The Fascias of the Forehead and Temple Aligned—An Anatomic Narrative Review

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KEYWORDS

• Forehead anatomy • Temple anatomy • Frontalis muscle • Facial anatomy • Fascial layers

KEY POINTS

- The 5-layered arrangement of the scalp is continuous with the forehead and the temple. A total of 8 layers can be identified in the forehead and a total of 13 layers in the scalp, which show complex interconnections.
- The layers of the scalp are continuous with the layers of the forehead. Although the other layers of the scalp remain the same in the forehead region, the galea aponeurotica (layer III) of the scalp separates into 3 more layers: suprafrontalis fascia, frontalis muscle, and subfrontalis fascia.
- In the temple, the skin (layer I) and the superficial fatty layer (layer II) are continuous with the scalp. The galea aponeurotica (layer III) separates into 2 laminae (superficial temporal fascia) that enclose the superficial temporal artery. The loose areolar tissue (layer IV) of the scalp forms a separate fascia (innominate fascia) in its superficial aspect, which is overlying the loose areolar tissue of the temple. The periosteum (layer V) of the scalp is continuous with the deep temporal fascia that separates into a superficial and a deep lamina.

INTRODUCTION

In recent years, facial anatomy has received increasing attention because of the rise of minimally-invasive procedures for esthetic purposes.[1,2] These procedures involve neuromodulators or soft tissue fillers injected into the facial soft tissues to ameliorate the signs of aging.[3–6] Facial anatomy, however, has evolved from a 2-dimensional and static understanding into a 3-dimensional (3D) and functional understanding because of the incorporation of novel research methodologies like skin vector displacement analyses,[7] 3D volumetric assessment,[8] skin-surface derived electromyography,[9,10] eye tracking technology,[11–13] and ultrasound imaging.[14–16] The latter allows for the in-vivo real-time visualization of the facial soft tissues, which enables health care professionals to identify subdermal structures without performing surgery or anatomic dissections.

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With this new research, the understanding of facial anatomy has evolved to the concept that facial soft tissues are arranged in layers and that those layers are interconnected throughout the face.[17–24] This pan-facial connection of facial layers allows for the development of new treatment strategies like the "temporal lifting technique"[25–27] and the use of soft tissue fillers for lifting the facial soft tissues[8]; this is a different and novel approach, which can be best explained by the underlying anatomy.

The understanding of the layered anatomy of the upper face is crucial when trying to relate the layers of the forehead to the temple and between these two to the layers of the scalp. The clinical relevance of this understanding has recently been demonstrated with the development of the interfascial injection technique for the temple.[26] Here, the layers of the forehead are being used to safely and precisely target the temple for treating temporal hollowing and to influence the appearance of the periorbital area and the midface.[28] This is one example, demonstrating the clinical applicability of advanced anatomic knowledge for best practice and increased patient safety.

However, to date, there is no clear alignment between the anatomic layers of the scalp, forehead, and temple. Therefore, it is the objective of this anatomic narrative review to summarize currently accepted concepts of the layers of the upper face and to align them into a unifying nomenclature and understanding.

MATERIALS AND METHODS

This study is based on a literature review and on the anatomic experience of the authors who have multiple years of experience in cadaveric dissections, facial surgery, and minimally invasive facial procedures.

For the literature review, the PubMed electronic database was screened. Two different search queries were conducted to gather the appropriate articles. The first search focused on the anatomy of the temple and included the following terms: temple AND anatomy OR nomenclature OR layers, temporal fascia AND anatomy OR names OR layers, temporoparietal fascia AND anatomy, temporal AND layer OR anatomy OR flap OR reconstruction OR fascia, temporal layers, tempo* AND fascia AND anatomy, tempo* AND fascia, and temporal region AND layers. The second query identified articles for the forehead. This search was conducted by using the following search terms: forehead AND anatomy OR surgical anatomy OR imaging OR flap OR reconstruction, forehead AND imaging AND anatomy, galea AND anatomy OR flap or fascia, subgaleal AND anatomy, galea aponeurotica AND anatomy, and scalp AND anatomy OR surgical anatomy. Both queries were limited to English studies that had been conducted in humans. Articles relevant for the temple were limited to the years 2013 to 2021, whereas relevant articles for the forehead had no period limitation. The reason to limit the temple literature search to 2013 was based on a previous literature review.[29] Careful selection was made based on the title and the abstract. Studies were only eligible for inclusion if the anatomic structure of the temple and forehead anatomy were discussed. The remaining articles were excluded if they did not contain information about the layers of one of the aforementioned anatomic regions.

