

External endoscopic multiportal frontal sinus obliteration for laterally pneumatized frontal sinus: a feasibility study

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Introduction

Osteoplastic flap procedure is a standard method used for frontal sinus obliteration. Endoscopic external frontal sinus obliteration is a minimally invasive new technique confined to small-sized and medium-sized pneumatized frontal sinuses.

Objective

The aim of this study was assess the feasibility and surgical application of this technique for far-lateral pneumatized frontal sinuses.

Materials and methods

Ten sides of adult dry skull were assessed for frontal sinus pneumatization and supraorbital cells by computerized tomography. Three sides were selected with frontal sinus pneumatization extending beyond midorbital line. Feasibility of obliteration of frontal sinus was tested. Endoscopic external multiportal frontal sinus approach was done using angled endoscopy and standard instrumentation. Classic frontal sinus trephine port was performed initially to safely locate the frontal sinus. In-situ nondisplaced superiorly based miniosteoplastic flap reaching to midorbital plane was performed providing another port. Additional lateral trephine port beyond midorbital plane was performed. Angled endoscopy and standard instrumentation were used reciprocally through different ports to reach different areas of frontal sinus. Outcome parameters were ability to reach corners of frontal sinus, remove sinus septae and nasofrontal duct, and maintain integrity of anterior wall of frontal sinus. Surgical application was done in two cases of frontal sinus mucocele and meningoencephalocele.

Results

In three laterally pneumatized frontal sinuses of dry skulls, corners, septae, and nasofrontal ducts could be handled using external multiportal endoscopic approach without disruption of anterior frontal wall. Three ports allowed two-hand surgical technique. Surgical application in two cases with follow-up over 6 months revealed no significant complication. Subcutaneous collection developed in one case after 2 weeks and resolved with medical treatment.

Conclusion

External endoscopic multiportal obliteration is feasible for frontal sinuses with lateral pneumatization beyond midorbital line. This technique is minimally invasive with less morbidity. Long-term follow-up in a larger series is needed.

Keywords:

endoscopic, frontal sinus obliteration, feasibility, laterally pneumatized

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Introduction

Frontal sinus obliteration is indicated in chronic frontal sinusitis with failed or infeasible endoscopic endonasal surgical treatment like Draf III procedure. According to Draf and colleagues, type III endoscopic endonasal frontal sinostomy is technically not possible if anterior-posterior diameter of frontal sinus is less than 0.8 cm. This fact excludes from the beginning a significant portion of frontal sinuses to be amenable to full range of endoscopic frontal sinostomies. Other indications of frontal obliteration include lateral-placed pathology like mucoceles, destruction of posterior wall, marked destruction of anterior wall, cerebrospinal fluid (CSF) leak, and tumors and risk factors for failure of endonasal endoscopic sinostomy

like sinonasal polyposis and recurrence. Frontal sinus obliteration is usually performed through bicoronal or unilateral frontal incision with osteoplastic elevation and fat or synthetic material sinus packing [1].

Complications of obliteration include injury of frontal branch of facial nerve, disruption of osteoplastic flap with necessary reconstruction, intracranial entry during flap elevation, and long-term danger of mucocele formation, esthetic defects, infection, and prolonged

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hospital stay [2,3]. In an attempt to reduce these morbidities, Ung *et al.* [4] reported an endoscopic minimally invasive frontal sinus obliteration with equivalent short-term results to osteoplastic flap and obliteration. The procedure was performed through a small supraorbital incision and frontal trephine port and therefore confined only to small-sized to medium-sized frontal sinus [4]. In the endoscopic era, obliteration is still needed particularly in far-lateral frontal pathology. The aim of this study was to test the feasibility of external endoscopic multiportal approach for frontal sinus obliteration with far-lateral pneumatization.

