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Melvin A. Shiffman
Editors

Advanced Surgical Facial Rejuvenation

Art and Clinical Practice

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Foreword

The trend of this last century is undoubtedly to look young and youthful for the longest time possible. I believe this is due to many factors. Certainly progress in medicine, precocious diagnosis of many diseases and new therapeutic protocols have contributed in increasing longevity but most of all never like in these last decades has the image of a person been so important. We have surely become a society of appearances.

This book will certainly help the young cosmetic surgeon to choose the best techniques in order to achieve excellent results. Another important aspect that comes out of this well-described book is that invasive surgery is not necessary all the times as we once used to believe. Today, traditional lifting is usually proposed in fewer patients than before. It is possible to achieve ameliorations with other, less-invasive techniques such as fat transfer and others. In this way the patient can have short postoperative recovery periods. We should learn to satisfy our patients with the less aggressive techniques possible. Theses combined techniques is the answer that this book can give to its readers. I think that we should really be grateful to Anthony Erian, Melvin Shiffman, and to the other authors for lending us their knowledge.

I would like to add a simple thought of mine to the reader of this book. Besides the technique chosen, the cosmetic surgeon should always keep in mind that he or she is not infallible. In no way does he or she have divine power, so humbleness should be his or her main character trait. Personal hypertrophic ego can lead to major mistakes! We should make our patients happy and try to help them find a better way of living with themselves. My advice is always not to promise your patients what they will not receive.

I would like to quote a beautiful thought of the author of the book *The Face* by Charles H. Willi, published in 1926: "The plastic surgeon is undoubtedly the greatest of all contemporary artists, he paints on living canvas and sculpts on human flesh contributing to the health and happiness and success of his patient."

Rome, Italy　　　　Giorgio Fischer, M.D.

Preface

This book is the result of the hard work of many surgeons who wish to share with you their passion of facial aesthetic surgery. They are experts in their field and have agreed to share their knowledge and experience. The book covers comprehensive and "state-of-the-art" techniques in facial aesthetic surgery, and specific accounts and special techniques, both general and personal, are included.

The aim of this book is to give an up-to-date account of the latest in cosmetic facial surgery, as the trends and techniques seems to change with the times. We surgeons spend our lives learning and improving our techniques, honing and refining them. Both a beginner and an experienced surgeon will learn something from this text book.

A new trend of nonsurgical solutions has been added, as now facial rejuvenation encompasses both surgical and nonsurgical. It is acknowledged that anatomy is 90% of surgery, hence the inclusion of a detailed account relevant to facial rejuvenation.

This book has also stressed pre- and postoperative preparation to reduce complications and avoid litigation which is essential to our society nowadays.

Also, assessments and concepts of beauty have been added as it is difficult to have a basic parameter in this subjective industry.

I am very grateful to all the doctors who contributed with their time, knowledge, and dedication to make this book a special one.

I would like to refer to a facelift as surgical facial rejuvenation, as I feel the word "facelift" is confusing to both the patient and surgeon. It is also a misnomer. It is very difficult to divide the face into zones as all the anatomy is interlinked and interdependent.

In modern surgery today, one tends to combine more than one procedure, both surgical and nonsurgical, so it is more appropriate to name it Surgical Facial Rejuvenation.

I hope and believe that this book will be extremely useful to colleagues and students who want to know more about Facial Rejuvenation.

Cambridge, UK — Anthony Erian, M.D.

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Anatomy

Facial Anatomy

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Peter M. Prendergast

1.1 Introduction

Safe and effective surgical facial rejuvenation relies on a clear knowledge and understanding of facial anatomy. Techniques evolve and improve as the complex, layered architecture and soft tissue compartments of the face are discovered and delineated through imaging, staining techniques, and dissections both intraoperatively and in the research laboratory on cadavers [1]. To create a more youthful, natural-looking form, the surgeon endeavors to reverse some of the changes that occur due to aging. These include volumetric changes in soft tissue compartments, gravitational changes, and the attenuation of ligaments. Whether the plan of rejuvenation includes rhytidectomy, blepharoplasty, autologous fat transfer, implants, or endoscopic techniques, a sound knowledge of facial anatomy will increase the likelihood of success and reduce the incidence of undesirable results or complications.

This chapter describes the anatomy of the face in layers or planes, with some important structures or regions described separately, including the facial nerve, sensory nerves, and facial arteries. The facial skeleton forms the hard tissue of the face and provides important structural support and projection for the overlying soft tissues, as well as transmitting nerves through foramina and providing attachments for several mimetic muscles and muscles of mastication. Following a description of the hard tissue foundation, the soft tissues will be described, from superficial to deep, in the following order:

1. Superficial fat compartments
2. Superficial musculoaponeurotic system (SMAS)
3. Retaining ligaments
4. Mimetic muscles
5. Deep plane including the deep fat compartments

1.2 Facial Skeleton

Facial appearance is to a large extent determined by the convexities and concavities of the underlying facial bones (Fig. 1.1). The "high" cheekbones and strong chin associated with attractiveness are attributable to the convexities and projection provided by the zygomatic bone and mental protuberance of the mandible, respectively (Fig. 1.2). The facial skeleton consists of the frontal bone superiorly, the bones of the midface, and the mandible inferiorly. The midface is bounded superiorly by the zygomaticofrontal suture lines, inferiorly by the maxillary teeth, and posteriorly by the sphenoethmoid junction and the pterygoid plates. The bones of the midface include the maxillae, the zygomatic bones, palatine bones, nasal bones, the zygomatic processes of the temporal bones, the lacrimal bones, the ethmoid bones, and the turbinates. The facial skeleton contains four apertures: the two orbital apertures, the nasal aperture, and the oral aperture. The supraorbital foramen (or notch) and the frontal notch are found at the superior border of each orbit and transmit the supraorbital and supratrochlear nerves, respectively. The maxillary bones contribute to the nasal aperture, bridge of the nose, maxillary teeth, floor of the orbits, and cheekbones. The

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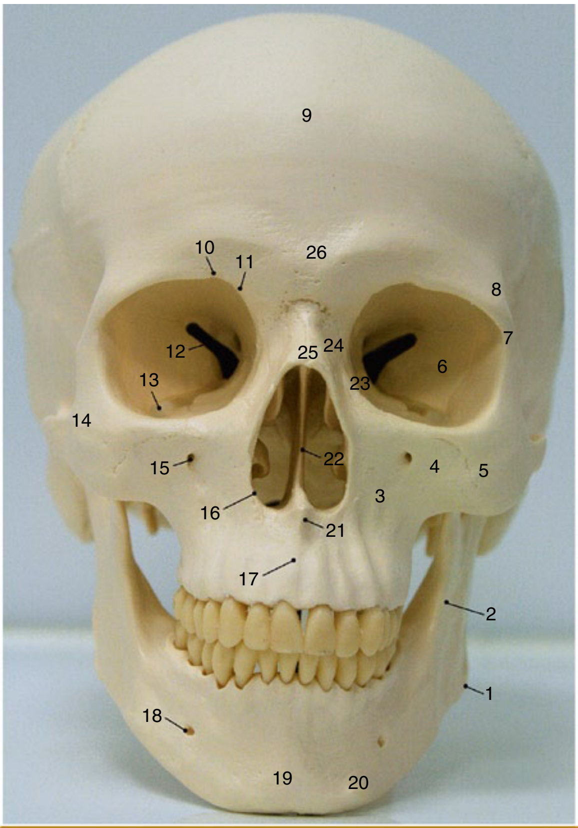

1 Angle of mandible
2 Ramus of mandible
3 Body of maxilla
4 Zygomatic process of maxilla
5 Zygomatic bone
6 Greater wing of sphenoid bone
7 Zygomaticofrontal suture
8 Zygomatic process of frontal bone
9 Frontal bone
10 Supra-orbital notch
11 Frontal notch
12 Superior orbital fissure
13 Inferior orbital fissure
14 Zygomaticofacial foramen
15 Infra-orbital foramen
16 Anterior nasal aperture
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18 Mental foramen
19 Mental protruberance
20 Body of mandible
21 Anterior nasal spine
22 Nasal septum
23 Lacrimal bone
24 Frontal process of maxilla
25 Nasal bone
26 Glabella

Fig. 1.1 The facial skeleton

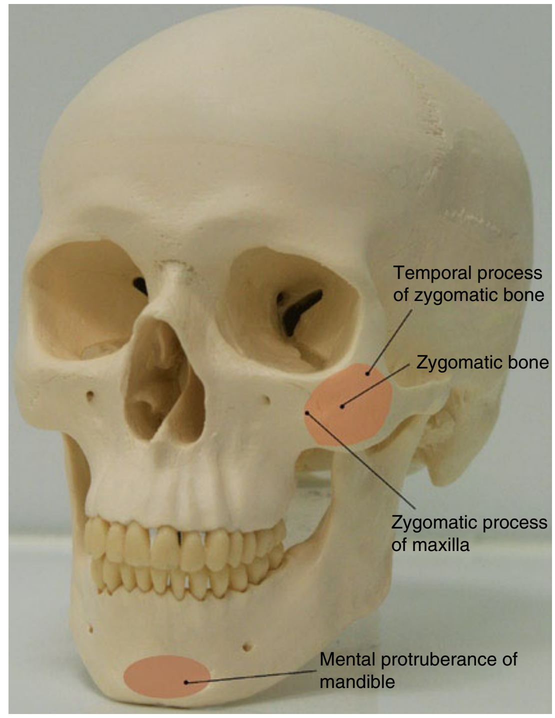


Fig. 1.2 Convexities of the facial skeleton

infraorbital foramen lies in the maxilla below the inferior orbital rim and transmits the infraorbital nerve. The zygomaticofacial foramen transmits the zygomaticofacial nerve inferolateral to the junction of the inferior and lateral orbital rim.

The mandible forms the lower part of the face. In the midline, the mental protuberance gives anterior projection to the overlying soft tissues. Laterally, the ramus of the mandible underlies the masseter muscle and continues superiorly to articulate with the cranium through the coronoid process and condylar process of the mandible.

The mental nerve emerges from the mental foramen on the body of the mandible in line vertically with the infraorbital and supraorbital nerves.

As well as providing structural support, projection, and protection of sensory organs such as the eyes, the facial skeleton provides areas of attachment for the muscles of facial expression and the muscles of mastication (Fig. 1.3).

1.3 Superficial Fat Compartments

The pioneering work of Rohrich [2], using staining techniques and cadaver dissections, has revealed a number of distinct superficial fat compartments in the face. These compartments are separated from one another by delicate fascial tissue and septae that converge where adjacent compartments meet to form retaining ligaments. The superficial fat compartments of the face comprise the following: the nasolabial fat compartment, the medial, middle, and lateral temporal-cheek "malar" fat pads, the central, middle, and lateral temporal-cheek pads in the forehead, and the superior, inferior, and lateral orbital fat pads (Fig. 1.4). Nasolabial fat lies medial to the cheek fat pad

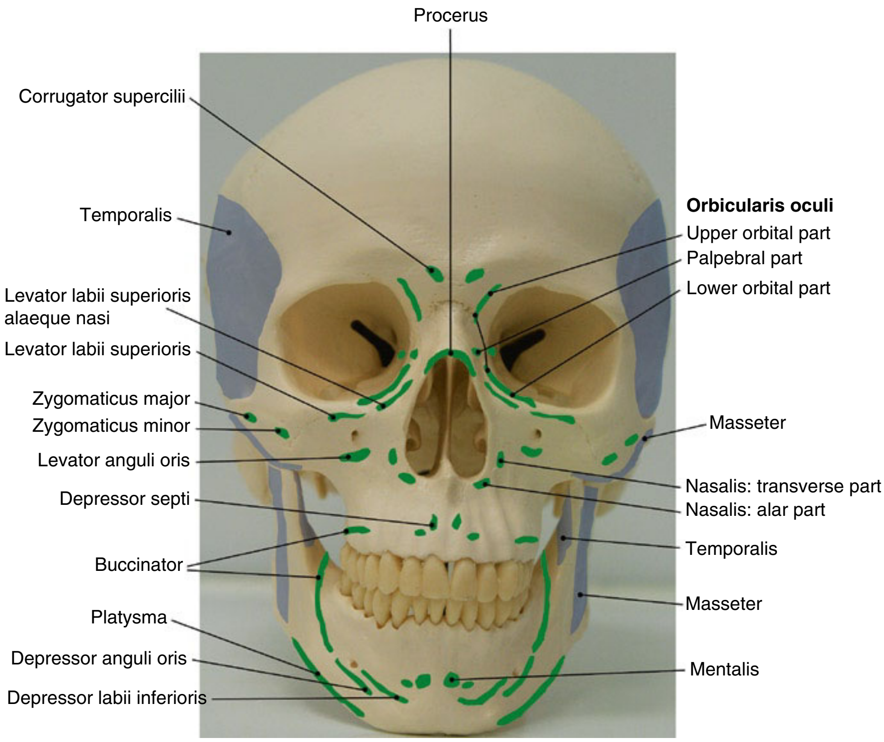


Fig. 1.3 Areas of muscle attachments to the facial skeleton

compartments and contributes to the overhang of the nasolabial fold. The orbicularis retaining ligament below the inferior orbital rim represents the superior border of the nasolabial fat compartment and the medial cheek compartment (Fig. 1.5). The middle cheek fat compartment lies between the medial and lateral temporal-cheek fat compartments and is bounded superiorly by a band of fascia termed the superior cheek septum. The borders of the middle cheek compartment, inferior, and lateral orbital fat pad compartments converge to form a tougher band of tissue called the zygomatic ligament [3]. The condensation of connective tissue at the borders of the medial and middle fat compartments correlates with the masseteric ligaments in the same location [4]. The lateral temporal-cheek fat pads span the entire face from the forehead to the cervical area. Its anterior boundary, the lateral cheek septum, is encountered during facelift procedures with medial dissection from the preauricular incision. In the forehead, its upper and lower boundaries are identifiable as the superior and inferior temporal septa. Medial to the lateral temporal-cheek fat compartment in the forehead, the middle forehead fat pad is bounded inferiorly by the orbicularis retaining ligament and medially by the central forehead fat compartment. Above and below the eyes, the superior