Anatomic descriptions provided herein represent the knowledge and the experience of the authors and should be regarded as such.

RESULTS

Scalp

The term "scalp" can be regarded as an acronym for the 5 parallel layers that can be found in the area of the upper face which is covered by hairs: skin (layer 1), superficial (subdermal) fatty layer (layer 2) (= connective tissue), galea aponeurotica (layer 3) (= aponeurosis), loose areolar tissue (layer 4), and periosteum (layer 5) (**Table 1**).

Most arterial and venous blood supply travel within layer 2 but some arteries can be found in layer 5 as well. Layer 4 is predominantly avascular and can be considered as a safe and feasible dissection plane.

Forehead

The layers of the forehead are continuous with the layers of the scalp. The change in nomenclature occurs anterior to the hairline and is bounded laterally by the temporal crests (= the boundary between forehead and temple) and inferiorly by the superior orbital rim. The following layers can be identified in the forehead: skin (layer 1), superficial (subdermal) fatty layer (layer 2), suprafrontalis fascia (layer 3), frontalis muscle (layer 4), retrofrontalis fat (layer 5), subfrontalis fascia (layer 6), loose areolar tissue in the upper forehead and preperiosteal fat in the lower lateral forehead (layer 7), and periosteum (layer 8) (**Figs. 1–3** and **Table 1**).

Although the skin (layer 1), superficial (subdermal) fatty layer (layer 2), loose areolar tissue (layer 4), and periosteum (layer 5) are continuous between scalp and forehead, the layer 3 structures change and diversify when transitioning into the forehead. The galea aponeurotica separates into 3 layers:

Table 1
Overview of the fascial connections and the numbered layered arrangement of the forehead, scalp, and temple

Layers	Forehead	Scalp	Temple	Layers
1	Skin[30,31]	Skin[31–33]	Skin[26,33]	*1*
2	Superficial (Subdermal) fatty layer[26]	Superficial (Subdermal) fatty layer[26]	Superficial (Subdermal) fatty layer[26]	*2*
3	Suprafrontalis fascia[34,35]	Galea aponeurotica[31–33]	Superficial lamina of superficial temporal fascia[36,37]	*3*
4	Frontalis muscle[30,31]		Deep lamina of superficial temporal fascia[36,37]	*4*
5	Retrofrontalis fat[34,35]		Deep temporal fat[38,39]	*5*
6	Subfrontalis fascia[34,35]		Innominate fascia[17,40,41]	*6*
7	Loose areolar tissue[31,42,43] (in upper forehead) Preperiosteal fat[34,35] (in lower forehead)	Loose areolar tissue[31]	Loose areolar tissue[44–46] (in upper temple)	*7*
8	Periosteum[30,31]	Periosteum[31–33]	Superficial lamina of deep temporal fascia[26,40,47]	*8*
			Superficial temporal fat pad[26,40,48]	*9*
			Deep lamina of deep temporal fascia[26,40,47]	*10*
			Deep temporal fat pad[26,41,49] (= Temporal extension of buccal fat pad of Bichat)[26,47]	*11*
			Temporalis muscle[26,33]	*12*
			Periosteum[26,33]	*13*

