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Original Research

Analytical and comparative study of pterional craniotomy related to temporalis muscle dissection techniques: Interfascial temporalis and myocutaneous flap

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ABSTRACT

Background and objectives: The pterional craniotomy (PT) is a widely used neurosurgery approach that provides access to various intracranial structures. This study compared the exposure provided by 2 techniques for temporalis muscle mobilization: interfascial dissection (IF) and myocutaneous flap (MF).
Methods: Eight adult cadavers underwent sequential craniotomies on the left side using both techniques. The measurement areas of surgical exposure, angular exposure, and linear exposure of the basilar artery were determined.
Results: Results showed no significant difference in the total area of exposure or linear exposure of the basilar artery between the IF and MF. However, interfascial dissection provided significantly greater vertical angular exposure.
Conclusion: Although both techniques offer comparable horizontal exposures, the choice between them should consider the anticipated working angles. The interfascial temporalis flap may be preferred for broader vertical exposure is required.

1. Introduction

Pterional craniotomy (PT), also known as frontotemporosphenoidal craniotomy, was first described by Yasargil in 1976 [1]. Since then, this approach has been one of the most widely used in neurosurgery [2].

PT allows access to various intracranial structures, from the optic chiasm to the bifurcation of the basilar artery. The pterional transsylvian corridor is used to treat various conditions, including aneurysms (anterior circulation, basilar apex, proximal segment of the superior cerebellar artery, and posterior cerebral artery), arteriovenous malformations, cavernous hemangiomas, skull base tumors, gliomas, and orbital lesions [2–4].

Despite its versatility, PT requires substantial temporalis muscle mobilization [5]. There are some ways to detach this muscle from its insertion in the skull, and among them, 2 techniques stand out: interfascial dissection (IF) and myocutaneous flap (MF). The selection of the technique relies on the experience or preference of the surgeon and does not involve quantifiable or objective data.

In this study, we aimed to objectively compare the exposure provided by the interfascial approach and the myocutaneous flap technique in the PT craniotomy scenario to understand how surgical exposure changes when using different strategies of mobilizing the temporalis. Therefore, the objective of the study was to quantify and compare the exposures, performed with rotation of the temporal muscle in a single plane or after interfascial dissection, through measurements of exposure area, angular exposure in the horizontal and vertical axes, and linear exposure of the basilar artery in the interpeduncular fossa and prepontine cistern.

2. Material and methods

The study was conducted in the neurosurgical and microsurgical

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technique laboratory of the School of Medicine at the University of São Paulo. Eight fresh adult cadavers were used for the dissections in the Death Verification System of the Capital (SVOC) of the State of São Paulo, Brazil. The study was approved by the Research Ethics Committee (No. 78485224.7.0000.0068 May 2024).

The procedures were performed using microsurgical instruments commonly used in neurosurgery and a surgical microscope (Zeiss Contraves, Carl Zeiss AG, Oberkochen, Germany). To perform the craniotomies, a high-speed electric craniotome (NSK Primado, Kanuma, Japan) was used. The cadavers were placed in the supine position and rigidly fixed using a skull clamp Headfix HF03B (Micromar, Diadema, Brasil) simulating the actual surgical position. The measurements were performed using neuronavigation system coordinates (Artis Eximus, São Paulo, Brazil).

The procedures were performed sequentially on the same cadaver using only the left side of the skull to minimize biases due to individual anatomical variations (Fig. 1). First, the temporalis muscle was divided immediately below the arched frontotemporoparietal skin incision and rotated in a single layer to perform the PT craniotomy (Fig. 2). Next, we dissected the temporalis muscle using the interfascial technique (Fig. 3). This process was repeated for the remaining cadavers.

After each muscle dissection technique, measurements using the Eximius neuronavigation system (Artis Tecnologia, Brasilia, Brazil) assisted by a probe-type instrument with 4 retroreflective spheres were performed. The computer connected to the navigation system allows identification of any point in space visible by the infrared capture cameras, determining its location using the Cartesian system x, y, z. With this methodology, we calculated the coordinates, areas, angles, and distances through digital processing with millimetric precision.

