Neurosurg Rev (2007) 30:8–15
DOI 10.1007/s10143-006-0053-5

REVIEW

The relationship of the fronto-temporal branches of the facial nerve to the fascias of the temporal region: a literature review applied to practical anatomical dissection

Niklaus Krayenbühl · Gustavo Rassier Isolan · Ahmad Hafez · M. Gazi Yaşargil

Received: 26 June 2006 / Revised: 13 September 2006 / Accepted: 14 September 2006 / Published online: 10 November 2006

Abstract The understanding of the course of the facial nerve and its relationship to the different connective tissue layers in the temporal area is paramount to preserving this nerve during surgery. But the use of different nomenclatures for anatomical structures such as for the different fascial layers or fat pads in the temporal region as well as the difference in description of the course of the fronto-temporal branches of the facial nerve in relationship to the fascial layers can lead to confusion. Therefore we have reviewed the literature about this topic and tried to apply the information to practical anatomical dissection.

Keywords Facial nerve · Temporal muscle · Surgical anatomy

Introduction

The course of the fronto-temporal branches of the facial nerve, which innervate the frontal belly of the frontalis muscle, the orbicularis oculi and corrugator supercilii muscles, was described by the senior author 22 years ago with the proposition of an interfascial dissection technique to protect the nerves during pterional craniotomy [57, 58]. The development of skull base approaches for middle and anterior cranial fossa lesions with wider exposures, including partial removal or mobilization of the orbit or the zygomatic arch made protection of the fronto-temporal branches of the facial nerve a bigger issue [3–5, 12, 29, 47, 55]. Moreover, the advances in plastic, reconstructive and maxillofacial surgery have improved the understanding of the relationship between the different fascial layers and the nerves in the temporal region [2, 9, 20, 21, 45, 53, 56].

A clear understanding of the course of the facial nerve and its relationship to the different galeal-fascial layers is paramount to preserve this nerve during surgery. But the increase in information has led to more confusion than clarification regarding this topic as we had to realize during an anatomical dissection course for residents and fellows at our institution. The different nomenclatures used for anatomical structures such as for the different fascial layers or fat pads in the temporal region, as well as the difference in description of the course of the fronto-temporal branches of the facial nerve in relationship to the fascial layers, have led to us to review the literature about this topic and to compare the findings described in the literature with the results gained during our course.

Materials and methods

For the anatomical nomenclature, we followed the "terminologia anatomica" drawn up by the Federative Committee on Anatomical Terminology (FCAT) in 1998 [16]. In a first step we reviewed the literature about the anatomy of the fascial layers and the course of the fronto-temporal branch of the facial nerve in the temporal region as well as the vascularization and innervations of the temporalis muscle.

N. Krayenbühl · G. R. Isolan · A. Hafez · M. G. Yaşargil
University of Arkansas for Medical Sciences,
Little Rock, AR, USA

N. Krayenbühl (✉)
4301 West Markham # 507,
Little Rock, AR 72205, USA
e-mail: nkrayenbuehl@bluewin.ch

In a second step we dissected 15 cadaver heads fixed in Carolina's perfect solution® (Carolina Biological Supply company, Burlington, NC) in order to compare the literature findings with our dissections. Arteries and veins were perfused with colored latex to enhance their visibility. Following the program of our microsurgical anatomy course, a pterional craniotomy was performed in 15 sides and an orbitozygomatic craniotomy on the other 15. The preauricular incision was extended all the way down to the neck to identify the facial nerve at the level of the stylomastoid foramen and its cervico-facial, and especially temporo-facial trunks. The soft tissue was dissected layer by layer under an operating microscope using 6× to 40× magnification. To facilitate understanding of the relationship and the continuity of the structures, we compared the findings of the different layers above the temporal muscle (scalp) with the layers over the muscle just above the zygoma (temporal region).

Literature review

One possible explanation for the inconsistency in reports about the anatomy in the temporal region is probably due to the fact that different preservation techniques of cadavers were used. It is known that fixation of cadavers with formalin distort connective tissue [36]. There is not only a change in color of the tissue but also a change in consistency, which may make differentiation of different layers more difficult [1].

Scalp

There is general agreement that the scalp consists of five concentric organized layers [2, 31, 53, 54].

Skin and subcutaneous fibro-adipose tissue

These two layers are considered together as they are normally not separated during surgery. The subcutaneous fibro-adipose tissue contains the hair follicles and sweat gland located right beneath the dermis. A network of connective-tissue fibers attaches the subcutaneous layer to the epicranial aponeurosis [53].

Epicranial aponeurosis

This layer is also called galea aponeurotica or musculo-aponeurotic layer [53]. It consists of the paired occipito-frontalis muscles and the auricular muscles connected through the galea. When the epicranial aponeurosis moves, the subcutaneous fibro-adipose tissue and the skin connected to it move with it.

Loose connective (areolar) tissue

The loose connective (areolar) tissue is also called subgaleal fascia [9, 11, 53, 54], innominate fascia [2, 10, 39, 52] or subaponeurotic plane [1]. It is between 1 and 3 mm thick and can histologically be divided in several laminae of different vascularization [2, 9, 31, 53, 54]. These very thin layers, compared to a "mille-feuille-cake" by some authors, glide over one another, leading to the mobility of the scalp [1, 14].

Pericranium

This last layer is the periosteum of the skull to which it is firmly attached, especially along the sutures.

