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Original article

Depth Transitions of the Frontal Branch of the Facial Nerve: Implications in SMAS rhytidectomy

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ABSTRACT

Background: Anatomy of the frontal branch of the facial nerve relative to the zygomatic arch and the superficial musculoaponeurotic system (SMAS) has been well described. The variability centers on the location where the frontal branch traverses from a deeper to more superficial plane in the SMAS. The goal of this study is to examine the depth transition of the frontal branch of the facial nerve relative to the zygomatic arch with hopes of pinpointing a caution zone for dissection to avoid nerve injury.

Methods: The frontal branch of the facial nerve was dissected in 36 hemifacial fresh cadaver specimens. Pitanguy's line, the zygomatic arch, and temporal crest were marked. Measurements were taken from the zygomatic arch to the location where the frontal branch pierced the temporoparietal fascia. Locations of the superficial temporal artery (STA), the frontal branch cross relative to the lateral orbital rim and frontalis muscle were also measured.

Results: In 94.4% ($n = 36$) of the specimens, the frontal branch was found to transition to an intra-SMAS plane approximately 9.6 mm above the zygomatic arch. In all specimens, the frontal branch transitioned to an intra-SMAS plane approximately 12.2 mm posterior to Pitanguy's line.

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Conclusions: This study describes a surgical "caution zone" centered on a point 9.6 mm above the arch and 12.2 mm posterior to Pitanguy's line, and related to the anterior branch of the STA. We hope this anatomical detail will help to decrease the likelihood of intraoperative injury to the frontal branch of the facial nerve.

Introduction

Although buccal branches are the most commonly injured facial nerve branches, these injuries are often clinically insignificant because of wide cross-innervation. In contrast, the lack of interconnections within the marginal mandibular and frontal branches of the facial nerve make injury to them far more likely to yield clinically significant problems.[1–20] Frontal branch injury can lead to brow ptosis.

Several studies have described the course and the branching pattern of the frontal branch of the facial nerve and its relationship with adjacent fascial layers, and specific anatomic landmarks. As a result, the facial esthetic surgeon is equipped with a strong knowledge of the anatomy of the frontal branch.[1–20] However, the one data point that remains variable in published literature is the frontal branch "transition-point." In other words, the location where the nerve traverses from a deeper subsuperficial musculoaponeurotic system (SMAS) plane to a more superficial sub-SMAS plane. Common dictum suggests a range of 1.5–2.0 cm above the arch, but some studies provide an even broader range of 1.5 cm–3 cm. The authors of this study believe that in facial surgery an area of 1.5 cm is too broad when trying to isolate and avoid injury to a nerve. The goal of this study was to examine the nerve from its origin, through its path within the innominate fascia and then its terminal insertions in the frontalis muscle. These data may help to further isolate this "transition point" and describe a dissection "caution zone" that can be readily marked intraoperatively to help avoid nerve injury.

Methods

Thirty-six hemifacial fresh cadaveric dissections were performed at Kansas City University of Medicine and Biosciences from December 2016 to February 2018. Pitanguy's line, the zygomatic arch, and the temporal crest were marked (Figure 1). Pitanguy's line was drawn from 0.5 cm below the tragus to 0.5 cm above the lateral margin of the bony orbit. Dissection was performed using 2.5x loupe magnification (SurgiTel, Ann Arbor, MI).

Subcutaneous dissection was performed, Pitanguy's line and zygomatic arch transposed onto the subcutaneous fat (Figure 2). Dissection proceeded deep to the SMAS at the tragal pointer to identify the main trunk of the facial nerve. The most superior branch was traced cephalically through the innominate fascia and the location of the frontal branch as it pierced the temporoparietal fascia was identified (Figure 2). At this point, the superficial temporal artery (STA) was also identified. The STA was followed cephalically to locate the anterior branch of the STA. The course of the anterior branch of the STA was followed to the intersection of the frontal branch and the anterior branch of the STA.

