CHAPTER 7

The Neck

SURFACE ANATOMY **Soft Tissue Landmarks of the Neck** ***External Jugular Vein*** ***Sternocleidomastoid Muscle*** **Skeletal Landmarks of the Neck** ***Skull*** ***Vertebrae***	***Hyoid Bone*** ***Thyroid Cartilage*** ***Cricoid Cartilage*** **Trachea and Thyroid Gland** **Carotid Arteries** **Internal Jugular Vein** **Subclavian Artery and Nearby Nerves** **Repeating Some Important Relationships of Nerves**

The neck is that portion of the body between the head and the thorax. Posteriorly it extends from the base of the skull down to the top of the 1st thoracic vertebra. In front it extends from the mandible to the top of the manubrium and 1st costal cartilage. Thus, the anterior limits of the neck are displaced caudally relative to its posterior boundaries.

The fundamental difference between the neck and the trunk is that the former contains no coelomic cavity (unless one pointlessly wishes to consider the cupola of the pleura as crossing the cervicothoracic boundary). Because no coelom forms in the neck, no division of the lateral plate mesoderm into somatic and splanchnic layers occurs. Thus, there is an indefinite interface between body wall and body cavity. As a result, striated muscle derived from occipital somites has come to invest that portion of the gut tube located in the cervical cavity.

BODY WALL OF THE NECK

Deep to the skin, the cervical body wall contains both skeletal and muscular elements, with the latter quite predominant. Whereas there should be no argument that the cervical vertebrae are proper structures of the body wall, it is a moot question whether certain other skeletal elements (e.g., hyoid bone) are part of the body wall or represent something we ought to classify as visceral skeleton. The laryngeal cartilages would seem almost certainly to be skeletal structures associated with viscera. Regardless, it is convenient to describe some of these visceral bones or cartilages at this time.

Skeletal Components

Cervical Vertebrae

The major bony component of the cervical body wall is formed by the seven cervical vertebrae. Let me remind the reader of some traits of cervical vertebrae (see Fig. 3-1). Their transverse processes are compound structures formed of transverse elements (homologous to the transverse processes of thoracic vertebrae) and costal elements (homologous to ribs). The transverse and costal elements are fused at the site of the presumptive costotransverse joint, turning the gap between the back of the "rib" and the front of the transverse "process" into a foramen--the so-called transverse (or costotransverse) foramen of a cervical vertebra.

All the cervical transverse processes are terminated by posterior tubercles, corresponding to the tubercles of thoracic ribs.[25] The 3rd, 4th, 5th, and 6th cervical transverse processes also have substantial

[25] We know that the term "posterior tubercle" has a different meaning when applied to the atlas (Chapter 3). However, in this chapter I would like dispensation to refer to the tip of the atlas transverse process as a posterior tubercle when discussing the origins and insertions of various neck muscles.

anterior tubercles, which are secondary bumps related to muscular attachments. Other specializations of cervical vertebrae are discussed in Chapter 3.

The Hyoid Bone and the Styloid Process of the Skull

Although lying at the interface between body wall and body cavity, the hyoid bone and the styloid process of the skull are conveniently described at this time.

The **hyoid** is a U-shaped bone (Fig. 7-1) that sits in the neck immediately inferior to the posterior half of the mandibular corpus (Fig. 7-2). The bend in the U lies anteriorly and is called the **body**; each side-arm is called a **greater horn** (**greater cornu**). The body of the hyoid is joined to its greater horns by cartilage until middle-age, when they fuse. From each such junction a short process extends upward and backward. These are the **lesser horns** (**lesser cornua**) of the hyoid, bound to the remainder of the bone by fibrous tissue.

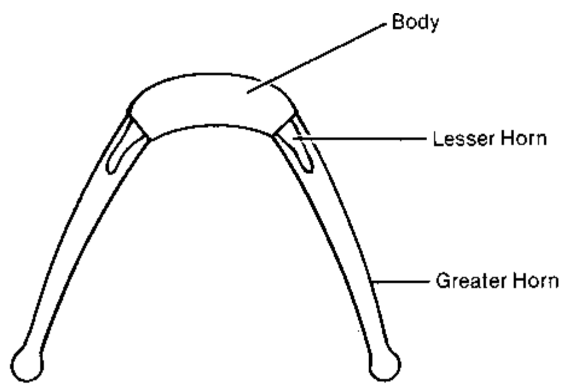

Figure 7-1. Superior view of the hyoid bone (schematic). Anterior is at the *top* of the figure, posterior at the *bottom*.

The **styloid process** is a deeply placed spike-like bone that projects downward and forward from a site on the skull just lateral to the jugular foramen (see Fig. 8-5). The styloid process is 2 to 3 cm in length and ends deep to the back edge of the mandibular ramus at its midpoint (see Fig. 7-2).

The periosteum of the styloid process is continued beyond that structure, maintaining its forward and downward course, to reach the periosteum of the lesser horn of the hyoid bone. This connective tissue band linking the tip of the styloid process to the hyoid bone is called the **stylohyoid ligament** (see Fig. 7-2). It may partially ossify.

The styloid process, stylohyoid ligament, lesser cornu, and superior half of the body of the hyoid bone are all skeletal derivatives of the 2nd branchial arch. The greater cornu and inferior half of the hyoid body are derivatives of the 3rd branchial arch.

Thyroid Cartilage (see Figs. 7-2, 7-12, 7-13)

The thyroid cartilage lies a short distance below the hyoid bone. It consists primarily of two flat, slightly elongate, pentagonal plates called **laminae**. Each lamina is turned on its side so that its base faces posteriorly and its apex is directed toward the front. The external surface of each lamina faces anterolaterally, precisely so in males, but slightly more anteriorly than laterally in females. Of the two

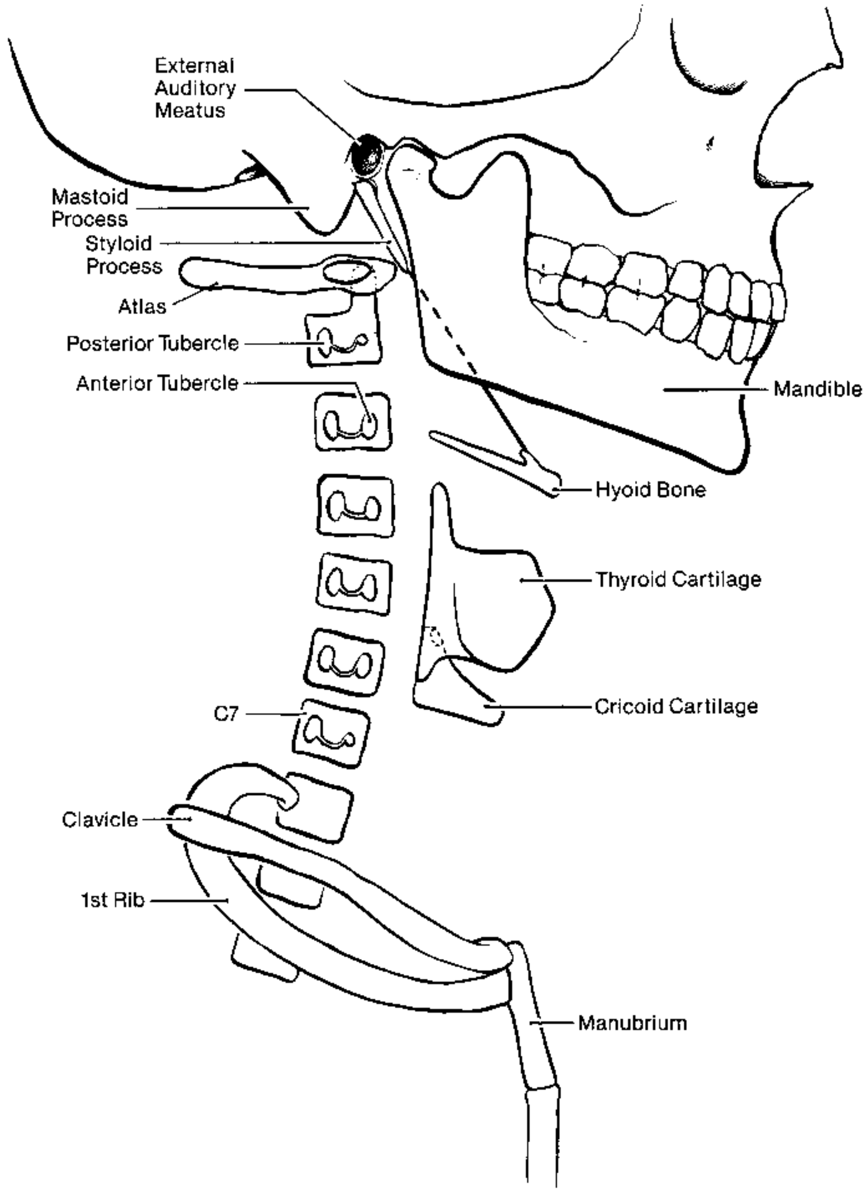

Figure 7–2. Lateral view of the skeletal framework of the neck. The *dashed ellipse* on the superior rim of the cricoid cartilage represents the facet for articulation with the arytenoid cartilage (not figured).

edges that form the apex of a thyroid lamina, the lower one of the left thyroid lamina is fused to the corresponding edge of the right lamina. This site of joining is called the **angle** of the thyroid cartilage. The failure of the upper apical edges to fuse produces the so-called **superior thyroid notch**. The anteriorly directed apex of the fused laminae is known as the **laryngeal prominence**. It is more prominent in men than in women.

From the back edge of each lamina (i.e, the base of the pentagon) a slender process extends superiorly toward (but not reaching) the tip of the greater horn of the hyoid bone. This process is the **superior horn** (**superior cornu**) of the thyroid cartilage. The postero-inferior corner of each lamina lies superficial to the cricoid cartilage. Passing downward from this corner is a short, stout process - the

inferior horn (**inferior cornu**) of the thyroid cartilage - whose tip forms a true synovial joint with the more deeply placed cricoid cartilage.

On the external surface of each lamina is a curvilinear ridge running downward and then a bit forward. This is called the **oblique line** and serves as the attachment site for three muscles (the sternothyroid, thyrohyoid, and the inferior constrictor of the pharynx) to be described subsequently.

Cricoid Cartilage (see Figs. 7-2, 7-13)

Everybody describes the cricoid cartilage as being in the shape of a signet ring with its broad surface facing posteriorly. This broad posterior part of the cricoid cartilage is called its **lamina**. The semicircle formed by the lateral and anterior portions is said to comprise the **arch** of the cricoid. In side view, the cricoid cartilage presents the outline of a right triangle, with the superior rim of the cartilage being the hypotenuse. It is the postero-superior angle of this triangle that is under cover of the thyroid lamina. The lower rim of the cricoid cartilage is joined by connective tissue to the 1st cartilaginous ring of the trachea.

On the external surface of the cricoid, at the junctions of its arch and lamina, are facets for articulation with the inferior horns of the thyroid cartilage. On the superior rim of the cricoid, also at the junctions of the arch and lamina, are facets for articulation with the arytenoid cartilages. These latter facets are convex ovals whose long axes parallel the sloping superior rim of the cricoid (thus, run downward, outward, and forward).

Muscular Components

As we might expect, the muscular components of the cervical body wall are largely derived from the hypaxial portions of cervical dermomyotomes. However, as elsewhere in the body, some muscles either wholly or partly of foreign origin have moved into the region.

Of the muscles derived wholly from cervical dermomyotomes, some (anterior and lateral intertransversarii, scalenes) can be homologized to the intercostal muscles of thorax (or equally, the trilaminar muscles of the abdomen). Others (the infrahyoid strap muscles) can be homologized to the rectus of the abdomen. Yet a third muscle group--the prevertebral--finds no counterpart elsewhere in the body.

Two muscles--trapezius and sternocleidomastoid--derive some cellular material from hypaxial cervical dermomyotomes and other cellular material from somites of the head. The bulk of the trapezius does not even lie in the neck, but the part that does is so important that the whole muscle will be discussed in this chapter.

The platysma is an immigrant of wholly foreign origin. So are certain muscles above the hyoid bone but below the jaw. Finally, the extrinsic tongue muscles, also not derived from cervical dermomyotomes, lie partly in the neck.

Whereas the hypaxial parts of the upper four cervical dermomyotomes are concerned solely with giving rise to neck muscles, the lower four cervical hypaxial dermomyotomes provide cells for some muscles inside and some muscles outside the neck. This dual fate should not be surprising. After all, the reader will recall that most of the cells from the hypaxial parts of abdominopelvic dermomyotomes L2-S3 migrated away from the trunk into an outgrowth of the abdominopelvic body wall that is called the lower limb. It turns out that the upper limb is an outgrowth of the cervicothoracic body wall, and that it parasitizes most of the hypaxial dermomyotome cells from C5-C8 (and T1). Yet other cells from the lower cervical dermomyotomes leave the neck to become trunk muscles associated with the shoulder girdle (rhomboids, levator scapulae, serratus anterior, and subclavius). It is these developmentally cervical muscles that lie partly or wholly outside the neck that I would like to describe first.

Cervical Muscles Associated With the Shoulder Girdle

Rhomboideus Major and Rhomboideus Minor. The rhomboid muscle sheet, derived from the hypaxial part of the 5th cervical dermomyotome, arises from the lower end of the ligamentum nuchae and the spines of the upper thoracic vertebrae. From this origin the muscle fibers pass inferolaterally to reach their insertion on vertebral border of the scapula from the root of its spine down to its inferior angle. The highest fibers can be dissected away from the rest and are called **rhomboideus minor**; the bulk of the muscle sheet is **rhomboideus major**. Both are innervated by the same branch of the **ventral ramus of the 5th cervical spinal nerve**, which branch is called the **nerve to the rhomboids** (or sometimes the **dorsal scapular nerve**).

These muscles retract and, to a lesser extent, elevate the scapula. They also help to rotate the scapula so that the glenoid cavity faces more caudally, a movement that is not terribly important.

Levator Scapulae and Serratus Anterior. In the abdomen there exists quadratus lumborum, a muscle that runs from the costal elements of lumbar vertebrae to the ilium. In the neck and thorax of many nonhuman primates there is a serially homologous muscle, called serratus magnus, passing from an origin on the posterior tubercles (thus, costal elements) of all the cervical vertebrae and from the lateral surfaces of the upper ribs to gain an insertion along the whole length of the vertebral border of the scapula. The serratus magnus is derived from the hypaxial portions of dermomyotomes C3-C7. In humans the same muscle sheet lacks an origin from the C5-C8; thus, it appears to form two separate muscles: levator scapulae and serratus anterior.

The **levator scapulae** arises from C1-C4 and inserts along the vertebral border of the scapula from its superior angle to the root of its spine, where the rhomboid attachment begins. It represents that portion of the serratus magnus derived from 3rd and 4th cervical hypaxial dermomyotomes; thus, it is innervated by branches of the 3rd and 4th cervical ventral rami. As its name suggests, the levator scapulae contributes to elevation of the scapula. It simultaneously pulls it forward. Levator scapulae is used during extension of the arm and when reaching far forward.

The **serratus anterior** arises from the outer surfaces of the upper nine ribs, more or less along the anterior axillary line. The part arising from each rib is called a digitation. The digitations from ribs 1 and 2 insert on the ventral surface of the scapula along a narrow strip immediately adjacent to its vertebral border. This insertion passes all the way from the superior angle to near the inferior angle of the scapula. The ventral surface of the inferior angle itself receives the insertion of the remaining seven digitations of the serratus anterior. These digitations, arising all the way from rib 3 down to rib 9 but having a restricted insertion, form a fan-shaped segment of the muscle.

The serratus anterior represents that portion of the serratus magnus derived from the 5th-7th cervical hypaxial dermomyotomes and, thus, is innervated by branches of the 5th-7th cervical ventral rami. The three branches join to form a single nerve bundle called the **nerve to the serratus anterior**, or the **long thoracic nerve**. It runs down the outer surface of the serratus anterior, one to two centimeters posterior to the midaxillary line.

As a whole, the serratus anterior is a protractor of the scapula, i.e., it pulls the bone anteriorly. Those digitations that insert on the inferior angle pull only this part of the scapula forward, thus causing a rotation so that the glenoid cavity faces more superiorly. In fact, the serratus anterior is the major glenoid-up rotator of the scapula, especially when this motion is part of flexion of the upper limb. After all, effective flexion of the upper limb requires both scapular protraction and rotation. The trapezius provides assistance to the serratus in producing the glenoid-up rotation that accompanies abduction of the arm (see further on).

CLINICAL CONSIDERATIONS REGARDING THE SERRATUS ANTERIOR

When the serratus anterior is paralyzed, the only change in appearance of the scapula is that its inferior angle moves posteriorly away from the chest wall to make a noticeable ridge beneath the skin of the back, a condition known as **winging** of the scapula. As we shall see later, paralysis of the trapezius yields a similar change in appearance of the back. The examiner may be unable to decide whether winging of the scapula is due to a serratus anterior or a trapezius paralysis. The determination is then made by requiring the patient to perform a motion for which one of the muscles is significantly more important than the other. If that important muscle is damaged, the winging will become worse; if that muscle is intact, the winging will become less noticeable. For example, if the patient abducts the arm, a trapezius-winging will become more prominent but a serratus-winging will lessen (or remain unchanged). If the patient flexes the arm, a serratus-winging will worsen but any winging caused by a paralyzed trapezius will diminish. Winging due to a paralyzed serratus anterior is also accentuated by applying a dorsally directed force to the scapula that the paralyzed serratus is unable to resist. In diagnosis, this is accomplished by asking the patient to hold his or her hands stretched out in front of the body and then lean against a wall supported by the outstretched hands. This maneuver causes a serratus-winging to become very pronounced. Had appearance of winging at rest been due to a weak trapezius, the winging would virtually disappear when the patient performed such a test.

The Subclavius. The subclavius is a small muscle derived from the hypaxial part of the 5th cervical dermomyotome. It arises tendinously from the superior surface of the 1st rib and costal cartilage at their junction, and passes laterally, and slightly upward, to insert fleshily into the inferior surface of the middle third of the clavicle. Its embryonic origin dictates that it be innervated by a branch of the ventral ramus of C5, which branch is called the nerve to the subclavius.

The function of the subclavius is obscure. My own preliminary electromyographic experiments demonstrate that it is used when the upper limb pushes down on an object alongside the trunk. The best example of such a behavior is using one's hands to push down on the arms of a chair when rising from a seated position.

Developmentally Cervical Muscles That Stay in the Neck

Anterior and Lateral Intertransverse Muscles (Including Rectus Capitis Anterior and Rectus Capitis Lateralis) and the Scalenes--All Representing the "Intercostal" Muscles of the Neck. The trilaminar musculature represented in the thorax by the intercostal muscles has a variety of members in the neck. The purest versions of this muscle block are (1) the **anterior intertransverse muscles**, running between the anterior tubercles of adjacent cervical transverse processes, and (2) the **lateral intertransverse muscles**, running between the posterior tubercles of adjacent cervical transverse processes. It will be recalled that both sets of tubercles are part of the costal element of a cervical vertebra. In that the ventral ramus of a cervical spinal nerve passes laterally between the anterior and lateral intertransverse muscles (see Fig. 7-5), the former may be homologized to an innermost intercostal and the latter to an internal intercostal.[26]

The highest in the series of anterior intertransverse muscles is the **rectus capitis anterior**, between the atlas and the occipital bone immediately in front of the foramen magnum. The highest member of the lateral intertransverse series is the **rectus capitis lateralis**, again between the atlas and occipital bone. Its attachment to the occipital bone is in a region just lateral to the posterior part of the occipital condyle.

In the neck, the "intercostal" muscle block also specializes into three other muscles--the scaleni. **Scalenus anterior** (see Figs. 7-3, 7-4, 7-5) arises from the anterior tubercles of cervical vertebrae 3, 4, 5, and 6. (In fact, the origin of scalenus anterior is in part responsible for the development of these tubercles.) The muscle fibers pass inferolaterally to converge on a short tendon that inserts onto the

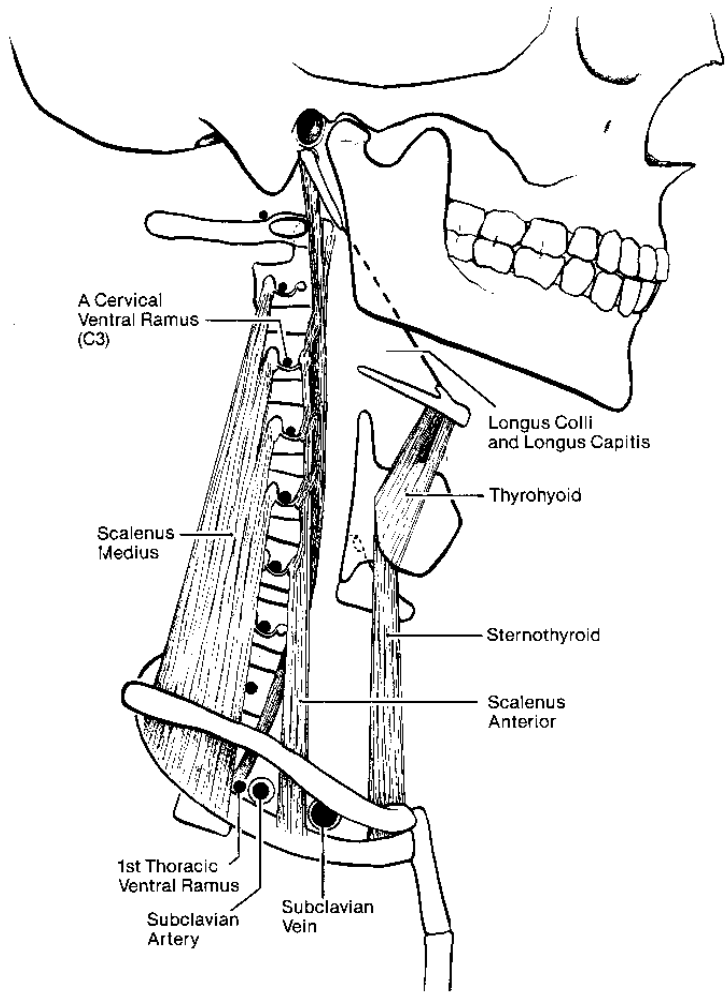

Figure 7-3. Lateral view of the scalene muscles, prevertebral muscles, the deep layer of infrahyoid muscles, and the relationships of the subclavian vessels to the 1st rib.

[26] The possibility also exists that the lateral intertransverse muscles are serial homologues of the external intercostals, and that the internal layer is simply unrepresented in the neck.

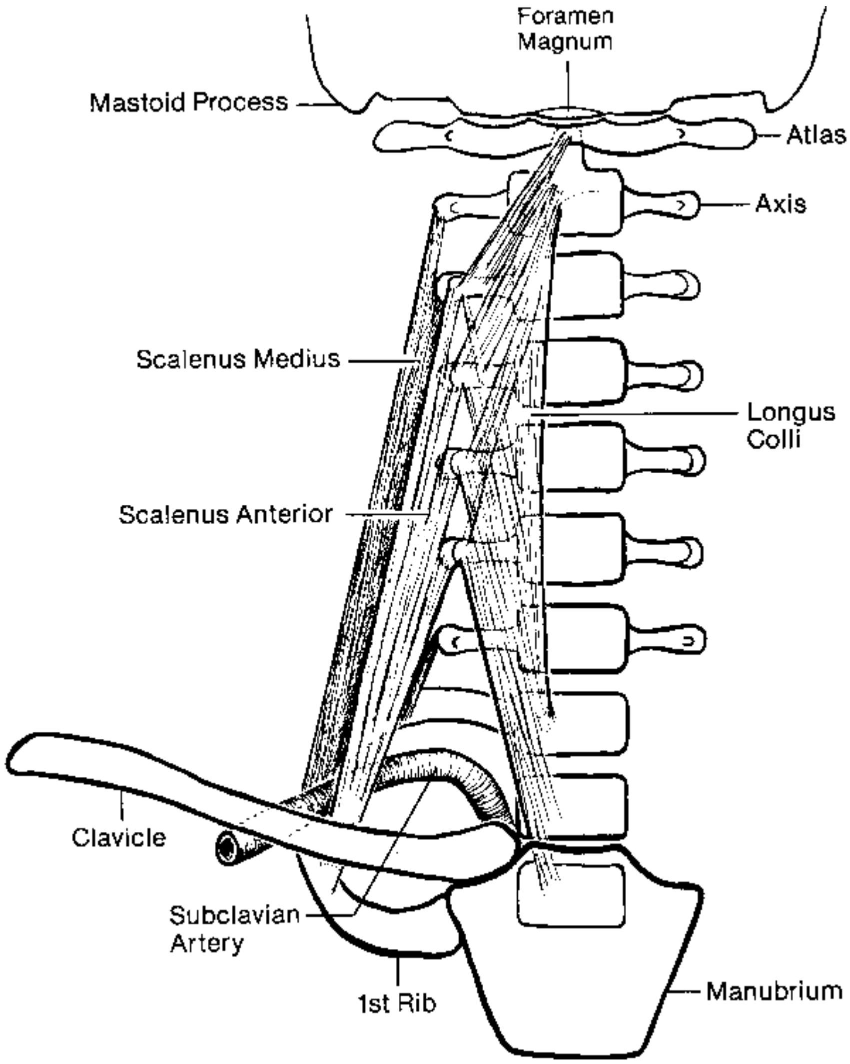

Figure 7-4. Anterior view of the scalene muscles, longus colli, and the subclavian artery.

medial aspect of the superior surface of the 1st rib, slightly in advance of its midpoint. The site of insertion is marked by a bump--the **scalene tubercle**--that also separates two grooves on the upper surface of the 1st rib. The groove posterior to the scalene tubercle is caused by passage of the subclavian artery and the 1st thoracic ventral ramus (see Fig. 7-3). The groove anterior to the scalene tubercle is caused by the subclavian vein.