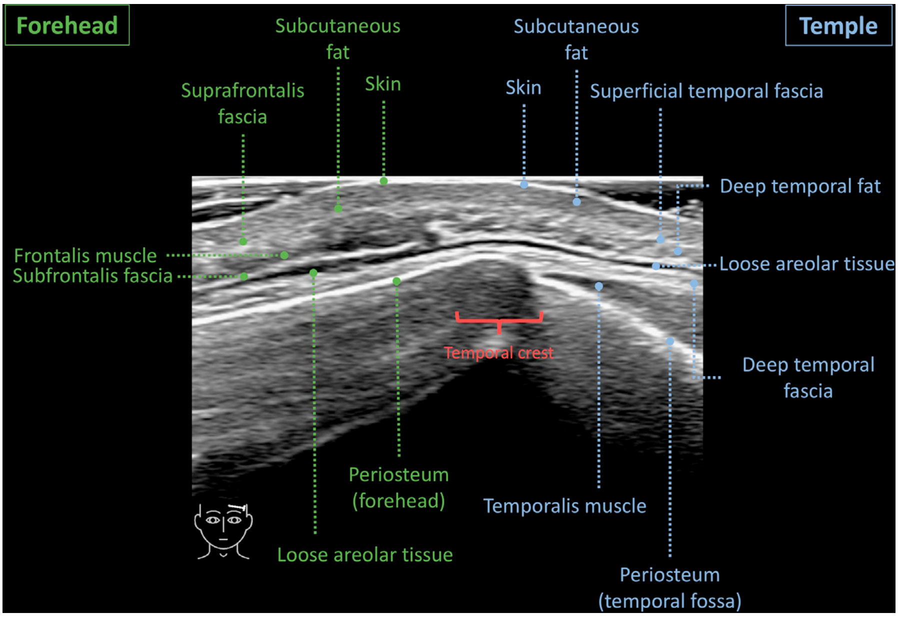

Fig. 1. Ultrasound image showing the layered arrangement of the frontotemporal transition at the temporal crest. Anatomic structures labeled in green indicate structures of the forehead, whereas structures labeled in blue indicate structures of the temple.

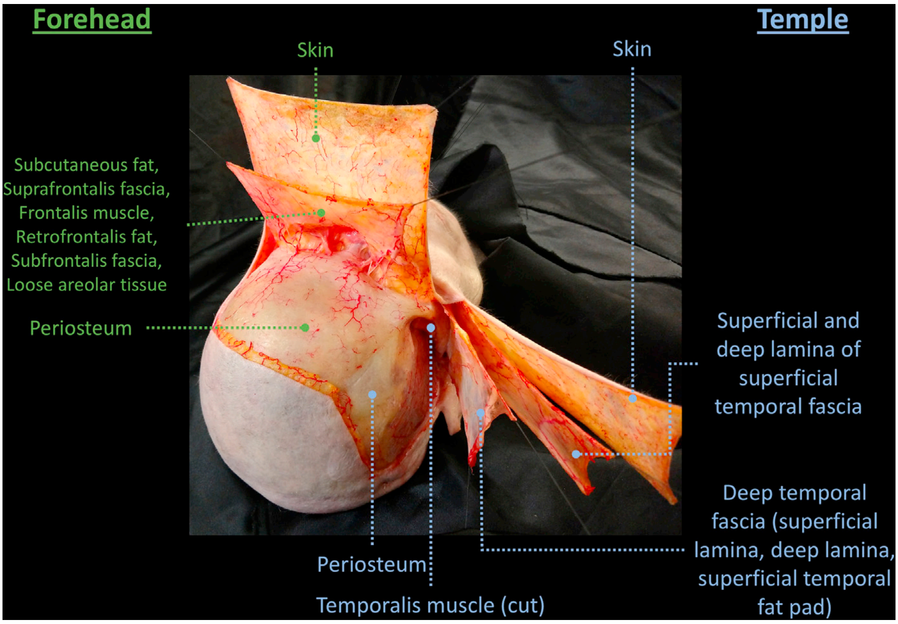

Fig. 2. Cadaveric dissection of the layers of the forehead and temple. Anatomic structures labeled in green indicate structures of the forehead, whereas structures labeled in blue indicate structures of the temple.

