1
SURGICAL ANATOMY OF THE HEAD AND NECK

Susan D. John

Michael D. Maves

Susan D. John: *Pediatric Radiology Section, Memorial/Hermann Children's Hospital; Department of Radiology, University of Texas—Houston Medical School, Houston, Texas.*

M. D. Maves: *Department of Otolaryngology, Georgetown University Medical Center and School of Medicine, Washington, D.C.*

Anatomy is the basic science of all surgery. Surgery in the region of the head and neck cannot be considered safe unless the surgeon thoroughly understands the anatomy of this area and its important variations. Although anatomic structures and the relations between them do not change, our knowledge of anatomy must be continually updated to meet the challenge of new surgical techniques and approaches. This chapter is overview of surgical anatomy of the head and neck with a focus on the major regions. It is not a substitute for thorough anatomic knowledge, which can be gained only through intensive study in a cadaver laboratory and an operating room.

THE CRANIUM

Scalp

The cranium is covered by the hair-bearing scalp, which is divided into layers of skin and subcutaneous tissue, galea aponeurotica, loose connective tissue, and periosteum or pericranium covering the calvarial vault. The blood supply of the scalp comes from the paired supraorbital and supratrochlear arteries anteriorly, the terminal branches of the superficial temporal arteries laterally, and the occipital vessels posteriorly. This rich vascularity provides a network on which small scalp flaps can be based and rotated, as in the management of male pattern baldness. Sensation to the scalp is provided by branches of cranial and spinal nerves.

Calvaria

The bony vault of the cranium, the calvaria, consists of the unpaired frontal bone, the paired parietal bones, and the unpaired occipital bone (Fig. 1.1). In the lateral aspect, the greater wing of the sphenoid bone and the temporal bone complete the cranium. There is a rich layer of diploic bone between the inner and outer tables of the calvaria. This is a source for split-thickness calvarial bone grafts, which often are used in head and neck reconstruction. The calvarium is thickest at the external occipital protuberance and in the parietal region. It is thinnest over the temporal region. This allows ready access for neurotologic operations on the middle fossa. The venous circulation of the calvaria is provided by diploic veins, which drain to the veins of the scalp or into the dural venous sinuses. In some instances the diploic veins are connected to each other, and this

communication allows osteomyelitis that originates in the frontal sinus to involve the frontal bone, scalp, and dura.

FIGURE 1.1. Scalp, cranium, and intracranial cavity. **A:** *1*, Coronal suture; *2*, superior temporal line; *3*, inferior temporal line; *4*, os parietale; *5*, squamous suture; *6*, parietomastoid suture; *7*, lambdoid suture; *8*, occipital bone; *9*, occipitomastoid suture; *10*, mastoid process; *11*, external acoustic meatus; *12*, styloid process; *13*, condyle of mandible; *14*, coronoid process of mandible; *15*, body of mandible; *16*, mental foramen; *17*, zygomatic bone; *18*, infraorbital foramen; *19*, frontal process (maxilla); *20*, anterior nasal spine; *21*, nasal bone; *22*, lacrimal bone; *23*, orbital lamina of ethmoid bone; *24*, glabella; *25*, sphenoid bone; *26*, pterion; *27*, temporal bone. **B:** *1*, Sphenoid bone; *2*, frontal bone; *3*, anterior cranial fossa; *4*, anterior clinoid process; *5*, carotid sulcus; *6*, middle cranial fossa; *7*, petrous portion of temporal bone; *8*, internal acoustic meatus; *9*, jugular foramen; *10*, mastoid foramen; *11*, hypoglossal canal; *12*, foramen magnum; *13*, posterior cranial fossa; *14*, sulcus for greater and lesser petrosal nerves; *15*, foramen spinosum; *16*, foramen ovale; *17*, foramen lacerum; *18*, foramen rotundum; *19*, superior orbital fissure; *20*, optic canal; *21*, anterior ethmoidal foramen; *22*, anterior ethmoidal foramen; *23*, foramen cecum.

Cranial Fossae

The intracranial cavity is roughly divided into three fossae. The anterior or frontal cranial fossa contains the paired frontal lobes and provides access to the nasal cavity for the olfactory nerves through the cribriform plate. The crista galli provides superior midline extension of the nasal septum. The middle cranial fossa contains the temporal lobes. In this important junction of the cranial cavity, the middle meningeal artery arises from the foramen spinosum, and the trigeminal nerve enters through the superior orbital fissure (V1), the foramen rotundum (V2), and the foramen ovale (V3). Cranial nerves II, III, IV, and VI, which traverse the cavernous sinus and enter the orbit, also course through the middle cranial fossa. The internal carotid artery is in its place in the carotid siphon as it traverses the cavernous sinus in this region. The posterior cranial fossa contains the paired cerebellar hemispheres and the brainstem. In this location, the internal auditory meatus is associated with the seventh and eighth cranial nerve complex. The jugular foramen, transverse sinus, and foramen magnum are the major landmarks of the posterior cranial fossa.

EYELID, ORBIT, AND EYE

Eyelids

The upper and lower eyelids are similar in structure, although the upper eyelid is more mobile and has features not found in the lower eyelid. The space between the eyelids is known as the palpebral fissure, which is limited medially and laterally by the canthi. At the medial canthus is the lacrimal caruncle, where there is a small lake of tears and the tiny papillae of the lacrimal duct system. The conjunctiva is a thin mucous membrane layer that covers the inner aspects of the eyelids and extends onto the surface of the globe.

