Title

Preserving the Facial Nerve during Orbitozygomatic Craniotomy: Surgical Anatomy and Stepwise Illustration

Authors

Meybodi, Ali
Lawton, Micheal
Yousef, Sonia
et al.

Publication Date

2021

Data Availability

The data associated with this publication are not available for this reason: N/A

Preserving the Facial Nerve during Orbitozygomatic Craniotomy: Surgical Anatomy and Stepwise Illustration

Ali Tayebi Meybodi, Micheal T. Lawton, **Sonia Yousef**, J.J. Gonzalez, Arnau Benet

OBJECTIVE:

Surgical safety and efficiency during an orbitozygomatic (OZ) osteotomy rely on thorough knowledge of the surgical anatomy of the facial nerve. Although the anatomy of the facial nerve and its relation to the pterional craniotomy are described, a thorough assessment of facial nerve preservation techniques during the OZ approach and its variations is lacking. We assessed the surgical anatomy of the facial nerve related to the OZ approach and provided a thorough stepwise description on how to preserve it.

METHODS:

The OZ approach was performed bilaterally in 20 cadaveric heads. The interfascial and subfascial techniques were performed to study their nuances in pre- serving the facial nerve. We compared the 2 techniques and provided a thorough description on how to preserve the facial nerve during each step of the OZ approach.

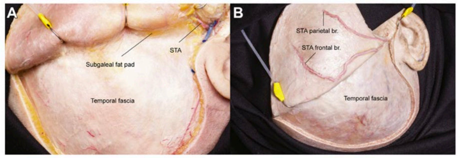

Figure 1. Cadaveric dissection showing the frontotemporal skin incision for an orbitozygomatic craniotomy. (**A**) The reflection of the skin flap should stop at ~4 cm from the orbital rim. This limit corresponds to the appearance of the subgaleal fat pad which harbors the frontal branch of the facial nerve. (**B**) Another guide is to cease flap refection when the frontal branch of the STA is encountered on the underside of the flap. br., branch; STA, superficial temporal artery. (Printed with the permission of the Skull Base and Cerebrovascular Laboratory, University of California, San Francisco.)

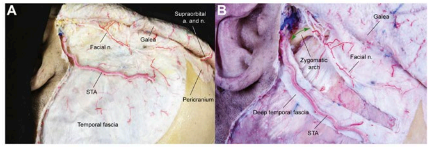

Figure 3. Cadaveric dissection showing the course of the frontal branch of the facial nerve. (**A**) A left frontotemporal incision has been made and the subgaleal plane has been completely dissected to show the course of the facial nerve in the subgaleal space. The STA has been harvested from the underside of the flap during galeal dissection. (**B**) The temporal fascia has been dissected to expose the temporalis muscle. The posterior third of the zygomatic arch is also exposed (*green double-arrow line*). No facial nerve branch crosses the posterior third of the zygomatic arch. This fact is the basis of beginning the fascial dissection during the orbitozygomatic approach form the posterior end of the zygomatic arch. a., artery; n., nerve; STA, superficial temporal artery. (Printed with the permission of the Skull Base and Cerebrovascular Laboratory, University of California, San Francisco.)

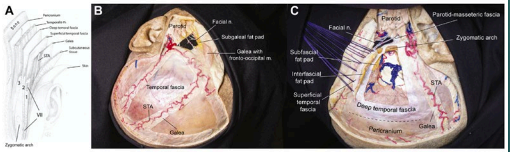

Figure 2. (**A**) Illustration of the scalp layers below the level of the superior temporal line. Three important fat pads should be noted: 1, the subgaleal fat pad which harbors the facial nerve branches; 2, the interfascial fat pad, whose identification is important for a successful completion of the interfascial technique; and 3, the subfascial fat pad, which should not be mistaken for the interfascial fat pad. (**B**) Scalp layer dissection in a cadaver head showing the course of the STA in the galea. Please note that the facial nerve branches run in the subgaleal fat pad. (**C**) Dissection of scalp layers around the zygomatic arch in a cadaver head on the right side. Near the zygomatic arch, the deep and superficial temporal fasciae merge and invest the arch. This merged fascial layer continues as the parotid-masseteric fascia below the zygoma and also forms the capsule of the parotid. The facial nerve branches pierce this fascia to run on top of it and under the galea. Note the 2 layers of the temporal fascia enveloping the interfascial fat pad posterior to the frontozygomatic region. At the superior temporal line (dashed line), the 2 layers of the temporal fascia merge together, and with the pericranium. m., muscle; n., nerve; STA, superficial temporal artery; VII, facial nerve. (Printed with the permission of the Skull Base and Cerebrovascular Laboratory, University of California, San Francisco.)