Temporal region

Skin and subcutaneous fibro-adipose tissue

There is no difference in these layers compared with the anatomy of the scalp.

Temporoparietal fascia

This fascia is also termed superficial fascia [11] or superficial temporal fascia [1, 30, 32, 55, 56], which is confusing as this fascia has nothing to do with the temporal muscle and also extends backward onto the parietal region [1]. It is well accepted that the temporoparietal fascia is part of the superficial musculoaponeurotic system (SMAS) and that it is in continuity with the epicranial aponeurosis [1, 2, 8, 13, 19, 22, 31, 35, 36, 47, 50, 52–54, 56]. Whether it is continuous with the SMAS of the face is discussed controversially, as even histological cuts show different results [2, 22, 52]. But in most macroscopic dissections it is described as continuous [1, 8, 19, 35, 50, 54]. The temporoparietal fascia can be divided in two laminae [28, 52]. Also Salas et al. showed in the lowest histological cut, a separation of the fascia with fat lying in between [47]. The outer lamina joins the SMAS and the inner lamina merges with the loose areolar tissue in the most caudal portion [52]. Gosain was the only one who reported that the whole temporoparietal fascia fuses 1 cm above the zygoma with the superficial layer of the temporal fascia without connectivity to the SMAS [22].

Loose connective (areolar) tissue

This layer is not well described or missing in most of the neurosurgical literature [5, 12, 58], although it is used by plastic surgeons as flap [9, 11, 37, 53]. Following it toward the zygoma, this plane gets fattier and lost along a curved line between the supero-lateral border of the orbit and the zygomatic arch [47]. At the same place, the temporoparietal fascia is adherent to the superficial layer of the deep temporal fascia [47, 52]. This adherence is also described as inferior temporal septum lying in average 27 mm above the zygoma at the level of the frontal process of the zygoma and 21 mm above the superior border of the zygoma at its midportion [36]. Behind this septum the continuity of the loose areolar tissue is an adherent, fatty fibrous system or compartment with a variable amount of adipose tissue between the temporoparietal fascia and the temporal fascia [36, 47].

Temporal fascia

This dense, tough and uniform layer is also called deep temporal fascia [1, 30, 47, 56]. Ammirati et al. call it superficial temporal fascia, which is very confusing, and they mention that the deep temporal fascia is nothing else, but a loose connective tissue that envelopes the temporalis muscle, a structure they do not show in their illustrations [5]. The temporal fascia is attached to periosteum at every margin [1]. Cranial to the superior temporal line, it blends or is in continuity with the pericranium. Caudal, it splits into two layers approximately 2–3 cm above the zygomatic arch called superficial and deep laminae, confusingly named by some authors superficial and deep temporal fascia [12, 29] or superficial and deep layer [55]. This is, therefore, above its adherence to the temporoparietal fascia (inferior temporal septum) [36].

The superficial and deep laminae fuse again superior to the zygomatic arch [44]. Huang et al. showed by histological cuts a fusion of the laminae at the superior margin of the zygoma (56%) or at its superolateral surface (44%) [25]. This is in contrast to other reports stating that the superficial lamina attaches to the lateral and the deep lamina to the medial surface of the zygoma [12, 18, 30, 47, 51, 55, 58]. Campiglio showed that the laminae fuse in the anterior and posterior part superior to the zygoma and are still separated in the middle part [8].

Temporal muscle and periosteum

These two layers are considered together as they are in close contact. The muscle is composed of a main portion and three bundles (anteromedial, anterolateral and middle lateral) [29]. The main portion originates from the temporal fossa and converges to a thick aponeurosis inserting at the coronoid process. The anteromedial bundle, arising from the infratemporal crest, inserts at the anterior aspect of the anterior ramus of the mandible [29]. The innervation of the temporal muscle is provided by three different motor nerve branches of the anterior trunk of the mandibular nerve (anterior and posterior deep temporal nerves and temporal branch of the buccal nerve) [7, 23, 29]. They run superiorly to the periosteum after exiting the foramen ovale running over the infratemporal crest entering the muscle in its center. The periosteum is the extension of the pericranium between muscle and bone [31].

Fat layers

As there are no defined names for the different fat layers in the temporal region, the nomenclature is very confusing [2, 5, 8, 12, 29, 30, 51, 55, 58].

The only fat layer upon which everybody agrees is the subcutaneous fibro-adipose tissue.

The fibro-fatty tissue (the extension of the loose areolar tissue) between the temporoparietal fascia and temporal fascia [36, 47], just caudal to the inferior temporal septum [36], is called suprafascial fat pad [12], subgaleal fat pad [5] or superficial temporal fat pad [2, 8, 44].

The fat layer between the deep and superficial laminae of the temporal fascia is called the superficial temporal fat pad [30, 47, 50, 51], middle or intermediate fat pad [2, 8, 44], intrafascial fat pad [5], interfascial fat pad [12] or temporal fat pad [55]. The most consistent name is the deep temporal fat pad for the fat under the deep lamina of the temporal fascia, which envelops the temporal muscle tendon and is in continuity with the buccal fat [2, 30, 47, 59]. But there are other names like subfascial fat pad [12], buccal fat [55] or just deep fat pad [5, 8].

Vascular supply of the temporal region

Various reports describe the vascularization of the temporal region [7, 11, 15, 27, 29, 32, 34, 37, 41].