suprafrontalis fascia, frontalis muscle, and subfrontalis fascia. Between the frontalis muscle and the subfrontalis fascia, a layer of fat can be identified, which is continuous with the preseptal fat and the retro-orbicularis fat and is termed analogous as retrofrontalis fat (see **Fig. 3**). This fat provides protection and insulation for the deep branch of the supraorbital and supratrochlear arteries and for the branches of the supraorbital and supratrochlear nerve. In the lower lateral forehead, a deep layer of fat can be found in layer 4, which is termed the preperiosteal fat, analogous to the fat within the prezygomatic space in the lateral infraorbital region.

The superficial branches of the supraorbital and supratrochlear arteries travel after they emerge from their respective foraminae superficial to the frontalis muscle but covered by the suprafrontalis fascia and enveloped by the superficial (subdermal) fatty layer. The deep branches travel within the retrofrontalis fat until they change their planes in the upper forehead and travel likewise superficial to the frontalis muscle but deep to the suprafrontalis fascia to connect to the superficial/anterior branch of the superficial temporal artery.

The sensory supraorbital and supratrochlear nerves travel within the retrofrontalis fat initially and become superficial as they accompany the arteries in their change of plane. However, the deep/lateral branch of the supraorbital nerve travels within the periosteum with connections to the subfrontalis fascia and forms in this way the lateral boundary of the deep central forehead compartment or the medial boundary of the deep lateral forehead compartment.

Temple

The layers of the temple are continuous with the layers of the scalp. The change in nomenclature occurs inferior to the hairline and is bounded medially by the temporal crests (= boundary between forehead and temple) and inferiorly by the zygomatic arch. The following layers can be identified in the temple: skin (layer 1), superficial (subdermal) fatty layer (layer 2), superficial lamina of superficial temporal fascia (layer 3), deep lamina of superficial temporal fascia (layer 4), deep temporal fat (layer 5), innominate fascia (layer 6), loose areolar tissue (layer 7), superficial lamina of deep temporal fascia (layer 8), superficial temporal fat pad (layer 9), deep lamina of deep temporal fascia (layer 10), deep temporal fat pad (= temporal extension of the buccal fat pad of Bichat) (layer 11), temporalis muscle (layer 12), and periosteum (layer 13) (see **Figs. 1–3**; **Fig. 4** and **Table 1**).

The skin and the superficial (subdermal) fatty layer are continuous with the scalp. The galea aponeurotica, however, separates into two very thin laminae that enclose the superficial temporal artery on its course toward the forehead and are termed the superficial temporal fascia together. The loose areolar tissue in the scalp forms in its superficial aspect a separate fascia, which is termed in the temple the innominate fascia. This fascia is

