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The lateral supraorbital approach, doable and cosmetic access to anterior skull base

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Abstract

Background: The anterior skull base region can be reached through multiple corridors. The most frequently used are the pterional, bifrontal, unifrontal, and orbitozygomatic approaches. These approaches are more extensive and time consuming. The lateral supraorbital approach is a less extensive frontal modification of the classic pterional approach designed to manage tumors and aneurysms of this region.

Objective: To evaluate efficacy, safety, and cosmetic results of the lateral supraorbital approach and to present some tricks to have an easy access to different pathologies at the anterior skull base through this approach.

Methods: Analysis of 50 operations for anterior skull base pathologies, vascular and neoplastic, made through the lateral supraorbital approach in Neurosurgery Department, Tanta University Hospitals between January 2013 and April 2017. The basic steps in performing the procedure are described. Special tricks required in individual cases and how to identify their need from preoperative images are discussed.

Results: We operated on 50 patients having 34 neoplastic and 16 vascular lesions. The mean incision length was 11 cm, mean bone flap size was 3.5 × 5.4 cm, and mean craniotomy time was 20 min.
All patients were satisfied with their scars; there were no limitations to this approach regarding nature or size of the lesion. We had 8 morbidities (4 transient and 4 permanent) and 2 mortalities; all morbidities and mortalities were not related to the approach.

Conclusion: The lateral supraorbital approach is simple, fast, and effective corridor to anterior skull base pathologies without significant morbidities or mortalities related to the approach.

Keywords: Lateral Supraorbital approach, Aneurysm, Anterior skull base tumors

Introduction

The anterior skull base extends from the orbital ridge to the anterior clinoids and sphenoid ridges. It can be reached through multiple corridors; the most frequently used are the pterional, bicoronal, unifrontal, orbitozygomatic, transnasal, and endoscopic endonasal approaches [1].

The idea of the lateral supraorbital approach appeared because most of classic anterior skull base approaches are time consuming, extensive, and associated with bad cosmetic outcomes; at the same time, the temporal lobe does not obscure the anterior skull base, and its exposure is not needed in most of the cases. This approach is a less extensive frontal modification of the classic pterional approach [2].

We used the lateral supraorbital approach that was first described by Broke and Dietz. This approach can be used for management of all anterior circulation aneurysms except the pericallosal aneurysm. Anterior and middle skull base meningiomas can also be reached through this approach. The term lateral supraorbital approach was used to name a different procedure from the traditional supraorbital macro-craniotomy described by Krause in 1908 and modified by Delashaw et al. in 1993 till the supraorbital key-hole approach developed by Axel Pernesky since 1980

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with the help of the endoscope to overcome limitation of small craniotomy [3–9].

Patients and method

All patients were subjected to history taking, complete physical examination, and routine laboratory investigations. CT and MRI of the brain were obtained for tumor cases. CTA was done in vascular cases.

After careful studying of patient clinical status and images, talking with patient relatives, the patient or one of his close relatives signed informed consent then we proceeded to surgery.

Perfect neuroanesthesia ensures low intracranial pressure while maintaining adequate cerebral perfusion. To have a slack brain, we routinely use an epidural catheter to be inserted in the lumbar intradural space, connected to a haemoset collection bag and clamped to be opened when needed to release 50–100 cc of CSF to decrease intracranial pressure and allow surgery without brain retraction.

Perfect positioning is the first key to operate comfortably through the lateral supraorbital approach. Generally, the patient's head is fixed to a Mayfield frame with about 20° head elevation above heart level, mild extension, mild rotation, and mild tilt.

Fine adjustment of patient head should be tailored case by case according to the 3D imagination of target pathology and its relation to the skull base. The operating table can be rotated intraoperatively to have comfortable working angle.

We do minimal shaving 2 cm behind the hairline then we make a curvilinear frontotemporal skin incision that stops 1 cm above the zygoma (Fig. 1a).

We make a small incision in the anterior superior part of the temporalis muscle (Fig. 1b); this way decreases the risk of disfiguring temporalis muscle wasting and postoperative mastication problems, then one layer skin muscle flap is dissected from the periosteum, elevated, and retracted anteriorly by fishhooks and rubber bands attached to a long arm fixed to the operating table till the supraorbital rim and zygomatic arch are exposed (Fig. 1c). This diminishes the risk of injury of frontotemporal branch of facial nerve.

