the sternal furrow. Its clavicular origin is somewhat depressed and flattened, and between the two portions of the muscle is often an oblique depression which differentiates the one from the other. The outer margin of the muscle is generally well marked above, and bounds the infraclavicular fossa, a triangular interval which separates the Pectoralis major from the Deltoid. It gradually becomes less marked as it approaches the tendon of insertion, and becomes more closely blended with the Deltoid muscle. The lower border of the Pectoralis major forms the rounded anterior axillary fold, and corresponds with the direction of the fifth rib. The *Pectoralis minor* influences surface form. When the arm is raised its lowest slip of origin produces a local fulness just below the border of the anterior fold of the axilla, and so serves to break the sharp line of the lower border of the Pectoralis major muscle, which is produced when the arm is in this position. The origin of the *Serratus magnus* produces a very characteristic surface marking. When the arm is raised from the side in a well-developed subject, the five or six lower serrations are plainly discernible, forming a zigzag line, caused by the series of digitations, which diminish in size from above downward, and have their apices arranged in the form of a curve. When the arm is lying by the side, the first serration to appear, at the lower margin of the Pectoralis major, is the one attached to the fifth rib. The *Deltoid*, with the prominence of the upper extremity of the humerus, produces the rounded outline of the shoulder. It is rounder and fuller in front than behind, where it presents a somewhat flattened form. Its anterior border, above, presents a rounded, slightly curved eminence, which bounds externally the infraclavicular fossa; below, it is closely united with the

FIG. 944.—The Dorsal Interossei of left hand.

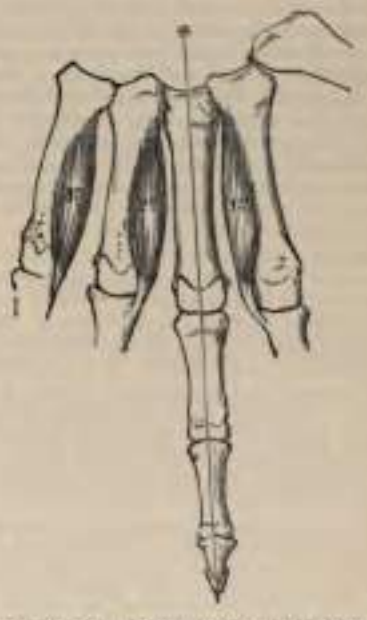


FIG. 945.—The Palmar Interossei of left hand.

Pectoralis major. Its posterior border is thin, flattened, and scarcely marked above; below, it is thicker and more prominent. When the muscle is in action, the middle portion becomes irregular, presenting alternate longitudinal elevations and depressions, the elevations corresponding to the fleshy portions, the depressions to the tendinous intersections of the muscle. The insertion of the Deltoid is marked by a depression on the outer side of the middle of the arm. Of the scapular muscles, the only one which materially influences surface form is the *Teres major*, which assists the Latissimus dorsi in forming the thick, rounded fold of the posterior boundary of the axilla. When the arm is raised, the Coraco-brachialis reveals itself as a long, narrow elevation which emerges from under cover of the anterior fold of the axilla and runs downward, internal to the shaft of the humerus. When the arm is hanging by the side, its

front and inner part presents the prominence of the Biceps, bounded on either side by an intermuscular depression. This muscle determines the contour of the front of the arm, and extends from the anterior margin of the axilla to the bend of the elbow. Its upper tendons are concealed by the Pectoralis major and the Deltoid, and its lower tendon sinks into the space at the bend of the elbow. When the muscle is in a state of complete contraction—that is to say, when the forearm has been flexed and supinated—it presents a rounded convex form, bulged out laterally, and its length is diminished. On each side of the Biceps, at the lower part of the arm, the *Brachialis anticus* is discernible. On the outer side it forms a narrow eminence which extends some distance up the arm along the border of the Biceps. On the inner side it shows itself only as a little fulness just above the elbow. On the back of the arm the long head of the *Triceps* may be seen as a longitudinal eminence emerging from under cover of the Deltoid, and gradually merging into the longitudinal flattened plane of the tendon of the muscle on the lower part of the back of the arm. The tendon of insertion of the muscle extends about halfway up the back of the arm, where it forms an elongated flattened plane when the muscle is in action. Under similar conditions the surface forms produced by the three heads of the muscle are well seen. On the anterior aspect of the elbow are to be seen two muscular elevations, one on each side, separated above and converging below so as to form a triangular space. Of these, the inner elevation, consisting of the flexors and pronator, forms the prominence along the inner side and front of the forearm. It is a fusiform mass, pointed above at the internal condyle and gradually tapering off below. The *Pronator radii teres*, the innermost muscle of the group, forms the boundary of the triangular space at the bend of the elbow. It is shorter, less prominent, and more oblique than the outer boundary. The most prominent part of the eminence is produced by the *Flexor carpi radialis*, the muscle next in order on the inner side of the preceding one. It forms a rounded prominence above, and can be traced downward to its tendon, which can be felt lying on the front of the wrist, nearer to the radial than to the ulnar border, and to the inner side of the radial artery. The *Palmaris longus* presents no surface marking above, but below is the most prominent tendon on the front of the wrist, standing out, when the muscle is in action, as a sharp, tense cord beneath the skin. The *Flexor sublimis digitorum* does not directly influence surface form. The position of its four tendons on the front of the lower part of the forearm is indicated by an elongated depression between the tendons of the Palmaris longus and the Flexor carpi ulnaris. The *Flexor carpi ulnaris* occupies a small part of the posterior surface of the forearm, and is separated from the extensor and supinator group, which occupies the greater part of this surface, by the ulnar furrow, produced by the subcutaneous posterior border of the ulna. Its tendon can be perceived along the ulnar border of the front of the forearm, and is most marked when the hand is flexed and adducted. The deep muscles of the front of the forearm have no direct influence on surface form. The external group of muscles of the forearm, consisting of the extensors and supinators, occupy the outer and a considerable portion of the posterior surface of this region. It has a fusiform outline, which is altogether on a higher level than the pronato-flexor group. Its apex emerges from between the Triceps and Brachialis anticus muscles some distance above the elbow-joint, and acquires its greatest breadth opposite the external condyle, and thence gradually shades off into a flattened surface. About the middle of the forearm it divides into two longitudinal eminences which diverge from each other, leaving a triangular interval between them. The outer of these two groups of muscles consists of the Supinator longus and the Extensor carpi radialis longior et brevior, which form a longitudinal eminence descending from the external condylar ridge in the direction of the styloid process of the radius. The other and more posterior group consists of the Extensor communis digitorum, the Extensor minimi digiti, and the Extensor carpi ulnaris. It commences above as a tapering form at the external condyle of the humerus, and is separated behind at its upper part from the Anconeus by a well-marked furrow, and below, from the pronato-flexor mass, by the ulnar furrow. In the triangular interval left between these two groups the extensors of the thumb and index finger are seen. The only two muscles of this region which require special mention as independently influencing surface form are the Supinator longus and the Anconeus. The inner border of the *Supinator longus* forms the outer boundary of the triangular space at the bend of the elbow. It commences as a rounded border above the condyle, and is longer, less oblique, and more prominent than the inner boundary. Lower down, the muscle forms a full fleshy mass on the outer side of the upper part of the forearm, and below tapers into a tendon, which may be traced down to the styloid process of the radius. The *Anconeus* presents a well-marked and characteristic surface form in the shape of a triangular, slightly elevated surface, immediately external to the subcutaneous posterior surface of the olecranon, and differentiated from the common extensor group by a well-marked oblique longitudinal depression. The upper angle of the triangle corresponds to the external condyle, and is marked by a depression or dimple in this situation. In the interval caused by the divergence from each other of the two groups of muscles into which the extensor and supinator group is divided at the lower part of the forearm an oblique elongated eminence is seen, caused by the emergence of two of the extensors of the thumb from their deep origin at the back of the forearm. This eminence, full above and becoming flattened out and partially subdivided below, runs downward and outward over the back and outer surface of the radius to the outer side of the wrist-joint, where it forms a ridge, especially marked when the thumb is extended, which passes outward to the posterior aspect of the thumb. The tendons of most of the extensor muscles are to be seen and felt at the level of the wrist-joint. Most externally are the tendons of the Extensor ossis metacarpi pollicis and

the Extensor brevis pollicis, forming a vertical ridge over the outer side of the joint from the styloid process of the radius to the thumb. Internal to this is the oblique ridge produced by the tendon of the Extensor longus pollicis, very noticeable when the muscle is in action. The Extensor carpi radialis longior is scarcely to be felt, but the Extensor carpi radialis brevior can be distinctly perceived as a vertical ridge emerging from under the inner border of the tendon of the Extensor longus pollicis, when the hand is forcibly extended at the wrist. Internal to this, again, can be felt the tendons of the Extensor indicis, Extensor communis digitorum, and Extensor minimi digiti; the latter tendon being separated from those of the common extensor by a slight furrow. The muscles of the hand are principally concerned, as far as regards surface-form, in producing the thenar and hypothenar eminences, and individually are not to be distinguished, on the surface, from each other. The *Adductor transversus pollicis* is, however, an exception to this: its anterior border gives rise to a ridge across the web of skin connecting the thumb to the rest of the hand. The thenar eminence is much larger and rounder than the hypothenar one, which presents a longer and narrower eminence along the ulnar side of the hand. When the *Palmaris brevis* is in action it produces a wrinkling of the skin over the hypothenar eminence, and a deep dimple on the ulnar border of the hand. The anterior extremities of the *Lumbrical muscles* help to produce the soft eminences just behind the clefts of the fingers, separated from each other by depressions corresponding to the flexor tendons in their sheaths. Between the thenar and hypothenar eminences, at the wrist-joint, is a slight groove or depression, widening out as it approaches the fingers; beneath this we have the strong central part of the palmar fascia. Here we have some furrows, which are pretty constant in their arrangement, and bear some resemblance to the letter M. One of these furrows passes obliquely outward from the groove between the thenar and hypothenar regions near the wrist to the head of the metacarpal bone of the index finger. A second passes inward, with a slight inclination upward, from the termination of the first to the ulnar side of the hand. A third runs nearly parallel with the second and about three-quarters of an inch below it. Lastly, crossing these two latter furrows, is an oblique furrow parallel with the first. The skin of the palm of the hand differs considerably from that of the forearm. At the wrist it suddenly becomes hard and dense, and covered with a thick layer of cuticle. The skin in the thenar region presents these characteristics less than elsewhere. In spite of this hardness and density, the skin of the palm is exceedingly sensitive and very vascular. It is destitute of hair, and no sebaceous follicles have been found in this region. Over the fingers the skin again becomes thinner, especially at the flexures of the joints, and over the terminal phalanges it is thrown into numerous ridges in consequence of the arrangement of the papillæ in it. These ridges form, in different individuals, distinctive and permanent patterns, which may be used for purposes of identification. The superficial fascia in the palm is made up of dense fibro-fatty tissue. This tissue binds down the skin so firmly to the deep palmar fascia that very little movement is permitted between the two. On the back of the hand the *Dorsal interossei* produce elongated swellings between the metacarpal bones. The first dorsal interosseous (Abductor indicis), when the thumb is closely adducted to the hand, forms a prominent fusiform bulging; the other interossei are not so marked.

SURGICAL ANATOMY OF THE UPPER EXTREMITY.

The student, having completed the dissection of the muscles of the upper extremity, should consider the effects likely to be produced by the action of the various muscles in fracture of the bones.

In considering the actions of the various muscles upon fractures of the upper extremity, the most common forms of injury have been selected both for illustration and description.

Fracture of the *middle of the clavicle* (Fig. 246) is always attended with considerable displacement: the inner end of the outer fragment is displaced inward and backward, while the outer end of the same fragment is rotated forward. The whole outer fragment is somewhat depressed.

The displacement is produced as follows: *inward*, by the muscles passing from the chest to the outer fragment of the clavicle, to the scapula, and to the humerus, viz., the Subclavius and the Pectoralis minor, and, to a less extent, the Pectoralis major and the Latissimus dorsi; *backward*, in consequence of the rotation of the outer fragment. The Serratus magnus causes the scapula to rotate on the wall of the chest; this carries the acromion and outer end of the outer fragment of the clavicle forward and causes the piece of bone to rotate round a vertical axis through its centre, and so carries the inner end of the outer portion backward. The depression of the whole outer fragment is produced by the weight of the arm and by the contraction of the Deltoid. The outer end of the inner fragment appears to be elevated, the skin being drawn tensely over it; this is owing to the depression of the outer fragment, as the inner fragment is usually kept fixed by the costo-clavicular ligament and by the antagonism between the Sterno-mastoid and Pectoralis major muscles. But it may be raised by an unusually strong Sterno-mastoid, or by the inner end of the outer fragment getting below and behind it. The causes of displacement having been ascertained, it is easy to apply the appropriate treatment. The outer fragment is to be drawn outward, and, together with the scapula, raised upward to a level with the inner fragment, and retained in that position.

In fracture of the *acromial end of the clavicle*, between the conoid and trapezoid ligaments, only slight displacement occurs, as these ligaments, from their oblique insertion, serve to hold both portions of the bone in apposition. Fracture, also, of the *sternal end*, internal to the costo-clavicular ligament, is attended with only slight displacement, this ligament serving to retain the fragments in close apposition.

Fig. 246.—Fracture of the middle of the clavicle.

Fracture of the *acromion process* usually arises from violence applied to the upper and outer part of the shoulder; it is generally known by the rotundity of the shoulder being lost, from the Deltoid drawing the fractured portion downward and forward; and the displacement may easily be discovered by tracing the margin of the clavicle outward, when the fragment will be found resting on the front and upper part of the head of the humerus. In order to relax the anterior and outer fibres of the Deltoid (the opposing muscle), the arm should be drawn forward across the chest and the elbow well raised, so that the head of the bone may press the acromion process upward and retain it in its position.

Fracture of the *coracoid process* is an extremely rare accident, and is usually caused by a sharp blow on the point of the shoulder. Displacement is here produced by the combined actions of the Pectoralis minor, short head of the Biceps, and Coraco-brachialis, the former muscle drawing the fragment inward, and the latter directly downward, the amount of displacement being limited by the connection of this process to the acromion by means of the coraco-acromial ligament. In many cases there appears to have been little or no displacement, from the fact that the coraco-clavicular ligament has remained intact, and has kept the separated fragment from displacement. In order to relax these muscles and replace the fragments in close apposition, the forearm should be flexed so as to relax the Biceps, and the arm drawn forward and inward across the chest, so as to relax the Coraco-brachialis; the humerus should then be pushed upward against the coraco-acromial ligament, and the arm retained in that position.

Fracture of the *surgical neck of the humerus* (Fig. 247) is very common, is attended with considerable displacement, and its appearances correspond somewhat with those of dislocation of the head of the humerus into the axilla. The upper fragment is slightly elevated under the coraco-acromial ligament by the muscles attached to the greater and lesser tuberosities; the lower fragment is drawn inward by the Pectoralis major, Latissimus dorsi, and Teres major; and the humerus is thrown obliquely outward from the side by the Deltoid, and occasionally elevated so as to cause the upper end of the lower fragment to project beneath and in front of the coracoid process. The deformity is reduced by fixing the shoulder, and drawing the arm outward and downward. To counteract the opposing muscles, and to keep the fragments in position, a small conical-shaped pad should be placed in the axilla, and the arm bandaged to the side by a broad roller passed round the chest, in such a manner that the elbow is carried slightly forward, so as to throw the upper end of the lower fragment backward and outward toward the head of the bone. The whole is then covered with a carefully moulded gutta-percha or parioplastic shoulder cap.

Fig. 247.—Fracture of the surgical neck of the humerus.

In fracture of the *shaft of the humerus* below the insertion of the Pectoralis major, Latissimus dorsi, and Teres major, and above the insertion of the Deltoid, there is also considerable deformity, the upper fragment being drawn inward by the first-mentioned muscles, and the lower fragment upward and outward by the Deltoid, producing shortening of the limb and a considerable prominence at the seat of fracture, from the fractured ends of the bone riding over one another, especially if the fracture takes place in an oblique direction. The fragments may be brought into apposition by extension from the elbow, and retained in that position by adopting the same means as in the preceding injury.

In fractures of the *shaft of the humerus* immediately below the insertion of the Deltoid, the amount of deformity depends greatly upon the direction of the fracture. If it occurs in a transverse direction, only slight displacement takes place, the upper fragment being drawn a little forward; but in oblique fracture the combined actions of the Biceps and Brachialis anticus muscles in front and the Triceps behind draw upward the lower fragment, causing it to glide over the upper fragment, either backward or forward, accord-

ing to the direction of the fracture. Simple extension reduces the deformity, and the application of a shoulder cap and splints to the arm will retain the fragments in apposition. Care should be taken not to raise the elbow, but the forearm and hand may be supported in a sling.

Fracture of the *humerus* (Fig. 248) immediately above the condyles deserves very attentive consideration, as the general appearances correspond somewhat with those produced by separation of the epiphysis of the humerus, and with those of dislocation of the radius and ulna backward. If the direction of the fracture is oblique from above, downward and forward, the lower fragment is drawn upward by the Brachialis anticus and Biceps in front and the Triceps behind; and at the same time is drawn backward behind the upper fragment of the Triceps. This injury may be diagnosed from dislocation by the increased mobility in fracture, the existence of crepitus, and the fact of the deformity being remedied by extension, on the discontinuance of which it is reproduced. The age of the patient is of importance in distinguishing this form of injury from separation of the epiphysis. If fracture occurs in the opposite direction to that shown in Fig. 248, the lower fragment is drawn upward and forward, causing a considerable prominence in front, and the upper fragment projects backward beneath the tendon of the Triceps muscle.

Fracture of the *olecranon process* (Fig. 249) is a frequent accident. The detached fragment is displaced upward, by the action of the Triceps muscle, from half an inch to two inches; the

FIG. 248.—Fracture of the humerus above the condyles.

FIG. 249.—Fracture of the olecranon.

prominence of the elbow is consequently lost, and a deep hollow is felt at the back part of the joint, which is much increased on flexing the limb. The patient at the same time loses, more or less, the power of extending the forearm. The treatment consists in relaxing the Triceps by extending the limb, and retaining it in the extended position by means of a long straight splint applied to the front of the arm; the fragments are thus brought into close apposition, and may be further approximated by drawing down the upper fragment. Union is generally ligamentous.

Fracture of the *neck of the radius* is an exceedingly rare accident, and is generally caused by direct violence. Its diagnosis is somewhat obscure, on account of the slight deformity visible, the injured part being surrounded by a large number of muscles; but the movements of pronation and supination are entirely lost. The upper fragment is drawn outward by the Supinator brevis, its extent of displacement being limited by the attachment of the orbicular ligament. The lower fragment is drawn forward and slightly upward by the Biceps, and inward by the Pronator radii teres, its displacement forward and upward being counteracted in some degree by the Supinator brevis. The treatment essentially consists in relaxing the Biceps, Supinator brevis, and Pronator radii teres muscles by flexing the forearm, and placing it in a position midway between pronation and supination, extension having been previously made so as to bring the parts in apposition.

In fracture of the *radius* below the insertion of the Biceps, but above the insertion of the Pronator radii teres, the upper fragment is strongly supinated by the Biceps and Supinator brevis, and at the same time drawn forward and flexed by the Biceps; the lower fragment is pronated and drawn inward toward the ulna by the pronators. Thus there is extreme displacement with very little deformity. In treating such a fracture the arm must be put up in

a position of supination, otherwise union will take place with great impairment of the movements of the hand. In fractures of the radius below the insertion of the Pronator radii teres (Fig. 250), the upper fragment is drawn upward by the Biceps and inward by the Pronator radii teres, holding a position midway between pronation and supination, and a degree of fulness in the upper half of the forearm is thus produced: the lower fragment is drawn downward and inward toward the ulna by the Pronator quadratus, and thrown into a state of pronation by the same muscle; at the same time, the Supinator longus, by elevating the styloid process, into which it is inserted, will serve to depress the upper end of the lower fragment still more toward the ulna. In order to relax the opposing muscles the forearm should be bent, and the limb placed in a position midway between pronation and supination: the fracture is then easily reduced by extension from the wrist and elbow: well-padded splints should be applied on both sides of the forearm from the elbow to the wrist; the hand being allowed to fall, will, by its own weight, counteract the action of the Pronator quadratus and Supinator longus, and elevate the lower fragment to the level of the upper one.

Fig. 250.—Fracture of the shaft of the radius.

In fracture of the *shaft of the ulna* the upper fragment retains its usual position, but the lower fragment is drawn outward toward the radius by the Pronator quadratus, producing a well-marked depression at the seat of fracture and some fulness on the dorsal and palmar surfaces of the forearm. The fracture is easily reduced by extension from the wrist and forearm. The forearm should be flexed, and placed in a position midway between pronation and supination, and well-padded splints applied from the elbow to the ends of the fingers.

In fracture of the *shafts of the radius and ulna together* the lower fragments are drawn upward, sometimes forward, sometimes backward, according to the direction of the fracture, by the combined actions of the Flexor and Extensor muscles, producing a degree of fulness on the dorsal or palmar surface of the forearm; at the same time the two fragments are drawn into contact by the Pronator quadratus, the radius being in a state of pronation: the upper fragment of the radius is drawn upward and inward by the Biceps and Pronator radii teres to a higher level than the ulna; the upper portion of the ulna is slightly elevated by the Brachialis anticus. The fracture may be reduced by extension from the wrist and elbow, and the forearm should be placed in the same position as in fracture of the ulna.

In fracture of the *lower end of the radius* (Fig. 251) the displacement which is produced is very considerable, and bears some resemblance to dislocation of the carpus backward, from which it should be carefully distinguished. The lower fragment is displaced backward and upward, but this displacement is probably due to the force of the blow driving the portion of the bone into this position and not to any muscular influence. The upper fragment projects forward, often lacerating the substance of the Pronator quadratus, and is drawn by this muscle into close contact with the lower end of the ulna, causing a projection on the anterior surface of

Fig. 251.—Fracture of the lower end of the radius.

the forearm, immediately above the carpus, from the flexor tendons being thrust forward. This fracture may be distinguished from dislocation by the deformity being removed on making sufficient extension, when crepitus may be occasionally detected; at the same time, on extension being discontinued, the parts immediately resume their deformed appearance (see also page 128). The age of the patient will also assist in determining whether the injury is fracture or separation of the epiphysis. The treatment consists in flexing the forearm, and making powerful extension from the wrist and elbow, depressing at the same time the radial side of the hand, and retaining the parts in that position by well-padded *pistol-shaped* splints.

MUSCLES AND FASCIÆ OF THE LOWER EXTREMITY.

The Muscles of the Lower Extremity are subdivided into groups corresponding with the different regions of the limb.

I. Iliac Region.

Psoas magnus.
Psoas parvus.
Iliacus.

II. Thigh.

1. *Anterior Femoral Region.*

Tensor fasciæ femoris.
Sartorius.
Quadriceps extensor: Rectus. Vastus externus. Vastus internus. Crureus.
Subcrureus.

2. *Internal Femoral Region.*

Gracilis.
Pectineus.
Adductor longus.
Adductor brevis.
Adductor magnus.

3. *Gluteal Region.*

Gluteus maximus.
Gluteus medius.
Gluteus minimus.
Pyriformis.
Obturator internus.
Gemellus superior.
Gemellus inferior.
Quadratus femoris.
Obturator externus.

4. *Posterior Femoral Region.*

Biceps.
Semitendinosus.
Semimembranosus.

III. Leg.

5. *Anterior Tibio-fibular Region.*

Tibialis anticus.
Extensor proprius hallucis.
Extensor longus digitorum.
Peroneus tertius.

6. *Posterior Tibio-fibular Region.*

Superficial Layer.

Gastrocnemius.
Soleus.
Plantaris.

Deep Layer.

Popliteus.
Flexor longus hallucis.
Flexor longus digitorum.
Tibialis posticus.

7. *Fibular Region.*

Peroneus longus.
Peroneus brevis.

IV. Foot.

8. *Dorsal Region.*

Extensor brevis digitorum.

9. *Plantar Region.*

First Layer.

Abductor hallucis.
Flexor brevis digitorum.
Abductor minimi digiti.

Second Layer.

Flexor accessorius.
Lumbricales.

Third Layer.

Flexor brevis hallucis.
Adductor obliquus hallucis.
Flexor brevis minimi digiti.
Adductor transversus hallucis.

Fourth Layer.

The Interossei.

I. MUSCLES AND FASCIÆ OF THE ILIAC REGION.

Psoas magnus. Psoas parvus. Iliacus.

Dissection.—No detailed description is required for the dissection of these muscles. On the removal of the viscera from the abdomen they are exposed, covered by the peritoneum and a thin layer of fascia, the iliac fascia.

The **iliac fascia**[1] is the aponeurotic layer which lines the back part of the abdominal cavity, and covers the Psoas and Iliacus muscles throughout their whole

[1] The student must not confound this fascia with the *iliac portion of the fascia lata* (see p. 420).

extent. It is thin above, and becomes gradually thicker below as it approaches the crural arch.

The *portion covering the Psoas* is attached, above, to the ligamentum arcuatum internum; internally, by a series of arched processes to the intervertebral substances and prominent margins of the bodies of the vertebræ, and to the upper part of the sacrum, the intervals so left, opposite the constricted portions of the bodies, transmitting the lumbar arteries and veins and filaments of the sympathetic cord. Externally, above the crest of the ilium, this portion of the iliac fascia is continuous with the anterior lamella of the lumbar fascia (see page 342), but below the crest of the ilium it is continuous with the fascia covering the Iliacus.

The *portion investing the Iliacus* is connected externally to the whole length of the inner border of the crest of the ilium, and internally to the brim of the true pelvis, where it is continuous with the periosteum; and at the ilio-pectineal eminence it receives the tendon of insertion of the Psoas parvus, when that muscle exists. External to the femoral vessels, this fascia is intimately connected to the posterior margin of Poupart's ligament, and is continuous with the fascia transversalis. Immediately to the outer side of the femoral vessels the fascia iliaca is prolonged backward and inward from Poupart's ligament as a band, the *ilio-pectineal ligament*, which is attached to the ilio-pectineal eminence. This ligament divides the space between Poupart's ligament and the innominate bone into two parts, the inner of which transmits the femoral vessels, the outer the ilio-psoas and the anterior crural nerve (Fig. 160). Internal to the vessels the iliac fascia is attached to the ilio-pectineal line behind the conjoined tendon, where it is again continuous with the transversalis fascia; and, corresponding to the point where the femoral vessels pass into the thigh, this fascia descends behind them, forming the posterior wall of the femoral sheath. This portion of the iliac fascia which passes behind the femoral vessels is also attached to the ilio-pectineal line beyond the limits of the attachment of the conjoined tendon; at this part it is continuous with the pubic portion of the fascia lata of the thigh. The external iliac vessels lie in front of the iliac fascia, but all the branches of the lumbar plexus behind it; it is separated from the peritoneum by a quantity of loose areolar tissue.

The **Psoas magnus** (Fig. 253) is a long fusiform muscle placed on the side of the lumbar region of the spine and margin of the pelvis. It arises from the front of the bases and lower borders of the transverse processes of the lumbar vertebræ by five fleshy slips; also from the sides of the bodies and the corresponding intervertebral substances of the last dorsal and all the lumbar vertebræ. The muscle is connected to the bodies of the vertebræ by five slips; each slip is attached to the upper and lower margins of two vertebræ, and to the intervertebral substance between them, the slips themselves being connected by the tendinous arches which extend across the constricted part of the bodies, and beneath which pass the lumbar arteries and veins and filaments of the sympathetic cord. These tendinous arches also give origin to muscular fibres, and protect the blood-vessels and nerves from pressure during the action of the muscle. The first slip is attached to the contiguous margins of the last dorsal and first lumbar vertebræ; the last to the contiguous margins of the fourth and fifth lumbar vertebræ, and to the intervertebral substance. From these points the muscle passes down across the brim of the pelvis, and, diminishing gradually in size, passes beneath Poupart's ligament, and terminates in a tendon which, after receiving nearly the whole of the fibres of the Iliacus, is inserted into the lesser trochanter of the femur.

Relations.—In the lumbar region: by its *anterior surface*, which is placed behind the peritoneum, with the iliac fascia, the ligamentum arcuatum internum, the kidney, Psoas parvus, renal vessels, ureter, spermatic vessels, genito-crural nerve, and the colon; by its *posterior surface*, with the transverse processes of the lumbar vertebræ and the Quadratus lumborum, from which it is separated by the anterior lamella of the lumbar fascia. The lumbar plexus is situated in the posterior part of the substance of the muscle. By its *inner side* the muscle is in relation with the bodies of the lumbar vertebræ, the lumbar arteries, the ganglia

of the sympathetic nerve, and their branches of communication with the spinal nerves; the lumbar glands; the vena cava inferior on the right and the aorta on the left side, and along the brim of the pelvis with the external iliac artery. In the thigh it is in relation, in front, with the fascia lata; behind, with the capsular ligament of the hip, from which it is separated by a synovial bursa, which frequently communicates with the cavity of the joint through an opening of variable size; by its *inner border*, with the Pectineus and internal circumflex artery, and also with the femoral artery, which slightly overlaps it: by its *outer border*, with the anterior crural nerve and Iliacus muscle.

The **Psoas parvus** is a long slender muscle placed in front of the Psoas magnus. It arises from the sides of the bodies of the last dorsal and first lumbar vertebræ and from the intervertebral substance between them. It forms a small flat muscular bundle, which terminates in a long flat tendon inserted into the ilio-pectineal eminence, and, by its outer border, into the iliac fascia. This muscle is often absent, and, according to Cruveilhier, sometimes double.

Relations.—It is covered by the peritoneum, and, at its origin, by the ligamentum arcuatum internum; it rests on the Psoas magnus.

The **Iliacus** is a flat, triangular muscle which fills up the whole of the iliac fossa. It arises from the upper two-thirds of this fossa and from the inner margin of the crest of the ilium; behind, from the ilio-lumbar ligament and base of the sacrum; in front, from the anterior superior and anterior inferior spinous processes of the ilium, from the notch between them, and by a few fibres from the capsule of the hip-joint. The fibres converge to be inserted into the outer side of the tendon of the Psoas, some of them being prolonged on to the shaft of the femur for about an inch below and in front of the lesser trochanter.[1]

Relations.—*Within the abdomen:* by its *anterior surface*, with the iliac fascia, which separates the muscle from the peritoneum, and with the external cutaneous nerve; on the right side, with the cæcum; on the left side, with the sigmoid flexure of the colon; by its *posterior surface*, with the iliac fossa; by its *inner border*, with the Psoas magnus and anterior crural nerve. In the thigh, it is in relation, by its *anterior surface*, with the fascia lata, Rectus, Sartorius, and profunda femoris artery; behind, with the capsule of the hip-joint, a synovial bursa common to it and the Psoas magnus being interposed.

Nerves.—The Psoas magnus is supplied by the anterior branches of the second and third lumbar nerves; the Psoas parvus, when it exists, is supplied by the anterior branch of the first lumbar nerve; and the Iliacus by the anterior branches of the second and third lumbar nerves through the anterior crural.

Actions.—The Psoas and Iliacus muscles, acting from above, flex the thigh upon the pelvis. Acting from below, the femur being fixed, the muscles of both sides bend the lumbar portion of the spine and pelvis forward. They also serve to maintain the erect position, by supporting the spine and pelvis upon the femur, and assist in raising the trunk when the body is in the recumbent posture.

The *Psoas parvus* is a tensor of the iliac fascia.

Surgical Anatomy.—In the iliac fascia there is no definite septum between the portions of fascia covering the Psoas and Iliacus respectively, and the fascia is only connected to the subjacent muscles by a quantity of loose connective tissue. When abscess forms beneath this fascia, as it is very apt to do, the matter is contained in an osseo-fibrous cavity which is closed on all sides within the abdomen, and is open only at its lower part, where the fascia is prolonged over the muscle into the thigh.

Abscess within the sheath of the Psoas muscle (*Psoas abscess*) is generally due to tubercular caries of the bodies of the lower dorsal and lumbar vertebræ. When the disease is in the dorsal region, the matter tracts down the posterior mediastinum, in front of the bodies of the vertebræ, and, passing beneath the ligamentum arcuatum internum, enters the sheath of the Psoas muscle, down which it passes as far as the pelvic brim; it then gets beneath the iliac portion of the fascia and fills up the iliac fossa. In consequence of the attachment of the fascia to the pelvic brim, it rarely finds its way into the pelvis, but passes by a narrow opening under Poupart's ligament

[1] The Psoas and Iliacus are sometimes regarded as a single muscle, the *Ilio-psoas*, having two heads of origin and a single insertion.

into the thigh, to the outer side of the femoral vessels. It thus follows that a Psoas abscess may be described as consisting of four parts: (1) a somewhat narrow channel at its upper part, in the Psoas sheath; (2) a dilated sac in the iliac fossa; (3) a constricted neck under Poupart's ligament; and (4) a dilated sac in the upper part of the thigh. When the lumbar vertebræ are the seat of the disease, the matter finds its way directly into the substance of the muscle. The muscular fibres are destroyed, and the nervous cords contained in the abscess are isolated and exposed in its interior; the femoral vessels which lie in front of the fascia remain intact, and the peritoneum seldom becomes implicated. All Psoas abscesses do not, however, pursue this course: the matter may leave the muscle above the crest of the ilium, and, tracking backward, may point in the loin (*lumbar abscess*); or it may point above Poupart's ligament in the inguinal region; or it may follow the course of the iliac vessels into the pelvis, and, passing through the great sacro-sciatic notch, discharge itself on the back of the thigh; or it may open into the bladder or find its way into the perinæum.

II. MUSCLES AND FASCIÆ OF THE THIGH.

1. Anterior Femoral Region.

Tensor fasciæ femoris.	Quadriceps extensor	Rectus.
		Vastus externus.
Sartorius.		Vastus internus.
		Crureus.
Subcrureus.		

Dissection.—To expose the muscles and fasciæ in this region, make an incision along Poupart's ligament, from the anterior superior spine of the ilium to the spine of the os pubis; a vertical incision from the centre of this, along the middle of the thigh to below the knee-joint; and a transverse incision from the inner to the outer side of the leg, at the lower end of the vertical incision. The flaps of integument having been removed, the superficial and deep fasciæ should be examined. The more advanced student should commence the study of this region by an examination of the anatomy of femoral hernia and Scarpa's triangle, the incisions for the dissection of which are marked out in the figure 252.

The **superficial fascia** forms a continuous layer over the whole of the thigh, consisting of areolar tissue, containing in its meshes much fat, and capable of being separated into two or more layers, between which are found the superficial vessels and nerves. It varies in thickness in different parts of the limb: in the groin it is thick, and the two layers are separated from one another by the superficial inguinal lymphatic glands, the internal saphenous vein, and several smaller vessels. One of these two layers, the superficial, is continuous above with the superficial fascia of the abdomen. The deep layer of the superficial fascia is a very thin, fibrous layer, best marked on the inner side of the long saphenous vein and below Poupart's ligament. It is placed beneath the subcutaneous vessels and nerves and upon the surface of the fascia lata. It is intimately adherent to the fascia lata a little below Poupart's ligament. It covers the saphenous opening in the fascia lata, being closely united to its circumference, and is connected to the sheath of the femoral vessels, corresponding to its under surface. The portion of fascia covering this aperture is perforated by the internal saphenous vein and by numerous blood- and lymphatic vessels; hence it has been termed the *cribriform fasciæ*, the openings for these vessels having been likened to the holes in a sieve. The cribriform fascia adheres closely both to the superficial fascia and to the fascia lata, so that it is described by some anatomists as part of the fascia lata, but is usually considered (as in this work) as belonging to the superficial fascia. It is not until the cribriform fascia has been cleared away that the saphenous opening is seen, so that this opening does not in ordinary cases exist naturally, but is the result of dissection. Mr. Callender, however, speaks of cases in which, probably as the result of pressure from enlarged inguinal lymphatic glands, the fascia has become atrophied, and a saphenous opening exists independent of dissection. A femoral hernia in passing through the saphenous opening receives the cribriform fascia as one of its coverings. A large subcutaneous bursa is found in the superficial fascia over the patella.

The **deep fascia** of the thigh is exposed on the removal of the superficial fascia,

and is named, from its great extent, the *fascia lata*; it forms a uniform investment for the whole of this region of the limb, but varies in thickness in different parts; thus, it is thicker in the upper and outer part of the thigh, where it receives a fibrous expansion from the Gluteus maximus muscle, and the Tensor fasciæ femoris is inserted between its layers: it is very thin behind, and at the upper and inner part where it covers the Adductor muscles, and again becomes stronger around the knee, receiving fibrous expansions from the tendon of the Biceps externally, and from the Sartorius internally, and Quadriceps extensor cruris in front. The fascia lata is attached, above and behind, to the back of the sacrum and coccyx; externally, to the crest of the ilium; in front, to Poupart's ligament and to the body of the os pubis; and internally, to the descending ramus of the os pubis, to the ramus and tuberosity of the ischium, and to the lower border of the great sacro-sciatic ligament. From its attachment to the crest of the ilium it passes down over the Gluteus medius muscle to the upper border of the Gluteus maximus, where it splits into two layers, one passing superficial to and the other beneath this muscle. At the lower border of the muscle the two layers reunite. Externally the fascia lata receives the greater part of the tendon of insertion of the Gluteus maximus, and becomes proportionately thickened. The portion of the fascia lata arising from the front part of the crest of the ilium, corresponding to the origin of the Tensor fasciæ femoris, passes down the outer side of the thigh as two layers, one superficial to and the other beneath this muscle; these at its lower end become blended together into a thick and strong band, having first received the insertion of the muscle. This band is continued downward, under the name of the *ilio-tibial band*, to be inserted into the external tuberosity of the tibia. Below, the fascia lata is attached to all the prominent points around the knee-joint—viz., the condyles of the femur, tuberosities of the tibia, and head of the fibula. On each side of the patella it is strengthened by transverse fibres given off from the lower part of the Vasti muscles, which are attached to and support this bone. Of these the outer is the stronger, and is continuous with the ilio-tibial band. From the inner surface of the fascia lata are given off two strong intermuscular septa, which are attached to the whole length of the linea aspera and its prolongations above and below: the external and stronger one, which extends from the insertion of the Gluteus maximus to the outer condyle, separates the Vastus externus in front from the short head of the Biceps behind, and gives partial origin to these muscles; the inner one, the thinner of the two, separates the Vastus internus from the Adductor and Pectineus muscles. Besides these there are numerous smaller septa, separating the individual muscles and enclosing each in a distinct sheath. At the upper and inner part of the thigh, a little below Poupart's ligament, a large oval-shaped aperture is observed after the superficial fascia has been cleared off: it transmits the internal saphenous vein and other smaller vessels, and is termed the *saphenous opening*. In order more correctly to consider the mode of formation of this aperture, the fascia lata in this

FIG. 252.—Dissection of lower extremity. Front view.

FIG. 258.—Muscles of the iliac and anterior femoral region.

part of the thigh is described as consisting of two portions—an iliac portion and a pubic portion.

The *iliac portion* is all that part of the fascia lata on the outer side of the saphenous opening. It is attached, externally, to the crest of the ilium and its anterior superior spine, to the whole length of Poupart's ligament as far internally as the spine of the os pubis, and to the pectineal line in conjunction with Gimbernat's ligament. From the spine of the os pubis it is reflected downward and outward, forming an arched margin, the *falciform process* or boundary (*superior cornu*) of the saphenous opening; this margin overlies and is adherent to the anterior layer of the sheath of the femoral vessels: to its edge is attached the cribriform fascia; and, below, it is continuous with the pubic portion of the fascia lata.

The *pubic portion* is situated at the inner side of the saphenous opening: at the lower margin of this aperture it is continuous with the iliac portion; traced upward, it covers the surface of the Pectineus, Adductor longus, and Gracilis muscles, and, passing behind the sheath of the femoral vessels, to which it is closely united, is continuous with the sheath of the Psoas and Iliacus muscles, and is attached above to the ilio-pectineal line, where it becomes continuous with the iliac fascia. From this description it may be observed that the iliac portion of the fascia lata passes in front of the femoral vessels, and the pubic portion behind them, so that an apparent aperture exists between the two, through which the internal saphenous joins the femoral vein.[1]

The fascia should now be removed from the surface of the muscles. This may be effected by pinching it up between the forceps, dividing it, and separating it from each muscle in the course of its fibres.

The **Tensor fasciæ femoris** arises from the anterior part of the outer lip of the crest of the ilium, and from the outer surface of the anterior superior spinous process, and part of the outer border of the notch below it, between the Gluteus medius and Sartorius, and from the surface of the fascia covering the Gluteus medius. It is inserted between two layers of the fascia lata, about one-fourth down the outer side of the thigh. From the point of insertion the fascia is continued downward to the external tuberosity of the tibia as a thickened band, the *ilio-tibial band*.

[1] These parts will be again more particularly described with the anatomy of Hernia.

Relations.—By its *superficial surface*, with the fascia lata and the integument; by its *deep surface*, with the Gluteus medius, Rectus femoris, Vastus externus, and the ascending branches of the external circumflex artery; by its *anterior border*, with the Sartorius, from which it is separated below by a triangular space, in which is seen the Rectus femoris; by its *posterior border*, with the Gluteus medius.

The **Sartorius**, the longest muscle in the body, is flat, narrow, and ribbon-like; it arises by tendinous fibres from the anterior superior spinous process of the ilium and the upper half of the notch below it, passes obliquely across the upper and anterior part of the thigh, from the outer to the inner side of the limb, then descends vertically, as far as the inner side of the knee, passing behind the inner condyle of the femur, and terminates in a tendon which, curving obliquely forward, expands into a broad aponeurosis, inserted, in front of the Gracilis and Semitendinosus, into the upper part of the inner surface of the shaft of the tibia, nearly as far forward as the crest. The upper part of the tendon is curved backward over the upper edge of the tendon of the Gracilis so as to be inserted behind it. An offset is derived from the upper margin of this aponeurosis, which blends with the fibrous capsule of the knee-joint, and another, given off from its lower border, blends with the fascia on the inner side of the leg.

The relations of this muscle to the femoral artery should be carefully examined, as it constitutes the chief guide in tying the vessel. In the upper third of the thigh it forms the outer side of a triangular space, *Scarpa's triangle*, the inner side of which is formed by the inner border of the Adductor longus, and the base, turned upward, by Poupart's ligament; the femoral artery passes perpendicularly through the middle of this space from its base to its apex. In the middle third of the thigh the femoral artery lies first along the inner border, and then behind the Sartorius.

Relations.—By its *superficial surface*, with the fascia lata and integument; by its *deep surface*, with the Rectus, Iliacus, Vastus internus, anterior crural nerve, sheath of the femoral vessels, Adductor longus, Adductor magnus, Gracilis, Semitendinosus, long saphenous nerve, and internal lateral ligament of the knee-joint.

The **Quadriceps extensor** includes the four remaining muscles on the front of the thigh. It is the great Extensor muscle of the leg, forming a large fleshy mass which covers the front and sides of the femur, being united below into a single tendon, attached to the patella, and above subdivided into separate portions, which have received distinct names. Of these, one occupying the middle of the thigh, connected above with the ilium, is called the *Rectus femoris*, from its straight course. The other divisions lie in immediate connection with the shaft of the femur, which they cover from the trochanters to the condyles. The portion on the outer side of the femur is termed the *Vastus externus;* that covering the inner side, the *Vastus internus;* and that covering the front of the femur, the *Crureus*.

The **Rectus femoris** is situated in the middle of the anterior region of the thigh; it is fusiform in shape, and its superficial fibres are arranged in a bipenniform manner, the deep fibres running straight down to the deep aponeurosis. It arises by two tendons: one, the anterior or straight, from the anterior inferior spinous process of the ilium; the other, the posterior or reflected tendon, from a groove above the brim of the acetabulum; the two unite at an acute angle and spread into an aponeurosis, which is prolonged downward on the anterior surface of the muscle and from which the muscular fibres arise.[1] The muscle terminates in a broad and thick aponeurosis, which occupies the lower two-thirds of its pos-

[1] Mr. W. R. Williams, in an interesting paper in the *Journ. of Anat. and Phys.*, vol. xiii. p. 204, points out that the reflected tendon is the real origin of the muscle, and is alone present in early fœtal life. The direct tendon is merely an accessory band of condensed fascia. The paper will well repay perusal, though in some particulars I think the description in the text more generally accurate.—Ed.

terior surface, and, gradually becoming narrowed into a flattened tendon, is inserted into the patella in common with the Vasti and Crureus.

Relations.—By its *superficial surface*, with the anterior fibres of the Gluteus minimus, the Tensor fasciæ femoris, the Sartorius, and the Iliacus; by its lower three-fourths, with the fascia lata. By its *posterior surface*, with the hip-joint, the external circumflex vessels, branches of the anterior crural nerve, and the Crureus and Vasti muscles.

The **Vastus externus** is the largest part of the Quadriceps extensor. It arises by a broad aponeurosis, which is attached to the upper half of the anterior intertrochanteric line, to the anterior and inferior borders of the root of the great trochanter, to the outer lip of the gluteal ridge, and to the upper half of the outer lip of the linea aspera: this aponeurosis covers the upper three-fourths of the muscle, and from its inner surface many fibres take origin. A few additional fibres arise from the tendon of the Gluteus maximus, and from the external intermuscular septum between the Vastus externus and short head of the Biceps. The fibres form a large fleshy mass, which is attached to a strong aponeurosis, placed on the under surface of the muscle at its lower part: this becomes contracted and thickened into a flat tendon, which is inserted into the outer border of the patella, blending with the great Extensor tendon, and giving an expansion to the capsule of the knee-joint.

Relations.—By its *superficial surface*, with the Rectus, the Tensor fasciæ femoris, the fascia lata, and the tendon of the Gluteus maximus, from which it is separated by a synovial bursa. By its *deep surface*, with the Crureus, some large branches of the external circumflex artery and anterior crural nerve being interposed.

The **Vastus internus** and **Crureus** appear to be inseparably united, but when the Rectus femoris has been reflected, a narrow interval will be observed extending upward from the inner border of the patella between the two muscles. Here they can be separated, and the separation should be continued upward as far as the lower part of the anterior intertrochanteric line, where, however, the two muscles are frequently continuous.

The **Vastus internus** arises from the lower half of the anterior intertrochanteric line, the spiral line, the inner lip of the linea aspera, the upper part of the internal supra-condylar line, and the tendon of the Adductor magnus and internal intermuscular septum. Its fibres are directed downward and forward, and are chiefly attached to an aponeurosis which lies on the deep surface of the muscle and is inserted into the inner border of the patella and the Quadriceps extensor tendon, an expansion being sent to the capsule of the knee-joint.

The **Crureus** arises from the front and outer aspect of the shaft of the femur in its upper two-thirds and from the lower part of the external intermuscular septum. Its fibres end in a superficial aponeurosis, which forms the deep part of the Quadriceps extensor tendon.

Relations.—The inner edge of the Crureus is in contact with the anterior edge of the Vastus internus, but when separated from each other, as directed above, the latter muscle is seen merely to overlap the inner aspect of the femoral shaft without taking any fibres of origin from it. The Vastus internus is partly covered by the Rectus and Sartorius, but where these separate near the knee it becomes superficial, and produces a well-marked prominence above the inner aspect of the knee. In the middle third of the thigh it forms the outer wall of Hunter's canal, which contains the femoral vessels and the long saphenous nerve—the roof of the canal being formed by a strong fascia which extends from the Vastus internus to the Adductores longus and magnus. The Crureus is almost completely hidden by the Rectus femoris and Vastus externus. The deep surface of the two muscles is in relation to the femur and Subcrureus muscle. A synovial bursa is situated between the femur and the portion of the Quadriceps extensor tendon above the patella; in the adult it communicates with the synovial cavity of the knee-joint.

The *tendons* of the different portions of the Quadriceps extensor unite at the

lower part of the thigh, so as to form a single strong tendon, which is inserted into the upper part of the patella, some few fibres passing over it to blend with the Ligamentum patellæ. More properly, the patella may be regarded as a sesamoid bone, developed in the tendon of the Quadriceps; and the Ligamentum patellæ, which is continued from the lower part of the patella to the tuberosity of the tibia, as the proper tendon of insertion of the muscle. A synovial bursa, the *post-patellar bursa*, is interposed between the tendon and the upper part of the tuberosity of the tibia; and another, the *pre-patellar bursa*, is placed over the patella itself. This latter bursa often becomes enlarged, constituting "house-maid's knee."

The **Subcrureus** is a small muscle, usually distinct from the Crureus, but occasionally blended with it, which arises from the anterior surface of the lower part of the shaft of the femur, and is inserted into the upper part of the *cul-de-sac* of the capsular ligament which projects upward beneath the Quadriceps for a variable distance. It sometimes consists of several separate muscular bundles.

Nerves.—The Tensor fasciæ femoris is supplied by the fourth and fifth lumbar and first sacral nerves through the superior gluteal nerve; the other muscles of this region, by the second, third, and fourth lumbar nerves, through branches of the anterior crural.

Actions.—The Tensor fasciæ femoris is a tensor of the fascia lata; continuing its action, the oblique direction of its fibres enables it to abduct and to rotate the thigh inward. In the erect posture, acting from below, it will serve to steady the pelvis upon the head of the femur, and by means of the ilio-tibial band it steadies the condyles of the femur on the articular surfaces of the tibia, and assists the Gluteus maximus in supporting the knee in the extended position. The Sartorius flexes the leg upon the thigh, and, continuing to act, flexes the thigh upon the pelvis; it next rotates the thigh outward. It was formerly supposed to adduct the thigh, so as to cross one leg over the other, and hence received its name of Sartorius, or tailor's muscle (*sartor*, a tailor), because it was supposed to assist in crossing the legs in the squatting position. When the knee is bent the Sartorius assists the Semitendinosus, Semimembranosus, and Popliteus in rotating the tibia inward. Taking its fixed point from the leg, it flexes the pelvis upon the thigh, and, if one muscle acts, assists in rotating the pelvis. The Quadriceps extensor extends the leg upon the thigh. The Rectus muscle assists the Psoas and Iliacus in supporting the pelvis and trunk upon the femur. It also assists in flexing the thigh on the pelvis, or if the thigh is fixed it will flex the pelvis. The Vastus internus draws the patella inward as well as upward.

Surgical Anatomy.—A few fibres of the Rectus muscle are liable to be ruptured from severe strain. This accident is especially liable to occur during the games of football and cricket, and is sometimes known as "cricket thigh." The patient experiences a sudden pain in the part, as if he had been struck, and the Rectus muscle stands out and is felt to be tense and rigid. The accident is often followed by considerable swelling from inflammatory effusion. Occasionally the Quadriceps extensor may be torn away from its insertion into the patella, or the tendon of the patella may be ruptured about an inch above the bone. This accident is caused in the same manner as fracture of the patella by muscular action is produced—viz. by a violent muscular effort to prevent falling whilst the knee is in a position of semiflexion. A distinct gap can be felt above the patella, and, owing to the retraction of the muscular fibres, union may fail to take place.

2. Internal Femoral Region.

Gracilis.	Adductor longus.
Pectineus.	Adductor brevis.
	Adductor magnus.

Dissection.—These muscles are at once exposed by removing the fascia from the fore part and inner side of the thigh. The limb should be abducted, so as to render the muscles tense and easier of dissection.

The **Gracilis** (Figs. 253, 256) is the most superficial muscle on the inner side of the thigh. It is thin and flattened, broad above, narrowing and tapering below. It arises by a thin aponeurosis from the lower half of the margin of the symphysis and the anterior half of the pubic arch. The fibres pass vertically downward, and

terminate in a rounded tendon which passes behind the internal condyle of the femur, and, curving round the inner tuberosity of the tibia, becomes flattened, and is inserted into the upper part of the inner surface of the shaft of the tibia, below the tuberosity. A few of the fibres of the lower part of the tendon are prolonged into the deep fascia of the leg. The tendon of this muscle is situated immediately above that of the Semitendinosus, and its upper edge is overlapped by the tendon of the Sartorius, with which it is in part blended. As it passes across the internal lateral ligament of the knee-joint it is separated from it by a synovial bursa common to it and the Semitendinosus muscle.

Fig. 254.—Deep muscles of the internal femoral region.

Relations.—By its *superficial surface*, with the fascia lata and the Sartorius below: the internal saphenous vein crosses it obliquely near its lower part, lying superficial to the fascia lata; the internal saphenous nerve emerges between its tendon and that of the Sartorius; by its *deep surface*, with the Adductor brevis and the Adductor magnus and the internal lateral ligament of the knee-joint.

The **Pectineus** (Fig. 253) is a flat, quadrangular muscle, situated at the anterior part of the upper and inner aspect of the thigh. It arises from the linea ilio-pectinea, and to a slight extent from the surface of the bone in front of it between the pectineal eminence and spine of the os pubis, and from the fascia covering the anterior surface of the muscle; the fibres pass downward, backward, and outward, to be inserted into a rough line leading from the lesser trochanter to the linea aspera.

Relations.—By its *anterior surface*, with the pubic portion of the fascia lata, which separates it from the femoral vessels and internal saphenous vein; by its *posterior surface*, with the capsular ligament of the hip-joint, the Adductor brevis and Obturator externus muscles, the obturator vessels and nerve being interposed; by its *outer border*, with the Psoas, a cellular interval separating them, through which pass the internal circumflex vessels; by its *inner border*, with the margin of the Adductor longus.

The **Adductor longus**, the most superficial of the three Adductors, is a flat triangular muscle lying on the same plane as the Pectineus. It arises, by a flat narrow tendon, from the front of the os pubis, at the angle of junction of the crest with the symphysis; and soon expands into a broad fleshy belly, which, passing downward, backward, and outward, is inserted, by an aponeurosis, into the linea

aspera, between the Vastus internus and the Adductor magnus, with both of which it is usually blended.

Relations.—By its *anterior surface*, with the fascia lata, the Sartorius, and, near its insertion, with the femoral artery and vein: by its *posterior surface*, with the Adductor brevis and magnus, the anterior branches of the obturator nerve, and with the profunda artery and vein near its insertion; by its *outer border*, with the Pectineus; by its *inner border*, with the Gracilis.

The Pectineus and Adductor longus should now be divided near their origin, and turned downward, when the Adductor brevis and Obturator externus will be exposed.

The **Adductor brevis** is situated immediately behind the two preceding muscles. It is somewhat triangular in form, and arises by a narrow origin from the outer surface of the body and descending ramus of the os pubis, between the Gracilis and Obturator externus. Its fibres, passing backward, outward, and downward, are inserted, by an aponeurosis, into the lower part of the line leading from the lesser trochanter to the linea aspera and the upper part of the same line, immediately behind the Pectineus and upper part of the Adductor longus.

Relations.—By its *anterior surface*, with the Pectineus, Adductor longus, profunda femoris artery, and anterior branches of the obturator nerve; by its *posterior surface*, with the Adductor magnus and posterior branch of the obturator nerve; by its *outer border*, with the internal circumflex artery, the Obturator externus, and conjoined tendon of the Psoas and Iliacus; by its *inner border*, with the Gracilis and Adductor magnus. This muscle is pierced, near its insertion, by the second or first and second perforating branches of the profunda femoris artery.

The Adductor brevis should now be cut away near its origin, and turned outward, when the entire extent of the Adductor magnus will be exposed.

The **Adductor magnus** is a large triangular muscle forming a septum between the muscles on the inner and those on the back of the thigh. It arises from a small part of the descending ramus of the os pubis, from the ramus of the ischium, and from the outer margin of the inferior part of the tuberosity of the ischium. Those fibres which arise from the ramus of the os pubis are very short, horizontal in direction, and are inserted into the rough line leading from the great trochanter to the linea aspera, internal to the Gluteus maximus; those from the ramus of the ischium are directed downward and outward with different degrees of obliquity, to be inserted, by means of a broad aponeurosis, into the linea aspera and the upper part of its internal prolongation below. The internal portion of the muscle, consisting principally of those fibres which arise from the tuberosity of the ischium, forms a thick fleshy mass consisting of coarse bundles which descend almost vertically, and terminate about the lower third of the thigh in a rounded tendon, which is inserted into the Adductor tubercle on the inner condyle of the femur, being connected by a fibrous expansion to the line leading upward from the tubercle to the linea aspera. Between the two portions of the muscle an interval is left, tendinous in front, fleshy behind, for the passage of the femoral vessels into the popliteal space. The external portion of the muscle at its attachment to the femur presents three or four osseo-aponeurotic openings, formed by tendinous arches attached to the bone, from which muscular fibres arise. The three superior of these apertures are for the three perforating arteries, and the fourth, when it exists, for the terminal branch of the profunda.

Relations.—By its *anterior surface*, with the Pectineus, Adductor brevis, Adductor longus, and the femoral and profunda vessels and obturator nerve; by its *posterior surface*, with the great sciatic nerve, the Gluteus maximus, Biceps, Semitendinosus, and Semimembranosus. By its *superior* or *shortest border* it lies parallel with the Quadratus femoris, the internal circumflex artery passing between them; by its *internal* or *longest border*, with the Gracilis, Sartorius, and fascia lata; by its *external* or *attached border* it is inserted into the femur behind the Adductor brevis and Adductor longus, which separate it from the Vastus internus,

and in front of the Gluteus maximus and short head of the Biceps, which separate it from the Vastus externus.

Nerves.—The three Adductor muscles and the Gracilis are supplied by the third and fourth lumbar nerves through the obturator nerve; the Adductor magnus receiving an additional branch from the sacral plexus through the great sciatic. The Pectineus is supplied by the second, third, and fourth lumbar nerves through the anterior crural, and by the accessory obturator, from the third lumbar, when it exists. Occasionally it receives a branch from the obturator nerve.[1]

Actions.—The Pectineus and three Adductors adduct the thigh powerfully; they are especially used in horse exercise, the flanks of the horse being grasped between the knees by the actions of these muscles. In consequence of the obliquity of their insertion into the linea aspera they rotate the thigh outward, assisting the external Rotators, and when the limb has been abducted they draw it inward, carrying the thigh across that of the opposite side. The Pectineus and Adductor brevis and longus assist the Psoas and Iliacus in flexing the thigh upon the pelvis. In progression, also, all these muscles assist in drawing forward the hinder limb. The Gracilis assists the Sartorius in flexing the leg and rotating it inward; it is also an adductor of the thigh. If the lower extremities are fixed, these muscles may take their fixed point from below and act upon the pelvis, serving to maintain the body in an erect posture, or, if their action is continued, to flex the pelvis forward upon the femur.

Surgical Anatomy.—The Adductor longus is liable to be severely strained in those who ride much on horseback, or its tendon to be ruptured by suddenly gripping the saddle. And, occasionally, especially in cavalry soldiers, the tendon may become ossified, constituting the "rider's bone."

THE HIP.

3. Gluteal Region.

Gluteus maximus.	Obturator internus.
Gluteus medius.	Gemellus superior.
Gluteus minimus.	Gemellus inferior.
Pyriformis.	Quadratus femoris.

Obturator externus.

Dissection (Fig. 255).—The subject should be turned on its face, a block placed beneath the pelvis to make the buttocks tense, and the limbs allowed to hang over the end of the table, with the foot inverted and the thigh abducted. Make an incision through the integument along the crest of the ilium to the middle of the sacrum, and thence downward to the tip of the coccyx, and carry a second incision from that point obliquely downward and outward to the outer side of the thigh, four inches below the great trochanter. The portion of integument included between these incisions is to be removed in the direction shown in the figure.

The **Gluteus maximus** (Fig. 256), the most superficial muscle in the gluteal region, is a very broad and thick, fleshy mass of a quadrilateral shape, which forms the prominence of the nates. Its large size is one of the most characteristic points in the muscular system in man, connected as it is with the power he has of maintaining the trunk in the erect posture. In structure the muscle is remarkably coarse, being made up of muscular fasciculi lying parallel with one another, and collected together into large bundles, separated by deep cellular intervals. It arises from the superior curved line of the ilium and the portion of bone, including the crest, immediately above and behind it; from the posterior surface of the lower part of the sacrum, the side of the coccyx, the aponeurosis of the Erector spinæ muscle, the great sacro-sciatic ligament, and the fascia covering the Gluteus medius. The fibres are directed obliquely downward and outward; those forming the upper and larger portion of the muscle, together with the *superficial* fibres of the lower

[1] Professor Paterson describes the Pectineus as consisting of two incompletely separated strata, of which the outer or dorsal stratum, which is constant, is supplied by the anterior crural nerve, or in its absence by the accessory obturator, with which it is intimately related; while the inner or ventral stratum, when present, is supplied by the obturator nerve.—*Journal of Anatomy and Physiology*, vol. xxvi., p. 43.

portion, terminate in a thick tendinous lamina, which passes across the great trochanter and is inserted into the fascia lata covering the outer side of the thigh; the *deeper* fibres of the lower portion of the muscle are inserted into the rough line leading from the great trochanter to the linea aspera between the Vastus externus and Adductor magnus.

Three *synovial bursæ* are usually found in relation with this muscle. One of these, of large size, and generally multilocular, separates it from the great trochanter. A second, often wanting, is situated on the tuberosity of the ischium. A third is found between the tendon of this muscle and the Vastus externus.

Relations.—By its *superficial surface*, with a thin fascia, which separates it from the subcutaneous tissue; by its *deep surface*, from above downward, with the ilium, sacrum, coccyx, and great sacro-sciatic ligament, part of the Gluteus medius, Pyriformis, Gemelli, Obturator internus, Quadratus femoris, the tuberosity of the ischium, great trochanter, the origin of the Biceps, Semitendinosus, Semimembranosus, and Adductor magnus muscles. The superficial part of the gluteal artery reaches the deep surface of the muscle by passing between the Pyriformis and the Gluteus medius; the sciatic and internal pudic vessels and nerves and muscular branches from the sacral plexus issue from the pelvis below the Pyriformis. The first perforating artery and the terminal branches of the internal circumflex artery are also found under cover of the muscle. Its *upper border* is thin, and connected with the Gluteus medius by the fascia lata. Its *lower border* is free and prominent.

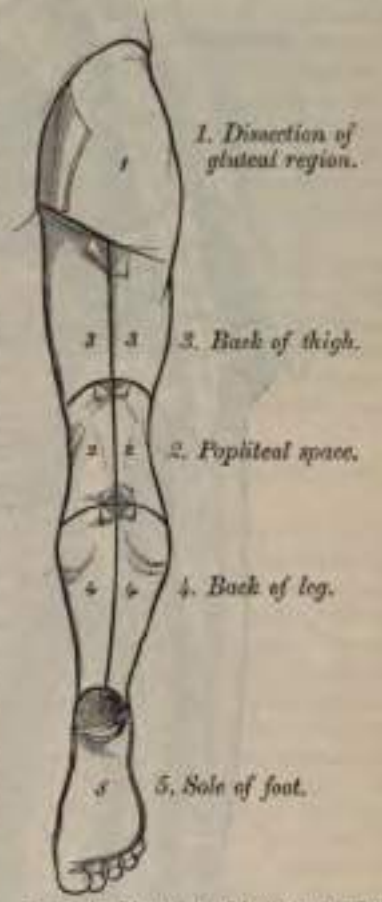


FIG. 25.—Dissection of lower extremity. Posterior view.

Dissection.—Divide the Gluteus maximus near its origin by a vertical incision carried from its upper to its lower border; a cellular interval will be exposed, separating it from the Gluteus medius and External rotator muscles beneath. The upper portion of the muscle is to be altogether detached, and the lower portion turned outward; the loose areolar tissue filling up the interspace between the trochanter major and tuberosity of the ischium being removed, the parts already enumerated as exposed by the removal of this muscle will be seen.

The **Gluteus medius** is a broad, thick, radiated muscle, situated on the outer surface of the pelvis. Its posterior third is covered by the Gluteus maximus; its anterior two-thirds by the fascia lata, which separates it from the integument. It arises from the outer surface of the ilium, between the superior and middle curved lines, and from the outer lip of that portion of the crest which is between them; it also arises from the dense fascia (Gluteal aponeurosis) covering its outer surface. The fibres converge to a strong flattened tendon which is inserted into the oblique line which traverses the outer surface of the great trochanter. A synovial bursa separates the tendon of the muscle from the surface of the trochanter in front of its insertion.

Relations.—By its *superficial surface*, with the Gluteus maximus behind, the Tensor fasciæ femoris and deep fascia in front; by its *deep surface*, with the Gluteus minimus and the gluteal vessels and superior gluteal nerve. Its *anterior border* is blended with the Gluteus minimus. Its *posterior border* lies parallel with the Pyriformis, the gluteal vessels intervening.

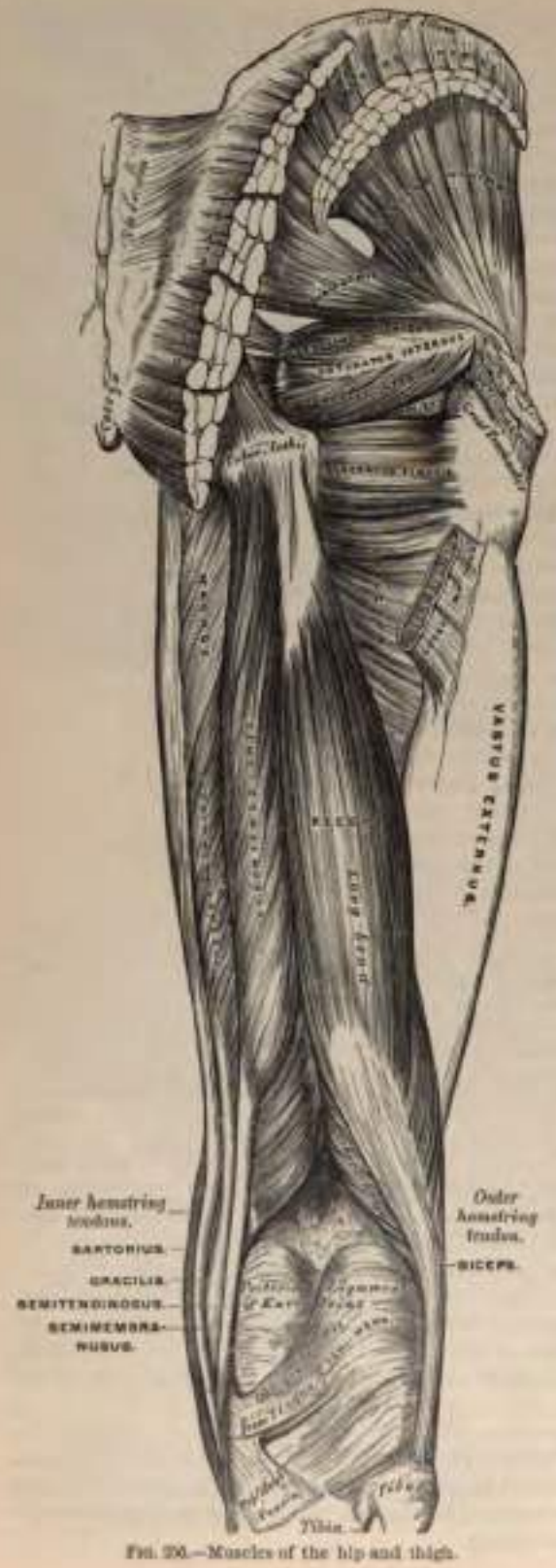


FIG. 206.—Muscles of the hip and thigh.

This muscle should now be divided near its insertion and turned upward, when the Gluteus minimus will be exposed.

The **Gluteus minimus**, the smallest of the three Glutei, is placed immediately beneath the preceding. It is fan-shaped, arising from the outer surface of the ilium, between the middle and inferior curved lines, and behind, from the margin of the great sacro-sciatic notch; the fibres converge to the deep surface of a radiated aponeurosis, which, terminating in a tendon, is inserted into an impression on the anterior border of the great trochanter. A synovial bursa is interposed between the tendon and the great trochanter.

Relations.—By its *superficial surface*, with the Gluteus medius and the gluteal vessels and superior gluteal nerve; by its *deep surface*, with the ilium, the reflected tendon of the Rectus femoris, and capsular ligament of the hip-joint. Its *anterior margin* is blended with the Gluteus medius; its *posterior margin* is in contact and sometimes joined with the tendon of the Pyriformis.

The **Pyriformis** is a flat muscle, pyramidal in shape, lying almost parallel with the posterior margin of the Gluteus medius. It is situated partly within the pelvis at its posterior part and partly at the back of the hip-joint. It arises from the front of the sacrum by three fleshy digitations attached to the portions of bone between the first, second, third, and fourth anterior sacral foramina, and also from the groove leading from the foramina: a few fibres also arise from the margin of the great sacro-sciatic foramen and from the anterior surface of the great sacro-sciatic ligament. The muscle passes out of the pelvis through the great sacro-sciatic foramen, the upper part of which it fills, and is inserted by a rounded tendon into the upper border of the great tro-

chanter, behind, but often partly blended with, the tendon of the Obturator internus and Gemelli muscles.

Relations.—By its *anterior surface, within the pelvis*, with the Rectum (especially on the left side), the sacral plexus of nerves, and the branches of the internal iliac vessels; *external to the pelvis*, with the posterior surface of the ischium and capsular ligament of the hip-joint; by its *posterior surface, within the pelvis*, with the sacrum, and *external to it*, with the Gluteus maximus; by its *upper border*, with the Gluteus medius, from which it is separated by the gluteal vessels and superior gluteal nerve; by its *lower border*, with the Gemellus superior and Coccygeus, the sciatic vessels and nerves, the internal pudic vessels and nerve, and muscular branches from the sacral plexus, passing from the pelvis in the interval between the two muscles.

The **Obturator membrane** (Fig. 166) is a thin layer of interlacing fibres which closes the obturator foramen. It is attached, externally, to the margin of the foramen; internally, to the posterior surface of the ischio-pubic ramus, below and internal to the margin of the foramen. It is occasionally incomplete, and presents at its upper and outer part a small canal, which is bounded below by a thickened band of fibres, for the passage of the obturator vessels and nerve. Both obturator muscles are connected with this membrane.

Dissection.—The next muscle, as well as the origin of the Pyriformis, can only be seen when the pelvis is divided and the viscera removed.

The **Obturator internus**, like the preceding muscle, is situated partly within the cavity of the pelvis, and partly at the back of the hip-joint. It arises from the inner surface of the anterior and external wall of the pelvis, where it surrounds the greater part of the obturator foramen, being attached to the descending ramus of the os pubis and the ramus of the ischium, and at the side to the inner surface of the innominate bone below and behind the pelvic brim, reaching from the upper part of the great sacro-sciatic foramen above and behind to the thyroid foramen below and in front. It also arises from the inner surface of the obturator membrane except at its posterior part, from the tendinous arch which completes the canal for the passage of the obturator vessels and nerve and to a slight extent from the obturator layer of the pelvic fascia, which covers it. The fibres converge rapidly, and are directed backward and downward, and terminate in four or five tendinous bands, which are found on its deep surface; these bands are reflected at a right angle over the inner surface of the tuberosity of the ischium, which is grooved for their reception; the groove is covered with cartilage, and lined by a synovial bursa. The muscle leaves the pelvis by the lesser sacro-sciatic foramen; and the tendinous bands unite into a single flattened tendon, which passes horizontally outward, and, after receiving the attachment of the Gemelli, is inserted into the fore part of the inner surface of the great trochanter in front of the Obturator externus. A synovial bursa, narrow and elongated in form, is usually found between the tendon of this muscle and the capsular ligament of the hip: it occasionally communicates with the bursa between the tendon and the tuberosity of the ischium, the two forming a single sac.

In order to display the peculiar appearances presented by the tendon of this muscle, it must be divided near its insertion and reflected inward.

Relations.—*Within the pelvis* this muscle is in relation, by its *anterior surface*, with the obturator membrane and inner surface of the anterior wall of the pelvis; by its *posterior surface*, with the pelvic and obturator fasciæ, which separate it from the Levator ani; and it is crossed by the internal pudic vessels and nerve. This surface forms the outer boundary of the ischio-rectal fossa. *External to the pelvis* it is covered by the Gluteus maximus, crossed by the great sciatic nerve, and rests on the back part of the hip-joint. As the tendon of the Obturator internus emerges from the lesser sacro-sciatic foramen it is overlapped by the two Gemelli, while nearer its insertion the Gemelli pass in front of it and form a groove in which the tendon lies.

The **Gemelli** are two small muscular fasciculi, accessories to the tendon of the Obturator internus, which is received into a groove between them. They are called *superior* and *inferior*.

The **Gemellus superior**, the smaller of the two, arises from the outer surface of the spine of the ischium, and, passing horizontally outward, becomes blended with the upper part of the tendon of the Obturator internus, and is inserted with it into the inner surface of the great trochanter. This muscle is sometimes wanting.

Relations.—By its *superficial surface*, with the Gluteus maximus and the sciatic vessels and nerves; by its *deep surface*, with the capsule of the hip-joint; by its *upper border*, with the lower margin of the Pyriformis; by its *lower border*, with the tendon of the Obturator internus.

The **Gemellus inferior** arises from the upper part of the tuberosity of the ischium, where it forms the lower edge of the groove for the Obturator internus tendon, and, passing horizontally outward, is blended with the lower part of the tendon of the Obturator internus, and is inserted with it into the inner surface of the great trochanter.

Relations.—By its *superficial surface*, with the Gluteus maximus and the sciatic vessels and nerves; by its *deep surface*, with the capsular ligament of the hip-joint; by its *upper border*, with the tendon of the Obturator internus; by its *lower border*, with the tendon of the Obturator externus and Quadratus femoris.

The **Quadratus femoris** is a short, flat muscle, quadrilateral in shape (hence its name), situated between the Gemellus inferior and the upper margin of the Adductor magnus. It arises from the upper part of the external lip of the tuberosity of the ischium, and, proceeding horizontally outward, is inserted into the upper part of the linea quadrata; that is, the line which crosses the posterior intertrochanteric line. A synovial bursa is often found between the under surface of this muscle and the lesser trochanter, which it covers.

Relations.—By its *posterior surface*, with the Gluteus maximus and the sciatic vessels and nerves; by its *anterior surface*, with the tendon of the Obturator externus and trochanter minor and with the capsule of the hip-joint; by its *upper border*, with the Gemellus inferior. Its *lower border* is separated from the Adductor magnus by the terminal branches of the internal circumflex vessels.

Dissection.—In order to expose the next muscle (the Obturator externus), it is necessary to remove the Psoas, Iliacus, Pectineus, and Adductor brevis and longus muscles from the front and inner side of the thigh, and the Gluteus maximus and Quadratus femoris from the back part. Its dissection should, consequently, be postponed until the muscles of the anterior and internal femoral regions have been explained.

The **Obturator externus** (Fig. 257) is a flat, triangular muscle, which covers the outer surface of the anterior wall of the pelvis. It arises from the margin of bone immediately around the inner side of the obturator foramen, viz., from the body and ramus of the os pubis and the ramus of the ischium; it also arises from the inner two-thirds of the outer surface of the obturator membrane, and from the tendinous arch which completes the canal for the passage of the obturator vessels and nerves. The fibres from the pubic arch extend on to the inner surface of the bone, from which they obtain a narrow origin between the margin of the foramen and the attachment of the membrane. The fibres converging pass backward, outward, and upward, and terminate in a tendon which runs across the back part of the hip-joint, and is inserted into the digital fossa of the femur.

Relations.—By its *anterior surface*, with the Psoas, Iliacus, Pectineus, Adductor magnus, and Adductor brevis; and more externally, with the neck of the femur and capsule of the hip-joint. The obturator artery and vein lie between this muscle and the obturator membrane; the superficial part of the obturator nerve lies above the muscle, and the deep branch perforates it; by its *posterior surface*, with the obturator membrane and Quadratus femoris.

Nerves.—The Gluteus maximus is supplied by the fifth lumbar and first and

second sacral nerves through the inferior gluteal nerve from the sacral plexus; the Gluteus medius and minimus, by the fourth and fifth lumbar and first sacral nerves through the superior gluteal; the Pyriformis is supplied by the first and second sacral nerves; the Gemellus inferior and Quadratus femoris by the last lumbar and first sacral nerve; the Gemellus superior and Obturator internus by the fifth lumbar and first and second sacral nerves, and the Obturator externus by the second, third, and fourth lumbar nerves through the obturator.

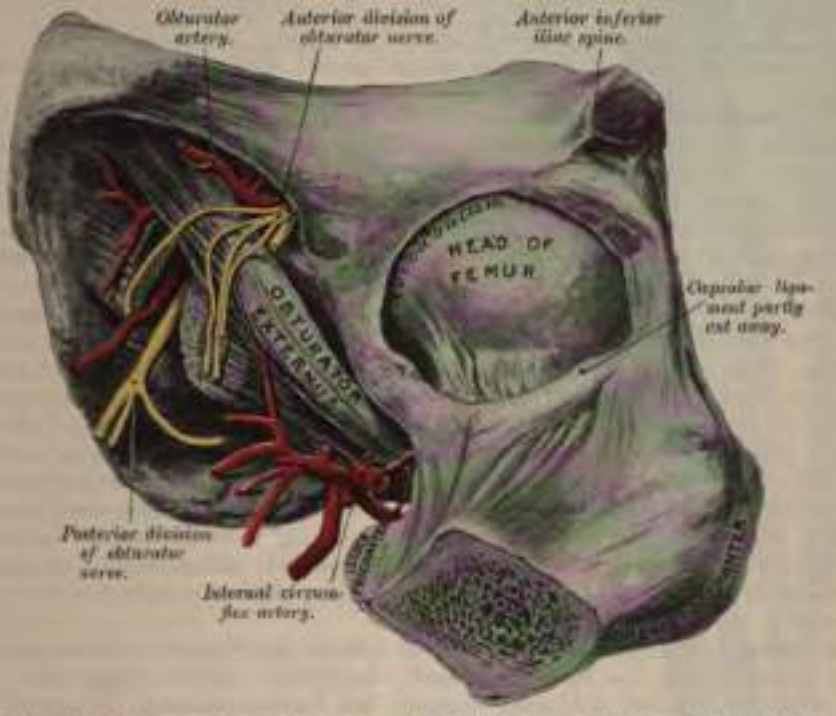


FIG. 257.—Obturator externus muscle. (From a preparation in the Museum of the Royal College of Surgeons of England.)

Actions.—The Gluteus maximus, when it takes its fixed point from the pelvis, extends the femur and brings the bent thigh into a line with the body. Taking its fixed point from below, it acts upon the pelvis, supporting it and the whole trunk upon the head of the femur, which is especially obvious in standing on one leg. Its most powerful action is to cause the body to regain the erect position after stooping by drawing the pelvis backward, being assisted in this action by the Biceps, Semitendinosus, and Semimembranosus. The Gluteus maximus is a tensor of the fascia lata, and by its connection with the ilio-tibial band it steadies the femur on the articular surface of the tibia during standing, when the extensor muscles are relaxed. The lower part of the muscle also acts as an adductor and external rotator of the limb. The Gluteus medius and minimus abduct the thigh when the limb is extended, and are principally called into action in supporting the body on one limb, in conjunction with the Tensor fasciæ femoris. Their anterior fibres, by drawing the great trochanter forward, rotate the thigh inward, in which action they are also assisted by the Tensor fasciæ femoris. The remaining muscles are powerful rotators of the thigh outward. In the sitting posture, when the thigh is flexed upon the pelvis, their action as rotator ceases, and they become abductors, with the exception of the Obturator externus, which still rotates the femur outward. When the femur is fixed, the Pyriformis and Obturator muscles serve to draw the pelvis forward if it has been inclined backward, and assist in steadying it upon the head of the femur.

4. Posterior Femoral Region.

Biceps. Semitendinosus. Semimembranosus.
(*Hamstring muscles.*)

Dissection (Fig. 255).—Make a vertical incision along the middle of the back of the thigh, from the lower fold of the nates to about three inches below the back of the knee-joint, and there connect it with a transverse incision, carried from the inner to the outer side of the leg. Make a third incision transversely at the junction of the middle with the lower third of the thigh. The integument having been removed from the back of the knee, and the boundaries of the popliteal space examined, the removal of the integument from the remaining part of the thigh should be continued, when the fascia and muscles of this region will be exposed.

The **Biceps** (*Biceps flexor cruris*) is a large muscle, of considerable length, situated on the posterior and outer aspect of the thigh (Fig. 256). It arises by two heads. One, the long head, arises from the lower and inner impression on the back part of the tuberosity of the ischium, by a tendon common to it and the Semitendinosus, and from the lower part of the great sacro-sciatic ligament. The femoral, or short head, arises from the outer lip of the linea aspera, between the Adductor magnus and Vastus externus, extending up almost as high as the insertion of the Gluteus maximus; from the outer prolongation of the linea aspera to within two inches of the outer condyle; and from the external intermuscular septum. The fibres of the long head form a fusiform belly, which, passing obliquely downward and a little outward, terminates in an aponeurosis which covers the posterior surface of the muscle, and receives the fibres of the short head: this aponeurosis becomes gradually contracted into a tendon, which is inserted into the outer side of the head of the fibula, and by a small slip into the lateral surface of the external tuberosity of the tibia. At its insertion the tendon divides into two portions, which embrace the long external lateral ligament of the knee-joint. From the posterior border of the tendon a thin expansion is given off to the fascia of the leg. The tendon of this muscle forms the outer hamstring.

