CHAPTER 9

The Neck

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.

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 a typical cervical vertebra (see Fig. 3-1, p. 38). 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. The 3rd, 4th, 5th, and 6th cervical transverse processes also have substantial anterior tubercles, which are secondary bumps related to muscular attachments. Other specializations of cervical vertebrae were discussed in Chapter 3 (p. 42).

The first cervical vertebra, called the atlas, and the second cervical vertebra, called the axis, are very atypical. The are seen during a dissection of the base of the skull and are discussed in Chapter 10 (p. 341).

POSTERIOR TRIANGLE OF THE NECK (Fig. 9-1)

It is convenient to divide the neck into regions bordered by some of the superficial 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. 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.

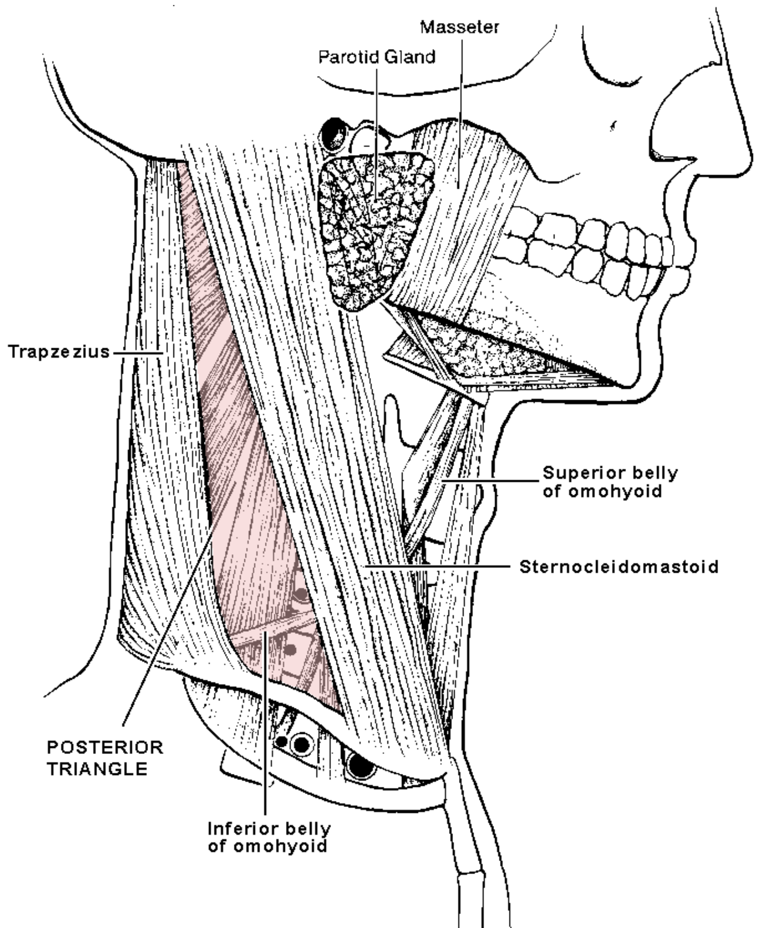

Figure 9-1. Shaded in pink is the posterior triangle of the neck, bounded by the posterior edge of the sternocleidomastoid, the anterior edge of the trapezius, and the clavicle.

Trapezius and Sternocleidomastoid (Fig. 9-1)

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 sternocleido-mastoid 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.

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 - the accessory nerve (C.N. XI). 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 (see Chapter 11, p. 415), 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 for C.N. XI 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.

In its path through the neck, the sternocleidomastoid crosses the more deeply placed omohyoid (Fig. 9-1). The intermediate tendon of the omohyoid lies deep to the posterior fibers of sternocleidomastoid 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.

It is worth mentioning here that cerebral control of the sternocleidomastoids is unusual. Whereas the general rule is that one side of the cerebral cortex controls muscles on the opposite side of the body (but see discussion of superior facial muscles in Chapter 10, p. 385), the sternocleidomastoids get cortical input from both cerebral hemispheres. As would be predicted from the general rule, the contralateral hemisphere stimulates the sternocleidomastoid when you use it to flex or laterally flex your neck. For example, a right hemisphere lesion causes weakness in the left sternocleidomastoid when you try to touch your left ear to your left shoulder. Unexpectedly, the ipsilateral hemisphere stimulates the sternocleidomastoid when you turn your head. For example, when you want to turn your head to the right, use of your left sternocleidomastoid is initiated by the ipsilateral left cerebral cortex. Since the left cortex also causes your eyes to turn to the right, deviation from the normal pattern for sternocleidomastoid during head turning behaviors is functionally sound.

External Cervical Fascia **(see Fig. 9-10)**

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**.

External Jugular Vein

The posterior fork of the retromandibular vein (which is running through the parotid gland) meets the posterior auricular vein (which drains subcutaneous tissues of the scalp behind the ear) at the anterior edge of the sternocleidomastoid, just behind the angle of the mandible. The joining of the posterior auricular vein with the posterior fork of the retromandibular vein creates the external jugular vein (Fig 9-2).

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 cervical fascia to empty into the subclavian vein very near that vein's juncture with the internal jugular.

The (Spinal) Accessory Nerve (C.N. XI)

The accessory nerve emerges from the skull through the medial part of the jugular foramen along with the glossopharyngeal and vagus nerves. After following a course described later (Chapter 10, p. 347), it reaches the upper part of the sternocleidomastoid muscle, which it penetrates and supplies. Then, about halfway along the length of the muscle, the accessory nerve makes a sharp turn to pass out the back edge of the sternocleidomastoid into the roof of the posterior triangle, which carries it along an oblique course toward a site on the anterior edge of the trapezius about 3 fingerbreadths above the clavicle (Fig. 9-2) Here the nerve dives deep to trapezius and descends applied to the muscle's deep surface, supplying it along the way.

The effects of damage to the accessory nerve, and how to test for it, are discussed in relationship to paralyses of the two muscles it innervates (see pp. 284-285.)

Branches of Cervical Ventral Rami Seen in the Posterior Triangle

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 muscles arising from the vertebral column. Then the upper four cervical ventral rami, continue laterally in the interval between two of these muscles - scalenus medius and longus capitis (see Fig. 9-20, p. 318). Upon emerging from under cover of the longus capitis, each one of the ventral 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 anterior surface of scalenus medius.

Cutaneous Branches of the Cervical Plexus. From C2 and C3 (or the loop between them) come three cutaneous nerves that pass toward the posterior border of the sternocleidomastoid . These nerves appear at the posterior border of the sternocleidomastoid, near its midpoint, within a few millimeters of one another (Fig. 9-2). The largest, and easiest to find, is the **great auricular nerve**. It turns upward onto the lateral surface of sternocleidomastoid and them ascends toward the anterior edge of the ear following a course posterior to the external jugular vein (Fig. 9-2). 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. In a dissection, probably the easiest way to locate the accessory nerve (described above) is first to find the great auricular nerve

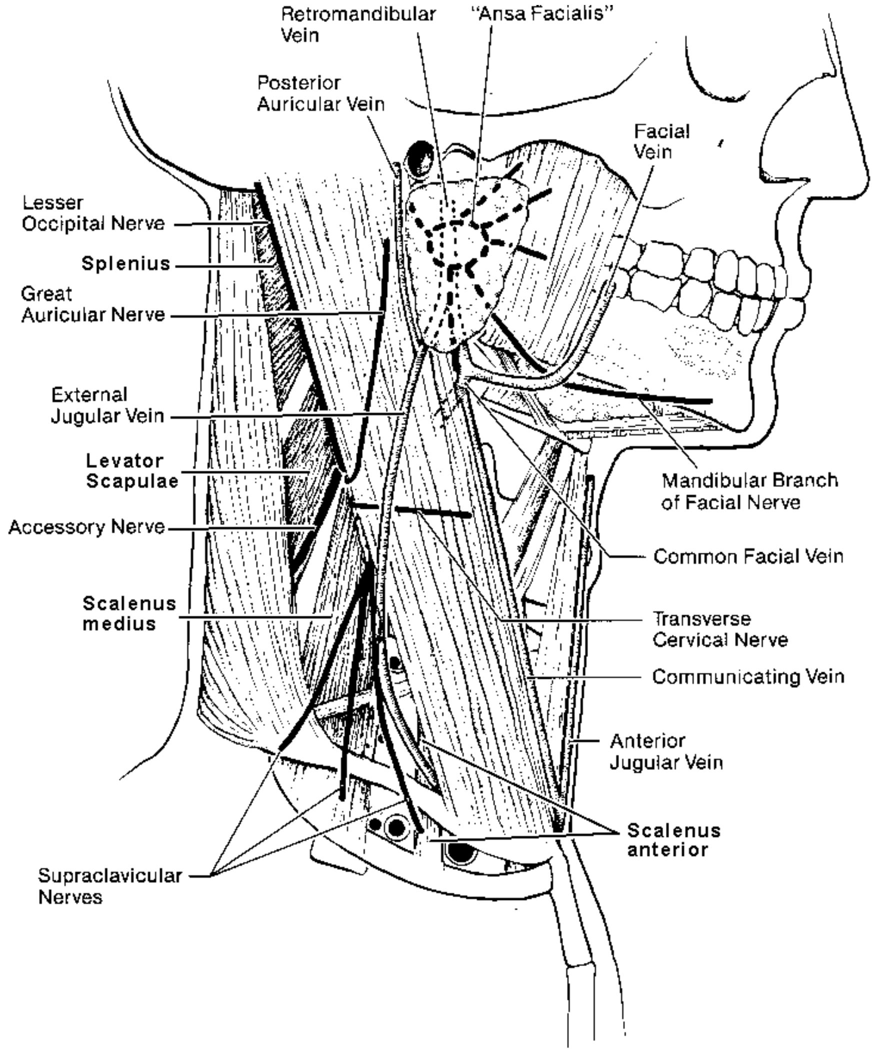

Figure 9-2. Lateral view of the important nerves passing through the posterior triangle and of the muscles that form the floor of the rtiangle.