Materials and methods

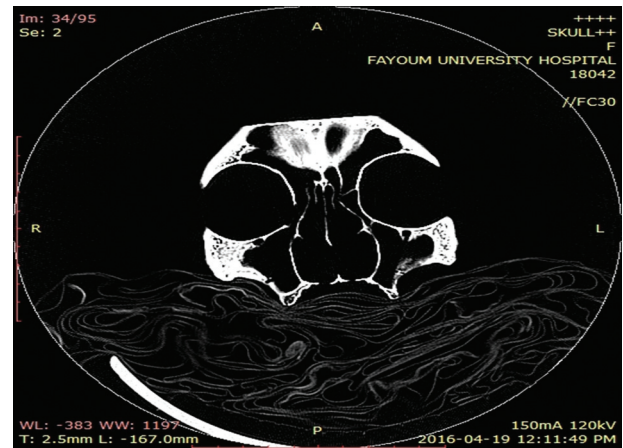
Radiological study

The anatomical part was done on noncadaver dry skull models. A detailed consent was taken from patients subjected to surgery. An ethical approval was obtained from Committee of the Department of Otorhinolaryngology, Fayoum University. Computerized tomography (CT) axial cuts bony windows of paranasal sinus (PNS) less than 1 mm were done for five adult dry skulls as part of navigation-guided study protocol. Registration error proved to be less than 0.025 mm during trial indicating high accuracy in all dry skulls. Reconstructed coronal and sagittal cuts were obtained to determine degree of frontal sinus pneumatization, supraorbital cells, and other cells if any. Lateral pneumatization of frontal sinus was defined as presence of pneumatization beyond the midorbital plane passing through superior rectus muscle. Lateral pneumatization was best assessed in cuts showing lateral orbital walls and frontal sinus (Fig. 1).

Dry skull feasibility study

The dry skull was fixed in supine position with slight extension allowed in a holder similar to that used for temporal bones. A classic frontal trephine was done 0.5 cm from midline at level of orbital roof. Angled 45° endoscopy was done to explore sinus cavity and dimensions. A superior miniosteoplastic flap was fashioned. Initially, a horizontal osteotomy with Kerrison punch ronguer was done from first trephine to midorbital plane 1 cm above orbital roof. Two vertical osteotomies were fashioned at both end of horizontal osteotomy. The second trephine port is performed along lateral vertical osteotomy preferably bisecting it. Care must be taken not to disrupt integrity of anterior frontal wall. The horizontal osteotomy serves as an additional port for fine instruments like dissectors. The miniosteoplastic flap is not elevated unless decision is taken to abandon the endoscopic technique.

Figure 1



Dry skull 5. Computerized tomography of paranasal sinuses coronal cuts bony windows showing bilateral frontal sinus pneumatization beyond midorbital plane (yellow star). Yellow arrow indicates interfrontal cell.

Performing multiple ports before fashioning of the miniosteoplastic flap make the later difficult to obtain in a stable manner. If more ports are needed or two-hand technique is acquired an additional port is done laterally midway between midorbital plane and lateral orbital wall. All bony septae were removed and sinus corners handled with different instrumentation. In case of supraorbital cells, septations with frontal sinus should be removed and junction with ethmoidal complex occluded (Fig. 2a and b).

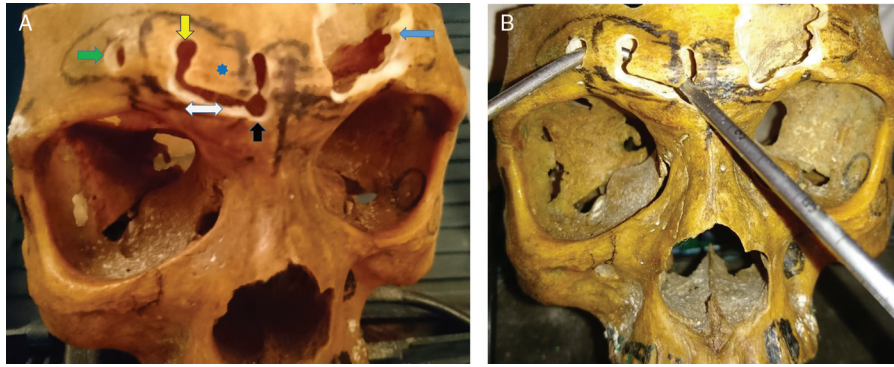
Surgical technique

A medial supraorbital incision was done through the eyebrow. In the two cases, an approach was adopted similar to that used in feasibility study. The mucosa and septation were removed and or ablated with unipolar diathermy. The nasofrontal duct was occluded and mucosa was inverted inside. In case of CSF leak, the meningoencephalocele was reduced with bipolar diathermy and posterior wall reconstructed with fascia lata. Similar occlusion of junction of supraorbital cells with ethmoid complex can be done with pledgets of fascia. The frontal sinus cavity was packed with fat impregnated in betadine solution. Additional gel-foam packing can be used. The supraorbital incision is closed in two layers with final subcuticular layer.