Relations.—By its *superficial surface*, with the Gluteus maximus and the small sciatic nerve, the fascia lata, and integument. By its *deep surface*, with the Semimembranosus, Adductor magnus, and Vastus externus, the great sciatic nerve, and, near its insertion, with the external head of the Gastrocnemius, Plantaris, the superior external articular artery, and the external popliteal nerve.

The **Semitendinosus**, remarkable for the great length of its tendon, is situated at the posterior and inner aspect of the thigh. It arises from the lower and inner impression on the tuberosity of the ischium by a tendon common to it and the long head of the Biceps; it also arises from an aponeurosis which connects the adjacent surfaces of the two muscles to the extent of about three inches after their origin. It forms a fusiform muscle, which, passing downward and inward, terminates a little below the middle of the thigh in a long round tendon which lies along the inner side of the popliteal space, then curves around the inner tuberosity of the tibia, and is inserted into the upper part of the inner surface of the shaft of that bone nearly as far forward as its anterior border. At its insertion it gives off from its lower border a prolongation to the deep fascia of the leg. This tendon lies behind the tendon of the Sartorius, and below that of the Gracilis, to which it is united. A tendinous intersection is usually observed about the middle of the muscle.

Relations.—By its *superficial surface*, with the Gluteus maximus and fascia lata; by its *deep surface*, with the Semimembranosus, Adductor magnus, inner head of the Gastrocnemius, and internal lateral ligament of the knee-joint, the last being separated from the tendon by a bursa.

The **Semimembranosus**, so called from its membranous tendon of origin, is situated at the back part and inner side of the thigh. It arises by a thick tendon from the upper and outer impression on the back part of the tuberosity of the ischium, above and to the outer side of the Biceps and Semitendinosus, and is inserted into the groove on the inner and back part of the inner tuberosity of the tibia, be-

neath the internal lateral ligament. The tendon of the muscle at its origin expands into an aponeurosis which covers the upper part of its anterior surface: from this aponeurosis muscular fibres arise, and converge to another aponeurosis, which covers the lower part of its posterior surface and contracts into the tendon of insertion. The tendon of the muscle at its insertion gives off certain fibrous expansions; one of these, of considerable size, passes upward and outward to be inserted into the back part of the outer condyle of the femur, forming part of the posterior ligament of the knee-joint; a second is continued downward to the fascia which covers the Popliteus muscle. The tendon also sends a few fibres to join the internal lateral ligament of the joint.

The tendons of the two preceding muscles, with that of the Gracilis, form the inner hamstring.

Relations.—By its *superficial surface*, with the Gluteus maximus, Semitendinosus, Biceps, and fascia lata; by its *deep surface*, with the origin of the Quadratus femoris, popliteal vessels, Adductor magnus, and inner head of the Gastrocnemius, from which it is separated by a synovial bursa; by its *inner border*, with the Gracilis; by its *outer border*, with the great sciatic nerve, and its internal popliteal branch.

Nerves.—The muscles of this region are supplied by the first, second, and third sacral nerves through the great sciatic nerve.

Actions.—The hamstring muscles flex the leg upon the thigh. When the knee is semiflexed, the Biceps, in consequence of its oblique direction downward and outward, rotates the leg slightly outward; and the Semitendinosus, and to a slight extent the Semimembranosus, rotate the leg inward, assisting the Popliteus. Taking their fixed point from below, these muscles serve to support the pelvis upon the head of the femur and to draw the trunk directly backward, as in raising it from the stooping position or in feats of strength, when the body is thrown backward in the form of an arch. When the leg is extended on the thigh, they limit the amount of flexion of the trunk on the lower limbs.

Surgical Anatomy.—The tendons of these muscles occasionally require subcutaneous division in some forms of spurious ankylosis of the knee-joint dependent upon permanent contraction and rigidity of the Flexor muscles, or from stiffening of the ligamentous and other tissues surrounding the joint, the result of disease. This is effected by putting the tendon upon the stretch, and inserting a narrow, sharp-pointed knife between it and the skin: the cutting edge being then turned toward the tendon, it should be divided, taking great care that the wound in the skin is not at the same time enlarged. The relation of the external popliteal nerve to the tendon of the Biceps must always be borne in mind in dividing this tendon.

FIG. 226.—Muscles of the front of the leg.

III. MUSCLES AND FASCIÆ OF THE LEG.

These may be divided into three groups: those on the anterior, those on the posterior, and those on the outer side of the leg.

5. Anterior Tibio-fibular Region.

Tibialis anticus.	Extensor longus digitorum.
Extensor proprius hallucis.[1]	Peroneus tertius.

Dissection (Fig. 252).—The knee should be bent, a block placed beneath it, and the foot kept in an extended position; then make an incision through the integument in the middle line of the leg to the ankle, and continue it along the dorsum of the foot to the toes. Make a second incision transversely across the ankle, and a third in the same direction across the bases of the toes; remove the flaps of integument included between these incisions in order to examine the deep fascia of the leg.

The **Deep Fascia of the Leg** forms a complete investment to the muscles, but is not continued over the subcutaneous surfaces of the bones. It is continuous above with the fascia lata, receiving an expansion from the tendon of the Biceps on the outer side, and from the tendons of the Sartorius, Gracilis, and Semitendinosus on the inner side; in front it blends with the periosteum covering the subcutaneous surface of the tibia, and with that covering the head and external malleolus of the fibula; below it is continuous with the annular ligaments of the ankle. It is thick and dense in the upper and anterior part of the leg, and gives attachment, by its deep surface, to the Tibialis anticus and Extensor longus digitorum muscles, but thinner behind, where it covers the Gastrocnemius and Soleus muscles. Over the popliteal space it is much strengthened by transverse fibres which stretch across from the inner to the outer hamstring muscles, and it is here perforated by the external saphenous vein. Its deep surface gives off, on the outer side of the leg, two strong intermuscular septa which enclose the Peronei muscles, and separate them from the muscles on the anterior and posterior tibial regions and several smaller and more slender processes which enclose the individual muscles in each region; at the same time a broad transverse intermuscular septum, called the *deep transverse fascia of the leg*, intervenes between the superficial and deep muscles in the posterior tibio-fibular region.

Remove the fascia by dividing it in the same direction as the integument, excepting opposite the ankle, where it should be left entire. Commence the removal of the fascia from below, opposite the tendons, and detach it in the line of direction of the muscular fibres.

The **Tibialis anticus** is situated on the outer side of the tibia; it is thick and fleshy at its upper part, tendinous below. It arises from the outer tuberosity and upper two-thirds of the external surface of the shaft of the tibia; from the adjoining part of the interosseous membrane; from the deep surface of the fascia; and from the intermuscular septum between it and the Extensor longus digitorum; the fibres pass vertically downward, and terminate in a tendon which is apparent on the anterior surface of the muscle at the lower third of the leg. After passing through the innermost compartment of the anterior annular ligament, it is inserted into the inner and under surface of the internal cuneiform bone and base of the metatarsal bone of the great toe.

Relations.—By its *anterior surface*, with the fascia and with the annular ligament; by its *posterior surface*, with the interosseous membrane, tibia, ankle-joint, and inner side of the tarsus: this surface also overlaps the anterior tibial vessels

[1] There is no such word as "Hallux, -cis." It is the result of some ignorant blunder, copied until it has become established by usage; it has been thought better, therefore, to retain it. According to Lewis and Short the word is ALLEX, masculine; genitive, ALLICIS, the great toe, and the correct rendering would be Extensor proprius allicis. It is a rare word, and is sometimes spelt, but not so correctly, "Hallex." It is used by Plautus, in the "Pœnulus" V., v. 31, of a little man, as we might say "a hop-o'-my-thumb." "Tunc hic amator audes esse, allex viri" (To think of you daring to make up to her, you hop-o'-my-thumb!). The word "alex," sometimes spelt "allex," a fish sauce, is probably a different word altogether. It is used by Horace and Pliny.

and nerve in the upper part of the leg. By its *inner surface*, with the tibia; by its *outer surface*, with the Extensor longus digitorum and Extensor proprius hallucis, and the anterior tibial vessels and nerve.

The **Extensor proprius hallucis** is a thin, elongated, and flattened muscle situated between the Tibialis anticus and Extensor longus digitorum. It arises from the anterior surface of the fibula for about the middle two-fourths of its extent, its origin being internal to that of the Extensor longus digitorum; it also arises from the interosseous membrane to a similar extent. The fibres pass downward, and terminate in a tendon which occupies the anterior border of the muscle, passes through a distinct compartment in the lower portion of the annular ligament, crosses the anterior tibial vessels near the bend of the ankle, and is inserted into the base of the last phalanx of the great toe. Opposite the metatarso-phalangeal articulation the tendon gives off a thin prolongation on each side, which covers the surface of the joint. It usually sends an expansion from the inner side of the tendon, to be inserted into the base of the first phalanx.

Relations.—By its *anterior surface*, with the fascia and the anterior annular ligament: by its *posterior surface*, with the interosseous membrane, fibula, tibia, and ankle-joint; by its *outer side*, with the Extensor longus digitorum above, the dorsalis pedis vessels, anterior tibial nerve, and Extensor brevis digitorum below; by its *inner side*, with the Tibialis anticus and the anterior tibial vessels above. The muscle is external to the anterior tibial vessels in the upper part of the leg; but in the lower third its tendon crosses over them, so that it lies internal to them on the dorsum of the foot.

The **Extensor longus digitorum** is an elongated, flattened, penniform muscle situated the most externally of all the muscles on the fore part of the leg. It arises from the outer tuberosity of the tibia; from the upper three-fourths of the anterior surface of the shaft of the fibula; from the interosseous membrane; from the deep surface of the fascia; and from the intermuscular septa between it and the Tibialis anticus on the inner and the Peronei on the outer side. The tendon enters a canal in the annular ligament with the Peroneus tertius, and divides into four slips, which run across the dorsum of the foot and are inserted into the second and third phalanges of the four lesser toes. The mode in which the tendons are inserted is the following: The three inner tendons opposite the metatarso-phalangeal articulation are joined, on their outer side, by a tendon of the Extensor brevis digitorum. They all receive a fibrous expansion from the Interossei and Lumbricales, and then spread out into a broad aponeurosis, which covers the dorsal surface of the first phalanx: this aponeurosis, at the articulation of the first with the second phalanx, divides into three slips—a middle one, which is inserted into the base of the second phalanx, and two lateral slips, which, after uniting on the dorsal surface of the second phalanx, are continued onward, to be inserted into the base of the third.

Relations.—By its *anterior surface*, with the fascia and the annular ligament; by its *posterior surface*, with the fibula, interosseous membrane, ankle-joint, and Extensor brevis digitorum; by its *inner side*, with the Tibialis anticus, Extensor proprius hallucis, and anterior tibial vessels and nerve; by its *outer side*, with the Peroneus longus and brevis.

The **Peroneus tertius** is a part of the Extensor longus digitorum, and might be described as its fifth tendon. The fibres belonging to this tendon arise from the lower fourth of the anterior surface of the fibula, from the lower part of the interosseous membrane, and from an intermuscular septum between it and the Peroneus brevis. The tendon, after passing through the same canal in the annular ligament as the Extensor longus digitorum, is inserted into the dorsal surface of the base of the metatarsal bone of the little toe. This muscle is sometimes wanting.

Nerves.—These muscles are supplied by the fourth and fifth lumbar and first sacral nerves through the anterior tibial nerve.

Actions.—The Tibialis anticus and Peroneus tertius are the direct flexors of the

foot at the ankle-joint; the former muscle, when acting in conjunction with the Tibialis posticus, raises the inner border of the foot (*i. e.*, inverts the foot); and the latter, acting with the Peroneus brevis and longus, draws the outer border of the foot upward and the sole outward (*i. e.*, everts the foot). The Extensor longus digitorum and Extensor proprius hallucis extend the phalanges of the toes, and, continuing their action, flex the foot upon the leg. Taking their fixed point from below, in the erect posture, all these muscles serve to fix the bones of the leg in the perpendicular position, and give increased strength to the ankle-joint.

6. Posterior Tibio-fibular Region.

Dissection (Fig. 255).—Make a vertical incision along the middle line of the back of the leg, from the lower part of the popliteal space to the heel, connecting it below by a transverse incision extending between the two malleoli; the flaps of integument being removed, the fascia and muscles should be examined.

The muscles in this region of the leg are subdivided into two layers—superficial and deep. The superficial layer constitutes a powerful muscular mass, forming the calf of the leg. Their large size is one of the most characteristic features of the muscular apparatus in man, and bears a direct connection with his ordinary attitude and mode of progression.

Superficial Layer.

Gastrocnemius. Soleus. Plantaris.

The **Gastrocnemius** is the most superficial muscle, and forms the greater part of the calf. It arises by two heads, which are connected to the condyles of the femur by two strong flat tendons. The inner and larger head arises from a depression at the upper and back part of the inner condyle and from the adjacent part of the femur. The outer head arises from an impression on the outer side of the external condyle and from the posterior surface of the femur immediately above the condyle. Both heads, also, arise by a few tendinous and fleshy fibres from the ridges which are continued upward from the condyles to the linea aspera. Each tendon spreads out into an aponeurosis, which covers the posterior surface of that portion of the muscle to which it belongs; the muscular fibres of the inner head being thicker and extending lower than those of the outer. From the anterior surface of these tendinous expansions muscular fibres are given off. The fibres in the median line, which correspond to the accessory portions of the muscle derived from the bifurcations of the linea aspera, unite at an angle upon a median tendinous raphe below; the remaining fibres converge to an aponeurosis which covers the anterior surface of the muscle, and this, gradually contracting, unites with the tendon of the Soleus, and forms with it the tendo Achillis.

Relations.—By its *superficial surface*, with the fascia of the leg, which separates it from the external saphenous vein and nerve; by its *deep surface*, with the posterior ligament of the knee-joint, the Popliteus, Soleus, Plantaris, popliteal vessels, and internal popliteal nerve. The tendon of the inner head corresponds with the back part of the inner condyle, from which it is separated by a synovial bursa, which, in some cases, communicates with the cavity of the knee-joint. The tendon of the outer head contains a sesamoid fibro-cartilage (rarely osseous) where it plays over the corresponding outer condyle; and one is occasionally found in the tendon of the inner head.

The Gastrocnemius should be divided across, just below its origin, and turned downward, in order to expose the next two muscles.

The **Soleus** is a broad flat muscle situated immediately beneath the Gastrocnemius. It has received its name from its resemblance in shape to a sole-fish. It arises by tendinous fibres from the back part of the head of the fibula and from the upper third of the posterior surface of its shaft; from the oblique line of the

tibia and from the middle third of its internal border; some fibres also arise from a tendinous arch placed between the tibial and fibular origins of the muscle, beneath which the popliteal vessels and internal popliteal nerve pass. The fibres pass backward to an aponeurosis which covers the posterior surface of the muscle, and this, gradually becoming thicker and narrower, joins with the tendon of the Gastrocnemius, and forms with it the tendo Achillis.

Relations.—By its *superficial surface*, with the Gastrocnemius and Plantaris; by its *deep surface*, with the Flexor longus digitorum, Flexor longus hallucis, Tibialis posticus, and posterior tibial vessels and nerve, from which it is separated by the transverse intermuscular septum or deep transverse fascia of the leg.

The **Tendo Achillis**, the common tendon of the Gastrocnemius and Soleus,[1] is the thickest and strongest tendon in the body. It is about six inches in length, and commences about the middle of the leg, but receives fleshy fibres on its anterior surface nearly to its lower end. Gradually becoming contracted below, it is inserted into the lower part of the posterior surface of the os calcis, a synovial bursa being interposed between the tendon and the upper part of this surface. The tendon spreads out somewhat at its lower end, so that its narrowest part is usually about an inch and a half above its insertion. The tendon is covered by the fascia and the integument, and is separated from the deep muscles and vessels by a considerable interval filled up with areolar and adipose tissue. Along its outer side, but superficial to it, is the external saphenous vein.

The **Plantaris** is an extremely diminutive muscle placed between the Gastrocnemius and Soleus, and remarkable for its long and delicate tendon. It arises from the lower part of the outer prolongation of the linea aspera and from the posterior ligament of the knee-joint. It forms a small fusiform belly, about three or four inches in length, terminating in a long slender tendon which crosses obliquely between the two muscles of the calf, and, running along the inner border of the tendo Achillis, is inserted with it into the posterior part of the os calcis. This muscle is occasionally double, and is sometimes wanting. Occasionally, its tendon is lost in the internal annular ligament or in the fascia of the leg.

FIG. 370.—Muscles of the back of the leg. Superficial layer.

Nerves.—The Gastrocnemius is supplied by the first and second sacral nerves,

[1] These two muscles with a common tendon are by some anatomists classed together as one muscle, the *Triceps suræ*, the two heads of origin of the Gastrocnemius and the Soleus constituting the three heads of the Triceps, and the tendo Achillis the single tendon of insertion.

and the Plantaris by the fourth and fifth lumbar and first sacral nerves through the internal popliteal. The Soleus is supplied by the fifth lumbar and first and second sacral nerves through the internal popliteal and posterior tibial.

Actions.—The muscles of the calf are the chief extensors of the foot at the ankle-joint. They possess considerable power, and are constantly called into use in standing, walking, dancing, and leaping; hence the large size they usually present. In walking these muscles draw powerfully upon the os calcis, raising the heel, and with it the entire body, from the ground; the body being thus supported on the raised foot, the opposite limb can be carried forward. In standing, the Soleus, taking its fixed point from below, steadies the leg upon the foot, and prevents the body from falling forward, to which there is a constant tendency from the superincumbent weight. The Gastrocnemius, acting from below, serves to flex the femur upon the tibia, assisted by the Popliteus. The Plantaris is the rudiment of a large muscle which exists in some of the lower animals and is continued over the os calcis to be inserted into the plantar fascia. In man it is an accessory to the Gastrocnemius, extending the ankle if the foot is free, or bending the knee if the foot is fixed. Possibly, acting from below, by its attachment to the posterior ligament of the knee-joint, it may pull that ligament backward during flexion, and so protect it from being compressed between the two articular surfaces.

Deep Layer (Fig. 260).

Popliteus.	Flexor longus digitorum.
Flexor longus hallucis.	Tibialis posticus.

Dissection.—Detach the Soleus from its attachment to the fibula and tibia, and turn it downward, when the deep layer of muscles is exposed, covered by the deep transverse fascia of the leg.

The **Deep Transverse Fascia** of the leg is a transversely placed, intermuscular septum, between the superficial and deep muscles in the posterior tibio-fibular region. On either side it is connected to the margins of the tibia and fibula. Above, where it covers the Popliteus, it is thick and dense, and receives an expansion from the tendon of the Semimembranosus; it is thinner in the middle of the leg, but below, where it covers the tendons passing behind the malleoli, it is thickened and continuous with the internal annular ligament.

This fascia should now be removed, commencing from below opposite the tendons, and detaching it from the muscles in the direction of their fibres.

The **Popliteus** is a thin, flat, triangular muscle, which forms part of the floor of the popliteal space. It arises by a strong tendon, about an inch in length, from a deep depression on the outer side of the external condyle of the femur, and from the posterior ligament of the knee-joint, and is inserted into the inner two-thirds of the triangular surface above the oblique line on the posterior surface of the shaft of the tibia, and into the tendinous expansion covering the surface of the muscle. The tendon of the muscle is covered by that of the Biceps and by the external lateral ligament of the knee-joint; it grooves the posterior border of the external semilunar fibro-cartilage, and is invested by the synovial membrane of the knee-joint.

Relations.—By its *superficial surface*, with the fascia covering it, which separates it from the Gastrocnemius, Plantaris, popliteal vessels, and internal popliteal nerve; by its *deep surface*, with the knee-joint and back of the tibia.

The **Flexor longus hallucis** is situated on the fibular side of the leg, and is the most superficial and largest of the three next muscles. It arises from the lower two-thirds of the posterior surface of the shaft of the fibula, with the exception of an inch at its lowest part; from the lower part of the interosseous membrane; from an intermuscular septum between it and the Peronei, externally; and from the fascia covering the Tibialis posticus internally. The fibres pass obliquely downward and backward, and terminate in a tendon which occupies nearly the whole length of the posterior surface of the muscle. This tendon occupies a groove on the posterior surface of the lower end of the tibia; it then lies in a second groove

on the posterior surface of the astragalus, and finally in a third groove, beneath the sustentaculum tali of the os calcis, and passes into the sole of the foot, where it runs forward between the two heads of the Flexor brevis hallucis, and is inserted into the base of the last phalanx of the great toe. The grooves in the astragalus and os calcis, which contain the tendon of the muscle, are converted by tendinous fibres into distinct canals lined by synovial membrane; and as the tendon crosses the sole of the foot, it is connected to the common flexor by a tendinous slip.

FIG. 269.—Muscles of the back of the leg. Deep layer.

Relations.—By its *superficial surface*, with the Soleus and tendo Achillis, from which it is separated by the deep transverse fascia; by its *deep surface*, with the fibula, Tibialis posticus, the peroneal vessels, the lower part of the interosseous membrane, and the ankle-joint; by its *outer border*, with the Peronei; by its *inner border*, with the Tibialis posticus and posterior tibial vessels and nerve. In the sole of the foot it lies above the Abductor hallucis and Flexor longus digitorum.

The **Flexor longus digitorum** (*perforans*) is situated on the tibial side of the leg. At its origin it is thin and pointed, but gradually increases in size as it descends. It arises from the posterior surface of the shaft of the tibia, immediately below the oblique line to within three inches of its extremity, internal to the tibial origin of the Tibialis posticus; some fibres also arise from the fascia covering the Tibialis posticus. The fibres terminate in a tendon which runs nearly the whole length of the posterior surface of the muscle. This tendon passes behind the internal malleolus in a groove, common to it and the Tibialis posticus, but separated from the latter by a fibrous septum, each tendon being contained in a special sheath lined by a separate synovial membrane. It then passes obliquely forward and outward, superficial to the internal lateral ligament into the sole of the foot (Fig. 262), where, crossing superficially to the tendon of the Flexor longus hallucis,[1] to which it is connected by a strong tendinous slip, it becomes expanded, is joined by the Flexor accessorius, and finally divides into four tendons which are inserted into the bases of the last phalanges of the four lesser toes, each tendon passing through a fissure in the tendon of the Flexor brevis digitorum opposite the base of the first phalanges.

Relations.—*In the leg:* by its *superficial surface*, with the posterior tibial vessels and nerve, and the deep transverse fascia, which separates it from the Soleus muscle; by its *deep surface*, with the Tibia and Tibialis posticus. *In the foot* it is covered by the Abductor hallucis and Flexor brevis digitorum, and crosses superficial to the Flexor longus hallucis.

The **Tibialis posticus** lies between the two preceding muscles, and is the most deeply seated of all the muscles in the leg. It commences above by two pointed processes, separated by an angular interval, through which the anterior tibial vessels pass forward to the front of the leg. It arises from the whole of the posterior surface of the interosseous membrane, excepting its lowest part, from the outer portion of the posterior surface of the shaft of the tibia, between the

[1] That is, in the order of dissection of the sole of the foot.

commencement of the oblique line above, and the junction of the middle and lower third of the shaft below; and from the upper two-thirds of the internal surface of the fibula; some fibres also arise from the deep transverse fascia and from the intermuscular septa, separating it from the adjacent muscles on each side. This muscle, in the lower fourth of the leg, passes in front of the Flexor longus digitorum, and terminates in a tendon which passes through a groove behind the inner malleolus with the tendon of that muscle, but enclosed in a separate sheath; it then passes through another sheath, over the internal lateral ligament into the foot, and then beneath the inferior calcaneo-navicular ligament, and is inserted into the tuberosity of the navicular and internal cuneiform bones. The tendon of this muscle contains a sesamoid fibro-cartilage as it passes over the navicular bone, and gives off fibrous expansions, one of which passes backward to the sustentaculum tali of the os calcis, others outward to the middle and external cuneiform and cuboid, and some forward to the bases of the second, third, and fourth metatarsal bones (Fig. 263).

Relations.—By its *superficial surface*, with the Soleus, from which it is separated by the deep transverse fascia, the Flexor longus digitorum, the posterior tibial vessels and nerve, and the peroneal vessels; by its *deep surface*, with the interosseous ligament, the tibia, fibula, and ankle-joint.

Nerves.—The Popliteus is supplied by the fourth and fifth lumbar and first sacral nerves, through the internal popliteal; the Flexor longus digitorum and Tibialis posticus by the fifth lumbar and first sacral; and the Flexor longus hallucis by the fifth lumbar and first and second sacral nerves through the posterior tibial.

Actions.—The Popliteus assists in flexing the leg upon the thigh; when the leg is flexed, it will rotate the tibia inward. It is especially called into action at the commencement of the act of bending the knee, inasmuch as it produces a slight inward rotation of the tibia, which is essential in the early stage of this movement. The Tibialis posticus is a direct extensor of the foot at the ankle-joint; acting in conjunction with the Tibialis anticus, it turns the sole of the foot inward (*i. e.*, inverts the foot), antagonizing the Peronei, which turn it outward (evert it). In the sole of the foot the tendon of the Tibialis posticus lies directly below the inferior calcaneo-scaphoid ligament, and is therefore an important factor in maintaining the arch of the foot. The Flexor longus digitorum and Flexor longus hallucis are the direct flexors of the phalanges, and, continuing their action, extend the foot upon the leg; they assist the Gastrocnemius and Soleus in extending the foot, as in the act of walking or in standing on tiptoe.

In consequence of the oblique direction of the tendon of the long flexor the toes would be drawn inward were it not for the Flexor accessorius muscle, which is inserted into the outer side of its tendon and draws it to the middle line of the foot during its action. Taking their fixed point from the foot, these muscles serve to maintain the upright posture by steadying the tibia and fibula perpendicularly upon the ankle-joint. They also serve to raise these bones from the oblique position they assume in the stooping posture.

7. Fibular Region.

Peroneus longus. Peroneus brevis.

Dissection.—The muscles are readily exposed by removing the fascia covering their surface, from below upward, in the line of direction of their fibres.

The **Peroneus longus** is situated at the upper part of the outer side of the leg, and is the more superficial of the two muscles. It arises from the head and upper two-thirds of the outer surface of the shaft of the fibula, from the deep surface of the fascia, and from the intermuscular septa between it and the muscles on the front, and those on the back of the leg, occasionally also by a few fibres from the outer tuberosity of the tibia. Between its attachment to the head and to the shaft of the fibula there is a small interval of bone from which no muscular fibres arise; through this gap the external popliteal nerve passes beneath the muscle.

It terminates in a long tendon, which passes behind the outer malleolus, in a groove common to it and the tendon of the Peroneus brevis, behind which it lies, the groove being converted into a canal by a fibrous band, and the tendons invested by a common synovial membrane; it is then reflected obliquely forward across the outer side of the os calcis, below its peroneal tubercle, being contained in a separate fibrous sheath, lined by a prolongation of the synovial membrane which lines the groove behind the malleolus. Having reached the outer side of the cuboid bone, it runs in a groove on the under surface of that bone, which is converted into a canal by the long calcaneo-cuboid ligament, and is lined by a synovial membrane: the tendon then crosses the sole of the foot obliquely, and is inserted into the outer side of the base of the metatarsal bone of the great toe and the internal cuneiform bone. Occasionally it sends a slip to the base of the second metatarsal bone. The tendon changes its direction at two points: first, behind the external malleolus; secondly, on the outer side of the cuboid bone; in both of these situations the tendon is thickened, and in the latter a sesamoid fibro-cartilage, or sometimes a bone, is usually developed in its substance.

Relations.—By its *superficial surface*, with the fascia and integument; by its *deep surface*, with the fibula, external popliteal nerve, the Peroneus brevis, os calcis, and cuboid bone; by its *anterior border*, with an intermuscular septum, which intervenes between it and the Extensor longus digitorum; by its *posterior border*, with an intermuscular septum, which separates it from the Soleus above and the Flexor longus hallucis below.

The **Peroneus brevis** lies beneath the Peroneus longus, and is shorter and smaller than it. It arises from the lower two-thirds of the external surface of the shaft of the fibula, internal to the Peroneus longus, and from the intermuscular septa separating it from the adjacent muscles on the front and back part of the leg. The fibres pass vertically downward, and terminate in a tendon which runs in front of that of the preceding muscle through the same groove, behind the external malleolus, being contained in the same fibrous sheath and lubricated by the same synovial membrane. It then passes through a separate sheath on the outer side of the os calcis, above that for the tendon of the Peroneus longus, the two tendons being here separated by the peroneal tubercle, and is finally inserted into the tuberosity at the base of the metatarsal bone of the little toe, on its outer side.

Relations.—By its *superficial surface*, with the Peroneus longus and the fascia of the leg and foot; by its *deep surface*, with the fibula and outer side of the os calcis.

Nerves.—The Peroneus longus and brevis are supplied by the fourth and fifth lumbar and first sacral nerves through the musculo-cutaneous branch of the external popliteal nerve.

Actions.—The Peroneus longus and brevis extend the foot upon the leg, in conjunction with the Tibialis posticus, antagonizing the Tibialis anticus and Peroneus tertius, which are flexors of the foot. The Peroneus longus also everts the sole of the foot: hence the extreme eversion occasionally observed in fracture of the lower end of the fibula, where that bone offers no resistance to the action of this muscle. From the oblique direction of the Peroneus longus tendon across the sole of the foot it is an important agent in the maintenance of the transverse arch of the foot. Taking their fixed point below, the Peronei serve to steady the leg upon the foot. This is especially the case in standing upon one leg, when the tendency of the superincumbent weight is to throw the leg inward: the Peroneus longus overcomes this tendency by drawing on the outer side of the leg, and thus maintains the perpendicular direction of the limb.

Surgical Anatomy.—The student should now consider the position of the tendons of the various muscles of the leg, their relation with the ankle-joint and surrounding blood-vessels, and especially their action upon the foot, as their rigidity and contraction give rise to one or other of the kinds of deformity known as *club-foot*. The most simple and common deformity, and one

that is rarely, if ever, congenital, is the *talipes equinus*, the heel being raised by rigidity and contraction of the Gastrocnemius muscle, and the patient walking upon the ball of the foot. In the *talipes varus* the foot is forcibly adducted and the inner side of the sole raised, sometimes to a right angle with the ground, by the action of the Tibialis anticus and posticus. In the *talipes valgus* the outer edge of the foot is raised by the Peronei muscles, and the patient walks on the inner ankle. In the *talipes calcaneus* the toes are raised by the extensor muscles, the heel is depressed, and the patient walks upon it. Other varieties of deformity are met with, as the *talipes equino-varus*, *equino-valgus*, and *calcaneo-valgus*, whose names sufficiently indicate their nature. Of these, the talipes equino-varus is the most common congenital form: the heel is raised by the tendo Achillis, the inner border of the foot drawn upward by the Tibialis anticus, the anterior two-thirds twisted inward by the Tibialis posticus, and the arch increased by the contraction of the plantar fascia, so that the patient walks on the middle of the outer border of the foot. Each of these deformities may sometimes be successfully relieved by division of the opposing tendons and fascia: by this means the foot regains its proper position, and the tendons heal by the organization of lymph thrown out between the divided ends. The operation is easily performed by putting the contracted tendon upon the stretch, and dividing it by means of a narrow, sharp-pointed knife inserted beneath it.

Rupture of a few of the fibres of the Gastrocnemius or rupture of the Plantaris tendon not uncommonly occurs, especially in men somewhat advanced in life, from some sudden exertion, and frequently occurs during the game of lawn tennis, and is hence known as "lawn-tennis leg." The accident is accompanied by a sudden pain, and produces a sensation as if the individual had been struck a violent blow on the part. The tendo Achillis is also sometimes ruptured. It is stated that John Hunter ruptured his tendo Achillis whilst dancing at the age of forty.

IV. MUSCLES AND FASCIÆ OF THE FOOT.

The fibrous bands, or thickened portions of the fascia of the leg, which bind down the tendons in front of and behind the ankle in their passage to the foot should now be examined; they are termed the *annular ligaments*, and are three in number—anterior, internal, and external.

The **Anterior Annular Ligament** consists of a superior or transverse portion, which binds down the Extensor tendons as they descend on the front of the tibia and fibula; and an inferior or Y-shaped portion, which retains them in connection with the tarsus, the two portions being connected by a thin intervening layer of fascia. The transverse portion is attached externally to the lower end of the fibula and internally to the tibia; above it is continuous with the fascia of the leg; it contains only one synovial sheath, for the tendon of the Tibialis anticus; the other tendons and the anterior tibial vessels and nerve passing beneath it, but without any distinct synovial sheath. The Y-shaped portion is placed in front of the ankle-joint, the stem of the Y being attached externally to the upper surface of the os calcis, in front of the depression for the interosseous ligament; it is directed inward, as a double layer, one lamina passing in front, and the other behind, the tendons of the Peroneus tertius and Extensor longus digitorum. At the inner border of the latter tendon these two layers join together, forming a sort of loop or sheath in which the tendons are enclosed, surrounded by a synovial membrane. From the inner extremity of this loop the two limbs of the Y diverge: one passes upward and inward, to be attached to the internal malleolus, passing over the Extensor proprius hallucis and the vessels and nerves, but enclosing the Tibialis anticus and its synovial sheath by a splitting of its fibres. The other limb extends downward and inward to be attached to the inner border of the plantar fascia, and passes over the tendons of the Extensor proprius hallucis and Tibialis anticus and also the vessels and nerves. These two tendons are contained in separate synovial sheaths situated beneath the ligament.

The **Internal Annular Ligament** is a strong fibrous band which extends from the inner malleolus above to the internal margin of the os calcis below, converting a series of grooves in this situation into canals for the passage of the tendons of the Flexor muscles and vessels into the sole of the foot. It is continuous by its upper border with the deep fascia of the leg, and by its lower border with the plantar fascia and the fibres of origin of the Abductor hallucis muscle. The four canals which it forms transmit, from within outward, first, the tendon of the Tibialis posticus; second, the tendon of the Flexor longus digitorum; third, the pos-

terior tibial vessels and nerve, which run through a broad space beneath the ligament; lastly, in a canal formed partly by the astragalus, the tendon of the Flexor longus hallucis. The canals for the tendons are lined by a separate synovial membrane.

The **External Annular Ligament** extends from the extremity of the outer malleolus to the outer surface of the os calcis: it binds down the tendons of the Peroneus longus and brevis muscles in their passage beneath the outer ankle. The two tendons are enclosed in one synovial sac.

Dissection of the Sole of the Foot.—The foot should be placed on a high block with the sole uppermost, and firmly secured in that position. Carry an incision round the heel and along the inner and outer borders of the foot to the great and little toes. This incision should divide the integument and thick layer of granular fat beneath until the fascia is visible; the skin and fat should then be removed from the fascia in a direction from behind forward, as seen in Fig. 255.

The **Plantar Fascia**, the densest of all the fibrous membranes, is of great strength, and consists of pearly-white glistening fibres, disposed, for the most part, longitudinally: it is divided into a central and two lateral portions.

The *central portion*, the thickest, is narrow behind and attached to the inner tubercle of the os calcis, posterior to the origin of the Flexor brevis digitorum, and, becoming broader and thinner in front, divides near the heads of the metatarsal bones into five processes, one for each of the toes. Each of these processes divides opposite the metatarso-phalangeal articulation into two strata, superficial and deep. The superficial stratum is inserted into the skin of the transverse sulcus which divides the toes from the sole. The deeper stratum divides into two slips which embrace the sides of the flexor tendons of the toes, and blend with the sheaths of the tendons, and laterally with the transverse metatarsal ligament, thus forming a series of arches through which the tendons of the short and long flexors pass to the toes. The intervals left between the five processes allow the digital vessels and nerves and the tendons of the Lumbricales muscles to become superficial. At the point of division of the fascia into processes and slips numerous transverse fibres are superadded, which serve to increase the strength of the fascia at this part by binding the processes together and connecting them with the integument. The central portion of the plantar fascia is continuous with the lateral portions at each side, and sends upward into the foot, at their point of junction, two strong vertical intermuscular septa, broader in front than behind, which separate the middle from the external and internal plantar group of muscles; from these, again, thinner transverse septa are derived, which separate the various layers of muscles in this region. The upper surface of this fascia gives attachment behind to the Flexor brevis digitorum muscle.

The *lateral portions* of the plantar fascia are thinner than the central piece, and cover the sides of the foot.

The *outer portion* covers the under surface of the Abductor minimi digiti; it is thick behind, thin in front, and extends from the os calcis, forward, to the base of the fifth metatarsal bone, into the outer side of which it is attached; it is continuous internally with the middle portion of the plantar fascia, and externally with the dorsal fascia.

The *inner portion* is very thin, and covers the Abductor hallucis muscle; it is attached behind to the internal annular ligament, and is continuous around the side of the foot with the dorsal fascia, and externally with the middle portion of the plantar fascia.

8. Dorsal Region.

Extensor brevis digitorum.

The **Fascia** on the dorsum of the foot is a thin membranous layer continuous above with the anterior margin of the annular ligament; it becomes gradually lost opposite the heads of the metatarsal bones, and on each side blends with the

lateral portions of the plantar fascia; it forms a sheath for the tendons placed on the dorsum of the foot. On the removal of this fascia the muscles and tendons of the dorsal region of the foot are exposed.

The **Extensor brevis digitorum** (Fig. 258) is a broad thin muscle which arises from the fore part of the upper and outer surfaces of the os calcis, in front of the groove for the Peroneus brevis, from the external calcaneo-astragaloid ligament, and from the common limb of the Y-shaped portion of the anterior annular ligament. It passes obliquely across the dorsum of the foot, and terminates in four tendons. The innermost, which is the largest, is inserted into the dorsal surface of the base of the first phalanx of the great toe, crossing the Dorsalis pedis artery; the other three, into the outer sides of the long extensor tendons of the second, third, and fourth toes.

Relations.—By its *superficial surface*, with the fascia of the foot, the tendons of the Extensor longus digitorum and Peroneus tertius; by its *deep surface*, with the tarsal and metatarsal arteries and bones and the Dorsal interossei muscles.

Nerves.—It is supplied by the anterior tibial nerve.

Actions.—The Extensor brevis digitorum is an accessory to the long Extensor, extending the phalanges of the four inner toes, but acting only on the first phalanx of the great toe. The obliquity of its direction counteracts the oblique movement given to the toes by the long Extensor, so that, both muscles acting together, the toes are evenly extended.

9. Plantar Region.

The muscles in the plantar region of the foot may be divided into three groups, in a similar manner to those in the hand. Those of the internal plantar region are connected with the great toe, and correspond with those of the thumb; those of the external plantar region are connected with the little toe, and correspond with those of the little finger; and those of the middle plantar region are connected with the tendons intervening between the two former groups. But in order to facilitate the dissection of these muscles it will be found more convenient to divide them into four layers, as they present themselves, in the order in which they are successively exposed.

First Layer.

Abductor hallucis. Flexor brevis digitorum.
Abductor minimi digiti.

Dissection.—Remove the fascia on the inner and outer sides of the foot, commencing in front over the tendons and proceeding backward. The central portion should be divided transversely in the middle of the foot, and the two flaps dissected forward and backward.

The **Abductor hallucis** lies along the inner border of the foot. It arises from the inner tubercle on the under surface of the os calcis; from the internal annular ligament; from the plantar fascia; and from the intermuscular septum between it and the Flexor brevis digitorum. The fibres terminate in a tendon which is inserted, together with the innermost tendon of the Flexor brevis hallucis, into the inner side of the base of the first phalanx of the great toe.

Relations.—By its *superficial surface*, with the plantar fascia; by its *deep surface*, with the Flexor brevis hallucis, the Flexor accessorius, and the tendons of the Flexor longus digitorum and Flexor longus hallucis, the Tibialis anticus and posticus, the plantar vessels and nerves. Its outer border is in relation to the Flexor brevis digitorum.

The **Flexor brevis digitorum** (*perforatus*) lies in the middle of the sole of the foot, immediately beneath[1] the plantar fascia, with which it is firmly united. It arises by a narrow tendinous process, from the inner tubercle

[1] That is, in order of dissection of the sole of the foot.

of the os calcis, from the central part of the plantar fascia, and from the intermuscular septa between it and the adjacent muscles. It passes forward, and divides into four tendons, one for each of the four outer toes. Opposite the bases of the first phalanges each tendon divides into two slips, to allow of the passage of the corresponding tendon of the Flexor longus digitorum; the two portions of the tendon then unite and form a grooved channel for the reception of the accompanying long flexor tendon. Finally, they divide a second time, to be inserted into the sides of the second phalanges about their middle. The mode of division of the tendons of the Flexor brevis digitorum and their insertion into the phalanges is analogous to the Flexor sublimis digitorum in the hand.

FIG. 261.—Muscles of the sole of the foot. First Layer.

Relations.—By its *superficial surface*, with the plantar fascia; by its *deep surface*, with the Flexor accessorius, the Lumbricales, the tendons of the Flexor longus digitorum, and the external plantar vessels and nerve, from which it is separated by a thin layer of fascia. The *outer* and *inner borders* are separated from the adjacent muscles by means of vertical prolongations of the plantar fascia.

Fibrous Sheaths of the Flexor Tendons.—These are not so well marked as in the fingers. The flexor tendons of the toes as they run along the phalanges are retained against the bones by a fibrous sheath, forming osseo-aponeurotic canals. These sheaths are formed by strong fibrous bands which arch across the tendons and are attached on each side to the margins of the phalanges. Opposite the middle of the proximal and second phalanges the sheath is very strong, and the fibres pass transversely, but opposite the joints it is much thinner, and the fibres pass obliquely. Each sheath is lined by a synovial membrane which is reflected on the contained tendon.

The **Abductor minimi digiti** lies along the outer border of the foot. It arises, by a very broad origin, from the outer tubercle of the os calcis, from the under surface of the os calcis between the two tubercles, from the fore part of the inner tubercle, from the plantar fascia and the intermuscular septum, between it and the Flexor brevis digitorum. Its tendon, after gliding over a smooth facet on the under surface of the base of the fifth metatarsal bone, is inserted with the short Flexor of the little toe into the outer side of the base of the first phalanx of this toe.

Relations.—By its *superficial surface*, with the plantar fascia; by its *deep surface*, with the Flexor accessorius, the Flexor brevis minimi digiti, the long plantar ligament, and the tendon of the Peroneus longus. On its *inner side* are the external plantar vessels and nerve, and it is separated from the Flexor brevis digitorum by a vertical septum of fascia.

Dissection.—The muscles of the superficial layer should be divided at their origin by inserting the knife beneath each, and cutting obliquely backward, so as to detach them from the bone; they should then be drawn forward, in order to expose the second layer, but not cut

away at their insertion. The two layers are separated by a thin membrane, the *deep plantar fascia*, on the removal of which is seen the tendon of the Flexor longus digitorum, the Flexor accessorius, the tendon of the Flexor longus hallucis, and the Lumbricales. The long flexor tendons diverge from each other at an acute angle; the Flexor longus hallucis runs along the inner side of the foot, on a plane superior to that of the Flexor longus digitorum, the direction of which is obliquely outward.

FIG. 302.—Muscles of the sole of the foot. Second layer.

Second Layer.

Flexor accessorius. Lumbricales.

The **Flexor accessorius** arises by two heads, which are separated from each other by the long plantar ligament: the inner or larger, which is muscular, being attached to the inner concave surface of the os calcis below the groove which lodges the tendon of the Flexor longus hallucis; the outer head, flat and tendinous, to the outer surface of the os calcis, in front of its lesser tubercle, and to the long plantar ligament; the two portions join at an acute angle, and are inserted into the outer margin and upper and under surfaces of the tendon of the Flexor longus digitorum, forming a kind of groove in which the tendon is lodged.[1]

Relations.—By its *superficial surface*, with the muscles of the superficial layer, from which it is separated by the external plantar vessels and nerves; by its *deep surface*, with the os calcis and long calcaneo-cuboid ligament.

The **Lumbricales** are four small muscles accessory to the tendons of the Flexor longus digitorum: they arise from the tendons of the long Flexor, as far back as their angle of division, each arising from two tendons, except the internal one. Each muscle terminates in a tendon, which passes forward on the inner side of the four lesser toes, and is inserted into the expansion of the long Extensor tendon on the dorsum of the first phalanx of the corresponding toe.

Dissection.—The flexor tendons should be divided at the back part of the foot, and the Flexor accessorius at its origin, and drawn forward, in order to expose the third layer.

Third Layer.

Flexor brevis hallucis.
Adductor obliquus hallucis.
Flexor brevis minimi digiti.
Adductor transversus hallucis.

The **Flexor brevis hallucis** arises, by a pointed tendinous process, from the inner part of the under surface of the cuboid bone, from the contiguous portion of the external cuneiform, and from the prolongation of the tendon of the Tibialis

[1] According to Turner, the fibres of the Flexor accessorius end in aponeurotic bands, which contribute slips to the second, third, and fourth digits.

posticus, which is attached to that bone. The muscle divides, in front, into two portions, which are inserted into the inner and outer sides of the base of the first phalanx of the great toe, a sesamoid bone being developed in each tendon at its insertion. The inner portion of this muscle is blended with the Abductor hallucis previous to its insertion, the outer with the Adductor obliquus hallucis, and the tendon of the Flexor longus hallucis lies in a groove between them.

Relations.—By its *superficial surface*, with the Abductor hallucis and the tendon of the Flexor longus hallucis; by its *deep surface*, with the tendon of the Peroneus longus and metatarsal bone of the great toe; by its *inner border*, with the Abductor hallucis; by its *outer border*, with the Adductor obliquus hallucis.

The **Adductor obliquus hallucis** is a large, thick, fleshy mass passing obliquely across the foot and occupying the hollow space between the four inner metatarsal bones. It arises from the tarsal extremities of the second, third and fourth metatarsal bones, and from the sheath of the tendon of the Peroneus longus, and is inserted, together with the outer portion of the Flexor brevis hallucis, into the outer side of the base of the first phalanx of the great toe.

The small muscles of the great toe, the Abductor, Flexor brevis, Adductor obliquus, and Adductor transversus, like the similar muscles of the thumb, give off fibrous expansions, at their insertions, to blend with the long Extensor tendon.

FIG. 283.—Muscles of the sole of the foot. Third layer.

The **Flexor brevis minimi digiti** lies on the metatarsal bone of the little toe, and much resembles one of the Interossei. It arises from the base of the metatarsal bone of the little toe, and from the sheath of the Peroneus longus; its tendon is inserted into the base of the first phalanx of the little toe on its outer side. Occasionally some of the deeper fibres of the muscle are inserted into the outer part of the distal half of the fifth metatarsal bone; these are described by some as a distinct muscle, the Opponens minimi digiti.

Relations.—By its *superficial surface*, with the plantar fascia and tendon of the Abductor minimi digiti; by its *deep surface*, with the fifth metatarsal bone.

The **Adductor transversus hallucis** (*Transversus pedis*) is a narrow, flat, muscular fasciculus, stretched transversely across the heads of the metatarsal bones, between them and the flexor tendons. It arises from the inferior metatarso-phalangeal ligaments of the three outer toes, sometimes only from the third and fourth and from the transverse ligament of the metatarsus; and is inserted into the outer side of the first phalanx of the great toe, its fibres being blended with the tendon of insertion of the Adductor obliquus hallucis.

Relations.—By its *superficial surface*, with the tendons of the long and short Flexors and Lumbricales; by its *deep surface*, with the Interossei.

Fourth Layer.

The Interossei.

The **Interossei muscles** in the foot are similar to those in the hand, with this exception, that they are grouped around the middle line of the *second* toe, instead of the middle line of the *third* finger, as in the hand. They are seven in number, and consist of two groups, dorsal and plantar.

The **Dorsal interossei,** four in number, are situated between the metatarsal bones. They are bipenniform muscles, arising by two heads from the adjacent sides of the metatarsal bones, between which they are placed; their tendons are inserted into the bases of the first phalanges, and into the aponeurosis of the common extensor tendon. In the angular interval left between the heads of

FIG. 264.—The Dorsal Interossei. Left foot.

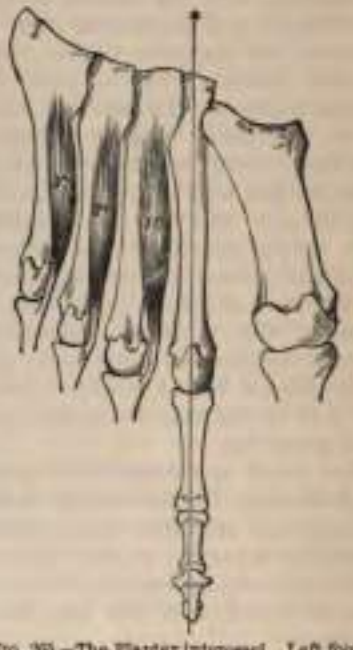


FIG. 265.—The Plantar Interossei. Left foot.

each muscle at its posterior extremity the perforating arteries pass to the dorsum of the foot, except in the First interosseous muscle, where the interval allows the passage of the communicating branch of the dorsalis pedis artery. The First dorsal interosseous muscle is inserted into the inner side of the second toe; the other three are inserted into the outer sides of the second, third, and fourth toes.

The **Plantar interossei,** three in number, lie beneath, rather than between, the metatarsal bones. They are single muscles, and are each connected with but one metatarsal bone. They arise from the base and inner sides of the shaft of the third, fourth, and fifth metatarsal bones, and are inserted into the inner sides of the bases of the first phalanges of the same toes, and into the aponeurosis of the common extensor tendon.

Nerves.—The Flexor brevis digitorum, the Flexor brevis and Abductor hallucis, and the innermost Lumbrical[1] are supplied by the internal plantar nerve. All

[1] Formerly the two inner Lumbricales were described as being supplied by the internal plantar nerve. Brooks, however (*Journal of Anatomy*, vol. xxi., p. 575), in ten dissections found that in nine of them only the inner Lumbrical obtained its nerve supply from this source. In the tenth instance the first and second Lumbricales were supplied by both external and internal plantar.

the other muscles in the sole of the foot by the external plantar. The first dorsal interosseous muscle frequently receives an extra filament from the internal branch of the anterior tibial nerve on the dorsum of the foot, and the second dorsal interosseous a twig from the external branch of the same nerve.

Actions.—All the muscles of the foot act upon the toes, and for purposes of description as regards their action may be grouped as Abductors, Adductors, Flexors, or Extensors. The *Abductors* are the Dorsal interossei, the Abductor hallucis, and the Abductor minimi digiti. The Dorsal interossei are abductors from an imaginary line passing through the axis of the second toe, so that the first muscle draws the second toe inward, toward the great toe; the second muscle draws the same toe, outward; the third draws the third toe, and the fourth draws the fourth toe, in the same direction. Like the interossei in the hand, they also flex the proximal phalanges and extend the two terminal phalanges. The Abductor hallucis abducts the great toe from the others, and also flexes the proximal phalanx of this toe. And in the same way the action of the Abductor minimi digiti is twofold—as an abductor of this toe from the others, and also as a flexor of the proximal phalanx. The *Adductors* are the Plantar interossei, the Adductor obliquus hallucis, and the Adductor transversus hallucis. The plantar interosseous muscles adduct the third, fourth, and fifth toes toward the imaginary line passing through the second toe, and by means of their insertion into the aponeurosis of the extensor tendon they flex the proximal phalanges and extend the two terminal phalanges. The Adductor obliquus hallucis is chiefly concerned in adducting the great toe toward the second one, but also assists in flexing this toe. The Adductor transversus hallucis approximates all the toes, and thus increases the curve of the transverse arch of the metatarsus. The *Flexors* are the Flexor brevis digitorum, the Flexor accessorius, the Flexor brevis hallucis, the Flexor brevis minimi digiti, and the Lumbricales. The Flexor brevis digitorum flexes the second phalanges upon the first, and, continuing its action, may flex the first phalanges also and bring the toes together. The Flexor accessorius assists the Long flexor of the toes, and converts the oblique pull of the tendons of that muscle into a direct backward pull upon the toes. The Flexor brevis minimi digiti flexes the little toe and draws its metatarsal bone downward and inward. The Lumbricales, like the corresponding muscles in the hand, assist in flexing the proximal phalanx, and by their insertion into the long Extensor tendon aid in straightening the two terminal phalanges. The only muscle in the *Extensor* group is the Extensor brevis digitorum. It extends the first phalanx of the great toe, and assists the long Extensor in extending the next three toes, and at the same time gives to the toes an outward direction when they are extended.

Surface Form.—Of the muscles of the thigh, those of the iliac region have no influence on surface form, while those of the anterior femoral region, being to a great extent superficial, largely contribute to the surface form of this part of the body. The *Tensor fasciæ femoris* produces a broad elevation immediately below the anterior portion of the crest of the ilium and behind the anterior superior spinous process. From its lower border a longitudinal groove, corresponding to the ilio-tibial band, may be seen running down the outer side of the thigh to the outer side of the knee-joint. The *Sartorius* muscle, when it is brought into action by flexing the leg on the thigh and the thigh on the pelvis, and rotating the thigh outward, presents a well-marked surface form. At its upper part, where it constitutes the outer boundary of Scarpa's triangle, it forms a prominent oblique ridge, which becomes changed into a flattened plane below, and this gradually merges in a general fulness on the inner side of the knee-joint. When the Sartorius is not in action, a depression exists between the Extensor quadriceps and the Adductor muscles, running obliquely downward and inward from the apex of Scarpa's triangle to the inner side of the knee, which corresponds to this muscle. In the depressed angle formed by the divergence of the Sartorius and Tensor fasciæ femoris muscles, just below the anterior superior spinous process of the ilium, the *Rectus femoris muscle* appears, and, below this, determines to a great extent the convex form of the front of the thigh. In a well-developed subject the borders of the muscle, when in action, are clearly to be defined. The *Vastus externus* forms a long flattened plane on the outer side of the thigh, traversed by the longitudinal groove formed by the ilio-tibial band. The *Vastus internus*, on the inner side of the lower half of the thigh, gives rise to a considerable prominence, which increases toward

the knee and terminates somewhat abruptly in this situation with a full, curved outline. The *Crureus* and *Subcrureus* are completely hidden, and do not directly influence surface form. The *Adductor muscles*, constituting the internal femoral group, are not to be individually distinguished from each other, with the exception of the upper tendon of the Adductor longus and the lower tendon of the Adductor magnus. The upper tendon of the *Adductor longus*, when the muscle is in action, stands out as a prominent ridge, which runs obliquely downward and outward from the neighborhood of the pubic spine, and forms the inner boundary of a flattened triangular space on the upper part of the front of the thigh, known as Scarpa's triangle. The lower tendon of the *Adductor magnus* can be distinctly felt as a short ridge extending down to the Adductor tubercle on the internal condyle, between the Sartorius and Vastus internus. The Adductor group of muscles fills in the triangular space at the upper part of the thigh, formed between the oblique femur and the pelvic wall, and to them is due the contour of the inner border of the thigh, the *Gracilis* largely contributing to the smoothness of the outline. These muscles are not marked off on the surface from those of the posterior femoral region by any intermuscular marking; but on the outer side of the thigh these latter muscles are defined from the Vastus externus by a distinct marking, corresponding to the external intermuscular septum. The *Gluteus maximus* and a part of the *Gluteus medius* are the only muscles of the buttock which influence surface form. The other part of the Gluteus medius, the Gluteus minimus, and the External rotators are completely hidden. The *Gluteus maximus* forms the full rounded outline of the buttock; it is more prominent behind, compressed in front, and terminates at its tendinous insertion in a depression immediately behind the great trochanter. Its lower border does not correspond to the gluteal fold, but is much more oblique, being marked by a line drawn from the side of the coccyx to the junction of the upper with the lower two-thirds of the thigh on the outer side. From beneath the lower margin of this muscle the *hamstring muscles* appear, at first narrow and not well marked, but as they descend becoming more prominent and widened out, and eventually dividing into two well-marked ridges, which constitute the upper boundaries of the popliteal space, and are formed by the tendons of the inner and outer hamstring muscles respectively. In the upper part of the thigh these muscles are not to be individually distinguished from each other, but lower down the separation between the Semitendinosus and Semimembranosus is denoted by a slight intermuscular marking. The external hamstring tendon formed by the *Biceps* is seen as a thick cord running down to the head of the fibula. The inner hamstring tendons comprise the Semitendinosus, the Semimembranosus, and the Gracilis. The *Semitendinosus* is the most internal of these, and can be felt, in certain positions of the limb, as a sharp cord; the *Semimembranosus* is thick, and the *Gracilis* is situated a little farther forward than the other two. All the muscles on the front of the leg appear to a certain extent somewhere on the surface, but the form of this region is mainly dependent upon the Tibialis anticus and the Extensor longus digitorum. The *Tibialis anticus* is well marked, and presents a fusiform enlargement at the outer side of the tibia, and projects beyond the crest of the shin-bone. From the muscular mass its tendon may be traced downward, standing out boldly, when the muscle is in action, on the front of the tibia and ankle-joint, and coursing down to its insertion along the inner border of the foot. A well-marked groove separates this muscle externally from the *Extensor longus digitorum*, which fills up the rest of the space between the upper part of the shaft of the tibia and fibula. It does not present so bold an outline as the Tibialis anticus, and its tendon below, diverging from the tendon of the Tibialis anticus, forms with the latter a sort of plane, in which may be seen the tendon of the Extensor proprius hallucis. A groove on the outer side of the Extensor longus digitorum, seen most plainly when the muscle is in action, separates the tendon from a slight eminence corresponding to the *Peroneus tertius*. The fleshy fibres of the *Peroneus longus* are strongly marked at the upper part of the outer side of the leg, especially when the muscle is in action. It forms a bold swelling, separated by furrows from the Extensor longus digitorum in front and the Soleus behind. Below, the fleshy fibres terminate abruptly in a tendon which overlaps the more flattened form of the *Peroneus brevis*. At the external malleolus the tendon of the Peroneus brevis is more marked than that of the Peroneus longus. On the dorsum of the foot the tendons of the Extensor muscles, emerging from beneath the anterior annular ligament, spread out and can be distinguished in the following order: The most internal and largest is the Tibialis anticus, then the Extensor proprius hallucis; next comes the Extensor longus digitorum, dividing into four tendons to the four outer toes; and lastly, most externally, is the Peroneus tertius. The flattened form of the dorsum of the foot is relieved by the rounded outline of the fleshy belly of the *Extensor brevis digitorum*, which forms a soft fulness on the outer side of the tarsus in front of the external malleolus, and by the Dorsal interossei, which bulge between the metatarsal bones. At the back of the knee is the popliteal space, bounded above by the tendons of the hamstring muscle; below, by the two heads of the Gastrocnemius. Below this space is the prominent fleshy mass of the calf of the leg, produced by the *Gastrocnemius* and *Soleus*. When these muscles are in action, as in standing on tiptoe, the borders of the Gastrocnemius are well defined, presenting two curved lines, which converge to the tendon of insertion. Of these borders, the inner is more prominent than the outer. The fleshy mass of the calf terminates somewhat abruptly below in the tendo Achillis, which stands out prominently on the lower part of the back of the leg. It presents a somewhat tapering form in the upper three-fourths of its extent, but widens out slightly below. When the muscles of the calf are in action, the lateral portions of the *Soleus* may be seen, forming

curved eminences, of which the outer is the longer, on either side of the Gastrocnemius. Behind the inner border of the lower part of the shaft of the tibia a well-marked ridge, produced by the tendon of the Tibialis posticus, is visible when this muscle is in a state of contraction.

On the sole of the foot the superficial layer of muscles influences surface form; the *Abductor minimi digiti* most markedly. This muscle forms a narrow rounded elevation along the outer border of the foot, while the *Abductor hallucis* does the same, though to a less extent, on the inner side. The *Flexor brevis digitorum*, bound down by the plantar fascia, is not very apparent; it produces a flattened form, covered by the thickened skin of the sole, which is here thrown into numerous wrinkles.

SURGICAL ANATOMY OF THE LOWER EXTREMITY.

The student should now consider the effects produced by the action of the various muscles in fractures of the bones of the lower extremity. The more common forms of fractures are selected for illustration and description.

In fracture of the *neck of the femur internal to the capsular ligament* (Fig. 266) the characteristic marks are slight shortening of the limb and eversion of the foot, neither of which symptoms occurs, however, in some cases until some time after the injury. The eversion is caused by the weight of the limb rotating it outward. The shortening is produced by the action of the Glutei, and by the Rectus femoris in front and the Biceps, Semitendinosus, and Semimembranosus behind.

FIG. 266.—Fracture of the neck of the femur within the capsular ligament.

FIG. 267.—Fracture of the femur below the trochanters.

In fracture of the *femur just below the trochanters* (Fig. 267), the upper fragment, the portion chiefly displaced, is tilted forward almost at right angles with the pelvis by the combined action of the Psoas and Iliacus, and, at the same time, everted and drawn outward by the External rotator and Glutei muscles, causing a marked prominence at the upper and outer side of the thigh, and much pain from the bruising and laceration of the muscles. The limb is shortened, in consequence of the lower fragment being drawn upward by the Rectus in front, and the Biceps, Semimembranosus, and Semitendinosus behind, and is at the same time everted. This fracture may be reduced in two different methods: either by direct relaxation of all the opposing muscles, to effect which the limb should be put up in such a manner that the thigh is flexed on the pelvis and the leg on the thigh; or by overcoming the contraction of the muscles by continued extension, which may be effected by means of the long splint.

Oblique fracture of the femur *immediately above the condyles* (Fig. 268) is a formidable

injury, and attended with considerable displacement. On examination of the limb the lower fragment may be felt deep in the popliteal space, being drawn backward by the Gastrocnemius and Plantaris muscles, and upward by the Hamstring and Rectus muscles. The pointed end of the upper fragment is drawn inward by the Pectineus and Adductor muscles, and tilted forward by the Psoas and Iliacus, piercing the Rectus muscle and occasionally the integument. Relaxation of these muscles and direct approximation of the broken fragments are effected by placing the limb on a double inclined plane. The greatest care is requisite in keeping the pointed extremity of the upper fragment in proper position; otherwise, after union of the fracture, the power of extension of the limb is partially destroyed, from the Rectus muscle being held down by the fractured end of the

FIG. 268.—Fracture of the femur above the condyles.

FIG. 269.—Fracture of the patella.

FIG. 270.—Oblique fracture of the shaft of the tibia.

bone, and from the patella, when elevated, being drawn upward against the projecting fragment.

In fracture of the *patella* (Fig. 269) the fragments are separated by the effusion which

FIG. 271.—Fracture of the fibula with dislocation of the foot outward—"Pott's fracture."

takes place into the joint, and possibly by the action of the Quadriceps extensor; the extent of separation of the two fragments depending upon the degree of laceration of the ligamentous structures around the bone.

In oblique fracture of the *shaft of the tibia* (Fig. 270), if the fracture has taken place obliquely from above, downward and forward, the fragments ride over one another, the lower fragments being drawn backward and upward by the powerful action of the muscles of the calf. the pointed extremity of the upper fragment projects forward immediately beneath the integument, often protruding through it and rendering the fracture a compound one. If the direction of the fracture is the reverse of that shown in the figure, the pointed extremity of the lower fragment projects forward, riding upon the lower end of the upper one. By bending the knee, which relaxes the opposing muscles, and making extension from the ankle and counter-extension at the knee, the fragments may be brought into apposition. It is often necessary, however, in compound fracture, to remove a portion of the projecting bone with the saw before complete adaptation can be effected.

Fracture of the *fibula with dislocation of the foot outward* (Fig. 271), commonly known as "Pott's fracture," is one of the most frequent injuries of the ankle-joint. The fibula is fractured about three inches above the ankle; in addition to this the internal malleolus is broken off, or the deltoid ligament torn through, and the end of the tibia displaced from the corresponding surface of the astragalus. The foot is markedly everted, and the sharp edge of the upper end of the fractured malleolus presses strongly against the skin; at the same time, the heel is drawn up by the muscles of the calf. This injury can generally be reduced by flexing the leg at right angles with the thigh, which relaxes all the opposing muscles, and by making extension from the ankle and counter-extension at the knee.

THE BLOOD-VASCULAR SYSTEM.

THE blood-vascular system comprises the heart and blood-vessels with their contained fluid, the blood. The composition of the blood and the minute anatomy of the blood-vessels will be considered in the section on Histology.

The Heart is the central organ of the entire system, and consists of a hollow muscle; by its contraction the blood is pumped to all parts of the body through a complicated series of tubes, termed *arteries*. The arteries undergo enormous ramification in their course throughout the body, and end in very minute vessels, called *arterioles*, which in their turn open into a close-meshed network of microscopic vessels, termed *capillaries*. After the blood has passed through the capillaries it is collected into a series of larger vessels, called *veins*, by which it is again returned to the heart. The passage of the blood through the heart and blood-vessels constitutes what is termed the *circulation* of the blood, of which the following is an outline.

The human heart is divided by a septum into two halves, right and left, each half being further constricted into two cavities, the upper of the two being termed the *auricle* and the lower the *ventricle*. The heart therefore consists of four chambers or cavities, two forming the right half, the right auricle and right ventricle, and two the left half, the left auricle and left ventricle. The right half of the heart contains venous or impure blood; the left, arterial or pure blood. From the cavity of the left ventricle the pure blood is carried into a large artery, the *aorta*, through the numerous branches of which it is distributed to all parts of the body, with the exception of the lungs. In its passage through the capillaries of the body the blood gives up to the tissues the materials necessary for their growth and nourishment, and at the same time receives from the tissues the waste products resulting from their metabolism, and in doing so becomes changed from arterial or pure blood into venous or impure blood, which is collected by the veins and through them returned to the right auricle of the heart. From this cavity the impure blood passes into the right ventricle, from which it is conveyed through the *pulmonary arteries* to the lungs. In the capillaries of the lungs it again becomes arterialized, and is then carried to the left auricle by the *pulmonary veins*. From this cavity it passes into that of the left ventricle, from which the cycle once more begins.

The course of the blood from the left ventricle through the body generally to the right side of the heart constitutes the greater or *systemic* circulation, while its passage from the right ventricle through the lungs to the left side of the heart is termed the lesser or *pulmonary* circulation.

It is necessary, however, to state that the blood which circulates through the spleen, pancreas, stomach, small intestine, and the greater part of the large intestine is not returned directly from these organs to the heart, but is collected into a large vein, termed the *portal vein*, by which it is carried to the liver. In the liver this vein divides, after the manner of an artery, and ultimately ends in capillary vessels, from which the rootlets of a series of veins, called the *hepatic veins*, arise; these carry the blood into the inferior vena cava, which conveys it to the right auricle.

From this it will be seen that the blood contained in the portal vein passes through two sets of capillary vessels: (1) those in the spleen, pancreas, stomach, etc., and (2) those in the liver.

Speaking generally, the arteries may be said to contain pure, and the veins impure, blood. This is true of the systemic, but not of the pulmonary, vessels, since it has been seen that the impure blood is conveyed from the heart to the lungs by the pulmonary arteries, and the pure blood returned from the lungs to the heart by the pulmonary veins. Arteries, therefore, must be defined as vessels which convey blood *from* the heart, and veins as vessels which return blood *to* the heart.

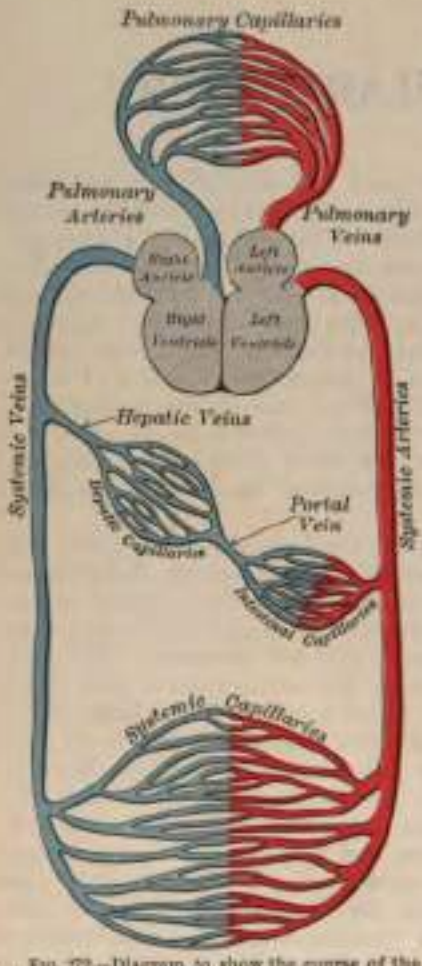


FIG. 272.—Diagram to show the course of the circulation of the blood.

The heart and lungs are contained within the cavity of the thorax, the walls of which afford them protection. The heart lies between the two lungs, and is there enclosed within a membranous bag, the *pericardium*, while each lung is invested by a serous membrane, the *pleura*. The skeleton of the thorax and the shape and boundaries of the cavity will be described in the section on General Anatomy.

The Cavity of the Thorax.—The capacity of the cavity of the thorax does not correspond with its apparent size externally, because (1) the space enclosed by the lower ribs is occupied by some of the abdominal viscera; and (2) the cavity extends above the first rib into the neck. The size of the cavity of the thorax is constantly varying during life with the movements of the ribs and Diaphragm, and with the degree of distention of the abdominal viscera. From the collapsed state of the lungs, as seen when the thorax is opened, in the dead body, it would appear as if the viscera only partly filled the cavity of the thorax, but during life there is no vacant space, that which is seen after death being filled up by the expanded lungs.

The Upper Opening of the Thorax.—The parts which pass through the upper opening of the thorax are, from before backward in or near the middle line, the Sterno-hyoid and Sterno-thyroid muscles, the remains of the thymus gland, the trachea, œsophagus, thoracic duct, the inferior thyroid veins, and the Longus colli muscle of each side; at the sides, the innominate artery, the left common carotid and left subclavian arteries, the internal mammary and superior intercostal arteries, the right and left innominate veins, the pneumogastric, cardiac, phrenic, and sympathetic nerves, the anterior branch of the first dorsal nerve, and the recurrent laryngeal nerve of the left side. The apex of each lung, covered by the pleura, also projects through this aperture, a little above the margin of the first rib.

The **Lower Opening of the Thorax** is wider transversely than from before backward. It slopes obliquely downward and backward, so that the cavity of the thorax is much deeper behind than in front. The Diaphragm (see page 325) closes in the opening, forming the floor of the thorax. The floor is flatter at the centre than at the sides, and is higher on the right side than on the left, corresponding in the dead body to the upper border of the fifth costal cartilage on the former, and to the corresponding part of the sixth costal cartilage on the latter. From the highest point on each side the floor slopes suddenly downward to the attachment

of the Diaphragm to the ribs; this is more marked behind than in front, so that only a narrow space is left between it and the wall of the thorax.

THE PERICARDIUM.

The **Pericardium** (Figs. 273, 274) is a conical membranous sac in which the heart and the commencement of the great vessels are contained. It is placed behind the sternum and the cartilages of the third, fourth, fifth, sixth, and seventh ribs of the left side, in the interval between the pleuræ.

FIG. 273.—Pericardium, from in front. The sac has been distended with plaster. (From a preparation in the Museum of the Royal College of Surgeons of England.)

Its *apex* is directed upward, and surrounds the great vessels about two inches above their origin from the base of the heart. Its *base* is attached to the central tendon and to the left part of the adjoining muscular structure of the Diaphragm. *In front* it is separated from the sternum by the remains of the thymus gland above and a little loose areolar tissue below, and is covered by the margins of the lungs, especially the left. *Behind*, it rests upon the bronchi, the œsophagus, and the descending aorta. *Laterally*, it is covered by the pleuræ, and is in relation to the inner surface of the lungs; the phrenic nerve with its accompanying vessels descends between the pericardium and pleura on either side.

Structure of the Pericardium.—The pericardium is a fibro-serous membrane, and consists, therefore, of two layers, an external fibrous and an internal serous.

The *fibrous layer* is a strong, dense membrane. Above, it surrounds the great vessels arising from the base of the heart, on which it is continued in the form of tubular prolongations which are gradually lost upon their external coat, the strongest being that which encloses the aorta. The pericardium may be traced over these vessels, to become continuous with the deep layer of the cervical fascia. In front the pericardium is connected to the posterior surface of the sternum by two fibrous bands, the *superior* and *inferior sterno-pericardiac ligaments*, the upper

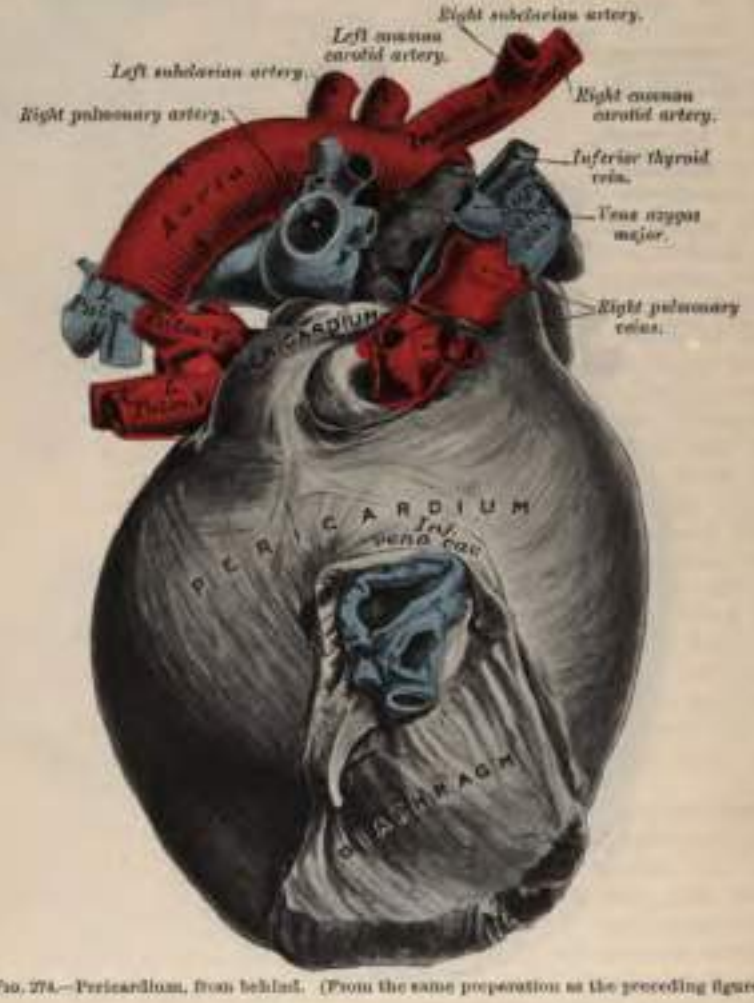


Fig. 274.—Pericardium, from behind. (From the same preparation as the preceding figure.)

passing to the manubrium, and the lower to the ensiform cartilage. On each side of the ascending aorta it sends upward a diverticulum: the one on the left side, somewhat conical in shape, passes upward and outward, between the arch of the aorta and the pulmonary artery, as far as the ductus arteriosus, where it terminates in a cæcal extremity, which is attached by loose connective tissue to the obliterated duct (Fig. 273). The one on the right side passes upward and to the right, between the ascending aorta and vena cava superior, and also terminates in a cæcal extremity. Below, the fibrous layer is attached to the central tendon of the Diaphragm, and on the left side to its muscular fibres.

The vessels receiving fibrous prolongations from this membrane are the aorta, the superior vena cava, the right and left pulmonary arteries, and the four pulmo-

nary veins. As the inferior vena cava enters the pericardium through the central tendon of the Diaphragm, it receives no covering from the *fibrous* layer.

The *serous layer* invests the heart, and is then reflected on the inner surface of the pericardium. It consists, therefore, of a visceral and parietal portion. The former invests the surface of the heart, and the commencement of the great vessels, to the extent of an inch and a half from their origin; from these it is reflected upon the inner surface of the fibrous layer, lining, below, the upper surface of the central tendon of the Diaphragm. The serous membrane encloses the aorta and pulmonary artery in a single tube, so that a passage, termed the *transverse sinus* of the pericardium, exists between these vessels in front and the auricles behind.

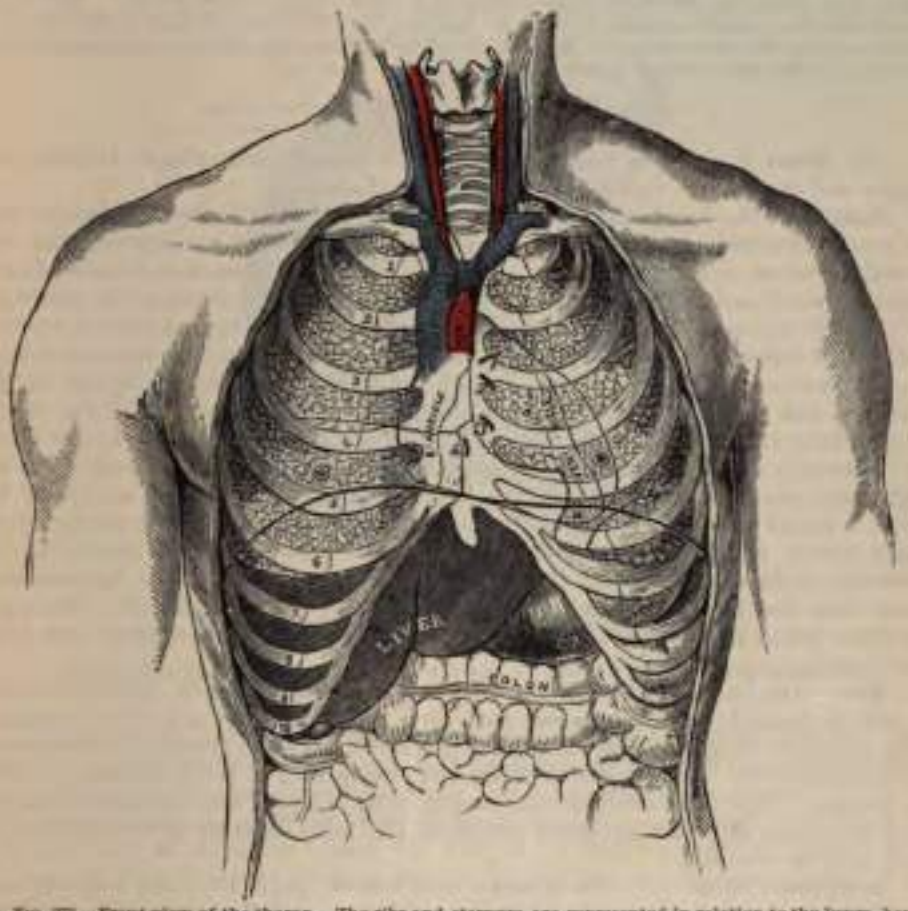


FIG. 278.—Front view of the thorax. The ribs and sternum are represented in relation to the lungs, heart, and other internal organs. 1. Pulmonary orifice. 2. Aortic orifice. 3. Left auriculo-ventricular orifice. 4. Right auriculo-ventricular orifice.

The membrane only partially covers the superior vena cava and the four pulmonary veins, and scarcely covers the inferior cava, as this vessel enters the heart almost directly after it has passed through the Diaphragm. Its inner surface is smooth and glistening, and secretes a serous fluid, which serves to facilitate the movements of the heart.

Arteries of the Pericardium.—These are derived from the internal mammary and its musculo-phrenic branch, and from the descending thoracic aorta.

Nerves of the Pericardium.—These are branches from the vagus, the phrenic, and the sympathetic.

The Vestigial Fold of the Pericardium.—Between the left pulmonary artery and subjacent pulmonary vein is a triangular fold of the serous pericardium; it is known

as the *vestigial fold of Marshall*. It is formed by the duplicature of the serous layer over the remnant of the lower part of the left superior cava (duct of Cuvier), which, after birth, becomes obliterated, and remains as a fibrous band stretching from the left superior intercostal vein to the left auricle, where it is continuous with a small vein, the oblique vein of Marshall, which opens into the coronary sinus.

Surgical Anatomy.—Paracentesis of the pericardium is sometimes required in cases of effusion into its cavity. The operation is best performed in the fifth intercostal space, one inch to the left of the sternum. The operation has been performed, however, in the fourth, sixth, and seventh spaces, and also on the right side of the sternum. Porter considers that by "reason of the uncertain and varying relations of the pleura, and also of the anterior position of the heart, whenever the pericardial sac is distended with fluid, aspiration of the pericardium is a much more dangerous procedure than open incision when done by skilled hands." He recommends that the operation should be done by resecting the fifth costal cartilage on the left side. By this means the surgeon avoids opening the pleural cavity, and secures continuous and free drainage, if the case is one of purulent pericarditis.

THE HEART.