and then look for the accessory emerging from under cover of the sternocleidomastoid 5 - 10 mm more superiorly.

The **lesser occipital nerve** (highly variable in size) emerges from under cover of the sternocleidomastoid slightly above the great auricular nerve. It turns sharply upward, crosses lateral to the accessory nerve, and then courses along the posterior edge of the sternocleidomastoid (Fig. 9-2) 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 (see Chapter 3, p. 53) and may be small if the latter is particularly large.

The **transverse cervical nerve** emerges from under cover of the sternocleidomastoid slightly below the great auricular nerve. It turns straight forward, crosses the superficial surface of the sternocleidomastoid either deep or superficial to the external jugular vein (Fig. 9-2), and fans out to supply skin on the front of the neck.

From the loop between C3 and C4 come the **supraclavicular nerves**. Usually three of these (anterior, middle, and posterior) are described as diverging from a large bundle that emerges from under cover of the sternocleidomastoid a fingerbreadths below the transverse cervical nerve (Fig. 9-2). 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.

Muscular Branches of the Cervical Plexus Seen in the Posterior Triangle. From the ventral rami C3 and C4 are small branches that cross the posterior triangle to reach the trapezius. These course inferior to the accessory nerve, but can be confused for it during dissection.

Muscular Floor of the Posterior Triangle (Fig. 9-2)

Three muscles are said to form the floor of the posterior triangle. From superior to inferior they are splenius, levator scapulae, and scalenus medius. Splenius was described in Chapter 3 (p. 51).

Levator Scapulae

In the abdomen there exists the 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. Both function to move the scapula, but I will describe levator scapulae here, rather than in the chapter on the upper limb, because it seen in a dissection of the neck.

The levator scapulae arises from the posterior tubercles of 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 (presumably to elevate the scapula) and when reaching far forward (presumably to help pull the scapula anteriorly).

Scalene Muscles

The trilaminar musculature represented in the thorax by the intercostal muscles has a variety of members in the neck. One of these - thee scalenus medius - is part of th e floor of the posterior triangle (Fig. 9-2). Another - the scalenus anterior - is mostly under cover of the sternocleidomastoid (Fig. 9-2) and is seen best when the anterior triangle of the neck is dissected. Nonetheless, I will describe it now.

The **scalenus anterior** (Fig. 9-3, see Fig. 9-10).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 medial aspect of the superior surface of the 1st rib, slightly anterior to 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 (Fig. 9-3). The groove anterior to the scalene tubercle is caused by the subclavian vein.

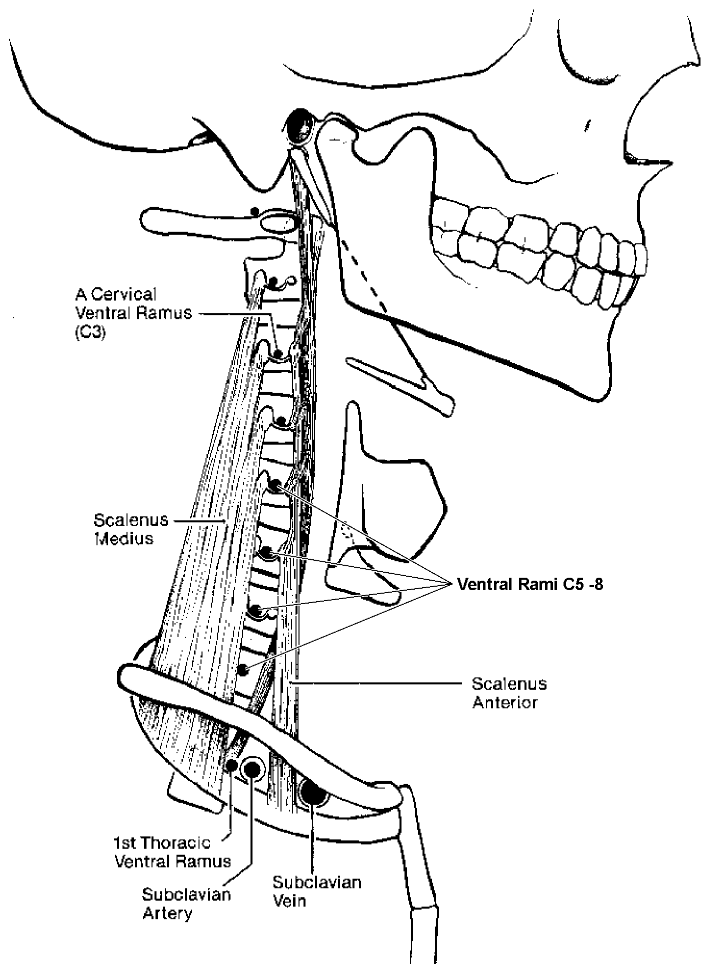

Figure 9-3. Lateral view of the scalene muscles and the relationships of the subclavian vessels to the 1st rib.

Arising from the posterior tubercles of all the cervical vertebrae (although sometimes the highest or lowest are skipped) is the **scalenus medius** (Fig. 9-3, see Fig. 9-10). 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** (not figured). 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.

The scalenus anterior and scalenus medius may be homologized to innermost and internal intercostals, respectively.[33] The ventral rami of the lower cervical nerves pass outward between the scalenus anterior and medius (Fig. 9-3, see Fig. 9-10). 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 scalenes are innervated by small branches of the nerves that pass between the innermost and internal layers, i.e., the cervical ventral rami.

The scalene muscles laterally flex the neck. The scalenus anterior is known to be active upon inspiratory efforts, even during quiet breathing. The scalenus medius is used in forced inspiration.

Arteries and Veins Seen the Posterior Triangle

The subclavian artery is arbitrarily divided into a part medial to scalenus anterior - part 1, a part posterior to scalenus anterior - part 2, and a part lateral to scalenus anterior - part 3. Only part 3 lies in the posterior triangle of the neck. However, two arteries - the transverse cervical and suprascapular - derived from a branch of part 1 also pass through this triangle.

Arising from the inferior (concave) surface of part 1 of the subclavian artery is the internal (mammary) artery, whose course in the chest was discussed in Chapter 4 (p. 70). From the superior (convex) surface of part 1 of the subclavian artery, directly opposite to site of origin of the internal thoracic artery, comes the **thyrocervical trunk**. **The thyrocervical trunk gives rise to the transverse cervical and suprascapular arteries,** both of which pass laterally onto the anterior surface of the scalenus anterior, cross in front of the phrenic nerve (which is running vertically on the anterior surface of this muscle), and enter the posterior triangle. The transverse cervical artery is the more superior of the two.

Further Course of the Transverse Cervical Artery

At the lateral edge of the scalenus anterior the transverse cervical artery turns posterolaterally and passes above the brachial plexus to reach the lateral surface of scalenus medius. It runs past this muscle toward the anterior edge of levator scapulae, where the artery 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 (see p. 319). Upon reaching the deep surface of trapezius, the superficial cervical artery bifurcates, sending one twig upward and another downward, supplying the overlying trapezius and other nearby muscles.

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[33] 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.

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 transverse cervical artery has no deep branch. Instead, coming off the third part of the subclavian artery (i.e., that part lateral to scalenus anterior) is a vessel that passes posteriorly between the nerves forming the brachial plexus to reach the anterior border of levator scapulae and then do precisely what I have described above as the dorsal scapular artery. When this independently arising dorsal scapular artery exists, it is technically correct to call the transverse cervical branch of the costocervical trunk by the name superficial cervical artery.

The transverse cervical artery is accompanied by a transverse cervical vein that terminates in the external jugular vein.

