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7 General, Surgical, and Functional Anatomy for Vascular Lesions of Head and Neck

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An understanding of the complex nature and involvement of various structures in vascular lesions of the head and neck is essential. Thorough knowledge of the primary cross-sectional anatomy of this region is invaluable. Most of these lesions are composite and involve more than a single layer in various proportions.

Nair et al.'s anatomical classification and its various modifications help understand these lesions' real involvement. Hence, the familiarity of different structures with a three-dimensional mental picture makes their treatment planning and subsequent management comprehensive.

Command over the vascular anatomy, identifying potential flow dynamics of the head and neck vasculature would assist in decision-making toward surgery alone or in combination with embolization.

We will review the surgical anatomy of different layers of the face, scalp, and neck. Also, the network of arteries, veins, and lymphatics is discussed. This is useful in approaching and surgically debulking these vascular lesions, which we have discussed as various approaches.

7.1 Layers of Scalp, Face, and Neck (Superficial to Deep)

Skin and subcutaneous tissue are common throughout the scalp, face, and neck, with their thickness varying in different areas. The skin over the scalp is thickest, followed by mid and lower face, thin in the anterior neck, and most delicate in the eyelids. It has a superficial epidermis and deeper dermis, which are the two identifiable skin layers to the naked eye. Vascular lesions involving the thin skin are more expansile due to its elasticity.

The thickness of the subcutaneous tissue usually corresponds to the skin above it due to varying subdermal fat. The subcutaneous and dermal appendages can get thin due to expansile and pressure atrophy, further getting missed or altered in Type-I and Type-II lesions.

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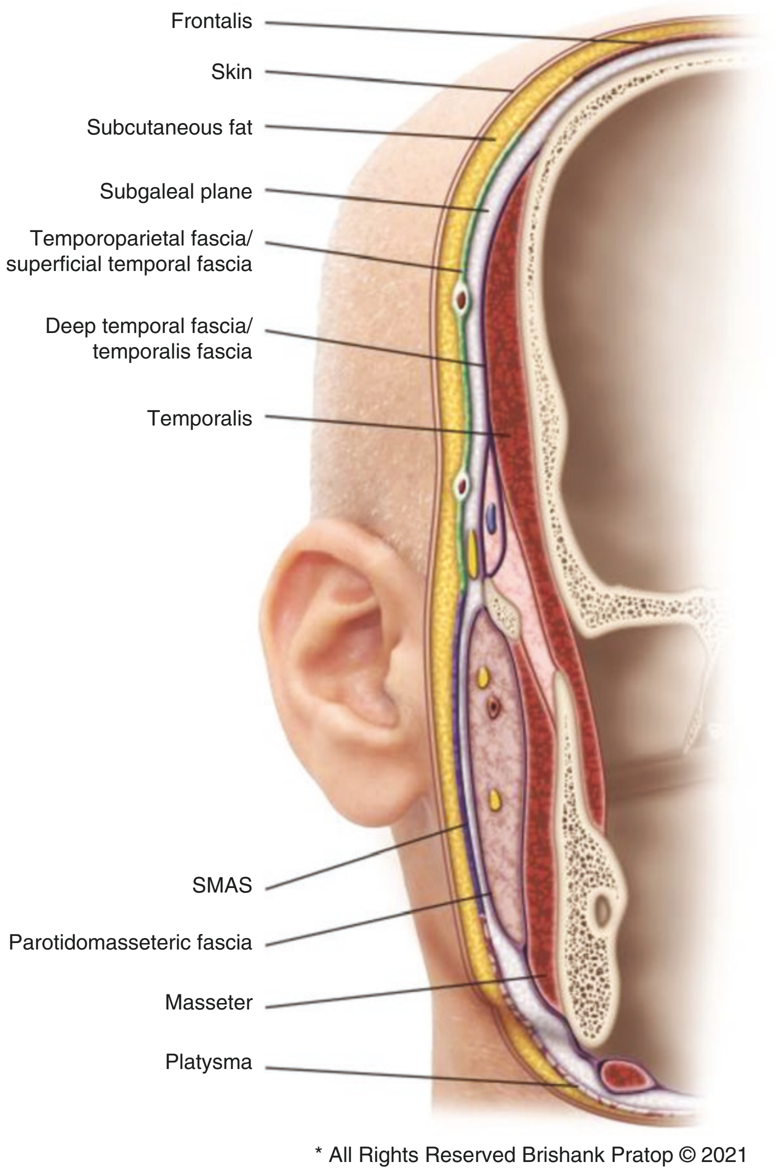


Fig. 7.1 Layers of the face from skin to deep. The SMAS layer and its continuation over the scalp and neck is seen

The layers below the skin and subcutaneous tissue can vary depending on the head and neck area. Scalp has the *musculoaponeurotic layer* (Fig. 7.1) with a strip of muscular component (frontalis anteriorly and occipital group posteriorly) and a deeper avascular aponeurotic layer (subgaleal plane). There is an excellent dissecting plane beneath the aponeurosis and is used to raise a flap or excise lesions above it.

Laterally, the aponeurosis forms the *temporoparietal layer* over the temporal area, splits into superficial, and deep temporalis fascia incorporating the superficial temporal fat pad in between and temporalis muscle underneath it (Fig. 7.2). The superficial temporalis fascia is in communication with the zygomatic arch and its superior border—the superficial temporalis fascia then continues over the face as the *SMAS (superficial musculoaponeurotic system).*

The SMAS is thickened over the parotid gland and masseter muscle (parotido-masseteric fascia) and is easily identifiable in these areas. This layer further continues around the face but becomes

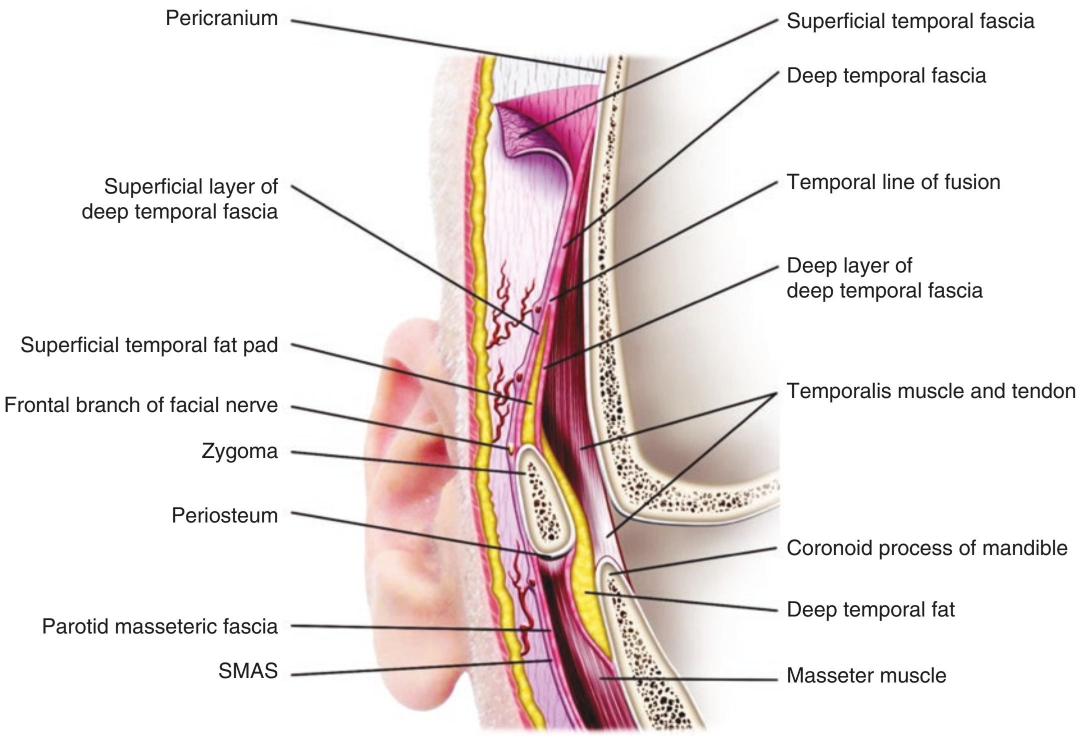


Fig. 7.2 Layers of temporal scalp and preauricular region

less conspicuous around the lips, nose, and eyes. Inferior to the mandible, SMAS continues as the platysma all around the anterior and lateral neck except slightly deficient in the midline.

The aponeurosis, SMAS, and platysma establish the skin tension's continuity over the face and neck (Fig. 7.1). This anatomical continuity aids in the reapproximation of expanded facial and neck skin after the excision of large vascular lesions to prevent sagging deformities and keep the incision lines cosmetic.

The *muscles* of the face and neck lay deep to the SMAS. Facial expressions amplify over the skin due to the SMAS interconnecting the facial muscles to the skin's dermis. Resuspend the SMAS to the dermis and facial muscles during surgery, whenever possible.

The *neck's deep cervical fascia* (Fig. 7.3) lies beneath the platysma and is divided into—investing layer, pre-tracheal fascia, prevertebral fascia, and carotid sheath.

The investing layer encloses the parotid gland, submandibular gland, sternomastoid, and trapezius muscles. This layer also forms a capsule over the parotid and submandibular glands.

The pre-tracheal layer lies in the midline and has muscular and visceral parts. The muscular layer encloses the midline neck's strap muscles, and the visceral layer surrounds the esophagus and trachea in the neck.

The prevertebral fascia encloses the vertebral column and prevertebral group of muscles.

The *carotid sheath* (Fig. 7.3) encloses the common carotid artery (CCA), internal carotid artery (ICA), internal jugular vein (IJV), and vagus nerve. The sympathetic trunk lies in the posterior sheath, and the ansa cervicalis lies in the anterior sheath.

Periosteum and bone are the next deep layers to the salivary glands and facial muscles in the region. The scalp has pericranium and is bone-deep to the aponeurosis.

The neck has the *major vessels* enclosed by the deep cervical fascia laterally and hyoid bone, thyroid, and cricoid cartilage medially. The lar-

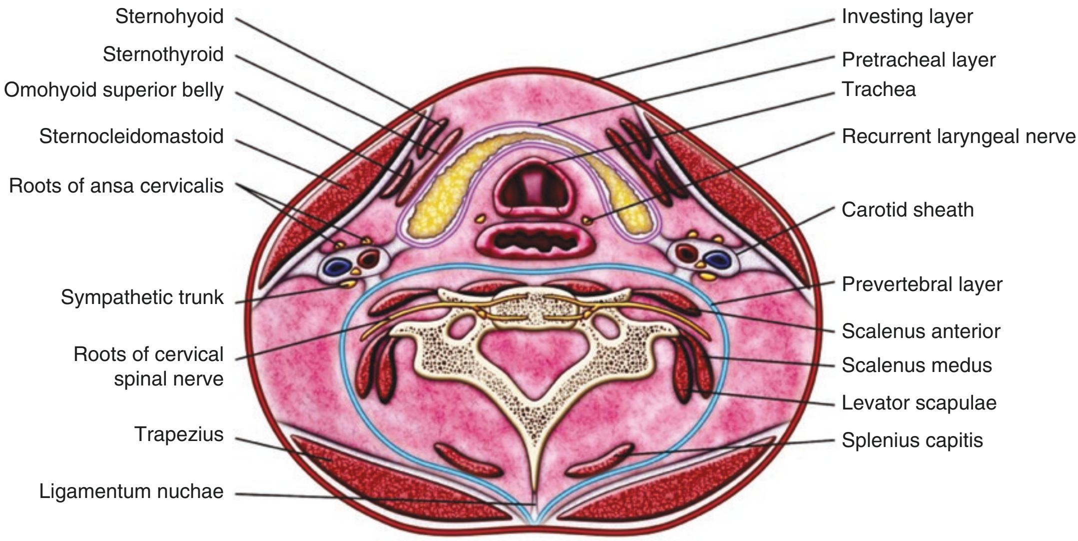


Fig. 7.3 Deep cervical fascia of the neck and its associations

ynx lies deep to it and extends until the lower end of the cricoid, where the trachea starts. The esophagus is present behind the trachea and in front of the prevertebral fascia (Fig. 7.4).

A *planned surgical airway* is many times necessary for large vascular lesions of the neck and is usually done around 1 cm below the cricoid cartilage in the area of the 2nd or 3rd tracheal ring. An *emergency airway* is usually established through the cricothyroid membrane. These should be in the surgeon's armamentarium of skills as large vascular lesions, especially longstanding venous and lymphatic malformations, can cause pressure symptoms over the trachea and esophagus, causing dyspnea and dysphagia.

The thyroid gland is located just below the thyroid cartilage's prominence, with its two lobes on either side of the trachea.

Intraorally, the tongue and floor mouth are present medial to the mandible and the pharyngeal space posterior to it.

Zygomatic body projection forms the face's malar prominence with the maxilla anteromedially and orbits superomedially, forming the "zygomaticomaxillary complex" and "orbitozygomatic complex." The frontal bone lies superior to the orbits, with nasal and ethmoid bones medial to it, forming the "fronto-orbito-naso-ethmoid" complex in the midline. The complex has the frontal sinus, dura mater, and brain deep to it.

Intrabony vascular lesions are generally high flow in nature and occasionally demand extracorporeal curettage and fixation in uncontrollable bleeding cases.

