

A Novel Combined Transorbital Transnasal Endoscopic Approach for Reconstruction of Posttraumatic Complex Anterior Cranial Fossa Defect

Abstract

The transorbital neuroendoscopic surgery (TONES), endoscopic transnasal skull base procedures, and the concept of multiportal minimal access neurosurgery are novel, rapidly evolving approaches in the management of complex skull base lesions. A 27-year-old male presented with a history of road traffic accident with nasal bleed, cerebrospinal fluid (CSF) rhinorrhea, and left eye deformity. There was left upper eyelid ecchymosis, orbital dystopia, left pupil was dilated, and fixed with no extraocular movements. The computed tomography scan showed basifrontal contusion and complex comminuted anterior cranial fossa (ACF) fracture involving left cribriform plate and left orbital roof with fracture fragment impinging on the superior rectus muscle with suspicious orbital CSF leak. There was no improvement with conservative management. Hence, a novel combined TONES, transnasal endoscopic multiportal surgery was undertaken for the removal of fracture fragments and multi-layered closure of the complex ACF defect. The patient had a complete resolution of orbital dystopia and visual loss with no evidence of CSF leak postoperatively.

Keywords: Anterior cranial fossa fracture, cerebrospinal fluid rhinorrhea repair, combined endoscopic transorbital transnasal approach, orbital cerebrospinal fluid leak, orbital trauma, transorbital neuroendoscopic surgery

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Introduction

The most common sites of traumatic cerebrospinal fluid (CSF) fistula are the anterior and middle cranial base, which leads to CSF rhinorrhea, otorrhea, or rarely CSF into the orbit (cranio-orbital fistula).^[1,2] Bone fragments may act as a trap door preventing the fistula from closing. A small subset of patients who are resistant to conservative management require surgical intervention.^[3]

Conventionally, CSF leaks were closed by neurosurgeons through a craniotomy approach.^[4,5] This approach is associated with the morbidity from frontal lobe retraction and anosmia.^[6,7] The endonasal repair of CSF leak has gained significance with the advent of endoscope. However, the endoscopic endonasal corridor used alone has the limitation of access to the far lateral supraorbital defects of the anterior cranial fossa (ACF). The superior transorbital portal gives access to the lateral frontal sinus lesions, superior and posterior orbital lesions, and ACF CSF leaks.^[8]

A multiportal surgery can be undertaken taking advantage of the eight orbital portals in transorbital neuroendoscopic surgery (TONES) and two nasal corridors in various combinations to treat various skull base pathologies. We have used one such novel technique of combination of superior transorbital portal in combination with transnasal corridor to manage a complex ACF defect.

Case Report

History and examination

A 27-year-old male presented to us with a history of road traffic accident following which he developed loss of consciousness, nasal bleed, left eye deformity, and lacerated wound in the left upper eyelid which was sutured elsewhere. There was left upper eyelid ecchymosis with inferior and mild lateral displacement of the globe [Figure 1c]. The left pupil was dilated and fixed with no extraocular movements. There was evidence of CSF rhinorrhea.

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DOI: 10.4103/ajns.AJNS_363_20

Quick Response Code:



How to cite this article: Vedhapoodi AG, Periyasamy A, Senthilkumar D. A novel combined transorbital transnasal endoscopic approach for reconstruction of posttraumatic complex anterior cranial fossa defect. Asian J Neurosurg 2021;16:136-40.

Submitted: 25-Jul-2020 Revised: 01-Oct-2020
Accepted: 11-Jan-2021 Published: 20-Mar-2021

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Initial computed tomography (CT) brain showed basifrontal contusion with complex comminuted fracture of ACF and the orbit [Figure 1a and b]. Although the patient's general condition improved the proptosis and chemosis of the left eye was increasing, and patient's vision was deteriorating from counting fingers to light perception, in spite of conservative measures. Hence, a repeat CT scan with paranasal sinus cuts was taken. This showed a resolving frontal contusion with a complex comminuted ACF fracture. There was fracture dislocation of entire lateral lamella of cribriform plate. It extended from the medial lamella of cribriform plate medially to the orbital plate of frontal bone laterally and from anterior fovea anteriorly to the junction with the planum sphenoidale posteriorly. A communication was evident between the ACF and the orbit. There was left orbital roof fracture with fracture fragment impinging on the superior rectus muscle. There was a floor of orbit fracture with herniation of orbital fat. Preoperative visual-evoked potential showed prolonged P100 latencies.