Further Course of the Suprascapular Artery

This is the more inferior of the two arteries that cross 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 11 (p. 427). 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.

The suprascapular artery is accompanied by a suprascapular vein that terminates in the external jugular vein.

ANTERIOR TRIANGLE OF THE NECK (Fig. 9-4)

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 simply 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.

All of the lower part of the anterior triangle , and much of its upper part, is covered by the subcutaneous platysma muscle. The more deeply lying roof of the anterior triangle is composed of external cervical fascia extending between the two sternocleidomastoids. Its floor consists of the vertebral column and the muscles that on its anterior surface - prevertebral muscles with their covering fascia.

Among the numerous contents of the anterior triangle are the superior belly of the omohyoid and the digastric muscle (Fig. 9-5). These structures are used to further subdivide the anterior triangle into lesser triangles

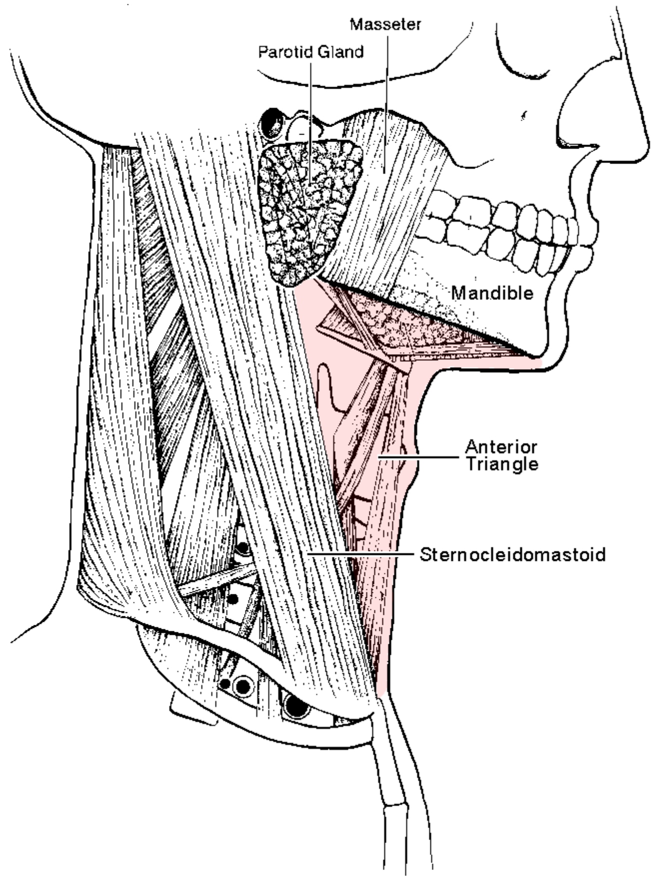

Figure 9-4. Shaded in pink is the anterior triangle of the neck, bounded by the anterior border of the sternocleidomastoid, the lower border of the mandible, and the anterior midline of the neck.

Digastric (Submandibular) Triangle

A digastric triangle (Fig. 9-5) 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 (see Fig. 9-15). 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 (Fig. 9-5) 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.

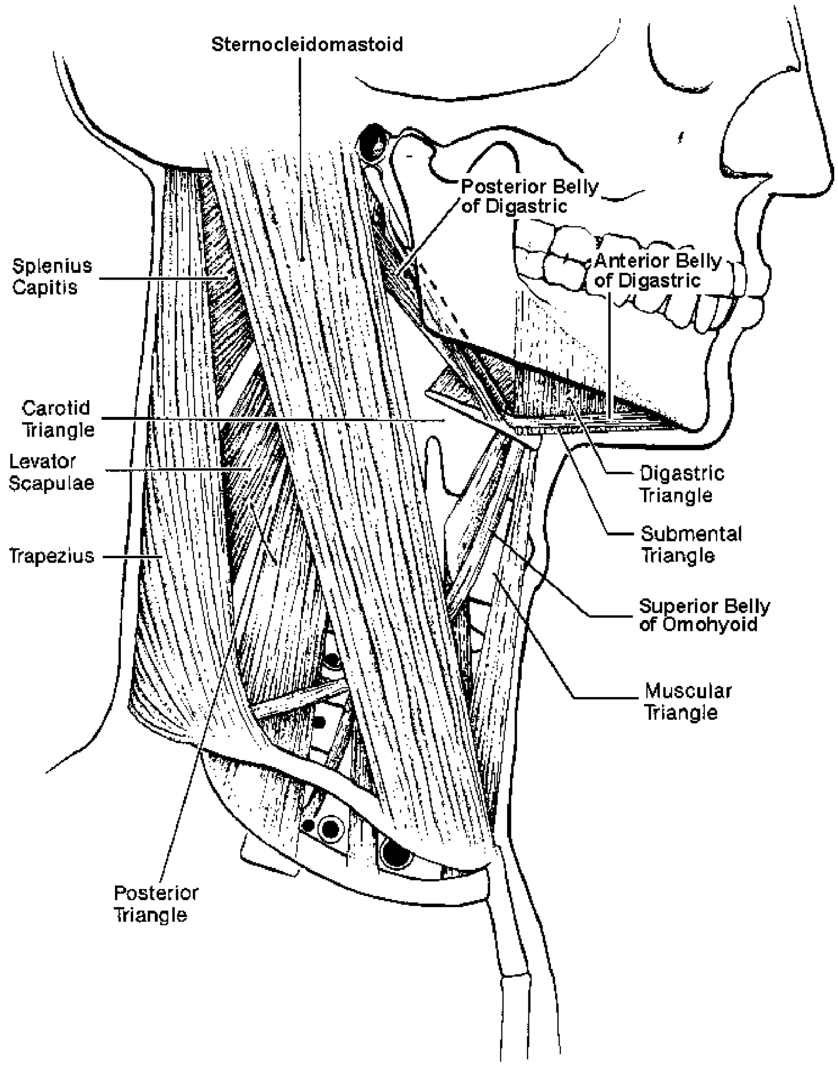

Figure 9-5 . The divisions of the anterior triangle of the neck.

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 (Fig. 9-5). 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 (Fig. 9-5), 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.

Skeletal Components of the Anterior Triangle

There are two bones (styloid process of the temporal bone, hyoid) and several cartilages (thyroid, cricoid, cuneiform, corniculate) that are found in the anterior triangle of the neck and may be viewed either as part of the body wall or as representing a visceral skeleton to which body wall skeletal muscles have gained attachment. The resolution of this conundrum is of no particular consequence.

The Hyoid Bone and the Styloid Process of the Skull

The **hyoid** is a U-shaped bone (Fig. 9-6) that sits in the neck immediately inferior to the posterior half of the mandibular corpus (Fig. 9-7). 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.

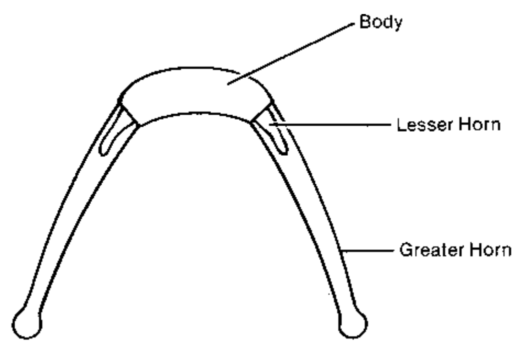

Figure 9-6. Superior view of the hyoid bone (schematic). Anterior is at the *top* of the figure, posterior at the *bottom*.

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. 8-8, p. 241). The styloid process is 2 to 3 cm in length and ends deep to the back edge of the mandibular ramus at its midpoint (Fig. 9-7).

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. 9-7). 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 (Figs. 9-7, 9-8)

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 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.

