43

Anterior Triangle of the Neck

Clinical Case 43.1

Patient Eleanor E. This elderly female nursing home resident aspirated some foreign substance (food) into the larynx. It induced a laryngospasm of the vocal cords. In a state of collapse she is rushed into the Emergency Department. The physician is unable to remove the aspirated debris and, with your help, immediately performs an emergency tracheostomy which re-establishes the airway. The tracheostomy is done through the upper tracheal rings superior to the isthmus of the thyroid gland.

Anterior Triangle and Median Line of the Neck

SUBDIVISIONS (*fig. 43.1*)

The anterior triangle of the neck is bounded by three borders: (a) median line of the neck from the chin to the manubrium; (b) the anterior margin of the sternomastoid muscle; and (c) the horizontal plane formed by the lower margin of the mandible. The anterior triangle is subdivided into three smaller triangles: **submandibular (digastric) triangle, carotid triangle**, and **muscular triangle**. The submandibular or digastric triangle is bounded by the posterior and anterior bellies of the digastric muscle and the inferior border of the mandible (*see fig. 43.8*). The carotid triangle is bounded by the posterior belly of the digastric, the superior belly of the omohyoid and the sternomastoid muscles. The muscular triangle overlies the strap muscles of the neck and is bounded by the superior belly of the omohyoid, the lower anterior margin of the sternomastoid, and the median line of the neck.

A **submental triangle** (*see fig. 43.8*) is formed by the anterior bellies of the right and left digastric muscles and a base above the hyoid bone. *Figure 43.1* also shows a parotid space beyond the superior margin of the anterior triangle in the area above the posterior belly of the digastric and posterior to the ramus of the mandible.

LANDMARKS (*figs. 43.2 and 43.3*)

The tips of the **transverse processes of the atlas (C1)** project more laterally than the transverse processes of the other higher cervical vertebrae. They can be palpated in the parotid space between the angle of the mandible and the mastoid process (*fig. 43.2*).

The **hyoid bone** can be felt in its subcutaneous relationship in the midline of the neck between the inferior border of the mandible and the upper border of the thyroid cartilage. The body of the hyoid bone is at the level of the 3rd cervical vertebra (C3) (*fig. 43.3*). It has a lesser and greater horn (cornu) that project posteriorly. The greater horns are palpable in the lateral aspect of the neck.

The **thyroid cartilage** is palpable in the midline of the neck at the levels of C4 and C5. The **laryngeal prominence** (Adam's Apple) is visible and most prominent in men. The vocal cords of the larynx attach anteriorly on the thyroid cartilage near the lower border of the laryngeal prominence. The thyroid cartilage possesses two lateral laminae that have superior and inferior horns (cornua). The inferior horns articulate with the cricoid cartilage.

The **cricoid cartilage** is at the level of C6 and its anterior arch can be palpated in the midline. This cartilage marks the upper limit of the trachea in the neck. The trachea and its cartilaginous rings are also palpable in the midline from the cricoid cartilage to the superior border of the manubrium. The lobes of the thyroid gland lie on the lateral aspects of the trachea in the neck (*fig. 43.4*).

Two important membranous structures are associated with the cartilages in the midline of the neck. The **thyrohyoid** membrane is between the thyroid cartilage and the hyoid bone. It is pierced by the **internal laryngeal nerve** and **vessels**. The **cricothyroid membrane** lies between the anterior arch of the cricoid cartilage and the

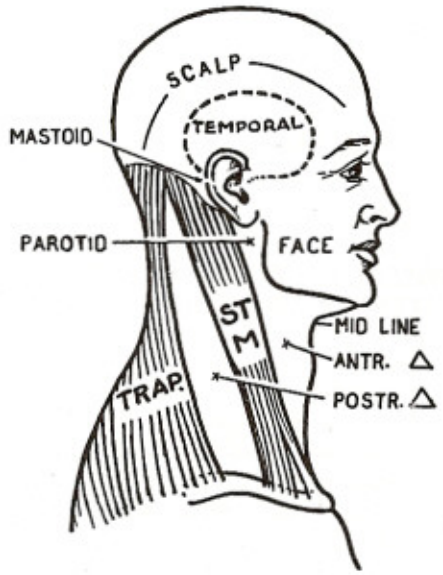

Figure 43.1. Superficial regions of head and neck. *STM*, sternomastoid.

inferior borders of the laminae of the thyroid cartilage. It is just below the level of the vocal cords and may be penetrated to create a **high tracheostomy**. Since this has some possibilities for damaging the vocal cords, the preferred sight for a tracheostomy is below the cricoid cartilage but above the level of the isthmus of the thyroid

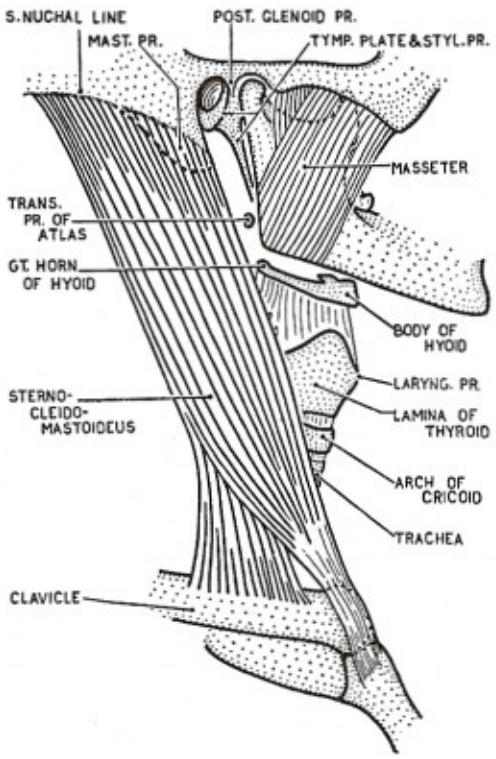

Figure 43.2. The sternomastoid and landmarks.

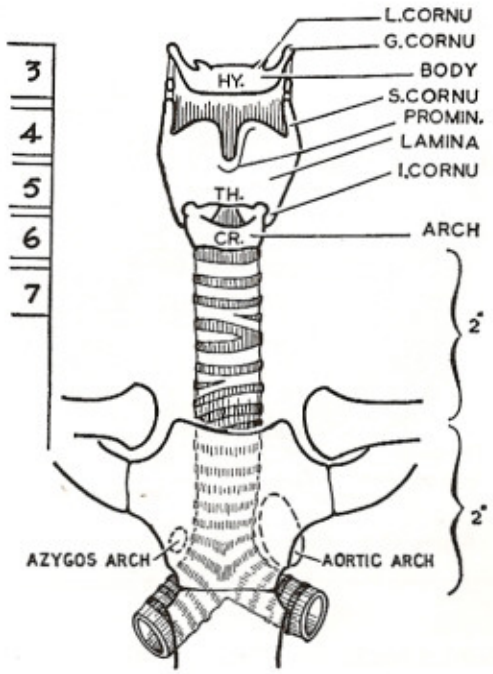

Figure 43.3. Landmarks and vertebral levels. *HY*, hyoid bone; *TH*, thyroid cartilage; *CR*, cricoid cartilage.

gland (2nd–4th tracheal cartilages). At this point, the only tissues penetrated during a tracheostomy are skin, subcutaneous tissue, platysma fibers, investing fascia, the visceral fascia of the trachea, and the tracheal wall (*fig.* 43.4).

SUPERFICIAL STRUCTURES

Platysma

The platysma (Gk = a plate) is a muscle of facial expression that lies in the subcutaneous tissue. It extends from the face, lower lip, and lower margin of the mandible over the neck and clavicle to the skin over the second rib (*fig.* 43.5). It is supplied by the **cervical branch of the facial nerve (VII)**. Its action is to tense the subcutaneous tissue of the neck and assist in depressing the lower lip. Damage to the nerve supply and paralysis of the muscle creates an unpleasant cosmetic effect.

Deep Fascia

The fascia, which encloses the trapezius muscle in the posterior neck, continues anteriorly to form the tough roof of the posterior triangle and then invests the sternomastoid muscle. At the anterior borders of the sternomastoid, this **investing fascia** again forms a single-layer sheet that covers the anterior triangle and fuses with its opposite component in the midline of the neck (*fig.* 43.4).

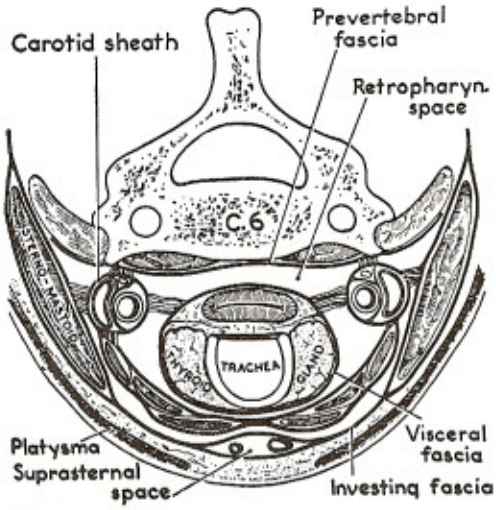

Figure 43.4. Front of neck (on cross-section).

The **investing fascia** also attaches firmly to the bony surfaces that it covers, i.e., the mandible superiorly and the clavicle and manubrium inferiorly.

Superficial Veins (*fig. 43.6*)

Superficial veins lie in the subcutaneous tissue external to and surrounding the investing fascia. **Anterior jugular veins** may be present near the midline. They arise in the submental triangle and descend near the midline to pierce the deep fascia above the manubrium. They usually pass between the posterior aspect of the sternomastoid and the upper border of the clavicle to enter the **external jugular veins** in the posterior triangle. These veins may be damaged in a tracheostomy procedure and cause extensive venous bleeding in the surgical field. Bleeding is easily controlled by pressure above the operative field. These venous channels are quite variant from one patient to another, and many variations in their anatomical distribution are noted.

Figure 43.5. The platysma muscle.

SUPERFICIAL CERVICAL NERVES OF THE ANTERIOR TRIANGLE (*fig. 43.7*)

Sensory nerves from the cervical plexus traverse the fascial planes and the subcutaneous tissues of the anterior triangle to reach the overlying skin. These include **the great auricular nerve** and the **transversus colli nerve** (anterior cutaneous nerve of neck), which supply the C2 and C3 dermatomes. The **cervical branch of VII** is also coursing through the subcutaneous fascia to enter the platysma on its deep surface near the angle of the mandible.

THE INFRAHYOID MUSCLES

These four paired muscles (*fig.* 43.8) are depressors of the larynx and the hyoid bone. Often referred to as "strap muscles," they lie between the layer of investing fascia and **visceral fascia**, which covers the thyroid gland, trachea, and esophagus (*fig.* 43.4). The infrahyoid muscles are innervated by the **ansa cervicalis**, which is a motor plexus formed by ventral rami of C1, 2, and 3. The C1 fibers are derived from fibers carried in the **hypoglossal nerve (XII)** and form the superior root (*fig.* 43.9). The C2 and C3 fibers are from the cervical plexus and form the inferior root. The **ansa** is the loop of fibers that joins the superior and inferior roots and gives off the major branches to the strap muscles. The ansa cervicalis is usually lateral to the internal jugular vein and the carotid sheath.

The **sternohyoid** and **omohyoid** attach adjacent to each other on the inferior aspect of the body of the hyoid bone. The sternohyoid descends to the posterior aspect of the capsule of the sternoclavicular joint and the manubrium. A superior belly of the omohyoid muscle descends on the lateral side of the sternohyoid to the level of the cricoid cartilage and then turns abruptly in a posterior direction deep to the sternomastoid. The omohyoid has an intervening tendon that is bound to the clavicle by a fascial sling (*fig.* 43.8). The inferior belly of omohyoid crosses the posterior triangle of the neck and inserts on the superior margin of the scapula, medial to the suprascapular notch.

The **thyrohyoid muscle** extends upward from the oblique line on the lamina of the thyroid cartilage to the inferior aspect of the body of the hyoid bone. This muscle is overlain by the sternohyoid and omohyoid muscles (*fig.* 43.8). The thyrohyoid has a nerve supply that is directly from XII (*fig.* 43.9) and consists of C1 anterior ramus fibers that were picked up by XII at the base of the skull.

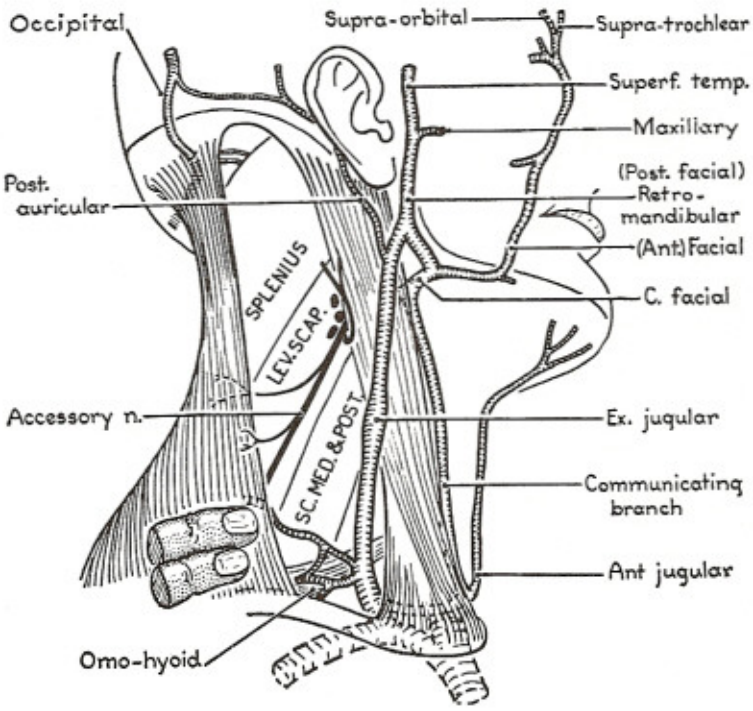

Figure 43.6. The superficial veins of the face and neck.

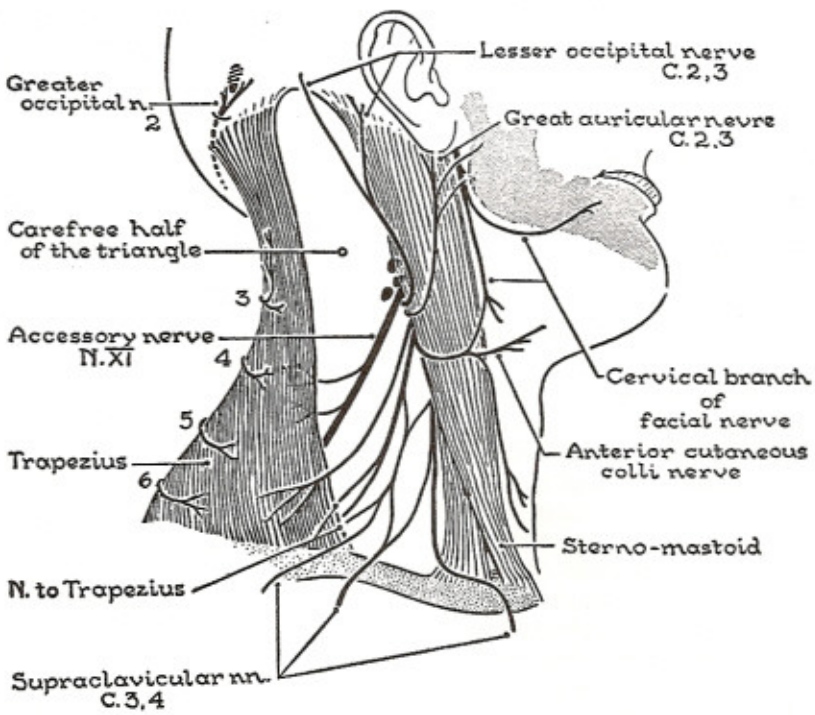

Figure 43.7. The superficial nerves of the neck. Of these, the facial and accessory are motor. (*Nerves of neck: anterior cutaneous = transverse.*)

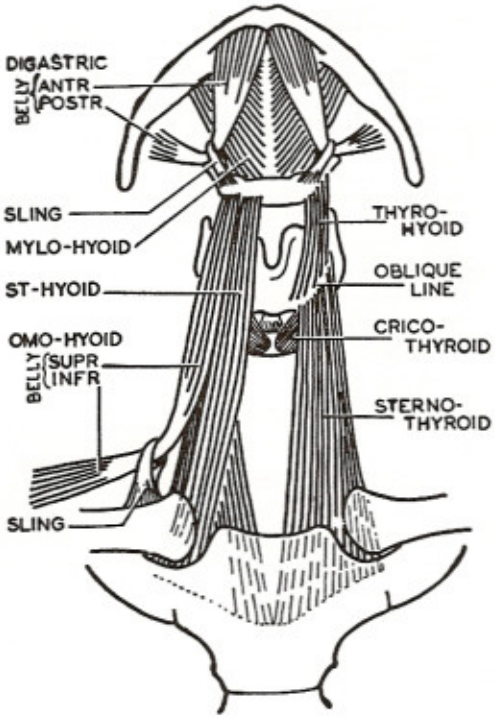

Figure 43.8. Muscles bounding midline of neck.