The distance from the zygomatic arch to the location of the frontal nerve as it transitions from a sub-SMAS position to an intra-SMAS plane was recorded (Figure 3). In addition, the distance from Pitanguy's line to the location of this transition point was measured. In the superior temporal region, measurements were taken from Pitanguy's line, the frontalis muscle, and lateral orbital rim to the location of the intersection of the anterior branch of the STA and frontal branch (Figures 3,4).

Descriptive statistics for these measurements were generated using IBM SPSS Statistics (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.).

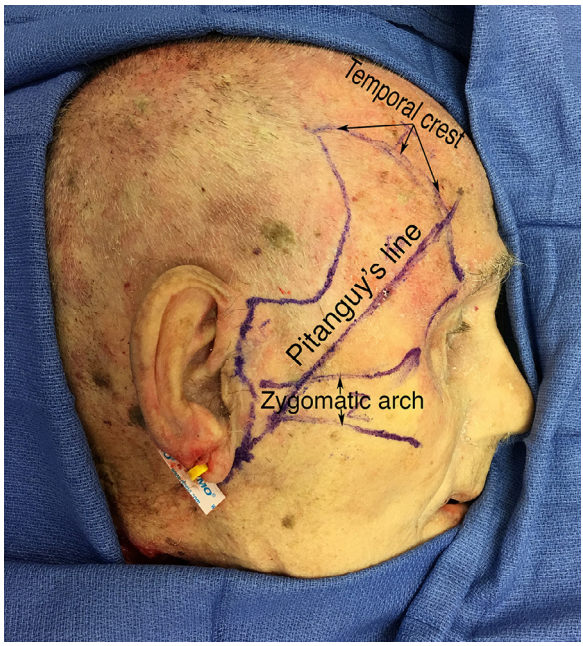

Figure 1. (Lateral View) Elderly male cadaveric specimen with the predissection skin markings of Pitanguy's line, zygomatic arch, and temporal crest.

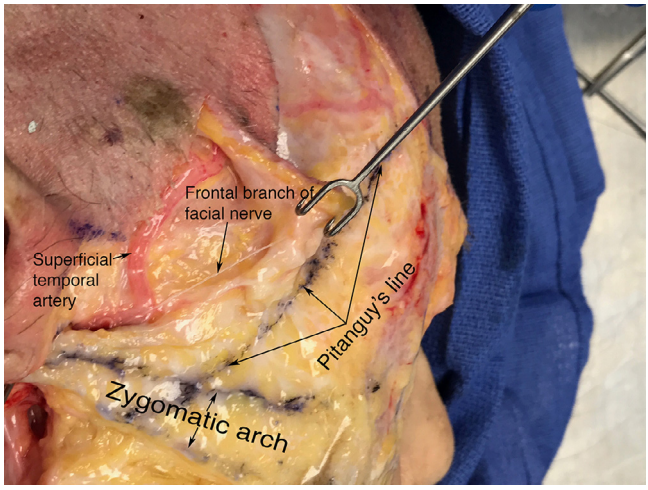

Figure 2. (Lateral View) Elderly male cadaveric specimen displaying the frontal branch of the facial nerve piercing the temporoparietal fascia relative to the zygomatic arch and Pitanguy's line.

Results

The frontal branch of the facial nerve was found in all 18 specimens (36 sides). In 94% (34 sides) of the specimens, the frontal branch of the facial nerve was found to course within the temporoparietal fascia above the zygomatic arch (Figures 2,3). In two hemifacial dissections, the nerve was found to