Tarsus

The upper tarsal plate provides rigidity to the upper eyelid and is larger than the lower tarsus (Fig. 1.2). Each eyelid consists from without inward of skin, subcutaneous tissue, voluntary muscle of the orbicularis oculi, orbital septum, tarsus, smooth muscle, and conjunctiva. The more freely mobile upper lid receives the insertion of the levator palpebrae superioris muscle. The orbicularis oculi is the sphincteric muscle of the upper and lower eyelids. It attaches at a medial palpebral ligament and spreads in an arc laterally and inferiorly to provide a sphincteric muscle to the eye. It receives innervation from the temporal and zygomatic branches of the facial nerve. This muscle interdigitates with the frontalis muscle and the corrugator supercilia.

FIGURE 1.2. Eyelids and external adnexa. **A:** *1*, Superior tarsus; *2*, levator palpebrae superioris muscle; *3*, supraorbital artery and nerve; *4*, supratrochlear artery and nerve; *5*, lacrimal caruncle; *6*, superior lacrimal papilla and puncta; *7*, bulbar conjunctiva over sclera; *8*, pupil; *9*, cornea; *10*, superior palpebral conjunctiva; *11*, inferior palpebral conjunctiva; *12*, inferior lacrimal papilla and puncta; *13*, maxilla; *14*, lacrimal sac; *15*, medial palpebral ligament; *16*, infraorbital foramen; *17*, orbital septum; *18*, inferior tarsus; *19*, orbicularis oculi muscle (cut); *20*, lateral palpebral ligament. **B:** *1*, Orbicularis oculi muscle; *2*, orbital septum; *3*, levator palpebrae superioris muscle; *4*, superior tarsal muscle (Müller muscle); *5*, superior conjunctival fornix; *6*, orbicularis oculi muscle (palpebral portion); *7*, superior tarsus; *8*, tarsal glands; *9*, palpebral conjunctiva; *10*, inferior tarsus; *11*, sclera; *12*, choroid; *13*, retina; *14*, lens; *15*, iris; *16*, anterior chamber; *17*, cornea.

Blood Supply

The arterial supply of the eyelids is provided by the angular branch of the facial artery, which forms an anastomotic network with the supraorbital and supratrochlear artery and shares a small contribution from the superficial temporal vessels. The veins of the eyelids are larger and more numerous than are the arteries and drain into the ophthalmic and angular veins medially and the superficial temporal vein laterally. Accompanying the peripheral arterial arcade of the upper eyelid, the veins of the small venous plexus drain into the ophthalmic vein, which drains posteriorly to the cavernous sinus. The veins in this region of the face do not have valves and may propagate septic emboli posteriorly. This is a particularly dangerous situation for patients who have infections in the areas of the eyelids or periorbital abscess. These patients are at risk of cavernous sinus thrombosis.

Lacrimal System

The lacrimal apparatus consists of a secretory portion, the lacrimal gland, its ducts, the drainage apparatus, the lacrimal canaliculi and sac, and the nasolacrimal duct (Fig. 1.3). The lacrimal gland is partially divided into two portions by the lateral

horn of the aponeurosis of the levator palpebrae. The larger orbital portion of the gland lies in a shallow fossa on the frontal bone and is in contact anteriorly with the orbital septum. The excretory ductules of the lacrimal gland run through the orbital part of the gland, run through or close to the posterior part of the palpebral portion, and are joined by ducts from this portion. Removal of the palpebral portion can destroy the drainage of the entire gland.

FIGURE 1.3. Lacrimal apparatus and drainage system. *1*, Lacrimal gland and ducts; *2*, superior lacrimal papilla and puncta; *3*, lacrimal caruncle; *4*, lacrimal sac; *5*, inferior lacrimal papilla and puncta; *6*, middle nasal concha; *7*, inferior nasal concha; *8*, opening of nasolacrimal duct.

Movement of the eyelid distributes tears over the surface of the eye, and any excess tends to accumulate in the lacrimal lake. This structure drains into the paired superior and inferior canaliculi and from there into the lacrimal sac. The lacrimal sac is housed in the bony lacrimal fossa of the medial orbital wall. This drains into the nasal lacrimal duct and eventually into the inferior meatus of the nose.

Orbit

The bony orbit consists of the medial wall occupied largely by the ethmoid bone, lacrimal bone, and a portion of the nasal

process of the maxilla (Fig. 1.4). The floor of the orbit consists of the roof of the maxilla. The inferior orbital fissure is at its lateral extent. The zygomatic bone and greater wing of the sphenoid form the lateral orbital wall and join the frontal bone superiorly to complete the pyramidal bony orbit. On its medial aspect are the paired ethmoidal foramina, which provide a route to the orbit for the anterior and posterior ethmoidal arteries. The optic canal posteriorly transmits the optic nerve and ophthalmic artery. The superior orbital fissure transmits cranial nerves III, IV, V, and VI and provides an aperture for the ophthalmic vein.

FIGURE 1.4. Bony orbit.