Operative procedure

A transorbital endoscopic approach was initially undertaken through the upper eyelid lacerated wound [Figures 1c and 2]. The orbital periosteum was incised, and subperiosteal plane was elevated. The orbital roof fracture fragments were dissected and removed [Figure 2a and b]. Dural tear was identified, and the defect margins were delineated all

around except medially [Figure 2c and d]. Through the transnasal approach, Hadad flap was raised. After initial exposure, bony fragments present in agger nasi region were removed, and the prolapsing medial orbital wall was delineated. A Draf IIB was performed. An active CSF leak was present. The anterior ethmoidal artery was identified, coagulated, and divided. Fracture fragments in the cribriform area were removed [Figure 3a and b]. The margins of the bony defect were delineated from the anterior fovea to junction with planum sphenoidale posteriorly (approximately 6 cm), medial lamella of cribriform to orbital roof laterally [Figure 3d]. There was a linear tear in the dura through which the basifrontal cortex region with contusion was visualized [Figure 3c]. The defect was plugged with fat harvested from thigh from the orbit side and then the nasal side. We used a novel maneuver wherein the fascia lata graft was spread from the orbit side [Figure 4 Upper], pulled through to the nasal side, draped over the entire defect and tucked [Figure 3e]. Surgicel was applied. Septal cartilage harvested was used to support the fascia lata on the nasal side, and this was covered with Hadad flap [Figure 4 Lower]. Another layer of surgicel and then fibrin glue were applied. Hemostasis was achieved and nasal cavity packed with merocel. The orbit wound was sutured in layers Video 1.

Postoperative course

Postoperatively, the patient's left eye proptosis and chemosis resolved, and his vision improved within a week with no further CSF leak [Figure 5a and b]. The

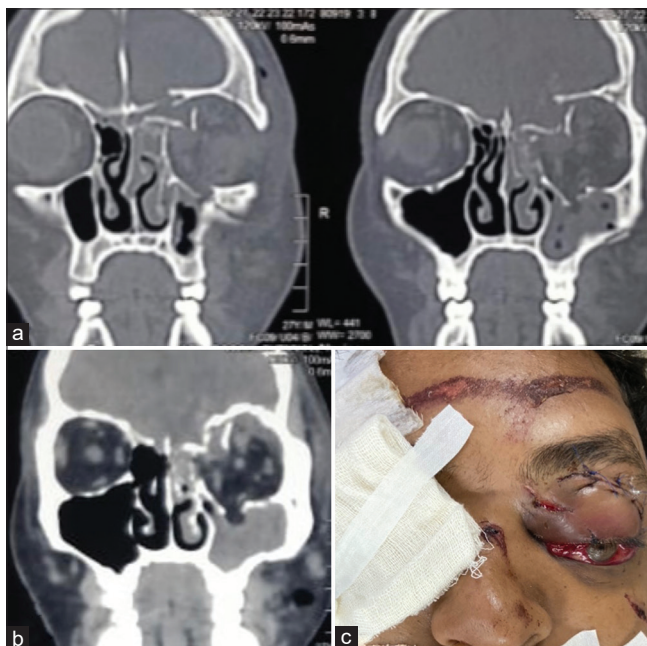


Figure 1: (a) Preoperative computed tomography coronal sections bone window showing the complex anterior cranial fossa fracture with floating lateral lamella of cribriform plate. (b) Preoperative computed tomography coronal section soft-tissue window with fracture fragment impinging on the superior rectus muscle. (c) Preoperative picture of the patient showing left eyeball displaced downward and laterally with conjunctival chemosis. Also note the edema of upper eyelid with linear sutured laceration through which the transorbital neuroendoscopic surgery approach was undertaken

