



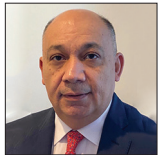
Technical Notes

Endoscope-controlled extended supraorbital keyhole approach through a modified eyebrow incision for a large dural-based solitary fibrous tumor of the frontal convexity: A technical note

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ABSTRACT

Background: The extended supraorbital approach through a modified eyebrow incision is a minimally invasive approach that has been recently described. It entails a lateral extension of the skin incision beyond the lateral end of the eyebrow and allows exposure of the proximal sylvian fissure with a superior degree of surgical freedom in the middle fossa and the parasellar region. In this technical note, we describe an endoscope-controlled extended supraorbital keyhole approach with modified eyebrow incision for excision of a large dural-based solitary fibrous tumor of the left frontal convexity.

Methods: An endoscope-controlled extended supraorbital keyhole approach with modified eyebrow incision was performed to excise a large extra-axial mass attached to the dura of the left frontal convexity and extends from the superior temporal line up to the midline in a 34-year-old male patient presented with 1-year history of headache, dizziness, and blurred vision.

Results: The patient had an uneventful postoperative course with gross total excision of the lesion and satisfying cosmetic appearance. Histopathological examination revealed a Grade 1 solitary fibrous tumor.

Conclusion: We demonstrated the feasibility of the endoscope-controlled extended supraorbital keyhole approach through a modified eyebrow incision for excision of tumors that abut the inner table of the frontal calvarial bone, extend highly above the skull base level, or extend medially reaching the midline. The approach is very versatile and allows a great exposure for a category of lesions deemed not perfectly suitable for the classic supraorbital keyhole approach.

Keywords: Endoscopic, Eyebrow, Keyhole, Solitary fibrous tumor, Supraorbital

INTRODUCTION

The supraorbital eyebrow approach is a minimally invasive approach that allows an excellent access to many pathologies located in the anterior cranial fossa, suprasellar, and parasellar regions.^[6,9,14,17] The technique has been refined over the years^[20] and is currently well-established as safe and effective approach for treating a large constellation of neoplastic, vascular, and traumatic lesions in these areas.^[4,6,7,10,16,18] Nevertheless, the approach has some potential disadvantages,

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specially pertaining to restricted surgical access that is sufficient for safe and effective intracranial surgery.^[20] Options to circumvent the limited visualization through the supraorbital keyhole approach have been introduced and include the incorporation of rigid endoscopes as viewing tools so that the exclusively microsurgical procedure is transformed into an endoscope-assisted^[6,14,17] or endoscope-controlled versions,^[3,8,11] and the utilization of extended supraorbital craniotomy through a modified eyebrow incision.^[5,12]

In this technical note, we describe an endoscope-controlled extended supraorbital keyhole approach with modified eyebrow incision for excision of a large dural-based solitary fibrous tumor of the left frontal convexity and demonstrate that the combination of the extended exposure and the use of the angled rigid endoscopes add greatly to the versatility of the approach.

CLINICAL PRESENTATION

A previously healthy 34-year-old male patient presented with 1-year history of headache, dizziness, and blurred vision. He had no history of trauma, seizures, or loss of consciousness. Neurological examination was normal except for Grade 4 papilledema. Magnetic resonance imaging of the brain [Figure 1] revealed a left frontal extra-axial mass measuring $4.8 \times 4.2 \times 5$ cm. The lesion was attached to the frontal convexity dura. At the level of the frontal skull base, the lesion extended from the superior temporal line laterally to reach the midline medially. The lesion avidly enhanced after contrast medium injection and exerted a significant mass effect with a midline shift of 2.5 cm, effacement of the ipsilateral frontal horn, and subfalcine herniation. Perifocal vasogenic edema was seen in T2-weighted images and involved the rostrum and genu of the corpus callosum as well as the frontal white matter. Although a solitary fibrous tumor was on the preoperative radiological list of differentials, the lesion was thought of as a meningioma before histopathological confirmation of the diagnosis. The mass was excised through a left endoscope-controlled supraorbital keyhole approach through a modified eyebrow incision. The patient had an uneventful postoperative course with gross total excision of the lesion [Figure 2] and satisfying cosmetic appearance.

