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Original Article

Evaluation of Supraorbital Keyhole Approach versus Pterional Approach in the Surgical Treatment of Anterior and Middle Cranial Fossae Tumors: A Comparative Study

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BACKGROUND: Multiple approaches exist to manage anterior and middle cranial fossae lesions such as frontal, fronto-temporal, pterional, orbitozygomatic, and supraorbital approaches.

OBJECTIVE: The current study was conducted to compare the classic pterional approach and the supraorbital eyebrow approache in the surgical treatment of anterior and middle cranial fossae lesions.

PATIENTS AND METHODS: This retrospective study included 40 patients divided into two groups; the pterional group included 21 cases, while the supraorbital one included 19 cases. The collected data included; preoperative data (age, gender, American Society of Anaesthesiologists (ASA) status, tumor size, and extension), operative data (operative time, operative complications, and blood loss), and postoperative data (hospital stay, pathology, complications, cosmoses, and mortality).

RESULTS: The two approaches did not express significant differences regarding all of the preoperative variables. However, operative time and blood loss were significantly increased in the pterional approach. Gross total resection was achieved in 85.71% and 84.21% of patients in pterional and suprafrontal approaches, respectively. The incidence of brain edema, cerebrospinal fluid (CSF) leakage, and surgical site infection did not significantly differ between the two approaches. However, the supraorbital group was significantly associated with increased eyebrow edema, increased supraorbital sensational loss, and more cosmetic satisfaction.

CONCLUSION: Supraorbital eyebrow approach has proven to be efficacious and safe in dealing with anterior and middle cranial fossae lesions.

KEYWORDS: Anterior cranial fossa, Middle cranial fossa, Pterional approach, Supraorbital approach.

INTRODUCTION

Multiple approaches exist for the management of anterior and middle cranial fossae lesions such as frontal, frontotemporal, pterional, orbitozygomatic, and supraorbital approaches.[1]

Generally, in neurosurgical practice, the standard pterional approach is considered the gold standard for operating anterior and middle cranial fossae lesions, including tumors and aneurysms.[2] However, the continuous and rapid evolution of surgical techniques has led to a smaller incision via an eyebrow incision. This is called the “supraorbital keyhole approach”.[3,4]

This approach does not only aim to provide a small surgical incision, but also it permits adequate exposure of skull base lesions together with limiting trauma to the surrounding structures, including brain tissue, dura, bone, and finally, the skin.[5]

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Multiple studies reported that the supraorbital approach have proved to be safe and efficacious in both neoplastic (e.g., craniopharyngioma and meningioma) and frontotemporal vascular lesions (aneurysms, hemangiomas, and arteriovenous malformations).[6-11]

Despite the previous advantages of this approach, it is associated with a narrow-angle of view that requires a frequent change in the position of the operating table and microscope in order to obtain better visualization of a certain lesion.[3,5]

However, the introduction of neuroendoscopy has overcome these obstacles. Endoscopy provides optimum visualization through narrow angles with great focus and better illumination.[12,13]

The aim of the current study was to compare the classic pterional approach and the supraorbital eyebrow approach in managing anterior and middle cranial fossa tumors.

PATIENTS AND METHODS

The data of 40 consecutive cases who were diagnosed with anterior or middle cranial fossa tumors and operated in the neurosurgical theater via either pterional (21 cases) or supraorbital eye brow (19 cases) eyebrow approaches during the period between January 2016 and December 2019 were retrospectively reviewed. We included cases whose ages was between 10 and 70 years, from either gender, with American Society of Anesthesiologists (ASA) status,[14] I or II. Cases whose age was beyond the previous limits, having malignant tumors, recurrent tumors, or ASA status > II were excluded.

Informed written consent was obtained from all the included cases, or their parents if they were children, before the operation, following a complete explanation of the pros and cons of each approach. This was a routine measure in both of the study hospitals. Furthermore, the study gained approval from the ethical committee of Helwan University.

All cases were assessed clinically and radiologically. Clinical assessment included complete history taking and a thorough neurological examination. Magnetic resonance imaging (MRI) and/or computerized tomography (CT) were ordered for all cases, and arteriography was performed as well to assess the relation of the lesion to the surrounding vasculature. Also, all cases were assessed by the anesthesia team and classified according to ASA score.[14] The decision for the approach depended on surgeon preference and experience.