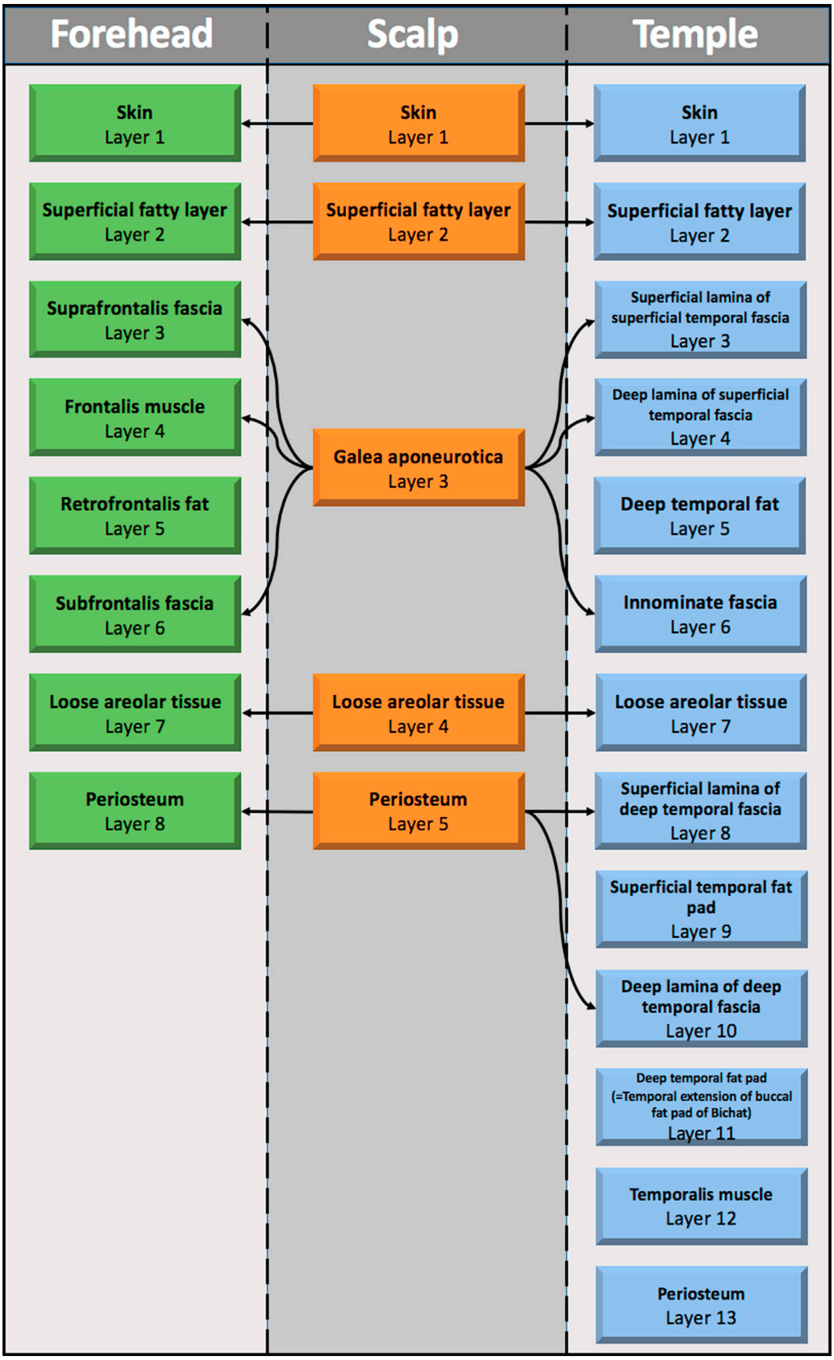

Fig. 3. Schematic diagram showing the layers of the forehead, scalp, and temple. Although only 5 layers can be distinguished in the scalp, the forehead consists of 8 layers and the temple consists of 13 layers. In the forehead, the suprafrontalis fascia (layer 4), frontalis muscle (layer 5), and subfrontalis fascia (layer 7) can be seen as a derivate of the galea aponeurotica (layer 3) of the scalp. In the temple, the superficial and deep lamina of the superficial temporal fascia, as well as the innominate fascia, can be seen as a derivate of the galea aponeurotica (layer 3) of the scalp. In the temple, the superficial and deep lamina of the deep temporal fascia are derived from the periosteum of the scalp, which resembles layer 5.

overlying the loose areolar tissue of the temple and does not extend caudal to the inferior temporal septum. Caudal to the inferior temporal septum, the deep fat of the temple can be found, which is supported by the underlying very thin layer of innominate fascia and loose connective tissue.