Case 1

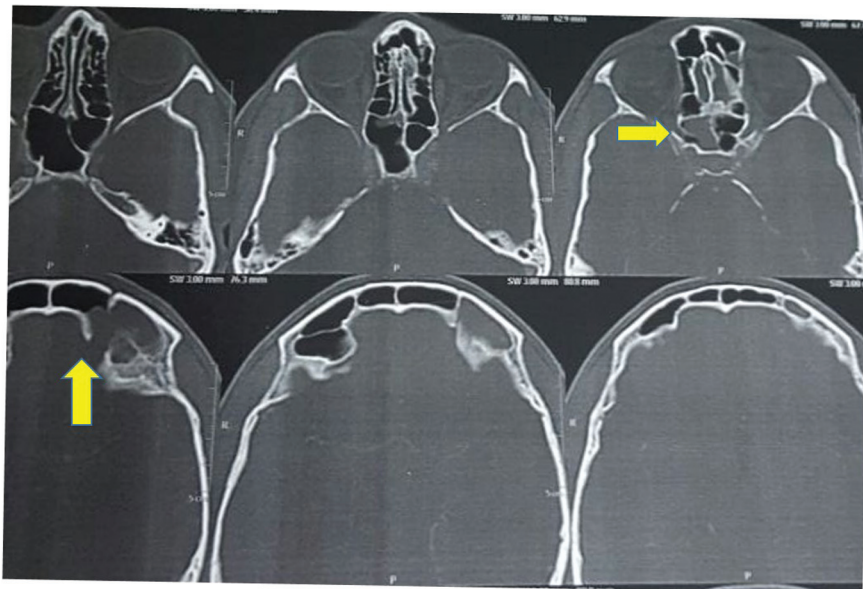
A 22-year-old male presented with late (after 1 year) post-traumatic CSF leak after motor car accident. Patient had failed conservative therapy. CT and magnetic resonance of PNSs (Fig. 3) revealed meningoencephalocele of right sphenoid and left frontal sinus. The latter was situated far-lateral in the frontal sinus with defect in posterior wall at junction with supraorbital cell. Endoscopic endonasal repair

Figure 2



(a) Dry skull model. Right frontal in situ mini osteoplastic flap (blue star) with horizontal limb (white arrow), three ports (green, black and yellow arrows). Left frontal sinus open showing septum and supraorbital cell (blue arrow). (b) Same dry skull model. Right frontal multiportal approach with two instruments (right curved suction tip and left 45 degrees angled Bleksely forceps).

Figure 3



CT paranasal sinus showing right sphenoidal (horizontal arrow) and left frontal (vertical arrow) meningoencephalocele. Left frontal posterior wall disrupted at septum with supraorbital cell.

and obliteration of right sphenoid sinus were done. External endoscopic multiportal repair and obliteration was performed. Follow-up after 6-month revealed successful repair without complications (Fig. 4a and b).

Case 2

A 17-year-old male presented with nasal obstruction and left inferolateral proptosis. CT and magnetic resonance of PNSs (Fig. 5a and b) revealed extensive allergic fungal sinusitis with left orbital invasion and laterally placed frontal mucocele with defect of orbital roof. Endoscopic endonasal eradication of fungal sinusitis was done with frontal recess clearance. CT PNS revealed distorted anatomy of frontal recess, asymmetrical skull base level, and distorted middle turbinate. Frontal ostium was not localized endoscopically. Frontal fungal

sinusitis and laterally placed mucocele were cleared through external endoscopic multiportal approach and obliteration (Fig. 6a and b). The patient developed subcutaneous collection 2 weeks postoperatively, which was cleared by antibiotic therapy. Otherwise follow-up 6 months later revealed successful obliteration with no complication (Fig. 7).

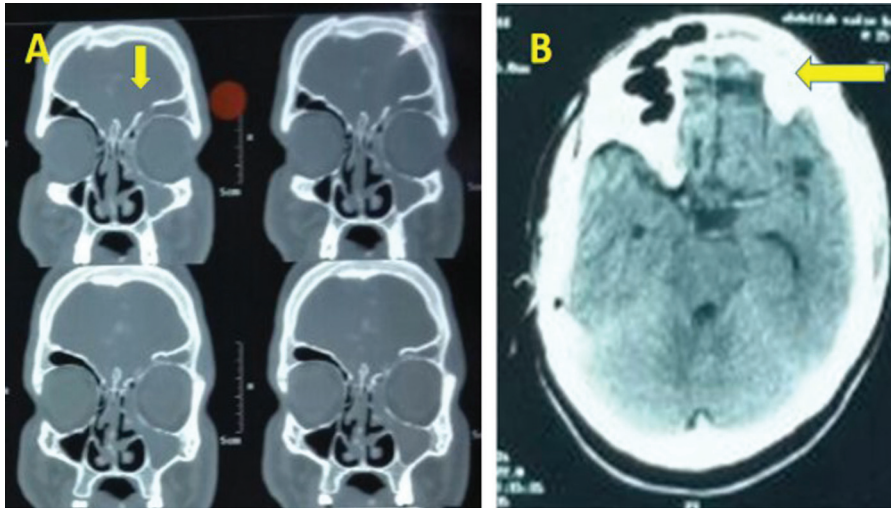
Results

Results of computerized tomography for selection of dry skull with lateral pneumatization of frontal sinus