The fine adjustment of craniotomy position and flap size depends on the pathology. A single burr hole is made at the superior temporal line, and bone flap is cut using the sidecutting drill with footplate (Fig. 1d). Then, the flap is detached from the dura and lifted (Fig. 1e).

The sphenoid ridge is drilled using the high-speed drill with cutting ball tip then with diamond ball tip without saline irrigation (hot drilling) to control oozing from the bone.

The dura is opened in curvilinear incision pointing anterolaterally and dural edges elevated by multiple stitches to prevent oozing from epidural space (Fig. 1f).

From this point, all surgery is performed under the operating microscope. To minimize brain retraction, the first goal during intradural dissection is to release CSF from the basal cisterns (if can be reached early) around the optic nerve, internal carotid artery, and the lamina terminalis especially in ruptured aneurysm cases to release significant amount of CSF from the third ventricle.

Results

Our series included 50 cases: 34 males and 16 females. Their age ranged from 17 to 70 years with mean age of 35 years. All patients had anterior skull base lesions, 16 aneurysms and 34 neoplasms operated through the lateral supraorbital approach in Tanta University Hospitals from January 2013 to April 2017. Example cases are shown in Figs. 2, 3, 4 and 5.

Most of aneurysm cases were in the anterior communicating artery (8 cases), most of neoplastic lesions were meningiomas (12 olfactory groove, 8 tuberculum sellae, 7 planum sphenoidale and 5 supraorbital), and our study included 2 craniopharyngiomas (Table 1).

The mean incision length was 11 cm, mean bone flap size was 3.5 × 5.4 cm, and mean craniotomy time was 20 min.

All of our patients had satisfactory cosmetic results with no temporalis atrophy and no injury to the frontotemporal branch of facial nerve (Fig. 1g).

Relation between lesion pathology and surgical outcome

All aneurysms were totally clipped except one case of a bilobed AcoA aneurysm where there was neck remnant; another surgery was performed, and one more clip was applied. Subtotal resection was done in 2 craniopharyngiomas, 2 tuberculum sellae meningiomas, and one olfactory grove meningioma due to solid consistency and adherence to neurovascular structures (Table 2).

Clinical outcome

We had 14 cases with preoperative visual affection, six of them improved, three cases remained stationary, and 5 cases deteriorated (2 olfactory groove, 2 tuberculum sellae, and one craniopharyngima); one more case of olfactory grove meningioma that had preoperative normal vision developed postoperative field defect. This visual deterioration was transient in