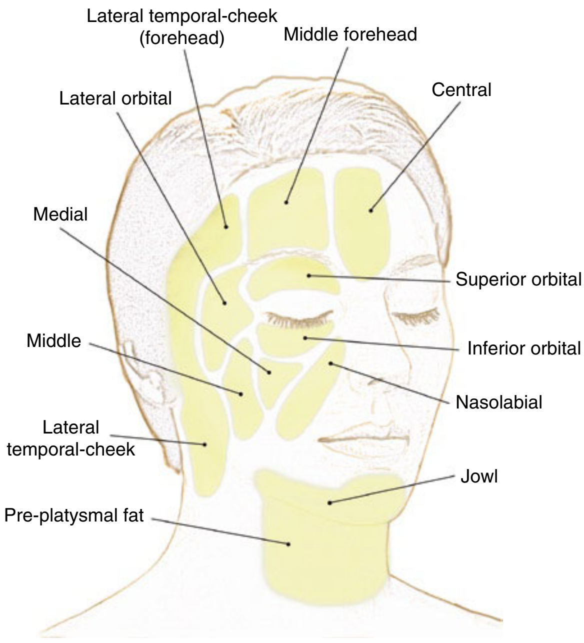


Fig. 1.4 The superficial fat compartments of the face

and inferior orbital fat compartments lie within the perimeter of the orbicularis retaining ligament. These periorbital fat pads are separated from one another medially and laterally by the medial and lateral canthi,

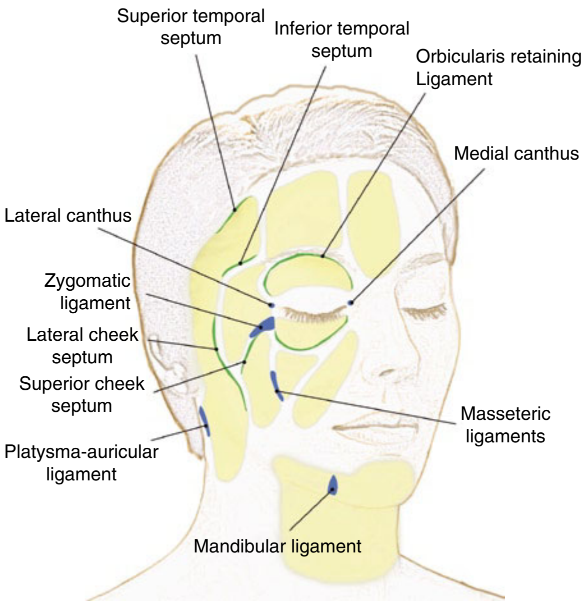


Fig. 1.5 Ligaments and septae between fat compartments of the face

respectively. The lateral orbital fat compartment is the third orbital fat pad and is bounded superiorly by the inferior temporal septum and inferiorly by the superior cheek septum. The zygomaticus major muscle attaches, through fibrous septae, to overlying superficial fat compartments along its length. In the lower third of the face, the jowl fat compartment adheres to the depressor anguli oris muscle and is bounded medially by the depressor labii and inferiorly by bands of the platysma muscle. Premental and preplatysmal fat abut the jowl fat compartment.

The compartmentalized anatomy of the superficial subcutaneous fat of the face has implications in the aging process. Volume loss appears to occur at different rates in different compartments, leading to irregularities in facial contour and loss of the seamless, smooth transitions between the convexities and concavities of the face associated with youthfulness and beauty.

1.4 Superficial Musculoaponeurotic System (SMAS)

In 1974, Mitz and Peyronie published their description of a fibrofatty superficial facial fascia they called the superficial musculoaponeurotic system (SMAS) [5]. This system or network of collagen fibers, elastic fibers, and fat cells connects the mimetic muscles to the overlying dermis and plays an important functional role in facial expression. The SMAS is central to most current facelift techniques where it is usually dissected, mobilized, and redraped. In simple terms, the SMAS can be considered as a sheet of tissue that extends from the neck (platysma) into the face (SMAS proper), temporal area (superficial temporal fascia), and medially beyond the temporal crest into the forehead (galea aponeurotica). However, the precise anatomy of the SMAS, regional variations, and even the existence of the SMAS are debated [6]. Ghassemi [7] describes two variations of SMAS architecture. Type I SMAS consists of a network of small fibrous septae that traverse perpendicularly between fat lobules to the dermis and deeply to the facial muscles or periosteum. This variation exists in the forehead, parotid, zygomatic, and infraorbital areas. Type II SMAS consists of a dense mesh of collagen, elastic, and muscle fibers and is found medial to the nasolabial fold, in the upper and lower lips. Although extremely thin, type II SMAS binds the facial muscles around the mouth to the overlying skin and has an important role in transmitting complex movements during animation. Over the parotid gland, the SMAS is relatively thick. Further medially, it thins considerably making it difficult to dissect. In the lower face, the SMAS covers the facial nerve branches as well as the sensory nerves. Dissection superficial to the SMAS in this region protects facial nerve branches [8]. Above the zygomatic arch, the SMAS exists as the superficial temporal fascia, which splits to enclose the temporal branch of the facial nerve and the intermediate temporal fat pad. Dissection in this area should proceed deep to the superficial temporal fascia, on the deep temporal fascia, to avoid nerve injury. Although considered as one "system" or plane, the surgeon should be mindful of the regional differences in SMAS anatomy from superior to inferior and lateral to medial.

1.5 Retaining Ligaments

True retaining ligaments are easily identifiable structures that connect the dermis to the underlying periosteum. False retaining ligaments are more diffuse condensations of fibrous tissue that connect superficial

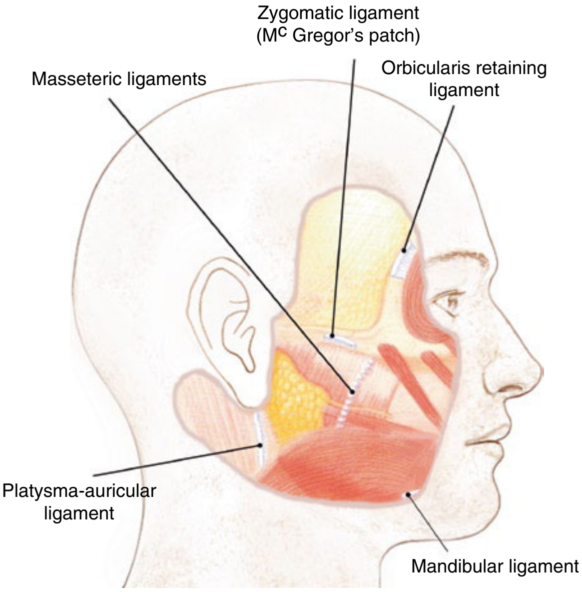


Fig. 1.6 The retaining ligaments of the face

and deep facial fasciae [9] (Fig. 1.6). The zygomatic ligament (McGregor's patch) is a true ligament that connects the inferior border of the zygomatic arch to the dermis and is found just posterior to the origin of the zygomaticus minor muscle [3]. Other true ligaments include the lateral orbital thickening on the superolateral orbital rim that arises as a thickening of the orbicularis retaining ligament, and the mandibular retaining ligament. The latter connects the periosteum of the mandible just medial to the origin of depressor anguli oris to the overlying dermis. This attachment gives rise to the labiomandibular fold just anterior to the jowl. The masseteric ligaments are false retaining ligaments that arise from the anterior border of masseter and insert into the SMAS and overlying dermis of the cheek. With aging, these ligaments attenuate, the SMAS over the masseter becomes ptotic, and this leads to the formation of jowls [10]. Below the lobule of the ear, the platysma-auricular ligament represents a condensation of fibrous tissue where the lateral temporal-cheek fat compartment meets the postauricular fat compartment. During facial rejuvenation procedures, true and false retaining ligaments are encountered and often released in order to mobilize and redrape tissue planes. Extra care should be taken when releasing ligaments as important facial nerve branches are intimately related to ligaments such as the zygomatic and mandibular retaining ligaments.

1.6 Mimetic Muscles

The muscles of facial expression are thin, flat muscles that act either as sphincters of facial orifices, as dilators, or as elevators and depressors of the eyebrows and mouth. Frontalis, corrugator supercilii, depressor supercilii, procerus, and orbicularis oculi represent the periorbital facial muscles. The perioral muscles include the levator muscles, zygomaticus major and minor, risorius, orbicularis oris, depressor anguli oris, depressor labii, and mentalis. The nasal group includes compressor naris, dilator naris, and depressor septi. In the neck, the platysma muscle lies superficially and extends into the lower face (Fig. 1.7).

The frontalis represents the anterior belly of the occipitofrontalis muscle and is the main elevator of the brows. It arises from the epicranial aponeurosis and passes forward over the forehead to insert into fibers of the orbicularis oculi, corrugators, and dermis over the brows. Contraction raises the eyebrows and causes horizontal furrows over the forehead. Frontalis receives innervation from the temporal branch of the facial nerve.

The orbicularis oculi acts as a sphincter around the eye. It consists of three parts: the orbital, preseptal, and pretarsal parts. The orbital part arises from the nasal part of the frontal bone, the frontal process of the maxilla, and the anterior part of the medial canthal tendon. Its fibers pass in concentric loops around the orbit, well beyond the confines of the orbital rim. Contraction causes the eyes to squeeze closed forcefully. Superior fibers also depress the brow. Preseptal orbicularis oculi arises from the medial canthal tendon, passes over the fibrous orbital septum of the orbital rim, and inserts into the lateral palpebral raphe. The pretarsal portion, involved in blinking, overlies the tarsal plate of the eyelid and has similar origins and insertions to its preseptal counterpart. These muscles receive innervation from the temporal and zygomatic branches of the facial nerve.

The corrugator supercilii arises from the superomedial aspect of the orbital rim and passes upward and outward to insert into the dermis of the middle of the brow. From its origin deep to frontalis, two slips of muscle, one vertical and one transverse, pass through fibers of frontalis to reach the dermis. The superficial and deep branches of the supraorbital nerve are intimately related to corrugator supercilii at its origin and are prone to injury during resection of this muscle. Corrugator supercilii depresses the brow and pulls it medially, as in frowning.

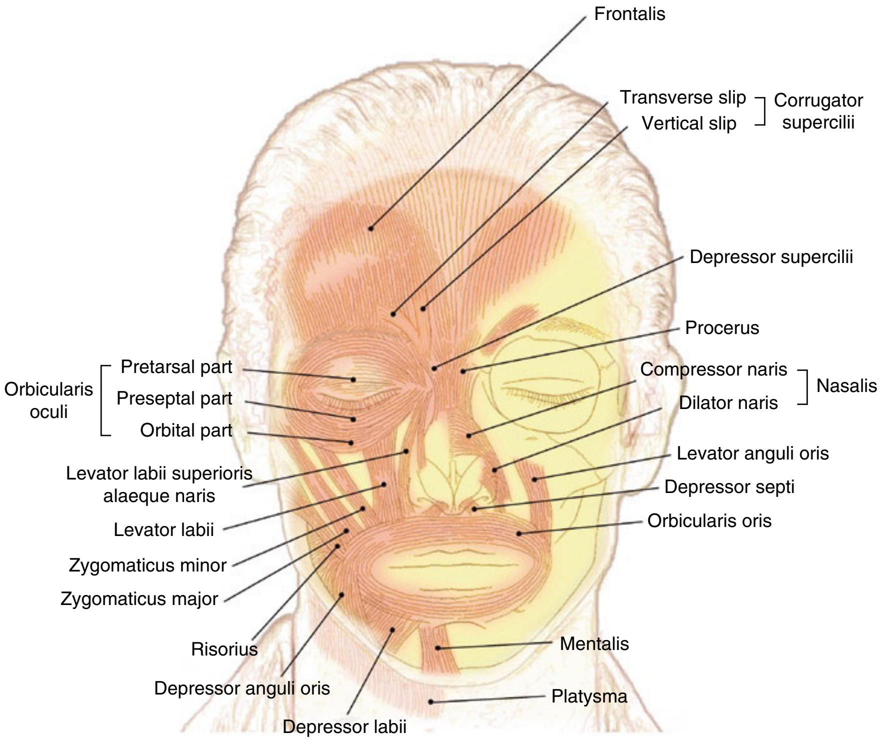


Fig. 1.7 The mimetic facial muscles

The depressor supercilii is a thin slip of muscle that is difficult to distinguish from the superomedial fibers of orbicularis oculi. It inserts into the medial brow and acts as a depressor.