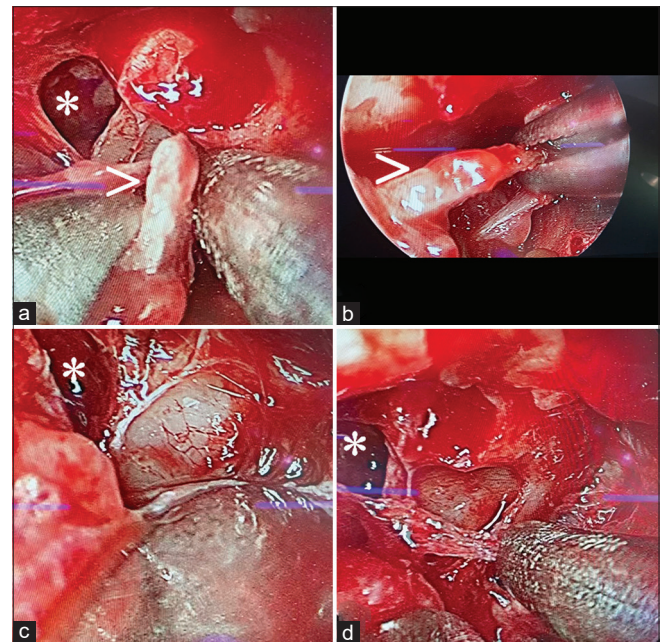


Figure 2: Transorbital neuroendoscopic surgery approach. (a) (>) Dissection of fracture fragment from inferior orbital periosteum and superior dural attachments. (*) The dural defect (tear) through which the basifrontal cortex with contusion can be visualized. (b) (>) Removal of the fracture fragment. (c and d) Visualizing the bony defect and the (*) dural defect. Note that all the margins of the bony defect are visualized except the medial margin

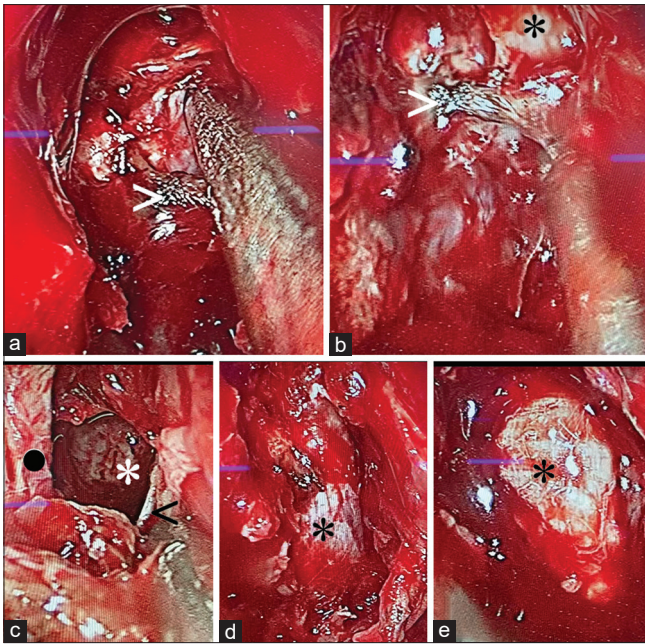


Figure 3: Endoscopic transnasal approach. (a) (>) Anterior ethmoidal artery (cauterized). (b) (>) Cauterized anterior ethmoidal artery. (*) The floating fragment of the lateral lamella of the cribriform plate. (c) (.) Torn medial dural margin. (*) Basifrontal cerebral cortex. (<) The lateral margin of the bony defect of the roof of orbit. (d) The margins of the bony defect on the nasal side. (*) Dura. (e) Fascia lata has been spread from the orbital side and pulled through to the nasal side and is tucked along the margins of the bony defect. (*) Fascia lata on the nasal side

postoperative CT scan showed an intact reconstruction and the preexisting floor of orbit fracture which was not addressed at present. His 4 months postoperative follow-up showed a complete resolution of orbital signs and complete visual improvement with no CSF leak [Figure 5c]. Visual-evoked potential at 8 months showed normal P100 latencies. The Institutional Ethical Committee clearance has been obtained.

Discussion

The CSF leakage into the orbital cavity usually resolves spontaneously with improvement of the orbital symptoms.^[9] In our case, the patient had worsening of orbital symptoms in spite of conservative management.

The optimal management of CSF orbital fistula, especially when compounded with CSF rhinorrhea remains controversial owing to its uncommon occurrence.^[3] Conventionally, intracranial intradural repair was the approach of choice for such complex comminuted ACF fractures with large dural tear.^[10,11]

The expanded endoscopic endonasal approach has opened new frontiers, especially in the management of ventral skull base defects with minimal morbidity and mortality. Various graft materials, including fascia lata, middle turbinate mucosa, and septal mucosa, have been used. Although most of the initial studies claimed that the size of the defect was not a significant factor for successful closure, there was