The **Heart** is a hollow muscular organ of a conical form, placed between the lungs, and enclosed in the cavity of the pericardium.

Position.—The heart is placed obliquely in the chest: the broad attached end, or base, is directed upward, backward, and to the right, and corresponds with the dorsal vertebræ, from the fifth to the eighth inclusive; the apex is directed downward, forward, and to the left, and corresponds to the space between the cartilages of the fifth and sixth ribs, three-quarters of an inch to the inner side, and an inch and a half below the left nipple, or about three and a half inches from the middle line of the sternum. The heart is placed behind the lower two-thirds of the sternum, and projects farther into the left than into the right half of the cavity of the chest, extending from the median line about three inches in the former direction, and only one and a half in the latter; about one-third of the heart lies to the right and two-thirds to the left of the mesial plane. The anterior surface of the heart is round and convex, directed upward and forward, and formed chiefly by the right auricle and ventricle, together with a small part of the left ventricle. Its posterior surface, which looks downward rather than backward, is flattened and rests upon the Diaphragm, and is formed chiefly by the left ventricle. The right or lower border is long, thin, and sharp; the left or upper border short, but thick and round.

Size.—The heart, in the adult, measures five inches in length, three inches and a half in breadth in the broadest part, and two inches and a half in thickness. The prevalent weight, in the male, varies from ten to twelve ounces; in the female, from eight to ten: its proportions to the body being as 1 to 169 in males; 1 to 149 in females. The heart continues increasing in weight, and also in length, breadth, and thickness, up to an advanced period of life: this increase is more marked in men than in women.

Component Parts.—As has already been stated (page 455), the heart is subdivided by a muscular septum into two lateral halves, which are named respectively right and left; and a transverse constriction subdivides each half of the organ into two cavities, the upper cavity on each side being called the *auricle*, the lower the *ventricle*. The course of the blood through the heart cavities and blood-vessels has already been described (page 455).

The division of the heart into four cavities is indicated by grooves upon its surface. The groove separating the auricles from the ventricles is called the *auriculo-ventricular groove*. It is deficient, in front, where it is crossed by the root of the pulmonary artery. It contains the trunks of the nutrient vessels of the heart. The auricular portion occupies the base of the heart, and is subdivided into two cavities by a median septum. The two ventricles are also separated into a right and left by two furrows, the *interventricular grooves*, which are situated one on the anterior, the other on the posterior, surface; these extend from the base of the ventricular portion to near the apex of the organ; the former being situated

nearer to the left border of the heart, and the latter to the right. It follows, therefore, that the right ventricle forms the greater portion of the anterior surface of the heart, and the left ventricle more of its posterior surface.

Each of these cavities should now be separately examined.

The **Right Auricle** is a little larger than the left, its walls somewhat thinner, measuring about one line; and its cavity is capable of containing about two ounces. It consists of two parts: a principal cavity, the *sinus venosus*, or *atrium*, situated posteriorly, and an anterior, smaller portion, the *appendix auriculæ*.

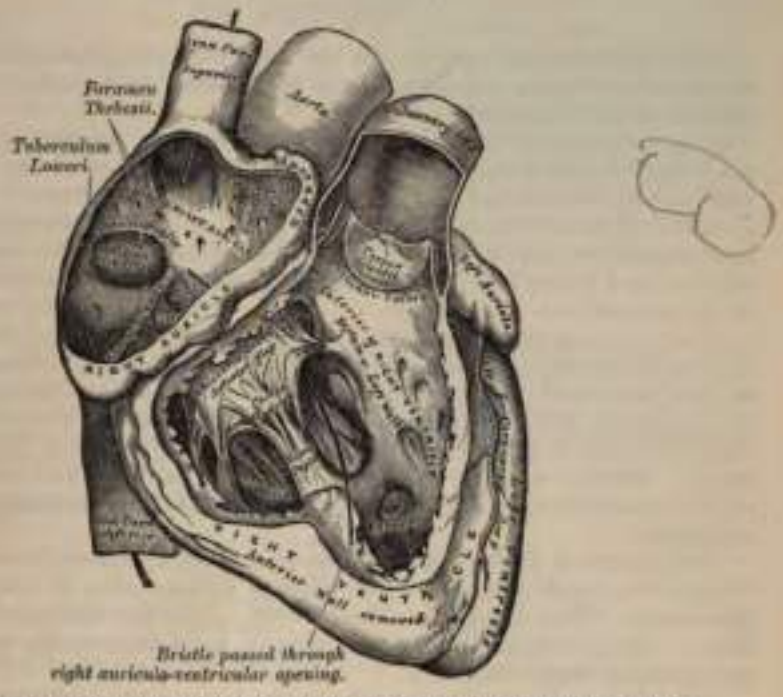


FIG. 278.—The right auricle and ventricle laid open, the anterior walls of both being removed.

The *sinus* is the large quadrangular cavity, placed between the two venæ cavæ; its walls are extremely thin; it is connected below with the right ventricle, and internally with the left auricle, being free in the rest of its extent.

The *appendix auriculæ*, so called from its fancied resemblance to a dog's ear, is a small conical muscular pouch, the margins of which present a dentated edge. It projects from the sinus forward and to the left side, overlapping the root of the aorta.

To examine the interior of the right auricle, an incision should be made along its right border, from the entrance of the superior vena cava to that of the inferior. A second cut is to be made from the centre of this first incision to the tip of the auricular appendix, and the flaps raised.

The internal surface of the right auricle is smooth, except in the appendix and adjacent part of the anterior wall of the sinus venosus, where the muscular wall is thrown into parallel ridges resembling the teeth of a comb and hence named the *musculi pectinati*. These end behind on a vertical smooth ridge, the *crista terminalis* of His, the position of which is indicated on the surface of the distended auricle by a furrow, the *sulcus terminalis* (His); this represents the line of fusion of the sinus venosus of the embryo with the primitive auricle proper.

It presents the following parts for examination:

- Openings
  - Superior cava.
  - Inferior cava.
  - Coronary sinus.
  - Foramina Thebesii.
  - Auriculo-ventricular.
- Valves
  - Eustachian.
  - Coronary.
- Fossa ovalis.
- Annulus ovalis.
- Tuberculum Loweri.
- Musculi pectinati.

The *superior vena cava* returns the blood from the upper half of the body, and opens into the upper and back part of the auricle, the direction of its orifice being downward and forward.

The *inferior vena cava*, larger than the superior, returns the blood from the lower half of the body, and opens into the lowest part of the auricle near the septum, the direction of its orifice being upward and inward. The direction of a current of blood through the superior vena cava would consequently be toward the auriculo-ventricular orifice, whilst the direction of the blood through the inferior cava would be toward the auricular septum. This is the normal direction of the two currents in fœtal life.

The *coronary sinus* opens into the auricle, between the inferior vena cava and the auriculo-ventricular opening. It returns the blood from the substance of the heart, and is protected by a semicircular fold of the lining membrane of the auricle, the *coronary valve (valve of Thebesius)*. The sinus, before entering the auricle, is considerably dilated—nearly to the size of the end of the little finger. Its wall is partly muscular, and at its junction with the great coronary vein is somewhat constricted and furnished with a valve consisting of two unequal segments.

The *foramina Thebesii* are numerous minute apertures, the mouths of small veins (*venæ cordis minimæ*), which open on various parts of the inner surface of the auricle. They return the blood directly from the muscular substance of the heart. Some of these foramina are minute depressions in the walls of the heart, presenting a closed extremity.

The *auriculo-ventricular opening* is the large oval aperture of communication between the auricle and the ventricle, to be presently described.

The *Eustachian valve* is situated between the anterior margin of the inferior vena cava and the auriculo-ventricular orifice. It is semilunar in form, its convex margin being attached to the wall of the vein; its concave margin, which is free, terminating in two cornua, of which the left is attached to the anterior edge of the annulus ovalis, the right being lost on the wall of the auricle. The valve is formed by a duplicature of the lining membrane of the auricle containing a few muscular fibres.

In the fœtus this valve is of large size, and serves to direct the blood from the inferior vena cava, through the foramen ovale, into the left auricle.

In the adult it is occasionally persistent, and may assist in preventing the reflux of blood into the inferior vena cava; more commonly it is small, and its free margin presents a cribriform or filamentous appearance; occasionally it is altogether wanting.

The *coronary valve* (valve of Thebesius) is a semicircular fold of the lining membrane of the auricle, protecting the orifice of the coronary sinus. It prevents the regurgitation of blood into the sinus during the contraction of the auricle. This valve is occasionally double.

The *fossa ovalis* is an oval depression corresponding to the situation of the foramen ovale in the fœtus. It is situated at the lower part of the septum auricularum, above and to the left of the orifice of the inferior vena cava.

The *annulus ovalis* is the prominent oval margin of the foramen ovale. It is

most distinct above and at the sides; below, it is deficient. A small slit-like valvular opening is occasionally found, at the upper margin of the fossa ovalis, which leads upward beneath the annulus into the left auricle, and is the remains of the aperture between the two auricles in the fœtus.

The *tuberculum Loweri* is a small projection on the right wall of the auricle, between the two venæ cavæ. It is most distinct in the hearts of quadrupeds; in man it is scarcely visible. It was supposed by Lower to direct the blood from the superior cava toward the auriculo-ventricular opening.

The **Right Ventricle** is triangular in form, and extends from the right auricle to near the apex of the heart. Its anterior or upper surface is rounded and convex, and forms the larger part of the front of the heart. Its under surface is flattened, rests upon the Diaphragm, and forms only a small part of the back of the heart. Its posterior wall is formed by the partition between the two ventricles, the *septum ventriculorum*, so that a transverse section of the cavity presents a semilunar outline. The surface of the septum is convex and bulges into the cavity of the right ventricle. Its upper and inner angle is prolonged into a conical pouch, the *infundibulum*, or *conus arteriosus*, from which the pulmonary artery arises. The walls of the right ventricle are thinner than those of the left, the proportion between them being as 1 to 3. The wall is thickest at the base, and gradually becomes thinner toward the apex. The cavity equals in size that of the left ventricle, and is capable of containing about three fluidounces.[1]

To examine the interior of the right ventricle, its anterior wall should be turned downward and to the right in the form of a triangular flap. This is accomplished by making two incisions: (1) from the pulmonary artery to the apex of the ventricle parallel to, but a little to the right of, the anterior interventricular furrow; (2) another, starting from the upper extremity of the first and carried outward parallel to, but a little below, the auriculo-ventricular furrow, care being taken not to injure the auriculo-ventricular valve.

The following parts present themselves for examination:

Openings { Auriculo-ventricular. / Opening of the pulmonary artery.
Valves { Tricuspid. / Semilunar.

And a muscular and tendinous apparatus connected with the tricuspid valve:

Columnæ carneæ. Chordæ tendineæ.

The *auriculo-ventricular orifice* is the large oval aperture of communication between the auricle and ventricle. It is situated at the base of the ventricle, near the right border of the heart. It is about an inch and a half in diameter,[2] oval from side to side, surrounded by a fibrous ring, covered by the lining membrane of the heart; it is considerably larger than the corresponding aperture on the left side, being sufficient to admit the ends of four fingers. It is guarded by the tricuspid valve.

The *opening of the pulmonary artery* is circular in form, and situated at the summit of the conus arteriosus, close to the septum ventriculorum. It is placed above and on the left side of the auriculo-ventricular opening, upon the anterior aspect of the heart. Its orifice is guarded by the pulmonary semilunar valves.

The *tricuspid valve* consists of three segments of a triangular or trapezoidal shape, formed by a duplicature of the lining membrane of the heart, strengthened by a layer of fibrous tissue, which contains, according to Kürschner and Senac,

[1] Morrant Baker says that "taking the mean of various estimates, it may be inferred that each ventricle is able to contain four to six ounces of blood" (Kirke's *Physiology*, 10th edition, p. 156).

[2] In the *Pathological Transactions*, vol. vi., p. 119, Dr. Peacock has given some careful researches upon the weight and dimensions of the heart in health and disease. He states, as the result of his investigations, that, in the healthy adult heart, the right auriculo-ventricular aperture has a mean circumference of 54.4 lines, or 4½ inches; the left auriculo-ventricular aperture a mean circumference of 44.3 lines, or 3¾ inches; the pulmonic orifice of 40 lines, or 3⅓ inches; and the aortic orifice of 35.5 lines, or 2⅞ inches; but the dimensions of the orifices varied greatly in different cases, the right auriculo-ventricular aperture having a range of from 40 to 50 lines, and the others in the same proportion.

muscular fibres. These segments are connected by their bases to the fibrous ring surrounding the auriculo-ventricular orifice, and by their sides with one another, so as to form a continuous annular membrane, which is attached round the margin of the auriculo-ventricular opening, their free margins and ventricular surfaces affording attachment to a number of delicate tendinous cords, the *chordæ tendineæ*. The largest and most movable segment is placed toward the left side of the auriculo-ventricular opening, interposed between that opening and the infundibulum; hence it is called the *left* or *infundibular cusp*. Another segment corresponds to the right part of the front of the ventricle, the *right* or *marginal cusp;* and a third to its posterior wall, the *posterior* or *septal cusp*. The central part of each segment is thick and strong: the lateral margins are thin and translucent. The chordæ tendineæ are connected with the adjacent margins of the principal segments of the valve, and are further attached to each segment in the following manner: 1. Three or four reach the attached margin of each segment, where they are continuous with the auriculo-ventricular tendinous ring. 2. Others, four to six in number, are attached to the central thickened part of each segment. 3. The most numerous and finest are connected with the marginal portion of each segment.

The *columnæ carneæ* are the rounded muscular columns which project from nearly the whole of the inner surface of the ventricle, excepting near the opening of the pulmonary artery, where the wall is smooth. They may be classified, according to their mode of connection with the ventricle, into three sets. The first set merely form prominent ridges on the inner surface of the ventricle, being attached by their entire length on one side, as well as by their extremities. The second set are attached by their two extremities, but are free in the rest of their extent: while the third set (*musculi papillares*) are attached by one extremity to the wall of the heart, the opposite extremity giving attachment to the *chordæ tendineæ*. There are two papillary muscles, anterior and posterior: of these, the anterior is the larger; its chordæ tendineæ are connected with the right and left segments of the valve. The posterior is not always single, but sometimes consists of two or three muscular columns; its chordæ tendineæ are connected with the posterior and the right segments. In addition to these, some few chordæ may be seen springing directly from the ventricular septum, or from small eminences on it, and passing to the left and posterior segments. A fleshy band, well marked in the ox and some other animals, is frequently seen passing from the base of the anterior papillary muscle to the interventricular septum. From its attachments it may assist in preventing over-distention of the auricle, and so has been named the *moderator band*.

The right auriculo-ventricular orifice allows the blood to pass freely from the right auricle into the right ventricle, and it will be noted that the surface of the tricuspid valve next the blood-current is quite smooth. When the right ventricle contracts to force the blood into the pulmonary artery, the segments of the tricuspid valve come together and close the auriculo-ventricular opening, and so prevent the blood from passing back into the auricle. The papillary muscles and chordæ tendineæ moor the segments of the valve, and prevent their being forced through into the auricle by the weight of blood behind them.

The *semilunar valves*, three in number,[1] guard the orifice of the pulmonary artery. They consist of three semicircular folds, two anterior (right and left) and one posterior, formed by a duplicature of the lining membrane, strengthened by fibrous tissue. They are attached, by their convex margins, to the wall of the artery, at its junction with the ventricle, the straight border being free, and directed upward in the lumen of the vessel. The free margin of each is somewhat thicker than the rest of the valve, is strengthened by a bundle of tendinous fibres, and presents, at its middle, a small projecting thickened nodule, called *corpus Arantii*, and consisting of bundles of interlacing connective-tissue fibres with branched connective-tissue cells and some few elastic fibres. From this nodule

[1] The pulmonary semilunar valves have been found to be two in number instead of three (Dr. Hand, of St. Paul, Minn., in *North Western Med. and Surg. Journ.*, July, 1873), and the same variety is more frequently noticed in the aortic semilunar valves.

tendinous fibres radiate through the valve to its attached margin, and these fibres form a constituent part of its substance throughout its whole extent, excepting two narrow lunated portions, the *lunulæ*, placed one on each side of the nodule immediately adjoining the free margin; here the valve is thin, and formed merely by the lining membrane. During the passage of the blood along the pulmonary artery these valves are opened, and the course of the blood along the tube is uninterrupted; but during the ventricular diastole, when the current of blood along the pulmonary artery is checked and partly thrown back by its elastic walls, these valves become immediately expanded, and effectually close the entrance of the tube. When the valves are closed, the lunated portions of each are brought into contact with one another by their opposed surfaces, the three corpora Arantii filling up the small triangular space that would be otherwise left by the approximation of the three semilunar valves.

Between the semilunar valves and the commencement of the pulmonary artery are three pouches or dilatations, one behind each valve. These are the pulmonary sinuses (*sinuses of Valsalva*). Similar sinuses exist between the semilunar valves and the commencement of the aorta; they are larger than the pulmonary sinuses. The blood, in its regurgitation toward the heart, finds its way into these sinuses, and so shuts down the valve-flaps.

In order to examine the interior of the left auricle, make an incision on the posterior surface of the auricle from the pulmonary veins on one side to those on the other, the incision being carried a little way into the vessels. Make another incision from the middle of the horizontal one to the appendix.

The **Left Auricle** is rather smaller than the right; its walls thicker, measuring about one line and a half; it consists, like the right, of two parts, a principal cavity, or *sinus*, and an *appendix auriculæ*.

The *sinus* is cuboidal in form, and concealed in front by the pulmonary artery and aorta: internally, it is separated from the right auricle by the septum auricularum; behind, it receives on each side two pulmonary veins, being free in the rest of its extent.

The *appendix auriculæ* is somewhat constricted at its junction with the auricle; it is longer, narrower, and more curved than that of the right side, and its margins are more deeply indented, presenting a kind of foliated appearance. Its direction is forward and toward the right side, overlapping the root of the pulmonary artery.

Within the auricle the following parts present themselves for examination:

The openings of the four pulmonary veins.
Auriculo-ventricular opening.
Musculi pectinati.

The *pulmonary veins*, four in number, open, two into the right, and two into the left side of the auricle. The two left veins frequently terminate by a common opening. They are not provided with valves.

The *auriculo-ventricular opening* is the large oval aperture of communication between the auricle and ventricle. It is rather smaller than the corresponding opening on the opposite side (see note, page 463).

The *musculi pectinati* are fewer in number and smaller than on the right side; they are confined to the inner surface of the appendix.

On the inner surface of the septum auricularum may be seen a lunated impression bounded below by a crescentic ridge the concavity of which is turned upward. The depression is just above the fossa ovalis in the right auricle.

To examine the interior of the left ventricle, make an incision a little to the left of the anterior interventricular groove from the base to the apex of the heart, and carry it up from thence, a little to the left of the posterior interventricular groove, nearly as far as the auriculo-ventricular groove.

The **Left Ventricle** is longer and more conical in shape than the right ventricle, and on transverse section its cavity presents an oval or nearly circular outline. It forms a small part of the anterior surface of the heart, and a considerable part of

its posterior surface. It also forms the apex of the heart by its projection beyond the right ventricle. Its walls are much thicker than those of the right side, the proportion being as 3 to 1. They are thickest opposite the widest part of the ventricle, becoming gradually thinner toward the base, and also toward the apex, which is the thinnest part.

The following parts present themselves for examination :

Openings { Auriculo-ventricular. / Aortic. } Valves { Mitral. / Semilunar. }

Chordæ tendineæ. Columnæ carneæ.

The *auriculo-ventricular opening* is placed below and to the left of the aortic orifice. It is a little smaller than the corresponding aperture of the opposite side,

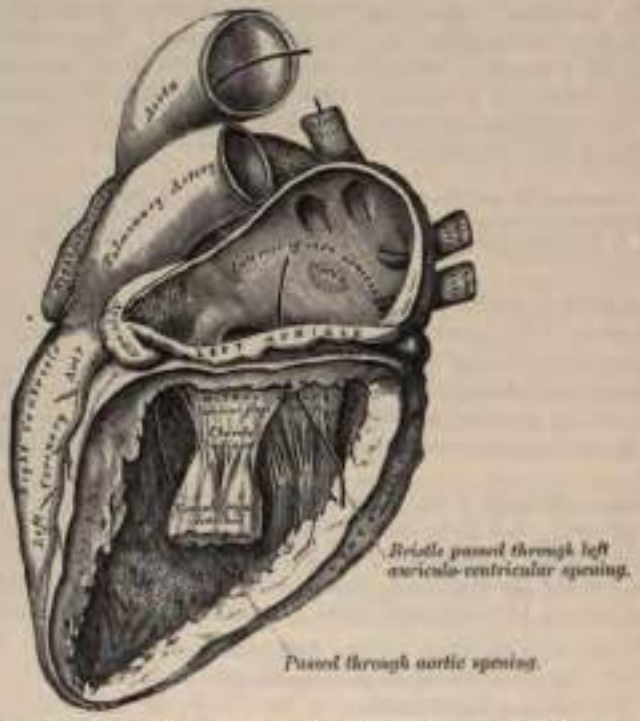


FIG. 277.—The left auricle and ventricle laid open, the posterior walls of both being removed.

admitting only two fingers; but, like it, is broader in the transverse than in the antero-posterior diameter. It is surrounded by a dense fibrous ring, covered by the lining membrane of the heart, and guarded by the mitral valves.

The *aortic opening* is a circular aperture, in front and to the right side of the auriculo-ventricular, from which it is separated by one of the segments of the mitral valve. Its orifice is guarded by the semilunar valves. The portion of the ventricle immediately below the aortic orifice is often termed the *aortic vestibule* of Sibson. It possesses fibrous instead of muscular walls, and so does not collapse during the ventricular diastole; it thus gives space for the segments of the aortic valve during its closure.

The *mitral valve* is attached to the circumference of the auriculo-ventricular orifice in the same way that the tricuspid valve is on the opposite side. It is formed by a duplicature of the lining membrane, strengthened by fibrous tissue, and contains a few muscular fibres. It is larger in size, thicker, and altogether stronger than the tricuspid, and consists of two segments of unequal size. The larger segment is placed in front and to the right between the auriculo-ventricular

and aortic orifices, the smaller to the left and behind the opening, close to the wall of the ventricle. Two smaller segments are usually found at the angles of junction of the larger. The mitral valve-flaps are furnished with chordæ tendineæ, the mode of attachment of which is precisely similar to those on the right side; but they are thicker, stronger, and less numerous.

The *semilunar valves* surround the orifice of the aorta; two are posterior (right and left) and one anterior: they are similar in structure and in their mode of attachment to those of the pulmonary artery. They are, however, larger, thicker, and stronger than those of the right side; the lunulæ are more distinct, and the corpora Arantii larger and more prominent. Opposite each segment the wall of the aorta presents a slight dilatation or bulging (sinus of Valsalva). They are larger than those at the commencement of the pulmonary artery.

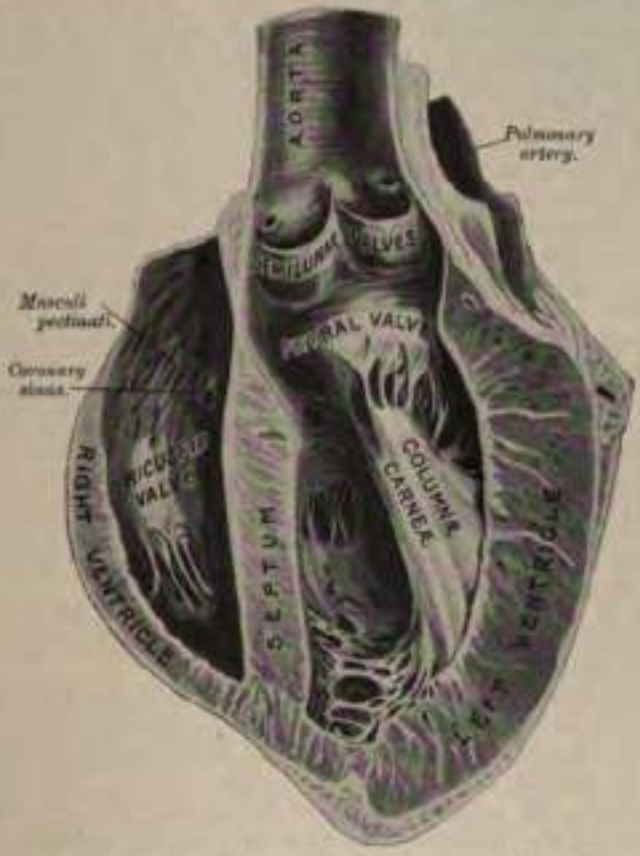


FIG. 278.—Section of the heart, showing the interventricular septum.

The *columnæ carneæ* admit of a subdivision into three sets, like those upon the right side; but they are smaller, more numerous, and present a dense interlacement, especially at the apex, and upon the posterior wall. Those attached by one extremity only, the *musculi papillares*, are two in number, being connected one to the anterior, the other to the posterior wall; they are of large size, and terminate by free rounded extremities, from which the chordæ tendineæ arise.

The septum between the two ventricles is thick, especially below (Fig. 278). At its upper part it suddenly tapers off and becomes destitute of muscular fibres, consisting only of fibrous tissue, covered by two layers of endocardium; and on the right side also covered, during diastole, by one of the flaps of the tricuspid valve. This upper portion is termed the *membranous part* of the septum, and is continued upward and forms the septum between the aortic vestibule and the right

auricle. It is derived from the lower part of the aortic septum of the fœtus, and an abnormal communication may exist at this part, owing to defective development of this septum.

The *Endocardium* is a thin membrane which lines the internal surface of the heart; it assists in forming the valves by its reduplications, and is continuous with the lining membrane of the great blood-vessels. It is a smooth, transparent membrane, giving to the inner surface of the heart its glistening appearance. It is more opaque on the left than on the right side of the heart, thicker in the auricles than in the ventricles, and thickest in the left auricle. It is thin on the musculi pectinati and on the columnæ carneæ, but thicker on the smooth part of the auricular and ventricular walls and on the tips of the musculi papillares.

Structure.—The heart consists of muscular fibres, and of fibrous rings which serve for their attachment. It is closely covered by the visceral layer of the serous pericardium (*epicardium*), and its cavities are lined by the *endocardium*. Between these two membranes is the muscular wall of the heart, the *myocardium*.

The *fibrous rings* surround the auriculo-ventricular and arterial orifices; they are stronger upon the left than on the right side of the heart. The auriculo-ventricular rings serve for the attachment of the muscular fibres of the auricles and ventricles, and also for the mitral and tricuspid valves; the ring on the left side is closely connected by its right margin with the aortic arterial ring. Between these and the right auriculo-ventricular ring is a mass of fibrous tissue, and in some of the larger animals, as the ox and elephant, a nodule of bone, the *os cordis*.

The fibrous rings surrounding the arterial orifices serve for the attachment of the great vessels and semilunar valves. Each ring receives, by its ventricular margin, the attachment of the muscular fibres of the ventricles; its opposite margin presents three deep semicircular notches, within which the middle coat of the artery (which presents three convex semicircular segments) is firmly fixed, the attachment of the artery to its fibrous ring being strengthened by the thin cellular coat and serous membrane externally and by the endocardium within. It is opposite the margins of these semicircular notches, in the arterial rings, that the endocardium by its reduplication, forms the semilunar valves, the fibrous structure of the ring being continued into each of the segments of the valve at this part. The middle coat of the artery in this situation is thin, and the sides of the vessel are dilated to form the sinuses of Valsalva.

The *muscular structure of the heart* consists of bands of fibres which present an exceedingly intricate interlacement. They are of a deep red color and marked with transverse striæ.

The muscular fibres of the heart admit of a subdivision into two groups, those of the auricles and those of the ventricles, which are quite independent of one another.

Fibres of the Auricles.—These are disposed in two layers—a superficial layer common to both cavities, and a deep layer proper to each. The *superficial fibres* are more distinct on the anterior surface of the auricles, across the bases of which they run in a transverse direction, forming a thin, but incomplete layer. Some of these fibres pass into the septum auricularum. The *internal* or *deep fibres* proper to each auricle consist of two sets, looped and annular fibres. The *looped fibres* pass upward over each auricle, being attached by two extremities to the corresponding auriculo-ventricular rings in front and behind. The *annular fibres* surround the whole extent of the appendices auricularum, and are continued upon the walls of the venæ cavæ and coronary sinus on the right side, and upon the pulmonary veins on the left side, at their connection with the heart. In the appendices they interlace with the longitudinal fibres.

Fibres of the Ventricles.—These are arranged in an exceedingly complex manner, and the accounts given by various anatomists differ considerably. This is probably due partly to the fact that the various layers of muscular fibres of which the heart is said to be composed are not independent, but their fibres are interlaced to a considerable extent, and therefore any separation into layers must be to a great extent artificial; and also partly to the fact, pointed out by Henle, that

there are varieties in the arrangement due to individual differences. If the *epicardium* and the subjacent fat are removed from a heart which has been subjected to prolonged boiling, so as to dissolve the connective tissues, the superficial fibres of the ventricles will be exposed. They will be seen to commence at the base of the heart, where they are attached to the tendinous rings around the orifices, and to pass obliquely downward toward the apex, with a direction from right to left. At the apex the fibres turn suddenly inward into the interior of the ventricle, forming what is called the *vortex*. On the back of the heart it will be seen that the fibres pass continuously from one ventricle to the other over the interventricular groove; and the same thing will be noticed on the front of the heart at the upper and lower end of the anterior interventricular groove, but in the middle portion of this groove the fibres passing from one ventricle to the other are interrupted by fibres emerging from the septum along the groove; many of the superficial fibres pass in also at this groove to the septum. The vortex is produced, as stated above, by the sudden turning inward of the superficial fibres in a peculiar spiral manner into the interior of the ventricle. Those fibres which descended on the posterior surface of the heart enter the left ventricle at the vortex, and, ascending, form the posterior part of the inner layer of muscular fibres lining this cavity and the right (posterior) musculus papillaris; those fibres which descend on the front of the heart to reach the apex also pass, at the vortex, into the interior of the ventricle, where they form the remainder of the innermost layer of the ventricle and the left (anterior) musculus papillaris. The fibres forming the inner layer of the wall of the ventricle ascend to be attached to the fibrous rings around the orifices.

By dissection these superficial fibres may be removed as a thin stratum, and it will then be found that the ventricles are made up of oblique fibres superimposed in layers one on the top of another, and assuming gradually a less oblique direction as they pass to the middle of the thickness of the ventricular wall, so that in the centre of the wall the fibres are transverse. Internal to this central transverse layer the fibres become oblique again, but in the opposite direction to the external ones. This division into distinct layers is, however, to a great extent artificial, as the fibres pass across from one layer to another, and have therefore to be divided in the dissection, and the change in the direction of the fibres is very gradual. These oblique fibres commence above at the fibrous rings at the base of the heart, and, descending toward the apex, they enter the septum near its lower end. In the septum the fibres which form the left ventricle may be traced in three directions: 1. Some pass upward to be attached to the central mass of fibrous tissue. 2. Others pass through the septum to become continuous with the fibres of the right ventricle. 3. The remainder pass through the septum to encircle the ventricle as annular fibres. Of the fibres of the right ventricle, some on entering the septum pass upward to be attached to the central mass of fibrous tissue; some, entering the septum from behind, pass forward to become continuous with the fibres on the anterior surface of the left ventricle; and others, entering in front, pass backward to join the fibres on the posterior wall of the left ventricle. The septum therefore consists of three varieties of fibres—viz., annular fibres, special to the left ventricle; ascending fibres, derived from both ventricles and ascending through the septum to the central fibro-cartilage; and decussating fibres, derived from the anterior wall of one ventricle and passing to the posterior wall of the other ventricle, or from the posterior wall of the right ventricle and passing to the anterior wall of the left. In addition to these fibres there are a considerable number which appear to encircle both ventricles and which pass across the septum without turning into it.

Vessels and Nerves.—The *arteries* supplying the heart are the right and left coronary from the aorta.

The *veins* accompany the arteries, and terminate in the right auricle. They are, the anterior or great, posterior, left and anterior cardiac veins, the right or small, and the left or great, coronary sinuses and the veme Thebesii (*venæ cordis minimæ*).

The *lymphatics* terminate in the thoracic and right lymphatic ducts.

The *nerves* are derived from the cardiac plexuses, which are formed partly from the cranial nerves and partly from the sympathetic. They are freely distributed both on the surface and in the substance of the heart, the separate filaments being furnished with small ganglia.

Surface Form.—In order to show the extent of the heart in relation to the front of the chest, draw a line from the lower border of the second left costal cartilage, one inch from the sternum, to the upper border of the third right costal cartilage, half an inch from the sternum. This represents the base-line or upper limit of the organ. Take a point an inch and a half below and three-quarters of an inch internal to the left nipple—that is, about three and a half inches to the left of the median line of the body. This represents the apex of the heart. Draw a line from this apex-point, with a slight convexity downward, to the junction of the seventh right costal cartilage to the sternum. This represents the lower limit of the heart. Join the right extremity of the first line—that is, the base-line—with the right extremity of this line—that is, to the seventh right chondro-sternal joint—with a slight curve outward, so that it projects about an inch and a half from the middle line of the sternum. Lastly, join the left extremity of the base-line and the apex-point by a line curved slightly to the left.

The position of the various orifices is as follows: viz. the pulmonary orifice is situated in the upper angle formed by the articulation of the third left costal cartilage with the sternum; the aortic orifice is a little below and internal to this, behind the left border of the sternum, close to the articulation of the third left costal cartilage to this bone. The left auriculo-ventricular opening is behind the sternum, rather to the left of the median line, and opposite the fourth costal cartilages. The right auriculo-ventricular opening is a little lower, opposite the fourth interspace and in the middle line of the body (Fig. 275).

A portion of the area of the heart thus mapped out is uncovered by lung, and therefore gives a dull note on percussion; the remainder, being overlapped by the lung, gives a more or less resonant note. The former is known as the area of superficial cardiac dulness; the latter as the area of deep cardiac dulness. The area of superficial cardiac dulness is included between a line drawn from the centre of the sternum, on a level with the fourth costal cartilages, to the apex of the heart and a line drawn from the same point down the lower third of the middle line of the sternum. Below, this area merges into the dulness which corresponds to the liver. Dr. Latham lays down the following rule as a sufficient practical guide for the definition of the portion of the heart which is uncovered by lung or pleura: "Make a circle of two inches in diameter round a point midway between the nipple and the end of the sternum."

Surgical Anatomy.—Wounds of the heart are often immediately fatal, but not necessarily so. They may be non-penetrating, when death may occur from hemorrhage, if one of the coronary vessels has been wounded, or subsequently from pericarditis; or, on the other hand, the patient may recover. Even a penetrating wound is not necessarily fatal, if the wound is a small one. A flap comprising the whole thickness of the thoracic wall may be made, the cavity of the pericardium opened, and the wound in the heart sutured. This has been done successfully.

Peculiarities in the Vascular System of the Fœtus.

The chief peculiarities in the heart of the fœtus are the direct communication between the two auricles through the foramen ovale and the large size of the Eustachian valve. There are also several minor peculiarities. Thus, the position of the heart is vertical until the fourth month, when it commences to assume an oblique direction. Its size is also very considerable as compared with the body, the proportion at the second month being 1 to 50; at birth it is as 1 to 120; whilst in the adult the average is about 1 to 160. At an early period of fœtal life the auricular portion of the heart is larger than the ventricular, the right auricle being more capacious than the left; but toward birth the ventricular portion becomes the larger. The thickness of both ventricles is at first about equal, but toward birth the left becomes much the thicker of the two.

The *foramen ovale* is situated at the lower and back part of the septum auriculorum, forming a communication between the auricles. It remains as a free oval opening until the middle period of fœtal life. About this period a fold grows up from the posterior wall of the auricle to the left of the foramen ovale, and advances over the opening so as to form a sort of valve, which allows the blood to pass only from the right to the left auricle, and not in the opposite direction.

The *Eustachian valve* is directed upward on the left side of the opening of the inferior vena cava, and serves to direct the blood from this vessel through the foramen ovale into the left auricle.

The peculiarities in the arterial system of the fœtus are the communication between the pulmonary artery and the descending aorta by means of the *ductus*

arteriosus, and the communication between the internal iliac arteries and the placenta by means of the umbilical arteries.

The *ductus arteriosus* is a short tube, about half an inch in length at birth, and of the diameter of a goosequill. In the early condition it forms the continuation of the pulmonary artery, and opens into the descending aorta just below the origin of the left subclavian artery, and so conducts the chief part of the blood from the right ventricle into this vessel. When the branches of the pulmonary artery have become larger relatively to the ductus arteriosus, the latter is chiefly connected to the left pulmonary artery; and the fibrous cord, which is all that remains of the ductus arteriosus in later life, will be found to be attached to the root of that vessel.

The *umbilical* or *hypogastric arteries* arise from the internal iliacs, in addition to the branches given off from those vessels in the adult. Ascending along the sides of the bladder to its apex, they pass out of the abdomen at the umbilicus and are continued along the umbilical cord to the placenta, coiling round the umbilical vein. They carry to the placenta the blood which has circulated in the system of the fœtus.

The peculiarity in the venous system of the fœtus is the communication established between the placenta and the liver and portal vein through the umbilical vein, and the inferior vena cava through the ductus venosus.

Fœtal Circulation.

The blood destined for the nutrition of the fœtus is returned from the placenta to the fœtus by the umbilical vein. This vein enters the abdomen at the umbilicus, and passes upward along the free margin of the suspensory ligament of the liver to the under surface of that organ, where it gives off two or three branches to the left lobe, one of which is of large size, and others to the lobus quadratus and lobulus Spigelii. At the transverse fissure it divides into two branches: of these, the larger is joined by the portal vein and enters the right lobe; the smaller branch continues outward, under the name of the ductus venosus, and joins the left hepatic vein at the point of junction of that vessel with the inferior vena cava. The blood, therefore, which traverses the umbilical vein reaches the inferior vena cava in three different ways: the greater quantity circulates through the liver with the portal venous blood before entering the vena cava by the hepatic veins; some enters the liver directly, and is also returned to the inferior cava by the hepatic veins; the smaller quantity passes directly into the vena cava by the junction of the ductus venosus with the left hepatic vein.

In the inferior cava the blood carried by the ductus venosus and hepatic veins becomes mixed with that returning from the lower extremities and wall of the abdomen. It enters the right auricle, and, guided by the Eustachian valve, passes through the foramen ovale into the left auricle, where it becomes mixed with a small quantity of blood returned from the lungs by the pulmonary veins. From the left auricle it passes into the left ventricle, and from the left ventricle into the aorta, by means of which it is distributed almost entirely to the head and upper extremities, a small quantity being probably carried into the descending aorta. From the head and upper extremities the blood is returned by the tributaries of the superior vena cava to the right auricle, where it becomes mixed with a small portion of the blood from the inferior cava. From the right auricle it descends over the Eustachian valve into the right ventricle, and from the right ventricle passes into the pulmonary artery. The lungs of the fœtus being inactive, only a small quantity of the blood of the pulmonary artery is distributed to them by the right and left pulmonary arteries, and is returned by the pulmonary veins to the left auricle: the greater part passes through the ductus arteriosus into the commencement of the descending aorta, where it becomes mixed with a small quantity of blood transmitted by the left ventricle into the aorta. Through

this vessel it descends to supply the lower extremities and viscera of the abdomen and pelvis, the chief portion being, however, conveyed by the umbilical arteries to the placenta.

From the preceding account of the circulation of the blood in the fetus it will be seen—

1. That the placenta serves the purposes of nutrition and excretion, receiving

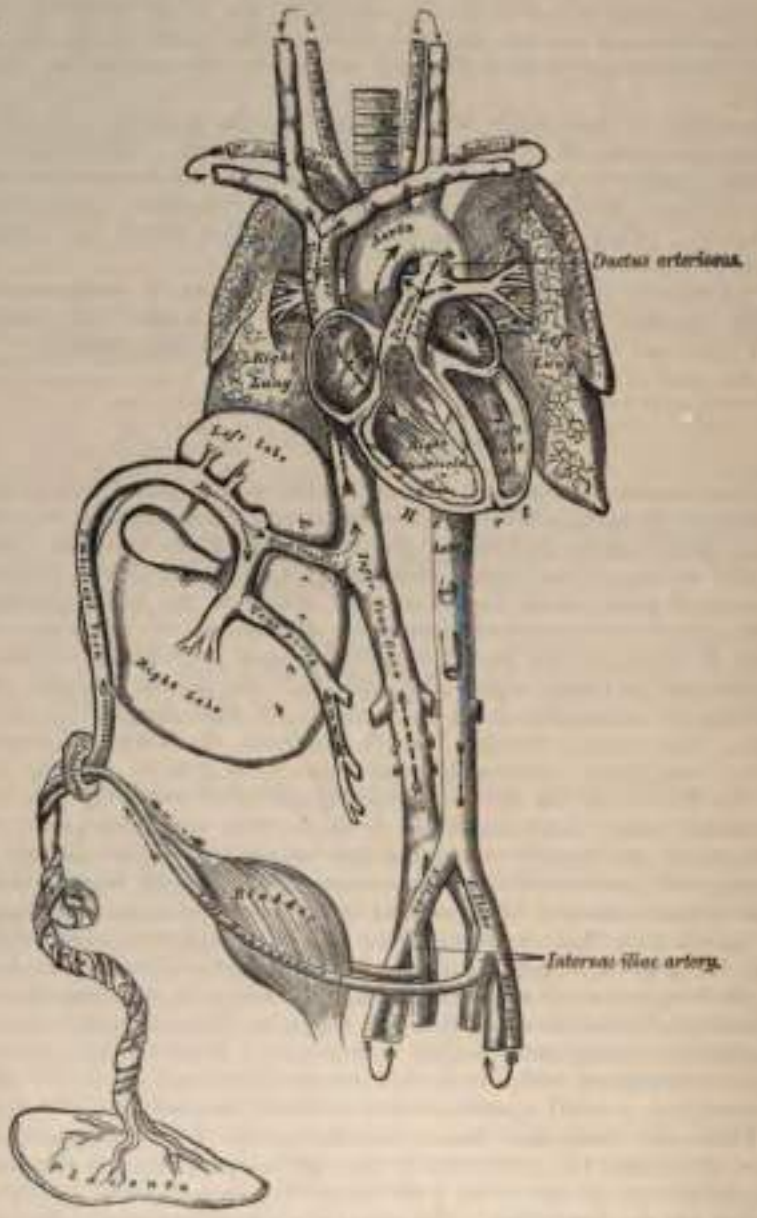


FIG. 279.—Plan of the fœtal circulation. In this plan the figured arrows represent the kind of blood, as well as the direction which it takes in the vessels. Thus, arterial blood is figured ➤——·····—>; venous blood, ➤———>; mixed (arterial and venous) blood, ➤——>.

the impure blood from the fetus, and returning it charged with additional nutritive material.

2. That nearly the whole of the blood of the umbilical vein traverses the liver

before entering the inferior cava; hence the large size of this organ, especially at an early period of fœtal life.

3. That the right auricle is the point of meeting of a double current, the blood in the inferior cava being guided by the Eustachian valve into the left auricle, whilst that in the superior cava descends into the right ventricle. At an early period of fœtal life it is highly probable that the two streams are quite distinct, for the inferior cava opens almost directly into the left auricle, and the Eustachian valve would exclude the current along the vein from entering the right ventricle. At a later period, as the separation between the two auricles becomes more distinct, it seems probable that some mixture of the two streams must take place.

4. The pure blood carried from the placenta to the fœtus by the umbilical vein, mixed with the blood from the portal vein and inferior cava, passes almost directly to the arch of the aorta, and is distributed by the branches of that vessel to the head and upper extremities; hence the large size and perfect development of those parts at birth.

5. The blood contained in the descending aorta, chiefly derived from that which has already circulated through the head and upper limbs, together with a small quantity from the left ventricle, is distributed to the lower extremities; hence the small size and imperfect development of these parts at birth.

Changes in the Vascular System at Birth.

At birth, when respiration is established, an increased amount of blood from the pulmonary artery passes through the lungs, which now perform their office as respiratory organs, and at the same time the placental circulation is cut off. The foramen ovale becomes gradually closed by about the tenth day after birth; the valvular fold above mentioned becomes adherent to the margins of the foramen for the greater part of its circumference, but above a slit-like opening is left between the two auricles which sometimes remains persistent.

The *ductus arteriosus* begins to contract immediately after respiration is established, becomes completely closed from the fourth to the tenth day, and ultimately degenerates into an impervious cord which serves to connect the left pulmonary artery to the descending aorta.

Of the *umbilical* or *hypogastric arteries*, the portion continued on to the bladder from the trunk of the corresponding internal iliac remains pervious as the superior vesical artery, and the part extending from the side of the bladder to the umbilicus becomes obliterated between the second and fifth days after birth, and projects as a fibrous cord toward the abdominal cavity, carrying on it a fold of peritoneum and separating two of the fossæ of the peritoneum spoken of in the section on the surgical anatomy of direct inguinal hernia.

The *umbilical vein* and *ductus venosus* become completely obliterated between the second and fifth days after birth, and ultimately dwindle to fibrous cords, the former becoming the round ligament of the liver, the latter the fibrous cord, which in the adult may be traced along the fissure of the ductus venosus.

THE ARTERIES.

The Arteries are cylindrical tubular vessels which serve to convey blood from both ventricles of the heart to every part of the body. These vessels were named arteries (*ἀήρ*, air; *τηρέω*, to contain) from the belief entertained by the ancients that they contained air. To Galen is due the honor of refuting this opinion; he showed that these vessels, though for the most part empty after death, contain blood in the living body.

The distribution of the systemic arteries is like a highly ramified tree, the common trunk of which, formed by the aorta, commences at the left ventricle of the heart, the smallest ramifications corresponding to the circumference of the body and the contained organs. The arteries are found in nearly every part of the body, with the exception of the hairs, nails, epidermis, cartilages, and cornea; and the larger trunks usually occupy the most protected situations, running, in the limbs, along the flexor side, where they are less exposed to injury.

There is considerable variation in the mode of division of the arteries: occasionally a short trunk subdivides into several branches at the same point, as we observe in the cœliac and thyroid axes; or the vessel may give off several branches in succession, and still continue as the main trunk, as is seen in the arteries of the limbs; but the usual division is dichotomous; as, for instance, the aorta dividing into the two common iliacs, and the common carotid into the external and internal.

The branches of arteries arise at very variable angles: some, as the superior intercostal arteries from the aorta, arise at an obtuse angle: others, as the lumbar arteries, at a right angle; or, as the spermatic, at an acute angle. An artery from which a branch is given off is smaller in size, but retains a uniform diameter until a second branch is derived from it. A branch of an artery is smaller than the trunk from which it arises; but if an artery divides into two branches, the combined area of the two vessels is, in nearly every instance, somewhat greater than that of the trunk; and the combined area of all the arterial branches greatly exceeds the area of the aorta; so that the arteries collectively may be regarded as a cone, the apex of which corresponds to the aorta, the base to the capillary system.

The arteries, in their distribution, communicate with one another, forming what is called an *anastomosis* (*διά*, between; *στόμα*, mouth), or inosculation; and this communication is very free between the large as well as between the smaller branches. The anastomosis between trunks of equal size is found where great activity of the circulation is requisite, as in the brain; here the two vertebral arteries unite to form the basilar, and the two internal carotid arteries are connected by a short communicating trunk; it is also found in the abdomen, the intestinal arteries having very ample anastomoses between their larger branches. In the limbs the anastomoses are most numerous and of largest size around the joints, the branches of an artery above inosculating with branches from the vessels below; these anastomoses are of considerable interest to the surgeon, as it is by their enlargement that a *collateral circulation* is established after the application of a ligature to an artery for the cure of aneurism. The smaller branches of arteries anastomose more frequently than the larger, and between the smallest twigs these inosculations become so numerous as to constitute a close network that pervades nearly every tissue of the body.

Throughout the body generally the larger arterial branches pursue a perfectly straight course, but in certain situations they are tortuous; thus, the facial artery in its course over the face, and the arteries of the lips, are extremely tortuous in their course, to accommodate themselves to the movements of the parts. The

uterine arteries are also tortuous, to accommodate themselves to the increase of size which the organ undergoes during pregnancy. Again, the internal carotid and vertebral arteries, previous to their entering the cavity of the skull, describe a series of curves, which are evidently intended to diminish the velocity of the current of blood by increasing the extent of surface over which it moves and adding to the amount of impediment which is produced by friction.

The arteries are dense in structure, of considerable strength, highly elastic, and, when divided, they preserve, although empty, their cylindrical form.

The minute structure of these vessels has been described in the chapter on General Anatomy.

In the description of the arteries we shall first consider the efferent trunk of the pulmonic circulation, the pulmonary artery, and then the efferent trunk of the systemic circulation, the aorta and its branches.

PULMONARY ARTERY (Fig. 280).

The **Pulmonary Artery** conveys the venous blood from the right side of the heart to the lungs. It is a short, wide vessel, about 2 inches in length and $1\frac{1}{8}$ inches (30 mm.) in diameter, arising from the left side of the base (conus arteriosus) of the right ventricle, in front of the aorta. It extends obliquely upward and backward, passing at first in front of and then to the left of the ascending aorta, as far as the under surface of the arch, where it divides, about on a level with the intervertebral substance between the fifth and sixth dorsal vertebræ, into two branches of nearly equal size, the *right* and *left pulmonary arteries*.

Relations.—The whole of this vessel is contained, together with the ascending aorta, in the pericardium. It is enclosed with the aorta in a single tube of the serous pericardium, which is continued upward upon them from the base of the heart and connects them together. The fibrous layer of the pericardium becomes gradually lost upon the external coat of its two branches. In front, the pulmonary artery is separated from the anterior extremity of the second left intercostal space by the pleura and left lung, in addition to the pericardium; it rests at first upon the ascending aorta, and higher up lies in front of the left auricle on a plane posterior to the ascending aorta. On each side of its origin is the appendix of the corresponding auricle and a coronary artery, the left coronary artery passing, in the first part of its course, behind the vessel.

The **right pulmonary artery**, longer and larger than the left, runs horizontally outward, behind the ascending aorta and superior vena cava, to the root of the right lung, where it divides into two branches, of which the lower and larger supplies the middle and lower lobes; the upper and smaller is distributed to the upper lobe.

The **left pulmonary artery**, shorter and somewhat smaller than the right, passes horizontally in front of the descending aorta and left bronchus to the root of the left lung, where it divides into two branches for the two lobes.

The root of the left pulmonary artery is connected to the under surface of the arch of the aorta by a short fibrous cord, the *ligamentum arteriosum*; this is the remains of a vessel peculiar to fetal life, the *ductus arteriosus*.

The terminal branches of the pulmonary artery will be described with the anatomy of the lung.

THE AORTA.

The **aorta** (*ἀορτή*, arteria magna) is the main trunk of a series of vessels which convey the oxygenated blood to the tissues of the body for their nutrition. This vessel commences at the upper part of the left ventricle, where it is about one and one-eighth inches in diameter, and, after ascending for a short distance, arches backward and to the left side, over the root of the left lung, then descends within the thorax on the left side of the vertebral column, passes through the aortic opening in the Diaphragm, and, entering the abdominal cavity, terminates, considerably diminished in size (about seven-tenths of an inch in diameter), opposite the lower border of the fourth lumbar vertebra, where it divides into the right and left common iliac arteries. Hence it is divided into the *ascending aorta*, the *arch* of

the aorta, and the *descending aorta*, which last is again divided into *thoracic aorta* and *abdominal aorta*, from the position of these parts.

THE ASCENDING AORTA.

The **ascending aorta** is about two inches in length. It commences at the upper part of the left ventricle, on a level with the lower border of the third costal cartilage, behind the left half of the sternum; it passes obliquely upward, forward, and to the right, in the direction of the heart's axis, as high as the upper border of the

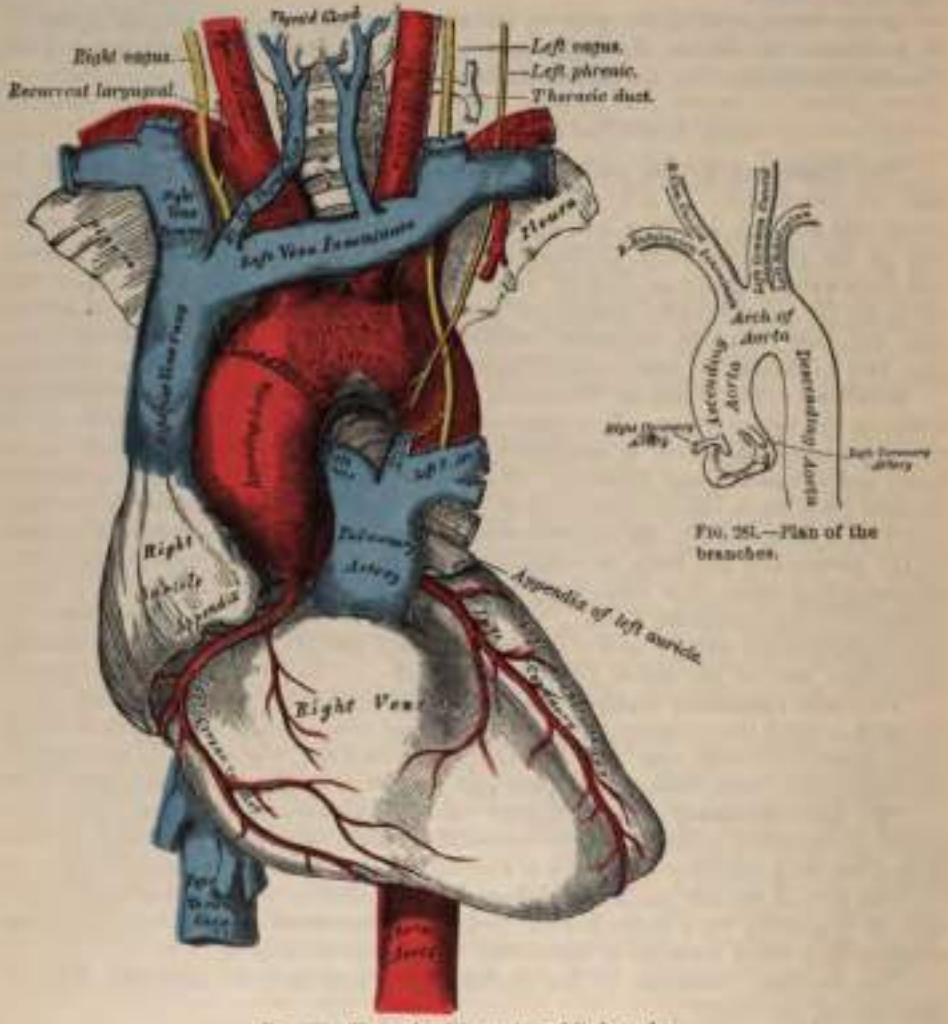


FIG. 281.—Plan of the branches.

FIG. 280.—The arch of the aorta and its branches.

second right costal cartilage, describing a slight curve in its course, and being situated, when distended, about a quarter of an inch behind the posterior surface of the sternum. A little above its commencement it is somewhat enlarged, and presents three small dilatations, called the sinuses of Valsalva, opposite to which are attached the three semilunar valves, which serve the purpose of preventing any regurgitation of blood into the cavity of the ventricle. These valves are placed one in front and two behind. At the union of the ascending with the transverse part of the aorta the calibre of the vessel is increased, owing to a bulging outward of its right wall. This dilatation is termed the *great sinus of the aorta*. A section of the aorta

opposite this part has a somewhat oval figure; but below the attachment of the valves it is circular. This portion of the aorta is contained in the cavity of the pericardium, and, together with the pulmonary artery, is invested in a tube of serous membrane, continued on to them from the surface of the heart.

Relations.—The ascending aorta is covered at its commencement by the trunk of the pulmonary artery and the right auricular appendix, and, higher up, is separated from the sternum by the pericardium, the right pleura, and anterior margin of right lung, some loose areolar tissue, and the remains of the thymus gland; *behind*, it rests upon the right pulmonary artery and left auricle. On the *right side* it is in relation with the superior vena cava and right auricle; on the *left side*, with the pulmonary artery.

PLAN OF THE RELATIONS OF THE ASCENDING AORTA.

In front.
Pulmonary artery.
Right auricular appendix.
Pericardium.
Right pleura and lung.
Remains of thymus gland.

Right side.
Superior vena cava.
Right auricle.

Left side.
Pulmonary artery.

Behind.
Right pulmonary artery.
Left auricle.

BRANCHES OF THE ASCENDING AORTA.

The only branches of the ascending aorta are the coronary arteries. They supply the heart, and are two in number, right and left, arising near the commencement of the aorta, immediately above the free margin of the semilunar valves.

THE CORONARY ARTERIES.

The **Right Coronary Artery**, about the size of a crow's quill, arises from the anterior sinus of Valsalva. It passes forward between the pulmonary artery and the right auricular appendix, then runs obliquely to the right side, in the groove between the right auricle and ventricle, and, curving around the right border of the heart, runs along its posterior surface as far as the posterior interventricular groove, where its divides into two branches, one of which (*transverse*) continues onward in the groove between the left auricle and ventricle, and anastomoses with the left coronary; the other (*descending*) courses along the posterior interventricular furrow, supplying branches to both ventricles and to the septum, and anastomosing at the apex of the heart with the descending branches of the left coronary.

This vessel sends a large branch (*marginal*) along the thin margin of the right ventricle to the apex, which in its course gives off numerous small branches to the anterior and posterior surfaces of the ventricle. It also gives off a branch (*infundibular*) which ramifies over the front part of the conus arteriosus of the right ventricle.

The **Left Coronary**, larger than the former, arises from the left posterior sinus of Valsalva; it passes forward between the pulmonary artery and the left auricular appendix, and divides into two branches. Of these, one (*transverse*) passes transversely outward in the left auriculo-ventricular groove, and winds around the left border of the heart to its posterior surface, where it anastomoses with the trans-

verse branch of the right coronary; the other (*descending*) passes along the anterior interventricular groove to the apex of the heart, where it anastomoses with the descending branches of the right coronary. The left coronary supplies the left auricle and its appendix, gives branches to both ventricles, and numerous small branches to the pulmonary artery and commencement of the aorta.[1]

Peculiarities.—These vessels occasionally arise by a common trunk, or their number may be increased to three, the additional branch being of small size. More rarely there are two additional branches.

THE ARCH OF THE AORTA.

The **arch,** or **transverse aorta,** commences at the upper border of the second chondro-sternal articulation of the right side, and passes at first upward and backward and from right to left, and then from before backward, to the left side of the lower border of the fourth dorsal vertebra behind. Its upper border is usually about an inch below the upper margin of the sternum.

Between the origin of the left subclavian artery and the attachment of the ductus arteriosus the lumen of the fœtal aorta is considerably narrowed, forming what is termed the *aortic isthmus*, while immediately beyond the ductus arteriosus the vessel presents a fusiform dilatation which His has named the *aortic spindle*—the point of junction of the two parts being marked in the concavity of the arch by an indentation or angle. These conditions persist, to some extent, in the adult, where His found that the average diameter of the spindle exceeded that of the isthmus by 3 mm. (about one-eighth of an inch).

Relations.—Its *anterior surface* is covered by the pleuræ and lungs and the remains of the thymus gland, and crossed toward the left side by the left pneumogastric and phrenic nerves and superficial cardiac branches of the left sympathetic and vagus, and by the left superior intercostal vein. Its *posterior surface* lies on the trachea, just above its bifurcation, on the great, or deep, cardiac plexus, the œsophagus, thoracic duct, and left recurrent laryngeal nerve. Its *upper border* is in relation with the left innominate vein, and from its upper part are given off the innominate, left common carotid and left subclavian arteries. Its *lower border* is in relation with the bifurcation of the pulmonary artery, the remains of the ductus arteriosus, which is connected with the left division of that vessel, and the superficial cardiac plexus; the left recurrent laryngeal nerve winds round it from before backward, whilst the left bronchus passes below it.

PLAN OF THE RELATIONS OF THE ARCH OF THE AORTA.

Above.
Left innominate vein.
Innominate artery.
Left carotid.
Left subclavian.

In Front.
Pleuræ and lungs.
Remains of thymus gland.
Left pneumogastric nerve.
Left phrenic nerve.
Superficial cardiac nerves.
Left superior intercostal vein.

Behind.
Trachea.
Deep cardiac plexus.
Œsophagus.
Thoracic duct.
Left recurrent nerve.

Below.
Bifurcation of pulmonary artery.
Remains of ductus arteriosus.
Superficial cardiac plexus.
Left recurrent nerve.
Left bronchus.

[1] According to Dr. Samuel West, there is a very free and complete anastomosis between the two coronary arteries (*Lancet*, June 2, 1883, p. 945). This, however, is not the view generally held by anatomists, for, with the exception of the anastomosis mentioned above in the auriculo-ventricular and interventricular grooves, it is believed that the two arteries only communicate by very small vessels in the substance of the heart.

Peculiarities.—The height to which the aorta rises in the chest is usually about an inch below the upper border of the sternum; but it may ascend nearly to the top of that bone. Occasionally it is found an inch and a half, more rarely two or even three inches, below this point.

In Direction.—Sometimes the aorta arches over the root of the right instead of the left lung, as in birds, and passes down on the right side of the spine. In such cases all of the viscera of the thoracic and abdominal cavities are transposed. Less frequently, the aorta, after arching over the root of the right lung, is directed to its usual position on the left side of the spine, this peculiarity not being accompanied by any transposition of the viscera.

In Conformation.—The aorta occasionally divides, as in some quadrupeds, into an ascending and descending trunk, the former of which is directed vertically upward, and subdivides into three branches, to supply the head and upper extremities. Sometimes the aorta subdivides soon after its origin into two branches, which soon reunite. In one of these cases the œsophagus and trachea were found to pass through the interval left by their division; this is the normal condition of the vessel in the reptilia.

Surgical Anatomy.—Of all the vessels of the arterial system, the aorta, and more especially its arch, is most frequently the seat of disease; hence it is important to consider some of the consequences that may ensue from aneurism of this part.

It will be remembered that the ascending aorta is contained in the pericardium, just behind the sternum, being crossed at its commencement by the pulmonary artery and right auricular appendix, and having the right pulmonary artery behind, the vena cava on the right side, and the pulmonary artery and left auricle on the left side.

Aneurism of the ascending aorta, in the situation of the sinuses of Valsalva, in the great majority of cases, affects the anterior sinus; this is mainly owing to the fact that the regurgita-

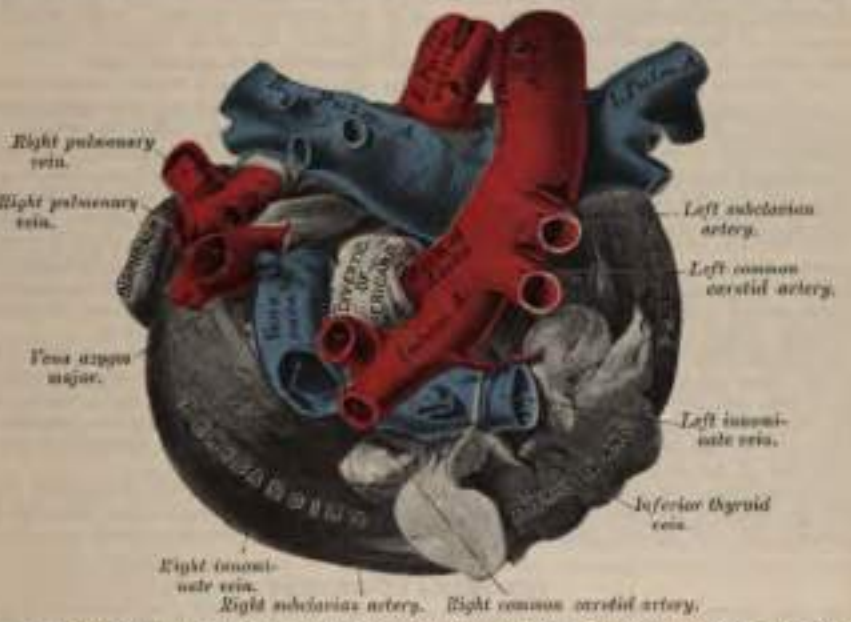


FIG. 282.—Relation of great vessels at base of heart, seen from above. (From a preparation in the Museum of the Royal College of Surgeons of England.)

tion of blood upon the sinuses takes place chiefly on the anterior aspect of the vessel. As the aneurismal sac enlarges it may compress any or all of the structures in immediate proximity with it, but chiefly projects toward the right anterior side, and, consequently, interferes mainly with those structures that have a corresponding relation with the vessel. In the majority of cases it bursts into the cavity of the pericardium, the patient suddenly drops down dead, and, upon a post-mortem examination, the pericardial sac is found full of blood; or it may compress the right auricle, or the pulmonary artery and adjoining part of the right ventricle, and open into one or the other of these parts, or may press upon the superior vena cava.

Aneurism of the ascending aorta, originating above the sinuses, most frequently implicates the right anterior wall of the vessel, where, as has been explained, there exists a normal dilatation, the great sinus of the aorta; this is probably mainly owing to the blood being impelled against this part. The direction of the aneurism is also chiefly toward the right of the median line. If it attains a large size and projects forward, it may absorb the sternum and the cartilages of the ribs, usually on the right side, and appear as a pulsating tumor on the front of the chest, just below the manubrium; or it may burst into the pericardium, or may compress or open into the right lung, the trachea, bronchi, or œsophagus.

Regarding the transverse aorta, the student is reminded that the vessel lies on the trachea, the œsophagus, and thoracic duct; that the recurrent laryngeal nerve winds around it; and that from its upper part are given off three large trunks, which supply the head, neck, and upper extremities. Now, an aneurismal tumor, taking origin from the posterior part of the vessel, its most usual site, may press upon the trachea, impede the breathing, or produce cough, hæmoptysis, or stridulous breathing, or it may ultimately burst into that tube, producing fatal hemorrhage. Again, its pressure on the laryngeal nerves may give rise to symptoms which so accurately resemble those of laryngitis that the operation of tracheotomy has in some cases been resorted to, from the supposition that disease existed in the larynx; or it may press upon the thoracic duct and destroy life by inanition; or it may involve the œsophagus, producing dysphagia; or may burst into the œsophagus, when fatal hæmorrhage will occur. Again, the innominate artery, or the subclavian, or left carotid, may be so obstructed by clots as to produce a weakness, or even a disappearance, of the pulse in one or the other wrist or in the left temporal artery; or the tumor may present itself at or above the manubrium, generally either in the median line or to the right of the sternum, and may simulate an aneurism of one of the arteries of the neck.

Branches of the Arch of the Aorta (Figs. 280, 281).

The branches given off from the arch of the aorta are three in number: the innominate artery, the left common carotid, and the left subclavian.

Peculiarities.—Position of the Branches.—The branches, instead of arising from the highest part of the arch (their usual position), may be moved more to the right, arising from the commencement of the transverse or upper part of the ascending portion; or the distance from one another at their origin may be increased or diminished, the most frequent change in this respect being the approximation of the left carotid toward the innominate artery.

The Number of the primary branches may be reduced to a single vessel, or more commonly two: the left carotid arising from the innominate artery, or (more rarely) the carotid and subclavian arteries of the left side arising from a left innominate artery. But the number may be increased to four, from the right carotid and subclavian arteries arising directly from the aorta, the innominate being absent. In most of these latter cases the right subclavian has been found to arise from the left end of the arch; in other cases it was the second or third branch given off instead of the first. Another common form in which there are four primary branches is that in which the left vertebral artery arises from the arch of the aorta between the left carotid and subclavian arteries. Lastly, the number of trunks from the arch may be increased to five or six; in these instances, the external and internal carotids arise separately from the arch, the common carotid being absent on one or both sides. In some cases, where six branches have been found, it has been due to a separate origin of the vertebral on both sides.

Number Usual, Arrangement Different.—When the aorta arches over to the right side, the three branches have an arrangement the reverse of what is usual, the innominate supplying the left side, and the carotid and subclavian (which arise separately) the right side. In other cases, where the aorta takes its usual course, the two carotids may be joined in a common trunk, and the subclavians arise separately from the arch, the right subclavian generally arising from the left end of the arch.[1]

In some instances other arteries are found to arise from the arch of the aorta. Of these the most common are the bronchial, one or both, and the thyroidea ima; but the internal mammary and the inferior thyroid have been seen to arise from this vessel.

INNOMINATE ARTERY.

The **innominate artery** (**brachio-cephalic**) is the largest branch given off from the arch of the aorta. It arises, on a level with the upper border of the second right costal cartilage, from the commencement of the arch of the aorta in front of the left carotid, and, ascending obliquely to the upper border of the right sterno-clavicular articulation, divides into the right common carotid and right subclavian arteries. This vessel varies from an inch and a half to two inches in length.

Relations.—*In front*, it is separated from the first piece of the sternum by the Sterno-hyoid and Sterno-thyroid muscles, the remains of the thymus gland, the left innominate and right inferior thyroid veins which cross its root, and sometimes the inferior cervical cardiac branch of the right pneumogastric. *Behind*, it lies upon the trachea, which it crosses obliquely. On the *right side* is the right innominate vein, right pneumogastric nerve, and the pleura; and on the *left side*,

[1] The anomalies of the aorta and its branches are minutely described by Krause in Henle's *Anatomy* (Brunswick, 1868), vol. iii., p. 203 *et seq.*

the remains of the thymus gland, the origin of the left carotid artery, the left inferior thyroid vein, and the trachea.

Branches.—The innominate usually gives off no branches, but occasionally a small branch, the *thyroidea ima*, is given off from this vessel. It also sometimes gives off a *thymic* or *bronchial branch*. The **Thyroidea ima** ascends in front of the trachea to the lower part of the thyroid body, which it supplies. It varies greatly in size, and appears to compensate for deficiency or absence of one of the other thyroid vessels. It occasionally is found to arise from the right common carotid or from the aorta, the subclavian, or internal mammary vessels.

PLAN OF THE RELATIONS OF THE INNOMINATE ARTERY.

In front.

Sternum.
Sterno-hyoid and Sterno-thyroid muscles.
Remains of thymus gland.
Left innominate and right inferior thyroid veins.
Inferior cervical cardiac branch from right pneumogastric nerve.

Right side.
Right innominate vein.
Right pneumogastric nerve.
Pleura.

Innominate Artery.

Left side.
Remains of thymus.
Left carotid.
Left inferior thyroid vein.
Trachea.

Behind.
Trachea.

Peculiarities in Point of Division.—When the bifurcation of the innominate artery varies from the point above mentioned, it sometimes ascends a considerable distance above the sternal end of the clavicle; less frequently it divides below it. In the former class of cases its length may exceed two inches, and in the latter be reduced to an inch or less. These are points of considerable interest for the surgeon to remember in connection with the operation of tying this vessel.

Position.—When the aorta arches over to the right side, the innominate is directed to the left side of the neck instead of the right.

Collateral Circulation.—Allan Burns demonstrated, on the dead subject, the possibility of the establishment of the collateral circulation after ligature of the innominate artery, by tying and dividing that artery, after which, he says, "Even coarse injection, impelled into the aorta, passing freely by the anastomosing branches into the arteries of the right arm, filling them and all the vessels of the head completely" (*Surgical Anatomy of the Head and Neck*, p. 62). The branches by which this circulation would be carried on are very numerous; thus, all the communications across the middle line between the branches of the carotid arteries of opposite sides would be available for the supply of blood to the right side of the head and neck; while the anastomosis between the superior intercostal of the subclavian and the first aortic intercostal (see *infra* on the collateral circulation after obliteration of the thoracic aorta) would bring the blood, by a free and direct course, into the right subclavian: the numerous connections, also, between the intercostal arteries and the branches of the axillary and internal mammary arteries would, doubtless, assist in the supply of blood to the right arm, while the deep epigastric, from the external iliac, would, by means of its anastomosis with the internal mammary, compensate for any deficiency in the vascularity of the wall of the chest.

Surgical Anatomy.—Although the operation of tying the innominate artery has been performed by several surgeons for aneurism of the right subclavian extending inward as far as the Scalenus, in only five instances, according to Mr. Jacobson, has the patient survived. Mott's patient, however, on whom the operation was first performed, lived nearly four weeks, and Graefe's more than two months. The chief danger of the operation appears to be the frequency of secondary hæmorrhage; but in the present day, with the practice of aseptic surgery and our greater knowledge of the use of the ligature, more favorable results may be anticipated. Other causes of death after operation are pleurisy, pericarditis, and suppurative cellulitis. The main obstacles to the operation are, as the student will perceive from his dissection of this vessel, the deep situation of the artery behind and beneath the sternum, and the number of important structures which surround it in every part.

In order to apply a ligature to this vessel, the patient is to be placed upon his back, with the thorax slightly raised, the head bent a little backward, and the shoulder on the side of the aneurism strongly depressed, so as to draw out the artery from behind the sternum into the neck. An incision three or more inches long is then made along the anterior border of the Sterno-mastoid muscle, terminating at the sternal end of the clavicle. From this point a second incision is carried about the same length along the upper border of the clavicle. The skin is then dissected back, and the Platysma divided on a director: the sternal end of the Sterno-mastoid is now brought into view, and, a director being passed beneath it and close to its under surface, so as to avoid any small vessels, it is to be divided; in like manner the clavicular origin is to be divided

throughout the whole or greater part of its attachment. By pressing aside any loose cellular tissue or vessels that may now appear the Sterno-hyoid and Sterno-thyroid muscles will be exposed, and must be divided, a director being previously passed beneath them. The inferior thyroid veins may come into view, and must be carefully drawn, either upward or downward, by means of a blunt hook, or tied with double ligatures and divided. After tearing through a strong fibro-cellular lamina, the right carotid is brought into view, and, being traced downward, the arteria innominata is arrived at. The left innominate vein should now be depressed; the right innominate vein, the internal jugular vein, and the pneumogastric nerve drawn to the right side; and a curved aneurism needle may then be passed around the vessel close to its surface, and in a direction from below upward and inward, care being taken to avoid the right pleural sac, the trachea, and cardiac nerves. The ligature should be applied to the artery as high as possible, in order to allow room between it and the aorta for the formation of the coagulum. The importance of avoiding the thyroid plexus of veins during the primary steps of the operation, and the pleural sac whilst including the vessel in the ligature, should be most carefully borne in mind. After the artery has been secured, the common carotid should be tied about half an inch above its origin, and also the thyroidea ima if the vessel is of any size. The several muscles are united by buried sutures.

ARTERIES OF THE HEAD AND NECK.

The artery which supplies the head and neck is the Common Carotid: it ascends in the neck and divides into two branches: the External Carotid, supplying the superficial parts of the head and face and the greater part of the neck; and the Internal Carotid, supplying to a great extent the parts within the cranial cavity.

The Common Carotid Arteries.

The **common carotid arteries**, although occupying a nearly similar position in the neck, differ in position, and, consequently, in their relation at their origin. The right carotid arises from the innominate artery, behind the right sterno-clavicular articulation; the left from the highest part of the arch of the aorta. The left carotid is, consequently, longer, and at its origin is contained within the thorax. The course and relations of that portion of the left carotid which intervenes between the arch of the aorta and the left sterno-clavicular articulation will first be described (see Fig. 280).

The left carotid within the thorax ascends obliquely outward from the arch of the aorta to the root of the neck. *In front*, it is separated from the first piece of the sternum by the Sterno-hyoid and Sterno-thyroid muscles, the left innominate vein, and the remains of the thymus gland; *behind*, it lies on the trachea, œsophagus, and thoracic duct. *Internally*, it is in relation with the innominate artery, inferior thyroid veins and remains of thymus gland; *externally*, with the left pneumogastric nerve, left pleura, and lung. The left subclavian artery is posterior and slightly external to it.

PLAN OF THE RELATIONS OF THE LEFT COMMON CAROTID.
THORACIC PORTION.

In front.
Sternum.
Sterno-hyoid and Sterno-thyroid muscles.
Left innominate vein.
Remains of thymus gland.

Internally.
Innominate artery.
Inferior thyroid veins.
Remains of thymus gland.

Externally.
Left pneumogastric nerve.
Left pleura and lung.
Left subclavian artery.

Behind.
Trachea.
Œsophagus.
Thoracic duct.
Left subclavian artery.

In the neck the two common carotids resemble each other so closely that one description will apply to both. Each vessel passes obliquely upward from behind the sterno-clavicular articulation to a level with the upper border of the thyroid cartilage, opposite the fourth cervical vertebra, where it divides into the external

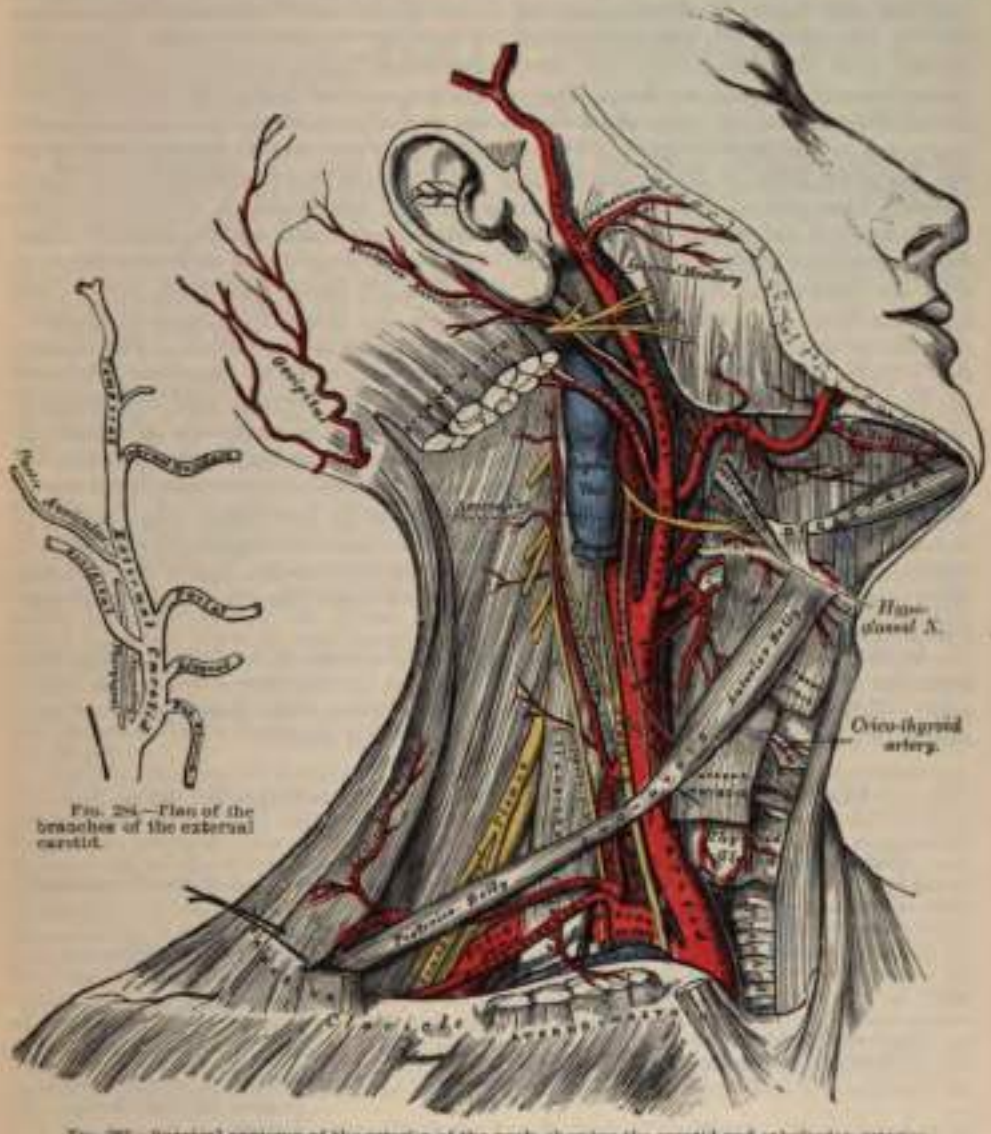


FIG. 284.—Plan of the branches of the external carotid.

FIG. 283.—Surgical anatomy of the arteries of the neck, showing the carotid and subclavian arteries.

and internal carotid; these names being derived from the distribution of the arteries to the external parts of the head and face and to the internal parts of the cranium and orbit respectively.

At the lower part of the neck the two common carotid arteries are separated from each other by a small interval, which contains the trachea; but at the upper part, the thyroid body, the larynx and pharynx project forward between the two vessels, and give the appearance of their being placed farther back in this situation. The common carotid artery is contained in a sheath derived from the deep cervical fascia, which also encloses the internal jugular vein and pneumogastric nerve, the vein lying on the outer side of the artery, and the nerve between

the artery and vein, on a plane posterior to both. On opening the sheath these three structures are seen to be separated from one another, each being enclosed in a separate fibrous investment.