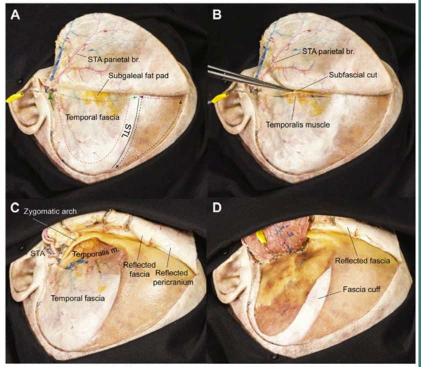

Figure 4. Cadaveric dissection showing the subfascial technique. (**A**) A frontotemporal skin incision is made and the skin flap is reflected anteriorly until the subgaleal fat pad is seen. Incising the temporal fascia may be done in different shapes. One choice is to place a semilunar incision parallel to the folded edge of the skin flap (*dashed green line*). If fascial reapproximation is intended at the conclusion of the surgery, a semicircular fascial incision parallel to the STL may be placed (*dashed red line*). Regardless of the shape of the fascial incision, it should start at the posterior end of the zygomatic arch, and should traverse both superficial and deep temporal fasciae to expose the underlying temporalis muscle. The incision then crosses the STL to reach the pericranium on the superior aspect of the STL. The pericranium may also be incised in different fashions at the discretion of the surgeon. It may be incised parallel to the folded edge of the skin flap (purple dashed line). Alternatively, a large pedicled pericranial flap may be harvested (black dashed lines). (**B**) The fascial cut has been placed and the underlying temporalis muscle is exposed. (**C**) The fascial-pericranial flap is reflected over the orbital rim and zygoma to expose the orbitozygomatic unit. (**D**) The muscle is cut leaving a cuff for future reapproximation. br., branch; m., muscle; STA, superficial temporal artery; STL, superior temporal line. (Printed with the permission of the Skull Base and Cerebrovascular Laboratory, University of California, San Francisco.)

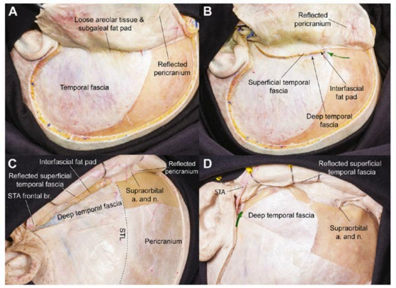

Figure 5. Cadaveric dissection showing the interfascial technique. (**A**) A frontotemporal skin incision is made and the skin flap is reflected anteriorly until the subgaleal fat pad is seen. A pedicled pericranial flap is harvested and reflected over the skin flap. (**B**) A semilunar fascial incision is started at the posterior end of the zygomatic arch such that it only crosses the superficial temporal fascia and the subgaleal fat pad, but not the ivory white deep temporal fascia. This cut crosses the STL to reach the pericranium (*green curved arrow*). (**C**) The superficial temporal fascia is reflected together with the medially attached pericranial flap over the orbital rim and the zygoma. (**D**) Complete reflection of the fascial-pericranial flap exposes the orbitozygomatic unit. It is important to note that peeling the fascial flap off the zygomatic arch should start posteriorly by placing a sharp cut down to the bone of the zygomatic arch (*green curved arrow*). This maneuver ensures complete separation of the fascia from the bone whereas no facial nerve branch is at risk. a., artery; br., branch; n., nerve; STA, superficial temporal artery; STL, superior temporal line. (Printed with the permission of the Skull Base and Cerebrovascular Laboratory, University of California, San Francisco.)

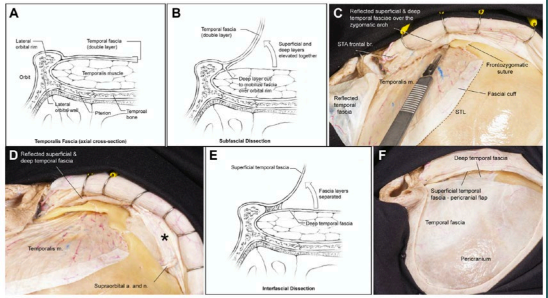

Figure 6. Comparison between the subfascial and interfascial techniques. (**A**) Illustration of the anatomy of the fascial layers at the region of the temporalis muscle and orbital rim. The temporalis fascia has 2 layers (superficial and deep). The interfascial fat pad has not been shown. (**B**) Illustration showing the anatomic basis of the subfascial method. In the subfascial method, the temporalis fascia is elevated off the temporalis muscle. At the orbital rim (and zygomatic arch), a cut is placed such that the deep temporal fascia is disconnected from the bone. This enables elevation of both layers of the fascia from the orbital rim and zygomatic arch. (**C**) Cadaveric dissection depicting the reflected fascial flap in the subfascial method. A blade is used to place a sharp cut on the double-layered fascial flap underneath the zygomatic arch. (**D**) Complete exposure of the orbitozygomatic unit in the subfascial method. *Asterisk* shows the reflected pericranium over the orbital contents. (**E**) Illustration showing the anatomical basis of the interfascial method. In this method, the superficial temporal fascia is the only layer reflected over the orbital rim and the zygomatic arch. (**F**) Cadaveric dissection showing the interfascial technique with the superficial temporal fascia-pericranial flap reflected over the orbital rim and the zygomatic arch. a., artery; br., branch; m., muscle; n., nerve; STA, superficial temporal artery. *(Printed with the permission of the Skull Base and Cerebrovascular Laboratory, University of California, San Francisco.)*

RESULTS:

At the zygomatic arch, the facial nerve was found between the galea and the superficial temporal fascia. A cut in the fascia at the posterior end of the zygomatic arch did not cross any facial nerve branches. The subfascial technique was simpler, more efficient, and provided more structural protection of the facial nerve branches than the interfascial technique.

CONCLUSIONS:

The frontal division of the facial nerve is related directly to dissection over the zygomatic bone and may be injured during fascial dissection or osteotomies. Both interfascial and subfascial techniques are feasible to use during the OZ craniotomy and provide ample exposure of the OZ unit. Regarding the preservation of the facial nerve branches, we favor the subfascial method.