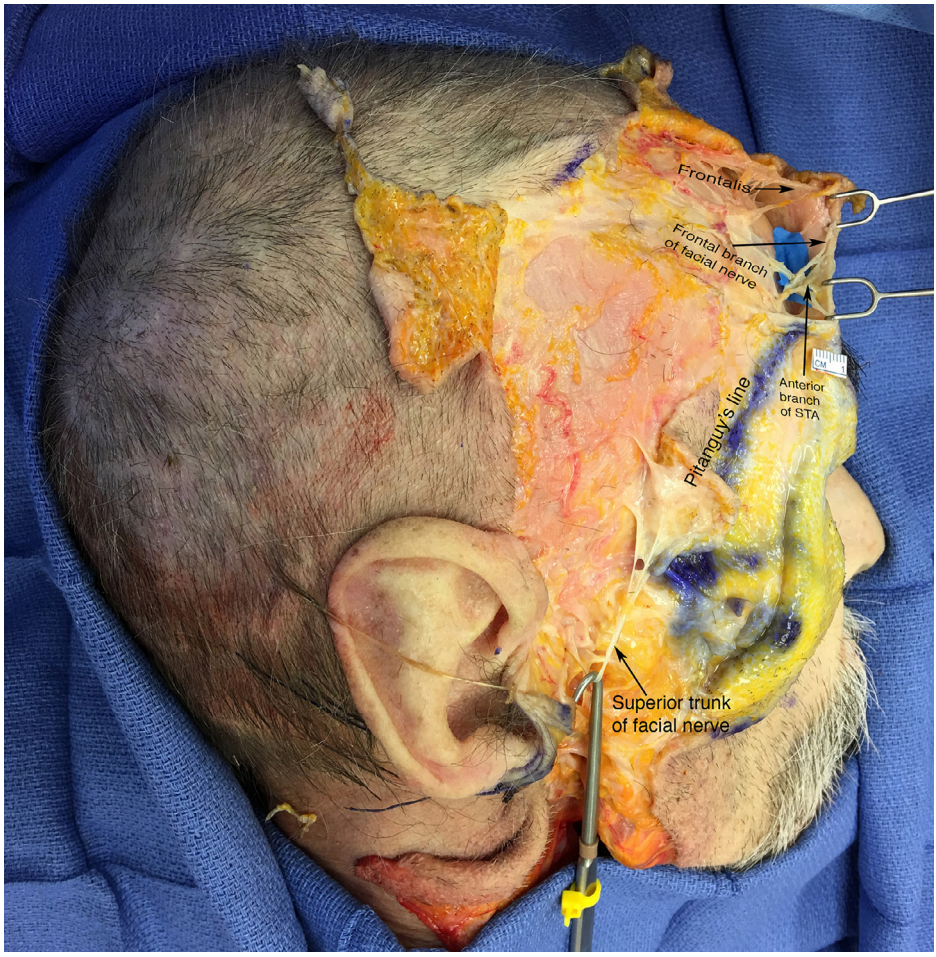

Figure 3. (Lateral View) Elderly male cadaveric specimen. The frontal branch of the facial nerve is seen traversing the temporoparietal fascia. A measurement was taken from zygomatic arch to this transition point. A second measurement was performed from Pitanguy line to the place where the nerve transitioned from a sub-SMAS plane to a supra-SMAS plane.

course within the temporoparietal fascia at the zygomatic arch. The mean distance from the zygomatic arch to the frontal branch of the facial nerve was 9.61 ± 5.08 mm (Table 1).

In all specimens, the frontal branch of the facial nerve transitioned to an intra-SMAS plane posterior to Pitanguy's line. The mean distance from the Pitanguy's line to the location where the nerve transitioned from a sub-SMAS plane to an intra-SMAS plane was 12.19 ± 4.77 mm (Table 1).

The intersection of the frontal branch of the facial nerve and the anterior branch of the STA was 8.08 ± 2.04 mm lateral to the frontalis muscle and 28.09 ± 6.37 mm superior to the lateral orbital rim (Table 1). In the superior temporal region, the nerve crossed the anterior branch of the STA posterior to Pitanguy's line. This intersection was 13.06 ± 6.19 mm posterior to Pitanguy's line (Figure 4).