7.2 Important Nerves of Head and Neck

The facial nerve (7th cranial nerve) is a motor nerve exiting the stylomastoid foramen in the skull base after having originated from the pons and having a long, tortuous course intracranially (Fig. 7.5). After its exit, it stems out—the posterior auricular nerve, nerve to stylohyoid, and nerve to the posterior belly of digastric. It then proceeds forward to the posteromedial surface of the parotid gland, where it divides into temporofacial and cervicofacial branches just behind the retromandibular vein and before entering the gland. Within the gland, it lies in close proximity to the ECA, forms a plexus of nerves superficial to the ECA and retromandibular vein. It then gives its terminal branches over the face, namely temporal, zygomatic, buccal (upper and lower),

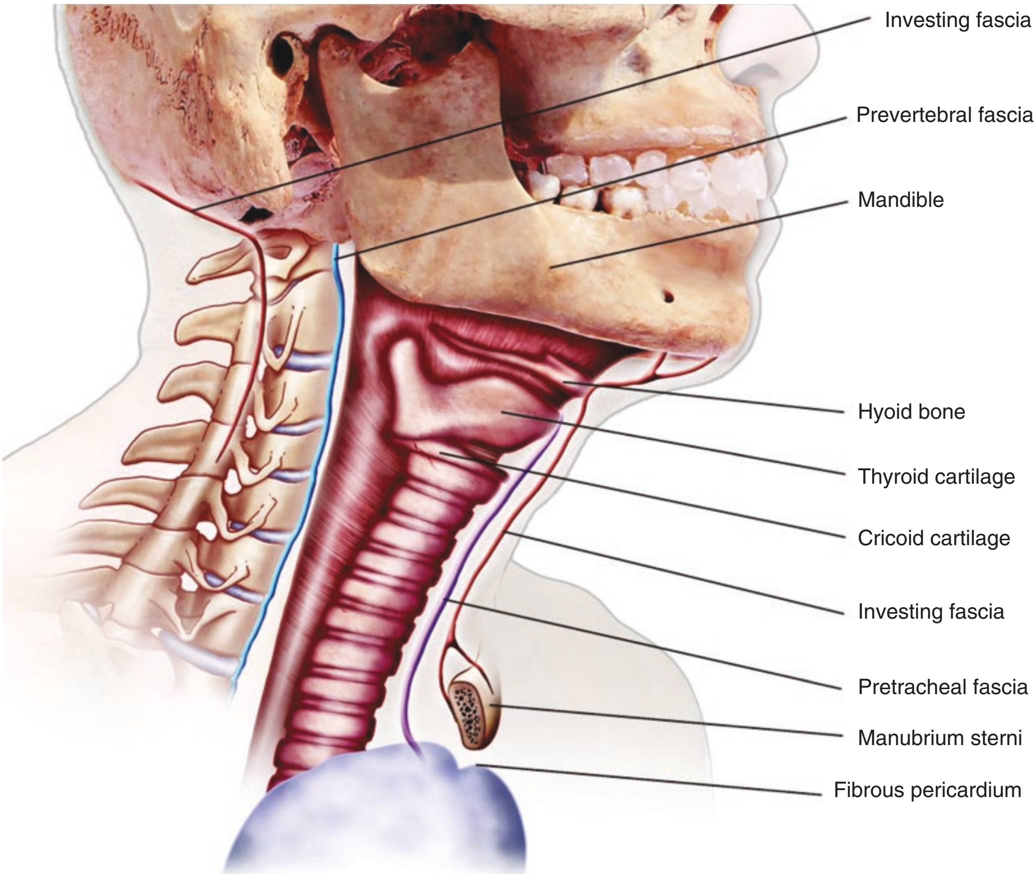


Fig. 7.4 Saggital view of midline structures in the neck

marginal mandibular, and cervical. All these branches supply the facial musculature and are solely responsible for their animation. They usually anastomose with the terminal branches from the opposite side.

The facial nerve is the most common nerve at risk of being damaged during the management of vascular lesions of the face. Every effort is made to preserve these branches by the operating surgeon. Raising large flaps using the rhytidectomy approach is one of the recommended ways while surgically treating lesions of the cheek to avoid risk to the zygomatic, buccal, and marginal mandibular branches. Sometimes the plane of dissection is determined by the lesion, which may be involving the SMAS plane, in which case sacrifice of the facial nerve is inevitable (Fig. 7.6).

Various facial animation procedures can be done to compensate for this partially. Corset suturing is recommended by Nair et al., to prevent long-term damage to the facial nerve in treating large low flow vascular lesions of the face and neck. The marginal mandibular nerve runs in the fascia over the facial vessels curving anteriorly to supply the lower lip. This can be protected when possible by ligating the facial vessels about 1–1.5 cm below the lower border of the mandible and swinging the upper part superiorly (Fig. 7.7).

The *hypoglossal* (12th cranial nerve) nerve is identified below the posterior belly of digastric muscle in the neck, and every effort is made to preserve it. Care is taken not to damage the nerve in this level during dissection around the deep

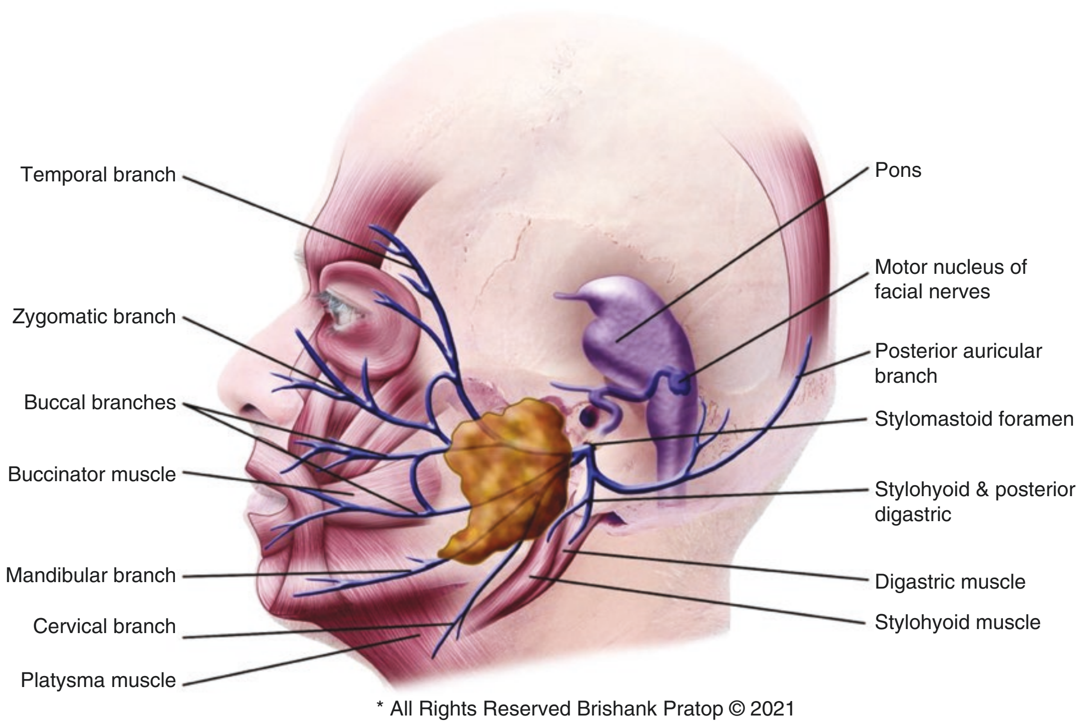
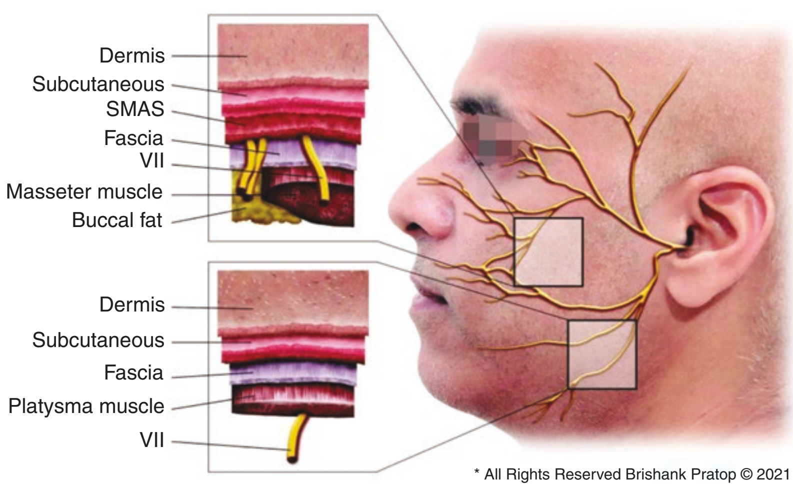


Fig. 7.5 Facial nerve origin, exit from skull and extracranial branches

Fig. 7.6 Relationship of facial nerve and its overlying structures over midface and upper neck



part of the submandibular gland and identification of the deep part of the facial artery.

This nerve can be located by following the ansa cervicalis cranially over the carotid sheath.

The *spinal accessory nerve* is located in the upper part of the posterior triangle beneath and behind the sternomastoid, over the scalene muscles. The great auricular nerve is a good landmark to preserve. The spinal accessory nerve is located about 1–1.5 cm below and behind the great auricular nerve (Fig. 7.8).

The terminal branches of the *trigeminal nerve (5th cranial nerve)* namely infraorbital nerve, inferior alveolar and mental nerves,

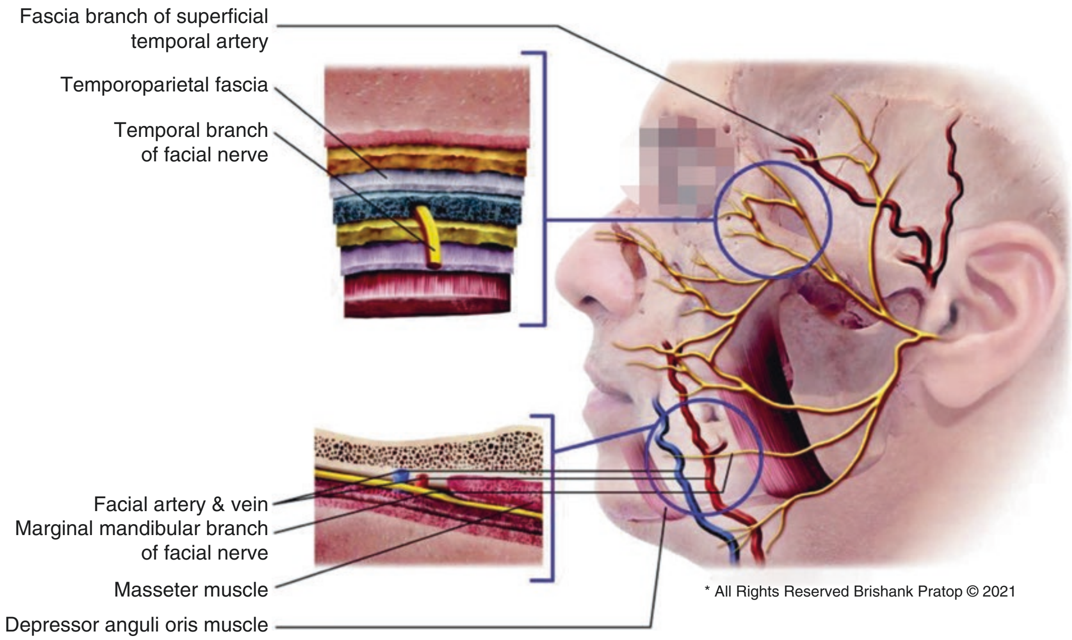


Fig. 7.7 Facial nerve in relation to facial artery and superficial temporal artery

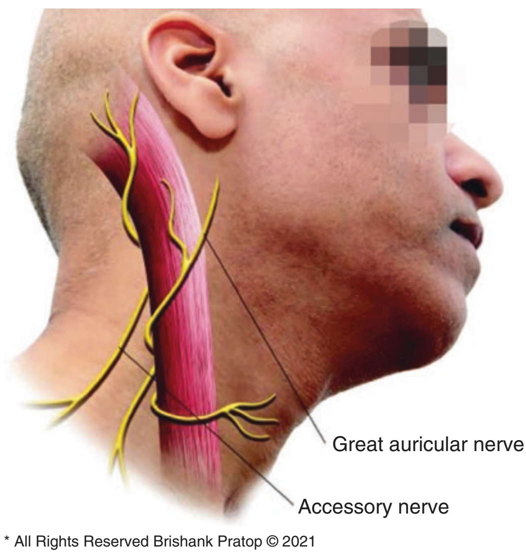


Fig. 7.8 Relation of Spinal accessory nerve to Great auricular nerve

greater palatine and nasopalatine nerves, posterior superior alveolar nerves are also encountered during surgical management of these lesions which if sacrificed or disturbed should be well consented for with the patient to avoid postoperative mishaps.

7.3 Arterial Supply of Head and Neck (Figs. 7.9, 7.10, and 7.11)

The arteries majorly of interest in the treatment of extracranial vascular lesions are *the external carotid artery and its branches*. Of all the branches of ECA, the facial, lingual/faciolingual trunk, maxillary and superficial temporal arteries supplying areas in front of the auricle and posterior auricular, occipital arteries supplying areas posterior to the auricle, are commonly encountered during treatment of these lesions.

The *ophthalmic artery*, the first major branch of the internal carotid artery intracranially, has terminal branches over the face via the supraorbital, supratrochlear, and lacrimal, dorsal nasal, and external nasal arteries supplying the central forehead, eyelids, and upper part of the nose.

The ECA is identified at its bifurcation from the CCA at the level of the upper border of the thyroid cartilage. The superior thyroid artery is sometimes seen at its origin and runs medially into the thyroid gland.