The superficial temporal artery, the terminal branch of the external carotid artery, runs between the two layers of the temporoparietal fascia [52] or if considered as one layer within the fascia and its continuity the galea. It divides into a frontal and parietal branch. This bifurcation normally lies above (60–80%) or over (10–30%) the zygomatic arch and rarely (<10%) below it [32, 34, 41, 49]. 64% of the bifurcations lie higher than a horizontal line through the superior orbital rim [32], on average 31.7 mm above the zygoma [34]. Both branches are relatively equal in diameter [41, 49]. The superficial temporal artery supplies predominately the scalp, and in the temporal region, the superficial layers down to the loose areolar tissue [11, 37, 39, 41, 53, 54]. But there are also 3–6 “perforators” to the temporal muscle [15].

The middle temporal artery originates from the superficial temporal artery below the zygomatic arch, ascends superficial to the arch piercing the superficial lamina of the temporal fascia near the upper insertion of the ear [7, 15, 29]. It mostly supplies the posterior and in 25% the posterior and upper part of the muscle resulting in a mean muscle supply of 19% [7].

The anterior and posterior deep temporal arteries originate from the maxillary artery anterior to the coronoid process and enter the anterior part of the temporal muscle [7]. Around the coronoid process there also exist direct perforators from the maxillary artery [15]. The anterior and deep temporal arteries, main supply for the temporal muscle, run between periost and muscle, making them vulnerable during muscle detachment from the bone [7, 29].

Zygomaticotemporal nerve

The zygomaticotemporal nerve is a branch of the zygomatic nerve originating from the maxillary nerve. It emerges through the zygomaticotemporal foramen and pierces the deep lamina of the temporal fascia adjacent to the zygomaticofrontal suture [26, 30, 36]. Then it divides into multiple branches running parallel to perforating vessels originating from the middle temporal artery [30]. Then the branches cross the superficial lamina of the temporal fascia, cross the fibro-fatty tissue and pierce the temporoparietal fascia to supply the skin over the temporal region [26, 30, 36].

Facial nerve

Soft-tissue landmarks (auricle, lateral aspect of the eyebrow) were classically described indicating an anatomical relationship for predicting the course of the temporal branch [18, 42], but these measurements are variable [20]. Most authors identified between two and five rami of the temporal branch crossing the zygomatic arch [6, 17, 21, 28, 38, 40]. The rami can be further divided into anterior, middle and posterior, with the middle ramus only seen in 66% [21, 28]. They cover 62% of the total length of the zygomatic arch and start to cross the inferior aspect of the