Skull 1

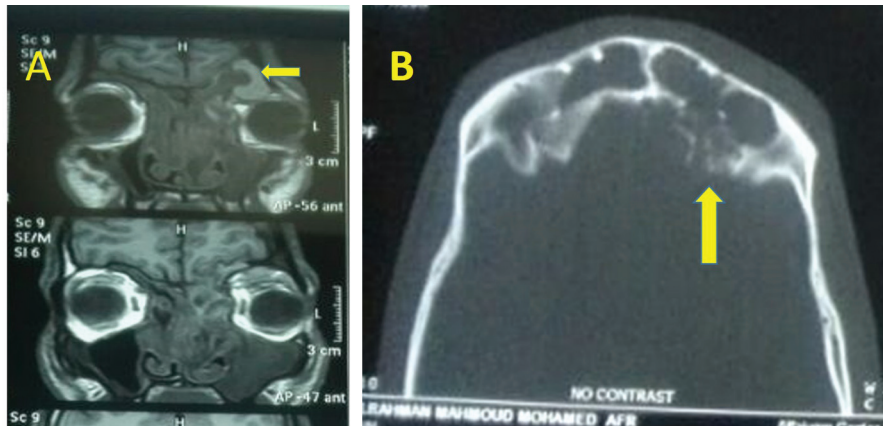
Left frontal pneumatization to midway between midorbital plane and lateral nasal wall, right frontal pneumatization to midorbital plane, and bilateral supraorbital cells were recorded.

Figure 4



(a) Axial soft tissue windows showing successful obliteration (yellow arrows). (b) Postoperative CT paranasal sinus bony windows.

Figure 5



(a) CT PNS showing left frontal posterior table disruption with left supra orbital cell. (b) MRI PNS showing extensive allergic fungal sinusitis with left frontal far lateral mucocele.

Skull 2

Bilateral frontal pneumatization reaching not extending beyond midorbital plane, with no supraorbital cells, was recorded.

Skull 3

Right frontal pneumatization reaching to midorbital plane and left hypoplastic pneumatization reaching the medial orbital wall were recorded.

Skull 4

Bilateral hypoplastic frontal sinus just reaching media orbital walls was recorded.

Skull 5

Bilateral lateral pneumatization extending to midway between midorbital line and lateral nasal wall,

no supraorbital cells, and large interfrontal and supraorbital cells were recorded.

Consequently, only three sides were included in the study.

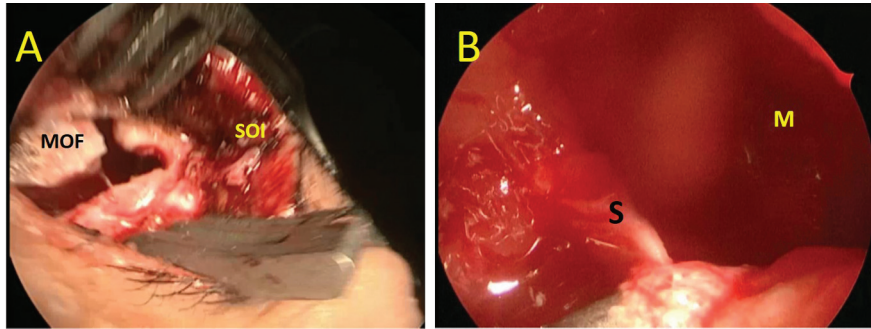
Dry skull feasibility study

In the three dry skull sides encountered in this study, frontal sinus corners, septae, and nasofrontal duct were accessible by angled endoscopy and standard curved instrumentations including curved suction tips, 30° and 45° angled Bleksely forceps, and straight hand pieces of drills. Two ports were enough for endoscopy and one instrument, whereas three ports allowed two-hand technique.

Surgical application results

The technique was used successfully in two cases removing mucosa and septa and drilling the sinus

Figure 6



(a) Endoscopic view of left frontal sinus after removal of septum (S) and far lateral mucocele (M). (b) Endoscopic view of supraorbital incision (SOI) and in situ mini osteoplastic flap with multiportal approach.