2.1. Anatomy

The facial nerve emerges from the stylomastoid foramen and lies within the fatty tissue 1–2 cm deep to the middle of the anterior border of the mastoid process. It runs anterolaterally over the ramus of the mandible into the parotid gland, where it divides into 5 main branches: cervical, marginal mandibular, buccal, zygomatic, and frontotemporal. The frontotemporal branch can be injured during craniotomy [6]. A previous study showed that the auricularis, frontalis, and orbicularis branches of the temporal branch of the facial nerve run within the galeal plane of the scalp, whereas the zygomatic branch lies in the superficial musculoaponeurotic layer [7].

An anatomical variation of the frontal nerve is possible, passing through the interfascial fat layer before entering the frontal muscle. This leads to injury to this branch when interfascial dissection is used [7].

Fig. 1. Anatomical dissection image showing the temporal muscle attached to the skull. In the subsequent step, the muscle is dissected in a subperiosteal plane to expose the sphenoid wing, frontal and temporal bones, and the pterion region, as illustrated in Fig. 3.

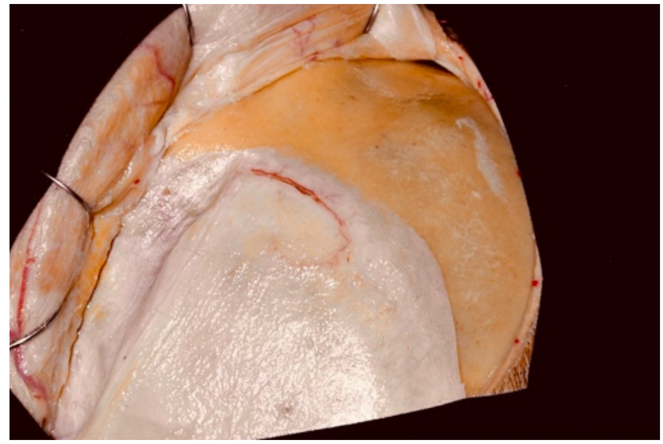

Fig. 2. Anatomical dissection image demonstrating the interfascial dissection, separating the superficial and deep layers of the temporalis fascia. The temporal muscle remains attached to the bone. Following this, the muscle is elevated subperiosteally to expose the sphenoid wing, frontal and temporal bones, and the pterion region, consistent with the exposure shown in Fig. 3. The subperiosteal dissection technique is performed in the same manner for both groups.

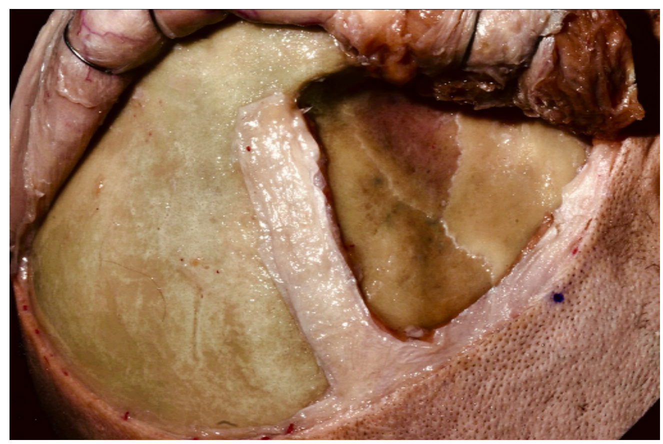

Fig. 3. Anatomical dissection image illustrating the subperiosteal elevation of the temporal muscle. The sphenoid wing, frontal and temporal bones, and the pterion region are fully exposed for craniotomy. This subperiosteal dissection approach is applied identically in both study groups.

When the frontotemporal branches of the facial nerve are injured, upper facial palsy occurs, leading to the loss of forehead wrinkles and eyebrow ptosis [8].

2.2. Interfascial temporalis flap

In the interfascial temporalis flap technique, the temporal fascia is incised along its insertion to the medial surface of the zygoma and frontal zygomatic process. The temporal fascia, aponeurotica, temporal muscle, and periosteum from the area of the origin of the temporalis muscle are released through an incision along the superior temporal line. The incised pericranium above the superior temporal line was removed toward the skin incision line. The temporal muscle, fascia, and periosteum are dissected from the temporal fossa to a local parallel to the zygomatic arch close to the floor of the middle fossa. The temporalis muscle is then reflected and rotated inferiorly and posteriorly along the plane of its remaining tendon insertion [6].