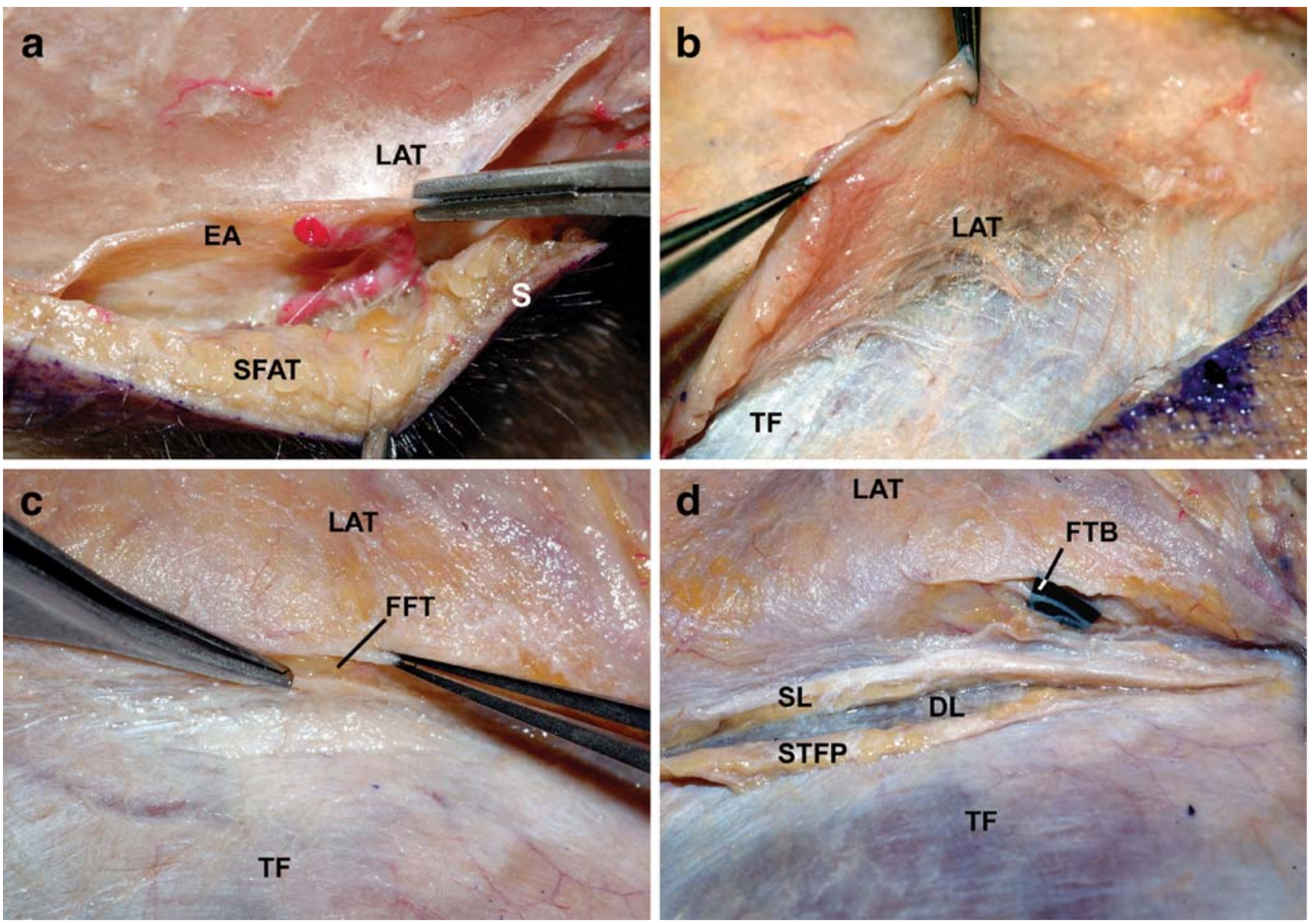

Fig. 1 (**a**) Cut at the level of the scalp showing the skin (S), subcutaneous fibro-adipose tissue (SFAT), epicranial aponeurosis (EA) and loose areolar tissue (LAT). (**b**) Over the temporal area the loose areolar tissue can be raised as a thick layer over the temporal fascia (TF). (**c**) The area where the loose areolar tissue (LAT) is replaced by fibrous tissue and attached to the temporal fascia (TF), also called inferior temporal septum. The fibers of attachment can be incised. Behind one will find fibro-fatty tissue (FFT), the continuity of the loose areolar tissue. (**d**) In the FFT one will find the fronto-temporal branches of the facial nerve (FTB). The superficial lamina (SL) of the TF can be incised showing the deep lamina (DL) and the superficial temporal fat pad (STFP) lying in between these two layers

zygoma, 10 mm anterior to the external acoustic meatus [21]. The fronto-temporal branches are described to be the most superficial branches of the facial nerve [45]. The temporal hairline was also thought be a landmark with the area behind it to be safe for dissection [18], but this has not been confirmed [46].

Distal to the parotid gland the fronto-temporal branches become gradually more superficial [45]. At the level of the zygomatic arch the fronto-temporal branches cross in the fibro-fatty layer underneath the temporoparietal fascia [1, 8, 36, 47]. Superior to the zygomatic arch the fronto-temporal branches are described to run within the temporoparietal fascia [8, 28, 33, 46, 47, 51, 55]. Ammirati describes its courses in the loose areolar tissue and he is the only one, who mentions some branches running through the superficial temporal fat pad [5]. Unfortunately he shows no anatomical picture of these branches, which could be branches of the zygomaticotemporal nerve. With serial histological sections Salas showed that the fronto-temporal branches have a different relationship to the temporoparietal fascia along their course [47]. Superior to the line where the temporoparietal fascia is attached to the temporal fascia (inferior temporal septum [36]), the branches run within the temporoparietal fascia [8, 47]. Below this line they run in the fibro-fatty tissue, the extension of the loose areolar tissue [47].

There have been attempts to distinguish which mimetic muscles are innervated by which rami of the temporal branches. Innervation patterns were found to overlap extensively, with anastomoses between the anterior- and posterior rami in up to 75% of cases [6, 28, 40, 43]. These anastomoses could be the explanation that neurotmesis, and not neuropraxia, of one or more temporal branches may result in spontaneous functional recovery following initial facial nerve injury [21]. Hwang et al. also showed anastomoses with the supraorbital nerve, but the functional significance of these sensory-motor anastomoses remain unclear [24].

The relationship between the superficial temporal artery and the temporal branch is also controversially discussed. While the majority of the researchers found the STA and the facial nerve running into the same plane at the deep surface of the temporoparietal fascia [6, 20, 21, 28, 51], Abul-Hassan observed the facial nerve at the level of the zygomatic arch in a plane just deep to the temporoparietal fascia and the superficial temporal artery within the fascia [1]. Stuzin found the temporal branch of the facial nerve running parallel to the frontal branch of the superficial temporal artery but anteroinferior [51]. There is general agreement that the fronto-temporal branch of the facial nerve is anteroinferior to the frontal branch of the