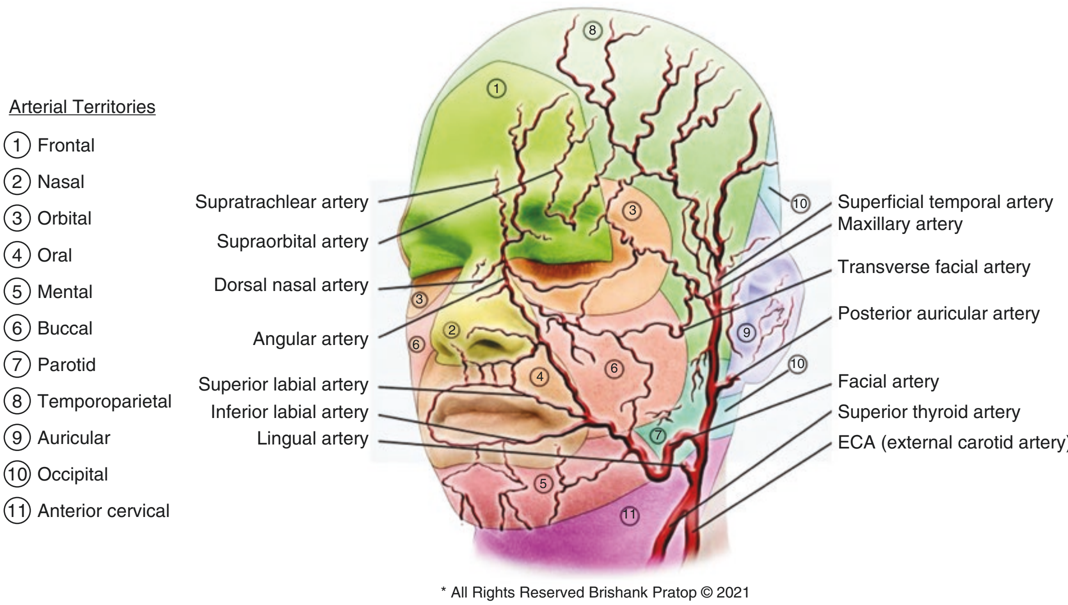


Fig. 7.9 Superficial arteries of face

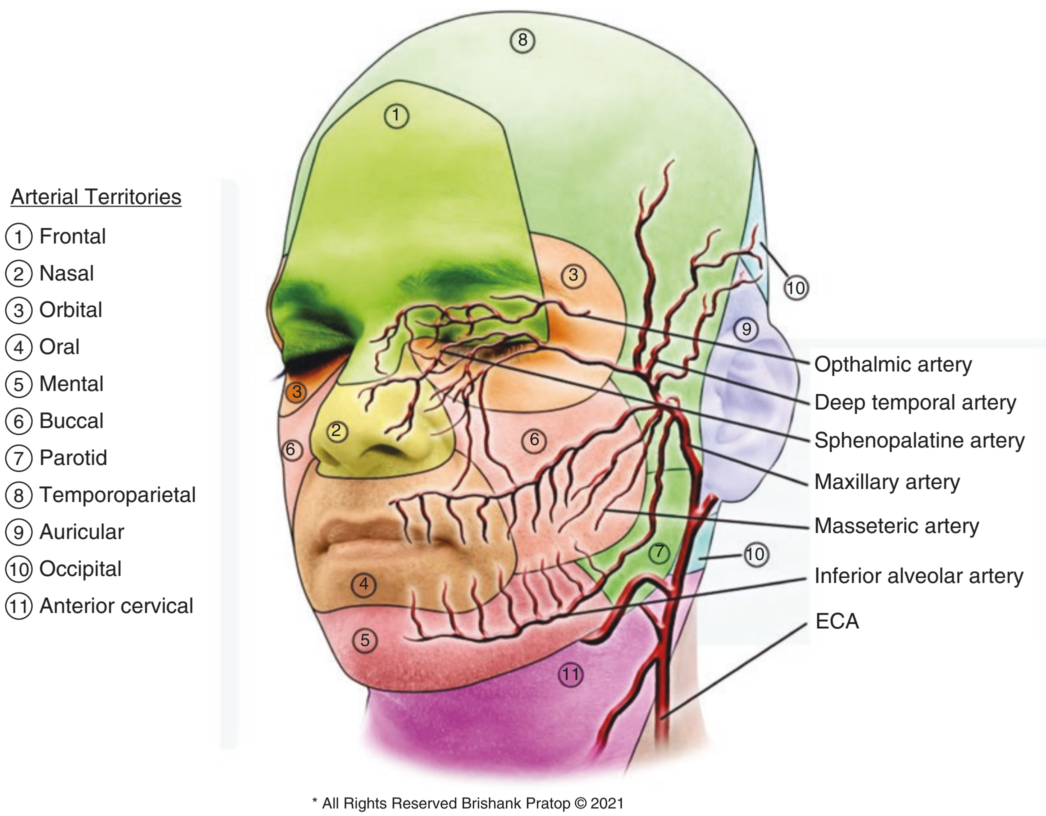


Fig. 7.10 Deep arteries of face

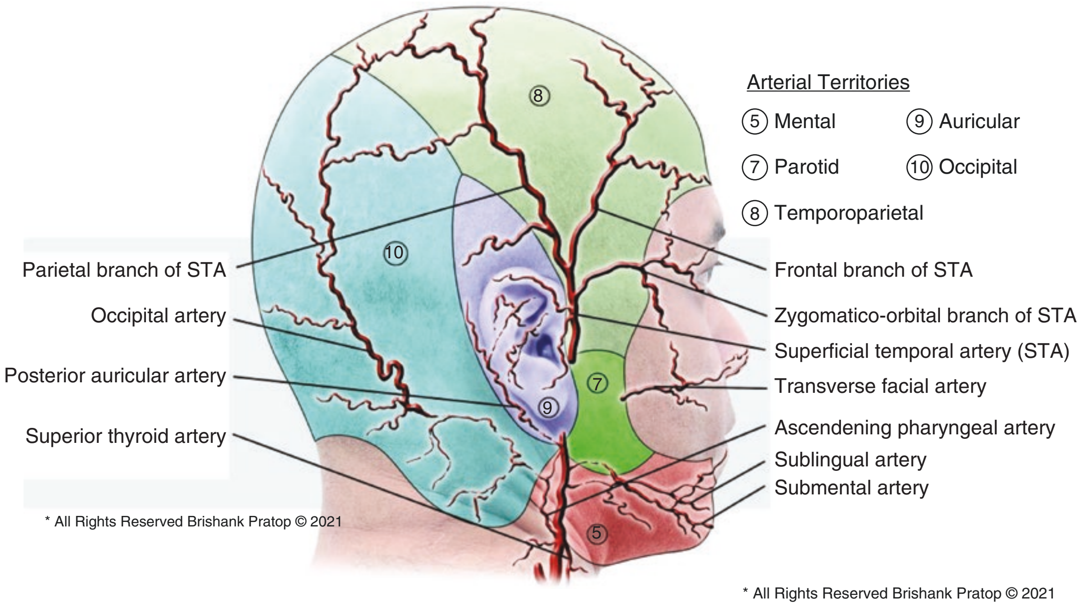


Fig. 7.11 Posterolateral arteries of face

The *lingual artery* can originate at the same level or slightly above the origin of the ECA, at the level of the greater cornu of hyoid bone and runs medially below the hyoglossus muscle, gives a sublingual branch to the anterior floor of the mouth, and continues further behind as the deep lingual artery to supply the lateral and posterior tongue. Care is taken to try and preserve the lingual artery to prevent avascularity of the lateral tongue, especially if the lingual artery on the opposite side is compromised, which usually has collateral branches to take over the blood supply.

The *facial artery*, the 4th branch of the ECA, is given off anteromedially above the bifurcation. It sometimes is the conglomerate of facio-lingual trunk. The facial artery then courses deep through the posterior belly of the digastric muscle. Commonly it then lodges in a groove at the posterior end of submandibular gland. It then runs a tortuous course between the submandibular gland and mandible, winding around the mandible at the anteroinferior angle of masseter to enter the face. It is easily identified and ligated here if necessary. Over the face, the facial artery gives ascending palatine, inferior and superior labial, tonsillar, glandular, lateral nasal, submental, muscular, and angular arteries. Angular artery is the terminal branch of the facial artery, which gives anastomotic branches to the infraorbital artery (terminal branch of maxillary artery). It also anastomoses with the inferior palpebral and dorsal nasal branch of the ophthalmic artery forming a communication with the ICA.

The *submental artery* is encountered in the submental triangle during dissection of the anterior neck, hyoglossus, and mylohyoid muscle.

The superior and inferior labial arteries are commonly compressed digitally to achieve a reduction in blood flow in vascular lesions involving the upper and lower lips, until they are excised and then released or ligated if necessary. It is a simple maneuver that is helpful during surgery and emergencies.

The maxillary and the superficial temporal arteries are the terminal branches of the ECA in the head and neck. In the facial region, the *maxillary artery* branches out of the ECA at the neck of condyle and travels around the mandibular neck, through the pterygoid musculature and pterygopalatine fossa further giving terminal branches in the nasal cavity, palate, and infraorbital region. The maxillary artery through its course gives various branches and sub-branches, supply the bones of face, calvarium, dura mater, floor of middle cranial fossa, external ear, middle ear, and tympanic membrane.

The *superficial temporal artery* branches off the ECA again at the neck of the mandibular condyle and enters the parotid gland, travelling upward toward the temporal area and scalp. It gives off a parotid branch and transverse facial artery within the parotid gland, zygomatic-orbital, middle temporal, anterior auricular branches at the level of zygomatic arch and anterior frontal, posterior parietal as terminal branches higher above.

The *posterior auricular artery* branches from the ECA just above the bifurcation travels upward between the parotid gland and styloid process to reach behind the auricle, runs between the auricular cartilage and mastoid process, thereafter anastomosing with the occipital artery. During its course, it supplies the sternomastoid, stylohyoid, digastric, posterior belly of occipitofrontalis, tympanic membrane, skin over medial surface of auricle, and provides oxygenated blood to the facial nerve.

One of many branches can be enormous and significantly increased in size, especially high-flow lesions, with a palpable bruit being the most characteristic feature. The bruit is palpable or dopplerable with a hand-held device throughout the course of the lesion.

7.3.1 Vessel and Luminal Dimensions

Internal carotid artery (ICA)		
Orbital and extracranial branches	Outer diameter (mm)	Inner diameter (mm)
Ophthalmic artery [1]		1.35–1.37 ± 0.16–0.18
Orbital group		
Anterior ethmoidal artery [2]	0.88–0.92 ± 0.15–0.20	
Posterior ethmoidal artery [2]	0.63–0.66 ± 0.19–0.21	
Dorsal nasal artery [3, 4]	0.74–0.88 ± 0.12–0.26	
Supratrochlear artery [3, 4]	0.74–0.91 ± 0.17–0.20	
Supraorbital artery [4]	0.84 ± 0.16	
Superior and inferior medial palpebral arteries [4]	0.43 ± 0.13	
Lacrimal artery [5]	1.02–1.03 ± 0.16–0.17	
Superior and inferior lateral palpebral arteries, zygomaticofacial artery, zygomaticotemporal artery [6, 7]		
Ocular group		
Ciliary arteries		
Central retinal artery		
Muscular branches		

External carotid artery (ECA)		
Arteries and branches	Outer diameter (mm)	Inner diameter (mm)
Superior thyroid artery [8–11]	2.1–3.53 ± 1.17–1.4	1.4–1.9 ± 0.3–0.7
Infrahyoid branch, superior laryngeal branch, sternomastoid branch, cricothyroid branch, glandular branches [12]		
Ascending pharyngeal artery [13, 14]	1.4–1.54 ± 0.25–0.3	
Posterior meningeal artery, pharyngeal branches, inferior tympanic artery		
Lingual artery [8–11]	2.2–3.06 ± 0.65–1.1	1.6–1.8 ± 0.4
Deep lingual artery, sublingual artery, dorsal lingual branches, suprahyoid branch		
Facial artery [8–11]	2.7–3.35 ± 0.68–1.6	1.9–2.2 ± 0.4–0.5
Cervical branches: ascending palatine artery, tonsillar branch, submental artery, glandular branches*Facial branches*: inferior labial, superior labial, inferior alar artery, lateral nasal artery, angular artery, forehead branch [15, 16]		

External carotid artery (ECA)		
Arteries and branches	Outer diameter (mm)	Inner diameter (mm)
Occipital artery [17, 18]	1.9–2.6	
SCM branches, meningeal branch, occipital branches, auricular branch, descending branch [19]		
Posterior auricular artery [20, 21]	0.7–1.2	
Stylomastoid artery, stapedial artery, auricular branch, occipital branch, parotid branch		
Maxillary artery [10, 22–24]	3.2–3.67 ± 0.07	2.1–2.3 ± 0.3–0.7
See table		
Superficial temporal artery [9, 10, 25]	2–2.73 ± 0.51–1.4	1.7 ± 0.4–0.5
Transverse facial artery, zygomatico-orbital artery, middle temporal artery, anterior auricular branch, frontal branches, parietal branch		

7.3.2 Maxillary Artery Branches

Maxillary artery			
Divisions and branches	Foramina	Outer diameter (mm)	Inner diameter (mm)
Mandibular segment [23, 24]		3.67 ± 0.07	2.1 ± 0.7
Deep auricular artery [23]	Squamotympanic fissure	1.0 ± 0.09	
Anterior tympanic artery [23]	Petrotympanic fissure	0.7 ± 0.002	
Middle meningeal artery [23, 24]	Foramen spinosum	2.53 ± 0.38	1.2 ± 0.2
Accessory meningeal artery [23]	Foramen ovale	1.9 ± 0.22	
Inferior alveolar artery [23, 24]	Mandibular foramen	1.3 ± 0.07	0.6 ± 0.1
Mylohyoid artery[a]			
Mental artery	Mental foramen		
Pterygoid segment [23]		3.24 ± 0.2	
Anterior deep temporal artery [23, 24]		1.45 ± 0.10	0.7 ± 0.2
Posterior deep temporal artery [23, 24]		1.48 ± 0.01	0.7 ± 0.1
Masseteric artery [23]		1.03 ± 0.02	
Buccal artery [23, 24]		1.05 ± 0.07	0.6 ± 0.2
Pterygoid branches [23]		0.7 ± 0.003	
Pterygopalatine segment [23]		2.75 ± 0.04	
Descending palatine artery	Greater palatine canal		
Greater palatine artery [23]	Greater palatine foramen	0.71	
Lesser palatine artery	Lesser palatine foramina		
Posterior superior alveolar artery [23, 24]	Pterygomaxillary fissure	1.31 ± 0.07	1.0 ± 0.2
Infraorbital artery [23, 24]	Infraorbital foramen	1.3 ± 0.08	1.0 ± 0.3
Anterior and middle superior alveolar arteries[b]			
Sphenopalatine artery [23, 24]	Sphenopalatine foramen	1.76 ± 0.48	1.2 ± 0.2
Lateral posterior nasal branches			
Posterior septal branches			
Pharyngeal artery	Pharyngeal (palatovaginal) canal		
Artery of the pterygoid canal (Vidian artery) [23]	Pterygoid canal	0.7 ± 0.005	

[a]The mylohyoid artery branches proximal to the mandibular foramen
[b]The anterior and middle superior alveolar arteries branch from the infraorbital artery proximal to the infraorbital foramen

7.3.3 Arterial Supply of the Neck

Subclavian artery
Arteries and extracranial branches
Vertebral artery
Thyrocervical trunk
Inferior thyroid artery
Inferior laryngeal artery, tracheal branches, esophageal branches, pharyngeal branches, glandular branches
Transverse cervical artery
Superficial branch, dorsal scapular artery
Suprascapular artery
Acromial branch
Ascending cervical artery
Costocervical trunk
Deep cervical artery, superior intercostal artery

7.4 Venous Drainage of Head and Neck (Fig. 7.12)

Veins of the head and neck drain into external and internal jugular veins. Most extracranial veins are named according to the accompanying arteries and areas they drain. The *external jugular vein* along with the vertebral vein drains into the subclavian vein. The *internal jugular vein (IJV)* and *subclavian vein* drain into the *brachiocephalic vein*, which then drains into the *superior vena cava* and *right atrium* of the heart.