Surgical technique

Under general anesthesia with the patient in supine position, the head was secured in a MAYFIELD skull clamp® and rotated 30° to the right. The head was then extended 15° with a slight contralateral lateral flexion to help providing easier instrument maneuverability during the procedure.

Skin incision

The skin incision was made within the eyebrow and started just lateral to the supraorbital notch and continued for

further 15 mm within a skin crease after the lateral end of the eyebrow. At the superior temporal line, the temporalis fascia was incised for about 2 cm then the frontalis fascia is cut from the temporal line in a semicircular fashion over the frontal bone with its base at the orbital rim. The temporalis muscle is subsequently dissected off the bone and retracted posteriorly for 2 cm [Figure 3].

Craniotomy

A single burr hole was made using a sharp pit attached to the high-speed drill in the temporal fossa lateral to the superior temporal line at a point that is slightly higher than the classic MacCarty's burr hole. A craniotome is then used to perform a 4×3 cm bone flap. The frontal air sinus was deliberately open. Although this should usually be avoided, it was necessary in our case because of the large lateral extension of the sinus and the tumor medial extent toward the midline.

Dural opening and tumor resection

In Figure 4, the details of dural opening and tumor resection are demonstrated. The exposed dura was incised all around the craniotomy edge because it represented the dural attachment of the tumor. The rigid 4 mm endoscope fixed by a mechanical holder was brought into the surgical field and used as the sole viewing device during the whole procedure. The endoscope trajectory and distance from the surface were frequently adjusted for optimal visualization. When necessary, the scope was held by the assistant surgeon for a more dynamic visualization and surgical manipulation. Furthermore, a 0° endoscope was replaced with angled scopes (30 and 45°) to obtain proper viewing angles toward midline. An irrigation sheath is used to clear the endoscope lens without a need for withdrawing the scope outside the field.

The tumor was encountered immediately on dural removal. Central debulking was undertaken and the tumor outer capsule was grasped and gently pulled toward the centrally debulked area to help developing a dissection plane between the tumor and brain. Cottonoid patties were used to maintain the circumferentially developed plane around the tumor. Bipolar coagulation was used to coagulate the vessels on the gradually exposed tumor surface. Attachment to skull base dura was freed and the tumor was removed *en bloc*.

Closure

The opened frontal sinus mucosa was coagulated and an autologous fat graft was used to obliterate its cavity. Surgicel® was used to support the fat graft and Tisseel® glue was used to seal the frontal sinus. Artificial dura was then used to close the dural defect and the bone flap was returned and secured