The pterional approach

It was performed like the technique described by Yasargil.[15] The incision was started at the zygoma, 1 cm anterior to the tragus, to avoid damage to the frontal branch of the superior temporal artery and the frontotemporal branch of the facial nerve. The incision was also extended cephalad to cross the superficial temporal artery. After that, interfascial dissection of the temporal muscle was done.

Two burr holes were created, one at the squamous temporal bone superior to the posterior zygomatic root and the other at the zygomatic bone intersection with the superior temporal line and the supraorbital edge. To cut the bone flap, a pneumatic craniotome with continuous irrigation was used.

A curvilinear dural incision was performed, and the flap was pediculated towards the greater wing of the sphenoid bone. After that, the flap was sutured to the temporal muscle base. The Sylvian fissure was opened for unlocking of the frontal from the temporal lobe. Tumor was identified and dissected from the surrounding neurovascular structures under microscopic guidance with or without navigation, and closure was performed in layers after ensuring good hemostasis. These steps are shown in **(Fig. 1).**

The supraorbital approach

The patient was placed in the supine position, the head was fixated using a Mayfield head holder, and it was

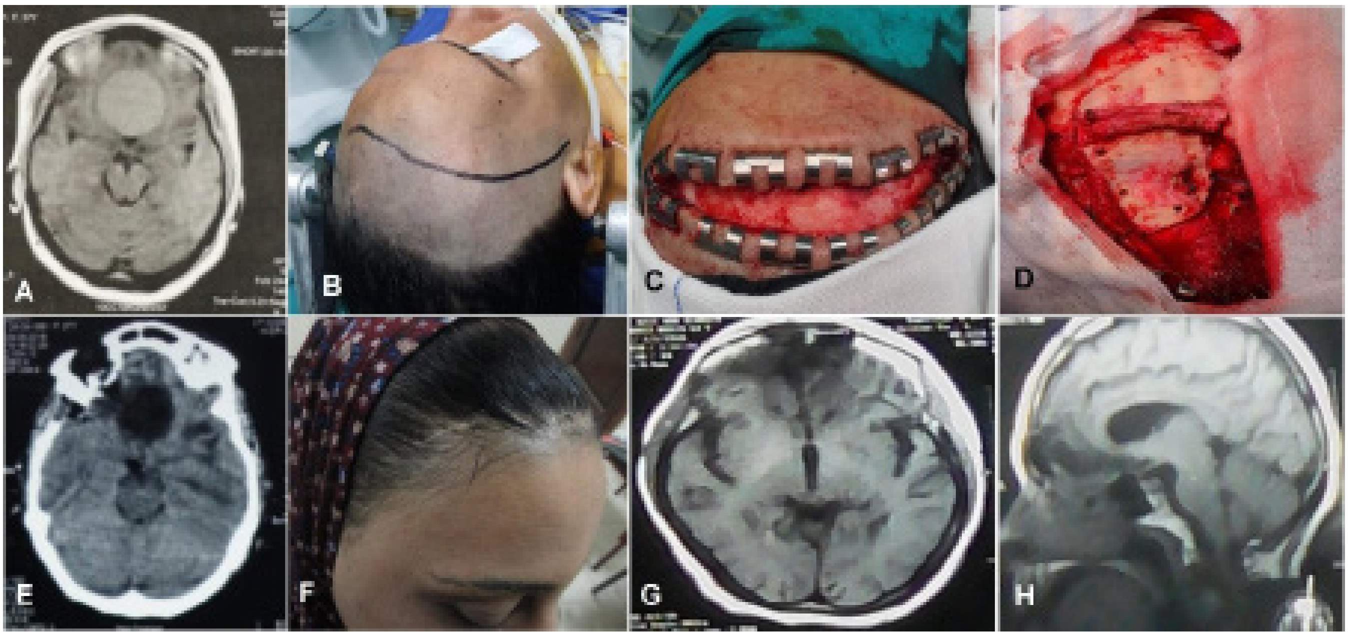

Fig 1: The pterional approach. (A) T1 MRI axial view with contrast, showing olfactory groove space occupying lesion (SOL). (B) Intraoperative image showing line of classic right fronto- temporal skin incision. (C) Intraoperative image showing skin and subgaleal dissection. (D) Intraoperative image showing boundaries of bony flap craniotomy. (E) Early Postoperative CT scan showing complete excision of the tumor with jet black dense tumor bed. (F) Postoperative image showing incision scar behind the hair line. (G) Postoperative T1 axial MR showing complete excision of the tumor. (H) Postoperative T1 sagittal MR showing complete excision of the tumor.