Eye

The eye consists of the cornea and sclera in the anterior aspect. The anterior chamber protrudes as a second sphere on the structure of the orbit. The lens and iris form the posterior portion of the anterior chamber. Contained within the substance of the eye is the vitreous. The retina rests on the choroid. The fovea centralis is the focal point of the eye. Asymmetric to the structure of the orbit is the insertion of the optic nerve and ciliary arteries.

The seven voluntary muscles of the orbit are the levator palpebrae superioris; the superior, inferior, medial, and lateral rectus muscles; and the superior and inferior oblique muscles (Fig. 1.5). The smooth muscles of the orbit are the orbitalis muscle, the superior and inferior tarsal muscles, and ciliary and iridial muscles within the eye. The superior oblique is supplied by cranial nerve IV, the lateral rectus by cranial nerve VI, and the other voluntary muscles of the orbit by cranial nerve III. The tarsal and orbital muscles (of Müller) are supplied by sympathetic fibers derived from the carotid plexus and from the superior cervical ganglion. The dilator pupillae, the sphincter pupillae, and the ciliary muscle are

supplied by parasympathetic fibers through the oculomotor nerve (III).

FIGURE 1.5. Eye muscles. *1*, Levator palpebrae superioris muscle; *2*, superior oblique muscle; *3*, superior rectus muscle; *4*, optic nerve; *5*, lateral rectus muscle; *6*, inferior rectus muscle; *7*, inferior oblique muscle; *8*, medial rectus muscle; *9*, trochlea; *10*, annular tendon.

The primary blood supply to the orbit is through the ophthalmic artery. The primary drainage is through the ophthalmic vein, which drains directly into the cavernous sinus. An additional anastomotic network is present on the anterior aspect of the face in the form of an arcade of vessels around the eyelids and through the pterygoid plexus.

THE EAR

The development and the anatomic and physiologic features of the ear are discussed in Chapter 128 and Chapter 129.

NOSE AND PARANASAL SINUSES

External Nose

The external part of the nose is a roughly pyramidal shape. The skeleton of the external nose is partly bony and partly cartilaginous and membranous. The nasal bones, which are usually narrow and thicker above, wider and thinner below, articulate firmly above with the nasal part of the frontal bone and with each other laterally with the nasal process of the maxilla (Fig. 1.6).

P.7

Attached to the inferior aspect of the nasal bones are the upper lateral cartilages. These are continuous with the cartilaginous septum. In the inferior aspect, the lobule of the nose is formed mostly by the lower lateral cartilages, which consist of a medial and lateral crus. There are several small cartilages within the nasal ala. The chief arterial supply of the nose is from the facial artery through the angular artery and superior labial arteries. Venous drainage is similar, with a component gaining access to the ophthalmic vein through draining vessels from the trochlear and angular veins.

FIGURE 1.6. Bony and cartilaginous anatomic configuration of the external nose.

Nasal Cavity

The nasal cavities are also known as the *nasal fossae*. The nasal septum consists of the nasal septal cartilage, the nasal crest of the maxilla, the nasal crest of the palatine bone, the vomer, and the perpendicular plate of the ethmoid bone. The lateral nasal wall is formed by the prominent nasal turbinates. The meatus are situated below the corresponding turbinates (Fig. 1.7). The inferior meatus provides drainage for the

nasolacrimal duct. The middle meatus provides drainage for the anterior nasal sinuses, namely the frontal sinus, anterior ethmoid sinuses, and the maxillary sinus. The superior meatus provides drainage for the posterior sinuses, namely the posterior ethmoid and sphenoid sinuses.

FIGURE 1.7. A: Lateral nasal wall. *1*, Frontal sinus; *2*, middle nasal concha; *3*, middle nasal meatus; *4*, agger nasi; *5*, atrium of middle nasal concha; *6*, limen; *7*, vestibule; *8*, inferior nasal meatus; *9*, incisive canal; *10*, palatine process of maxilla; *11*, soft palate; *12*, pharyngeal recess; *13*, eustachian tube orifice; *14*, toris tubarius; *15*, adenoid; *16*, sphenoid sinus; *17*, sphenoid sinus opening; *18*, sphenoethmoidal recess; *19*, inferior nasal concha; *20*, superior nasal meatus; *21*, superior nasal concha; *22*, palatine bone. **B:** Nasal septum. *1*, Perpendicular plate; *2*, cribriform plate; *3*, crista galli; *4*, frontal bone; *5*, nasal bone; *6*, septal cartilage; *7*, medial crus; *8*, anterior nasal spine; *9*, incisive canal; *10*, palatine process; *11*, perpendicular plate; *12*, postnasal spine; *13*, horizontal plate; *14*, lateral pterygoid plate; *15*, medial pterygoid plate; *16*, sphenoid sinus; *17*, crest; *18*, body.

The arterial supply of this region is from internal carotid sources through the anterior and posterior ethmoid arteries and from an external carotid source through the sphenopalatine artery. Contributions also may exist from the greater palatine vessels and the septal branch of the superior labial artery. These form an important anastomotic network in the anterior septum known as the *Kiesselbach plexus*, which accounts for most nosebleeds.

Sinuses

The paranasal sinuses consist of the paired frontal, ethmoid, maxillary, and sphenoid sinuses (Fig. 1.8). The frontal sinus

develops as one of several outgrowths from the region of the frontal recess. Two, three, or even more frontal sinuses on a side have been reported, and some persons have no frontal sinus. The degree of pneumatization of the frontal sinuses varies. Pneumatization may extend into the roof of the orbit and laterally into the frontal bone as far as the sphenoid wing. The frontal sinuses drain into the anterior aspect of the middle meatus.