The **sternothyroid muscle** descends from its attachment on the oblique line of the thyroid cartilage to the posterior aspect of the manubrium. It is deep to the sternohyoid muscle. The sternothyroid receives its innervation from the ansa cervicalis like the overlying sternohyoid and omohyoid muscles (*fig. 43.9*).

Pharynx

The pharynx is a musculofascial derivitive of the embryonic foregut that is suspended from the base of the skull and extends to the level of the 6th cervical vertebra. It lies between the bodies of the vertebrae and the larynx at C4–C6. At the level of the cricoid cartilage (C6), it becomes continuous with the esophagus (*fig. 43.10*).

The lateral and posterior walls of the pharynx are formed mainly from three muscular **constrictors: superior, middle, and inferior**. Each muscle is fan-shaped, and each is fixed anteriorly by a smaller attachment than its posterior insertion. The expanding constrictors pass posteriorly and insert on a midline **raphe** with the same constrictor on the opposite side. The three constrictors are arranged in an "overlapping" fashion so that they appear to be stacked like flower pots from the inferior aspect of the pharynx to the upper extent behind the nasal cavities. The spaces that exist between the constrictors on the lateral surface of the pharynx are "closed" by fascia but also serve as passages for vessels, nerves, and the auditory tube that penetrate the pharyngeal wall.

The **superior constrictor muscle** lies posterior to the nasal and oral cavities. It is continuous with the plane of the **buccinator** muscle of the cheek. Both the superior constrictor and the buccinator arise in part from the **pterygomandibular raphe**. In addition, the superior constrictor also arises from the upper extent of the **mylohyoid line of the mandible** and **medial pterygoid plate** of the sphenoid bone. Since the superior constrictor is a muscle associated with the nasopharynx, it is restricted in its ability to constrict and close the upper airway. Its superior bony attachments are to the **apex of the petrous temporal bone** and the **pharyngeal tubercle of the occipital bone** as well as the medial pterygoid plates.

The **middle constrictor** muscle is posterior to the base of the tongue and the larynx. It plays a major role in deglutition (swallowing) and is a true constrictor. It arises from the hyoid bone at the angle between the **lesser and greater horns** (cornua) and from the inferior aspect of the **stylohyoid ligament** that attaches to the lesser horn. Its

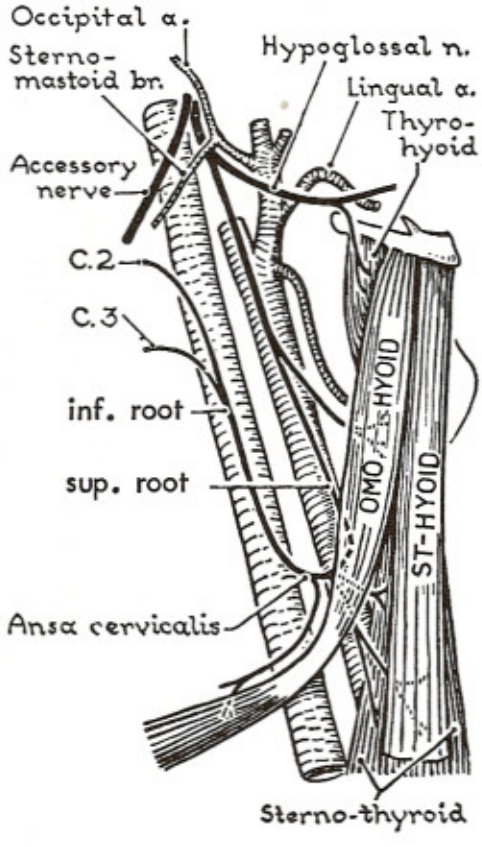

Figure 43.9. Ansa cervicalis: its roots and its branches to infrahyoid muscles.

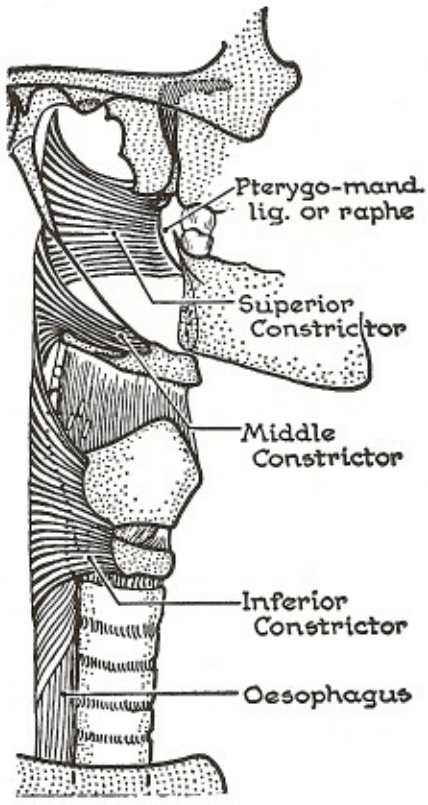

Figure 43.10. The 3 constrictors of the pharynx.

insertion is like the other constrictors into the middle raphe on the posterior aspect of the pharynx.

The **inferior constrictor muscle** arises from the **cricoid** and **thyroid cartilages**. The thyroid part is from the oblique line while the cricoid part is from the fascia overlying the cricothyroid muscle. The very inferior aspect of the inferior constrictor is termed the **cricopharyngeus** muscle and acts as a sphincter between the pharynx and the esophagus. The inferior constrictor and the cricopharyngeus are innervated by the recurrent laryngeal branch of the vagus (X). The superior and middle constrictor muscles are also skeletal muscles and under voluntary control via pharyngeal branches of the vagus nerve (X). The lower muscular fibers of the pharynx, however, are involved in the "swallowing reflex." The "orchestration" of this movement from skeletal muscles of the pharynx and upper esophagus to the smooth muscle of the thoracic esophagus is done by both the somatic (skeletal) motor fibers and the parasympathetic fibers of nerve X.

CAROTID SHEATH

The common and internal carotid arteries, the internal jugular vein, and the vagus nerve extend from the base of the skull to the thoracic cavity. They are all invested in a common loose areolar fascia, the **carotid sheath**. The artery lies deep and medial to the internal jugular vein, and the vagus nerve is posterior to the carotid artery. *Figure 43.4 shows the relationship of the carotid sheath* to the three layers of deep fascia in the neck; **investing, visceral**, and **prevertebral fascia**. The carotid sheath is also anterior to the cervical sympathetic trunk, which lies on the **longus colli** and **longus capitis muscles** in front of the cervical vertebrae.

THYROID GLAND (*figs. 43.11 and 43.12A*)

The thyroid gland is a bilobular gland that lies lateral to the larynx and trachea in the lower neck. The two lobes are connected anteriorly by an **isthmus** of thyroid tissue that crosses the trachea at the level of the 2nd–4th tracheal cartilages. The lobes are overlapped by the sternothyroid muscles and related laterally to the carotid sheaths. The recurrent laryngeal branches of the vagus nerves lie deep to the thyroid lobes near the posterior aspect of the trachea. They are vulnerable to damage during thyroid surgery and can cause respiratory and vocal problems if damaged.

The thyroid gland may also have a **pyramidal lobe** arising from the isthmus and connected to the thyroid cartilage and hyoid bone. This is a reflection of its developmental origin in the region of the tongue and subsequent descent into the lower neck (*fig. 43.12B*). **Four parathyroid glands** are usually associated with the posterior surface of the thyroid gland. These two endocrine glands will share a common blood supply from **superior** and **inferior thyroid arteries**.

Carotid Triangle

The carotid triangle is bounded by the anterior border of the sternomastoid, the superior border of the omohyoid, and the inferior border of the posterior belly of the digastric.

POSTERIOR BELLY OF THE DIGASTRIC (*fig. 43.13*)

The posterior belly of the digastric is a key muscle for relationships in the upper neck. The muscle arises from the **digastric** groove on the medial aspect of the **mastoid process of the temporal bone**. It joins the anterior belly of the digastric by an intermediate tendon that is held down to the **body of the hyoid** by a fascial sling. The posterior and anterior bellies of the digastric area derived from separate branchiomeric (branchial or pharyngeal) arches in the head.

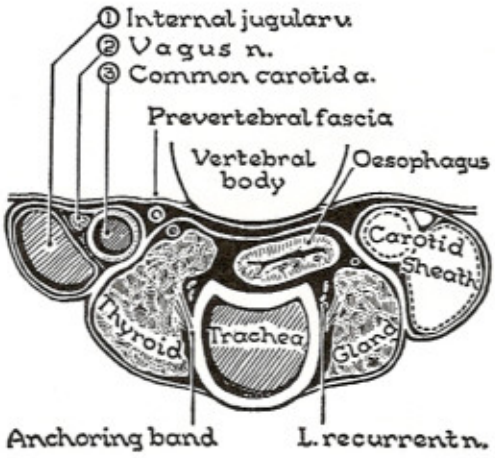

Figure 43.11. The thyroid gland and the carotid sheath (on cross-section).

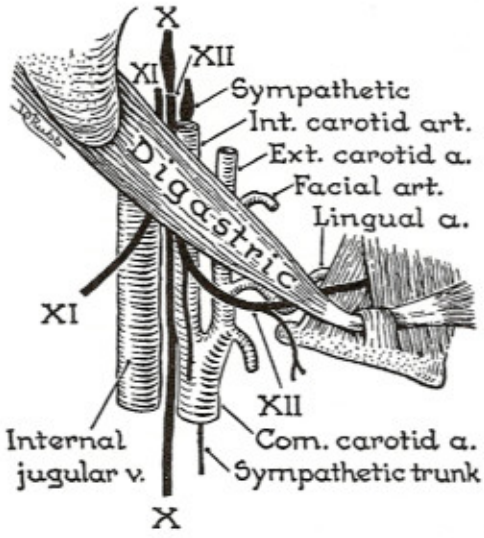

Figure 43.13. Key: posterior belly of digastric.

The posterior belly arises from the hyoid (2nd) arch and is innervated by the VII nerve, while the anterior belly arises from the mandibular (1st) arch and receives its nerve supply from V^3.

The posterior belly is also associated with the **stylohyoid muscle**. The VII nerve exits the stylomastoid canal on the base of the skull between these two muscles and innervates them before entering the substance of the parotid gland which lies superior to the posterior belly of the digastric muscle.

Important Relationships of the Posterior Belly of the Digastric

The parotid and the superficial lobe of the submandibular salivary glands contact the superior and lateral surfaces of the posterior belly of the digastric. Three superficial structures lie between the digastric and the skin of the upper neck. The cutaneous veins of the **external jugular** system, the cutaneous branches of the **great au-**

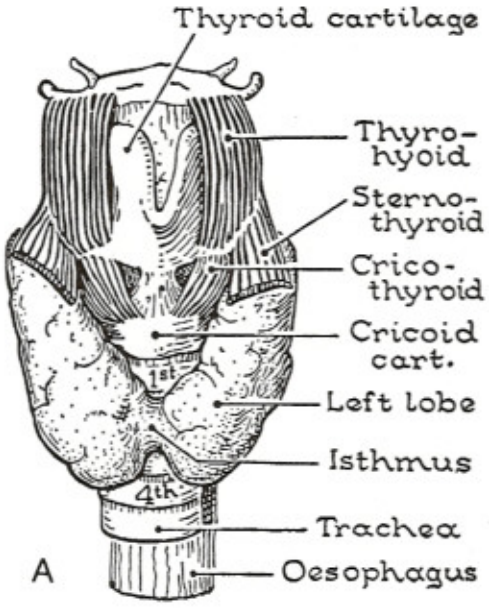

Figure 43.12A. The thyroid gland (front view).

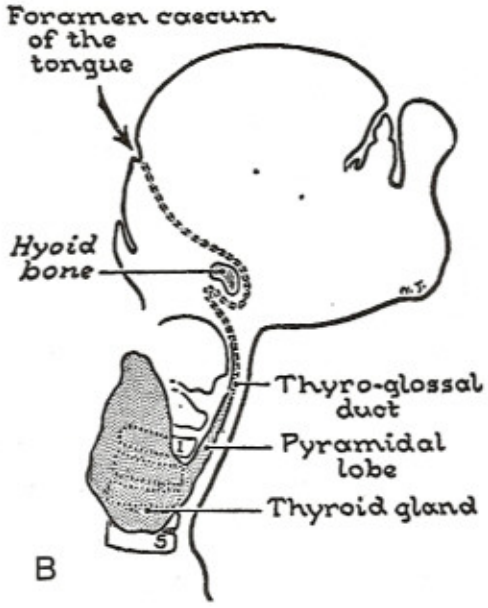

Figure 43.12B. The course of a developing thyroid gland. (From data by J. E. Frazer.)

ricular nerve and the important **cervical branch of the VII** nerve, which innervates the platysma (*figs. 43.6, 43.7*), all lie superficial to the posterior belly of the digastric muscle.

Deep to the posterior belly of the digastric (*fig. 43.13*), one can readily see 3 great vessels (**internal jugular vein, internal carotid artery** and **external carotid artery**) and 3 great cranial nerves (**vagus [X], accessory [XI]** and **hypoglossal [XII]**). In addition, deep to these structures are the **glossopharyngeal nerve (IX)** and the **sympathetic trunk**.

GENERAL DISPOSITION OF THE VESSELS AND NERVES

The internal jugular vein lies lateral and posterior to the internal and external carotid arteries when it descends deep to the posterior belly of the digastric. The jugular fossa lies posterior to the carotid canal in the base of the skull, and there is a gradual shift from this posterior to lateral relationship on the part of the vein as it descends into the lower neck region. The anterior aspect of the sternomastoid muscle overlies the internal jugular vein at the level of the posterior belly of the digastric muscle. The cranial nerves IX, X, XI, and XII descend together from the base of the skull in the carotid sheath to the level of the posterior belly of the digastric (C2). At this level, nerve IX passes medially to enter the pharynx between the superior and middle constrictors. The vagus nerve (X) continues inferiorly on the posterior aspect of the internal carotid artery; XI passes posteriorly to enter the sternomastoid muscle; and XII passes anteriorly, into the digastric triangle musculature above the hyoid bone.