rotated 10º - 60º to the contralateral side according to the exact lesion site. The more anterior and contralateral the lesion was, the more head rotation was needed. A 10 to 20° rotation was needed in ipsilateral tempromesial lesions, whereas a 20 - 40° rotation was performed in the supra- and retrosellar region. In addition, anterior cranial fossa lesions needed a 40 - 60º rotation. After that, the head was extended to 10 to 15 degrees. This allowed backward falling of the frontal lobe, creating gravity-related self-retraction, to be easily separated from the orbital roof with no major retraction. Also, the head may be lateroflexed about 5 – 15 degrees to the contralateral side, creating a more ergonomic working position for the surgeon. We started the incision just lateral to the supraorbital notch. The craniotomy was performed near the frontal floor (2-3 cm width and 1.5-2 cm height). Image guidance was helpful to identify the lateral wall of the frontal sinus, which was usually, but not always, medial to the supraorbital notch.

The dura was first separated from the orbital roof, and bony prominences were drilled down so that the orbital roof was flush with the sphenoid wing. The dural opening was a C-shaped incision based inferiorly. Tumor was identified and dissected from the surrounding neurovascular structures under microscopic guidance with or without using navigation. Hemostasis was ensured, and wound closure was performed in layers. **(Fig. 2)** illustrates these steps.