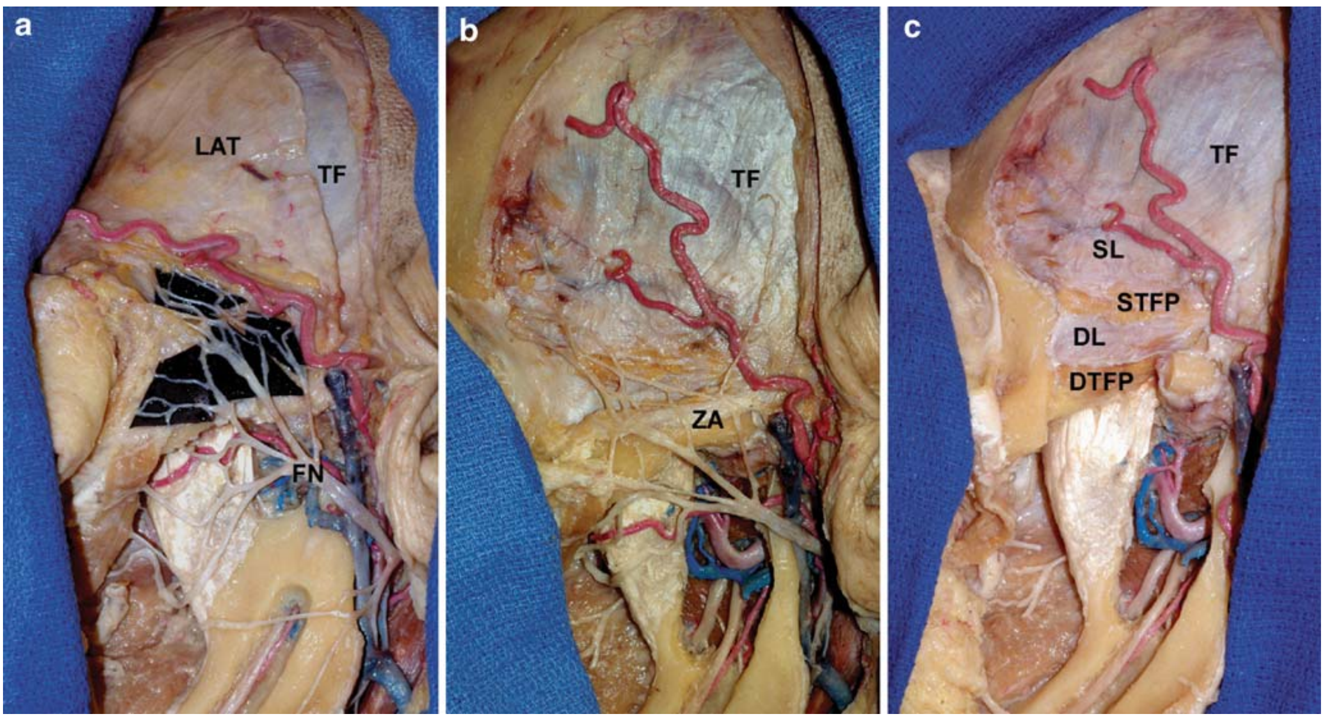

Fig. 2 (**a**) The relationship of the facial nerve (FN) with the superficial temporal artery. The fibro-fatty tissue, the extension of the loose areolar tissue (LAT), has been removed to reveal the fronto-temporal branches. (**b**) The Superficial lamina of the temporal fascia (TF) has been removed together with the superficial temporal fat pad and the periosteum of the zygomatic arch to reveal the relationship of the FN with the zygoma. (**c**) The zygomatic arch was removed showing the superficial lamina (SL) of the temporal fascia (TF), the deep lamina (DL) and the superficial temporal fat pad (STFP) lying between these layers. The deep temporal fat pad (DTFP) is lying under the DL of the TF over the tendon of the temporal muscle

superficial temporal artery [12, 38, 58]. Lei differentiated between high and low lying bifurcation of the superficial temporal artery in relation to a horizontal line through the superior orbital rim and showed that in high-location type, the fronto-temporal branches run anteroinferiorly immersing deeper in the temporoparietal fascia [32]. In the low-location type one or more terminal branches may run across the frontal branch and immerse deeper to the temporoparietal fascia. He concluded that in the high-location type the frontal branch of the superficial temporal artery can be used as a safe line to locate the fronto-temporal branches of the facial nerve [32].

Dissections

The dissection of the scalp confirmed the general opinion of the five layers (Fig. 1). Over the temporal region the skin and subcutaneous fibro-adipose tissue can easily be dissected.

The temporoparietal fascia (extension of the epicranial aponeurosis) is normally elevated with the skin flap during surgical procedures (Fig. 1). Depending on its thickness it can be dissected in two layers with the superficial temporal artery running in between these layers. In this case a thin layer is elevated with the skin-subcutaneous tissue-flap and the superficial artery left with the remaining layer over the loose areolar tissue.

The loose areolar tissue is a good dissection plane, which varies considerably in thickness among individuals (Fig. 1). Toward the zygomatic arch one can see some amount of fat in this layer and more fibrous adhesions to the temporoparietal and temporal fascia (Fig. 1). Dissection in this area is more difficult as these three layers (temporoparietal fascia, loose areolar tissue, temporal fascia) get fused [47], also known as inferior temporal septum (Fig. 1) [36]. After cutting through this septum or adhesion, one can easily find the fronto-temporal branches of the facial nerve behind it in a fibro-fatty layer (the continuity of the loose areolar tissue (Fig. 1)) [36, 47].

Just above the adhesion or septum, one can cut the temporal fascia, which is in continuity with the periosteum above the superior temporal line (Fig. 1). As the temporal fascia is already split at this level, the cut is carried out just through its superficial lamina to expose the superficial temporal fat pad and underneath the deep lamina (Figs. 1, 2). The two laminae and the superficial fat pad can be followed until the insertion at the superior level of the zygomatic arch and the zygoma can be exposed. Under the deep lamina of the temporal fascia, one can than find the deep temporal fat pad, which is in connection with the buccal fat (Fig. 2). The temporal muscle can be elevated to reveal the underlying periosteum, under which one will find the anterior and posterior deep temporal arteries. Finally the branches of the fascial nerve can be dissected back to the main trunk of the facial nerve, which will make its relationship to the zygomatic arch clear (Fig. 2).