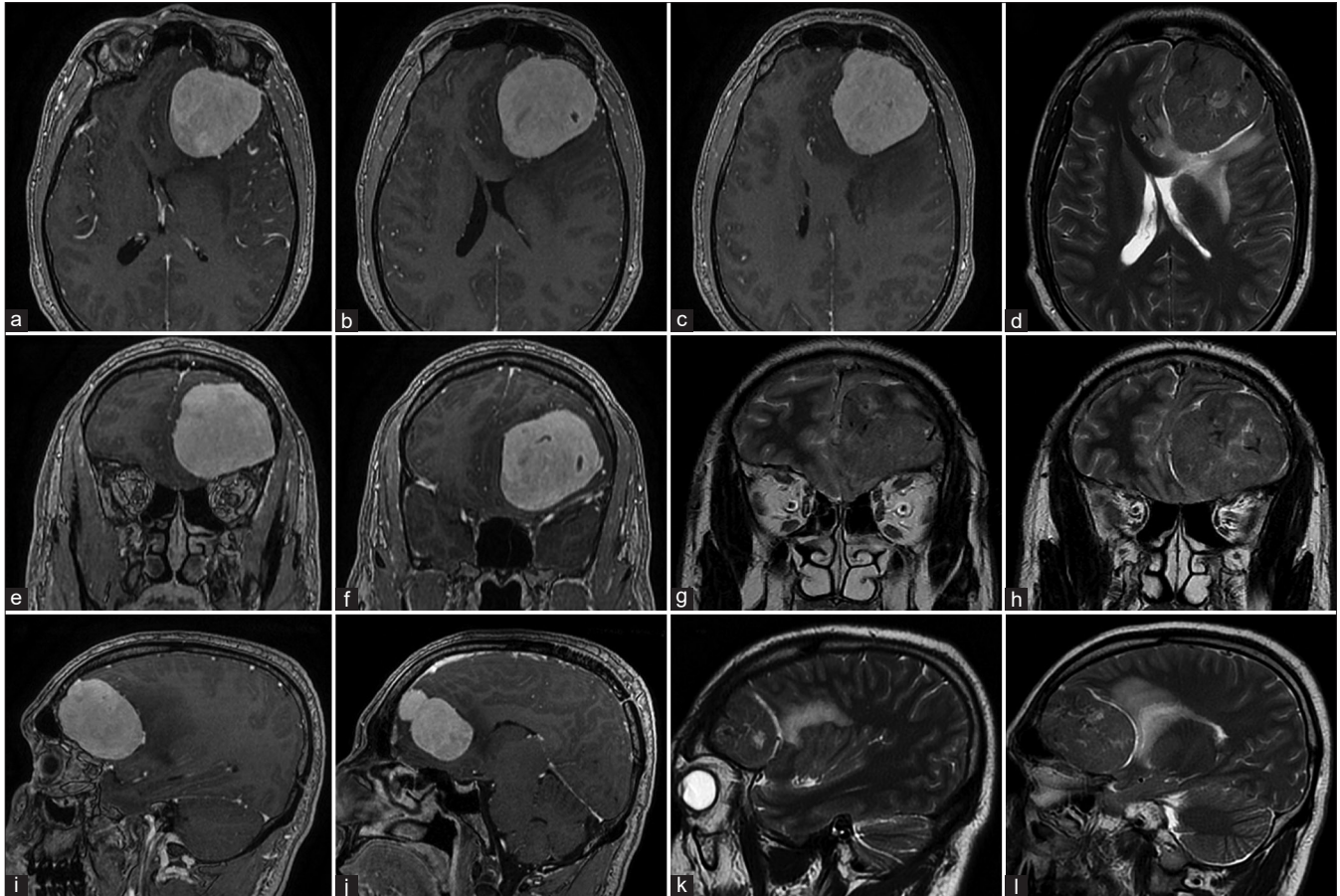


Figure 1: Preoperative magnetic resonance imaging. Serial images in axial (a-d), coronal (e-h), and sagittal planes (i-l) reveal a left frontal extra-axial mass based on the convexity dura. The mass avidly enhanced after contrast medium injection (a-c, e, f, i and j). At the level of the frontal skull base, the lesion extended from the superior temporal line laterally to reach the midline medially. Note the extent of the frontal air sinus in relation to the tumor base (a-c). In T2-wighted images (d, g-f, and k-l), a well-defined arachnoid plane is present between the tumor and the surrounding brain. Significant perifocal vasogenic edema is seen to involve the rostrum and genu of the corpus callosum as well as the frontal white matter.

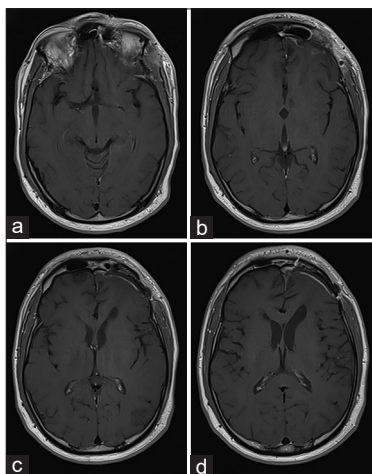


Figure 2: Postoperative T1-wighted post contrast serial MR images (a-d) revealing gross total resection of the tumor. The extent of the bone flap is seen in (c and d).

with titanium plates and screws. Wound closure is then undertaken in the usual manner.