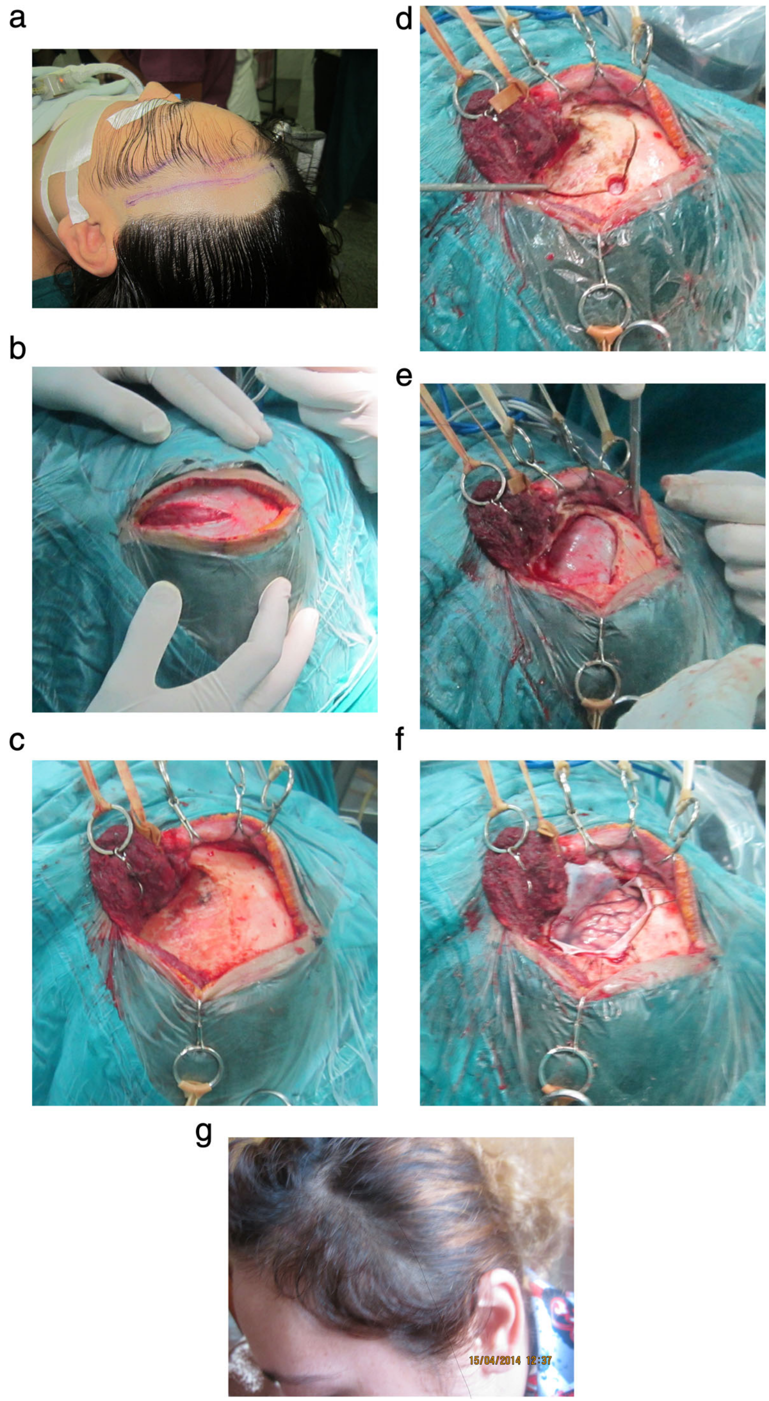

Fig. 1 Steps of lateral supraorbital approach on the left side. An oblique frontotemporal skin mark is placed behind the hairline after minimal hair shave (**a**). Skin and temporalis muscle are incised together (In the photograph the muscle is partially separated from the flap just for demonstration.) (**b**). The one-layer skin-muscle flap is retracted frontally (**c**). A single burr hole is placed just under the superior temporal line, and the bone flap is cut (**d**). Bone flap is detached, and sphenoid ridge is drilled (**e**). Dura is opened and tented with sutures (**f**). One-year postoperative image showing minimal atrophy of temporalis muscle and excellent cosmetic outcome (**g**)

4 cases and permanent in 2 cases. Two cases with ruptured aneurysms had vasospasm, but both were presented by extensive SAH and disturbed conscious level. One case of ruptured AcoA aneurysm developed hemiparesis due to ACA vasospasm. One patient with olfactory groove meningioma had postoperative CSF