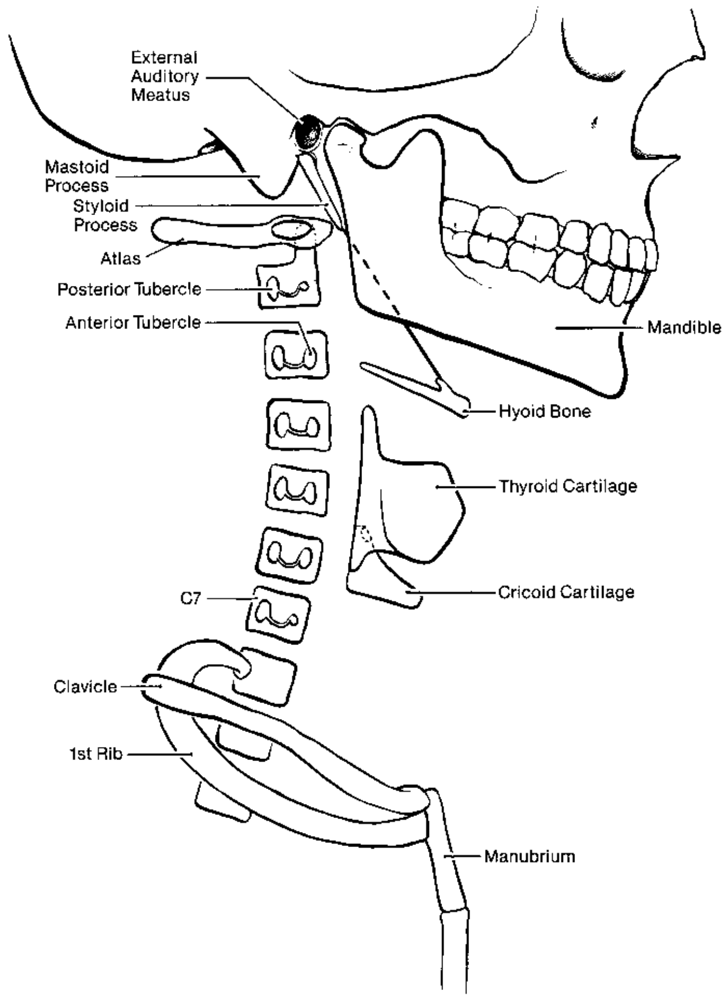

Figure 9-7. Lateral view of the skeletal framework of the neck. The *dashed ellipse* on the superior rim of the cricoid cartilage represents the facet for articulation with the arytenoid cartilage (not figured).

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.

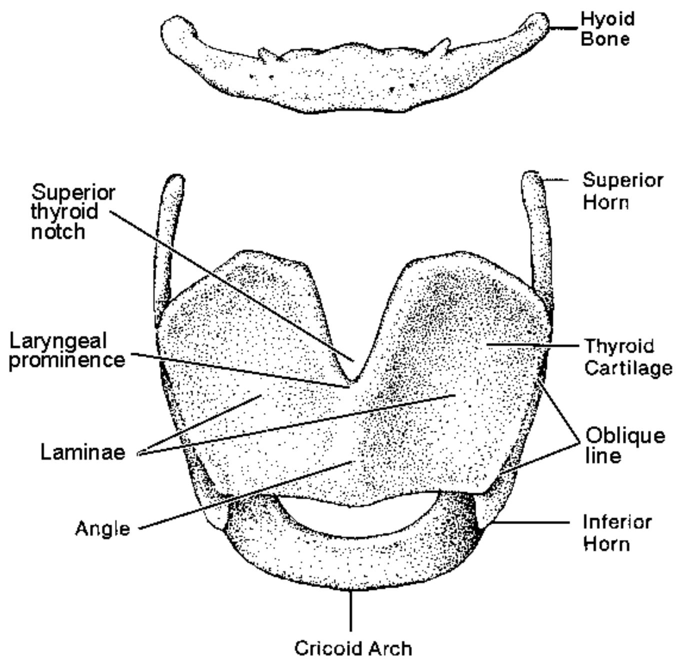

Figure 9-8. Anterior view of hyoid bone, thyroid cartilage, and cricoid cartilage.

Cricoid Cartilage (Figs. 9-7, 9-8)

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).

Skeletal Muscles of the Anterior Triangle

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 **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. 9-9). 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. 9-9). 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 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.

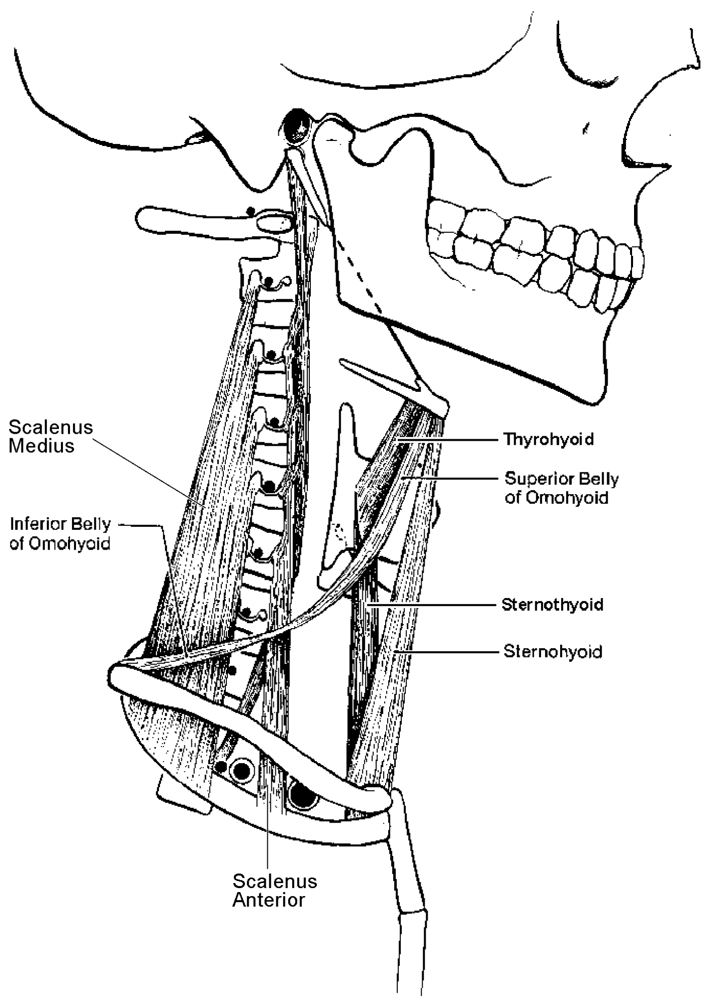

Figure 9-9. Lateral view of the superficial layer of the infrahyoid muscles. The scapular attachment of the inferior belly of omohyoid is not shown.

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 (Fig. 9-9). 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 (Fig. 9-9).

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. 9-10)

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.

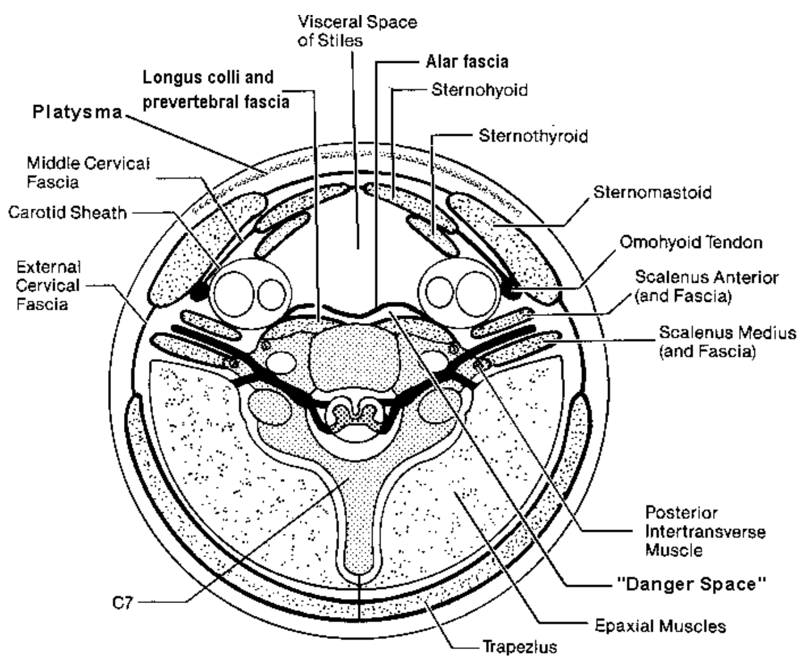

Figure 9-10. Transverse section through the neck (schematic) at the level of the 7th cervical vertebra. The contents of the visceral space and the major longitudinally running nerves have been left out.

Anterior Jugular and Communicating Veins (Fig. 9-2)

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 OF THE SUPERFICIAL NECK

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.

THE "CERVICAL CAVITY" (see Fig. 9-10)

The space between the middle cervical fascia and the muscles lying on the anterior surface of the cervical vertebrae (prevertebral muscles, see Chapter 10, p. 344) 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 (larynx, pharynx, trachea, esophagus, and two endocrine glands--the thyroid and parathyroid). This central region is called the visceral space of Stiles. The great vessels are themselves enveloped by a fascial tube called the **carotid sheath**. Adherence between the carotid sheath and fascia of neighboring muscles tends to seal off the visceral portion of the cervical cavity.