DISCUSSION

The extended supraorbital approach through a modified eyebrow incision is a minimally invasive approach that has been recently described and is essentially a modification of the classic supraorbital eyebrow keyhole approach. It entails a lateral extension of the skin incision beyond the end of the eyebrow and allows exposure of the proximal sylvian fissure with a superior degree of surgical freedom in the middle fossa and the parasellar region without large compromise of the cosmetic outcome.^[5,12] Out of our solid commitment to the concept of minimally invasive neurosurgery, we utilized this approach in combination with full endoscopic control to excise the tumor described herein. Indeed, the pathoanatomical features of the tumor make it not a very

suitable candidate for the classic supraorbital craniotomy. These features include the tumor's attachment to the dura of

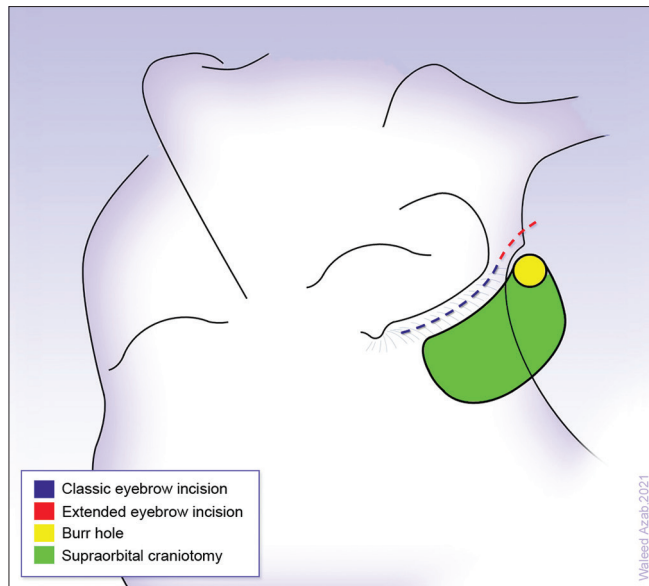


Figure 3: Illustration of the modified eyebrow incision. The standard skin incision (Dark blue) within the eyebrow is extended for further 15 mm within a skin crease after the lateral end of the eyebrow (Red). Modified from Azab *et al.*^[2] with permission.

the frontal convexity, its large size, its medial extension up to the midline, and the relatively broad extension of the frontal sinus behind the tumor attachment.

The extent of exposure

According to the keyhole principle, lesions located near the surface of the brain typically require a bony opening as large as the lesion, while deeper lesions can often be removed through a much smaller craniotomy [Figure 5].^[13,15,20] Although the extended supraorbital approach through a modified eyebrow incision was developed to achieve more exposure and surgical maneuverability of lesions in the middle fossa and parasellar region,^[5] we rationalized that the larger exposure gained by the extended eyebrow incision and craniotomy would offer a more ample area of tumor surface for both initial central debulking and dural attachment excision in our patient. Moreover, the larger lateral exposure would also allow greater freedom of visualization and manipulation in both superior and medial directions, that is, at both the tumor dome and midline, because further angulation of the shaft of the endoscope will still be possible without compromising the working space [Figure 6]. Throughout the procedure, sufficient degree of initial central debulking was possible and adequate working space was available.