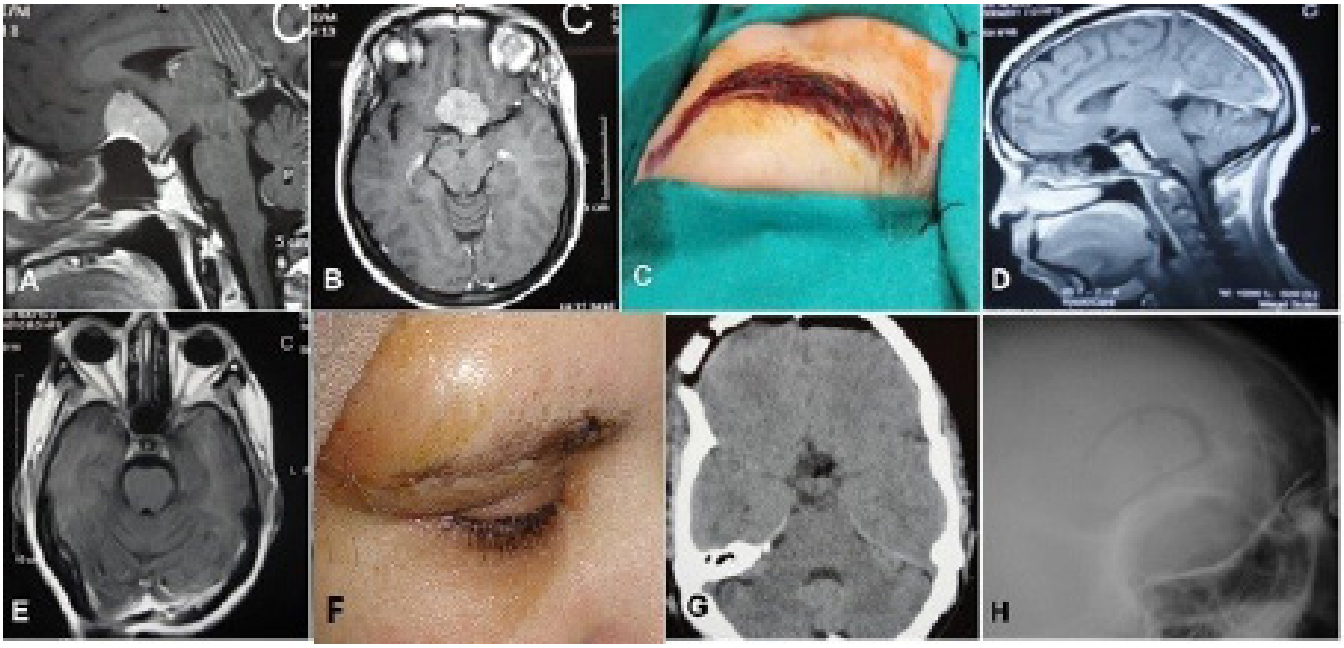

Fig 2: The supraorbital approach. (A) T1 MRI sagittal view with contrast showing tuberculum sella SOL with evident dural tail. (B) T1 axial view with contrast showing tuberculum sella SOL.(C) Intraoperative image showing right eyebrow incision. (D) Postoperative T1 MRI sagittal view showing compete excision of the tumor. (E) Postoperative T1 MRI axial view showing complete excision of the tumor. (F) Postoperative image showing eye brow incision scar with good cosmetic view. (G) Early postoperative CT image showing excision of the tumor with air bubbles in surgical corridor over frontal poles. (H) Plain radiography showing boundaries of limited small supraorbital craniotomy.

Follow up

Regular follow-up visits were scheduled for all cases as follows; weekly for the first month and every three months during the first year. After that, follow-up was performed every six months. Our cases had a median follow-up of 12 months (range, 8 – 35 months). During these visits, cases were assessed clinically and radiologically via brain MRI or CT.

Data collection

Data were retrieved from the medical archive of the neurosurgery department. The collected data included; preoperative data (age, gender, ASA status, tumor size, and extension), operative data (operative time, operative complications, and blood loss), and postoperative data (hospital stay, pathology, complications, cosmoses, and mortality).

Statistical analysis

We used the statistical packages for the social sciences (SPSS) software (version 24) for Mac for statistical analysis. Baseline characters were expressed as median and range, or frequency and percentage. The Chi-Square test (or Fisher's exact test) was used for the comparison of two independent groups of qualitative data. For quantitative data, independent-Samples t-test and Mann-Whitney U test were used to compare two groups of parametric and non-parametric quantitative data, respectively. For all the performed tests, a p-value < 0.05 was considered statistically significant.

RESULTS

The median age of the included cases was 32 and 35 years in the pterional and supraorbital approaches, respectively. Males represented 57.14% and 57.9% of cases in the same groups, respectively, while the remaining cases were females. All the included cases had an ASA score of I. The median tumor size was 5 and 4.5 cm in the study groups, respectively. Regarding tumor extension, the suprasellar area was the commonest site to be involved in both groups (47.62 and 52.63%, respectively), followed by optic chiasma (38.09 and 31.57%, respectively). Other sites of the extension were the carotid artery, cavernous sinus, and the orbital cavity. All of the previously mentioned variables were not significantly different between the two groups (p > 0.05), as shown in **(Table 1).**

Table 1: Preoperative data of the patients included in the study

	Pterional approach (n = 21)	Supraorbital approach (n = 19)	p value
Age (years)	32 (12 – 68)	35 (11 – 65)	0.248
Gender			
Male	12 (57.14%)	11 (57.9%)	0.729
Female	9 (42.86%)	8 (42.1%)	
ASA status	21 (I)	19 (I)	0.886
Tumour size (cm)	5 (3.5 – 8)	4.5 (3.5 – 8)	0.562
Tumour extension			
Suprasellar	10 (47.62%)	10 (52.63%)	
Optic chiasma	8 (38.09%)	6 (31.57%)	
Carotid artery	5 (23.81%)	5 (26.31%)	0.152
Cavernous sinus	3 (14.28%)	4 (21.05%)	
Intraorbital	2 (9.52%)	1 (5.26%)	

n: Number.

When it comes to the operative procedure, there was a significant prolongation of operative time in the pterional approach compared to the supraorbital one (one; 313 versus 220 minute. Respectively (p < 0.001). Also, blood loss was significantly increased in the same group (group; 450ml versus 300 ml in the supraorbital approach (p = 0.009). Intraoperative hemorrhage was encountered only in one case (4.76%) in the pterional approach due to cavernous sinus bleeding, and it was controlled by compression and gel foam, while the same complication was not encountered in the supraorbital group, as shown in **(Table 2).**

Table 2: Operative data of the patients included in the study

	Pterional approach (n = 21)	Supraorbital approach (n = 19)	P value
Operative time (minutes)	313 (293 – 480)	220 (180 – 436)	< 0.001*
Blood loss (ml)	450 (100 – 700)	300 (100 – 600)	0.009*
Intraoperative hemorrhage	1 (4.76%)	0 (0%)	0.358

Craniopharyngioma was the commonest tumor encountered in the current study (42.85% and 36.84% of cases in the pterional and supraorbital approaches, respectively). Other pathologies included olfactory groove meningioma, pituitary adenoma, and tuberculum sella meningiomas. Gross total resection was achieved in 85.71% and 84.21% of cases in both groups, respectively (p = 0.504).