Table 1. Mechanisms of Facial Nerve Injury During the OZ Approach and Techniques for Prevention

Mechanism of Neural Injury	Stage of Surgery During Which the Injury Is Expected	Technique(s) to Avoid Injury
Traction	Reflection of the scalp flap	Stopping the subgaleal dissection while reflecting the scalp flap at ~4 cm from the orbital rim, or when the frontal branch of the STA is seen under the scalp flap
	Reflection of the fascial-pericranial flap	■ Elevation of the flap off the bone with subperiosteal dissection. This requires a sharp cut on the fascia at the posterior end of the zygomatic arch, down to the bone to correctly develop the subperiosteal plane ■ Avoidance of pulling on the fascial-pericranial flap with fishhooks
Compression	Reflection of the fascial-pericranial flap	■ Avoidance of pulling on the fascial-pericranial flap with fishhooks ■ Directing the forces towards the bone rather than the fascia during subperiosteal dissection
Transection	Reflection of the fascial-pericranial flap	When the fascia is being elevated off the zygomatic arch, a sharp cut should be placed at the medial aspect of the zygomatic arch
Electric/thermal injury	Reflection of the scalp flap Reflection of the fascial-pericranial flap	Minimizing cauterization, early microsurgical dissection

OZ, orbitozygomatic.

REFERENCES

1. Schwartz MS, Anderson GJ, Horgan MA, Kellogg JX, McMenomey SO, Delashaw JB. Quantification of increased exposure resulting from orbital rim and orbitozygomatic osteotomy via the frontotemporal transsylvian approach. J Neurosurg. 1999;91:1020-1026.

http://refhub.elsevier.com/S1878-8750(17)30823-9/sref1

2. Gonzalez LF, Crawford [illegible] Deshmukh P, Zabramski JM, Spetzler RF. Working area and angle of attack in three cranial base approaches: pterional, orbitozygomatic, and maxillary extension of the orbitozygomatic approach. Neurosurgery. 2002;50:550-555 [discussion: 555-557].
3. Al-Mefty O. Supraorbital-pterional approach to skull base lesions. Neurosurgery. 1987;21:474-477.
4. al-Mefty O, Anand VK. Zygomatic approach to skull-base lesions. J Neurosurg. 1990;73:668-673.
5. Alaywan M, Sindou M. Fronto-temporal approach with orbito-zygomatic removal. Surgical anatomy. Acta Neurochir (Wien). 1990;104:79-83.
6. Delashaw JB, Jane JA, Kassell NF, Luce C. Supraorbital craniotomy by fracture of the anterior orbital roof. Technical note. J Neurosurg. 1993;79:615-618.
7. Hsu FP, Clatterbuck RE, Spetzler RF. Orbitozygomatic approach to basilar apex aneurysms. Neurosurgery. 2005;56(1 Suppl):172-177 [discussion: 172-177].
8. Ikeda K, Yamashita J, Hashimoto M, Futami K. Orbitozygomatic temporopolar approach for a high basilar tip aneurysm associated with a short intracranial internal carotid artery: a new surgical approach. Neurosurgery. 1991;28:105-110.
9. McDermott MW, Durity FA, Rootman J, Woodhurst WB. Combined frontotemporal-orbitozygomatic approach for tumors of the sphenoid wing and orbit. Neurosurgery. 1990;26:107-116.
10. Sekhar LN, Kalia KK, Yonas H, Wright DC, Ching H. Cranial base approaches to intracranial aneurysms in the subarachnoid space. Neurosurgery. 1994;35:472-481 [discussion: 481-483].
11. Smith RR, Al-Mefty O, Middleton TH. An orbitocranial approach to complex aneurysms of the anterior circulation. Neurosurgery. 1989;24:385-391.
12. Poblete T, Jiang X, Komune N, Matsushima K, Rhoton AL. Preservation of the nerves to the frontalis muscle during pterional craniotomy. J Neurosurg. 2015;122:1274-1282.
13. Seçkin H, Avci E, Uluç K, Niemann D, Başkaya MK. The work horse of skull base surgery: orbitozygomatic approach. Technique, modifications, and applications. Neurosurg Focus. 2008;25:E4.
14. Coscarella E, Vishteh AG, Spetzler RF, Seoane E, Zabramski JM. Subfascial and submuscular methods of temporal muscle dissection and their relationship to the frontal branch of the facial nerve. Technical note. J Neurosurg. 2000;92:877-880.
15. Salas E, Ziyal IM, Bejjani GK, Sekhar LN. Anatomy of the frontotemporal branch of the facial nerve and indications for interfascial dissection. Neurosurgery. 1998;43:563-568 [discussion: 568-569].
16. Ammirati M, Spallone A, Ma J, Cheatham M, Becker D. An anatomicosurgical study of the temporal branch of the facial nerve. Neurosurgery. 1993;33:1038-1043 [discussion: 1044].
17. Bernstein L, Nelson RH. Surgical anatomy of the extraparotid distribution of the facial nerve. Arch Otolaryngol. 1984;110:177-183.
18. Krayenbühl N, Isolan GR, Hafez A, Yaşargil MG. The relationship of the fronto-temporal branches of the facial nerve to the fascias of the temporal region: a literature review applied to practical