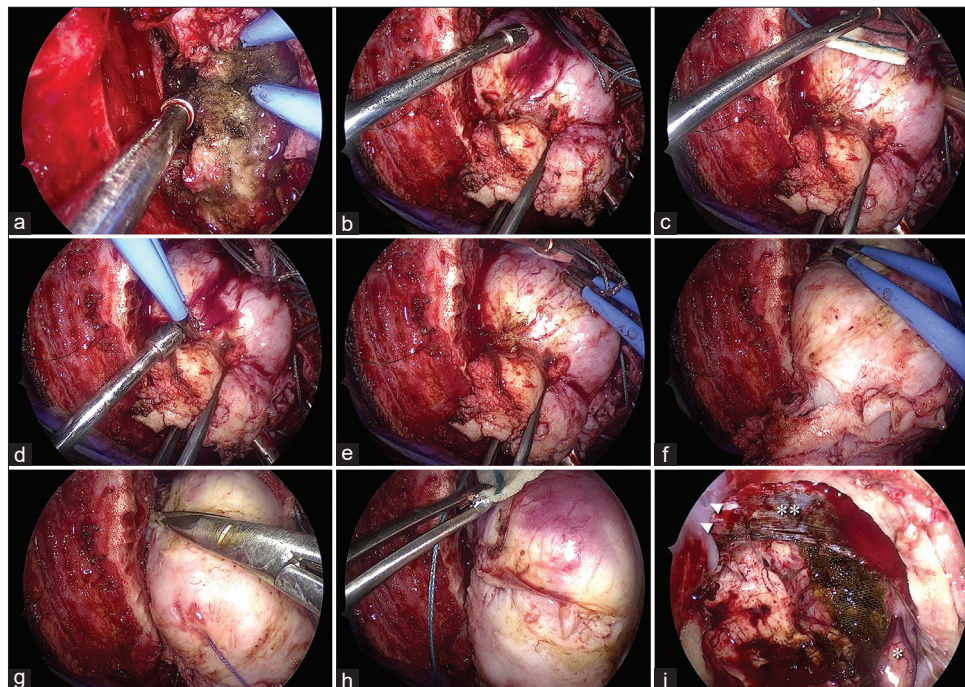


Figure 4: Intraoperative views during tumor excision under endoscopic control. (a) The tumor has been centrally debulked. Bipolar coagulation within the tumor is undertaken to control bleeding. (b and c) Tumor is grasped reflected toward the debulked center and cottonoid patties are inserted into the plane between tumor and brain. (d and e) Further tumor capsule is exposed and vessels on the surface are coagulated. Coagulation (f) and cutting (g) of the inferior attachment of the tumor capsule are then undertaken and a cottonoid patty is inserted before the tumor is removed (h). (i) Final hemostasis of the tumor bed has been undertaken and the normal brain at the upper extent of the tumor cavity (asterisk), falx cerebri (double asterisks), and Tisseel used for closure of the frontal air sinus (arrowheads) is viewed.

The use of the endoscope

The use of angled scopes was also critical because it allowed looking under the surface of the craniotomy so that the hidden parts of the tumor and neighboring brain tissue were seen and manipulated [Figure 6]. Although it can be argued that a microscopic approach can be used to resect the tumor in our patient, it is our opinion that in such a case, an

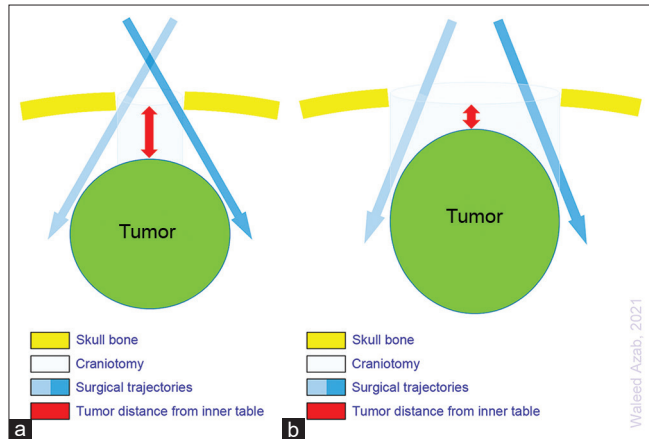


Figure 5: According to the keyhole principle, deeper lesions can often be removed through a much smaller craniotomy (a), while lesions located near the surface of the brain typically require a bony opening as large as the lesion (b).