2.3. Myocutaneous flap technique

In the myocutaneous flap technique, the temporalis muscle is incised in line with the scalp incision. A second incision is made in the muscle, which is extended anteriorly to the zygomatic process of the frontal bone. The muscle is then detached from the temporal fossa and retracted with the scalp using fish hooks. A portion of the fascia and muscle remain attached to the superior temporal line [9]. (Fig. 2).

2.4. Area of exposure

The exposure area for each craniotomy was determined by calculating the area of a hexagon delimited at the base of the skull in the region of the circle of Willis (Fig. 4). Six anatomical points that constitute the hexagon were selected as follows: (1) most lateral point of the superior orbital fissure on the lesser wing of the ipsilateral sphenoid bone; (2) ipsilateral middle cerebral artery (MCA) bifurcation; (3) most distal point of the ipsilateral posterior cerebral artery (PCA); (4) most distal point of the contralateral PCA; (5) most distal point of the contralateral MCA; (6) most lateral point on the lesser wing of the contralateral sphenoid.

2.5. Linear exposure

By measuring the linear exposure of the basilar artery, it was possible to assess the extent of exposure in the interpeduncular fossa and prepontine cistern provided by each technique. Using the neuronavigation, it was possible to measure the distance between a point located at the top of the basilar artery to another point located at the lower limit of the same artery, exposed under the maximum angulation of the microscope, after performing each technique.

2.6. Angular exposure

The angular exposure was determined based on 6 relevant structures in vascular neurosurgery: (1) ipsilateral MCA bifurcation; (2) ipsilateral internal carotid artery (ICA) bifurcation; (3) top of the basilar artery; (4) midpoint of the anterior communicating artery (CoA); (5) Bifurcation of the contralateral ICA; (6) Most distal point of the contralateral MCA. The angular exposure was obtained by calculating the relationship of these vascular structures with the limits of the craniotomy in its horizontal (anterior and posterior limits) and vertical upper limits axes, as defined by the neuronavigation system (Fig. 5). The vertical lower limit of the exposure was defined as the highest and posterior point of the rotated temporalis muscle at the level of the anterior wall of the middle fossa (Fig. 6). By definition, the horizontal axis parallel to the skull base was the horizontal axis. The vertical axis was perpendicular to the horizontal axis.

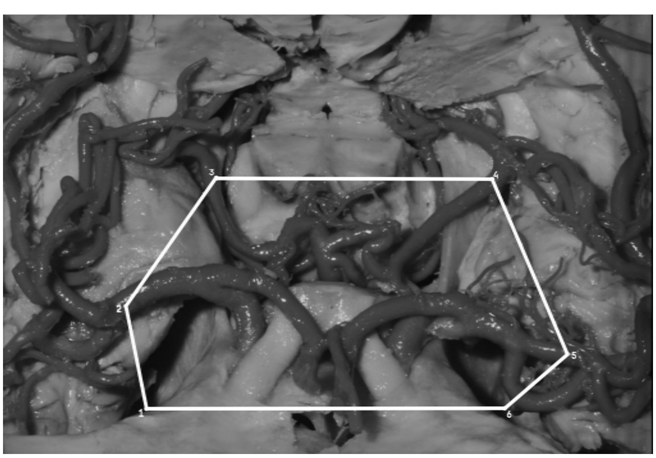

Fig. 4. The microsurgical exposure area was defined by six points to represent the main neurovascular structures accessed through pterional craniotomy, namely: (1) most lateral point of the superior orbital fissure on the lesser wing of the ipsilateral sphenoid bone; (2) ipsilateral middle cerebral artery (MCA) bifurcation; (3) most distal point of the ipsilateral posterior cerebral artery (PCA); (4) most distal point of the contralateral PCA; (5) most distal point of the contralateral MCA; (6) most lateral point on the lesser wing of the contralateral sphenoid.

2.7. Statistical Analysis

Data were analyzed in 2 different groups (interfascial and myocutaneous flap) and presented as mean ± standard deviation. Horizontal and vertical exposures were compared using paired T-tests. All analyses were conducted using R (R Foundation for Statistical Computing, Vienna, Austria, 2022).

Results with $P < 0.05$ were considered significant.

3. Results

3.1. Area of surgical exposure

There were no significant differences in the total areas of surgical exposure between the 2 techniques (MF = 1415.1 ± 232.7 mm^2; IF = 1575.6 ± 405.1 mm^2; $P > 0.05$). The results are presented in Table 1.