TRACHEA (Figs. 9-11, 9-12)

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

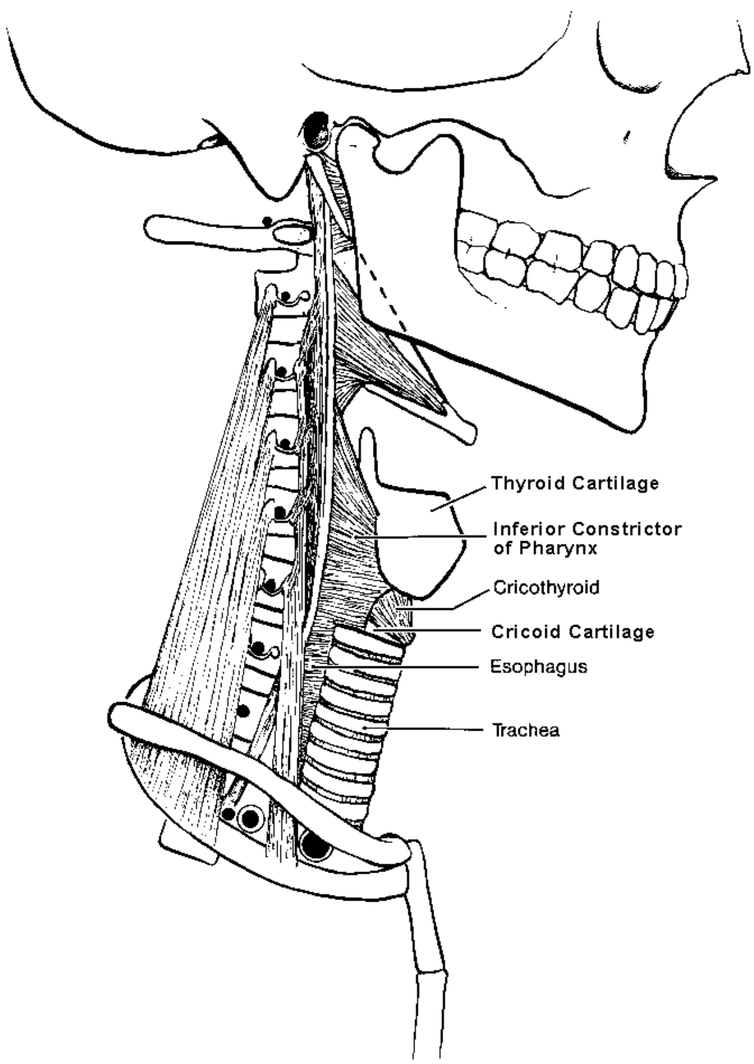

Figure 9-11. Lateral view of the trachea and esophagus.

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.

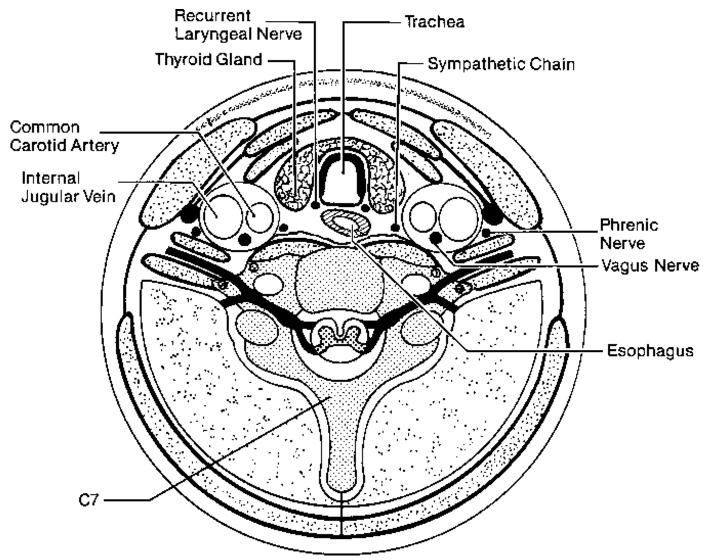

Figure 9-12. Transverse section of the neck at level of the 7th cervical vertebra, as in Figure 9-9, but with the contents of the visceral space and major longitudinally running nerves included.

ESOPHAGUS (Figs. 9-11, 9-12)

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 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. 9-12; 9-13)

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.

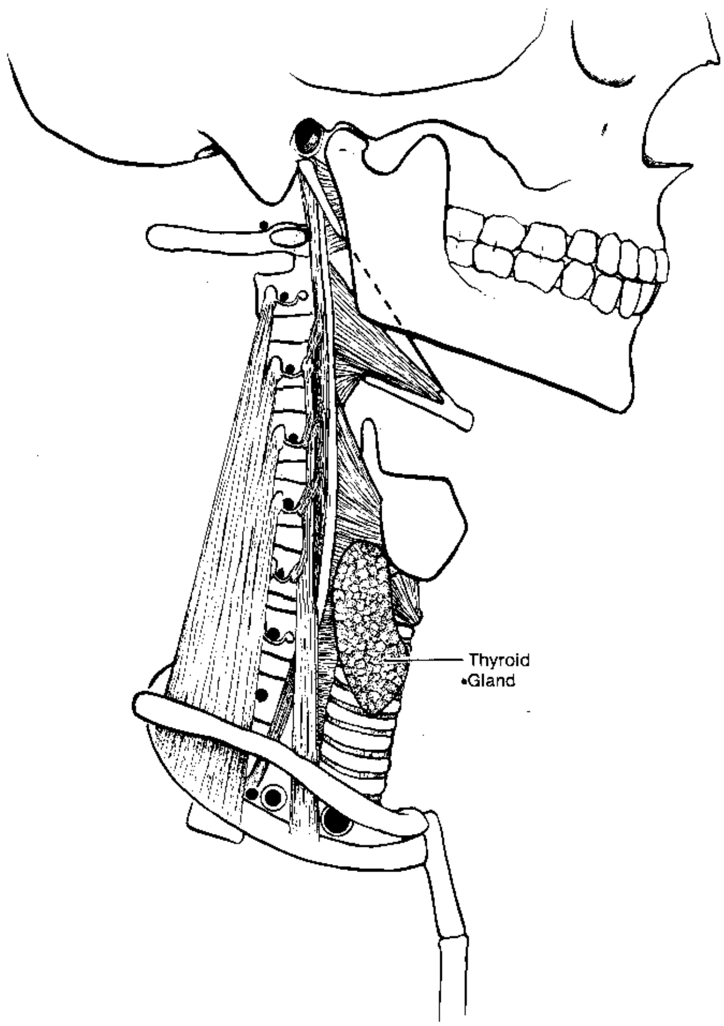

Figure 9-13. Lateral view of the thyroid gland in relation to the trachea, larynx, and pharynx.

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 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 7). 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**.

CAROTID ARTERIES (Figs. 9-14, 9-15)

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 from the pharynx by the lobe of the thyroid (also see Fig. 9-12). 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.

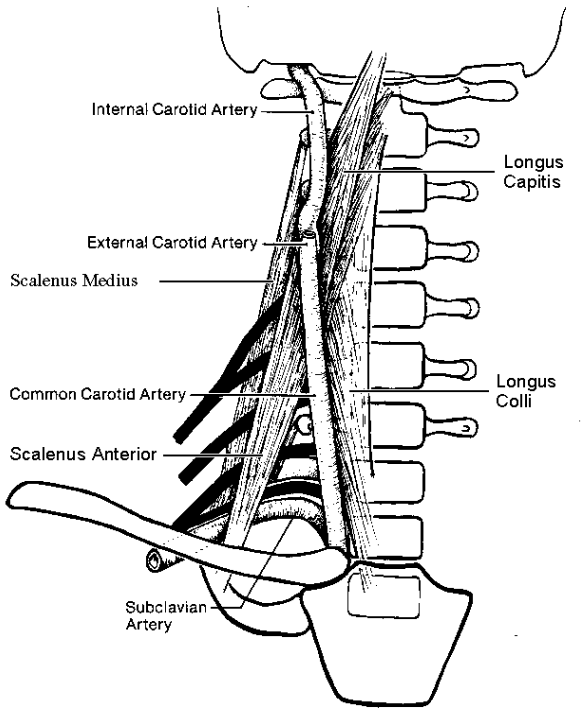

Figure 9-14. Anterior view of the carotid arteries in relation to the deep musculoskeletal structures of the neck. The longus colli and longus capitis are prevertebral mm..

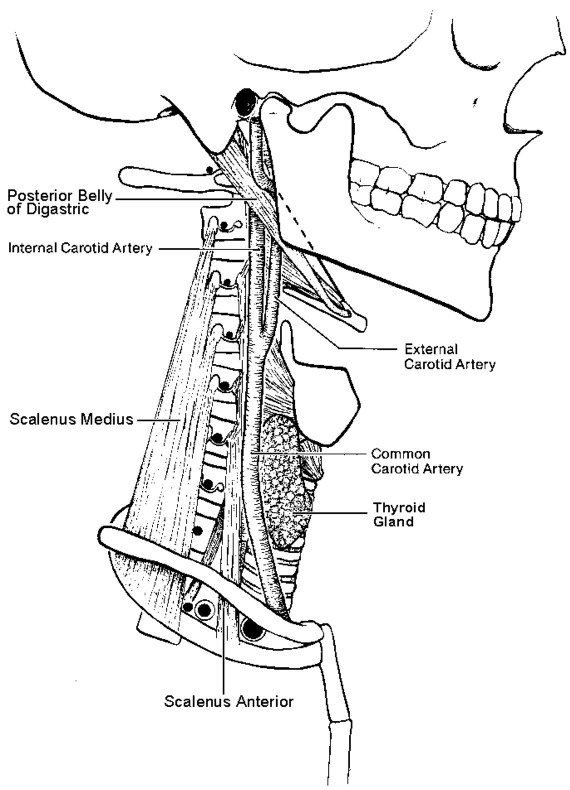

Figure 9-15. Lateral view of the carotid arteries in relation to the deep structures of the neck. The stylohyoid, normally visible in this view, has been excluded from the drawing but can be seen in Figure 10-???