endoscopic assistance is a minimum requirement to be able to excise the tumor through a minimally invasive supraorbital keyhole approach and avoid a traditional larger craniotomy. In addition to its larger field of view in comparison to surgical microscope, one of the greatest advantages of the rigid endoscope is that it brings the light inside the surgical field, a feature that results in a very highly illuminated area of interest. Furthermore, the close proximity of the light source to the structures being viewed eliminates shadows within the field, adding to the extreme clarity of the viewed images. Notably, one of the very important optical properties of the rigid endoscope is the greater depth of focus, which simply means that the viewed objects remain in focus within a greater range of distances from the viewing lens. This means lesser need to readjust the focus of the endoscope during the procedure, a feature that results in a seamless operative workflow.^[2]

Despite the fact that surgical microscopes with coaxial slit illumination provide the high magnification and good stereoscopy, using the surgical microscope during a keyhole procedure forces the surgeon to work along the microscope's line of view.^[20] This results in much less capability of looking around the corners and dictates frequent adjustment of the viewing angle during microscopic keyhole surgery to allow illumination and visualization of the area of interest deep in the surgical field. Such limited capability of the microscope is

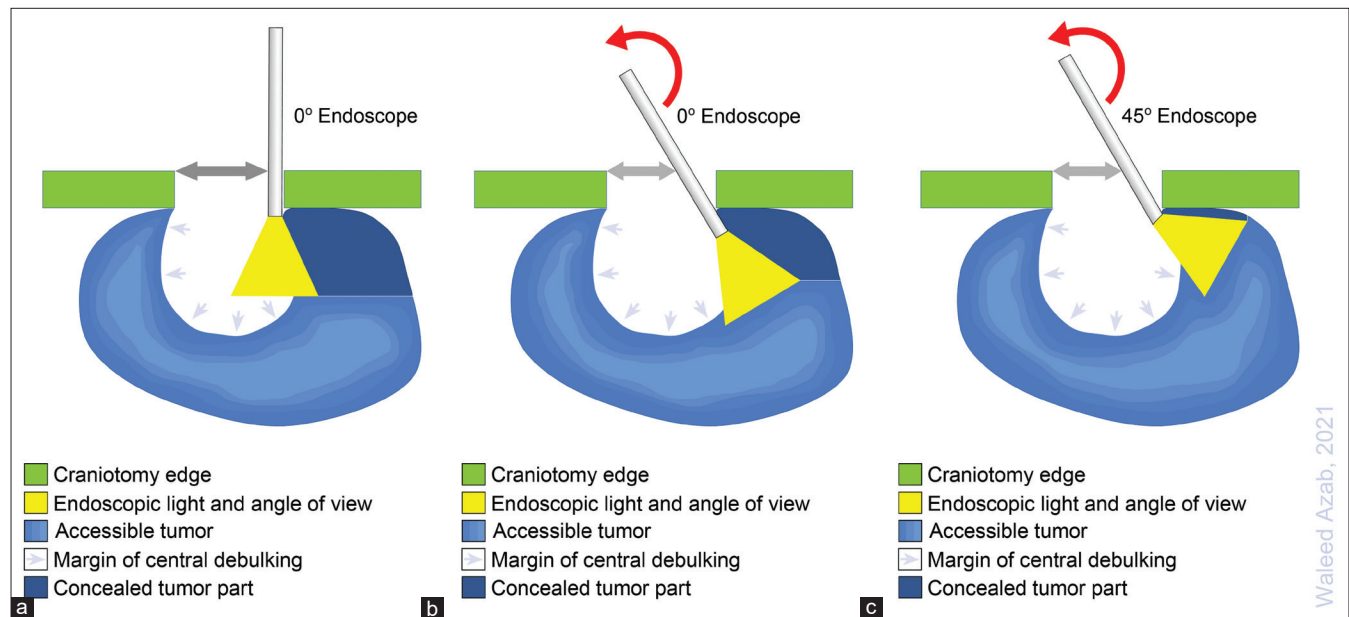


Figure 6: The significance of combining the relatively larger craniotomy offered by the extended supraorbital keyhole approach with endoscopic control. After initial central debulking, the 0° endoscope allows further tumor visualization and removal within the scope's field of view. Remaining tumor parts under the surface are, however, not visible (a). Angulating the shaft of the 0° endoscope enables further visualization and removal of these tumor parts while the working space is still uncompromised (b). Replacing the 0° with angled (30° and 45°) scopes further discloses the final remaining tumor tissue under the bone while the working space is still maintained (c). Red curved arrows indicate angulating the endoscope shaft. Grey arrows indicate the craniotomy width utilized for angulating the endoscope shaft.

understandably an inevitable consequence of the light source and the viewing lens being located outside the craniotomy. In addition, the loss of light energy at the edges of the small craniotomy and the dropped shadows on the structures within the field further contribute to the lesser quality of the microscopic view obtained during supraorbital keyhole surgery.^[2]

Endoscopic control versus endoscopic assistance