Figures 43.13 and *43.14* depict the important relationships of the nerves to the vessels. Nerve XI lies superficial to the internal jugular vein in about 75% of the cases as it passes posteriorly to the sternomastoid muscle. As noted, X lies posterior to the internal carotid and the common carotid arteries as it descends. The pharyngeal branch of X passes anteriorly between the internal and external carotid arteries, while the superior laryngeal branch is deep to both of these arteries as it passes anteriorly to enter the laryngeal wall. The hypoglossal nerve remains external to both the external and internal carotid arteries as it passes anteriorly into the floor of the mouth to innervate the muscles of the tongue.

NERVES OF THE CAROTID TRIANGLE

Glossopharyngeal nerve IX is deep to the internal carotid artery and penetrates the lateral pharyngeal wall with the **stylopharyngeus muscle**. Nerve IX is motor to stylopharyngeus and sensory to the mucosa of the pharynx, posterior one-third of the tongue, palatine tonsil and part of the soft palate region. It will be described in detail in the chapter on the pharynx.

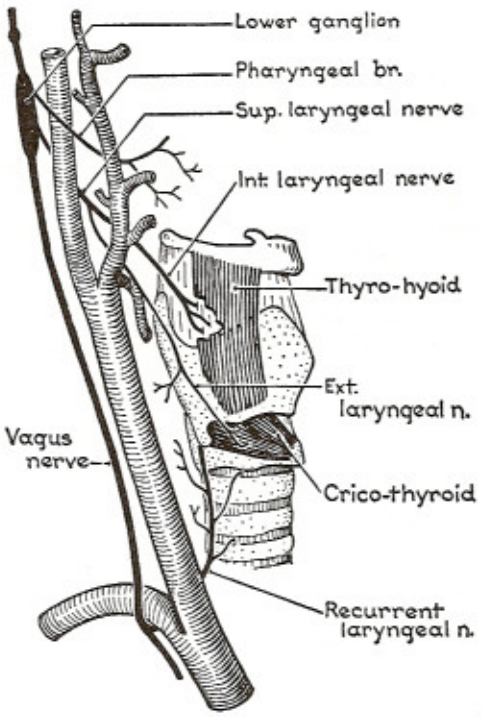

Figure 43.14. Pharyngeal and laryngeal branches of vagus.

Vagus Nerve (X) (*figs. 43.13 and 43.14*)

It descends through the entire length of the neck within the carotid sheath. As one of the most important nerves in the body, it is constantly assessed on examination of the patient. It maintains both voluntary motor control over skeletal muscles and involuntary control of smooth muscle, cardiac muscles, and glands. Its more superior branches are therefore voluntary motor nerves to muscles of the palate, pharynx, and larynx, and its lower cervical, thoracic, and abdominal branches are autonomic (parasympathetic) fibers. The vagus nerve also has extensive sensory fibers within it. Most are sensory to the visceral mucosa of the gastrointestinal and respiratory systems. The vagus has an **inferior (sensory) ganglion** in the jugular fossa (*fig. 43.14*). There are also some clinically important sensory fibers from the skin in the external auditory (ear) canal that have their sensory cell bodies located in a smaller superior ganglion in the jugular fossa.

The vagus innervates the skeletal muscles of the palate (except the tensor palati [V^3]), the pharynx (except stylopharyngeus, [IX]) and *all* the skeletal muscles of the larynx. The parasympathetic branches in the neck go to the mucous and serous glands of the endodermally derived foregut (pharynx, larynx, and trachea). Sensory branches arise from the same mucosa that contains these mucous glands as well as the skin of the external ear canal.

Branches of nerve X that relate specifically to the carotid triangle are two terminal branches of the superior

laryngeal nerve. The **internal laryngeal branch** pierces the thyrohyoid membrane (*fig. 43.14*) and is sensory primarily to the laryngeal mucosa above the vocal cords. This is an important component in the "coughing reflex" when material is aspirated onto the mucous membranes of the larynx and vocal cords. This nerve is frequently anesthetized to allow intubation of a tracheal tube for general anesthesia. The **external laryngeal branch** descends on the lateral aspect of the larynx to innervate the **cricothyroid muscle** (*fig. 43.14*). This muscle assists in tensing the vocal cords during phonation. Damage to the external laryngeal branch can cause changes in voice quality. This is an important clinical sign in vagal nerve disorders.

A cardiac branch of the vagus may join the superior cervical cardiac branch of the sympathetic trunk to descend into the thorax. These nerves provide some of the parasympathetic and sympathetic innervation to the heart. It should be remembered that the heart was derived from mesoderm in the head region and relocated in the thorax as the head fold occurred in embryogenesis. The nerve supply to the heart was established before this embryonic folding and is therefore derived from the cervical region.

Accessory Nerve (XI)

This is a peripheral nerve that innervates two large muscles of the neck, **sternomastoid** and **trapezius**. It passes posteriorly from the inferior border of the posterior belly of the digastric, lies on the deep surfaces of these muscles, and is contained in the intervening (investing) fascia that forms the roof of the posterior triangle of the neck. This nerve can be tested in a patient by asking them to flex their head (chin placed on the chest). This requires the bilateral contraction of the sternomastoids. Unilateral contractions cause the head to rotate in the opposite direction. The lower part of the peripheral nerve is tested by asking the patient to "shrug" or elevate their shoulders.

Hypoglossal Nerve (N. XII)

This nerve is motor to the tongue musculature and passes anteriorly, deep to the middle tendon of the digastric bellies, to reach the digastric triangle. It then enters the tongue between the mylohyoid and hyoglossus muscles.

Two branches arise from nerve XII in the carotid triangle. These are actually C1 fibers that are "hitchhiking" on nerve XII as they pass anteriorly from the area of the foramen magnum on the base of the skull. The first branch leaves nerve XII on the lateral side of the carotid sheath inferior to the posterior belly of the digastric. This is the **superior root** of the **ansa cervicalis** (*figs. 43.9 and 43.13*). The second branch innervates the thyrohyoid muscle and leaves nerve XII just as it passes under the posterior belly of the digastric for the second time.

Ansa Cervicalis (*fig. 43.9*)

This is a loop of motor fibers derived from the anterior rami of C1, 2, and 3. C1 fibers are carried in the hypoglossal nerve to the carotid triangle and then leave nerve XII as a descending **superior root (descendens hypoglossi)**. This superior root joins an **inferior root (descendens cervicalis)** from a loop of the cervical plexus containing C2, 3 ventral rami. The **ansa** (Gr. handle) is usually on the lateral aspect of the internal jugular vein but may be deep to the vein. The two roots may at times not be joined by an "ansa" but proceed directly to the strap muscles which they innervate.

ARTERIES OF THE CAROTID TRIANGLE (*fig. 43.15*)

The common carotid bifurcates at the level of the hyoid bone (C3) to form the internal and external carotid arteries within the carotid triangle. The internal carotid artery is somewhat posterior and lateral to the external carotid artery at this point. The internal carotid artery does not give branches in the neck but ascends to the base of the skull to enter the cranial vault to supply the brain and orbit. A swelling in the internal carotid artery at its origin marks the position of the **carotid sinus**. This is a collection of pressure (baroreceptors) sensitive nerve endings associated with nerve IX. Changes in blood pressure are monitored here and conveyed to the brainstem

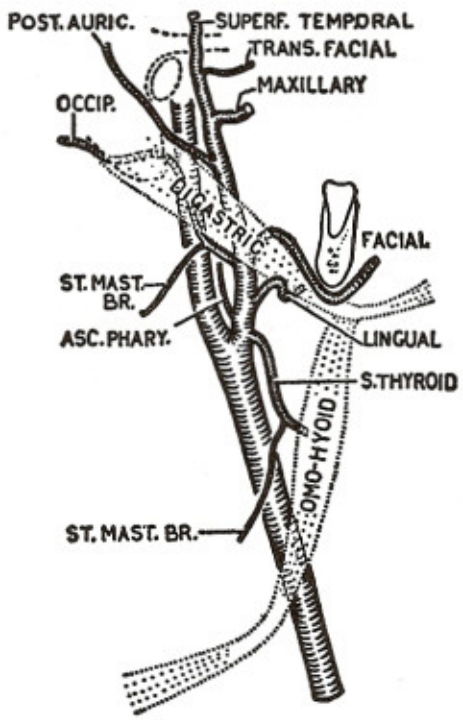

Figure 43.15. External carotid artery and branches.

for processing and maintenance of blood pressure. A **carotid body** is also present in the area of bifurcation of the common carotid artery. This is a microscopic structure containing neuronal chemoreceptors that are sensitive to oxygen content in the blood. They are also involved in mechanisms that control blood pressure and cardiac output.

The **external carotid artery** provides the major arterial branches to the extracranial structures of the head and upper neck. *Figure 43.15* shows the major branches of the external carotid artery that arise in the carotid triangle. The branches can be classified as being **inferior to, deep to** or **superior to the posterior belly of the digastric**.

Inferior to the posterior digastric muscle are three arteries. The **superior thyroid artery** arises from the base of the external carotid (sometimes from the common carotid artery) and descends to the superior pole of the thyroid gland at the level of the oblique line on the thyroid cartilage. Within the gland, branches ramify and anastomose with branches of the inferior thyroid artery as well as arterial branches from the opposite side through the isthmus of the gland. The superior thyroid arteries also give some vascular supply to the parathyroid glands within the thyroid. Three small branches of the superior thyroid artery come off as it descends to the thyroid gland. The **superior laryngeal artery** accompanies the internal laryngeal nerve as it pierces the thyrohyoid membrane to supply the larynx superior to the vocal cords. The **cricothyroid branch** accompanies the external laryngeal nerve to the cricothyroid muscle and enters the larynx to help supply the mucosa below the vocal cords. The superior thyroid artery also gives a **muscular branch** to the lower portion of the sternomastoid muscle. **The lingual artery** is the major blood supply to the tongue. It is a sinuous, S = shaped artery that projects anteriorly under the posterior belly of the digastric muscle. It accompanies the hypoglossal nerve into the digastric triangle. **The ascending pharyngeal artery** usually arises from the bifurcation of the common carotid artery and ascends deep to the posterior belly of the digastric muscle. It supplies the lateral wall of the pharynx and enters the nasopharynx with the auditory tube above the superior constrictor muscle.

Deep to the posterior belly of the digastric are the facial and occipital arteries. **The facial artery** arises from the external carotid and passes superiorly on the deep surface of the posterior belly of the digastric. It emerges on the *superior border of the digastric and grooves the submandibular gland as it courses superficially* to cross the inferior border of the mandible and masseter muscle (*fig.* 43.16). It can be palpated at this point as it rises to supply the angles of the mouth, lips, nose, and medial angles of eyes.

The **occipital artery** branches from the external carotid on its posterior surface (*fig. 43.15*). It lies on the deep surface of the posterior belly of the digastric. It is an *important blood supply to the scalp overlying the occip-*

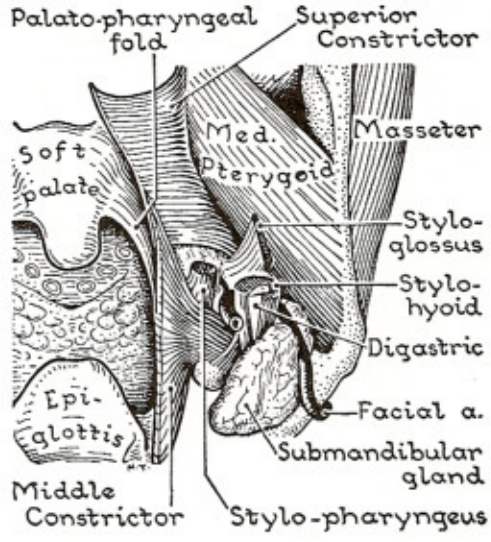

Figure 43.16. Details of S-shaped course of facial artery (posteroinferior view).

ital bone. It also has an important relationship to the hypoglossal nerve (*fig. 43.9*). The hypoglossal nerve passes inferiorly to the occipital artery as it passes anteriorly in the neck. The occipital artery also helps to supply the sternomastoid by a muscular branch and thereby assists the superior thyroid artery in supplying this muscle.

The **posterior auricular artery** arises from the superior border of the posterior belly of the digastric. It has an important **stylomastoid** branch, which supplies the facial nerve in the stylomastoid canal. Inflammation (neuritis) of VII can cause the nerve to "swell" and compress this artery. A sufficient lack of blood supply to nerve VII creates a unilateral palsy of the muscles of facial expression (Bell's Palsy). The posterior auricular artery also supplies the external auditory canal.

Additional branches of the external carotid artery arise within the parotid gland superior to the posterior belly of the digastric. They are the *maxillary, transverse facial* and *superficial temporal arteries*. They will be described in the chapter on the parotid gland (p. 518).

Digastric Triangle (Submandibular Triangle)

This area between the two bellies of the digastric muscles and the inferior border of the mandible contains the superficial lobe of the **submandibular (submaxillary) salivary gland** (*figs. 43.17 and 43.18*). The **floor** of the **di-**

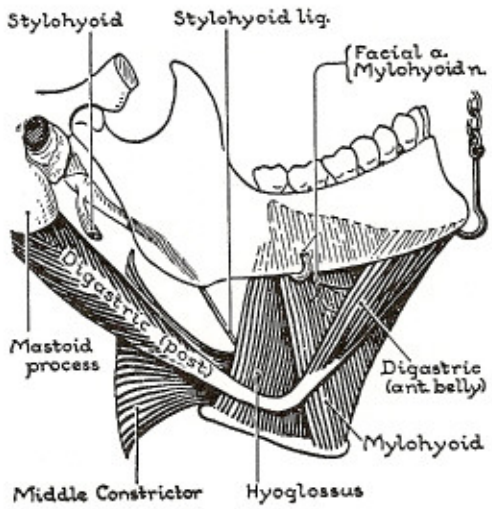

Figure 43.17. Floor of submandibular triangle.

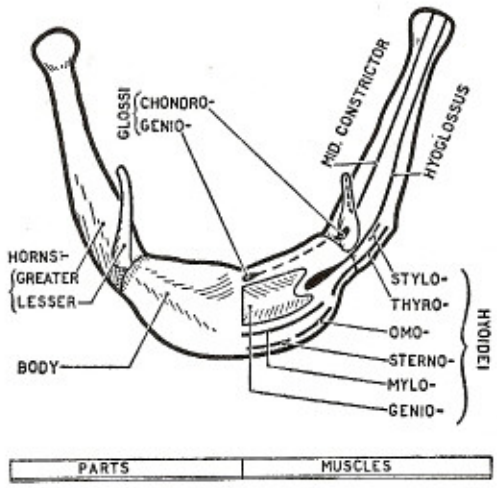

Figure 43.19. Hyoid and details of its muscles.

gastric triangle is formed by the fibers of 3 flat muscles: **mylohyoid, hyoglossus, and middle constrictor**.

The **mylohyoid** arises from the mylohyoid line on the medial aspect of the body of the mandible and inserts on the superior aspect of the body of the hyoid bone (*figs. 43.17 and 43.19*). It forms a "diaphragm" for the floor of the mouth and is continuous with the mylohyoid muscle on the opposite side through the midline raphe that extends from the mandible to the hyoid (*fig. 43.8*). Superficial to the mylohyoid is the anterior belly of the digastric muscle. Both the mylohyoid and anterior belly of the digastric are derived from the mandibular arch in the embryo, and they are both innervated by V^3 (**mylohyoid nerve**).