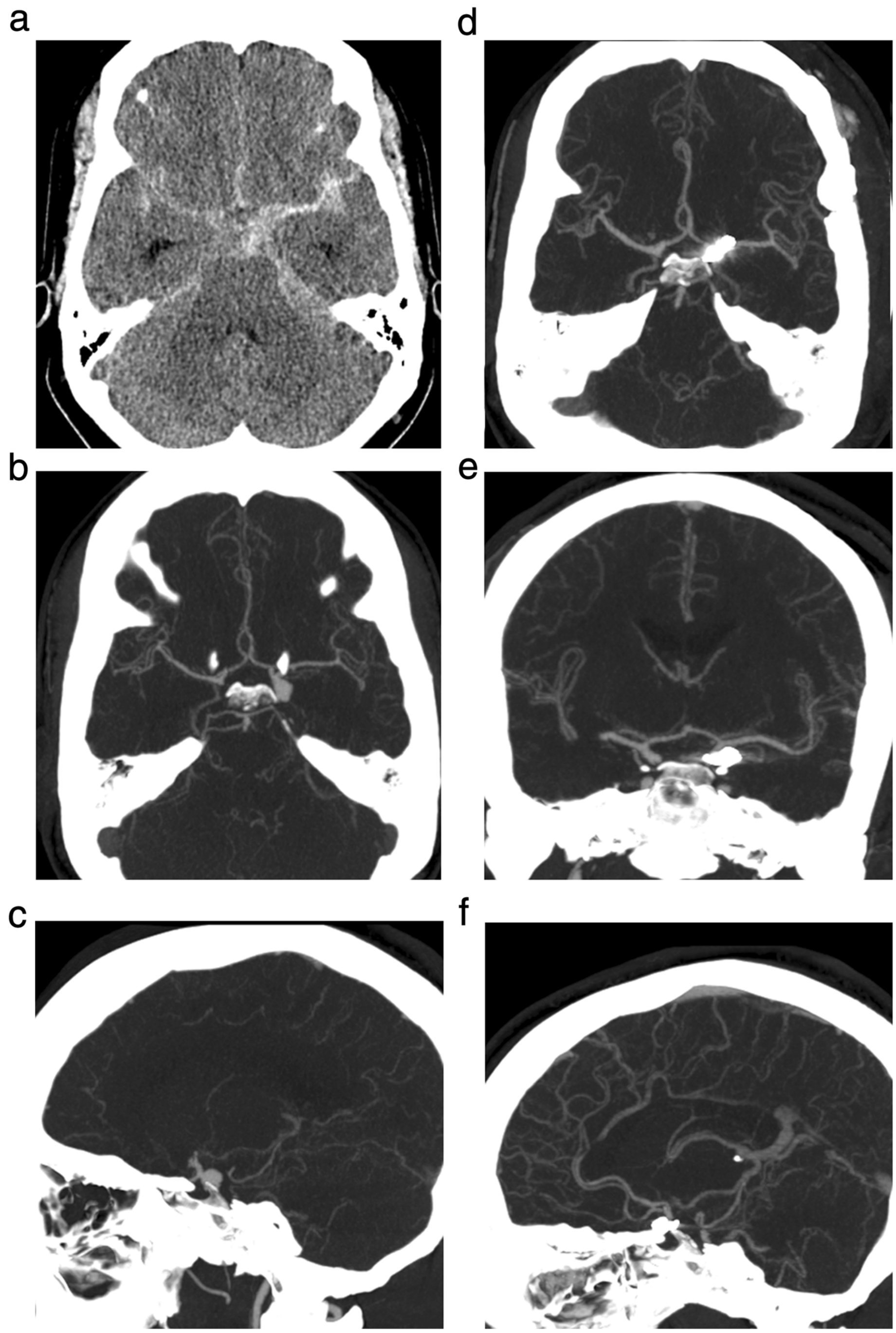

Fig. 2 A case of ruptured Pcom aneurysm successfully clipped through left-side supraorbital approach. Preoperative axial CT scan shows the SAH (**a**). Preoperative axial (**b**) and sagittal (**c**) CTA views show the ruptured Pcom aneurysm on the left side. Postoperative axial (**d**), coronal (**e**), and sagittal (**f**) CTA show clipping of the aneurysm

rhinorrhea that stopped spontaneously. One case of Pcom aneurysm had persistent 3rd nerve palsy and did not improve. One case had subcutaneous CSF collection that disappeared after single tapping and bandage. One case had periorbital edema that subsided spontaneously, and one diabetic case had superficial wound infection that improved with daily dressing and antibiotics.

The clinical outcome of our cases was evaluated according to Modified Rankin Scale and Glasgow Outcome Scale as shown in Tables 3 and 4, respectively.