Due to the benefits of endoscopic view, endoscopic assistance in supraorbital keyhole approach has by far been the most frequently reported since the early beginnings of using the procedure^[1,6,9,14,17,19] while only very few reports of endoscope-controlled approach are published.^[3,8,11] One of the main reasons for relying mainly on the surgical microscope for surgical control during the procedure and using the endoscope as a complimentary visualization tool is that the use of a non-stereoscopic (two-dimensional) endoscope result in loss of depth perception. This issue is easily overcome by moving the scope within the field of view and is usually not very troublesome for surgeons with familiarity with endoscopic use. It is our opinion that the full endoscopic control actually negates the problem of suboptimal visualization associated with a small exposure during the whole procedure. Based on the definite superiority of endoscopic view, it is our belief that the use of rigid endoscopes as the sole viewing tools is worth being more adopted and expanded.

Potential complications and choice of the approach

Avoidance of injury to the temporal branches of the facial nerve was achieved by bringing the incision posteriorly rather than inferiorly after its eyebrow component ends. Furthermore, the subperiosteal dissection of the temporalis muscle off the bone (subperiosteal dissection) is critical in avoiding frontalis branch injury. Although not performed in our case, the use of a neurostimulator to seek out the frontal facial branch once the temporalis muscle fascia is exposed has been described and allows safe dissection from the lateral canthal line back over the temporalis fascia.^[5] We are planning to adopt the use of neurostimulation in our future cases.

It is of note that other conventional approaches such as frontal, pterional, and mini-pterional approaches can also be utilized in this case. However, in our opinion, the endoscope-controlled extended supraorbital approach through a modified eyebrow incision is the least invasive and the shortest route to the tumor in our patient. Opening the frontal air sinus should of course be avoided; however, meticulous closure using a combination of autologous fat supported by Surgicel® and Tisseel® glue is very effective in

preventing CSF leaks. Based on our experience in using this technique for frontal sinus closure, we opted to perform the approach described herein in lieu of the other alternative approaches.

CONCLUSION

We demonstrated the feasibility of endoscope-controlled (purely endoscopic) extended supraorbital keyhole approach through a modified eyebrow incision for excision of tumors that abut the inner table of the frontal calvarial bone, extend highly above the skull base level, and extend medially reaching the midline. The approach is very versatile and allows a great exposure for a category of lesions deemed not perfectly suitable for the classic supraorbital keyhole approach.

Authors' contributions

All authors contributed equally to the manuscript.

Ethical approval

This is technical note. The Research Ethics Committee in Ibn Sina Hospital has confirmed that no ethical approval is required.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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