The procerus arises from the nasal bone, passes superiorly, and insert into the dermis of the glabella between the brows. It depresses the lower forehead skin in the midline to create a horizontal crease at the bridge of the nose. Chemodenervation of procerus and corrugator supercilii to alleviate frown lines is one of the most common aesthetic indications for botulinum toxins. Procerus is sometimes debulked during endoscopic brow lift procedures to reduce the horizontal frown crease.

The zygomaticus major and minor are superficial muscles that originate from the body of the zygoma and pass downward to insert into the corner of the mouth and lateral aspect of the upper lip, respectively. They receive their nerve supply on their deep surface from the zygomatic and buccal branches of the facial nerve. Zygomaticus major and minor lift the corners of the mouth.

The levator labii lies deep to orbicularis oculi at its origin from the maxilla just above the infraorbital foramen. It passes downward to insert into the upper lip and orbicularis oris. A smaller slip of muscle medial to this, levator labii superioris alaeque nasi, originates from the frontal process of the maxilla and inserts into the nasal cartilage and upper lip. Both of these muscles are supplied from branches of the zygomatic and buccal branches of the facial nerve and elevate the upper lip.

The levator anguli oris arises deeply from the canine fossa of the maxilla below the infraorbital foramen and inserts into the upper lip. It is innervated on its superficial aspect by the zygomatic and buccal branches of the facial nerve and elevates the corner of the mouth.

The risorius is often underdeveloped and arises from a thickening of the platysma muscle over the lateral cheek, the parotidomasseteric fascia, or both. It inserts into the corner of the mouth and pulls the mouth corners laterally.

The orbicularis oris acts as a sphincter around the mouth and its fibers interlace with all of the other facial muscles that act on the mouth. The buccal and marginal mandibular branches of the facial nerve provide motor supply to orbicularis oris, which has various actions including pursing, dilation, and closure of the lips.

The depressor anguli oris arises from the periosteum of the mandible along the oblique line lateral to depressor labii inferioris. Its fibers converge on the modiolus with fibers of orbicularis oris, risorius, and sometimes levator anguli oris. It is supplied by the marginal mandibular branch of the facial nerve and depresses the mouth corners on contraction. Depressor labii inferioris arises from the oblique line of the mandible in front of the mental foramen, where fibers of depressor anguli oris cover it. It passes upward and medially to insert into the skin and mucosa of the lower lip and into fibers of orbicularis oris.

The mentalis arises from the incisive fossa of the mandible and descends to insert into the dermis of the chin. Contraction elevates and protrudes the lower lip and creates the characteristic "peach-pit" dimpling of the skin over the chin. Motor supply arises from the marginal mandibular nerve.

The nasalis consists of two parts: the transverse part (compressor naris) and the alar part (dilator naris). The compressor naris arises from the maxilla over the canine tooth and passes over the dorsum of the nose to interlace with fibers from the contralateral side. It compresses the nasal aperture. The dilator naris originates from the maxilla just below and medial to compressor naris and inserts into the alar cartilage of the nose. It dilates the nostrils during respiration. The depressor septi is a slip of muscle arising from the maxilla above the central incisor, deep to the mucous membrane of the upper lip. It inserts into the cartilaginous nasal septum and pulls the nose tip inferiorly. The nasalis and depressor septi receive innervation from the superior buccal branches of the facial nerve.

The platysma is a broad thin sheet of muscle that arises from the fascia of the muscles of the chest and shoulders and passes upward over the clavicles and neck toward the lower face. Fibers insert into the border of the mandible, perioral muscles, modiolus, and dermis of the cheek. Although variations exist [11], the platysma usually decussates with fibers from the other side 1–2 cm below the mandible. As part of aging, its medial fibers attenuate or thicken to create platysmal bands. Functionally, the platysma depresses the mandible during deep inspiration but is probably more important as a mimetic muscle to express horror or disgust. It is regarded as the inferior most extension of the SMAS and is innervated by the cervical branch of the facial nerve.

1.7 Deep Plane Including the Deep Fat Compartments

The superficial fat compartments described above lie above the muscles of facial expression in the subcutaneous plane. In the midface, the suborbicularis oculi fat and deep cheek fat represent deeper fat compartments that provide volume and shape to the face and act as gliding planes within which the muscles of facial expression can move freely. Suborbicularis oculi fat (SOOF) has two parts, medial and lateral [12]. The medial component extends along the inferior orbital rim from the medial limbus (sclerocorneal junction) to the lateral canthus and the lateral component from the lateral canthus to the temporal fat pad. Between the SOOF and the periosteum of the zygomatic process of maxilla there is a gliding space, the prezygomatic space [13]. This space is bounded superiorly by the orbicularis retaining ligament and inferiorly by the zygomatic retaining ligament (Fig. 1.8). The sublevator fat pad lies medial to the medial SOOF compartment and represents the most medial of the deep infraorbital fat pads. This fat pad is an extension of the buccal fat pad, behind levator labii superioris alaeque nasi and is continuous below and laterally with the melolabial and buccal extensions of the buccal fat pad

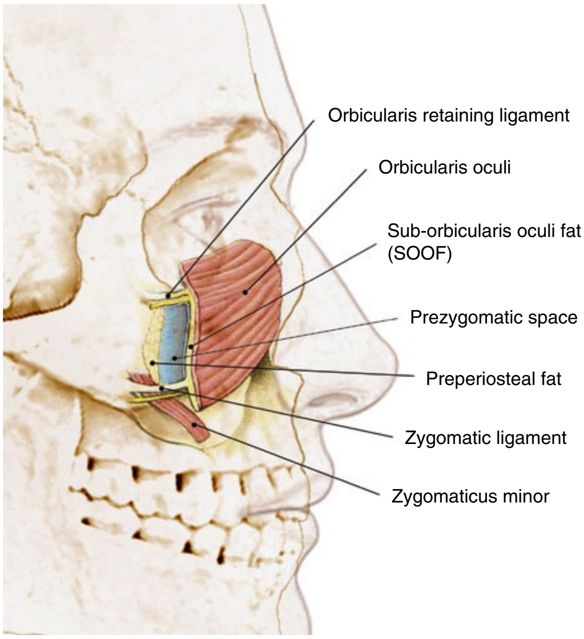


Fig. 1.8 The prezygomatic space

[1]. The buccal fat pad is an aesthetically important structure that sits on the posterolateral part of the maxilla superficial to the buccinator muscle and deep to the anterior part of masseter. Functionally, it facilitates a free gliding movement for the surrounding muscles of mastication [14]. As well as the medial extensions described above, it continues laterally as the pterygoid extension (Fig. 1.9). Buccal branches of the facial nerve and the parotid duct travel along its surface within the parotidomasseteric fascia after leaving the parotid gland.

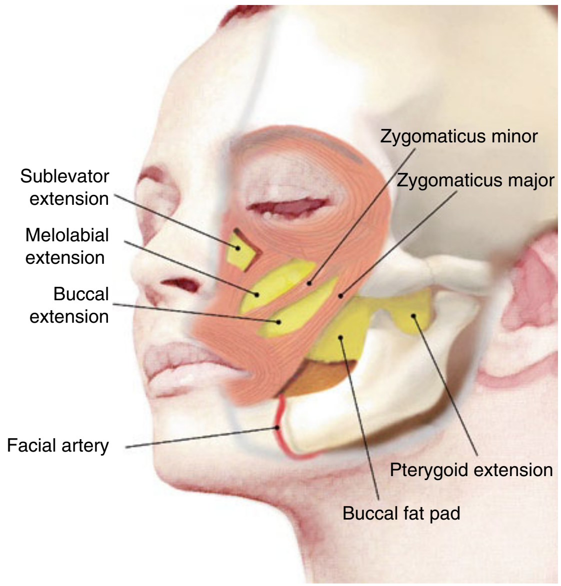


Fig. 1.9 The buccal fat pad and its extensions

The galea fat pad lies deep to frontalis in the forehead and extends superiorly for about 3 cm [15]. It envelops corrugator and procerus and aids gliding of these muscles during animation. The retroorbicularis oculi fat (ROOF) is part of the galea fat pad over the superolateral orbital rim from the middle of the rim to beyond the lateral part. It lies deep to the superolateral fibers of preseptal and orbital orbicularis oculi and contributes to the fullness (in youth) and heaviness (in senescence) of the lateral brow and lid.

With aging, the retaining ligaments under the eye attenuate. This, together with volume loss in the superficial and deep fat compartments, results in visible folds and grooves in the cheeks and under the eyes (Fig. 1.10).

The deep cervical fascia covering sternocleidomastoid in the neck continues upward to ensheath the parotid gland between the mandible and mastoid process. The layer of fascia covering the parotid gland and masseter, termed parotidomasseteric fascia, continues superiorly to insert into the inferior border of the zygomatic arch. In the temporal area, the corresponding fascia in the same plane is present as deep temporal fascia, which inserts into the superior border of the zygomatic arch. In the lower face, branches of

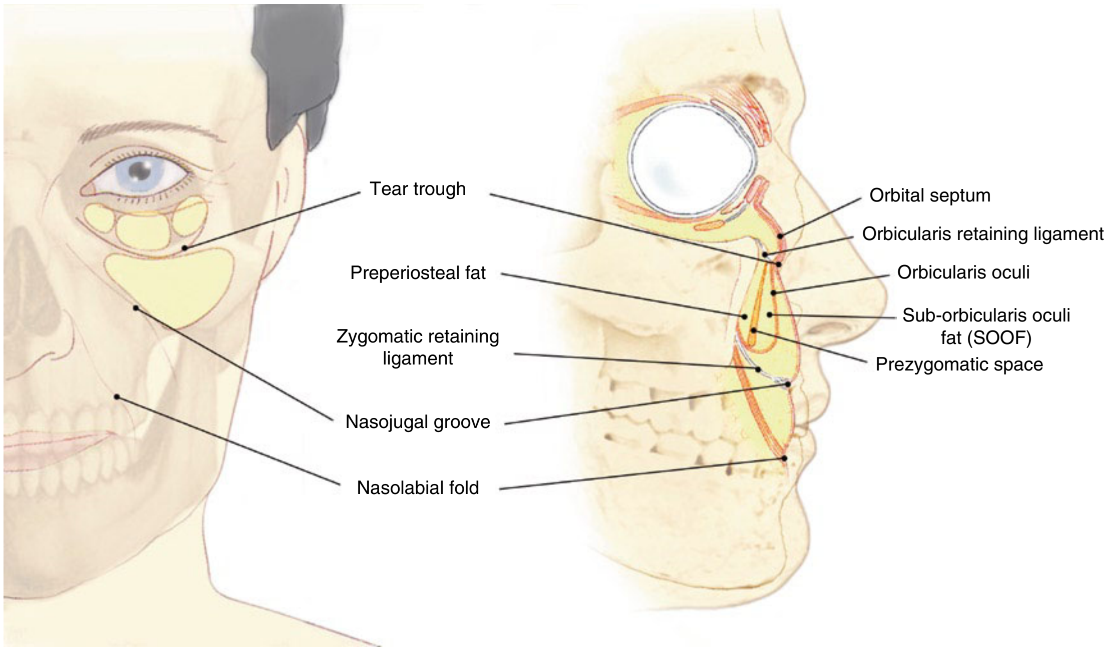


Fig. 1.10 Attenuated ligaments in the midface

the facial nerve lie underneath the deep fascia, whereas above the zygomatic arch and in the upper face, facial nerve branches lie superficial to the deep fascia and are susceptible to injury during superficial dissections.

1.8 Facial Nerve

The facial nerve (seventh cranial nerve) provides motor innervation to the muscles of facial expression. It begins in the face by emerging from the stylomastoid foramen 6–8 mm medial to the tympanomastoid suture of the skull. Before entering the substance of the parotid gland, the posterior auricular nerve and nerves to the posterior belly of digastric and stylohyoid branch from the main trunk. Within the parotid gland, the facial nerve divides into its main branches: temporal branch, zygomatic branch, buccal branch, marginal mandibular branch, and cervical branch (Fig. 1.11).

The temporal branch of the facial nerve leaves the superior border of the parotid gland as three or four rami. They cross the zygomatic arch between 0.8 and 3.5 cm anterior to the external acoustic meatus, and usually about 2.5 cm anterior to it. At the level of the zygomatic arch, the most anterior branch is always at least 2 cm posterior to the lateral orbital rim. The temporal branches pass in an envelope of superficial temporal fascia with the intermediate fat pad, superficial to the deep temporal fascia. The temporal branch enters frontalis about 2 cm above the brow, just below the anterior branch of the superficial temporal artery.