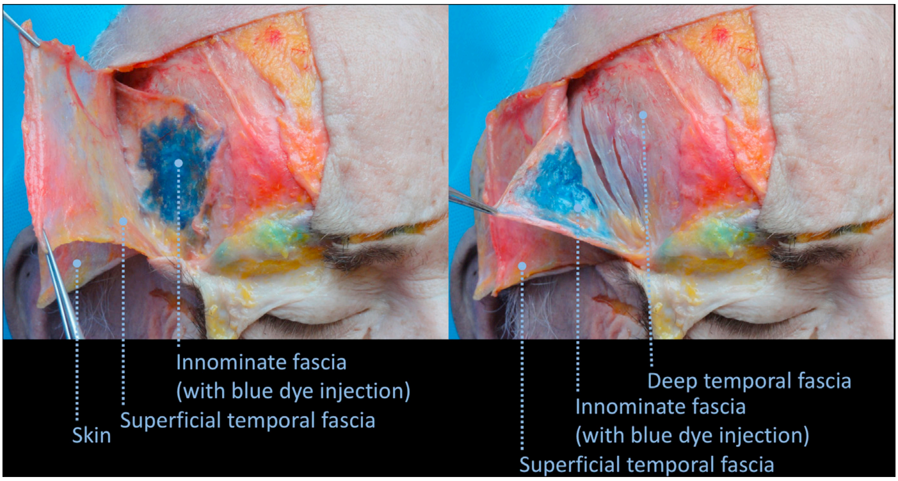

Fig. 4. Cadaveric dissection of the layers in the temple showing the innominate fascia (visualized using blue dye) between the superficial temporal fascia and the deep temporal fascia.

Together they overly the deep temporal fascia which is continuous with the periosteum of the scalp (see **Fig. 4**). The deep temporal fascia separates into a superficial and a deep lamina before their connection to the zygomatic arch and both laminae enclose the superficial temporal fat pad. The deep lamina of the deep temporal fascia covers the deep temporal fat pad (= temporal extension of the buccal fat pad of Bichat) and the temporalis muscle (see **Figs. 2** and **3**).

The frontal branch of the facial nerve travels protected by the deep temporal fat between the superficial and the deep temporal fascia from the temple into the forehead, whereas the middle temporal vein travels between the superficial and the deep lamina of the deep temporal fascia. The superficial temporal and the zygomatico-orbital arteries travel within the superficial temporal fascia and therefore between its 2 laminae (**Fig. 5**).

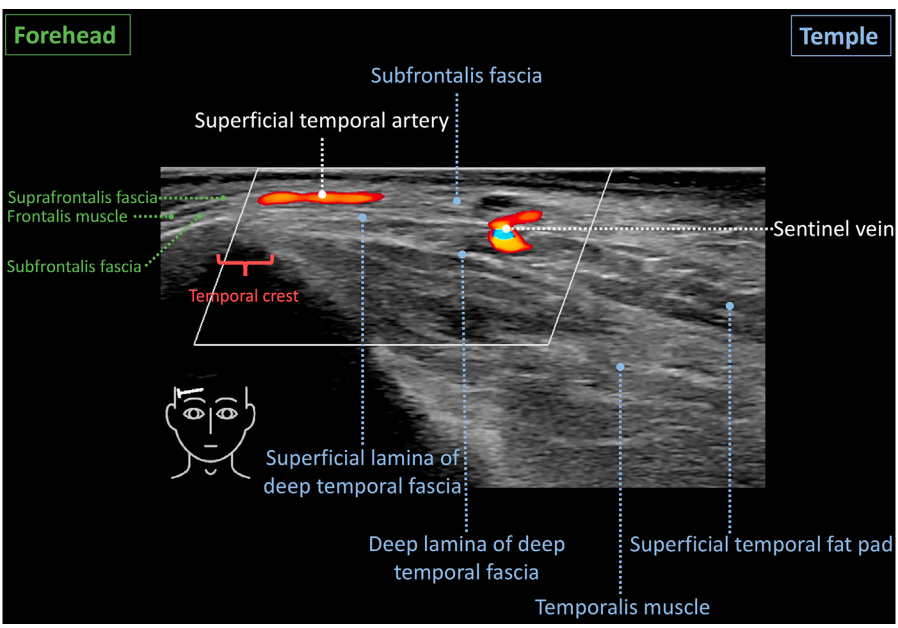

Fig. 5. Ultrasound image showing the superficial temporal artery located within the superficial temporal fascia in the temple and located between the frontalis muscle (deep) and the suprafrontalis fascia (superficial). The middle temporal vein is changing planes after piercing the superficial lamina of the deep temporal fascia and into the loose connective tissue of the temple and later of the forehead.