The hyoglossus arises from the greater cornu of the hyoid bone and inserts into the tongue. It has a very important relation with nerve XII on its external surface and the lingual artery on its internal surface in the digastric triangle (*fig. 43.13*).

The **middle constrictor** arises from the "V-shaped" union of the greater and lesser horns of the hyoid bone and from the **stylohyoid ligament** that attaches to the lesser cornu (*fig. 43.10*). Its fibers pass posteriorly to the lateral wall of the pharynx.

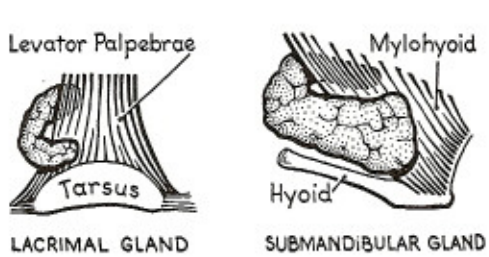

Figure 43.18. Two U-shaped glands and the two responsible muscles, compared.

CONTENTS OF THE DIGASTRIC TRIANGLE

1. The superficial lobe of the **submandibular gland** (submaxillary gland) fills this space and is separated from the parotid gland by an intervening fascial plane, **the stylomandibular ligament**. *Figure 43.18* shows how the submandibular gland forms a "U-shaped" gland around the posterior margin of the mylohyoid muscle. The deep part of the gland and the submandibular duct will be described in the floor of the mouth. The gland is innervated by parasympathetic secretomotor fibers in the chorda tympani and vasoconstrictive sympathetic fibers.
2. The **facial artery** and **facial vein** groove the superficial lobe of the submandibular gland as they traverse the digastric triangle (*fig. 43.16*).
3. The **hypoglossal nerve** and **lingual artery** enter the digastric triangle on the deep side of the posterior belly of the digastric and then become separated by the intervening hyoglossus muscle.
4. The mylohyoid nerve (V^3) and the submental artery and veins that arise from the facial artery and vein, respectively, lie on the superficial surface of the mylohyoid muscle. They are usually accompanied by lymphatics and a submental lymph node(s) is contained within the digastric triangle.

The **roof of the digastric triangle** is formed by **investing fascia** subcutaneous tissue, platysma muscle, and skin. Within the superficial fascia are the facial vein, cervical branch of VII, and branches of the transverse cervical nerve (C2, 3).

Clinical Mini-Problems

1. The hyoid bone is palpable at the level of the bifurcation of the common carotid artery. At which cervical vertebral level would one find the hyoid bone and carotid bifurcation?
2. How could an infection in the anterior triangle of the neck cause an inflammation of the pericardium (pericarditis)?
3. How could a disease of the thyroid gland cause a voice disorder in a patient?
4. A patient was given radioactive iodine to localize the thyroid tissue in a radiogram. The clinician found a large mass of thyroid tissue in the neck at the level of C6 and C7, but he also found some radioactivity in the posterior aspect of the tongue. How could there be two regions containing thyroid tissue?
5. Why would a local anesthetic deposited at the tip of each greater horn of the hyoid help prevent a patient from coughing when a bronchoscope is passed through the nasopharynx and larynx into the bronchial tree?
6. Which cranial nerve(s) are most susceptible to injury when the internal jugular vein is removed in radical neck surgery?

(Answers to these questions can be found on p. 587–588.)

44

Root of the Neck

Clinical Case 44.1

Patient Shirley V. This 46-year-old woman was thoroughly tested in the University Hospital and diagnosed as having a "goiter." She is scheduled for surgery and you are assigned to her case. The thyroidectomy is performed by successively clamping and ligating the terminal branches of the superior and inferior thyroid arteries from the posterior to the anterior aspect of the thyroid gland. Unfortunately, the left recurrent laryngeal nerve is damaged. When you examine her the next day, her voice quality is reduced to a whisper. This persists for 4 months following the surgery, and then her voice quality gradually improves to normal over the next 2 months. Meanwhile, her metabolism has normalized.

In the root of the neck the **key orienting structure** is the **scalenus anterior muscle**. It arises from the **anterior tubercles** of the cervical vertebrae C3–6 and inserts on the **scalene tubercle** on the superior aspect of the 1st rib. Virtually every important structure in the root of the neck approximates one of the surfaces of this important reference muscle.

The main vascular trunks to the head and neck and upper extremity pass posterior to the sternoclavicular joints and enter the root of the neck. On the right side, the brachiocephalic trunk divides into the right subclavian and right common carotid artery on the posterior aspect of the sternoclavicular joint. The left common carotid and left subclavian arteries arise from the arch of the aorta and ascend behind the left sternoclavicular joint to enter the root of the neck medial to the apex of the left lung.

Subclavian Artery

Arching over the apex of each lung (*fig. 44.1*), the subclavian artery passes **posterior to the scalenus anterior muscle** and superior to the 1st rib. At the lateral margin of the 1st rib, the subclavian artery becomes the axillary artery. As the subclavian passes through the root of the neck, it is divided into 3 parts by its relationship to the **scalenus anterior** muscle. The first part is medial to the scalenus anterior, the second part is directly posterior to the anterior scalene muscle, and the third part is lateral to the muscle in the posterior triangle of the neck above the 1st rib. The first part of the subclavian artery has the major arterial branches (*figs. 44.1 and 44.2*). A **dorsal scapular artery** frequently arises from the 2nd or 3rd part of the artery as the only other branch.

SURFACE ANATOMY

The artery can be traced by a curved line running from the sternoclavicular joint to 2–3 cm above the clavicle near its central point. The pulse in the subclavian artery can be felt against the 1st rib as it traverses its superior border above the level of the clavicle (*figs. 44.1 and 44.2*).

Subclavian Vein

The subclavian vein (*fig. 44.3*) has a similar course to the subclavian artery with the following 3 important differences: (*a*) the vein is inferior to the artery and within the arch formed by the artery as it arches over the apex of the lung; (*b*) the subclavian vein passes **anterior to**

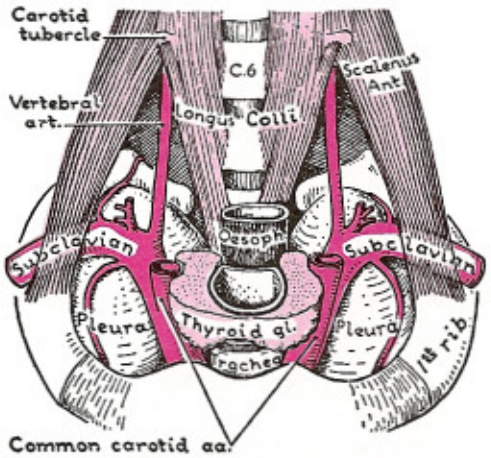

Figure 44.1. "The triangle of the vertebral artery." The "base" is the 1st part of the subclavian artery.

scalenus anterior at its insertion on the scalene tubercle; and (c) the subclavian vein is posterior and inferior to the clavicle and well protected by the clavicle. Access to the subclavian vein for intravenous catherization is done from the inferior aspect of the clavicle. The venous branches that join the subclavian vein are depicted in *Figure 44.4* and show a great deal of variation as compared to the comparable arterial branches of the subclavian artery that lie posterior and superior to the vein.

"Triangle of the Vertebral Artery" (*figs. 44.1, 44.3*)

The scalenus anterior forms the lateral side of this triangle, and the **longus colli muscle** forms the medial side. The base of the triangle is limited by the superior aspect of the subclavian artery.

CONTENTS

The **vertebral artery** and vein ascend to the apex of the triangle and enter the **foramen transversarum** of the transverse process of the 6th cervical vertebra (*figs. 44.1 and 44.2*). The **sympathetic trunk** and its associated **middle cervical ganglion** and **inferior cervical ganglion** (*fig. 44.5*) are within the triangle. The inferior cervical ganglion is associated with the posterior aspect of the vertebral artery at its origin from the subclavian, while the cervical sympathetic trunk is adherent to the anterior aspect of the longus colli muscle. The middle cervical ganglion is associated with the inferior thyroid artery.

The **common carotid artery** ascends through the anterior portion of the triangle to lie on the anterior aspect of the origins of the anterior scalene muscle. The carotid artery can be compressed against the transverse process of the 6th cervical vertebra. This area of the C6 transverse process is termed the **carotid tubercle** (*fig. 44.1*).

Surrounding the common carotid artery, the **internal jugular vein**, and the **vagus nerve** (*fig. 44.3*) is the carotid sheath. It descends through the neck on the medial border of the scalenus anterior. The right **recurrent** laryngeal nerve arises from the right vagus and loops under the right subclavian artery to ascend to the larynx between the trachea and esophagus.

The **phrenic nerve** enters the inferolateral corner of this triangle as it descends on the anterior surface of the **scalenus anterior**. It then crosses the anterior surface of the subclavian artery and apex of the lung to enter the superior aperture of the thorax within the internal borders of the 1st rib. On the left side, the phrenic nerve is crossed by the **thoracic duct** as it joins the venous system at the bifurcation of the **left brachiocephalic vein** (*fig. 44.3*). The **right lymphatic duct** joins the right brachiocephalic vein in the same manner, but it is small and difficult to demonstrate.

The **branches of the 1st part of the subclavian artery** are also located in this triangular area medial to the scalenus anterior muscle (*fig. 44.3*). They are:

1. Vertebral artery
2. Thyrocervical trunk
   - Inferior thyroid artery
   - Transverse cervical (transversa colli) artery
   - Suprascapular artery

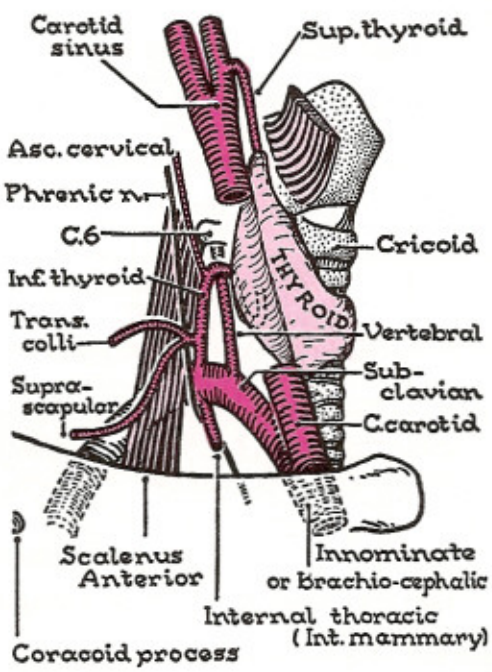

Figure 44.2. The arteries at the root of the neck.

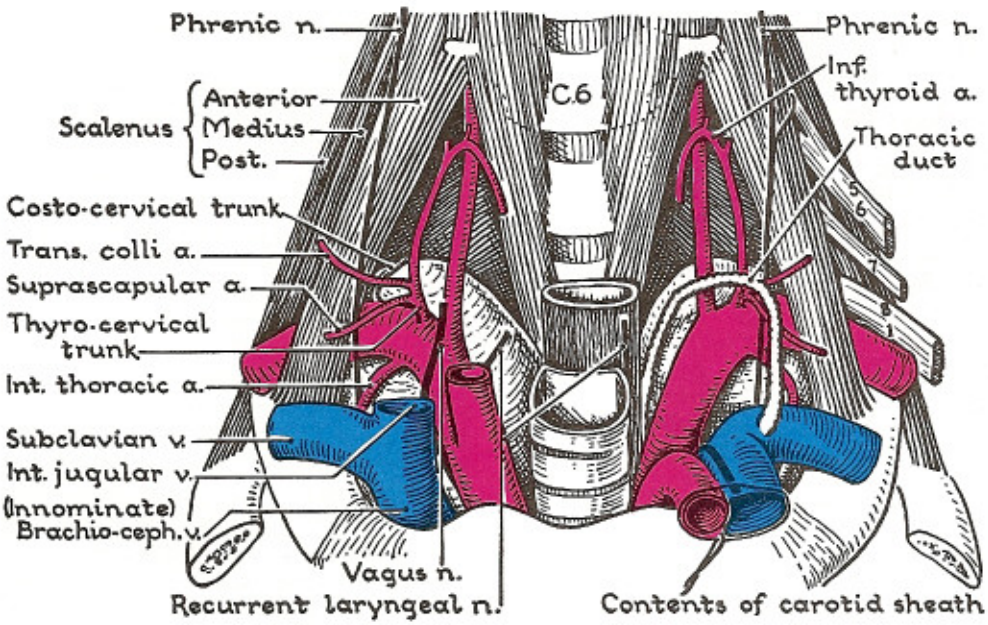

Figure 44.3. The root of the neck.

3. Internal thoracic (internal mammary) artery
4. Costocervical trunk
   - Deep cervical artery
   - Highest intercostal artery
     - 1st posterior intercostal artery
     - 2nd posterior intercostal artery

The **vertebral artery** is the largest branch and ascends to course through the foramen transversarii of the upper 6 cervical vertebrae. It enters the cranial cavity through the foramen magnum and joins with the vertebral artery of the opposite side to form the basilar artery in the midline of the posterior cranial fossa. The vertebral arteries are a major vascular supply to the brain along with the internal carotid arteries.

The **thyrocervical trunk** gives off three branches near its origin. The **suprascapular artery** and the **transverse cervical artery** pass anterior to the scalenus anterior and "clamp down" the phrenic nerve as they course into the posterior triangle of the neck. Both of these arteries supply muscles associated with the dorsal surface of the scapula. The **inferior thyroid artery** is the terminal branch of the thyrocervical trunk. It forms a loop at the level of C6, which is associated with the middle cervical ganglion of the sympathetic trunk (*figs. 44.3 and 44.5*). The inferior thyroid artery supplies the inferior pole of the thy-

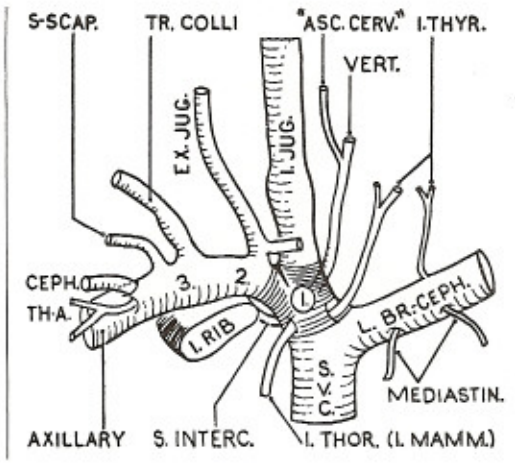

Figure 44.4. The veins at the root of the neck. 1, right brachiocephalic vein; 2, 3, right subclavian; *SVC*, superior vena cava; *THA*, thoracoacromial vein.

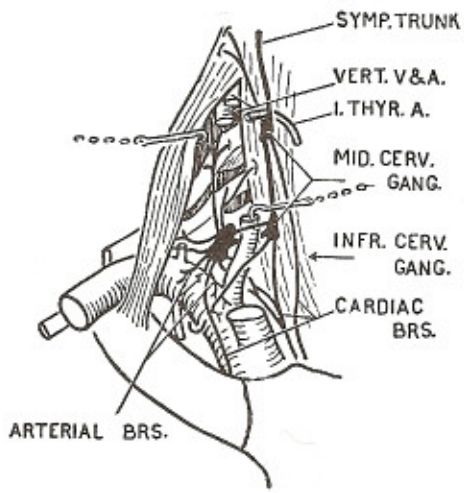

Figure 44.5. The sympathetic trunk, ganglia, and branches, at the root of the neck.

roid gland and anastomoses with the superior thyroid branch of the external carotid artery within the thyroid gland. A muscular branch of the inferior thyroid artery, the **ascending cervical artery** supplies the scalenus anterior and the longus colli muscles.