The conclusions of the literature review and anatomical dissections resulted in Fig. 3, which gives an overview of the different fascial layers and fat pads in relationship to the fronto-temporal branches of the facial nerve.

Surgical considerations

It has to be kept in mind that the fronto-temporal branches of the facial nerve change their level in the tissue within the temporal region, running from the fibrofatty tissue at the

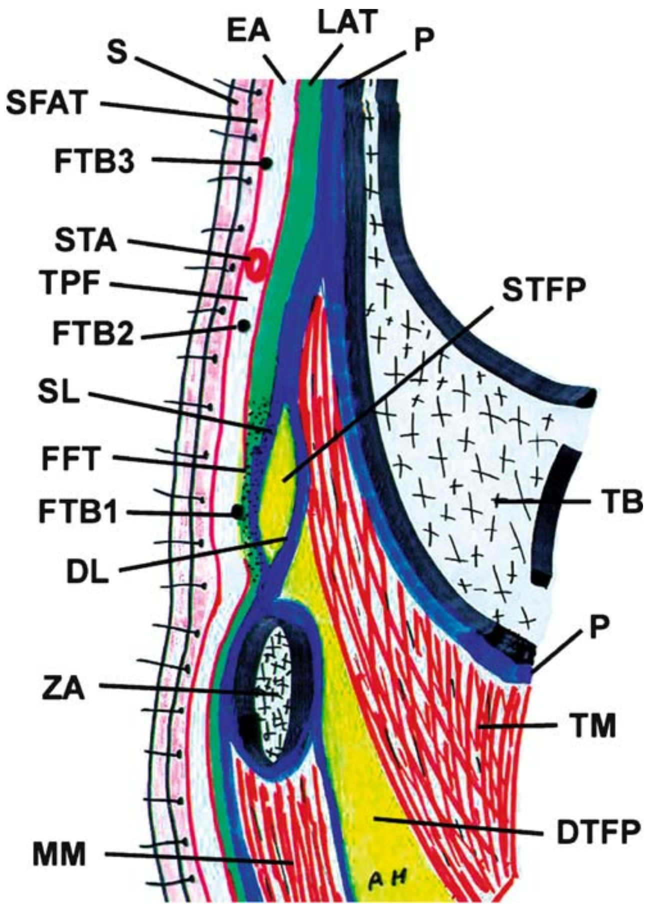

Fig. 3 A schematic drawing of the anatomical relationship over the temporal area showing: Skin (S), subcutaneous fibro-adipose tissue (SFAT), epicranial aponeurosis (EA), called temporoparietal fascia (TPF) over the temporal region and can be divided into an outer and inner layer, loose connective (areolar) tissue (LAT), pericranium (P) which blends with the temporal fascia (TF) over the temporal muscle (TM) and divides into a superficial lamina (SL) and deep lamina (DL), connected to the zygomatic arch (ZA). Fibro-fatty tissue (FFT), superficial temporal fat pad (STFP), deep temporal fat pad (DTFP), masseter muscle (MM). The fronto-temporal branches of the facial nerve (FTB1-3) are drawn at the different levels of their course, showing how they get more superficial above the zygomatic arch. Superficial temporal artery (STA)

level of the zygomatic arch through the temporoparietal fascia in which they reach their final destination [47]. Normally a subgaleal, sub-temporoparietal fascia dissection can be performed safely down to the fibrous attachment between the temporoparietal fascia, loose areolar tissue and temporal fascia, described as inferior temporal septum [36]. The loose areolar tissue can either be dissected separately or left with the temporoparietal fascia. During this first step, excessive coagulation on the galea or temporoparietal fascia anterior to the superficial temporal artery should be avoided so as not to injure the fronto-temporal branches of the facial nerve. Once the landmark where the adhesions start is reached, dissection superior to the temporal fascia should be stopped and an interfascial (correctly interlaminar: between the two laminae of deep temporal fascia) or subfascial (under the temporal fascia) dissection should be carried out. At the level of the zygomatic arch a subperiostal dissection is the key to protect the facial nerve and should start either from the orbital rim down and backward or from the level above the temporomandibular joint forward. When detaching the temporal muscle, care should be taken to elevate the muscle with the periosteum in order to protect the deep temporal arteries and the deep temporal nerves [29].