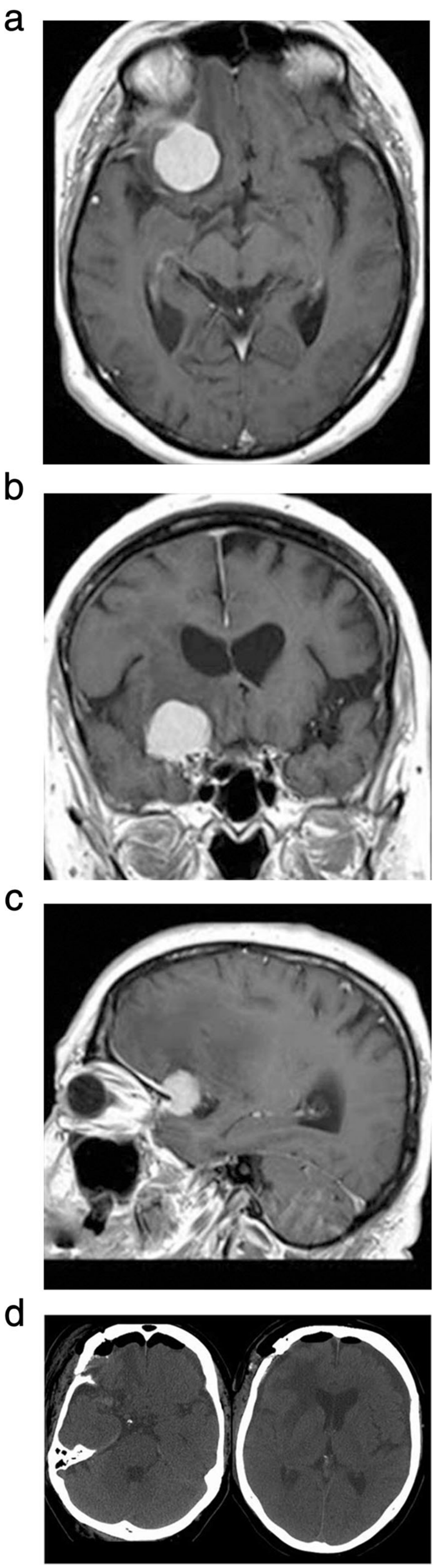

Fig. 3 A case of clinoidal meningioma successfully operated on through right-side lateral supraorbital approach. Preoperative axial (**a**), coronal (**b**), and sagittal (**c**) MRI views show clinoidal meningioma on the right side. Postoperative CT axial view (**d**) shows complete removal of the meningioma

Final outcome

One patient with ruptured AcoA aneurysm had persistent postoperative hydrocephalus, and a ventriculoperitoneal shunt was inserted; one case of craniopharyngioma had recurrence of the cyst, and an Ommaya reservoir was inserted. One case of ruptured AcoA aneurysm did not recover from his coma and developed persistent vegetative state.

We had 2 mortalities; one carotid ophthalmic aneurysm died from carotid vasospasm, and one craniopharyngioma died from diabetes insipidus.

Discussion

We can classify anterior skull base approaches according to bone flap size into macrocraniotomy and minicraniotomy approaches. Macrocraniotomy approaches like the bifrontal, bicoronal, orbitozygomatic, and classic pterional approaches. Minicraniotomy approaches like the supraorbital keyhole approach. The bifrontal and bicoronal approaches are time consuming, extensive with complications related to large craniotomy flap, more blood loss, superior sagittal sinus violation, frontal air sinus opening leading to postoperative CSF leak, and postoperative behavioral changes from brain edema of bilateral brain retraction. They are sometimes associated with bad cosmetic results. The classic pterional approach of Yasargil was associated with temporalis muscle atrophy leading to postoperative mastication problems and bad cosmetic outcome due to complete subperiosteal temporalis dissection beside the risk of injury of frontotemporal branch of facial nerve [10–13].

Minicraniotomy approaches like the supraorbital keyhole approach had some limitations such as difficult application for vascular lesions due to difficult proximal control, impossible to operate in case of intraoperative aneurysm rupture, or brain swelling which occlude the surgical field. Also, difficulty to perform on large-sized neoplastic lesions, Hammad et al. operated on 22 patients in Ain Shams University, Egypt. They used the keyhole approach only in tumor sizes less than 4 cm. The eyebrow incision used frequently in this approach is historically associated with loss of supraorbital sensation or palsy of frontal branch of facial nerve [14, 15].

We operated on 50 patients having anterior skull base lesions (16 vascular and 34 neoplastic) through the lateral supraorbital approach, a medium-sized