Arising from the posterior tubercles of all the cervical vertebrae (although sometimes the highest or lowest are skipped) is the **scalenus medius** (see Figs. 7-3, 7-4, 7-5). Like its anterior partner, the scalenus medius follows an inferolateral course to insert on the superior surface of the 1st rib. The area of insertion extends from the groove for the subclavian artery back to the tubercle of the rib, spanning the entire width of the bone. This broader insertion means that the outer edge of the scalenus medius lies lateral to that of the scalenus anterior.

Lying up against the back surface of the scalenus medius is an insignificant little muscle called the **scalenus posterior**. It arises from the posterior tubercles of the lower cervical vertebrae and descends across the lateral border of the 1st rib, to insert on the lateral border of the 2nd rib.

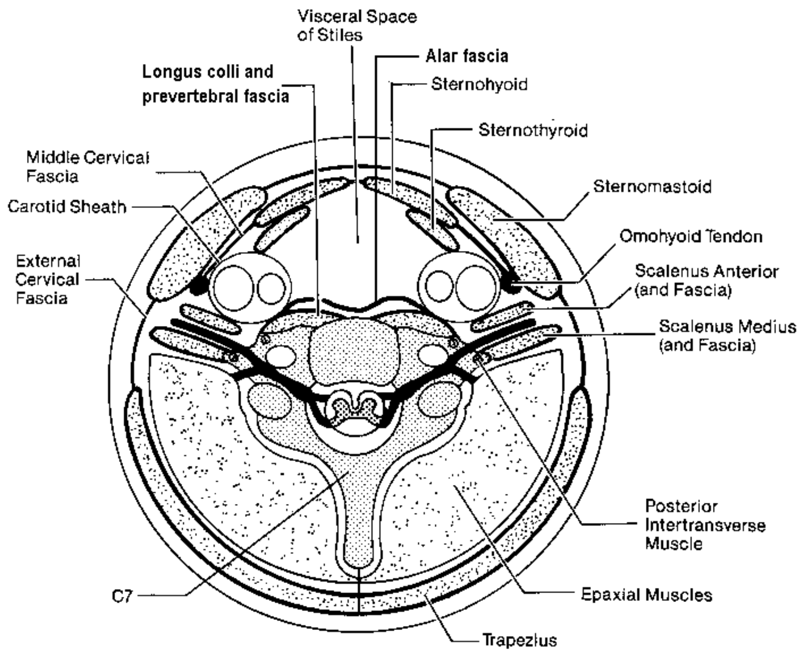

Figure 7-5. Transverse section through the neck (schematic) at the level of the 7th cervical vertebra. The contents of the visceral space and the major longitudinally running nerves have been left out.

The scalenus anterior and scalenus medius may be homologized to innermost and internal intercostals, respectively.[27] The ventral rami of the lower cervical nerves, after passing between the anterior and lateral intertransversarii continue outward between the scalenus anterior and medius (see Figs. 7-3, 7-4, 7-5). The space between these muscles is called the **interscalene triangle**. Its base is formed by the groove for the subclavian artery on the 1st rib.

Being good members of the hypaxial trilaminar muscle block, the anterior and lateral intertransverse muscles and the scalenes are innervated by the nerves that pass between the innermost and internal layers, i.e., the cervical ventral rami.

All these muscles laterally flex the neck. Obviously, the anterior and lateral rectus capitis muscles have an action on the head--the lateralis being a lateral flexor and the anterior being a flexor. The scalenus anterior is also known to be active upon inspiratory efforts, even during quiet breathing. The scalenus medius is also used in forced inspiration.

Longus Colli and Longus Capitis -The Prevertebral Muscles, Representing a Group Unique to the Neck. The hypaxial parts of the upper six cervical dermomyotomes send cells on a short course to a position just anterior to the developing vertebral column. These cells will form two **prevertebral muscles** that have no homologues lower in the body.

One of the prevertebral muscles is called the **longus colli**. It has a rather complicated pattern of origin and insertion. Some fibers arise from the front of the bodies of the upper three thoracic vertebrae and pass superolaterally to insert on the anterior tubercles of cervical vertebrae (see Fig. 7-4). Other fibers arise from such anterior tubercles and pass superomedially to insert on the named anterior tubercle

[27] Or the scalenus medius is a kind of external intercostal, and the internal layer is unrepresented in the neck. The scalenus posterior has been said to represent a levator costae. The truth may be interesting but is not important.

of the atlas (not homologous to an anterior tubercle of a transverse process). Finally, some fibers arise from the bodies of the upper three thoracic and lower three cervical vertebrae and pass pretty much straight upward to insert on the bodies of the upper four cervical vertebrae.

In that the medial border of the scalenus anterior passes downward and outward from the anterior tubercle of C6, and the lower lateral border of the longus colli passes downward and inward from the same site, there is a triangular gap between these two muscles in the lower reaches of the neck (see Fig. 7-4). This has been called the "triangle of the vertebral artery,"[28] because this artery is one of the major structures passing through the gap.

Each longus colli participates in flexion of the neck and lateral flexion to the same side. They also act during rotation of the head; the right longus colli acts when the head is turned to the right, and the left longus colli acts when the head is turned to the left. It may be that a longus colli functions during head rotation to counteract the tendency of the opposite sternocleidomastoid to laterally flex the neck (see further on).

The other prevertebral muscle is the **longus capitis**. It lies on the anterolateral surface of the upper half of the longus colli (Fig. 7-6). The muscle fibers arise from anterior tubercles of cervical

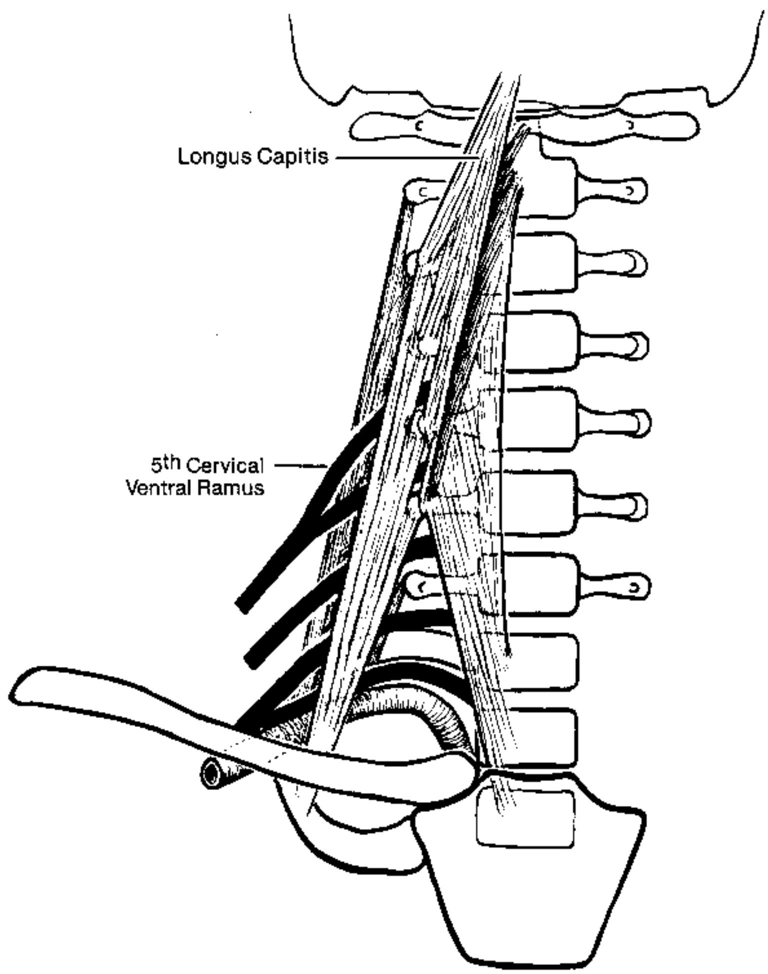

Figure 7-6. Anterior view of the longus capitis and of the relationships between the roots of the brachial plexus and the scalene muscles.

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28 Sauerland, EK: Grant's Dissector, ed 9. Williams & Wilkins, Baltimore, 1984.

vertebrae and pass superomedially to insert on the occipital bone in front of the foramen magnum (in fact, just anterior to the insertion of rectus capitis anterior). Acting across the atlanto-occipital joint, the longus capitis flexes the head. Acting across the atlanto-axial joint, the longus capitis rotates the head to the same side.

Because they are flexors, it falls upon the prevertebral muscles to protect the cervical part of anterior longitudinal ligament from further stretching after it has been damaged by a whiplash injury. To fulfill this function, the longus muscles undergo a sustained recruitment, to which they are unaccustomed. This leads to muscle fatigue and pain. One of the purposes of placing a collar around the neck of a person who has experienced whiplash is to provide for artificial flexion of the neck and head, thus relieving the prevertebral musculature from the need to contract continuously. Obviously, such a collar should be higher in the back than in the front.

The prevertebral muscles are innervated by direct branches from the upper six cervical ventral rami very soon after these rami split from their spinal nerves.

Prevertebral Fascia. The deep fascia on the anterior surface of the prevertebral muscles is called the **prevertebral fascia**. It is continuous laterally with the fascia of the scalene muscles. Anterior to the prevertebral fascia is a layer of **alar fascia** that is not bound down to the prevertebral muscles. This alar fascia blends with the back of the esophagus in the superior mediastinum. Between the prevertebral fascia and alar fascia is the **danger space**, so called because infections that enter it can travel downward into chest and through the posterior mediastinum all the way to the diaphragm.

Sternothyroid, Thyrohyoid, Sternohyoid, and Omohyoid--The Infrahyoid Strap Muscles, or "Rectus Cervicis". We know that in the abdomen there is a longitudinal muscle in the ventral part of the body wall. This muscle is the rectus abdominis, formed by lower thoracic dermomyotomes. Upper thoracic and lower cervical dermomyotomes normally produce no cells that migrate all the way around the body wall to produce a rectus muscle. Sometimes they do, producing the anomalous **sternalis** muscle overlying the sternum. On the other hand, the upper three cervical dermomyotomes always send cells to produce a "rectus cervicis" , from which four independent muscles differentiate. Two of these--the sternothyroid and the thyrohyoid--form a deep layer; the others--the sternohyoid and the omohyoid--lie more superficially.

The **sternothyroid** muscle arises from the back of the manubrium and 1st costal cartilage. The right and left muscles abut at their origins but diverge slightly as each passes superolaterally to insert on the oblique line of the thyroid cartilage (see Fig. 7-3). From this same line another muscle, the **thyrohyoid**, passes straight upward to insert on the inferior edge of the body and greater horn of the hyoid (see Fig. 7-3).

The **sternohyoid** arises from the backs of the manubrium and medial end of the clavicle. It passes directly upward to a narrow insertion on the body of the hyoid bone near the midline (Fig. 7-7). A narrow gap exists between the medial margins of the right and left sternohyoids. Through this gap the Adam's apple protrudes and the anterior arch of the cricoid cartilage can be felt.

The **omohyoid** is a muscle composed of two fleshy bellies separated by a thin tendon to which both bellies attach (see Fig. 7-7). The bellies are designated by the terms "superior" and "inferior." The **inferior belly** of the omohyoid arises from the superior border of the scapula just medial to the

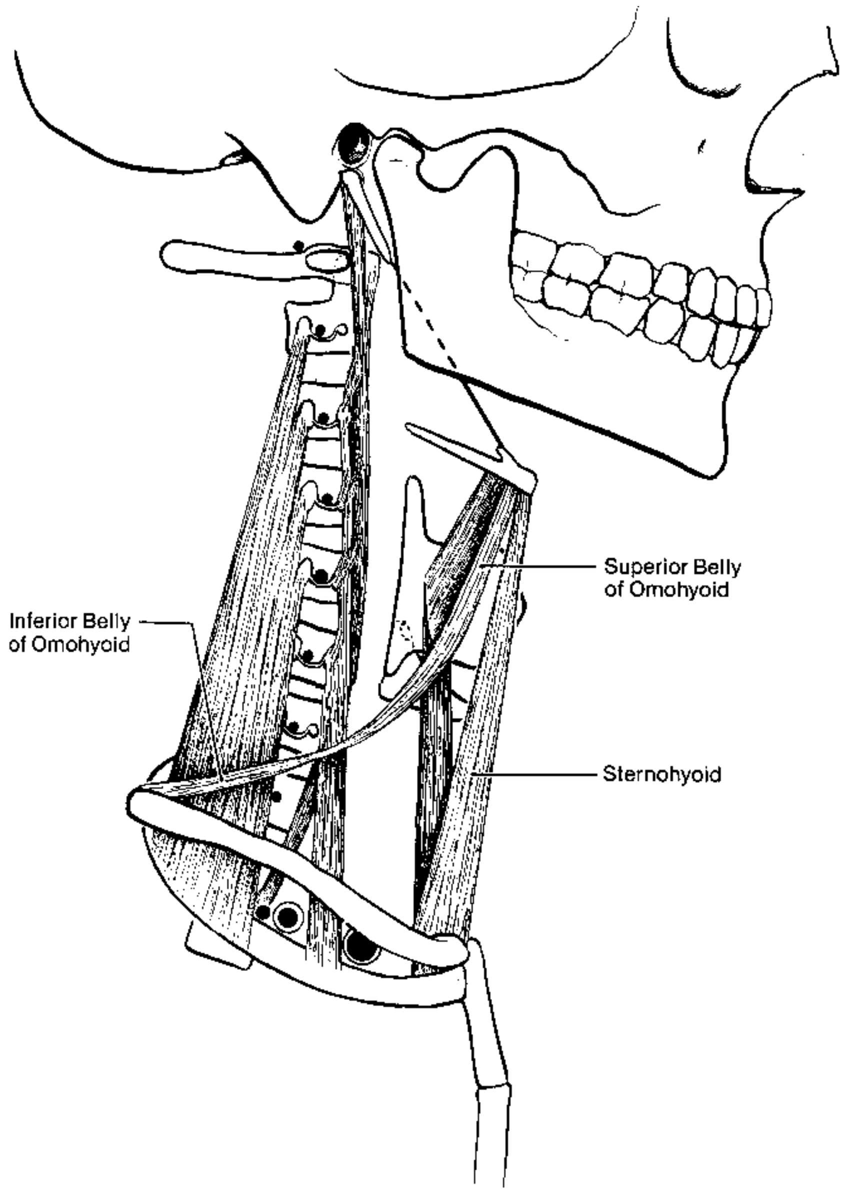

Figure 7-7. Lateral view of the superficial layer of the infrahyoid muscles. The scapular attachment of the inferior belly of omohyoid is not shown.

suprascapular notch. It inserts into the aforementioned intermediate tendon. The **superior belly** arises from the tendon and inserts into the body of the hyoid bone immediately lateral to the insertion of the sternohyoid.

The infrahyoid strap muscles pull the hyolaryngeal apparatus inferiorly. This movement occurs primarily in vocalization, and also at the end of swallowing. The thyrohyoid also enables any upward traction on the hyoid bone (exerted by muscles described subsequently) to be transmitted to the thyroid cartilage.

Being derived from the hypaxial parts of the upper three cervical dermomyotomes, the four infrahyoid strap muscles are innervated by the ventral rami of C1-C3, not directly but by branches that issue from a cervical nerve plexus (described later).

Middle Cervical Fascia (see Fig. 7-5). The narrow gap between sternohyoids is bridged by a continuation of the deep fascia surrounding one sternohyoid across the midline to join that around the other. Additionally, the deep fascia around each sternohyoid is prolonged laterally to merge with the deep fascia around each omohyoid. Thus, the sternohyoids, omohyoids, and their intervening fascia form a musculofascial apron at the front and, inferiorly, also at the side of the neck. The fascial component of the apron is called the middle cervical fascia. It has one important specialization. Where the middle cervical fascia envelopes the intermediate tendon of the omohyoid it is thickened and gains attachment to the back of the clavicle. In fact, it acts as a pulley to redirect the path of the intermediate tendon, which is held near the back of the clavicle at the level of C7.

The sternothyroid and thyrohyoid are enveloped in deep fascia that adheres to the deep surface of the middle cervical fascia and is generally not distinguished from it.

The Suprahyoid Muscles--Head Muscles in the Neck

Since the upper limit of neck is defined as the skull and mandible, there are a few muscles above the hyoid bone and below the skull or mandible that are found in the neck but, in fact, are all derived from either somitomeres or occipital somites.

Digastric and Stylohyoid--the Two Most Superficial Suprahyoid Muscles (Figs. 7-8, 7-9).
The digastric, like the omohyoid, is a muscle composed of two fleshy bellies joined by a thinner round tendon. The two bellies of the digastric derive from separate cranial somitomeres. The posterior belly is from the facial somitomere, whereas the anterior belly is from the trigeminal somitomere. These separate embryonic origins are betold by separate innervations: the posterior belly of digastric receiving a branch from the facial nerve, the anterior belly being innervated by the mylohyoid branch of the trigeminal nerve.

The **posterior belly of digastric** arises from the inferior surface of the temporal bone immediately medial to the mastoid process. A so-called **digastric groove** marks this site of origin (see Fig. 8-5). The muscle fibers pass downward and forward toward the hyoid bone. As they pass deep to the angle of the mandible, the muscle fibers begin to give way to a tendon. This **intermediate tendon** continues the course of the posterior belly toward the anterior extremity of the greater cornu of the hyoid bone, near which the tendon passes through a fascial sling that is attached to the hyoid at the junction of its greater horn and body. Once past the sling, the tendon immediately gives rise to fibers of the **anterior belly of digastric**, which pass anteromedially to gain an insertion on the posterior edge of the inferior border of the mandible near the midline. A depression--the **digastric fossa**--marks this attachment. It should be emphasized that the intermediate tendon of the digastric is essentially a continuation of its posterior belly between the angle of the mandible and the digastric sling.

Attachment of the intermediate tendon to the fascial sling prevents sliding of the tendon within it. Additionally, some fibers of the anterior belly often gain origin from the hyoid bone directly. As a result of these factors, the two bellies of the digastric are able to have independent actions. It turns out that both act together in depression of the mandible (i.e., opening the mouth). However, the anterior belly acts alone during closing of the mouth, presumably to reposition the hyoid.

A second superficial suprahyoid muscle is the **stylohyoid** (see Fig. 7-9). It has the same embryonic source as the posterior belly of digastric and, consequently, is innervated by the same nerve. The stylohyoid muscle arises by a thin tendon from the posterolateral surface of the styloid process of the skull. The muscle fibers pass antero-inferiorly toward the hyoid. For most of its course, the stylohyoid lies above the posterior belly of the digastric. However, as the stylohyoid nears the hyoid bone, its muscle belly splits around the intermediate tendon of the digastric to insert on the greater horn just behind the

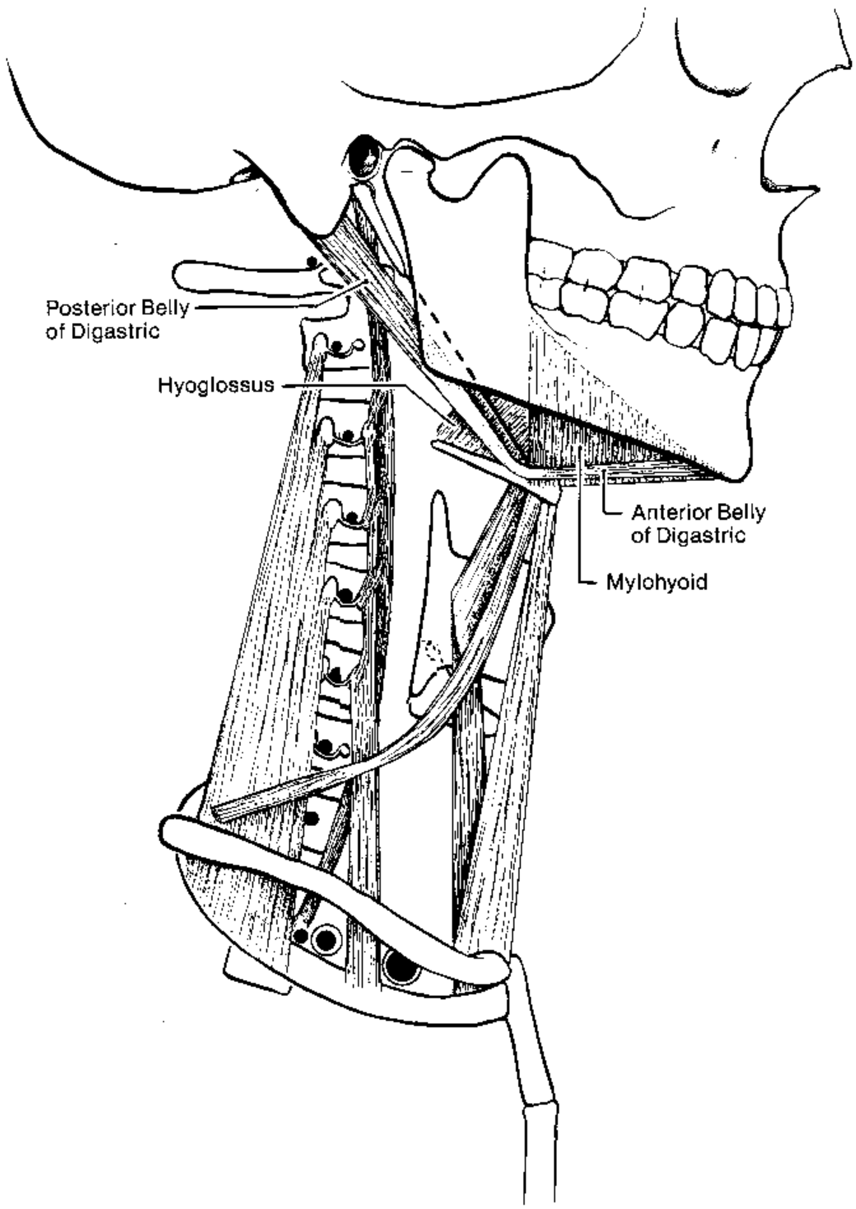

Figure 7–8. Lateral view of the digastric muscle, mylohyoid, and hyoglossus. The stylohyoid, normally visible in this view, has been excluded from the drawing but can be seen in Figure 7–9.

attachment of the digastric sling. Its function is presumably the same as the posterior belly of the digastric.

Mylohyoid--the Intermediate Suprahyoid Muscle (see Fig. 7-8). The mylohyoid, like the anterior belly of the digastric, is derived from the trigeminal somitomere. In fact, the anterior belly of digastric is often partly fused to the more deeply lying mylohyoid. Both are innervated by the same branch of the trigeminal nerve, called the nerve to the mylohyoid.

The mylohyoid arises from a ridge running the whole length of the body of the mandible on its inner surface. It is called the **mylohyoid ridge**. The vast majority of the fibers pass directly medially to meet those from the opposite side at a midline raphe that runs from the mandibular symphysis back to the middle of the body of the hyoid. These fibers form a hammock stretching from one side of the mandible to the other. Upon contraction, this part of the muscle provides a semirigid floor to the mouth, which is important in swallowing. The more posterior mylohyoid fibers, i.e., those that arise nearest to the ramus of the mandible, insert onto the body of the hyoid from its midline out to its junction with the greater cornu. These fibers are able to elevate the hyoid bone.

Much of the mylohyoid, especially near its origin, lies superior to the lower border of the mandible. Thus, technically, much of the muscle is above the neck.

Geniohyoid--the Deepest Suprahyoid Muscle (see Fig. 7-9). Deep to the mylohyoid, on either side of its midline raphe, are the geniohyoid muscles. In most mammals the geniohyoid is innervated by the hypoglossal nerve and, thus, must be derived from caudal occipital somites. Although the same muscle in humans is usually described as being innervated by fibers from the ventral ramus of C1 that join the hypoglossal nerve (see further on), I am aware of no indisputable evidence to substantiate such a claim.

Each geniohyoid arises via a short tendon from the inferior aspect of a little bump on the inner surface of the mandible just lateral to the symphysis. This bump is called the **mental spine**. (Each mental spine sometimes appears divided into two smaller bumps called genial tubercles.) The geniohyoid muscle fibers pass backward and downward to insert mainly on the body of the hyoid deep to the mylohyoid insertion (some superficial fibers of the geniohyoid extend onto the greater horn). The geniohyoids are elevators of the hyoid, important in swallowing and phonation.

Extrinsic Tongue Muscles

In addition to having intrinsic muscles that are completely confined within its substance, the tongue also receives the insertion of three extrinsic muscles that lie partly in the neck. Two of these--hyoglossus and genioglossus--lie deeply in the suprahyoid region; one--styloglossus--arises from the styloid process of the skull. All the tongue muscles, both intrinsic and extrinsic, are derived from caudal occipital somites and, thus, are innervated by the hypoglossal nerve.