References

1. Abul-Hassan HS, von Drasek Ascher G, Acland RD (1986) Surgical anatomy and blood supply of the fascial layers of the temporal region. Plast Reconstr Surg 77:17–28
2. Accioli de Vasconcellos JJ, Britto JA, Henin D, Vacher C (2003) The fascial planes of the temple and face: an en-bloc anatomical study and a plea for consistency. Br J Plast Surg 56:623–629
3. Al-Mefty O (1987) Supraorbital-pterional approach to the skull base lesions. Neurosurgery 21:474–477
4. Al-Mefty O, Anand VK (1990) Zygomatic approach to skull-base lesions. J Neurosurg 73:668–673
5. Ammirati M, Spallone A, Jianya M, Cheatham M, Becker D (1993) An anatomicosurgical study of the temporal branch of the facial nerve. Neurosurgery 33:1038–1044
6. Bernstein L, Nelson RH (1984) Surgical anatomy of the extraparotid distribution of the facial nerve. Arch Otolaryngol 110:177–183
7. Burggasser G, Happak W, Gruber H, Freilinger G (2002) The temporalis: blood supply and innervation. Plast Reconstr Surg 109:1862–1869
8. Campiglio GL, Candiani P (1997) Anatomical study on the temporal fascial layers and their relationships with the facial nerve. Aesthetic Plast Surg 21:69–74
9. Carstens MH, Greco RJ, Hurwitz DJ, Tolhust DE (1991) Clinical application of the subgaleal fascia. Plast Reconstr Surg 87:615–626
10. Casanova R, Cavalcante D, Grotting JC, Vasconez LO, Psillakis JM (1986) Anatomic basis for vascularized outer-table calvarial bone flaps. Plast Reconstr Surg 78:300–308
11. Casoli V, Dauphin N, Taki C, Pelissier P, Boudard P, Caix P, Delmas V (2004) Anatomy and blood supply of the subgaleal fascia flap. Clin Anat 17:392–399
12. Coscarella E, Vishteh AG, Spetzler RF, Seoane E, Zabramski JM (2000) Subfascial and submuscular methods of temporal muscle dissection and their relationship to the frontal branch of the facial nerve. Technical note. J Neurosurg 92:877–880
13. David SK, Cheney ML (1995) An anatomical study of the temporoparietal fascial flap. Arch Otolaryngol Head Neck Surg 121:1153–1156
14. De La Plaza R, Valiente E, Arroyo JM (1991) Supraperiostal lifting of the upper two thirds of the FACE. Br J Plast Surg 44:325–332
15. Elazab EE, Abdel-Hameed FA (2006) The arterial supply of the temporalis muscle. Surg Radiol Anat 28:241–247
16. Federative Committee on Anatomical Terminology (FCAT) (1998) Terminologia Anatomica: International Anatomical Terminology, Thieme, Stuttgart
17. Freilinger G, Gruber H, Happak W, Pechmann U (1987) Surgical anatomy of the mimic muscle system and the facial nerve: importance for reconstructive and aesthetic surgery. Plast Reconstr Surg 80:686–690
18. Furnas DW (1965) Landmarks for the trunk and the temporofacial division of the facial nerve. Br J Surg 52:694–696
19. Ghassemi A, Prescher A, Riediger D, Axer H (2003) Anatomy of the SMAS revisited. Aesthetic Plast Surg 27:258–264
20. Gosain AK (1995) Surgical anatomy of the facial nerve. Clin Plast Surg 222:241
21. Gosain AK, Sewall SR, Yousif NJ (1997) The temporal branch of the facial nerve:how reliably can we predict its path? Plast Reconstr Surg 99:1224–1233
22. Gosain AK, Yousif NJ, Madiedo G, Larson DL, Matloub HS, Sanger JR (1993) Surgical anatomy of the SMAS: a reinvestigation. Plast Reconstr Surg 92:1254–1263
23. Hwang K, Cho HJ, Chung IH (2004) Innervation of the temporalis muscle for selective electrical denervation. J Craniofac Surg 15:352–357
24. Hwang K, Hwang JH, Cho HJ, Kim DJ, Chung JH (2005) Horizontal branch of the supraorbital nerve and temporal branch of the facial nerve. J Craniofac Surg 16:647–649
25. Hwang K, Kim DJ (1999) Attachment of the deep temporal fascia to the zygomatic arch: an anatomic study. J Craniofac Surg 10:342–345
26. Hwang K, Suh MS, Lee SI, Chung IH (2004) Zygomaticotemporal nerve passage in the orbit and temporal area. J Craniofac Surg 15:209–214
27. Imanishi N, Nakajima H, Minabe T, Chang H, Aiso S (2002) Venous drainage architecture of the temporal and parietal regions: anatomy of the superficial temporal artery and vein. Plast Reconstr Surg 109:2197–2203
28. Ishikawa Y (1990) An anatomical study on the distribution of the temporal branch of the facial nerve. J Craniomaxillofac Surg 18:287–292
29. Kadri PA, Al-Mefty O (2004) The anatomical basis for surgical preservation of temporal muscle. J Neurosurg 100:517–522
30. Kim S, Matic DB (2005) The anatomy of temporal hollowing: the superficial temporal fat pad. J Craniofac Surg 16:760–763
31. Kirolles S, Haikal FA, Saadeh FA, Abul-Hassan H, el-Bakaury AR (1992) Fascial layers of the scalp. A study of 48 cadaveric dissections. Surg Radiol Anat 14:331–333
32. Lei T, Xu DC, Gao JH, Zhong SZ, Chen B, Zang DY, Cui L, Li ZH, Wang XH, Yang SM (2005) Using the frontal branch of the superficial temporal artery as a landmark for locating the course of the temporal branch of the facial nerve during rhytidectomy: an anatomical study. Plast Reconstr Surg 116: 623–629
33. Liebman EP, Webster RC, Berger AS, DellaVecchia M (1982) The frontalis nerve in the temporal brow lift. Arch Otolaryngol 108:232–235