The **internal thoracic artery** descends on the pleura behind the subclavian vein and enters the thorax on the posterior aspect of the sternum (*figs. 44.1 and 44.3*).

The **costocervical trunk** passes posteriorly over the apex of the lung and the neck of the 1st rib (*figs. 44.1 and 44.3*). The **deep cervical branch** supplies the deep musculature of the back of the neck and the descending intercostal branch gives rise to the posterior intercostal arteries of the 1st and 2nd intercostal spaces.

Phrenic Nerve (*fig. 44.3*)

The phrenic nerve receives fibers from the anterior rami of C3–5. The nerve is formed at the superior lateral portion of the scalenus anterior and courses to the medial border of the muscle as it descends in the neck. It is contained in the prevertebral fascia that covers the anterior aspect of the scalenus anterior and is crossed superficially (anteriorly) by the suprascapular and transverse cervical arteries. The phrenic nerve is motor to the diaphragm muscle and sensory to the parietal pleura and peritoneum that cover the domes of the diaphragm. The diaphragm, like the heart, is largely derived from mesoderm that was first located in the head of the embryo. When the head fold places the diaphragm in the future thoracic area, its cervical nerve supply is carried from the cervical region to the thorax.

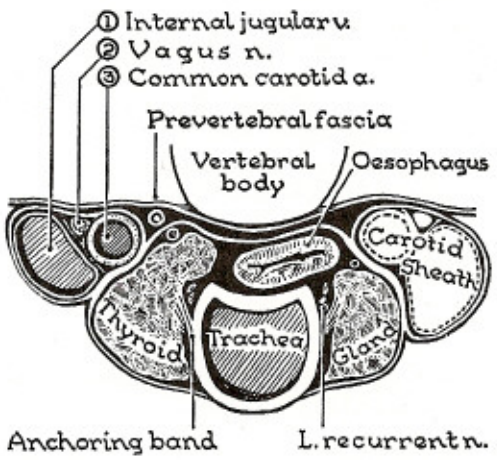

Figure 44.6. Trachea and esophagus (on cross-section). Note dense fibrous band attaching each lobe to trachea.

Recurrent Laryngeal Nerves

These important branches of the vagus are found in the root of the neck between the esophagus and trachea on the medial aspect of the thyroid glands (*figs. 44.3 and 44.6*). The **left recurrent laryngeal** is a branch of the left vagus nerve in the thorax, and the **right recurrent laryngeal nerve** arises from the right vagus at the base of the neck. The difference in these two origins is due to the persistence of the 6th aortic arch on the left side as the ductus arteriosus. On the right side, the most inferior aortic arch that is retained is the 4th, and it forms the initial segment of the right subclavian artery, which the right recurrent nerve loops around.

Trachea and Esophagus

The cervical portion of these two tubular organs exist in the root of the neck from C6 to the superior aperture of the thorax (T1, 1st rib, and manubrium). They are continuous with their thoracic components in the posterior mediastinum. *Figure 44.6* shows the trachea, the esophagus, and the thyroid gland invested by the visceral fascia of the neck. This visceral "column" is flanked by the carotid sheaths and lies anterior to the bodies of the vertebrae and the prevertebral fascia in the root of the neck.

Clinical Mini-Problems

1. **How would stimulation of the phrenic nerve produce shoulder pain in a patient?**
2. **How could disease in the apex of the right lung cause symptoms in the medial side of the hand?**
3. **How could disease in the apex of the lung cause a Horner's Syndrome in the right eye (pupillary constriction, partial ptosis, and lack of sweating around the eye)?**
4. **The carotid artery can be compressed against the transverse process of a cervical vertebra at the level of the cricoid cartilage.**
   (a) **Which vertebra is at this level?**
   (b) **Would one compress the vertebral artery in this maneuver?**

(Answers to these questions can be found on p. 588.)

45

Side of Skull, Parotid, Temporal and Infratemporal Regions

Clinical Case 45.1

Patient Peter L. This 48-year-old man has been diagnosed as having a benign left parotid tumor and scheduled for surgery by the otolaryngologist who is your clinical tutor. During the operation, the surgeon lays a skin flap in front of the left ear and exposes the parotid from the zygoma superiorly to the posterior belly of the digastric muscle inferiorly. The tumor is removed together with the superficial portion of the parotid gland. Special care is taken not to damage the facial nerve. The deep portion of the parotid is left intact around the retromandibular vein and external carotid artery. (At followup, the only postoperative symptom is some numbness over the left ear lobe.)

Lateral Aspect of the Skull

The view of the skull from the lateral aspect is termed **norma lateralis** (*fig. 45.1*). The skull can be divided into a superior cranial component and inferior facial component by a horizontal plane from the **external occipital protuberance (inion)** through the zygoma to the nasal cavity.

The cranial portion has an outer contour formed from the root of the nose by the frontal bone, the parietal bone, and the occipital bone. The highest point of this contour is reached on the parietal bone and termed the **vertex**. The **external occipital protuberance** is located at the base of this outer contour. An inferior surface of the occipital bone forms the roof of the suboccipital region, which is limited posteriorly by the **superior nuchal line**. This line is the bony attachment site on the skull of the trapezius muscle. The superior nuchal line continues anteriorly to blend with the **mastoid process** where the sternomastoid muscle arises from the skull.

Two prominent lines are formed on the lateral surfaces of the frontal and parietal bones. These are the **superior temporal line** and **inferior temporal line**. These mark the superior limit of the temporal fossa on the lateral aspect of the skull. The **superior temporal line** is the bony attachment site for the **temporal fascia** and the **inferior temporal line** is the attachment site of the **temporalis** muscle. The **pterion** is the H-shaped articulation site for the four bones that form the anterolateral portion of the temporal fossa. The parietal, frontal, greater wing of sphenoid, and the squamous part of the temporal bone form the margins of the pterion. This is an external landmark for the intracranial position of the **middle meningeal artery**.

The squamous portion of the temporal bone forms the central region of the temporal fossa. The inferior margin of the squamous portion of the temporal bone contains the **mandibular fossa** of the temporomandibular joint and its anterior **articulating tubercle** (*fig. 45.2*). The **external acoustic** (auditory) **meatus** is posterior to the mandibular fossa and anterior to the mastoid process of the temporal bone. The external ear orifice in the temporal bone is completed inferiorly by the **tympanic plate**. The external acoustic meatus projects medially into the petrous portion of the temporal bone. It is separated from the middle ear by the **tympanic membrane** (eardrum).

BONES OF THE FACE

The face is mainly supported by the **zygomatic bone, maxilla,** and **mandible**.

Zygomatic Bone

This "cheek bone" forms the lateral one-third of the orbital margin. It functions to disperse the forces generated in mastication over the frontal bone. Its major processes extend from the body of the bone to its articulating sutures. The zygomatic bone has a **frontal process**, a **maxillary process**, and a **temporal process**.

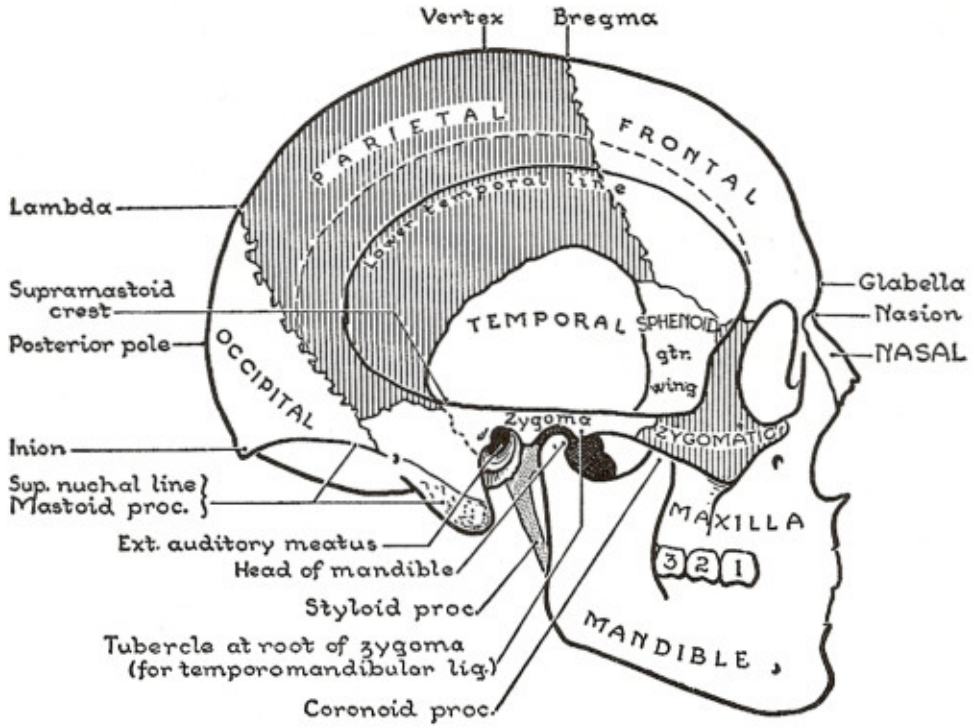

Figure 45.1. The skull, on side view (norma lateralis).

Mandible

The horseshoe-shaped mandible consists of a horizontally oriented **body** and two vertically oriented **rami**. The body of the mandible resulted from the fusion of a right and left component at 2 years of age. It has an **alveolar process** that surrounds the roots of the lower teeth and supports this dentition. Features on the lateral aspect of the body are: (*a*) the **oblique line** where the **depressor labii inferioris** and **depressor anguli oris** attach; (*b*) the **mental foramen** where the mental nerve (V^3) exits; and (*c*) the **mental protuberance**, which forms the "point" of the chin (*fig. 45.3*).

Each ramus has two major processes on its superior border. The **coronoid process** is a superior extension of the anterior margin of the ramus. It serves as an attachment for the strong **temporalis muscle**. The coronoid process lies deep to the zygomatic arch (*fig. 45.1*) and the tendon of the temporalis muscle passes medial to the zygomatic arch as it inserts onto the coronoid process and the anterior aspect of the ramus of the mandible. The **condylar process** of the mandible articulates with the mandibular fossa and articulating tubercle of the temporal bone (*figs. 45.1 and 45.2*). Each condyle has a **head** and **neck** (*fig. 45.3*). The head is covered by cartilage and is contained in the **temporomandibular joint**. The neck supports the head and also serves as an insertion site for the lateral pterygoid muscle on its anterior surface. The **mandibular notch** exits between the coronoid and condylar process. The mandibular notch is covered by the masseter muscle and transmits the masseter nerve and blood supply from the infratemporal fossa to the lateral aspect of the mandible. The **masseter** muscle arises from the zygomatic arch and inserts on the lateral aspect of the ramus from the **angle** to its junction with the body.

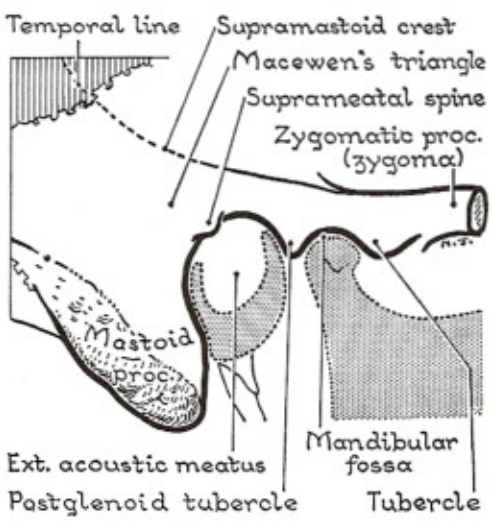

Figure 45.2. Twin depressions (external acoustic meatus and mandibular fossa) and postglenoid tubercle between. The suprameatal spine is the surgeon's guide to the mastoid antrum deep to the triangle behind.

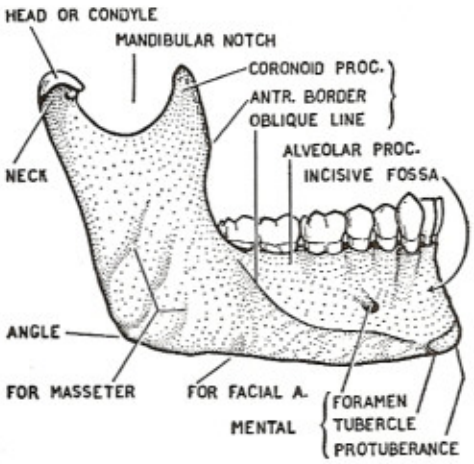

Figure 45.3. The lateral aspect of the mandible.

The medial aspect of the mandible is shown in Figure 45.4. The general features are the same as in the lateral view. The medial side of the ramus has an opening for the **mandibular canal**. This **mandibular foramen** permits the **inferior alveolar nerve** (V^3) and **vessels** to enter the ramus and body of the mandible and supply the pulps of the lower teeth. A small projection of bone extends above the anterior portion of the mandibular foramen. This is the **lingula** and is the attachment for the **sphenomandibular ligament**. A shallow **mylohyoid groove** extends inferiorly from the mandibular foramen. It contains the **mylohyoid nerve** and **vessels** that supply the **mylohyoid** and **anterior belly of the digastric** in the submental triangle of the neck. The mylohyoid muscle attaches to the **mylohyoid line** on the medial surface of the body of the mandible. The anterior belly of the digastric attaches to the **digastric fossa** on the inferior margin of the mandible. Just superior to the digastric fossa are the superior and inferior **mental (genial) spines** of the mandible. These are attachment sites for the **genioglossus** and **geniohyoid muscles**, respectively.

The body of the mandible is smooth on its medial aspect above and below the mylohyoid line. The sublingual gland and deep part of the submandibular gland lie in the superior **sublingual fossa**. The inferior **submandibular fossa** contains the superficial part of the submandibular salivary gland. The roughened area at the angle of the mandible on the medial side of the ramus is the attachment site of the **medial pterygoid** muscle. The **medial pterygoid** and **masseter** form a muscular sling on both sides of the angle of the ramus that supports the mandible and helps hold it firmly in the temporomandibular joint.

PAROTID BED AND GLAND

The parotid region (Gr. para = near, ous [otos] = the ear) lies between the ramus of the mandible and the external ear and is superior to the posterior belly of the digastric muscle (*fig. 43.1*). The region is a bony, muscular, and fascial-lined space, which is filled by the **parotid gland** (*fig. 45.5*). The parotid gland develops from the ectodermal lining of the oral cavity and migrates posteriorly over the external aspect of the ramus of the mandible and its associated **masseter muscle** to invade the parotid region. The developing gland fills the entire space and encompasses the neural (VII) and vascular (**external carotid artery, retromandibular vein**) structures that traverse this space (*fig. 45.6*). The parotid gland is described as having a deep and a superficial portion, which is "roughly" separated by the branching pattern of the **facial nerve** (VII) (*fig. 45.7*). The superficial part of the gland overlies much of the masseter muscle and extends anteriorly along the **parotid duct**. The deep portion of the gland contains the **external carotid artery**, its terminal branches (the **maxillary** and **superficial temporal arteries**), the **retromandibular vein**, and the **auriculotemporal nerve (V^3)** (*fig. 45.6*). Both the superficial and deep portions of the parotid gland are covered by a dense, tough capsule that is derived from the investing fascia that lines the **parotid bed** and the superficial aspect of the parotid gland. Swelling of the gland within this tough capsule and deep facial encasement produces a painful situation. "Mumps" is an example of parotid gland swelling induced by a virus.