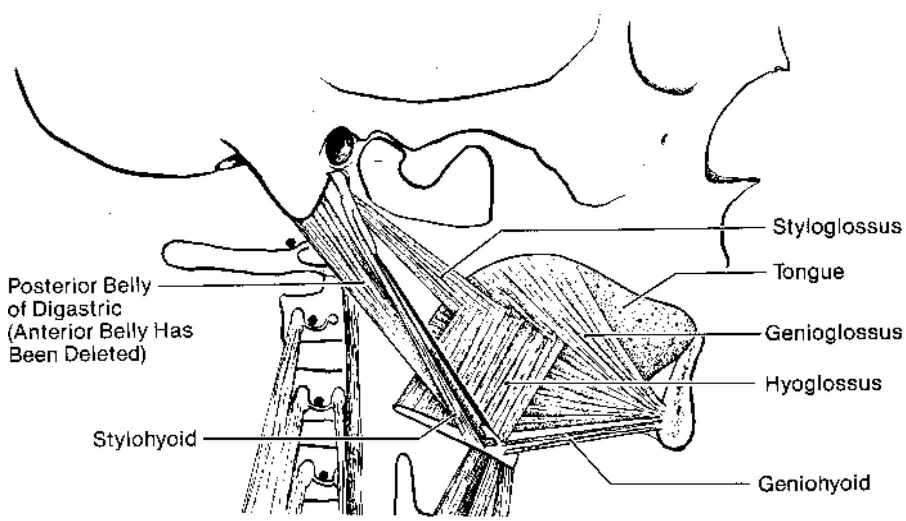

Figure 7–9. Lateral view of the stylohyoid, geniohyoid, and the three extrinsic muscles of the tongue—hyoglossus, styloglossus, and genioglossus (revealed by removal of the mylohyoid, anterior belly of the digastric, and most of the mandible).

Hyoglossus. The hyoglossus (see Figs. 7-8, 7-9) is a flat muscle with an origin from the superior border of the hyoid bone all the way from the tip of its greater horn forward onto the bit of the body deep to the superficial fibers of geniohyoid. The hyoglossus fibers pass upward and slightly forward, out of the neck, to insert into the fibrous tissue of the tongue near its dorsum. Upon contraction, the hyoglossus flattens the tongue and pulls it backward slightly.

Because the fibers of the hyoglossus are essentially parallel, the muscle is trapezoidal in shape. A line from its posterosuperior angle to its antero-inferior angle divides it into two regions. In front and above this line the hyoglossus is under cover of the mylohyoid (see Fig. 7-8).

Genioglossus. Another tongue muscle partly in the suprahyoid region of the neck is the genioglossus (see Fig. 7-9). It is a large muscle forming much of the body of the tongue. The genioglossus arises from the mental spine (remember, this is a small bump on the inner surface of the mandible near the symphysis). From this small area of origin the fibers pass more or less posteriorly, but also fanning out a great deal, to insert into the submucosal connective tissue of the tongue from the middle of its dorsum all the way back to the site where this submucosal tissue meets the epiglottis. The most inferior fibers of the genioglossus either skim right past the upper edge of the hyoid body or insert on it. Most of the genioglossus, lying as it does above the lower border of the mandible, is, technically, not in the neck.

The genioglossus is the protractor of the tongue. It is active in swallowing, speech, and, interestingly, during the inspiratory effort of breathing. This last activity serves to prevent the tongue from being sucked into the pharynx and thereby closing off the air passageway. For the same reason, the genioglossus is more or less continuously active when a person lies in the supine position. It has been suggested that some persons subject to respiratory distress during sleep may have periods of inactivity of the genioglossus. Certainly during general anesthesia, one must guard against the tongue falling backward and obstructing the air passageway.

Styloglossus. The last of the extrinsic tongue muscles is the styloglossus (see Fig. 7-9). It arises from the anterior surface of the styloid process and passes antero-inferiorly toward the upper edge of the hyoglossus. Styloglossus fibers interweave with hyoglossus fibers and insert into the connective tissue of the tongue. The styloglossus pulls the tongue backward and upward. This is a particularly important movement in propelling food from the oral cavity into the pharynx during swallowing.

Trapezius and Sternocleidomastoid--Two Neck Muscles of Partly Foreign Origins (Fig. 7-10; see Fig. 7-5)

Immediately deep to the superficial fascia of the neck are the trapezius and sternocleidomastoid. The trapezius is a composite muscle derived from occipital somites associated with the spinal accessory nerve and from the hypaxial portions of the 3rd and 4th cervical dermomyotomes. The sternocleidomastoid is also composite, being derived from the same occipital somites as the trapezius, but with an additional contribution from the 2nd and 3rd cervical hypaxial dermomyotomes. As a result of their embryonic origins, both muscles receive dual innervation: partly by the spinal accessory nerve and partly by cervical ventral rami.

Trapezius. The trapezius has migrated to gain an origin from all the thoracic spines, ligamentum nuchae, and a bit of the medial part of the superior nuchal line of the occipital bone. Its lower fibers pass superolaterally to insert on the tubercle of the scapular spine; its middle fibers pass directly laterally to insert on the superior lip of the crest of the scapular spine and onto medial edge of the acromion; its upper fibers pass inferolaterally to insert on the acromion and the lateral third of the clavicle.

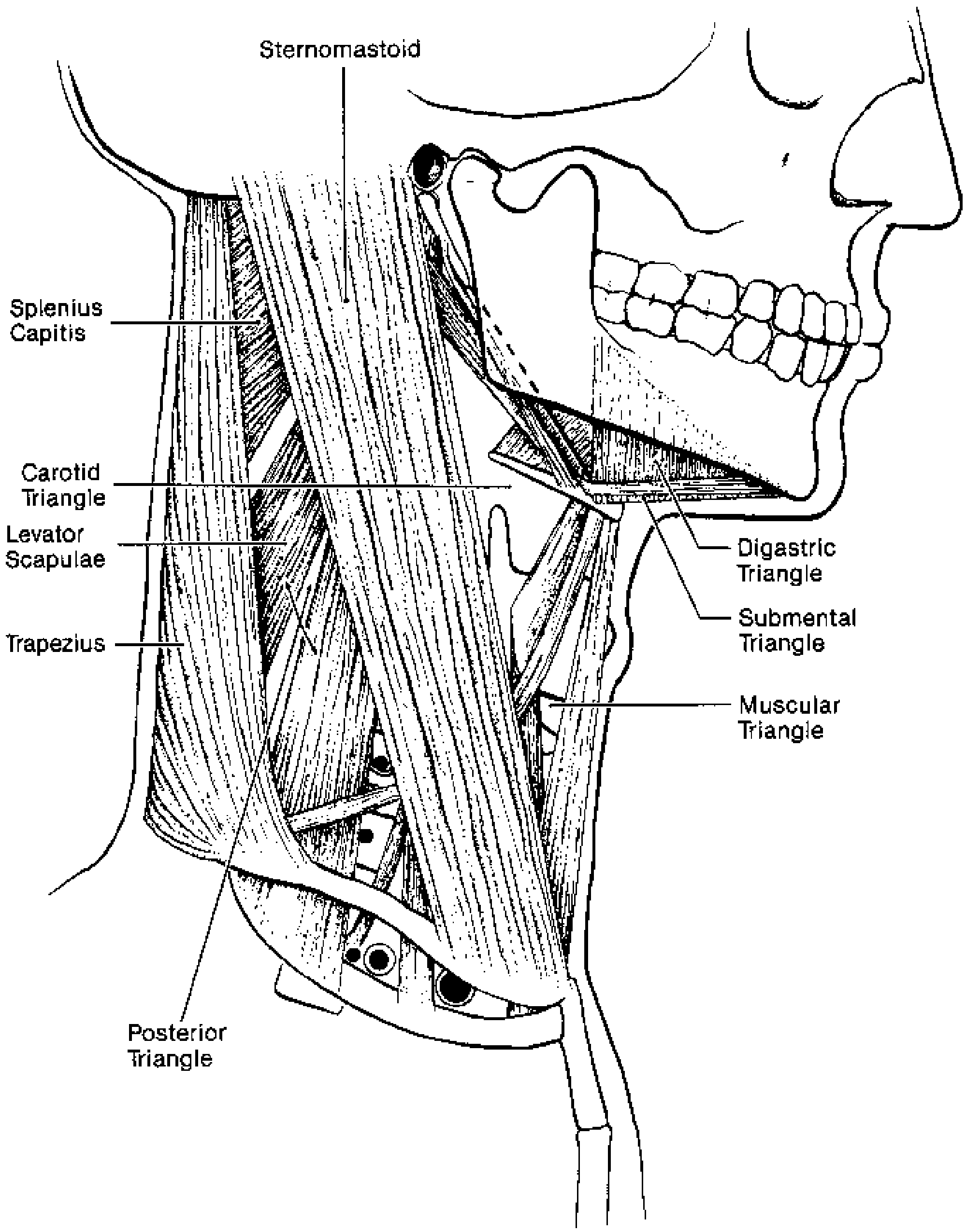

Figure 7–10. Lateral view of the trapezius, the sterno(cleido)mastoid, and the triangles of the neck.

The lower fibers retract (pull dorsally) and depress (pull inferiorly) the scapula; its middle fibers retract the scapula; its upper fibers elevate the tip of the shoulder. The lower and upper fibers, acting together, rotate the scapula so that the glenoid cavity faces more superiorly. This rotatory action of the trapezius on the scapula is important during abduction of the upper limb.

CLINICAL CONSIDERATIONS REGARDING TRAPEZIUS

The trapezius is an important muscle from the viewpoint of neurologic diagnosis because it is innervated by a cranial nerve. When the trapezius is paralyzed, the tip of the shoulder droops. Also, the vertebral border of the scapula (particularly its inferior angle) shifts dorsally so as to make a noticeable ridge in the skin of the back. Unlike the winging produced by a paralyzed serratus anterior, the winging caused by a paralyzed trapezius becomes even more prominent if the patient attempts to abduct the arm, but virtually disappears upon flexion of the upper limb.

A routine neurological examination always involves testing for integrity of the spinal accessory nerve. One way to do this is to assess the strength of the trapezius, particularly its upper part, which is derived mainly from occipital somites. The patient is asked to shrug the shoulders against resistance by the examiner. Both sides are tested simultaneously so that a weakness of one side relative to the other can be detected.

Sternocleidomastoid. The sternocleidomastoid arises fleshily from the medial third of the clavicle and also by a strong tendon from the front of the manubrium just below its articulation with the clavicle. The fibers pass upward and backward, around the side of the neck, to insert on the mastoid process of skull and the lateral half of the superior nuchal line. Because of its clavicular attachment, the correct name of the sternocleidomastoid is "sternocleidomastoid," but most people disregard this fact.

In its path through the neck, the sternocleidomastoid crosses the more deeply placed omohyoid (see Fig. 7-23). The intermediate tendon of the omohyoid lies deep to the posterior fibers of sterno-cleidomastoid at the level of C7. The superior belly of the omohyoid emerges from under cover of the anterior edge of sternocleidomastoid at the level of the 6th cervical vertebra (or cricoid cartilage).

By virtue of crossing so many joints of the neck, the sternocleidomastoid has a complicated set of actions: it (1) rotates the head to face toward the opposite side, (2) flexes the cervical vertebral column, (3) laterally flexes the cervical vertebral column, and (4) weakly extends the head at the atlanto-occipital joint. If both sternocleidomastoids act simultaneously, their lateral flexion and head-turning tendencies cancel, leaving neck flexion as the most prominent action.

CLINICAL CONSIDERATIONS REGARDING STERNOCLEIDOMASTOID

Paralysis of the sternocleidomastoid does not result in an altered position of the head or neck at rest. However, assessing the strength of the sternocleidomastoid should be done as a part of any routine test for the integrity of the accessory nerve. The patient is asked to turn the head to one side against resistance from the examiner. A resisted turn to the right tests the left sternocleidomastoid, and *vice versa*. Again, the examiner is trying to discover weakness of one side relative to the other. Another way to judge strength of the sternocleidomastoids is to have the patient attempt to flex the neck against resistance applied to the forehead. In this case, the examiner compares strength of the right and left muscles by palpating the rigidity of each tendon that comes from the manubrium.

External Cervical Fascia (see Fig. 7-5). The deep fascia (epimysium) of the trapezius is continued anteriorly as a sheet that crosses the gap between the anterior border of the trapezius and the posterior border of the sternocleidomastoid to then blend with the deep fascia of the latter. The deep fascia of one sternocleidomastoid is continued medially beyond the anterior border of the muscle to meet with the deep fascia of the sternocleidomastoid of the opposite side. As a result of these fascial continuations, the trapezius, sternocleidomastoid, and their fasciae form a musculofascial sleeve around the entire circumference of the neck. The fascial component of the sleeve is called the **external cervical fascia**.

Platysma--a Muscle in the Cervical Body Wall of Completely Foreign Origin.

The cells of the facial somitomere are characterized by extensive spreading out beneath the skin of the head and neck. Most of these cells differentiate into the muscles of facial expression. One such muscle--the **platysma**--lies in the subcutaneous tissue over the anterior aspect of the neck. Each platysma arises from the skin of the chest along a line immediately inferior to the clavicle. The fibers pass upward and medially, insert into the lower border of the mandible and into the skin of the cheek and corner of the mouth. At their origins, the right and left platysma are separated by about a handsbreadth. Their medial borders meet just before the muscles pass into the face. The action of the platysma is, obviously, to pull the skin below the mouth and the skin of the upper chest closer together. This produces a grimace of disgust.

The platysma is the most superficial of the named subcutaneous structures over the front of the neck. Even the major cutaneous nerves and superficial veins are deep to the platysma.

THE "CERVICAL CAVITY" (see Fig. 7-5)

The space between the prevertebral fascia and the middle cervical fascia houses the great vessels and viscera of the neck. In a sense it is the "cervical cavity." It is divided into right and left lateral regions for the great vessels, and a central region for viscera. The great vessels are themselves enveloped by a fascial tube called the **carotid sheath**. Adherence between the front of the carotid sheath and middle cervical fascia (or, more superiorly, the external cervical fascia) and adherence between the back of the carotid sheath and the prevertebral/alar fasciae tend to seal off the visceral portion of the cervical cavity. This portion is called the **visceral space of Stiles**. Infectious material that enters it may pass inferiorly into the superior mediastinum, but is stopped there by attachment of the alar fascia to the esophagus.

THE TRIANGLES OF THE NECK (see Fig. 7-10)

Now that all the muscles located in the neck have been described, we can mention that many anatomists believe it is convenient to divide the neck into regions bordered by some of these muscles. In each case the specified region has three boundaries and, consequently, is called a triangle. The two most commonly referred to are the posterior and anterior triangles of the neck.

Posterior Triangle

The posterior triangle is the space bordered by the anterior edge of the trapezius, the posterior edge of the sternocleidomastoid, and the middle third of the clavicle. It is approximately a right triangle, with the sternocleidomastoid being the hypotenuse. The external cervical fascia that extends between the trapezius and sternocleidomastoid is said to form the roof of the posterior triangle. The posterior triangle is also said to have a floor formed by the scalene muscles, levator scapulae, and splenius capitis.

Any structure embedded in its roof, or lying between the roof and floor, is said to be a part of the contents of the posterior triangle. One such structure is the inferior belly of the omohyoid. The path of this muscle has been used to divide the posterior triangle into one region above the inferior belly of omohyoid and another below it, but I won't even mention the names because they are so rarely used.

Anterior Triangle

The anterior triangle of the neck lies in front of the sternocleidomastoid. The anterior edge of this muscle is the posterior boundary of the triangle. The anterior boundary is just the midline at the front of the neck. The upper limit of the anterior triangle is not straight. It is formed mostly by the lower border of the mandible, but then turns upward and backward along a line between the angle of the mandible and the tip of the mastoid process. The anterior triangle of the neck is also more or less in the shape of a right triangle, with the hypotenuse being formed by the sternocleidomastoid.

The roof of the anterior triangle is composed of external cervical fascia extending between the two sternocleidomastoids. Its floor consists of the vertebral column and prevertebral muscles/fasciae.

Among the numerous contents of the anterior triangle are the superior belly of the omohyoid and the digastric muscle. These structures are used to further subdivide the anterior triangle into lesser triangles.

Digastric (Submandibular) Triangle

A digastric triangle is defined as being bounded by (1) the posterior belly and intermediate tendon of the digastric, (2) the anterior belly of the digastric, and (3) the lower border of the mandible. Since the posterior belly of the digastric is coincident with a line between the angle of the mandible and the mastoid process, the digastric triangle does not exist posterior to the mandible. Thus, for all practical purposes, the posterior border of the digastric triangle is formed solely by the intermediate tendon of the digastric.

The digastric triangle has a floor composed of the hyoglossus and mylohyoid muscles. Just in front of the intermediate tendon of the digastric, the hyoglossus alone forms this floor. More anteriorly lies a greater expanse in which the floor is formed by the mylohyoid muscle.

Submental Triangle

A submental triangle is said to comprise that part of the anterior triangle above the hyoid bone in front of the anterior belly of digastric. The floor of this triangle is formed by the mylohyoid. Some authors combine the right and left submental triangles into a single unpaired submental triangle.

Muscular Triangle

Below the hyoid bone, bounded by the superior belly of omohyoid, the lower third of sternocleidomastoid, and the anterior midline is the muscular triangle. It is called so because the first things one sees when its contents are exposed (upon removal of external cervical fascia) are the sternohyoid and sternothyroid muscles.

Carotid Triangle

The fourth subsidiary triangle of the anterior triangle lies in front of the upper part of the sternocleidomastoid. This muscle, the posterior belly of digastric, and the superior belly of omohyoid bound a carotid triangle, so-called because in this region the infrahyoid muscles do not intervene between the carotid arteries and the external cervical fascia of the anterior neck.

RETROMANDIBULAR REGION (see Fig. 7-9)

Above the posterior belly of the digastric and behind the ramus of the mandible is a narrow space called the retromandibular (or parotid) region. The retromandibular region has no real floor other than the styloid process of the skull. The stylohyoid muscle crosses through the retromandibular region on its way to surround the intermediate tendon of the digastric.

TWO RELATIVELY SUPERFICIAL VISCERA OF THE NECK--THE SUBMANDIBULAR SALIVARY GLAND AND PART OF THE PAROTID SALIVARY GLAND--WITH MENTION ALSO OF THE SUBLINGUAL SALIVARY GLAND, WHICH IS NOT IN THE NECK

Submandibular Salivary Gland (Fig. 7-11)

The bulk of the **submandibular salivary gland** lies in the digastric triangle on the external surfaces of the hyoglossus and mylohyoid, which form the floor of this triangle. The gland is usually sufficiently large to overlap onto the external surfaces of the intermediate tendon and anterior belly of digastric. It also extends superiorly, deep to the lower border of the mandible, until it is stopped by the attachment of the mylohyoid to this bone. Thus, technically, part of the submandibular gland lies above the neck.

From the posterior part of the submandibular salivary gland emanates its duct, which travels forward **deep to** the mylohyoid muscle, at first on the superficial surface of the hyoglossus and then on the superficial surface of genioglossus. The duct eventually opens into the floor of the mouth on either side of the frenulum of the tongue (see Chapter 8). For most of its course the submandibular duct actually lies superior to the lower edge of the mandible and, thus, is technically above the neck. There is always some actual glandular tissue that extends along the beginning of the duct and continues with it deep to the mylohyoid.

Depending on how wide the platysma is, the portion of the submandibular salivary gland within the digastric triangle lies either partly or wholly deep to the most lateral fibers of the muscle. The facial vein (see further on) intervenes between the gland and the platysma.

Sublingual Salivary Gland (Fig. 7-11)

Lying immediately deep to the mandible, on either side of its symphysis, are the **sublingual salivary glands**. Each gland raises a ridge in the mucous membrane of the floor of the mouth on either side of the frenulum of the tongue. The ridge is called the **plica sublingualis (or sublingual fold)**.

Clearly the sublingual salivary gland is not in the neck, yet I mention it here because it has an important relationship to the submandibular duct. The latter passes forward, trapped between the sublingual gland and the genioglossus. The submandibular duct opens up at the anterior extremity of the sublingual fold. The sublingual salivary gland itself does not have a single duct. Rather it has numerous small ducts that travel the short distance straight upward to open on the sublingual fold.

Parotid Salivary Gland (see Fig. 7-11)

The **parotid salivary gland** lies partly in the head, on the lateral surface of the mandibular ramus and masseter. However, a substantial portion of the gland lies in the retromandibular region of the neck. Here, obviously, it is behind the ramus of the mandible, on the external surfaces of the styloid process

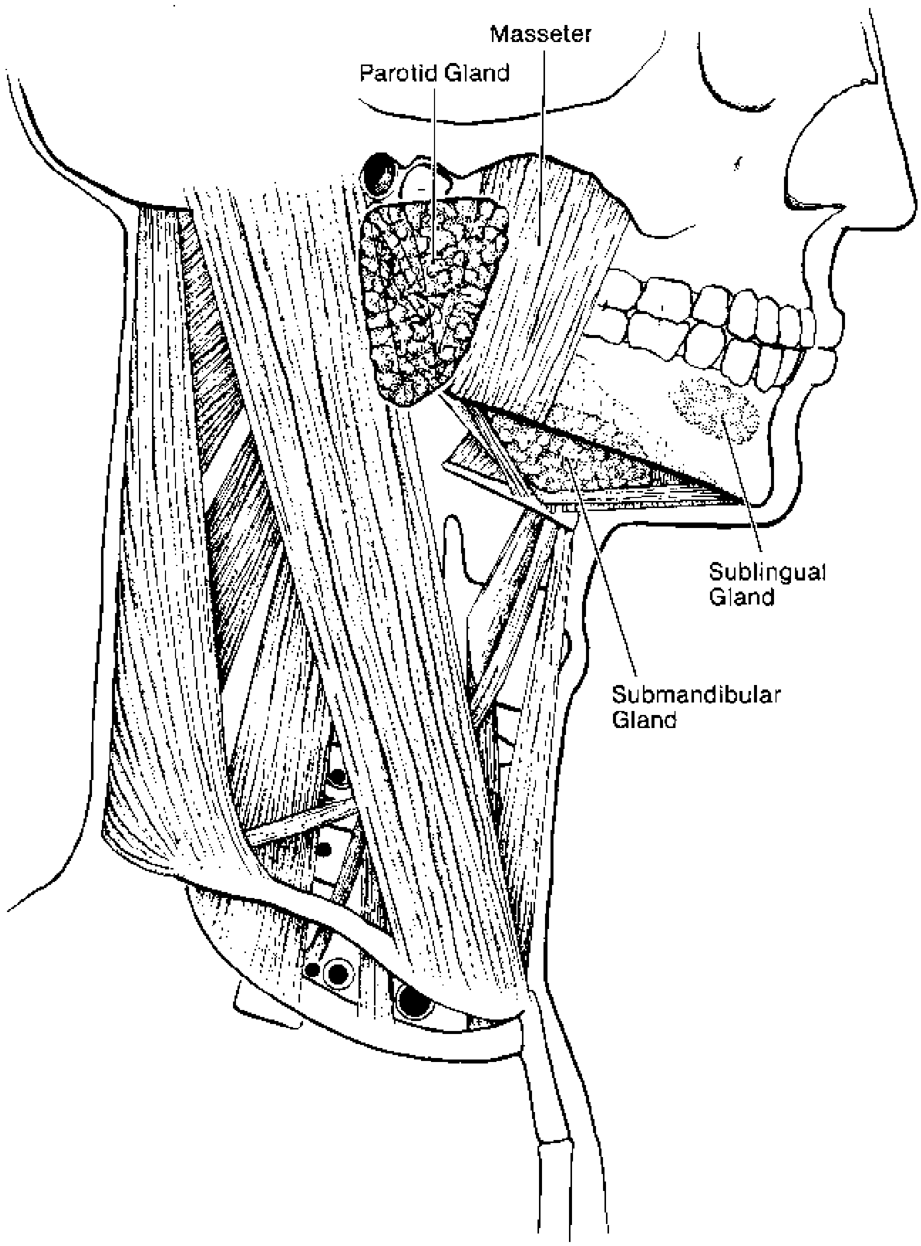

Figure 7-11. Positions of the salivary glands in relation to the musculoskeletal structures of the neck.

and stylohyoid muscle, in front of the mastoid process of the skull, and above the posterior belly of the digastric. The gland always extends downward onto the superficial surface of the posterior digastric. Large parotids may also continue backward onto the superficial surface of the sternocleidomastoid, and further downward into the carotid triangle.

THE VISCERAL COMPARTMENT OF THE NECK

Of the two compartments within the cervical cavity--vascular and visceral--it is best to describe the latter one first, so that the vessels may then be placed in relation to visceral structures.

Within the visceral compartment of the neck are the larynx, pharynx, trachea, esophagus, and two endocrine glands--the thyroid and parathyroid.

Larynx

The larynx is a passageway for air. It lies below the hyoid bone and above the trachea. Its most important structures are the vocal cords.

The larynx is composed of:

Four major cartilages--thyroid, cricoid, arytenoid (bilateral), and epiglottis
Two minor cartilages--corniculate and cuneiform (both bilateral)
Connective sheets between some of the cartilages
Muscles running between cartilages
A mucous membrane lining

The thyroid and cricoid cartilages were described previously.

Arytenoid and Corniculate Cartilages

There are two arytenoid cartilages--a right and a left. Their shape is difficult to describe. Roughly speaking, each arytenoid resembles a three-sided pyramid with the base inferiorly and the apex superiorly (Fig. 7-12). One side of the pyramid faces medially, another faces posteriorly, and the last faces anterolaterally. Thus, the base has medial, posterior, and anterolateral edges; it also has anteromedial, posteromedial, and posterolateral angles. The anteromedial angle is elongated to form the **vocal process**, to which the vocal ligament attaches. The posterolateral angle is expanded to receive the insertions of muscles, thus is called the **muscular process**. The undersurface of the arytenoid base has a concave elliptical facet for the convex elliptical facet on the superior rim of the cricoid. Surmounting the apex of the arytenoid pyramid, and fixed to it by perichondrium, is the small corniculate cartilage.

