

# Management of Frontal Sinus Injuries

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## Abstract

**Purpose:** The purpose of the present study is to report an overview of fracture patterns and surgical approaches for 15 patients who were treated in our Indira Gandhi Institute of Dental Sciences, Pondicherry, India from 2010 to 2015. **Method and Material:** Fifteen people were included in the study, which were diagnosed with anterior table fracture of the frontal sinus and were randomly admitted in our institution. All patients were evaluated preoperatively with axial and coronal computed tomography scans before operating. The parameters used to classify the patients were age, mode of injury, associated injury, and details of fracture, surgical approaches, fixation, and conservative management. **Results:** Analysis of 15 patients based on parameters showed that the ages of patients varied between 22 and 36 years due to road traffic accident as the common etiology. There were associated fractures in the maxillofacial region seen in 11 patients and the rest were isolated frontal sinus fractures. Conservative management was opted in six patients and for others, surgical approach to the fracture site was done through existing laceration and by bicoronal approach. Three of the cases showed comminuted fracture of anterior and posterior table. The overall contour of the frontal bone was good in all the patients. None of the patients required any immediate reoperation or developed any delayed abscess or mucocele formation. **Conclusion:** Decision-making regarding the best time to treat, the surgical approach and the technique depends on the severity and the extent of the fracture and associated complications. Our protocol was to follow up and observe the undisplaced fractures and operate anterior wall defects. If there was a fracture involvement of posterior frontal wall, treatment can be planned along with neurosurgical consultation and then operate depending on the associated complications.

**Keywords:** Anterior and posterior table fractures, frontal injuries, surgical management

## INTRODUCTION

Frontal sinus is protected by thick cortical bone and is highly resistant to fracture than any other bone.<sup>[1]</sup> Frontal bone injuries are predominantly caused by high-velocity injuries such as motor vehicle accidents, assaults, and sporting events.<sup>[2-5]</sup> It accounts for 5%–15% of maxillofacial injuries; 66% of patients with frontal sinus injuries have associated maxillofacial fractures. The frontal bone fracture appears 33% as isolated anterior table and 66% as combined anterior and posterior table. Isolated posterior table fractures occur very rarely.<sup>[2-5]</sup> Intracranial involvement should be suspected when posterior wall is fractured. Those cases have more complications and poor clinical outcome than fractures involving only the anterior wall.<sup>[6]</sup>

The sequence of treatment for frontal sinus fractures includes avoidance of short- and long-term complications, reestablishment of an esthetic facial contour, and maintaining normal sinus if possible. Long-term complications of frontal sinus fractures include chronic sinusitis, mucocele,

mucocele, meningitis, and brain abscess. The management of frontal sinus fracture is controversial. Trends in the care of skull base injuries have been directed by speculation and anecdotal information rather than evidence-based conclusions. Complications and adverse outcomes associated with treated and untreated frontal sinus fractures keep on contributing to the uncertainty about how those injuries are best managed. Rohrick and Hollier<sup>[4]</sup> developed an algorithm for treating frontal sinus fractures based on the degree of fracture displacement, frontonasal duct involvement, and the presence of cerebrospinal fluid. It is recommended that undisplaced fractures should be left untreated; uncomplicated anterior table

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displacement with an esthetic deformity should be treated by open reduction and fixation; fractures damaging frontonasal duct should be managed by sinus obliteration and comminuted, displaced anterior and posterior table fractures associated with persistent cerebrospinal fluid leakage and frontonasal duct involvement should be managed by cranialization.

In this article, we present an overview of the pattern, surgical approaches, and treatment by open reduction and internal fixation of frontal sinus fractures.

## PATIENTS AND METHODS

The records of patients admitted in the Indira Gandhi institute of Dental Sciences, Puducherry from 2010-2015 with the diagnosis of frontal bone fracture were overviewed. Fifteen

people were included in the study, which were diagnosed with anterior table fracture of the frontal sinus and were randomly admitted in our institution. All patients were evaluated preoperatively with axial and coronal computed tomography scans before operating. The parameters used to classify the patients were age, mode of injury, associated injury, and details of fracture, surgical approaches, fixation, and conservative management. All the patients consent were obtained [Table 1].

## RESULTS

The ages of patients varied between 22 and 36 years. The common etiology was a road traffic accident. There were associated fractures in the maxillofacial region in 11 patients including zygomatic complex fracture in six patients,

**Table 1: Demographic and perioperative summary of 15 patients**

Age	Mode of injury	Associated injury	Details of fracture		Surgical approaches	Fixation	Conservative management
			Isolated anterior table	Anterior and posterior table			
23	RTA	NOE and zygomatic arch fracture	Linear fracture-figure: 3		Bicoronal	Mini plates	
24	RTA		Displaced		Through existing laceration	Mini plates	
35	RTA		Displaced			Through existing laceration	Mini plates
26	RTA	Parasymphysis fracture of mandible	Comminuted fracture-figure: 1		Through existing laceration	Mesh fixation	
20	RTA		Comminuted-figure: 2		Through existing laceration	Mini plates/gel foam	
24	RTA	Left zygomaticomaxillary complex fracture	Undisplaced-figure: 4				Yes
27	RTA		Anterior displaced posterior undisplaced		Through existing laceration	Mini plates	
31	RTA	Le fort 1 fracture	Undisplaced				Yes
	RTA		Displaced		Through existing laceration	Mini plates	
36	RTA	Orbital floor fracture	Undisplaced		Through existing laceration	Mini plates	
18	RTA	Le fort 2 fracture with NOE fracture, left eye open globe injury with vitreous hemorrhage and retinal detachment	Undisplaced				Yes
	RTA		Displaced		Through existing laceration	Mini plates	
22	RTA	Left zygomaticomaxillary complex fracture	Undisplaced				Yes
26	RTA	Right zygomaticomaxillary complex fracture	Undisplaced				Yes
23	RTA		Undisplaced				Yes