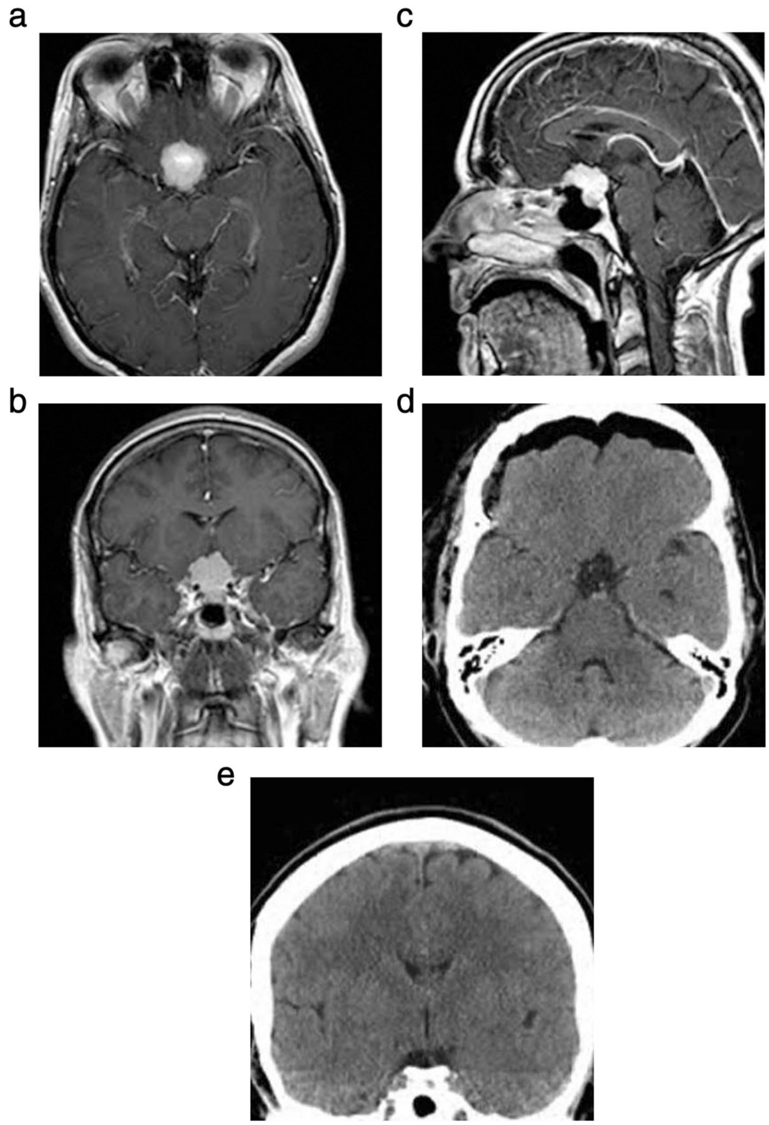

Fig. 4 A case of tuberculum sellae meningioma successfully operated on through right-side lateral supraorbital approach. Preoperative axial (**a**), coronal (**b**), and sagittal (**c**) MRI views show tuberculum sellae meningioma. Postoperative CT axial (**d**) and coronal (**e**) views show complete removal of the meningioma

approach, more sub-frontal, and less temporal exposure. This approach is a less extensive modification of the classic pterional approach. The craniotomy size was fair enough to decrease the risk of large craniotomy associated problems but at the same time sufficient to reach the entire anterior skull base [16].

Incomplete clipping was done in one bilobed AcoA aneurysm where there was remnant neck; another surgery was performed, and one more clip was applied. Subtotal resection was done in 5 tumors (2 craniopharyngiomas, 2 tuberculum sellae meningiomas, and one olfactory grove meningioma). This was not related to operating through the lateral supraorbital approach neither for vascular nor large neoplastic lesions. We believe that many other factors had affected the surgical outcome such as aneurysm morphology, tumor consistency, anatomical extension, and attachment to neurovascular structures.

Mean flap size in our series was 3.5 × 5.4 cm while in the series of Prof. Hernesneimi it was 3 × 5 cm because in the early beginning we used larger flaps due to lack of confidence and need of assistant hand in the field especially in aneurysm cases. In large-sized tumors, we preferred to extend the bone flap 1 cm posteriorly [8, 9, 13].

The lateral supraorbital approach takes short time; this shortens the overall operative time. Mean approach time

Fig. 5 A case of olfactory groove meningioma successfully operated on through right-side lateral supraorbital approach. Preoperative axial (**a**), coronal (**b**), and sagittal (**c**) MRI views show olfactory groove meningioma. Postoperative CT axial view (**d**) shows complete removal of the meningioma

in our series was 20 min while in the series of Prof. Hernesneimi it was 14 min because he is a well-known fast surgeon; he has some facilities that saves the time needed for hemostasis as the Sugita frame used for head fixation with strong fishhook retractors, using rani clips in skin edge hemostasis and fibrin glue in epidural space hemostasis [8, 9, 13].