As regard postoperative complications, no significant difference was detected between the two groups regarding brain edema (p = 0.482), CSF leakage (p = 0.621), or surgical site infection (p = 0.536). However, the supraorbital group was significantly associated with increased eyebrow edema (p < 0.001), increased temporary supraorbital sensational loss (p = 0.029), as well as more cosmetic satisfaction (p = 0.015). Hospital stay was significantly prolonged in the classic pterional cases (p = 0.021). In-hospital mortality was encountered in only one case in the pterional group. That case developed malignant brain edema with brain herniation. In the supraorbital group, follow-up mortality occurred in only one case, which developed growth of the residual craniopharyngioma along with obstructive hydrocephalus as illustrated in **(Table 3).**

Table 3: Postoperative data of the patients included in the study

	Pterional approach (n = 21)	Supraorbital approach (n = 19)	P value
Pathology			
Craniopharyngioma	9 (42.85%)	7 (36.84%)	0.138
Olfactory meningioma	6 (28.57%)	6 (31.58%)	
Pituitary adenoma	4 (19.05%)	3 (15.79%)	
Tuberculum sella meningioma	2 (9.52%)	3 (15.79%)	
Gross total resection	18 (85.71%)	16 (84.21%)	0.504
Complications			
Brain edema	3 (14.28%)	3 (15.78%)	0.482
Eye brow edema	8 (38.09%)	15 (78.94%)	< 0.001*
CSF leakage	1 (4.76%)	1 (5.26%)	0.621
Surgical site infection	1 (4.76%)	1 (5.26%)	0.536
Supraorbital sensational loss	1 (4.76%)	4 (21.05%)	0.029*
Cosmetic dissatisfaction	6 (28.57%)	1 (5.26%)	0.015*
Hospital stay	5 (4 – 9)	3 (3 – 6)	0.021*
In-hospital mortality	1 (4.76%)	0 (0%)	0.279
Follow up mortality	0 (0%)	1 (5.26%)	0.228

n: Number.

DISCUSSION

Generally speaking, the pterional approach proposed by Yasargil,[15] has been the standard approach for anterior and middle cranial fossae lesions. However, keyhole surgery has gained popularity after it was introduced by Perneczky[16] as many neurosurgeons reported successful outcomes using that approach.

There was a great controversy when the supraorbital approach was performed through an eyebrow incision, as many surgeons thought that this small incision would decrease the operative field leading to inadequate visualization during the procedure. Also, the cosmetic outcome after both bone and skin repair has been questioned as well.[3,5]

However, with different reports about that minimally invasive approach, it has achieved faster postoperative recovery associated with excellent cosmoses.[5,17] Therefore, we conducted this study to compare the classic pterional approach versus the supraorbital eyebrow approach in managing anterior and middle cranial fossae lesions.

In our study, tumor size did not significantly differ between the two groups. It had a median value of 5 and 4.5 cm in the pterional and supraorbital approaches, respectively ($p = 0.562$). Likewise, another study reported that the mean size of the tumors resected was 3.1 cm (range, 0.6 – 8.4).[18] This coincides is close to the range of tumor size reported in our study.

In the current study, the supraorbital approach had a significantly shorter operative time than the pterional approach; 220 versus 313 minute, respectively ($p < 0.001$). Another recent study supported our findings regarding operative time, as it was significantly shorter in the supraorbital group; 274.9 minutes versus 390.9 minutes in the pterional group ($p < 0.01$).[19]

Ditzel Filho and his coworkers reported that the overall mean duration of the operative procedure using the supraorbital approach was 181 minutes (±56). Nevertheless, the same authors mentioned that operative time was significantly prolonged up to 233 minutes in large (>5 cm) or deep-seated lesions[20] which came in line with our findings.