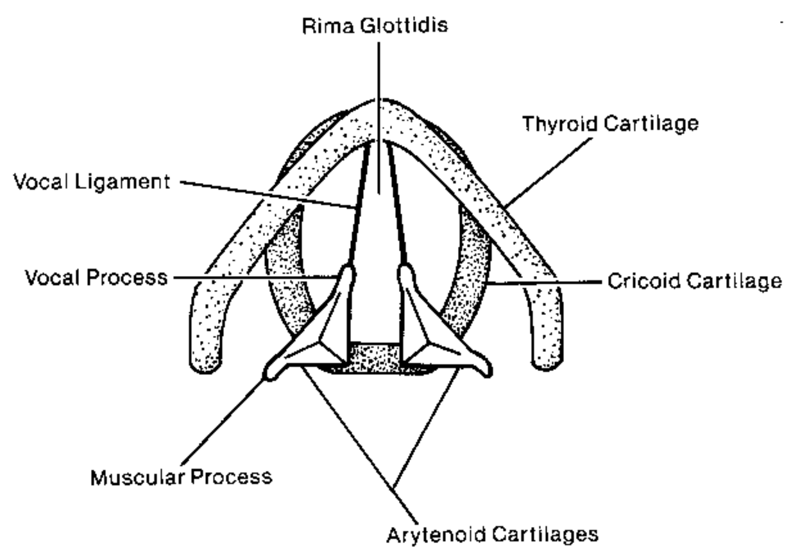

Figure 7-12. Schematic superior view of the arytenoid cartilages, vocal ligaments, and the space they bound—the rima glottidis. Anterior is at the *top* of the figure, posterior at the *bottom*.

Epiglottic Cartilage (Fig. 7-13)

The epiglottis is an elongate leaf-shaped cartilage lying posterior to the body of the hyoid bone. The stem of the "leaf" is directed inferiorly and passes deep to the superior thyroid notch. The rounded (or notched) tip of the leaf rises a centimeter or so above the upper edge of the hyoid body, to a position behind the back of the tongue. The epiglottis is curved from side to side so that the surface facing the

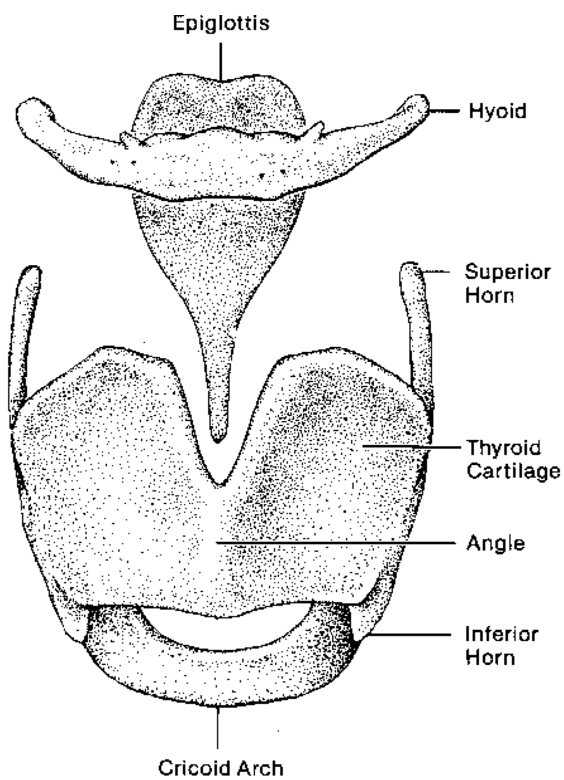

Figure 7-13. Anterior view of the skeletal framework of the larynx.

hyoid bone is convex, whereas that facing the interior of the larynx is concave.

Connective Tissue Membranes and Ligaments

Thyrohyoid Membrane and Ligaments. The whole length of the inferior edge of edge of hyoid bone is connected to the whole length of the superior edge of the thyroid cartilage by a connective tissue sheet called the **thyrohyoid membrane**. It is a bit thicker in the anterior midline, where it is said to form a **median thyrohyoid ligament**, and also between the tips of the cornua of the two elements, where it is said to form **lateral thyrohyoid ligaments**.

Hyo-epiglottic and Thyro-epiglottic Ligaments, Ary-epiglottic Membrane. The epiglottic cartilage is bound to the neighboring skeletal structures by two ligaments and a connective tissue sheet (i.e., membrane).

The stem of the epiglottis is connected to the inner surface of the thyroid angle (immediately below the superior thyroid notch) by a strong elastic **thyro-epiglottic ligament** (Fig. 7-14). A broader condensation of fibrous tissue connects the anterior surface of the epiglottis to the upper edge of the hyoid bone. This is called the **hyo-epiglottic ligament**. Between hyo-epiglottic and thyro-epiglottic

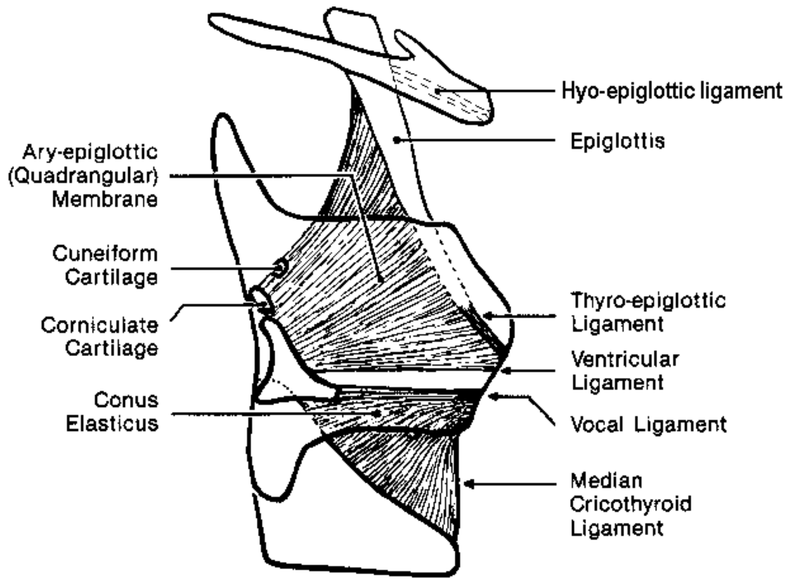

Figure 7–14. Lateral view of the skeletal framework of the larynx and of certain connective tissue sheets binding it together. The thyrohyoid membrane has been excluded.

ligaments, the anterior surface of the epiglottis is separated from the body of the hyoid bone and the thyrohyoid membrane by fat.

Above the hyo-epiglottic ligament lies the free part of the epiglottis, covered by mucous membrane and related to the back of the tongue. As the mucous membrane reflects from the anterior surface of the epiglottis onto the back of the tongue it is thrown into three longitudinal ridges, each running anteroposteriorly. The one in the middle is called the **median glosso-epiglottic fold**. The two lateral ones are called **lateral glosso-epiglottic folds**. The depressions on either side of the median fold are called **valleculae**.

Inferior to each lateral glosso-epiglottic fold, the mucous membrane on the anterior surface of the epiglottis reflects onto the inner surface of the thyrohyoid membrane. The grooves marking this reflection are called the **piriform recesses**.

On each side, attached to the lateral edge of the epiglottis and, below this, to the thyro-epiglottic ligament, is a flat connective tissue sheet that sweeps downward and backward to reach the corniculate cartilage and the anteromedial edge of the arytenoid almost down to its vocal process (see Fig. 7-14). These sheets are called **quadrangular, or ary-epiglottic, membranes**. Each has a free upper edge called the ary- epiglottic ligament and a free lower edge called the **ventricular ligament**. Embedded in each ary-epiglottic ligament just in front of the corniculate cartilage is the **cuneiform cartilage**. An ary-epiglottic ligament, together with its adherent mucous membrane is called an **ary-epiglottic fold**. Each ventricular ligament together with its adherent mucous membrane forms a **ventricular (or vestibular) fold**, which is also called the **false vocal cord**.

The Conus Elasticus (see Fig. 7-14). This highly elastic membrane is the most important of the laryngeal connective tissues. It has an origin from the perichondrium along the superior rim of the cricoid arch. At the back of the arch, this origin passes upward in front of the crico-arytenoid joints onto the anterolateral edges of the arytenoid bases and then forward out along their vocal processes. From this broad origin, the fibers converge anteriorly on a much shorter vertical insertion into the inner surface of the thyroid angle below the attachment of the hyo-epiglottic ligament. Thus, fibers arising from the arytenoid pass straight forward, while fibers arising progressively further toward the front of the cricoid arch pass more directly superiorly. Those fibers arising from each arytenoid form free upper edges to the conus elasticus. The two upper edges are called **vocal ligaments**. Together with their overlying squamous epithelium, they form the **vocal folds** (**cords**). The most anterior fibers of the conus elasticus run in the midline between the cricoid arch and inferior border of the thyroid angle. These fibers are thickened to form a **median cricothyroid ligament**.

On each side, between an upper edge of the conus elasticus (i.e., vocal ligament) and a lower edge of a quadrangular membrane (i.e., ventricular ligament) there is a gap. The mucous membrane lining the inside of the quadrangular membrane does not simply bridge across this gap to reach the conus elasticus. Instead, it evaginates into the gap to form the so-called **ventricle of the larynx**. Of course there are right and left laryngeal ventricles.

Regions of the Larynx

The superior edges of the epiglottis and the ary-epiglottic folds encircle a space called the **laryngeal aperture**. From this aperture down to the ventricular folds, the cavity of the larynx is called the **vestibule**. The space between the right and left ventricular folds is called the **rima vestibuli**, below which is the part of the laryngeal cavity that opens up into the ventricles. Immediately inferior to the ventricles the laryngeal cavity narrows dramatically as the space between the vocal folds, vocal processes of the arytenoids, and medial arytenoid surfaces (covered by mucous membrane). This space is the **rima glottidis** (see Fig. 7-12). The vocal folds and the part of the rima between them form the **glottis** *per se*.

Movements and Muscles of the Larynx

Epiglottis and Sphincter Vestibuli. The epiglottis is a mobile structure. During swallowing, the bolus of food contacts the upper, exposed part of the anterior epiglottic surface and pushes the cartilage down over the laryngeal aperture. There is also a sheet of muscle on the external surface of the quadrangular membrane that acts as a **sphincter vestibuli**. Because different fibers of the sphincter vestibuli have different attachments, bundles of muscle are customarily given specific names, but these names are not important.

Cricothyroid Joints and Cricothyroid Muscle. The thyroid cartilage can rotate forward around a horizontal axis that passes between the right and left cricothyroid joints. The muscles that produce such rotation are the **cricothyroid muscles** (Fig. 7-15). The fibers of each cricothyroid arise from the external surface of the cricoid arch lateral to the anterior midline. They pass posterosuperiorly to insert on the lower rim of a thyroid lamina and into its inferior horn. By pulling the thyroid cartilage downward and forward, the cricothyroid muscles cause the vocal cords to become tighter and to move slightly closer together (i.e., to adduct).

Upon surgical entrance to the visceral compartment of the neck, the cricothyroid muscle is the only laryngeal muscle that can be visualized without further dissection. Thus it is called an **external laryngeal muscle**. It also has a nerve supply different from all the other, so-called internal, laryngeal muscles (see further on).

Crico-arytenoid Joint and the Muscles Acting Across It. Each crico-arytenoid joint is elliptical and condyloid. The articular surface on the cricoid cartilage is convex; that on the arytenoid is concave. The long axis of each joint follows the superior rim of cricoid at its lamina-arch junction. That is, the long axis passes from posterior, superior, and medial to anterior, inferior, and lateral. The movements that are permitted at a crico-arytenoid joint consist of rotation around this long axis and sliding to and fro parallel to it.[29] Virtually no rotation around a vertical axis can occur since such would dislocate the joint (remember the atlanto-occipital joint!).

Rotation of an arytenoid cartilage around the long axis of the crico-arytenoid joint either carries the vocal process inward and downward so that the vocal cords are adducted and the rima glottidis closed, or outward and upward so that the vocal cords are abducted and the rima opened. Sliding of the arytenoid backward parallel to the long axis of the joint adducts and tightens the vocal cords.

Almost all the muscles acting across a crico-arytenoid joint cause the vocal cords to adduct. The adductors are:

1. **Lateral crico-arytenoideus**, which arises from the upper rim of the cricoid arch and passes backward and upward to insert onto the muscular process of the arytenoid. This muscle runs under cover of the cricothyroid, on the external surface of the lower end of the conus elasticus.

2. **Thyro-arytenoideus (proper)**, which arises from the inner surface of the thyroid cartilage near its angle and passes back to the arytenoid. This muscle runs along external surface of the upper end of conus elasticus and its vocal ligament. The most medial of the superiormost fibers of the thyro-arytenoideus are called **vocalis**.

3. **Arytenoideus** is an unpaired muscle on the posterior surfaces of the arytenoid cartilages that has two parts: a **transverse** bundle passing horizontally from the back surface of one arytenoid to the back surface of the other, and **oblique** bundles passing from the back surface of one arytenoid near its apex to the back surface of the other arytenoid near its base.

Not much purpose is served by detailing the individual actions of these adductor muscles, since they don't ever act alone. However, it should be noted that although they act together to adduct the vocal cords, they do not have equal effects on tension within the cord. The thyroarytenoideus (particularly its vocalis part) causes the cord to slacken; the arytenoideus causes it to tighten.

When both arytenoid cartilages rotate so that their vocal processes move upward and outward, the vocal cords are abducted (brought away from another) and the rima glottidis thus opened. The only muscles that produce this motion are the paired **posterior crico-arytenoidei**. On each side the fibers of the posterior crico-arytenoideus arise from the back of the cricoid lamina and pass upward and laterally to the muscular process of the ipsilateral arytenoid. Being the only abductors of the vocal cords, the posterior crico-arytenoids play a vital role in holding the glottis open during breathing.

Somatic Motor Innervation of the Larynx

All laryngeal muscles are derived from the more caudal of the two vagal somites. Consequently, all these muscles are innervated by branches of the vagus. The cricothyroid muscle is uniquely different from the internal laryngeal muscles. **Each cricothyroid gets its nerve supply from the external laryngeal nerve, which is a branch of the superior laryngeal branch of the vagus. The internal laryngeal muscles of one side are all supplied by the recurrent laryngeal branch of the ipsilateral vagus**. As each recurrent laryngeal nerve enters the larynx (from below), it changes its name to inferior laryngeal nerve, thus giving us symmetry of nomenclature.

Vagal fibers innervating the striated muscles of the larynx are considered by most authors to be the homologue of the cranial accessory nerve found in lower vertebrates. No such thing as a cranial

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[29] Landman, GHM: Laryngography and Cinelaryngography. Excerpta Medica, Amsterdam, 1970.

accessory nerve is dissectible in humans. It is for this reason that most anatomists do not feel it is necessary to use the word "spinal" as a preface when referring to the only part of the accessory nerve identifiable in humans.

Sensory and Parasympathetic Innervation of the Larynx

Two separate branches of the vagus are responsible for the sensory and preganglionic parasympathetic innervation of the larynx. The internal laryngeal nerve, which is the other branch of the superior laryngeal branch of the vagus, pierces the thyrohyoid membrane to serve these functions above the glottis. The inferior laryngeal nerve (mentioned above) is sensory and parasympathetic to the infraglottic larynx. The two nerves overlap in supply of the glottis itself.

Pharynx

The pharynx is the most cranial end of the foregut. It extends from the base of the skull down to the lower border of the cricoid cartilage, where it turns into the esophagus. The internal structure of the pharynx is pretty much like that of the rest of the gut. It is lined by a mucous membrane, has an intermediate muscle layer, and has an external fibrous layer called tunica fibrosa. The tunica fibrosa of the pharynx is more often referred to as **buccopharyngeal fascia**.

Some differences between the pharynx and the rest of the gut do exist. Notable among them is the absence of a well-defined submucosal layer except in the region immediately inferior to the skull base. A submucosal layer is developed at this site because both side walls of pharynx are devoid of muscle here (see Fig. 7-15). The limited submucosal layer of the pharynx is called **pharyngobasilar fascia**. A second noteworthy characteristic of the pharynx is that its muscle is striated (not smooth) and derived from *somites* associated with the vagus nerve. Finally, at the sites where the embryonic nasal and oral cavities ruptured into the pharynx, this gut tube is missing an anterior wall.

Anatomists divide the pharynx into three regions. The uppermost region lies between the base of the skull and the palate. Because it opens up into the nasal cavities, it is called the **nasopharynx**. The nasopharynx has no anterior wall (unless one wishes to consider the back edge of the nasal septum as all that is left of an anterior wall after the nasal cavities rupture into the pharynx during development).

Below the palate and above the epiglottis is a region of pharynx that opens forward into the oral cavity. The palatoglossal arches (see Chapter 8) mark the boundary between this **oropharynx** and the oral cavity *per se*. Owing to the oblique disposition of the epiglottis, the oropharynx is taller in front than in back. Like the nasopharynx, the oropharynx has not much of an anterior wall. However, it must be remembered that the dorsum of tongue is a curved structure. Its anterior two thirds faces superiorly, but its posterior third faces backward. Thus, just above the hyoid bone, the oropharynx has an anterior wall composed of the posterior third of the tongue.

Below the oropharynx is the **laryngopharynx**. In embryonic life the laryngotracheal diverticulum formed as an outpocketing of the anterior wall of the foregut at the lower end of the pharynx. The opening into this laryngotracheal diverticulum was the primitive laryngeal aperture. The diverticulum grew downward into the chest, hugging the anterior wall of the esophagus along the way. The cranial part of the laryngotracheal diverticulum becomes the larynx. During its development, the larynx pushes backward and upward into the lower part of the pharynx, raising the laryngeal aperture so that it lies behind and partly above the hyoid bone, and causing the anterior wall of the lower pharynx to curve around the sides of the larynx (hence the piriform recesses).

It is interesting that the larynx actually sits higher in the newborn than in the adult.[30] At birth, the superior tip of the epiglottis lies just behind the palate. The oropharynx exists only as a small region anterior to the epiglottis. An oropharynx of significant dimensions develops concomitantly with descent of the larynx in early childhood. As a result of the high position of the larynx in the newborn, the food and air passageways are separate, enabling liquid food to be swallowed at the same time as breathing occurs. Newborns tend to breathe solely through their noses, although they outgrow this habit before the larynx descends.

Pharyngeal Muscles

Constrictors (see Fig. 7-15). The lateral and posterior walls of the pharynx are composed primarily of the three pharyngeal constrictor muscles: superior, middle, and inferior. The **superior constrictor** arises from (1) the lower part of the posterior edge of the medial pterygoid plate (see Fig. 8-5), (2) the hamulus at the inferior extremity of this plate (see Fig. 8-5), (3) the pterygomandibular raphe (which is a narrow connective tissue band that runs from the pterygoid hamulus to the mandible posterior to the 3rd molar), and (4) the mandible a short distance behind the attachment of the pterygomandibular raphe. From this rather extensive linear origin, the fibers of each superior constrictor pass backward and then turn medially to meet their opposite members in the midline, with only a thin band of connective tissue interposed. This band, which thus receives the insertion of both the right and left superior pharyngeal constrictors, is the **median raphe** of the superior constrictor.

The fibers of the superior constrictor fan out slightly as they follow their backward and then medial course. Thus the raphe into which they insert is longer than the origin of the muscle. The most superior muscle fibers arch upward and actually terminate in a bump--the **pharyngeal tubercle**--on the inferior surface of the occipital bone about a centimeter in front of the foramen magnum. The upper end of the median raphe is also attached here. Between these arching muscle fibers and the base of the skull, the pharyngeal wall lacks muscle but gains a well-developed submucous connective tissue (**pharyngobasilar fascia**) that provides strength. Piercing this tissue, above the muscle fibers themselves, are the auditory tube and levator veli palatini muscle (see Chapter 8).

The **middle constrictor** of the pharynx arises deep to the hyoglossus from the superior surface of the greater cornu of the hyoid all the way from its tip to its junction with the lesser cornu. The origin then passes upward and backward along the postero-inferior edge of the lesser horn and up onto the lower part of the stylohyoid ligament. Although this origin is long from front to back, it is short from top to bottom. The fibers of the middle constrictor pass backward and, like the other constrictors, turn medially to meet their opposite members at a midline raphe.

The middle constrictor fibers fan out dramatically as they pass from origin to raphe. The uppermost fibers pass superficial to the lower fibers of the superior constrictor. Thus, the upper part of the middle constrictor raphe overlaps the superior constrictor raphe and the two raphe are fused. On either side there is a small muscle free area between the upward arching fibers of the middle constrictor and the downward arching fibers of the superior constrictor (see Fig. 7-15). Through this gap pass the styloglossus muscle and the glossopharyngeal nerve on their way to the tongue.

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[30] Crelin, ES: Functional Anatomy of the Newborn. Yale University Press, New Haven, CT, 1973.

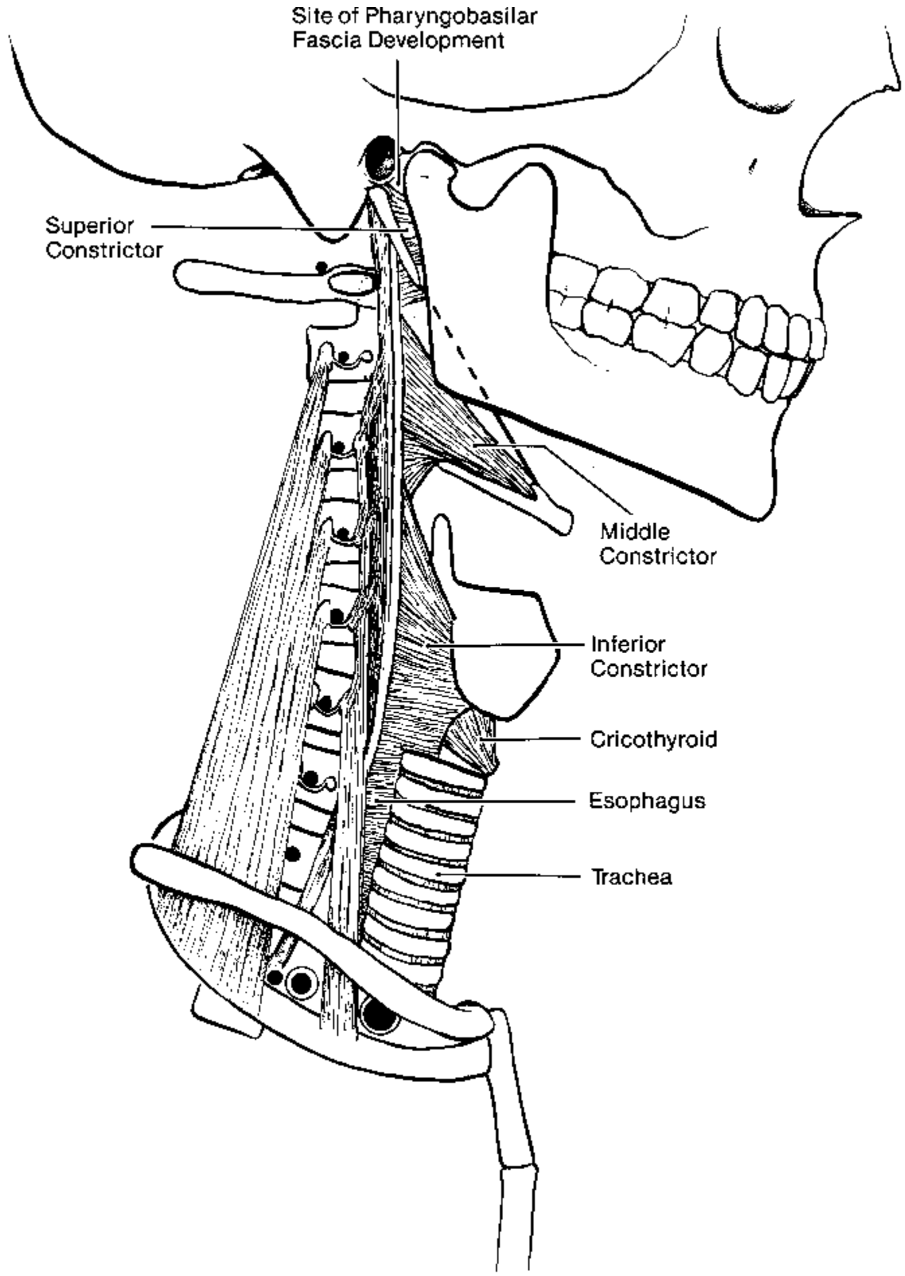

Figure 7-15. Lateral view of the three pharyngeal constrictors, the trachea, the esophagus, and the one external laryngeal muscle—the cricothyroideus.

The origin of each **inferior constrictor** starts at the top of the oblique line of thyroid cartilage and passes downward along this line (just posterior to the insertion of the sternothyroid) and then onto the fascia on the superficial surface of the cricothyroid muscle, and finally onto the arch of the cricoid itself. The muscle fibers pass backward from this origin and then turn medially to meet their opposite members in a midline raphe.