We had one case of postoperative CSF rhinorrhea that stopped spontaneously. One case had subcutaneous CSF collection that disappeared after single tapping and bandage. One case had periorbital edema that subsided spontaneously, and one diabetic case had superficial wound infection that improved with daily dressing and antibiotics.

The cosmetic results were assessed according to the patient and surrounding personnel opinion in follow-up visit despite depending on cultural background and expectation before surgery; the scar was accepted in all patients.

We used a curvilinear skin incision situated behind the hair-line (better for healing and can be sutured intradermally with small invisible linear scar) with better cosmetic results. The skin incision stops 1 cm above the zygoma with less trauma to temporalis muscle. The frontotemporal branch of the facial nerve is safe in this approach because we do not do superficial dissection. The temporalis muscle is split only in its anterior and superior parts, which decreases the incidence of postoperative temporalis wasting and mastication problems. Our cosmetic results were similar to Prof. Hernesneimi because we used the same technique. We did not use the eyebrow incision, which is historically associated with loss of supraorbital sensation or palsy of frontal branch of facial

Table 1 Pathological lesions

Pathology	No.	%
ACoA aneurysm	8	16
PCom aneurysm	5	10
Carotid ophthalmic aneurysm	2	4
ICA bifurcation aneurysm	1	2
Olfactory grove meningioma	12	24
Tuberculum sellae meningioma	8	16
Planum sphenoidale meningioma	7	14
Supraorbital meningioma	5	10
Craniopharyngioma	2	4

Table 2 Relation between tumor type and degree of surgical excision

Pathology	No	Total excision No.	Subtotal excision No.
Olfactory grove meningioma	12	11	1
Tuberculum sellae meningioma	8	6	2
Planum sphenoidale meningioma	7	7	0
Supraorbital meningioma	5	5	0
Craniopharyngioma	2	0	2

nerve. Beseoglu et al. had a series of 54 patients operated through the supraorbital keyhole approach reported. Forty-nine (90.7%) rated the cosmetic results as very good or good, and 5 patients had bad outcome [12, 17, 18].

Sánchez-Vázquez et al. reported hypesthesia of the frontal region appeared in all patients; however, it disappeared completely in all patients as early as the 2nd month after surgery. Inability to raise the eyebrow immediately after surgery was a complaint in all patients; however, in five, the defect disappeared during the 1st month after surgery; in eight others, it disappeared after the 2nd month, and in the remaining patients, it disappeared completely after the 3rd month following surgery [19].

All morbidities and mortalities in our approach were related to lesion pathology or clinical condition of our patients, and there were no approach-related morbidities or mortalities.

The lateral supraorbital approach cannot be done in the presence of angry brain with high intracranial pressure so we paid all efforts to have a slack brain from perfect positioning, perfect neuroanasthesia, and CSF release either from the lumbar subarachnoid space or basal cisterns with minimal brain retraction. The Sylvian fissure appears at the posterior edge of the dural flap and can be easily opened when necessary [8, 9, 13].

Table 3 Clinical outcome according to Modified Rankin scale

Grade	Description	No.
0	No symptoms at all	25
1	No significant disability despite symptoms: able to carry out all usual duties and activities	10
2	Slight disability: unable to carry out all previous activities, able to look after own affairs without assistance	9
3	Moderate disability: requiring some help but able to walk without assistance	2
4	Moderately severe disability: unable to walk without assistance and unable to attend own bodily needs without assistance	1
5	Severe disability: bedridden, incontinent, and requiring constant nursing care and attention	1
Died	Died	2

Table 4 Clinical outcome according to Glasgow Outcome scale

Grade	Description	No.
5	Good recovery: resumption of normal life despite minor deficits, return to work	40
4	Moderate disability(disabled but independent) travel by public transportation, can work in sheltered setting (exceeds mere ability to perform activities of daily living)	6
3	Severe disability(conscious but disabled): dependent for daily support (may be institutionalized but this is not a criteria)	1
2	Persistent vegetative state: unresponsive and speechless, after 2–3 weeks may open eyes and have sleep/wake cycles	1
1	Death	2

Conclusion

The lateral supraorbital approach is a doable, cosmetic and effective corridor to anterior skull base pathologies without significant morbidities or mortalities related to the approach.