Figure 7



CT PNS coronal cut showing clearance of allergic fungal sinusitis, far lateral mucocele and successful obliteration (yellow arrow).

floor and narrow corners. The nasofrontal duct was successfully occluded. No disruption of anterior wall or esthetic complication has occurred. In case 2, subcutaneous collection occurred 2 weeks postoperatively and subsided without recurrence with short-term medical treatment. The same case developed transient postoperative frontal numbness.

Discussion

In the era of endoscopic endonasal sinus surgery, frontal sinus obliteration is still indicated in a significant portion of patients particularly in far-lateral frontal pathologies. Limited reports suggested the use of flexible endoscopy to reduce the need of open approaches [5]. This applies for visualization but not for surgical procedures. Osteoplastic flap obliteration has better results and less recurrence in comparison with endoscopic approaches. Osteoplastic frontal flap with obliteration is still a highly efficient procedure for

long-term results, yet with considerable morbidity and relative invasiveness. Undue cost effectiveness is attributed to possible need of navigation-guided harvest of osteoplastic flap to avoid intracranial and orbital entrance, long hospital stay, and possibility of mini plates or titanium mesh reconstruction [6]. Furthermore, the learning curve of the procedure among rhinologists is poor, amenable to few cases and predominance of endoscopic procedures. Although highly effective, the procedure does not exclude future development of mucocele. Therefore, candidate patients are asked to consent for such complications and long-term follow-up [1].

Early attempts to reduce such morbidity were the suggestion of performing miniosteoplastic flap. It, however, does not resolve the problem of reconstruction [2]. Further reports of Ung *et al.* [4] described an endoscopic frontal obliteration through trephine with equivalent short-term results to osteoplastic flap obliteration. Ung *et al.* [4] confined the procedure to small-sized and medium-sized frontal sinuses. They used a single port through classic trephine, which limited instrumentation to reach different areas of frontal sinus [4]. This study therefore tested the feasibility of performing obliteration of laterally pneumatized frontal sinuses through minimally invasive external endoscopic multiportal approach. Lateral pneumatization was defined as extension beyond midorbital line with an incidence of 30% of dry skull sides in this study in CT. The use of multiportal access to frontal sinus allowed better visualization, ease of instrumentation allowing surgery in large frontal sinuses, and probably improving essential steps for successful obliteration. These steps include total removal of septae and mucosa, drilling of corners, and obliteration of nasofrontal duct. Our results show that extension lateral to midway between midorbital plane and lateral orbital wall usually necessitates two ports for endoscopic maneuverability. Extension beyond this level may

indicate addition of third port in lateral part of frontal sinus. The first port of classic frontal trephine is essential not only for safe location of frontal sinus but also for control and obliteration of nasofrontal duct. In comparison, fashioning of osteoplastic flap needs preferably neuronavigation to avoid intracranial entry. The horizontal limb of in-situ miniosteoplastic flap allowed free instrumentation of frontal sinus while still maintaining anterior frontal wall integrity. At same time, the option of osteoplastic flap is maintained in case the surgeon doubts proper removal of frontal sinus mucosa.

Radiological assessment of frontal sinus is essential to select proper surgical treatment. Distance between anterior and posterior tables less than 8 mm excludes the trial of Draf III endoscopic sinostomy [1]. Far-lateral pneumatization beyond midorbital plane makes endonasal endoscopic surgery difficult even if combined with 'from above' approach. Volumetric classification of frontal pneumatization is impractical for surgical decision between endoscopic or open approaches [7]. Meticulous search for presence or absence of supraorbital cell is mandatory. After removal of septa between frontal sinus proper and supraorbital cells, obliterating the opening of lateral in ethmoidal complex is important to avoid mucocele formation. The presence of other frontal cells in infundibulum or interfrontal cells must be studied preoperatively to avoid residual mucosa or missing the nasofrontal duct.

The follow-up period in this study was 6 months, being primarily a feasibility study. This is in comparison with a study by Ung *et al.* [4] where follow-up period was 2.5 years comparing similar technique with osteoplastic flap. Both studies showed successful obliteration with minimal complications [4].

One disadvantage of this study was the use of dry skull model. The model lacks sinus mucosa but allowed perfect testing of possible visualization of sinus

corners and instrument maneuverability. Another disadvantage was the small sample size attributed to strict selection criteria of lateral frontal pneumatization beyond midorbital plane. This led to exclusion of seven sides of dry skulls. The two cases used for surgical application had same selection criteria.

Conclusion

The external endoscopic multiportal frontal sinus obliteration is feasible for far-lateral pneumatized frontal sinuses. The technique is minimally invasive, with minimal complications and achieved successful frontal sinus obliteration over short-term follow-up. A larger sample is needed with long-term follow-up to compare these results with conventional osteoplastic frontal sinus obliteration.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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