3.2. Linear exposure

There were no significant differences in the linear exposure of the basilar artery between the 2 techniques (MF = 10.8 ± 2.5 mm; IF = 11 ± 3.3 mm; $P > 0.05$). The results are presented in Table 1.

3.3. Angular exposure

There were no statistically significant differences between the horizontal angular exposure provided by IF and MF temporalis muscle dissection. There was an increase in vertical angular exposures in the interfascial approach for all surgical targets ($p < 0.05$) (Table 1).

4. Discussion

4.1. Analysis of surgical exposure

The area of surgical exposure is the useful working space available

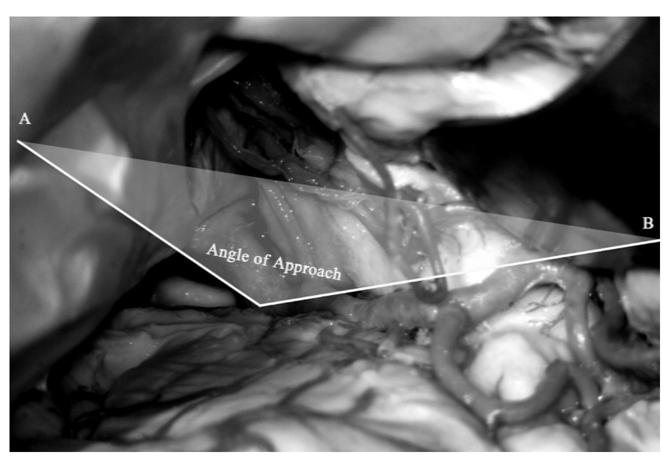

Fig. 5. Representation of the calculation of the horizontal angular exposure, centered on the vascular structure for which the horizontal angular exposure is being calculated. (A) Anterior limit of the craniotomy; (B) Posterior limit of the craniotomy.

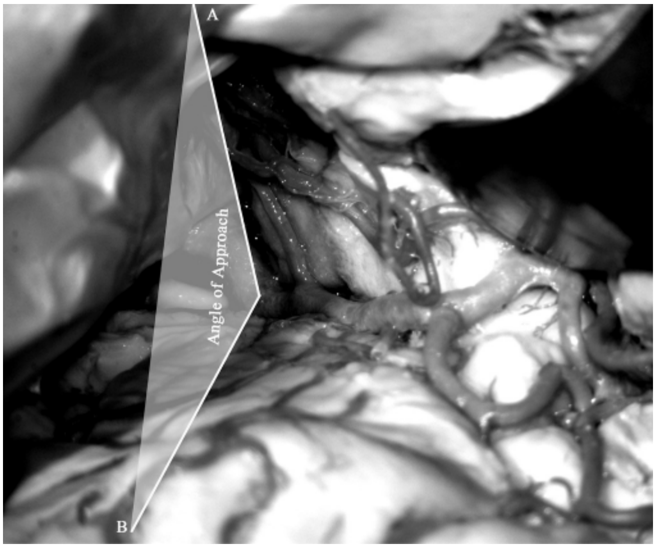

Fig. 6. Representation of the calculation of the vertical angular exposure, centered on the vascular structure for which the vertical angular exposure is being calculated. (A) Upper limit of the craniotomy; (B) Lower limit of the craniotomy.

Table 1
Comparison of Surgical Exposure Parameters Between MF and IF Approaches.

	MF		IF		P-value
	Mean	SD	Mean	SD	
Surgical exposure area (mm^2)	1415.1	232.7	1575.6	405.1	0.17
Linear exposure (mm)	10.8	2.5	11.0	3.3	0.85
Angular exposure (°)					
Horizontal					
Ipsilateral MCA bifurcation	78.4	16.0	78.0	17.1	0.76
Ipsilateral ICA bifurcation	68.1	5.9	67.6	7.9	0.58
Basilar artery top	54.6	5.5	53.7	6.8	0.28
Middle point of the AComm	61.5	6.5	59.4	5.4	0.08
Contralateral ICA bifurcation	51.4	5.1	52.1	4.1	0.31
Most distal point of the contralateral MCA	48.6	6.3	48.7	5.5	0.96
Vertical					
Ipsilateral MCA bifurcation	64.2	10.7	69.6	12.1	**0.03**
Ipsilateral ICA bifurcation	47.8	6.4	56.8	11.0	**0.01**
Basilar artery top	40.6	4.4	46.4	6.7	**< 0.01**
Middle point of the AComm	44.7	5.4	50.2	6.6	**< 0.01**
Contralateral ICA bifurcation	37.3	4.6	43.6	6.1	**< 0.01**
Most distal point of the contralateral MCA	35.8	6.2	41.2	7.1	**0.02**