Venous blood from the intracranial cavity is picked up by multiple sinuses, which drain ultimately into the sigmoid sinus, which further

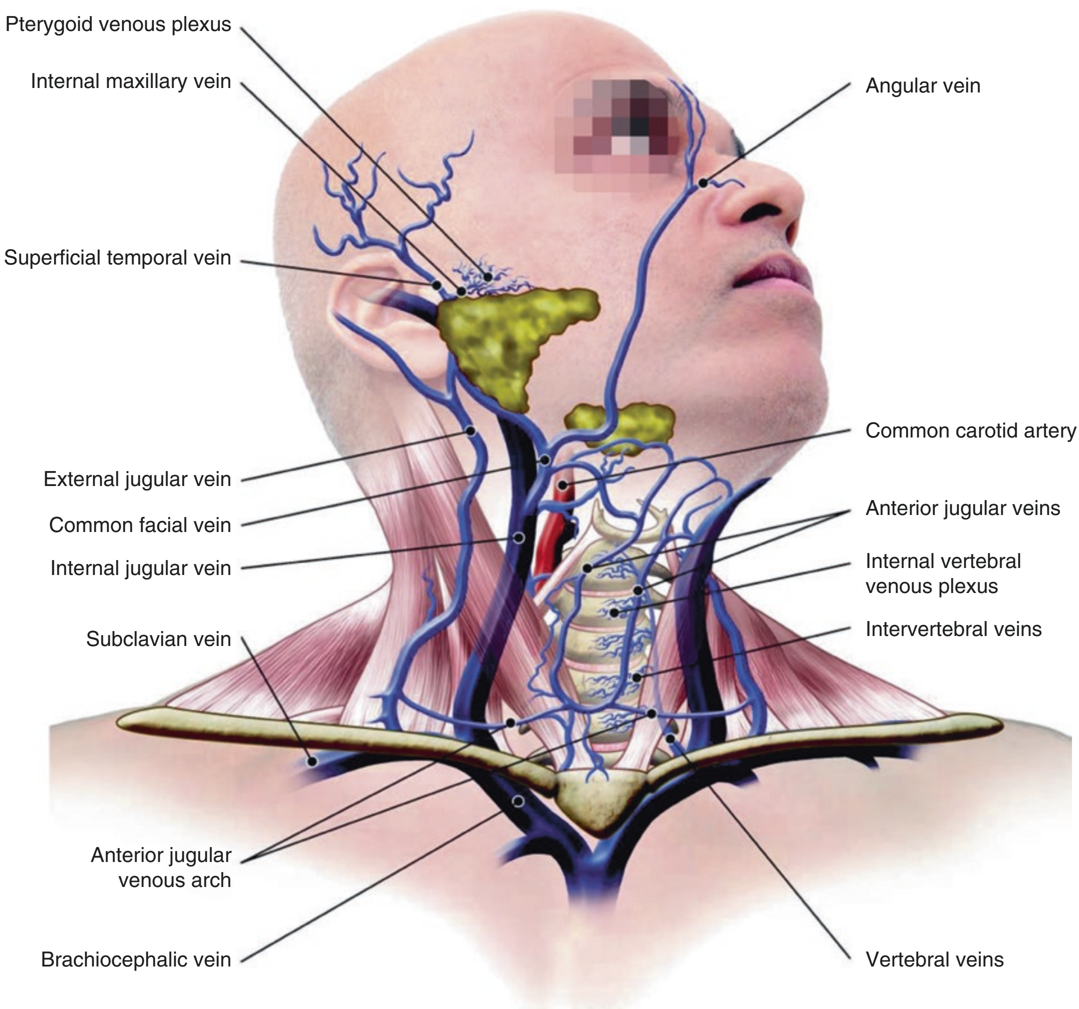


Fig. 7.12 Venous drainage of head and neck

drains into the IJV before leaving the jugular foramen. The ophthalmic vein and facial vein give communications to the cavernous sinus, which then drains into the IJV via the sigmoid and petrosal sinuses. The superficial temporal vein also drains into the internal jugular vein.

The superior and middle thyroid veins drain into the IJV in the neck.

The *facial vein* and its communications are commonly in a plexus in most venous malformations and AVM of the face. The vein lies posterior to the facial artery over the face and then joins the anterior branch of the retromandibular vein at the lower pole of the parotid gland to become the common facial vein, which drains into the IJV.

The *retromandibular vein* is another important vein formed by the merger of superficial temporal and maxillary veins. This runs through the parotid gland, posterior to the ramus of mandible, gives anterior branch as described above and a posterior branch which meets the external jugular vein. The occipital and posterior auricular veins also drain into the external jugular vein from behind the ear.

Since veins are thin-walled, low in blood flow, and so many in number over the face, they have a potential to expand easily on head-down posture, which is usually the first sight of these lesions in most small-sized venous malformations.

7.5 Lymphatic Drainage of Head and Neck (Fig. 7.13)

Lymphatic malformations of the head and neck are commonly seen in children and young adults. They are sometimes disfiguring and cause skeletal deformations over the long term due to its pressure effects. The lymphatics of the head and neck are divided into superficial and deep systems.

The *superficial system* drains the scalp, face, and neck into occipital, mastoid, pre-auricular, parotid, facial, submandibular, submental, and superficial cervical nodes.

The *deeper system* collects lymph from the entire head and neck and drains within a vertical chain into the carotid sheath. The superior and inferior deep cervical nodes are primarily laryngeal, pre-tracheal, retropharyngeal, jugulodigastric, jugular-omohyoid, and supraclavicular nodes. Efferent vessels from the above converge to form the jugular lymphatic trunks. The left jugular lymphatic trunk joins the thoracic duct at

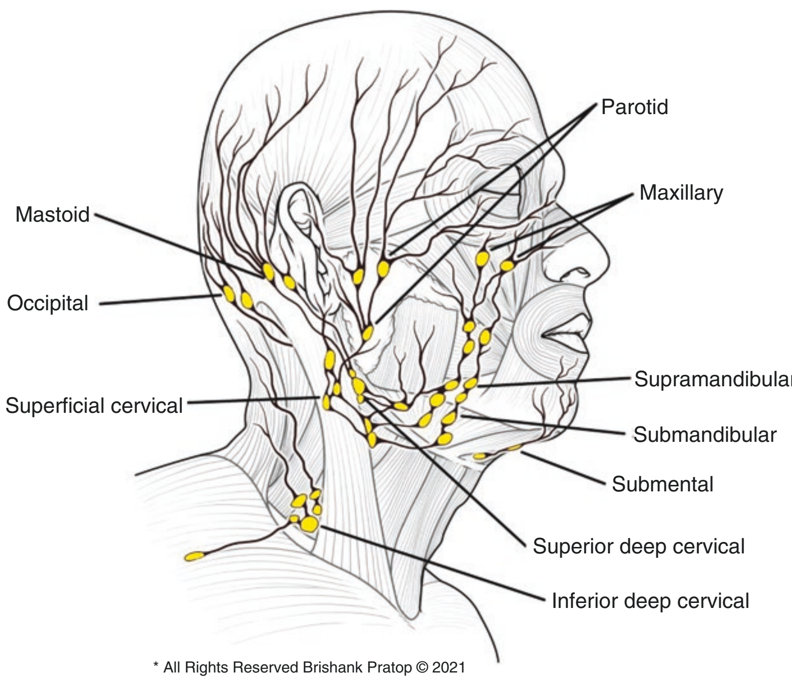


Fig. 7.13 Common lymphatics of face and neck

the root of the neck to drain into the left subclavian vein. The right jugular lymphatic trunk forms the right lymphatic duct at the root of the neck, which drains into the right subclavian vein.

Most lymphatic malformations are diffuse due to their widespread network in the head and neck. They are most times easily excised but quite incompletely. These lesions pose a challenge in areas close to the orbit, and alternate options to facilitate lymph drainage is sought recently. Good knowledge of the way our lymphatic system works helps in treatment of these lesions.

7.5.1 Approaches to the Face for Vascular Tumors and Malformations

Surgery of the face is different from surgery in the rest of the body due to the prime reason of aesthetics; hence, the placement of an incision should be inconspicuous and involve scar management postoperatively. The muscles of facial expression lay below the skin and if the incision traumatize their nerve supply, it can have disastrous functional and cosmetic outcomes. Of importance are the sphincter muscles—orbicularis occuli and orbicularis oris, as reconstruction of their dynamic function may be difficult. The surgeon must also be cognizant of the nerves exiting various foramina of the skull while planning their incisions and dissections so as to not disrupt sensory information to the skin. The coronal approach is an excellent example of a hidden scar while providing almost entire visibility of the upper facial skeleton. Incisions are placed parallel to the direction of the hair so as not to transect the hair follicles. To prevent stretching of sensitive tissue due to traction, the incisions are made long enough. Closure of incision should be considered while planning incisions to avoid marginal necrosis or overlapping, hence designing of incision plays a vital role in the success of a surgery. Aging skin provides us with the resting skin tension lines which occur due to the skin's adaptation to repetitive function and the elastic nature of the underlying dermis (Fig. 7.14).

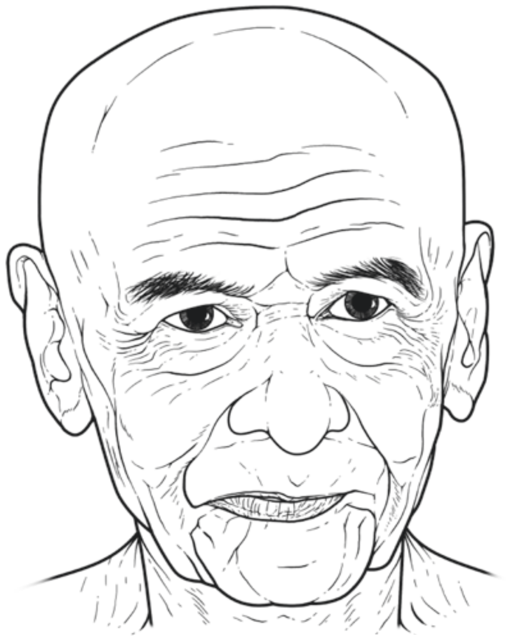


Fig. 7.14 Resting skin tension lines conspicuous in the aged face and are good choices for incision

Incisional wound closures are under the influence of elastin whereas excision wounds depend on collagen, this knowledge would minimize scarring [26]. These relaxed skin tension lines should never be crossed as they would leave behind a conspicuous scar which is unacceptable on the face. However, if an incision cannot be placed in the lines of minimal tension, it can be kept within an orifice such as nasal cavity, mouth, eyelid, or hair-bearing area to keep it inconspicuous. The same purpose is served by placing incision at the junction of two anatomic landmarks such as aesthetic subunit of the face, e.g., nasolabial crease (Fig. 7.15) [27].

The face can be divided into specific "aesthetic units," within which the skin has similar characteristics like color, thickness, subcutaneous fat, and texture. These units are separated by "aesthetic borders" which are hairline, eyebrows, philtrum, labiomental fold, nasolabial fold, and the vermillion (Fig. 7.15) [28]. These can also be further divided into smaller "aesthetic subunits" (Fig. 7.16) [28].

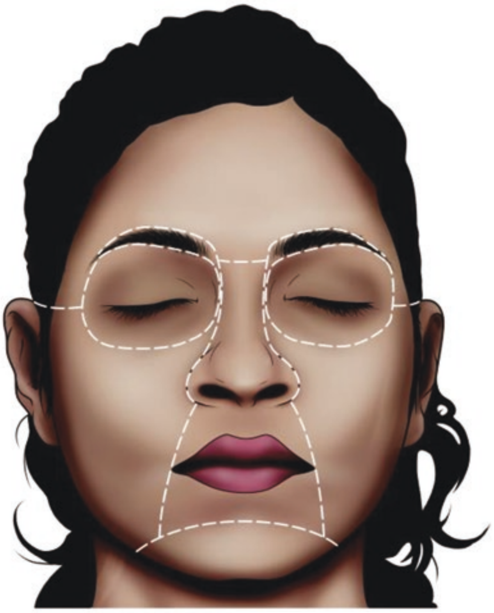


Fig. 7.15 Aesthetic borders

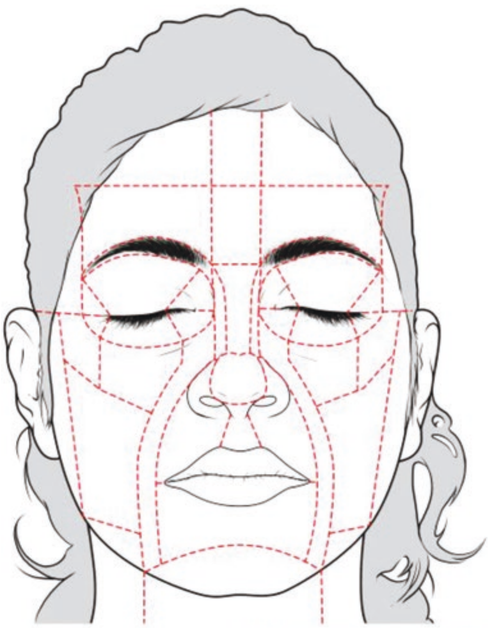


Fig. 7.16 Aesthetic subunits

The various incisions over the face are given keeping in mind these aesthetic units as described above (Fig. 7.17).