Relations.—At the lower part of the neck the common carotid artery is very deeply seated, being covered by the integument, superficial fascia, Platysma, and deep cervical fascia, the Sterno-mastoid, Sterno-hyoid, and Sterno-thyroid muscles, and by the Omo-hyoid, opposite the cricoid cartilage; but in the upper part of its course, near its termination, it is more superficial, being covered merely by the integument, the superficial fascia, Platysma, deep cervical fascia, and inner margin of the Sterno-mastoid, and, when the latter is drawn backward, it is seen to be contained in a triangular space, bounded behind by the Sterno-mastoid, above by the posterior belly of the Digastric, and below by the anterior belly of the Omo-hyoid. This part of the artery is crossed obliquely, from within outward, by the sterno-mastoid artery; it is crossed also by the superior and middle thyroid veins, which terminate in the internal jugular; and, descending on its sheath in front, is seen the descendens hypoglossi nerve, this filament being joined by one or two branches from the cervical nerves, which cross the vessel from without inward. Sometimes the descendens hypoglossi is contained within the sheath. The middle thyroid vein crosses the artery about its middle, and the anterior jugular vein below; the latter, however, is separated from the artery by the Sterno-hyoid and Sterno-thyroid muscles. *Behind*, the artery is separated from the transverse processes of the vertebræ by the Longus colli and Rectus capitis anticus major, the sympathetic nerve being interposed between it and the muscles. The recurrent laryngeal nerve and inferior thyroid artery cross behind the vessel at its lower part. *Internally*, it is in relation with the trachea and thyroid gland, the later overlapping it, the inferior thyroid artery and recurrent laryngeal nerve being interposed: higher up, with the larynx and pharynx. On its *outer side* are placed the internal jugular vein and pneumogastric nerve.

At the lower part of the neck the internal jugular vein on the right side diverges from the artery, but on the left side it approaches it, and often overlaps its lower part. This is an important fact to bear in mind during the performance of any operation on the lower part of the left common carotid artery.

PLAN OF THE RELATIONS OF THE COMMON CAROTID ARTERY.

In front.

Integument and superficial fascia.
Deep cervical fascia.
Platysma.
Sterno-mastoid.
Sterno-hyoid.
Sterno-thyroid.
Omo-hyoid.
Descendens and Communicans hypoglossi nerves.
Sterno-mastoid artery.
Superior and middle thyroid veins.
Anterior jugular vein.

Externally.

Internal jugular vein.
Pneumogastric nerve.

Common Carotid.

Internally.

Trachea.
Thyroid gland.
Recurrent laryngeal nerve.
Inferior thyroid artery.
Larynx.
Pharynx.

Behind.

Longus colli.
Rectus capitis anticus major.
Sympathetic nerve.
Inferior thyroid artery.
Recurrent laryngeal nerve.

Peculiarities as to Origin.—The *right common carotid* may arise above or below the upper border of the sterno-clavicular articulation. This variation occurs in one out of about eight cases and a half, and the origin is more frequently below than above; or the artery may arise as a separate branch from the arch of the aorta or in conjunction with the left carotid. The *left common carotid* varies more frequently in its origin than the right. In the majority of abnormal cases it arises with the innominate artery, or, if the innominate artery is absent, the two carotids arise usually by a single trunk. It rarely joins with the left subclavian, except in cases of transposition of the arch.

Peculiarities as to Point of Division.—The most important peculiarities of this vessel, in a surgical point of view, relate to its place of division in the neck. In the majority of abnormal cases this occurs higher than usual, the artery dividing into two branches opposite the hyoid bone, or even higher; more rarely it occurs below, opposite the middle of the larynx or the lower border of the cricoid cartilage; and one case is related by Morgagni where the common carotid, only an inch and a half in length, divided at the root of the neck. Very rarely the common carotid ascends in the neck without any subdivision, the internal carotid being wanting; and in a few cases the common carotid has been found to be absent, the external and internal carotids arising directly from the arch of the aorta. This peculiarity existed on both sides in some instances, on one side in others.

Occasional Branches.—The common carotid usually gives off no branch previous to its bifurcation; but it occasionally gives origin to the superior thyroid or its laryngeal branch, the ascending pharyngeal, the inferior thyroid, or, more rarely, the vertebral artery.

Surface Marking.—The carotid arteries are covered throughout their entire extent by the Sterno-mastoid muscle, but their course does not correspond to the anterior border of the muscle, which passes in a somewhat curved direction from the mastoid process to the sterno-clavicular joint. The course of the artery is indicated more exactly by a line drawn from the sternal end of the clavicle below, to a point midway between the angle of the jaw and the mastoid process above. That portion of the line below the level of the upper border of the thyroid cartilage would represent the course of the vessel.

Surgical Anatomy.—The operation of tying the common carotid artery may be necessary in a case of wound of that vessel or its branches, in aneurism, or in a case of pulsating tumor of the orbit or skull. If the wound involves the trunk of the common carotid, it will be necessary to tie the artery above and below the wounded part. But in cases of aneurism, or where one of the branches of the common carotid is wounded in an inaccessible situation, it may be judged necessary to tie the trunk. In such cases the whole of the artery is accessible, and any part may be tied except close to either end. When the case is such as to allow of a choice being made, the lower part of the carotid should never be selected as the spot upon which to place a ligature, for not only is the artery in this situation placed very deeply in the neck, but it is covered by three layers of muscles, and, on the left side, the internal jugular vein, in the great majority of cases, passes obliquely in front of it. Neither should the upper end be selected, for here the superior thyroid vein and its tributaries would give rise to very considerable difficulty in the application of a ligature. The point most favorable for the operation is that part of the vessel which is at the level of the cricoid cartilage. It occasionally happens that the carotid artery bifurcates below its usual position: if the artery be exposed at its point of bifurcation, both divisions of the vessel should be tied near their origin, in preference to tying the trunk of the artery near its termination; and if, in consequence of the entire absence of the common carotid or from its early division, two arteries, the external and internal carotids, are met with, the ligature should be placed on that vessel which is found on compression to be connected with the disease.

In this operation the direction of the vessel and the inner margin of the Sterno-mastoid are the chief guides to its performance. The patient should be placed on his back with the head thrown back and turned slightly to the opposite side: an incision is to be made, three inches long, in the direction of the anterior border of the Sterno-mastoid, so that the centre corresponds to the level of the cricoid cartilage: after dividing the integument, superficial fascia, and Platysma, the deep fascia must be cut through on a director, so as to avoid wounding numerous small veins that are usually found beneath. The head may now be brought forward so as to relax the parts somewhat, and the margins of the wound held asunder by retractors. The descendens hypoglossi nerve may now be exposed, and must be avoided, and, the sheath of the vessel having been raised by forceps, is to be opened to a small extent over the artery at its inner side. The internal jugular vein may present itself alternately distended and relaxed; this should be compressed both above and below, and drawn outward, in order to facilitate the operation. The aneurism needle is passed from the outside, care being taken to keep the needle in close contact with the artery, and thus avoid the risk of injuring the internal jugular vein or including the vagus nerve. Before the ligature is tied it should be ascertained that nothing but the artery is included in it.

Ligature of the Common Carotid at the Lower Part of the Neck.—This operation is sometimes required in cases of aneurism of the upper part of the carotid, especially if the sac is of large size. It is best performed by dividing the sternal origin of the Sterno-mastoid muscle, but may be done in some cases, if the aneurism is not of very large size, by an incision along the anterior border of the Sterno-mastoid, extending down to the sterno-clavicular articulation, and by then retracting the muscle. The easiest and best plan, however, is to make an incision two or three inches long down the lower part of the anterior border of the Sterno-mastoid muscle to the sterno-clavicular joint, and a second incision, starting from the termination of the first, along the upper border of the clavicle for about two inches. This incision is made through the superficial and deep fascia, and the sternal origin of the muscle exposed. This is to be divided on a director, and turned up, with the superficial structures, as a triangular flap. Some loose connective tissue is to be divided or torn through, and the outer border of the Sterno-hyoid muscle exposed. In doing this care must be taken not to wound the anterior jugular vein, which crosses the muscle to reach the external jugular or subclavian vein. The Sterno-hyoid, and with it the Sterno-thyroid, are to be drawn inward by means of a retractor.

and the sheath of the vessel is exposed. This must be opened with great care on its inner or tracheal side, so as to avoid the internal jugular vein. This is especially necessary on the left side, where the artery is commonly overlapped by the vein. On the right side there is usually an interval between the artery and the vein, and not the same risk of wounding the latter.

The common carotid artery, being a long vessel without any branches, is particularly suitable for the performance of Brasdor's operation for the cure of an aneurism of the lower part of the vessel. Brasdor's procedure consists in ligaturing the artery on the distal side of the aneurism, and in the case of the common carotid there are no branches given off from the vessel between the aneurism and the site of the ligature; hence the flow of blood through the sac of the aneurism is diminished and cure takes place in the usual way, by the deposit of laminated fibrin.

Collateral Circulation.—After ligature of the common carotid the collateral circulation can be perfectly established, by the free communication which exists between the carotid arteries of opposite sides, both without and within the cranium, and by enlargement of the branches of the subclavian artery on the side corresponding to that on which the vessel has been tied—the chief communication outside the skull taking place between the superior and inferior thyroid arteries and the profunda cervicis and arteria princeps cervicis of the occipital; the vertebral taking the place of the internal carotid within the cranium.

Sir A. Cooper had an opportunity of dissecting, thirteen years after the operation, the case in which he first successfully tied the common carotid (the second case in which he performed the operation).[1] The injection, however, does not seem to have been a successful one. It showed merely that the arteries at the base of the brain (circle of Willis) were much enlarged on the side of the tied artery, and that the anastomosis between the branches of the external carotid on the affected side and those of the same artery on the sound side was free, so that the external carotid was pervious throughout.

The External Carotid Artery.

The **external carotid artery** (Fig. 283) commences opposite the upper border of the thyroid cartilage, and, taking a slightly curved course, passes upward and forward, and then inclines backward to the space between the neck of the condyle of the lower jaw and the external meatus, where it divides into the temporal and internal maxillary arteries. It rapidly diminishes in size in its course up the neck, owing to the number and large size of the branches given off from it. In the child it is somewhat smaller than the internal carotid, but in the adult the two vessels are of nearly equal size. At its commencement this artery is more superficial, and placed nearer the middle line than the internal carotid, and is contained in the triangular space bounded by the Sterno-mastoid behind, the Omo-hyoid below, and the posterior belly of the Digastric and Stylo-hyoid above.

Relations.—It is covered by the skin, superficial fascia, Platysma, deep fascia, and anterior margin of the Sterno-mastoid, crossed by the hypoglossal nerve, and by the lingual and facial veins; it is afterward crossed by the Digastric and Stylo-hyoid muscles, and higher up passes deeply into the substance of the parotid gland, where it lies beneath the facial nerve and the junction of the temporal and internal maxillary veins. *Internally* is the hyoid bone, wall of the pharynx, the superior laryngeal nerve, and the ramus of the jaw, from which it is separated by a portion of the parotid gland. *Externally*, in the lower part of its course, is the internal carotid artery. *Behind* it, near its origin, is the superior laryngeal nerve; and higher up, it is separated from the internal carotid by the Stylo-glossus and Stylo-pharyngeus muscles, the glosso-pharyngeal nerve, and part of the parotid gland.

PLAN OF THE RELATIONS OF THE EXTERNAL CAROTID.

In front.

Skin, superficial fascia.
Platysma and deep fascia.
Anterior border of Sterno-mastoid.
Hypoglossal nerve.
Lingual and facial veins.
Digastric and Stylo-hyoid muscles.
Parotid gland with facial nerve and temporo-maxillary vein in its substance.

[1] *Guy's Hospital Reports*, i., 56.

Internally.
Hyoid bone.
Pharynx.
Superior laryngeal nerve.
Parotid gland.
Ramus of jaw.

Externally.
Internal carotid artery.

Behind.
Superior laryngeal nerve.
Stylo-glossus.
Stylo-pharyngeus.
Glosso-pharyngeal nerve.
Parotid gland.

Surface Marking.—The position of the external carotid artery may be marked out with sufficient accuracy by a line drawn from the front of the meatus of the external ear to the side of the cricoid cartilage, slightly arching the line forward.

Surgical Anatomy.—The application of a ligature to the external carotid may be required in case of wounds of this vessel, or of its branches when these cannot be tied, and in some cases of pulsating tumor of the scalp or face. The operation has not received the attention which it deserves, owing to the fear which surgeons have entertained of secondary hæmorrhage, on account of the number of branches given off from the vessel. This fear, however, has been shown by Mr. Cripps not to be well founded.[1] To tie this vessel near its origin, below the point where it is crossed by the Digastric, an incision about three inches in length should be made along the margin of the Sterno-mastoid, from the angle of the jaw to the upper border of the thyroid cartilage. The ligature should be applied between the lingual and superior thyroid branches. To tie the vessel above the Digastric, between it and the parotid gland, an incision should be made, from the lobe of the ear to the great cornu of the os hyoides, dividing successively the skin, Platysma, and fascia. By drawing the Sterno-mastoid outward, and the posterior belly of the Digastric and Stylo-hyoid muscles downward, and separating them from the parotid gland, the vessel will be exposed, and a ligature may be applied to it. The circulation is at once re-established by the free communication between most of the large branches of the artery (facial, lingual, superior thyroid, occipital) and the corresponding arteries of the opposite side, and by the anastomosis of its branches with those of the internal carotid, and of the occipital with the branches of the subclavian, etc.

Branches.—The external carotid artery gives off eight branches, which, for convenience of description, may be divided into four sets. (See Fig. 284, Plan of the Branches).

Anterior.	*Posterior.*	*Ascending.*	*Terminal.*
Superior Thyroid.	Occipital.	Ascending Pharyngeal.	Superficial Temporal.
Lingual.	Posterior Auricular.		Internal Maxillary.
Facial.			

The student is here reminded that many variations are met with in the number, origin, and course of these branches in different subjects; but the above arrangement is that which is found in the great majority of cases.

The **Superior Thyroid Artery** (Figs. 283 and 288) is the first branch given off from the external carotid, being derived from that vessel just below the great cornu of the hyoid bone. At its commencement it is quite superficial, being covered by the integument, fascia, and Platysma, and is contained in the triangular space bounded by the Sterno-mastoid, Digastric, and Omo-hyoid muscles. After running upward and inward for a short distance, it curves downward and forward, in an arched and tortuous manner, to the upper part of the thyroid gland, passing beneath the Omo-hyoid, Sterno-hyoid, and Sterno-thyroid muscles, and supplying them. It distributes numerous branches to the upper part of the gland, anastomosing with its fellow of the opposite side and with the inferior thyroid arteries. The branches supplying the gland are generally three in number: one, the largest, supplies principally the anterior surface of the gland; it courses along the inner border of the lobe as far as the upper border of the isthmus, and then passes in the substance of the isthmus to the middle line of the neck, where it anastomoses with the corresponding artery of the opposite side: a second branch courses along the external border of the lobe, and supplies this portion of the gland, and the third passes to the posterior surface, the upper part of which it supplies.

[1] *Med.-Chir. Trans.*, lxi., 229.

Besides the arteries distributed to the muscles by which it is covered and to the substance of the gland, the branches of the superior thyroid are the following:

Hyoid.	Superior laryngeal.
Superficial descending branch (Sterno-mastoid).	Crico-thyroid.

The **hyoid (infra-hyoid)** is a small branch which runs along the lower border of the os hyoides beneath the Thyro-hyoid muscle; after supplying the muscles connected to that bone, it forms an arch, by anastomosing with the vessel of the opposite side.

The **superficial descending** or **Sterno-mastoid branch** runs downward and outward across the sheath of the common carotid artery, and supplies the Sterno-mastoid and neighboring muscles and integument. There is frequently a separate branch from the external carotid distributed to the Sterno-mastoid muscle.

The **superior laryngeal,** larger than either of the preceding, accompanies the internal laryngeal nerve, beneath the Thyro-hyoid muscle; it pierces the thyro-hyoid membrane, and supplies the muscles, mucous membrane, and glands of the larynx, anastomosing with the branch from the opposite side.

The **crico-thyroid** is a small branch which runs transversely across the crico-thyroid membrane, communicating with the artery of the opposite side.

Surgical Anatomy.—The superior thyroid, or one of its branches, is often divided in cases of cut throat, giving rise to considerable hemorrhage. In such cases the artery should be secured, the wound being enlarged for that purpose, if necessary. The operation may be easily performed, the position of the artery being very superficial, and the only structures of importance covering it being a few small veins. The operation of tying the superior thyroid artery in bronchocele has been performed in numerous instances with partial or temporary success. When, however, the collateral circulation between this vessel and the artery of the opposite side, and the inferior thyroid, is completely re-established, the tumor usually regains its former size, and hence the operation has been given up, especially as better results are obtained by other means. Both thyroid arteries on the same side, and indeed all the four thyroid arteries, have been tied in enlarged thyroid.

The position of the superficial descending branch is of importance in connection with the operation of ligation of the common carotid artery. It crosses and lies on the sheath of this vessel, and may chance to be wounded in opening the sheath. The position of the crico-thyroid branch should be remembered, as it may prove the source of troublesome hemorrhage during the operation of laryngotomy.

The **Lingual Artery** (Fig. 288) arises from the external carotid between the superior thyroid and facial; it first runs obliquely upward and inward to the great cornu of the hyoid bone; it then curves downward and forward, forming a loop which is crossed by the hypoglossal nerve, and, passing beneath the Digastric and Stylo-hyoid muscles, it runs horizontally forward, beneath the Hyo-glossus, and finally, ascending almost perpendicularly to the tongue, turns forward on its under surface as far as the tip, under the name of the *ranine artery*.

Relations.—Its first, or oblique, portion is superficial, being contained in the same triangular space as the superior thyroid artery, resting upon the middle constrictor of the pharynx, and covered by the Platysma and fascia of the neck. Its second, or curved, portion also lies upon the middle constrictor, being covered at first by the tendon of the Digastric and the Stylo-hyoid muscle, and afterward by the Hyo-glossus, the latter muscle separating it from the hypoglossal nerve. Its third, or horizontal, portion lies between the Hyo-glossus and Genio-hyo-glossus muscles. The fourth, or terminal, part, under the name of the *ranine*, runs along the under surface of the tongue to its tip: it is very superficial, being covered only by the mucous membrane, and rests on the Linguales on the outer side of the Genio-hyo-glossus. The hypoglossal nerve crosses the lingual artery, and then becomes separated from it, in the second part of its course, by the Hyo-glossus muscle.

The branches of the lingual artery are—the

Hyoid.	Sublingual.
Dorsalis Linguæ.	Ranine.

The **hyoid branch (supra-hyoid)** runs along the upper border of the hyoid bone, supplying the muscles attached to it and anastomosing with its fellow of the opposite side.

The **dorsalis linguæ** (Fig. 288) arises from the lingual artery beneath the Hyo-glossus muscle (which, in the figure, has been partly cut away, to show the vessel); it ascends to the dorsum of the tongue, and supplies the mucous membrane, the tonsil, soft palate, and epiglottis, anastomosing with its fellow from the opposite side. This artery is frequently represented by two or three small branches.

The **sublingual**, which may be described as a branch of bifurcation of the lingual artery, arises at the anterior margin of the Hyo-glossus muscle, and runs forward between the Genio-hyo-glossus and the sublingual gland. It supplies the substance of the gland, giving branches to the Mylo-hyoid and neighboring muscles, the mucous membrane of the mouth and gums. One branch runs behind the alveolar process of the lower jaw in the substance of the gum to anastomose with a similar artery from the other side.

The **ranine** may be regarded as the other branch of bifurcation, or, as is more usual, as the continuation of the lingual artery; it runs along the under surface of the tongue, resting on the Inferior lingualis, and covered by the mucous membrane of the mouth; it lies on the outer side of the Genio-hyo-glossus, accompanied by the lingual nerve. On arriving at the tip of the tongue it has been said to anastomose with the artery of the opposite side, but this is denied by Hyrtl. These vessels in the mouth are placed one on each side of the frænum.

Surgical Anatomy.—The lingual artery may be divided near its origin in cases of cut throat, a complication that not unfrequently happens in this class of wounds; or severe hæmorrhage which cannot be restrained by ordinary means may ensue from a wound or deep ulcer of the tongue. In the former case the primary wound may be enlarged if necessary, and the bleeding vessels secured. In the latter case it has been suggested that the lingual artery should be tied near its origin. Ligature of the lingual artery is also occasionally practised, as a palliative measure, in cases of cancer of the tongue, in order to check the progress of the disease by starving the growth, and it is sometimes tied as a preliminary measure to removal of the tongue. The operation is a difficult one, on account of the depth of the artery, the number of important parts by which it is surrounded, the loose and yielding nature of the parts upon which it is supported, and its occasional irregularity of origin. An incision is to be made in a curved direction from a finger's breadth external to the symphysis of the jaw downward to the cornu of the hyoid bone, and then upward to near the angle of the jaw. Care must be taken not to carry this incision too far backward, for fear of endangering the facial vein. In the first incision the skin, superficial fascia, and Platysma will be divided, and the deep fascia exposed. This is then to be incised and the submaxillary gland exposed and pulled upward by retractors. A triangular space is now exposed, bounded internally by the posterior border of the Mylo-hyoid muscle; below and externally, by the tendon of the Digastric; and above, by the hypo-glossal nerve. The floor of the space is formed by the Hyo-glossus muscle, beneath which the artery lies. The fibres of this muscle are now to be cut through horizontally and the vessel exposed, care being taken, while near the vessel, not to open the pharynx.

Troublesome hæmorrhage may occur in the division of the frænum in children if the ranine artery, which lies on each side of it, is wounded. The student should remember that the operation is always to be performed with a pair of blunt-pointed scissors, and the mucous membrane only is to be divided by a very superficial cut, which cannot endanger any vessel. The scissors, also, should be directed away from the tongue. Any further liberation of the tongue which may be necessary can be effected by tearing.

The **Facial Artery** (Fig. 285) arises a little above the lingual, and passes obliquely upward, beneath the Digastric and Stylo-hyoid muscles, and frequently beneath the hypoglossal nerve; it now runs forward under cover of the body of the lower jaw, lodged in a groove on the posterior surface of the submaxillary gland; this may be called the cervical part of the artery. It then curves upward over the body of the jaw at the anterior inferior angle of the Masseter muscle; passes forward and upward across the cheek to the angle of the mouth, then upward along the side of the nose, and terminates at the inner canthus of the eye, under the name of the *angular artery*. This vessel, both in the neck and on the face, is remarkably tortuous: in the former situation, to accommodate itself to the movements of the pharynx in deglutition, and in the latter to the movements of the jaw and the lips and cheeks.

Relations.—*In the neck* its origin is superficial, being covered by the integument, Platysma, and fascia; it then passes beneath the Digastric and Stylo-hyoid muscles and part of the submaxillary gland. It lies upon the middle constrictor of the pharynx, and is separated from the Stylo-glossus and Hyo-glossus muscles by a portion of the submaxillary gland. *On the face*, where it passes over the body of the lower jaw, it is comparatively superficial, lying immediately beneath the Platysma. In this situation its pulsation may be distinctly felt, and compression of the vessel against the bone can be effectually made. In its course over the

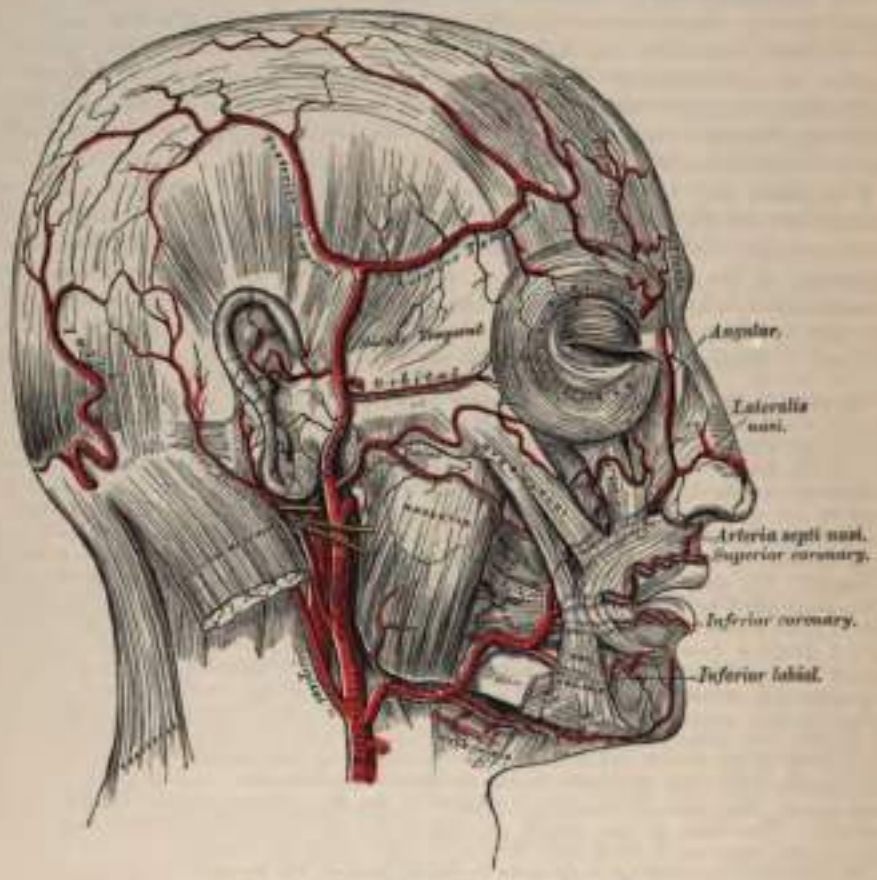


FIG. 280.—The arteries of the face and scalp.[1]

face it is covered by the integument, the fat of the cheek, and, near the angle of the mouth, by the Platysma, Risorius, and Zygomatici muscles. It rests on the Buccinator, the Levator anguli oris, and the Levator labii superioris (sometimes piercing or else passing under this last muscle). The facial vein lies to the outer side of the artery, and takes a more direct course across the face, where it is separated from the artery by a considerable interval. In the neck it lies superficial to the artery. The branches of the facial nerve cross the artery, and the infra-orbital nerve lies beneath it.

The branches of this vessel may be divided into two sets: those given off below the jaw (cervical), and those on the face (facial).

[1] The muscular tissue of the lips must be supposed to have been cut away, in order to show the course of the coronary arteries.

Cervical Branches.	*Facial Branches.*
Inferior or Ascending Palatine.	Muscular.
Tonsillar.	Inferior Labial.
Submaxillary.	Inferior Coronary.
Submental.	Superior Coronary.
Muscular.	Lateral Nasal.
	Angular.

The **inferior** or **ascending palatine** (Fig. 289) passes up between the Stylo-glossus and Stylo-pharyngeus to the outer side of the pharynx, along which it is continued between the Superior constrictor and the Internal pterygoid to near the base of the skull. It supplies the neighboring muscles, the tonsil, and Eustachian tube, and divides, near the Levator palati, into two branches: one follows the course of the Levator palati, and, winding over the upper border of the Superior constrictor, supplies the soft palate and the palatine glands, anastomosing with its fellow of the opposite side and with the posterior palatine branch of the internal maxillary artery; the other pierces the Superior constrictor and supplies the tonsil, anastomosing with the tonsillar and ascending pharyngeal arteries.

The **tonsillar branch** (Fig. 289) passes up between the Internal pterygoid and Stylo-glossus, and then ascends along the side of the pharynx, perforating the Superior constrictor, to ramify in the substance of the tonsil and root of the tongue.

The **submaxillary** or **glandular branches** consist of three or four large vessels, which supply the submaxillary gland, some being prolonged to the neighboring muscles, lymphatic glands, and integument.

The **submental,** the largest of the cervical branches, is given off from the facial artery just as that vessel quits the submaxillary gland: it runs forward upon the Mylo-hyoid muscle, just below the body of the jaw and beneath the Digastric; after supplying the surrounding muscles, and anastomosing with the sublingual artery by branches which perforate the Mylo-hyoid muscle, it arrives at the symphysis of the chin, where it turns over the border of the jaw and divides into a superficial and a deep branch; the former passes between the integument and Depressor labii inferioris, supplies both, and anastomoses with the inferior labial. The deep branch passes between the latter muscle and the bone, supplies the lip, and anastomoses with the inferior labial and mental arteries.

The **muscular branches** are distributed to the Internal pterygoid and Stylo-hyoid in the neck, and to the Masseter and Buccinator on the face.

The **inferior labial** passes beneath the Depressor anguli oris, to supply the muscles and integument of the lower lip, anastomosing with the inferior coronary and submental branches of the facial, and with the mental branch of the inferior dental artery.

The **inferior coronary** is derived from the facial artery, near the angle of the mouth: it passes upward and inward beneath the depressor anguli oris, and, penetrating the Orbicularis oris muscle, runs in a tortuous course along the edge of the lower lip between this muscle and the mucous membrane, inosculating with the artery of the opposite side. This artery supplies the labial glands, the mucous membrane, and muscles of the lower lip, and anastomoses with the inferior labial and the mental branch of the inferior dental artery.

The **superior coronary** is larger and more tortuous in its course than the preceding. It follows the same course along the edge of the upper lip, lying between the mucous membrane and the Orbicularis oris, and anastomoses with the artery of the opposite side. It supplies the textures of the upper lip, and gives off in its course two or three vessels which ascend to the nose. One, named the *inferior artery of the septum*, ramifies on the septum of the nares as far as the point of the nose; another, the *artery of the ala*, supplies the ala of the nose.

The **lateralis nasi** is derived from the facial, as that vessel is ascending along the side of the nose; it supplies the ala and dorsum of the nose, anastomosing

with its fellow, the nasal branch of the ophthalmic, the inferior artery of the septum, the artery of the ala, and the infra-orbital.

The **angular artery** is the termination of the trunk of the facial; it ascends to the inner angle of the orbit, imbedded in the fibres of the Levator labii superioris alæque nasi, and accompanied by a large vein, the *angular*; it distributes some branches on the cheek which anastomose with the infra-orbital, and after supplying the lachrymal sac and Orbicularis palpebrarum muscle, terminates by anastomosing with the nasal branch of the ophthalmic artery.

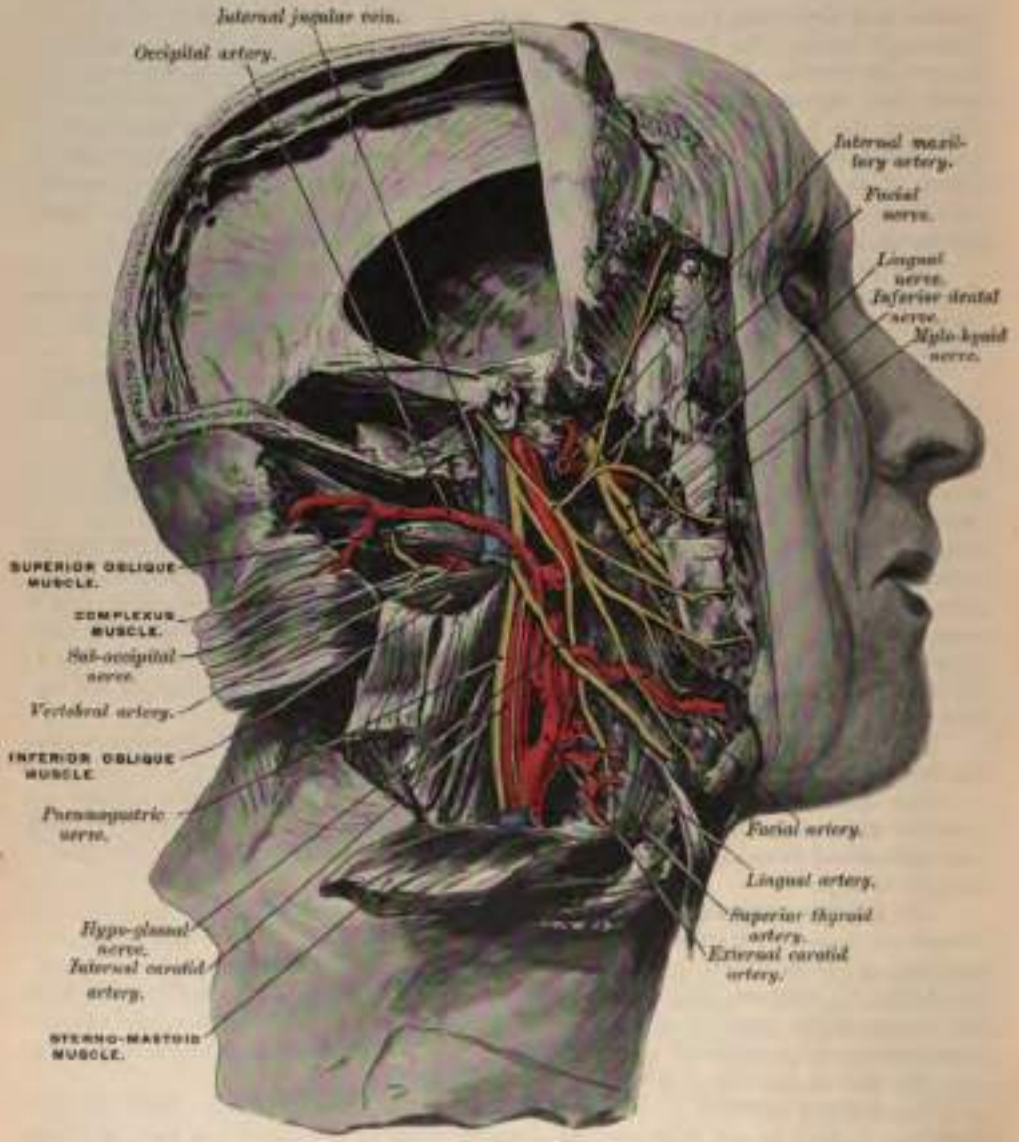


FIG. 286.—The occipital artery and its relations. (From a dissection by Mr. Gerald F. Hughes.)

The anastomoses of the facial artery are very numerous, not only with the vessel of the opposite side, but, in the neck, with the sublingual branch of the lingual; with the ascending pharyngeal; with the posterior palatine, a branch of the internal maxillary, by its inferior or ascending palatine and tonsillar branches; on the face, with the mental branch of the inferior dental as it emerges from the mental

foramen, with the transverse facial, a branch of the temporal; with the infra-orbital, a branch of the internal maxillary, and with the nasal branch of the ophthalmic.

Peculiarities.—The facial artery not unfrequently arises by a common trunk with the lingual. This vessel is also subject to some variations in its size and in the extent to which it supplies the face. It occasionally terminates as the submental, and not unfrequently supplies the face only as high as the angle of the mouth or nose. The deficiency is then supplied by enlargement of one of the neighboring arteries.

Surgical Anatomy.—The passage of the facial artery over the body of the jaw would appear to afford a favorable position for the application of pressure in case of hæmorrhage from the lips, the result either of an accidental wound or during an operation; but its application is useless, except for a very short time, on account of the free communication of this vessel with its fellow and with numerous branches from different sources. In a wound involving the lip it is better to seize the part between the fingers, and evert it, when the bleeding vessel may be at once secured with pressure-forceps. In order to prevent hæmorrhage in cases of removal of diseased growths from the part, the lip should be compressed on each side between the fingers and thumb or by a pair of specially devised clamp-forceps, whilst the surgeon excises the diseased part. In order to stop hæmorrhage where the lip has been divided in an operation, it is necessary, in uniting the edges of the wound, to pass the sutures through the cut edges, almost as deep as its mucous surface; by these means not only are the cut surfaces more nearly and securely adapted to each other, but the possibility of hæmorrhage is prevented by including in the suture the divided artery. If the suture is, on the contrary, passed through merely the cutaneous portion of the wound, hæmorrhage occurs into the cavity of the mouth. The student should, lastly, observe the relation of the angular artery to the lachrymal sac, and it will be seen that, as the vessel passes up along the inner margin of the orbit, it ascends on its nasal side. In operating for fistula lachrymalis the sac should always be opened on its outer side, in order that this vessel may be avoided.

The **Occipital Artery** (Figs. 285, 286) arises from the posterior part of the external carotid, opposite the facial, near the lower margin of the Digastric muscle. At its origin it is covered by the posterior belly of the Digastric and Stylo-hyoid muscles, and the hypoglossal nerve winds around it from behind forward; higher up, it passes across the internal carotid artery, the internal jugular vein, and the pneumogastric and spinal accessory nerves; it then ascends to the interval between the transverse process of the atlas and the mastoid process of the temporal bone, and passes horizontally backward, grooving the surface of the latter bone, being covered by the Sterno-mastoid, Splenius, Trachelo-mastoid, and Digastric muscles, and resting upon the Rectus lateralis, the Superior oblique, and Complexus muscles; it then changes its course and passes vertically upward, pierces the fascia which connects the cranial attachment of the Trapezius with the Sterno-mastoid, and ascends in a tortuous course over the occiput, as high as the vertex, where it divides into numerous branches. It is accompanied in the latter part of its course by the great occipital, and occasionally by a cutaneous filament from the suboccipital nerve.

The branches given off from this vessel are—

Muscular.	Auricular.
Sterno-mastoid.	Meningeal.

Arteria Princeps Cervicis.

The **muscular branches** supply the Digastric, Stylo-hyoid, Splenius, and Trachelo-mastoid muscles.

The **sterno-mastoid** is a large and constant branch, generally arising from the artery close to its commencement, but sometimes springing directly from the external carotid. It first passes downward and backward over the hypoglossal nerve, and enters the substance of the muscle in company with the spinal accessory nerve.

The **auricular branch** supplies the back part of the concha. It frequently gives off a branch, which enters the skull through the mastoid foramen and supplies the dura mater, the diploë, and the mastoid cells.

The **meningeal branch** ascends with the internal jugular vein, and enters the skull through the foramen lacerum posterius, to supply the dura mater in the posterior fossa.

The **arteria princeps cervicis** (Fig. 289), the largest branch of the occipital, descends along the back part of the neck and divides into a superficial and a deep

portion. The former runs beneath the Splenius, giving off branches which perforate that muscle to supply the Trapezius, which anastomose with the superficial cervical artery, a branch of the transversalis colli: the latter passes beneath the Complexus between it and the Semispinalis colli, and anastomoses with branches from the vertebral and with the deep cervical artery, a branch of the superior intercostal. The anastomosis between these vessels serves mainly to establish the collateral circulation after ligation of the carotid or subclavian artery.

The cranial branches of the occipital artery are distributed upon the occiput; they are very tortuous, and lie between the integument and Occipito-frontalis, anastomosing with the artery of the opposite side, the posterior auricular and temporal arteries. They supply the back part of the Occipito-frontalis muscle, the integument, and pericranium.

The **Posterior Auricular Artery** (Fig. 285) is a small vessel which arises from the external carotid, above the Digastric and Stylo-hyoid muscles, opposite the apex of the styloid process. It ascends, under cover of the parotid gland, on the styloid process of the temporal bone, to the groove between the cartilage of the ear and the mastoid process, immediately above which it divides into its two terminal branches, the auricular and mastoid. Just before arriving at the mastoid process, this artery is crossed by the portio dura, and has beneath it the spinal accessory nerve.

Besides several small branches to the Digastric, Stylo-hyoid, and Sterno-mastoid muscles and to the parotid gland, this vessel gives off three branches:

Stylo-mastoid. Auricular. Mastoid.

The **stylo-mastoid branch** enters the stylo-mastoid foramen, and supplies the tympanum, mastoid cells, and semicircular canals. In the young subject a branch from this vessel forms, with the tympanic branch from the internal maxillary, a vascular circle, which surrounds the membrana tympani, and from which delicate vessels ramify on that membrane. It anastomoses with the petrosal branch of the middle meningeal artery by a twig which enters the hiatus Fallopii.

The **auricular branch**, one of the terminal branches, ascends behind the ear, beneath the Retrahens auriculam muscle, and is distributed to the back part of the cartilage of the ear, upon which it ramifies minutely, some branches curving round the margin of the fibro-cartilage, others perforating it, to supply its anterior surface. It anastomoses with the posterior branch of the superficial temporal and also with its anterior auricular branches.

The **mastoid branch** passes backward, over the Sterno-mastoid muscle, to the scalp above and behind the ear. It supplies the posterior belly of the Occipito-frontalis muscle and the scalp in this situation. It anastomoses with the occipital artery.

The **Ascending Pharyngeal Artery** (Fig. 289), the smallest branch of the external carotid, is a long, slender vessel, deeply seated in the neck, beneath the other branches of the external carotid and the Stylo-pharyngeus muscle. It arises from the back part of the external carotid, near the commencement of that vessel, and ascends vertically between the internal carotid and the side of the pharynx, to the under surface of the base of the skull, lying on the Rectus capitis anticus major. Its branches may be subdivided into four sets:

Prevertebral. Pharyngeal. Tympanic. Meningeal.

The **prevertebral branches** are numerous small vessels which supply the Recti capitis antici and Longus colli muscles, the sympathetic, hypoglossal, and pneumogastric nerves, and the lymphatic glands, anastomosing with the ascending cervical artery.

The **pharyngeal branches** are three or four in number. Two of these descend to supply the middle and inferior Constrictors and the Stylo-pharyngeus, ramifying in their substance and in the mucous membrane lining them. The largest of the pharyngeal branches passes inward, running upon the Superior constrictor, and sends ramifications to the soft palate and tonsil, which take the place of the

ascending palatine branch of the facial artery when that vessel is of small size. A twig from this branch supplies the Eustachian tube.

The **tympanic branch** is a small artery which passes through a minute foramen in the petrous portion of the temporal bone, in company with the tympanic branch of the Glosso-pharyngeal nerve to supply the inner wall of the tympanum and anastomose with the other tympanic arteries.

The **meningeal branches** consist of several small vessels, which pass through foramina in the base of the skull, to supply the dura mater. One, the posterior meningeal, enters the cranium through the foramen lacerum posterius; a second passes through the foramen lacerum medium; and occasionally a third through the anterior condyloid foramen. They are all distributed to the dura mater.

Surgical Anatomy.—The ascending pharyngeal artery has been wounded from the throat, as in the case in which the stem of a tobacco-pipe was driven into the vessel, causing fatal hemorrhage.

The **Superficial Temporal Artery** (Fig. 285), the smaller of the two terminal branches of the external carotid, appears, from its direction, to be the continuation of that vessel. It commences in the substance of the parotid gland, in the interspace between the neck of the lower jaw and the external auditory meatus, crosses over the posterior root of the zygoma, passes beneath the Attrahens auriculam muscle, lying on the temporal fascia, and divides, about two inches above the zygomatic arch, into two branches, an anterior and a posterior.

The **anterior temporal** runs tortuously upward and forward to the forehead, supplying the muscles, integument, and pericranium in this region, and anastomoses with the supra-orbital and frontal arteries.

The **posterior temporal**, larger than the anterior, curves upward and backward along the side of the head, lying superficial to the temporal fascia, and inosculates with its fellow of the opposite side, and with the posterior auricular and occipital arteries.

The superficial temporal artery, as it crosses the zygoma, is covered by the Attrahens auriculam muscle, and by a dense fascia given off from the parotid gland: it is crossed by the temporo-facial division of the facial nerve and one or two veins, and is accompanied by the auriculo-temporal nerve, which lies behind it. Besides some twigs to the parotid gland, the articulation of the jaw, and the Masseter muscle, its branches are, the

Transverse Facial. Middle Temporal.
Anterior Auricular.

The **transverse facial** is given off from the temporal before that vessel quits the parotid gland; running forward through its substance, it passes transversely across the face, between Stenson's duct and the lower border of the zygoma, and divides on the side of the face into numerous branches, which supply the parotid gland, the Masseter muscle, and the integument, anastomosing with the facial, masseteric, and infra-orbital arteries. This vessel rests on the Masseter, and is accompanied by one or two branches of the facial nerve. It is sometimes a branch of the external carotid.

The **middle temporal artery** arises immediately above the zygomatic arch, and, perforating the temporal fascia, gives branches to the Temporal muscle, anastomosing with the deep temporal branches of the internal maxillary. It occasionally gives off an **orbital** branch, which runs along the upper border of the zygoma, between the two layers of the temporal fascia, to the outer angle of the orbit. This branch, which may arise directly from the superficial temporal artery, supplies the Orbicularis palpebrarum, and anastomoses with the lachrymal and palpebral branches of the ophthalmic artery.

The **anterior auricular branches** are distributed to the anterior portion of the pinna, the lobule, and part of the external meatus, anastomosing with branches of the posterior auricular.

Surgical Anatomy.—Formerly the operation of arteriotomy was performed upon this vessel in cases of inflammation of the eye or brain, but now the operation is probably never performed. If the student will consider the relations of the trunk of the vessel as it crosses the zygomatic arch, with the surrounding structures, he will observe that it is covered by a thick and dense fascia, crossed by one of the main divisions of the facial nerve and one or two veins, and accompanied by the auriculo-temporal nerve. Bleeding should not be performed in this situation, as much difficulty may arise from the dense fascia over the vessel preventing a free flow of blood, and considerable pressure is requisite afterward to arrest the hemorrhage. Again, a varicose aneurism may be formed by the accidental opening of one of the veins in front of the artery; or severe neuralgic pain may arise from the operation implicating one of the nervous filaments in the neighborhood. The anterior branch, on the contrary, is subcutaneous, is a large vessel, and is readily compressed; it is consequently more suitable for the operation.

The **Internal Maxillary** (Fig. 287), the larger of the two terminal branches of the external carotid, arises from that vessel opposite the neck of the condyle of the lower jaw, and is at first embedded in the substance of the parotid gland; it passes inward between the ramus of the jaw and the internal lateral ligament, and then upon the outer surface of the External pterygoid muscle to the spheno-maxillary fossa, to supply the deep structures of the face. For convenience of description it is divided into three portions: a maxillary, a pterygoid, and a spheno-maxillary.

In the first part of its course (*maxillary portion*) the artery passes horizontally forward and inward, between the ramus of the jaw and the internal lateral ligament. The artery here lies parallel to and a little below the auriculo-temporal nerve; it crosses the inferior dental nerve, and lies along the lower border of the External pterygoid muscle.

In the second part of its course (*pterygoid portion*) it runs obliquely forward and upward upon the outer surface of the External pterygoid muscle, being covered by the ramus of the lower jaw and lower part of the Temporal muscle; or it may pass on the inner surface of the External pterygoid muscle to reach the interval between its two heads, between which it passes to reach the spheno-maxillary fossa.

In the third part of its course (*spheno-maxillary portion*) it approaches the superior maxillary bone, and enters the spheno-maxillary fossa in the interval between the two heads of the External pterygoid, where it lies in relation with Meckel's ganglion, and gives off its terminal branches.

The branches of this vessel may be divided into three groups, corresponding with its three divisions.

Branches of the First or Maxillary Portion (Fig. 288).

Tympanic (anterior).	Small meningeal.
Deep auricular.	Inferior dental.
Middle meningeal.	

The **tympanic branch** passes upward behind the articulation of the lower jaw, enters the tympanum through the Glaserian fissure, and ramifies upon the membrana tympani, forming a vascular circle around the membrane with the stylo-mastoid artery, and anastomosing with the Vidian and the tympanic branch from the internal carotid.

The **deep auricular branch** often arises in common with the preceding. It passes upward in the substance of the parotid gland, behind the temporo-maxillary articulation, pierces the cartilaginous or bony wall of the external auditory meatus, and supplies its cuticular lining and the outer surface of the membrana tympani.

The **middle meningeal** is the largest of the branches which supply the dura mater. It arises from the internal maxillary, between the internal lateral ligament and the neck of the jaw, and passes vertically upward between the two roots of the auriculo-temporal nerve to the foramen spinosum of the sphenoid bone. On entering the cranium it divides into two branches, anterior and posterior. The *anterior branch*, the larger, crosses the great ala of the sphenoid, and

reaches the groove, or canal, in the anterior inferior angle of the parietal bone: it then divides into branches which spread out between the dura mater and internal surface of the cranium, some passing upward over the parietal bone as far as the vertex, and others backward to the occipital bone. The *posterior branch* crosses the squamous portion of the temporal, and on the inner surface of the parietal

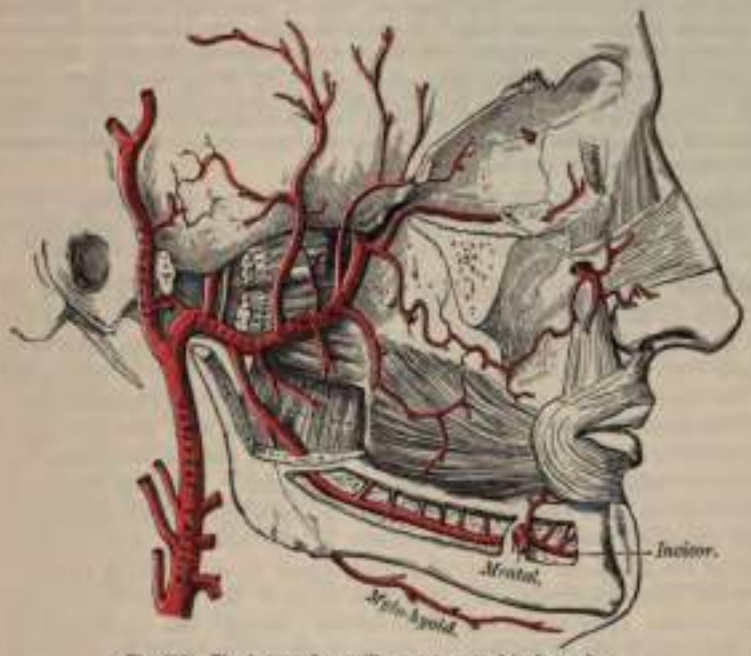


FIG. 287.—The internal maxillary artery and its branches.

FIG. 288.—Plan of the branches.

bone divides into branches which supply the posterior part of the dura mater and cranium. The branches of this vessel are distributed partly to the dura mater, but chiefly to the bones; they anastomose with the arteries of the opposite side, and with the anterior and posterior meningeal.

The middle meningeal on entering the cranium gives off the following collateral branches: 1. Numerous small vessels to the Gasserian ganglion, and to the dura mater in this situation. 2. A branch (*petrosal branch*), which enters the hiatus Fallopii, supplies the facial nerve, and anastomoses with the stylo-mastoid branch of the posterior auricular artery. 3. A minute *tympanic* branch, which runs in the canal for the Tensor tympani muscle, and supplies this muscle and the lining membrane of the canal. 4. Orbital branches, which pass through the sphenoidal fissure, or through separate canals in the great wing of the sphenoid to anastomose with the lachrymal or other branches of the ophthalmic artery. 5. Temporal or anastomotic branches, which pass through foramina in the great wing of the sphenoid, and anastomose in the temporal fossa with the deep temporal arteries.

Surgical Anatomy.—The middle meningeal is an artery of considerable surgical importance, as it may be injured in fractures of the temporal region of the skull, and the injury may be followed by considerable hæmorrhage between the bone and dura mater, which may cause compression of the brain and require the operation of trephining for its relief. This artery crosses the anterior inferior angle of the parietal bone at a point 1½ inches behind the external angular process of the frontal bone, and 1½ inches above the zygoma. From this point the anterior branch passes upward and slightly backward to the sagittal suture, lying about ½ inch to ¾ inch behind the coronal suture. The posterior branch passes upward and backward over the squamous portion of the temporal bone. In order to expose the artery as it lies in the canal in the parietal bone, a semilunar incision, with its convexity upward, should be made, commencing an inch behind the external angular process, and carried backward for 2 inches. The structures cut through are: (1) skin; (2) superficial fascia, with branches of the superficial temporal vessels and nerves; (3) the fascia continued down from the aponeurosis of the Occipito-frontalis; (4) the two layers of the temporal fascia; (5) the temporal muscle; (6) the deep temporal vessels; (7) the pericranium; and (8) the bone.

The **small meningeal** is sometimes derived from the preceding. It enters the skull through the foramen ovale, and supplies the Gasserian ganglion and dura mater.

The **inferior dental** descends with the inferior dental nerve to the foramen on the inner side of the ramus of the jaw. It runs along the dental canal in the substance of the bone, accompanied by the nerve, and opposite the first bicuspid tooth divides into two branches, incisor and mental; the former is continued forward beneath the incisor teeth as far as the symphysis, where it anastomoses with the artery of the opposite side; the mental branch escapes with the nerve at the mental foramen, supplies the structures composing the chin, and anastomoses with the submental inferior labial and inferior coronary arteries. Near its origin the inferior dental artery gives off a *lingual* branch, which descends with the lingual (gustatory) nerve and supplies the mucous membrane of the mouth. As the inferior dental artery enters the foramen it gives off a *mylo-hyoid branch*, which runs in the mylo-hyoid groove, and ramifies on the under surface of the Mylo-hyoid muscle. The dental and incisor arteries during their course through the substance of the bone give off a few twigs which are lost in the cancellous tissue, and a series of branches which correspond in number to the roots of the teeth: these enter the minute apertures at the extremities of the fangs and supply the pulp of the teeth.

Branches of the Second or Pterygoid Portion.

Deep Temporal.	Masseteric.
Pterygoid.	Buccal.

These branches are distributed, as their names imply, to the muscles in the maxillary region.

The **deep temporal branches,** two in number, anterior and posterior, each occupy that part of the temporal fossa indicated by its name. Ascending between the Temporal muscle and pericranium, they supply that muscle and anastomose with the middle temporal artery, the anterior branch communicating with the lachrymal through small branches which perforate the malar bone and great wing of the sphenoid.

The **pterygoid branches,** irregular in their number and origin, supply the Pterygoid muscles.

The **masseteric** is a small branch which passes outward, above the sigmoid notch of the lower jaw, to the deep surface of the Masseter. It supplies that muscle, and anastomoses with the masseteric branches of the facial and with the transverse facial artery.

The **buccal** is a small branch which runs obliquely forward between the Internal pterygoid and the ramus of the jaw, to the outer surface of the Buccinator, to which it is distributed, anastomosing with branches of the facial artery.

BRANCHES OF THE THIRD OR SPHENO-MAXILLARY PORTION.

Alveolar.	Vidian.
Infra-orbital.	Pterygo-palatine.
Posterior or Descending Palatine.	Naso- or Spheno-palatine.

The **alveolar** or **posterior dental branch** is given off from the internal maxillary by a common branch with the infra-orbital, and just as the trunk of the vessel is passing into the spheno-maxillary fossa. Descending upon the tuberosity of the superior maxillary bone, it divides into numerous branches, some of which enter the posterior dental canals, to supply the molar and bicuspid teeth and the lining of the antrum, and others are continued forward on the alveolar process to supply the gums.

The **infra-orbital** appears, from its direction, to be the continuation of the trunk of the internal maxillary. It arises from that vessel by a common trunk with the preceding branch, and runs along the infra-orbital canal with the superior maxillary nerve, emerging upon the face at the infra-orbital foramen, beneath the Levator labii superioris. Whilst contained in the canal, it gives off branches which ascend into the orbit, and assist in supplying the Inferior rectus and Inferior oblique muscles and the lachrymal gland. Other branches (*anterior dental*) descend through the anterior dental canals in the bone, to supply the mucous membrane of the antrum and the front teeth of the upper jaw. On the face, some branches pass upward to the inner angle of the orbit and the lachrymal sac, anastomosing with the angular branch of the facial artery; other branches pass inward toward the nose, anastomosing with the nasal branch of the ophthalmic; and other branches descend beneath the Levator labii superioris, and anastomose with the transverse facial and buccal arteries.

The four remaining branches arise from that portion of the internal maxillary which is contained in the spheno-maxillary fossa.

The **descending palatine** descends through the posterior palatine canal with the anterior palatine branch of Meckel's ganglion, and, emerging from the posterior palatine foramen, runs forward in a groove on the inner side of the alveolar border of the hard palate to the anterior palatine canal, where the terminal branch of the artery passes upward through the foramen of Stenson to anastomose with the naso-palatine artery. Its branches are distributed to the gums, the mucous membrane of the hard palate, and the palatine glands. Whilst it is contained in the palatine canal it gives off branches which descend in the accessory palatine canals to supply the soft palate and tonsil, anastomosing with the ascending palatine artery.

Surgical Anatomy.—The position of the descending palatine artery on the hard palate should be borne in mind in performing an operation for the closure of a cleft in the hard palate, as it is in danger of being wounded, and may give rise to formidable hemorrhage. In one case in which it was wounded it was necessary to plug the posterior palatine canal in order to arrest the bleeding.

The **Vidian branch** passes backward along the Vidian canal with the Vidian nerve. It is distributed to the upper part of the pharynx and Eustachian tube, sending a small branch into the tympanum, which anastomoses with the other tympanic arteries.

The **pterygo-palatine** is a very small branch, which passes backward through the pterygo-palatine canal with the pharyngeal nerve, and is distributed to the upper part of the pharynx and Eustachian tube.

The **spheno-palatine** passes through the spheno-palatine foramen into the cavity of the nose, at the back part of the superior meatus, and divides into two branches: one internal, the *naso-palatine* or *artery of the septum*, passes obliquely downward and forward along the septum nasi, supplies the mucous membrane, and anastomoses in front with the terminal branch of the descending palatine. The external branches, two or three in number, supply the mucous membrane covering the lateral wall of the nose, the antrum, and the ethmoid and sphenoid cells.

SURGICAL ANATOMY OF THE TRIANGLES OF THE NECK.

The student having considered the relative anatomy of the large arteries of the neck and their branches, and the relations they bear to the veins and nerves, should now examine these structures collectively, as they present themselves in certain regions of the neck, in each of which important operations are constantly being performed.

The side of the neck presents a somewhat quadrilateral outline, limited, above, by the lower border of the body of the jaw, and an imaginary line extending from the angle of the jaw to the mastoid process; below, by the prominent upper border of the clavicle; in front, by the median line of the neck; behind, by the anterior margin of the Trapezius muscle. This space is subdivided into two large triangles by the Sterno-mastoid muscle, which passes obliquely across the neck, from the sternum and clavicle below to the mastoid process above. The triangular space in front of this muscle is called the *anterior triangle*; and that behind it, the *posterior triangle*.

Anterior Triangle of the Neck.

The **anterior triangle** is bounded, in front, by a line extending from the chin to the sternum; behind, by the anterior margin of the Sterno-mastoid; its base, directed upward, is formed by the lower border of the body of the jaw and a line extending from the angle of the jaw to the mastoid process; its apex is below, at the sternum. This space is subdivided into three smaller triangles by the Digastric muscle above and the anterior belly of the Omo-hyoid below. These smaller triangles are named, from below upward, the inferior carotid, the superior carotid, and the submaxillary triangle.

The **Inferior Carotid Triangle** is bounded, in front, by the median line of the neck; behind, by the anterior margin of the Sterno-mastoid; above, by the anterior belly of the Omo-hyoid; and is covered by the integument, superficial fascia, Platysma, and deep fascia, ramifying between which are some of the descending branches of the superficial cervical plexus. Beneath these superficial structures are the Sterno-hyoid and Sterno-thyroid muscles, which, together with the anterior margin of the Sterno-mastoid, conceal the lower part of the common carotid artery.[1]

This vessel is enclosed within its sheath, together with the internal jugular vein and pneumogastric nerve; the vein lying on the outer side of the artery on the right side of the neck, but overlapping it below on the left side; the nerve lying between the artery and vein, on a plane posterior to both. In front of the sheath are a few filaments descending from the loop of communication between the descendens and communicans hypoglossi; behind the sheath are seen the inferior thyroid artery, the recurrent laryngeal nerve, and the sympathetic nerve; and on its inner side, the trachea, the thyroid gland—much more prominent in the female than in the male—and the lower part of the larynx. By cutting into the upper part of this space and slightly displacing the Sterno-mastoid muscle the common carotid artery may be tied below the Omo-hyoid muscle.

The **Superior Carotid Triangle** is bounded, behind, by the Sterno-mastoid; below, by the anterior belly of the Omo-hyoid; and above, by the Posterior belly of the Digastric muscle. It is covered by the integument, superficial fascia, Platysma, and deep fascia, ramifying between which are branches of the facial and superficial cervical nerves. Its floor is formed by parts of the Thyro-hyoid, Hyo-glossus, and the inferior and middle Constrictor muscles of the pharynx. This space, when dissected, is seen to contain the upper part of the common carotid

[1] Therefore the common carotid artery and internal jugular vein are not, strictly speaking, contained in this triangle, since they are covered by the Sterno-mastoid muscle; that is to say, lie behind the anterior border of that muscle, which forms the posterior border of the triangle. But as they lie very close to the structures which are really contained in the triangle, and whose position it is essential to remember in operating on this part of the artery, it has seemed expedient to study the relations of all these parts together.

artery, which bifurcates opposite the upper border of the thyroid cartilage into the external and internal carotid. These vessels are occasionally somewhat concealed from view by the anterior margin of the Sterno-mastoid muscle, which overlaps them. The external and internal carotids lie side by side, the external being the more anterior of the two. The following branches of the external carotid are also met with in this space: the superior thyroid, running forward and downward; the lingual, directly forward; the facial, forward and upward; the occipital, backward; and the ascending pharyngeal directly upward on the inner side of the internal carotid. The veins met with are: the internal jugular, which lies on the outer side of the common and internal carotid arteries, and veins corresponding to the above-mentioned branches of the external carotid—viz., the superior thyroid, the lingual, facial, ascending pharyngeal, and sometimes the occipital, all of which accompany their corresponding arteries and terminate in the internal jugular. The nerves in this space are the following: In front of the sheath of the common carotid is the descendens hypoglossi. The hypoglossal nerve crosses both the internal and external carotids above, curving round the occipital artery at its origin. Within the sheath, between the artery and vein, and behind both, is the pneumogastric nerve; behind the sheath, the sympathetic. On the outer side of the vessels the spinal accessory nerve runs for a short distance before it pierces the Sterno-mastoid muscle; and on the inner side of the external carotid, just below the hyoid bone, may be seen the internal laryngeal nerve; and, still more inferiorly, the external laryngeal nerve. The upper part of the larynx and lower part of the pharynx are also found in the front part of this space.

The **Submaxillary Triangle** corresponds to the part of the neck immediately beneath the body of the jaw. It is bounded, above, by the lower border of the body of the jaw and a line drawn from its angle to the mastoid process; below, by the posterior belly of the Digastric and Stylo-hyoid muscles; in front, by the anterior belly of the Digastric. It is covered by the integument, superficial fascia, Platysma, and deep fascia, ramifying between which are branches of the facial and ascending filaments of the superficial cervical nerves. Its floor is formed by the Mylo-hyoid and Hyo-glossus muscles. This space contains, in front, the submaxillary gland, superficial to which is the facial vein, while imbedded in it are the facial artery and its glandular branches; beneath this gland, on the surface of the Mylo-hyoid muscle, are the submental artery and the mylo-hyoid artery and nerve. The posterior part of this triangle is separated from the anterior part by the stylo-maxillary ligament: it contains the external carotid artery, ascending deeply in the substance of the parotid gland: this vessel here lies in front of, and superficial to, the internal carotid, being crossed by the facial nerve, and gives off in its course the posterior auricular, temporal, and internal maxillary branches: more deeply are the internal carotid, the internal jugular vein, and the pneumogastric nerve, separated from the external carotid by the Stylo-glossus and Stylo-pharyngeus muscles and the glosso-pharyngeal nerve.[1]

Posterior Triangle of the Neck.

The **posterior triangle** is bounded, in front, by the Sterno-mastoid muscle; behind, by the anterior margin of the Trapezius; its base corresponds to the middle third of the clavicle; its apex, to the occiput. The space is crossed, about an inch above the clavicle, by the posterior belly of the Omo-hyoid, which divides it unequally into two, an upper or occipital and a lower or subclavian triangle.

The **Occipital**, the larger division of the posterior triangle, is bounded, in

[1] The same remark will apply to this triangle as was made about the inferior carotid triangle. The structures enumerated as contained in the back part of the space lie, strictly speaking, beneath the muscles which form the posterior boundary of the triangle; but as it is very important to bear in mind their close relation to the parotid gland and its boundaries (on account of the frequency of surgical operations on this gland), all these parts are spoken of together.

front, by the Sterno-mastoid; behind, by the Trapezius; below, by the Omo-hyoid. Its floor is formed from above downward by the Splenius, Levator anguli scapulæ, and the middle and posterior Scaleni muscles. It is covered by the integument, the Platysma below, the superficial and deep fasciæ; the spinal accessory nerve is directed obliquely across the space from the Sterno-mastoid, which it pierces, to the under surface of the Trapezius; below, the descending branches of the cervical plexus and the transversalis colli artery and vein cross the space. A chain of lymphatic glands is also found running along the posterior border of the Sterno-mastoid, from the mastoid process to the root of the neck.

The **Subclavian**, the smaller of the two posterior triangles, is bounded, above, by the posterior belly of the Omo-hyoid; below, by the clavicle, its base, directed forward, being formed by the Sterno-mastoid. The size of the subclavian triangle varies according to the extent of attachment of the clavicular portion of the Sterno-mastoid and Trapezius muscles, and also according to the height at which the Omo-hyoid crosses the neck above the clavicle. Its height also varies much according to the position of the arm, being much diminished by raising the limb, on account of the ascent of the clavicle, and increased by drawing the arm downward, when that bone is depressed. This space is covered by the integument, the Platysma, the superficial and deep fasciæ, and crossed by the descending branches of the cervical plexus. Just above the level of the clavicle the third portion of the subclavian artery curves outward and downward from the outer margin of the Scalenus anticus, across the first rib, to the axilla. Sometimes this vessel rises as high as an inch and a half above the clavicle, or to any point intermediate between this and its usual level. Occasionally it passes in front of the Scalenus anticus or pierces the fibres of that muscle. The subclavian vein lies behind the clavicle, and is usually not seen in this space; but it occasionally rises as high up as the artery, and has even been seen to pass with that vessel behind the Scalenus anticus. The brachial plexus of nerves lies above the artery, and in close contact with it. Passing transversely behind the clavicle are the suprascapular vessels, and traversing its upper angle in the same direction, the transversalis colli artery and vein. The external jugular vein runs vertically downward behind the posterior border of the Sterno-mastoid, to terminate in the subclavian vein; it receives the transverse cervical and suprascapular veins, which occasionally form a plexus in front of the artery, and a small vein which crosses the clavicle from the cephalic. The small nerve to the Subclavius muscle also crosses this triangle about its middle. A lymphatic gland is also found in the space. Its floor is formed by the first rib with the first digitation of the Serratus magnus.

The Internal Carotid Artery.

The **internal carotid artery** supplies the anterior part of the brain, the eye, and its appendages, and sends branches to the forehead and nose. Its size in the adult is equal to that of the external carotid, though in the child it is larger than that vessel. It is remarkable for the number of curvatures that it presents in different parts of its course. It occasionally has one or two flexures near the base of the skull, whilst in its passage through the carotid canal and along the side of the body of the sphenoid bone it describes a double curvature which resembles the italic letter *s* placed horizontally. These curvatures most probably diminish the velocity of the current of blood, by increasing the extent of surface over which it moves and adding to the amount of impediment produced from friction.

In considering the course and relations of this vessel it may be conveniently divided into four portions: a cervical, petrous, cavernous, and cerebral.

Cervical Portion.—This portion of the internal carotid commences at the bifurcation of the common carotid, opposite the upper border of the thyroid cartilage, and runs perpendicularly upward, in front of the transverse processes of the three upper cervical vertebræ, to the carotid canal in the petrous portion of the temporal bone. It is superficial at its commencement, being contained in the superior

carotid triangle, and lying on the same level as the external carotid, but behind that artery overlapped by the Sterno-mastoid and covered by the deep fascia, Platysma, and integument: it then passes beneath the parotid gland, being crossed by the hypoglossal nerve, the Digastric and Stylo-hyoid muscles, and the occipital and posterior auricular arteries. Higher up, it is separated from the external carotid by the Stylo-glossus and Stylo-pharyngeus muscles, the glosso-pharyngeal nerve, and pharyngeal branch of the pneumogastric. It is in relation, *behind*, with the Rectus capitis anticus major, the superior cervical ganglion of the sympathetic, and superior laryngeal nerve; *externally*, with the internal jugular vein and pneumogastric nerve, the nerve lying on a plane posterior to the artery; *internally*, with the pharynx, tonsil, the superior laryngeal nerve, and ascending pharyngeal artery. At the base of the skull the glosso-pharyngeal, vagus, spinal accessory, and hypoglossal nerves lie between the artery and the internal jugular vein.

PLAN OF THE RELATIONS OF THE INTERNAL CAROTID ARTERY IN THE NECK.

In front.
Skin, superficial and deep fascia.
Platysma.
Sterno-mastoid.
Occipital and posterior auricular arteries.
Hypoglossal nerve.
Parotid gland.
Stylo-glossus and Stylo-pharyngeus muscles.
Glosso-pharyngeal nerve.
Pharyngeal branch of the pneumogastric.

Externally.
Internal jugular vein.
Pneumogastric nerve.

Interna Carotid Artery.

Internally.
Pharynx.
Superior laryngeal nerve.
Ascending pharyngeal artery.
Tonsil.

Behind.
Rectus capitis anticus major.
Sympathetic.
Superior laryngeal nerve.

Petrous Portion.—When the internal carotid artery enters the canal in the petrous portion of the temporal bone, it first ascends a short distance, then curves forward and inward, and again ascends as it leaves the canal to enter the cavity of the skull between the lingula and petrosal process. In this canal the artery lies at first in front of the cochlea and tympanum; from the latter cavity it is separated by a thin, bony lamella, which is cribriform in the young subject, and often absorbed in old age. Farther forward it is separated from the Gasserian ganglion by a thin plate of bone, which forms the floor of the fossa for the ganglion and the roof of the horizontal portion of the canal. Frequently this bony plate is more or less deficient, and then the ganglion is separated from the artery by fibrous membrane. The artery is separated from the bony wall of the carotid canal by a prolongation of dura mater, and is surrounded by filaments of the carotid plexus, derived from the ascending branch of the superior cervical ganglion of the sympathetic, and a number of small veins.

Cavernous Portion.—The internal carotid artery in this part of its course is situated between the layers of the dura mater forming the cavernous sinus, but covered by the lining membrane of the sinus. It at first ascends to the posterior clinoid process, then passes forward by the side of the body of the sphenoid bone, and again curves upward on the inner side of the anterior clinoid process, and perforates the dura mater, forming the roof of the sinus. In this part of its course it is surrounded by filaments of the sympathetic nerve, and has in relation with it externally the sixth nerve.

Cerebral Portion.—Having perforated the dura mater, on the inner side of the anterior clinoid process, the internal carotid passes between the second and third

cranial nerves to the anterior perforated spot at the inner extremity of the fissure of Sylvius, where it gives off its terminal or cerebral branches. This portion of the artery has the optic nerve on its inner side, and the third nerve externally.

Peculiarities.—The length of the internal carotid varies according to the length of the neck, and also according to the point of bifurcation of the common carotid. Its origin some-

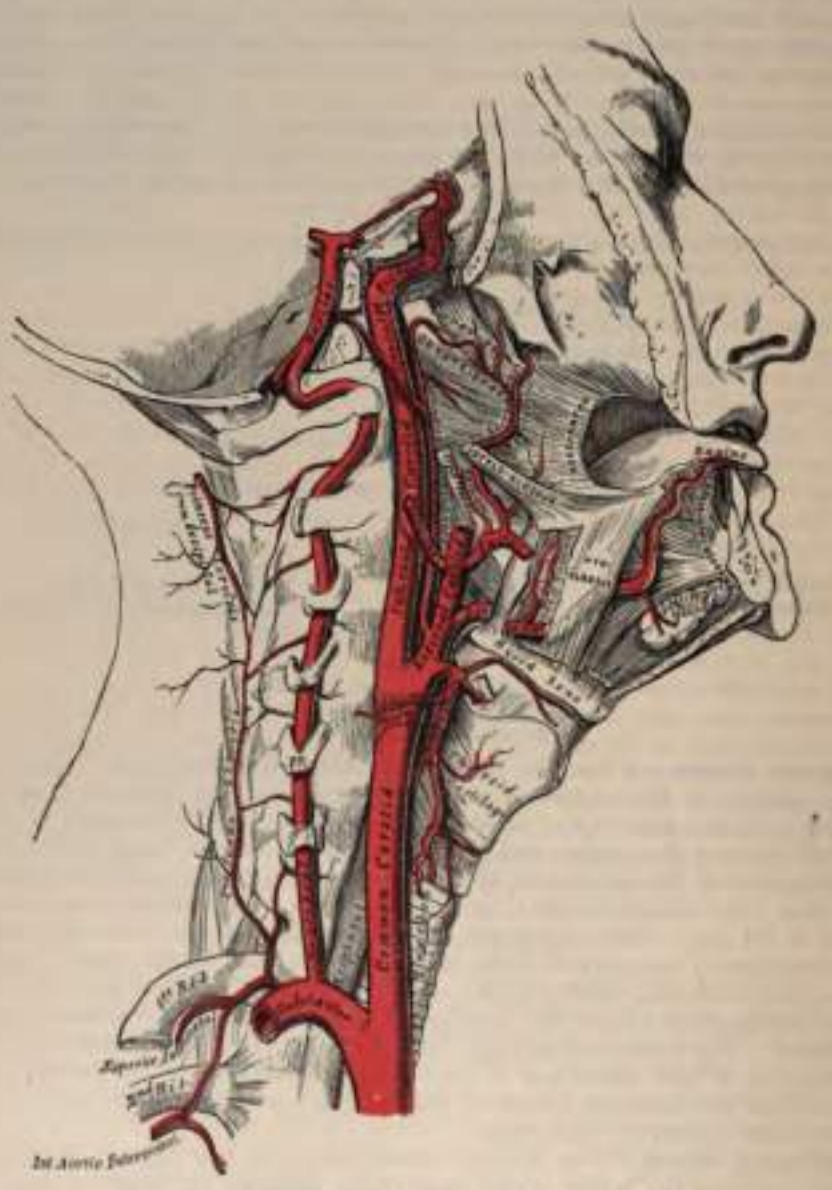


FIG. 289.—The internal carotid and vertebral arteries. Right side.

times takes place from the arch of the aorta; in such rare instances this vessel has been found to be placed nearer the middle line of the neck than the external carotid, as far upward as the larynx, when the latter vessel crossed the internal carotid. The course of the vessel, instead of being straight, may be very tortuous. A few instances are recorded in which this vessel was altogether absent: in one of these the common carotid passed up the neck, and gave off the usual branches of the external carotid, the cranial portion of the internal carotid being replaced by two branches of the internal maxillary, which entered the skull through the foramen rotundum and ovale and joined to form a single vessel.

Surgical Anatomy.—The cervical part of the internal carotid is very rarely wounded. Mr. Cripps, in an interesting paper in the *Medico-Chirurgical Transactions*, compares the rareness of a wound of the internal carotid with one of the external or its branches. It is, however, sometimes injured by a stab or gunshot wound in the neck, or even occasionally by a stab from within the mouth, as when a person receives a thrust from the end of a parasol or falls down with a tobacco-pipe in his mouth. The relation of the internal carotid with the tonsil should be especially remembered, as instances have occurred in which the artery has been wounded during the operation of scarifying the tonsil, and fatal hæmorrhage has supervened. The indications for ligature are wounds, when the vessel should be exposed by a careful dissection and tied above and below the bleeding point; and aneurism, which if non-traumatic may be treated by ligature of the common carotid, but if traumatic in origin by exposing the sac and tying the vessel above and below. The incision for ligature of the cervical portion of the internal carotid should be made along the anterior border of the Sterno-mastoid, from the angle of the jaw to the upper border of the thyroid cartilage. The superficial structures being divided and the Sterno-mastoid defined and drawn outward, the cellular tissue must be carefully separated and the posterior belly of the Digastric and hypoglossal nerve sought for as guides to the vessel. When the artery is found the external carotid should be drawn inward and the Digastric muscles upward, and the aneurism needle passed from without inward.

The branches given off from the internal carotid are—

From the Petrous portion	Tympanic (internal or deep).
From the Cavernous portion	Arteriæ Receptaculi. Anterior Meningeal. Ophthalmic.
From the Cerebral portion	Anterior Cerebral. Middle Cerebral. Posterior Communicating. Anterior Choroid.

The cervical portion of the internal carotid gives off no branches.

The **tympanic** is a small branch which enters the cavity of the tympanum through a minute foramen in the carotid canal, and anastomoses with the tympanic branch of the internal maxillary, and with the stylo-mastoid artery.

The **arteriæ receptaculi** are numerous small vessels, derived from the internal carotid in the cavernous sinus; they supply the pituitary body, the Gasserian ganglion, and the walls of the cavernous and inferior petrosal sinuses. Some of these branches anastomose with branches of the middle meningeal.

The **anterior meningeal** is a small branch which passes over the lesser wing of the sphenoid to supply the dura mater of the anterior fossa; it anastomoses with the meningeal branch from the posterior ethmoidal artery.

The **Ophthalmic Artery** arises from the internal carotid, just as that vessel is emerging from the cavernous sinus, on the inner side of the anterior clinoid process, and enters the orbit through the optic foramen, below and on the outer side of the optic nerve. It then passes over the nerve to the inner wall of the orbit, and thence horizontally forward, beneath the lower border of the Superior oblique muscle, to a point behind the internal angular process of the frontal bone, where it divides into two terminal branches, the *frontal* and *nasal*. As the artery crosses the optic nerve it is accompanied by the nasal nerve, and is separated from the frontal nerve by the Rectus superior and Levator palpebræ superioris muscles.

Branches.—The branches of this vessel may be divided into an *orbital group*, which are distributed to the orbit and surrounding parts, and an *ocular group*, which supply the muscles and globe of the eye:

Orbital Group.	*Ocular Group.*
Lachrymal.	Short Ciliary.
Supra-orbital.	Long Ciliary.
Posterior Ethmoidal.	Anterior Ciliary.
Anterior Ethmoidal.	Arteria Centralis Retinæ.
Internal Palpebral.	Muscular.
Frontal.	
Nasal.	

The **lachrymal** is one of the largest branches derived from the ophthalmic, arising close to the optic foramen; not infrequently it is given off from the artery before it enters the orbit. It accompanies the lachrymal nerve along the upper border of the External rectus muscle, and is distributed to the lachrymal gland. Its terminal branches, escaping from the gland, are distributed to the eyelids and conjunctiva: of those supplying the eyelids, two are of considerable size and are named the *external palpebral*; they run inward in the upper and lower lids

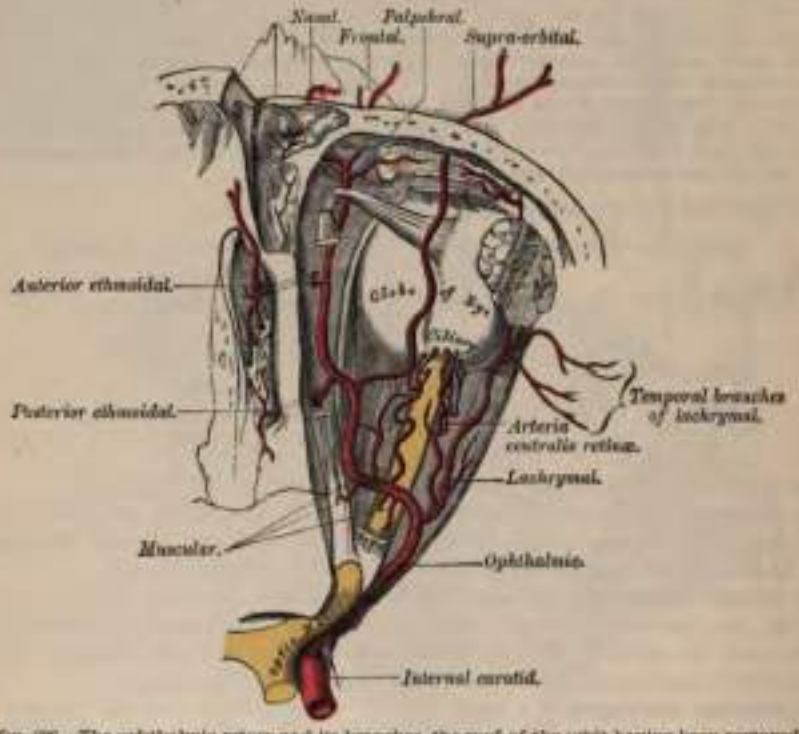


FIG. 286.—The ophthalmic artery and its branches, the roof of the orbit having been removed.

respectively, and anastomose with the internal palpebral arteries, forming an arterial circle in this situation. The lachrymal artery gives off one or two *malar branches*, one of which passes through a foramen in the malar bone, to reach the temporal fossa, and anastomoses with the deep temporal arteries; the other appears on the cheek through the malar foramen, and anastomoses with the transverse facial. A branch is also sent backward through the sphenoidal fissure to the dura mater, which anastomoses with a branch of the middle meningeal artery.

Peculiarities.—The lachrymal artery is sometimes derived from one of the anterior branches of the middle meningeal artery.