There are up to three zygomatic branches of the facial nerve. The upper branch passes above the eye to supply frontalis and orbicularis oculi. The lower branch always passes under the origin of zygomaticus major and supplies this muscle, other lip elevators and the lower orbicularis oculi. Smaller branches continue around the medial aspect of the eye to supply depressor supercilii and the superomedial orbicularis oculi.

The buccal branch exits the parotid and is tightly bound to the anterior surface of masseter within the parotidomasseteric fascia. It continues anteriorly over the buccal fat pad, below and parallel to the parotid duct, to supply the buccinators and muscles of the upper lip and nose. A second branch is occasionally present, but this travels superior to the parotid duct in its course anteriorly.

The marginal mandibular nerve exits the lower part of the parotid gland as one to three major branches. It usually runs above the inferior border of the mandible, but may drop up to 4 cm below it. About 2 cm posterior to the angle of the mouth, the nerve passes upward and more superficially to innervate the lip depressors. Although it remains deep to the platysma, it is vulnerable to injury during surgical procedures in the lower face at this location.

The cervical branch of the facial nerve passes into the neck at the level of the hyoid bone to innervate the platysma muscle.

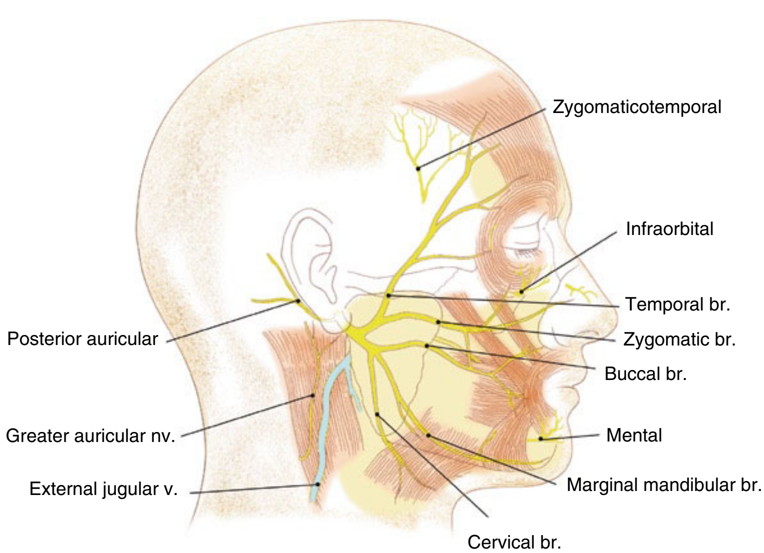


Fig. 1.11 The branches of the facial nerve. Note, the greater auricular, zygomaticotemporal, infraorbital, and mental nerves are sensory nerves

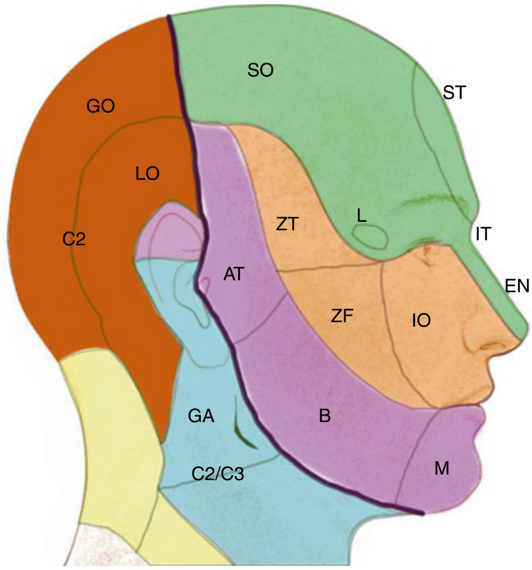
1.9 Sensory Nerves

The sensory innervation of the face is via the three divisions of the trigeminal nerve (fifth cranial nerve): ophthalmic nerve, maxillary nerve, and mandibular nerve. The ophthalmic nerve supplies the forehead, upper eyelid, and dorsum of the nose via the supraorbital, supratrochlear, infratrochlear, lacrimal, and external nasal nerves. The maxillary nerve supplies the lower eyelid, cheek, upper lip, ala of the nose, and part of the temple, through the infraorbital, zygomaticofacial, and zygomaticotemporal nerves. The maxillary nerve also supplies the maxillary teeth and nasal cavity via the alveolar nerves and pterygopalatine nerves, respectively. The mandibular nerve has motor and sensory fibers. Its branches include the inferior alveolar nerve, lingual nerve, buccal nerve, and auriculotemporal nerve. These supply the skin over the mandible, lower cheek, part of the temple and ear, the lower teeth, gingival mucosa, and the lower lip (Fig. 1.12). The greater auricular nerve, derived from the anterior primary rami of the second and third cervical nerves, supplies the skin over the angle of the mandible.

The supraorbital nerve emerges from the orbit at the supraorbital notch (or foramen) 2.3–2.7 cm from the midline in men and 2.2–2.5 cm from the midline in women [16]. It has superficial and deep branches that straddle the corrugator muscle. Sometimes these branches exit from separate foramina, the deep branch arising lateral to the superficial one. The deep branch usually runs superiorly between the galea and the periosteum of the forehead 0.5–1.5 cm medial to the superior temporal crest line. The supratrochlear nerve exits the orbit about 1 cm media to the supraorbital nerve and runs close to the periosteum under the corrugator and frontalis. Its several branches supply the skin over the medial eyelid and lower medial forehead. The infratrochlear nerve is a terminal branch of the nasociliary nerve that supplies a small area on the medial aspect of the upper eyelid and bridge of the nose. The external nasal nerve supplies the skin of the nose below the nasal bone, except for the skin over the external nares. The lacrimal nerve supplies the skin over the lateral part of the upper eyelid.

The infratrochlear nerve exits the orbit about 1 cm media to the supraorbital nerve and supplies the skin over the medial eyelid and bridge of the nose.

The infraorbital nerve is the largest cutaneous branch of the maxillary nerve. It enters the face through the infraorbital foramen 2.7–3 cm from the midline in men and 2.4–2.7 cm from the midline in women, about 7 and 6 mm inferior to the inferior orbital rim in men and women, respectively. The nerve appears from the foramen just below the origin of levator labii superioris. It supplies the lower eyelid, ala of the nose, and upper lip. The zygomaticofacial nerve arises from the zygomaticofacial foramen below and lateral to the orbital rim and supplies skin of the malar eminence. The zygomaticotemporal nerve emerges from its foramen on the deep surface of the zygomatic bone and supplies the anterior temple.



Green = ophthalmic nerve (V1)
Supraorbital nerve (SO)
Supratrochlear nerve (ST)
Infratrochlear nerve (IT)
External nasal nerve (EN)
Lacrimal nerve (L)
Orange = maxillary nerve (V2)
Zygomaticotemporal nerve (ZT)
Zygomaticofacial nerve (ZF)
Infraorbital nerve (IO)
Purple = mandibular nerve (V3)
Auriculotemporal nerve (AT)
Buccal nerve (B)
Mental nerve (M)
Red and Blue = Cervical nerves (C2/C3)
Greater occipital nerve (GO)
Lesser occipital nerve (LO)
Greater auricular nerve (GA)

Fig. 1.12 Sensory innervation of the face

The mental nerve is a branch of the inferior alveolar nerve that exits the mental foramen in line vertically with the infraorbital foramen, between the apices of the premolar teeth. It is often visible and easily palpable through stretched oral mucosa. It supplies the skin over the lower lip and mandible. The buccal branch of the mandibular nerve supplies the buccal mucosa and skin of the cheek, and the lingual nerve provides sensory innervation to the anterior two-thirds of the tongue and the floor of the mouth. The auriculotemporal nerve emerges from behind the temporomandibular joint to supply the skin of the upper one-third of the ear, the external acoustic meatus, tympanic membrane, as well as the skin over the temporal region. Secretomotor fibers also pass via the auriculotemporal nerve to the parotid gland.

1.10 Arteries of the Face

The skin and soft tissue of the face receive their arterial supply from branches of the facial, maxillary, and superficial temporal arteries – all branches of the external carotid artery. The exception is a masklike area including the central forehead, eyelids, and upper part of the nose, which are supplied through the internal carotid system by the ophthalmic arteries (Fig. 1.13).

The facial artery arises from the external carotid and loops around the inferior and anterior borders of the mandible, just anterior to masseter. It pierces the masseteric fascia and ascends upward and medially toward the eye. It lies deep to the zygomaticus and risorius muscles but superficial to buccinator and levator anguli oris [17]. At the level of the mouth, the facial artery sends two labial arteries, inferior and superior, into the lips where they pass below orbicularis oris. The continuation of the facial artery near the medial canthus beside the nose is the angular artery.

The maxillary artery is a terminal branch of the external carotid with three main branches, mental, buccal, and infraorbital arteries. The mental artery is the terminal branch of the inferior alveolar artery that passes through the mental foramen to supply the chin and lower lip. The buccal artery crosses the buccinators to supply the cheek tissue. The infraorbital artery reaches the face through the infraorbital foramen and supplies the lower eyelid, cheek, and lateral nose. It anastomoses with branches of the transverse facial, ophthalmic, buccal, and facial arteries.

The superficial temporal artery is the terminal branch of the external carotid artery. In the substance of the parotid, just before reaching the zygomatic arch, it gives off the transverse facial artery which runs inferior and parallel to the arch and supplies the parotid, parotid duct, masseter, and skin of the lateral canthus. The superficial temporal artery crosses the zygomatic arch superficially within the superficial temporal fascia. Above the arch, it gives off a middle temporal artery that pierces the deep temporal fascia and supplies the temporalis muscle. Thereafter, about 2 cm above the zygomatic arch, the superficial temporal artery divides into anterior and posterior branches. The anterior branch supplies the forehead and forms anastomoses with the supraorbital and supratrochlear

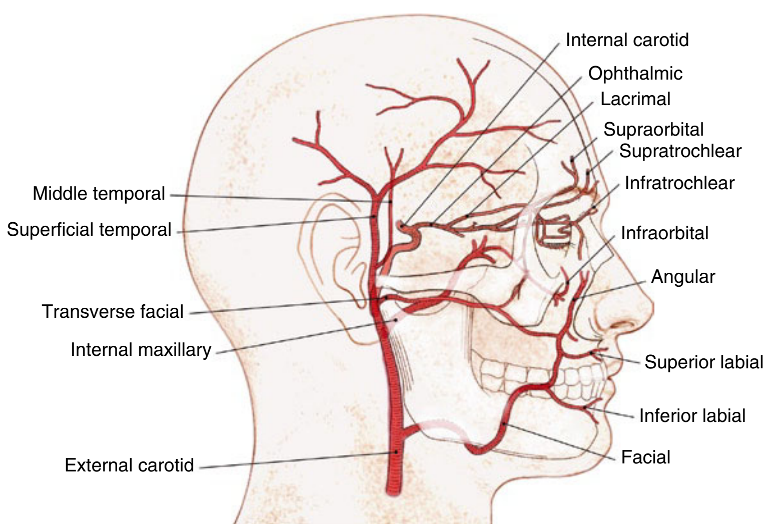


Fig. 1.13 Arterial supply to the face

vessels. The posterior part supplies the parietal scalp and periosteum.

The ophthalmic artery is a branch of the internal carotid system (Fig. 1.13). Its branches include the lacrimal, supraorbital, supratrochlear, infratrochlear, and external nasal arteries. There is significant communication between the external and internal carotid artery systems around the eye through several anastomoses. Inadvertent intra-arterial injection of fillers for soft tissue augmentation around the eye can lead to occlusion of the central retinal vessels and potentially blindness [18–20]. To avoid this complication, fillers should be injected in small volumes using a careful retrograde injection technique [21].

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2 Facial Proportions

Peter M. Prendergast

2.1 Introduction

Although facial proportions, angles, and contours vary with age, sex, and race [1], it is worthwhile to consider aesthetic "ideals" when analyzing the face preoperatively and planning surgical rejuvenation. This chapter describes the surface markings of the face, soft-tissue cephalometric points for orientation, and commonly described facial planes and angles. Facial proportions, measurements, and angles that are deemed "ideal" are outlined to facilitate the surgeon with facial analysis and add a quantifiable dimension to perioperative assessment in surgical facial rejuvenation.

2.2 Surface Markings

The area anterior to the auricles, from the hairline superiorly to the chin inferiorly, represents the human face (Fig. 2.1). The forehead occupies the upper face, from the hairline to the eyebrows. Its contour, usually convex, is determined by the shape of the underlying frontal bone and distribution of subcutaneous and submuscular fat pads. There is a subtle prominence between the eyebrows called the glabella. Contraction of the procerus and corrugator muscles in this area results in hyperdynamic wrinkles. The eyebrows are positioned horizontally in males, overlying the supraorbital ridges. In females, the brows arch slightly from medial to lateral, with the highest part ideally in line vertically with the lateral limbus, or between the lateral limbus and lateral canthus.