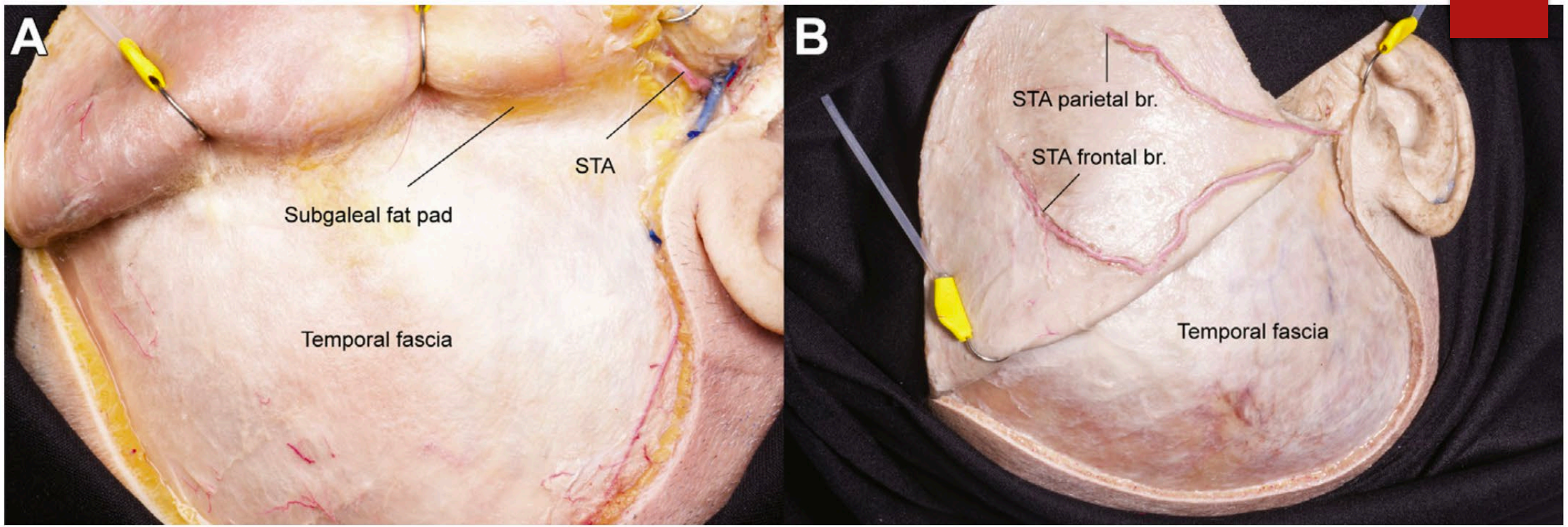

Figure 1. Cadaveric dissection showing the frontotemporal skin incision for an orbitozygomatic craniotomy. (**A**) The reflection of the skin flap should stop at ~4 cm from the orbital rim. This limit corresponds to the appearance of the subgaleal fat pad which harbors the frontal branch of the facial nerve. (**B**) Another guide is to cease flap refection when the frontal branch of the STA is encountered on the underside of the flap. br., branch; STA, superficial temporal artery. (Printed with the permission of the Skull Base and Cerebrovascular Laboratory, University of California, San Francisco.)