FIGURE 1.8. Paranasal sinuses. *1*, Nasal septum; *2*, frontal sinus; *3*, nasal cavities; *4*, ethmoidal cells; *5*, middle nasal concha; *6*, middle nasal meatus; *7*, maxillary sinus; 8, inferior nasal concha; *9*, hard palate.

Ethmoid Sinuses

The ethmoid sinuses consist of a variable number of separate cavities that honeycomb the ethmoid bone between the upper part of the lateral nasal wall and the medial wall of the orbit. The anterior ethmoid cells are divided into frontal recess cells, which open into the frontal recess of the middle meatus; infundibular cells, which open into the ethmoid infundibulum; and bullar or middle ethmoid cells, which open directly into the middle meatus on or above the ethmoid bulla. There may be one to seven posterior ethmoid cells. The bullae and posterior ethmoid cells may encroach on each other and overlap, the bullar

cells spreading backward or the posterior cells forward. The posterior ethmoid cells drain into the superior meatus.

Sphenoid Sinus

The sphenoid sinus usually opens into the sphenoethmoidal recess above and behind the superior nasal concha. The ostium usually is in the posterior wall of the recess, but sometimes it is

on its lateral wall. The degree of pneumatization of the sphenoid sinus varies. This variation is an important factor in surgical approaches to the pituitary gland. The relations of the sphenoid sinus are important because of the surrounding anatomic structures. The optic nerves are superior to the sinus, and the internal carotid artery is lateral to the sinus within the cavernous sinus. The maxillary nerve lies in the inferior lateral portion of the sinus in the anterior aspect. The hypophysis lies within the posterior superior portion of the sphenoid sinus and can be approached through transsphenoidal hypophysectomy.

Maxillary Sinus

The maxillary sinus usually is the largest of the paranasal sinuses and is situated in the body of the maxilla. Its anterior wall is the facial surface of this bone, and its posterior wall is the infratemporal surface. Its medial wall is that of the nasal cavity. The roof of the maxillary sinus is also the floor of the orbit, and it also may be affected in blowout fractures of the orbit. The maxillary sinus drains into the middle meatus of the nasal cavity. The roots of the posterior molar teeth may extend into the sinus. The maxillary sinus is bounded posteriorly by the pterygomaxillary fossa, through which course the terminal branches of the internal maxillary artery. These vessels can be approached through the maxillary sinus for relief of epistaxis.

THE FACE

Facial Bones and Muscles

The bones of the face include the frontal and nasal bones and the facial bones proper—maxilla, mandible, zygomatic, and palatine bones. The facial and mimetic muscles are divided into five chief groups concerned with the mouth, nose, orbit, ear, and scalp (Fig. 1.9). The platysma muscle in the neck also belongs to the facial group. The chief action of these muscles is on skin into which they insert. All these muscles are innervated by the facial nerve.

FIGURE 1.9. Facial muscles. *1*, Galea aponeurotica; *2*, frontalis; *3*, procerus; *4*, depressor supercilii; *5*, corrugator supercilii; *6*, orbicularis oculi; *7*, nasalis; 8, levator labii superioris; *9*, levator anguli oris; *10*, levator labii superioris alaeque nasi; *11*, orbicularis oris; *12*, mentalis; *13*, depressor labii inferioris; *14*, depressor anguli oris; *15*, platysma; *16*, masseter; *17*, zygomaticus major; *18*, zygomaticus minor; *19*, temporalis; *20*, lateral pterygoid; *21*, medial pterygoid; *22*, buccinator.

Parotid Gland

The parotid gland, which is anterior to and below the lower part of the ear, extends subcutaneously backward over the anterior portion of the sternocleidomastoid muscle, forward over the masseter muscle, and deeply behind the ramus of the mandible to lie between the mandible and the external acoustic meatus and mastoid process (Fig. 1.10). The gland is roughly divided into a lateral and medial portion by the course of the facial nerve. Related to the parotid gland are several periparotid and intraparotid lymph nodes, which may swell. The parotid gland drains through the parotid duct. It is innervated by the auriculotemporal nerve from the otic ganglion.

FIGURE 1.10. Parotid gland and facial nerve. *1*, Temporal branch; *2*, zygomatic branch; *3*, buccal branch; *4*, masseter muscle; *5*, marginal mandibular branch; *6*, anterior digastric muscle; *7*, cervical branch; 8, parotid gland; *9*, posterior digastric muscle; *10*, seventh cranial or facial nerve; *11*, pes anserinus.

Facial Nerve

The anatomic characteristics of the facial nerve vary in the extracranial portion of the nerve. Identification of the nerve depends on marking the position of the posterior belly of the digastric muscle, the external meatal cartilage, the tympanomastoid suture line, and the styloid process.

ORAL STRUCTURES

Maxilla

The maxilla is the chief component of the upper jaw (Fig. 1.11). In addition to housing the dental apparatus and the maxillary sinus, it is related posteriorly to the medial and lateral pterygoid plates. The hard palate unites the paired maxilla and forms the bony roof of the oral cavity. Sensation to the upper teeth is provided by the maxillary nerve through the posterior superior and anterior superior alveolar nerves. The infraorbital nerve, another branch of V2, provides sensation over the face of the maxilla and soft tissues.