The lowermost fibers of the inferior constrictor are essentially horizontal and intertwine with the circular muscle of the esophagus. They are said to constitute a **cricopharyngeus** muscle. The higher fibers of the inferior constrictor fan upward to a marked degree and cover the inferior part of the middle constrictor. The raphe of the inferior constrictor overlies most of the middle constrictor raphe, and the two are fused.

Lesser Pharyngeal Muscles--Stylopharyngeus, Palatopharyngeus, Salpingopharyngeus. There are three small pharyngeal muscles (with common insertions) whose fibers run more or less longitudinally. The biggest of these is the **stylopharyngeus**. It arises from the medial surface of the styloid process (i.e., that surface closest to the pharynx). The fibers pass medially and downward to contact the external surface of the lower fibers of the superior constrictor. The stylopharyngeus then slips deep to the upper border of the middle constrictor and continues deep to it and then the inferior constrictor all the way to an insertion on the posterior border of the thyroid lamina and (possibly) the actual connective tissue of the pharyngeal wall.

The **palatopharyngeus** arises from the connective tissue of the soft palate and descends almost straight vertically deep to the superior constrictor (thus, separated by it from the stylopharyngeus). At the lower border of the superior constrictor, the palatopharyngeus and stylopharyngeus meet and pass together to a common insertion.

The **salpingopharyngeus** arises from the medial end of the cartilaginous auditory tube and descends almost straight vertically deep to the superior constrictor to contact the back edge of the palatopharyngeus and pass with it to join the stylopharyngeus.

Function of Pharyngeal Muscles. The pharyngeal muscles play a role in swallowing. The constrictors are activated in sequence, from top to bottom, to propel food toward the esophagus. The longitudinal muscles elevate the larynx and pharynx at the initiation of the swallow.

Innervation of the Pharynx

The pharyngeal muscles are somatic motor structures derived from vagal somites. They receive motor innervation from the pharyngeal branch of the vagus nerve. The inferior constrictor receives some additional nerve fibers traveling in the external laryngeal and recurrent laryngeal branches of the vagus. The same nerves as innervate the striated muscle also bring parasympathetic preganglionic fibers for pharyngeal glands. Most authors believe that sensation to the pharynx is provided by branches of the glossopharyngeal nerve (but see Chapter 8).

Trachea (Fig. 7-16; see Fig. 7-15)

The trachea is a midline structure extending downward from the cricoid cartilage into the chest. More will be said of its surface anatomy later in this chapter. At this point, all that one needs to remember is that embedded in the connective tissue wall of the trachea is a series of C-shaped cartilages (deficient posteriorly) called **tracheal rings**.

The sensory and parasympathetic innervation of the cervical trachea is handled by the recurrent laryngeal branch of the vagus. The trachea has no striated muscle and, thus, requires no somatic motor innervation.

Esophagus (see Figs. 7-15, 7-16)

The esophagus is that part of the gut tube into which the pharynx opens. It begins behind the lower border of the cricoid cartilage and extends downward into the chest posterior to the trachea. However, the cervical esophagus is slightly to the left of the trachea. Thus, surgery on the cervical esophagus approaches it from the left side, where it is partly exposed.

The cervical esophagus differs from the rest of the esophagus by having a muscular coat composed of striated, not smooth, muscle. The striated fibers are derived from vagal somites. The

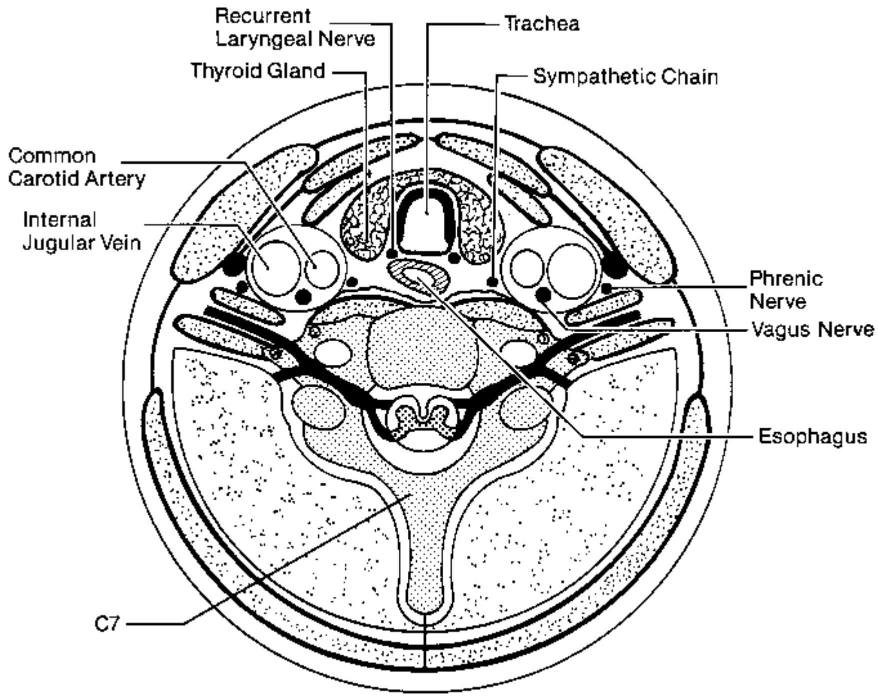

Figure 7-16. Transverse section of the neck at level of the 7th cervical vertebra, as in Figure 7-5, but with the contents of the visceral space and major longitudinally running nerves included.

recurrent laryngeal branch of the vagus supplies these striated muscle fibers with somatic motor innervation. The sensory and parasympathetic innervation of the cervical esophagus is by the same nerve.

Thyroid Gland (Fig. 7-17; see 7-16)

In embryonic life a slender tubular **thyroid diverticulum** pushes out from the ventral pharyngeal epithelium at the cranial end of this epithelium's contribution to the surface of the tongue. In the adult, this site corresponds to a point in the midline at the junction of the posterior third and anterior two thirds of the tongue. The tubular diverticulum turns caudally and grows down the neck passing ventral to the developing hyoid bone and then the larynx. The thyroid diverticulum stops growing downward when its tip is just below the cricoid cartilage. Here the diverticulum bifurcates, sending off two lateral branches. The entire diverticulum thus takes on the shape of an inverted T (⊥). As a general rule the vertical bar degenerates and the horizontal bar proliferates to become the thyroid gland. The ends of the horizontal bar expand vertically to form the **lobes** of the H-shaped thyroid gland; the remainder of the horizontal bar becomes the **isthmus**.

The thyroid isthmus lies in front of the 2nd-4th tracheal rings. The lower pole of each lobe lies lateral to the 5th and 6th tracheal rings, but since the lobe inclines posteriorly as it ascends in the neck, the thyroid gland progressively overlaps more of the gut tube (i.e., esophagus and pharynx) and less of the air tube as the superior pole is approached. Each lobe is separated from the cricoid cartilage by the cricothyroid muscle and the cricoid origin of the inferior constrictor. It is separated from the thyroid lamina by the thyroid origin of the inferior constrictor. Each thyroid lobe is under cover of a sternothyroid muscle.

Not infrequently the lower end of the vertical bar of the thyroid diverticulum also becomes glandular. Thus, a **pyramidal lobe** of the thyroid gland may exist as a midline structure running

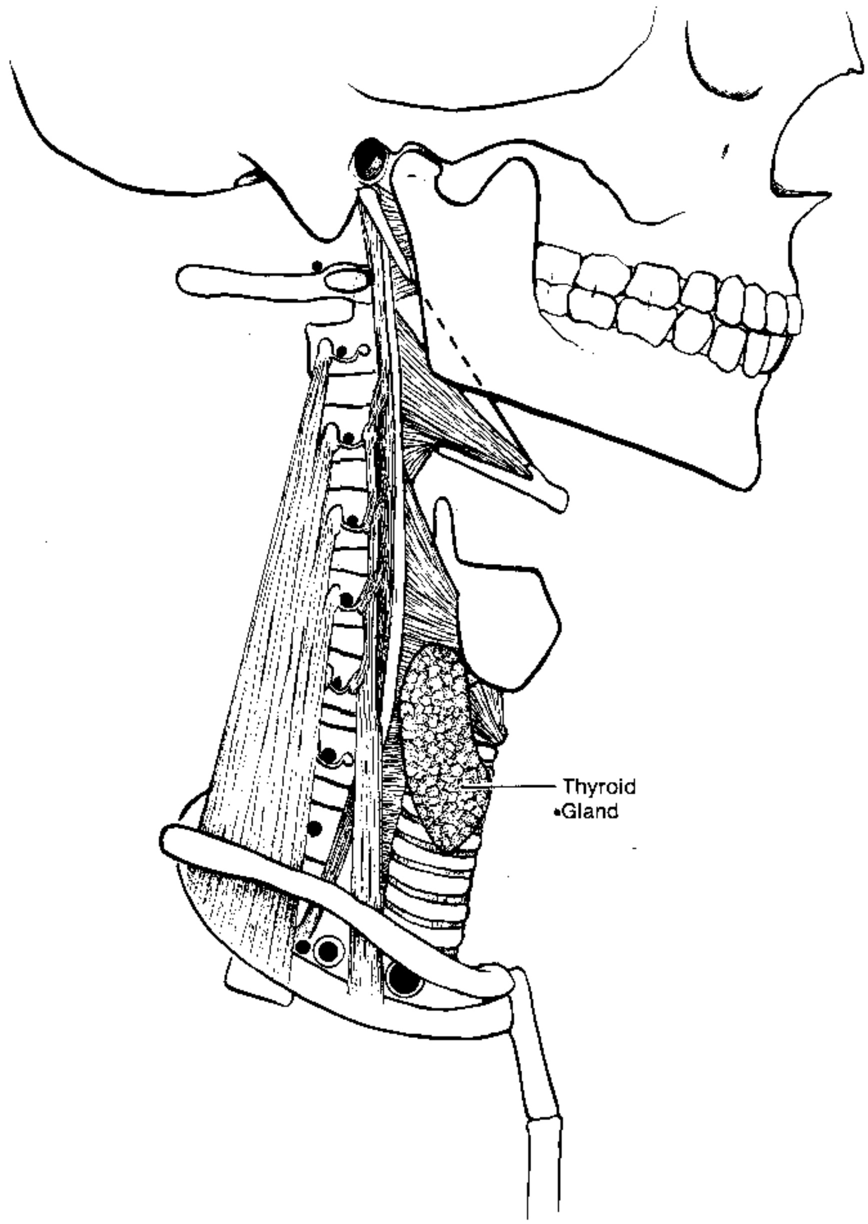

Figure 7-17. Lateral view of the thyroid gland in relation to the trachea, larynx, and pharynx.

superiorly from the isthmus in front of the larynx. More rarely, the upper end of the vertical bar of the thyroid diverticulum also persists either as a fibrous cord (the **thyroglossal ligament**) or a hollow tube (the **thyroglossal duct**) crossing in front of the hyoid bone to reach the tongue.

The thyroid gland has an outer fibrous capsule, which in turn is surrounded by a condensation of deep fascia called the **pretracheal fascia**. The pretracheal fascia is attached to the laryngeal cartilages.

Parathyroid Glands

The parathyroid glands also develop from the epithelial lining of the embryonic pharynx, not in the ventral midline, but from lateral outpocketings called pharyngeal pouches (Chapter 6). On each side, one clump of epithelial cells separates off from the third such pouch and another from the fourth pouch.

These clumps are called parathyroid III and parathyroid IV, respectively. They also descend in the neck and come to rest on the posterior surfaces of the thyroid lobes, attached to or embedded in its capsule. Parathyroids III have a developmental link to the thymus, which will migrate all the way into the thorax. As a result, parathyroids III actually descend further inferiorly before coming to rest than do parathyroids IV.

Parathyroids IV are fairly constant in adult position, lying on the backs of the thyroid lobes at the level of the junction between pharynx and esophagus (thus, lower border of cricoid cartilage). These are the **superior parathyroid glands**. **Parathyroids III** are more variable in position, but usually lie on the backs of the lower poles of the thyroid lobes. These are the **inferior parathyroid glands**.

THE GREAT ARTERIES OF THE NECK--SUBCLAVIAN AND CAROTID

Entering the neck from the thorax, on each side, are two large arteries: the common carotid and subclavian. The right common carotid and subclavian are products of the division of the brachiocephalic artery deep to the sternothyroid and sternohyoid muscles at the medial end of the right sternoclavicular joint. The split in the brachiocephalic is such that the subclavian comes off its posterior surface and the common carotid off its anterior surface. The left common carotid and subclavian arteries are separate branches of the aortic arch. They approach a site deep to sternothyroid and sternohyoid muscles at the medial end of the left sternoclavicular joint, with the subclavian assuming a position posterior to the common carotid.

Further Course of the Subclavian Artery (see Fig. 7-4)

The subclavian artery turns laterally, arching in front of the pleural cupola to reach the upper surface of the first rib between the insertions of the scalenus anterior and scalenus medius. The artery continues its lateral course on top of the 1st rib, but when the vessel reaches the lateral edge of the rib, anatomists change its name to axillary artery. The pressure of the subclavian artery often creates a groove on the upper surface of the 1st rib between the scalene insertions.

The subclavian artery is arbitrarily divided into three parts according to its relationship to the scalenus anterior. From the origin of the artery to the medial border of the muscle is the first part, which is the part in front of the pleura and lung. Behind the scalenus anterior is the second part of the subclavian artery, the lateral portion of which lies on the upper surface of the 1st rib. It will be recalled that the insertion of scalenus anterior does not span completely across the upper surface of the first rib, thus there is a part of the subclavian artery exposed beyond the lateral edge of the scalenus anterior. This is the third part of the artery, also lying on the superior surface of the 1st rib. Its pulse can be felt by placing a finger just above the clavicle next to the lateral edge of the sternocleidomastoid (thus just lateral to the junction of the medial and middle thirds of the bone) and pressing straight backward.

Most (sometimes all) of the branches of the subclavian artery come off its first part. These will be described later.

Carotid Arteries (Figs. 7-18, 7-19)

The right **common carotid artery** arises from the brachiocephalic, and the left common carotid enters the neck, deep to the medial ends of their respective sternoclavicular joints (with both the sternothyroid and sternohyoid muscles intervening). Each common carotid artery passes upward behind the inferior pole of a thyroid lobe, thus lateral to the interval between the trachea and esophagus. Continuing upward, the common carotid arteries are pushed gently laterally by the thyroid lobes so that, at the level of the cricoid cartilage, each artery lies in front of the anterior tubercle of C6 and is separated

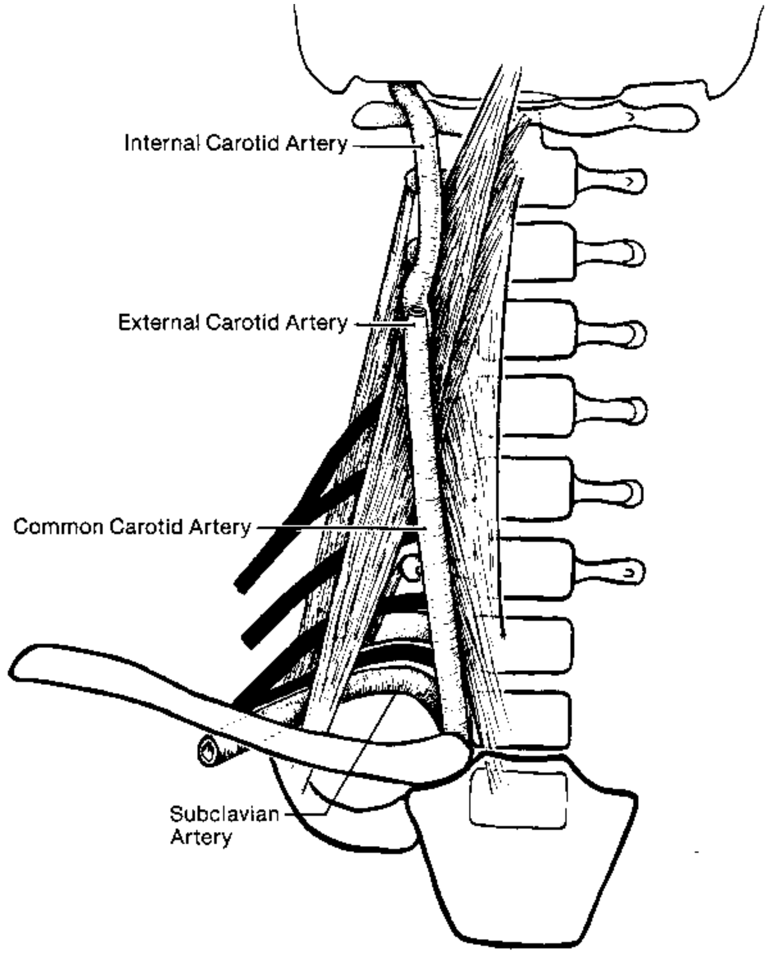

Figure 7–18. Anterior view of the carotid arteries in relation to the deep musculoskeletal structures of the neck.

from the inferior constrictor of the pharynx by the lobe of the thyroid. Superior to the gland, the common carotids come into contact with the lateral surface of the pharynx posterior to the thyroid laminae. The arteries continue their ascent (sometimes diverging slightly, as do the thyroid laminae) to their points of bifurcation just behind the superior horns of the thyroid cartilage.

The common carotid splits into internal and external branches, with the internal carotid artery arising from the posterior surface of the common carotid, and the external carotid artery arising from its anterior surface.

The **external carotid artery** takes an upward course that is slightly anterior to that of its parent vessel. The internal carotid artery often begins by deviating laterally from the course of its parent vessel (more so with increasing age), but soon comes back in again to assume a position posterior to the external carotid artery and directly in front of the anterior tubercles of cervical vertebrae (virtually in contact with the posterolateral "angle" of the pharynx). In anteroposterior angiograms of the carotid bifurcation, identification of the internal carotid is often made possible by virtue of its initial lateral deviation.

After the internal carotid artery has once again assumed a position behind the external carotid, the two vessels rise straight upward together. Both arteries will pass deep to the posterior belly of the digastric. However, because the posterior belly of digastric follows an oblique course, and the external carotid artery is in front of the internal carotid, the vessels encounter the inferior edge of the muscle at

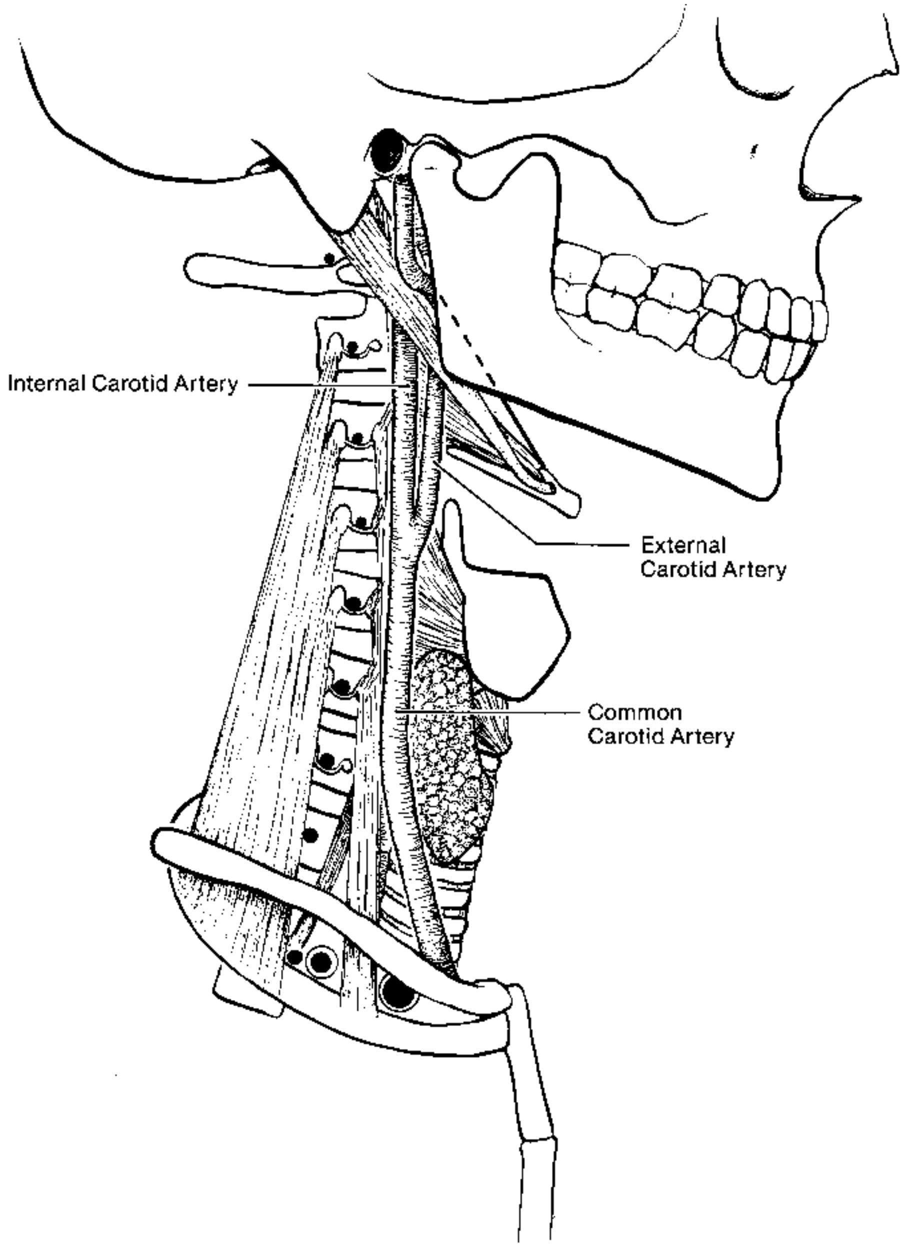

Figure 7–19. Lateral view of the carotid arteries in relation to the deep structures of the neck. The stylohyoid, normally visible in this view, has been excluded from the drawing but can be seen in Figure 7–9.

different times during their ascent. The external carotid artery is the first to pass beneath the posterior belly of digastric, at the site where the intermediate tendon is forming deep to the angle of the mandible. By the time the internal carotid artery encounters the lower edge of the fleshy part of the muscle, the external carotid has already moved deep to the stylohyoid. At the upper border of the stylohyoid, the external carotid takes a sharp turn posterolaterally into the substance of the parotid gland and then turns back up again directly behind the posterior edge of the mandibular ramus. It is only then that the external carotid can be said to be truly *external* to its counterpart.

Further upward, the courses of the two vessels take them on opposite sides of the styloid process. The internal carotid artery passes from its position deep to the posterior belly of digastric to one that it is deep to the styloid process. The stylopharyngeus muscle, arising from the medial surface of the styloid process, cuts in front of the internal carotid to reach the pharynx. The external carotid artery, within the parotid gland, passes superficial to the styloid process.

Throughout most of its course the internal carotid artery maintains a location in front of the anterior tubercles of cervical vertebrae. However, near the base of the skull, it moves slightly laterally to enter the carotid foramen. Anteroposterior carotid angiograms usually display this terminal lateral movement of the internal carotid.

The internal carotid artery has no branches in the neck. The external carotid does, but these will be discussed later.

Carotid Sinus and Carotid Body

At the site of the common carotid bifurcation, the walls of all three arteries are slightly dilated and contain nerve endings (feeding to the glossopharyngeal nerve) that are sensitive to stretching. These dilated regions form the **carotid sinus**, whose job it is to monitor blood pressure. In the connective tissue between the roots of the internal and external carotid arteries is a small clump of specialized cells sensitive to the concentration of O_2 and CO_2 in the arterial blood that feeds it. This is the **carotid body**, also innervated by fibers feeding to the glossopharyngeal nerve.

THE GREAT VEINS OF THE NECK

The subclavian artery is accompanied by a subclavian vein. The internal and common carotid arteries are accompanied by a single vein: the internal jugular. There is no external carotid vein. Most of the veins that accompany the branches of the external carotid artery empty into the internal jugular vein.

Subclavian Vein (Figs. 7-20, 7-21)

The subclavian vein lies in front of and slightly below its companion artery. Starting at the lateral border of the first rib, the vein passes medially in front of the scalenus anterior. At the medial edge of this muscle, the subclavian vein is joined by the internal jugular vein to form the brachiocephalic vein. Thus, the beginning of the brachiocephalic vein lies anterior to the first part of the subclavian artery. It, and not the subclavian vein, receives most of the veins that accompany the branches of the subclavian artery (which branches, after all, come from the first part of the artery). The only tributary of the subclavian vein is the external jugular vein (see further on), which empties into the subclavian just before that vein's junction with the internal jugular.

Internal Jugular Vein (see Figs. 7-20, 7-21)

This long vein begins at the jugular foramen of the skull immediately posterior to the internal carotid artery and deep to the root of the styloid process. A little below the skull the internal jugular vein comes to lie on the lateral surface of the internal carotid artery and, maintaining this relationship, descends deep to the posterior belly of digastric and on down to the site of the carotid bifurcation, at which point the internal jugular maintains a position lateral to the common carotid artery for the remainder of its course in the neck.