Discussion

The frontal branch has been described to transition both at the zygomatic arch and above the zygomatic arch.[1,6–8] While it is well-known that the nerve typically will course either within or on the direct undersurface of the temporoparietal fascia after it arises from a sub-SMAS plane, the location

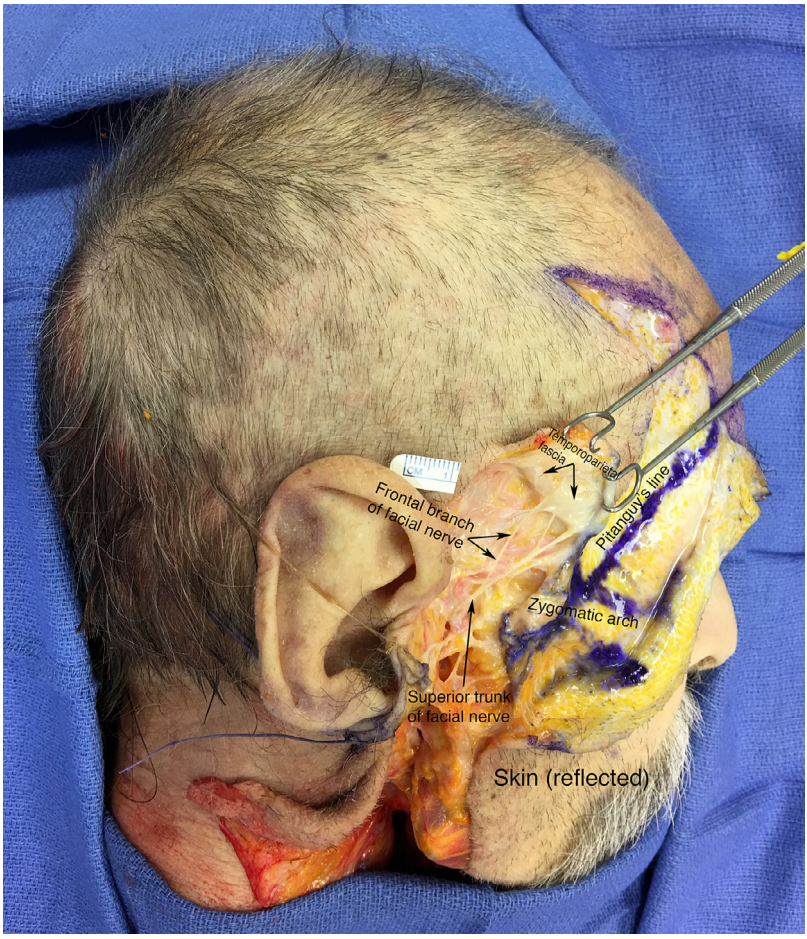

Figure 4. (Lateral View) Elderly male cadaveric specimen. The frontal branch of the facial nerve is seen crossing the anterior branch of the superficial temporal artery in the superior temporal region before innervating the frontalis muscle.

Table 1
Distance between the frontal branch of facial nerve from various anatomic structures.

Anatomical Detail	Mean Distance (mm)
Zygomatic arch to frontal branch of facial nerve	9.61 ± 5.08 superior
Frontal branch of facial nerve relative to Pitanguy's line	12.20 ± 4.77 posterior
Frontal branch of facial nerve crossing the anterior branch of the superficial temporal artery relative to the frontalis muscle	8.08 ± 2.04 lateral
Frontal branch of facial nerve crossing the anterior branch of the superficial temporal artery relative to the lateral orbital rim	28.09 ± 6.37 superior
Frontal branch of facial nerve crossing the anterior branch of the superficial temporal artery relative to Pitanguy's line	13.06 ± 6.19 posterior

where the nerve begins to transition from a deeper depth to then course within the temporoparietal fascia has varied. Clinically, this location is of importance for surgeons performing procedures in the lateral face, specifically SMAS elevation in face-lifting or brow- elevating procedures.