DISCUSSION

This anatomic narrative review seeks to align the nomenclature of the layered arrangement of the scalp, forehead, and temple. Although these regions have connecting fascial layers, vessels, and nerves, to the authors' knowledge, there is no study to date that aligns the anatomy between those 3 sites, describing how distinct fascial layers are interconnected (see **Fig. 3**).

One of the findings of this narrative review is the diverse nomenclature being used in surgical procedures and anatomic descriptions of the scalp, forehead, and temple throughout the literature. The authors did their best to summarize the literature but might have not included all articles published this far; this can be regarded as a limitation of this study.

It is a novel concept that the galea aponeurotica separates into three different fascial layers when transitioning from the scalp to the forehead but this idea is supported by functional anatomic and clinical reports.[20,50,51] Recently, the line of convergence was introduced into the literature which has greatest clinical relevance for treating horizontal forehead lines with neuromodulators.[52] This horizontal functional line describes a region of the frontalis muscle where its cranial end (= attachment to the galea aponeurotica) and its caudal end (= attachment to the skin of the eyebrow medially and attachment and fusion with the orbicularis oculi muscle laterally) converge during muscular contraction. In this area, no movement of the overlying forehead skin is observed because of the antagonistic movements of the muscle, which is the result of appropriating its caudal and cranial ends. This is only possible when envisioning the frontalis muscle to be encapsulated between two covering fascias comparable to a sleeping bag. The fascia on its superficial surface connects with the overlying skin and allows for proper and direct force transmission corresponding to the muscle contraction status.[34,53,54] This explains why with frontalis muscle contraction the overlying skin forms horizontal wrinkles as opposed to some other facial areas and why the eyebrows move cranially while the hairline moves caudally. These antagonistic movements are possible if there is a strong connection of the muscles' surface and a gliding plane deep to the muscle but separated from the supraperiosteal plane. The presence of a deep fascia = subfrontalis fascia (layer 6) allows for the approximation of the hairline to the eyebrows without compressing the underlying vessels and nerves against the frontal bone.

The anterior branch of the superficial temporal artery emerges from deeper planes 1 cm anterior and 1 cm superior to the apex of the tragus,[26] and travels inside the superficial temporal fascia to reach the forehead. To allow for the coverage of the artery on both sides with a protective fascia, a superficial (layer 3) and a deep (layer 4) lamina is needed. When the artery passes the temporal crest medially, it can be identified superficial to the frontalis muscle.[55] This implies that the superficial lamina of the superficial temporal fascia of the temple (layer 3) is continuous with the suprafrontalis fascia of the forehead (layer 3), whereas the deep lamina of the superficial temporal fascia of the temple (layer 4) is continuous with the frontalis muscle in the forehead (layer 4). This allows for the understanding of the pathway of the artery and the connection between the superficial fascial layers of the forehead and temple (see **Fig. 5**). This is supported by the finding that the superficial temporal fascia is continuous with the orbicularis oculi muscle[17–19] and that this superficially locate muscle is also in direct continuation with the frontalis muscle.[20,21]