The **supra-orbital artery** arises from the ophthalmic as that vessel is crossing over the optic nerve. Ascending so as to arise above all the muscles of the orbit, it passes forward, with the supra-orbital nerve, between the periosteum and Levator palpebræ; and, passing through the supra-orbital foramen, divides into a superficial and deep branch, which supply the integument, the muscles, and the pericranium of the forehead, anastomosing with the frontal, the anterior branch of the temporal, and the artery of the opposite side. This artery in the orbit supplies the Superior rectus and the Levator palpebræ, and sends a branch inward, across the pulley of the Superior oblique muscle, to supply the parts at the inner canthus. At the supra-orbital foramen it frequently transmits a branch to the diploë.

The **ethmoidal branches** are two in number—posterior and anterior. The

former, which is the smaller, passes through the posterior ethmoidal foramen, supplies the posterior ethmoidal cells, and, entering the cranium, gives off a meningeal branch, which supplies the adjacent dura mater, and nasal branches which descend into the nose through apertures in the cribriform plate, anastomosing with branches of the spheno-palatine. The anterior ethmoidal artery accompanies the nasal nerve through the anterior ethmoidal foramen, supplies the

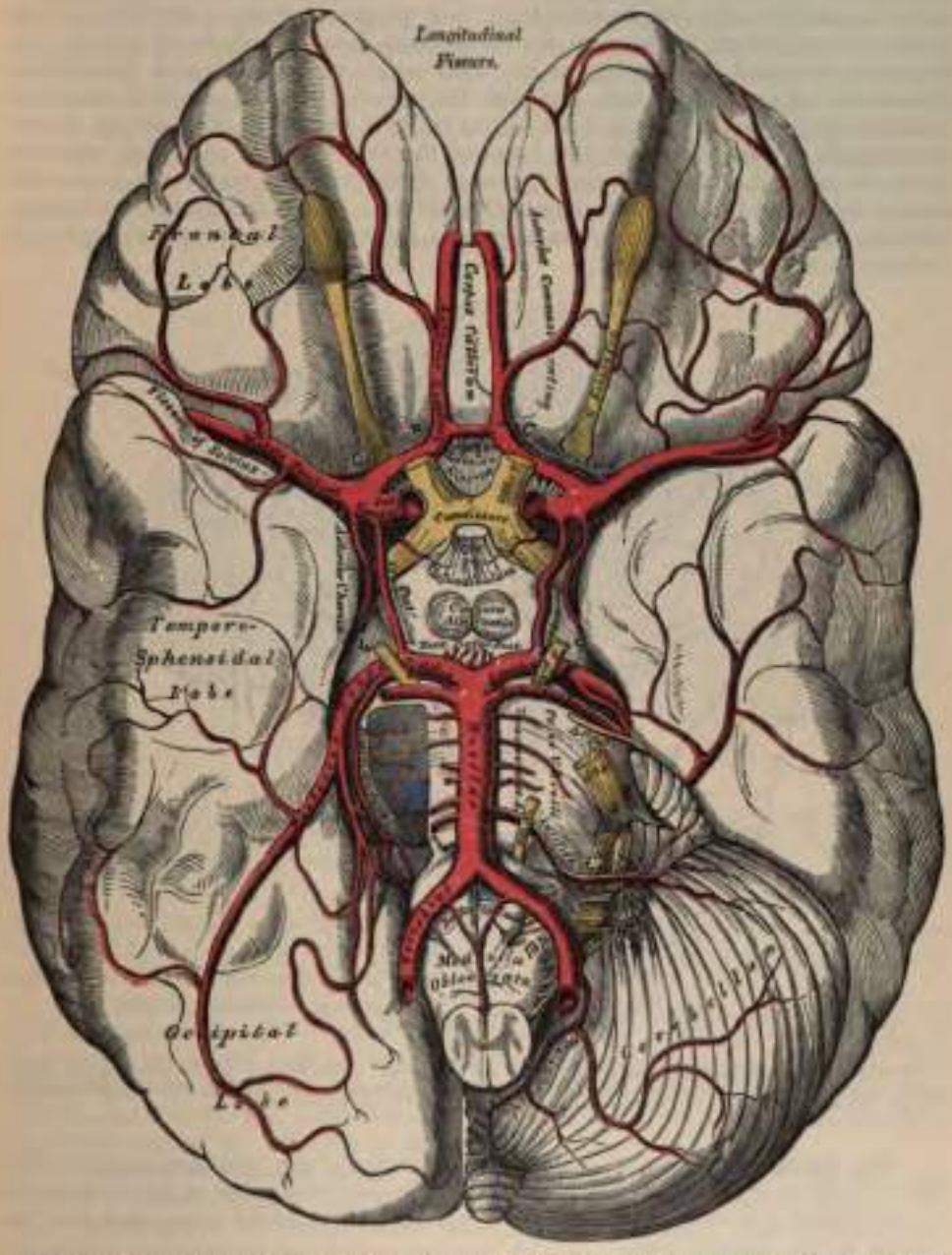


FIG. 391.—The arteries of the base of the brain. The right half of the cerebellum and pons have been removed.

N. B.—It will be noticed that in the illustration the two anterior cerebral arteries have been drawn at a considerable distance from each other: this makes the anterior communicating artery appear very much longer than it really is.

anterior ethmoidal cells and frontal sinuses, and, entering the cranium, gives off a meningeal branch, which supplies the adjacent dura mater and nasal branches, which descend into the nose, through the slit by the side of the crista galli, and, running along the groove on the under surface of the nasal bone, supply the skin of the nose.

The **palpebral arteries**, two in number, superior and inferior, arise from the ophthalmic, opposite the pulley of the Superior oblique muscle; they leave the orbit to encircle the eyelids near their free margin, forming a superior and an inferior arch, which lie between the Orbicularis muscle and tarsal plates; the superior palpebral inosculating at the outer angle of the orbit with the orbital branch of the temporal artery, and with the upper of the two external palpebral branches from the lachrymal artery—the inferior palpebral inosculating, at the outer angle of the orbit, with the lower of the two external palpebral branches from the lachrymal and with the transverse facial arteries, and at the inner side of the lid with a branch from the angular artery. From this last anastomosis a branch passes to the nasal duct, ramifying in its mucous membrane, as far as the inferior meatus.

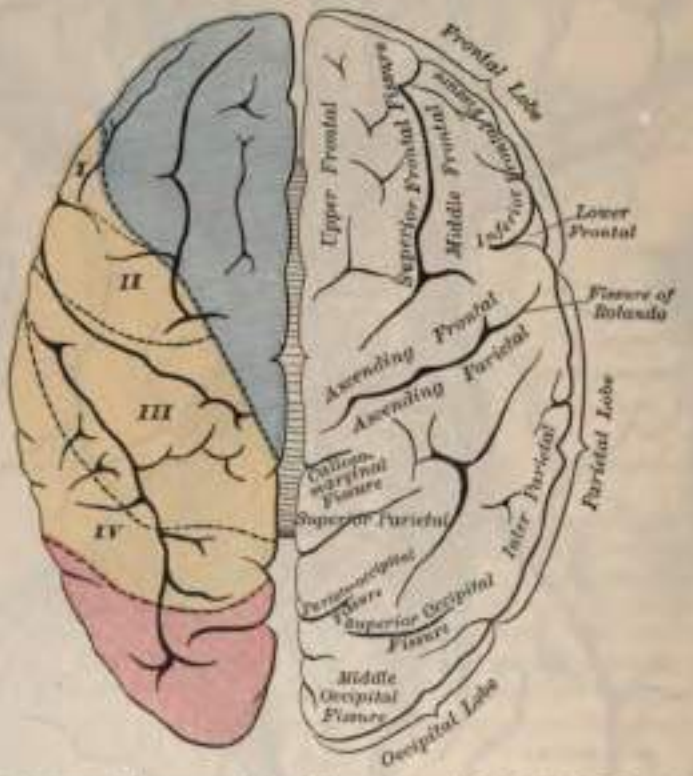


FIG. 282.—Vascular area of the upper surface of the cerebrum. (After Duret.) I. The part supplied by the external and inferior frontal artery. II. The part supplied by the ascending frontal. III. The part supplied by the ascending parietal. IV. The part supplied by the parieto-sphenoidal artery.

The **frontal artery**, one of the terminal branches of the ophthalmic, passes from the orbit at its inner angle, and, ascending on the forehead, supplies the integument, muscles, and pericranium, anastomosing with the supraorbital artery and with the artery of the opposite side.

The **nasal artery**, the other terminal branch of the ophthalmic, emerges from the orbit above the tendo oculi, and, after giving a branch to the upper part of the lachrymal sac, divides into two branches, one of which crosses the root of the nose, the *transverse nasal*, and anastomoses with the angular artery; the

other, the *dorsalis nasi*, runs along the dorsum of the nose, supplies its outer surface, and anastomoses with the artery of the opposite side and with the lateral nasal branch of the facial.

The **ciliary arteries** are divisible into three groups, the short, long, and anterior. The *short ciliary arteries*, from six to twelve in number, arise from the ophthalmic or some of its branches; they surround the optic nerve as they pass forward to the posterior part of the eyeball, pierce the sclerotic coat around the entrance of the nerve, and supply the choroid coat and ciliary processes. The *long ciliary arteries*, two in number, pierce the posterior part of the sclerotic at some little distance from the optic nerve, and run forward, along each side of the eyeball, between the sclerotic and choroid, to the ciliary muscle, where they divide into two branches; these form an arterial circle, the *circulus major*, around the circumference of the iris, from which numerous radiating branches pass forward, in its substance, to its free margin, where they form a second arterial circle, the *circulus minor*, around its pupillary margin. The *anterior ciliary arteries* are derived from the muscular branches; they pass to the front of the

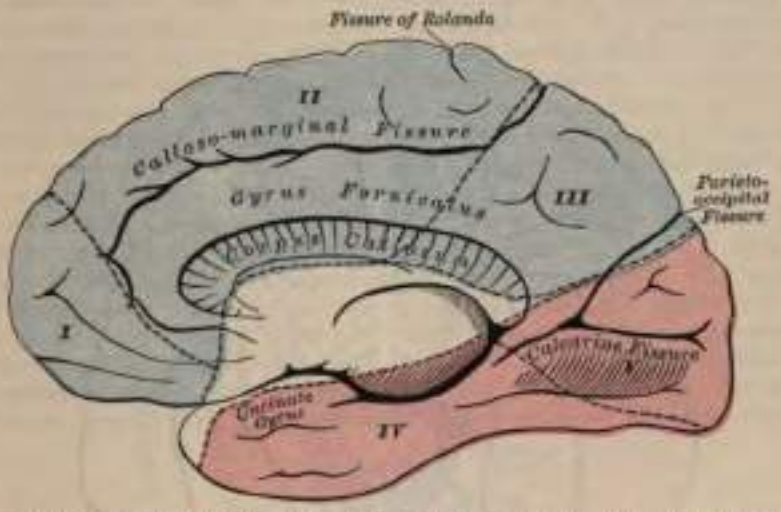


FIG. 288.—Vascular area of the internal surface of the cerebrum. (After Duret.) I. The part supplied by the anterior and internal frontal. II. The part supplied by the middle and internal frontal. III. The part supplied by the posterior and internal frontal. IV. The part supplied by the posterior temporal, and V. The part supplied by the occipital, both terminal branches of the posterior cerebral.

eyeball in company with the tendons of the Recti muscles, form a vascular zone beneath the conjunctiva, and then pierce the sclerotic a short distance from the cornea and terminate in the circulus major of the iris.

The **arteria centralis retinæ** is the first and one of the smallest branches of the ophthalmic artery. It runs for a short distance within the dural sheath of the nerve, but about half an inch behind the eyeball it pierces the optic nerve obliquely, and runs forward in the centre of its substance, and enters the globe of the eye through the porus opticus. Its mode of distribution will be described in the account of the anatomy of the eye.

The **muscular branches**, two in number, superior and inferior, frequently spring from a common trunk. The superior, the smaller, often wanting, supplies the Levator palpebræ, Superior rectus, and Superior oblique. The inferior, more constant in its existence, passes forward, between the optic nerve and Inferior rectus, and is distributed to the External, Internal, and Inferior recti, and Inferior oblique. This vessel gives off most of the anterior ciliary arteries. Additional muscular branches are given off from the lachrymal and supra-orbital arteries or from the ophthalmic itself.

The **anterior cerebral** arises from the internal carotid at the inner extremity of the fissure of Sylvius. It passes forward and inward across the anterior perforated space, above the optic nerve, to the commencement of the great longitudinal fissure. Here it comes into close relationship with the artery of the opposite side, and the two vessels are connected together by a short anastomosing trunk, about two lines in length, the *anterior communicating* artery. From this point the two vessels run side by side in the longitudinal fissure, curve round the genu of the corpus callosum, and, turning backward, continue along its upper surface to its posterior part, where they terminate by anastomosing with the posterior cerebral arteries. In their course they give off the following branches:

Antero-median ganglionic.	Anterior internal frontal.
Inferior internal frontal.	Middle internal frontal.
Posterior internal frontal.	

The *antero-median ganglionic* is a group of small arteries which arise at the commencement of the anterior cerebral artery; they pierce the anterior perforated space and lamina cinerea, and supply the head of the caudate nucleus.

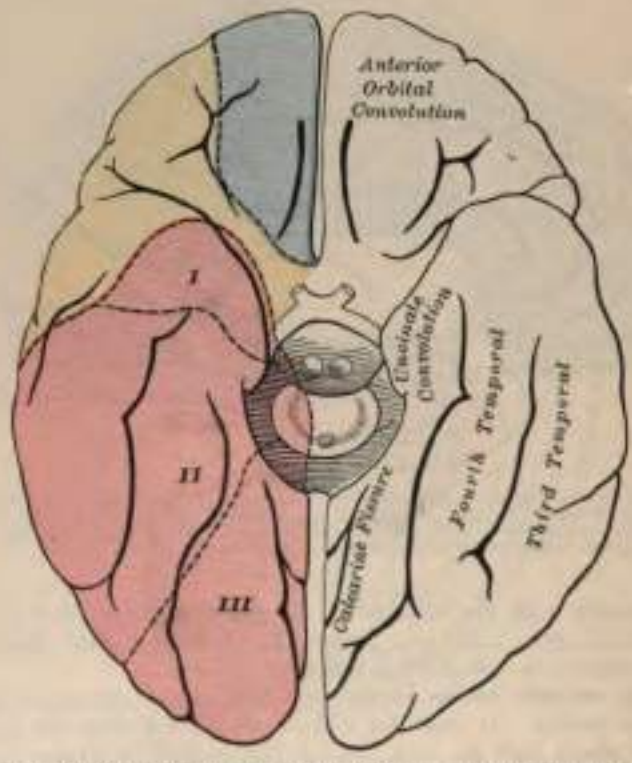


FIG. 284.—Vascular area of the inferior surface of the cerebrum. (After Duret.) I. The part supplied by the anterior temporal artery. II. The part supplied by the posterior temporal artery. III. The part supplied by the occipital artery.

The *inferior internal frontal*, two or three in number, are distributed to the orbital surface of the frontal lobe, where they supply the olfactory lobe, gyrus rectus, and internal orbital convolution.

The *anterior internal frontal branches* supply a part of the marginal convolution, and send branches over the edge of the hemisphere to the superior and middle frontal convolutions and upper part of the ascending frontal convolution. The *middle internal frontal branches* supply the corpus callosum, the convolution of the corpus callosum, the inner surface of the first frontal convolution, and the

upper part of the ascending frontal convolution. The *posterior internal frontal branches* supply the lobus quadratus and adjacent outer surface of the hemisphere.

The **anterior communicating artery** is a short branch, about two lines in length, but of moderate size, connecting together the two anterior cerebral arteries across the longitudinal fissure. Sometimes this vessel is wanting, the two arteries joining together to form a single trunk, which afterward divides. Or the vessel may be wholly or partially divided into two; frequently it is longer and smaller than usual. It gives off some of the antero-median ganglionic group of vessels, which are, however, principally derived from the anterior cerebral.

The **middle cerebral artery** (Fig. 295), the largest branch of the internal carotid, passes obliquely outward along the fissure of Sylvius, and opposite the island of Reil divides into its terminal branches. The branches of the middle cerebral artery are—

Antero-lateral ganglionic.	Ascending frontal.
Inferior external frontal.	Ascending parietal.
Parieto-temporal.	

The *antero-lateral ganglionic branches* are a group of small arteries which arise at the commencement of the middle cerebral artery; they pierce the anterior perforated space and supply the greater part of the caudate nucleus, the lenticular nucleus, the internal capsule, and a part of the optic thalamus. One artery of this group is of larger size than the rest, and is of special importance, as being the artery in the brain most frequently ruptured; it has been termed by Charcot the "*artery of cerebral hemorrhage.*" It passes up between the lenticular nucleus and the external capsule, and ultimately ends in the caudate nucleus. The *inferior external frontal* supplies the third or inferior frontal convolution (Broca's convolution) and the outer part of the orbital surface of the frontal lobe. The *ascending frontal* supplies the ascending frontal convolution. The *ascending parietal* supplies the ascending parietal convolution and the lower part of the superior parietal convolution. The *parieto-temporal* supplies the supra-marginal, the superior, and part of the middle temporal convolutions, and the angular gyrus.

The **posterior communicating artery** arises from the back part of the internal carotid, runs directly backward, and anastomoses with the posterior cerebral, a

FIG. 295.—The distribution of the middle cerebral artery. (After Charcot.)

branch of the basilar. This artery varies considerably in size, being sometimes small, and occasionally so large that the posterior cerebral may be considered as arising from the internal carotid rather than from the basilar. It is frequently

larger on one side than on the other side. From the posterior half of this vessel are given off a number of small branches, the *postero-median ganglionic branches*, which, with similar vessels from the posterior cerebral, pierce the posterior perforated space and supply the internal surfaces of the optic thalami and the walls of the third ventricle.

The **anterior choroid** is a small but constant branch which arises from the back part of the internal carotid, near the posterior communicating artery. Passing backward and outward between the temporal lobe and the crus cerebri, it enters the descending horn of the lateral ventricle through the transverse fissure and ends in the choroid plexus. It is distributed to the hippocampus major, corpus fimbriatum, velum interpositum, and choroid plexus.

The Blood-vessels of the Brain.

Recent investigations have tended to show that the mode of distribution of the vessels of the brain has an important bearing upon a considerable number of the anatomical lesions of which this part of the nervous system may be the seat; it therefore becomes important to consider a little more in detail the way in which the cerebral vessels are distributed.

The cerebral arteries are derived from the internal carotid and the vertebral, which at the base of the brain form a remarkable anastomosis known as the *circle of Willis*. It is formed in front by the anterior cerebral arteries, branches of the internal carotid, which are connected together by the anterior communicating; behind by the two posterior cerebrals, branches of the basilar which are connected on each side with the internal carotid by the posterior communicating (Fig. 291, p. 507). The parts of the brain included within this arterial circle are the lamina cinerea, the commissure of the optic nerves, the infundibulum, the tuber cinereum, the corpora albicantia, and the posterior perforated space.

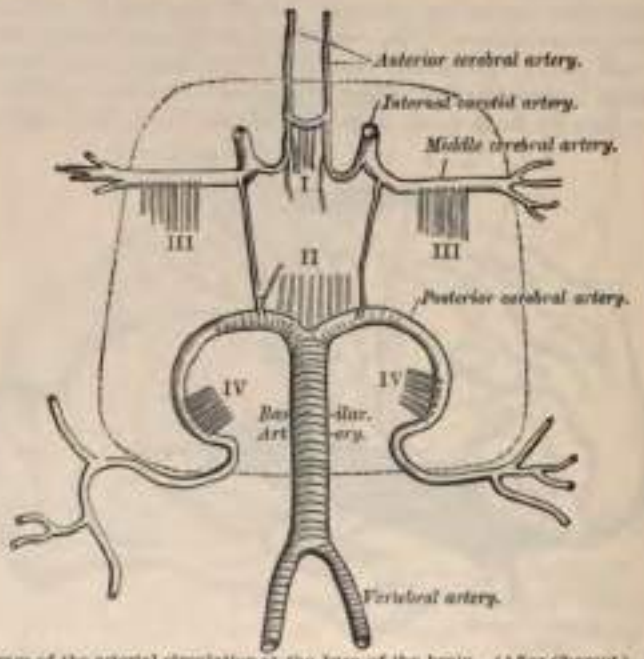


FIG. 298.—Diagram of the arterial circulation at the base of the brain. (After Charcot.) I. Antero-median group of ganglionic branches. II. Postero-median group. III. Right and left antero-lateral group. IV. Right and left postero-lateral group. The dotted line shows the limit of the ganglionic circle.

From the circle of Willis arise the three trunks which together supply each cerebral hemisphere. From its anterior part proceed the two anterior cerebrals, from its antero-lateral part the middle cerebrals, and from its posterior part the

posterior cerebrals. Each of these principal arteries gives origin to two very different systems of secondary vessels. One of these systems has been named the *central ganglionic system*, and the vessels belonging to it supply the central ganglia of the brain; the other has been named the *cortical arterial system*, and its vessels ramify in the pia mater and supply the cortex and subjacent medullary matter. These two systems, though they have a common origin, do not communicate at any point of their peripheral distribution, and are entirely independent of each other. Though some of the arteries of the cortical system approach, at their terminations, the regions supplied by the central ganglionic system, no communication between the two sets of vessels takes place, and there is between the parts supplied by the two systems a borderland of diminished nutritive activity, where, it is said, softening is especially liable to occur in the brains of old people.

The Central Ganglionic System.—All the vessels belonging to this system are given off from the circle of Willis or from the vessels immediately after their origin

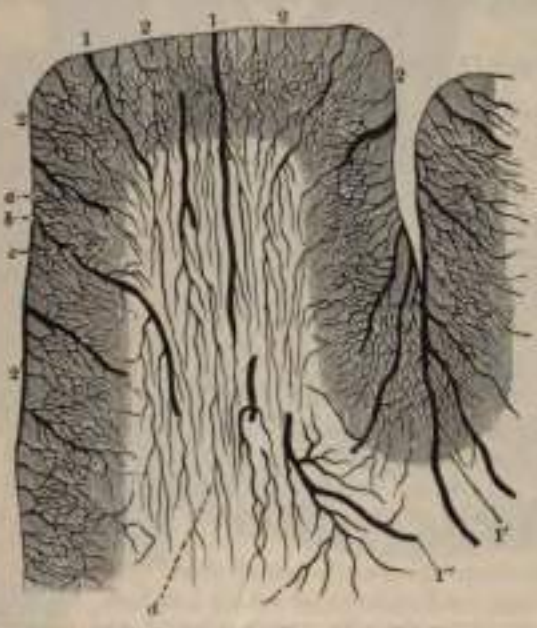


FIG. 297.—Distribution of the cortical arteries. (After Charcot.) 1. Medullary arteries. 1'. Group of medullary arteries in the sulcus between two adjacent convolutions. 1''. Arteries situated among the short association fibres. 2, 2. Cortical arteries. a. Capillary network with fairly wide meshes, situated beneath the pia mater. b. Network with more compact, polygonal meshes, situated in the cortex. c. Transitional network with wider meshes. d. Capillary network in the white matter.

from it, so that if a circle is drawn at a distance of about an inch from the circle of Willis, it will include the origin of all the arteries belonging to this system (Fig. 296). The vessels of this system form six principal groups: (I.) the *antero-median group*, derived from the anterior cerebrals and anterior communicating; (II.) the *postero-median group*, from the posterior cerebrals and posterior communicating; (III.) the right and left *antero-lateral group*, from the middle cerebrals: and (IV.) the right and left *postero-lateral group*, from the posterior cerebrals, after they have wound round the crura cerebri. The vessels belonging to this system are larger than those of the cortical system, and are what Cohnheim has termed "terminal" arteries; that is to say, vessels which from their origin to their termination neither supply nor receive any anastomotic branch, so that by one of the small vessels only a limited area of the central ganglia can be injected; and the injection cannot be driven beyond the area of the part supplied by the particular vessel which is the subject of the experiment.

The Cortical Arterial System.—The vessels forming this system are the terminal branches of the anterior, middle, and posterior cerebral arteries, described above.

These vessels divide and ramify in the substance of the pia mater, and give off nutrient arteries which penetrate the cortex perpendicularly. These nutrient vessels are divisible into two classes—the long and short. The *long*—or, as they are sometimes called, the *medullary—arteries* pass through the gray matter to penetrate the centrum ovale to the depth of about an inch and a half, without intercommunicating otherwise than by very fine capillaries, and thus constitute so many independent small systems. The *short vessels* are confined to the cortex, where they form with the long vessels a compact network in the middle zone of the gray matter, the outer and inner zones being sparingly supplied with blood (Fig. 297). The vessels of the cortical arterial system are not so strictly "terminal" as those of the central ganglionic system, but they approach this type very closely, so that injection of one area from the vessel of another area, though it may be possible, is frequently very difficult, and is only effected through vessels of small calibre. As a result of this, obstruction of one of the main branches or its divisions may have the effect of producing softening in a very limited area of the cortex.[1]

ARTERIES OF THE UPPER EXTREMITY.

The artery which supplies the upper extremity continues as a single trunk from its commencement down to the elbow, but different portions of it have received different names according to the region through which it passes. That part of the vessel which extends from its origin to the outer border of the first rib is termed the subclavian; beyond this point to the lower border of the axilla it is termed the axillary; and from the lower margin of the axillary space to the bend of the elbow it is termed brachial; here the single trunk terminates by dividing into two branches, the radial and ulnar—an arrangement precisely similar to what occurs in the lower limb.

THE SUBCLAVIAN ARTERIES (Fig. 298).

The **subclavian artery** on the right side arises from the innominate artery opposite the right sterno-clavicular articulation; on the left side it arises from the arch of the aorta. It follows, therefore, that these two vessels must, in the first part of their course, differ in their length, their direction, and their relation with neighboring parts.

In order to facilitate the description of these vessels, more especially from a surgical point of view, each subclavian artery has been divided into three parts. The first portion, on the right side, passes upward and outward from the origin of the vessel to the inner border of the Scalenus anticus. On the left side it ascends nearly vertically, to gain the inner border of that muscle. The second part passes outward, behind the Scalenus anticus; and the third part passes from the outer margin of that muscle, beneath the clavicle, to the outer border of the first rib, where it becomes the axillary artery. The first portion of these two vessels differs so much in its course and in its relation with neighboring parts that it will be described separately. The second and third parts are alike on the two sides.

First Part of the Right Subclavian Artery (Figs. 280, 283, 298).

The **right subclavian artery** arises from the arteria innominata, opposite the upper part of the right sterno-clavicular articulation, and passes upward and outward to the inner margin of the Scalenus anticus muscle. In this part of its course it ascends a little above the clavicle, the extent to which it does so varying in different cases. It is covered, *in front*, by the integument, superficial fascia, Platysma, deep fascia, the clavicular origin of the Sterno-mastoid, the Sterno-

[1] The student who desires further information on this subject is referred to Charcot's *Localisation of Cerebral and Spinal Diseases*, p. 42 *et seq.*, whence the facts above given have been principally derived.

hyoid, and Sterno-thyroid muscles, and another layer of the deep fascia. It is crossed by the internal jugular and vertebral veins, and by the pneumogastric and the cardiac branches of the sympathetic. A loop of the sympathetic nerve itself also crosses the artery, forming a ring around the vessels. The anterior jugular vein passes outward in front of the artery but is not in contact with it, being separated from it by the Sterno-hyoid and Sterno-thyroid muscles. Below and behind the artery is the pleura, which separates it from the apex of the lung; *behind* is the cord of the sympathetic nerve; the recurrent laryngeal nerve winds round the lower and back part of the vessel.

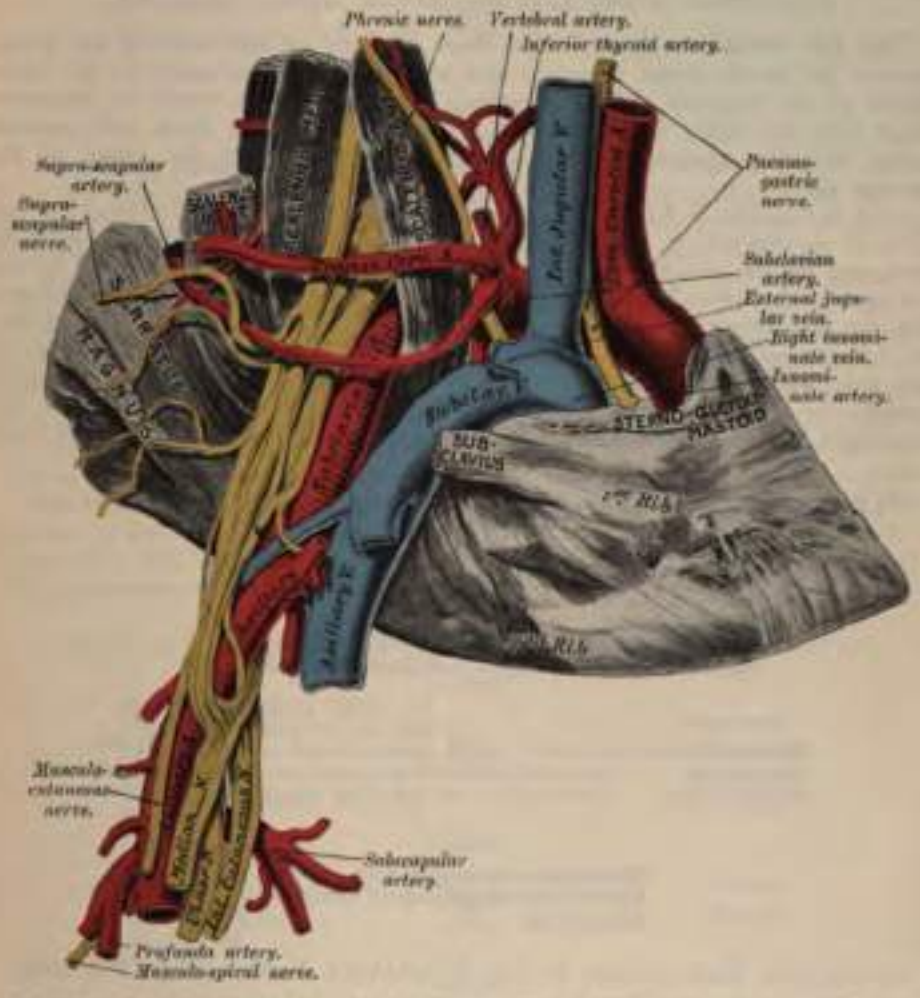


FIG. 206.—The subclavian artery, showing its relations. (From a preparation in the Museum of the Royal College of Surgeons of England.)

PLAN OF RELATIONS OF FIRST PORTION OF THE RIGHT SUBCLAVIAN ARTERY.

In front.

Skin, superficial fascia.
Platysma, deep fascia.
Clavicular origin of Sterno-mastoid.
Sterno-hyoid and Sterno-thyroid.
Anterior jugular, Internal jugular, and vertebral veins.
Pneumogastric and cardiac nerves.
Loop from the sympathetic.

Beneath.
Pleura.
Recurrent laryngeal nerve.

Behind.
Recurrent laryngeal nerve.
Sympathetic.
Pleura and apex of lung.

First Part of the Left Subclavian Artery (Fig. 280).

The **left subclavian artery** arises from the end of the arch of the aorta, opposite the fourth dorsal vertebra, and ascends nearly vertically to the inner margin of the Scalenus anticus muscle. This part of the vessel is, therefore, longer than the right, situated deeply in the cavity of the chest, and directed nearly vertically upward, instead of arching outward like the vessel of the opposite side.

It is in relation, *in front*, with the pneumogastric, cardiac, and phrenic nerves, which lie parallel with it, the left carotid artery, left internal jugular and vertebral veins, and the commencement of the left innominate vein, and is covered by the Sterno-thyroid, Sterno-hyoid, and Sterno-mastoid muscles; *behind*, it is in relation with the œsophagus, thoracic duct, inferior cervical ganglion of the sympathetic, and Longus colli; higher up, however, the œsophagus and thoracic duct lie to its right side; the latter ultimately arching over the vessel to join the angle of union between the subclavian and internal jugular veins. To its *inner side* are the œsophagus, trachea, and thoracic duct; to its *outer side*, the left pleura and lung.

Plan of Relations of First Portion of Left Subclavian Artery.

In front.
Pneumogastric, cardiac, and phrenic nerves.
Left carotid artery.
Thoracic duct.
Left internal jugular, vertebral, and innominate veins.
Sterno-thyroid, Sterno-hyoid, and Sterno-mastoid muscles.

Inner side.
Trachea.
Œsophagus.
Thoracic duct.

Outer side.
Pleura and left lung.

Behind.
Œsophagus and thoracic duct.
Inferior cervical ganglion of sympathetic.
Longus colli.

Second and Third Parts of the Subclavian Artery (Figs. 283, 298).

The **Second Portion of the Subclavian Artery** lies behind the Scalenus anticus muscle; it is very short, and forms the highest part of the arch described by that vessel.

Relations.—It is covered, *in front*, by the skin, superficial fascia, Platysma, deep cervical fascia, Sterno-mastoid, and the Scalenus anticus muscle. On the right side the phrenic nerve is separated from the second part of the artery by the Anterior scalene muscle, while on the left side the nerve crosses the first part of the artery immediately to the inner edge of the muscle. *Behind*, it is in relation with the pleura and the Middle scalene. *Above*, with the brachial plexus of nerves. *Below*, with the pleura. The subclavian vein lies below and in front of the artery, separated from it by the Scalenus anticus.

PLAN OF RELATIONS OF SECOND PORTION OF SUBCLAVIAN ARTERY.

In front.
Skin and superficial fascia.
Platysma and deep cervical fascia.
Sterno-mastoid.
Phrenic nerve.
Scalenus anticus.
Subclavian vein.

Above.
Brachial plexus.

Below.
Pleura.

Behind.
Pleura and Middle Scalenus.

The **Third Portion of the Subclavian Artery** passes downward and outward from the outer margin of the Scalenus anticus to the outer border of the first rib, where it becomes the axillary artery. This portion of the vessel is the most superficial, and is contained in a subclavian triangle (see page 502).

Relations.—It is covered, in *front*, by the skin, the superficial fascia, the Platysma, the descending clavicular branches of the cervical plexus, and the deep cervical fascia; by the clavicle, the Subclavius muscle, and the suprascapular artery and vein, and the transverse cervical vein; the nerve to the Subclavius muscle passes vertically downward in front of the artery. The external jugular vein crosses it at its inner side, and receives the suprascapular and transverse cervical veins, which frequently form a plexus in front of it. The subclavian vein is below and in front of the artery, lying close behind the clavicle. *Behind*, it lies on the Middle scalene muscle and the lowest cord of the brachial plexus, formed by the union of the last cervical and first dorsal nerves. *Above* it, and to its outer side, is the brachial plexus and Omo-hyoid muscle. *Below*, it rests on the upper surface of the first rib.

PLAN OF RELATIONS OF THIRD PORTION OF SUBCLAVIAN ARTERY.

In front.
Skin and superficial fascia.
Platysma and deep cervical fascia.
Descending branches of cervical plexus. Nerve to Subclavius muscle.
Subclavius muscle, suprascapular artery, and vein.
The external jugular and transverse cervical veins.
The clavicle.

Above.
Brachial plexus.
Omo-hyoid.

Below.
First rib.

Behind.
Scalenus medius.
Lower cord of brachial plexus.

Peculiarities.—The subclavian arteries vary in their origin, their course, and the height to which they rise in the neck.

The origin of the right subclavian from the innominate takes place, in some cases, above the sterno-clavicular articulation, and occasionally, but less frequently, in the cavity of the thorax, below that joint. Or the artery may arise as a separate trunk from the arch of the aorta. In such cases it may be either the first, second, third, or even the last branch derived from that vessel; in the majority of cases it is the first or last, rarely the second or third. When it is the first branch, it occupies the ordinary position of the innominate artery; when the second or third, it gains its usual position by passing behind the right carotid; and when the last branch, it arises from the left extremity of the arch, at its upper or back part, and passes obliquely toward the

right side, usually behind the trachea, œsophagus, and right carotid, sometimes between the œsophagus and trachea to the upper border of the first rib, whence it follows its ordinary course. In very rare instances this vessel arises from the thoracic aorta, as low down as the fourth dorsal vertebra. Occasionally it perforates the anterior Scalenus; more rarely it passes in front of that muscle. Sometimes the subclavian vein passes with the artery behind the Anterior Scalene. The artery may ascend as high as an inch and a half above the clavicle or any intermediate point between this and the upper border of the bone, the right subclavian usually ascending higher than the left.

The left subclavian is occasionally joined at its origin with the left carotid.

Surface Marking.—The course of the subclavian artery in the neck may be mapped out by describing a curve, with its convexity upward at the base of the posterior triangle. The inner end of this curve corresponds to the sterno-clavicular joint, the outer end to the centre of the lower border of the clavicle. The curve is to be drawn with such an amount of convexity that its mid-point reaches half an inch above the upper border of the clavicle. The left subclavian artery is more deeply placed than the right in the first part of its course, and, as a rule, does not reach quite as high a level in the neck. It should be borne in mind that the posterior border of the Sterno-mastoid muscle corresponds to the outer border of the Scalenus anticus, so that the third portion of the artery, that part most accessible for operation, lies immediately external to the posterior border of the Sterno-mastoid.

Surgical Anatomy.—The relations of the subclavian arteries of the two sides having been examined, the student should direct his attention to a consideration of the best position in which compression of the vessel may be effected, or in what situation a ligature may be best applied in cases of aneurism or wound.

Compression of the subclavian artery is required in cases of operations about the shoulder, in the axilla, or at the upper part of the arm; and the student will observe that there is only one situation in which it can be effectually applied—viz. where the artery passes across the upper surface of the first rib. In order to compress the vessel in this situation, the shoulder should be depressed, and the surgeon, grasping the side of the neck, should press with his thumb in the angle formed by the posterior border of the Sterno-mastoid with the upper border of the clavicle, downward, backward, and inward against the rib; if from any cause the shoulder cannot be sufficiently depressed, pressure may be made from before backward, so as to compress the artery against the middle Scalenus and transverse process of the seventh cervical vertebra. In appropriate cases, a preliminary incision may be made through the cervical fascia, and the finger may be pressed down directly upon the artery.

Ligature of the subclavian artery may be required in cases of wounds or of aneurism in the axilla, or in cases of aneurism on the cardiac side of the point of ligature; and the third part of the artery is that which is most favorable for an operation, on account of its being comparatively superficial and most remote from the origin of the large branches. In those cases where the clavicle is not displaced, this operation may be performed with comparative facility; but where the clavicle is pushed up by a large aneurismal tumor in the axilla the artery is placed at a great depth from the surface, which materially increases the difficulty of the operation. Under these circumstances it becomes a matter of importance to consider the height to which this vessel reaches above the bone. In ordinary cases its arch is about half an inch above the clavicle, occasionally as high as an inch and a half, and sometimes so low as to be on a level with its upper border. If the clavicle is displaced, these variations will necessarily make the operation more or less difficult according as the vessel is more or less accessible.

The chief points in the operation of tying the third portion of the subclavian artery are as follows: The patient being placed on a table in the supine position, with the head drawn over to the opposite side and the shoulder depressed as much as possible, the integument should be drawn downward over the clavicle, and an incision made through it, upon that bone, from the anterior border of the Trapezius to the posterior border of the Sterno-mastoid, to which may be added a short vertical incision meeting the inner end of the preceding. The object in drawing the skin downward is to avoid any risk of wounding the external jugular vein, for as it perforates the deep fascia above the clavicle, it cannot be drawn downward with the skin. The soft parts should now be allowed to glide up, and the cervical fascia should be divided upon a director, and if the interval between the Trapezius and Sterno-mastoid muscles be insufficient for the performance of the operation, a portion of one or both may be divided. The external jugular vein will now be seen toward the inner side of the wound: this and the suprascapular and transverse cervical veins, which terminate in it, should be held aside. If the external jugular vein is at all in the way and exposed to injury, it should be tied in two places and divided. The suprascapular artery should be avoided, and the Omo-hyoid muscle held aside if necessary. In the space beneath this muscle careful search must be made for the vessel: a deep layer of fascia and some connective tissue having been divided carefully, the outer margin of the Scalenus anticus muscle must be felt for, and, the finger being guided by it to the first rib, the pulsation of the subclavian artery will be felt as it passes over the rib. The sheath of the vessels having been opened, the aneurism needle may then be passed around the artery from above downward and inward, so as to avoid including any of the branches of the brachial plexus. If the clavicle is so raised by the tumor that the application of the ligature cannot be effected in this situation, the artery may be tied above the first rib, or even behind the Scalenus anticus muscle; the difficulties of the operation in such a case will be materially increased, on account of the greater depth of the artery and the alteration in position of the surrounding parts.

The second part of the subclavian artery, from being that portion which rises highest in the neck, has been considered favorable for the application of the ligature when it is difficult to tie the artery in the third part of its course. There are, however, many objections to the operation in this situation. It is necessary to divide the Scalenus anticus muscle, upon which lies the phrenic nerve, and at the inner side of which is situated the internal jugular vein; and a wound of either of these structures might lead to the most dangerous consequences. Again, the artery is in contact, below, with the pleura, which must also be avoided; and, lastly, the proximity of so many of its large branches arising internal to this point must be a still further objection to the operation. In cases, however, where the sac of an axillary aneurism encroaches on the neck, it may be necessary to divide the outer half or two-thirds of the Scalenus anticus muscle, so as to place the ligature on the vessel at a greater distance from the sac. The operation is performed exactly in the same way as ligature of the third portion, until the Scalenus anticus is exposed, when it is to be divided on a director (never to a greater extent than its outer two-thirds), and it immediately retracts. The operation is therefore merely an extension of ligature of the third portion of the vessel.

In those cases of aneurism of the axillary or subclavian artery which encroach upon the outer portion of the Scalenus muscle to such an extent that a ligature cannot be applied in that situation, it may be deemed advisable, as a last resource, to tie the first portion of the subclavian artery. On the left side this operation is almost impracticable; the great depth of the artery from the surface, its intimate relation with the pleura, and its close proximity to the thoracic duct and to so many important veins and nerves, present a series of difficulties which it is next to impossible to overcome.[1] On the right side the operation is practicable, and has been performed, though never with success. The main objection to the operation in this situation is the smallness of the interval which usually exists between the commencement of the vessel and the origin of the nearest branch. The operation may be performed in the following manner: The patient being placed on the table in the supine position with the neck extended, an incision should be made along the upper border of the inner part of the clavicle, and a second along the inner border of the Sterno-mastoid, meeting the former at an angle. The attachment of both heads of the Sterno-mastoid must be divided on a director and turned outward; a few small arteries and veins, and occasionally the anterior jugular, must be avoided, or, if necessary, ligatured in two places and divided, and the Sterno-hyoid and Sterno-thyroid muscles divided in the same manner as the preceding muscle. After tearing through the deep fascia with the finger-nail, the internal jugular vein will be seen crossing the subclavian artery; this should be pressed aside and the artery secured by passing the needle from below upward, by which the pleura is more effectually avoided. The exact position of the vagus nerve, the recurrent laryngeal, the phrenic and sympathetic nerves should be remembered, and the ligature should be applied near the origin of the vertebral, in order to afford as much room as possible for the formation of a coagulum between the ligature and the origin of the vessel. It should be remembered that the right subclavian artery is occasionally deeply placed in the first part of its course when it arises from the left side of the aortic arch, and passes in such cases behind the œsophagus or between it and the trachea.

Collateral Circulation.—After ligature of the third part of the subclavian artery the collateral circulation is mainly established by three sets of vessels, thus described in a dissection:

"1. A posterior set, consisting of the suprascapular and posterior scapular branches of the subclavian, anastomosing with the subscapular from the axillary.

"2. An internal set produced by the connection of the internal mammary on the one hand, with the superior and long thoracic arteries, and the branches from the subscapular on the other.

"3. A middle or axillary set, which consisted of a number of small vessels derived from branches of the subclavian, above, and, passing through the axilla, terminated either in the main trunk or some of the branches of the axillary below. This last set presented most conspicuously the peculiar character of newly-formed or, rather, dilated arteries, being excessively tortuous, and forming a complete plexus.

"The chief agent in the restoration of the axillary artery below the tumor was the subscapular artery, which communicated most freely with the internal mammary, suprascapular, and posterior scapular branches of the subclavian, from all of which it received so great an influx of blood as to dilate it to three times its natural size."[2]

When a ligature is applied to the first part of the subclavian artery, the collateral circulation is carried on by—1, the anastomosis between the superior and inferior thyroid; 2, the anastomosis of the two vertebrals; 3, the anastomosis of the internal mammary with the deep epigastric and the aortic intercostals; 4, the superior intercostal anastomosing with the aortic intercostals; 5, the profunda cervicis anastomosing with the princeps cervicis; 6, the scapular branches of the thyroid axis anastomosing with the branches of the axillary; and 7, the thoracic branches of the axillary anastomosing with the aortic intercostals.

[1] The operation was, however, performed in New York by Dr. J. K. Rodgers, and the case is related in *A System of Surgery*, edited by T. Holmes, 2d ed., vol. iii., pp. 623, etc.

[2] *Guy's Hospital Reports*, vol. i., 1836; case of axillary aneurism, in which Mr. Aston Key had tied the subclavian artery on the outer edge of the Scalenus muscle twelve years previously.

Branches.—The branches given off from the subclavian artery are:

Vertebral.	Thyroid axis.
Internal mammary.	Superior intercostal.

On the left side all four branches generally arise from the first portion of the vessel; but on the right side, the superior intercostal usually arises from the second portion of the vessel. On both sides of the body the first three branches arise close together at the inner margin of the Scalenus anticus; in the majority of cases, a free interval of from half an inch to an inch exists between the commencement of the artery and the origin of the nearest branch; in a smaller number of cases, an interval of more than an inch exists, but it never exceeds an inch and three-quarters. In a very few instances, the interval has been found to be less than half an inch. The vertebral artery arises from the upper and posterior part of the artery, the internal mammary from the lower part of the artery; the thyroid axis from in front, and the superior intercostal from behind.

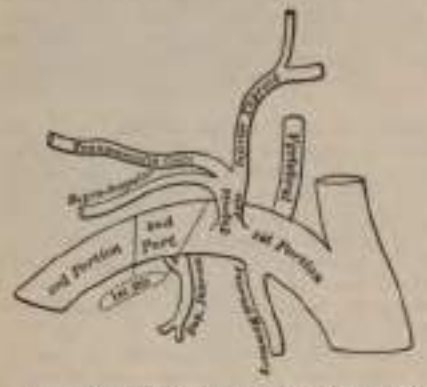


Fig. 288.—Plan of the branches of the right subclavian artery.

The **Vertebral Artery** (Fig. 289) is generally the first and largest branch of the subclavian; it arises from the upper and back part of the first portion of the vessel, and, passing upward, enters the foramen in the transverse process of the sixth cervical vertebra,[1] and ascends through the foramina in the transverse processes of all the vertebræ above this. Above the upper border of the axis it inclines outward and upward to the foramen in the transverse process of the atlas, through which it passes; it then winds backward behind its articular process, runs in a deep groove on the upper surface of the posterior arch of this bone, and, passing beneath the posterior occipito-atlantal ligament, pierces the dura mater and arachnoid, and enters the skull through the foramen magnum. It then passes forward and upward, inclining from the lateral aspect to the front of the medulla oblongata. It unites in the middle line with the vessel of the opposite side at the lower border of the pons Varolii to form the *basilar artery*.

Relations.—At its origin, it is situated behind the internal jugular and vertebral veins, and is crossed by the inferior thyroid artery: it lies between the Longus colli and Scalenus anticus muscles, having the thoracic duct in front of it on the left side. It rests on the transverse process of the seventh cervical vertebra and the sympathetic nerve. Within the foramina formed by the transverse processes of the vertebræ it is accompanied by a plexus of nerves from the inferior cervical ganglion of the sympathetic, and is surrounded by a dense plexus of veins which unite to form the vertebral vein at the lower part of the neck. It is situated in front of the cervical nerves, as they issue from the intervertebral foramina. While winding round the articular process of the atlas, it is contained in a triangular space (*suboccipital triangle*) formed by the Rectus capitis posticus major, the Superior and Inferior oblique muscles; and at this point is covered by the Complexus muscle. The suboccipital nerve here lies between the artery and the bone. Within the skull, as it winds round the medulla oblongata, it is placed between the hypoglossal nerve and the anterior root of the suboccipital nerve, beneath the first digitation of the ligamentum denticulatum, and finally ascends between the basilar process of the occipital bone and the anterior surface of the medulla oblongata.

[1] The vertebral artery sometimes enters the foramen in the transverse process of the fifth vertebra. Dr. Smyth, who tied this artery in the living subject, found it, in one of his dissections, passing into the foramen in the seventh vertebra.

Branches.—These may be divided into two sets—those given off in the neck and those within the cranium.

Cervical Branches.	*Cranial Branches.*
Lateral Spinal.	Posterior Meningeal.
Muscular.	Anterior Spinal.
	Posterior Spinal.
	Posterior Inferior Cerebellar.
	Bulbar.

The **lateral spinal branches** enter the spinal canal through the intervertebral foramina and divide into two branches. Of these, one passes along the roots of the nerves to supply the spinal cord and its membranes, anastomosing with the other arteries of the spinal cord; the other divides into an ascending and a descending branch, which unite with similar branches from the artery above and below, so that two lateral anastomotic chains are formed on the posterior surface of the bodies of the vertebræ near the attachment of the pedicles. From these anastomotic chains branches are given off to supply the periosteum and the bodies of the vertebræ, and to communicate with similar branches from the opposite side; from these latter small branches are given off which join similar branches above and below, so that a central anastomotic chain is formed on the posterior surface of the bodies of the vertebræ.

Muscular branches are given off to the deep muscles of the neck, where the vertebral artery curves round the articular process of the atlas. They anastomose with the occipital and with the ascending and deep cervical arteries.

The **posterior meningeal** are one or two small branches given off from the vertebral opposite the foramen magnum. They ramify between the bone and dura mater in the cerebellar fossæ, and supply the falx cerebelli.

The **anterior spinal** is a small branch which arises near the termination of the vertebral, and, descending in front of the medulla oblongata, unites with its fellow of the opposite side at about the level of the foramen magnum. One of these vessels is usually larger than the other, but occasionally they are about equal in size. The single trunk thus formed descends on the front of the spinal cord, and is reinforced by a succession of small branches which enter the spinal canal through the intervertebral foramina; these branches are derived from the vertebral and ascending cervical of the inferior thyroid in the neck; from the intercostal in the dorsal region; and from the lumbar, ilio-lumbar, and lateral sacral arteries in the lower part of the spine. They unite, by means of ascending and descending branches, to form a single anterior median artery, which extends as far as the lower part of the spinal cord. This vessel is placed in the pia mater along the anterior median fissure; it supplies that membrane and the substance of the cord, and sends off branches at its lower part to be distributed to the cauda equina, and ends on the central fibrous prolongation of the cord.

The **posterior spinal** arises from the vertebral at the side of the medulla oblongata: passing backward to the posterior aspect of the spinal cord, it descends on each side, lying behind the posterior roots of the spinal nerves, and is reinforced by a succession of small branches which enter the spinal canal through the intervertebral foramina, and by which it is continued to the lower part of the cord and to the cauda equina. Branches from these vessels form a free anastomosis round the posterior roots of the spinal nerves, and communicate, by means of very tortuous transverse branches, with the vessel of the opposite side. At its commencement it gives off an ascending branch, which terminates on the side of the fourth ventricle.

The **posterior inferior cerebellar artery** (Fig. 291), the largest branch of the vertebral, winds backward round the upper part of the medulla oblongata, passing between the origin of the pneumogastric and spinal accessory nerves, over the restiform body to the under surface of the cerebellum, where it divides into two

branches—an internal one, which is continued backward to the notch between the two hemispheres of the cerebellum; and an external one, which supplies the under surface of the cerebellum as far as its outer border, where it anastomoses with the anterior inferior cerebellar and the superior cerebellar branches of the basilar artery. Branches from this artery supply the choroid plexus of the fourth ventricle.

The **bulbar arteries** comprise several minute vessels which spring from the vertebral and its branches and are distributed to the medulla oblongata.

Surgical Anatomy.—The vertebral artery has been tied in several instances: 1, for wounds or traumatic aneurism; 2, after ligation of the innominate, either at the same time to prevent hemorrhage, or later on to arrest bleeding where it has occurred at the seat of ligature; and 3, in epilepsy. In these latter cases the treatment has been recommended by Dr. Alexander, of Liverpool, in the hope that by diminishing the supply of blood to the posterior part of the brain and the spinal cord a diminution or cessation of the epileptic fits would result. But, on account of the uncertainty as to what cases, if any, derived benefit from the operation, it has now been abandoned. The operation of ligation of the vertebral is performed by making an incision along the posterior border of the Sterno-mastoid muscle, just above the clavicle. The muscle is pulled to the inner side, and the anterior tubercle of the transverse process of the sixth cervical vertebra sought for. A deep layer of fascia being now divided, the interval between the Scalenus anticus and the Longus colli just below their attachment to the tubercle is defined, and the artery and vein found in the interspace. The vein is to be drawn to the outer side, and the aneurism needle passed from without inward. Drs. Ramskill and Bright have pointed out that severe pain at the back of the head may be symptomatic of disease of the vertebral artery just before it enters the skull. This is explained by the close connection of the artery with the suboccipital nerve in the groove on the posterior arch of the atlas. Disease of the same artery has been also said to affect speech, from pressure on the hypoglossal where it is in relation with the vessel, leading to paralysis of the muscles of the tongue.

The **Basilar Artery** (Fig. 291), so named from its position at the base of the skull, is a single trunk formed by the junction of the two vertebral arteries; it extends from the posterior to the anterior border of the pons Varolii, lying in its median groove, under cover of the arachnoid. It ends by dividing into the two *posterior cerebral arteries*. Its branches are, on each side, the following:

Transverse.	Superior Cerebellar.
Anterior Inferior Cerebellar.	Posterior Cerebral.

The **transverse branches** supply the pons Varolii and adjacent parts of the brain; one branch, the *internal auditory*, accompanies the auditory nerve into the internal auditory meatus.

The **anterior inferior cerebellar artery** passes backward across the crus cerebelli, to be distributed to the anterior border of the under surface of the cerebellum, anastomosing with the posterior inferior cerebellar branch of the vertebral.

The **superior cerebellar arteries** arise near the termination of the basilar. They pass outward, immediately behind the third nerves, which separate them from the posterior cerebral, wind round the crura cerebri, close to the fourth nerve, and, arriving at the upper surface of the cerebellum, divide into branches which ramify in the pia mater and, reaching the circumference of the cerebellum, anastomose with the branches of the inferior cerebellar arteries. Several branches are given to the pineal gland, the valve of Vieussens, and the velum interpositum.

The **posterior cerebral arteries**, the two terminal branches of the basilar, are larger than the preceding, from which they are separated near their origin by the third nerves. Passing outward, parallel to the superior cerebellar artery, and receiving the posterior communicating from the internal carotid, they wind round the crura cerebri, and pass to the under surface of the occipital lobes of the cerebrum, and break up into branches for the supply of the temporal and occipital lobes. The branches of the posterior cerebral artery are:

Postero-median ganglionic.		Anterior temporal.
Posterior choroid.	Three terminal.	Posterior temporal.
Postero-lateral ganglionic.		Occipital.

The *postero-median ganglionic branches* (Fig. 290) are a group of small arteries which arise at the commencement of the posterior cerebral artery; these, with similar branches from the posterior communicating, pierce the posterior perforated space, and supply the internal surfaces of the optic thalami and the walls of the third ventricle. The *posterior choroid* enters the interior of the brain beneath the splenium of the corpus callosum, and supplies the velum interpositum and the choroid plexus. The *postero-lateral ganglionic branches* are a group of small arteries which arise from the posterior cerebral artery, after it has turned round the crus cerebri; they supply a considerable portion of the optic thalamus. The *terminal branches* are distributed as follows: the first (*anterior temporal*) to the uncinate gyrus; the second (*posterior temporal*) to the external occipital and the third temporal convolutions; and the third (*occipital*) to the inner and outer surfaces of the occipital lobe.

Circle of Willis.—The remarkable anastomosis which exists between the branches of the internal carotid and vertebral arteries at the base of the brain constitutes the *circle of Willis*. It is formed, in front, by the anterior cerebral arteries, branches of the internal carotid, which are connected together by the anterior communicating; behind, by the two posterior cerebrals, branches of the basilar, which are connected on each side with the internal carotid by the posterior communicating arteries (Fig. 291). It is by this anastomosis that the cerebral circulation is equalized, and provision made for effectually carrying it on if one or more of the branches are obliterated. The parts of the brain included within this arterial circle are—the lamina cinerea, the commissure of the optic nerves, the infundibulum, the tuber cinereum, the corpora albicantia, and the posterior perforated space.

The **Thyroid Axis** (Fig. 283) is a short thick trunk which arises from the fore part of the first portion of the subclavian artery, close to the inner border of the Scalenus anticus muscle, and divides, almost immediately after its origin, into three branches—the *inferior thyroid*, *suprascapular*, and *transversalis colli*.

The **Inferior thyroid artery** passes upward, in front of the vertebral artery and Longus colli muscle; then turns inward behind the sheath of the common carotid artery and internal jugular vein, and also behind the sympathetic nerve, the middle cervical ganglion resting upon the vessel, and, reaching the lower border of the lateral lobe of the thyroid gland, it divides into two branches, which supply the posterior and under part of the organ, and anastomose in its substance with the superior thyroid and with the corresponding artery of the opposite side. The recurrent laryngeal nerve passes upward, generally behind but occasionally in front of the artery. Its branches are: the

Inferior Laryngeal.	Œsophageal.
Tracheal.	Ascending Cervical.
Muscular.	

The **inferior laryngeal branch** ascends upon the trachea to the back part of the larynx, in company with the recurrent laryngeal nerve, and supplies the muscles and mucous membrane of this part, anastomosing with the branch from the opposite side and with the laryngeal branch from the superior thyroid artery.

The **tracheal branches** are distributed upon the trachea, anastomosing below with the bronchial arteries.

The **œsophageal branches** are distributed to the œsophagus, and anastomose with the œsophageal branches of the aorta.

The **ascending cervical** is a small branch which arises from the inferior thyroid just where that vessel is passing behind the common carotid artery, and runs up on the anterior tubercles of the transverse processes of the cervical vertebræ in the interval between the Scalenus anticus and Rectus capitis anticus major. It gives branches to the muscles of the neck, which anastomose with branches of the vertebral, and sends one or two branches into the spinal canal through the intervertebral foramina to be distributed to the spinal cord and its membranes, and to

the bodies of the vertebræ in the same manner as the lateral spinal branches from the vertebral. It anastomoses with the ascending pharyngeal and occipital arteries.

The **muscular branches** supply the depressors of the hyoid bone, the Longus colli, the Scalenus anticus, and the Inferior constrictor of the pharynx.

Surgical Anatomy.—This artery has been tied, in conjunction with the superior thyroid, in cases of bronchocele. An incision is made along the anterior border of the Sterno-mastoid down to the clavicle. After the deep fascia has been divided, the Sterno-mastoid and carotid vessels are drawn outward and the carotid (Chassaignac's) tubercle sought for. The vessel will be found just below this tubercle, between the carotid sheath on the outer side of the trachea and œsophagus on the inner side. In passing the ligature great care must be exercised to avoid including the recurrent laryngeal nerve, which is occasionally found crossing in *front* of the vessel.

The **Suprascapular artery** (**transversalis humeri**), smaller than the transversalis colli, passes obliquely from within outward, across the root of the neck. It at first passes downward and outward across the Scalenus anticus and phrenic nerve, being covered by the Sterno-mastoid; it then crosses the subclavian artery and the cords of the brachial plexus, and runs outward, behind and parallel with the clavicle and Subclavius muscle, and beneath the posterior belly of the Omo-hyoid, to the superior border of the scapula, where it passes over the transverse ligament of the scapula, which separates it from the suprascapular nerve, to the supraspinous fossa. In this situation it lies close to the bone, and ramifies between it and the Supraspinatus muscle, to which it supplies branches. It then passes downward

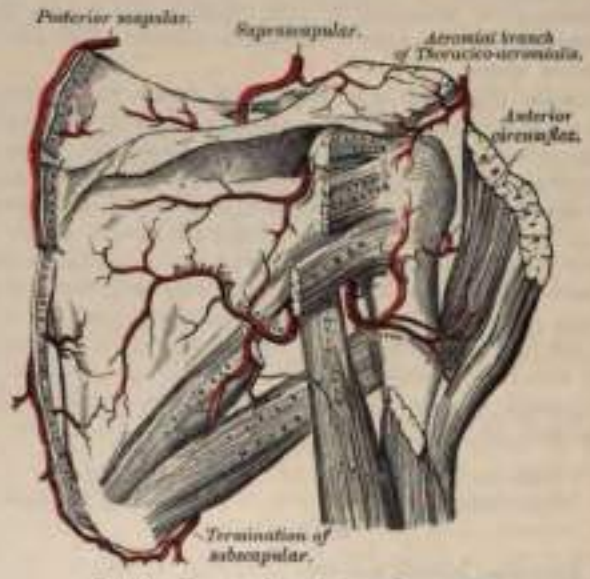


FIG. 300.—The scapular and circumflex arteries.

behind the neck of the scapula, to reach the infraspinous fossa, where it anastomoses with the dorsalis scapulæ and posterior scapular arteries. Besides distributing branches to the Sterno-mastoid, Subclavius, and neighboring muscles, it gives off a *supra-sternal branch*, which crosses over the sternal end of the clavicle to the skin of the upper part of the chest; and a *supra-acromial branch*, which, piercing the Trapezius muscle, supplies the skin over the acromion, anastomosing with the acromial thoracic artery. As the artery passes over the transverse ligament of the scapula, a branch descends into the subscapular fossa, ramifies beneath that muscle, and anastomoses with the posterior and subscapular arteries. It also sends branches to the acromio-clavicular and shoulder joints, and a nutrient artery to the clavicle.

The **Transversalis Colli** passes transversely outward, across the upper part of the subclavian triangle, to the anterior margin of the Trapezius muscle, beneath which it divides into two branches, the *superficial cervical* and the *posterior scap-*

ular. In its passage across the neck it crosses in front of the phrenic nerve, Scaleni muscles, and the brachial plexus, between the divisions of which it sometimes passes, and is covered by the Platysma, Sterno-mastoid, Omo-hyoid, and Trapezius muscles.

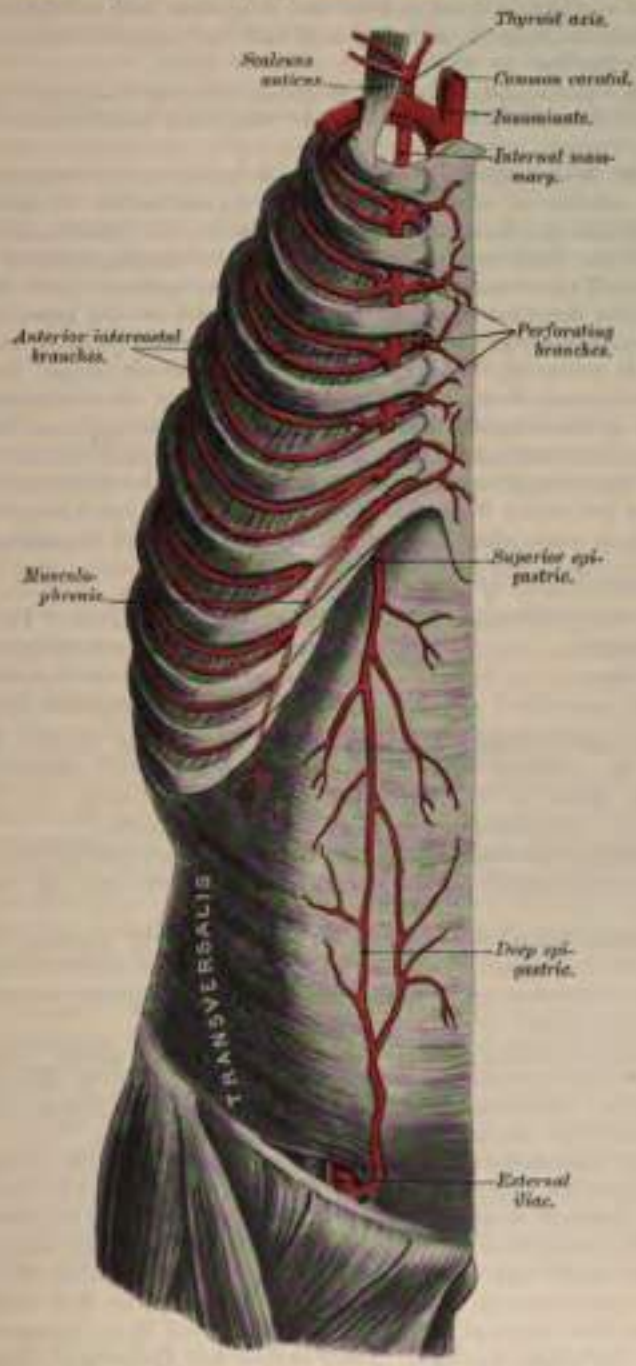


FIG. 301.—The internal mammary artery and its branches.

The **superficial cervical** ascends beneath the anterior margin of the Trapezius, distributing branches to it and to the neighboring muscles and glands in the neck, and anastomoses with the superficial branch of the arteria princeps cervicis.

The **posterior scapular** passes beneath the Levator anguli scapulæ to the superior angle of the scapula, and then descends along the posterior border of that bone as far as the inferior angle. In its course it is covered by the Rhomboid muscles, supplying them and the Latissimus dorsi and Trapezius, and anastomosing with the suprascapular and subscapular arteries, and with the posterior branches of some of the intercostal arteries.

Peculiarities.—The *superficial cervical* frequently arises as a separate branch from the thyroid axis; and the posterior scapular, from the third, more rarely from the second, part of the subclavian.

The **Internal mammary** (Fig. 301) arises from the under surface of the first portion of the subclavian artery, opposite the thyroid axis. It passes downward and inward behind the costal cartilage of the first rib to the inner surface of the anterior wall of the chest, resting against the costal cartilages about half an inch from the margin of the sternum; and, at the interval between the sixth and seventh cartilages, divides into two branches, the *musculo-phrenic* and *superior epigastric*.

Relations.—At its origin it is covered by the internal jugular and subclavian veins, and as it enters the thorax is crossed from without inward by the phrenic nerve, and then passes forward close to the outer side of the innominate vein. In the upper part of the thorax it lies behind the costal cartilages and Internal intercostal muscles, and is crossed by the terminations of the upper six intercostal nerves. At first it lies upon the pleura, but at the lower part of the thorax the Triangularis sterni separates the artery from this membrane. It has two venæ comites; these unite into a single vein, which joins the innominate vein of its own side.

The branches of the internal mammary are—

Comes Nervi Phrenici (Superior Phrenic).	Anterior Intercostal.
Mediastinal.	Perforating.
Pericardiac.	Musculo-phrenic.
Sternal.	Superior Epigastric.

The **comes nervi phrenici (superior phrenic)**, is a long slender branch which accompanies the phrenic nerve, between the pleura and pericardium, to the Diaphragm, to which it is distributed, anastomosing with the other phrenic arteries from the internal mammary and abdominal aorta.

The **mediastinal branches** are small vessels which are distributed to the areolar tissue and lymphatic glands in the anterior mediastinum and the remains of the thymus gland.

The **pericardiac branches** supply the upper part of the anterior surface of the pericardium, the lower part receiving branches from the musculo-phrenic artery.

The **sternal branches** are distributed to the Triangularis sterni and to the posterior surface of the sternum.

The mediastinal, pericardiac, and sternal branches, together with some twigs from the comes nervi phrenici, anastomose with branches from the intercostal and bronchial arteries, and form a minute plexus beneath the pleura, which has been named by Turner the *subpleural mediastinal plexus*.

The **anterior intercostal arteries** supply the five or six upper intercostal spaces. The branch corresponding to each space soon divides into two, or the two branches may come off separately from the parent trunk. The small vessels pass outward in the intercostal spaces, one lying near the lower margin of the rib above, and the other near the upper margin of the rib below, and anastomose with the intercostal arteries from the aorta. They are at first situated between the pleura and the Internal intercostal muscles, and then between the Internal and External intercostal muscles. They supply the Intercostal muscles, and, by branches which perforate the External intercostal muscle, the Pectoral muscles and the mammary gland.

The **perforating arteries** correspond to the five or six upper intercostal spaces. They arise from the internal mammary, pass forward through the intercostal spaces, and, curving outward, supply the Pectoralis major and the integument.

Those which correspond to the second, third, and fourth spaces are distributed to the mammary gland. In females, during lactation, these branches are of large size.

The **musculo-phrenic artery** is directed obliquely downward and outward, behind the cartilages of the false ribs, perforating the Diaphragm at the eighth or ninth rib, and terminating, considerably reduced in size, opposite the last intercostal space. It gives off anterior intercostal arteries to each of the intercostal spaces across which it passes; these diminish in size as the spaces decrease in length, and are distributed in a manner precisely similar to the anterior intercostals from the internal mammary. The musculo-phrenic also gives branches to the lower part of the pericardium, and others which run backward to the Diaphragm and downward to the abdominal muscles.

The **superior epigastric** continues in the original direction of the internal mammary; it descends through the cellular interval between the costal and sternal attachments of the Diaphragm, and enters the sheath of the Rectus abdominis muscle, at first lying behind the muscle, and then perforating it and supplying it, and anastomosing with the deep epigastric artery from the external iliac. Some vessels perforate the sheath of the Rectus, and supply the muscles of the abdomen and the integument, and a small branch, which passes inward upon the side of the ensiform appendix, anastomoses in front of that cartilage with the artery of the opposite side. It also gives some twigs to the Diaphragm, while from the artery of the right side small branches extend into the falciform ligament of the liver and anastomose with the hepatic artery.

Surgical Anatomy.—The course of the internal mammary artery may be defined by drawing a line across the six upper intercostal spaces half an inch from and parallel with the sternum. The position of the vessel must be remembered, as it is liable to be wounded in stabs of the chest-wall. It is most easily reached by a transverse incision in the second intercostal space.

The **Superior Intercostal** (Fig. 289) arises from the upper and back part of the subclavian artery, behind the Anterior scalenus muscle on the right side, and to the inner side of that muscle on the left side. Passing backward, it gives off the *deep cervical branch*, and then descends behind the pleura in front of the necks of the first two ribs, and inosculates with the first aortic intercostal. As it crosses the neck of the first rib it lies to the inner side of the anterior division of the first dorsal nerve and to the outer side of the first thoracic ganglion of the sympathetic. In the first intercostal space it gives off a branch which is distributed in a manner similar to the distribution of the aortic intercostals. The branch for the second intercostal space usually joins with one from the highest aortic intercostal. Each intercostal gives off a branch to the posterior spinal muscles, and a small one which passes through the corresponding intervertebral foramen to the spinal cord and its membranes.

The *deep cervical branch* (*profunda cervicis*) arises, in most cases, from the superior intercostal, and is analogous to the posterior branch of an aortic intercostal artery; occasionally it arises as a separate branch from the subclavian artery. Passing backward, above the eighth cervical nerve and between the transverse process of the seventh cervical vertebra and the first rib, it runs up the back part of the neck, between the Complexus and Semispinalis colli muscles, as high as the axis, supplying these and adjacent muscles, and anastomosing with the deep branch of the arteria princeps cervicis of the occipital, and with branches which pass outward from the vertebral. It gives off a special branch which enters the spinal canal through the intervertebral foramen between the seventh cervical and first dorsal vertebræ.

SURGICAL ANATOMY OF THE AXILLA.

The **Axilla** is a pyramidal space, situated between the upper and lateral part of the chest and the inner side of the arm.

Boundaries.—Its *apex*, which is directed upward toward the root of the neck, corresponds to the interval between the first rib, the upper edge of the scapula,

and the clavicle, through which the axillary vessels and nerves pass. The *base*, directed downward, is formed by the integument and a thick layer of fascia, the *axillary fascia*, extending between the lower border of the Pectoralis major in front and the lower border of the Latissimus dorsi behind; it is broad internally at the chest, but narrow and pointed externally at the arm. The *anterior boundary* is formed by the Pectoralis major and minor muscles, the former covering the whole of the anterior wall of the axilla, the latter covering only its central part. The space between the inner border of the Pectoralis minor and the clavicle is occupied by the costo-coracoid membrane. The *posterior boundary*, which extends somewhat lower than the anterior, is formed by the Subscapularis above, the Teres major and Latissimus dorsi below. On the *inner side* are the first four ribs with their corresponding Intercostal muscles, and part of the Serratus magnus. On the *outer side*, where the anterior and posterior boundaries converge, the space is narrow, and bounded by the humerus, the Coraco-brachialis and Biceps muscles.

Contents.—This space contains the axillary vessels and brachial plexus of nerves, with their branches, some branches of the intercostal nerves, and a large number of lymphatic glands, all connected together by a quantity of fat and loose areolar tissue.

Their Position.—The axillary artery and vein, with the brachial plexus of nerves, extend obliquely along the outer boundary of the axillary space, from its apex to its base, and are placed much nearer the anterior than the posterior wall, the vein lying to the inner or thoracic side of the artery and partially concealing it. At the fore part of the axillary space, in contact with the Pectoral muscles, are the thoracic branches of the axillary artery, and along the anterior margin

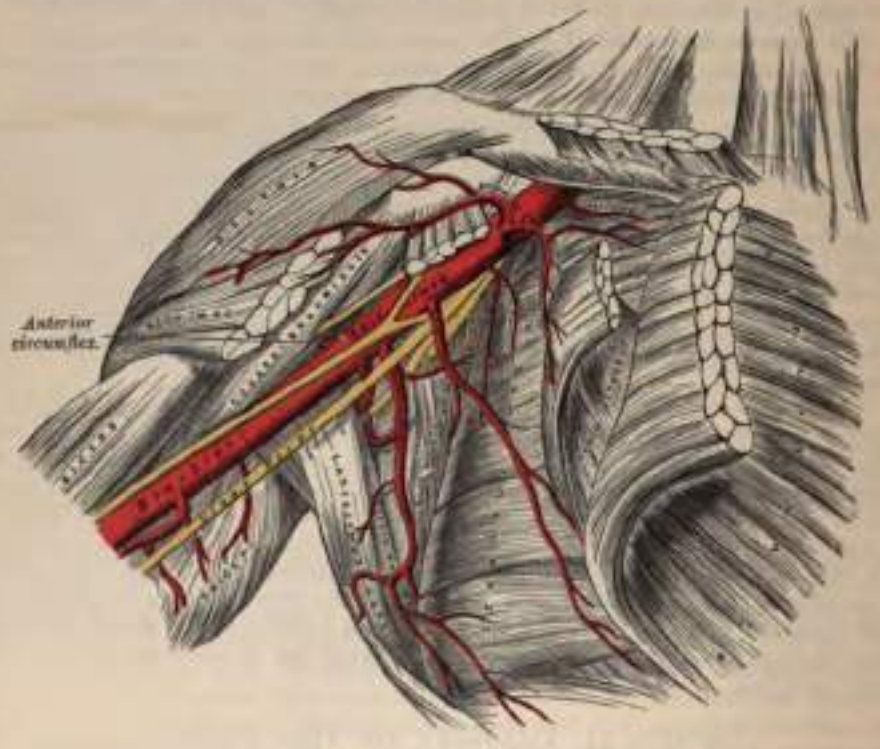


Fig. 382.—The axillary artery and its branches.

are the thoracic branches of the axillary artery, and along the lower margin of the Pectoralis minor the long thoracic artery extends to the side of the chest. At the back part, in contact with the lower margin of the Subscapularis muscle, are the subscapular vessels and nerves; winding around the outer border of this muscle is

the dorsalis scapulæ artery and veins; and, close to the neck of the humerus, the posterior circumflex vessels and the circumflex nerve are seen curving backward to the shoulder.

Along the inner or thoracic side no vessel of any importance exists, the upper part of the space being crossed merely by a few small branches from the superior thoracic artery. There are some important nerves, however, in this situation—viz. the posterior thoracic or external respiratory nerve, descending on the surface of the Serratus magnus, to which it is distributed; and perforating the upper and anterior part of this wall, the intercosto-humeral nerve or nerves, passing across the axilla to the inner side of the arm.

The cavity of the axilla is filled by a quantity of loose areolar tissue and a large number of small arteries and veins, all of which are, however, of inconsiderable size, and numerous lymphatic glands, the position and arrangement of which are described on a subsequent page.

Surgical Anatomy.—The axilla is a space of considerable surgical importance. It transmits the large vessels and nerves to the upper extremity, and these may be the seat of injury or disease: it contains numerous lymphatic glands which may require removal when diseased: in it is a quantity of loose connective and adipose tissue which may be readily infiltrated with blood or inflammatory exudation, and it may be the seat of rapidly-growing tumors. Moreover, it is covered at its base by thin skin, largely supplied with sebaceous and sweat glands, which is frequently the seat of small cutaneous abscesses and boils, and of eruptions due to irritation.

In suppuration in the axilla the arrangement of the fasciæ plays a very important part in the direction which the pus takes. As described on page 379, the costo-coracoid membrane, after covering in the space between the clavicle and the upper border of the Pectoralis minor, splits to enclose this muscle, and, reblending at its lower border, becomes incorporated with the axillary fascia at the anterior fold of the axilla. This is known as the clavi-pectoral fascia. Suppuration may take place either superficial to or beneath this layer of fascia; that is, either between the Pectorals or below the Pectoralis minor: in the former case, it would point either at the anterior border of the axillary fold or in the groove between the Deltoid and the Pectoralis major; in the latter, the pus would have a tendency to surround the vessels and nerves and ascend into the neck, that being the direction in which there is least resistance. Its progress toward the skin is prevented by the axillary fascia; its progress backward, by the Serratus magnus; forward, by the clavi-pectoral fascia; inward, by the wall of the thorax; and outward, by the upper limb. The pus in these cases, after extending into the neck, has been known to spread through the superior opening of the thorax into the mediastinum.

In opening an axillary abscess the knife should be entered in the floor of the axilla, midway between the anterior and posterior margins and near the thoracic side of the space. It is well to use a director and dressing forceps after an incision has been made through the skin and fascia in the manner directed by the late Mr. Hilton.

The student should attentively consider the relation of the vessels and nerves in the several parts of the axilla, for it is the almost universal plan, in the present day, to remove the glands from the axilla in operating for cancer of the breast. In performing such an operation it will be necessary to proceed with much caution in the direction of the outer wall and apex of the space, as here the axillary vessels will be in danger of being wounded. Toward the posterior wall it will be necessary to avoid the subscapular, dorsalis scapulæ, and posterior circumflex vessels. Along the anterior wall it will be necessary to avoid the thoracic branches. In clearing out the axilla the axillary vein should be first defined and cleared by the fingers and an elevator up to the apex of the axilla, the Pectoralis major being pulled up by an assistant with a retractor. When the apex of the space is reached, all fat and glands must be carefully removed and the whole axilla cleared by separating the tissues along the inner and posterior walls, so that when the proceeding is completed, the axilla is cleared of all its contents except the main vessels and nerves.

THE AXILLARY ARTERY.

The **Axillary Artery**, the continuation of the subclavian, commences at the outer border of the first rib, and terminates at the lower border of the tendon of the Teres major muscle, where it takes the name of brachial. Its direction varies with the position of the limb: when the arm lies by the side of the chest, the vessel forms a gentle curve, the convexity being upward and outward; when it is directed at right angles with the trunk, the vessel is nearly straight; and when it is elevated still higher, the artery describes a curve the concavity of which is directed upward. At its commencement the artery is very deeply situated, but near its termination is superficial, being covered only by the skin and fascia. The description of the relations of this vessel is facilitated by its division into three

portions, the first portion being that above the Pectoralis minor; the second portion, behind; and the third below, that muscle.

The **first portion of the axillary artery** is in relation, *in front*, with the clavicular portion of the Pectoralis major, the costo-coracoid membrane, the external anterior thoracic nerve, and the acromio-thoracic and cephalic veins; *behind*, with the first intercostal space, the corresponding Intercostal muscle, the second and a portion of the third digitations of the Serratus magnus, and the posterior thoracic and internal anterior thoracic nerves; on its *outer side*, with the brachial plexus, from which it is separated by a little cellular interval; on its *inner* or thoracic side, with the axillary vein, which overlaps the artery.

RELATIONS OF THE FIRST PORTION OF THE AXILLARY ARTERY.

In front.
Pectoralis major.
Costo-coracoid membrane.
External anterior thoracic nerve.
Acromio-thoracic and Cephalic veins.

Outer side.
Brachial plexus.

Inner side.
Axillary vein.

Behind.
First Intercostal space and Intercostal muscle.
Second and third digitations of Serratus magnus.
Posterior thoracic and Internal anterior thoracic nerves.