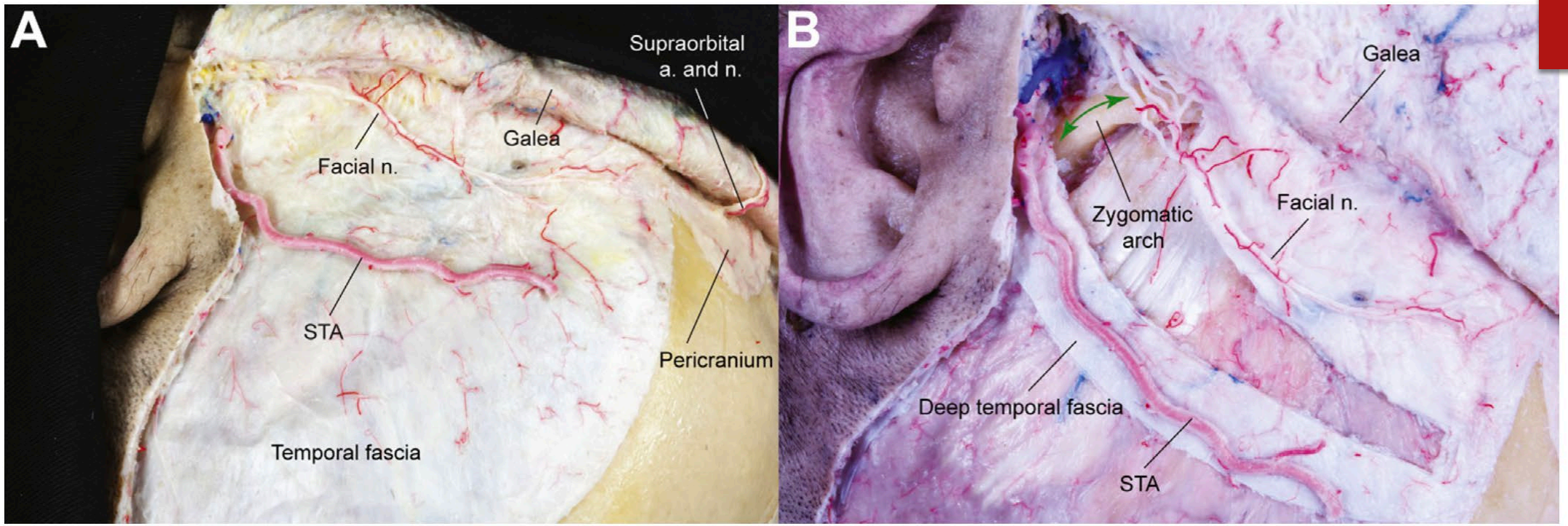

Figure 3. Cadaveric dissection showing the course of the frontal branch of the facial nerve. (**A**) A left frontotemporal incision has been made and the subgaleal plane has been completely dissected to show the course of the facial nerve in the subgaleal space. The STA has been harvested from the underside of the flap during galeal dissection. (**B**) The temporal fascia has been dissected to expose the temporalis muscle. The posterior third of the zygomatic arch is also exposed (*green double-arrow line*). No facial nerve branch crosses the posterior third of the zygomatic arch. This fact is the basis of beginning the fascial dissection during the orbitozygomatic approach form the posterior end of the zygomatic arch. a., artery; n., nerve; STA, superficial temporal artery. (Printed with the permission of the Skull Base and Cerebrovascular Laboratory, University of California, San Francisco.)

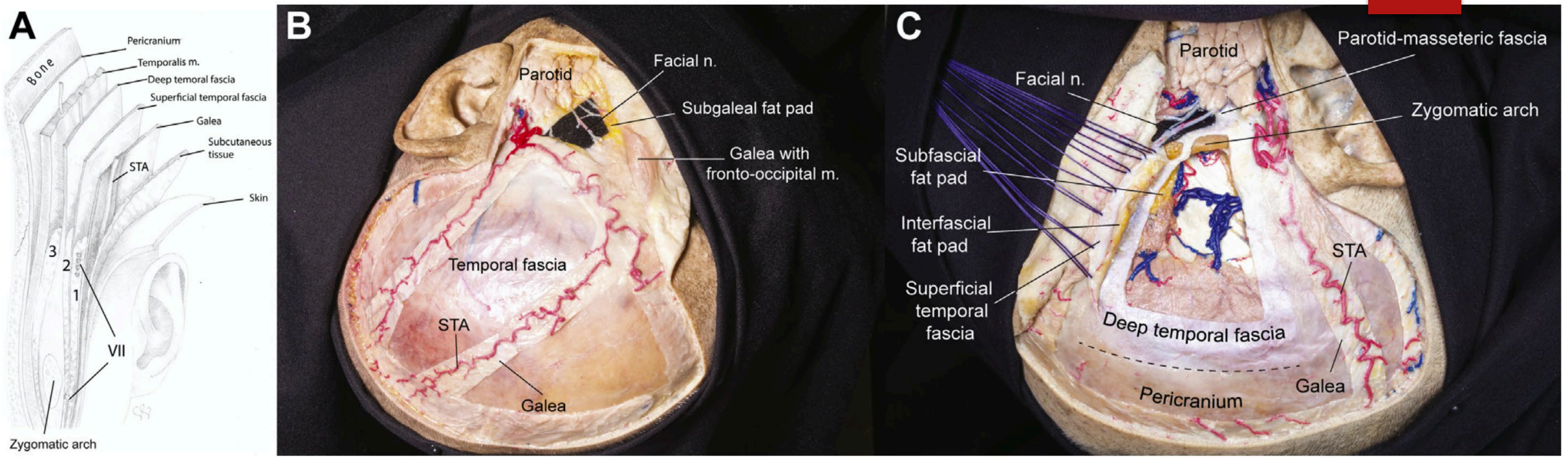

Figure 2. (**A**) Illustration of the scalp layers below the level of the superior temporal line. Three important fat pads should be noted: 1, the subgaleal fat pad which harbors the facial nerve branches; 2, the interfascial fat pad, whose identification is important for a successful completion of the interfascial technique; and 3, the subfascial fat pad, which should not be mistaken for the interfascial fat pad. (**B**) Scalp layer dissection in a cadaver head showing the course of the STA in the galea. Please note that the facial nerve branches run in the subgaleal fat pad. (**C**) Dissection of scalp layers around the zygomatic arch in a cadaver head on the right side. Near the zygomatic arch, the deep and superficial temporal fasciae merge and invest the arch. This merged fascial layer continues as the parotid-masseteric fascia below the zygoma and also forms the capsule of the parotid. The facial nerve branches pierce this fascia to run on top of it and under the galea. Note the 2 layers of the temporal fascia enveloping the interfascial fat pad posterior to the frontozygomatic region. At the superior temporal line (dashed line), the 2 layers of the temporal fascia merge together, and with the pericranium. m., muscle; n., nerve; STA, superficial temporal artery; VII, facial nerve. (Printed with the permission of the Skull Base and Cerebrovascular Laboratory, University of California, San Francisco.)