It will be recalled that the internal and common carotid arteries are more or less in front of the anterior tubercles of cervical transverse processes. Thus, the arteries lie at the junction of the scalene and longus musculature. The position of the internal jugular vein lateral to the arteries places it on the anterior surface of the scalenus medius in the upper part of the neck and on the anterior surface of the

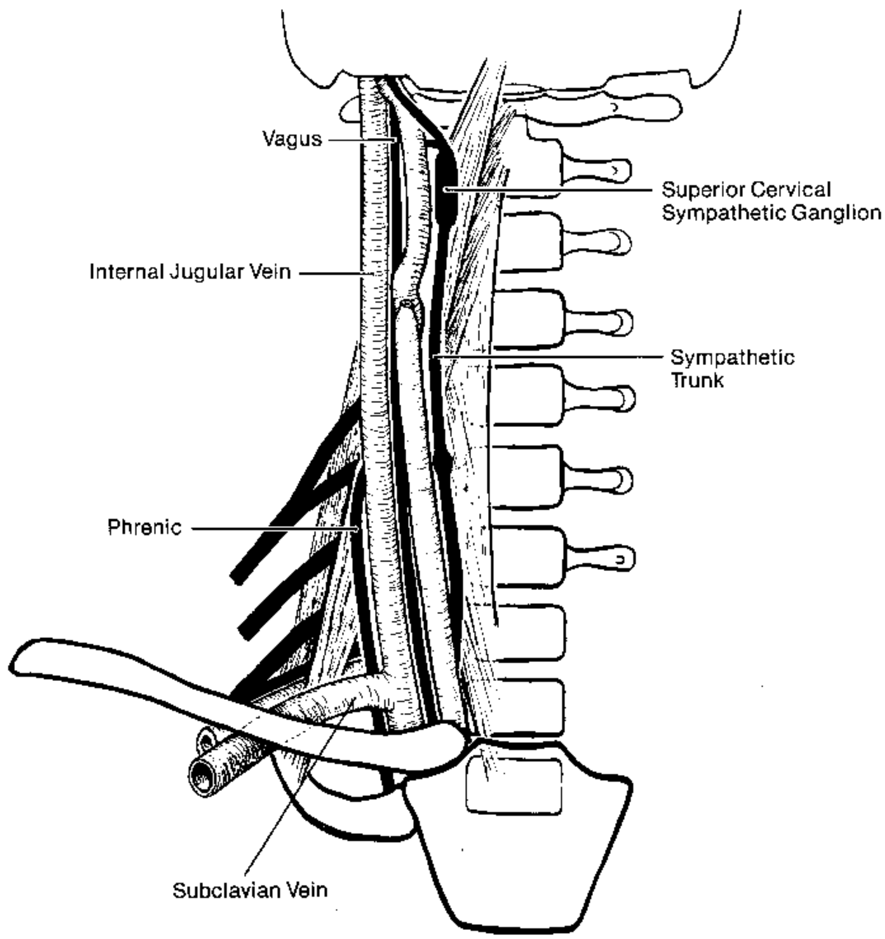

Figure 7-20. Anterior view of the internal jugular vein, phrenic nerve, vagus nerve, and sympathetic trunk in relation to the carotid arteries and deep musculoskeletal structures of the neck. As drawn, the diameters of the nerves do not reflect their true sizes.

scalenus anterior in the lower neck. Of course, as the scalenus anterior proceeds to its insertion it moves laterally. Thus, at the root of the neck, the internal jugular vein passes off the surface of the muscle to join the subclavian vein in front of the first part of the subclavian artery.

The Carotid Sheath (see Fig. 7-5)

A tube of deep fascia surrounds the internal jugular vein and common/internal carotid arteries for most of their lengths. Its upper and lower limits are unclear. This tube is called the carotid sheath. Its anterior surface blends with the middle or external cervical fasciae; its posterior surface blends with the alar and prevertebral fasciae. Thus, the visceral compartment of the cervical cavity is sealed off.

SOME LESSER VEINS OF THE NECK--RETROMANDIBULAR, EXTERNAL JUGULAR, FACIAL, ANTERIOR JUGULAR, AND COMMUNICATING (Fig. 7-22)

Retromandibular Vein

The retromandibular vein (also called **posterior facial vein**) is a structure that forms within the substance of the parotid gland superficial to the external carotid artery. The vein descends embedded in

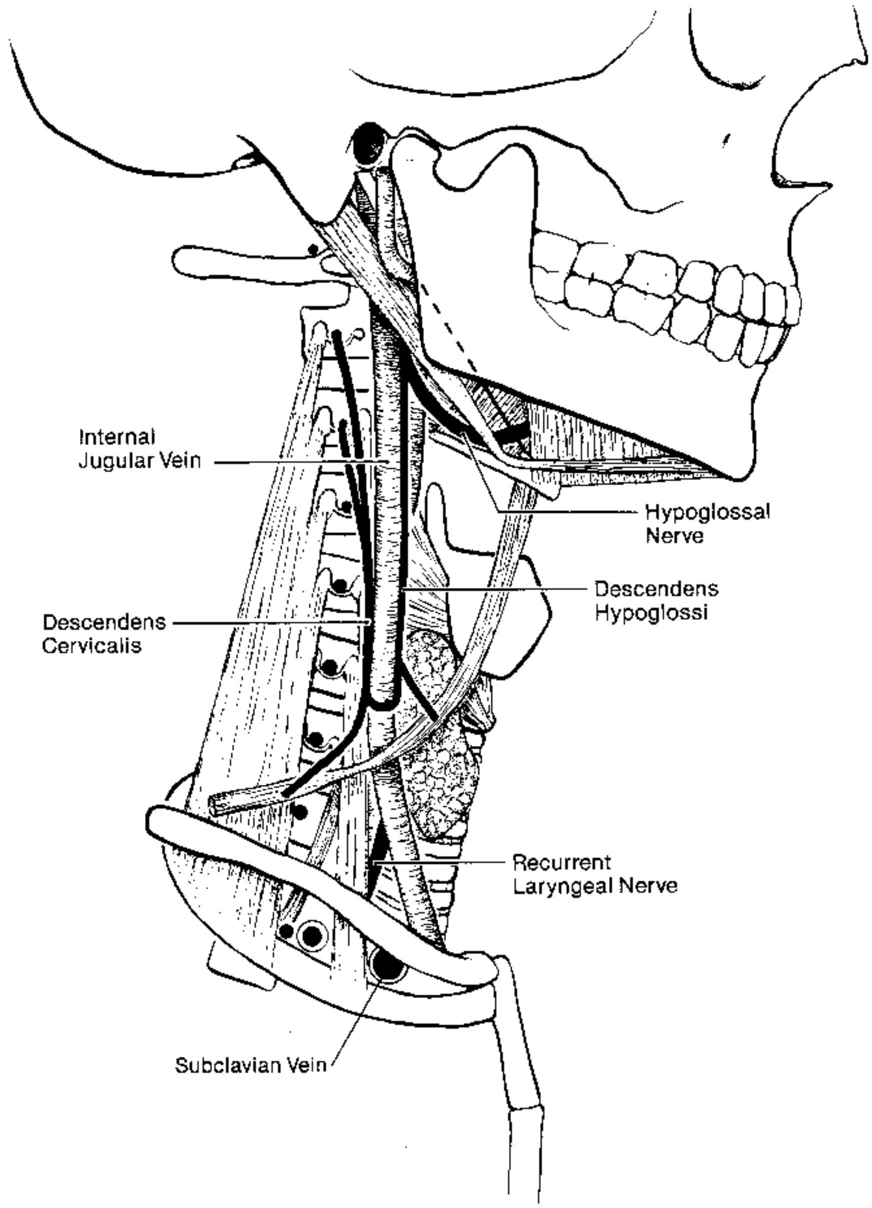

Figure 7–21. Lateral view of the internal jugular vein, hypoglossal nerve, ansa cervicalis, and recurrent laryngeal nerve in relation to the deep structures of the neck. The stylohyoid, normally visible in this view, has been excluded from the drawing but can be seen in Figure 7–9. As drawn, the diameters of the nerves do not reflect their true sizes.

the gland, but unlike the artery, stays superficial to the stylohyoid muscle and posterior belly of the digastric. Near the inferior pole of the parotid, the retromandibular vein bifurcates into one branch that passes backward toward the anterior edge of the sternocleidomastoid and a second branch that continues downward to emerge from the lower pole of the gland onto the surface of the carotid sheath.

External Jugular Vein

The posterior fork of the retromandibular vein meets the posterior auricular vein at the anterior edge of the sternocleidomastoid, just behind the angle of the mandible. The posterior auricular vein is a superficial vein of the scalp that has descended behind the ear to reach the same site. The joining of the

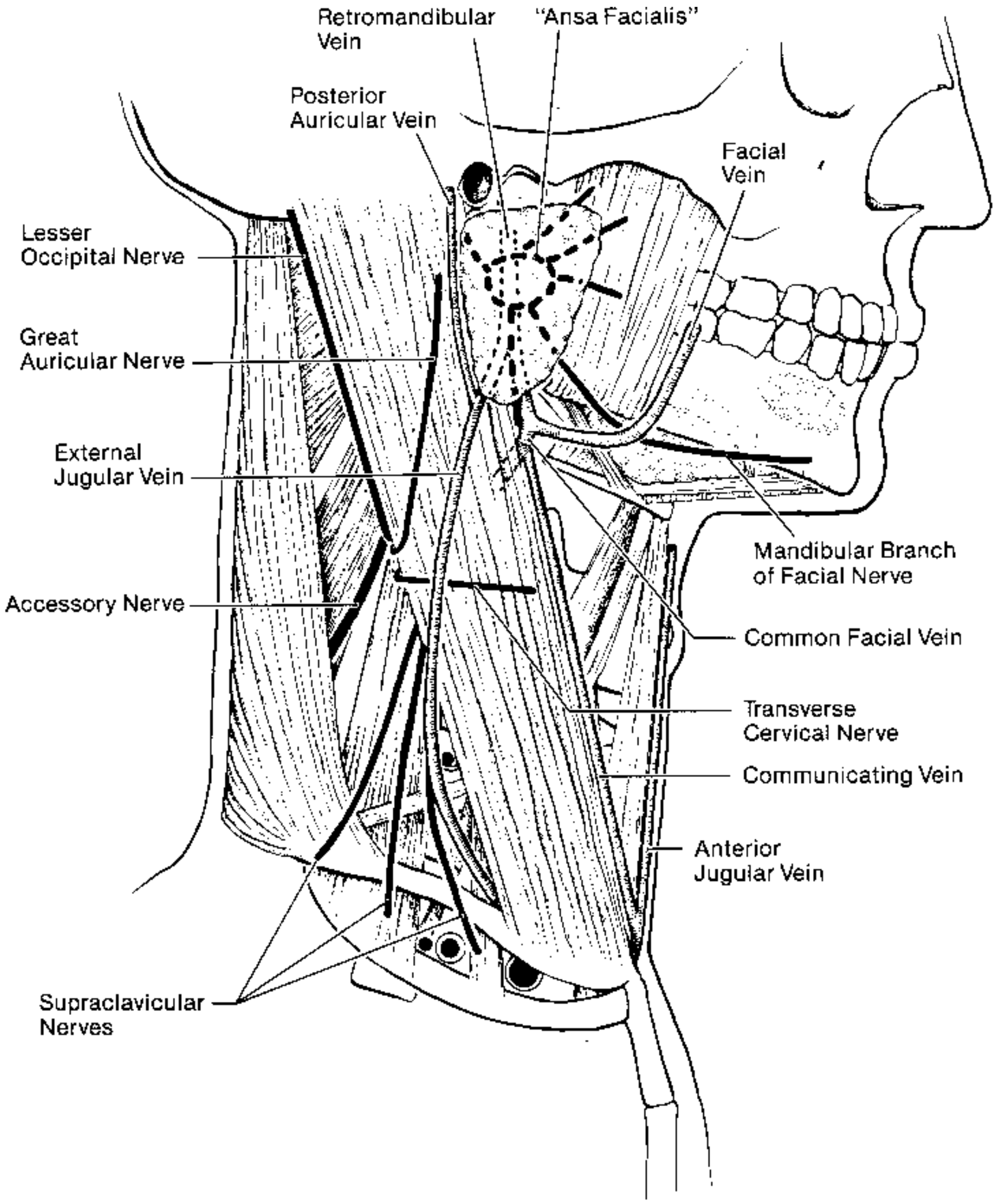

Figure 7–22. **Lateral view of certain small named veins of the neck, the nerves of the posterior triangle, and the "ansa facialis." As drawn, the diameters of the nerves do not reflect their true sizes.**

posterior auricular vein with the posterior fork of the retromandibular vein creates the external jugular vein.

The external jugular vein is a superficial vein, i.e., it runs in the subcutaneous tissue. From its formation, the external jugular vein descends across the external surface of the sternocleidomastoid toward the middle of the clavicle. As it nears the clavicle, the external jugular vein pierces the external and middle layers of cervical fascia to empty into the subclavian vein very near that vein's juncture with the internal jugular.

Facial Vein (in the Neck)

The facial vein (also called **anterior facial** vein) is a superficial vein of the face that passes only a short distance through the neck. At the inferior border of the mandible the facial vein lies adjacent to the anterior edge of the masseter. From this point, it descends into the digastric triangle on the external surface of the submandibular salivary gland. The vein then turns posteriorly to meet the anterior fork of the retromandibular vein below the lower pole of the parotid gland, on the surface of the carotid sheath. The product of their joining is called the **common facial vein**, which pierces the carotid sheath to empty into the internal jugular.

Anterior Jugular and Communicating Veins

The anterior jugular and communicating veins are often described as superficial, but they are not. They actually lie in the plane between the external and middle cervical fasciae. Each **anterior jugular vein** forms on either side of the midline just below the chin. It descends along a line coinciding with the medial edge of the sternohyoid to just above the sternoclavicular joint, where the anterior jugular vein bifurcates. One fork passes medially to meet with the corresponding fork of the opposite side and thereby creates the so-called **jugular venous arch**, lying just superior to the jugular notch of the manubrium. The other fork passes laterally, deep to the sternocleidomastoid, and then pierces the middle cervical fascia to empty into the external jugular vein.

The **communicating vein**, so called because it communicates between the common facial vein and the anterior jugular, runs along a line coinciding with the anterior border of sternocleidomastoid, from about the level of the hyoid bone down to the bifurcation of the anterior jugular, which bifurcation it joins.

VARIATION IN THE VEINS JUST DESCRIBED

There is nothing more disconcerting to a person dissecting the neck for the first time than the failure of the veins just described to follow the paths they ought to. But one must accept that fact that many more venous channels form in embryonic life than persist to birth. The ones that do persist are those that are hemodynamically favored. Because venous blood pressure is so low, there is often little hemodynamic difference between one embryonic route and another. Thus, all but the largest veins of the body are highly variable.

The external jugular vein sometimes appears to be no more than a continuation of the posterior auricular, lacking any connection to the retromandibular. At other times the external jugular appears to be no more than a continuation of the posterior fork of the retromandibular, then lacking any connection to a posterior auricular. Not infrequently, the external jugular is minuscule or absent.

There are three common circumstances in which a common facial vein will not exist: (1) the anterior fork of the retromandibular and the facial vein enter the internal jugular independently; (2) the retromandibular lacks an anterior fork and instead drains completely to the external jugular, leaving the facial vein to empty into the internal jugular alone; or (3) the facial vein fails to join the anterior fork of the retromandibular vein but instead empties completely into the communicating vein. It is also possible for the common facial vein to exist but to empty completely into the communicating vein instead of the internal jugular.

There are other variations I have not mentioned. It is not even important that the reader memorize those I have described, but it is important to realize that one or more variations occur so frequently that the standard description is, in fact, rarely accurate.

BRANCHES OF THE SUBCLAVIAN ARTERY

The subclavian artery gives off four or more named branches. When only four are given off, they all come from the first part of the artery, i.e., that part medial to the scalenus anterior. They constitute the (1) vertebral artery, (2) internal thoracic artery, (3) thyrocervical trunk, and (4) costocervical trunk. The vertebral artery comes off first, posterior to the common carotid artery. The others come off a bit further laterally, arising very close to one another behind the termination of the internal jugular vein, but from different surfaces of the subclavian artery.

Vertebral Artery

The vertebral artery arises from the subclavian artery behind the common carotid artery, and ascends in the triangle between the lower parts of scalenus anterior and longus colli. This course takes the vertebral artery anterior to the transverse process of C7, after which the vessel turns slightly backward to reach the costotransverse foramen of the 6th cervical vertebra, which it enters. The vertebral artery then continues upward through all the higher costotransverse foramina. During its ascent, it passes anterior to the spinal nerves (see Fig. 7-5), giving branches to nearby structures, including some branches that pass medially alongside the spinal nerves to reach the spinal cord.

Upon passing through the costotransverse foramen of the axis, the vertebral artery makes a sharp turn laterally to reach a point just below the transverse foramen of the atlas, and then it turns sharply upward to go through this foramen. Having passed through the transverse foramen of the atlas, the vertebral artery makes yet another series of turns, at first posteriorly and then medially, following the base of superior articular process around onto the upper surface of the posterior arch of the atlas, with only the 1st cervical nerve interposed between vessel and bone. The posterior arch of the atlas is grooved by the presence of the artery. It is at this site that the vertebral artery can be seen through the space of the suboccipital triangle.

The attachment of the posterior atlanto-occipital membrane to the posterior arch of the atlas is interrupted by the passage of the vertebral artery. Thus, for a short stretch, the membrane has free lower border stretching above the vertebral artery between the posterior arch and the superior articular process. This free lower border is called the **oblique ligament of the atlas** and it is frequently ossified.

After passing inferior to the oblique ligament of the atlas, the vertebral artery turns upward to pass through the foramen magnum into the cranial cavity. Each vessel gives off a small meningeal branch to the dura of the posterior cranial fossa (see Chapter 8) and then pierces the dura to run in the subdural space along the side of the medulla onto its ventral surface. At the caudal border of the pons, the two vertebral arteries meet in the midline to form the basilar artery, which pierces the arachnoid to run through the subarachnoid space in a groove on the ventral surface of the pons.

During its subdural course, each vertebral artery gives off (1) a **posterior spinal artery** that descends on the surface of the spinal cord along a path crossing the entrance sites of the dorsal rootlets, and (2) a contribution to the **anterior spinal artery** that descends in the ventral part of the anterior median fissure of the spinal cord. Closer to the pons, each vertebral gives off a **posterior inferior cerebellar artery**.

Because of the series of directional changes undergone by the vertebral artery in the upper neck, an anteroposterior view of a vertebral angiogram presents a very characteristic appearance. The vessel rises straight upward to the level of C2 and then jogs outward, upward, inward, and once again upward.

Internal Thoracic Artery

The internal thoracic is a branch from the inferior (concave) surface of the subclavian. It descends in front of the pleural cupola toward the back of the 1st costal cartilage and then continues its course down the chest 1 finger's breadth (fb) from the sternal margin. Its intrathoracic course and branches have been described in Chapter 4.

Costocervical Trunk

The costocervical trunk is a branch off the back surface of the subclavian artery. It loops backward over the pleural cupola toward the neck of the 1st rib. During this course the costocervical trunk gives off its two branches: superior intercostal and deep cervical.

Superior Intercostal Artery

The superior intercostal loops downward behind the pleural cupola, ventral to the neck of the 1st rib. As described in Chapter 4, the superior intercostal gives off the 1st and 2nd posterior intercostal arteries.

Deep Cervical Artery

The deep cervical artery continues straight backward above the neck of the 1st rib to gain the deep surface of the semispinalis capitis, where it then turns cranially to run up the neck, supplying nearby muscles.

Thyrocervical Trunk

This is the most variable of the branches of the subclavian artery. The classical thyrocervical trunk issues from the superior (convex) surface of the subclavian artery and almost immediately "sprays out" four smaller arteries. But any or all of these four arteries may arise separately from the subclavian. The four branches of the thyrocervical trunk are the inferior thyroid, ascending cervical, transverse cervical, and suprascapular arteries.

Inferior Thyroid Artery

Like the vertebral artery, the inferior thyroid artery ascends in the triangle between the lower parts of the scalenus anterior and longus colli. In this triangle, the inferior thyroid is anterolateral to the vertebral. Whereas the latter vessel lies behind the common carotid artery, the inferior thyroid is behind the internal jugular vein.

Upon reaching the level of the cricotracheal junction (lower border of C6), the inferior thyroid artery makes a sharp turn medially, passes behind the common carotid artery and then crosses the anterior surface of longus colli to reach the thyroid gland. The inferior thyroid artery not only supplies branches to structures along its course (e.g., muscles, pharynx, esophagus, trachea) but also it is one of the major suppliers to the thyroid and parathyroid glands. Just before it enters glandular tissue, the inferior thyroid artery gives off an inferior laryngeal branch that passes upward underneath the lower edge of the inferior constrictor muscle to enter the larynx.

Ascending Cervical Artery

The ascending cervical branch of the thyrocervical trunk runs upward onto the anterior surface of the scalenus anterior muscle, posterior to the carotid sheath, supplying branches to structures along its path. The ascending cervical artery is frequently a branch of the inferior thyroid artery.

Transverse Cervical Artery

The transverse cervical and suprascapular arteries both pass laterally onto the anterior surface of the scalenus anterior. The transverse cervical is the more superior of the two. At the lateral edge of scalenus anterior, the transverse cervical artery turns posterolaterally and travels above the brachial plexus to reach the lateral surface of scalenus medius. It runs across this surface toward the anterior edge of levator scapulae, where the vessel splits, sending one branch superficial to levator scapulae and the other deep to it. The superficial branch is often called the **superficial cervical artery** (in contrast to the deep cervical, which is a branch of the costocervical trunk). It travels across the superficial surface of the levator scapulae to reach the deep surface of the trapezius, where it then bifurcates, sending one twig upward and another downward, supplying the overlying trapezius and other nearby muscles.

The branch of the transverse cervical artery that passes deep to the levator scapulae travels downward toward the superior angle of the scapula and then continues a descent along the vertebral border of the scapula between the attachment sites of the rhomboids and serratus anterior. This deep branch of the transverse cervical is called the **dorsal scapular artery** and it supplies any structure near its path.

At least half the time, the dorsal scapular artery is not a branch of the transverse cervical. Rather, it comes off the third part of the subclavian artery all by itself. Such an independent dorsal scapular artery passes posteriorly between the nerves forming the brachial plexus to reach the anterior border of levator scapulae. When an independent dorsal scapular artery exists, it is technically correct to call the transverse cervical branch of the costocervical trunk by the name superficial cervical artery.

Suprascapular Artery

This the more inferior of the two arteries that pass laterally onto the anterior surface of the scalenus anterior. Upon reaching the lateral edge of the muscle, the suprascapular artery turns posterolaterally to follow a course deep to the clavicle toward the suprascapular notch of the scapula. Its supply of scapular muscles is described in Chapter 9. Occasionally, the suprascapular artery may be absent, in which case its role in supplying scapular muscles is taken over by other arteries in the vicinity of the scapula.

VEINS THAT ACCOMPANY THE BRANCHES OF THE SUBCLAVIAN ARTERY, AND WHY THEY DON'T EMPTY DIRECTLY INTO THE SUBCLAVIAN VEIN

There are veins called inferior thyroid veins, but they do not run alongside the inferior thyroid arteries. Rather, the inferior thyroid veins pass straight downward from the lower poles of the thyroid lobes, and from the isthmus, onto the anterior surface of the trachea, often uniting there to form a single **inferior thyroid vein**. Whether single or multiple, the inferior thyroid vein(s) descends into the thorax to empty into the left brachiocephalic vein as it passes deep to the upper half of the manubrium.

There is also a **middle thyroid vein** on each side, even though there is no such thing as a middle thyroid artery. The vein passes from the gland directly laterally (in front of the carotid sheath) to empty into the internal jugular vein.

The other branches of the subclavian artery are actually accompanied by veins (vena comitantes). We might expect that these would empty into the subclavian vein, but our expectations would be unfulfilled for two reasons. First, the arteries are branches of the first part of the subclavian artery, but there is no part of the subclavian vein medial to the scalenus anterior. Where there ought to be a first part of the subclavian vein, there is instead the formation of the brachiocephalic. Thus, we can now change our expectation to be that the vena comitantes of the branches of the subclavian artery ought to drain to the brachiocephalic vein at its formation. This expectation is fulfilled for the vertebral, costocervical, and internal thoracic veins. A different reason explains why the transverse cervical and suprascapular veins don't drain directly to the subclavian. As they near the scalenus anterior they diverge from their companion arteries to empty into the external jugular vein just before the latter joins the subclavian.

BRANCHES OF THE EXTERNAL CAROTID ARTERY

Superior Thyroid Artery

As we know, the external carotid artery arises from the anterior surface of the common carotid just behind the superior horn of the thyroid cartilage. Almost immediately the external carotid artery gives off the superior thyroid artery. The **superior thyroid artery** passes downward, deep to the sterno-thyroid muscle. Of course, the anterior edge of the superior pole of the thyroid gland also lies here, so that the superior thyroid artery follows this edge down to the isthmus, where the vessel anastomoses with its companion of the opposite side and with the inferior thyroid artery. The superior thyroid artery supplies the thyroid gland and nearby structures, but it also has two other important branches that come off near its origin. One travels backward to the sternocleidomastoid. The other travels forward onto the thyrohyoid membrane, which it pierces for supply of the larynx. This branch is called the **superior laryngeal artery**.

Ascending Pharyngeal Artery

The ascending pharyngeal artery may come off the very beginning of the external carotid, or a bit further along its course. It arises from the medial surface of the external carotid and ascends plastered against the lateral pharyngeal wall, giving branches to the pharynx along the way. At the free upper border of the superior constrictor, the ascending pharyngeal artery terminates in branches to the auditory tube and a **palatine branch** that passes with the levator veli palatini down to the soft palate.