ICA = internal carotid artery; MCA = middle cerebral artery; AComm = anterior communicating artery; SD = standard deviation.
P-values refer to paired T-tests.

under the surgical microscope for dissection, clipping, or resection. In this study, it relates to the capability to dissect and expose the subarachnoid space and the anatomic structures contained within it. In terms of PT, the area of surgical exposure is related to the capability to expose the subarachnoid space and its anatomic structures. A larger area increases the freedom to use instruments, visualization, and safety of the approach[10].

No statistical differences were observed between the surgical and linear exposure areas afforded by the approaches evaluated in this study. There was no anatomical reason for any difference in the horizontal angles between the 2 techniques because the horizontal angles were not affected by the final positions of the temporalis muscles.

4.2. Analysis of angular exposure

Angular exposure is increased by working in the superficial region of the craniotomy (i.e., by removing bone or retracting the brain). Wide angles allow for several-direction surgery and provide a more comfortable surgical route while minimizing the need for brain retraction. A wider surgical angle allows for greater mobility with the microscope in critical surgical scenarios [5,10].

Regarding specific anatomical targets, the interfascial temporalis flap seems to provide better working angles, mainly in the vertical axis for anatomical structures near the skull base.

4.3. Arguments in favor of the interfascial temporalis flap

Yasargil stated that "maximum surface exposure and minimum brain retraction are the keys to successful surgery via the pterional approach" [6]. In this regard, he developed the interfascial temporalis flap technique to retract the temporalis muscle as much as possible and increase visibility along the sphenoid ridge.

The goal is to retract the temporalis muscle as far as possible from the temporal fossa while avoiding injury to the frontotemporal nerve. Yasargil argued that a combined skin and muscle flap practically eliminates the risk of injury to this nerve but at the cost of reducing exposure due to the blockage caused by the temporal muscle along the sphenoid ridge. Therefore, greater brain retraction is necessary for treating aneurysms. He claims that the interfascial approach protects the frontalis nerve, allows maximum retraction of the temporalis muscle, and provides an exposure that prevents excessive brain retraction.

There is a study showing that the frontalis branch runs parallel and just caudal to the frontal branch of the superficial temporal artery (STA), 2 cm anterior to the tragus, and within 1 cm or less of this artery branch. Therefore, if the interfascial approach is used, it should start before subgaleal exposure of the STA frontal branch on the lower part of the scalp flap [7]. Baucher et al. advocated that the interfascial approach is still the safest way to avoid injury to the branches of the facial nerve and to preserve the temporalis muscle [8].

4.4. Arguments in favor of the myocutaneous flap

As mentioned previously, the frontotemporal branch of the facial nerve is the most vulnerable structure to injury during pterional exposure. Youssef A. et al. argued that the best way to protect this nerve is through the myocutaneous flap approach, but he agreed with Yasargil that limited mobilization of this muscle can make it difficult for deeper skull base exposures[11].

Spetzler argued that the interfascial approach is complex and can cause nerve injury. He stated that the myocutaneous flap technique seldom results in nerve damage and that the limitation in the exposure along the sphenoid ridge can be eliminated using fishhooks for retraction of the scalp and muscle [9].

The problem with this approach is that there is no muscle attachment along the superior temporalis line because the muscle is detached from its superior insertion and is only reapproximated posteriorly. This may cause inferior muscle retraction, creating a mass along the zygoma, and a depression in the local muscle is separated from the skull [9].

5. Limitations of the study

This is a purely anatomical study that addresses the important characteristics of superficial layer mobilization before the microsurgical technique. It was not possible to predict the clinical risks of a real surgical scenario, such as bleeding, cerebral edema, intracranial injuries, temporal contusion, and cosmetic outcomes, for each craniotomy.

Regardless of the advantages of each surgical access route, this study should be used as an anatomical guide in the context of each disease and the patient's individual conditions.