In the midline, several soft-tissue cephalometric points are defined along the midsagittal plane from the glabella superiorly to the cervical point inferiorly (Fig. 2.2). These landmark points are used to describe facial proportions and angles. The external nose is pyramidal in shape with its base sitting over the nasal aperture of the skull. The root of the nose lies inferior to the glabella in the midline, over the frontonasal suture. The nose projects anteriorly and inferiorly from the nasion, or deepest part at the root, to the tip, or apex. The dorsum connects the nasion to the apex and is supported by immobile nasal bone superiorly and mobile cartilage inferiorly. The widest part of the nose consists of the alae, or nostrils, which lead into the nasal vestibule. Centrally, the columella connects the apex of the nose to the philtrum of the cutaneous upper lip. The junction of the red part of the lips with the skin is the vermillion border. Immediately adjacent to the vermillion border is the white roll, a tubelike structure that runs the length of the lip. In the midline, the top lip projects anteriorly as the tubercle. Below the lower lip, the labiomental groove passes between the lip and the chin. Between the alae of the nose and the lateral borders of the lip, the nasolabial groove or fold separates the upper lip from the cheek.

The soft tissue of the upper lateral cheek projects anteriorly over the zygomatic arch and represents a feature of beauty in most cultures. Anteriorly, the convexity of the cheek and smooth lid–cheek junction are attributable to the deep cheek fat compartments below the eye and deep to the cheek muscles. Further down and laterally, the buccal fat pad gives the cheek its roundness, especially in children.

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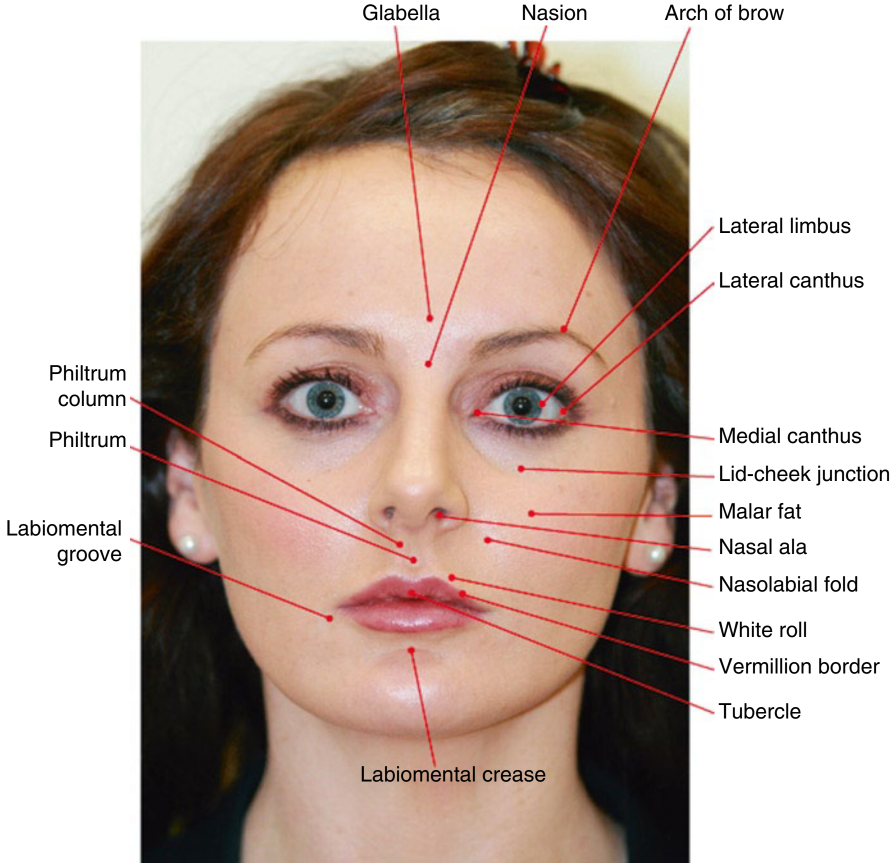

Fig. 2.1 Surface markings of the face

The inferior margin of the face runs from the menton in the midline at the chin, laterally along the inferior and lateral borders of the mandible, to the auricle. Jowl fat and laxity of platysma lead to ptosis and interrupt the definition of the jawline along this margin and are improved with lipoplasty and rhytidectomy.

2.3 Proportions

The face is divided into horizontal thirds (Fig. 2.3). The upper third extends from the hairline to the glabella, the middle third from the glabella to the subnasale, and the lower third from the subnasale to the menton. These facial thirds are rarely equal. In Caucasians, the middle third is often less than the upper third, and the middle and upper thirds are less than the lower third [2]. In East Asians, the middle third of the face is often greater than the upper third and equal to the lower third, and the upper third is less than the lower third [3]. The lower third is further divided into its own thirds, defining the upper lip, lower lip, and chin (Fig. 2.3). Anic-Milosevic et al. [4] compared the proportions of the lower facial third segments in males and females. The chin represented the largest segment and the lower lip height the smallest in both sexes. Although the vermilion height of upper and lower lips did not differ between men and women, the upper and lower lip heights were larger in males. In both genders, the upper vermilion height was smaller than the lower vermilion height. The height of the upper lip vermilion relative to the upper lip was significantly greater in females than in males. The width of the lips should be about 40% of the width of the lower face, and usually equal to the distance between the medial limbi. The width-to-height ratio of the face is typically 3:4, with an oval-shaped face being the aesthetic ideal.

The neoclassical canon of facial proportions divides the face vertically into fifths, with the width of each eye, the intercanthal distance, and the nasal width all

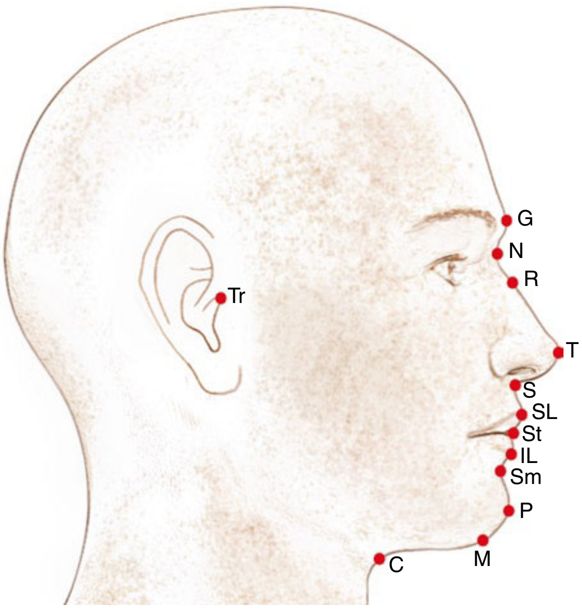

Fig. 2.2 Soft-tissue cephalometric points. The glabella (*G*) is the most prominent part in the midline between the brows. The nasion (*N*) lies at the root of the nose in the midline. The rhinion (*R*) is the junction of the bony and cartilaginous dorsum of the nose in the midline. The tip (*T*) is the most anterior part of the nose. The subnasale (*S*) is the junction of the columella and upper cutaneous lip. The superior labrum (*SL*) is the junction of the red and cutaneous parts of the lip at the vermilion border in the midline. The stomion (*St*) is the point where the lips meet in the midline. The inferior labrum (*IL*) is the point in the midline of the lower lip at the vermilion border. The supramentale (*Sm*) is midpoint of the labiomental crease between the lower lip and chin. The pogonion (*P*) is the most anterior point of the chin. The menton (*M*) is the most inferior point of the chin. The cervical point (*C*) is the point in the midline where the neck meets the submental area. The tragion (*Tr*) is the most superior point on the tragus

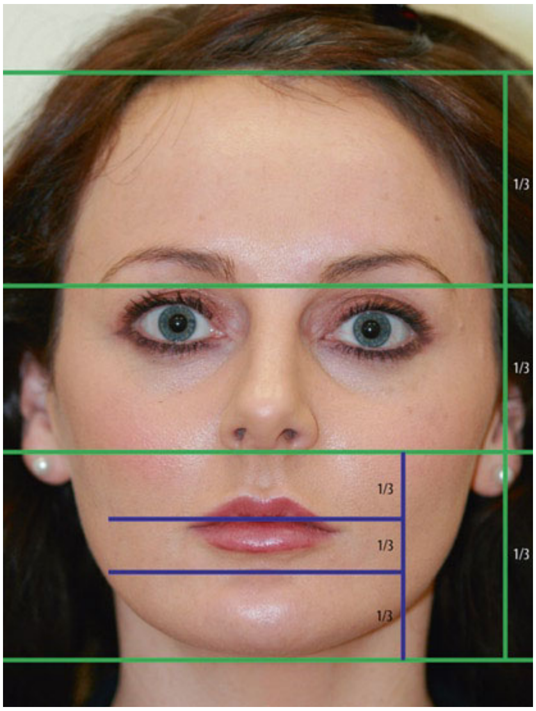

Fig. 2.3 Horizontal facial thirds. The upper third extends from the hairline to glabella, the middle third from glabella to subnasale, and lower third from subnasale to menton. The lower third is further divided into thirds: the upper third from subnasale to stomion, middle third from stomion to the labiomental crease, and the lower third from the labiomental crease to menton. These thirds define the upper lip, lower lip, and chin. Note that the thirds are not equal

measuring one-fifth (Fig. 2.4). However, studies using direct anthropometry and photogrammetric analyses in white and Asian subjects found variations in these proportions, with the width of the eyes and nasal widths often being either less than or greater than the intercanthal distance [2, 3, 5].

Crumley and Lancer describe appropriate projection of the nose and nasal tip [6]. A ratio of 5:4:3 should apply, respectively, to a line from the nasion to the nasal tip, a line from the nasion to the alar crease, and a perpendicular line joining the other two (Fig. 2.5). Nasal tip projection can be measured using other parameters. The Baum ratio is calculated by dividing the length of a line from the nasion to the nasal tip by the length of a perpendicular line from the nasal tip to a vertical line from the subnasale (Fig. 2.6). The Simons ratio also reflects nasal tip projection and is found by dividing the length from the subnasale to the nasal tip by the length from the subnasale to the superior labium (Fig. 2.7). According to Powell and Humphreys [7], the ideal Baum and Simons ratios for whites are 2.8:1 and 1, respectively. The rotation of the nose is described by the nasolabial angle: the angle formed between a line from the anterior columella and the subnasale and a line from the subnasale to the mucocutaneous border of the upper lip. According to Leach [8], this measurement is inaccurate as a representation of nasal rotation if the subject has a protruding maxilla or procumbent incisors. As such, a more accurate measurement is to use a line perpendicular to the Frankfurt horizontal plane in lieu of the subnasale to upper lip line (Fig. 2.8). The basal view of the nose can be divided into thirds with the ratio of the columella to the lobule about 2:1 (Fig. 2.9). Aesthetically,

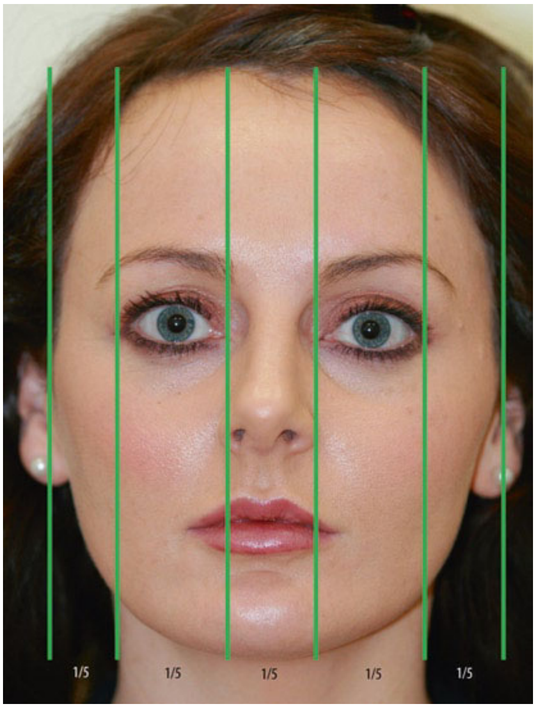

Fig. 2.4 Vertical fifths. The eye usually measures one-fifth the width of the face

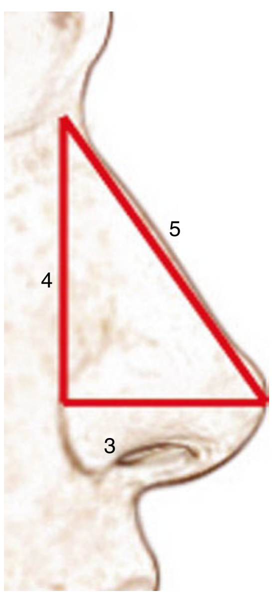

Fig. 2.5 Nasal proportions

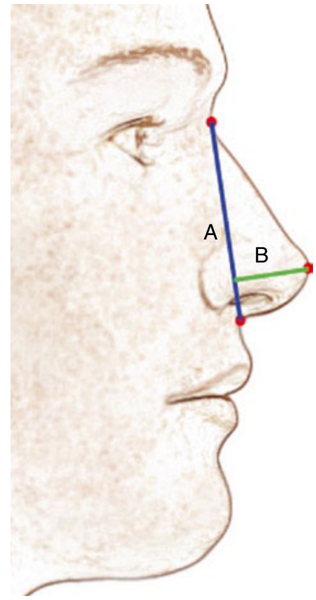

Fig. 2.6 The Baum ratio used to calculate nasal tip projection. The length of the nose (*a*) divided by a perpendicular line (*b*) from the nasal tip to the line from the nasion to subnasale gives the ratio