34. Marano SR, Fischer DW, Gaines C, Sonntag VK (1985) Anatomical study of the superficial temporal artery. Neurosurgery 16:786–790
35. Mitz V, Peyronie M (1976) The superficial musculo-aponeurotic system (SMAS) in the parotid and cheek area. Plast Reconstr Surg 58:80–88
36. Moss CJ, Mendelson BC, Taylor GI (2000) Surgical anatomy of the ligamentous attachments in the temple and periorbital regions. Plast Reconstr Surg 105:175–190
37. Nakajima H, Imanishi N, Minabe T (1995) The arterial anatomy of the temporal region and the vascular basis of various temporal flaps. Br J Plast Surg 48:439–450
38. Ozersky D, Baek SM, Biller HF (1980) Percutaneous identification of the temporal branch of the facial nerve. Ann Plast Surg 4:276–280
39. Park C, Lew DH, Yoo WM (1999) An analysis of 123 temporoparietal fascial flaps: anatomic and clinical considerations in total auricular reconstruction. Plast Reconstr Surgv104:1295–1306
40. Pérez-Rull J, Brette MD, Levignac J, Hadjean E, Miron C, Freyss G (1992) Surgical landmarks of the temporo-frontal branch of the facial nerve. Ann Chir Plast Esthet 37:11–17
41. Pinar YA, Govsa F (2006) Anatomy of the superficial temporal artery and its branches: its importance for surgery. Surg Radiol Anat 28:248–253
42. Pitanguy I, Ramos AS (1966) The frontal branch of the facial nerve: The importance of its variations in face lifting. Plast Reconstr Surg 38:352–356
43. Quattara D, Vacher C, de Vasconcellos JJ, Kassanyou S, Gnanazan G, N'Guessan B (2004) Anatomical study of the variations in innervation of the orbicularis oculi by the facial nerve. Surg Radiol Anat 26:51–53
44. Ramirez OR, Maillard GF, Musolas A (1991) The extended subperiostal face lift: a definitive soft-tissue remodeling for fascial rejunvenation. Plast Reconstr Surg 88:227–238
45. Rudolph R (1990) Depth of the facial nerve in face lift dissection. Plast Reconstr Surg 85:537–544
46. Sabini P, Wayne I, Quatela VC (2003) Anatomical guides to precisely localize the frontal branch of the facial nerve. Arch Facial Plast Surg 5:150–152
47. Salas E, Ziyal IM, Bejjani GK, Sekhar LN (1998) Anatomy of the frontotemporal branch of the facial nerve and indications for interfascial dissection. Neurosurgery 43:563–568
48. Schmidt BL, Pogrel MA, Hakim-Faal Z (2001) The course of the temporal branch of the facial nerve in the periorbital region. J Oral Maxillofac Surg 59:178–184
49. Stock AL, Collins HP, Davidson TM (1980) Anatomy of the superficial temporal artery. Head Neck Surg 2:466–469
50. Stuzin JM, Baker TJ, Gordon HL (1992) The relationship of the superficial and deep facial fascias: relevance to rhytidectomy and aging. Plast Reconstr Surg 89:441–449
51. Stuzin JM, Wagstrom L, Kawamoto HK, Wolfe SA (1989) Anatomy of the frontal branch of the facial nerve: the significance of the temporal fat pad. Plast Reconstr Surg 83:265–275
52. Tellioglu AT, Tekdemir I, Erdemli EA, Tuccar E, Ulusoy G (2000) Temporoparietal fascia: an anatomic and histologic reinvestigation with new potential clinical applications. Plast Reconstr Surg 105:40–45
53. Tolhurst DE, Carstens MH, Greco RJ, Hurwitz DJ (1991) The surgical anatomy of the scalp. Plast Reconstr Surg 87:603–612
54. Tremolada C, Candiani P, Signorini M, Vigano M, Donati L (1994) The surgical anatomy of the subcutaneous fascial system of the scalp. Ann Plast Surg 32:8–14
55. Wen HT, de Oliveira E, Tedeschi H, Andrade FC Jr, Rhoton AL (2001) The pterional approach: Surgical anatomy, operative technique, and rationale. Operative Techniques in Neurosurgery 4:60–72
56. Wormald PJ, Alun-Jones T (1991) Anatomy of the temporalis fascia. J Laryngol Otol 105:522–524
57. Yasargil MG (1984) Interfascial pterional (frontotemporosphenoidal) craniotomy. In: Yasargil MG (ed) Microneurosurgery, vol I. Georg Thieme Verlag, New York, pp 217–220
58. Yasargil MG, Reichman MV, Kubik S (1987) Preservation of frontotemporal branch of the facial nerve using the interfascial temporalis flap for pterional craniotomy. Technical article. J Neurosurg 67:463–466
59. Zhang HM, Yan YP, Qi KM, Wang JQ, Liu ZF (2002) Anatomical structure of the buccal fat pad and its clinical adaptions. Plast Reconstr Surg 109:2509–2518

Comments

David Rojas, Jorge Mura, Evandro de Oliveira, Sao Paulo, Brazil

Krayenbühl et al. review the relationship of the frontotemporal branches of the facial nerve to the fascias of the temporal region. This article has two important advantages for the reader. First, it is well written, the anatomy is clearly and systematically reviewed, with references to milestone articles of this topic. The relationship of main neural and vascular structures is well analyzed, and landmarks for their identification in surgery are clear for the reader. Second, it shows the perspective of the senior author who described the interfacial technique 20 years ago. This was a major advance for achieving not only better esthetic results decreasing the risk of frontal branch palsy, but also allowed for an extra exposure in the frontotemporal flap, avoiding the bulky temporal muscle, and facilitating the variations of the pterional approach like the fronto-orbito zygomatic access route. In conclusion, this is a good review that will be illustrative for young neurosurgeons.