The **parotid bed** is formed by 4 bony processes that are related to the base of the skull and their associated soft tissue elements. Posteriorly, the mastoid process and its two muscular origins for the sternomastoid and the posterior belly of the digastric form a limit for the parotid bed (*fig. 45.5*). The medial boundary of the parotid gland is formed by the **styloid process of the temporal bone** and the **stylohyoid muscle**. The **styloglossus** and **stylopharyngeus** muscles are medial to the parotid bed within the **lateral pharyngeal space**. The parotid fascia extends from the styloid process anteriorly to the **spine of the sphenoid bone** and then lateral to the posterior aspect of

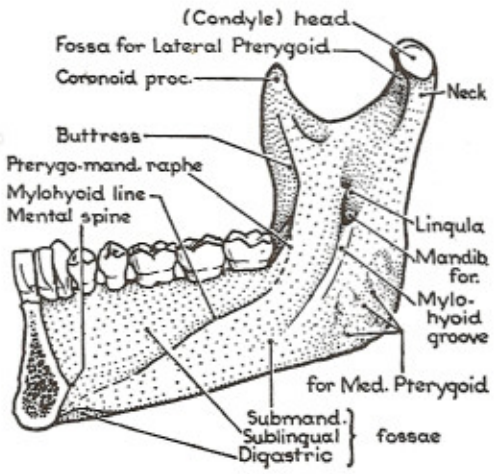

Figure 45.4. The medial aspect of the mandible.

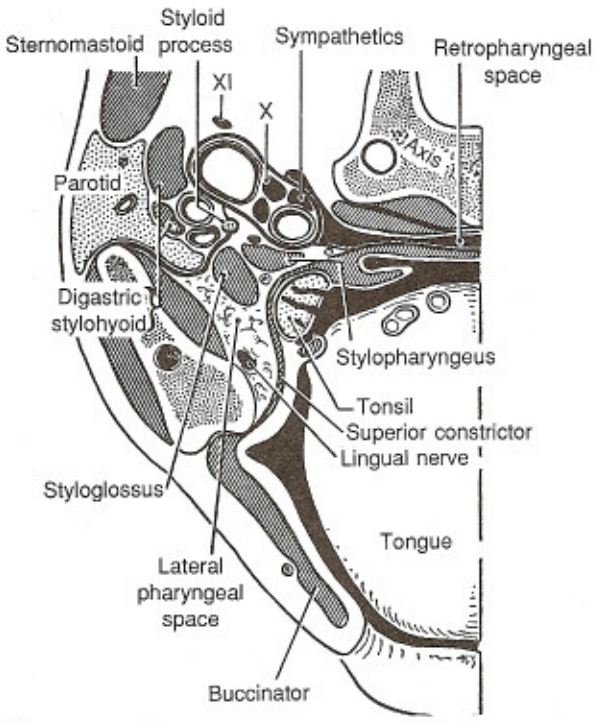

Figure 45.5. Cross-section at level of parotid gland and tonsil.

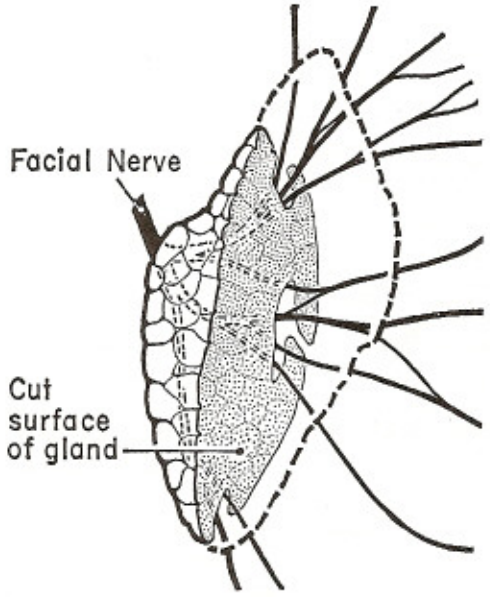

Figure 45.7. To show the relation of the facial nerve to the parotid gland. (After McKenzie.)

the ramus of the mandible. This parotid fascia blends with the **sphenomandibular** and **stylomandibular ligaments** as well as the fascia of the **medial pterygoid** and **masseter muscles** to form the anterior margin of the parotid bed. The superficial portion of the gland extends from the zygomatic arch superiorly to the posterior belly of the digastric inferiorly. The **investing fascia of the neck** that encircled the sternomastoid posteriorly also "invests" the entire parotid gland as it passes forward to attach to the mandible over the anterior triangle of the neck. The weakest part of this fascia is between the **styloid process** and the **spine** of the **sphenoid**. Therefore, infections that "break out" of the parotid fascia usually drain into the lateral pharyngeal space, which is in direct communication with the **retropharyngeal space** (*fig. 45.5*) between the pharynx and prevertebral musculature. These infections have the potential to "track" inferiorly through the neck and into the thorax along the course of the **carotid sheath** between the **visceral** and **prevertebral** fascia.

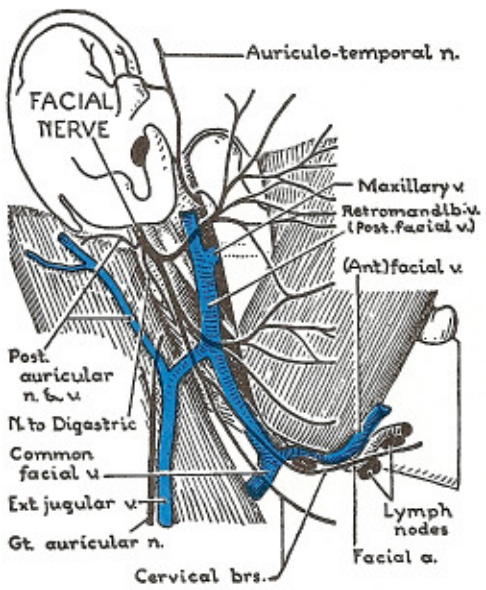

Figure 45.6. Facial nerve and veins in parotid region.

The parotid gland is a major salivary gland that is contained within the parotid fascia. The secretomotor control is via the **lesser petrosal branch** of the glossopharyngeal nerve (IX) (*fig. 45.8*). The **preganglionic fibers** arise from the tympanic plexus in the middle ear, enter the middle cranial fossa through a hiatus on the anterior aspect of the petrous bone and course through the periosteal dura to exit the middle cranial fossa with V^3 in the foramen ovale. The preganglionic parasympathetic fibers synapse on **postganglionic parasympathetic neurons** within the **otic ganglion** on the medial aspect of the trunk of V^3. These postganglionic fibers leave the otic ganglion and join the **auriculotemporal nerve** to be distributed to the parotid gland. Intraglandular branches of the auriculotemporal nerve carry both secretomotor fibers of nerve IX and sensory fibers of V^3. Pain sensation in the parotid gland in conditions such as "mumps" is carried in V^3. The parotid also receives **postganglionic sympathetic** innervation from the superior cervical ganglion via the arteries.

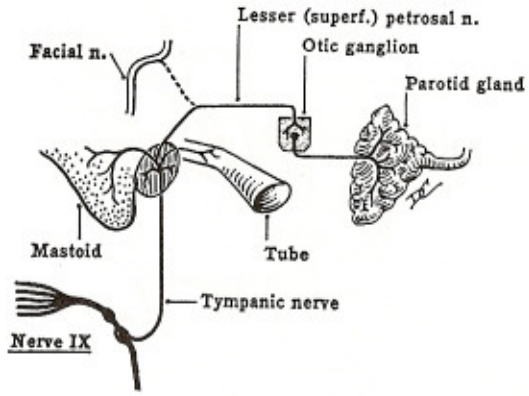

Figure 45.8. Secretomotor nerve to parotid gland.

The gland will expand slightly between meals as its cells produce and store new enzyme granules in their cytoplasm. Release of the extracellular zymogens at meal time is under parasympathetic control. Fluid content of saliva is controlled by the sympathetic innervation to the parotid vessels. The saliva is collected into a major single **parotid duct** that passes superficially over the masseter muscle and pierces the buccinator muscle to **open into the oral cavity** in the mucosa adjacent to the **upper 2nd molar tooth**. Saliva becomes thick during excitement due to a general sympathetic vasconstriction. This reduces the blood flow to the parotid gland vessels and decreases the fluid content of the saliva.

Figure 45.9 shows the relationship of the **important structures that radiate from the periphery of the parotid gland**.

1. Superiorly, the **superficial temporal artery and vein, auriculotemporal nerve**, and the **temporal** and **zygomatic branches of nerve VII** pass superficial to the zygomatic arch.
2. Anteriorly, the parotid duct (and occasionally accessory collections of parotid gland tissues), **transverse facial artery** and **buccal** and **mandibular branches** of nerve VII lie on the superficial aspect of the masseter muscle.
3. Inferiorly, the **cervical branch of nerve VII** to platysma passes under the angle of the mandible, and the external jugular vein and greater auricular nerve approach the parotid gland.
4. Posteriorly, the **occipital vein** and **posterior auricular** branch of the external carotid artery pass over the sternomastoid to supply the tissues of the scalp posterior to the ear.

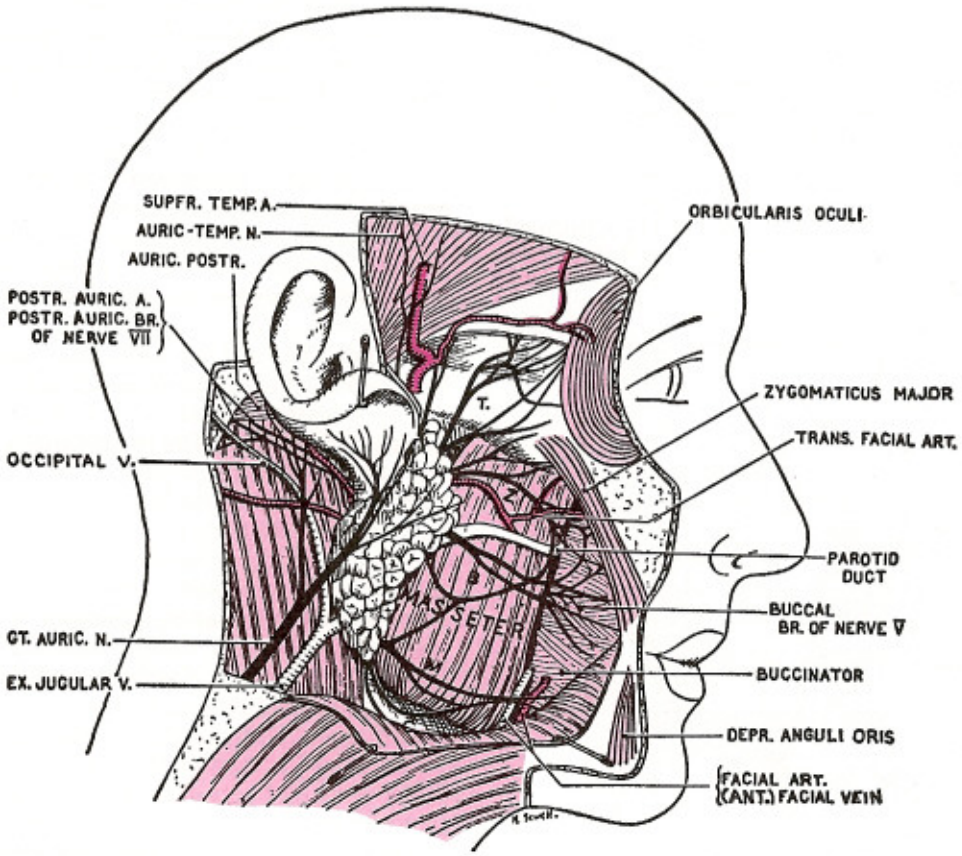

Figure 45.9. Dissection of the side of the face and facial nerve: *T*, temporal branches; *Z*, zygomatic branches; *B*, buccal branches; *M*, mandibular branch.

Structures within the parotid gland are shown in *Figure 45.6* after the parotid tissue has been removed.

1. The **facial nerve** is most superficial within the gland and passes lateral to the vascular elements between the superficial and deep portions of the parotid gland.
2. The **retromandibular vein** is formed within the deep portion of the parotid by the union of the **maxillary** and **superficial temporal veins**. It descends vertically to drain into both the **external** and **internal jugular veins** via the **common facial vein**.
3. The **external carotid artery** ascends in the deep portion of the parotid gland medial to the retromandibular vein and the facial nerve. It terminates in the gland by dividing into the **superficial temporal** and **maxillary arteries**.

The facial nerve is considered the most critical of these three structures when surgery is performed on the parotid gland. The veins and arteries can be tied off if necessary but damage to nerve VII may result in paralysis of the facial musculature with adverse cosmetic and functional effects.

THE FACIAL NERVE (VII) IN THE FACE

The facial nerve exits the base of the skull via the stylomastoid foramen as a purely motor nerve to the muscles of facial expression, the posterior belly of the digastric muscle, and the stylohyoid muscle. All of the sensory and parasympathetic fibers of VII have branched from the nerve within the middle ear and temporal bone.

Figure 45.7 shows how the facial nerve enters the posterior aspect of the deep portion of the parotid gland. As it traverses the gland, it becomes more superficial and leaves the periphery of the gland on the undersurface of the superficial part of the gland.

Branches of VII

The main trunk of nerve VII gives branches to the stylohyoid muscle and posterior belly of the digastric muscle that arise from the bone surrounding the stylomastoid foramen. A small posterior auricular branch also arises from the trunk to pass posteriorly into the scalp to innervate the **posterior auricular muscles** and **occipitalis muscle** behind the ear (*fig. 45.9*). The remaining branches to the muscles of facial expression arise within the parotid gland.

1. 3 **branches** of the temporofacial division (*figs. 45.7 and 45.9*).
   (a) **Temporal branches**—they supply mainly the muscles of the forehead and eyes (**anterior** and **superior auricular muscles, frontalis muscle, corrugator muscle**, and **orbicularis oculi muscle**) (*fig. 45.10*).
   (b) **Zygomatic branches**—they supply **orbicularis oculi** and **zygomaticus major muscles**.
   (c) **Buccal branches**—they supply **levator labii superioris** and the muscles of the nose and upper lip (*fig. 45.10*).

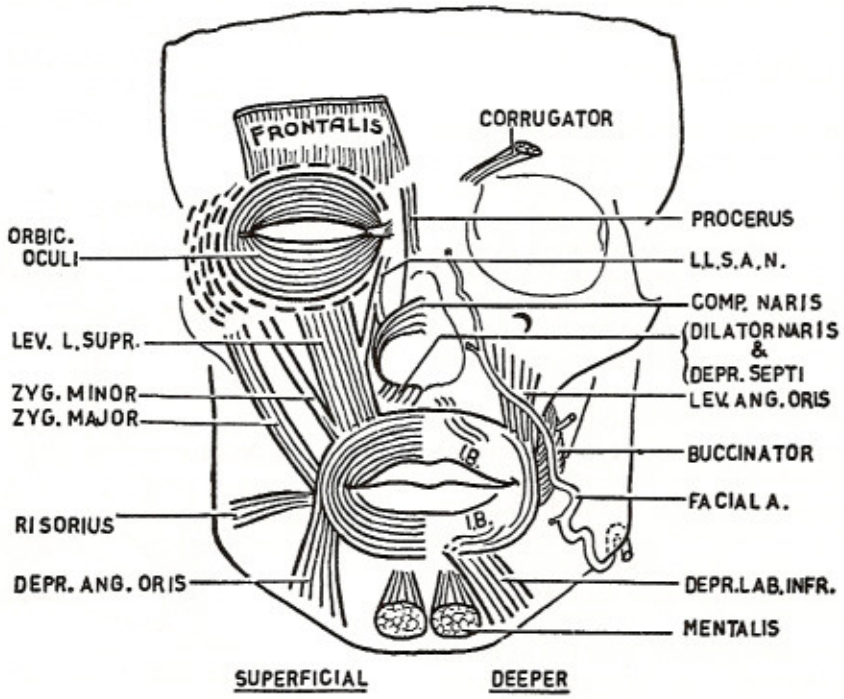

Figure 45.10. The muscles of the face. *LLSAN*, levator labii superioris alaeque nasi.