FIGURE 1.11. Maxilla and jaw. **A:** *1*, Sphenopalatine artery; *2*, posterior lateral nasal artery; *3*, posterior septal arteries; *4*, anastomosis in the incisive canal; *5*, greater palatine artery; *6*, lesser palatine artery; *7*, descending palatine artery; *8*, superior alveolar arteries; *9*, artery of the pterygoid canal; *10*, anterior and posterior deep temporal arteries; *11*, accessory meningeal artery; *12*, middle meningeal artery; *13*, anterior tympanic artery; *14*, deep auricular artery; *15*, auriculotemporal nerve; *16*, superficial temporal artery; *17*, buccal artery; *18*, masseteric artery; *19*, inferior alveolar artery; *20*, ascending pharyngeal artery; *21*, ascending palatine artery; *22*, tonsillar artery; *23*, external carotid artery; *24*, facial artery; *25*, superior constrictor muscle. **B:** *D*, Digastric muscle (cut); *M*, mylohyoid artery and nerve; *IA*, inferior alveolar artery and nerve; *LA*, lingual artery; *L*, lingual nerve; *MPT*, medial pterygoid muscle and artery; *A*, angular artery; *ST*, supratrochlear artery; *SO*, supraorbital artery; *LPT*, lateral pterygoid muscle; *SL*, sphenomandibular ligament; *O*, ophthalmic artery.

Palate

The palate intervenes between the nasal and oral cavities (Fig. 1.12). It consists of the maxilla, the horizontal process of the palatine bone, and the pterygoid plates. Soft tissues covering this area form the hard and soft palates of the roof of the mouth. The skeletal core of the soft palate is the palatine aponeurosis. The most superficial muscle fibers on the pharyngeal surface of the soft palate are those of the palatopharyngeus muscle. The levator veli palatini, tensor veli palatini, and uvular muscle complete the structures of the soft palate.

FIGURE 1.12. Palate. *1*, Veli palati muscles; *2*, greater palatine foramina; *3*, lesser palatine foramina; *4*, pterygoid hamulus; *5*, superior pharyngeal constrictor muscle; *6*, pterygomandibular raphe; *7*, buccinator muscle; *8*, palatopharyngeus muscle; *9*, palatoglossus muscle; *10*, uvula; *11*, palatine tonsil; *12*, palatopharyngeal arch; *13*, uvular muscle; *14*, palatoglossal arch; *15*, palatine glands; *16*, greater palatine artery and nerve; *17*, lesser palatine artery and nerve; *18*, salpingopharyngeus muscle; *19*, levator veli palatini muscle; *20*, tensor veli palati muscle; *21*, pharyngobasilar fascia; *22*, cartilaginous auditory tube; *23*, carotid canal; *24*, vallate papillae; *25*, incisive foramen.

Mandible

The mandible, or lower jaw, consists of the tooth-bearing body and the ramus that extends upward from the angle of the mandible. The ramus, including the angle, is covered externally by the masseter muscle, which is crossed by the facial nerve and parotid duct. Between the ramus and the medial pterygoid muscle are the inferior alveolar and lingual nerves. Overlapping the posterior border of the ramus is the parotid gland, and within and paralleling this border is the upper portion of the external carotid artery. The superficial branch of this artery emerges from the parotid gland behind the temporomandibular joint, and its internal maxillary branch runs transversely deep to the ramus. Inferiorly and medially, the angle and posterior part of the body of the mandible are related to the submandibular gland, and medially, the anterior part of the mandible is adjacent to the sublingual glands. The musculature most intimately concerned with the mandible and its movements consists of the masseter, temporal, and two pterygoid muscles (Fig. 1.9). These muscles govern mastication and are innervated by the third division of the trigeminal

nerve.

Hyoid Bone and Tongue

The hyoid bone, to which are attached infrahyoid and suprahyoid muscles, effectively separates the anterior suprahyoid and infrahyoid fascial compartments. The suprahyoid muscles are the digastric and stylohyoid muscles, the mylohyoid and the geniohyoid muscles, and the muscles of the tongue (Fig. 1.13). The extrinsic muscles of the tongue are the genioglossus, the hyoglossus, and the styloglossus. The intrinsic muscles of the tongue are complicated bundles of interlacing fibers, among which are connective tissue septa. The midline septum lies between and effectively separates the muscles, nerves, and vessels of the two sides. It is an almost bloodless midline plane.

FIGURE 1.13. Suprahyoid muscles.

Submandibular Gland

The submandibular gland occupies most of the submandibular triangle and expands beyond this area over the superficial structures of the anterior and posterior bellies of the digastric muscle (Fig. 1.14). Its posterior border is close to the lower part of the parotid gland at the angle of the jaw, where it is separated from this gland by the stylomandibular ligament. The submandibular gland is crossed superficially by the facial vein and sometimes by the ramus mandibularis branch of the facial nerve. The larger submandibular lymph nodes lie along

P.11

P.12

the superficial upper border of the gland, between it and the mandible. The anterior portion of the submandibular gland lies directly against the mylohyoid muscle and the mylohyoid nerve. Medial to the mandible and above the level of the submandibular gland is the lingual nerve in its course toward the tongue. When the submandibular gland is removed, the facial vein is sacrificed, but the ramus mandibularis branch of the facial nerve is preserved to avoid disruption of the corner of the mouth. The facial artery passes across the upper surface of the gland, usually grooving it deeply before rounding the lower border of the mandible, and must be sacrificed in removal of the gland. The submandibular and sublingual glands are innervated from the submaxillary ganglion fibers that accompany the sensory fibers of the lingual nerve. These fibers originate in the chorda tympani and pass into the submandibular ganglion.