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 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 muscle (see p. 314). 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.

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.

Some Branches of the External Carotid Artery

The branches of the external carotid artery, with the exception of its terminal branches - the superficial temporal and maxillary arteries - are seen in a dissection of the anterior triangle.

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. It course in the face was described in Chapter 8 (p. 234). The pulse of the facial artery y 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.

DEEP VEINS OF THE NECK

Internal Jugular Vein (see Figs. 9-16, 9-17)

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.

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 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.

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 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** (see Fig. 9-2), which pierces the carotid sheath to empty into the internal jugular. The posterior auricular vein (see Fig. 9-2) joins the posterior fork of the retromandibular vein to form the external jugular vein. 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.

NERVES SEEN IN THE ANTERIOR TRIANGLE

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. 9-16). 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. 9-16) 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. 9-16). It may occur higher, especially if the descendens cervicalis passes between vein and artery rather than lateral to the vein.

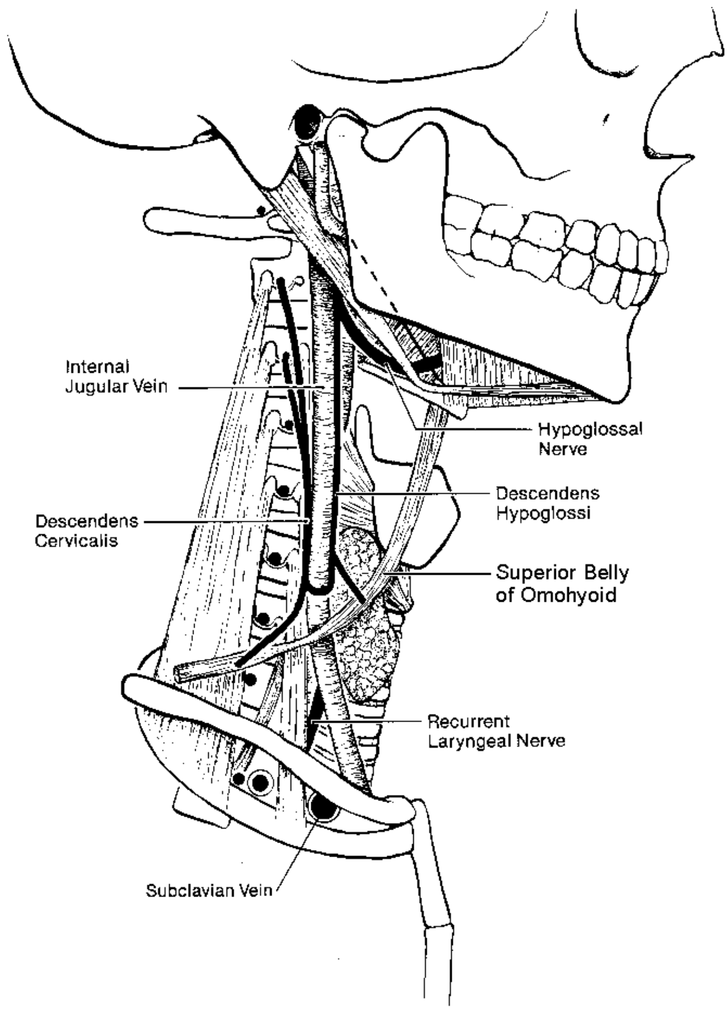

Figure 9-16. Lateral view of the internal jugular vein, hypoglossal nerve, ansa cervicalis, and recurrent laryngeal nerve in relation to the deep structures of the neck. The stylohyoid, normally visible in this view, has been excluded from the drawing but can be seen in Figure   As drawn, the diameters of the nerves do not reflect their true sizes.

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.

Phrenic Nerve

If one From C3 and C4 also come branches that join to form the phrenic nerve, which innervates the diaphragm. This nerve descends on the anterior surface of the scalenus anterior just lateral to the internal jugular vein, outside the carotid sheath (see Figs. 9-12, 9-17). 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 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.

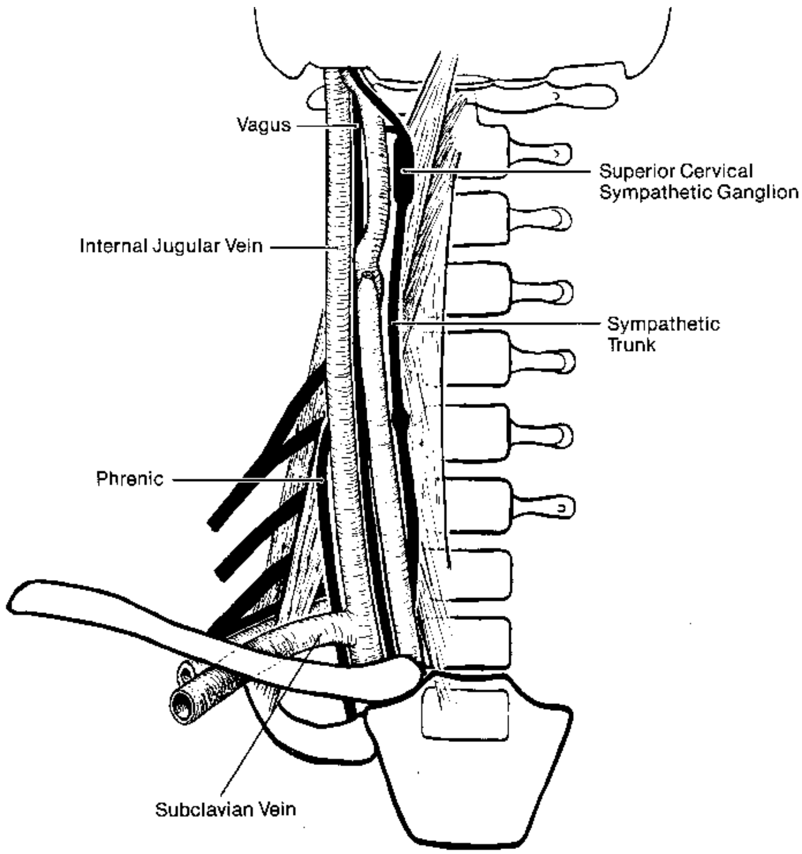

Figure 9-17. Anterior view of the internal jugular vein, phrenic nerve, vagus nerve, and sympathetic trunk in relation to the carotid arteries and deep musculoskeletal structures of the neck. As drawn, the diameters of the nerves do not reflect their true sizes.

Vagus Nerve (C.N. 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. 9-12, 9-17). 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. 9-17).

Branches Seen in the Anterior Triangle

Internal and External Laryngeal Nerves. When you dissect structures at the base of the skull you will see that immediately after the vagus exits the jugular foramen it gives off the superior laryngeal nerve, which in turn 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 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 part 1 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. 9-12, 9-16). 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. 9-16) and separated from the artery by the thyroid gland above its isthmus (see Fig. 9-12).

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 (see Chapter 10, pp. 375-376).

Vagal Cardiac Branches. A few slender branches destined for the cardiac plexus arise as the vagus runs in the carotid sheath. These usually join sympathetic cardiac nerves.

Hypoglossal Nerve (C.N. XII) in The Anterior Triangle

The hypoglossal nerve enters the anterior triangle of the neck from under cover of the posterior belly of the digastric muscle (see Fig. 9-16). 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. 9-16). 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. 9-16).. While on the surface of the hyoglossus, the hypoglossal nerve at first passes deep to the intermediate tendon of the digastric (with its stylohyoid muscle investment) to enter the digastric triangle. Thus, the hyoglossus muscle separates the hypoglossal nerve from the more deeply placed lingual artery. Very shortly thereafter, the nerve encounters the posterior edge of the mylohyoid and passes deep to it, now sandwiched between hyoglossus and mylohyoid. The nerve is now in the tongue (see Chapter 10, p. 370)

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 was discussed above (p. 308).

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, a branch is given to geniohyoid (see Chapter 10, p. 366). All the remaining branches of the hypoglossal nerve are destined for muscles of the tongue (Chapter 10, pp. 366-367).