Limitations of the study

The number of cases is relatively small. A comparative study between different approaches for the anterior skull base could reveal more consistent results.

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Authors' contributions

Both authors shared in operating on the cases included and their follow-up. Both authors shared in writing and preparing the manuscript. The author(s) read and approved the final manuscript.

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Availability of data and materials

Available on demand

Ethics approval and consent to participate

Ethical approval was obtained from the Ethical committee of our university for this research (approval code: 33476/11/19). Consent to participate is not applicable as this is a retrospective study.

Consent for publication

Not applicable

Competing interests

No competing interests

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References

1. Heros RC. The supraorbital "keyhole" approach. J Neurosurg. 2011;114(3):850–1 discussion 851.
2. Paladino J, et al. The keyhole concept in aneurysm surgery--a comparative study: keyhole versus standard craniotomy. Minim Invasive Neurosurg. 2005;48(5):251–8.

3. Brock M, Dietz H. The small frontolateral approach for the microsurgical treatment of intracranial aneurysms. Neurochirurgia (Stuttg). 1978;21(6):185–91.
4. Delashaw JB Jr, et al. Supraorbital craniotomy by fracture of the anterior orbital roof. Technical note. J Neurosurg. 1993;79(4):615–8.
5. Perneczky A, et al. Keyhole approaches in neurosurgery: volume 1: concept and surgical technique. Vienna: Springer; 2009.
6. Beseoglu K, et al. The transorbital keyhole approach: early and long-term outcome analysis of approach-related morbidity and cosmetic results. Technical note. J Neurosurg. 2011;114(3):852–6.
7. Salma A, et al. Lateral supraorbital approach vs pterional approach: an anatomic qualitative and quantitative evaluation. Neurosurgery. 2011;68(2 Suppl Operative):364–72 discussion 371-2.
8. Romani R, et al. Lateral supraorbital approach applied to tuberculum sellae meningiomas: experience with 52 consecutive patients. Neurosurgery. 2012; 70(6):1504–18 discussion 1518-9.
9. Romani R, et al. Lateral supraorbital approach applied to anterior clinoidal meningiomas: experience with 73 consecutive patients. Neurosurgery. 2011; 68(6):1632–47 discussion 1647.
10. Ormond DR, Hadjipanayis CG. The supraorbital keyhole craniotomy through an eyebrow incision: its origins and evolution. Minim Invasive Surg. 2013; 2013:296469.
11. Bahgat D, Amin R, Hafez M, Zohdi A. Comparison between the lateral supraorbital and the pterional approach, in Neurosurgery department. Egypt: Cairo University; 2004.
12. Gonzalez LF, et al. Working area and angle of attack in three cranial base approaches: pterional, orbitozygomatic, and maxillary extension of the orbitozygomatic approach. Neurosurgery. 2002;50(3):550–5 discussion 555-7.
13. Hernesniemi J, et al. Lateral supraorbital approach as an alternative to the classical pterional approach. Acta Neurochir Suppl. 2005;94:17–21.
14. Tang C, et al. Supraorbital keyhole approach for anterior circulation aneurysms. Turk Neurosurg. 2013;23(4):434–8.
15. Hammad OY, Ali AK, Ezzat WA, Elbahy K, Elhakim AH. Mini craniotomy for anterior skull base lesions. E.J.N.S. 2006;21(2):12.
16. Delfini R, et al. A two-step supraorbital approach to lesions of the orbital apex. Technical note. J Neurosurg. 1992;77(6):959–61.
17. Huynh-Le P, Natori Y, Sasaki T. Surgical anatomy of the anterior clinoid process. J Clin Neurosci. 2004;11(3):283–7.
18. Luo J, Qi K, Chen G. Anatomy of the eyebrow and upper eyelid region and its significance in ptosis surgery. Zhonghua Zheng Xing Shao Shang Wai Ke Za Zhi. 1994;10(6):466–9.
19. Sanchez-Vazquez MA, et al. Transciliary subfrontal craniotomy for anterior skull base lesions. Technical note. J Neurosurg. 1999;91(5):892–6.

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