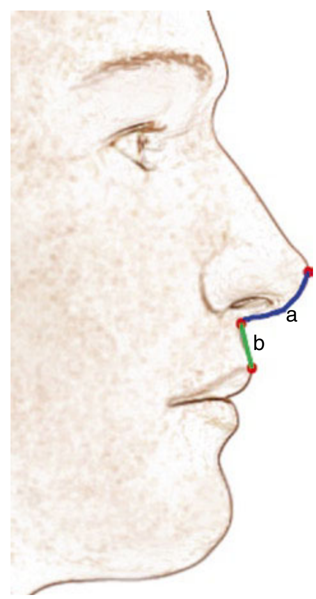

Fig. 2.7 The Simons ratio used to calculate nasal tip projection. A line from the subnasale along the anterior aspect of the columella to the nasal tip (*a*) divided by a line from the subnasale to the superior labium (*b*) gives the Simons ratio

a narrow nasal tip width, measured as a lobule to nasal base ratio, is preferred. Biller's study [9] showed a preference for a nasal tip width ratio of 0.35 in 30-year-old Asian women and 60-year-old white and Asian women, although a ratio of 0.45 was considered more attractive in 30-year-old white women. On basal view, the nasal apertures are usually oriented at an angle of 45–60° to the vertical, although racial variations exist (Fig. 2.10). Abdelkader et al. compared the length and

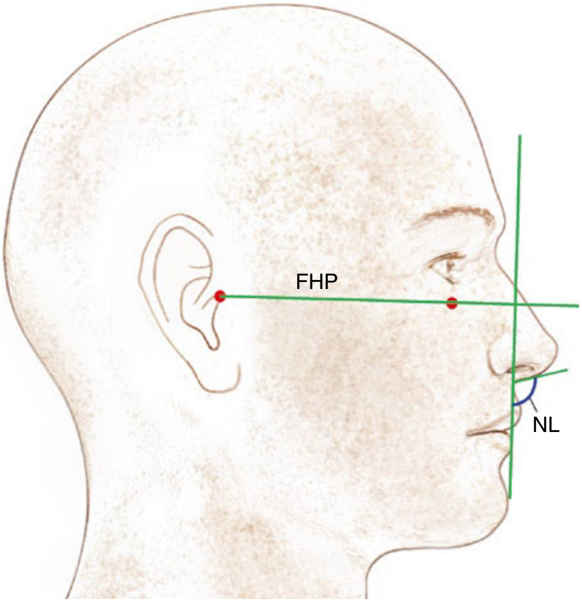

Fig. 2.8 Nasolabial angle. The Frankfurt horizontal plane (*FHP*) is found by drawing a line from the superior aspect of the external auditory canal to the most inferior point of the orbital rim. The nasolabial angle is formed between a line along the anterior part of the columella and a line perpendicular to the FHP

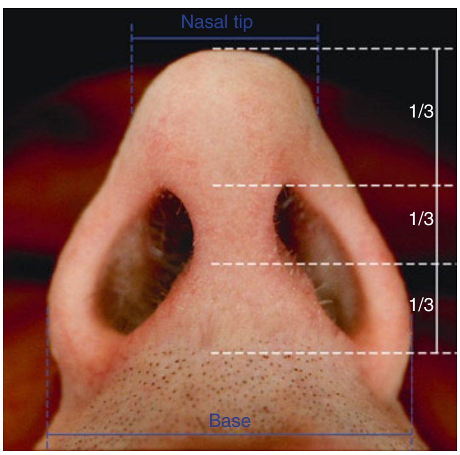

Fig. 2.9 Basal view of the nose. The lobule should represent approximately one-third (upper third) and the columella two-thirds (lower two-thirds) of the basal view. The width of the lobule (nasal tip) should be about 35–45% the width of the nasal base

width of the nasal aperture in men of three racial groups [10]. The nasal aperture was longer at maximum length in the Indian group compared to the Chinese and white groups. There was no significant difference between the length and width of the columella in all three racial groups.

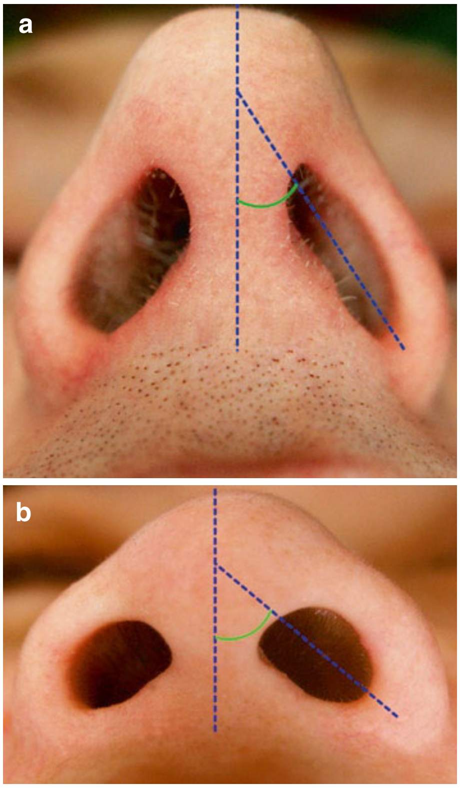

Fig. 2.10 Orientation of nasal apertures. (**a**) Caucasian nose showing an angle less than 45° and (**b**) Chinese nose showing an angle greater than 45°

2.4 The Golden Ratio

Beauty and facial attractiveness are easy to identify but difficult to quantify. Despite its subjective nature, we can attempt to define, measure, and explain the captivating phenomenon of beauty by describing it numerically and geometrically [11]. The measurement of aesthetically pleasing features, animate and inanimate, over at least the last two millennia, has produced an extraordinary finding. The same number, or ratio, appears so frequently as a measurement of beauty that it has almost become synonymous with beautiful and harmonious form. This number has been called the golden ratio.

The golden ratio, denoted by the symbol Φ (phi), is an irrational number of the order of 1.618033988. The ratio is obtained when a line a + b is sectioned such that a + b/a = a/b (Fig. 2.11). Although Indian mathematicians studied the golden ratio over 2,000 years ago, it first appeared in written documentation in Euclid's

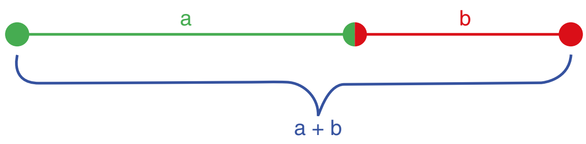

Fig. 2.11 The golden proportion. A line (a + b) is sectioned such that (a + b)/a = a/b = 1.618033988

elements about 300 B.C. [12]. The golden ratio, also known as the divine proportion, is considered by many to be the key to the mystery of aesthetics, attraction, and human beauty [13]. From the era of the ancient Greeks, through to the Renaissance, and the present day, mathematicians, scientists, architects, artists, and cosmetic surgeons have been intrigued by the ubiquitous nature of the divine proportion and its correlation with aesthetics. Ricketts showed that the proportions in a face generally perceived as being beautiful are intimately related to the golden ratio [14–17]. The width of the mouth is Φ times the width of the nose. The distance between the lateral canthi is Φ times the width of the mouth. The height of the face from pupils to chin is Φ times the height from the hairline to the pupils. Marquardt devised a mathematical model using Φ as the central measurement to map out facial proportions and aesthetically "ideal" shapes and sizes [18]. The result is a "Phi mask" that can be used as a tool to analyze facial beauty and determine its closeness to the aesthetically ideal golden proportion. Despite enthusiasm for the thesis that Φ is the Holy Grail in defining beauty and harmony of the human form, Holland [19] reminds us that several studies have not found a relationship between facial attractiveness and the golden ratio. Furthermore, Marquardt's mask does not represent the ideal female face but rather a masculinized face, with prominent supraorbital ridges, low eyebrows, high cheekbones, and a square jaw. These observations tell us that while the golden proportion is certainly a prominent and recurring theme in aesthetics, it should not be embraced as the only method by which we measure human beauty to the exclusion of other factors.

2.5 Planes and Angles

Powell and Humphreys [7] provide a detailed analysis of facial contours, proportions, and angles on profile (Fig. 2.12). These angles facilitate preoperative assessment and planning in facial rejuvenation. The ideal

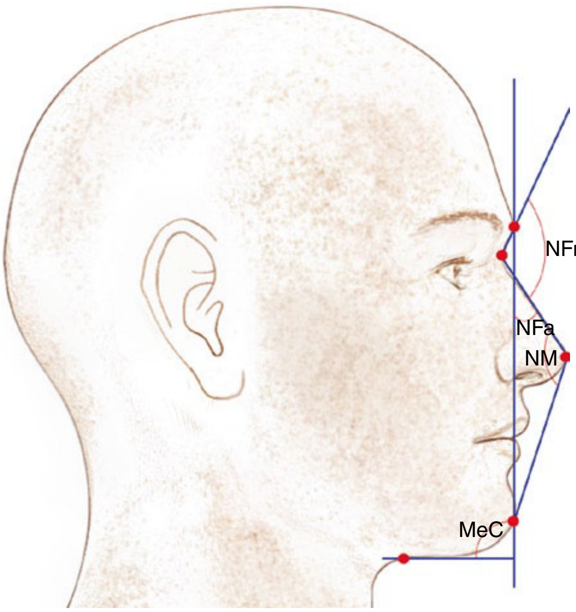

Fig. 2.12 Powell and Humphreys' aesthetic angles. A line from the glabella to pogonion creates the anterior facial plane. The angle formed by lines from the nasion to the glabella and from the nasion to the nasal tip is the nasofrontal angle (*NFr*). The nasomental angle (*NM*) lies between the line along the dorsum to the nasion, and a line drawn from the nasal tip to the pogonion. The nasofacial angle (*NFa*) is formed between the anterior facial plane and the line tangent to the dorsum of the nose. A line is drawn from the cervical point to the menton. This line intersects the anterior facial plane to create the mentocervical angle (*MeC*)

ranges in Caucasians are as follows: nasofrontal angle, 115–130°; nasofacial angle, 30–40°; nasomental angle, 120–130°; mentocervical angle, 80–95°. Racial variations include a wider nasofrontal angle in Chinese. The upper and lower lips are usually posterior to the nasomental line in Caucasians, but on or anterior to this line in individuals of African or Asian descent.

Peck and Peck [20] describe another orientation plane formed by a line from the tragion that bisects a line from the nasion to the pogonion (Fig. 2.13). The facial, maxillofacial, and nasomaxillary angles developed from these lines relate the upper lip to the chin and nasal tip and the nasion to the chin. In Caucasians, the mean facial angle as described by Peck and Peck is 102.5°, maxillofacial angle 5.9°, and nasomaxillary angle 106.1°. Holdaway's "H angle" [21] describes the degree of soft-tissue protrusion of the maxilla relative to the mandible and is ideally about 10° (Fig. 2.14). This angle can be manipulated by surgical intervention on the chin, by lip augmentation, or indeed by orthodontics.