FIGURE 1.14. Submandibular triangle. *1*, Palatoglossus muscle; *2*, lingual nerve; *3*, superior constrictor muscle; *4*, styloglossus muscle; *5*, stylopharyngeus muscle; *6*, hyoglossus muscle (cut); *7*, stylohyoid muscle (cut); *8*, external carotid artery; *9*, internal jugular vein; *10*, hypoglossal nerve; *11*, digastric muscle, anterior belly; *12*, geniohyoid muscle; *13*, genioglossus muscle; *14*, sublingual artery and vein; *15*, submandibular duct; *16*, deep lingual artery and vein; *17*, submandibular ganglion; *18*, deep lingual artery; *19*, common facial vein; *20*, hyoid bone.

P.13

PHARYNX AND LARYNX

The wall of the pharynx consists of mucosa and voluntary muscle. The mucosal structure of the pharynx varies. That of the nasal part is ciliated and resembles the mucosa of the nose. In the rest of the pharynx, the epithelium is stratified squamous tissue. The muscular wall of the pharynx with its thin covering of buccal pharyngeal or visceral fascia is separated from the prevertebral fascia by an area of loose connective tissue that constitutes the retropharyngeal space.

Nasopharynx

The nasal part of the pharynx, the nasopharynx, is continuous anteriorly through the choana with the nasal cavities (Fig. 1.15). The floor is the upper surface of the soft palate. The fornix or roof, the mucosa of which is attached close to the base of the skull, slopes downward and backward to become continuous with the posterior wall. The eustachian tubes are prominent on the lateral aspect of the nasal pharynx. There may be adenoid tissue in the superior recess of the nasopharynx.

FIGURE 1.15. Pharynx. *1*, Digastric muscle, posterior belly; *2*, adenoid; *3*, pharyngeal raphe; *4*, pharyngobasilar fascia; *5*, stylopharyngeus muscle; *6*, longitudinal esophageal muscle; *7*, circular esophageal muscle; *8*, posterior cricoarytenoid muscle; *9*, cricopharyngeus muscle; *10*, transverse and oblique interarytenoid muscle; *11*, inferior constrictor muscle; *12*, hyoid bone; *13*, middle constrictor muscle; *14*, palatopharyngeus muscle; *15*, uvula; *16*, superior constrictor muscle; *17*, levator veli palati muscle; *18*, cartilaginous auditory tube.

Oropharynx

The oropharynx is continuous anteriorly through the fauces, or oral pharyngeal isthmus, with the oral cavity. The boundaries of the fauces are the posterior border of the soft palate above, the palatine arches laterally, and the dorsum of the tongue. Below the fauces, the anterior wall of the pharynx is the posterior or pharyngeal dorsum of the tongue. On the posterior parts of the dorsum of the tongue lie irregular nodules of tissue known as the lingual tonsils. The lateral wall of the passageway of the fauces houses the large palatine tonsils. The

P.14

lingual tonsils in the anterior aspect, the palatine tonsils in the lateral aspect, and the

pharyngeal tonsils or adenoids in the posterior and superior aspects form a ring of lymphoid tissue known as the Waldeyer ring.

Hypopharynx

The laryngeal part of the pharynx, or hypopharynx, extends from just above the level of the hyoid bone superiorly to the lower border of the cricoid cartilage inferiorly, narrowing rapidly to become continuous with the esophagus. The anterior wall is formed laterally by mucosa on the medial surface of the thyroid cartilage and centrally or medially by the larynx and its appendages. Above is the epiglottis and the aditus of the larynx. Below the aditus, the anterior wall of the pharynx is also the posterior wall of the larynx. Lateral to the epiglottis are the lateral glossoepiglottic folds that form the anterolateral boundary between the oral and laryngeal parts of the pharynx. Below these folds, the hypopharynx extends forward around the sides of the larynx between this area and the thyroid cartilage. These bilateral expansions are the piriform recesses or sinuses.

The intrinsic portion of the larynx consists of the epiglottis, false vocal folds, laryngeal ventricles, paired true vocal folds, and arytenoid cartilages in the posterior aspect. Contained within the aryepiglottic folds are the paired corniculate and cuneiform cartilages. The space between the two vocal folds is the glottis.

The muscles of the pharynx are the superior, middle, and inferior constrictors. These muscles look like ice cream cones inserted into one another. They gradually merge to form the cricopharyngeus muscle at its inferior extent and then the esophagus. Each constrictor inserts with the corresponding muscle of the opposite side and the midline into a posterior midline raphe. These muscles are innervated by cranial nerve X through the pharyngeal plexus. Dehiscence in the pharyngeal constrictors may give rise to Zenker diverticula. Immediately lateral to the pharyngeal muscles are the great vessels of the neck and cranial nerve X.