The main trunk of the facial nerve emerges anterior to the mid earlobe about 20 mm deep. As the frontal branch exits the parotid gland at an average depth of 9 mm,[9] the nerve courses superficial to

the periosteum of the zygomatic arch and may be up to 3 mm superficial to the arch.[10] Stuzin and colleagues indicated that the frontal branch of the facial nerve courses in an intra-SMAS plane at the level of the zygomatic arch. They also indicated that the nerve coursed in a plane that was separate to both the superficial layer of deep temporal fascia and the loose areolar plane. Thus, they postulated that a cephalic approach in the areolar plane to 20 mm above the arch followed by dissection through the superficial layer of deep temporal fascia and traversing the superficial temporal fat pad would protect the frontal branch of the facial nerve.[7]

However, other studies have reported that the transition zone is above the zygomatic arch. Agarwal and colleagues described a fascial transition zone 15–30 mm above the superior border of the zygomatic arch.[6] Furthermore, they found that the frontal branch coursed superficial to the SMAS before innervating the frontalis and orbicularis oculi muscles.[6]

Trussler and colleagues described the frontal branch of the facial nerve to be deep to both the SMAS and parotid-temporal fascia at the zygomatic arch. The frontal branch coursed deep to the temporoparietal fascia up to 20 mm above the zygomatic arch. In addition, the nerve did not course within the temporoparietal fascia. Thus, it was concluded that the utilization of the high-SMAS technique is a safe approach for protecting the frontal branch of the facial nerve.[7]

Alternatively, Roostaeian and colleagues described the frontal branch to lie deep into the temporal fascia at the zygomatic arch and becomes more superficial as it courses superiorly.[1] Thus, they indicated that safe dissection techniques should remain superficial to the temporal fascia when dissecting from inferior to superior.[1] However, Sabini and colleagues also noted that the frontal branch ran within the temporoparietal fascia superior to the zygomatic arch.[5]

To further delineate the position of the nerve, additional studies have been done showing the nerve's location relative to other anatomic landmarks such as the sentinel vein.[13] Trinei and colleagues indicated a zone of caution in the upper temporal region, where there was a relationship between the sentinel vein and frontal branch.[13]

The frontal branch of the facial nerve traverses the innominate fascia and subsequently runs in an intra-SMAS plane within or directly underneath the temporoparietal fascia. In contrast to studies showing the nerve traversing at the zygomatic arch,[7] our study indicates that the frontal branch remains deep in the SMAS as it crosses the zygomatic arch before traversing to an intra-SMAS plane. This is consistent with previous studies indicating that the transition point lies above the zygomatic arch.[1,6,8]

Conventionally, Pitanguy's line provided a topographic marking for the frontal branch of the facial nerve, as it branches from the main facial nerve trunk within the parenchyma of the parotid gland.[4] This line has been a commonly used landmark for over 50 years.[4] Our study found that the frontal branch of the facial nerve pierces the temporoparietal fascia approximately 9.6 mm superior to the zygomatic arch and 12 mm posterior to the Pitanguy's line. Furthermore, the intersection of the frontal branch and the anterior branch of the STA was also posterior to the Pitanguy's line indicating that in this sample size the nerve remains posterior to the line as it courses toward the frontalis muscle. This finding may aid in locating the nerve by using an instrument such as Doppler ultrasound to locate the anterior branch of the STA.

Surgeons performing procedures in the lateral face and temporal region must be aware of the location of the frontal branch of the facial nerve to prevent its injury, particularly when selecting the level to incise and elevate a SMAS flap in rhytidectomy. Studies have proposed certain "safe" fascial planes and anatomic landmarks to prevent nerve injury.[1–8] However, our study has isolated a point that extends 9.6 mm above the zygomatic arch and 12.2 mm posterior to Pitanguy's line (Figure 5). This area can serve as a surgical dissection "caution zone," particularly when selecting a suture anchoring point once the SMAS has been elevated and is ready to be secured.