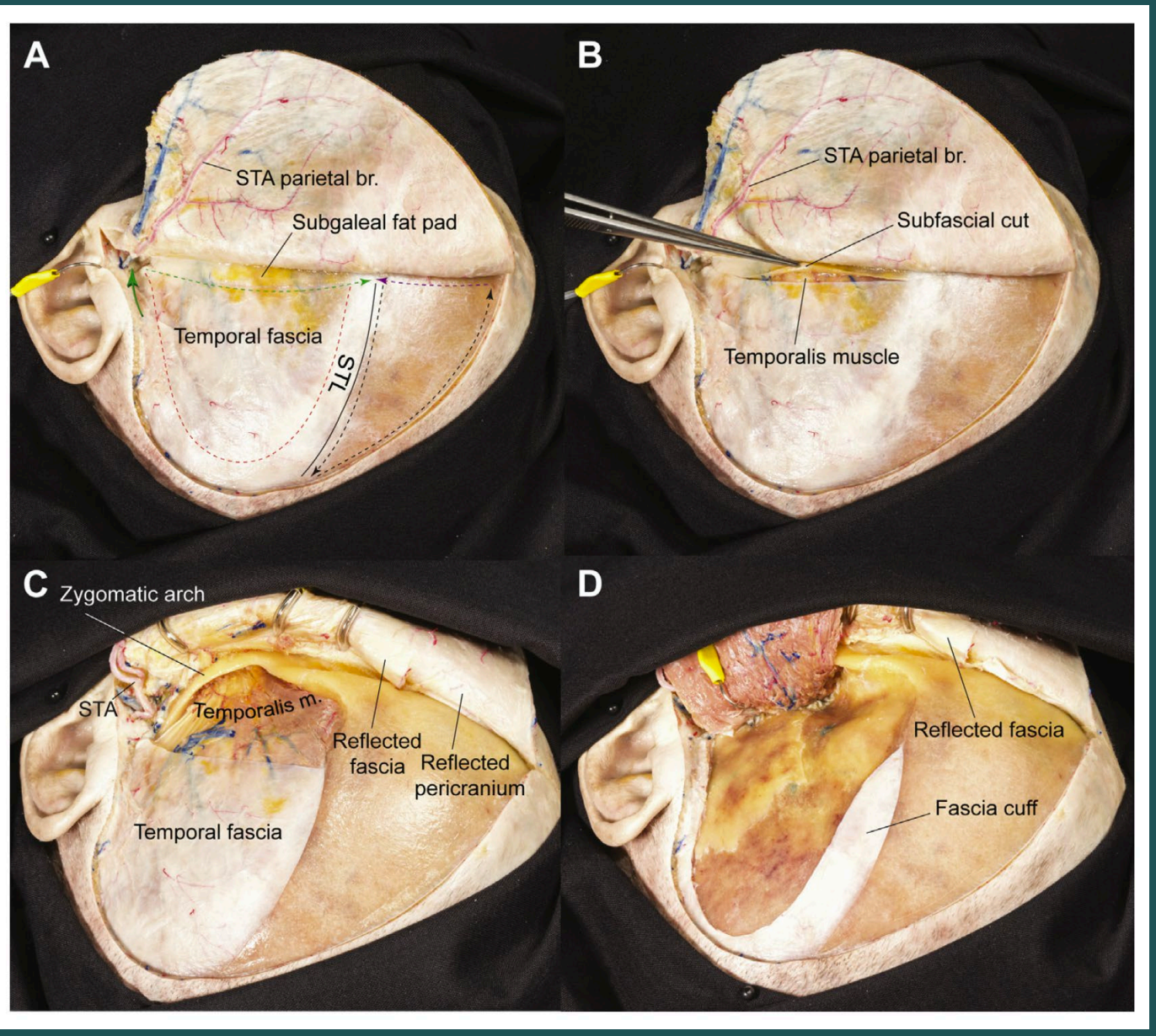

Figure 4. Cadaveric dissection showing the subfascial technique. (**A**) A frontotemporal skin incision is made and the skin flap is reflected anteriorly until the subgaleal fat pad is seen. Incising the temporal fascia may be done in different shapes. One choice is to place a semilunar incision parallel to the folded edge of the skin flap (*dashed green line*). If fascial reapproximation is intended at the conclusion of the surgery, a semicircular fascial incision parallel to the STL may be placed (*dashed red line*). Regardless of the shape of the fascial incision, it should start at the posterior end of the zygomatic arch, and should traverse both superficial and deep temporal fasciae to expose the underlying temporalis muscle. The incision then crosses the STL to reach the pericranium on the superior aspect of the STL. The pericranium may also be incised in different fashions at the discretion of the surgeon. It may be incised parallel to the folded edge of the skin flap (purple dashed line). Alternatively, a large pedicled pericranial flap may be harvested (black dashed lines). (**B**) The fascial cut has been placed and the underlying temporalis muscle is exposed. (**C**) The fascial-pericranial flap is reflected over the orbital rim and zygoma to expose the orbitozygomatic unit. (**D**) The muscle is cut leaving a cuff for future reapproximation. br., branch; m., muscle; STA, superficial temporal artery; STL, superior temporal line. (Printed with the permission of the Skull Base and Cerebrovascular Laboratory, University of California, San Francisco.)