Lingual Artery

The lingual artery arises from the anterior surface of the external carotid artery just behind the tip of the greater cornu of the hyoid bone. The vessel passes slightly upward and then turns forward deep to the posterior edge of the hyoglossus muscle. It continues forward deep to this muscle, close to the hyoid bone, giving off branches to the back of the tongue and nearby structures. At the anterior border of the hyoglossus, the lingual artery turns upward (technically leaving the neck) and then terminates on the lateral surface of genioglossus by dividing into a **sublingual artery**, for the gland of the same name, and a **deep lingual artery** that continues toward the tip of the tongue.

Facial Artery

Subsequent to its lingual branch, the external carotid artery passes toward the lower border of the posterior belly of the digastric at the angle of the mandible. At the lower border of the muscle, two additional branches are given off. From the front surface of the external carotid comes the **facial artery**; from the back surface comes the occipital. However, it is not at all uncommon for the facial and lingual arteries to arise from a common trunk, which in turn may come off the external carotid anywhere between the normal origins of the two vessels when independent.

Regardless of its origin, the facial artery passes superiorly in front of the external carotid and (like it) deep to the posterior belly of digastric. At the upper edge of the posterior digastric, the facial artery turns forward and runs a sinuous course in the digastric triangle deep to the submandibular salivary gland, thus separated by the gland from the anterior facial vein. Upon passing as far forward as the anterior limit of the masseter's insertion on the mandible, the facial artery makes a turn laterally to cross the lower border of the mandible and then turns upward into the subcutaneous tissue of the face just in front of the anterior facial vein.

The further course of the facial artery will be described later, but it should be noted now that its pulse can be most easily felt by **gently** compressing it against the outer surface of the mandible just as it makes this turn into the face at the anterior edge of the masseter.

In addition to unnamed branches to nearby structures, the facial artery gives off three important named branches in the neck. Two of them are given off before it turns forward into the digastric triangle. These two ascend on the side of the pharynx anterior to the ascending pharyngeal artery. One, the **tonsillar branch of the facial**, ends by piercing the superior constrictor to go to the palatine tonsil. The other, **ascending palatine branch of the facial**, continues higher and, like the ascending pharyngeal artery, passes over the free edge of the superior constrictor to follow the levator veli palatini muscle into the soft palate. Since the ascending pharyngeal artery, the ascending palatine branch of the facial artery, and the tonsillar branch of the facial artery all do pretty much the same thing, one or the other may be small or absent if its partners are big.

While in the digastric triangle, but just before it enters the face, the facial artery gives off a submental branch. The **submental artery** continues forward on the superficial surface of the mylohyoid into the submental triangle. It supplies structures along its course.

Occipital Artery

The **occipital artery** arises from the posterior surface of the external carotid at the lower border of the posterior belly of the digastric. The occipital artery essentially follows the inferior edge of the muscle all the way back to its origin, just medial to the mastoid process. Here the vessel encounters the deep surface of the splenius capitis (which inserts partly on the mastoid process) and runs around toward the back of the skull deep to that muscle, immediately inferior to its insertion. At the medial limit of the splenius insertion, the occipital artery turns superiorly, meets the greater occipital nerve, and with it enters the subcutaneous tissue of the scalp, running to the vertex.

The occipital artery has only two significant named branches. One is a **sternocleidomastoid artery**, which comes off very near the origin of the occipital and passes out to the sternocleidomastoid muscle. The other is a **descending cervical artery**, given off much later, at the back of the neck, just before the occipital artery emerges from under cover of the splenius. The descending cervical gives off branches that travel downward to the muscles of the neck. Some of these are relatively superficial and anastomose with branches from the superficial cervical artery. Others are deeper and anastomose with branches of the deep cervical and vertebral arteries. All these anastomoses link the external carotid system with the thyrocervical and costocervical trunks of the subclavian, as well as with its vertebral artery. The only other external carotid/subclavian anastomoses are between the superior and inferior thyroid arteries.

Posterior Auricular Artery

After passing upward deep to the posterior belly of digastric, the external carotid artery gives off from its posterior surface a small **posterior auricular artery** that follows the superior edge of this muscle backward and upward to the junction of the mastoid process and external auditory meatus. Here the posterior auricular artery gives off a branch that enters the stylomastoid foramen, and then the remainder of the artery continues superficially into the scalp behind the ear.

Termination of the External Carotid Artery

As mentioned previously, once the external carotid artery has passed deep to the stylohyoid it makes a sharp turn posterolaterally over this muscle into the parotid gland. The external carotid then turns upward again to run behind the posterior edge of the mandibular ramus toward the back of the mandibular neck, where it divides into its two terminal branches: **maxillary** and **superficial temporal**. These will be discussed in Chapter 8.

VEINS THAT ACCOMPANY BRANCHES OF THE EXTERNAL CAROTID ARTERY

The superior thyroid vein has a vena comitans that empties into the internal jugular vein. On the posterior surface of the pharynx is a pharyngeal plexus of veins that drains directly into the internal jugular. The lingual vein, also going to the internal jugular, is formed of two tributaries, one the accompanies the lingual artery, and one that runs on the *superficial* surface of the hyoglossus muscle. The facial and posterior auricular veins were described previously. The occipital vein generally empties into the deep cervical vein (i.e., the vena comitans of the deep cervical artery) rather than continuing with the occipital artery toward the front of the neck. The superficial temporal and maxillary veins will be discussed in Chapter 8.

THYROID IMA ARTERY

In a small percentage of cases, a slender artery arises from the aortic arch within the chest and ascends in front of the trachea to reach the isthmus of the thyroid gland. This vessel is called the thyroid ima artery. Its greatest significance lies in the fact that it may be accidentally cut during tracheostomies (see further on).

THORACIC DUCT

The thoracic duct has a short course in the neck. It enters the neck on the left surface of the esophagus and ascends with this relationship until the level of the lower pole of the thyroid gland. The duct then turns to run laterally, passing behind the common carotid artery and in front of the origin of the vertebral artery. It continues laterally, running behind the internal jugular vein to reach the beginning of the left brachiocephalic vein, where it terminates.

NERVES OF THE NECK

Several nerves that innervate structures in the neck have already been mentioned by name. Now is the time to describe their courses in detail. Some of these are cranial nerves that also have distributions to structures in the head. The path of these cranial nerves through the neck will be described, but a complete consideration of their functions will be deferred to Chapter 8.

Branches of Trigeminal Nerve (Cranial Nerve V) That Pass Into the Neck, or Almost Do

Nerve to the Mylohyoid

The nerve to the mylohyoid (which also innervates the anterior belly of the digastric) is a branch of the trigeminal nerve. The nerve to the mylohyoid runs forward on the external surface of the mylohyoid muscle, at the lower border of the mandible. If the nerve were any higher it would, technically, be superior to the digastric triangle and above the neck. Within the digastric triangle the nerve to the mylohyoid has the submental artery as a companion. The two structures pass forward deep to the submandibular salivary gland, then run beneath the anterior belly of digastric into the submental triangle, where they end.

Lingual Nerve

The lingual nerve is a branch of the trigeminal nerve that is never really within the neck. However, it can be seen on deep dissection of the digastric triangle and so will be discussed here. The course of the lingual nerve takes it onto the external surface of the hyoglossus and deep to the posterior edge of the mylohyoid very near that muscle's origin from the mandible. At this site the lingual nerve is superior to the submandibular duct. The nerve then runs forward between hyoglossus and mylohyoid, but also moves inferiorly, causing it to cross the external surface of the duct. Thus when the lingual nerve and submandibular duct pass together onto the genioglossus, the nerve is below the duct. While on the genioglossus, the lingual nerve turns superiorly again, but this time passes deep to the submandibular duct and then dives into the tongue.

The lingual nerve carries fibers for somatic sensation from the anterior two thirds of the tongue back to the trigeminal ganglion, where the sensory cell bodies lie. Also running within the distal part of the lingual nerve are sensory fibers carrying taste from the anterior two thirds of the tongue. But these fibers will eventually leave the lingual nerve to course back to the sensory ganglion of the facial nerve. They are not trigeminal fibers, even though they run for part of their course with a branch of the trigeminal nerve. Their route will be described in Chapter 8.

The lingual nerve carries yet another set of axons that are not originally part of the trigeminal nerve. It picks up preganglionic parasympathetic axons that left the brain with the facial nerve. The route will be discussed in Chapter 8. These axons travel with the lingual nerve onto the external surface of the hyoglossus and then leave the inferior edge of the lingual nerve to travel a millimeter or so to a clump of postganglionic parasympathetic cell bodies located on the surface of the hyoglossus above the submandibular duct. This clump is called the **submandibular ganglion**. Some of its cells send postganglionic axons to the submandibular salivary gland; other of its cells send axons back up to the lingual nerve, where they turn forward and are carried by it to the sublingual salivary gland.

Facial Nerve (Cranial Nerve VII) in the Neck (see Fig. 7-22)

Course

The facial nerve exits the skull through a hole immediately posterior to the root of the styloid process (see Fig. 8-5). This hole is called the **stylomastoid foramen**. Since the lateral surface of the styloid process is in contact with the parotid gland, so is the facial nerve as it exits the skull. The nerve passes laterally into the gland, descending a little bit as it does so, and then turns forward and bifurcates into an upper and a lower division. These continue forward within the parotid gland, diverging a bit as they do so, and cross the external surface of the retromandibular vein to reach that part of the parotid lying over the masseter. Here the two divisions join again, so that we may be speak of an "ansa facialis" (L. *ansa*, handle or loop). From the ansa arise most of the branches that distribute to the muscles of facial expression. These will be described in the Chapter 8.

Branches

Before entering the parotid gland, the facial nerve gives off (1) a **communication to the auricular branch of the vagus** that probably carries somatic sensation from the external auditory meatus; (2) a **posterior auricular branch** to the occipitalis, auricularis posterior, and auricularis superior, which are muscles of facial expression not exactly in the face, and (3) the **nerve to the posterior belly of the digastric and the stylohyoid**.

From the lower division of the facial nerve comes its **cervical branch**, which descends within the parotid gland to exit at its inferior pole and then travel toward the deep surface of platysma for supply of this muscle.

Also splitting off from the lower division is the **marginal mandibular branch** of the facial nerve. This branch very frequently leaves the parotid gland to enter the digastric triangle on the superficial surface of the submandibular salivary gland, deep to platysma, before looping back up to supply the facial muscles below the lower lip.

Although the marginal mandibular branch of the facial does not always follow such a course below the jaw, it is very important to anticipate this possibility so that any damage to the nerve is avoided during surgery on the submandibular salivary gland.

Glossopharyngeal Nerve (Cranial Nerve IX) (see Fig. 8-30)

Course

The glossopharyngeal nerve exits the skull through the medial part of the jugular foramen immediately medial to the interval between the internal carotid artery and internal jugular vein. The nerve passes onto the back surface of the stylopharyngeus muscle, which it follows downward a short distance and then crosses the muscle's lateral surface to reach the inferior edge of the styloglossus muscle. The glossopharyngeal nerve follows the inferior edge of the styloglossus into the tongue.

Branches

While still in the jugular foramen, the glossopharyngeal nerve is slightly swollen at two sites by the presence of sensory cell bodies. These regions of swelling are said to constitute a **superior (jugular) ganglion** and an **inferior (petrosal) ganglion** of the glossopharyngeal. From the inferior ganglion comes a slender twig that connects to the vagus. This **communication with the vagus** contains somatic sensory fibers that travel with the auricular branch of the vagus (see further on) to the external auditory meatus.

Immediately after leaving the jugular foramen, the glossopharyngeal nerve gives off a **tympanic branch** that re-enters the skull through a small hole on the ridge of bone between the jugular and carotid foramina. This hole leads to a canal that carries the tympanic branch of the glossopharyngeal into the tympanic cavity. The tympanic branch of the glossopharyngeal contains sensory fibers for the tympanic cavity and auditory tube, as well as parasympathetic preganglionic fibers for the parotid salivary gland. The further course of the parasympathetic fibers will be described in the Chapter 8.

As soon as it contacts the posterior surface of the stylopharyngeus the glossopharyngeal nerve gives off a variable number of small **branches to the pharynx**. In the wall of the pharynx, these branches participate with pharyngeal branches of the sympathetic trunk and vagus to form a **pharyngeal nerve plexus**. The role of the glossopharyngeal fibers is to provide sensation to the pharynx. Afferents from the carotid sinus and carotid body join one of the pharyngeal branches of the glossopharyngeal.

While hugging the posterior edge of the stylopharyngeus, the glossopharyngeal innervates this striated muscle.

In the tongue, the glossopharyngeal provides for general sensation and taste to the posterior third of the tongue.

Vagus Nerve (Cranial Nerve X)

Course

The vagus exits the jugular foramen of skull adjacent to the glossopharyngeal nerve. The vagus assumes a position within the carotid sheath between the posterior edges of the internal carotid artery and internal jugular vein, and holds such a position throughout the length of the neck (see Figs. 7-16, 7-20). Its course in the "jugulocarotid interval" takes the vagus down the neck on the anterior surface of the scalene musculature and, finally, between the first part of the subclavian artery and the brachiocephalic vein into the chest (see Fig. 7-20).

Branches

While in the jugular foramen, the vagus is slightly swollen owing to the presence of sensory cells said to form a **superior (jugular) ganglion** of the vagus. The **auricular branch** of the vagus leaves this jugular ganglion to run through the bone of the skull and eventually reach the external auditory meatus. This small nerve carries somatic sensation from the skin of the external auditory meatus. Within the auricular branch of the vagus are not only somatic sensory fibers with their cell bodies in the jugular ganglion of the vagus, but also some fibers from a communication with the glossopharyngeal nerve, and others from a communication with the facial. The glossopharyngeal fibers have their cell bodies in one of the sensory ganglia contained within the glossopharyngeal nerve; the facial fibers have their sensory cell bodies in the geniculate ganglion of the facial nerve. The importance of learning these seemingly trivial facts is that pain of the external auditory meatus can result from irritative lesions of the facial, glossopharyngeal, or vagus nerves.

Immediately below the skull, the vagus clearly appears swollen owing to the presence of sensory cell bodies said to form the **inferior (nodose) ganglion** of the vagus. From the swollen region come two important branches of the vagus--the pharyngeal and superior laryngeal. Lower in the neck the vagus gives off its direct contributions to cervical cardiac nerves. The role of the vagus in providing nerve supply to the infraglottic larynx and to the cervical parts of the trachea and esophagus is handled by its recurrent laryngeal branch.

Pharyngeal Branch of the Vagus. The pharyngeal branch of the vagus leaves the nodose ganglion and follows a path forward between the internal carotid artery and internal jugular vein. Having passed between the artery and vein, the pharyngeal branch of the vagus turns medially, running in front of the artery to reach the nearby pharynx and participate in formation of the pharyngeal nerve plexus.

The major role of vagal fibers in the pharynx is to innervate the three constrictors and the two small longitudinal muscles not supplied by the glossopharyngeal (i.e., palatopharyngeus and salpingopharyngeus). Somatic motor fibers also ascend to supply most of the palatal muscles. (In fact, with the exception of the tensor veli palatini, all muscles with the root "palat" in their names are innervated by the vagus nerve.) A less important role is to serve as the source of preganglionic parasympathetic innervation for the glandular cells of the pharynx

Superior Laryngeal Nerve. The superior laryngeal branch of the vagus passes forward and downward on the *medial* surface of the internal carotid artery, sandwiched between this vessel and the superior cervical sympathetic ganglion. It is the only cranial nerve branch to run medial to the internal carotid artery. As it does so, the superior laryngeal nerve bifurcates into a slender branch called the external laryngeal nerve and a larger branch called the internal laryngeal nerve. Both the external and internal laryngeal nerves continue a downward course medial to the carotid sheath on the lateral surface of the pharynx. Below the tip of the greater hyoid cornu, the **internal laryngeal nerve** turns forward to pierce the thyrohyoid membrane and enter the larynx. This turn brings the nerve alongside the superior laryngeal branch of the superior thyroid artery, which is heading toward the same place.

Fibers within the internal laryngeal nerve provide for sensation to the supraglottic larynx, including whatever taste buds lie on the anterior surface of the epiglottis. The internal laryngeal nerve also carries vagal parasympathetic preganglionic fibers for supraglottic laryngeal gland cells.

The **external laryngeal nerve** continues further downward on the lateral surface of the pharynx. It reaches the inferior constrictor close to the origin of the muscle from the oblique line of the thyroid cartilage (thus, deep to the lobe of the thyroid gland). The nerve courses just behind the oblique line onto the cricothyroid muscle. The external laryngeal nerve innervates some inferior constrictor fibers and, more importantly, the cricothyroid itself.

Recurrent Laryngeal Nerve. It will be recalled that the left recurrent laryngeal nerve is given off in the thorax. On the other hand, the recurrent laryngeal branch of the right vagus separates from the parent nerve at the lower border of the first part of the right subclavian artery. The right recurrent laryngeal nerve loops backward underneath this vessel and then turns superomedially on a short course to the tracheo-esophageal interval. It then runs upward in the lateral region of this interval (see Fig. 7-16). The left recurrent laryngeal nerve differs from the right only in that it gains the left side of the tracheo-esophageal interval in the thorax.

As a recurrent laryngeal nerve ascends, it supplies nearby structures with sensory and parasympathetic fibers and it innervates the striated muscle of the cervical esophagus. The position of the recurrent laryngeal nerve in the lateral region of the tracheo-esophageal interval causes it to be medial to the common carotid artery below the thyroid isthmus (see Fig. 7-21) and separated from the artery by the thyroid gland above its isthmus (see Fig. 7-16).

Its close relationship to the thyroid gland places the recurrent laryngeal nerve in danger of damage during surgery on the thyroid or parathyroids.

Upon reaching the lower border of inferior constrictor, the recurrent laryngeal nerve gives a few branches to that muscle, and then passes deep to it as the **inferior laryngeal nerve**, which is sensory and parasympathetic to the infraglottic larynx and, more importantly, somatic motor to all the internal laryngeal muscles.

The (Spinal) Accessory Nerve (Cranial Nerve XI)

The accessory nerve emerges from the skull with the glossopharyngeal and vagus nerves. It immediately embarks on an inferolateral course that takes it either behind or in front of the internal jugular vein. Upon passing the lateral edge of this vessel, the accessory nerve runs inferior to the posterior belly of the digastric and thereby reaches the upper part of the sternocleidomastoid muscle, which it penetrates. While continuing to descend within the sternocleidomastoid, the nerve supplies muscular branches to it. Then, about halfway down the muscle, the accessory makes a sharp turn to course out the back edge of the sternocleidomastoid into the roof of the posterior triangle, which carries it to the trapezius (see Fig. 7-22).

Hypoglossal Nerve (Cranial Nerve XII)

Course

The hypoglossal emerges from the hypoglossal foramen of the skull, which lies posterior to that part of the jugular foramen transmitting cranial nerves IX, X, and XI (see Fig. 8-5). In fact, the hypoglossal becomes so firmly bound to the back of the vagus that they almost appear to be one. The two nerves pass a short distance so conjoined. Then the hypoglossal leaves the vagus and gradually works its way forward between the artery and vein to emerge from between them at the lower border of the posterior belly of the digastric (see Fig. 7-21). Very shortly thereafter, the hypoglossal turns more dramatically forward to cross the lateral surface of the external carotid artery at a site immediately below the origin of the occipital artery (see Fig. 7-21). The sternocleidomastoid branch of the occipital artery loops over the hypoglossal nerve to reach its destination.

Once past the external carotid artery, the hypoglossal nerve moves onto the superficial surface of the hyoglossus immediately superior to the greater horn of the hyoid bone (see Fig. 7-21). Thus, the hyoglossus muscle separates the hypoglossal nerve from the more deeply placed lingual artery.

While on the surface of the hyoglossus, the hypoglossal nerve at first passes deep to the intermediate tendon of the digastric (with its stylohyoid investment) to enter the digastric triangle. Very shortly thereafter, the nerve encounters the posterior edge of the mylohyoid and passes deep to it, now sandwiched between hyoglossus and mylohyoid. Continuing forward in this plane, the hypoglossal nerve eventually passes beyond the hyoglossus onto the lateral surface of the genioglossus, into which it dives.

The hypoglossal nerve is the third structure to lie on the external surface of the hyoglossus deep to the mylohyoid. In this same interval, above the hypoglossal nerve, is the deep part of the submandibular gland with its duct. Above the gland and duct is the lingual nerve, with the submandibular ganglion hanging down from it. The lingual nerve will eventually cross the duct to lie between it and the hypoglossal nerve, and then cross back again to regain a position superior to both structures.

Branches

Very soon after it exits the skull, the hypoglossal nerve is joined by a branch from the 1st cervical ventral ramus carrying most of the latter's axons. The majority of these C1 fibers leave the hypoglossal nerve as it runs between the internal jugular vein and internal carotid artery. They form the descendens hypoglossi , which will be discussed later.

Just before entering the suprahyoid part of its course, the hypoglossal nerve gives off a branch that passes downward and forward to supply the thyrohyoid muscle. The axons within this branch derive from the 1st cervical ventral ramus. While on the surface of the hyoglossus, branches are given to it, to the styloglossus, and to the geniohyoid. The intrinsic muscles of the tongue and the genioglossus are supplied by the hypoglossal nerve after it dives into the latter muscle. It might be noted that, with the exception of the *palat*oglossus (which we can deduce is innervated by the vagus), all muscles with the root "glossus" in their names are innervated by the hypoglossal nerve.

Sympathetic Trunk in the Neck

Course

The reader will recall that in the upper part of the thorax the sympathetic trunk ran a longitudinal course taking it across the heads of the ribs. The same course is followed in the neck, but here the heads of ribs correspond to the anterior bars of transverse processes, and these in turn are overlain by the prevertebral muscles. Thus, the cervical sympathetic trunk lies on the anterior surfaces of the longus colli and, higher up, longus capitis. This places the trunk outside the carotid sheath just medial to the common/internal carotid axis (see Figs. 7-16, 7-20).

The lower part of the cervical sympathetic trunk is doubled, with the smaller of the two bundles passing anterior to the subclavian artery and the larger passing posterior to it. The two bundles rejoin one another inferior to the artery. This doubled part of the cervical sympathetic trunk is called the **ansa subclavia** (meaning loop associated with the subclavian). Just before it passes behind the subclavian artery, the posterior limb of the ansa subclavia splits around the vertebral artery near this vessel's origin.

Ganglia

The cervical sympathetic trunk usually contains three ganglia. The highest--**superior cervical ganglion**--is a constant, rather long structure lying at the level of C1 and C2, or C2 and C3 (see Fig. 7-20). From it come a variable number of gray rami that pass laterally to the upper three or four cervical ventral rami. It also sends postganglionic bundles (1) directly to the visceral organs of the neck, (2) upward along the internal carotid artery, forming an **internal carotid sympathetic nerve plexus**; (3) out to the external carotid artery, forming an **external carotid sympathetic nerve plexus**, and (4) that communicate with the cranial nerves IX, X, and XII. The carotid plexuses distribute with branches of these arteries to supply their smooth muscle walls and glands fed by the arteries. Additionally, the internal carotid plexus gives off branches that join nerves entering the orbit for supply of certain ocular smooth muscles.

A dissectible **middle cervical ganglion** is usually (though not always) present. It may be located anywhere between the levels of 4th-6th cervical vertebrae, often where the sympathetic trunk is crossed by the inferior thyroid artery.

An **inferior cervical ganglion** is found at or just below the level of the 7th cervical vertebra. It may be on the posterior limb of the ansa subclavia, or where the two limbs meet below the subclavian artery. It may be fused to the 1st thoracic ganglion to form the so-called **stellate ganglion**. The inferior cervical ganglion sends gray rami to ventral rami C6-C8, as well as postganglionic nerves to visceral structures in the neck. Also issuing from the inferior cervical ganglion is a bundle of postganglionic fibers that follow the vertebral artery upward into the transverse foramina of cervical vertebrae. At intervals, this "**vertebral nerve**" sends additional gray rami to the lower four or five cervical ventral rami.

As mentioned in Chapter 4, a variable number of bundles carrying postganglionic axons for the heart leave the cervical sympathetic chain from variable sites. These constitute **cervical sympathetic cardiac nerves** or they join with branches of the vagus to form **cervical [T41]autonomic[T40] cardiac nerves**.

Cervical Ventral Rami

The cervical ventral rami are best considered in two groups: the upper four, which will participate in the formation of a **cervical plexus**, and the lower four, which participate with the ventral ramus of T1 in formation of a **brachial plexus.** The two groups of ventral rami are linked by a small bundle that passes from C4 to C5.

The Upper Four Cervical Nerves and the Cervical Plexus

Very soon after the ventral rami C1-C4 split from their spinal nerves they give off short unnamed branches to nearby anterior and lateral intertransversarii (including the highest members of this series, which are rectus capitis muscles), to the longus capitis, and to some upper fibers of the scalenus medius and longus colli. After all these little muscular branches have separated from the upper four cervical ventral rami, the latter continue laterally in the interval between scalenus medius and longus capitis. Upon emerging from under cover of the longus capitis, each one of the rami gives off a branch that joins with one from its neighbors. Thus C1 sends a branch to join one from C2, creating a loop between them. A similar loop forms between C2 and C3, and another between C3 and C4. Subsequent nerves that carry fibers from C1-C4 may appear either as branches from these loops or as branches from the ventral rami distal to the loops. The entire complex of loops, branches from loops, and direct branches from ventral rami distal to loops is said to form a cervical plexus of nerves. It lies on the surface of scalenus medius.