The limitations of this study include small sample size and possible distortion of Pitanguy's line secondary to elastic recoil of the skin following incision release. Our sample size was similar to the number of hemifaces (12–24) used in previous studies.[3–8] We believe the possible distortion limitation was mitigated by transposing Pitanguy's line and zygomatic arch onto the subcutaneous tissue following skin release to ensure that the position of Pitanguy's line was accurate when performing comparative measurements to the frontal branch of the facial nerve.

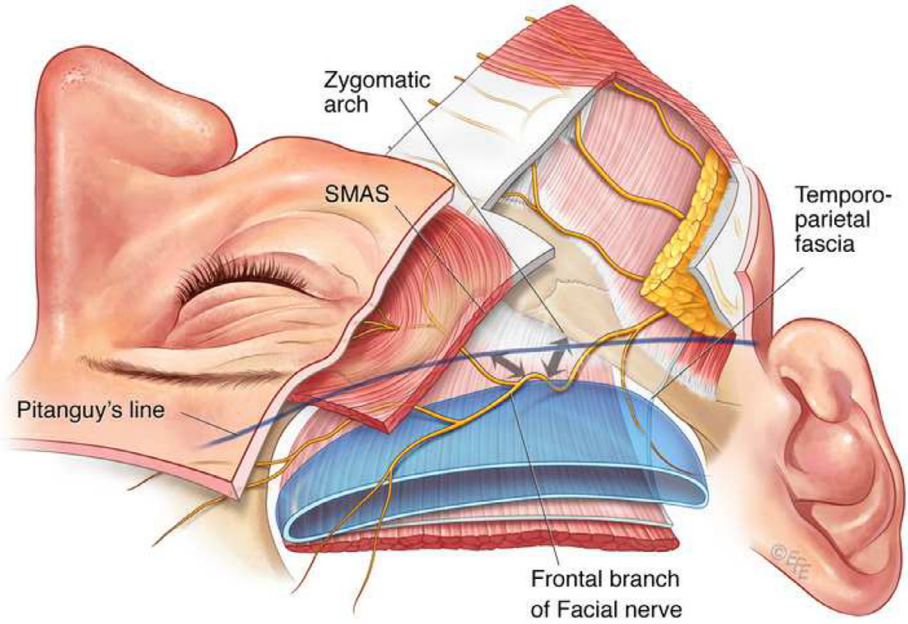

Figure 5. (Lateral View) The frontal branch of the facial nerve is shown exiting the superior border of parotid gland. It continues coursing superiorly before traversing from a sub-SMAS plane to a supra-SMAS plane both above the zygomatic arch and posterior to Pitanguy's line (blue line). Arrows indicate the specific region where the frontal nerve transitions from the sub-SMAS plane to an intra-SMAS plane relative to Pitanguy's line (left arrow) and the zygomatic arch (right arrow). Measurements for these arrows are in the same plane. The left arrow indicates a mean distance of 12.2 ± 4.77 mm posterior to Pitanguy's line. The right arrow indicates a mean distance of 9.6 ± 5.08 mm superior to the zygomatic arch. Used with permission of Levent Efe.

Conclusion

This study describes a surgical "caution zone" centered on a point 9.6 mm above the arch and 12.2 mm posterior to Pitanguy's line (See supplementary video). Utilization of these data can assist in further localizing the depth and relative location of the frontal branch of the facial nerve intraoperatively. It is our hope that this translates into more precise SMAS flap elevation and anchoring in rhytidectomy procedures along with decreased morbidity related to nerve injury in this anatomical region.

Declaration of Competing Interest

Dr. Surek is a consultant for Galderma, Allergan, and Cypris Medical.

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Ethical approval

Not required.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jpra.2019.11.009.

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