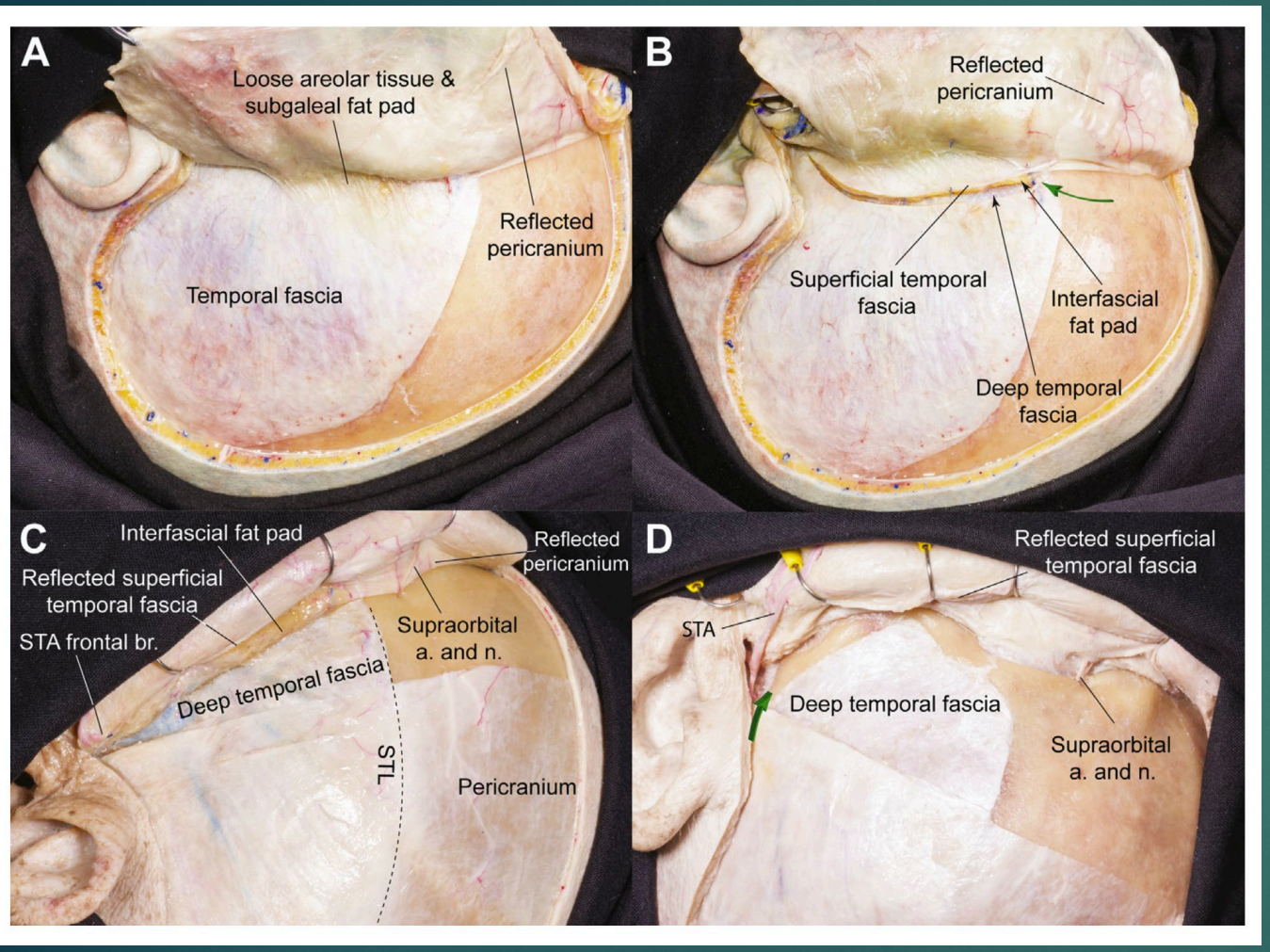

Figure 5. Cadaveric dissection showing the interfascial technique. (**A**) A frontotemporal skin incision is made and the skin flap is reflected anteriorly until the subgaleal fat pad is seen. A pedicled pericranial flap is harvested and reflected over the skin flap. (**B**) A semilunar fascial incision is started at the posterior end of the zygomatic arch such that it only crosses the superficial temporal fascia and the subgaleal fat pad, but not the ivory white deep temporal fascia. This cut crosses the STL to reach the pericranium (*green curved arrow*). (**C**) The superficial temporal fascia is reflected together with the medially attached pericranial flap over the orbital rim and the zygoma. (**D**) Complete reflection of the fascial-pericranial flap exposes the orbitozygomatic unit. It is important to note that peeling the fascial flap off the zygomatic arch should start posteriorly by placing a sharp cut down to the bone of the zygomatic arch (*green curved arrow*). This maneuver ensures complete separation of the fascia from the bone whereas no facial nerve branch is at risk. a., artery; br., branch; n., nerve; STA, superficial temporal artery; STL, superior temporal line. (Printed with the permission of the Skull Base and Cerebrovascular Laboratory, University of California, San Francisco.)