Clinical testing of the temporofacial division (upper half of the face) is done by asking patients to "wrinkle" their forehead or close their eyes against resistance.

2. **Branches of the cervicofacial division:**
   (a) **Buccal Branches**—to the muscles of the **cheek and mouth, buccinator, orbicularis oris,** and **levator anguli oris.**
   (b) **Mandibular branches**—to the muscles within the lower lip (**depressor anguli oris, depressor labii inferioris,** and **mentalis muscles**).
   (c) Cervical branch—to the **platysma** (*fig. 45.9*).

Clinical testing of the cervicofacial division is done by asking patients to show their teeth, purse their lips, or blow out on their cheeks. The lower face is sometimes paralyzed in patients who suffer "strokes" or ischemia to brain tissue. One must therefore test both upper and lower parts of nerve VII to distinguish between peripheral nerve problems that cause hemiparalysis of the face and certain diseases within the brain tissue. Since the muscles of facial expression are within the subcutaneous tissue of the face, the branches of the facial nerve are also vulnerable to damage in facial lacerations. One must therefore be able to test the terminal branches of the facial nerve as well.

Temporal and Infratemporal Regions

TEMPORALIS

The **temporalis muscle** arises from the temporal fossa (*fig. 45.1*) and the overlying temporal fascia, which attaches to the superior temporal line of the skull. It is a fan-shaped muscle with a single tendon descending deep to the zygomatic arch to insert on the **coronoid process** of the mandible and the anterior margin of the ramus. Some of the posteroinferior fibers of the temporalis are oriented in a horizontal plane that parallels the superior border of the zygomatic arch, but most temporalis fibers are oriented in a vertical manner with respect to the coronoid process. The action of the temporalis is therefore primarily to elevate the jaw and close the mouth through the contraction of its vertically oriented muscle fibers. The horizontally oriented component of the muscle acts to retract the mandible and thereby pull the head of the condyle into its most posterior (retruded) position in the mandibular fossa of the temporal bone (temporomandibular joint).

The nerve supply of the temporalis is by the **posterior** and **anterior temporal nerves** from the anterior division of V^3. These nerves arise in the infratemporal fossa and enter the temporal fossa by passing over the squamous part of the temporal bone (*see fig. 45.15*). They are therefore on the deep aspect of the temporal muscle.

INFRATEMPORAL REGION

This region lies inferior to the temporal fossa and zygomatic arch and deep to the ramus of the mandible. This area extends from the parotid fascia that attaches to the posterior aspect of the mandibular ramus anteriorly to the tuberosity of the maxilla.

Bony Boundaries

The **lateral wall** of the infratemporal fossa is formed by the medial aspect of the ramus of the mandible (*figs. 45.4 and 45.11*). The mandibular foramen of the ramus transmits the inferior alveolar nerve (V^3) and vessels into the substance of the mandible to supply the teeth and bone with their neural and vascular supply. This foramen is partially covered by a bony projection, the **lingula**, which is the inferior attachment of the **sphenomandibular ligament**. The superior attachment is on the spine of the sphenoid in the "roof" of the infratemporal fossa.

The **anterior wall** is formed by the body and tuberosity of the maxilla. This lies deep to the zygoma and zygomatic process of the maxilla that acts as the **buttress** for transmitting the forces of mastication from the upper dentition into the frontal bone of the cranial vault. In the medial aspect of the anterior wall is the **pterygomaxillary fissure**, which opens into the more medial **pterygopalatine fossa** as well as the **inferior orbital fissure** (*fig. 45.12*). Inferior to the **pterygomaxillary fissure** is a bony projection, the **hamulus**, which serves as the superior attachment of the **pterygomandibular raphe** (*fig. 43.10*). This ligamentous structure runs vertically between the hamulus and the upper **one-fifth of the mylohyoid line**

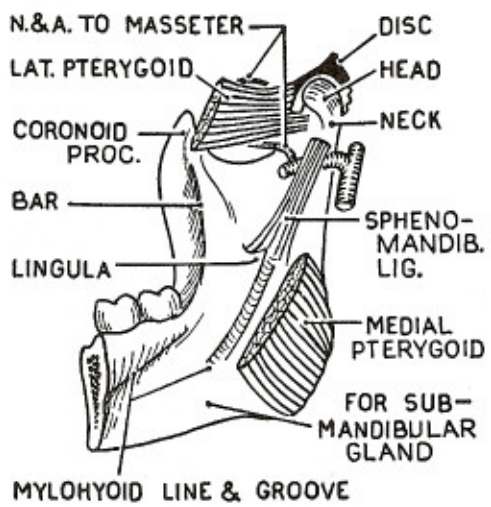

Figure 45.11. The lateral wall of the infratemporal fossa, i.e., the ramus of the jaw.

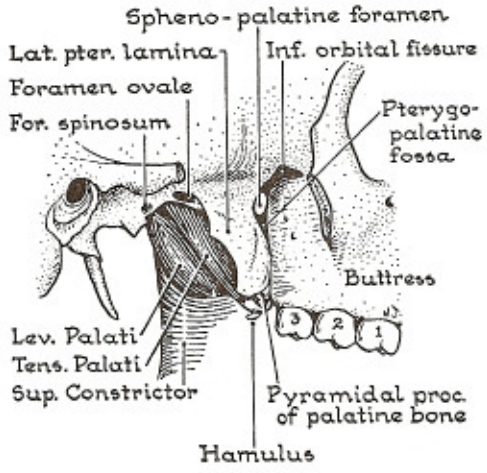

Figure 45.12. Anterior wall, medial wall, and roof of the infratemporal fossa.

on the mandible. It serves as a common site of origin for both the **buccinator muscle and the superior constrictor muscle**. The buccinator projects anteriorly to cross the mandible behind the molar teeth and enter the substance of the cheek (*fig. 45.5*). The superior constrictor projects posteriorly from the pterygomandibular raphe to form the upper part of the pharynx and part of the medial wall of the infratemporal fossa (*figs. 45.5 and 45.12*).

The **medial wall** of the infratemporal fossa is formed by the **lateral pterygoid plate** of the sphenoid bone, the **superior constrictor muscle**, and two small muscles arising from the roof of the fossa, the **levator and tensor palati muscles** (*fig. 45.12*). The lateral pterygoid plate serves as an attachment site for the pterygoid muscles, which act on the mandible. The medial pterygoid plate, its hamulus and pterygomandibular raphe are more medial and serve as attachments for the pharyngeal musculature.

The **roof** of the infratemporal fossa consists of two bones: the **greater wing of the sphenoid** anteriorly and the **squamous portion** of the temporal bone posteriorly. The **infratemporal crest** is on the anterior aspect of the undersurface of the greater wing of the sphenoid and serves as an attachment site for the upper head of the lateral pterygoid muscle. Posterior to this crest are two important foramina: (*a*) the **foramen ovale**, which transmits **V³** and the **lesser petrosal nerve (IX)** from the middle cranial fossa to the infratemporal fossa and (*b*) the **foramen spinosum**, which transmits the **middle meningeal artery** from the infratemporal fossa to the middle cranial fossa. The foramen spinosum is located on the sphenoid bone at the base of the spine (*fig. 45.12*).

Contents of the Infratemporal Fossa

The key orientation structure for the contents of the infratemporal fossa is the **lateral pterygoid muscle**.

The **lateral pterygoid muscle** arises from the infratemporal crest of the greater wing of the sphenoid and the lateral side of the *lateral pterygoid plate*. Its two heads are oriented horizontally below the zygomatic arch in the superior half of the infratemporal fossa (*fig. 45.13*). The superior head inserts into the capsule that is attached to the **interarticulating disc** of the temporomandibular joint (*fig. 45.14*). The inferior head is much larger and inserts into the **fovea** on the neck of the mandible. The action of this muscle is to protrude the mandible by pulling the head of the condyle onto the **articulating tubercle** of the temporal bone. The **articular disc** between the head of the condyle and the mandibular fossa of the temporal bone separates the temporomandibular joint into a lower hinge joint and upper sliding joint. The disc is always intervening between the mandibular head and the temporal bone. The disc is pulled anteriorly by the superior head of the lateral pterygoid muscle while the inferior head protrudes the mandible. **The protrusive actions of lateral pterygoid are used to clinically test the intactness of V³.** Bilateral contraction causes the mandible to protrude in the midline. Paralysis or severe weakness of either lateral pterygoid muscle will cause the mandible to deviate to the side of the damaged muscle or injured V³ nerve.

Lateral to the lateral pterygoid muscle is the maxillary artery and the ramus of the mandible (*fig. 45.13*). **Medial** and inferior to the lateral pterygoid muscle is the mandibular division of the trigeminal nerve V³ and the medial pterygoid muscle.

The **maxillary artery** (*fig. 45.13*) arises in the parotid gland and enters the posterior aspect of the infratemporal fossa by passing deep to the neck of the condyle of the mandible. It crosses the lateral side of the lateral pterygoid muscle and enters the pterygomaxillary fissure on the posterior aspect of the maxilla. The artery is divided into 3 parts by this lateral pterygoid muscle relationship: (*a*) 1st or mandibular part, (*b*) 2nd or pterygoid part, and (*c*) 3rd or pterygopalatine part. The mandibular and pterygoid parts are associated with the infratemporal fossa, and the pterygopalatine part is associated with the deep face and nasal region.

The mandibular portion of the maxillary artery has five branches. All of them enter a bony canal to supply their areas of distribution.

1. The **middle meningeal artery** is the largest and most important arterial branch. It ascends from the maxillary artery on the medial side of the lateral pterygoid muscle to pass through the foramen spinosum and enter the middle cranial fossa. It is the principal arterial supply to the periosteal dura of the cranial cavity.
2. The **inferior alveolar artery** enters the substance of the mandible through the mandibular foramen. It supplies the dental pulps of all the lower teeth as well as the mandible. The angle of the mandible has a poor blood supply and is a common site for al-

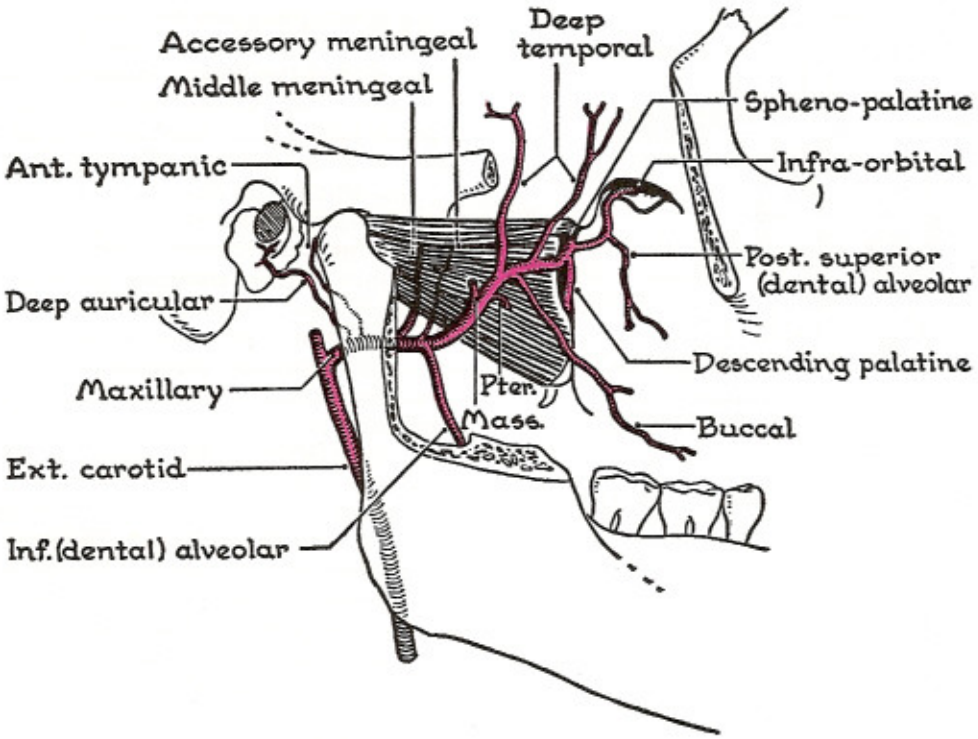

Figure 45.13. The lateral pterygoid muscle and the maxillary artery.

veolar osteitis (dry socket) following the extraction of the lower 3rd molars (wisdom teeth). Using an anesthetic with a vasoconstrictor (epinephrine) can induce an alveolar osteitis following dental surgery.

3. The **deep auricular artery** supplies the external auditory meatus and reaches the bony portion in a canal between the cartilaginous and bony canals.
4. The **anterior tympanic artery** accompanies the chorda tympani through the petrotympanic fissure to reach the middle ear.
5. The **accessory meningeal branch** is inconsistent, but when it is present, it enters the middle cranial fossa through the foramen ovale and supplies the trigeminal ganglion and the surrounding dura.

The pterygoid portion of the maxillary artery also has five branches and they are all muscular supplying the muscles of mastication in the pterygoid fossa. The two **deep temporal branches**, the **masseter, pterygoid**, and the **buccal** branch are all shown in *Figure 45.13*.

The **pterygoid plexus of veins** complements the maxillary artery in the infratemporal fossa. The veins are usually doubled (venae comitantes) and, in large part, lie lateral to the maxillary artery. These veins are extremely important because of their connections with the cavernous sinus via the deep facial, inferior ophthalmic, and emissary veins in the sphenoid bone. Since the veins of the head lack valves and constitute a very low-pressure system, infection and intravenously injected anesthetics can be forced in a retrograde fashion from the infratemporal region to the intracranial meninges. Facial infections can therefore lead to meningitis.

The **medial pterygoid** lies deep to the lateral pterygoid and arises from the medial side of the lateral pterygoid plate and the tuberosity of the maxilla. It projects in an inferior and posterior direction to insert on the medial aspect of the angle of the mandible (*figs. 45.11 and 45.15*). It largely complements the masseter muscle on the lateral side of the mandibular ramus and acts as a major elevator

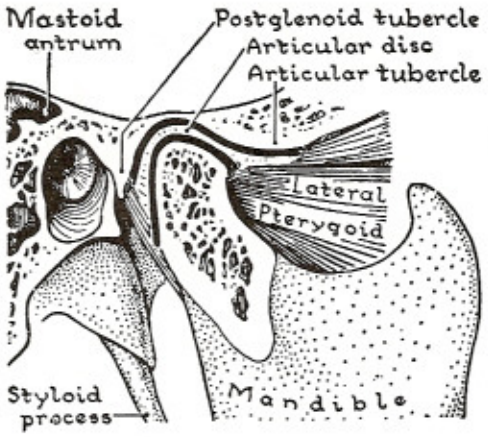

Figure 45.14. Mandibular joint (on sagittal section).