The subfrontalis fascia of the forehead is a recently discovered structure and its connection to the temple can be established when accepting the existence of the innominate fascia.[17,18,38,40] The latter was not incorporated in recent descriptions of temporal anatomy but plays an integral role when trying to align the layers of the forehead and temple.[26,56,57] In the forehead, the branches of the supraorbital and supratrochlear nerve travel protected within the retrofrontalis fat which is continuous with the retro-orbicularis oculi fat. Previously, a connection between the forehead and the temple was termed the "superior interval" and described the spatial connection between the inferior temporal compartment and the retro-orbicularis oculi fat.[29] This connection was based on the continuation of a deep layer of fat which protects nerve branches traveling from the temple to the forehead and vice versa (layer 5). As it is known that the frontalis muscle receives its neural supply from deep,[58,59] it is plausible that the frontal branches of the facial nerve travel deep to the frontalis muscle (layer 4) and therefore have to be deep to the deep lamina of the superficial temporal fascia (layer 4) located within the deep fat of the temple.[38,60,61] In the forehead, however, these branches are protected from the supraperiosteal plane by the subfrontalis fascia (layer 6),[38,62] which indicates that this fascial plane has to be deep to the deep fat of the temple. During surgical repair of zygomatic arch fractures, reposition of the arch is performed by approaching the arch deep to the frontal branches of the facial nerve. This is possible due to the presence of a protective layer of fascia and loose areolar tissue. The innominate fascia of the temple continues in the forehead as the subfrontalis fascia and in the scalp as the deep portion of the galea aponeurotica and the connecting interface between the loose areolar tissue and galea.[17,29,63](see **Fig. 3**).

Previous studies have shown that the middle temporal vein pierces the superficial lamina of the deep temporal fascia lateral to the tail of the eyebrow.[64,65] (see **Fig. 5**) Upon emergence from the deep temporal fascia, the vein does not penetrate the innominate fascia but travels deep to this fascia when reaching the supraorbital region of the forehead. There, the vein can be found deep to the subfrontalis fascia within the preperiosteal fat which is in close relationship to the supraorbital attachment of the orbicularis retaining ligament. Here the vein is termed sentinel vein and connects to the superficial temporal vein close to the auricle.[64] The course of the middle temporal/sentinel vein can be best understood when incorporating the concept of the continuation between the innominate fascia of the temple and the subfrontalis fascia of the forehead; the vein travels deep to this fascia.

Recent advancements in treating temporal hollowing with soft tissue fillers include the interfascial injection technique.[26,28,66] This technique entails injecting the product deep to the superficial temporal fascia and superficial to the deep temporal fascia with periosteal contact of a 22G–25G 50 mm blunt tip cannula of the forehead 1 cm medial and 1 cm inferior to the hairline.[66] After periosteal contact is established in the forehead (layer 8), the cannula is pointed toward the temple and advanced in constant contact with bone. This bony contact is lost lateral to the temporal crest as here the frontal periosteum transitions into the deep temporal fascia of the temple. The blunt tip cannula is gliding on top of the deep temporal fascia, that is, the superficial lamina of the deep temporal fascia (layer 8) when reaching the temple. During product administration, the cannula is deep to the deep temporal fat which includes the motor branches of the facial nerve relevant for the upper facial muscles of expression (layer 5), deep to the innominate fascia (layer 6), but within the loose areolar tissue. This smooth gliding plane allows for homogenous product distribution without risk to the nerve branches. Because the sentinel vein is located in the same plane, care needs to be taken to avoid hematoma formation after accidental injury. Local pressure could help to ameliorate signs and symptoms of sentinel vein injury, and ultrasound follow-up can be performed.

SUMMARY

This anatomic narrative review describes the layered anatomy of the scalp, forehead, and temple and establishes the fascial connections based on literature review, ultrasound imaging, and anatomic dissections. Despite the highly variable nomenclature used for describing fascial layers and their extensions, the anatomy of the 3 upper facial regions can be combined into a unified concept. The 5 layers of the scalp transition into the forehead's 8 layers. In the temple, a total of 13 layers include the innominate fascia as a part of the loose areolar connective tissue. Aligning those anatomic and fascial concepts might allow for the further development of novel surgical and nonsurgical treatment options to enhance outcomes and patient safety.

DISCLOSURE

The authors have nothing to disclose.

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