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. 9-12, 9-17).

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. 9-17). 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 autonomic cardiac nerves**.

Sympathetic Innervation of the Head

The preganglionic sympathetic neurons concerned with the head and neck lie in the upper three or four thoracic segments of the spinal cord, with T1 being particularly important. As we know, at each relevant level, the preganglionic axons leave via the ventral root, enter the spinal nerve, pass into its ventral ramus, and proceed to the nearest paravertebral ganglion via a white ramus communicans. Upon reaching the nearest ganglion, the axons turn cranially and travel upward in the sympathetic trunk, passing through any ganglia along the way, until they reach the superior cervical ganglion, where they synapse. From this ganglion, postganglionic axons accompany both the internal and external carotid arteries.

The postganglionic sympathetic axons running with the external carotid artery and its branches form an **external carotid nerve plexus** that innervates the vascular smooth muscle and nearby sweat glands.

Accompanying the internal carotid artery are one to three nerve bundles that are called **internal carotid nerves**. They exchange some fibers forming a minimal **internal carotid plexus**, not tightly bound to the vessel. Along the way, fibers to the smooth muscle of the internal carotid artery are given off, as are the **caroticotympanic** and **deep petrosal nerves**. Within the cavernous sinus, all grossly visible fibers of the plexus join the abducens nerve, but almost immediately leave it to join V_1. They are distributed with the branches of V_1. Among their functions are innervation of the vasculature of the orbit, the dilator pupillae, Müller's muscle, and the vasculature and sweat glands of the forehead supplied by the frontal nerve. However, it is certainly possible that some of these tasks are controlled by internal carotid plexus sympathetic axons that join other orbital nerves passing through the cavernous sinus.

CLINICAL CONSIDERATIONS

Interruption of the sympathetic pathway to the head leads to a set of four symptoms known as Horner's syndrome: (1) constriction of the pupil (**miosis**), (2) slight drooping (**ptosis**) of the upper eyelid, (3) loss of cutaneous vasodilatation in response to thermal or emotional stimuli, and (4) anhydrosis (loss of sweating) in response to a thermal stimulus. These symptoms occur on the same side as the sympathetic pathway damage. All four components of Horner's syndrome occur if the sympathetic trunk or superior cervical ganglion is damaged. If only the sympathetic input from the T1 spinal segment is interrupted, the two ocular symptoms occur but vascular responses and sweating, both controlled by T2, are normal. The ptosis of a Horner's syndrome can be easily distinguished from that due to oculomotor nerve injury simply by asking the patient to direct the gaze upward. This movement will elicit elevation of the upper lid by the striated fibers of levator palpebrae superioris no matter what the state of the innervation to its smooth muscle.

No disease states have been described that involve only the external carotid plexus, but there are some pathological conditions affecting the internal carotid artery within the petrous canal that either compress the internal carotid plexus or interfere with the blood supply to these nerves. Specific injury to the internal carotid plexus leads to a miosis and ptosis, but any loss of sweating is confined to the part of the forehead supplied by the frontal nerve.

Submandibular Region

Digastric and Stylohyoid Muscles (Figs. 9-18, see Fig. 10 -13)

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. 8-8). 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. 10-13, p. 367). It has the same embryonic source as the posterior belly of digastric and, consequently, is innervated by the same nerve.

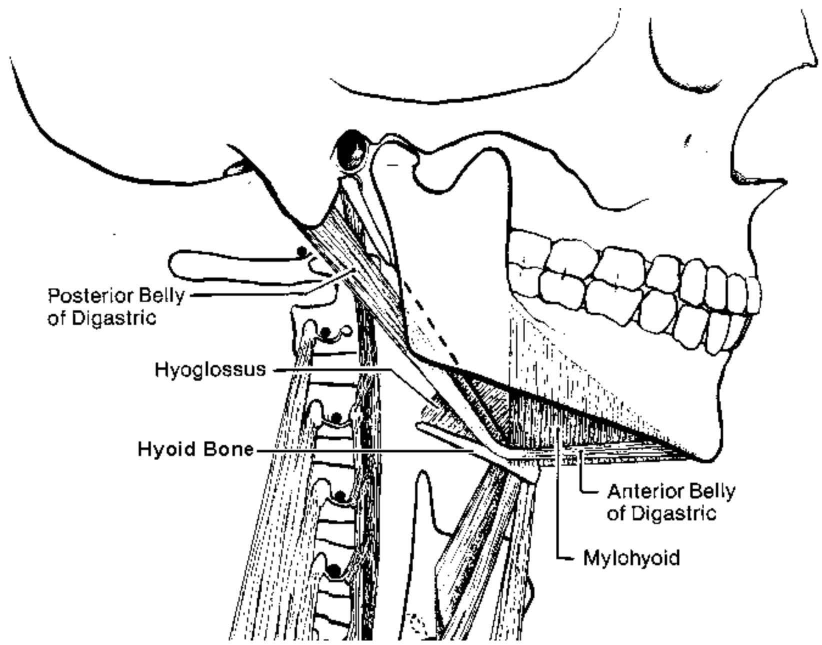

Figure 9-18. Lateral view of the digastric muscle, mylohyoid, and hyoglossus. The stylohyoid, normally visible in this view, has been excluded from the drawing but can be seen in Figure

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

Mylohyoid Muscle (see Fig. 9-18)

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 contractile hammock stretching from one side of the mandible to the other. In this capacity, the mylohyoid contracts during swallowing so that the intrinsic muscles of the tongue will cause this organ to swell upward against the palate and not downward into the neck. Although the mylohyoid is usually classified with other muscles innervated by V_3 as a “muscle of mastication”, it quite unable to move the jaw itself. It is conceivable that the most posterior fibers of the mylohyoid, i.e., those that run between mandible and the hyoid bone directly, could have some action on the mandible, but this is very unlikely to be important in moving the jaw. Any role the mylohyoid plays in chewing is probably limited to its ability to assist the tongue in positioning food between upper and lower teeth.

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.

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.

Hyoglossus Muscle

The hyoglossus (see Figs. 9-18) is an extrinsic tongue muscle, part of which is found in the digastric triangle of the neck. It has 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 (Fig. 9-18).

Since the hypoglossal nerve innervates all tongue muscles, it obviously innervates the hyoglossus.

Submandibular Salivary Gland (Fig. 9- 19)

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 (see Fig. 9-18). 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.

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.

SUBCLAVIAN ARTERY IN THE NECK

Not only do the common carotid arteries enter the neck from the thorax, so do the subclavian arteries. The right subclavian is one of the terminal branches of the brachiocephalic artery, arising from the back surface of this vessel deep to the sternothyroid and sternohyoid muscles at the medial end of the right sternoclavicular joint. The subclavian artery is a separate branch of the aortic arch. It approaches the medial end of the left sternoclavicular joint, here lying behind the left common carotid, which in turn is deep to the sternothyroid and sternohyoid muscles.

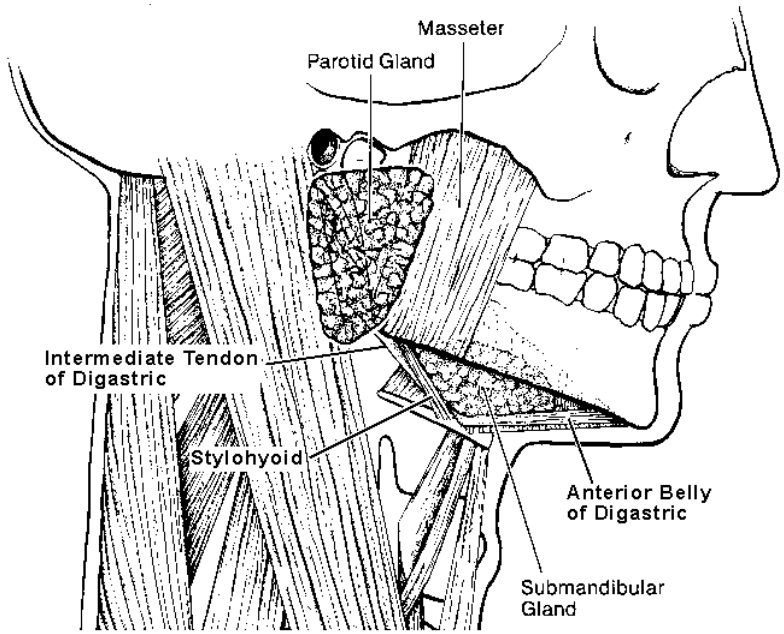

Figure 9-19. Position of the submandibular gland in relation to the musculoskeletal structures of the neck.

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 (Fig. 9-20, see Fig. 9-3). 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.

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.