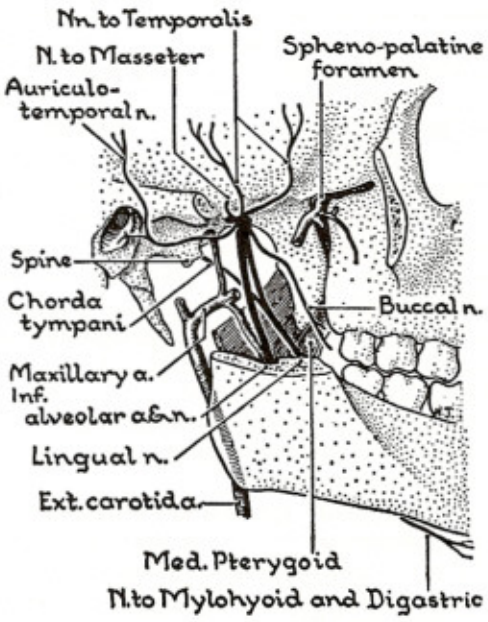

Figure 45.15. The mandibular nerve.

of the mandible along with the masseter and temporalis muscles. The fascia that invests the medial pterygoid muscle forms the floor of the infratemporal fossa. The mandibular division of the trigeminal nerve (V^3) lies between the lateral and medial pterygoid muscles.

The **mandibular nerve (V^3)** (*fig. 45.15*) leaves the trigeminal ganglion area in the middle cranial fossa and enters the infratemporal fossa through the **foramen ovale**. V^3 has a large component of sensory fibers whose cell bodies are located in the trigeminal ganglion. The smaller motor root has its cell bodies in the brainstem and not in the trigeminal ganglion.

In the infratemporal fossa, V^3 divides into two subsequent divisions: a smaller anterior division that is mainly motor to the muscles of mastication and a larger posterior division that contains mainly sensory nerves.

Branches of the Anterior Division of V^3

On the undersurface of the squamous portion of the temporal bone, branches of V^3 project to the **masseter muscle** by passing over the superior head of the lateral pterygoid, traversing the mandibular notch, and entering the deep surface of the masseter. Branches to the posterior and anterior portions of temporalis also ascend on the temporal bone above the superior head of the lateral pterygoid muscle to enter the undersurface of the temporalis muscle. The nerve to the lateral pterygoid is associated with the **buccal nerve** of V^3 that passes between the two heads of the lateral pterygoid muscle. The buccal nerve continues into the cheek on the lateral surface of the buccinator muscle. It is the terminal branch of the anterior division and is a **sensory nerve** to the mucosa of the inside of the cheek and lower gingiva (gums) around the molar teeth. The buccal nerve of V^3 must penetrate the buccinator muscle to supply the mucosa **but is not motor to buccinator**. The motor supply to the buccinator muscle is via the **buccal branches** of VII. The medial pterygoid muscle receives innervation by a branch directly from the trunk of V^3.

Three major nerves of the infratemporal fossa are associated with the larger posterior division of V^3. They are the **auriculotemporal, inferior alveolar (dental)**, and **lingual nerves**.

The Auriculotemporal Nerve (*fig. 45.15*)

The auriculotemporal nerve arises from V^3 just inferior to the foramen ovale and projects posteriorly in the infratemporal fossa parallel to the roof. The initial segment of the auriculotemporal nerve has two important features: (*a*) it encircles the middle meningeal artery as the artery ascends to enter the foramen spinosum; and (*b*) it receives the postganglionic parasympathetic fibers from the otic ganglion that are secretomotor to the parotid gland. The auriculotemporal nerve leaves the infratemporal fossa by passing medial to the head of the mandibular condyle and sending a sensory branch to the temporomandibular joint. The auriculotemporal nerve then enters the deep portion of the parotid gland. It gives sensory branches to the gland and its capsule as well as the secretomotor parasympathetic fibers that were carried from the otic ganglion (*fig. 45.8*). The terminal part of the auriculotemporal nerve accompanies the superficial temporal artery in its exit from the superior border of the parotid gland to the skin and superficial tissue of the upper half of the pinna of the ear and the temporal area (*fig. 45.6*). The auriculotemporal nerve is therefore sensory for pain and general sensation over the upper portion of the V^3 dermatome of the face (*fig. 38.11*).

The Inferior Alveolar (Dental) Nerve (*fig. 45.15*)

The inferior alveolar nerve descends from the foramen ovale to enter the mandibular foramen on the medial aspect of the ramus of the mandible. In its course through the infratemporal fossa, it lies between the medial and lateral pterygoid muscles and just posterior to the lingual nerve. Its only branch in the infratemporal fossa is a **motor** branch to the **mylohyoid muscle** and the **anterior belly of the digastric muscle**. This **mylohyoid nerve** arises from the inferior alveolar nerve just before it enters the mandibular foramen. The mylohyoid nerve then runs in the mylohyoid groove on the medial aspect of the ramus (*fig. 45.4*) and enters the submental triangle (*fig. 43.17*) on the inferior (superficial) aspect of the mylohyoid muscle.

The portion of the inferior alveolar nerve that enters the mandibular canal then courses through the ramus and

body of the mandible. This portion is entirely sensory to the teeth, bone and mucosa of the lower lip and gingiva (gums) adjacent to the lower incisive teeth. *Figure 45.3* shows the mental foramen on the lateral aspect of the body, which allows the **mental nerve** branch of the inferior alveolar nerve to exit from the mandibular canal and reach the gingival and mucosal tissue in the vicinity of the lower lip.

The Lingual Nerve (*fig. 45.15*)

The lingual nerve has a similar course to the inferior alveolar nerve through the infratemporal fossa. It lies anterior to the inferior alveolar nerve, and it remains medial to the mandible throughout its entire course. The two nerves therefore become separated when the inferior alveolar nerve enters the mandibular canal. Within the infratemporal fossa, the lingual nerve **receives** a branch called the **chorda tympani**. These are preganglionic **parasympathetic secretomotor fibers of VII** from the tympanic plexus and **special sensory fibers for taste** that are running from the anterior two-thirds of the tongue to their cell bodies in the **geniculate ganglion of VII**. The chorda tympani passes through the **petrotympanic fissure** as it communicates between the middle ear cavity and the infratemporal fossa. This petrotympanic fissure is in the temporal bone but related to the medial aspect of the spine of the sphenoid bone, and therefore, the foramen spinosum and middle meningeal artery. The chorda tympani lies medial to the spine of the sphenoid, and the middle meningeal artery and the auriculotemporal nerve lie lateral to this structure in the infratemporal fossa (*fig. 45.15*).

The terminal distribution of the lingual nerve (V^3) and its associated fibers that are derived from VII are to the floor of the mouth and tongue. The lingual nerve is sensory for general sensation (pain, temperature, touch, and pressure) to the anterior two-thirds of the tongue and mucosa on the lingual surface of the mandible and floor of the mouth. Nerve VII is sensory for taste in this region and also secretomotor to *all* the glands in the floor of the mouth. The details of this innervation are discussed in Chapter 49.

Dentists manipulate the mandibular nerve division by placing anesthetics in the fascial compartment, defined by the fascia covering the medial pterygoid muscle and the medial aspect of the ramus of the mandible (*fig. 45.11*). The lipid-soluble anesthetic rapidly diffuses through this fat-filled space and enters the lipid (myelin) surrounding the inferior alveolar and lingual nerves. Anesthesia of the lower teeth, gingiva, lip, and mucosa of the tongue is thereby established in this **mandibular block technique**.

Temporomandibular Joint (TMJ)

The articulation of the mandible (jaw) with the temporal bone (base of the skull) occurs between the **head of the mandible** and the **mandibular fossa and articular tubercle of the temporal bone**. These bony surfaces are covered by cartilage and this synovial joint is somewhat unique in that it contains an intra-articular disc. The **articular disc** (*fig. 45.14*) divides the joint into a superior and inferior compartment. The inferior compartment permits a hinge rotation for the mandibular head, while the superior compartment is a sliding joint to permit the head to move either in the mandibular fossa or on the articular tubercle when the mandible is protruded (moved anteriorly). The articular disc is completely attached to the capsule of the joint throughout its periphery. The superior head of the lateral pterygoid muscle inserts into the capsule and disc and provides the force to move the disc anteriorly on the articulating tubercle when the lower head of the lateral pterygoid muscle pulls the mandible anteriorly during protrusion.

External to the joint capsule are three ligaments: the **lateral temporomandibular ligament** (simply a thickening of the capsule); the **stylomandibular ligament** (separating the parotid and submandibular glands); and the **sphenomandibular ligament** (*fig. 45.11*). These ligaments play a minor role in the stability and support of the joint. The **major supportive elements are the muscles of mastication**, which keep the mandibular head in contact with its articulating surfaces on the temporal bone. The masseter and medial pterygoid muscles form a "sling" that supports the angle of the mandible and the temporalis supports the anterior aspect of the ramus. All three muscles act to elevate the mandible and secure it into the temporal fossa.

Movements of the Mandible through the TMJ

Elevation (closure of the mouth)—Masseter, medial pterygoid, and temporalis (vertical fibers).

Depression (opening of the mouth)—Gravity, mylohyoid, anterior belly of digastric, and lateral pterygoid (as it pulls the head over the descending slope of the articular tubercle).

Protrusion (Anterior Projection)—Lateral pterygoid (medial pterygoid fibers may also assist since they course anterosuperiorly).

Retraction (Posterior Movement)—Temporalis (horizontal fibers).

Chewing or masticatory movements are complex intermixtures of these basic movements. Unilateral movements of the TMJ occur when one TMJ is stabilized in the mandibular fossa and, protrusive and depressive forces are applied to the opposite side of the mandible.

Clinical testing of the muscles of mastication and V^3 motor intervention can be done in 2 ways: (1) Superficial palpation of the temporalis and masseter is done while the patient clenches the teeth. (2) The patient is asked to protrude the jaw. A midline projection indicates a balanced protrusion by the right and left lateral pterygoid muscles. Weakness or paralysis of either muscle would produce a deviation of the protruded mandible toward the side of weakness.

DISLOCATION OF THE MANDIBLE (SUBLUXATION)

The head of the mandible may be dislocated from its articulating surface of the temporal bone in cases of extreme protrusion. Such movement usually occurs if the muscles are unresponsive to the impulses from the muscle stretch receptors, which normally prevent the excessive forces that would cause dislocation. Excessive yawning, having the mouth open continuously for extended periods during anesthesia or dental procedures, or having the anterior division of V^3 anesthetized by a local nerve block can interfere with the feedback influences that prevent dislocation.

When dislocation does occur (*fig. 45.16*), the head of the mandible "rides" over the crest of the articular tubercle and contacts the base of the skull, which is formed by the greater wing of the sphenoid bone. One must then depress the dislocated head and retract it into the mandibular fossa. Frequently muscle spasms of the masseter and temporalis are too great to do this. One then anesthetizes the nerves to these muscles by placing an anesthetic in the temporal fossa or notch of the mandible. This relaxes the muscles and allows reduction of the dislocation. The mandible must then be supported by a sling or by wiring the teeth together in an occluded position. This will assist the stability of the TMJ, while the muscles and ligaments heal and restore their support of the joint.

Figure 45.16. Diagrams illustrating the changing position of the head of the mandible and the temporal bone when *A*, the mouth is closed, *B*, the mouth is open, and *C*, the temporomandibular joint is dislocated. Note that the head of the mandible and the articular disc slide forward over the articular tubercle as the head rotates on the disc. (From Basmajian.)

EMBRYOLOGICAL NOTES

The mandible and its associated structures are derived from the mesoderm that surround the first aortic arch in the embryo (**1st branchial or 1st pharyngeal arch**). The mesoderm gives rise to cartilage, bone, muscle, and connective tissue elements. Since the 1st arch is innervated by the nerve V, the adult derivatives of this tissue will also have V innervation.

All the muscles that insert onto and move the mandible through the TMJ are innervated by V^3 (masseter, temporalis, medial pterygoid, lateral pterygoid, mylohyoid and anterior belly of the digastric muscles).

Meckel's cartilage in the embryo induces the formation of the mandible from mesodermal tissue in the pharyngeal arch. Structures that are derived from Meckel's cartilage directly are shown in *Figure 45.17*. They are the **sphenomandibular ligament, anterior ligament of the malleus, malleus,** and **incus**. The malleus and incus are two of the three middle ear bones (ossicles). The malleus is moved by the tympanic membrane (eardrum) vibration and a muscle (the **tensor tympani**). Since the **tensor tympani** muscle acts on a bone derived from the 1st pharyngeal arch, it will also be innervated by a branch from V^3. The V^3 branch to **tensor tympani** arises with the branch to the medial pterygoid just as the V^3 trunk exits the foramen ovale.

This embryonic relationship between the mandibular structures and the ear also explains, in part, how pain is "referred" from the mandible to the ear and **vice versa**. Dental pain can frequently be interpreted as an "earache." Temporomandibular joint pain and TMJ disorders may also exhibit earache and ear symptoms. Both are

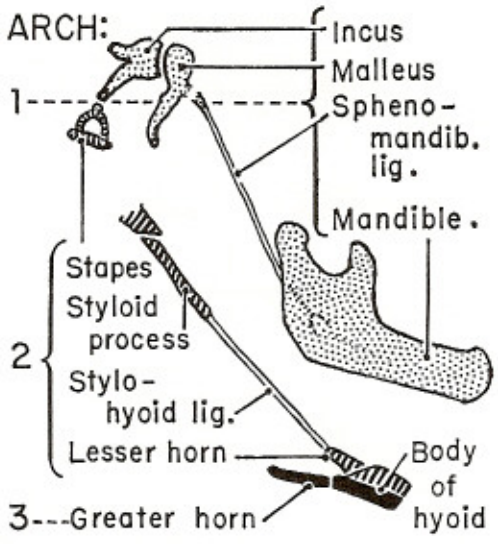

Figure 45.17. Two vestigial ligaments (sphenomandibular and stylohyoid) derived from the cartilages of the 1st and 2nd pharyngeal arches.

innervated by branches of the auriculotemporal nerve and have similar embryonic origins.

Clinical Mini-Problems

1. **Which major nerve(s) and vessel(s) would a surgeon need to avoid in removing the deep part of the parotid gland? What are the lateral to medial relationships of these intraglandular structures?**
2. **Why is pain in the parotid gland more intense prior to meal times and somewhat relieved after eating?**
3. **Why did a physician suspect that a child had "mumps" when the child presented with a fever, pain in the ear, and a sensitive and inflamed oral mucous membrane opposite to the upper second molar?**
4. **Where would one expect to find a lesion (disorder) in nerve VII of a patient who has paralysis of all the facial muscles on the right side but has normal parasympathetic function in the glands on the right side of the face?**
5. **If nerve axons regenerate by growing approximately 1 mm per day (1 inch per month), how would you advise the patient in problem 4 on the approximate time for recovery of this type of nerve damage?**
6. **Headache in the temporal region may be caused by stimulation of general pain receptors of the auriculotemporal nerve V^3, by vascular disorders (migraine) or by muscle spasms in the temporalis muscle. Where would one place a local anesthetic to temporarily "relax" the temporalis muscle in differentially diagnosing the possible cause for a patient's headache?**
7. **A 14-year-old girl with severely prognathic (anteriorly protruding) mandible was scheduled for a mandibular resection of the rami in order to shift the mandible posteriorly before orthodontic therapy. Why would the oral surgeon place the horizontal cuts through the rami above the level of the lingulae?**
8. **Which cranial nerve would be damaged if a patient's mandible deviated to the left side during protrusive movement?**
9. **"Shingles" is a painful skin disorder that results from a viral infection in the cell bodies of sensory neurons. If a patient presented with a painful rash and tiny raised skin blisters over their left jaw, upper ear and temporal region, where would you expect the viral infection to be located?**
10. **(a) When a dentist gives an anesthetic in the infratemporal fossa for anesthetizing the lower teeth, why are the tongue and skin of the same side also "numbed"?**
    (b) Would general sensation, taste sensation, or both be absent in the anesthetized tongue?

(Answers to these questions can be found on p. 588.)