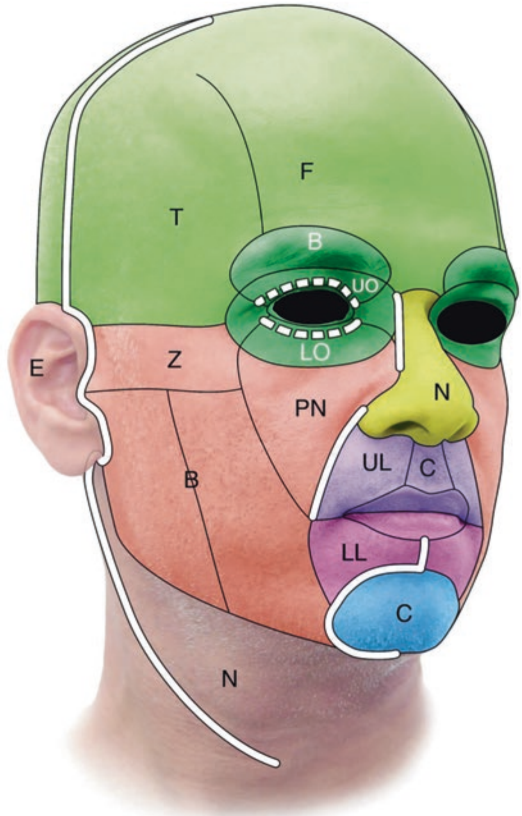


Fig. 7.17 Facial incisions based on aesthetic subunits

7.6 Approaches to Upper Face and Temporal Region

The forehead is limited by the hairline superiorly and the supraorbital margin, brow, and glabella inferiorly. The hairline, however, is an important but highly variable boundary between the scalp and the forehead [29].

The muscles in the forehead are the frontalis, the corrugator supercilii oblique and transverse, depressor supercilia, the procerus, and parts of orbicularis oculi. The movement of these muscles as in frequent frowning or as a person ages provides transverse lines on the forehead, while forming oblique and vertical lines between medial eyebrows. These lines are used to place incisions in a less conspicuous manner.

7.6.1 Approaches to the Temporal Region (Fig. 7.18)

Laterally in the temporal region, vascular lesions over the temporalis muscle warrant a lateral approach. Of anatomic importance in this region is the temporal branch of facial nerve. A line drawn from a point 5 mm beneath the tragus to a point 15 mm above the lateral brow charts the course of this branch [30] and serves as an aid to the surgeon while operating in this area.

The superior attachment of the temporalis muscle is the temporal line which is on the frontal and parietal bones. The superficial and the deep temporal fascia fuse with the periosteum of the central forehead at the temporal line. The frontal branch of the facial nerve travels within the temporoparietal fascia after its exit from the parotid gland [31]. Sharp dissection is done to transition the subperiosteal layer of the central forehead [30]. The superficial musculoaponeurotic system (SMAS) layer in this region is the temporal fascia.

The deep temporal fascia is separated to superficial and deep by the temporalis muscle which attaches to the zygoma and infratemporal fossa (Fig. 7.2). Hence, lesions deep to the temporalis muscle can be approached from the infratemporal fossa. Larger lesions superficial to the temporalis can be approached by a preauricular with Al-Kayat and Bramley extension [32], which is very versatile and provides access to a larger area while contributing to a cosmetic scar (Fig. 7.19). Since this incision is proximal to the facial nerve branches, the surgeon should approach this zone with caution. The approach has been elaborated in the chapter, including detailed information on the facial nerve in the area. The advantage of this incision is the aesthetics and the visibility for the surgeon. This provides access to temporal region, malar area, and the temporomandibular region for which it was primarily designed.

7.6.2 Approaches to Parotid

Approach to the TMJ is done through a Blair [33] incision (later modified by Bailey) [34]. The superficial lobe of the parotid gland, enclosed in the parotid masseteric fascia overlaps the capsule of the TMJ in front of the external auditory meatus, hence the modified incision is used to access the intraglandular lesions (Type III) [35].

The facial flap is raised at the SMAS layer (Fig. 7.1). The Parotid fascia is left intact with the Auriculo temporal Nerve seen on its surface. For exposure of Facial Nerve, the dissection is kept on the surface of the tragal cartilage. The tail of the parotid is freed off the sternocleidomastoid muscle. The posterior belly of the digastric is traced superiorly to its insertion on the mastoid,

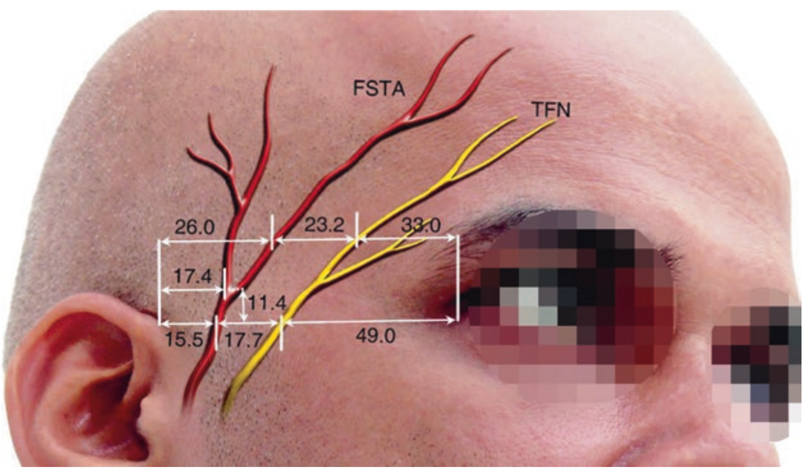


Fig. 7.18 Relations of facial nerve in temporal region (in mm)

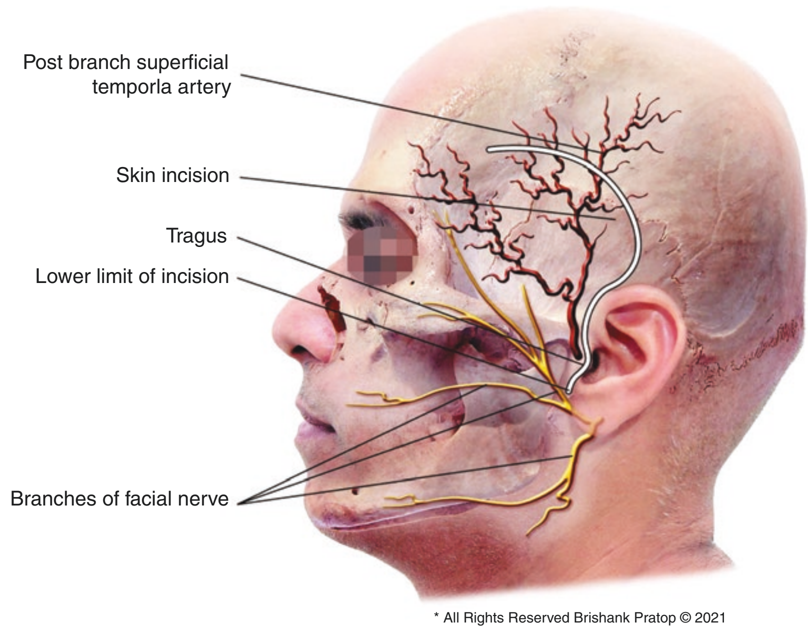


Fig. 7.19 Preauricular with Al-Kayat and Bramley extension

beneath the SCLDM. The facial nerve is identified at this point approximately 1 cm deep and anterior to the tragal pointer. Brisk bleeding is encountered from small vessels overlying the main trunk of the facial nerve. Further dissection is carried out bluntly on the surface of the nerve keeping it in sight at all times.

The deep portion of the gland is found in areas beneath the nerve and over the masseter muscle. It also has a retromandibular portion [36]. Dissection here is complicated by the presence of the auriculotemporal nerve, superficial temporal vessels, and facial nerve. The superficial temporal artery is a terminal branch of the external carotid, bifurcating within the gland and is accompanied by the superficial temporal vein, the artery also is posteriorly accompanied by the auriculotemporal nerve. The other terminal branch of the external carotid is the maxillary artery, and both superficial temporal and maxillary artery - the terminal arteries could be potential bleeders. Placing an incision close to cartilaginous part of the external acoustic meatus will reduce injury to the auriculotemporal nerve. Also, since temporal branch of the facial nerve is seen 8–35 mm anterior to the external auditory meatus, incisions in this zone are placed less than 8 mm away. Since some surgeons use the nerve stimulator to identify branches of the facial nerve, vasoconstrictor injection should be subcutaneous and not deep. The incision is carried out through skin, subcutaneous tissue, and temporal fascia which is hypovascular. When bleeders are coagulated, this flap along with the superficial temporal vessels and auriculotemporal nerve are retracted anteriorly to reach the parotid. The modified facelift approach is also used, and it has incisions in three regions including preaural, postaural, and hairline [37] (Fig. 7.20).

Post-auricular approach has better cosmetic outcomes and prevents injury to the auriculotemporal nerve. The incision is arc shaped and transects the external auditory canal, then the ear is reflected anteriorly, however, it presents a smaller access. Parotidectomy has been performed through a 4–5 cm incision in the postaural sulcus. However, this approach is for most small (Fig. 7.21) to medium size parotid tumors located in the mid and lower pole regions of the parotid gland [38]. VM within the parotid or preauricular region is tough to deal with this approach.

Deep lobe of the parotid if involved in the vascular lesion would require a trans-parotid approach, trans-parotid approach with mandibu-

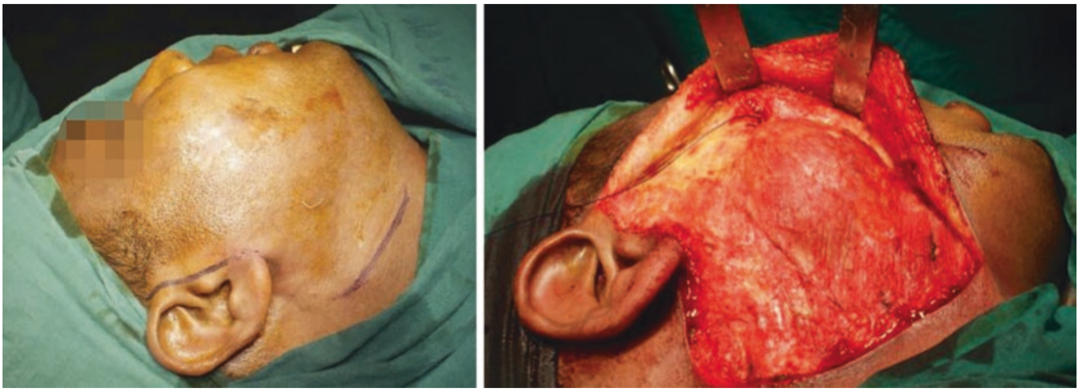


Fig. 7.20 Modified facelift incision (SMAS layer) for parotid and lesions of pre-auricular region

Fig. 7.21 Post-auricular approach

lotomy, trans-cervical approach, or a combined trans-parotid and trans-cervical approach [39]. The trans-cervical approach is for lesions with para-pharyngeal extension of the tumor. Frey's syndrome is caused by damage to auriculotemporal nerve, which innervates the skin of the tragus and the temple and it, gives secretomotor branches to the parotid gland. Damage to this nerve produces functional morbidity and should be prevented, discussion of which is beyond the scope of this chapter.

Bicoronal Approaches to the Cranium, cranial cavity, frontal, and orbital regions can be through the Bicoronal incision with elevation of the scalp. The bicoronal incision begins inferiorly in the preauricular crease bilaterally and is restricted to the inferior limit of the tragus. The incision in the preauricular skin crease is curved posteriorly onto the scalp. It is concealed within the hairline superiorly. The scalp flap is raised at the relatively avascular loose areolar level easily and bluntly, modified depending on the location of the VM. Lesions on the bone may need a pericranial elevation. The exposure is obtained inferiorly from the Zygomatic root on either side, temporal region and parietal areas. Anteriorly the Frontal zone, Nasal bridge, and Superior Orbital rims can be exposed conveniently. The supraorbital foramen and its contents can be protected by staying subperiosteal . An osteotome can be used to free the Supra orbital Nerve from the foramen.

Lateral elevation of the flap is deep to the superficial layer of the deep temporal fascia, this protects the zygomatic and temporal branches of the facial nerve (Fig. 7.22).

7.6.3 Supra Orbital Approach

A commonly used approach in the upper face is the supraorbital approach, which provides access to the frontozygomatic area. The scar resulting from this incision is not conspicuous. The incision is placed within the eyebrow hair (Fig. 7.23) and made through the skin and subcutaneous tissue till periosteum. There are no important neurovascular structures in this region. If extended exposure is desired, incision can be extended into the crow's feet line, lateral to the lateral canthus. It is vital to stay in the subperiosteal zone of dissection to avoid injury to the eyeball. Periosteum integrity should be maintained so as to avoid herniation of the lacrimal gland.