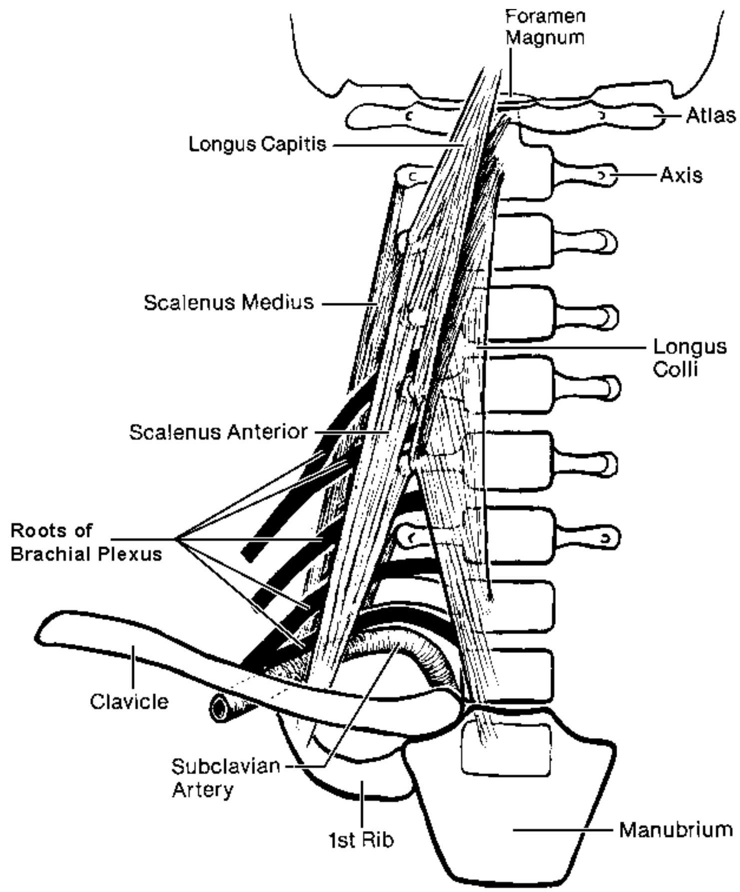

Figure 9-20. Anterior view of the subclavian artery passing laterally onto the first rib between the scalenus anterior and scalenus medius muscles.

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. 9-12), 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 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 (Internal Mammary) 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 (p. 70).

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. The latter two were described on pp. 290-291 above.

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. See pp. 290-291, above.

Suprascapular Artery. See page 291, above.

SUBCLAVIAN VEIN

The subclavian artery is accompanied by a subclavian vein. 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 (see Figs. 9-17, 9-3). 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 p. 286, above), which empties into the subclavian just before that vein's junction with the internal jugular.

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.

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.

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).

RETROMANDIBULAR REGION (Fig. 9-21)

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.

Parotid Salivary Gland (see Fig. 9-19)

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 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.

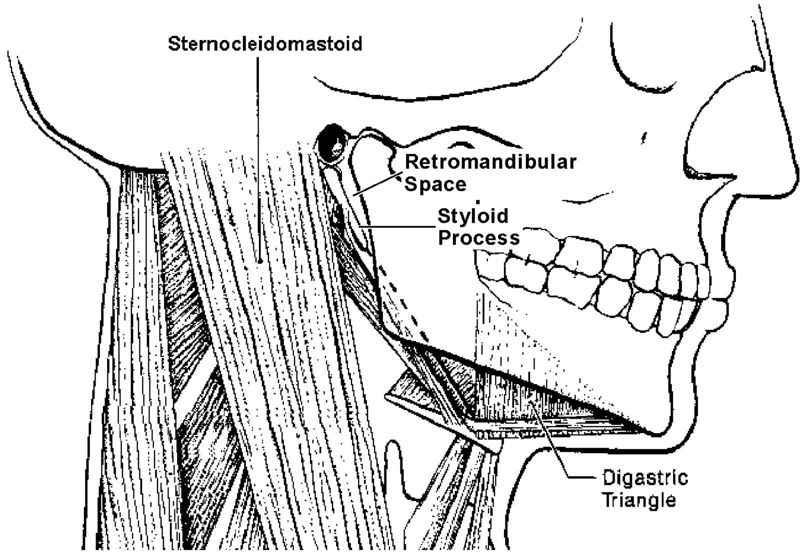

Figure 9-21. Location of the retromandibular region and the styloid process in its floor.

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 10.

Retromandibular Vein (see Fig. 9-2)

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 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.

Facial Nerve (C.N. VII) in the Neck (see Fig. 9-2)

Course

The facial nerve exits the skull through a hole immediately posterior to the root of the styloid process (see Fig. 8-8). This hole is called the **stylomastoid foramen**. Upon exiting the skull through the stylomastoid foramen, the facial nerve enters the retromandibular region of the neck. 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, which turn forward, pass lateral to the retromandibular vein, and thereby reach the part of the parotid lying in the face (see Fig. 9-2). Here, within the gland, the two divisions join again to form the "ansa facialis."

From the ansa arise most of the branches that distribute to the muscles of facial expression. These were described in the Chapter 8 (p. 235).

Branches in the Neck

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**.

LYMPHATIC STRUCTURES IN THE NECK

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 (thus, partly in the face), 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 OF THE NECK

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. 9-2). 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. 9-22). Above the carotid bifurcation, the external carotid artery lies immediately in front of the anterior edge of sternocleidomastoid (see Fig. 9-22), whereas the internal carotid artery and internal jugular vein stay deep to the muscle until the angle of the mandible.

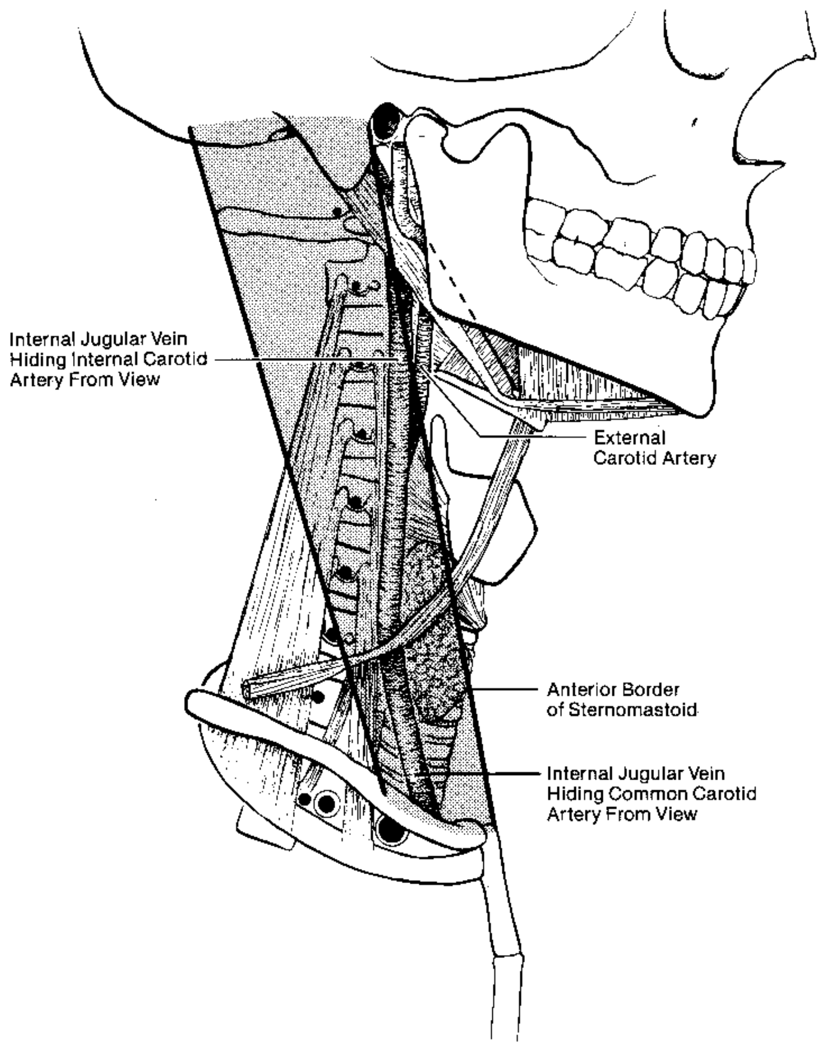

Figure 9-22. Lateral view of the neck illustrating the relationship of the internal jugular vein and carotid arteries to the more superficially placed sterno(cleido)mastoid muscle.

The midpoint of the posterior edge of the sternocleidomastoid is an important landmark for certain nerves (see Fig.9-2). 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. 9-7)

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.

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.

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. 9-22).

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. 9-11, 9-13)

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**[34] here. Such a procedure is called a superior tracheotomy. More commonly, for longstanding **tracheostomy**[35] 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.

[34] 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.

[35] 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.

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. 9-15, 9-17)

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.

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. 9-20)

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. 9-12, 9-17)

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.