Larynx

The major structural elements of the larynx are the shield-shaped thyroid cartilage and cricoid cartilages (Fig. 1.16). They join through the cricothyroid joint. The superior cornua of the thyroid ala articulate through several small cartilages with the hyoid bone. Overlying the structure of this skeletal framework are the infrahyoid muscles, which include the paired sternohyoid, sternothyroid, omohyoid, and thyrohyoid muscles.

FIGURE 1.16. Larynx.

The epiglottis is formed of fibroelastic cartilage and has multiple perforations that allow free access of lymphatic drainage or tumor to the preepiglottic space. The preepiglottic space is a C-shaped space bounded superiorly by the median glossoepiglottic ligament, inferiorly by the thyroid cartilage, anteriorly by the thyrohyoid membrane, and posterolaterally by the epiglottis and aryepiglottic folds. Free dissemination of tumor can

occur within the preepiglottic space. The paired arytenoid cartilages provide an attachment for the vocal ligament and movement of the vocal folds. The intrinsic muscles of the larynx are innervated by the recurrent laryngeal nerve. The exception is the cricothyroid muscle, which is innervated by the superior laryngeal nerve. The recurrent laryngeal nerve enters inferiorly and laterally to the cricothyroid articulation through the Killian-Jamieson area. The recurrent laryngeal nerve on the left originates over the aortic arch and ascends in the neck to innervate the larynx. On the right, this structure goes around the subclavian artery.

P.15

THE NECK

Cervical Triangles

The prominent landmarks of the neck are the hyoid bone, the thyroid cartilage, the trachea, and the sternocleidomastoid muscles (Fig. 1.17). The sternocleidomastoid muscles divide each side of the neck into two major triangles, anterior and posterior. The anterior triangle of the neck may be further delimited by the strap muscles into the superior and inferior carotid triangles. The posterior triangles or lateral triangles of the neck are formed by the posterior border of

P.16

P.17

the sternocleidomastoid muscle anteriorly, the clavicle inferiorly, and the anterior border of the trapezius muscle posteriorly. The omohyoid muscle divides this triangle of the neck into a small inferior subclavian triangle and a larger posterior occipital triangle. Deep to these muscles are the scalenes, which form much of the muscle mass of the posterior and lateral portions of the neck. The brachial plexus and subclavian artery course between the anterior and middle scalene muscles. The subclavian vein courses anteriorly to the anterior scalene muscle.

FIGURE 1.17. Muscles and triangles of the neck. *S*, Scalene muscle; *M*, masseter.

Inferior Portion of the Neck

In the inferior root of the neck and closely associated with the brachial plexus are the paired phrenic nerves that course medially to innervate the diaphragm (Fig. 1.18). These nerves originate in the ventral rami of the cervical plexus of the third, fourth, and fifth cervical nerve rootlets. The subclavian artery gives rise to the thyrocervical trunk. The transverse cervical and suprascapular arteries typically course laterally over the surface of the phrenic nerve. This relation allows identification of these structures. The vagus nerve lies further medially and is contained within the carotid sheath. It shares the sheath with the common, internal, and external carotid arteries and jugular vein. Posterior to the carotid sheath lies the cervical sympathetic nerve. On the surface of the carotid sheath lie the ansa hypoglossi nerves.

FIGURE 1.18. Root of neck. *1*, Stylohyoid muscle; *2*, hypoglossal nerve (cranial nerve XII); *3*, digastric muscle; *4*, parotid gland; *5*, sternocleidomastoid muscle; *6*, greater auricular nerve; *7*, lesser occipital nerve; *8*, ventral ramus (C2); *9*, ventral ramus (C3); *10*, accessory nerve (cranial nerve XI); *11*, ventral ramus (C5); *12*, anterior scalene muscle; *13*, phrenic nerve; *14*, brachial plexus; *15*, subclavian artery and vein; *16*, thyrocervical trunk; *17*, vagus nerve; *18*, inferior root ansa cervicalis; *19*, superior root ansa cervicalis; *20*, superior thyroid artery.

Lateral Portion of the Neck

The dominant structure of the lateral cervical triangle is the spinal accessory nerve. It emanates from the posterior border of the sternocleidomastoid muscle in close association with the splay of nerves of the cervical sensory plexus. It innervates the trapezius muscle on its inferior aspect in close association with the transverse cervical artery or suprascapular artery, which variably supplies the trapezius muscle.

Arterial Supply

The two common carotid arteries differ in length because the right carotid usually arises from the brachycephalic artery behind the sternoclavicular joint, and the left arises from the arch of the aorta (Fig. 1.19). Both arteries end by bifurcating into the internal and external carotid arteries. Over the lateral aspect of these arteries course the paired hypoglossal nerves. The internal carotid artery is situated more posteriorly and has no branches. The external carotid artery has branches and lies slightly anteriorly. This information can be crucial in differentiating the two vessels for ligation. From its origin, the internal carotid artery ascends directly toward the carotid canal and is crossed laterally, in ascending order, by the hypoglossal nerve, occipital artery, posterior belly of the digastric and associated stylohyoid muscle, and the posterior auricular artery. Still higher and close to the base of the skull, the external carotid artery is anterolateral to the internal carotid artery, and the stylopharyngeus muscle and associated glossopharyngeal nerve, the pharyngeal branch of the vagus, and the stylohyoid ligament all pass laterally to the internal carotid, between it and the external carotid artery.