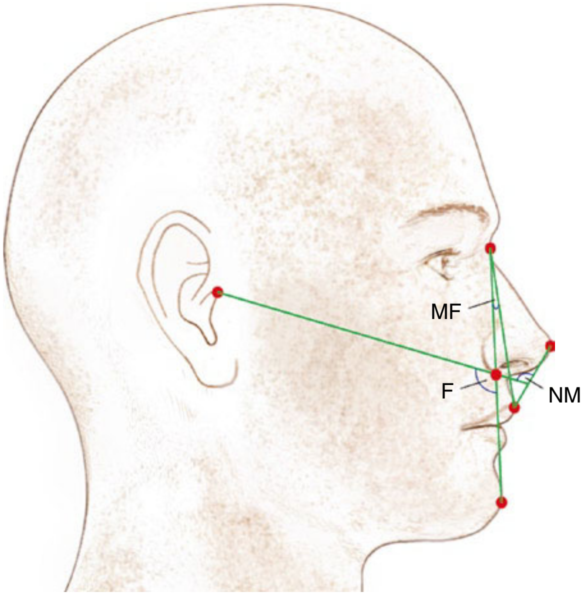

Fig. 2.13 Peck and Peck's aesthetic angles. A plane is developed by drawing a line from the tragion anteriorly to bisect a line from the nasion to pogonion. The angle created by the intersection of these two lines is the facial angle (*F*). A line dropped from the nasion to the superior labium creates the maxillofacial angle (*MF*) with the line from nasion to pogonion. The nasomaxillary angle (*NM*) relates the upper lip to the nasal tip and arises between a line from the tip to the superior labium and the orientation plane from the tragion

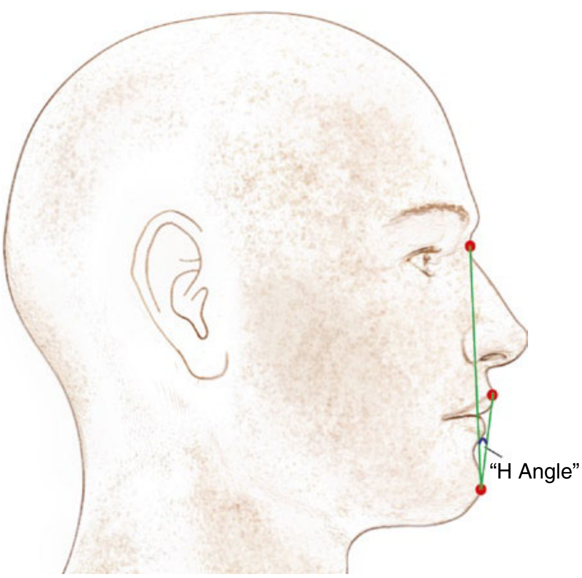

Fig. 2.14 Holdaway's "H angle." This angle is formed between a line from the nasion to pogonion and a line from the pogonion to the most anterior part of the upper lip. The angle is normally about 10°

2.6 Conclusions

Patients often are specific in their request for facial rejuvenation procedures: nose reduction, nose tip elevation, lip enhancement, brow lift, or chin augmentation. Creating the aesthetic "ideal" relies less on site-specific reduction, augmentation, or straightening of facial features and more on a holistic approach, considering each feature as it relates to the rest of the face. The aesthetic surgeon should be mindful of average and ideal proportions and facial angles as they apply to the patient's race so that rejuvenation procedures can be performed with the goal in mind of achieving an attractive and harmonious appearance. Facial proportions and angles are easily determined in the office using photogrammetric analysis. With this information, the surgeon should educate the patient on the role of facial proportions in aesthetics, discuss the most appropriate measures, and tailor a plan to achieve the best results. Once there is an understanding of the importance of proportion in facial aesthetics, the proposed surgical plan is usually more acceptable, even if it deviates from the patient's initial requests.

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Danger Zones in Surgical Facial Rejuvenation

3

Peter M. Prendergast

3.1 Introduction

The increase in our knowledge of facial anatomy and the anatomy of aging has brought an evolution in techniques for aesthetic facial surgery [1]. More extensive procedures that access deeper planes and lift tissues in several vectors are favored over those that lift only subcutaneous tissue in a superolateral vector. These include extended sub-SMAS dissections, deep plane and composite rhytidectomies, and subperiosteal facelift techniques. Additionally, less invasive techniques such as the short scar facelift, minimal access cranial suspension (MACS) lift, and endoscopic brow lift have gained popularity because they provide effective rejuvenation and a relatively quick recovery. Since the first description of the superficial musculoaponeurotic system (SMAS) by Mitz and Peyronie in 1976 [2], the importance of addressing this layer for effective surgical rejuvenation has been realized. Dissecting, undermining, and redraping the SMAS provides a more natural and long-lasting rejuvenation compared to subcutaneous rhytidectomy alone. There are several regions, or danger zones, in the face where branches of the facial nerve lie immediately beneath the SMAS and are prone to injury if sharp dissection is performed in this plane. Nerve injuries can arise as a result of direct transection with sharp instruments, blunt trauma, traction, thermal injury from electrocautery, or inflammation. Facial nerve injuries can have serious sequelae such as brow ptosis, lid ptosis, lip weakness, and mouth asymmetries. Although most iatrogenic facial nerve palsies following aesthetic surgery are temporary, they can be distressing and may take months to fully recover. As such, preventing nerve injuries by careful planning, meticulous technique, and a sound knowledge of the precise location of important motor and sensory nerves in relation to the path of dissection is crucial.

This chapter outlines three main danger zones where facial nerve branches lie superficially and are susceptible to injury during commonly performed surgical rejuvenation techniques. The nerves associated with each zone are as follows:

Zone 1: Temporal branch of the facial nerve where it passes over the zygomatic arch and lies superficially within the superficial temporal fascia.

Zone 2: Zygomatic and buccal branches of the facial nerve where they emerge from the anterior aspect of the parotid and lie exposed during their course beneath a thin layer of SMAS.

Zone 3: Marginal mandibular branch of the facial nerve where it travels near the lower border of the mandible and passes superficially at its anterior part near the corner of the mouth.

In addition to the above motor nerves, four further danger zones are described that identify five sensory nerves. Although there are several other sensory nerves in the face, the ones highlighted here are regularly encountered during commonly performed surgical procedures, and are therefore more prone to injury. These procedures include coronal and endoscopic brow lift, subperiosteal midface lift, genioplasty, and SMAS-platysma rhytidectomy. The consequences of trauma to these sensory nerves, perhaps more than others, are more significant. Injury to the infraorbital or mental nerve can cause dysesthesias that impair

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speech and the ability to keep food in the mouth. The sensory nerves occupying these danger zones are:

Zone 4: The supraorbital and supratrochlear nerve trunks and the deep branch of the supraorbital nerve as it travels on the periosteum toward the frontoparietal scalp.

Zone 5: The infraorbital nerve where it emerges from its foramen on the anterior surface of the maxilla below the inferior orbital rim.

Zone 6: The mental nerve at the mental foramen below the root of the second mandibular premolar tooth on the lateral aspect of the chin.

Zone 7: The greater auricular nerve as it lies on the sternocleidomastoid muscle parallel to the external jugular vein and behind the posterior edge of the platysma.

3.2 Details of Zones

3.2.1 Zone 1

At the level of the zygomatic arch, the temporal branch of the facial nerve emerges from the substance of the parotid and passes over the bony arch toward the frontalis muscle between two slips of superficial temporal fascia. The nerve is prone to injury during its course superficially in this zone. The superficial temporal fascia is considered part of the superficial musculoaponeurotic system (SMAS) and splits at approximately the level of the hairline to envelop the intermediate fat pad, temporal branch of facial nerve, and frontal branch of superficial temporal artery. Although variations exist, the nerve always crosses the zygomatic arch between 0.8 and 3.5 cm anterior to the external auditory meatus (EAM), and not less than 2 cm posterior to the lateral orbital rim [3]. The temporal branch of facial nerve is usually described as having a consistent course from 0.5 cm below the tragus to 1.5 cm above the lateral brow [4]. However, soft tissue landmarks are not always reliable and should not be used as definite guides to the position of the nerve. More accurately, the nerve can be found 2.1–4 cm above the bony lateral canthus [3]. Therefore, this zone can be considered a triangle, with its base along the zygomatic arch from 0.8 to 3.5 cm anterior to the anterior border of EAM. A vertical line dropped from the superior part of the tragus represents the anterior border of EAM. A line is drawn from the anterior limit of the first line, superiorly to a point 4 cm above the bony lateral canthus, representing the anterior border of this danger zone. A straight line connecting the first two lines completes the triangular danger zone (Fig. 3.1).

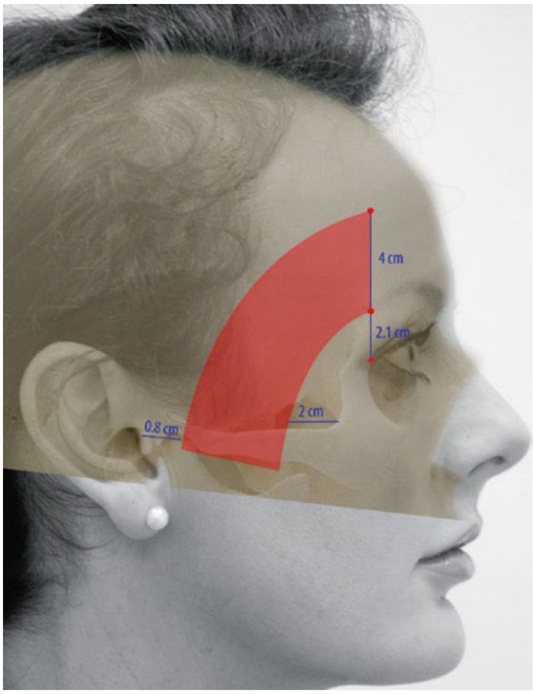

Fig. 3.1 Danger zone 1. This danger zone (*red*) extends from the inferior border of the zygomatic arch to a line above the bony lateral canthus. The zone curves anteriorly as shown from the lower line to the upper one. Within this zone, the temporal branch of the facial nerve is vulnerable to injury where it passes superficially in the superficial temporal fascia

Dissecting immediately deep to the superficial temporal fascia above the zygomatic arch should be avoided. It is safe to dissect immediately below the dermis in the subcutaneous plane above the superficial temporal fascia [5], deep to the superficial temporal fascia along the deep temporal fascia [6], or under the deep temporal fascia. Injury to the temporal branch of the facial nerve results in weakness or paralysis of the ipsilateral frontalis muscle, leading to brow ptosis and smoothing of the forehead above the brow. Orbicularis oculi is usually spared since it also receives motor innervation from superior branches of the zygomatic branch of the facial nerve.

3.2.2 Zone 2

The zygomatic and buccal branches of the facial nerve emerge from the anterior border of the parotid invested in the parotidomasseteric fascia. There are up to three zygomatic branches and one or two buccal branches. The superior zygomatic branch passes over the orbit to innervate part of orbicularis oculi. Lower branches supply the lip elevators; one of the lower zygomatic branches always passes posterior to the origin of zygomaticus major on the body of the zygoma. The buccal nerve passes on the surface of the buccal fat pad below and parallel to the parotid duct and supplies the lip elevators, orbicularis oris, and nasalis. When a second buccal nerve is present, it passes above the parotid duct. The danger zone for these nerves lies anterior to the parotid and posterior to zygomaticus major and minor, where only the SMAS protects them (Fig. 3.2). The anterior border of parotid can be found by drawing a line from the most anterior inferior aspect of the temporal fossa to the masseteric tuberosity. Wilhelmi found that the most posterior part of the anterior border lies up to 2.5 mm posterior to this vector [7]. The upper lateral border of zygomaticus major is intimately related to the zygomatic branch of the facial nerve. The lateral border of zygomaticus major can be estimated to be 2.2–6.6 mm lateral and parallel to a line drawn from the mental protuberance to the most anterior inferior aspect of the temporal fossa [8]. The nerves, as well as parotid duct and facial vessels, are susceptible to injury during extended sub-SMAS dissections or composite rhytidectomy. Dissection should be performed only under direct vision in this zone. Signs of injury to the zygomatic and buccal branches of the facial nerve include weakness in forcefully closing the eyes, drooping of the ipsilateral upper lip and oral commissure, and significant asymmetry at rest and during animation [9, 10]. Since orbicularis oculi receives dual innervation from the temporal and zygomatic branches, complete iatrogenic paralysis of this muscle is rare following aesthetic surgery.

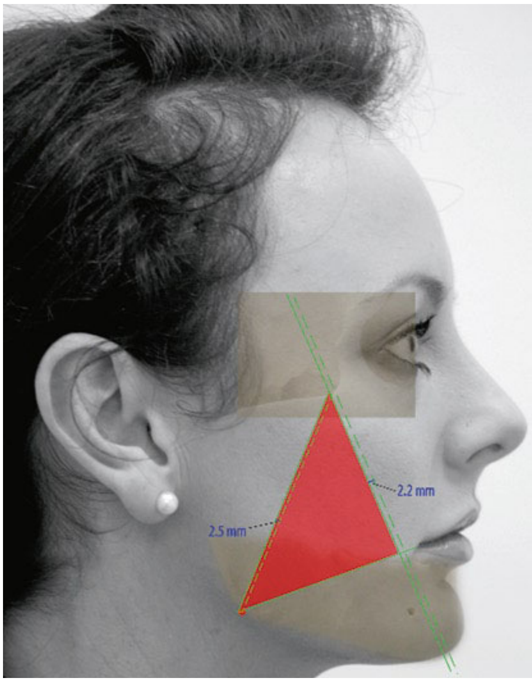

Fig. 3.2 Danger zone 2. The anterior continuous green line represents the most anterior position of the lateral border of zygomaticus major. The posterior continuous green line marks the most posterior part of the anterior border of the parotid gland. The borders of this triangular danger zone are formed in relation to these lines, with the base of the triangle running from the masseteric tuberosity at the angle of the mandible toward the oral commissure. The zygomatic and buccal branches of the facial nerve occupy this zone as they run on the buccal fat just underneath platysma

3.2.3 Zone 3

The marginal mandibular branch of the facial nerve emerges from the anterior aspect of the parotid as one to three main branches and runs along the mandible deep to the cervical fascia toward the lip depressors. The nerve usually runs along the inferior border of the mandible, but may drop up to 4 cm below it [11]. It starts its course deep to the cervical fascia, but pierces the fascia approximately halfway along the body of the mandible to lie just deep to the SMAS. Anteriorly, the nerve is prone to injury where the overlying SMAS becomes very thin and the nerve courses more superficially toward depressor anguli oris and depressor labii. About 2–3 cm posterior to the oral commissure, the nerve is most vulnerable where it crosses superficial to the anterior facial artery and vein. These vessels are also prone to injury during sub-SMAS dissections in this area. As such, this danger zone is defined by a circle with a radius of 2 cm with its center located 2 cm posterior to the oral commissure at the inferior border of the mandible (Fig. 3.3).