Other authors reported a shorter operative time using the supraorbital approach, as the mean operative time was 116 minutes (range, 43–442). Interestingly, the operative time in that study had a significant positive correlation with tumor size (which was 3.1 cm in that study).[18] In the current study, the median tumor size was 4.5 cm in the same approach, and that explains the longer operative time in our study. Also, surgical expertise may play an important role in decreasing that parameter.

In our study, intraoperative blood loss was significantly decreased in the supraorbital approach compared to the classic pterional one; median 300ml versus 450 ml, respectively ($p = 0.009$). This could be explained by the fact that a smaller craniotomy is performed in the supraorbital approach than the pterional approach. Thus, less bleeding from the bony edges is anticipated. Also, there is a significant association between large tumor size and the amount of intraoperative bleeding[18] and that explains the larger amount of blood loss in the supraorbital group in our study compared to the existing literature.

Park et al. reported that intraoperative bleeding had the mean amount of 537.4 ml and 356.4 ml in the pterional and supraorbital groups, respectively ($p = 0.014$).[19] Another study reported that the mean amount of blood loss during the supraorbital approach was 155 ml (±141).[20] In addition, Romani et al. reported a mean operative blood loss of 196 ml (range, 0 – 800 ml).[18]

Regarding our primary outcome, gross total resection was achieved in 85.7% and 84.21% of cases in the pterional and supraorbital approaches, respectively, with no significant difference between the two groups. This indicates that the supraorbital approach can achieve oncological outcomes similar to the classic one. In previous larger series, gross total resection was achieved in 89.2% of cases performed via the supraorbital approach.[3,5,21] This supports our study findings.

Reisch and his associates reported the safety and feasibility of the same approach while dealing with intraaxial lesions, as gross total resection was performed in 14 out of 15 cases (93.33%).[17] Moreover, previous authors reported that the supraorbital approach was more efficacious while dealing with platum sphenoidal and pituitary tumors.[22]

Fernandes and his associates also reported that gross total resection was performed in all of the included 16 cases using the supraorbital approach, except for two cases, one was optic nerve meningioma, and the other was craniopharyngioma.[23] In another study, total resection was done in 50% of cases, while near-total and subtotal resections were achieved in 30% and 20% of cases, respectively.[20]

Although multiple authors stated that narrow viewing angle is one of the drawbacks of that approach, if one is suspicious about the degree of tumor resection due to brain edema or large tumor size, the supraorbital incision could be extended. The medial part of the incision could be extended to perform a front ocraniotomy for low anterior basal lesions. Furthermore, it could be extended laterally to the frontozygomatic suture if the lesion is laterally located.[22]

In our study, postoperative eyebrow edema was encountered more significantly in the supraorbital approach; 78.94% (78.94% versus 38.09% of cases in the pterional approach ($p < 0.001$). On the other hand, another study reported that postoperative periorbital edema occurred in 15.38% and 18.4% of cases in the supraorbital and pterional approaches, respectively, with no significant difference between the two groups.[22]

As regards CSF leakage in our study, it occurred in 4.76% and 5.26% of cases in the pterional and supraorbital groups, respectively, without significant difference between the two groups ($p = 0.621$). Romani et al. reported that CSF leak was encountered in 3 cases after the supraorbital approach (5.76%).[18] This is similar to the CSF leakage rate reported by us.

In the current study, the supraorbital sensational loss was more encountered in the supraorbital group (21.05%) compared to the classic approach (4.76%) ($p = 0.029$). All of these cases were temporary and resolved with conservative treatment. Fernandes and his colleagues reported that transient anesthesia of the frontal part of the scalp was encountered in 12.5% of cases undergoing the supraorbital approach.[23] Historically, the eyebrow approach was associated with a higher incidence of supraorbital sensational loss. Nevertheless, the incidence of that complication decreased significantly by creating an incision lateral to the supraorbital notch, and that was performed in the current study.