FIGURE 1.19. Arterial supply of the neck. *1*, Common carotid artery; *2*, superior laryngeal artery; *3*, superior thyroid artery; *4*, internal carotid artery; *5*, external carotid artery; *6*, lingual artery; *7*, occipital artery; *8*, ascending pharyngeal artery; *9*, inferior alveolar artery; *10*, maxillary artery; *11*, ascending palatine artery; *12*, facial artery; *13*, mental artery; *14*, submental artery; *15*, angular artery; *16*, infraorbital artery; *17*, buccal artery; *18*, sphenopalatine artery; *19*, middle meningeal artery; *20*, superficial temporal artery.

After its origin in the carotid triangle, the external carotid artery passes upward, deep to the posterior belly of the digastric and stylohyoid muscles, crosses the styloglossus and the stylopharyngeus muscles on their lateral aspects, and parallel to the ramus of the mandible passes into the deeper portion of the parotid gland. The external carotid artery has branches to the superior thyroid, lingual, facial, ascending pharyngeal, occipital, posterior

auricular, maxillary, transverse facial, and superficial temporal arteries.

Venous Supply

The veins of the neck vary considerably in their connections with each other and in their relative sizes (Fig. 1.20). Those conducting blood downward from the head and face include the external jugular, anterior jugular, internal jugular, and vertebral veins. At the base of the neck are the suprascapular and transverse cervical veins and the subclavian vein, which unites with the internal jugular vein to form the brachycephalic or innominate vein. The subcutaneous veins and the external and anterior jugular veins are especially variable in size and course.

FIGURE 1.20. Venous supply of the neck. *1*, Subclavian vein; *2*, internal jugular vein; *3*, anterior external jugular vein; *4*, superior laryngeal vein; *5*, superior thyroid vein; *6*, common facial vein; *7*, posterior external jugular vein; *8*, retromandibular vein, anterior division; *9*, retromandibular vein, posterior division; *10*, inferior alveolar vein; *11*, posterior auricular vein; *12*, superficial temporal vein; *13*, deep temporal vein; *14*, pterygoid plexus; *15*, deep facial vein; *16*, infraorbital vein; *17*, angular vein; *18*, mental vein; *19*, facial vein; *20*, external palatine vein.

Lymphatic Vessels

The lymphatic system of the neck consists of numerous lymph nodes intimately connected with each other by lymphatic channels and the terminations of the thoracic and right lymphatic ducts. The deep cervical lymph nodes are numerous and prominent, and many of them are large. They form a chain embedded in the connective tissue of the carotid sheath. Most are in that portion of the sheath around the internal jugular vein. They extend from the base of the skull to the base of the neck. Two nodes that deserve particular attention are the superior jugulodigastric node at the junction of the internal jugular vein and the posterior belly of the digastric and the inferior juguloomohyoid node at the junction of that muscle and the internal jugular vein. Block resection of the neck in a standard radical or modified manner relies on reproducible and consistent lymphatic drainage pathways for success.

Viscera

The visceral structures of the neck include the thyroid and parathyroid glands, a portion of the pharynx, the larynx, the trachea, the esophagus, and sometimes portions of the thymus

(Fig. 1.21). The thyroid gland lies below and on the side of the thyroid cartilage covered anteriorly by the infrahyoid muscles. A pyramidal lobe of the thyroid may extend superiorly from the isthmus that connects the two lobes of the thyroid gland. On the posterior surface of the thyroid gland lie the paired parathyroid glands. Successful parathyroid exploration and thyroidectomy depend on accurate identification and preservation of the recurrent laryngeal nerves and identification of the parathyroid glands. Landmarks that are used successfully to locate these structures include the trachea, common carotid artery, and inferior thyroid artery, which form a triangle within which the surgeon usually finds the

recurrent laryngeal nerve. Lymphatic drainage occurs along the peritracheal nodes. Venous drainage similarly is directed inferiorly along the inferior thyroid veins.

FIGURE 1.21. Thyroid and parathyroid glands.

The four or more parathyroid glands develop from the dorsal extremities of the third and fourth pharyngeal pouches. As the thyroid and thymus and their associated parathyroid glands move caudally from the region in which they originate, the thymus normally descends beyond the level at which the thyroid halts. The parathyroids from the fourth pouches (superior parathyroid glands) typically are situated more craniad than the thyroid gland, and those derived from the third pouches (inferior parathyroid glands) are typically freed from the thymus and become associated with the thyroid gland at its lower pole. Both sets of parathyroid glands usually are situated on the posterior aspect of the lateral lobes of the thyroid gland, but there are many exceptions. Because of the manner in which they arise and migrate into the neck, the glands often are displaced and may be situated in other portions of the thyroid gland or lie above or below it.

BIBLIOGRAPHY

Hollinshead WH. *Anatomy for surgeons: the head and neck*, 2nd ed. Hagerstown, MD: Harper & Row, 1968.

Netter FH. *Atlas of human anatomy*. Summit, NJ: Ciba-Geigy, 1989.

Pernkopf E. *Atlas of topographical and applied human anatomy: head and neck*. Philadelphia: WB Saunders, 1963.

Williams PL, Warwick R, Dyson M, eds. *Gray's anatomy*, 37th ed. Edinburgh: Churchill Livingstone, 1989.