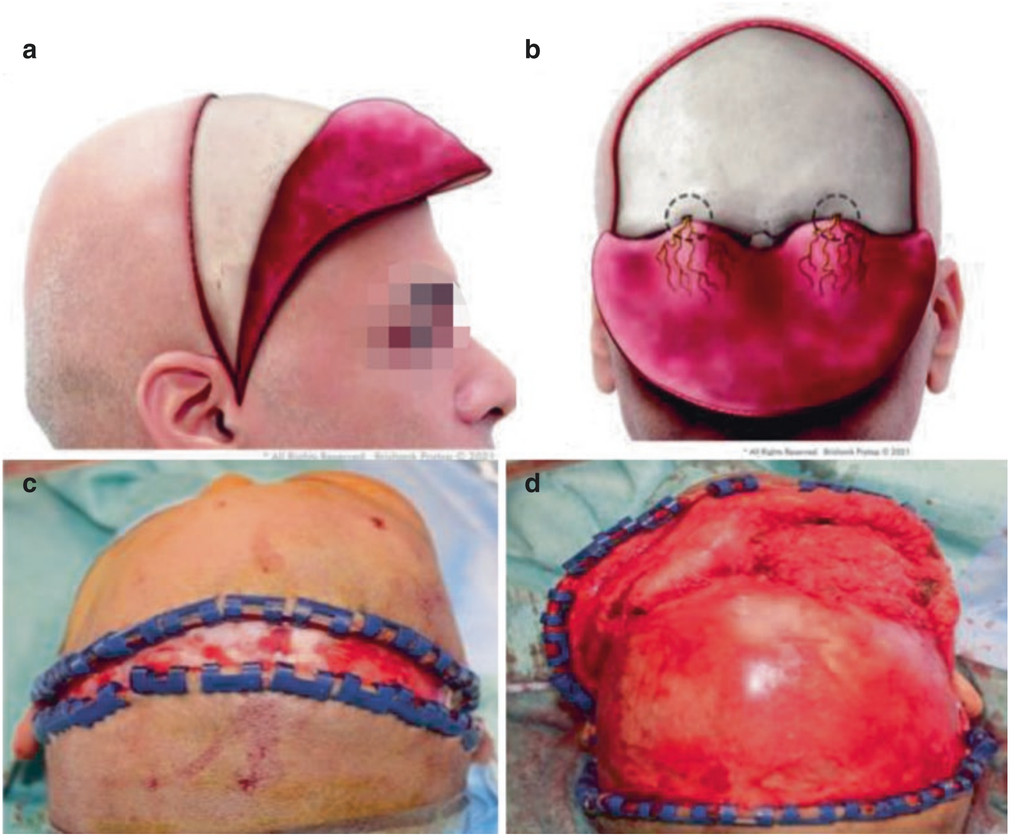


Fig. 7.22 Bicoronal approach. (**a**) Schematic lateral view (**b**) Schematic frontal view (**c**) Bicoronal skin incision, and (**d**) Bicoronal flap elevated to expose LM in right fronto-orbital region

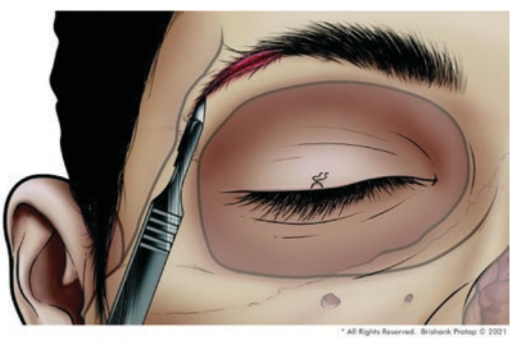


Fig. 7.23 Supraorbital approach with incision in the hairline

7.6.4 Upper Eyelid Approach

Another approach that gained popularity due to its aesthetic outcome is the upper eyelid approach also known as the supra-tarsal fold approach. The incision follows the natural crease of the upper eyelid, which is present in most individuals (Fig. 7.24). Lateral extension of this incision into a crows feet skin crease allows good exposure. About 1 cm above the eyelid margin slanting downward and 6 mm above the lateral canthus laterally. Once the incision is placed, a skin muscle flap is raised and the incision can be undermined until the periosteum to provide enhanced visualization. This approach provides access to the upper bony orbit and can be used to excise tumors of soft tissue around the upper eye (Fig. 7.24b) while producing almost an invisible scar.

7.7 Approaches to the Midface

Midface is one of the regions of the face that has shown to have the most congenital problems [40]. The midface encompasses the cheek and nose aesthetic subunits. The most important fac-

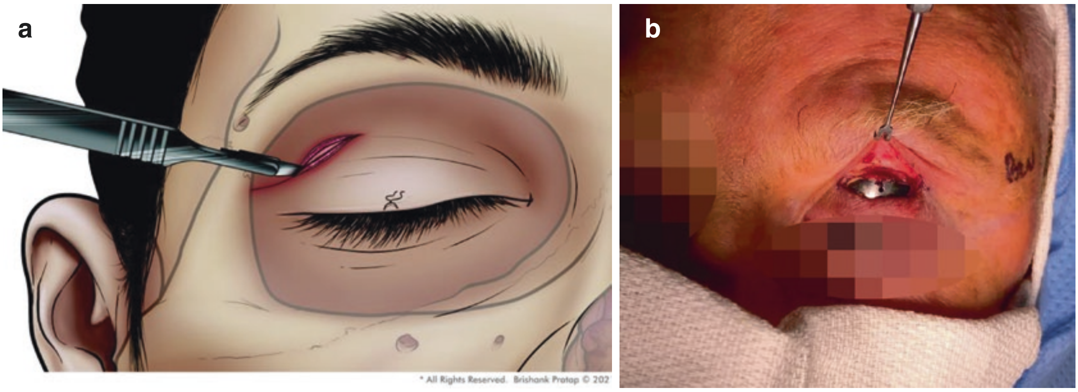


Fig. 7.24 (**a**) Upper eyelid crease approach. (**b**) Excision of lesion in mid upper eyelid

tor to consider is the position of the lesion. If they can be approached and excised completely via an intraoral approach that should be the first choice for a surgeon. What aids in making that decision usually is whether the lesion can be accessed below or above a muscle or bone. Lesions involving the mandible or maxilla can most times be accessed intraorally and sometimes combined with other approaches for extended access.

7.7.1 Subciliary Incision

Subciliary incision with dissection exposes areas in the infraorbital and supra zygomatic zone (Fig. 7.25a–d). Vascular sacs present in this area are mostly VM. They are seen in the subcutaneous plane. Adhering to the infraorbital periosteum protects the Infraorbital neurovascular bundle. The vascular sac can be identified and dissected out.

7.7.2 Lateral Rhinotomy Incision

The first lateral rhinotomy incision was introduced by Moure in 1902 [28]. The rhinotomy incision (Fig. 7.26) provides access to the nasal cavity, ethmoidal sinuses, maxillary sinuses, and nasopharynx. It has the advantage of creating a minimal cosmetic or functional disability. Intraoral extensions can be performed on a case-by-case basis, depending on the extent of the lesion. The incision line below the medial eyebrow, along the deepest part of nasomaxillary groove and curves below the ala of the nose. If extension is desired the philtral ridge down the upper lip and intraorally. Once intraoral, a buccal sulcus incision till the first molar with dissection provides a wide exposure. The anterior and posterior ethmoid arteries can be identified in or above the fronto-ethmoid suture. Lesions arising from these vessels can be identified here and the vessels may be ligated. The maxillary antrum can be accessed via this approach as well through the anterior maxillary wall and the antrostomy can be enlarged with ronguers to maximize visualization inside the antrum [41].

7.7.3 Nasolabial with Subciliary Extension

The surgical approach to lesions presents in the nasolabial region can be placed in the Nasolabial skin crease. Lesions beneath the skin and subcutaneous plane, either superficial to or in between the paranasal muscles such as levator labii superioris, Zygomaticus major and minor can be exposed and excised. The scar is concealed within the nasolabial skin crease (Fig. 7.27).

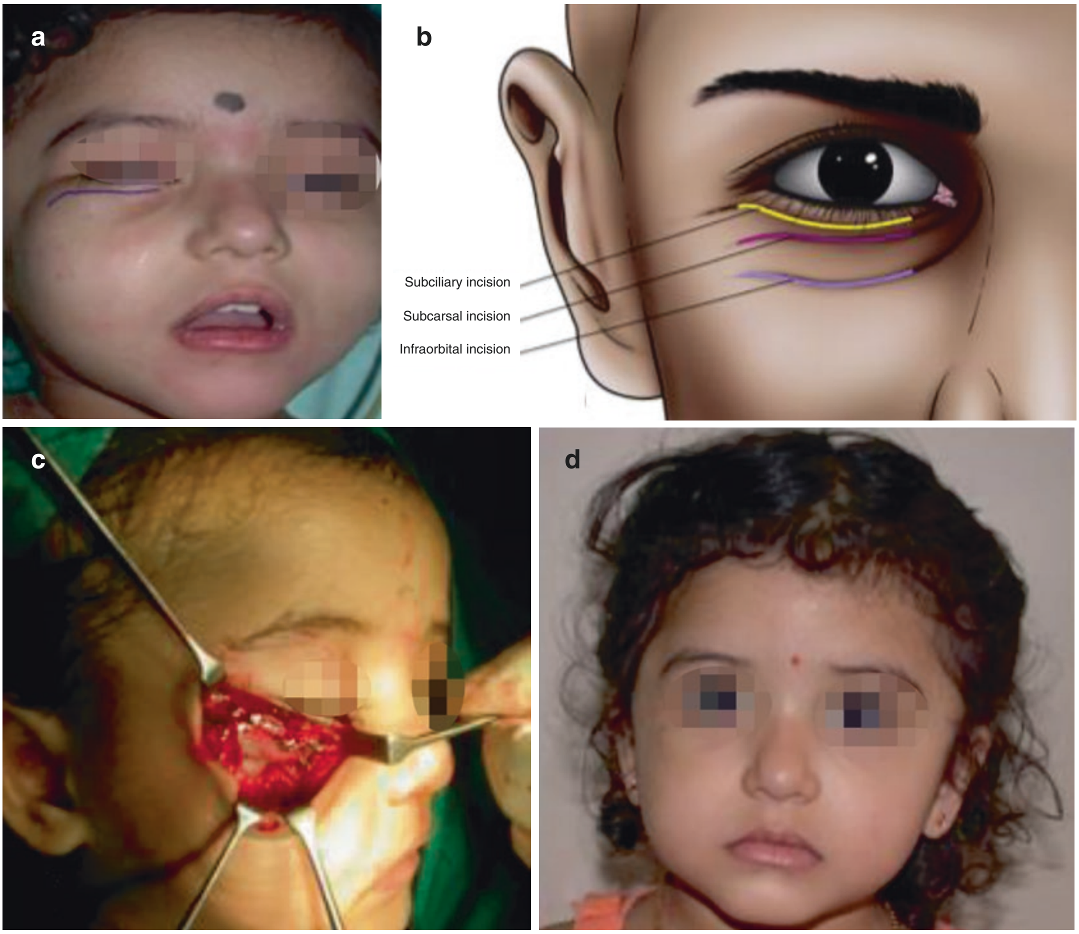


Fig. 7.25 (**a**–**d**) Subciliary incision for exposure of VM in infraorbital and zygomatic region (**a**, **b**) incision marking (**c**) excision of lesion (**d**) Postoperative healing without obvious scar)

7.7.4 Weber–Fergusson Approach

The Webber–Fergusson's incision and its modifications are used for approach to the anterior maxilla [42] another approach is the Midface degloving incision [43]. The former incision remains a controversy. Gensoul (1893) was believed to have first described it and later popularized by Weber and Fergusson. Another theory exists about it being first described Weber in German literature and later modified by Fergusson in English literature [44]. This standard technique, which follows the facial subunits, underwent various modifications depending on the extent of the tumor [45]. The various modifications of the weber-ferguson insicion for accessing the maxillofacial and skull base are [46]:

The Weber–Fergusson incision is suitable for superficial lesions which cannot be approached intraorally or when wide excision of the maxilla is required for type IV intraosseous lesions [35]. Due to the various modifications available, the incision has diverse utilities producing a less conspicuous scar.

The incision line is drawn through the vermillion border, along the philtrum of the lip, extending around the base of the nose and along the facial nasal groove (Fig. 7.28). It then extends infraor-

Fig. 7.26 Lateral rhinotomy incision

bitally 3–4 mm below the cilium to the lateral canthus. The intraoral part of the incision continues along the inner mucosal part of the upper lip proceeding laterally along the Gigivo buccal sulcus unto desired posterior extension. The soft tissue of the cheek is raised from the anterior surface of the maxilla, transecting the infraorbital nerves and vessels should the superior and lateral walls of the maxilla need to be approached.

The Lynch modification is used to approach tumors involving the frontal sinus. lateral extension up to the level of the lateral canthus, or inferiorly to be included in a lateral rhinotomy incision. The incision may be along the lower border of the eyebrow or in a skin crease along the upper eyelid. The incision is extended down, 0.5 cm medial to the medial canthus.

The Dieffenbach modification is used for lesions occurring at the infraorbital margin, anterior floor of orbit, and the zygomatic bone.

7.7.5 Intraoral Approach to Maxilla

Location of the lesion, access to the lesion, and need for reconstruction are usually three reasons to decide if an intraoral or extraoral approach is warranted. For example, lesions medial to the buccinator, can be accessed intraorally while if

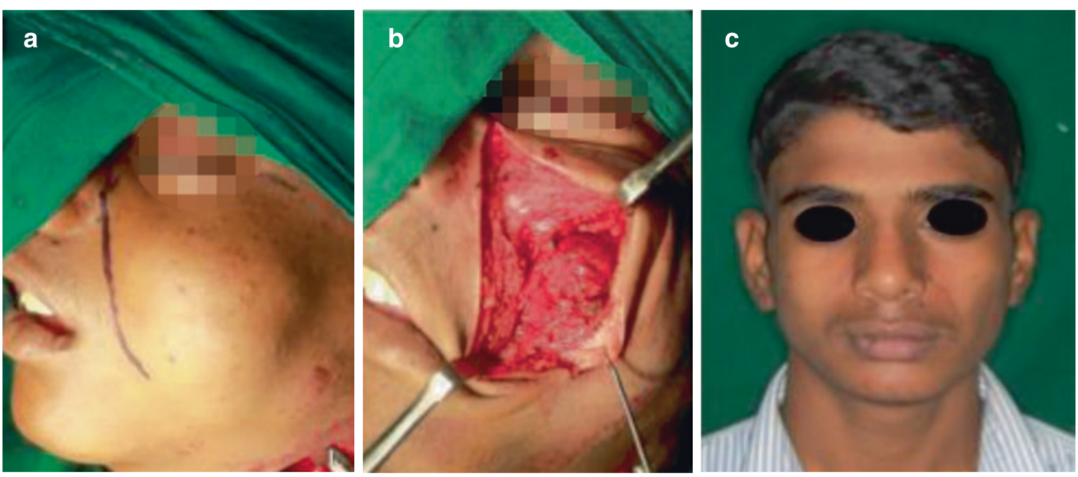


Fig. 7.27 (**a**–**c**) Nasolabial incision to expose the VM in the Sub Zygomatic area. Subciliary extension may be required for better access. (**a**) Incision (**b**) Exposure, (**c**) Post-operative