As regards to the cosmetic outcome, it was significantly better in the supraorbital group ($p = 0.015$). Dissatisfaction was reported by 28.57% and 5.26% of cases in the pterional and supraorbital approaches, respectively. In fact, all of these cases had temporalis wasting which was the main cause of their dissatisfaction (not shown in the results). The one in the supraorbital group reported dissatisfaction of her wound, which was complicated by post-operative infection. Likewise, Fernandes et al. reported that skin scar following the supraorbital approach was cosmetically accepted in all cases[23] wich supports our findings. This was also confirmed by another recent study that reported that cosmetic outcomes were significantly better in the supraorbital approach.[24] On the other hand, a previous study also reported that there was no much difference between the two approaches regarding the cosmetic outcome. Unacceptable cosmetic problems were reported by 3.8% and 6.15% of cases in supraorbital and pterional approaches, respectively.[22]

In our study, surgical site infection was encountered only in one case in each group; 4.76 and 5.26% of cases, respectively ($p = 0.536$). Wongsirisuwan and his associates reported that postoperative infection was encountered in 4.6% of cases in the pterional approach, while it was not encountered in any cases in the supraorbital approach.[22]

In the current study, the duration of hospital stay was significantly decreased in the supraorbital approach; three versus five days in the classic approach ($p = 0.021$). As the supraorbital approach is minimally invasive with less tissue manipulation, better patient recovery and shorter hospital stay are anticipated. Park et al. confirmed our findings ($p < 0.01$). However, these authors reported longer hospital stay compared to ours; 9.9 and 13.1 days in the supraorbital and pterional groups, respectively.[19]

Similar to our findings, another study reported that the median duration of hospital stay was three days (range, 2 – 6 days) in the cases performed via the supraorbital approach.[20]

Mortality was encountered in only one case in each group; 4.76% and 5.26% of cases in both groups, respectively). This agrees with what was published in the literature, as it ranged between 2% and 15% when orbitozygomatic and pterional approaches were performed.[25,26] Other studies handling the supraorbital approach have stated that mortality rates ranged between 2% and 4%.[7,20]

Our study has some limitations; first of all, it is a single-center study, also, the number of the included cases was relatively small. Finally, cases with malignant lesions were not included, hence, more studies should be conducted in the near future to cover these drawbacks.

CONCLUSION

Based on our results, the supraorbital eyebrow approach has proved itself to be efficacious and safe in dealing with anterior and middle cranial fossae lesions. Nevertheless, it cannot replace the classic pterional approach. It offers many advantages, including less brain manipulation, shorter operative time, and hospital stay. However, it needs good surgical expertise as the relatively small surgical field may hinder good visualization, surgical instrument manipulation, and proper handling of intraoperative complications.

List of abbreviations

ASA: American Society of Anaesthesiologists.
CSF: cerebrospinal fluid.
CT: Computerized tomography.
MRI: Magnetic resonance imaging.
SOL: Space occupying lesion.
SPSS: Statistical packages for the social sciences.

Disclosure

The authors report no conflict of interest in the materials or methods used in this study or the findings specified in this paper.