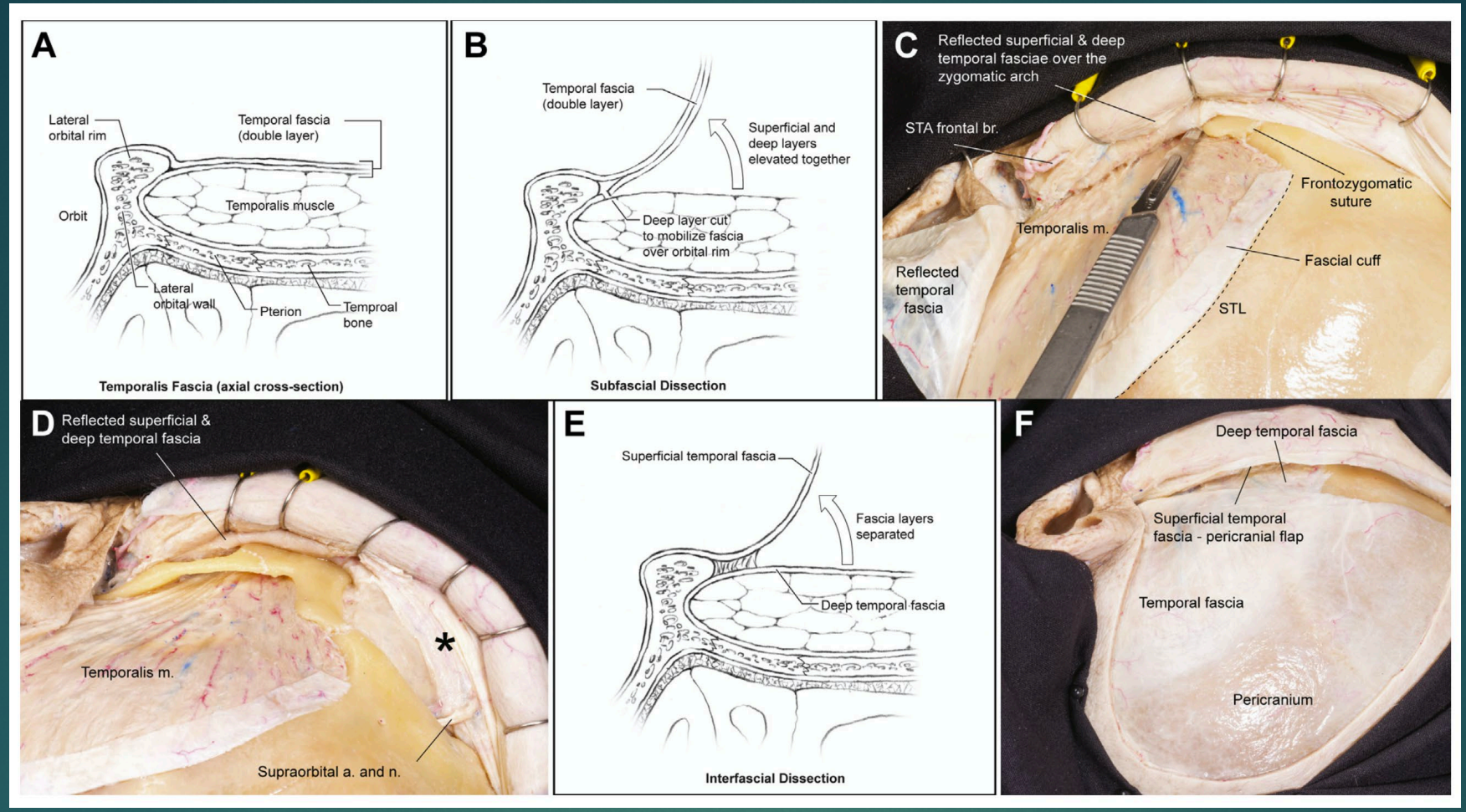

Figure 6. Comparison between the subfascial and interfascial techniques. (**A**) Illustration of the anatomy of the fascial layers at the region of the temporalis muscle and orbital rim. The temporalis fascia has 2 layers (superficial and deep). The interfascial fat pad has not been shown. (**B**) Illustration showing the anatomic basis of the subfascial method. In the subfascial method, the temporalis fascia is elevated off the temporalis muscle. At the orbital rim (and zygomatic arch), a cut is placed such that the deep temporal fascia is disconnected from the bone. This enables elevation of both layers of the fascia from the orbital rim and zygomatic arch. (**C**) Cadaveric dissection depicting the reflected fascial flap in the subfascial method. A blade is used to place a sharp cut on the double-layered fascial flap underneath the zygomatic arch. (**D**) Complete exposure of the orbitozygomatic unit in the subfascial method. *Asterisk* shows the reflected pericranium over the orbital contents. (**E**) Illustration showing the anatomical basis of the interfascial method. In this method, the superficial temporal fascia is the only layer reflected over the orbital rim and the zygomatic arch. (**F**) Cadaveric dissection showing the interfascial technique with the superficial temporal fascia-pericranial flap reflected over the orbital rim and the zygomatic arch. a., artery; br., branch; m., muscle; n., nerve; STA, superficial temporal artery. *(Printed with the permission of the Skull Base and Cerebrovascular Laboratory, University of California, San Francisco.)*

Table 1. Mechanisms of Facial Nerve Injury During the OZ Approach and Techniques for Prevention

Mechanism of Neural Injury	Stage of Surgery During Which the Injury Is Expected	Technique(s) to Avoid Injury
Traction	Reflection of the scalp flap	Stopping the subgaleal dissection while reflecting the scalp flap at ~4 cm from the orbital rim, or when the frontal branch of the STA is seen under the scalp flap
	Reflection of the fascial-pericranial flap	■ Elevation of the flap off the bone with subperiosteal dissection. This requires a sharp cut on the fascia at the posterior end of the zygomatic arch, down to the bone to correctly develop the subperiosteal plane ■ Avoidance of pulling on the fascial-pericranial flap with fishhooks
Compression	Reflection of the fascial-pericranial flap	■ Avoidance of pulling on the fascial-pericranial flap with fishhooks ■ Directing the forces towards the bone rather than the fascia during subperiosteal dissection
Transection	Reflection of the fascial-pericranial flap	When the fascia is being elevated off the zygomatic arch, a sharp cut should be placed at the medial aspect of the zygomatic arch
Electric/thermal injury	Reflection of the scalp flap Reflection of the fascial-pericranial flap	Minimizing cauterization, early microsurgical dissection

OZ, orbitozygomatic.

We express our sincere gratitude to the body donors and their families, which, through their altruism, contributed this project possible. We also thank Simar Singh and Ken Probst for the illustrations.

Thank you!