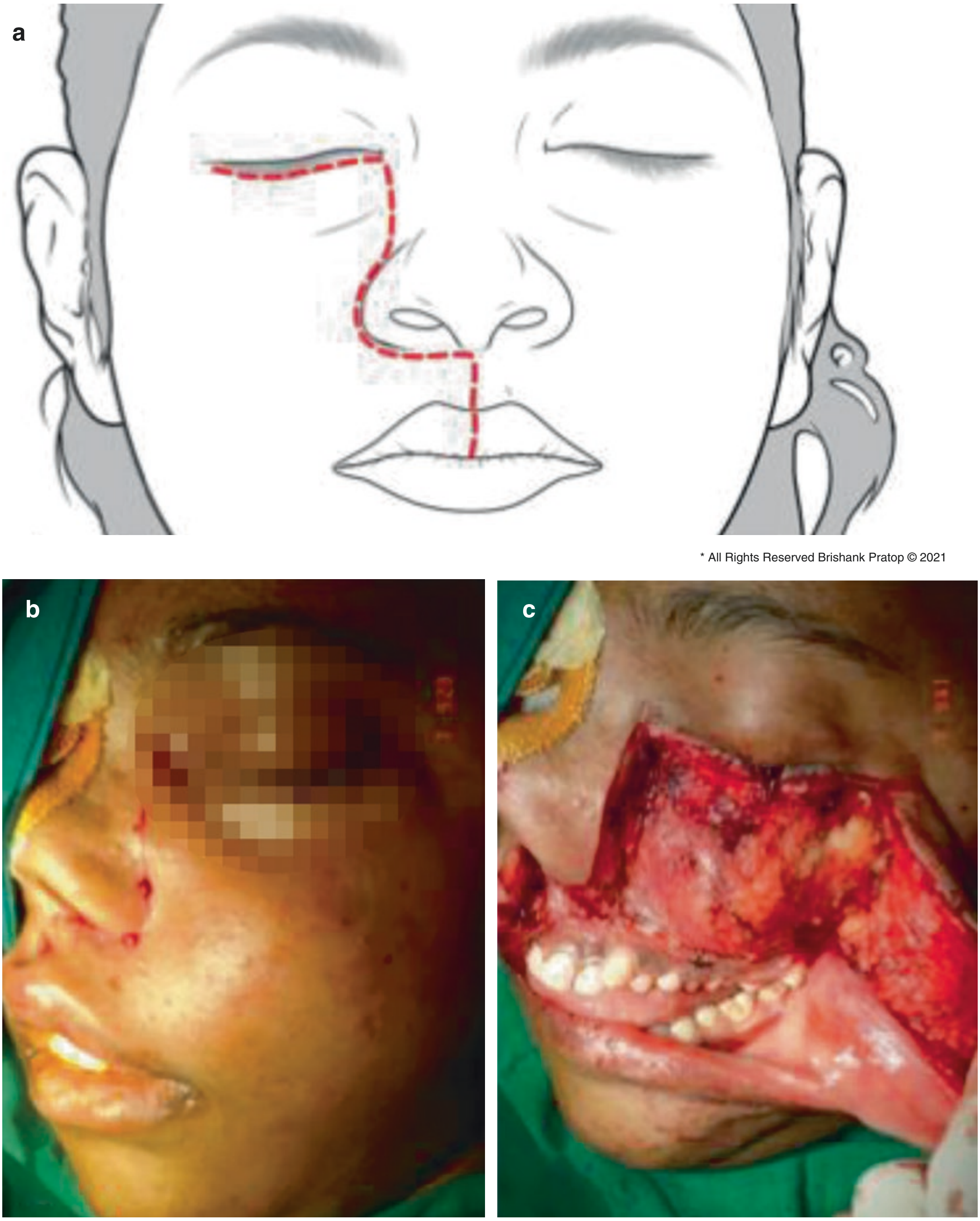


Fig. 7.28 (**a–c**) Dieffenbach's modification of Weber–Fergusson's approach. (**a**) Incision outline (**b**, **c**) Intraoperative incision and exposure

lateral to the buccinator an extraoral approach would provide better access.

Relevant anatomy for the surgeon while performing a maxillary intraoral approach is the infraorbital nerves and the buccal fat pad posteriorly. The infraorbital nerve supplies sensation to the ipsilateral upper lip, side and ala of the nose, and lower eyelid. This nerve must be preserved while dissection from the maxilla to the orbital bone, as it exits the infra-orbital foramen less than a centimeter inferior to the orbital rim. The buccal fat pad will be discussed in the intraoral mandibular approach in detail, the surgeon needs to be cautious while incising around the maxillary second molar. This approach can be used for intraosseous maxillary tumors.

Before infiltration, the upper lip midline is marked on the mucogingival junction to aid proper closure. Vestibular/sublabial incision is made as far as the first molar tooth in the sulcus with adequate attached gingiva for closure. The incision is made till the periosteum and then the bone is exposed subperiosteally (Fig. 7.29). Subperiosteal dissection is carried out till piriform aperture and strip its attachments to perinasal musculature, while posterior extend is till the pterygomaxillary fissure. While dissecting the nasal region injury to nasal mucosa should be prevented, bleeding can be expected in this zone which is easily controlled with packing. The dissection is extended superiorly till the orbital rim with caution around the infraorbital nerve. Even with cautious dissection, some amount of temporary paraesthesia can be expected. This approach exposes the entire maxilla for intraosseous lesions or even lesions of the nasal cavity and maxillary sinus. This gives access to lesions in the anterior nasal area and maxillary sinus. A Lefort 1 osteotomy with down fracture of the maxilla allows access to vascular tumors such as Nasopharyngeal Angiofibroma in the posterior maxillary space.

7.7.6 Midface Degloving Approach

This is an all-inclusive approach with no extra-oral scar and hence an excellent choice for large tumors of the midface region (Fig. 7.30). Due to the nature of the incisions, it is performed under oro-endotracheal intubation. It begins with an intranasal incision which is made circumferentially on the mucosa followed by a transfixion incision that spans the membranous septum, between the lower end of the cartilaginous septum and the medial crura of the lower lateral cartilages. Now an inter-cartilaginous incision is made to release the soft tissue from the upper lateral nasal cartilage and bone, this is done in a subperiosteal plane. Now, an incision is placed intraorally along the buccal sulcus till the molars (as in trauma or orthognathic surgery) and the entire midface can be raised till the infraorbital rim and glabella Access can be made via various osteotomies to the central cranial base as well if needed, from the frontal base down to the upper cervical spine [47]. The exposure obtained using the degloving approach is excellent and the absence of the resultant facial scar or deformity makes this a popular approach in the midface. Nasal obstruction and infraorbital paresthesia can result from this approach.

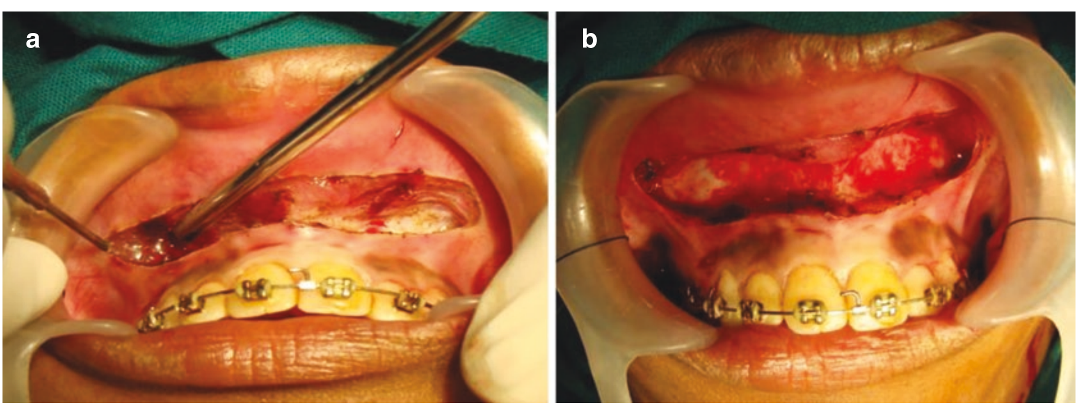


Fig. 7.29 (**a**, **b**) Intraoral approach: Maxillary Vestibular approach

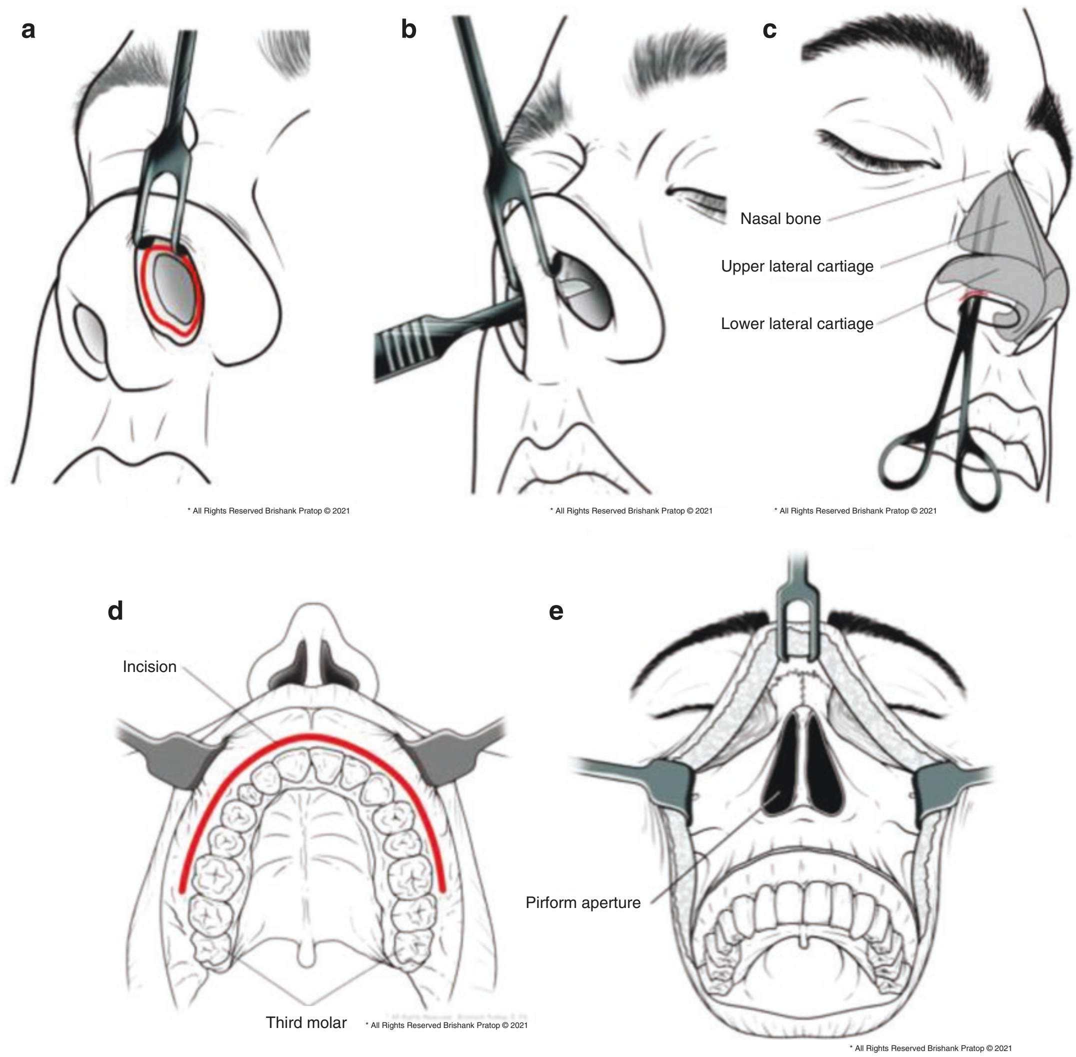


Fig. 7.30 Midface degloving approach (steps **a**–**e**)

7.8 Approaches to the Lower Face

7.8.1 Mandibular Vestibular Approach

Intraoral vascular lesions within the substance of the vestibule and deep to the SMAS/buccinator, it is wise to approach this intraorally via a vestibular approach. The anatomy to be aware of the mandibular vestibular approach are mental vessels, facial vessels, mentalis muscle, and buccal fat pad. The mental nerve is of significance when accessing the soft tissue or bone anterior to the molar region. Mucosal incisions are made anterior and posterior to this region, pass through submucosa and periosteum (Fig. 7.31). The nerve needs to be isolated while accessing this region. The facial vessels can be encountered in the inferior border of the mandible and in this region, the only structure separating them from bone is the periosteum. Since the facial artery arises from the