The **second portion of the axillary artery** lies behind the Pectoralis minor. It is covered, *in front*, by the Pectoralis major and minor muscles; *behind*, it is separated from the Subscapularis by a cellular interval; on the *inner side* is the axillary vein, separated from the artery by the inner cord of the plexus and the internal anterior thoracic nerve. The brachial plexus of nerves surrounds the artery on three sides, and separates it from direct contact with the vein and adjacent muscles.

RELATIONS OF THE SECOND PORTION OF THE AXILLARY ARTERY.

In front.
Pectoralis major and minor.

Outer side.
Outer cord of plexus.

Inner side.
Axillary vein.
Inner cord of plexus.
Internal anterior thoracic nerve.

Behind.
Subscapularis.
Posterior cord of plexus.

The **third portion of the axillary artery** lies below the Pectoralis minor. It is in relation, *in front*, with the lower part of the Pectoralis major above, being covered only by the integument and fascia below, where it is crossed by the inner head of the median nerve; *behind*, with the lower part of the Subscapularis and the tendons of the Latissimus dorsi and Teres major; on its *outer side*, with the Coraco-brachialis; on its *inner* or thoracic side, with the axillary vein. The nerves of the brachial plexus bear the following relation to the artery in this part of its course: on the *outer side* is the median nerve, and the musculo-cutaneous for a short distance; on the *inner side*, the ulnar (between the vein and artery) and lesser internal cutaneous nerves (to the inner side of the vein); in *front*, is the

internal cutaneous nerve, and *behind*, the musculo-spiral and circumflex, the latter extending only to the lower border of the Subscapularis muscle.

RELATIONS OF THE THIRD PORTION OF THE AXILLARY ARTERY.

In front.
Integument and fascia.
Pectoralis major.
Inner head of median nerve.
Internal cutaneous nerve.

Outer side.
Coraco-brachialis.
Median nerve.
Musculo-cutaneous nerve.

Inner side.
Ulnar nerve.
Axillary vein.
Lesser internal cutaneous nerve.

Behind.
Subscapularis.
Tendons of Latissimus dorsi and Teres major.
Musculo-spiral and circumflex nerves.

Peculiarities.—The axillary artery, in about one case out of every ten, gives off a large branch, which forms either one of the arteries of the forearm or a large muscular trunk. In the first set of cases this artery is most frequently the radial (1 in 33), sometimes the ulnar (1 in 72), and, very rarely, the interosseous (1 in 506). In the second set of cases the trunk has been found to give origin to the subscapular, circumflex, and profunda arteries of the arm. Sometimes only one of the circumflex, or one of the profunda arteries, arose from the trunk. In these cases the brachial plexus surrounded the trunk of the branches and not the main vessel.

Surface Marking.—The course of the axillary artery may be marked out by raising the arm to a right angle and drawing a line from the middle of the clavicle to the point where the tendon of the Pectoralis major crosses the prominence caused by the Coraco-brachialis as it emerges from under cover of the anterior fold of the axilla. The third portion of the artery can be felt pulsating beneath the skin and fascia, at the junction of the anterior with the middle third of the space between the anterior and posterior folds of the axilla, close to the inner border of the Coraco-brachialis.

Surgical Anatomy.—The student, having carefully examined the relations of the axillary artery in its various parts, should now consider in what situation compression of this vessel may be most easily effected, and the best position for the application of a ligature to it when necessary.

Compression of the vessel may be required in the removal of tumors or in amputation of the upper part of the arm; and the only situation in which this can be effectually made is in the lower part of its course; by pressing on it in this situation from within outward against the humerus the circulation may be effectually arrested.

The axillary artery is perhaps more frequently lacerated than any other artery in the body, with the exception of the popliteal, by violent movements of the upper extremity, especially in those cases where its coats are diseased. It has occasionally been ruptured in attempts to reduce old dislocations of the shoulder-joint. This lesion is most likely to occur during the preliminary breaking down of adhesions, in consequence of the artery having become fixed to the capsule of the joint. Aneurism of the axillary artery is of frequent occurrence, a large percentage of the cases being traumatic in their origin, due to the violence to which it is exposed in the varied, extensive, and often violent movement of the limb.

The **application of a ligature to the axillary artery** may be required in cases of aneurism of the upper part of the brachial or as a distal operation for aneurism of the subclavian; and there are only two situations in which it can be secured—viz. in the first and in the third parts of its course; for the axillary artery at its central part is so deeply seated, and, at the same time, so closely surrounded with large nervous trunks, that the application of a ligature to it in that situation would be almost impracticable.

In the **third part** of its course the operation is most simple, and may be performed in the following manner: The patient being placed on a bed and the arm separated from the side, with the hand supinated, an incision is made through the integument forming the floor of the axilla about two inches in length, a little nearer to the anterior than the posterior fold of the axilla. After carefully dissecting through the areolar tissue and fascia, the median nerve and axillary vein are exposed; the former having been displaced to the outer and the latter to the inner side of the arm, the elbow being at the same time bent, so as to relax the structures and facilitate their separation, the ligature may be passed round the artery from the ulnar to the radial side.

This portion of the artery is occasionally crossed by a muscular slip, the *axillary arch*, derived from the Latissimus dorsi, which may mislead the surgeon during an operation. The occasional existence of this muscular fasciculus was spoken of in the description of the muscles. It may easily be recognized by the transverse direction of its fibres.

The **first portion** of the axillary artery may be tied in cases of aneurism encroaching so far upward that a ligature cannot be applied in the lower part of its course. Notwithstanding that this operation has been performed in some few cases, and with success, its performance is attended with much difficulty and danger. The student will remark that in this situation it would be necessary to divide a thick muscle, and, after incising the costo-coracoid membrane, the artery would be exposed at the bottom of a more or less deep space, with the cephalic and axillary veins in such relation with it as must render the application of a ligature to this part of the vessel particularly hazardous. Under such circumstances it is an easier, and at the same time more advisable, operation to tie the subclavian artery in the third part of its course.

The vessel can be best secured by a curved incision with the convexity downward from a point half an inch external to the Sterno-clavicular joint to a point half an inch internal to the coracoid process. The limb is to be well abducted and the head inclined to the opposite side, and this incision carried through the superficial structures, care being taken of the cephalic vein at the outer angle of the incision. The clavicular origin of the Pectoralis major is then divided in the whole extent of the wound. The arm is now to be brought to the side, and the upper edge of the Pectoralis minor defined and drawn downward. The costo-coracoid membrane is to be carefully divided on a director close to the coracoid process, and the axillary sheath exposed; this is to be opened with especial care on account of the vein overlapping the artery. The needle should be passed from below, so as to avoid wounding the vein.

In a case of wound of the vessel the general practice of cutting down upon, and tying it above and below the wounded point should be adopted in all cases.

Collateral Circulation after Ligature of the Axillary Artery.—If the artery be tied above the origin of the acromial thoracic, the collateral circulation will be carried on by the same branches as after the ligature of the subclavian; if at a lower point, between the acromial thoracic and subscapular arteries, the latter vessel, by its free anastomoses with the other scapular arteries, branches of the subclavian, will become the chief agent in carrying on the circulation, to which the long thoracic, if it be below the ligature, will materially contribute by its anastomoses with the intercostal and internal mammary arteries. If the point included in the ligature be below the origin of the subscapular artery, it will most probably also be below the origins of the two circumflex arteries. The chief agents in restoring the circulation will then be the subscapular and the two circumflex arteries anastomosing with the superior profunda from the brachial, which will be afterward referred to as performing the same office after ligation of the brachial. The cases in which the operation has been performed are few in number, and no published account of dissections of the collateral circulation appears to exist.

Branches of the Axillary Artery.

The branches of the axillary artery are—

From first part { Superior Thoracic. / Acromial Thoracic. } *From second part* { Long Thoracic. / Alar Thoracic. }

From third part { Subscapular. / Posterior Circumflex. / Anterior Circumflex. }

The **superior thoracic** is a small artery which arises from the axillary separately or by a common trunk with the acromial thoracic. Running forward and inward along the upper border of the Pectoralis minor, it passes between it and the Pectoralis major to the side of the chest. It supplies these muscles and the parietes of the thorax, anastomosing with the internal mammary and intercostal arteries.

The **acromial thoracic** is a short trunk which arises from the fore part of the axillary artery, its origin being generally overlapped by the upper edge of the Pectoralis minor. Projecting forward to the upper border of the Pectoralis minor, it divides into three sets of branches—*thoracic*, *acromial*, and *descending*. The *thoracic branches*, two or three in number, are distributed to the Serratus magnus and Pectoral muscles, anastomosing with the intercostal branches of the internal mammary. The *acromial branches* are directed outward toward the acromion, supplying the Deltoid muscle, and anastomosing, on the surface of the acromion, with the suprascapular and posterior circumflex arteries. The *descending* or *humeral branch* passes in the space between the Pectoralis major and Deltoid in the same groove as the cephalic vein, and supplies both muscles. The artery also gives off a very small branch, the *clavicular*, which passes upward to the Subclavius muscle.

The **long thoracic** passes downward and inward along the lower border of the Pectoralis minor to the side of the chest, supplying the Serratus magnus, the

Pectoral muscles, and mammary gland, and sending branches across the axilla to the axillary glands and Subscapularis; it anastomoses with the internal mammary and intercostal arteries.

The **alar thoracic** is a small branch which supplies the glands and areolar tissue of the axilla. Its place is frequently supplied by branches from some of the other thoracic arteries.

The **subscapular**, the largest branch of the axillary artery, arises opposite the lower border of the Subscapularis muscle, and passes downward and backward along its lower margin to the inferior angle of the scapula, where it anastomoses with the long thoracic and intercostal arteries and with the posterior scapular, a branch of the transversalis colli, from the thyroid axis of the subclavian. About an inch and a half from its origin it gives off a large branch, the *dorsalis scapulæ*, and terminates by supplying branches to the muscles in the neighborhood.

The **dorsalis scapulæ** is given off from the subscapular about an inch and a half from its origin, and is generally larger than the continuation of the vessel. It curves round the axillary border of the scapula, leaving the axilla through the space between the Teres minor above, the Teres major below, and the long head of the Triceps externally (Fig. 300), and enters the infraspinous fossa by passing under cover of the Teres minor, where it anastomoses with the posterior scapular and suprascapular arteries. In its course it gives off two sets of branches: one enters the subscapular fossa beneath the Subscapularis, which it supplies, anastomosing with the posterior scapular and suprascapular arteries; the other is continued along the axillary border of the scapula, between the Teres major and minor, and, at the dorsal surface of the inferior angle of the bone, anastomoses with the posterior scapular. In addition to these, small branches are distributed to the back part of the Deltoid muscle and the long head of the Triceps, anastomosing with an ascending branch of the superior profunda of the brachial.

The **circumflex arteries** wind round the neck of the humerus. The *posterior circumflex* (Fig. 300), the larger of the two, arises from the back part of the axillary opposite the lower border of the Subscapularis muscle, and, passing backward with the circumflex veins and nerve through the quadrangular space bounded by the Teres major and minor, the scapular head of the Triceps and the humerus, winds round the neck of that bone and is distributed to the Deltoid muscle and shoulder-joint, anastomosing with the anterior circumflex and acromial thoracic arteries, and with the superior profunda branch of the brachial artery. The *anterior circumflex* Figs. 300, 302), considerably smaller than the preceding, arises nearly opposite that vessel from the outer side of the axillary artery. It passes horizontally outward beneath the Coraco-brachialis and short head of the Biceps, lying upon the fore part of the neck of the humerus, and, on reaching the bicipital groove, gives off an ascending branch which passes upward along the groove to supply the head of the bone and the shoulder-joint. The trunk of the vessel is then continued outward beneath the Deltoid, which it supplies, and anastomoses with the posterior circumflex artery.

THE BRACHIAL ARTERY (Fig. 303).

The **Brachial Artery** commences at the lower margin of the tendon of the Teres major, and, passing down the inner and anterior aspect of the arm, terminates about half an inch below the bend of the elbow, where it divides into the *radial* and *ulnar arteries*. At first the brachial artery lies internal to the humerus; but as it passes down the arm it gradually gets in front of the bone, and at the bend of the elbow it lies midway between the two condyles.

Relations.—This artery is superficial throughout its entire extent, being covered, *in front*, by the integument, the superficial and deep fasciæ; the bicipital fascia separates it opposite the elbow from the median basilic vein; the median nerve crosses it at its middle; *behind*, it is separated from the long head of the Triceps by the musculo-spiral nerve and superior profunda artery. It then lies upon the

inner head of the Triceps, next upon the insertion of the Coraco-brachialis, and lastly on the Brachialis anticus; by its *outer side*, it is in relation with the commencement of the median nerve and the Coraco-brachialis and Biceps muscles, which overlap the artery to a considerable extent; by its *inner side*, its upper half is in relation with the internal cutaneous and ulnar nerves, its lower half with the median nerve. The basilic vein lies on the inner side of the artery, but is separated from it in the lower part of the arm by the deep fascia. It is accompanied by two venæ comites, which lie in close contact with the artery, being connected together at intervals by short transverse communicating branches.

PLAN OF THE RELATIONS OF THE BRACHIAL ARTERY.

In front.
Integument and fasciæ.
Bicipital fascia, median basilic vein.
Median nerve.
Overlapped by Coraco-brachialis and Biceps.

Outer side.
Median nerve (above).
Coraco-brachialis.
Biceps.

Brachial Artery.

Inner side.
Internal cutaneous and Ulnar nerves.
Median nerve (below).
Basilic vein.

Behind.
Triceps (long and inner heads).
Musculo-spiral nerve.
Superior profunda artery.
Coraco-brachialis.
Brachialis anticus.

SURGICAL ANATOMY OF THE BEND OF THE ELBOW.

At the bend of the elbow the brachial artery sinks deeply into a triangular interval, the base of which is directed upward, and may be represented by a line connecting the two condyles of the humerus; the sides are bounded, externally, by the inner edge of the Supinator longus: internally, by the outer margin of the Pronator radii teres; its floor is formed by the Brachialis anticus and Supinator brevis. This space contains the brachial artery with its accompanying veins, the radial and ulnar arteries, the median and musculo-spiral nerves, and the tendon of the Biceps. The brachial artery occupies the middle line of this space, and divides opposite the neck of the radius into the radial and ulnar arteries; it is covered, *in front*, by the integument, the superficial fascia, and the median basilic vein, the vein being separated from direct contact with the artery by the bicipital fascia. *Behind*, it lies on the Brachialis anticus, which separates it from the elbow-joint. The median nerve lies on the inner side of the artery, close to it above, but separated from it below by the coronoid origin of the Pronator radii teres. The tendon of the Biceps lies to the outer side of the space, and the musculo-spiral nerve still more externally, situated upon the Supinator brevis and partly concealed by the Supinator longus.

Peculiarities of the Brachial Artery as regards its Course.—The brachial artery, accompanied by the median nerve, may leave the inner border of the Biceps and descend toward the inner condyle of the humerus, where it usually curves round a prominence of bone, the *supra-condylar process*, from which a fibrous arch is usually thrown over the artery; it then inclines outward, beneath or through the substance of the Pronator radii teres muscle, to the bend of the elbow. The variation bears considerable analogy to the normal condition of the artery in some of the carnivora: it has been referred to in the description of the humerus (page 146).

As regards its Division.—Occasionally, the artery is divided for a short distance at its upper part into two trunks, which are united above and below. A similar peculiarity occurs in the main vessel of the lower limb.

The point of bifurcation may be above or below the usual point, the former condition being by far the more frequent. Out of 481 examinations recorded by Mr. Quain, some made on the right and some on the left side of the body, in 386 the artery bifurcated in its normal position. In one case only was the place of division lower than usual, being two or three inches below the elbow-joint. "In 94 cases out of 481, or about 1 in 5¼, there were two arteries instead of one in some part or in the whole of the arm."

There appears, however, to be no correspondence between the arteries of the two arms with respect to their irregular division; for in 61 bodies it occurred on one side only in 43; on both sides, in different positions, in 13; on both sides, in the same position, in 5.

The point of bifurcation takes place at different parts of the arm, being most frequent in the upper part, less so in the lower part, and least so in the middle, the most usual point for the application of a ligature; under any of these circumstances two large arteries would be found in the arm instead of one. The most frequent (in three out of four) of these peculiarities is the high division of the radial. That artery often arises from the inner side of the brachial, and runs parallel with the main trunk to the elbow, where it crosses it, lying beneath the fascia; or it may perforate the fascia and pass over the artery immediately beneath the integument.

The ulnar sometimes arises from the brachial high up, and accompanies that vessel to the lower part of the arm, and descends toward the inner condyle. In the forearm it generally lies beneath the deep fascia, superficial to the flexor muscles; occasionally between the integument and deep fascia, and very rarely beneath the flexor muscles.

The interosseous artery sometimes arises from the upper part of the brachial or axillary; as it passes down the arm it lies behind the main trunk, and at the bend of the elbow regains its usual position.

In some cases of high division of the radial the remaining trunk (ulnar interosseous) occasionally passes, together with the median nerve, along the inner margin of the arm to the inner condyle, and then passing from within outward, beneath or through the Pronator radii teres, regains its usual position at the bend of the elbow.

Occasionally the two arteries representing the brachial are connected at the bend of the elbow by a short transverse branch, and are even sometimes reunited.

FIG. 393.—The brachial artery.

Sometimes, long slender vessels, vasa *aberrantia*, connect the brachial or axillary arteries with one of the arteries of the forearm or a branch from them. These vessels usually join the radial.

Varieties in Muscular Relations.[1]—The brachial artery is occasionally concealed in some part of its course by muscular or tendinous slips derived from the Coraco-brachialis, Biceps, Brachialis anticus, and Pronator radii teres muscles.

Surface Marking.—The direction of the brachial artery is marked by a line drawn along the inner edge of the Biceps from the insertion of the Teres major muscle to the point midway between the condyles of the humerus.

Surgical Anatomy.—Compression of the brachial artery is required in cases of amputation and some other operations in the arm and forearm; and it will be observed that it may be effected in almost any part of the course of the artery. If pressure is made in the upper part of the limb, it should be directed from within outward; and if in the lower part, from before backward, as the artery lies on the inner side of the humerus above and in front below. The most favorable situation is about the middle of the arm, where it lies on the tendon of the Coraco-brachialis on the inner flat side of the humerus.

[1] See Struther's *Anatomical and Physiological Observations.*

The application of a ligature to the brachial artery may be required in case of wound of the vessel and in some cases of wound of the palmar arch. It is also sometimes necessary in cases of aneurism of the brachial, the radial, ulnar, or interosseous arteries. The artery may be secured in any part of its course. The chief guides in determining its position are the surface markings produced by the inner margin of the Coraco-brachialis and Biceps, the known course of the vessel, and its pulsation, which should be carefully felt for before any operation is performed, as the vessel occasionally deviates from its usual position in the arm. In whatever situation the operation is performed, great care is necessary, on account of the extreme thinness of the parts covering the artery and the intimate connection which the vessel has throughout its whole course with important nerves and veins. Sometimes a thin layer of muscular fibre is met with concealing the artery; if such is the case, it must be cut across in order to expose the vessel.

In the upper third of the arm the artery may be exposed in the following manner: The patient being placed supine upon a table, the affected limb should be raised from the side and the hand supinated. An incision about two inches in length should be made on the inner side of the Coraco-brachialis muscle, and the subjacent fascia cautiously divided, so as to avoid wounding the internal cutaneous nerve or basilic vein, which sometimes runs on the surface of the artery as high as the axilla. The fascia having been divided, it should be remembered that the ulnar and internal cutaneous nerves lie on the inner side of the artery, the median on the outer side, the latter nerve being occasionally superficial to the artery in this situation, and that the venæ comites are also in relation with the vessel, one on either side. These being carefully separated, the aneurism needle should be passed round the artery from the inner to the outer side.

If two arteries are present in the arm in consequence of a high division, they are usually placed side by side: and if they are exposed in an operation, the surgeon should endeavor to ascertain, by alternately pressing on each vessel, which of the two communicates with the wound or aneurism, when a ligature may be applied accordingly; or if pulsation or hæmorrhage ceases only when both vessels are compressed, both vessels may be tied, as it may be concluded that the two communicate above the seat of disease or are reunited.

It should also be remembered that two arteries may be present in the arm in a case of high division, and that one of these may be found along the inner intermuscular septum, in a line toward the inner condyle of the humerus, or in the usual position of the brachial, but deeply placed beneath the common trunk: a knowledge of these facts will suggest the precautions necessary in every case, and indicate the measures to be adopted when anomalies are met with.

In the middle of the arm the brachial artery may be exposed by making an incision along the inner margin of the Biceps muscle. The forearm being bent so as to relax the muscle, it should be drawn slightly aside, and, the fascia being carefully divided, the median nerve will be exposed lying upon the artery (sometimes beneath); this being drawn inward and the muscle outward, the artery should be separated from its accompanying veins and secured. In this situation the inferior profunda may be mistaken for the main trunk, especially if enlarged, from the collateral circulation having become established; this may be avoided by directing the incision externally toward the Biceps, rather than inward or backward toward the Triceps.

The lower part of the brachial artery is of interest in a surgical point of view, on account of the relation which it bears to the veins most commonly opened in venesection. Of these vessels, the median basilic is the largest and most prominent, and, consequently, the one usually selected for the operation. It should be remembered that this vein runs parallel with the brachial artery, from which it is separated by the bicipital fascia, and that care should be taken in opening the vein not to carry the incision too deeply, so as to endanger the artery.

Collateral Circulation.—After the application of a ligature to the brachial artery in the upper third of the arm, the circulation is carried on by branches from the circumflex and subscapular arteries, anastomosing with ascending branches from the superior profunda. If the brachial is tied *below* the origin of the profunda arteries, the circulation is maintained by the branches of the profundæ, anastomosing with the recurrent radial, ulnar, and interosseous arteries. In two cases described by Mr. South,[1] in which the brachial artery had been tied some time previously, in one "a long portion of the artery had been obliterated, and sets of vessels are descending on either side from above the obliteration, to be received into others which ascend in a similar manner from below it. In the other the obliteration is less extensive, and a single curved artery about as big as a crow-quill passes from the upper to the lower open part of the artery."

The branches of the brachial artery are—the

Superior Profunda.	Inferior Profunda.
Nutrient.	Anastomotica Magna.

Muscular.

[1] Chelius's *Surgery*, vol. ii. p. 254. See also White's engraving, referred to by Mr. South, of the anastomosing branches after ligature of the brachial, in White's *Cases in Surgery*. Porta also gives a case (with drawings) of the circulation after ligature of both brachial and radial (*Alterazioni Patologiche delle Arterie*).

The **superior profunda** arises from the inner and back part of the brachial, just below the lower border of the Teres major, and passes backward to the interval between the outer and inner heads of the Triceps muscle, accompanied by the musculo-spiral nerve; it winds around the back part of the shaft of the humerus in the spiral groove, between the outer head of the Triceps and the bone, to the outer side of the humerus, where it reaches the external intermuscular septum and divides into two terminal branches. One of these pierces the external intermuscular septum, and descends, in company with the musculo-spiral nerve, to the space between the Brachialis anticus and Supinator longus, where it anastomoses with the recurrent branch of the radial artery; while the other, much the larger of the two, descends along the back of the external intermuscular septum to the back of the elbow-joint, where it anastomoses with the posterior interosseous recurrent, and across the back of the humerus with the posterior ulnar recurrent, the anastomotica magna, and inferior profunda (Fig. 306). The superior profunda supplies the Triceps muscle and gives off a nutrient artery which enters the bone at the upper end of the musculo-spiral groove. Near its commencement it sends off a branch which passes upward between the external and long heads of the Triceps muscle to anastomose with the posterior circumflex artery, and, while in the groove, a small branch which accompanies a branch of the musculo-spiral nerve through the substance of the Triceps muscle and ends in the Anconeus below the outer condyle of the humerus.

The **nutrient artery** of the shaft of the humerus arises from the brachial, about the middle of the arm. Passing downward it enters the nutrient canal of that bone near the insertion of the Coraco-brachialis muscle.

The **inferior profunda**, of small size, arises from the brachial, a little below the middle of the arm; piercing the internal intermuscular septum, it descends on the surface of the inner head of the Triceps muscle to the space between the inner condyle and olecranon, accompanied by the ulnar nerve, and terminates by anastomosing with the posterior ulnar recurrent and anastomotica magna. It sometimes supplies a branch to the front of the internal condyle, which anastomoses with the anterior ulnar recurrent.

The **anastomotica magna** arises from the brachial about two inches above the elbow-joint. It passes transversely inward upon the Brachialis anticus, and, piercing the internal intermuscular septum, winds round the back part of the humerus between the Triceps and the bone, forming an arch above the olecranon fossa by its junction with the posterior articular branch of the superior profunda. As this vessel lies on the Brachialis anticus, branches ascend to join the inferior profunda, and others descend in front of the inner condyle to anastomose with the anterior ulnar recurrent. Behind the internal condyle an offset is given off which anastomoses with the inferior profunda and posterior ulnar recurrent arteries and supplies the Triceps.

The **muscular** are three or four large branches, which are distributed to the muscles in the course of the artery. They supply the Coraco-brachialis, Biceps, and Brachialis anticus muscles.

The Anastomosis around the Elbow-joint (Fig. 306).—The vessels engaged in this anastomosis may be conveniently divided into those situated *in front* and *behind* the internal and external condyles. The branches anastomosing *in front* of the internal condyle are the anastomotica magna, the anterior ulnar recurrent, and the anterior terminal branch of the inferior profunda. Those *behind* the internal condyle are the anastomotica magna, the posterior ulnar recurrent, and the posterior terminal branch of the inferior profunda. The branches anastomosing *in front* of the external condyle are the radial recurrent and the anterior terminal branch of the superior profunda. Those *behind* the external condyle (perhaps more properly described as being situated between the external condyle and the olecranon) are the anastomotica magna, the interosseous recurrent, and the posterior terminal branch of the superior profunda. There is also a large arch of anastomosis above the olecranon, formed by the interosseous recurrent, joining with the anastomotica magna and posterior ulnar recurrent (Fig. 306).

From this description it will be observed that the anastomotica magna is the vessel most engaged, the only part of the anastomosis in which it is not employed being that *in front* of the external condyle.

Radial Artery (Fig. 304).

The **Radial Artery** appears, from its direction, to be the continuation of the brachial, but in size it is smaller than the ulnar. It commences at the bifurcation of the brachial, just below the bend of the elbow, and passes along the radial side of the forearm to the wrist; it then winds backward, round the outer side of the carpus, beneath the extensor tendons of the thumb, to the upper end of the space between the metacarpal bones of the thumb and index finger, and, finally, passes forward, between the two heads of the First dorsal interosseous muscle, into the palm of the hand, where it crosses the metacarpal bones to the ulnar border of the hand, to form the deep palmar arch. At its termination it inosculates with the deep branch of the ulnar artery. The relations of this vessel may thus be conveniently divided into three parts—viz., in the forearm, at the back of the wrist, and in the hand.

Relations.—*In the forearm* this vessel extends from opposite the neck of the radius to the fore part of the styloid process, being placed to the inner side of the shaft of the bone above and in front of it below. It is overlapped in the upper part of its course by the fleshy belly of the Supinator longus muscle; throughout the rest of its course it is superficial, being covered by the integument, the superficial and deep fasciæ. In its course downward it lies upon the tendon of the Biceps, the Supinator brevis, the Pronator radii teres, the radial origin of the Flexor sublimis digitorum, the Flexor longus pollicis, the Pronator quadratus, and the lower extremity of the radius. In the upper third of its course it lies between the Supinator longus and the Pronator radii teres; in its lower two-thirds, between the tendons of the Supinator longus and the Flexor carpi radialis. The radial nerve lies close to the outer side of the artery in the middle third of its course, and some filaments of the musculo-cutaneous nerve, after piercing the deep fascia, run along the lower part of the artery as it winds round the wrist. The vessel is accompanied by venæ comites throughout its whole course.

PLAN OF THE RELATIONS OF THE RADIAL ARTERY IN THE FOREARM.

In front.
Skin, superficial and deep fascia.
Supinator longus.

Inner side.
Pronator radii teres.
Flexor carpi radialis.

Radial Artery in Forearm.

Outer side.
Supinator longus.
Radial nerve (middle third).

Behind.
Tendon of Biceps.
Supinator brevis.
Pronator radii teres.
Flexor sublimis digitorum.
Flexor longus pollicis.
Pronator quadratus.
Radius.

At the wrist, as it winds round the outer side of the carpus from the styloid process to the first interosseous space, it lies upon the external lateral ligament, and then upon the scaphoid bone and trapezium, being covered by the extensor tendons of the thumb, subcutaneous veins, some filaments of the radial nerve, and the integument. It is accompanied by two veins and a filament of the musculo-cutaneous nerve.

In the hand it passes from the upper end of the first interosseous space, between the heads of the Abductor indicis or First dorsal interosseous muscle, transversely across the palm, to the base of the metacarpal bone of the little finger, where it inosculates with the communicating branch from the ulnar artery, forming the deep palmar arch. It lies upon the carpal extremities of the metacarpal bones and the Interossei muscles, being covered by the Adductor obliquus pollicis, the flexor tendons of the fingers, the Lumbricales, the Opponens, and Flexor brevis minimi digiti. Alongside of it is the deep branch of the ulnar nerve, but running in the opposite direction; that is to say, from within outward.

Peculiarities.—The origin of the radial artery, according to Quain, is, in nearly one case in eight, higher than usual; more frequently arising from the axillary or upper part of the brachial than from the lower part of this vessel. The variations in the position of this vessel in the arm and at the bend of the elbow have been already mentioned. In the forearm it deviates less frequently from its position than the ulnar. It has been found lying over the fascia instead of beneath it. It has also been observed on the surface of the Supinator longus, instead of under its inner border; and in turning round the wrist it has been seen lying over, instead of beneath, the extensor tendons of the thumb.

Surface Marking.—The position of the radial artery in the forearm is represented by a line drawn from the outer border of the tendon of the Biceps in the centre of the hollow in front of the elbow-joint with a straight course to the inner side of the fore part of the styloid process of the radius.

Surgical Anatomy.—The radial artery is much exposed to injury in its lower third, and is frequently wounded by the hand being driven through a pane of glass, by the slipping of a knife or chisel held in the other hand, and such-like accidents. The injury is often followed by a traumatic aneurism, for which the old operation of laying open the sac and securing the vessel above and below is required.

The operation of tying the radial artery is required in cases of wounds either of its trunk or of some of its branches, or for aneurism; and it will be observed that the vessel may be exposed in any part of its course through the forearm without the division of any muscular fibres. The operation in the middle or inferior third of the forearm is easily performed, but in the upper third, near the elbow, it is attended with some difficulty, from the greater depth of the vessel and from its being overlapped by the Supinator longus muscle.

To tie the artery in the upper third an incision three inches in length should be made through the integument, in a line drawn from the centre of the bend of the elbow to the front of the styloid process of the radius, avoiding the branches of the median vein; the fascia of the arm being divided and the Supinator longus drawn a little outward, the artery will be exposed. The venæ comites should be carefully separated from the vessel, and the ligature passed from the radial to the ulnar side.

In the middle third of the forearm the artery may be exposed by making an incision of similar length on the inner margin of the Supinator longus. In this situation the radial nerve lies in close relation with the outer side of the artery, and should, as well as the veins, be carefully avoided.

In the lower third the artery is easily secured by dividing the integument and fascia in the interval between the tendons of the Supinator longus and Flexor carpi radialis muscles.

The branches of the radial artery may be divided into three groups, corresponding with the three regions in which the vessel is situated.

In the Forearm.	Radial Recurrent. Muscular. Anterior Carpal. Superficialis Volæ.	*Wrist.*	Posterior Carpal. Metacarpal. Dorsales Pollicis. Dorsalis Indicis.
Hand.	Princeps Pollicis. Radialis Indicis. Perforating. Palmar Interosseous. Palmar Recurrent.		

The **radial recurrent** is given off immediately below the elbow. It ascends between the branches of the musculo-spiral nerve lying on the Supinator brevis, and then between the Supinator longus and Brachialis anticus, supplying these muscles and the elbow-joint, and anastomosing with the terminal branches of the superior profunda.

The **muscular branches** are distributed to the muscles on the radial side of the forearm.

The **anterior carpal** is a small vessel which arises from the radial artery near the lower border of the Pronator quadratus, and, running inward in front of the radius, anastomoses with the anterior carpal branch of the ulnar artery. In this way an arterial anastomosis, *anterior carpal arch*, is formed in front of the wrist; it is joined by branches from the anterior interosseous above, and by recurrent branches from the deep palmar arch below, and gives off branches which descend to supply the articulations of the wrist and carpus.

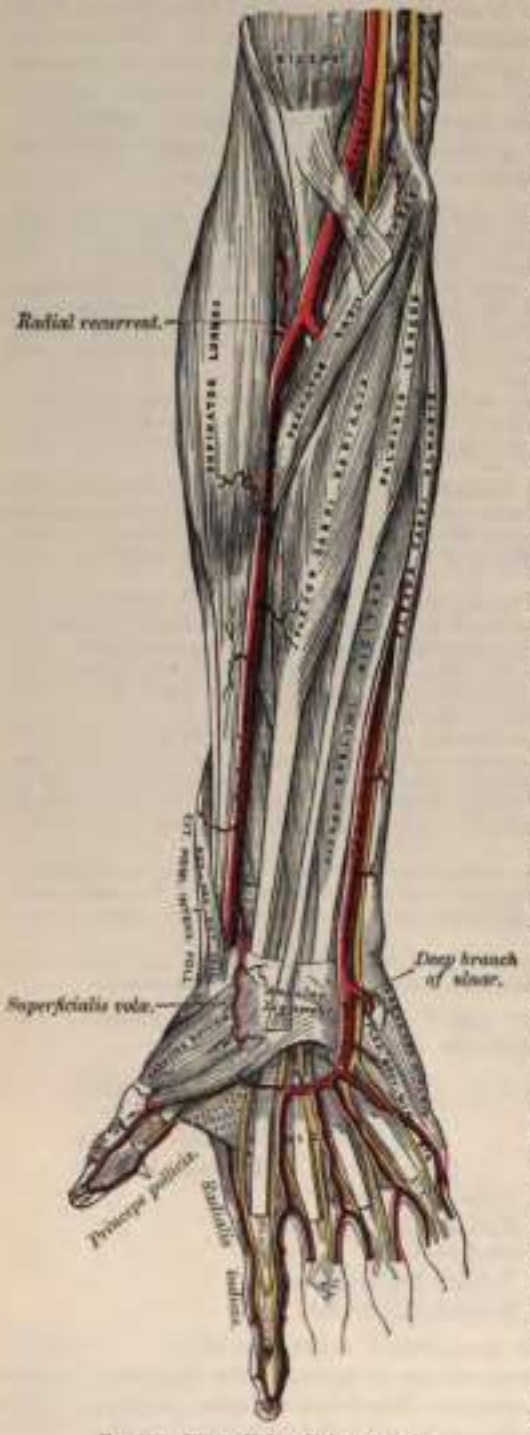


FIG. 304.—The radial and ulnar arteries.

The **superficialis volæ** arises from the radial artery, just where this vessel is about to wind round the wrist. Running forward, it passes between, occasionally over, the muscles of the thumb, which it supplies, and sometimes anastomoses with the palmar portion of the ulnar artery, completing the superficial palmar arch. This vessel varies considerably in size: usually it is very small, and terminates in the muscles of the thumb; sometimes it is as large as the continuation of the radial.

The **posterior carpal** is a small vessel which arises from the radial artery beneath the extensor tendons of the thumb; crossing the carpus transversely to the inner border of the hand, it anastomoses with the posterior carpal branch of the ulnar, forming the *posterior carpal arch*, which is joined by the termination of the anterior interosseous artery. From this arch are given off descending branches, the *dorsal interosseous arteries* for the third and fourth interosseous spaces, which run forward on the Third and Fourth dorsal interossei muscles, and divide into dorsal digital branches which supply the adjacent sides of the middle, ring, and little fingers respectively, communicating with the digital arteries of the superficial palmar arch. At their origin they anastomose with the perforating branches from the deep palmar arch.

The **metacarpal (first dorsal interosseous branch)** arises beneath the extensor tendons of the thumb, sometimes with the posterior carpal artery; running forward on the Second dorsal interosseous muscle, it communicates, behind, with the corresponding perforating branch of the deep palmar arch; and

in front it divides into two *dorsal digital branches*, which supply the adjoining sides of the index and middle fingers, inosculating with the digital branch of the superficial palmar arch.

The **dorsales pollicis** are two vessels which run along the sides of the dorsal aspect of the thumb. They arise separately, or occasionally by a common trunk, near the base of the first metacarpal bone.

The **dorsalis indicis**, also a small branch, runs along the radial side of the back of the index finger, sending a few branches to the Abductor indicis.

The **princeps pollicis** arises from the radial just as it turns inward to the deep part of the hand; it descends between the Abductor indicis and Adductor obliquus pollicis, then between the Adductor transversus pollicis and Adductor obliquus pollicis, along the ulnar side of the metacarpal bone of the thumb, to the base of the first phalanx, where it divides into two branches, which run along the sides of the palmar aspect of the thumb, and form an arch on the palmar surface of the last phalanx, from which branches are distributed to the integument and pulp of the thumb.

The **radialis indicis** arises close to the preceding, descends between the Abductor indicis and Adductor transversus pollicis, and runs along the radial side of the index finger to its extremity, where it anastomoses with the collateral digital artery from the superficial palmar arch. At the lower border of the Adductor transversus pollicis this vessel anastomoses with the princeps pollicis, and gives a communicating branch to the superficial palmar arch.

The **perforating arteries**, three in number, pass backward from the deep palmar arch between the heads of the last three Dorsal interossei muscles, to inosculate with the dorsal interosseous arteries.

The **palmar interosseous**, three or four in number, arise from the convexity of the deep palmar arch; they run forward upon the Interossei muscles, and anastomose at the clefts of the fingers with the digital branches of the superficial arch.

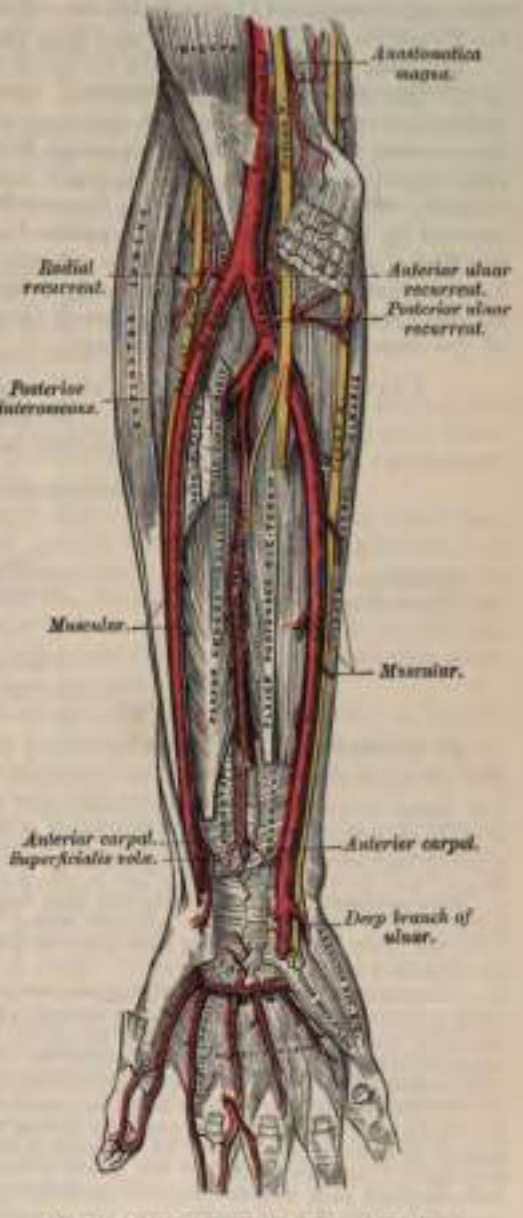


FIG. 355.—Ulnar and radial arteries. Deep view.

The **palmar recurrent branches** arise from the concavity of the deep palmar arch. They pass upward in front of the wrist, supplying the carpal articulations and anastomosing with the anterior carpal arch.

Ulnar Artery (Fig. 305).

The **Ulnar Artery**, the larger of the two terminal branches of the brachial, commences a little below the bend of the elbow, and crosses obliquely the inner side of the forearm, to the commencement of its lower half; it then runs along its ulnar border to the wrist, crosses the annular ligament on the radial side of the pisiform bone, and immediately beyond this bone divides into two branches which enter into the formation of the superficial and deep palmar arches.

Relations in the Forearm.—In its *upper half* it is deeply seated, being covered by all the superficial Flexor muscles, excepting the Flexor carpi ulnaris; the median nerve is in relation with the inner side of the artery for about an inch and then crosses the vessel, being separated from it by the deep head of the Pronator radii teres; it lies upon the Brachialis anticus and Flexor profundus digitorum muscles. In the *lower half* of the forearm it lies upon the Flexor profundus, being covered by the integument, the superficial and deep fasciæ, and is placed between the Flexor carpi ulnaris and Flexor sublimis digitorum muscles. It is accompanied by two venæ comites; the ulnar nerve lies on its inner side for the lower two-thirds of its extent, and a small branch from the nerve descends on the lower part of the vessel to the palm of the hand.

PLAN OF RELATIONS OF THE ULNAR ARTERY IN THE FOREARM.

In front.
Superficial layer of flexor muscles. } Upper half.
Median nerve.
Superficial and deep fasciæ. Lower half.

Inner side.
Flexor carpi ulnaris.
Ulnar nerve (lower two-thirds).

Ulnar Artery in Forearm.

Outer side.
Flexor sublimis digitorum.

Behind.
Brachialis anticus.
Flexor profundus digitorum.

At the wrist (Fig. 304) the ulnar artery is covered by the integument and fascia, and lies upon the anterior annular ligament. On its inner side is the pisiform bone. The ulnar nerve lies at the inner side, and somewhat behind the artery; here the nerve and artery are crossed by a band of fibres, which extends from the pisiform bone to the anterior annular ligament.

Peculiarities.—The ulnar artery has been found to vary in its origin nearly in the proportion of one in thirteen cases, in one case arising lower than usual, about two or three inches below the elbow, and in all other cases much higher, the brachial being a more frequent source of origin than the axillary.

Variations in the position of this vessel are more frequent than in the radial. When its origin is normal the course of the vessel is rarely changed. When it arises high up it is almost invariably superficial to the flexor muscles in the forearm, lying commonly beneath the fascia, more rarely between the fascia and integument. In a few cases its position was subcutaneous in the upper part of the forearm, subaponeurotic in the lower part.

Surface Marking.—On account of the curved direction of the ulnar artery the line on the surface of the body which indicates its course is somewhat complicated. First, draw a line from the front of the internal condyle of the humerus to the radial side of the pisiform bone; the lower two-thirds of this line represents the course of the middle and lower third of the ulnar artery. Secondly, draw a line from the centre of the hollow in front of the elbow-joint to the junction of the upper and middle third of the first line; this represents the course of the upper third of the artery.

Surgical Anatomy.—The application of a ligature to this vessel is required in cases of wound of the artery or of its branches, or in consequence of aneurism. In the upper half of the forearm the artery is deeply seated beneath the superficial flexor muscles, and the application of a ligature in this situation is attended with some difficulty. An incision is to be made in the course of a line drawn from the front of the internal condyle of the humerus to the outer side of the pisiform bone, so that the centre of the incision is three fingers' breadth below the internal condyle. The skin and superficial fascia having been divided and the deep fascia exposed, the white line which separates the Flexor carpi ulnaris from the other flexor muscles

is to be sought for, and the fascia incised in this line. The Flexor carpi ulnaris is now to be carefully separated from the other muscles, when the ulnar nerve will be exposed, and must be drawn aside. Some little distance below the nerve the artery will be found accompanied by its venæ comites, and may be ligatured by passing the needle from within outward. In the middle and lower third of the forearm this vessel may be easily secured by making an incision on the radial side of the tendon of the Flexor carpi ulnaris; the deep fascia being divided, and the Flexor carpi ulnaris and its companion muscle, the Flexor sublimis, being separated from each other, the vessel will be exposed, accompanied by its venæ comites, the ulnar nerve lying on its inner side. The veins being separated from the artery, the ligature should be passed from the ulnar to the radial side, taking care to avoid the ulnar nerve.

The branches of the ulnar artery may be arranged in the following groups:

Forearm.	Anterior Ulnar Recurrent. Posterior Ulnar Recurrent. Interosseous: Anterior Interosseous, Posterior Interosseous. Muscular.
Wrist.	Anterior Carpal. Posterior Carpal.
Hand.	Deep Palmar or Communicating. Superficial Palmar Arch.

The **anterior ulnar recurrent** (Fig. 305) arises immediately below the elbow-joint, passes upward and inward between the Brachialis anticus and Pronator radii teres, supplies twigs to those muscles, and, in front of the inner condyle, anastomoses with the anastomotica magna and inferior profunda.

The **posterior ulnar recurrent** is much larger, and arises somewhat lower than the preceding. It passes backward and inward, beneath the Flexor sublimis, and ascends behind the inner condyle of the humerus. In the interval between this process and the olecranon it lies beneath the Flexor carpi ulnaris, and ascending between the heads of that muscle, in relation with the ulnar nerve; it supplies the neighboring muscles and joint, and anastomoses with the inferior profunda, anastomotica magna, and interosseous recurrent arteries (Fig. 306).

The **interosseous artery** (Fig. 305) is a short trunk about half an inch in length, and of considerable size, which arises immediately below the tuberosity of the radius, and, passing backward to the upper border of the interosseous membrane, divides into two branches, the *anterior* and *posterior interosseous*.

The **anterior interosseous** passes down the forearm on the anterior surface of the interosseous membrane, to which it is connected by a thin aponeurotic arch. It is accompanied by the interosseous branch of the median nerve, and overlapped by the contiguous margins of the Flexor profundus digitorum and Flexor longus pollicis muscles, giving off in this situation muscular branches and the nutrient arteries of the radius and ulna. At the upper border of the Pronator quadratus a branch descends beneath the muscle to anastomose in front of the carpus with the anterior carpal arch. The continuation of the artery passes behind the Pronator quadratus, and, piercing the interosseous membrane, reaches the back of the forearm, and anastomoses with the posterior interosseous artery (Fig. 306). It then descends to the back of the wrist to join the posterior carpal arch. The anterior interosseous gives off a long, slender branch, the *median artery*, which accompanies the median nerve and gives offsets to its substance. This artery is sometimes much enlarged, and accompanies the nerve into the palm of the hand.

The **posterior interosseous artery** passes backward through the interval between the oblique ligament and the upper border of the interosseous membrane. It appears between the contiguous borders of the Supinator brevis and the Extensor ossis metacarpi pollicis, and runs down the back part of the forearm, between the superficial and deep layer of muscles, to both of which it distributes branches. At the lower part of the forearm it anastomoses with the termination of the anterior interosseous artery. Then, continuing its course over the head of the ulna, it

joins the posterior carpal branch of the ulnar artery. This artery gives off, near its origin, the *interosseous recurrent branch*.

The **interosseous recurrent artery** is a large vessel which ascends to the interval between the external condyle and olecranon, on or through the fibres of the Supinator brevis, but beneath the Anconeus, anastomosing with a branch from the superior profunda, and with the posterior ulnar recurrent and anastomotica magna.

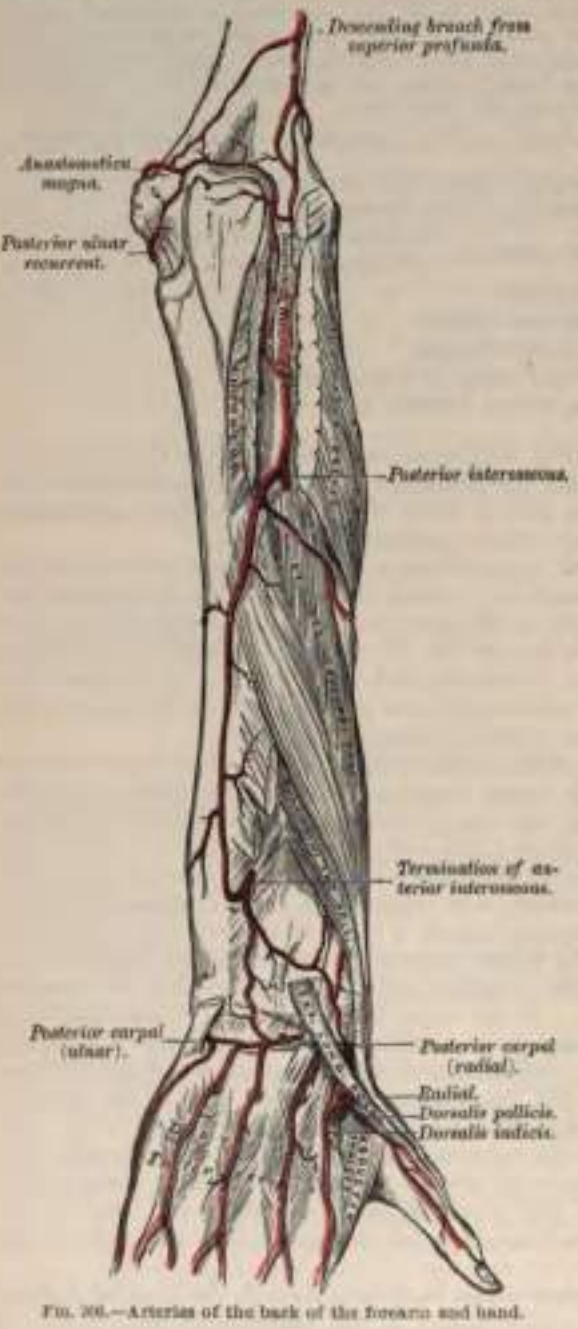


FIG. 305.—Arteries of the back of the forearm and hand.

The **muscular branches** are distributed to the muscles along the ulnar side of the forearm.

The **anterior carpal** is a small vessel which crosses the front of the carpus beneath the tendons of the Flexor profundus, and inosculates with a corresponding branch of the radial artery.

The **posterior carpal** arises immediately above the pisiform bone, and winds backward beneath the tendon of the Flexor carpi ulnaris: it passes across the dorsal surface of the carpus beneath the extensor tendons, anastomosing with a corresponding branch of the radial artery, and forming the *posterior carpal arch*. Immediately after its origin it gives off a small branch which runs along the ulnar side of the metacarpal bone of the little finger, forming one of the *metacarpal arteries*, and supplies the ulnar side of the dorsal surface of the little finger.

The **branch to the deep palmar arch** (**deep** or **communicating branch**) (Fig. 305) passes deeply inward between the Abductor minimi digiti and Flexor brevis minimi digiti, near their origins: it anastomoses with the termination of the radial artery, completing the deep palmar arch.

The continuation of the trunk of the ulnar artery in the hand forms the greater part of the superficial palmar arch.

The Superficial Palmar Arch (Fig. 304).

The **Superficial Palmar Arch** is formed by the ulnar artery in the hand, and is completed on the outer side by this vessel anastomosing with a branch from the radialis indicis, though sometimes the arch is completed by the ulnar anastomosing

with the superficialis volæ or princeps pollicis of the radial artery. The arch passes across the palm, describing a curve, with its convexity forward, to the space between the ball of the thumb and the index finger, where the above-mentioned anastomosis takes place.

Relations.—The superficial palmar arch is covered by the skin, the Palmaris brevis, and the palmar fascia. It lies upon the annular ligament, the Flexor brevis of the little finger, the tendons of the superficial flexor of the fingers, and the divisions of the median and ulnar nerves.

PLAN OF THE RELATIONS OF THE SUPERFICIAL PALMAR ARCH.

In front.

Skin.
Palmaris brevis.
Palmar fascia.

Behind.

Annular ligament.
Flexor brevis of little finger.
Superficial flexor tendons.
Divisions of median and ulnar nerves.

BRANCHES OF THE SUPERFICIAL PALMAR ARCH.

Digital.

The **digital branches** (Fig. 304), four in number, are given off from the convexity of the superficial palmar arch. They supply the ulnar side of the little finger and the adjoining sides of the little, ring, middle, and index fingers, the radial side of the index finger and thumb being supplied from the radial artery. The digital arteries at first lie superficial to the flexor tendons, but as they pass forward with the digital nerves to the clefts between the fingers they lie between them, and are there joined by the interosseous branches from the deep palmar arch. The digital arteries on the sides of the fingers lie beneath the digital nerves; and about the middle of the last phalanx the two branches for each finger form an arch, from the convexity of which branches pass to supply the pulp of the finger.

Surface Marking.—The superficial palmar arch is represented by a curved line, starting from the outer side of the pisiform bone and carried downward as far as the middle third of the palm, and then curved outward on a level with the upper end of the cleft between the thumb and index finger.

The deep palmar arch is situated about half an inch nearer to the carpus.

Surgical Anatomy.—Wounds of the palmar arches are of special interest, and are always difficult to deal with. When the superficial arch is wounded it is generally possible, by enlarging the wound if necessary, to secure the vessel and tie it; or in cases where it is found impossible to encircle the vessel with a ligature, a pair of Wells's artery clips may be applied and left on for twenty-four or forty-eight hours. Wounds of the deep arch are not so easily dealt with. It may be possible to secure the vessel by forcipressure forceps, which may be left on; or, failing this, the wound may be carefully plugged with gauze and an outside dressing carefully bandaged on. The plug should be allowed to remain untouched for three or four days. In wounds of the deep palmar arch a ligature may be applied to the bleeding points from the dorsum of the hand by resection of the upper part of the third metacarpal bone. It is useless in these cases to ligate one of the arteries of the forearm alone, and indeed simultaneous ligation of both radial and ulnar arteries above the wrist is often unsuccessful, on account of the anastomosis carried on by the carpal arches. Therefore, upon the failure of pressure to arrest hemorrhage, it is expedient to apply a ligature to the brachial artery.

ARTERIES OF THE TRUNK.

THE DESCENDING AORTA.

The **Descending Aorta** is divided into two portions, the *thoracic* and *abdominal*, in correspondence with the two great cavities of the trunk in which it is situated.

THE THORACIC AORTA.

The **Thoracic Aorta** commences at the lower border of the fourth dorsal vertebra, on the left side, and terminates at the aortic opening in the Diaphragm, in front of the lower border of the last dorsal vertebra. At its commencement it is situated on the left side of the spine; it approaches the median line as it descends, and at its termination lies directly in front of the column. The direction of this vessel being influenced by the spine, upon which it rests, it describes a curve which is concave forward in the dorsal region. As the branches given off from it are small, the diminution in the size of the vessel is inconsiderable. It is contained in the back part of the posterior mediastinum.

Relations.—It is in relation, *in front*, from above downward, with the root of the left lung, the pericardium, the œsophagus, and the Diaphragm: *behind*, with the vertebral column and the vena azygos minor; on the *right side*, with the vena azygos major and thoracic duct; on the *left side*, with the left pleura and lung. The œsophagus, with its accompanying nerves, lies on the right side of the aorta *above*; but at the lower part of the thorax it gets in front of the aorta, and close to the Diaphragm is situated to its left side.

PLAN OF THE RELATIONS OF THE THORACIC AORTA.

In front.
Root of left lung.
Pericardium.
Œsophagus.
Diaphragm.

Right side.
Œsophagus (above).
Vena azygos major.
Thoracic duct.

Left side.
Pleura.
Left lung.
Œsophagus (below).

Behind.
Vertebral column.
Superior and inferior azygos minor veins.

The aorta is occasionally found to be obliterated at a particular spot—viz., at the junction of the arch with the thoracic aorta, just below the ductus arteriosus. Whether this is the result of disease or of congenital malformation is immaterial to our present purpose; it affords an interesting opportunity of observing the resources of the collateral circulation. The course of the anastomosing vessels, by which the blood is brought from the upper to the lower part of the artery, will be found well described in an account of two cases in the *Pathological Transactions*, vols. viii. and x. In the former (p. 162) Mr. Sydney Jones thus sums up the detailed description of the anastomosing vessels: "The principal communications by which the circulation was carried on, were—Firstly, the internal mammary, anastomosing with the intercostal arteries, with the phrenic of the abdominal aorta by means of the musculo-phrenic and comes nervi phrenici, and largely with the deep epigastric. Secondly, the superior intercostal, anastomosing anteriorly by means of a large branch with the first aortic intercostal, and posteriorly with the posterior branch of the same artery. Thirdly, the inferior thyroid, by means of a branch about the size of an ordinary radial, formed a communication with the first aortic intercostal. Fourthly, the transversalis colli, by means of very large communications with the posterior branches of the intercostals. Fifthly, the branches (of the subclavian and axillary) going to the side of the chest were large, and anastomosed freely with the lateral branches of the intercostals." In the second case also (vol. x. p. 97) Mr. Wood describes the anastomoses in a somewhat similar manner, adding the remark that "the blood which was brought into the aorta through the anastomoses of the intercostal arteries appeared to be expended principally in supplying the abdomen and pelvis, while the supply to the lower extremities had passed through the internal mammary and epigastrics."

Surgical Anatomy.—The student should now consider the effects likely to be produced by aneurism of the thoracic aorta, a disease of common occurrence. When we consider the great depth of the vessel from the surface and the number of important structures which surround it on every side, it may easily be conceived what a variety of obscure symptoms may arise from disease of this part of the arterial system, and how they may be liable to be mistaken for those of other affections. Aneurism of the thoracic aorta most usually extends backward along the left side of the spine, producing absorption of the bodies of the vertebræ, with curvature of the spine; whilst the irritation or pressure on the cord will give rise to pain, either in the chest, back, or loins, with radiating pain in the left upper intercostal spaces, from pressure on the intercostal nerves; at the same time the tumor may project backward on each side of the spine, beneath the integument, as a pulsating swelling, simulating abscess connected with diseased bone, or it may displace the œsophagus and compress the lung on one or the other side. If the tumor extend forward, it may press upon and displace the heart, giving rise to palpitation and other symptoms of disease of that organ; or it may displace, or even compress, the œsophagus, causing pain and difficulty of swallowing, as in stricture of that tube; and ultimately even open into it by ulceration, producing fatal hæmorrhage. If the disease extends to the right side, it may press upon the thoracic duct; or it may burst into the pleural cavity or into the trachea or lung; and lastly, it may open into the posterior mediastinum.

Branches of the Thoracic Aorta.

Pericardiac.	Œsophageal.
Bronchial.	Posterior Mediastinal.
Intercostal.	

The **pericardiac** are a few small vessels, irregular in their origin, distributed to the pericardium.

The **bronchial arteries** are the nutrient vessels of the lungs, and vary in number, size, and origin. That of the right side arises from the first aortic intercostal, or by a common trunk with the left bronchial from the front of the thoracic aorta. Those of the left side, usually two in number, arise from the thoracic aorta, one a little lower than the other. Each vessel is directed to the back part of the corresponding bronchus along which it runs, dividing and subdividing along the bronchial tube, supplying them, the cellular tissue of the lungs, the bronchial glands, and the œsophagus.

The **œsophageal arteries**, usually four or five in number, arise from the front of the aorta, and pass obliquely downward to the œsophagus, forming a chain of anastomoses along that tube, anastomosing with the œsophageal branches of the inferior thyroid arteries above, and with ascending branches from the phrenic and gastric arteries below.

The **posterior mediastinal arteries** are numerous small vessels which supply the glands and loose areolar tissue in the mediastinum.

The **Intercostal arteries** arise from the back of the aorta. They are usually nine in number on each side, the two superior intercostal spaces being supplied by the superior intercostal, a branch of the subclavian. The second space usually receives a considerable branch from the first aortic intercostal, which joins with the branch from the superior intercostal of the subclavian. The branch which runs along the lower border of the last rib is named the *subcostal artery*. The right intercostals are longer than the left, on account of the position of the aorta on the left side of the spine: they pass outward, across the bodies of the vertebræ, to the intercostal spaces, being covered by the pleura, the œsophagus, thoracic duct, sympathetic nerve, and the vena azygos major; the left, passing outward, are crossed by the sympathetic; the upper two are also crossed by the superior intercostal vein, the lower by the azygos minor veins. In each intercostal space the artery passes outward, at first lying upon the External intercostal muscle, covered in front by the pleura and a thin fascia. It then passes between the two layers of Intercostal muscles, and, having ascended obliquely to the lower border of the rib above it, is continued forward in the groove on its lower border and anastomoses with the anterior intercostal branches of the internal mammary. The first aortic intercostal anastomoses with the superior intercostal, and the last three pass between the abdominal muscles, inosculating with the epigastric in front

and with the phrenic and lumbar arteries. Each intercostal artery is accompanied by a vein and nerve, the former being above, and the latter below, except in the upper intercostal spaces, where the nerve is at first above the artery. The arteries are protected from pressure during the action of the Intercostal muscles by fibrous arches thrown across, and attached by each extremity to the bone. The lower intercostal arteries are continued anteriorly from the intercostal spaces into the

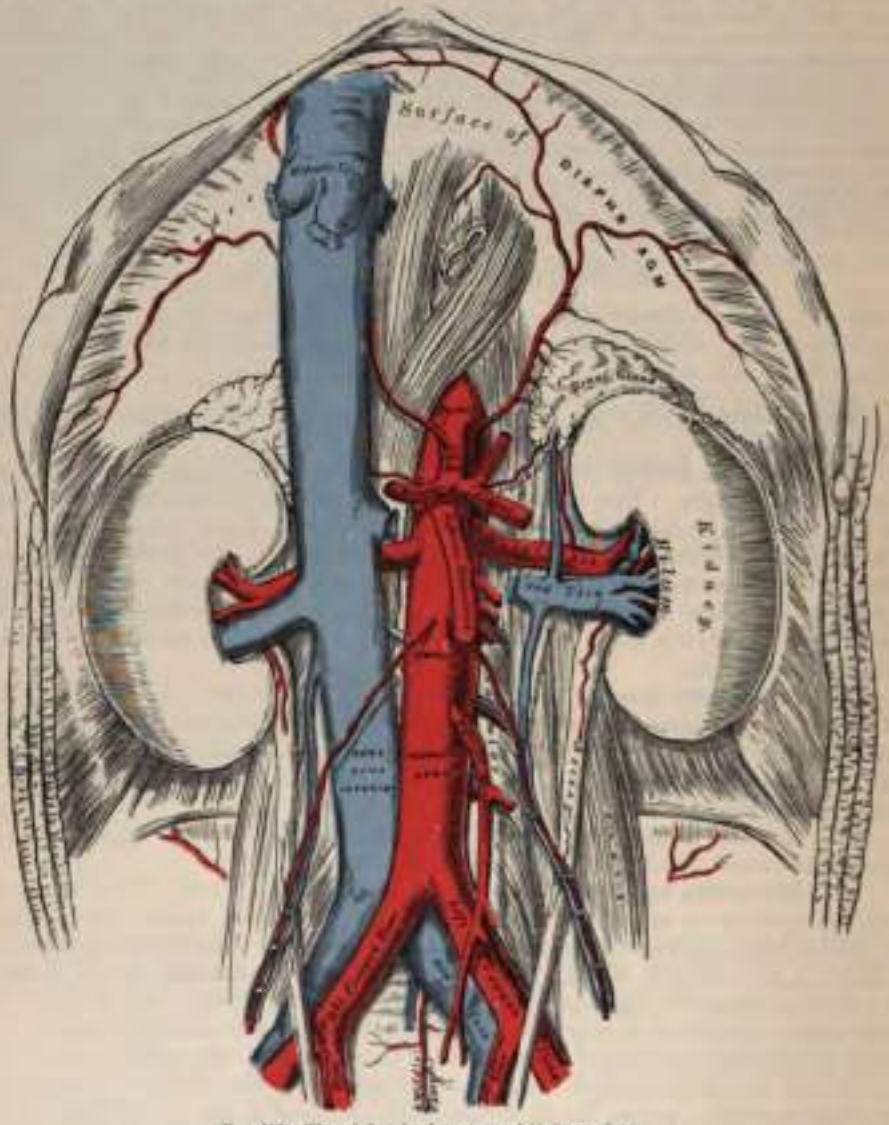


FIG. 307.—The abdominal aorta and its branches.

abdominal wall, except the *subcostal*, which lies throughout its whole course in the abdominal wall, since it is placed below the last rib. They pass behind the costal cartilages between the internal oblique and Transversalis muscle to the sheath of the Rectus, where they anastomose with the internal mammary and the deep epigastric arteries. Behind, the subcostal artery anastomoses with the first lumbar artery.

Each intercostal artery gives off the following branches:

Posterior or dorsal branch. Spinal.
Collateral intercostal.

The **posterior or dorsal branch** of each intercostal artery passes backward to the inner side of the anterior costo-transverse ligament, and divides into an external and internal branch, which are distributed to the muscles and integument of the back.

The **spinal branch**, which enters the spinal canal through the intervertebral foramen, is distributed to the spinal cord and its membranes, and to the bodies of the vertebræ in the same manner as the lateral spinal branches from the vertebral.

The **collateral intercostal branch** comes off from the intercostal artery near the angle of the rib, and descends to the upper border of the rib below, along which it courses to anastomose with the anterior intercostal branch of the internal mammary.

Surgical Anatomy.—The position of the intercostal vessels should be borne in mind in performing the operation of paracentesis thoracis. The puncture should never be made nearer the middle line posteriorly than the angle of the rib, as the artery crosses the space internal to this point. In the lateral portion of the chest, where the puncture is usually made, the artery lies at the upper part of the intercostal space, and therefore the puncture should be made just above the upper border of the rib forming the lower boundary of the space.

THE ABDOMINAL AORTA (Fig. 307).

The **Abdominal Aorta** commences at the aortic opening of the Diaphragm, in front of the lower border of the body of the last dorsal vertebra, and, descending a little to the left side of the vertebral column, terminates on the body of the fourth lumbar vertebra, commonly a little to the left of the middle line,[1] where it divides into the two common iliac arteries. It diminishes rapidly in size, in consequence of the many large branches which it gives off. As it lies upon the bodies of the vertebræ, the curve which it describes is convex forward, the greatest convexity corresponding to the third lumbar vertebra, which is a little above and to the left side of the umbilicus.

Relations.—It is covered, *in front*, by the lesser omentum and stomach, behind which are the branches of the cœliac axis and the solar plexus; below these, by the splenic vein, the pancreas, the left renal vein, the transverse portion of the duodenum, the mesentery, and aortic plexus. *Behind*, it is separated from the lumbar vertebræ and intervening discs by the anterior common ligament and left lumbar veins. On the *right side* it is in relation with the inferior vena cava (the right crus of the Diaphragm being interposed above), the vena azygos major, thoracic duct, and right semilunar ganglion; on the *left side*, with the sympathetic nerve and left semilunar ganglion.

PLAN OF THE RELATIONS OF THE ABDOMINAL AORTA.

In front.
Lesser omentum and stomach.
Branches of the cœliac axis and solar plexus.
Splenic vein.
Pancreas.
Left renal vein.
Transverse duodenum.
Mesentery.
Aortic plexus.

Right side.
Right crus of Diaphragm.
Inferior vena cava.
Vena azygos major.
Thoracic duct.
Right semilunar ganglion.

Left side.
Sympathetic nerve.
Left semilunar ganglion.

Behind.
Left lumbar veins.
Vertebral column.

[1] Lord Lister, having accurately examined 30 bodies in order to ascertain the exact point of termination of this vessel, found it "either absolutely, or almost absolutely, mesial in 15, while in 13 it deviated more or less to the left, and in 2 was slightly to the right" (*System of Surgery*, edited by T. Holmes, 2d ed., vol. v., p. 652).

Surface Marking.—In order to map out the abdominal aorta on the surface of the abdomen, a line must be drawn from the middle line of the body, on a level with the distal extremity of the seventh costal cartilage, downward and slightly to the left, so that it just skirts the umbilicus, to a zone drawn round the body opposite the highest point of the crest of the ilium. This point is generally half an inch below and to the left of the umbilicus, but as the position of this structure varies with the obesity of the individual, it is not a reliable landmark as to the situation of the bifurcation of the aorta.

Surgical Anatomy.—Aneurisms of the abdominal aorta near the cœliac axis communicate in nearly equal proportion with the anterior and posterior parts of the artery.

When an aneurismal sac is connected with the back part of the abdominal aorta, it usually produces absorption of the bodies of the vertebræ, and forms a pulsating tumor that presents itself in the left hypochondriac or epigastric regions, and is accompanied by symptoms of disturbance in the alimentary canal. Pain is invariably present, and is usually of two kinds—a fixed and constant pain in the back, caused by the tumor pressing on or displacing the branches of the solar plexus and splanchnic nerves; and a sharp lancinating pain, radiating along those branches of the lumbar nerves which are pressed on by the tumor; hence the pain in the loins, the testes, the hypogastrium, and in the lower limb (usually of the left side). This form of aneurism usually bursts into the peritoneal cavity or behind the peritoneum in the left hypochondriac region; or it may form a large aneurismal sac, extending down as low as Poupart's ligament; hæmorrhage in these cases being generally very extensive, but slowly produced, and not rapidly fatal.

When an aneurismal sac is connected with the front of the aorta near the cœliac axis, it forms a pulsating tumor in the left hypochondriac or epigastric regions, usually attended with symptoms of disturbance of the alimentary canal, as sickness, dyspepsia, or constipation, and accompanied by pain, which is constant, but nearly always fixed in the loins, epigastrium, or some part of the abdomen; the radiating pain being rare, as the lumbar nerves are seldom implicated. This form of aneurism may burst into the peritoneal cavity or behind the peritoneum, between the layers of the mesentery, or, more rarely, into the duodenum; it rarely extends backward so as to affect the spine.

The abdominal aorta has been tied several times, and although none of the patients permanently recovered, still, as one of them lived as long as ten days, the possibility of the re-establishment of the circulation may be considered to be proved. In the lower animals this artery has been often successfully tied. The vessel may be reached in several ways. In the original operation, performed by Sir A. Cooper, an incision was made in the linea alba, the peritoneum opened in front, the finger carried down amongst the intestines toward the spine, the peritoneum again opened behind by scratching through the mesentery, and the vessel thus reached. Or either of the operations described below for securing the common iliac artery may, by extending the dissection a sufficient distance upward, be made use of to expose the aorta. The chief difficulty in the dead subject consists in isolating the artery in consequence of its great depth; but in the living subject the embarrassment resulting from the proximity of the aneurismal tumor, and the great probability of disease in the vessel itself, add to the dangers and difficulties of this formidable operation so greatly that it is very doubtful whether it ought ever to be performed.

The collateral circulation would be carried on by the anastomosis between the internal mammary and the deep epigastric; by the free communication between the superior and inferior mesenteries if the ligature were placed above the latter vessel; or by the anastomosis between the inferior mesenteric and the internal pudic when (as is more common) the point of ligature is below the origin of the inferior mesenteric; and possibly by the anastomoses of the lumbar arteries with the branches of the internal iliac.

The circulation through the abdominal aorta may be commanded, in thin persons, by firm pressure with the fingers. A tourniquet has been invented for this purpose which is sometimes used in amputation at the hip-joint and some other operations.

Branches of the Abdominal Aorta.

Phrenic.		Superior Mesenteric.	Ovarian in female.
Cœliac Axis.	Gastric.	Suprarenal.	Inferior Mesenteric.
	Hepatic.	Renal.	Lumbar.
	Splenic.	Spermatic in male.	Sacra Media.

The branches may be divided into two sets: 1. Those supplying the viscera. 2. Those distributed to the walls of the abdomen.

Visceral Branches.

Cœliac Axis: Gastric, Hepatic, Splenic.
Superior Mesenteric.
Inferior Mesenteric.
Suprarenal.
Renal.
Spermatic or Ovarian.

Parietal Branches.

Phrenic.
Lumbar.
Sacra Media.

The Cœliac Axis (Fig. 308).

To expose this artery raise the liver, draw down the stomach, and then tear through the layers of the lesser omentum.

The **Cœliac Axis** is a short thick trunk, about half an inch in length, which

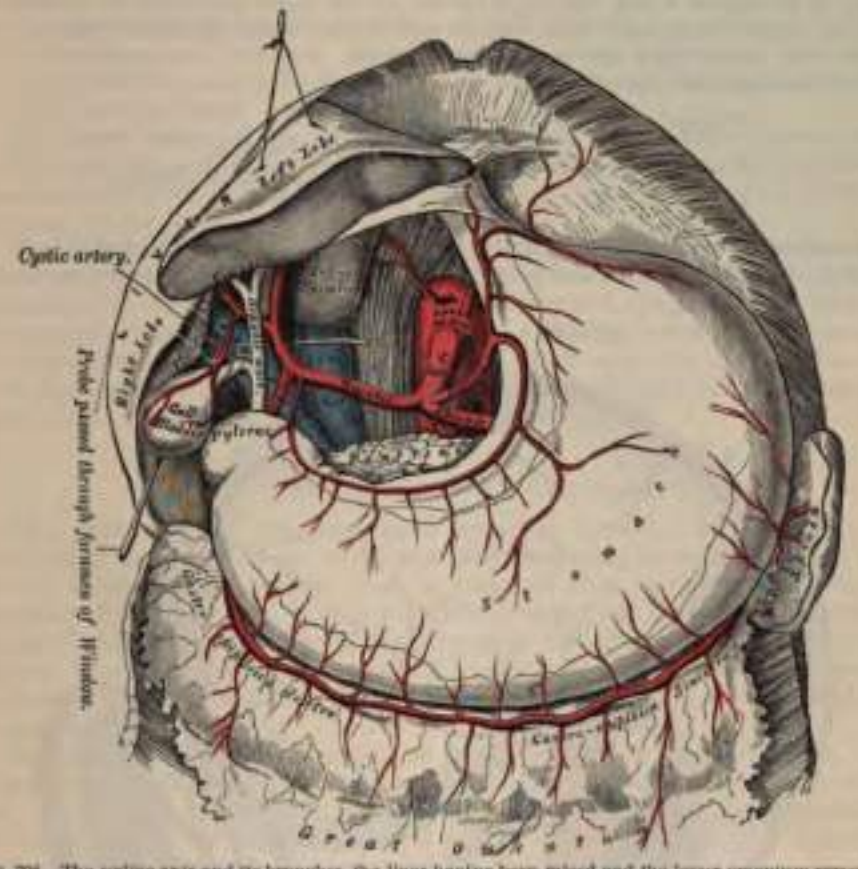


FIG. 308.—The cœliac axis and its branches, the liver having been raised and the lesser omentum removed.

arises from the aorta, close to the margin of the opening in the Diaphragm, and, passing nearly horizontally forward (in the erect posture), divides into three large branches, the *gastric*, *hepatic*, and *splenic*, occasionally giving off one of the phrenic arteries.

Relations.—It is covered by the lesser omentum. On the *right side* it is in relation with the right semilunar ganglion and the lobus Spigelii; on the *left side*, with the left semilunar ganglion and cardiac end of the stomach. *Below*, it rests upon the upper border of the pancreas.

The **Gastric** or **Coronary Artery**, the smallest of the three branches of the cœliac axis, passes upward and to the left side, to the cardiac orifice of the stomach, distributing branches to the œsophagus which anastomose with the aortic œsophageal arteries; others supply the cardiac end of the stomach, inosculating with branches of the splenic artery; it then passes from left to right, along the lesser curvature of the stomach to the pylorus, lying in its course between the layers of the lesser omentum, and giving branches to both surfaces of the organ: at its termination it anastomoses with the pyloric branch of the hepatic.

The **Hepatic Artery** in the adult is intermediate in size between the gastric and splenic; in the fœtus it is the largest of the three branches of the cœliac axis. It is first directed forward and to the right, to the upper margin of the pyloric end

of the stomach, forming the lower boundary of the foramen of Winslow. It then passes upward between the layers of the lesser omentum, and in front of the foramen of Winslow, to the transverse fissure of the liver, where it divides into two branches, right and left, which supply the corresponding lobes of that organ, accompanying the ramifications of the vena portæ and hepatic duct. The hepatic artery, in its course along the right border of the lesser omentum, is in relation with the ductus communis choledochus and portal veins, the duct lying to the right of the artery and the vena portæ behind.

Its branches are—the

Pyloric.
Gastro-duodenalis { Gastro-epiploica Dextra. / Pancreatico-duodenalis Superior.
Cystic.

The **pyloric branch** arises from the hepatic, above the pylorus, descends to the pyloric end of the stomach, and passes from right to left along its lesser curvature,

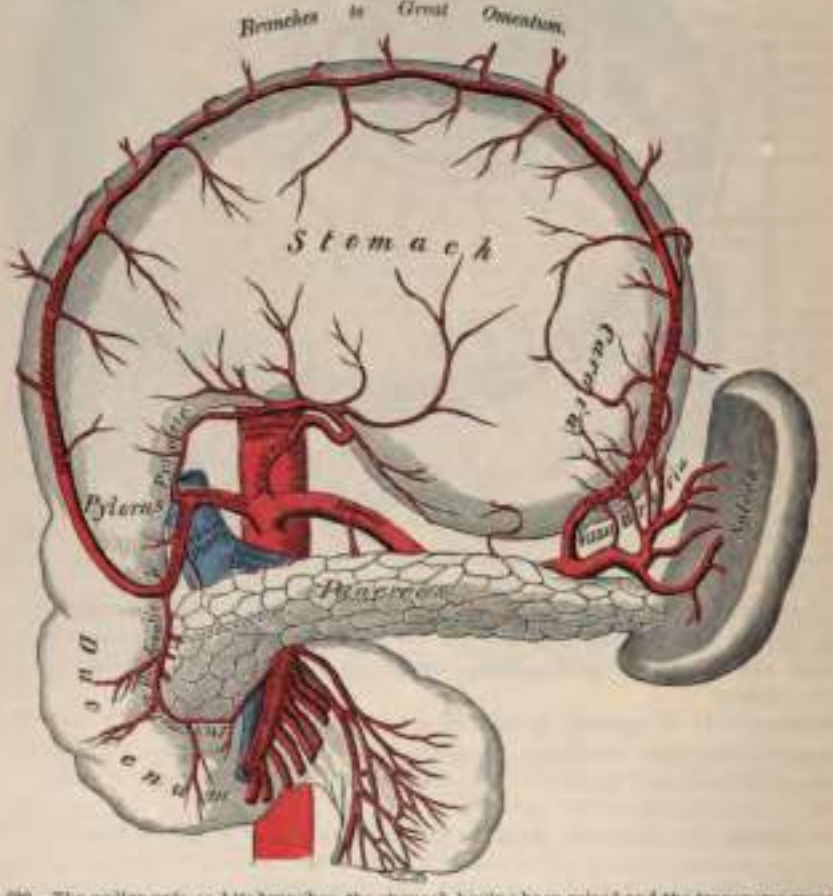


FIG. 309.—The coeliac axis and its branches, the stomach having been raised and the transverse meso-colon removed (semi-diagrammatic).

supplying it with branches and inosculating with the gastric branches of the coronary artery.

The **gastro-duodenalis** (Fig. 309) is a short but large branch, which descends, near the pylorus, behind the first portion of the duodenum, and divides at the lower border of this viscus into two branches, the *gastro-epiploica dextra* and the *pancreatico-duodenalis superior*. Previous to its division, it gives off two or three small inferior pyloric branches to the pyloric end of the stomach and pancreas.

The **gastro-epiploica dextra** runs from right to left along the greater curvature of the stomach, between the layers of the great omentum, anastomosing about the middle of the lower border of the stomach with the gastro-epiploica sinistra from the splenic artery. This vessel gives off numerous branches, some of which ascend to supply both surfaces of the stomach, whilst others descend to supply the great omentum.

The **pancreatico-duodenalis superior** descends between the contiguous margins of the duodenum and pancreas. It supplies both these organs, and anastomoses with the inferior pancreatico-duodenal branch of the superior mesenteric artery and with the pancreatic branches of the splenic.

The **cystic artery** (Fig. 308), usually a branch of the right hepatic, passes upward and forward along the neck of the gall-bladder, and divides into two branches, one of which ramifies on its free surface, the other between it and the substance of the liver.

The **Splenic Artery**, in the adult, is the largest of the three branches of the cœliac axis, and is remarkable for the extreme tortuosity of its course. It passes horizontally to the left side, behind the peritoneum and along the upper border of the pancreas, accompanied by the splenic vein, which lies below it, and on arriving near the spleen divides into branches, some of which enter the hilum of that organ to be distributed to its structure, whilst others are distributed to the pancreas and great end of the stomach. Its branches are—the

Pancreaticæ Parvæ.	Gastric (Vasa Brevia).
Pancreatica Magna.	Gastro-epiploica Sinistra.

The **pancreatic** are numerous small branches derived from the splenic as it runs behind the upper border of the pancreas, supplying its middle and left parts. One of these, larger than the rest, is given off from the splenic near the left extremity of the pancreas; it runs from left to right near the posterior surface of the gland, following the course of the pancreatic duct, and is called the *pancreatica magna*. These vessels anastomose with the pancreatic branches of the pancreatico-duodenal arteries, derived from the hepatic on the one hand and superior mesenteric on the other.