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REFERENCES

1. Iaconetta G, Ferrer E, Galino AP, Enseñat J, de Notaris M. Frontotemporal approach. In: Cappabianca P, Califano L, Iaconetta G, eds. Cranial, Craniofacial and Skull Base Surgery. Springer. 2010:39-59.
2. Ormond DR, Hadjipanayis CG. The supraorbital keyhole craniotomy through an eyebrow incision: Its origins and evolution. *Minim Invasive Surg.* 2013;2013:296469.
3. Reisch R, Perneczky A. Ten-year experience with the supraorbital subfrontal approach through an eyebrow skin incision. *Oper Neurosurg.* 2005;57(4):242-255.
4. Zhao C, Chen Z, Xu N, et al. Comparative analysis on microsurgical removal of craniopharyngioma via lateral supraorbital approach and standard pterional approach. *Chin Neurosurg J.* 2018;4:16.
5. Reisch R, Perneczky A, Filippi R. Surgical technique of the supraorbital key-hole craniotomy. *Surg Neurol***.** 2003;59(3):223-227.
6. Romani R, Lehecka M, Gaal E, et al. Lateral supraorbital approach applied to olfactory groove meningiomas: Experience with 66 consecutive patients. *Neurosurgery***.** 2009;65(1):39-53.
7. Romani R, Laakso A, Kangasniemi M, Lehecka M, Hernesniemi J. Lateral supraorbital approach applied to anterior clinoidal meningiomas: Experience with 73 consecutive patients. *Neurosurgery.* 2011;68(6): 1632-1647.
8. McLaughlin N, Ditzel Filho LF, Shahlaie K, Solari D, Kassam AB, Kelly DF. The supraorbital approach for recurrent or residual suprasellar tumors. *Minim Invasive Neurosurg.* 2011;54(4):155-161.
9. Hayhurst C, Teo C. Tuberculum sella meningioma. *Otolaryngol Clin North Am.* 2011;44(4):953-963.
10. Zheng X, Liu W, Yang X, et al. Endoscope assisted supraorbital keyhole approach for the resection of benign tumors of the sellar region. *Minim Invasive Ther Allied Technol.* 2007;16(6):363-366.
11. Telera S, Carapella CM, Caroli F, et al. Supraorbital keyhole approach for removal of midline anterior cranial fossa meningiomas: A series of 20 consecutive cases. *Neurosurg Rev.* 2012;35(1):67-83.
12. Arnaout MM, Luzzi S, Galzio R, Aziz K. Supraorbital keyhole approach: Pure endoscopic and endoscope-assisted perspective. *Clin Neurol Neurosurg.* 2020;189:105623.
13. Martinez-Perez R, Albonette-Felicio T, Hardesty DA, Shahein M, Carrau RL, Prevedello DM. The endoscopic supraorbital translaminar approach: A technical note. *Acta Neurochir (Wien).* 2021;163(3):635-641.
14. Sankar A, Johnson S, Beattie W, Tait G, Wijeysundera D. Reliability of the American Society of Anesthesiologists physical status scale in clinical practice. *Br J Anaesth.* 2014;113(3):424-432.
15. Yaşargil MG, Reichman MV, Kubik S. Preservation of the frontotemporal branch of the facial nerve using the interfascial temporalis flap for pterional craniotomy: Technical article. *J Neurosurg.* 1987;67(3):463-466.
16. Perneczky A, Tschabitscher M, Resch KD. Endoscopic Anatomy for Neurosurgery: *George Thieme Verlag;* 1993.
17. Reisch R, Stadie A, Kockro R, Gawish I, Schwandt E, Hopf N. The minimally invasive supraorbital subfrontal key-hole approach for surgical treatment of temporomesial lesions of the dominant hemisphere. *Minim Invasive Neurosurg.* 2009;52(4):163-169.

18. Romani R, Laakso A, Kangasniemi M, Niemelä M, Hernesniemi J. Lateral supraorbital approach applied to tuberculum sellae meningiomas: Experience with 52 consecutive patients. *Neurosurgery.* 2012;70(6):1504-1519.

19. Park HH, Sung KS, Moon JH, et al. Lateral supraorbital versus pterional approach for parachiasmal meningiomas: Surgical indications and esthetic benefits. *Neurosurg Rev.* 2020;43(1):313-322.

20. Ditzel Filho LF, McLaughlin N, Bresson D, Solari D, Kassam AB, Kelly DF. Supraorbital eyebrow craniotomy for removal of intraaxial frontal brain tumors: A technical note. *World Neurosurg.* 2014;81(2):348-356.

21. Perneczky A. Planning strategies for the suprasellar region: Philosophy of approaches. Proceeding of the Japanese Congress of Neurological Surgeons. 1992;11:343-348.

22. Wongsirisuwan M, Ananthanandorn A, Prachasinchai P. The comparison of conventional pterional and transciliary keyhole approaches: Pro and con. *J Med Assoc Thai*. 2004;87(8):891-897.

23. Fernandes YB, Maitrot D, Kehrli P, Tella Jr OI, Ramina R, Borges G. Supraorbital eyebrow approach to skull base lesions. *Arq Neuropsiquiatr.* 2002;60(2-A):246-250.

24. Park J, Son W, Kwak Y, Ohk B. Pterional versus superciliary keyhole approach: Direct comparison of approach-related complaints and satisfaction in the same patient. *J Neurosurg.* 2018;130(1):220-226.

25. Al-Mefty O. Clinoidal meningiomas. *J Neurosurg.* 1990;73(6):840-849.

26. Risi P, Uske A, Tribolet ND. Meningiomas involving the anterior clinoid process. *Br J Neurosurg.* 1994;8(3):295-305.