Branches of the Cervical Plexus

Ansa Cervicalis. From C1, or from the loop between C1 and C2, comes a nerve bundle that joins the nearby hypoglossal nerve just below the base of the skull. The fibers descend within the hypoglossal nerve as it passes forward between the internal carotid artery and internal jugular vein. At this site most of the cervical fibers leave the hypoglossal nerve in a bundle that continues a descent in the anterior wall of the carotid sheath between the internal jugular vein and carotid axis (see Fig. 7-21). This bundle that descends from the hypoglossal nerve is called, cleverly, the **descendens hypoglossi**. It ends by joining a second nerve bundle that arises from C2 and C3 (or the loop between them) and descends a bit before turning anteriorly across the lateral surface of the internal jugular vein (see Fig. 7-21) or in the interval between the vein and the carotid artery. This branch that comes directly from the cervical plexus is called, equally cleverly, the **descendens cervicalis**. Because they join one another, the descendens hypoglossi and descendens cervicalis seem to form a loop that runs downward from hypoglossal nerve, then backward, and finally up again to the cervical plexus. The whole loop, comprising the two "descendens" nerves and their connection, is called the **ansa cervicalis**. Sometimes the descendens hypoglossi is referred to as the **superior limb** of the ansa, while the descendens cervicalis is said to form an **inferior limb** of the ansa. The bend of the ansa is usually formed on the lateral side of the internal jugular vein just above the site where it is crossed by the intermediate tendon of the omohyoid (see Fig. 7-21). It may occur higher, especially if the descendens cervicalis passes between vein and artery rather than lateral to the vein.

From the ansa cervicalis spring small branches to all the infrahyoid strap muscles except the thyrohyoid. As mentioned above, this muscle receives a separate branch from the hypoglossal nerve, but the branch contains fibers having exited the spinal cord in the ventral ramus of C1.

Muscular Branches of Cervical Plexus Not Carried in the Ansa Cervicalis, Including the Phrenic Nerve. There are other muscular branches from the cervical plexus. Some go to the sternocleidomastoid (C2 and C3), levator scapulae (C3 and C4), and trapezius (C3 and C4). Only those to the latter muscle have very far to go, and they do so by coursing in the roof of the posterior triangle inferior to the accessory nerve.

From C3 and C4 also come branches that join to form the phrenic nerve. This nerve descends on the anterior surface of the scalenus anterior just lateral to the internal jugular vein, outside the carotid sheath (see Figs. 7-16, 7-20). It picks up a contribution from C5 before that ventral ramus joins the brachial plexus. Like the vagus nerve, which is medial to the internal jugular vein, the phrenic nerve crosses in front of the first part of the subclavian artery to enter the chest. The transverse cervical and suprascapular arteries, arising behind the termination of the internal jugular vein, cross in front of the phrenic nerve as the vessels course laterally on the anterior surface of the scalenus anterior.

Cutaneous Branches of the Cervical Plexus. The remaining branches of the cervical plexus are cutaneous. From C2 and C3 (or the loop between them) come three cutaneous nerves that pass toward the posterior border of the sternocleidomastoid near its midpoint. These nerves appear at the posterior border of the sternocleidomastoid within a few millimeters of one another, and just below the accessory nerve.

The most superior of the cutaneous nerves is the **lesser occipital**; the middle one is the **great auricular**; the lowest is the **transverse cervical**.

The **lesser occipital nerve** turns sharply upward, crosses lateral to the accessory nerve, and then courses along the posterior edge of the sternocleidomastoid (see Fig. 7-22) to supply the skin of the scalp behind the auricle of the ear and at the back of the temple. It communicates with the greater occipital nerve and may be small if the latter is particularly large.

The **great auricular nerve** turns upward onto the lateral surface of sternocleidomastoid (see Fig. 7-22). It ascends toward the ear lobe following a course posterior to the external jugular vein. The great auricular nerve supplies the skin over the lower half of the auricle, the scalp immediately behind this, the skin of the neck just below the auricle, and a variable region of skin extending forward over the parotid gland.

The **transverse cervical nerve** turns straight forward, crosses the superficial surface of the sternocleidomastoid either deep or superficial to the external jugular vein (see Fig. 7-22), and fans out to supply skin of the anterior triangle.

From the loop between C3 and C4 come the **supraclavicular nerves**. Usually three of these (anterior, middle, and posterior) are described as appearing in sequence from under cover of the sternocleidomastoid below the transverse cervical nerve (see Fig. 7-22). The posterior supraclavicular nerve passes superficial to the trapezius, supplying an area of skin encompassing the entire shoulder and lower lateral surface of the neck. The middle and anterior nerves pass deep to the platysma and across the clavicle to supply a strip of skin superficial to the clavicle, and extending several centimeters below it, all the way from the midline to the shoulder.

The distribution of the supraclavicular nerves has a particular relevance for clinical diagnosis. It will be recalled that the bulk of the phrenic nerve derives from the same spinal segments (C3 and C4) as do the supraclavicular nerves. It will also be recalled that the phrenic carries sensation from the mediastinal and central diaphragmatic pleura. Disease of these regions of the pleura may give rise not only to pain perceived as being deep within the chest, but also to a referred pain perceived as being located in the skin and superficial fascia supplied by the supraclavicular nerves.

The Lower Four Cervical Ventral Rami

Although it is the main job of the 5th-8th cervical ventral rami to participate in formation of the brachial plexus, which plays no role in innervating the neck, nonetheless these ventral rami give off branches to a few neck structures before the plexus actually begins.

Very soon after the lower four cervical ventral rami split from their spinal nerves, they give off small unnamed muscular branches to the anterior and lateral intertransversarii, to the scalenus anterior, most of the scalenus medius, the scalenus posterior, and most of the longus colli. The ventral ramus of C5 then gives off two branches, and the ventral rami of C6 and C7 each give off one branch, that pierce (or pass in front of) the scalenus medius to emerge on its lateral surface. These branches will form the dorsal scapular and long thoracic nerves.

Dorsal Scapular Nerve (Nerve to the Rhomboids). One of the branches from C5 constitutes the dorsal scapular nerve. It runs backward and downward on the surface of the scalenus medius toward the levator scapulae. Upon reaching this muscle, the dorsal scapular nerve dives deep to it, meets the dorsal scapular artery, and continues toward the superior angle of the scapula. The artery and nerve descend along the vertebral border between the attachments of the rhomboids and serratus anterior. In its descent, the nerve supplies the rhomboids.

Long Thoracic Nerve (Nerve to the Serratus Anterior). The other branch from C5 joins the branch from C6 on the lateral surface of the scalenus medius. The common trunk turns straight inferiorly and runs down the lateral surface of the scalenus medius, picking up the branch from C7 along the way. At this point, the long thoracic nerve is said to be formed. It continues the inferior course, passing from scalenus medius onto the lateral surface of serratus anterior a centimeter or two behind the midaxillary line. It continues a descent on the serratus anterior, supplying it.

Other Branches. After the afore-mentioned muscular branches have left the lower four cervical ventral rami, these rami continue laterally into the interscalene triangle. Upon emergence from the interscalene triangle, the ventral ramus of C5 gives off the **nerve to the subclavius** (which descends to this muscle) and a **contribution to the phrenic nerve**. Only then does the rest of the 5th ventral ramus, and the 6th-8th ventral rami, participate with T1 in formation of the brachial plexus (see Fig. 7-6). The 1st thoracic ventral ramus has passed upward and laterally behind the pleural cupola to gain the upper surface of the first rib immediately posterior to the subclavian artery.

LYMPHATIC STRUCTURES IN THE NECK

In this section I will discuss not only the lymphatic drainage of cervical structures, but also any lymph nodes that lie in the neck but receive their lymph primarily from structures in the head.

Deep Cervical Nodes

Lymph from all structures (both superficial and deep) superior to the clavicle eventually passes through one or more nodes that form a chain lying on the surface of the carotid sheath alongside the internal jugular vein. This is the **deep cervical chain of lymph nodes**. Like the vessel they lie along, the deep cervical nodes are deep to the sternocleidomastoid (though a few may extend either a little bit behind or a little bit in front of the muscle).

The site where the superior belly of the omohyoid crosses the carotid sheath (about the level of the cricoid cartilage) is used to demarcate a **superior group** of deep cervical nodes from an **inferior group**. The inferior nodes are also referred to as **supraclavicular, or scalene, nodes**. Superior deep cervical nodes drain to inferior deep cervical nodes. The efferent lymphatic vessels from the inferior nodes join together to form the so-called **jugular trunk**, which empties into the junction of the internal jugular and subclavian veins. On the right side, this same venous junction also receives the subclavian and bronchomediastinal lymph trunks, either or both of which may join the jugular trunk before emptying into the blood. On the left side, the jugular trunk may join the thoracic duct just prior to its termination.

Two particularly large nodes of the deep cervical chain have been given special names. One lies just inferior to the site where the posterior belly of the digastric crosses the carotid sheath; this is the **jugulodigastric node**. It is also called the **node of the tonsil** because that structure sends its lymph to the jugulodigastric node. The second named node of the deep cervical chain is located just superior to the site where the omohyoid crosses the carotid sheath. This **jugulo-omohyoid node** is also called the **node of the tip of the tongue** in recognition of one of its sources of lymph.

The lowest members of the inferior group of deep cervical nodes are connected by communicating lymphatic vessels to both axillary nodes and tracheal nodes. This accounts for the fact that cancer from the breast or thoracic viscera may metastasize to the cervical chain.

Three Groups of Outlying Nodes That Drain Structures in the Neck

Although most lymph vessels from structures in the neck pass directly to deep cervical nodes, there are a few outlying groups of nodes that may serve as intermediary sites of lymph passage:

1. **Anterior cervical nodes** scattered alongside the larynx and cervical trachea
2. Some **retropharyngeal nodes** behind the pharynx
3. A few **accessory nodes** along the path of the accessory nerve in the posterior triangle

Three Groups of Outlying Nodes That Lie in the Neck But Mainly Drain Structures in the Head

There are three groups of intermediary nodes that lie in the neck but receive the bulk of their lymph from structures in the head.

Parotid Nodes

Attached to the superficial surface of the parotid gland, and also embedded within it, are a set of parotid lymph nodes that send their efferents to the deep cervical chain. Since part of the parotid gland lies in the retromandibular region of the neck, so do some of the parotid nodes. A few nodes lying alongside the upper part of the external jugular vein are often called superficial cervical nodes, but they are best viewed as a downward continuation of nodes on the surface of the parotid.

Submandibular Nodes

There are several lymph nodes attached to the superficial surface of the submandibular salivary gland in the digastric triangle. Like the parotid nodes, these submandibular nodes drain directly to the deep cervical chain.

Submental Nodes

A couple of lymph nodes lie on the surface of the mylohyoid in each submental triangle. These submental nodes drain in part to submandibular nodes and in part directly to deep cervical nodes.

SURFACE ANATOMY

Soft Tissue Landmarks of the Neck

Most of the important landmarks of the neck concern skeletal structures that can be palpated. However, two soft-tissue structures--the sternocleidomastoid muscle and external jugular vein--are visible in most persons and can serve as useful guides to certain related structures.

External Jugular Vein

In many persons the external jugular vein is visible along the side of the neck. Even among persons in whom this vein is not normally seen, it can be made to stand out by asking the person to try to exhale with the glottis closed. The increased intrathoracic pressure causes retardation in venous return to the heart with consequent distension of the external jugular vein (if the patient has one).

The external jugular vein runs from the angle of the mandible toward the middle of the clavicle (see Fig. 7-21). Its upper half is a guide to the great auricular nerve, which passes parallel and posterior to the vein.

Sternocleidomastoid Muscle

This muscle is visible in many slender persons and, in others, can be made to stand out if the patient turns the head to the opposite side. The anterior edge of the sternocleidomastoid passes less than a finger's breadth from the angle of the mandible. The muscle is a guide to the carotid arteries and internal jugular vein. The common carotid artery and internal jugular vein lie deep to the sternocleidomastoid (Fig. 7-23). Above the carotid bifurcation, the external carotid artery lies immediately in front of the anterior edge of sternocleidomastoid (see Fig. 7-23), whereas the internal carotid artery and internal jugular vein stay deep to the muscle until the angle of the mandible.

The midpoint of the posterior edge of the sternocleidomastoid is an important landmark for certain nerves (see Fig. 7-22). The accessory enters the roof of the posterior triangle near this point and then runs posterolaterally toward the anterior edge of the trapezius about 3 fb above the clavicle. Also from near the midpoint of the posterior border of sternocleidomastoid, the lesser occipital, great auricular and transverse cervical nerves emerge from under cover of the muscle. The lesser occipital nerve follows the posterior border of the sternocleidomastoid upward and backward; the great auricular nerve makes a turn onto the lateral surface of the muscle and courses up to the auricle; the transverse cervical nerve turns anteriorly and passes across the neck deep to the external jugular vein.

The posterior border of the sternocleidomastoid is also the landmark for feeling the subclavian pulse in the supraclavicular fossa.

Skeletal Landmarks of the Neck (see Fig. 7-2)

Skull

A few bony structures of the skull are important landmarks in discussing the surface anatomy of the neck.

The mastoid process of the temporal bone is palpable behind the earlobe. The most inferior point on the mastoid process is its tip.

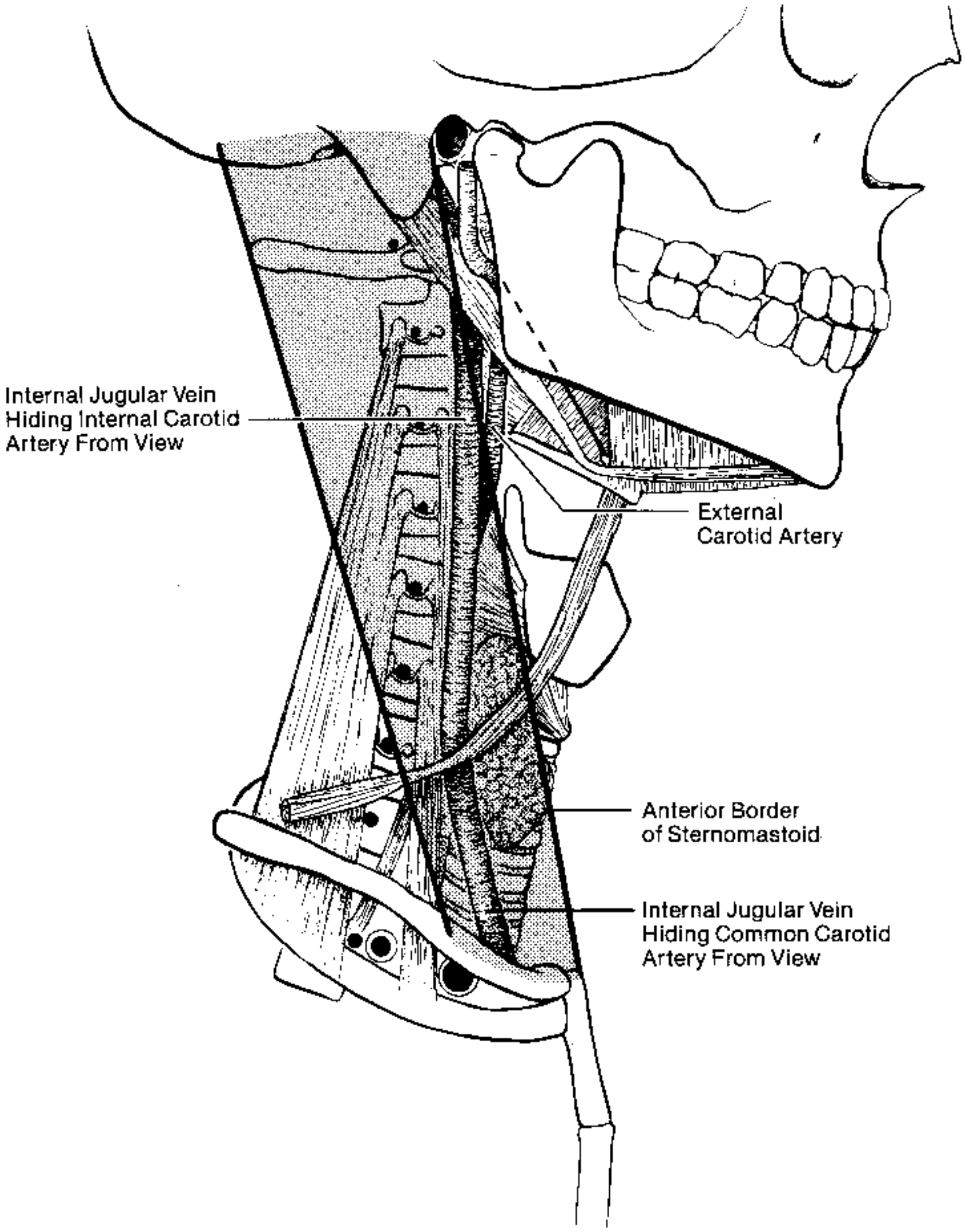

Figure 7-23. Lateral view of the neck illustrating the relationship of the internal jugular vein and carotid arteries to the more superficially placed sterno(cleido)mastoid muscle.

The entire inferior border of the body of the mandible and the lower half of the posterior border of the mandibular ramus can be felt. Their junction is called the **angle**. It lies opposite the C2/C3 intervertebral disc. The inferior border of the mandible then slopes downward toward the chin, one vertebral level lower. A line from the tip of the mastoid process to the mandibular angle coincides with the course of the posterior belly of the digastric. The tip of the styloid process lies deeply, usually at a site corresponding to the midpoint of the posterior edge of the mandibular ramus.

The other important landmarks of the skull are the **external auditory meatus** and the condyle of the mandible. The former can be visualized and serves as the guide for more deeply placed structures: (1)

the origin of the styloid process, (2) the jugular foramen (which marks the beginning of the internal jugular vein), and (3) the exit of the hypoglossal nerve from the skull.

The **mandibular condyle** lies anterior to external auditory meatus. The lateral tip of the condyle can be palpated if a finger is placed in front of the external auditory meatus and the patient is asked to open and close the jaw. The condyle is felt as it passes forward and downward during opening. When the jaw is closed, a point between the mandibular condyle and external auditory meatus is the surface projection of the carotid foramen of the skull, where the internal carotid artery enters its canal in the petrous portion of the temporal bone. At the base of the skull the internal carotid artery is anterior to the internal jugular vein. Medial to the interval between them exit the 9th, 10th, and 11th nerves.

Vertebrae

Very few parts of the cervical vertebrae can be palpated. Mention has already been made that the spine of C7 (vertebra prominens) is readily felt, and that the spine of C2 can be palpated on deep pressure below the skull. More interestingly, the tip of the transverse process of the atlas can be felt by applying firm pressure in a medial direction just below and in front of the tip of the mastoid process (along a line between the mastoid tip and the angle of the mandible). The sternocleidomastoid and posterior belly of digastric intervene between the transverse process of the atlas and the skin (see Fig. 7-23).

Hyoid Bone

The hyoid bone (body and both greater cornua) is palpable a little below the posterior half of the mandibular body. **As a whole the hyoid bone lies at the level of C3/C4 intervertebral disc**: the body is actually a bit lower and the tips of the greater cornua a bit higher.

Thyroid Cartilage

The anterior aspect of the thyroid cartilage is palpable below the hyoid bone. Its laryngeal prominence is readily visible in many persons, especially males. The superior edge of a thyroid cartilage lamina is often palpable.

The thyroid laminae span C5 and the discs on either side of C5. The superior horns of the thyroid cartilage extend upward at the level of C4, toward the tips of the greater cornua of the hyoid bone. The shorter inferior horns extend downward at the level of C6, to articulate with the cricoid.

Cricoid Cartilage

The cricoid lamina lies opposite the body of C6. The arch narrows anteriorly so that at the front it lies opposite only the bottom of C6. Here it is palpable below the angle of the thyroid cartilage. Between the two cartilages, in the anterior midline, extends the median cricothyroid ligament. Its location can be determined readily by palpation of the cricoid and it lies very close to the surface of the skin, not covered by any other significant structure.

The median cricothyroid ligament is a natural site for gaining entrance to the infraglottic airway when speed is the paramount consideration. A hollow metal tube (or whatever is handy) is jammed through the ligament into the larynx. The proper name for this procedure is a **median cricothyroidotomy**.

Trachea and Thyroid Gland (see Figs. 7-15, 7-17)

The trachea extends downward from the cricoid cartilage into the neck. It inclines posteriorly as it descends, so that at the level of the jugular notch of the manubrium the trachea is halfway between this bone and the vertebral column.

The isthmus of the thyroid gland is less than 1 fb below the cricoid, overlying the 2nd-4th tracheal rings. Below this, the inferior pole of the thyroid gland lies on the lateral surface of the trachea down to the 5th or 6th tracheal ring. Above the isthmus, the thyroid lobes are on the lateral surfaces of the cricoid and thyroid cartilages (with some muscles intervening).

Only fascia intervenes between skin and the anterior surface of that short stretch of trachea above the thyroid isthmus. It is possible to perform a **tracheotomy**[31] here. Such a procedure is called a superior tracheotomy. More commonly, for longstanding **tracheostomy**[32] the thyroid isthmus is incised to give freer access to the trachea.

Only fascia intervenes between the thyroid isthmus and the skin on the front of the neck. On the other hand, both the sternothyroid and sternohyoid muscles lie in front of the lobes of the thyroid gland.

Some physicians believe that they can palpate a normal thyroid gland by placing fingers on either side of the cricoid cartilage and sensing the up-and-down movement of the thyroid lobes beneath the fingers as the patient swallows. Other physicians believe that the gland can be palpated only if it is enlarged.

Carotid Arteries (see Figs. 7-19, 7-20)

The carotid axis can be approximated by a straight line from a point just deep to the medial end of the sternoclavicular joint up to a point between the external auditory meatus and mandibular condyle. In the lower half of the neck the common carotid artery lies deep to the anterior fibers of the sternocleidomastoid muscle. Higher in the neck, the internal jugular vein, which lies deep to the posterior fibers of the sternocleidomastoid, intervenes between the muscle and internal carotid artery. The external carotid artery is given off from the anterior surface of the common carotid and courses toward the mandibular angle. The external carotid artery is anterior to the internal carotid until just below the jaw joint, at which site the external carotid makes it bend over the stylohyoid muscle to become more laterally placed.

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[31] The ending of the word tracheotomy derives from the Greek *tomos*, a cut or slice. Thus, a tracheotomy is a simple cut into the trachea for brief access to its lumen.

[32] The ending of the word tracheostomy derives from the Greek *stoma*, a mouth. Thus, a tracheostomy is a procedure in which a "mouth" is made in the trachea for prolonged access to its lumen.

As we know, **the carotid bifurcation is located behind the superior horn of the thyroid cartilage**. This level can be palpated as the interval between the hyoid bone and thyroid lamina. It corresponds to C4.

In that the common carotid artery follows the anterior border of the sternocleidomastoid so very closely (but deep to the muscle), its pulse can be palpated by placing one's fingers along the muscle border and pressing posteriorly. The artery is then squeezed against the cervical anterior tubercles, or muscles attaching thereto.

> The anterior tubercle of C6 is the largest of all. It is called the **carotid tubercle** because, by placing a finger lateral to the cricoid cartilage and pressing directly backward, one can easily compress the common carotid artery against the anterior tubercle of C6, even to the point of total occlusion. This might be necessary to control hemorrhage in the head. Also, before treating intracranial aneurysms by ligation of the common carotid, it is common practice to occlude the artery by paracricoid compression in order to determine if collateral circulation through the circle of Willis is adequate to maintain consciousness.

The pulse of the external carotid artery is easily felt anterior to the sternocleidomastoid below the angle of the jaw.

Internal Jugular Vein

This lies lateral to the common/internal carotid axis. Thus, **the internal jugular vein is also deep to the sternocleidomastoid for much of its course**. In the lower part of the neck, the muscle is more or less anterior to both the artery and vein. In the carotid triangle, the vein separates the artery from the sternocleidomastoid.

Subclavian Artery and Nearby Nerves (see Fig. 7-6)

Place some fingers just above the clavicle next to the back edge of the sternocleidomastoid (or just lateral to the junction of the medial and middle thirds of the clavicle) and press backward. The third part of the subclavian artery is pushed against the scalenus medius and its pulse should be palpable.

The trunks of the brachial plexus are behind and above the third part of the artery. More medially, in the interscalene triangle, are the ventral rami that will form the plexus.

Repeating Some Important Relationships of Nerves (see Figs. 7-16, 7-20)

Five major nerves have extensive longitudinal courses in the neck. Each has important relationships to the common/internal carotid axis or to the internal jugular vein.

The vagus runs from top to bottom in the posterior part of the jugulocarotid interval. It is within the carotid sheath, on the anterior surface of the scalene musculature.

The sympathetic trunk runs from top to bottom medial to the common/internal carotid axis, outside the carotid sheath, on the anterior surface of the prevertebral musculature.

The phrenic nerve runs vertically in the lower half of the neck lateral to the internal jugular vein, outside the carotid sheath on the anterior surface of the scalenus anterior.

The descendens hypoglossi runs vertically in the midregion of the neck, embedded in the anterior wall of the carotid sheath between the carotid axis and the internal jugular vein.

The recurrent laryngeal nerve is found in the infracricoid region of the neck, in the lateral part of the tracheo-esophageal interval. Below the thyroid isthmus the nerve is medial to the common carotid artery, outside the carotid sheath. Above the thyroid isthmus, the nerve is separated from the carotid sheath by the thyroid gland.