The **gastric (vasa brevia)** consists of from five to seven small branches, which arise either from the termination of the splenic artery or from its terminal branches, and, passing from left to right, between the layers of the gastro-splenic omentum, are distributed to the great curvature of the stomach, anastomosing with branches of the gastric and gastro-epiploica sinistra arteries.

The **gastro-epiploica sinistra**, the largest branch of the splenic, runs from left to right along the great curvature of the stomach, between the layers of the great omentum, and anastomoses with the gastro-epiploica dextra. In its course it distributes several branches to the stomach, which ascend upon both surfaces; others descend to supply the omentum.

The Superior Mesenteric Artery (Fig. 310).

In order to expose this vessel raise the great omentum and transverse colon, draw down the small intestines, and cut through the peritoneum where the transverse meso-colon and mesentery join: the artery will then be exposed just as it issues from beneath the lower border of the pancreas.

The **Superior Mesenteric Artery** supplies the whole length of the small intestine, except the first part of the duodenum; it also supplies the cæcum, ascending and transverse colon; it is a vessel of large size, arising from the fore part of the aorta about a quarter of an inch below the cœliac axis; being covered at its origin by the splenic vein and pancreas. It passes forward, between the pancreas and transverse portion of the duodenum, crosses in front of this portion of the intestine, and descends between the layers of the mesentery to the right iliac fossa, where, considerably diminished in size, it anastomoses with one of its own branches —viz., ileo-colic. In its course it forms an arch, the convexity of which is directed

forward and downward to the left side, the concavity backward and upward to the right. It is accompanied by the superior mesenteric vein, and is surrounded by the superior mesenteric plexus of nerves. Its branches are—the

Inferior Pancreatico-duodenal.
Vasa Intestini Tenuis.
Colica Media.
Ileo-colic.
Colica Dextra.

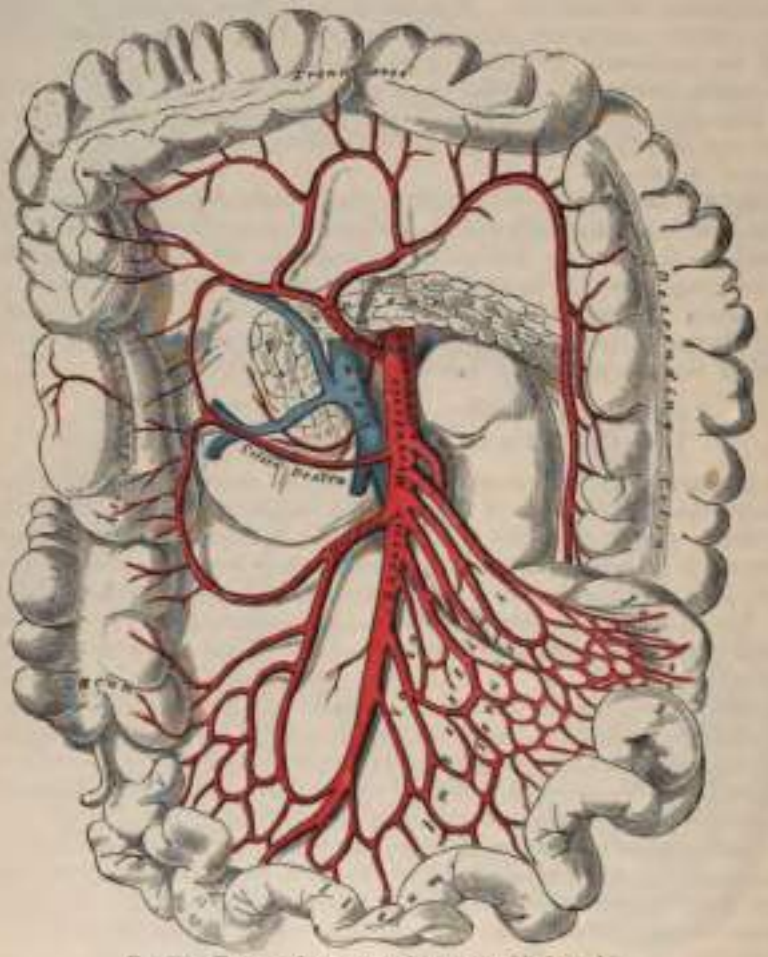


Fig. 339.—The superior mesenteric artery and its branches.

The **inferior pancreatico-duodenal** is given off from the superior mesenteric, or from its first intestinal branch behind the pancreas. It courses to the right between the head of the pancreas and duodenum, and then ascends to anastomose with the superior pancreatico-duodenal artery. It distributes branches to the head of the pancreas and to the transverse and descending portions of the duodenum.

The **vasa intestini tenuis** arise from the convex side of the superior mesenteric artery. They are usually from twelve to fifteen in number, and are distributed to the jejunum and ileum. They run parallel with one another between the layers of the mesentery, each vessel dividing into two branches, which unite with a similar branch on each side, forming a series of arches the convexities of which are directed toward the intestine. From this first set of arches branches arise, which again unite with similar branches from either side, and thus a second series of arches is formed; and from these latter, a third, and a fourth, or even fifth, series of arches is constituted, diminishing in size the nearer they approach the

intestine. From the terminal arches numerous small straight vessels arise which encircle the intestine, upon which they are distributed, ramifying between its coats. Throughout their course small branches are given off to the glands and other structures between the layers of the mesentery.

The **ileo-colic artery** is the lowest branch given off from the concavity of the superior mesenteric artery. It descends between the layers of the mesentery to the right iliac fossa, where it divides into two branches. Of these, the inferior division inosculates with the termination of the superior mesenteric artery, forming with it an arch, from the convexity of which branches proceed to supply the termination of the ileum, the cæcum and appendix cæci, and the ileo-cæcal valve. The superior division inosculates with the colica dextra and supplies the commencement of the colon.

The **colica dextra** arises from about the middle of the concavity of the superior mesenteric artery, and, passing behind the peritoneum to the middle of the ascending colon, divides into two branches—a descending branch, which inosculates with the ileo-colic; and the ascending branch, which anastomoses with the colica media. These branches form arches, from the convexity of which vessels are distributed to the ascending colon. The branches of this vessel are covered with peritoneum only on their anterior aspect.

The **colica media** arises from the upper part of the concavity of the superior mesenteric, and, passing forward between the layers of the transverse meso-colon, divides into two branches, the one on the right side inosculating with the colica dextra; that on the left side, with the colica sinistra, a branch of the inferior mesenteric. From the arches formed by their inosculation branches are distributed to the transverse colon. The branches of this vessel lie between two layers of the transverse meso-colon.

The Inferior Mesenteric Artery (Fig. 311).

In order to expose this vessel draw the small intestines and mesentery over to the right side of the abdomen, raise the transverse colon toward the thorax, and divide the peritoneum covering the front side of the aorta.

The **Inferior Mesenteric Artery** supplies the descending and sigmoid flexure of the colon and the greater part of the rectum. It is smaller than the superior mesenteric, and arises from the left side of the aorta, between one and two inches above its division into the common iliacs. It passes downward to the left iliac fossa, and then descends, between the layers of the meso-rectum, into the pelvis, under the name of the *superior hæmorrhoidal artery*. It lies at first in close relation with the left side of the aorta, and then passes as the superior hæmorrhoidal in front of the left common iliac artery. Its branches are—the

Colica Sinistra. Sigmoid.
Superior Hæmorrhoidal.

The **colica sinistra** passes behind the peritoneum, in front of the left kidney, to reach the descending colon, and divides into two branches—an ascending branch, which inosculates with the colica media; and a descending branch, which anastomoses with the sigmoid artery. From the arches formed by these inosculations branches are distributed to the descending colon.

The **sigmoid artery** runs obliquely downward across the Psoas muscle to the sigmoid flexure of the colon, and divides into branches which supply that part of the intestine, anastomosing above with the colica sinistra, and below with the superior hæmorrhoidal artery. This vessel is sometimes replaced by three or four small branches.

The **superior hæmorrhoidal artery**, the continuation of the inferior mesenteric, descends into the pelvis between the layers of the meso-rectum, crossing, in its course, the ureter and left common iliac vessels. It divides into two branches, which descend one on each side of the rectum, and about five inches from the anus break up into several small branches, which pierce the muscular coat of the bowel

and run downward, as straight vessels, placed at regular intervals from each other in the wall of the gut between its muscular and mucous coat, to the level of the internal sphincter; here they form a series of loops around the lower end of the rectum, and communicate with the middle hæmorrhoidal arteries, branches of the internal iliac, with the inferior hæmorrhoidal branches of the internal pudic.

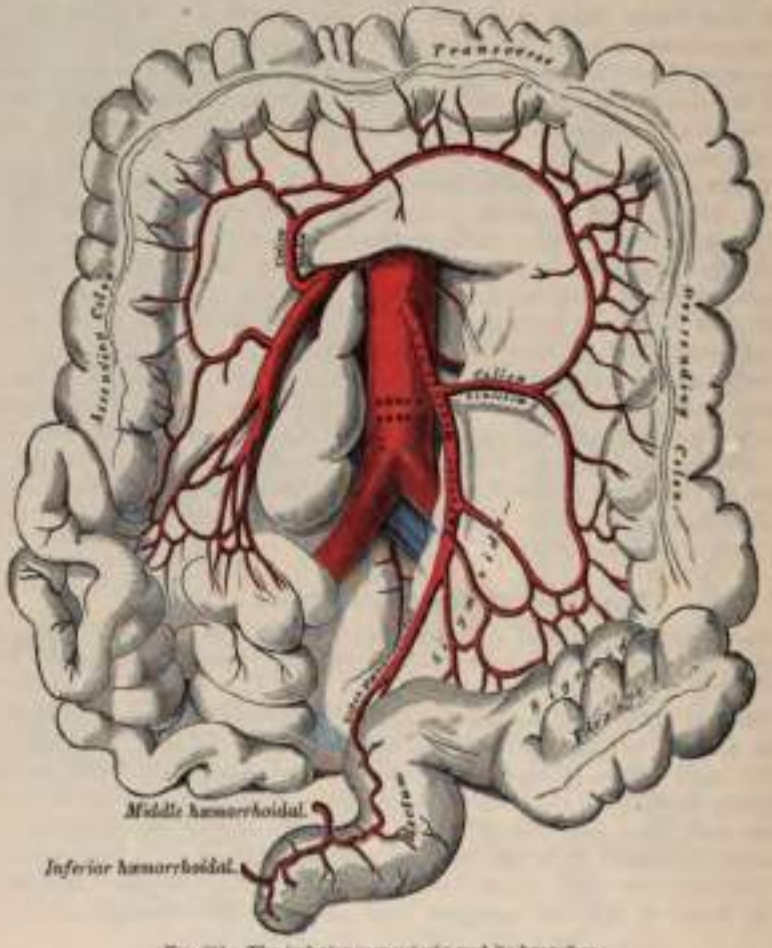


FIG. 311.—The inferior mesenteric and its branches.

The Suprarenal Arteries (Fig. 307).

The **suprarenal arteries** are two small vessels which arise, one on each side of the aorta, opposite the superior mesenteric artery. They pass obliquely upward and outward, over the crura of the Diaphragm, to the under surface of the suprarenal capsules, to which they are distributed, anastomosing with capsular branches from the phrenic and renal arteries. In the adult these arteries are of small size; in the fœtus they are as large as the renal arteries.

The Renal Arteries (Fig. 307).

The **renal arteries** are two large trunks which arise from the sides of the aorta immediately below the superior mesenteric artery. Each is directed outward across the crus of the Diaphragm, so as to form nearly a right angle with the aorta. The right is longer than the left, on account of the position of the aorta; it passes behind the inferior vena cava. The left is somewhat higher than the

right. Before reaching the hilum of the kidney, each artery divides into four or five branches; the greater number of which generally lie between the renal vein and ureter, the vein being in front, the ureter behind. Each vessel gives off some small branches to the suprarenal capsule, the ureter, and the surrounding cellular tissue and muscles. Frequently there is a second renal artery, which is given off from the abdominal aorta either above or below the renal artery proper, the former being the more common position. Instead of entering the kidney at the hilum, these accessory renal arteries usually pierce the upper or lower part of the gland.

The Spermatic Arteries.

The **spermatic arteries** are distributed to the testes. They are two slender vessels of considerable length, which arise from the front of the aorta a little below the renal arteries. Each artery passes obliquely outward and downward behind the peritoneum, resting on the Psoas muscle, the right spermatic lying in front of the inferior vena cava, the left behind the sigmoid flexure of the colon. It then crosses obliquely over the ureter and the lower part of the external iliac artery to reach the internal abdominal ring, through which it passes, and accompanies the other constituents of the spermatic cord along the inguinal canal to the scrotum, where it becomes tortuous, and divides into several branches, two or three of which accompany the vas deferens and supply the epididymis, anastomosing with the artery of the vas deferens; others pierce the back part of the tunica albuginea, and supply the substance of the testis.

The Ovarian Arteries.

The **ovarian arteries** (Fig. 313) are the corresponding arteries in the female to the spermatic in the male. They supply the ovaries, are shorter than the spermatic, and do not pass out of the abdominal cavity. The origin and course of the first part of the artery are the same as the spermatic in the male, but on arriving at the margin of the pelvis the ovarian artery passes inward, between the two layers of the broad ligament of the uterus, to be distributed to the ovary. One or two small branches supply the Fallopian tube; another passes on to the side of the uterus and anastomoses with the uterine arteries. Other offsets are continued along the round ligament through the inguinal canal, to the integument of the labium and groin.

At an early period of fœtal life, when the testes or ovaries lie by the side of the spine below the kidneys, the spermatic or ovarian arteries are short; but as these organs descend from the abdomen into the scrotum or pelvis, the arteries become gradually lengthened.

The Phrenic Arteries.

The **phrenic arteries** are two small vessels which present much variety in their origin. They may arise separately from the front of the aorta, immediately above the cœliac axis, or by a common trunk, which may spring either from the aorta or from the cœliac axis. Sometimes one is derived from the aorta, and the other from one of the renal arteries. In only one out of thirty-six cases examined did these arteries arise as two separate vessels from the aorta. They diverge from one another across the crura of the Diaphragm, and then pass obliquely upward and outward upon its under surface. The left phrenic passes behind the œsophagus and runs forward on the left side of the œsophageal opening. The right phrenic passes behind the inferior vena cava, and ascends along the right side of the aperture for transmitting that vein. Near the back part of the central tendon each vessel divides into two branches. The internal branch runs forward to the front of the thorax, supplying the Diaphragm and anastomosing with its fellow of

the opposite side, and with the musculo-phrenic and comes nervi phrenici, branches of the internal mammary. The external branch passes toward the side of the thorax and inosculates with the intercostal arteries. The internal branch of the right phrenic gives off a few vessels to the inferior vena cava, and the left one some branches to the œsophagus. Each vessel also sends capsular branches to the suprarenal capsule of its own side. The spleen on the left side and the liver on the right also receive a few branches from these vessels.

The Lumbar Arteries.

The **lumbar arteries** are analogous to the intercostal. They are usually four in number on each side, and arise from the back part of the aorta, nearly at right angles with that vessel. They pass outward and backward, around the sides of the body of the lumbar vertebra, behind the sympathetic nerve and the Psoas magnus muscle, those on the right side being covered by the inferior vena cava, and the two upper ones on each side by the crura of the Diaphragm. In the interval between the transverse processes of the vertebræ each artery divides into a *dorsal* and an *abdominal branch*.

The **dorsal branch** gives off, immediately after its origin, a spinal branch, which enters the spinal canal; it then continues its course backward between the transverse processes, and is distributed to the muscles and integument of the back, anastomosing with the similar branches of the adjacent lumbar arteries and with the posterior branches of the intercostal arteries.

The **spinal branch** enters the spinal canal through the intervertebral foramen, to be distributed to the spinal cord and its membranes and to the bodies of the vertebræ in the same manner as the lateral spinal branches from the vertebral (see page 521).

The **abdominal branches** pass outward, having a variable relation to the Quadratus lumborum muscle. Most frequently the first branch passes in front of the muscle and the others behind it; sometimes the order is reversed and the lowest branch passes in front of the muscle. At the outer border of the Quadratus they are continued between the abdominal muscles, anastomose with branches of the epigastric and internal mammary *in front*, the intercostals *above*, and those of the ilio-lumbar and circumflex iliac *below*.

The Middle Sacral Artery.

The **Middle Sacral Artery** is a small vessel, which arises from the back part of the aorta just at its bifurcation. It descends upon the last lumbar vertebra, and along the middle line of the front of the sacrum, to the upper part of the coccyx, where it anastomoses with the lateral sacral arteries, and terminates in a minute branch, which runs down to the situation of the body immediately to be described as "Luschka's gland." From it branches arise which run through the meso-rectum to supply the posterior surface of the rectum. Other branches are given off on each side, which anastomose with the lateral sacral arteries, and send off small offsets which enter the anterior sacral foramina.

The artery is the representative of the caudal prolongation of the aorta of animals, and its lateral branches correspond to the intercostal and lumbar arteries in the dorsal and lumbar regions.

Coccygeal Gland, or Luschka's Gland.—Lying near the tip of the coccyx in a small tendinous interval formed by the union of the Levator ani muscles of each side, and just above the coccygeal attachment of the Sphincter ani, is a small conglobate body about as large as a lentil or a pea, first described by Luschka,[1] and named by him the *coccygeal gland*. Its most obvious connections are with the arteries of the part.

Structure.—It consists of a congeries of small arteries with little aneurismal dilatations derived from the middle sacral and freely communicating with each

[1] *Der Hirnanhang und die Steissdrüse des Menschen*, Berlin, 1860; *Anatomie des Menschen*, Tübingen, 1864, vol. ii. pt. 2, p. 187.

other. These vessels are enclosed in one or more layers of polyhedral granular cells, and the whole structure is invested in a capsule of connective tissue which sends in trabeculæ, dividing the interior into a number of spaces in which the vessels and cells are contained. Nerves pass into this little body from the sympathetic, but their mode of termination is unknown. Macalister believes the glomerulus of vessels "consists of the condensed and convoluted metameric dorsal arteries of the caudal segments imbedded in tissue which is possibly a small persisting fragment of the neurenteric canal."

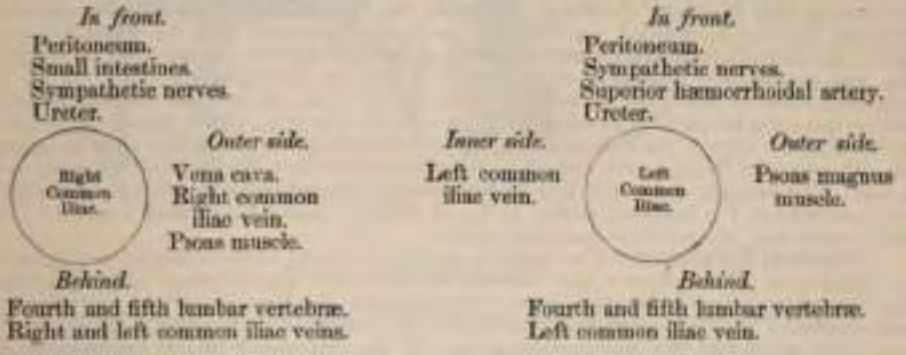
THE COMMON ILIAC ARTERIES.

The abdominal aorta divides into the two **common iliac arteries.** The bifurcation usually takes place on the left side of the body of the fourth lumbar vertebra. The common iliac arteries are about two inches in length; diverging from the termination of the aorta, they pass downward and outward to the margin of the pelvis, and divide opposite the intervertebral substance, between the last lumbar vertebra and the sacrum, into two branches, the *external* and *internal iliac arteries*, the former supplying the lower extremity; the latter, the viscera and parietes of the pelvis.

The **right common iliac** is somewhat longer than the left, and passes more obliquely across the body of the last lumbar vertebra. In front of it are the peritoneum, the small intestines, branches of the sympathetic nerve, and, at its point of division, the ureter. *Behind*, it is separated from the fourth and fifth lumbar vertebræ, with the intervening intervertebral disc, by the two common iliac veins. On its *outer side*, it is in relation with the inferior vena cava and the right common iliac vein, above, and the Psoas magnus muscle below.

The **left common iliac** is in relation, in front, with the peritoneum, branches of the sympathetic nerve, and the superior hæmorrhoidal artery; and is crossed at its point of bifurcation by the ureter. It rests on the bodies of the fourth and fifth lumbar vertebræ, with the intervening intervertebral disc. The left common iliac vein lies partly on the inner side, and partly beneath the artery; on its outer side, the artery is in relation with the Psoas magnus muscle.

PLAN OF THE RELATIONS OF THE COMMON ILIAC ARTERIES.



Branches.—The common iliac arteries give off small branches to the peritoneum Psoas magnus, ureters, and the surrounding cellular tissue, and occasionally give origin to the ilio-lumbar or renal arteries.

Peculiarities.—The *point of origin* varies according to the bifurcation of the aorta. In three-fourths of a large number of cases the aorta bifurcated either upon the fourth lumbar vertebra or upon the intervertebral disk between it and the fifth, the bifurcation being, in one case out of nine below, and in one out of eleven above, this point. In ten out of every thirteen cases the vessel bifurcated within half an inch above or below the level of the crest of the ilium more frequently below than above.

The point of division is subject to great variety. In two-thirds of a large number of cases it was between the last lumbar vertebra and the upper border of the sacrum being above that

point in one case out of eight; and below it in one case out of six. The left common iliac artery divides lower down more frequently than the right.

The *relative length*, also, of the two common iliac arteries varies. The right common iliac was the longer in sixty-three cases, the left in fifty-two, whilst they were both equal in fifty-three. The length of the arteries varied in five-sevenths of the cases examined from an inch and a half to three inches; in about half of the remaining cases the artery was longer and in the other half shorter, the minimum length being less than half an inch, the maximum four and a half inches. In two instances the right common iliac has been found wanting, the external and internal iliacs arising directly from the aorta.

Surface Marking.—Draw a zone round the body opposite the highest part of the crest of the ilium; in this line take a point half an inch to the left of the middle line. From this draw two lines to points midway between the anterior superior spines of the ilium and the symphysis pubis. These two diverging lines will represent the course of the common and external iliac arteries. Draw a second zone round the body corresponding to the level of the anterior superior spines of the ilium: the portion of the diverging lines between the two zones will represent the course of the common iliac artery; the portion below the lower zone, that of the external iliac artery.

Surgical Anatomy.—The application of a ligature to the common iliac artery may be required on account of aneurism or hæmorrhage implicating the external or internal iliacs. Now that the surgeon no longer dreads opening the peritoneal cavity, there can be no question that the easiest and best method of tying the artery is by a transperitoneal route. The abdomen is opened by an incision in either the semilunar line or the linea alba; the intestines are drawn to one side and the peritoneum covering the artery divided. The sheath is then opened, and the needle passed from within outward. On the right side great care must be exercised in passing the needle, since both the common iliac veins lie behind the artery. After the vessel has been tied the incision in the peritoneum over the artery should be sutured. Formerly there were two different methods by which the common iliac artery was tied, without opening the peritoneal cavity: 1, an anterior or iliac incision, by which the vessel is approached more directly from the front; and 2, a posterior abdominal or lumbar incision, by which the vessel is reached from behind. If the surgeon select the iliac region, a curved incision, from five to eight inches in length according to the amount of fat, is made, commencing just outside the middle of Poupart's ligament and a finger's breadth above it, and carried outward toward the anterior superior iliac spine, then upward toward the ribs, and finally curving inward toward the umbilicus. The abdominal muscles and transversalis fascia are divided, and the peritoneum raised upward and inward until the Psoas is reached. The artery will be found on the inner side of this muscle, and is to be cleared with a director, especial care being taken on the right side, as here the common iliac veins lie behind the artery. The aneurism needle is to be passed from within outward. But if the aneurismal tumor should extend high up in the abdomen, along the external iliac, it is better to select the posterior or lumbar, by making an incision partly in the abdomen, partly in the loin. The incision is commenced at the anterior extremity of the last rib, proceeding directly downward to the ilium; it is then curved forward along the crest of the ilium and a little above it to the anterior superior spine of that bone. The abdominal muscles having been cautiously divided in succession, the transversalis fascia must be carefully cut through, and the peritoneum, together with the ureter, separated from the artery and pushed aside; the sacro-iliac articulation must then be felt for, and upon it the vessel will be felt pulsating, and may be fully exposed in close connection with its accompanying vein. On the right side both common iliac veins, as well the inferior vena cava, are in close connection with the artery, and must be carefully avoided. On the left side the vein usually lies on the inner side and behind the artery; but it occasionally happens that the two common iliac veins are joined on the left instead of the right side, which would add much to the difficulty of an operation in such a case. The common iliac artery may be so short that danger may be apprehended from secondary hæmorrhage if a ligature is applied to it. It would be preferable, in such a case, to tie both the external and internal iliacs near their origin.

Collateral Circulation.—The principal agents in carrying on the collateral circulation after the application of a ligature to the common iliac are—the anastomoses of the hæmorrhoidal branches of the internal iliac with the superior hæmorrhoidal from the inferior mesenteric; the anastomoses of the uterine and ovarian arteries and of the vesical arteries of opposite sides; of the lateral sacral with the middle sacral artery; of the epigastric with the internal mammary, inferior intercostal, and lumbar arteries; of the circumflex iliac with the lumbar arteries; of the ilio-lumbar with the last lumbar artery; of the obturator artery, by means of its pubic branch, with the vessel of the opposite side and with the deep epigastric.

Compression of the Common Iliac Arteries.—The common iliac arteries are most efficiently compressed by Davy's lever. The instrument consists of a gum-elastic tube about two feet long, in which fits a round wooden "lever" considerably longer than the tube. A small quantity of olive oil having been injected into the rectum, the gum-elastic tube, softened in hot water, is passed into the bowel sufficiently far to permit its pressing upon the common iliac artery as it lies in the groove between the last lumbar vertebra and the Psoas muscle. The wooden lever is then inserted into the tube, and the projecting end carried toward the opposite thigh and raised, when it acts as a lever of the first order, the anus being the fulcrum. In cases

where the meso-rectum is abnormally short it may be impossible, without unjustifiable force, to compress the artery on the right side.

Internal Iliac Artery (Fig. 312).

The **internal iliac artery** supplies the walls and viscera of the pelvis, the generative organs, and inner side of the thigh. It is a short thick vessel, smaller in the adult than the external iliac, and about an inch and a half

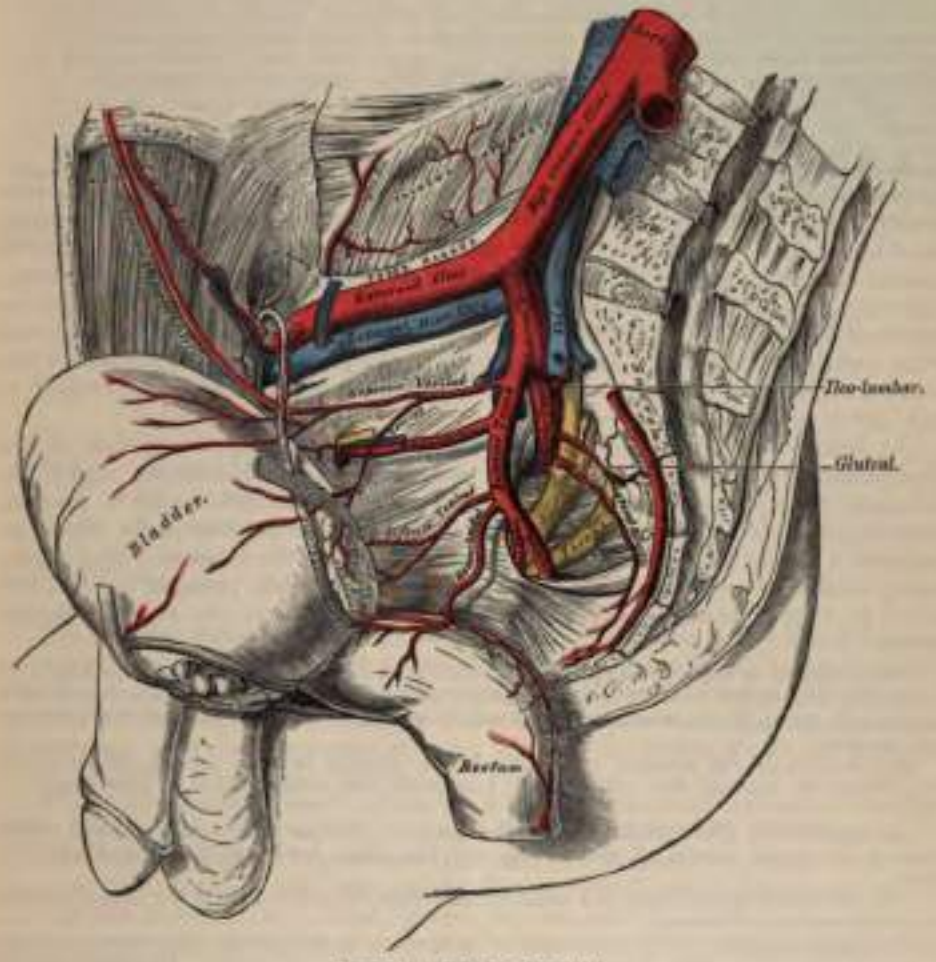
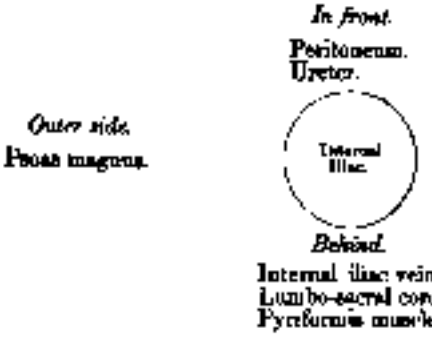


FIG. 312.—Arteries of the pelvis.

in length. It arises at the point of bifurcation of the common iliac, and, passing downward to the upper margin of the great sacro-sciatic foramen, divides into two large trunks, an *anterior* and *posterior*; from its anterior division a partially obliterated cord, the *hypogastric artery*, extends forward to the bladder.

Relations.—*In front*, with the ureter, which separates it from the peritoneum. *Behind*, with the internal iliac vein, the lumbo-sacral cord, and Pyriformis muscle. By its *outer side*, near its origin, with the Psoas magnus muscle.

PLAN OF THE RELATIONS OF THE INTERNAL ILIAC ARTERY.



In the fœtus the internal iliac artery (*hypogastric*) is twice as large as the external iliac, and appears to be the continuation of the common iliac. Instead of dipping into the pelvis, it passes forward to the bladder, and ascends along the sides of that viscus to its summit, to which it gives branches; it then passes upward along the back part of the anterior wall of the abdomen to the umbilicus, converging toward its fellow of the opposite side. Having passed through the umbilical opening, the two arteries twine round the umbilical vein, forming with it the umbilical cord, and ultimately ramify in the placenta. The portion of the vessel within the abdomen is called the *hypogastric artery*, and that external to that cavity, the *umbilical artery*.

At birth, when the placental circulation ceases, the upper portion of the hypogastric artery, extending from the summit of the bladder to the umbilicus, contracts, and ultimately dwindles to a solid fibrous cord; but the lower portion, extending from its origin (in what is now the internal iliac artery) for about an inch and a half to the wall of the bladder, and thence to the summit of that organ, is not totally impervious, though it becomes considerably reduced in size, and serves to convey blood to the bladder under the name of the *superior vesical artery*.

Peculiarities as regards Length.—In two-thirds of a large number of cases the length of the internal iliac varied between an inch and an inch and a half; in the remaining third it was more frequently longer than shorter, the maximum length being three inches, the minimum half an inch.

The lengths of the common and internal iliac arteries bear an inverse proportion to each other, the internal iliac artery being long when the common iliac is short, and vice versâ.

As regards its Place of Division.—The plane of division of the internal iliac curves between the upper margin of the sacrum and the upper border of the sacro-sciatic foramen.

The arteries of the two sides in a series of cases often differed in length, but neither exceed constantly to exceed the other.

Surgical Anatomy.—The application of a ligature to the internal iliac artery may be required in cases of aneurism or hæmorrhage affecting one of its branches. The vessel may be secured by making an incision through the abdominal parietes in the iliac region in a direction and to an extent similar to that for securing the common iliac: the transversalis fascia having been carefully divided, and the peritoneum pushed inward from the iliac fossa toward the pelvis, the finger may feel the pulsation of the external iliac at the bottom of the wound, and by tracing this vessel upward the internal iliac is arrived at, opposite the sacro-iliac articulation. It should be remembered that the vein lies behind and on the right side, a little external to the artery, and in close contact with it; the ureter and peritoneum, which lie in front, must also be avoided. The degree of facility in applying a ligature to this vessel will mainly depend upon its length. It has been seen that in the great majority of the cases examined the artery was short, varying from an inch to an inch and a half; in these cases the artery is deeply seated in the pelvis; when, on the contrary, the vessel is longer, it is found partly above that cavity. If the artery is very short, as occasionally happens, it would be preferable to apply a ligature to the common iliac or upon the external and internal iliacs at their origin.

Probably a better method of tying the internal iliac artery is by an abdominal section in the median line and reaching the vessel through the peritoneal cavity. This plan has been advocated by Dennis of New York on the following grounds: (1) It no way increases the danger of the operation; (2) it prevents a series of accidents which have occurred during ligature of the artery by the older methods; (3) it enables the surgeon to ascertain the exact extent of disease

in the main arterial trunk, and select his spot for the application of the ligature; and (4) it occupies much less time.

Collateral Circulation.—In Professor Owen's dissection of a case in which the internal iliac artery had been tied by Stevens ten years before death for aneurism of the sciatic artery, the internal iliac was found impervious for about an inch above the point where the ligature had been applied, but the obliteration did not extend to the origin of the external iliac, as the ilio-lumbar artery arose just above this point. Below the point of obliteration the artery resumed its natural diameter, and continued so for half an inch, the obturator, lateral sacral, and gluteal arising in succession from the latter portion. The obturator artery was entirely obliterated. The lateral sacral artery was as large as a crow's quill, and had a very free anastomosis with the artery of the opposite side and with the middle sacral artery. The sciatic artery was entirely obliterated as far as its point of connection with the aneurismal tumor, but on the distal side of the sac it was continued down along the back of the thigh nearly as large in size as the femoral, being pervious about an inch below the sac by receiving an anastomosing vessel from the profunda.[1] The circulation was carried on by the anastomoses of the uterine and ovarian arteries; of the opposite vesical arteries; of the hæmorrhoidal branches of the internal iliac with those from the inferior mesenteric; of the obturator artery, by means of its pubic branch, with the vessel of the opposite side and with the epigastric and internal circumflex; of the circumflex and perforating branches of the profunda femoris with the sciatic, of the gluteal with the posterior branches of the sacral arteries; of the ilio lumbar with the last lumbar; of the lateral sacral with the middle sacral; and of the circumflex iliac with the ilio-lumbar and gluteal.

BRANCHES OF THE INTERNAL ILIAC.

From the Anterior Trunk.	*From the Posterior Trunk.*
Superior Vesical.	Ilio-lumbar.
Middle Vesical.	Lateral Sacral.
Inferior Vesical.	Gluteal.
Middle Hæmorrhoidal.	
Obturator.	
Internal Pudic.	
Sciatic.	
In female { Uterine.	
In female { Vaginal.	

The **superior vesical** is that part of the fœtal hypogastric artery which remains pervious after birth. It extends to the side of the bladder, distributing numerous branches to the apex and body of the organ. From one of these a slender vessel is derived which accompanies the vas deferens in its course to the testis, where it anastomoses with the spermatic artery. This is the *artery of the vas deferens*. Other branches supply the ureter.

The **middle vesical**, usually a branch of the superior, is distributed to the base of the bladder and under surface of the vesiculæ seminales.

The **inferior vesical** arises from the anterior division of the internal iliac, frequently in common with the middle hæmorrhoidal, and is distributed to the base of the bladder, the prostate gland, and vesiculæ seminales. The branches distributed to the prostate communicate with the corresponding vessel of the opposite side.

The **middle hæmorrhoidal artery** usually arises together with the preceding vessel. It supplies the anus and parts outside the rectum, anastomosing with the other hæmorrhoidal arteries.

The **uterine artery** (Fig. 313) passes inward from the anterior trunk of the internal iliac to the neck of the uterus. Ascending in a tortuous course on the side of this viscus, between the layers of the broad ligament, it distributes branches to its substance, anastomosing, near its termination, with a branch from the ovarian artery. It gives off branches to the cervix uteri (*cervical*), and branches which descend on the vagina, and, joining with branches from the vaginal arteries, form a median longitudinal vessel both in front and behind; these descend on the anterior and posterior surfaces of the vagina, and are named the *azygos arteries of the vagina*.

[1] *Medico-Chirurgical Trans.*, vol. xvi.

The **vaginal artery** is analogous to the inferior vesical in the male; it descends upon the vagina, supplying its mucous membrane, and sending branches to the neck of the bladder and contiguous part of the rectum. It assists in forming the azygos arteries of the vagina.

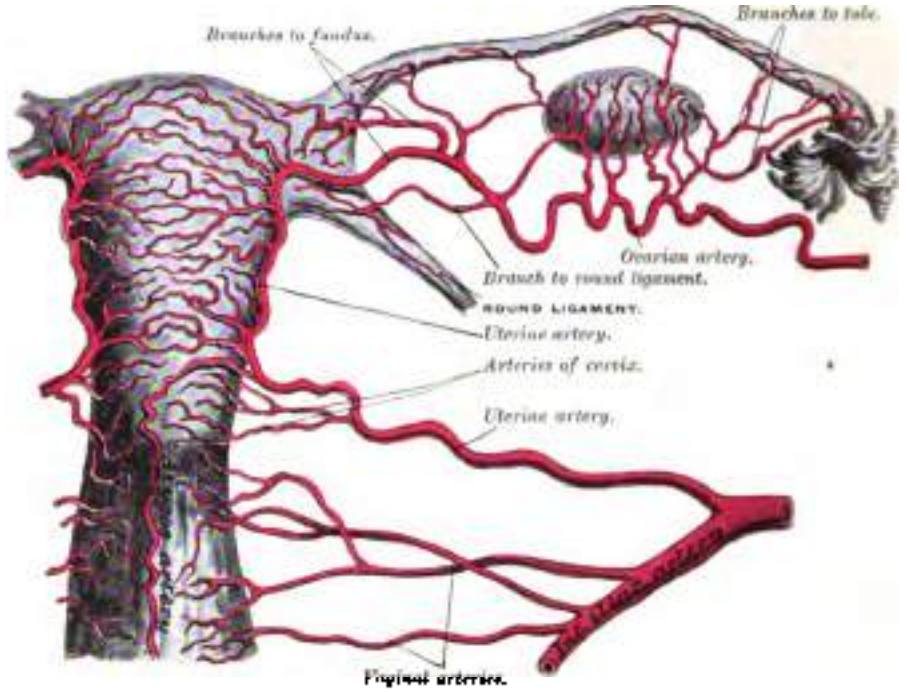


FIG. 313.—The arteries of the internal organs of generation of the female, seen from behind. (After Hirtl.)

The **Obturator Artery** usually arises from the anterior trunk of the internal iliac; frequently from the posterior. It passes forward, below the brim of the pelvis, to the upper part of the obturator foramen, and, escaping from the pelvic cavity through a short canal formed by a groove on the under surface of the ascending ramus of the os pubis and the arched border of the obturator membrane, it divides into an internal and external branch. In the pelvic cavity this vessel lies upon the pelvic fascia, beneath the peritoneum, and a little below the obturator nerve.

Branches.— *Within the pelvis*, the obturator artery gives off an *iliac branch* to the iliac fossa, which supplies the bone and the Iliacus muscle, and anastomoses with the ilio-lumbar artery; a *vesical branch*, which runs backward to supply the bladder; and a *pubic branch*, which is given off from the vessel just before it leaves the pelvic cavity. This branch ascends upon the back of the os pubis, communicating with offsets from the deep epigastric artery and with the corresponding vessel of the opposite side. It is placed on the inner side of the femoral ring. *External to the pelvis*, the obturator artery divides into an *internal* and an *external branch*, which are deeply situated beneath the Obturator externus muscle.

The **internal branch** curves downward along the inner margin of the obturator foramen, lying beneath the Obturator externus muscle; it distributes branches to the Obturator externus, Pectineus, Adductors, and Gracilis, and anastomoses with the external branch and with the internal circumflex artery.

The **external branch** curves round the outer margin of the foramen, also lying beneath the Obturator externus muscle, to the space between the Gemellus inferior and Quadratus femoris, where it divides into two branches: one, the smaller, courses inward around the lower margin of the foramen and anastomoses with the internal branch and with the internal circumflex; the other inclines outward in the groove

below the acetabulum, and supplies the muscles attached to the tuberosity of the ischium and anastomoses with the sciatic artery. It sends a branch to the hip-joint through the cotyloid notch, which ramifies on the round ligament as far as the head of the femur.

Peculiarities.—In two out of every three cases the obturator arises from the internal iliac; in one case in three and a half from the epigastric; and in about one in seventy-two cases by two roots from both vessels. It arises in about the same proportion from the external iliac artery. The origin of the obturator from the epigastric is not commonly found on both sides of the same body.

When the obturator artery arises at the front of the pelvis from the epigastric, it descends almost vertically to the upper part of the obturator foramen. The artery in this course usually lies in contact with the external iliac vein and on the outer side of the femoral ring (Fig. 314, A); in such cases it would not be endangered in the operation for femoral hernia. Occasionally, however, it curves inward along the free margin of Gimbernat's ligament (Fig. 314, B), and

FIG. 314.—Variations in origin and course of obturator artery.

under such circumstances would almost completely encircle the neck of a hernial sac (supposing a hernia to exist in such a case), and would be in great danger of being wounded if an operation was performed.

The **internal pudic** is the smaller of the two terminal branches of the anterior trunk of the internal iliac, and supplies the external organs of generation. Though the course of the artery is the same in the two sexes, the vessel is much smaller in the female than in the male, and the distribution of its branches somewhat different. The description of its arrangement in the male will first be given, and subsequently the differences which it presents in the female will be mentioned.

The **Internal Pudic Artery in the Male** passes downward and outward to the lower border of the great sacro-sciatic foramen, and emerges from the pelvis between the Pyriformis and Coccygeus muscles: it then crosses the spine of the ischium and re-enters the pelvis through the lesser sacro-sciatic foramen. The artery now crosses the Obturator internus muscle along the outer wall of the ischio-rectal fossa, being situated about an inch and a half above the lower margin of the ischial tuberosity. It is here contained in a sheath of the obturator fascia, and gradually approaches the margin of the ramus of the ischium, along which it passes forward and upward, pierces the base of the superficial layer of the triangular ligament of the urethra, and runs forward along the inner margin of the ramus of the os pubis, and divides into its two terminal branches, the *dorsal artery of the penis* and the *artery of the corpus cavernosum*.

Relations.—In the first part of its course, within the pelvis, it lies in front of the Pyriformis muscle and sacral plexus of nerves, and the sciatic artery, and on the outer side of the rectum (on the left side). As it crosses the spine of the ischium it is covered by the Gluteus maximus and overlapped by the great sacro-sciatic ligament. Here the obturator nerve lies to the inner side and the nerve to the Obturator internus to the outer side of the vessel. In the pelvis it lies on the outer side of the ischio-rectal fossa, upon the surface of the Obturator internus muscle, contained in a fibrous canal (canal of Alcock) formed by the splitting of the obturator fascia. It is accompanied by the pudic veins and the pudic nerve.

Peculiarities.—The internal pudic is sometimes smaller than usual, or fails to give off one or two of its usual branches: in such cases the deficiency is supplied by branches derived from an additional vessel, the *accessory pudic*, which generally arises from the internal pudic artery before its exit from the great sacro-sciatic foramen. It passes forward along the lower part of the bladder and across the side of the prostate gland to the root of the penis, where it perforates the triangular ligament and gives off its branches usually derived from the pudic artery. The deficiency most frequently met with is that in which the internal pudic ends as the artery of the bulb, the artery of the corpus cavernosum and arteria dorsalis penis being derived from the accessory pudic. The pudic may terminate as the superficial perineal, the artery of the bulb being derived with the other two branches from the accessory vessel. Occasionally the accessory pudic artery is derived from one of the other branches of the internal iliac, most frequently the inferior vesical or the obturator.

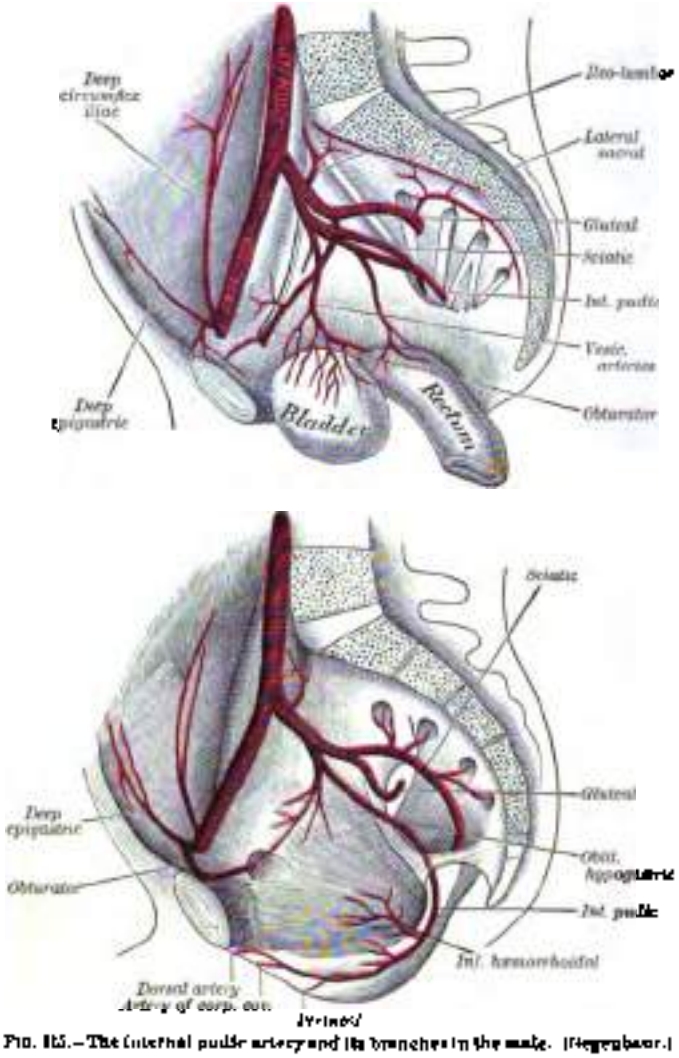


FIG. 415.—The internal pudic artery and its branches in the male. (Hirschfeld.)

Surgical Anatomy.—The relation of the accessory pudic to the prostate gland and urethra is of the greatest interest in a surgical point of view, as the vessel is in danger of being wounded in the lateral operation of lithotomy. The student should also study the position of the internal pudic artery and its branches, when pursuing a normal course with regard to the same operation. The superficial and the transverse perineal arteries are of necessity divided in the operation, but the hæmorrhage from these vessels is seldom excessive; should a ligature be required, it can readily be applied on account of their superficial position. The artery of the bulb may be divided if the incision be carried too far forward, and injury of this vessel may be attended with serious or even fatal consequences. The main trunk of the internal pudic artery may be wounded if the incision be carried too far outward; but, being bound down by the strong obturator fascia and under cover of the ramus of the ischium, the accident is not very likely to occur unless the vessel runs an anomalous course.

Branches.—The branches of the internal pudic artery are—

Muscular.	Transverse Perineal.
Inferior Hæmorrhoidal.	Artery of the Bulb.
Superficial Perineal.	Artery of the Corpus Cavernosum.
	Dorsal Artery of the Penis.

The **muscular branches** consist of two sets—one given off in the pelvis, the other as the vessel crosses the ischial spine. The former are several small offsets which supply the Levator ani, the Obturator internus, the Pyriformis, and the

Coccygeus muscles. The branches given off outside the pelvis are distributed to the adjacent part of the Gluteus maximus and External rotator muscles. They anastomose with branches of the sciatic artery.

The **inferior hæmorrhoidal** are two or three small arteries which arise from the internal pudic as it passes above the tuberosity of the ischium. Crossing the ischio-rectal fossa, they are distributed to the muscles and integument of the anal region.

The **superficial perineal artery** supplies the scrotum and muscles and integument of the perinæum. It arises from the internal pudic in front of the preceding branches, and turns upward, crossing either over or under the Transversus perinæi muscle, and runs forward, parallel to the pubic arch, in the interspace between the Accelerator urinæ and Erector penis muscles, both of which it supplies, and is finally distributed to the skin and dartos of the scrotum. In its passage through the perinæum it lies beneath the superficial perineal fascia.

The **transverse perineal** is a small branch which arises either from the internal pudic or from the superficial perineal artery as it crosses the Transversus perinæi muscle. It runs transversely inward along the cutaneous surface of the Transversus perinæi muscle, which it supplies, as well as the structures between the anus and bulb of the urethra, and anastomoses with the one of the opposite side.

The **artery of the bulb** is a large but very short vessel which arises from the internal pudic between the two layers of the triangular ligament, and, passing nearly transversely inward, between the fibres of the Compressor urethræ muscle, it pierces the bulb of the urethra, in which it ramifies. It gives off a small branch which descends to supply Cowper's gland.

Surgical Anatomy.—This artery is of considerable importance in a surgical point of view, as it is in danger of being wounded in the lateral operation of lithotomy—an accident usually attended in the adult with alarming hæmorrhage. The vessel is sometimes very small, occasionally wanting, or even double. It sometimes arises from the internal pudic earlier than usual, and crosses the perinæum to reach the back part of the bulb. In such a case the vessel could hardly fail to be wounded in the performance of the lateral operation of lithotomy. If, on the contrary, it should arise from an accessory pudic, it lies more forward than usual and is out of danger in the operation.

The **artery of the corpus cavernosum**, one of the terminal branches of the internal pudic, arises from that vessel while it is situated between the two layers of the triangular ligament; it pierces the superficial layer, and, entering the crus penis obliquely, it runs forward in the centre of the corpus cavernosum, to which its branches are distributed.

The **dorsal artery of the penis** ascends between the crus and pubic symphysis, and, piercing the triangular ligament, passes between the two layers of the suspensory ligament of the penis, and runs forward on the dorsum of the penis to the glans, where it divides into two branches, which supply the glans and prepuce. On the dorsum of the penis it lies immediately beneath the integument, parallel with the dorsal vein and the corresponding artery of the opposite side. It supplies the integument and fibrous sheath of the corpus cavernosum, sending branches through the sheath to anastomose with the preceding vessel.

The **Internal Pudic Artery in the Female** is smaller than in the male. Its origin and course are similar, and there is considerable analogy in the distribution of its branches. The superficial perineal artery supplies the labia pudendi; the artery of the bulb supplies the bulbi vestibuli and the erectile tissue of the vagina; the artery of the corpus cavernosum supplies the cavernous body of the clitoris; and the arteria dorsalis clitoridis supplies the dorsum of that organ, and terminates in the glans and in the membranous fold corresponding to the prepuce of the male.

The **Sciatic Artery** (Fig. 316), the larger of the two terminal branches of the anterior trunk of the internal iliac, is distributed to the muscles at the back of the pelvis. It passes down to the lower part of the great sacro-sciatic foramen behind the internal pudic artery, resting on the sacral plexus of nerves and Pyriformis

muscle, and escapes from the pelvis through this foramen between the Pyriformis and Coccygeus. It then descends in the interval between the trochanter major and tuberosity of the ischium, accompanied by the sciatic nerves, and covered by the Gluteus maximus, and is continued down the back of the thigh supplying the skin, and anastomosing with branches of the perforating arteries.

Within the pelvis it distributes branches to the Pyriformis, Coccygeus, and Levator ani muscles; some hæmorrhoidal branches, which supply the rectum, and occasionally take the place of the middle hæmorrhoidal artery; and vesical branches to the base and neck of the bladder, vesiculæ seminales, and prostate gland. *External to the pelvis* it gives off the following branches:

Coccygeal.
Inferior Gluteal.
Comes Nervi Ischiadici.
Muscular.
Anastomotic.
Articular.

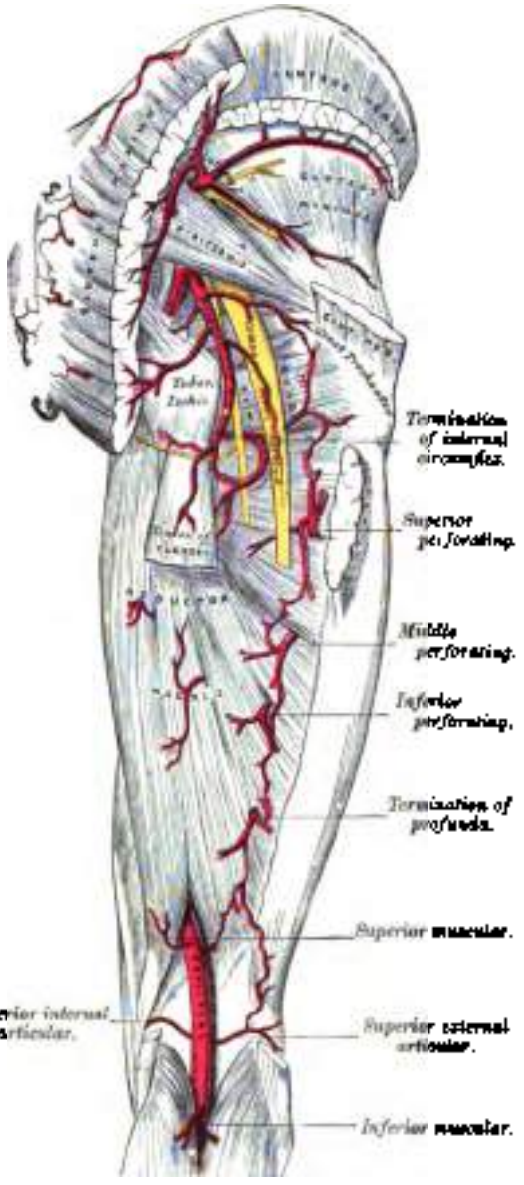


Fig. 336.—The arteries of the gluteal and posterior femoral regions.

The **coccygeal branch** runs inward, pierces the great sacro-sciatic ligament, and supplies the Gluteus maximus, the integument, and other structures on the back of the coccyx.

The **inferior gluteal branches**, three or four in number, supply the Gluteus maximus muscle, anastomosing with the gluteal artery in the substance of the muscle.

The **comes nervi ischiadici** is a long, slender vessel which accompanies the great sciatic nerve for a short distance; it then penetrates it and runs in its substance to the lower part of the thigh.

The **muscular branches** supply the Gluteus maximus, anastomosing with the gluteal artery in the substance of the muscle: the external rotators, anastomosing with the internal pudic artery; and the muscles attached to the tuberosity of the ischium, anastomosing with the external branch of the obturator and the internal circumflex.

[illegible]ic artery is directed downward across the external rotators, and [illegible]g the so-called *crucial anastomosis* by anastomosing with the [illegible]ng and the internal and external circumflex.

The articular branch, generally derived from the anastomotic, is distributed to the capsule of the hip-joint.

The **Ilio-lumbar Artery**, given off from the posterior trunk of the internal iliac, runs upward and outward between the obturator nerve and lumbo-sacral cord to the inner margin of the Psoas muscle, behind which it divides into a lumbar and an iliac branch.

The **lumbar branch** supplies the Psoas and Quadratus lumborum muscles, anastomosing with the last lumbar artery, and sends a small spinal branch through the intervertebral foramen, between the last lumbar vertebra and the sacrum, into the spinal canal, to supply the cauda equina.

The **iliac branch** descends to supply the Iliacus muscle; some offsets, running between the muscle and the bone, anastomose with the iliac branch of the obturator; one of these enters an oblique canal to supply the diploë, whilst others run along the crest of the ilium, distributing branches to the Gluteal and Abdominal muscles, and anastomose in their course with the gluteal, circumflex iliac, and external circumflex arteries.

The **Lateral Sacral Arteries** (Fig. 312) are usually two in number on each side, superior and inferior.

The superior, which is of large size, passes inward, and, after anastomosing with branches from the middle sacral, enters the first or second anterior sacral foramen, is distributed to the contents of the sacral canal, and, escaping by the corresponding posterior sacral foramen, supplies the skin and muscles on the dorsum of the sacrum, anastomosing with the gluteal.

The **inferior** passes obliquely across the front of the Pyriformis muscle and sacral nerves to the inner side of the anterior sacral foramina, descends on the front of the sacrum, and anastomoses over the coccyx with the sacra media and opposite lateral sacral arteries. In its course it gives off branches which enter the anterior sacral foramina; these, after supplying the contents of the sacral canal, escape by the posterior sacral foramina, and are distributed to the muscles and skin on the dorsal surface of the sacrum, anastomosing with the gluteal.

The Gluteal Artery is the largest branch of the internal iliac, and appears to be the continuation of the posterior division of that vessel. It is a short, thick trunk, which passes out of the pelvis above the upper border of the Pyriformis muscle, and immediately divides into a *superficial* and *deep branch*. Within the pelvis it gives off a few muscular branches to the Iliacus, Pyriformis, and Obturator internus, and, just previous to quitting that cavity, a nutrient artery, which enters the ilium.

The **superficial branch** passes beneath the Gluteus maximus and divides into numerous branches, some of which supply that muscle, whilst others perforate its tendinous origin, and supply the integument covering the posterior surface of the sacrum, anastomosing with the posterior branches of the sacral arteries.

The **deep branch** runs between the Gluteus medius and minimus, and subdivides into two. Of these, the superior division, continuing the original course of the vessel, passes along the upper border of the Gluteus minimus to the anterior superior spine of the ilium, anastomosing with the circumflex iliac and ascending branches of the external circumflex artery. The inferior division crosses the Gluteus minimus obliquely to the trochanter major, distributing branches to the Glutei muscles, and inosculates with the external circumflex artery. Some branches pierce the Gluteus minimus to supply the hip-joint.

Surface Marking.—The position of the three main branches of the internal iliac, the sciatic, internal pudic, and gluteal, which may occasionally be the object of surgical interference, is indicated on the surface in the following way: A line is to be drawn from the posterior superior iliac spine to the posterior superior angle of the great trochanter, with the limb slightly flexed and rotated inward: the point of emergence of the *gluteal artery* from the upper part of the sciatic notch will correspond with the junction of the upper with the middle third of this line. A second line is to be drawn from the same point to the outer part of the tuberosity of the ischium: the junction of the lower with the middle third marks the point of emergence of the *sciatic* and *pudic arteries* from the great sciatic notch.

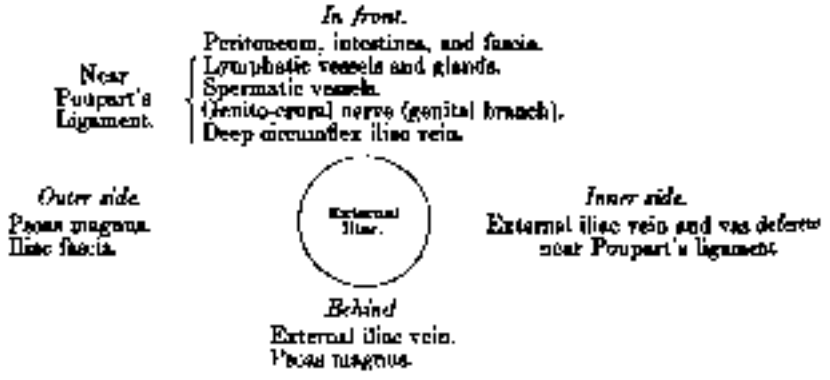
Surgical Anatomy.—Any of these three vessels may require ligating for a wound or for aneurism, which is generally traumatic. The *gluteal* artery is ligated by turning the patient two-thirds over on his face and making an incision from the posterior superior spine of the ilium to the upper and posterior angle of the great trochanter. This must expose the Gluteus maximus muscle, and its fibres are to be separated through the whole thickness of the muscle and pulled apart with retractors. The contiguous margins of the Gluteus medius and Pyriformis are now to be separated from each other, and the artery will be exposed emerging from the sciatic notch. In ligation of the *sciatic* artery, the incision should be made parallel with that for ligation of the gluteal, but one inch and a half lower down. After the fibres of the Gluteus maximus have been separated, the vessel is to be sought for at the lower border of the Pyriformis, the great sciatic nerve, which lies just above it, forming the chief guide to the artery.

The External Iliac Artery (Fig. 312).

The **external iliac artery** is larger in the adult than the internal iliac, and passes obliquely downward and outward along the inner border of the Psoas muscle, from the bifurcation of the common iliac to Poupart's ligament, where it enters the thigh and becomes the femoral artery.

Relations.—*In front*, with the peritoneum, subperitoneal areolar tissue, the termination of the ileum on the right side, and the sigmoid flexure on the left, and a thin layer of fascia derived from the iliac fascia, which surrounds the artery and vein. At its origin it is occasionally crossed by the ureter. The spermatic vessels descend for some distance upon it near its termination, and it is crossed in this situation by the genital branch of the genito-crural nerve and the deep circumflex iliac vein: the vas deferens curves down along its inner side. *Behind*, it is in relation with the external iliac vein, which, at Poupart's ligament, lies at its inner side; on the left side the vein is altogether internal to the artery. *Externally*, it rests against the Psoas muscle, from which it is separated by the iliac fascia. The artery rests upon this muscle, near Poupart's ligament. Numerous lymphatic vessels and glands are found lying on the front and inner side of the vessel.

PLAN OF THE RELATIONS OF THE EXTERNAL ILIAC ARTERY.



Surface Marking.—The surface line indicating the course of the external iliac artery has been already given (see page 560).

Surgical Anatomy.—The application of a ligature to the external iliac may be required in cases of aneurism of the femoral artery or for a wound of the artery. This vessel may be secured in any part of its course, excepting near its upper end, which is to be avoided on account of the proximity of the great stream of blood in the internal iliac, and near its lower end, which should also be avoided, on account of the proximity of the deep epigastric and circumflex iliac vessels. The patient having been placed in the supine position, an incision should be made, commencing below at a point about three-quarters of an inch above Poupart's ligament, and a little external to its middle, and running upward and outward, parallel to Poupart's ligament, to a point one inch internal and one inch above the anterior superior spine of the ilium. When the artery is deeply seated, more room will be required, and may be obtained by curving the incision from the point last named inward toward the umbilicus for a short distance. Another mode of ligating the vessel is the plan advocated by Sir Astley Cooper, by making an incision close to Poupart's ligament from about half an inch outside of the external abdominal ring to one inch internal to the anterior superior spine of the ilium. This incision lays

made in the course of the fibres of the aponeurosis of the external oblique, is less likely to be followed by a ventral hernia, but there is danger of wounding the epigastric artery, and only the lower end of the vessel can be ligated. Abernethy, who first tied this artery, made his incision in the course of the vessel. The abdominal muscles and transversalis fascia having been cautiously divided, the peritoneum should be separated from the iliac fossa and raised toward the pelvis; and on introducing the finger to the bottom of the wound, the artery may be felt pulsating along the inner border of the Psoas muscle. The external iliac vein is generally found on the inner side of the artery, and must be cautiously separated from it by the finger-nail or handle of the knife, and the aneurism needle should be introduced on the inner side, between the artery and the vein.

Ligation of the external iliac artery has recently been performed by a transperitoneal method. An incision four inches in length is made in the semilunar line, commencing about an inch below the umbilicus and carried through the abdominal wall into the peritoneal cavity. The intestines are then pushed upward and held out of the way by a broad abdominal retractor, and an incision made through the peritoneum at the margin of the pelvis in the course of the artery, and the vessel secured in any part of its course which may seem desirable to the operator. The advantages of this operation appear to be that if it is found necessary, the common iliac artery can be ligated instead of the external iliac without extension or modification of the incision; and secondly, that the vessel can be ligated without in any way interfering with the coverings of the sac. Possibly a disadvantage may exist in the greater risk of hernia after this method.

Collateral Circulation.—The principal anastomoses in carrying on the collateral circulation, after the application of a ligature to the external iliac, are—the ilio-lumbar with the circumflex iliac; the gluteal with the external circumflex; the obturator with the internal circumflex; the sciatic with the superior perforating and circumflex branches of the profunda artery; and the internal pudic with the external pudic. When the obturator arises from the epigastric, it is supplied with blood by branches, either from the internal iliac, the lateral sacral, or the internal pudic. The epigastric receives its supply from the internal mammary and inferior intercostal arteries, and from the internal iliac by the anastomoses of its branches with the obturator.

In the dissection of a limb eighteen years after the successful ligature of the external iliac artery by Sir A. Cooper, which is to be found in *Guy's Hospital Reports*, vol. i. p. 50, the anastomosing branches are described in three sets: *An anterior set.*—1, a very large branch from the ilio-lumbar artery to the circumflex iliac; 2, another branch from the ilio-lumbar, joined by one from the obturator, and breaking up into numerous tortuous branches to anastomose with the external circumflex; 3, two other branches from the obturator, which passed over the brim of the pelvis, communicated with the epigastric, and then broke up into a plexus to anastomose with the internal circumflex. *An internal set.*—Branches given off from the obturator, after quitting the pelvis, which ramified among the adductor muscles on the inner side of the hip-joint, and joined most freely with branches of the internal circumflex. *A posterior set.*—1, three large branches from the gluteal to the external circumflex; 2, several branches from the sciatic around the great sciatic notch to the internal and external circumflex, and the perforating branches of the profunda.

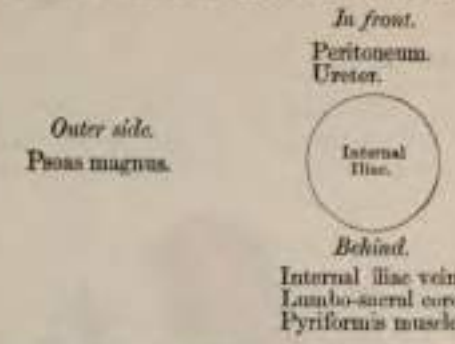
Branches.—Besides several small branches to the Psoas muscle and the neighboring lymphatic glands, the external iliac gives off two branches of considerable size—the

Deep Epigastric and Deep Circumflex Iliac.

The **Deep Epigastric Artery** arises from the external iliac a few lines above Poupart's ligament. It at first descends to reach this ligament, and then ascends obliquely along the inner margin of the internal abdominal ring, lying between the transversalis fascia and peritoneum, and, continuing its course upward, it pierces the transversalis fascia, and, passing over the semilunar fold of Douglas, enters the sheath of the Rectus muscle. It then ascends on the posterior surface of the muscle, and finally divides into numerous branches, which anastomose, above the umbilicus, with the superior epigastric branch of the internal mammary and with the inferior intercostal arteries (Fig. 301). The deep epigastric artery bears a very important relation to the internal abdominal ring as it passes obliquely upward and inward from its origin from the external iliac. In this part of its course it lies along the lower and inner margin of the ring and beneath the commencement of the spermatic cord. As it passes to the inner side of the internal abdominal ring it is crossed by the vas deferens in the male and the round ligament in the female.

Branches.—The branches of this vessel are the following: The *cremasteric*, which accompanies the spermatic cord, and supplies the Cremaster muscle and

PLAN OF THE RELATIONS OF THE INTERNAL ILIAC ARTERY.



In the fœtus the internal iliac artery (*hypogastric*) is twice as large as the external iliac, and appears to be the continuation of the common iliac. Instead of dipping into the pelvis, it passes forward to the bladder, and ascends along the sides of that viscus to its summit, to which it gives branches; it then passes upward along the back part of the anterior wall of the abdomen to the umbilicus, converging toward its fellow of the opposite side. Having passed through the umbilical opening, the two arteries twine round the umbilical vein, forming with it the umbilical cord, and ultimately ramify in the placenta. The portion of the vessel within the abdomen is called the *hypogastric artery*, and that external to that cavity, the *umbilical artery*.

At birth, when the placental circulation ceases, the upper portion of the hypogastric artery, extending from the summit of the bladder to the umbilicus, contracts, and ultimately dwindles to a solid fibrous cord; but the lower portion, extending from its origin (in what is now the internal iliac artery) for about an inch and a half to the wall of the bladder, and thence to the summit of that organ, is not totally impervious, though it becomes considerably reduced in size, and serves to convey blood to the bladder under the name of the *superior vesical artery*.

Peculiarities as regards Length.—In two-thirds of a large number of cases the length of the internal iliac varied between an inch and an inch and a half; in the remaining third it was more frequently longer than shorter, the maximum length being three inches, the minimum half an inch.

The lengths of the common and internal iliac arteries bear an inverse proportion to each other, the internal iliac artery being long when the common iliac is short, and *vice versâ*.

As regards its Place of Division.—The place of division of the internal iliac varies between the upper margin of the sacrum and the upper border of the sacro-sciatic foramen.

The arteries of the two sides in a series of cases often differed in length, but neither seemed constantly to exceed the other.

Surgical Anatomy.—The application of a ligature to the internal iliac artery may be required in cases of aneurism or hæmorrhage affecting one of its branches. The vessel may be secured by making an incision through the abdominal parietes in the iliac region in a direction and to an extent similar to that for securing the common iliac; the transversalis fascia having been cautiously divided, and the peritoneum pushed inward from the iliac fossa toward the pelvis, the finger may feel the pulsation of the external iliac at the bottom of the wound, and by tracing this vessel upward the internal iliac is arrived at, opposite the sacro-iliac articulation. It should be remembered that the vein lies behind and on the right side, a little external to the artery, and in close contact with it; the ureter and peritoneum, which lie in front, must also be avoided. The degree of facility in applying a ligature to this vessel will mainly depend upon its length. It has been seen that in the great majority of the cases examined the artery was short, varying from an inch to an inch and a half; in these cases the artery is deeply seated in the pelvis; when, on the contrary, the vessel is longer, it is found partly above that cavity. If the artery is very short, as occasionally happens, it would be preferable to apply a ligature to the common iliac or upon the external and internal iliacs at their origin.

Probably a better method of tying the internal iliac artery is by an abdominal section in the median line and reaching the vessel through the peritoneal cavity. This plan has been advocated by Dennis of New York on the following grounds: (1) It no way increases the danger of the operation; (2) it prevents a series of accidents which have occurred during ligature of the artery by the older methods; (3) it enables the surgeon to ascertain the exact extent of disease

in the main arterial trunk, and select his spot for the application of the ligature; and (4) it occupies much less time.

Collateral Circulation.—In Professor Owen's dissection of a case in which the internal iliac artery had been tied by Stevens ten years before death for aneurism of the sciatic artery, the internal iliac was found impervious for about an inch above the point where the ligature had been applied, but the obliteration did not extend to the origin of the external iliac, as the ilio-lumbar artery arose just above this point. Below the point of obliteration the artery resumed its natural diameter, and continued so for half an inch, the obturator, lateral sacral, and gluteal arising in succession from the latter portion. The obturator artery was entirely obliterated. The lateral sacral artery was as large as a crow's quill, and had a very free anastomosis with the artery of the opposite side and with the middle sacral artery. The sciatic artery was entirely obliterated as far as its point of connection with the aneurismal tumor, but on the distal side of the sac it was continued down along the back of the thigh nearly as large in size as the femoral, being pervious about an inch below the sac by receiving an anastomosing vessel from the profunda.[1] The circulation was carried on by the anastomoses of the uterine and ovarian arteries; of the opposite vesical arteries; of the hæmorrhoidal branches of the internal iliac with those from the inferior mesenteric; of the obturator artery, by means of its pubic branch, with the vessel of the opposite side and with the epigastric and internal circumflex; of the circumflex and perforating branches of the profunda femoris with the sciatic; of the gluteal with the posterior branches of the sacral arteries; of the ilio-lumbar with the last lumbar; of the lateral sacral with the middle sacral; and of the circumflex iliac with the ilio-lumbar and gluteal.

BRANCHES OF THE INTERNAL ILIAC.

From the Anterior Trunk.	*From the Posterior Trunk.*
Superior Vesical.	Ilio-lumbar.
Middle Vesical.	Lateral Sacral.
Inferior Vesical.	Gluteal.
Middle Hæmorrhoidal.	
Obturator.	
Internal Pudic.	
Sciatic.	
In female { Uterine.	
In female { Vaginal.	

The **superior vesical** is that part of the fœtal hypogastric artery which remains pervious after birth. It extends to the side of the bladder, distributing numerous branches to the apex and body of the organ. From one of these a slender vessel is derived which accompanies the vas deferens in its course to the testis, where it anastomoses with the spermatic artery. This is the *artery of the vas deferens*. Other branches supply the ureter.

The **middle vesical**, usually a branch of the superior, is distributed to the base of the bladder and under surface of the vesiculæ seminales.

The **inferior vesical** arises from the anterior division of the internal iliac, frequently in common with the middle hæmorrhoidal, and is distributed to the base of the bladder, the prostate gland, and vesiculæ seminales. The branches distributed to the prostate communicate with the corresponding vessel of the opposite side.

The **middle hæmorrhoidal artery** usually arises together with the preceding vessel. It supplies the anus and parts outside the rectum, anastomosing with the other hæmorrhoidal arteries.

The **uterine artery** (Fig. 313) passes inward from the anterior trunk of the internal iliac to the neck of the uterus. Ascending in a tortuous course on the side of this viscus, between the layers of the broad ligament, it distributes branches to its substance, anastomosing, near its termination, with a branch from the ovarian artery. It gives off branches to the cervix uteri (*cervical*), and branches which descend on the vagina, and, joining with branches from the vaginal arteries, form a median longitudinal vessel both in front and behind; these descend on the anterior and posterior surfaces of the vagina, and are named the *azygos arteries of the vagina*.

[1] *Medico-Chirurgical Trans.*, vol. xvi.

The **vaginal artery** is analogous to the inferior vesical in the male; it descends upon the vagina, supplying its mucous membrane, and sending branches to the neck of the bladder and contiguous part of the rectum. It assists in forming the azygos arteries of the vagina.

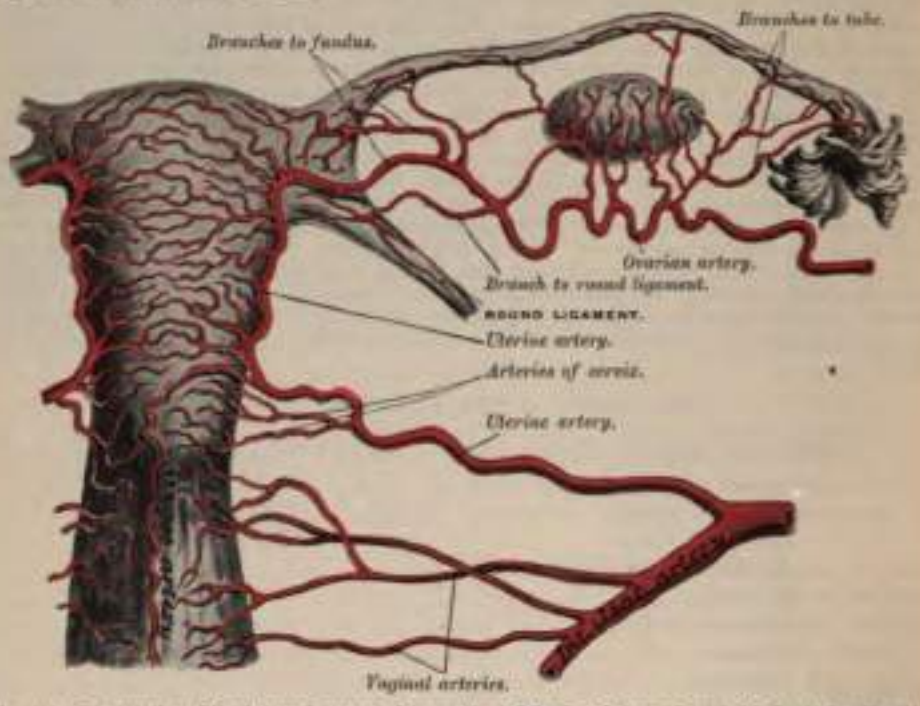


FIG. 333.—The arteries of the internal organs of generation of the female, seen from behind. (After Hyrtl.)

The **Obturator Artery** usually arises from the anterior trunk of the internal iliac; frequently from the posterior. It passes forward, below the brim of the pelvis, to the upper part of the obturator foramen, and, escaping from the pelvic cavity through a short canal formed by a groove on the under surface of the ascending ramus of the os pubis and the arched border of the obturator membrane, it divides into an internal and external branch. In the pelvic cavity this vessel lies upon the pelvic fascia, beneath the peritoneum, and a little below the obturator nerve.

Branches.— *Within the pelvis*, the obturator artery gives off an *iliac branch* to the iliac fossa, which supplies the bone and the Iliacus muscle, and anastomoses with the ilio-lumbar artery; a *vesical branch*, which runs backward to supply the bladder; and a *pubic branch*, which is given off from the vessel just before it leaves the pelvic cavity. This branch ascends upon the back of the os pubis, communicating with offsets from the deep epigastric artery and with the corresponding vessel of the opposite side. It is placed on the inner side of the femoral ring. *External to the pelvis*, the obturator artery divides into an *internal* and an *external branch*, which are deeply situated beneath the Obturator externus muscle.

The **internal branch** curves downward along the inner margin of the obturator foramen, lying beneath the Obturator externus muscle; it distributes branches to the Obturator externus, Pectineus, Adductors, and Gracilis, and anastomoses with the external branch and with the internal circumflex artery.

The **external branch** curves round the outer margin of the foramen, also lying beneath the Obturator externus muscle, to the space between the Gemellus inferior and Quadratus femoris, where it divides into two branches: one, the smaller, courses inward around the lower margin of the foramen and anastomoses with the internal branch and with the internal circumflex; the other inclines outward in the groove

below the acetabulum, and supplies the muscles attached to the tuberosity of the ischium and anastomoses with the sciatic artery. It sends a branch to the hip-joint through the cotyloid notch, which ramifies on the round ligament as far as the head of the femur.

Peculiarities.—In two out of every three cases the obturator arises from the internal iliac; in one case in three and a half from the epigastric; and in about one in seventy-two cases by two roots from both vessels. It arises in about the same proportion from the external iliac artery. The origin of the obturator from the epigastric is not commonly found on both sides of the same body.

When the obturator artery arises at the front of the pelvis from the epigastric, it descends almost vertically to the upper part of the obturator foramen. The artery in this course usually lies in contact with the external iliac vein and on the outer side of the femoral ring (Fig. 314, A); in such cases it would not be endangered in the operation for femoral hernia. Occasionally, however, it curves inward along the free margin of Gimbernat's ligament (Fig. 314, B), and

FIG. 314.—Variations in origin and course of obturator artery.

under such circumstances would almost completely encircle the neck of a hernial sac (supposing a hernia to exist in such a case), and would be in great danger of being wounded if an operation was performed.

The **internal pudic** is the smaller of the two terminal branches of the anterior trunk of the internal iliac, and supplies the external organs of generation. Though the course of the artery is the same in the two sexes, the vessel is much smaller in the female than in the male, and the distribution of its branches somewhat different. The description of its arrangement in the male will first be given, and subsequently the differences which it presents in the female will be mentioned.

The **Internal Pudic Artery in the Male** passes downward and outward to the lower border of the great sacro-sciatic foramen, and emerges from the pelvis between the Pyriformis and Coccygeus muscles: it then crosses the spine of the ischium and re-enters the pelvis through the lesser sacro-sciatic foramen. The artery now crosses the Obturator internus muscle along the outer wall of the ischio-rectal fossa, being situated about an inch and a half above the lower margin of the ischial tuberosity. It is here contained in a sheath of the obturator fascia, and gradually approaches the margin of the ramus of the ischium, along which it passes forward and upward, pierces the base of the superficial layer of the triangular ligament of the urethra, and runs forward along the inner margin of the ramus of the os pubis, and divides into its two terminal branches, the *dorsal artery of the penis* and the *artery of the corpus cavernosum*.

Relations.—In the first part of its course, within the pelvis, it lies in front of the Pyriformis muscle and sacral plexus of nerves, and the sciatic artery, and on the outer side of the rectum (on the left side). As it crosses the spine of the ischium it is covered by the Gluteus maximus and overlapped by the great sacro-sciatic ligament. Here the obturator nerve lies to the inner side and the nerve to the Obturator internus to the outer side of the vessel. In the pelvis it lies on the outer side of the ischio-rectal fossa, upon the surface of the Obturator internus muscle, contained in a fibrous canal (canal of Alcock) formed by the splitting of the obturator fascia. It is accompanied by the pudic veins and the pudic nerve.