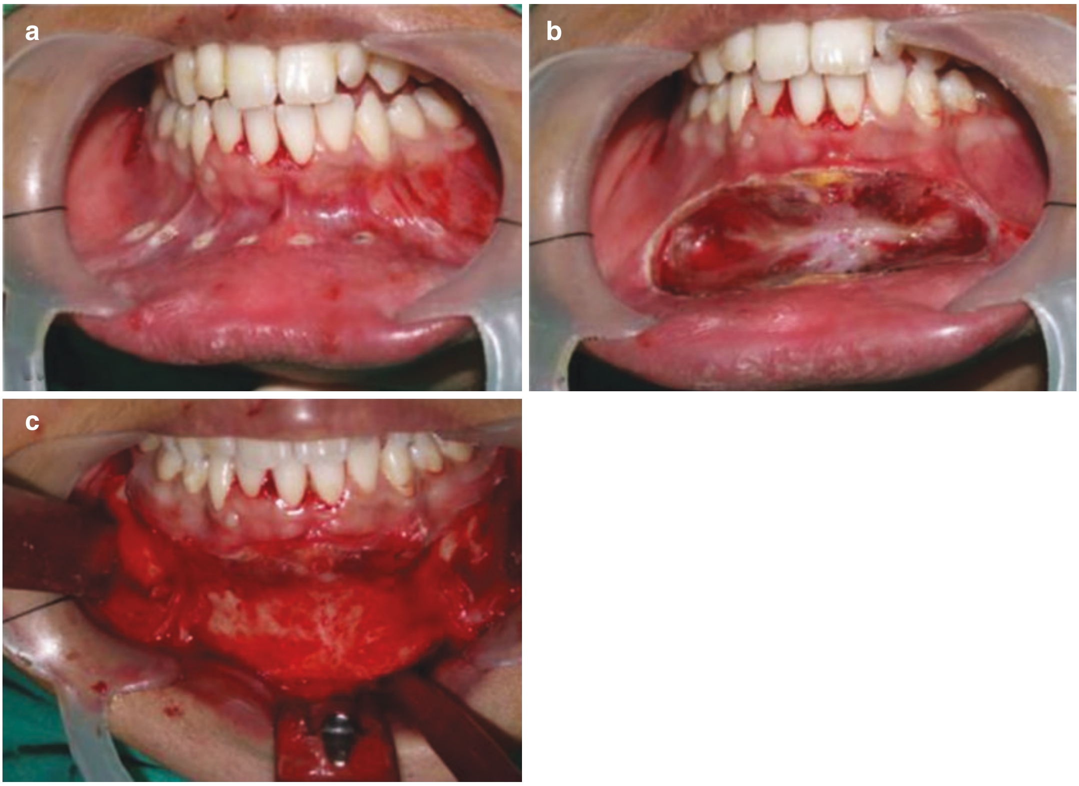


Fig. 7.31 (**a**–**c**) Mandibular vestibular approach

external carotid, vascular lesions arising from this vessel must be ligated prior to accessing this lesion. The mentalis muscle is the elevator of the lower lip and chin and without proper approximation will cause the chin to droop and expose the lower anterior teeth. This muscle is innervated by the marginal branch of the facial nerve and passes from the bony chin to the skin of the chin, hence can be transected in subperiosteal dissections of this zone. The buccal fat pad is a unique structure, which has four extensions: buccal, temporal, pterygoid, and pterygomandibular. The buccal extension is superficial and imparts fullness to the cheek while the rest are deeply seated. The parotid duct travels superficial to the fat pad and penetrates the oral mucosa through the fat pad and buccinator muscle to enter the oral cavity opposite the second molar. Intraoral incision should not be placed, if possible, higher than the occlusal plane of mandibular teeth, to prevent herniation of the buccal fat pad. The incision is placed with these structures in mind, on the sulcular mucosa extending all the way to the external oblique ridge. Exposure is achieved till the lateral border of the ramus of the mandible and even to the condylar neck and coronoid. It is to be noted that in edentulous mandible that incisions should be made on the alveolus, in older patients the resorption causes the mental nerve move closer to the superficial surface.

7.8.2 Visor Incision

Submandibular, submental, and cervical parts of the head and neck are accessible through the cervical visor incision (Fig. 7.32). The flap is raised in a sub-platysmal plane all the way to the lower border of the mandible. The EJV can be identified and ligated at the level of the incision or raised off the flap. Investing layer of the deep cervical fascia is exposed. Supra-platysmal dissec-

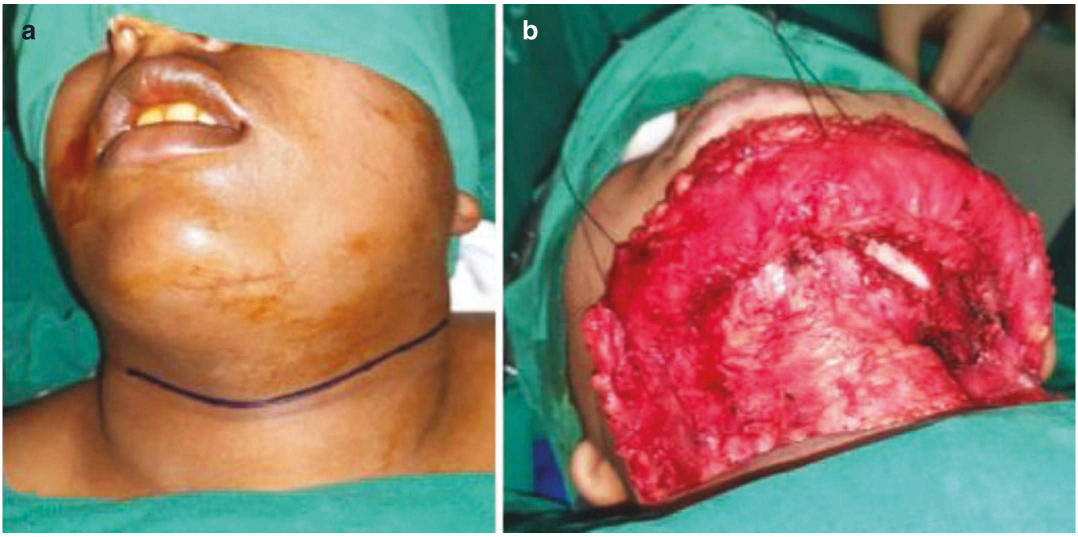


Fig. 7.32 The visor incision is an ample access to the neck, mandible, skull base and parotid areas. (**a**) skin incision (**b**) elevation of the skin and platysma flap elevation to the inferior border of the mandible

tion is required for lesions present in the subcutaneous plane. Care taken not to perforate the flap.

The marginal mandibular and cervical branch of the facial nerve can be identified deep to the investing layer of cervical fascia and is identified at the lower mandibular border emerging below the cervical fascia to cross the facial artery (Fig. 7.7). From here on the nerve is traced posteriorly into the lobe of the parotid gland.

Vascular lesions present in the subcutaneous plane (Type II), Submandibular Gland (Type III), Deep to Mylohyoid, and sternocleidomastoid (SCM), and supraclavicular region can be accessed. The posterior retraction of the SCM exposes the contents of the Carotid sheath (common Carotid Artery, IJV, and vagus nerve). Control of External Carotid can be achieved as well through this approach.

7.8.3 Submandibular Approach

These approaches are for lesions usually deep to the SMAS layer but superficial to the mylohyoid and facial muscles and cannot be accessed intraorally. The relevant anatomy to this region is the facial artery, facial vein, and the marginal branch of facial nerve (Figs. 7.7 and 7.33a). The facial artery, a tortuous branch of the external carotid, arises medial to the mandible, passes the submandibular salivary gland and circles around the lower border of the mandible, anterior to the masseter, and is anterior to the facial vein. The facial vein is formed as a direct continuation of the angular vein which joins the retromandibular vein to form the common facial vein and drains into the internal jugular vein. The facial vein is not as tortuous as the artery. The marginal mandibular branch arises from the facial nerve when it divides in the parotid, extend inferiorly, and supply motor fibers to the facial muscles of the lower lip and corner of the mouth. Injury to this nerve results in facial asymmetry, deviation of the contralateral angle of the mouth, drooling of saliva, and difficulty of speech and chewing. Multiple variations have been mentioned in literature of this nerve. In a study by P.G. Balagopal et al. [48], 161 of the 202 patients (79.7%) the nerve was a single division, formed of two branches in 26 (12.9%) patients, three branches in 14 (6.9%) patients, and four branches in one patient. In patients with a single branch, the nerve crossed the facial artery below the lower border of the mandible in 97/161 (60%) patients, at the lower border of the mandible in 42/161 (26%) patients and above the lower border in 22/161 (14%) patients. The furthest distance the nerve

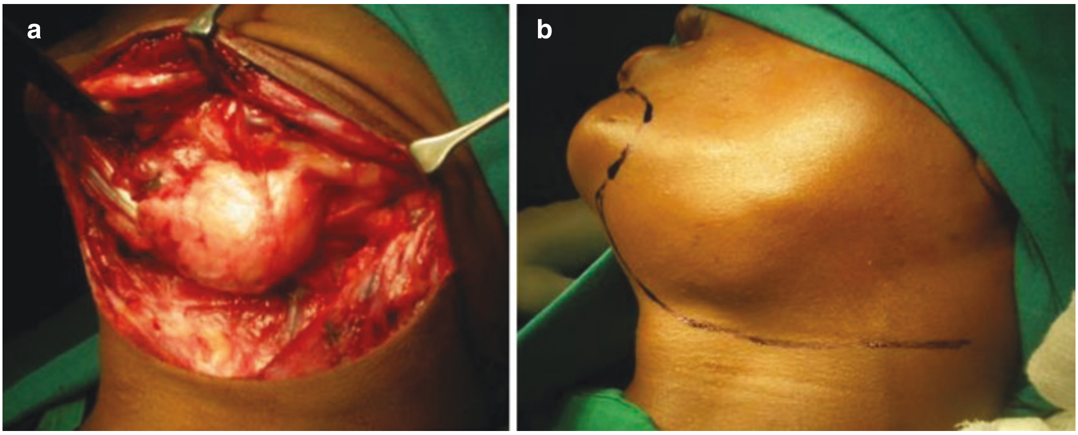


Fig. 7.33 (**a**) Relationship of marginal mandibular nerve and facial vessels (**b**) Submandibular incision extended around chin unto the lip

has been reported from the lower border of the mandible is 1.5 cm and hence incisions for submandibular approach are always placed 1.5–2 cm away from the inferior border. Incisions to ligate the facial artery or vein at this location should follow a low cervical approach.

The layers encountered in this region are skin, subcutaneous tissue, platysma muscle which extends from subcutaneous tissue of periclavicular region to insert into symphysis menti and merge with orbicularis oris. Elevating a subplatysmas flap will expose the superficial layer of deep cervical fascia and in this region, we can encounter the facial vessels and/or the marginal mandibular branch of the facial nerve. The facial vessels can be ligated if necessary or retracted anteriorly depending on the location of the lesion. The capsule of the submandibular gland and the submandibular node can also be encountered here. Further dissection leads to the mandibular periosteum at the lower border of the mandible and the pterygomasseteric sling, This avascular zone is sharply incised in the inferior border of the mandible.

7.9 Mandibular Access Osteotomy [35]

The incision is placed in the submandibular skin crease as described previously and extended anteriorly in a wavy curve toward the mid part of the chin, follows the submental skin crease laterally and continuing around the bulbous part of the chin onto the lower part of the face (Fig. 7.34a). The lip split may be done either medial to the corner of the mouth or carried closer to the midline of the lip with a stagger. Across the vermilion onto the labial mucosa and continued upward to the gingival mucoperiosteum anterior to the desired osteotomy line. Lingual mucosal incision may be placed along the floor of the mouth, at its junction with the attached lingual muco periosteum or a lingual crevicular gingival incision is placed. The lingual mucoperiosteal incision at the junction of the floor and mucoperosteum has the risk of damaging the submandibular duct, sublingual gland, and more importantly the lingual nerve. The lingual incision is extended to the retromolar region around the last erupted tooth and continued buccally at 45°. The mandible is split anterior to the mental foramina between two teeth (usually canine and premolar).

Prior to the osteotomy, a 4-holed plate is adapted on the desired split site, the osteotomy is initiated with a saw preferably to allow good osteosynthesis (Fig. 7.34b). The lingual mucosa or the mucoperiosteum is elevated with the lingual nerve in sight. Posteriorly the medial pterygoid is stripped off the mandible. Lateral traction to the mandible gives good visibility and eases dissection. Medial side of the ramus is visualized and the inferior alveolar neurovascular bundle can be seen before it enters the canal (Fig. 7.34d) Temporalis

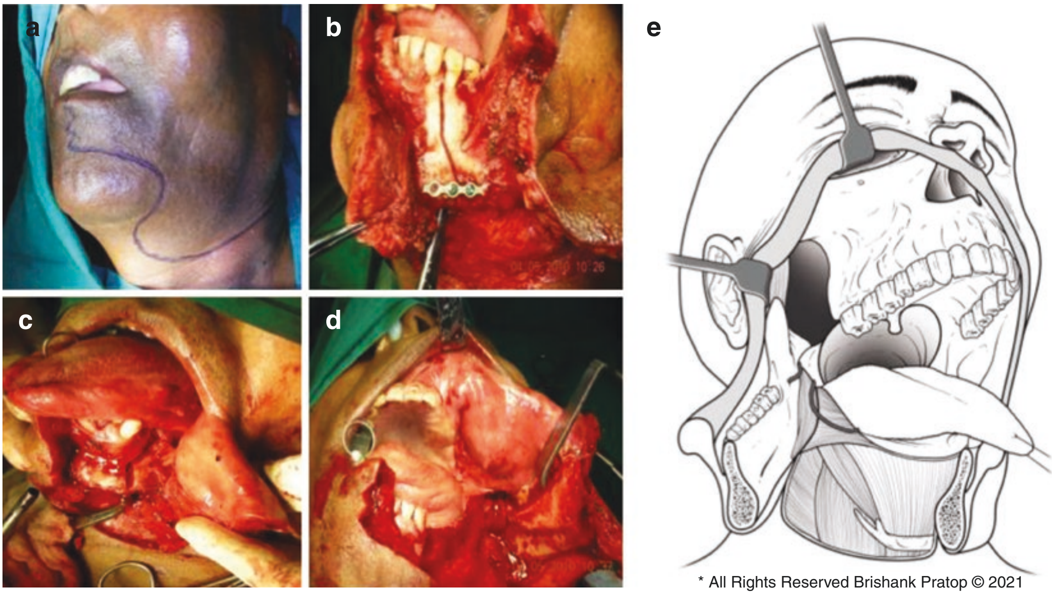


Fig. 7.34 Mandibular access osteotomy. (**a**) Skin marking of the incision (**b**) Mini-plate adapted prior to osteotomy (**c**) Osteotomy completed (**d**) Mandible swung laterally after stripping muscles (**e**) Diagrammatic illustration of the procedure

fibers from the anterior margin of the ramus are elevated using a monopolar cautery. This allows a good lateral and upward swing of the mandible.

The mandibulotomy allows access to lesions in the deep lobe of parotid, parapharynx, and infra-temporal fossa. Following access and excision of the lesion, after obtaining homeostasis the mandible is swung back and plated. Two 4-holed plates are used for fixation in this region. In case of intraoral defect caused by mucosal excision, a temporoparietal flap or radial forearm vascularized flap is used. The rest of the surgical wound is closed in layers with a vacuum drain in situ.

Incisions placed in the head and neck regions are objectively done bearing in mind good access is obtained for excision of the lesion and the scars are well concealed in skin creases or at junctions of aesthetic facial subunits. All wounds are closed in layers with underlying muscles restored to restore function. Skin sutures are placed with 4/0 monofilament non absorbable sutures. Subcuticular sutures are preferred in straight-line wounds. The sutures are removed on the 7th postoperative day.

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Section A

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