In this danger zone, the nerve can be injured during overzealous subcutaneous dissections from above or below when redraping the soft tissues over the mandible. Care should be taken to stay in the superficial subcutaneous plane in the jowl to avoid breaching the platysma where it exists only as a thin layer. Similarly, aggressive liposuction of the jowl should be avoided. Posteriorly, where the SMAS is more substantial, the nerve is

Fig. 3.3 Danger zone 3. The marginal mandibular nerve occupies this danger zone, represented by a circle centered on the inferior border of the mandible, 2 cm posterior to the oral commissure. The nerve courses superficially in this zone

susceptible to injury during composite rhytidectomy where the SMAS-platysma is mobilized over the anterior border of masseter. Dissection under direct vision and careful cautery of facial vein branches in this area are essential to preserve the nerve, especially where it crosses the facial vessels as they pass over the mandible. Injury to the marginal mandibular branch of the facial nerve results in elevation and protrusion of the lip on the ipsilateral side. The smile is asymmetric with an inability to show the lower teeth on the affected side. Abnormal lower lip elevation is also a sign of cervical branch injury due to weakness of platysma. However, since the mentalis receives innervation from the marginal mandibular nerve, the patient can still evert the lower lip if the marginal mandibular nerve has been spared [12].

3.2.4 Zone 4

This danger zone includes the supraorbital and supratrochlear nerves, branches of the ophthalmic division of the trigeminal nerve, and sensory nerves to the upper eyelid and forehead. The supraorbital nerve emerges from the supraorbital foramen or notch 2.3–2.7 cm from the midline in men and 2.2–2.5 cm from the midline in women [13]. The supratrochlear nerve appears from its foramen or notch about 1 cm medial to the supraorbital nerve. The supraorbital nerve has superficial and deep branches that straddle the corrugator muscle. Sometimes, the deep branch arises from its own foramen lateral to the superficial branch. These nerves are most commonly injured during coronal or endoscopic brow lift procedures where direct trauma or traction on the nerves leads to numbness or dysesthesias over the upper eyelid, dorsum of the nose, medial forehead, and scalp [14]. The deep branch of the supraorbital nerve runs superiorly between the galea and the periosteum 0.5–1.5 cm medial to the superior temporal crest line. Resection of the corrugator at its origin to alleviate glabellar frown lines is a frequent cause of injury to the supratrochlear nerve. To identify this danger zone, a circle of 3 cm diameter is centered on either the supraorbital foramen or notch if it is palpable, or a point along the superior orbital rim 2.5 cm from the midline. The danger zone is extended from the superolateral aspect of the circle along the superior temporal crest line and for 1.5 cm medially (Fig. 3.4). Any dissection or incision deep to the galea in the danger zone risks injury to the supraorbital nerve. Medially, fibers from the superficial branch of the supraorbital nerve and the supratrochlear nerves overlap so that injury to one of these nerves is not likely to result in significant sensory loss or disturbance.

3.2.5 Zone 5

This danger zone lies over the maxilla under the eye to include the infraorbital nerve. The nerve enters the face through the infraorbital foramen 2.5–3 cm from the midline, about 7 mm below the inferior orbital rim. The nerve appears from the foramen just below the origin of levator labii superioris. The infraorbital nerve is a branch of the maxillary division of the facial nerve and provides sensory innervation to the lower eyelid, cheek, side of the nose, and upper lip. The danger zone is a circular area centered on the foramen, with a diameter of 3 cm (Fig. 3.5). Deep dissections in this area, such as during an extended subperiosteal facelift, place the nerve at risk of injury. Subperiosteal dissections on the anterior maxilla can also injure the infraorbital vessels and the zygomatic branches of the facial nerve.

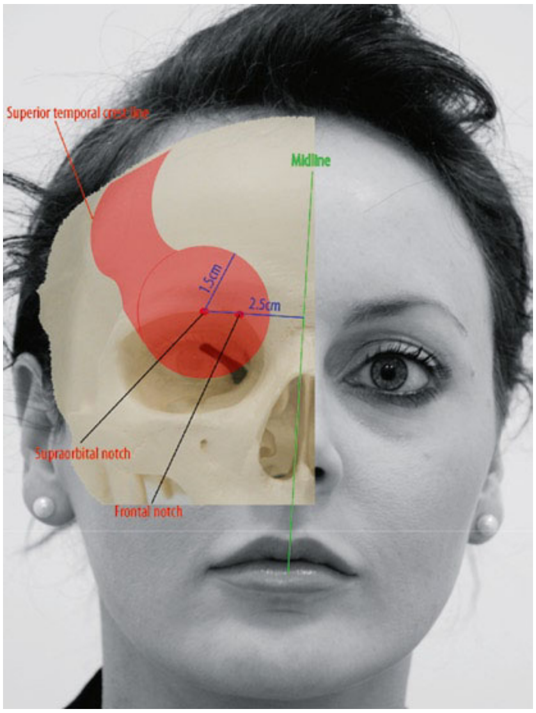

Fig. 3.4 Danger zone 4. A circle of 1.5 cm diameter is centered on a point 2.5 cm from the midline along the supraorbital ridge, or on the supraorbital foramen or notch if palpable. The danger zone extends from the superolateral part of the circle along the superior temporal crest lines and for 1.5 cm medial to it, where the deep branch of supraorbital nerve passes on the periosteum. This danger zone includes the supraorbital nerve, deep branch of supraorbital nerve, and supratrochlear nerve

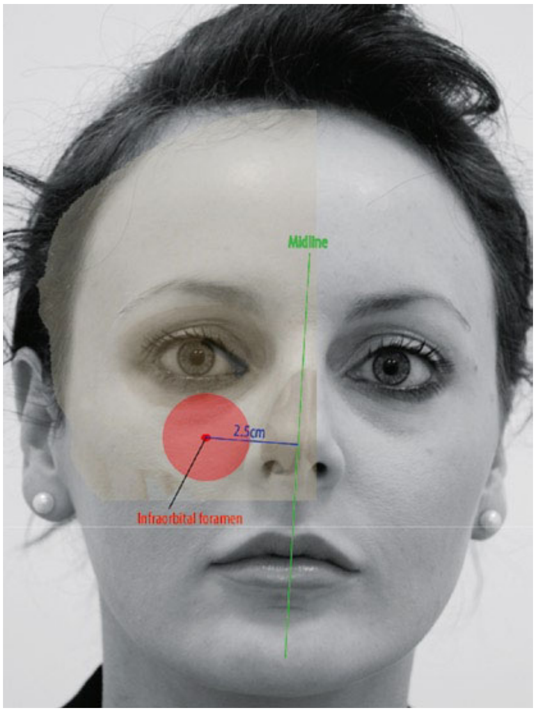

Fig. 3.5 Danger zone 5. This danger zone is circular, centered on the infraorbital foramen. The foramen is usually 2.5 cm from the midline, close to the midpupillary line. The infraorbital nerve can be damaged here during deep dissections over the maxilla

Direct visualization of these nerves and vessels using endoscopy may help prevent such injuries [15]. Trauma to the infraorbital nerve presents as numbness, dysesthesia, or hypesthesia of the skin it innervates.

3.2.6 Zone 6

The mental nerve is susceptible to injury during genioplasty either through a buccal or submental incision when the dissection is performed on the periosteum. The nerve arises roughly in line with the infraorbital and supraorbital nerves, emerging from the mental foramen below the lower second premolar tooth. A circle of 3 cm diameter centered on the mental foramen defines this danger zone (Fig. 3.6). Injury to the mental nerve can result in numbness of the lower lip, chin, and mucous membrane on the same side. Drooling can also occur due to sensory loss in this area.

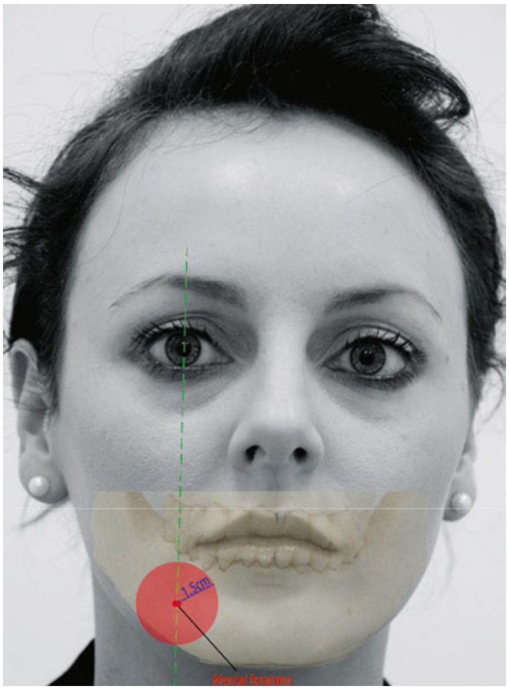

Fig. 3.6 Danger zone 6. A circular area of 3 cm diameter centered on the mental foramen defines this danger zone. Note that the foramen is approximately in the midpupillary line

3.2.7 Zone 7

The greater auricular nerve arises from the anterior primary rami of the second and third cervical nerves. It provides sensory innervation to the lower two-thirds of the auricle, the skin underneath the ear, and the posterior two-thirds of the jawline. The nerve pierces the deep cervical fascia at the posterior border of sternocleidomastoid and runs on the muscle, superficial and posterior to platysma toward the angle of the jaw. At a point 6.5 cm inferior to the external auditory canal, the nerve can be found halfway between the posterior and anterior borders of the sternocleidomastoid [16]. Below the ear it divides into anterior and posterior branches. This danger zone can be considered as an oblong, 2 cm wide and 6 cm long, with its center on a point 6.5 cm below the external auditory meatus oriented parallel to the external jugular vein (Fig. 3.7). The greater auricular nerve is prone to injury during neck dissections and suture plication of platysma to the mastoid fascia. Great care should be taken as dissections proceed forward from the postauricular incision toward the nerve. It is identifiable about 1 cm posterior to the external jugular vein and runs parallel to it. The dissection in this zone should be in the subcutaneous plane, superficial to the nerve. When platysma is mobilized, it should be redraped over the nerve, and care should be taken not to compress or include the nerve or its branches in the suture. Injury to the greater auricular nerve may result in numbness, dysesthesia, or chronic hypesthesia in the skin of the inferior part of the ear, and skin anterior and inferior to this area.

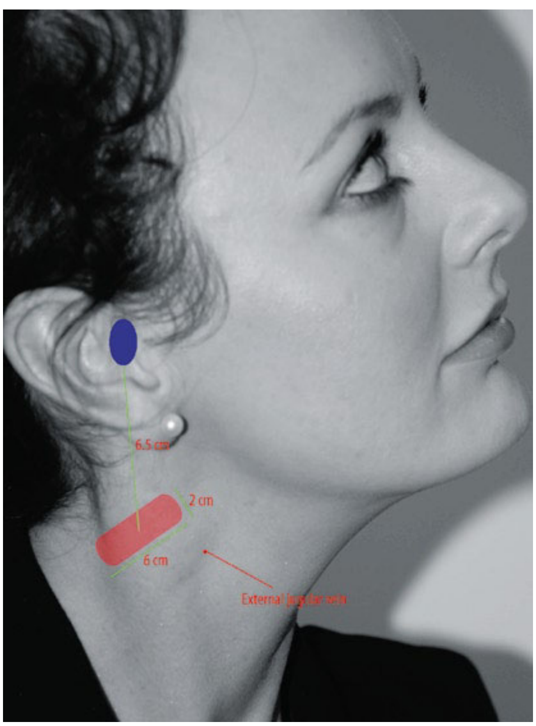

Fig. 3.7 Danger zone 7. This lies 6.5 cm below the external auditory meatus, in the middle of sternocleidomastoid, parallel to the external jugular vein. The greater auricular nerve is prone to injury as it passes through this danger zone behind the border of platysma

3.3 Conclusions

No surgical procedure is without risks and potential complications. In the face, although there are several risks associated with surgery, such as infection, bleeding, and hematoma, the most serious complication is injury to one of the cranial nerves. Injury to one of the facial nerve branches, such as transection, traction, thermal injury, or blunt trauma, may present as weakness, asymmetry, or total paralysis of the brow, eye, lips, and mouth. There are several, well-defined areas or zones in the face where the important motor and sensory nerves have a predictable path. Mapping these danger zones out before surgical intervention, using bony landmarks where possible, helps orient the surgeon during dissections of the face and neck and may reduce the incidence of significant complications.

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