Peculiarities.—The internal pudic is sometimes smaller than usual, or fails to give off one or two of its usual branches; in such cases the deficiency is supplied by branches derived from an additional vessel, the *accessory pudic*, which generally arises from the internal pudic artery before its exit from the great sacro-sciatic foramen. It passes forward along the lower part of the bladder and across the side of the prostate gland to the root of the penis, where it perforates the triangular ligament and gives off the branches usually derived from the pudic artery. The deficiency most frequently met with is that in which the internal pudic ends as the artery of the bulb, the artery of the corpus cavernosum and arteria dorsalis penis being derived from the accessory pudic. Or the pudic may terminate as the superficial perineal, the artery of the bulb being derived, with the other two branches, from the accessory vessel. Occasionally the accessory pudic artery is derived from one of the other branches of the internal iliac, most frequently the inferior vesical or the obturator.

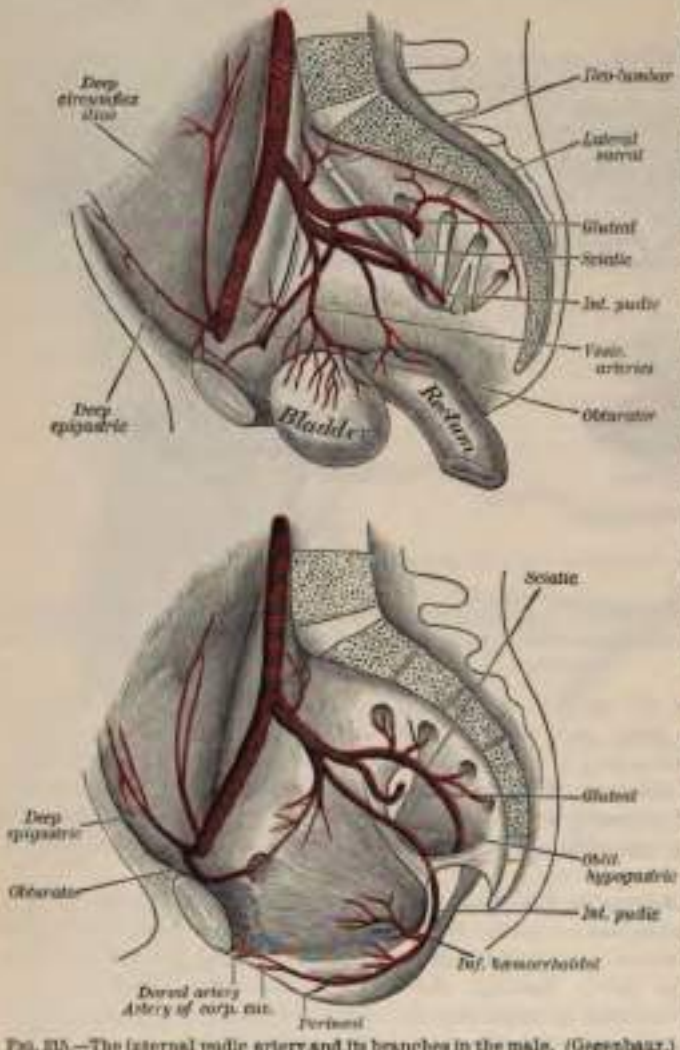


FIG. 313.—The internal pudic artery and its branches in the male. (Gegenbaur.)

Surgical Anatomy.—The relation of the accessory pudic to the prostate gland and urethra is of the greatest interest in a surgical point of view, as this vessel is in danger of being wounded in the lateral operation of lithotomy. The student should also study the position of the internal pudic artery and its branches, when running a normal course with regard to the same operation. The superficial and the transverse perineal arteries are, of necessity, divided in this operation, but the hemorrhage from these vessels is seldom excessive; should a ligature be required, it can readily be applied on account of their superficial position. The artery of the bulb may be divided if the incision be carried too far forward, and injury of this vessel may be attended with serious or even fatal consequences. The main trunk of the internal pudic artery may be wounded if the incision be carried too far outward; but, being bound down by the strong obturator fascia and under cover of the ramus of the ischium, the accident is not very likely to occur unless the vessel runs an anomalous course.

Branches.—The branches of the internal pudic artery are—

Muscular.	Transverse Perineal.
Inferior Hæmorrhoidal.	Artery of the Bulb.
Superficial Perineal.	Artery of the Corpus Cavernosum
	Dorsal Artery of the Penis.

The **muscular branches** consist of two sets—one given off in the pelvis, the other as the vessel crosses the ischial spine. The former are several small offsets which supply the Levator ani, the Obturator internus, the Pyriformis, and the

Coccygeus muscles. The branches given off outside the pelvis are distributed to the adjacent part of the Gluteus maximus and External rotator muscles. They anastomose with branches of the sciatic artery.

The **inferior hæmorrhoidal** are two or three small arteries which arise from the internal pudic as it passes above the tuberosity of the ischium. Crossing the ischio-rectal fossa, they are distributed to the muscles and integument of the anal region.

The **superficial perineal artery** supplies the scrotum and muscles and integument of the perinæum. It arises from the internal pudic in front of the preceding branches, and turns upward, crossing either over or under the Transversus perinæi muscle, and runs forward, parallel to the pubic arch, in the interspace between the Accelerator urinæ and Erector penis muscles, both of which it supplies, and is finally distributed to the skin and dartos of the scrotum. In its passage through the perinæum it lies beneath the superficial perineal fascia.

The **transverse perineal** is a small branch which arises either from the internal pudic or from the superficial perineal artery as it crosses the Transversus perinæi muscle. It runs transversely inward along the cutaneous surface of the Transversus perinæi muscle, which it supplies, as well as the structures between the anus and bulb of the urethra, and anastomoses with the one of the opposite side.

The **artery of the bulb** is a large but very short vessel which arises from the internal pudic between the two layers of the triangular ligament, and, passing nearly transversely inward, between the fibres of the Compressor urethræ muscle, it pierces the bulb of the urethra, in which it ramifies. It gives off a small branch which descends to supply Cowper's gland.

Surgical Anatomy.—This artery is of considerable importance in a surgical point of view, as it is in danger of being wounded in the lateral operation of lithotomy—an accident usually attended in the adult with alarming hemorrhage. The vessel is sometimes very small, occasionally wanting, or even double. It sometimes arises from the internal pudic earlier than usual, and crosses the perinæum to reach the back part of the bulb. In such a case the vessel could hardly fail to be wounded in the performance of the lateral operation of lithotomy. If, on the contrary, it should arise from an accessory pudic, it lies more forward than usual and is out of danger in the operation.

The **artery of the corpus cavernosum**, one of the terminal branches of the internal pudic, arises from that vessel while it is situated between the two layers of the triangular ligament; it pierces the superficial layer, and, entering the crus penis obliquely, it runs forward in the centre of the corpus cavernosum, to which its branches are distributed.

The **dorsal artery of the penis** ascends between the crus and pubic symphysis, and, piercing the triangular ligament, passes between the two layers of the suspensory ligament of the penis, and runs forward on the dorsum of the penis to the glans, where it divides into two branches, which supply the glans and prepuce. On the dorsum of the penis it lies immediately beneath the integument, parallel with the dorsal vein and the corresponding artery of the opposite side. It supplies the integument and fibrous sheath of the corpus cavernosum, sending branches through the sheath to anastomose with the preceding vessel.

The **Internal Pudic Artery in the Female** is smaller than in the male. Its origin and course are similar, and there is considerable analogy in the distribution of its branches. The superficial perineal artery supplies the labia pudendi; the artery of the bulb supplies the bulbi vestibuli and the erectile tissue of the vagina; the artery of the corpus cavernosum supplies the cavernous body of the clitoris; and the arteria dorsalis clitoridis supplies the dorsum of that organ, and terminates in the glans and in the membranous fold corresponding to the prepuce of the male.

The **Sciatic Artery** (Fig. 316), the larger of the two terminal branches of the anterior trunk of the internal iliac, is distributed to the muscles at the back of the pelvis. It passes down to the lower part of the great sacro-sciatic foramen behind the internal pudic artery, resting on the sacral plexus of nerves and Pyriformis

muscle, and escapes from the pelvis through this foramen between the Pyriformis and Coccygeus. It then descends in the interval between the trochanter major and tuberosity of the ischium, accompanied by the sciatic nerves, and covered by the Gluteus maximus, and is continued down the back of the thigh supplying the skin, and anastomosing with branches of the perforating arteries.

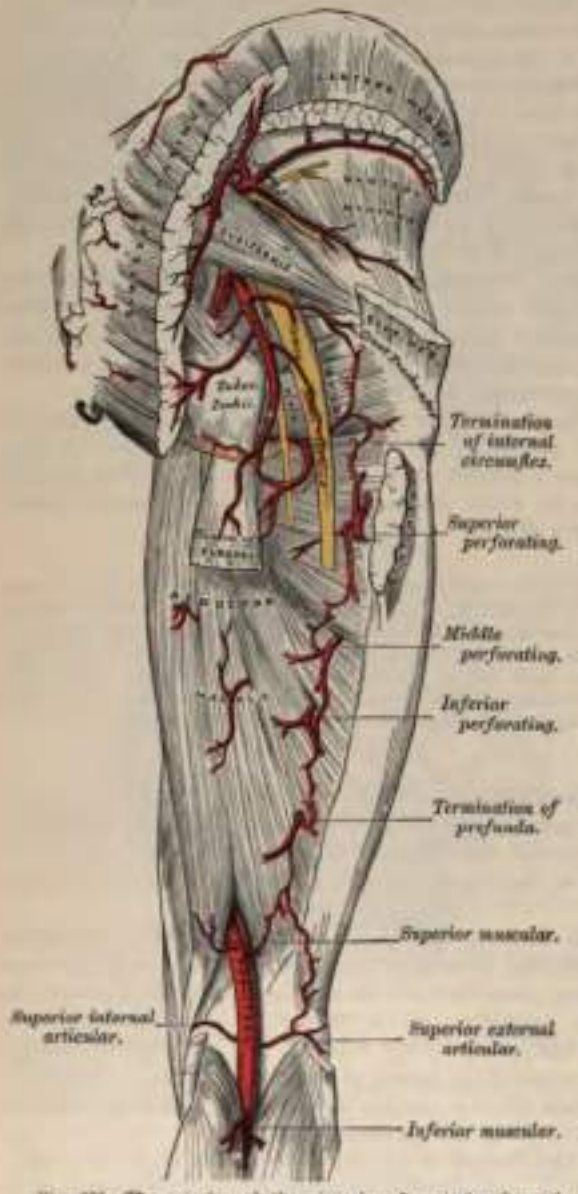


FIG. 326.—The arteries of the gluteal and posterior femoral regions.

Within the pelvis it distributes branches to the Pyriformis, Coccygeus, and Levator ani muscles; some hæmorrhoidal branches, which supply the rectum, and occasionally take the place of the middle hæmorrhoidal artery; and vesical branches to the base and neck of the bladder, vesiculæ seminales, and prostate gland. *External to the pelvis* it gives off the following branches:

Coccygeal.
Inferior Gluteal.
Comes Nervi Ischiadici.
Muscular.
Anastomotic.
Articular.

The **coccygeal branch** runs inward, pierces the great sacro-sciatic ligament, and supplies the Gluteus maximus, the integument, and other structures on the back of the coccyx.

The **inferior gluteal branches**, three or four in number, supply the Gluteus maximus muscle, anastomosing with the gluteal artery in the substance of the muscle.

The **comes nervi ischiadici** is a long, slender vessel which accompanies the great sciatic nerve for a short distance; it then penetrates it and runs in its substance to the lower part of the thigh.

The **muscular branches** supply the Gluteus maximus, anastomosing with the gluteal artery in the substance of the muscle: the external rotators, anastomosing with the internal pudic artery; and the muscles attached to the tuberosity of the ischium, anastomosing with the external branch of the obturator and the internal circumflex arteries.

The **anastomotic artery** is directed downward across the external rotators, and assists in forming the so-called *crucial anastomosis* by anastomosing with the superior perforating and the internal and external circumflex.

The **articular branch**, generally derived from the anastomotic, is distributed to the capsule of the hip-joint.

The **Ilio-lumbar Artery**, given off from the posterior trunk of the internal iliac, turns upward and outward between the obturator nerve and lumbo-sacral cord, to the inner margin of the Psoas muscle, behind which it divides into a lumbar and an iliac branch.

The **lumbar branch** supplies the Psoas and Quadratus lumborum muscles, anastomosing with the last lumbar artery, and sends a small spinal branch through the intervertebral foramen, between the last lumbar vertebra and the sacrum, into the spinal canal, to supply the cauda equina.

The **iliac branch** descends to supply the Iliacus muscle; some offsets, running between the muscle and the bone, anastomose with the iliac branch of the obturator; one of these enters an oblique canal to supply the diploë, whilst others run along the crest of the ilium, distributing branches to the Gluteal and Abdominal muscles, and anastomose in their course with the gluteal, circumflex iliac, and external circumflex arteries.

The **Lateral Sacral Arteries** (Fig. 312) are usually two in number on each side, superior and inferior.

The **superior**, which is of large size, passes inward, and, after anastomosing with branches from the middle sacral, enters the first or second anterior sacral foramen, is distributed to the contents of the sacral canal, and, escaping by the corresponding posterior sacral foramen, supplies the skin and muscles on the dorsum of the sacrum, anastomosing with the gluteal.

The **inferior** passes obliquely across the front of the Pyriformis muscle and sacral nerves to the inner side of the anterior sacral foramina, descends on the front of the sacrum, and anastomoses over the coccyx with the sacra media and opposite lateral sacral arteries. In its course it gives off branches which enter the anterior sacral foramina; these, after supplying the contents of the sacral canal, escape by the posterior sacral foramina, and are distributed to the muscles and skin on the dorsal surface of the sacrum, anastomosing with the gluteal.

The **Gluteal Artery** is the largest branch of the internal iliac, and appears to be the continuation of the posterior division of that vessel. It is a short, thick trunk, which passes out of the pelvis above the upper border of the Pyriformis muscle, and immediately divides into a *superficial* and *deep branch*. Within the pelvis it gives off a few muscular branches to the Iliacus, Pyriformis, and Obturator internus, and, just previous to quitting that cavity, a nutrient artery, which enters the ilium.

The **superficial branch** passes beneath the Gluteus maximus and divides into numerous branches, some of which supply that muscle, whilst others perforate its tendinous origin, and supply the integument covering the posterior surface of the sacrum, anastomosing with the posterior branches of the sacral arteries.

The **deep branch** runs between the Gluteus medius and minimus, and subdivides into two. Of these, the superior division, continuing the original course of the vessel, passes along the upper border of the Gluteus minimus to the anterior superior spine of the ilium, anastomosing with the circumflex iliac and ascending branches of the external circumflex artery. The inferior division crosses the Gluteus minimus obliquely to the trochanter major, distributing branches to the Glutei muscles, and inosculates with the external circumflex artery. Some branches pierce the Gluteus minimus to supply the hip-joint.

Surface Marking.—The position of the three main branches of the internal iliac, the sciatic, internal pudic, and gluteal, which may occasionally be the object of surgical interference, is indicated on the surface in the following way: A line is to be drawn from the posterior superior iliac spine to the posterior superior angle of the great trochanter, with the limb slightly flexed and rotated inward: the point of emergence of the *gluteal artery* from the upper part of the sciatic notch will correspond with the junction of the upper with the middle third of this line. A second line is to be drawn from the same point to the outer part of the tuberosity of the ischium; the junction of the lower with the middle third marks the point of emergence of the *sciatic* and *pudic arteries* from the great sciatic notch.

Surgical Anatomy.—Any of these three vessels may require ligating for a wound or for aneurism, which is generally traumatic. The *gluteal* artery is ligated by turning the patient two-thirds over on his face and making an incision from the posterior superior spine of the ilium to the upper and posterior angle of the great trochanter. This must expose the Gluteus maximus muscle, and its fibres are to be separated through the whole thickness of the muscle and pulled apart with retractors. The contiguous margins of the Gluteus medius and Pyriformis are now to be separated from each other, and the artery will be exposed emerging from the sciatic notch. In ligation of the *sciatic* artery, the incision should be made parallel with that for ligation of the gluteal, but one inch and a half lower down. After the fibres of the Gluteus maximus have been separated, the vessel is to be sought for at the lower border of the Pyriformis; the great sciatic nerve, which lies just above it, forming the chief guide to the artery.

The External Iliac Artery (Fig. 312).

The **external iliac artery** is larger in the adult than the internal iliac, and passes obliquely downward and outward along the inner border of the Psoas muscle, from the bifurcation of the common iliac to Poupart's ligament, where it enters the thigh and becomes the femoral artery.

Relations.—*In front*, with the peritoneum, subperitoneal areolar tissue, the termination of the ileum on the right side, and the sigmoid flexure on the left, and a thin layer of fascia derived from the iliac fascia, which surrounds the artery and vein. At its origin it is occasionally crossed by the ureter. The spermatic vessels descend for some distance upon it near its termination, and it is crossed in this situation by the genital branch of the genito-crural nerve and the deep circumflex iliac vein; the vas deferens curves down along its inner side. *Behind*, it is in relation with the external iliac vein, which, at Poupart's ligament, lies at its inner side; on the left side the vein is altogether internal to the artery. *Externally*, it rests against the Psoas muscle, from which it is separated by the iliac fascia. The artery rests upon this muscle, near Poupart's ligament. Numerous lymphatic vessels and glands are found lying on the front and inner side of the vessel.

PLAN OF THE RELATIONS OF THE EXTERNAL ILIAC ARTERY.

In front.
Peritoneum, intestines, and fascia.
Near Poupart's Ligament.
- Lymphatic vessels and glands.
- Spermatic vessels.
- Genito-crural nerve (genital branch).
- Deep circumflex iliac vein.

Outer side.
Psoas magnus.
Iliac fascia.

External iliac.

Inner side.
External iliac vein and vas deferens near Poupart's ligament.

Behind.
External iliac vein.
Psoas magnus.

Surface Marking.—The surface line indicating the course of the external iliac artery has been already given (see page 560).

Surgical Anatomy.—The application of a ligature to the external iliac may be required in cases of aneurism of the femoral artery or for a wound of the artery. This vessel may be secured in any part of its course, excepting near its upper end, which is to be avoided on account of the proximity of the great stream of blood in the internal iliac, and near its lower end, which should also be avoided, on account of the proximity of the deep epigastric and circumflex iliac vessels. The patient having been placed in the supine position, an incision should be made, commencing below at a point about three-quarters of an inch above Poupart's ligament, and a little external to its middle, and running upward and outward, parallel to Poupart's ligament, to a point one inch internal and one inch above the anterior superior spine of the ilium. When the artery is deeply seated, more room will be required, and may be obtained by carving the incision from the point last named inward toward the umbilicus for a short distance. Another mode of ligating the vessel is the plan advocated by Sir Astley Cooper, by making an incision close to Poupart's ligament from about half an inch outside of the external abdominal ring to one inch internal to the anterior superior spine of the ilium. This incision, being

made in the course of the fibres of the aponeurosis of the external oblique, is less likely to be followed by a ventral hernia, but there is danger of wounding the epigastric artery, and only the lower end of the vessel can be ligated. Abernethy, who first tied this artery, made his incision in the course of the vessel. The abdominal muscles and transversalis fascia having been cautiously divided, the peritoneum should be separated from the iliac fossa and raised toward the pelvis; and on introducing the finger to the bottom of the wound, the artery may be felt pulsating along the inner border of the Psoas muscle. The external iliac vein is generally found on the inner side of the artery, and must be cautiously separated from it by the finger-nail or handle of the knife, and the aneurism needle should be introduced on the inner side, between the artery and the vein.

Ligation of the external iliac artery has recently been performed by a transperitoneal method. An incision four inches in length is made in the semilunar line, commencing about an inch below the umbilicus and carried through the abdominal wall into the peritoneal cavity. The intestines are then pushed upward and held out of the way by a broad abdominal retractor, and an incision made through the peritoneum at the margin of the pelvis in the course of the artery, and the vessel secured in any part of its course which may seem desirable to the operator. The advantages of this operation appear to be that if it is found necessary, the common iliac artery can be ligated instead of the external iliac without extension or modification of the incision; and secondly, that the vessel can be ligated without in any way interfering with the coverings of the sac. Possibly a disadvantage may exist in the greater risk of hernia after this method.

Collateral Circulation.—The principal anastomoses in carrying on the collateral circulation, after the application of a ligature to the external iliac, are—the ilio-lumbar with the circumflex iliac; the gluteal with the external circumflex; the obturator with the internal circumflex; the sciatic with the superior perforating and circumflex branches of the profunda artery; and the internal pudic with the external pudic. When the obturator arises from the epigastric, it is supplied with blood by branches, either from the internal iliac, the lateral sacral, or the internal pudic. The epigastric receives its supply from the internal mammary and inferior intercostal arteries, and from the internal iliac by the anastomoses of its branches with the obturator.

In the dissection of a limb eighteen years after the successful ligature of the external iliac artery by Sir A. Cooper, which is to be found in *Guy's Hospital Reports*, vol. i. p. 50, the anastomosing branches are described in three sets: *An anterior set.*—1, a very large branch from the ilio-lumbar artery to the circumflex iliac; 2, another branch from the ilio-lumbar, joined by one from the obturator, and breaking up into numerous tortuous branches to anastomose with the external circumflex; 3, two other branches from the obturator, which passed over the brim of the pelvis, communicated with the epigastric, and then broke up into a plexus to anastomose with the internal circumflex. *An internal set.*—Branches given off from the obturator, after quitting the pelvis, which ramified among the adductor muscles on the inner side of the hip-joint, and joined most freely with branches of the internal circumflex. *A posterior set.*—1, three large branches from the gluteal to the external circumflex; 2, several branches from the sciatic around the great sciatic notch to the internal and external circumflex, and the perforating branches of the profunda.

Branches.—Besides several small branches to the Psoas muscle and the neighboring lymphatic glands, the external iliac gives off two branches of considerable size—the

Deep Epigastric and Deep Circumflex Iliac.

The **Deep Epigastric Artery** arises from the external iliac a few lines above Poupart's ligament. It at first descends to reach this ligament, and then ascends obliquely along the inner margin of the internal abdominal ring, lying between the transversalis fascia and peritoneum, and, continuing its course upward, it pierces the transversalis fascia, and, passing over the semilunar fold of Douglas, enters the sheath of the Rectus muscle. It then ascends on the posterior surface of the muscle, and finally divides into numerous branches, which anastomose, above the umbilicus, with the superior epigastric branch of the internal mammary and with the inferior intercostal arteries (Fig. 301). The deep epigastric artery bears a very important relation to the internal abdominal ring as it passes obliquely upward and inward from its origin from the external iliac. In this part of its course it lies along the lower and inner margin of the ring and beneath the commencement of the spermatic cord. As it passes to the inner side of the internal abdominal ring it is crossed by the vas deferens in the male and the round ligament in the female.

Branches.—The branches of this vessel are the following: The *cremasteric*, which accompanies the spermatic cord, and supplies the Cremaster muscle and

other coverings of the cord, anastomosing with the spermatic artery; a *pubic branch*, which runs along Poupart's ligament, and then descends behind the os pubis to the inner side of the femoral ring, and anastomoses with offsets from the obturator artery; *muscular branches*, some of which are distributed to the abdominal muscles and peritoneum, anastomosing with the lumbar and circumflex iliac arteries; others perforate the tendon of the External oblique, and supply the integument, anastomosing with branches of the superficial epigastric.

Peculiarities.—The origin of the epigastric may take place from any part of the external iliac between Poupart's ligament and two inches and a half above it, or it may arise below this ligament, from the common femoral or from the deep femoral.

Union with Branches.—It frequently arises from the external iliac by a common trunk with the obturator. Sometimes the epigastric arises from the obturator, the latter vessel being furnished by the internal iliac, or the epigastric may be formed of two branches, one derived from the external iliac, the other from the internal iliac.

Surgical Anatomy.—The deep epigastric artery follows a line drawn from the middle of Poupart's ligament toward the umbilicus; but shortly after this line crosses the linea semilunaris the direction changes, and the course of the vessel is directly upward in the line of junction of the inner third with the outer two-thirds of the Rectus muscle. It has important surgical relations, in addition to the fact that it is one of the principal means, through its anastomosis with the internal mammary, in establishing the collateral circulation after ligature of either the common or external iliac arteries. It lies close to the internal abdominal ring, and is therefore *internal* to an oblique inguinal hernia, but *external* to a direct inguinal hernia, as it emerges from the abdomen. It forms the outer boundary of Hesselbach's triangle. It is in close relationship with the spermatic cord, which lies in front of it in the inguinal canal, separated only by the transversalis fascia. The vas deferens hooks round its outer side.

The **Deep Circumflex Iliac Artery** arises from the outer side of the external iliac nearly opposite the epigastric artery. It ascends obliquely outward behind Poupart's ligament, contained in a fibrous sheath formed by the junction of the transversalis and iliac fascia, to the anterior superior spinous process of the ilium. It then runs along the inner surface of the crest of the ilium to about its middle, where it pierces the Transversalis, and runs backward between that muscle and the Internal oblique, to anastomose with the ilio-lumbar and gluteal arteries. Opposite the anterior superior spine of the ilium it gives off a large branch, which ascends between the Internal oblique and Transversalis muscles, supplying them, and anastomosing with the lumbar and epigastric arteries.

ARTERIES OF THE LOWER EXTREMITY.

The artery which supplies the greater part of the lower extremity is the direct continuation of the external iliac. It continues as a single trunk from Poupart's ligament to the lower border of the Popliteus muscle, and here divides into two branches, the anterior and posterior tibial, an arrangement exactly similar to what occurs in the upper limb. For convenience of description, the upper part of the main trunk is named femoral, the lower part, popliteal.

The Femoral Artery (Fig. 317).

The **femoral artery** commences immediately behind Poupart's ligament, midway between the anterior superior spine of the ilium and the symphysis pubis, and, passing down the fore part and inner side of the thigh, terminates at the opening in the Adductor magnus, at the junction of the middle with the lower third of the thigh, where it becomes the popliteal artery. The vessel, at the upper part of the thigh, lies in front of the hip-joint, just on a line with the innermost part of the head of the femur; in the lower part of its course it is in close relation with the inner side of the shaft of the bone, and between these two parts the vessel is some distance from the bone. In the upper third of the thigh it is contained in a triangular space called *Scarpa's triangle*. In the middle third of the thigh it is contained in an aponeurotic canal called *Hunter's canal*.

Scarpa's Triangle.—Scarpa's triangle corresponds to the depression seen immediately below the fold of the groin. It is a triangular space, the apex of which is directed downward, and the sides formed externally by the Sartorius, internally by the inner margin of the Adductor longus, and above by Poupart's

ligament. The floor of the space is formed from without inward by the Iliacus, Psoas, Pectineus (in some cases a small part of the Adductor brevis), and the Adductor longus muscles; and it is divided into two nearly equal parts by the femoral vessels, which extend from the middle of its base to its apex, the artery giving off in this situation its cutaneous and profunda branches, the vein receiving the deep femoral and internal saphenous. On the outer side of the femoral artery is the anterior crural nerve dividing into its branches. Besides the vessels and nerves, this space contains some fat and lymphatics.

Hunter's Canal.—This is the aponeurotic space in the middle third of the thigh, extending from the apex of Scarpa's triangle to the femoral opening in the Adductor magnus muscle. It is bounded, externally, by the Vastus internus; internally by the Adductors longus and magnus muscles; and covered in by a strong aponeurosis which extends transversely from the Vastus internus across the femoral vessels to the Adductor longus and magnus; lying on which aponeurosis is the Sartorius muscle. It contains the femoral artery and vein enclosed in their own sheath of areolar tissue, the vein being behind and on the outer side of the artery, and the internal or long saphenous nerve lying at first on the outer side and then in front of the vessels.

For convenience of description, and also in reference to its surgical anatomy, the femoral artery is divided into a short trunk, about an inch and a half or two inches long, which is known as the *common femoral artery*, while the remainder of the vessel is termed the *superficial femoral*, to distinguish it from the deep femoral (profunda femoris), a large branch given off from the common femoral at its termination, and which, by its derivation from the parent trunk, marks the commencement of the superficial femoral artery.

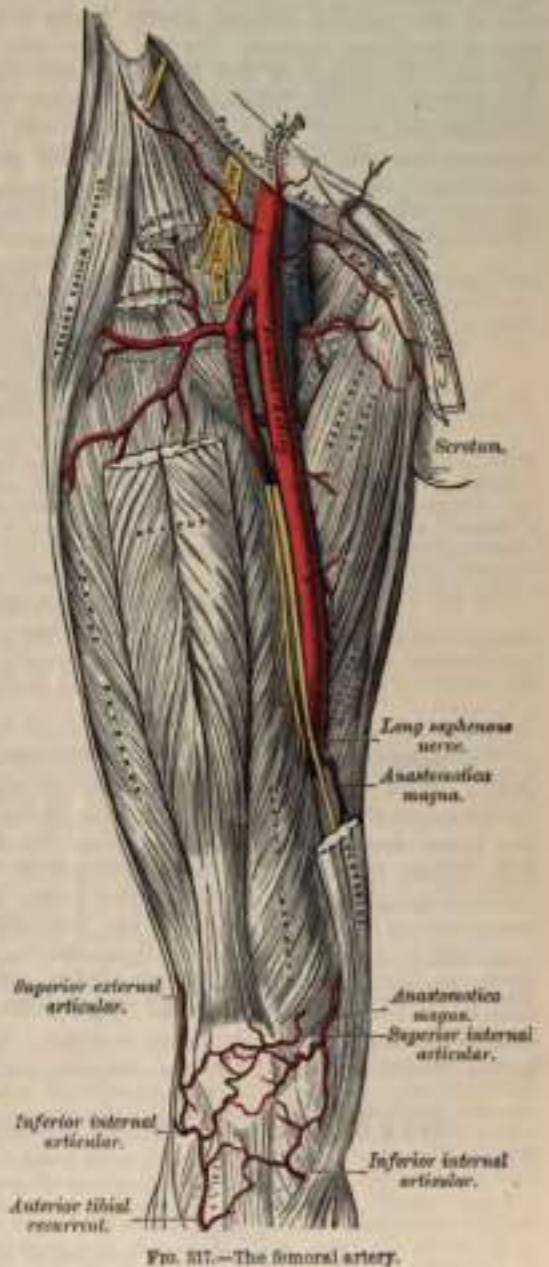


FIG. 317.—The femoral artery.

The **common femoral artery** is very superficial, being covered by the skin and superficial fascia, superficial inguinal lymphatic glands, the iliac portion of the fascia lata, and the prolongation downward of the Transversalis fascia, which forms the anterior part of the sheath of the vessels. It has in front of it filaments from the crural branch of the genito-crural nerve, the superficial circumflex iliac vein, and

occasionally the superficial epigastric vein. It rests on the inner margin of the Psoas muscle, which separates it from the capsular ligament of the hip-joint, and a little lower on the Pectineus muscle; and crossing behind it is the branch to the Pectineus from the anterior crural nerve. Separating the artery from the Pectineus muscles in the pubic portion of the fascia lata and the prolongation from the fascia covering the Iliacus muscle, which forms the posterior layer of the sheath of the vessels. The anterior crural nerve lies about half an inch to the outer side of the common femoral artery, being separated from the artery by a small part of the Psoas muscle. To the inner side of the artery is the femoral vein, between the margins of the Pectineus and Psoas muscles. The two vessels are enclosed in a strong fibrous sheath formed by the proper sheath of the vessels, strengthened by the fascia lata (see page 419); the artery and vein are separated, however, from one another by a thin fibrous partition.

PLAN OF RELATIONS OF THE COMMON FEMORAL ARTERY.

In front.
Skin and superficial fascia.
Superficial inguinal glands.
Iliac portion of fascia lata.
Prolongation of transversalis fascia.
Crural branch of genito-crural nerve.
Superficial circumflex iliac vein.
Superficial epigastric vein.

Inner side.
Femoral vein.

Outer side.
Small part of Psoas muscle, separating the artery from the anterior crural nerve.

Behind.
Prolongation of fascia covering Iliacus muscle.
Pubic portion of fascia lata.
Nerve to Pectineus.
Psoas muscle.
Pectineus muscle.
Capsule of hip-joint.

The **superficial femoral artery** is only superficial where it lies in Scarpa's triangle. Here it is covered by the skin, superficial and deep fascia, and crossed by the internal cutaneous branch of the anterior crural nerve. In Hunter's canal it is more deeply seated, being covered by the integument, the superficial and deep fascia, the Sartorius and aponeurotic covering of Hunter's canal. The internal saphenous nerve crosses the artery from without inward. Behind, the artery lies at its upper part on the femoral vein and the profunda artery and vein, which separate it from the Pectineus muscle, and lower down on the Adductor longus and Adductor magnus muscles. To the outer side is the long saphenous nerve and the nerve to the Vastus internus, the Vastus internus muscle, and, at its lower part, the femoral vein. To the inner side is the Adductor longus above and the Adductor magnus and Sartorius below.

PLAN OF RELATIONS OF THE SUPERFICIAL FEMORAL ARTERY.

In front.
Skin, superficial and deep fascia.
Internal cutaneous nerve.
Sartorius.
Aponeurotic covering of Hunter's canal.
Internal saphenous nerve.

Inner side.
Adductor longus.
Adductor magnus.
Sartorius.

Outer side.
Long saphenous nerve.
Nerve to vastus internus.
Vastus internus.
Femoral vein (below).

Behind.

Femoral vein.
Profunda artery and vein.
Pectineus muscle.
Adductor longus.
Adductor magnus.

The *femoral vein*, at Poupart's ligament, lies close to the inner side of the artery, separated from it by a thin fibrous partition; but lower down it is behind it, and then to its outer side.

The *internal saphenous nerve* is situated on the outer side of the artery, in the middle third of the thigh, beneath the aponeurotic covering of Hunter's canal, but not usually within the sheath of the vessels. The internal cutaneous nerve passes obliquely across the upper part of the sheath of the femoral artery.

Peculiarities.—Double Femoral reunited.—Several cases are recorded in which the femoral artery divided into two trunks below the origin of the profunda, and became reunited near the opening in the Adductor magnus so as to form a single popliteal artery. One of them occurred in a patient operated upon for popliteal aneurism.

Change of Position.—A few cases have been recorded in which the femoral artery was situated at the back of the thigh, the vessel being continuous above with the internal iliac, escaping from the pelvis through the great sacro-sciatic foramen, and accompanying the great sciatic nerve to the popliteal space, where its division occurred in the usual manner. The external iliac in these cases was small, and terminated in the profunda.

Position of the Vein.—The femoral vein is occasionally placed along the inner side of the artery, throughout the entire extent of Scarpa's triangle, or it may be slit so that a large vein is placed on each side of the artery for a greater or less extent.

Origin of the Profunda.—This vessel occasionally arises from the inner side, and, more rarely, from the back of the common trunk; but the more important peculiarity, in a surgical point of view, is that which relates to the height at which the vessel arises from the femoral. In three-fourths of a large number of cases it arose between one or two inches below Poupart's ligament; in a few cases the distance was less than an inch; more rarely, opposite the ligament; and in one case, above Poupart's ligament, from the external iliac. Occasionally, the distance between the origin of the vessel and Poupart's ligament exceeds two inches, and in one case it was found to be as much as four inches.

Surface Marking.—The upper two-thirds of a line drawn from a point midway between the anterior superior spine of the ilium and the symphysis pubis to the prominent tuberosity on the inner condyle of the femur, with the thigh abducted and rotated outward, will indicate the course of the femoral artery.

Surgical Anatomy.—*Compression* of the femoral artery, which is constantly requisite in amputations and other operations on the lower limb, and also for the cure of popliteal aneurisms, is most effectually made immediately below Poupart's ligament. In this situation the artery is very superficial, and is merely separated from the ascending ramus of the os pubis by the Psoas muscle; so that the surgeon, by means of his thumb or a compressor, may effectually control the circulation through it. This vessel may also be compressed in the middle third of the thigh by placing a compress over the artery, beneath the tourniquet, and directing the pressure from within outward, so as to compress the vessel against the inner side of the shaft of the femur.

The **application of a ligature** to the femoral artery may be required in the cases of wound or aneurism of the arteries of the leg, of the popliteal or femoral;[1] and the vessel may be exposed and tied in any part of its course. The great depth of this vessel at its lower part, its close connection with important structures, and the density of its sheath render the operation in this situation one of much greater difficulty than the application of a ligature at its upper part, where it is more superficial.

Ligature of the common femoral artery is usually considered unsafe, on account of the connection of large branches with it—viz. the deep epigastric and the deep circumflex iliac arising just above Poupart's ligament; on account of the number of small branches which arise from it in its short course; and on account of the uncertainty of the origin of the profunda femoris, which, if it arise high up, would be too close to the ligature for the formation of a firm coagulum. The profunda sometimes arises higher than the point above mentioned, and rarely between two or three inches (in one case four) below Poupart's ligament. It would appear, then, that the most favorable situation for the application of a ligature to the femoral is between four and five inches from its point of origin. In order to expose the artery in this situation, an incision between three and four inches long should be made in the course of the vessel, the patient lying in the recumbent position, with the limb slightly flexed and abducted, and rotated outward. A large vein is frequently met with, passing in the course of the artery to join the internal saphenous vein; this must be avoided, and, the fascia lata having been cautiously divided and the Sartorius exposed, that muscle must be drawn outward in order to expose fully the sheath of

[1] Ligation of the femoral artery has been also recommended and performed for elephantiasis of the leg and acute inflammation of the knee-joint (Maunder, *Clin. Soc. Trans.*, vol. ii., p. 37).

the vessels. The finger being introduced into the wound and the pulsation of the artery felt, the sheath should be opened on the outer side of the vessel to a sufficient extent to allow of the introduction of the ligature, but no farther; otherwise the nutrition of the coats of the vessel may be interfered with, or muscular branches which arise from the vessel at irregular intervals may be divided. In this part of the operation the long saphenous nerve and the nerve to the Vastus internus, which is in close relation with the sheath, should be avoided. The aneurism needle must be carefully introduced and kept close to the artery, to avoid the femoral vein, which lies behind the vessel in this part of its course.

To expose the artery in Hunter's canal, an incision should be made through the integument, between three and four inches in length, a finger's breadth internal to the line of the artery, in the middle of the thigh—*i. e.*, midway between the groin and the knee. The fascia lata having been divided, and the outer border of the Sartorius muscle exposed, it should be drawn inward, when the strong fascia which is stretched across from the Adductors to the Vastus internus will be exposed, and must be freely divided; the sheath of the vessels is now seen, and must be opened, and the artery secured by passing the aneurism needle between the vein and artery in the direction from without inward. The femoral vein in this situation lies on the outer side of the artery, the long saphenous nerve on its anterior and outer side.

It has been seen that the femoral artery occasionally divides into two trunks below the origin of the profunda. If in the operation for tying the femoral two vessels are met with, the surgeon should alternately compress each, in order to ascertain which vessel is connected with the aneurismal tumor or with the bleeding from the wound, and that one only should be tied which controls the pulsation or hæmorrhage. If, however, it is necessary to compress both vessels before the circulation in the tumor is controlled, both should be tied, as it would be probable that they became reunited, as in the instances referred to above.

In wounds of the femoral artery the question of the mode of treatment is of considerable importance. If the wound in the superficial structures is a large one, the injured vessel must be exposed and tied; but if the wound is a punctured one and the bleeding has ceased, the question will arise whether to cut down upon the artery or to trust to pressure. Mr. Cripps[1] advises that if the wound is in the "upper part of the thigh—that is to say, in a position where the femoral artery is comparatively superficial—the surgeon may enlarge the opening with a good prospect of finding the wounded vessel without an extensive or prolonged operation. If the wound be in the lower half of the thigh, owing to the greater depth of the artery and the possibility of its being the popliteal that is wounded, the search is rendered a far more severe and hazardous operation, and it should not be undertaken until a thorough trial of pressure has proved ineffectual."

Great care and attention are necessary for the successful application of pressure. The limb should be carefully bandaged from the foot upward to the wound, which is not covered, and then onward to the groin. The wound is then dusted with iodoform or boracic powder and a conical pad applied over the wound. Rollers the thickness of the index finger are then placed along the course of the vessel above and below the wound, and the whole carefully bandaged to a back splint with a foot-piece.

Collateral Circulation.—When the common femoral is tied the main channels for carrying on the circulation are the anastomoses of the gluteal and circumflex iliac arteries above with the external circumflex below; of the obturator and sciatic above with the internal circumflex below; and of the comes nervi ischiadici with the arteries in the ham.

The principal agents in carrying on the collateral circulation after ligature of the superficial femoral artery are, according to Sir A. Cooper, as follows:

"The arteria profunda formed the new channel for the blood." "The first artery sent off passed down close to the back of the thigh-bone, and entered the two superior articular branches of the popliteal artery."

"The second new large vessel, arising from the profunda at the same part with the former, passed down by the inner side of the Biceps muscle to a branch of the popliteal which was distributed to the Gastrocnemius muscle; whilst a third artery, dividing into several branches, passed down with the sciatic nerve behind the knee-joint, and some of its branches united themselves with the inferior articular arteries of the popliteal, with some recurrent branches of those arteries, with arteries passing to the Gastrocnemii, and, lastly, with the origin of the anterior and posterior tibial arteries."

"It appears, then, that it is those branches of the profunda which accompany the sciatic nerve that are the principal supporters of the new circulation."[2]

In Porta's work[3] (tab. xii., xiii.) is a good representation of the collateral circulation after the ligature of the femoral artery. The patient had survived the operation three years. The lower part of the artery is at least as large as the upper; about two inches of the vessel appear to have been obliterated. The external and internal circumflex arteries are seen anastomosing by a great number of branches with the lower branches of the femoral (muscular and anastomotica magna) and with the articular branches of the popliteal. The branches from the external circumflex are extremely large and numerous. One very distinct anastomosis can be traced between this artery on the outside and the anastomotica magna on the inside through the intervention of the superior external articular artery, with which they both anastomose; and

[1] Heath's *Dictionary of Practical Surgery*, vol. i. p. 525.
[2] *Med.-Chir. Trans.*, vol. ii. 1811.
[3] *Alterazioni patologiche delle Arterie.*

blood reaches even the anterior tibial recurrent from the external circumflex by means of anastomoses with the same external articular artery. The perforating branches of the profunda are also seen bringing blood round the obliterated portion of the artery into long branches (muscular) which have been given off just below that portion. The termination of the profunda itself anastomoses most freely with the superior external articular. A long branch of anastomosis is also traced down from the internal iliac by means of the comes nervi ischiadici of the sciatic, which anastomoses on the popliteal nerves with branches from the popliteal and posterior tibial arteries. In this case the anastomosis had been too free, since the pulsation and growth of the aneurism recurred, and the patient died after ligature of the external iliac.

There is an interesting preparation in the Museum of the Royal College of Surgeons of a limb on which John Hunter had tied the femoral artery fifty years before the patient's death. The whole of the superficial femoral and popliteal artery seems to have been obliterated. The

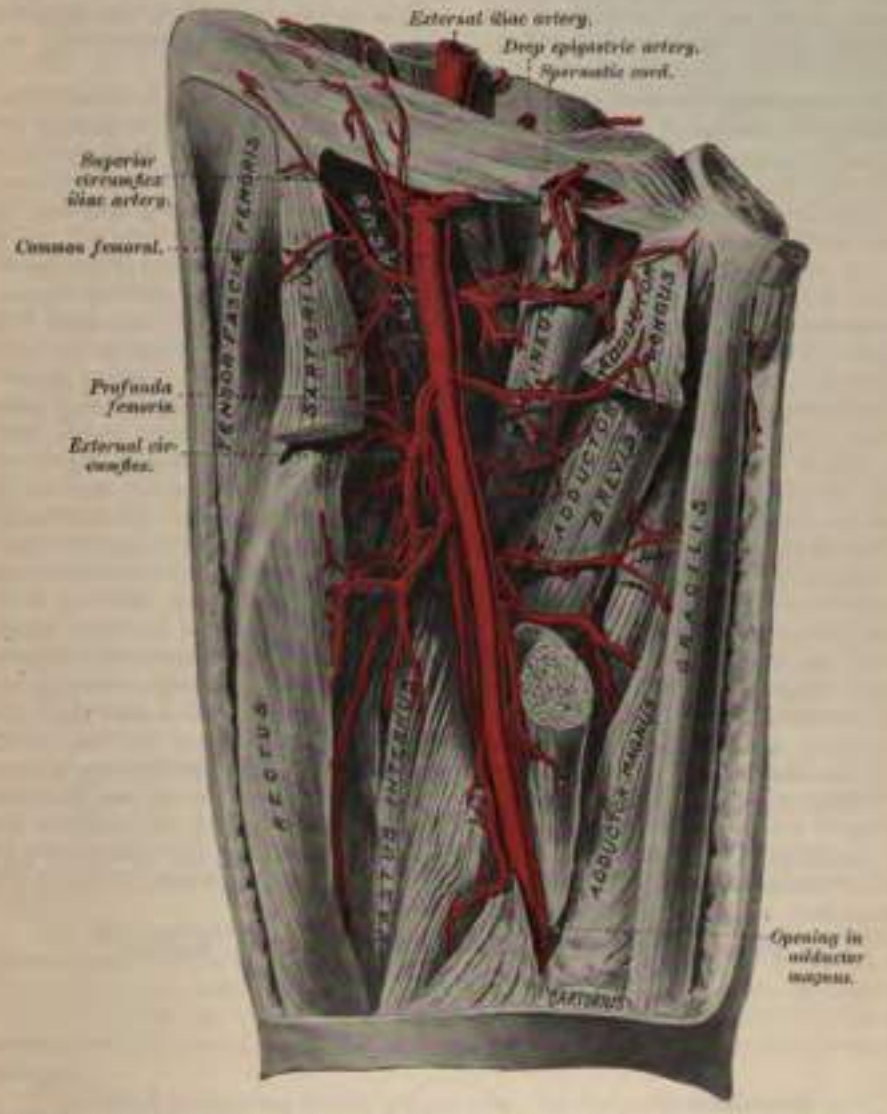


FIG. 318.—Femoral artery and its branches. (From a preparation in the Museum of the Royal College of Surgeons of England.)

anastomosis by means of the comes nervi ischiadici, which is shown in Porta's plate, is distinctly seen: the external circumflex and the termination of the profunda artery seem to have been the chief channels of anastomoses; but the injection has not been a very successful one.

Branches.—The branches of the femoral artery are—the

Superficial Epigastric.		External Circumflex.
Superficial Circumflex Iliac.	Profunda	Internal Circumflex.
Superficial External Pudic.		Three Perforating.
Deep External Pudic.	Muscular.	
	Anastomotica Magna.	

The **superficial epigastric** arises from the femoral about half an inch below Poupart's ligament, and, passing through the saphenous opening in the fascia lata, ascends on the abdomen, in the superficial fascia covering the External oblique muscle, nearly as high as the umbilicus. It distributes branches to the superficial inguinal glands, the superficial fascia, and the integument, anastomosing with branches of the deep epigastric.

The **superficial circumflex iliac**, the smallest of the cutaneous branches, arises close to the preceding, and, piercing the fascia lata, runs outward, parallel with Poupart's ligament, as far as the crest of the ilium, dividing into branches which supply the integument of the groin, the superficial fascia, and the superficial inguinal lymphatic glands, anastomosing with the deep circumflex iliac and with the gluteal and external circumflex arteries.

The **superficial external pudic** (superior) arises from the inner side of the femoral artery, close to the preceding vessels, and, after passing through the saphenous opening, courses inward, across the spermatic cord or round ligament, to be distributed to the integument on the lower part of the abdomen, the penis and scrotum in the male, and the labium in the female, anastomosing with branches of the internal pudic.

The **deep external pudic** (inferior), more deeply seated than the preceding, passes inward across the Pectineus and Adductor longus muscles, covered by the fascia lata, which it pierces at the inner border of the thigh, its branches being distributed, in the male, to the integument of the scrotum and perinæum; and in the female to the labium, anastomosing with branches of the superficial perineal artery.

The **Profunda Femoris** (*deep femoral artery*) (Fig. 318) nearly equals the size of the superficial femoral. It arises from the outer and back part of the femoral artery, from one to two inches below Poupart's ligament. It at first lies on the outer side of the superficial femoral, and then passes behind it and the femoral vein to the inner side of the femur, and, passing downward beneath the Adductor longus, terminates at the lower third of the thigh in a small branch which pierces the Adductor magnus (and from this circumstance is sometimes called the fourth perforating artery), and is distributed to the flexor muscles on the back of the thigh, anastomosing with branches of the popliteal and inferior perforating arteries.

Relations.—*Behind*, it lies first upon the Iliacus, and then on the Pectineus, Adductor brevis, and Adductor magnus muscles. *In front*, it is separated from the superficial femoral artery, above by the femoral and profunda veins, and below by the Adductor longus. On its *outer side* the origin of the Vastus internus separates it from the femur.

PLAN OF THE RELATIONS OF THE PROFUNDA ARTERY.

In front.
Superficial femoral artery.
Femoral and Profunda veins.
Adductor longus.

Outer side.
Vastus internus.

Behind.
Iliacus.
Pectineus.
Adductor brevis.
Adductor magnus.

The profunda gives off the following named branches:

External circumflex. Internal circumflex. Four perforating.

The **External Circumflex Artery** supplies the muscles on the front of the thigh. It arises from the outer side of the profunda, passes horizontally outward, between the divisions of the anterior crural nerve and behind the Sartorius and Rectus muscles, and divides into three sets of branches—ascending, transverse, and descending.

The **ascending branches** pass upward, beneath the Tensor fasciæ femoris muscle, to the outer side of the hip, anastomosing with the terminal branches of the gluteal and deep circumflex iliac arteries.

The **descending branches**, three or four in number, pass downward, behind the Rectus, upon the Vasti muscles, to which they are distributed, one or two passing beneath the Vastus externus as far as the knee, anastomosing with the superior articular branches of the popliteal artery. These are accompanied by the branch of the anterior crural nerve to the Vastus externus.

The **transverse branch**, the smallest, passes outward over the Crureus, pierces the Vastus externus, and winds round the femur to its back part, just below the great trochanter, anastomosing at the back of the thigh with the internal circumflex, sciatic, and superior perforating arteries.

The **Internal Circumflex Artery**, smaller than the external, arises from the inner and back part of the profunda, and winds round the inner side of the femur, between the Pectineus and Psoas muscles. On reaching the upper border of the Adductor brevis it gives off two branches, one of which passes inward to be distributed to the Adductor muscles, the Gracilis, and Obturator externus, anastomosing with the obturator artery; the other descends, and passes beneath the Adductor brevis, to supply it and the great Adductor; while the continuation of the vessel passes backward and divides into an ascending and a transverse branch (Fig. 257). The *ascending branch* passes obliquely upward upon the tendon of the Obturator externus and under cover of the Quadratus femoris toward the digital fossa, where it anastomoses with twigs from the gluteal and sciatic arteries. The *transverse branch*, larger than the ascending, appears between the Quadratus femoris and upper border of the Adductor magnus, anastomosing with the sciatic, external circumflex, and superior perforating arteries ("the *crucial anastomosis*"). Opposite the hip-joint, the artery gives off an articular vessel, which enters the joint beneath the transverse ligament; and, after supplying the adipose tissue, passes along the round ligament to the head of the bone.

The **perforating arteries** (Fig. 316), usually four in number, are so called from their perforating the tendon of the Adductor magnus muscle to reach the back of the thigh. They pass backward close to the linea aspera of the femur, under cover of small tendinous arches in the Adductor magnus. The first is given off above the Adductor brevis, the second in front of that muscle, and the third immediately below it.

The **first perforating artery** passes backward between the Pectineus and Adductor brevis (sometimes perforates the latter); it then pierces the Adductor magnus close to the linea aspera. It gives off branches which supply the Adductor brevis, the Adductor magnus, the Biceps, and Gluteus maximus muscles, and anastomoses with the sciatic, internal and external circumflex, and middle perforating arteries.

The **second perforating artery**, larger than the first, pierces the tendons of the Adductor brevis and Adductor magnus muscles, and divides into ascending and descending branches, which supply the flexor muscles of the thigh, anastomosing with the first and third perforating. The second artery frequently arises in common with the first. The nutrient artery of the femur is usually given off from this branch.

The **third perforating artery** is given off below the Adductor brevis; it pierces the Adductor magnus, and divides into branches which supply the flexor muscles

of the thigh; anastomosing above with the higher perforating arteries, and below with the terminal branches of the profunda and the muscular branches of the popliteal.

The **fourth perforating artery** is represented by the termination of the profunda femoris artery.

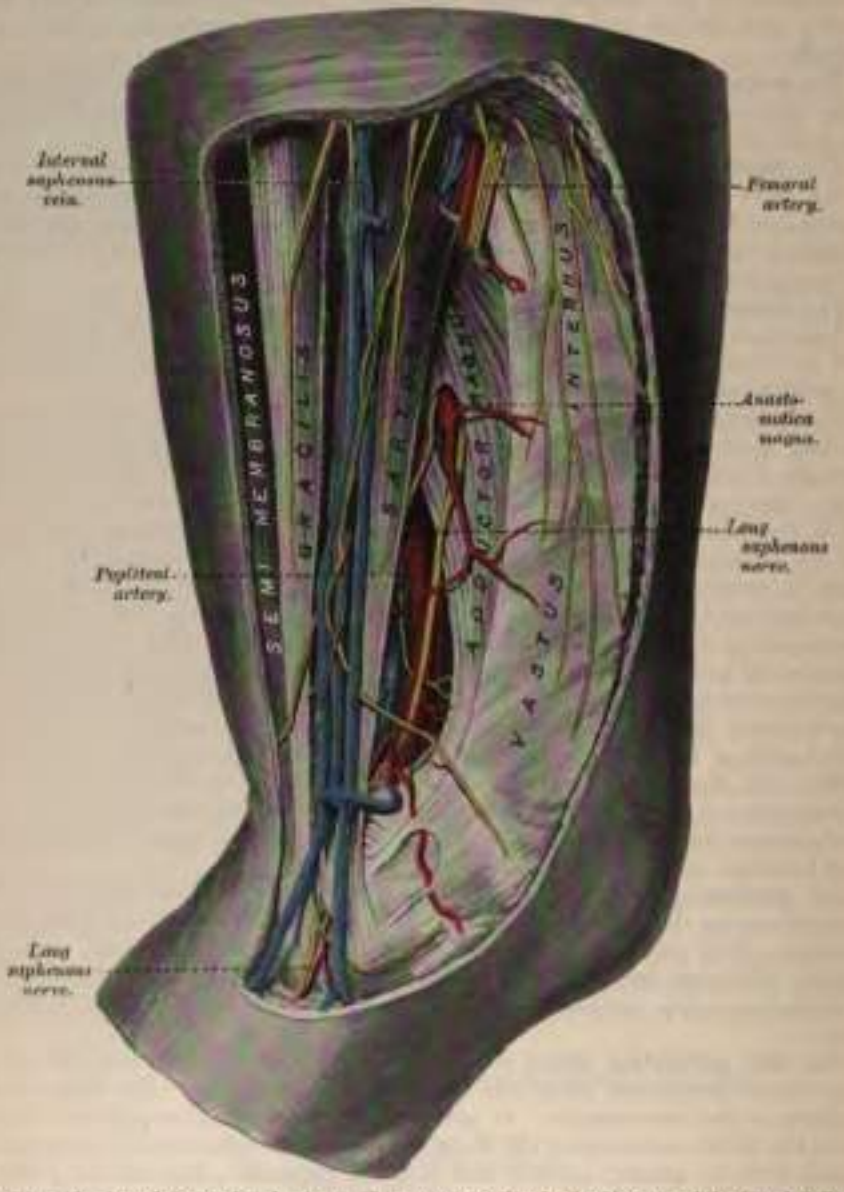


FIG. 319.—Side view of the popliteal artery. (From a preparation in the Museum of the Royal College of Surgeons of England.)

Muscular branches are given off from the superficial femoral throughout its entire course. They vary from two to seven in number, and supply chiefly the Sartorius and Vastus internus.

The **anastomotica magna** (Fig. 319) arises from the femoral artery just before it passes through the tendinous opening in the Adductor magnus muscle, and immediately divides into a superficial and deep branch.

The *superficial branch* pierces the aponeurotic covering of Hunter's canal, and

accompanies the long saphenous nerve to the inner side of the thigh. It passes between the Sartorius and Gracilis muscles, and, piercing the fascia lata, is distributed to the integument of the upper and inner part of the leg, anastomosing with the inferior internal articular.

The **deep branch** descends in the substance of the Vastus internus, lying in front of the tendon of the Adductor magnus, to the inner side of the knee, where it anastomoses with the superior internal articular artery and anterior recurrent branch of the anterior tibial. A branch from this vessel crosses outward above the articular surface of the femur, forming an anastomotic arch with the superior external articular artery, and supplies branches to the knee-joint.

Popliteal Artery.

The **popliteal artery** commences at the termination of the femoral at the opening in the Adductor magnus, and, passing obliquely downward and outward behind the knee-joint to the lower border of the Popliteus muscle, divides into the *anterior* and *posterior tibial arteries*. A portion of the artery lies in the popliteal space; but above and below, to a considerable extent, it is covered by the muscles which form the boundaries of the space, and is therefore beyond the confines of the hollow.

THE POPLITEAL SPACE (Fig. 320).

Dissection.—A vertical incision about eight inches in length should be made along the back part of the knee-joint, connected above and below by a transverse incision from the inner to the outer side of the limb. The flaps of integument included between these incisions should be reflected in the direction shown in Fig. 255, page 427.

Boundaries.—The **popliteal space**, or the **ham**, is a lozenge-shaped space, widest at the back part of the knee-joint, and deepest above the articular end of the femur. It is bounded externally, above the joint, by the Biceps, and, below the joint, by the Plantaris and external head of the Gastrocnemius. Internally, above the joint, by the Semimembranosus, Semitendinosus, Gracilis, and Sartorius; below the joint, by the inner head of the Gastrocnemius.

Above, it is limited by the apposition of the inner and outer hamstring muscles; below, by the junction of the two heads of the Gastrocnemius. The floor is formed by the lower part of the posterior surface of the shaft of the femur, the posterior ligament of the knee-joint, the upper end of the tibia, and the fascia covering the Popliteus muscle, and the space is covered in by the fascia lata.

Contents.—It contains the popliteal vessels and their branches, together with the termination of the external saphenous vein, the internal and external popliteal nerves and some of their branches, the lower extremity of the small sciatic nerve, the articular branch from the obturator nerve, a few small lymphatic glands, and a considerable quantity of loose adipose tissue.

Position of Contained Parts.—The internal popliteal nerve descends in the middle line of the space, lying superficial and crossing the artery from without inward. The external popliteal nerve descends on the outer side of the upper part of the space, lying close to the tendon of the Biceps muscle. More deeply at the bottom of the space are the popliteal vessels, the vein lying superficial to the artery, to which it is closely united by dense areolar tissue; it is a thick-walled vessel, and lies at first to the outer side of the artery, and then crosses it to gain the inner side below; sometimes the vein is double, the artery lying between the two venæ comites, which are usually connected by short transverse branches. More deeply, and, at its upper part, close to the surface of the bone, is the popliteal artery, and passing off from it at right angles are its articular branches. The articular branch from the obturator nerve descends upon the popliteal artery to supply the knee, and occasionally there is found deep in the space an articular filament from the great sciatic nerve. The popliteal lymphatic

glands, four or five in number, are found surrounding the artery; one usually lies superficial to the vessel; another is situated between it and the bone, and the rest are placed on either side of it.

The **Popliteal Artery,** in its course downward from the aperture in the Adductor magnus to the lower border of the Popliteus muscle, rests first on the inner surface of the femur, and is then separated by a little fat from the hollowed popliteal surface of the bone; in the middle of its course it rests on the posterior ligament of the knee-joint, and below on the fascia covering the Popliteus muscle. *Superficially*, it is covered above by the Semimembranosus; in the middle of its course, by a quantity of fat, which separates it from the deep fascia and integument; and below it is overlapped by the Gastrocnemius, Plantaris, and Soleus muscles, the popliteal vein, and the internal popliteal nerve. The popliteal vein, which is intimately attached to the artery, lies superficial and external to it above; it then crosses it and lies to its inner side. The internal popliteal nerve is still more superficial and external above, but below the joint it crosses the artery and lies on its inner side. *Laterally*, the artery is bounded by the muscles which are situated on either side of the popliteal space.

PLAN OF RELATIONS OF POPLITEAL ARTERY.

In front.
Femur.
Ligamentum posticum.
Popliteus.

Inner side.
Semimembranosus.
Internal condyle.
Gastrocnemius (inner head).

Popliteal Artery.

Outer side.
Biceps.
Outer condyle.
Gastrocnemius (outer head).
Plantaris.

Behind.
Semimembranosus.
Fascia.
Popliteal vein.
Internal popliteal nerve.
Gastrocnemius.
Plantaris.
Soleus.

Peculiarities in Point of Division.—Occasionally the popliteal artery divides prematurely into its terminal branches; this unusual division occurs most frequently opposite the knee-joint. The anterior tibial under these circumstances may pass in front of the Popliteus muscle.

Unusual Branches.—The artery sometimes divides into the anterior tibial and peroneal, the posterior tibial being wanting or very small. Occasionally the popliteal is found to divide into three branches, the anterior and posterior tibial and peroneal.

Surface Marking.—The course of the upper part of the popliteal artery is indicated by a line drawn from the outer border of the Semimembranosus muscle at the junction of the middle and lower third of the thigh obliquely downward to the middle of the popliteal space, exactly behind the knee-joint. From this point it passes vertically downward to the level of a line drawn through the lower part of the tubercle of the tibia.

Surgical Anatomy.—The popliteal artery is not infrequently the seat of injury. It may be torn by direct violence, as by the passage of a cart-wheel over the knee or by hyper-extension of the knee; and in the dead body, at all events, the middle and internal coats may be ruptured by extreme flexion. It may also be lacerated by fracture of the lower part of the shaft of the femur or by antero-posterior dislocation of the knee-joint. It has been torn in breaking down adhesions in cases of fibrous ankylosis of the knee, and is in danger of being wounded, and in fact has been wounded, in performing Macewen's operation of osteotomy of the lower end of the femur for genu valgum. In addition, Spencer records a case in which the popliteal artery was wounded from in front by a stab just below the knee, the knife passing through the intercondyloid space. The popliteal artery is more frequently the seat of aneurism than is any other artery in the body, with the exception of the thoracic aorta. This is due no doubt, in a great measure to the amount of movement to which it is subjected, and to the fact that it is supported by loose and lax tissue only, and not by muscles, as is the case with most arteries.

Ligature of the popliteal artery is required in cases of wound of that vessel, but for aneurism of the posterior tibial it is preferable to tie the superficial femoral. The popliteal may be tied in the upper or lower part of its course; but in the middle of the ham the operation is attended

with considerable difficulty, from the great depth of the artery and from the extreme degree of tension of the lateral boundaries of the space.

In order to expose the vessel in the upper part of its course, the patient should be placed in the supine position, with the knee flexed and the thigh rotated outward, so that it rests on its outer surface; an incision three inches in length, beginning at the junction of the middle and lower third of the thigh, is to be made parallel to and immediately behind the tendon of the Adductor magnus, and the skin, superficial and deep fascia divided. The tendon of the muscle is thus exposed, and is to be drawn forward and the hamstring tendons backward. A quantity of fatty tissue will now be opened up, in which the artery will be felt pulsating. This is to be separated with the point of a director until the artery is exposed. The vein and nerve will not be seen, as they lie to the outer side of the artery. The sheath is to be opened and the aneurism needle passed from before backward, keeping its point close to the artery for fear of injuring the vein. The only structure to avoid is the long saphenous vein in the superficial incision. The upper part of the popliteal artery may also be tied by an incision on the back of the limb, along the outer margin of the Semimembranosus, but the operation is a more difficult one, as the internal popliteal nerve and the popliteal vein are first exposed, and great care has to be exercised in separating them from the artery.

To expose the vessel in the lower part of its course, where the artery lies between the two heads of the Gastrocnemius, the patient should be placed in the prone position with the limb extended. An incision should then be made through the integument in the middle line, commencing opposite the head of the knee-joint, care being taken to avoid the external saphenous vein and nerve. After dividing the deep fascia and separating some dense cellular membrane, the artery, vein, and nerve will be exposed, descending between the two heads of the Gastrocnemius. Some muscular branches of the popliteal should be avoided if possible, or, if divided, tied immediately. The leg being now flexed, in order the more effectually to separate the two heads of the Gastrocnemius, the nerve should be drawn inward and the vein outward, and the aneurism needle passed between the artery and vein from without inward.

Branches.—The branches of the popliteal artery are—the

Muscular { Superior.	Superior External Articular.
Muscular { Inferior or Sural.	Azygos Articular.
Cutaneous.	Inferior Internal Articular.
Superior Internal Articular.	Inferior External Articular.

The **superior muscular branches**, two or three in number, arise from the upper part of the popliteal artery, and are distributed to the lower part of the Adductor magnus and flexor muscles of the thigh, anastomosing with the fourth perforating branch of the profunda.

The **inferior muscular (sural)** are two large branches which are distributed to the two heads of the Gastrocnemius and to the Plantaris muscle. They arise from the popliteal artery opposite the knee-joint.

The **cutaneous branches** arise separately from the popliteal artery or from some of its branches; they descend between the two heads of the Gastrocnemius muscle, and, piercing the deep fascia, are distributed to the integument of the calf. One branch usually accompanies the short, or external, saphenous vein.

The **superior articular arteries**, two in number, arise one on each side of the popliteal, and wind round the femur immediately above its condyles to the front of the knee-joint. The *internal branch* winds inward beneath the hamstring muscles, to which it supplies branches, above the inner head of the Gastrocnemius, and, passing beneath the tendon of the Adductor magnus, divides into two branches, one of which supplies the Vastus internus, inosculating with the anastomotica magna and inferior internal articular; the other ramifies close to the surface of the femur, supplying it and the knee-joint, and anastomosing with the superior external articular artery. This branch is frequently of small size, a condition which is associated with an increase in the size of the anastomotica magna. The *external branch* passes above the outer condyle, beneath the tendon of the Biceps, and divides into a superficial and deep branch: the superficial branch supplies the Vastus externus, and anastomoses with the descending branch of the external circumflex and the inferior external articular arteries; the deep branch supplies the lower part of the femur and knee-joint, and forms an anastomotic arch across the bone with the anastomotica magna and the inferior internal articular arteries.

The **azygos articular** is a small branch arising from the popliteal artery oppo-

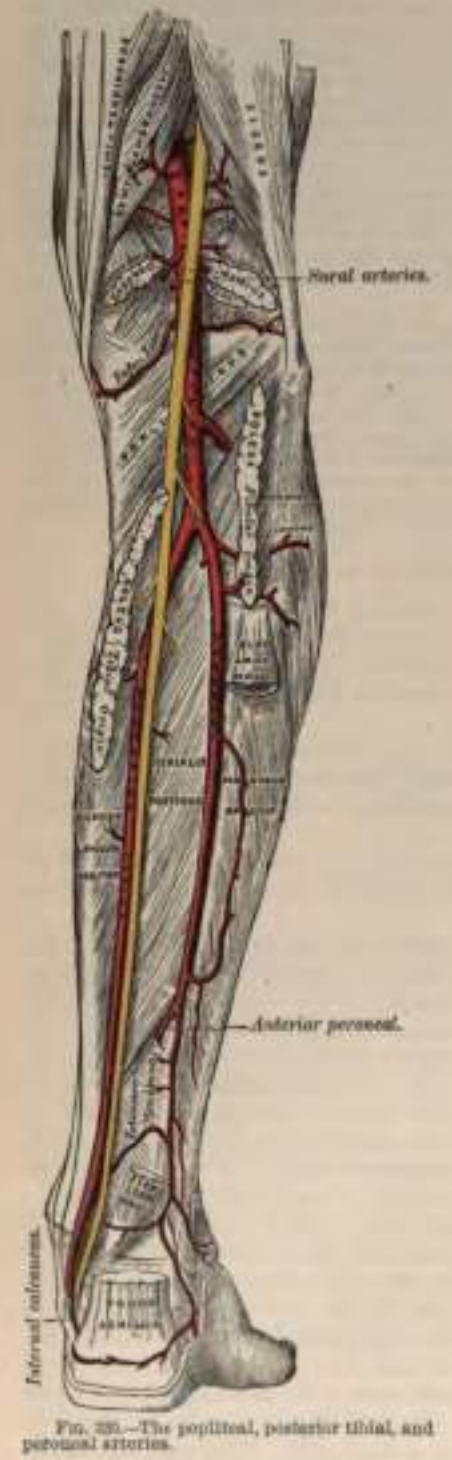


FIG. 220.—The popliteal, posterior tibial, and peroneal arteries.

FIG. 221.—Surgical anatomy of the anterior tibial and dorsalis pedis arteries.

site the bend of the knee-joint. It pierces the posterior ligament, and supplies the ligaments and synovial membrane in the interior of the articulation.

The **inferior articular arteries**, two in number, arise from the popliteal beneath the Gastrocnemius, and wind round the head of the tibia below the joint. The *internal* one first descends along the upper margin of the Popliteus muscle, to which it gives branches; it then passes below the inner tuberosity, beneath the internal lateral ligament, at the anterior border of which it ascends to the front and inner side of the joint, to supply the head of the tibia and the articulation of the knee, anastomosing with the inferior external articular and superior internal articular arteries. The *external* one passes outward above the head of the fibula, to the front of the knee-joint, passing in its course beneath the outer head of the Gastrocnemius, the external lateral ligament, and the tendon of the Biceps muscle, and divides into branches which anastomose with the inferior internal articular artery, the superior external articular artery, and the anterior recurrent branch of the anterior tibial.

Circumpatellar Anastomosis.—Around and above the patella, and on the contiguous ends of the femur and tibia, is a large network of vessels, forming a superficial and deep plexus. The superficial plexus is situated between the fascia and skin round about the patella; the deep plexus, which forms a close network of vessels, lies on the surface of the lower end of the femur and upper end of the tibia around their articular surfaces, and sends numerous offsets into the interior of the joint. The arteries from which this plexus is formed are the two internal and two external articular branches of the popliteal, the anastomotica magna, the terminal branch of the profunda, the descending branch from the external circumflex, and the anterior recurrent branch of the anterior tibial.

The Anterior Tibial Artery (Fig. 321).

The **anterior tibial artery** commences at the bifurcation of the popliteal at the lower border of the Popliteus muscle, passes forward between the two heads of the Tibialis posticus, and through the large oval aperture above the upper border of the interosseous membrane to the deep part of the front of the leg: it here lies close to the inner side of the neck of the fibula; it then descends on the anterior surface of the interosseous membrane, gradually approaching the tibia; and at the lower part of the leg lies on this bone, and then on the anterior ligament of the ankle to the bend of the ankle-joint, where it lies more superficially, and becomes the *dorsalis pedis*.

Relations.—In the upper two-thirds of its extent it rests upon the interosseous membrane, to which it is connected by delicate fibrous arches thrown across it; in the lower third, upon the front of the tibia and the anterior ligament of the ankle-joint. In the upper third of its course it lies between the Tibialis anticus and Extensor longus digitorum; in the middle third, between the Tibialis anticus and Extensor proprius hallucis. At the bend of the ankle it is crossed by the tendon of the Extensor proprius hallucis, and lies between it and the innermost tendon of the Extensor longus digitorum. It is covered, in the upper two-thirds of its course, by the muscles which lie on either side of it and by the deep fascia; in the lower third, by the integument, anterior annular ligament, and fascia.

The anterior tibial artery is accompanied by two veins (venæ comites), which lie one on each side of the artery; the anterior tibial nerve, coursing round the outer side of the neck of the fibula, comes into relation with the outer side of the artery shortly after it has passed through the opening in the interosseous membrane; about the middle of the leg it is placed superficial to it; at the lower part of the artery the nerve is generally again on the outer side.

Plan of the Relations of the Anterior Tibial Artery.

In front.

Integument, superficial and deep fascia.
Anterior tibial nerve.
Tibialis anticus (overlaps it in the upper part of the leg).
Extensor longus digitorum } (overlap it slightly).
Extensor proprius hallucis }
Anterior annular ligament.

Inner side.

Tibialis anticus.
Extensor proprius hallucis (crosses it at its lower part).

Outer side.

Anterior tibial nerve.
Extensor longus digitorum.
Extensor proprius hallucis.

Behind.

Interosseous membrane.
Tibia.
Anterior ligament of ankle-joint.

Peculiarities in Size.—This vessel may be diminished in size, may be deficient to a greater or less extent, or may be entirely wanting, its place being supplied by perforating branches from the posterior tibial or by the anterior division of the peroneal artery.

Course.—The artery occasionally deviates in its course toward the fibular side of the leg, regaining its usual position beneath the annular ligament at the front of the ankle. In two instances the vessel has been found to approach the surface in the middle of the leg, being covered merely by the integument and fascia below that point.

Surface Marking.—Draw a line from the inner side of the head of the fibula to midway between the two malleoli. In this line take a point one inch and a quarter below the head of the fibula, and the portion of the line below this point will mark the course of the artery.

Surgical Anatomy.—The anterior tibial artery may be tied in the upper or lower part of the leg. In the upper part the operation is attended with great difficulty, on account of the depth of the vessel from the surface. An incision, about four inches in length, should be made through the integument, midway between the spine of the tibia and the outer margin of the fibula, and the deep fascia exposed. The wound must now be carefully dried, its edges retracted, and the white line separating the Tibialis anticus from the Extensor longus digitorum sought for. When this has been clearly defined, the deep fascia is to be divided in this line, and the Tibialis anticus separated from adjacent muscles with the handle of the scalpel or a director until the interosseous membrane is reached. The foot is to be flexed in order to relax the muscles, and upon drawing them apart, the artery will be found lying on the interosseous membrane with the nerve on its outer side or on the top of the artery. The nerve should be drawn outward, and the venæ comites separated from the artery and the needle passed around it.

To tie the vessel in the lower third of the leg above the ankle-joint an incision about three inches in length should be made through the integument between the tendons of the Tibialis anticus and Extensor proprius hallucis muscles, the deep fascia being divided to the same extent. The tendon on either side should be held aside, when the vessel will be seen lying upon the tibia, with the nerve on the outer side and one of the venæ comites on either side.

The branches of the anterior tibial artery are—the

Posterior Recurrent Tibial.	Muscular.
Superior Fibular.	Internal Malleolar.
Anterior Recurrent Tibial.	External Malleolar.

The **posterior recurrent tibial** is not a constant branch, and is given off from the anterior tibial before that vessel passes through the interosseous space. It ascends beneath the Popliteus muscle, which it supplies, and anastomoses with the lower articular branches of the popliteal artery, giving off an offset to the superior tibio-fibular joint.

The **superior fibular** is sometimes given off from the anterior tibial, sometimes from the posterior tibial. It passes outward, round the neck of the fibula, through the Soleus, which it supplies, and ends in the substance of the Peroneus longus muscle.

The **anterior recurrent tibial branch** arises from the anterior tibial as soon as that vessel has passed through the interosseous space; it ascends in the Tibialis anticus muscle, and ramifies on the front and sides of the knee-joint, anastomos-

ing with the articular branches of the popliteal and with the anastomotica magna, assisting in the formation of the circumpatellar plexus.

The **muscular branches** are numerous; they are distributed to the muscles which lie on each side of the vessel, some piercing the deep fascia to supply the integument, others passing through the interosseous membrane, and anastomosing with branches of the posterior tibial and peroneal arteries.

The **malleolar arteries** supply the ankle-joint. The *internal* arises about two inches above the articulation, and passes beneath the tendons of the Extensor proprius hallucis and Tibialis anticus to the inner ankle, upon which it ramifies, anastomosing with branches of the posterior tibial and internal plantar arteries and with the internal calcanean from the posterior tibial. The *external* passes beneath the tendons of the Extensor longus digitorum and Peroneus tertius, and supplies the outer ankle, anastomosing with the anterior peroneal artery and with ascending branches from the tarsal branch of the dorsalis pedis.

The Dorsalis Pedis Artery (Fig. 321).

The **dorsalis pedis,** the continuation of the anterior tibial, passes forward from the bend of the ankle along the tibial side of the foot to the back part of the first intermetatarsal space, where it divides into two branches, the *dorsalis hallucis*, and *communicating*.

Relations.—This vessel, in its course forward, rests upon the astragalus, navicular, and middle cuneiform bones and the ligaments connecting them, being covered by the integument and fascia, anterior annular ligament, and crossed near its termination by the innermost tendon of the Extensor brevis digitorum. On its *tibial side* is the tendon of the Extensor proprius hallucis; on its *fibular side*, the innermost tendon of the Extensor longus digitorum, and the termination of the anterior tibial nerve. It is accompanied by two veins.

PLAN OF THE RELATIONS OF THE DORSALIS PEDIS ARTERY.

In front.
Integument and fascia.
Anterior annular ligament.
Innermost tendon of Extensor brevis digitorum.

Tibial side.
Extensor proprius hallucis.

Fibular side.
Extensor longus digitorum.
Anterior tibial nerve.

Behind.
Astragalus.
Navicular.
Middle cuneiform.
and their ligaments.

Peculiarities in Size.—The dorsal artery of the foot may be larger than usual, to compensate for a deficient plantar artery; or it may be deficient in its terminal branches to the toes, which are then derived from the internal plantar; or its place may be supplied altogether by a large anterior peroneal artery.

Position.—This artery frequently curves outward, lying external to the line between the middle of the ankle and the back part of the first interosseous space.

Surface Marking.—The dorsalis pedis artery is indicated on the surface of the dorsum of the foot by a line drawn from the centre of the space between the two malleoli to the back of the first intermetatarsal space.

Surgical Anatomy.—This artery may be tied, by making an incision through the integument between two and three inches in length, on the fibular side of the tendon of the Extensor proprius hallucis, in the interval between it and the inner border of the short Extensor muscle. The incision should not extend further forward than the back part of the first intermetatarsal

space, as the artery divides in that situation. The deep fascia being divided to the same extent, the artery will be exposed, the nerve lying upon its outer side.

Branches.—The branches of the dorsalis pedis are—the

Tarsal.	Dorsalis Hallucis.
Metatarsal—Interosseous.	Communicating.

The **tarsal artery** arises from the dorsalis pedis, as that vessel crosses the navicular bone; it passes in an arched direction outward, lying upon the tarsal bones, and covered by the Extensor brevis digitorum; it supplies that muscle and the articulations of the tarsus, and anastomoses with branches from the metatarsal, external malleolar, peroneal, and external plantar arteries.

The **metatarsal** arises a little anterior to the preceding; it passes outward to the outer part of the foot, over the bases of the metatarsal bones, beneath the tendons of the short Extensor, its direction being influenced by its point of origin; and it anastomoses with the tarsal and external plantar arteries. This vessel gives off three branches, the *interosseous arteries*, which pass forward upon the three outer Dorsal interossei muscles, and, in the clefts between the toes, divide into two dorsal collateral branches for the adjoining toes. At the back part of each interosseous space these vessels receive the posterior perforating branches from the plantar arch, and at the fore part of each interosseous space they are joined by the anterior perforating branches from the digital arteries. The outermost interosseous artery gives off a branch which supplies the outer side of the little toe.

The **dorsalis hallucis** (*first dorsal interosseous*) runs forward along the outer border of the first metatarsal bone, and at the cleft between the first and second toes divides into two branches, one of which passes inward, beneath the tendon of the Extensor proprius hallucis, and is distributed to the inner border of the great toe; the outer branch bifurcates, to supply the adjoining sides of the great and second toes.

The **communicating artery** dips down into the sole of the foot, between the two heads of the First dorsal interosseous muscle, and inosculates with the termination of the external plantar artery, to complete the plantar arch. It here gives off its plantar digital branch, which is named the *arteria magna hallucis*. This artery passes forward along the first interosseous space, and, after sending a branch along the inner side of the great toe, bifurcates for the supply of the adjacent sides of the great and second toes.

The Posterior Tibial Artery.

The **posterior tibial** is an artery of large size, which extends obliquely downward from the lower border of the Popliteus muscle, along the tibial side of the leg, to the fossa between the inner ankle and the heel, where it divides beneath the origin of the Abductor hallucis, on a level with a line drawn from the point of the internal malleolus to the centre of the convexity of the heel, into the *internal* and *external plantar arteries*. At its origin it lies opposite the interval between the tibia and fibula; as it descends, it approaches the inner side of the leg, lying behind the tibia, and, in the lower part of its course, is situated midway between the inner malleolus and the tuberosity of the os calcis.

Relations.—It lies successively upon the Tibialis posticus, the Flexor longus digitorum, the tibia, and the back part of the ankle-joint. It is *covered* by the deep transverse fascia, which separates it above from the Gastrocnemius and Soleus muscles: at its termination it is covered by the Abductor hallucis muscle. In the lower third, where it is more superficial, it is covered only by the integument and fascia, and runs parallel with the inner border of the tendo Achillis. It is accompanied by two veins and by the posterior tibial nerve, which lies at first to the inner side of the artery, but soon crosses it, and is, in the greater part of its course, on its outer side.