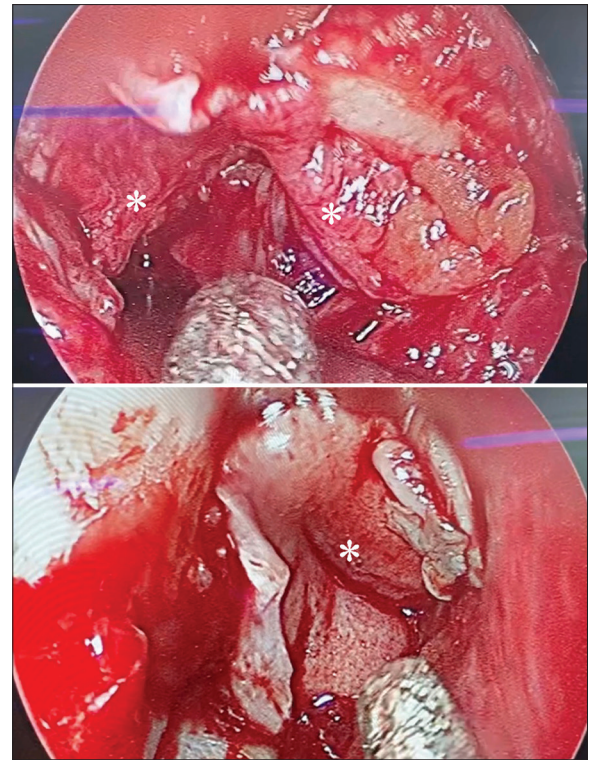


Figure 4: Upper – Fascia lata spread on the orbital roof. (*) Fascia lata on the orbital side. Lower – Multi-layered reconstruction on the nasal side with nasal septal cartilage and Hadad flap over the fascia lata. (*) Hadad flap

a natural bias to deal with large size defects (usually >2 cms) through transcranial approach.^[12,13] With the recent advances in technology, instrumentation and development of multi-layered reconstruction coupled with use of pedicled flaps like Hadad and inferior turbinate flaps have significantly increased the success rates for closure of large ventral skull base defects.^[14-16] However, the endoscopic endonasal corridor used alone has the limitation of access to the far lateral supraorbital defects of the ACF.

To tide over this difficulty, Moe *et al.* have done extensive study on the TONES approaches namely superior lid crease and precaruncular approaches to deal with complex ACF defects.^[17-19] They used purely transorbital corridors to deal with these complex defects. Dallon *et al.* have described novel endoscopic transorbital approaches to various orbital, superior orbital fissure, and cavernous sinus lesions.^[20-23] Lubbe *et al.* have proposed the concept of multiportal surgery which includes a combination of transnasal and supraorbital approach to lesions of ACF.^[8]

In our case, we have undertaken a TONES approach to remove the fracture fragments of the orbital roof which were impinging on the superior rectus muscle. This otherwise could not be achieved through the transnasal corridor. The medial margin of the defect could not be visualized through the TONES approach and hence was combined with the transnasal corridor to delineate the entire dural and bony defect. Once this was achieved, then

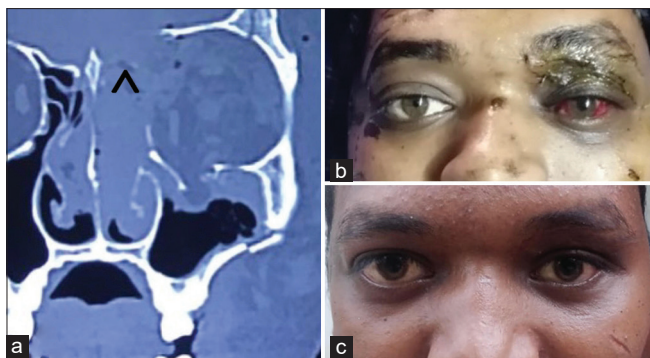


Figure 5: (a) Postoperative computed tomography coronal cut. (^) Shows the fascia lata spread across the defect. (b) One week postoperative picture of the patient which showed improvement of orbital signs. (c) Four months postoperative picture of the patient which showed complete resolution of orbital signs with very minimal enophthalmos

the principles of multi-layered reconstruction were used. First with fat, then a novel pull through of fascia lata graft covering the defect of the orbital and nasal sides. Then, septal cartilage and pedicled nasoseptal flap on the nasal side were used to successfully to reconstruct the defect.

Conclusion

The concept of minimal access multiportal surgery is rapidly evolving in managing complex skull base lesions. Large complex ACF defects are most often repaired through transcranial approach. Minimal access multiportal surgery is a novel option for the management of such complex defects.

Declaration of patient consent

The authors certify that they had obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the journal. The patient understands that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Acknowledgment

We would like to thank the director and the entire team of the Institute of Neurosurgery, Madras Medical College, Chennai, Tamil Nadu, India, for their support to report this case.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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