Furthermore, the aspects of the injuries to be treated, as well as the surgeon's expertise and familiarity with each technique used.

6. Conclusion

Regarding angular exposure, the interfascial approach provided quantitative broader exposure and greater surgical freedom in the vertical axis. There were no differences between the methods in terms of exposure area, linear exposure of the basilar artery, and angular exposure on the horizontal axis. Therefore, the choice between techniques should be based on the required working angles rather than the area of exposure. The interfascial temporalis flap should be performed when the position of the flap on exposure is anticipated.

Disclosures: The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

CRediT authorship contribution statement

Pedro Henrique Mouty Rabello: Writing – review & editing, Writing – original draft, Project administration, Formal analysis, Data curation, Conceptualization. **Yuri Estevam Bandeira:** Writing – review & editing, Methodology, Investigation, Formal analysis, Data curation. **Victor Zanetti Strutz:** Writing – review & editing, Data curation. **João Paulo Mota Telles:** Software, Methodology, Formal analysis, Data curation. **Gustavo Rassier Isolan:** Visualization, Supervision, Conceptualization. **Carlos G. Carlotti Jr:** Conceptualization. **Eberval Gadelha Figueiredo:** Writing – review & editing, Visualization, Validation, Supervision, Project administration, Methodology, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Yasargil MG, Antic J, Laciga R, Jain KK, Hodosh RM, Smith RD. Microsurgical pterional approach for the resection of aneurysms of the basilar bifurcation. *Surg Neurol* 1976;6(2).

[2] Luzzi S, Giotta Lucifero A, Bruno N, Baldoncini M, Campero A, Galzio R. Pterional Approach.Â *Acta Biomed*. 2022;92(S4):e2021346. doi:10.23750/abm.v92iS4.12775.

[3] Vishteh AG, Marciano FF, David CA, Baskin JJ, Spetzler RF. The pterional approach. *Oper Tech Neurosurg* 1998;1(1):39–49. https://doi.org/10.1016/S1092-440X(98)80007-8.

[4] Figueiredo EG, Oliveira AMP, Plese JPP, Teixeira MJ. Perspective of the frontolateral craniotomies.Â. *Arq Neuropsiquiatr* 2010;68(3):430–2. https://doi.org/10.1590/S0004-282X2010000300020.

[5] Figueiredo EG, Deshmukh V, Nakaji P et al.Â An anatomical evaluation of the mini-supraorbital approach and comparison with standard craniotomies. *Neurosurgery*. 2006;59(4 Suppl 2):ONS212-20; discussion ONS220. doi:10.1227/01.NEU.0000223365.55701.F2.

[6] Yasargil MG, Reichman MV, Kubik S. Preservation of the frontotemporal branch of the facial nerve using an interfascial temporalis flap for pterional craniotomy. *J Neurosurg* 1987;67(3):463–6. https://doi.org/10.3171/jns.1987.67.3.0463.

[7] Coscarella E, Vishteh AG, Spetzler RF, Seoane E, Zabramski JM. Subfascial and submuscular methods of temporal muscle dissection and their relationship to the frontalis branch of the facial nerve. *J Neurosurg* 2000;92(5):877–80. https://doi.org/10.3171/jns.2000.92.5.0877.

[8] Baucher G, Bernard F, Graillon T, Dufour H. Interfascial approach for pterional craniotomy: a technique and adjustment to prevent cosmetic complications. *Acta Neurochir (Wien)* 2019;161(11):2353–7. https://doi.org/10.1007/s00701-019-04058-1.

[9] Spetzler RF, Lee KS. Reconstruction of the temporalis muscle for the pterional craniotomy. *J Neurosurg* 1990;73(4):636–7. https://doi.org/10.3171/jns.1990.73.4.0636.

[10] Figueiredo EG, Deshmukh P, Nakaji P, et al. The minipterional craniotomy: technical description and anatomic assessment. *Neurosurgery*. 2007;61(5 Suppl 2):256-264; discussion 264-5. doi: 10.1227/01.neu.0000303978.11752.45.

[11] Youssef AS, Ahmadian A, Ramos E, Vale F, van Loveren HR. Combined subgaleal/myocutaneous technique for temporalis muscle dissection. *J Neurol Surg B Skull Base* 2012;73(6):387–93. https://doi.org/10.1055/s-0032-1326778.