RTA=Road traffic accident; NOE=Nasoorbitoethmoid

nasoethmoid fractures in two patients, orbital injuries in two patients and mandible fracture in one patient.

The undisplaced anterior table was fractured in seven patients; displaced anterior table was fractured in five patients. In three cases, comminuted fracture of anterior and posterior table was present. The surgical approaches to the fracture site were through existing laceration and by bicoronal approach. In eight patients, the fractured fragments were reduced, and fixation was done by miniplates and mesh was used in one patient. Conservative management was opted in six patients. The overall contour of the frontal bone was good in all the patients. No patients required immediate reoperation or delayed abscess or mucocele formation requiring surgery. We have included four different front bone fracture cases for the reference; frontal sinus repair through existing laceration using mesh fixation [Figure 1], frontal sinus repair using gelfoam application and using titanium plates and screws [Figure 2], frontal sinus repair through coronal incision [Figure 3], and finally undisplaced frontal sinus fracture for follow-up and observation [Figure 4].

## DISCUSSION

Surgical management of skull base and craniofacial fractures are more controversial than lower face fractures. There is a reported frequency of 10% adverse outcome following frontal sinus fracture repair<sup>[4,7]</sup> compared to 17%–45% complication rate associated with angle fracture treatment.<sup>[4,8,9]</sup> Brain infection a unique life-threatening complication appears to dramatize the care of frontal sinus fractures and illuminate the controversy. The goal of treating any frontal sinus injury should be the creation of a safe sinus with normal sinus function and esthetics.

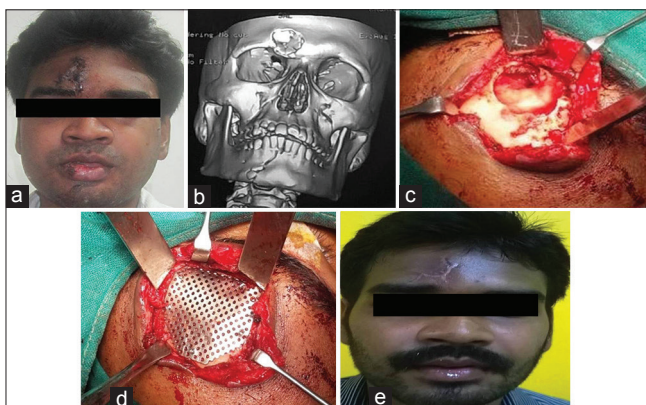
Nondisplaced linear outer table fractures can be managed by observation alone. Depressed outer table fractures need elevation and fixation to avoid esthetic deformity. Open frontal sinus fractures can be approached through the laceration and

if access is restricted the laceration can be extended. Best access can be achieved through a coronal flap and is also justified if there is an associated orbital and malar injury. When there is suspicion of frontonasal duct involvement and frontal sinus fracture associated with supraorbital rim and naso-orbitoethmoidal fracture the segments of the outer table should be removed and thorough inspection of the frontonasal duct.

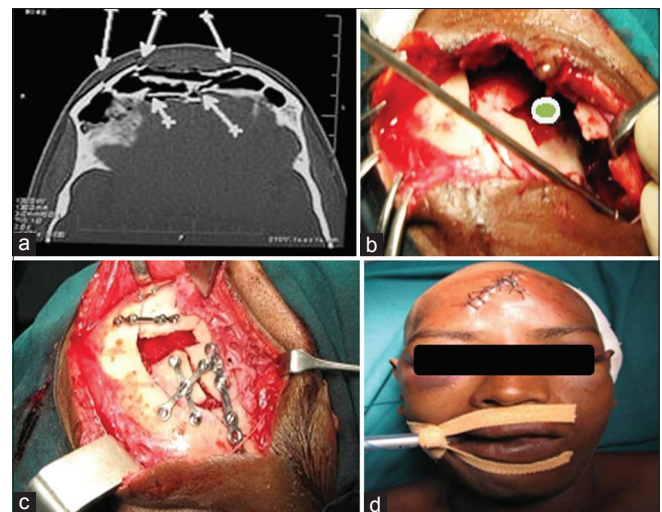
If there is a history of recurrent sinusitis, the entire sinus membrane should be curetted. One patient underwent removal of the entire sinus membrane, and the sinus was filled with gel foam. Some surgeons use fat<sup>[10]</sup> as it is found to be resistant to infection and has a slow resorption rate being gradually replaced by fibrous tissue. Neurosurgery and canalization would be indicated in comminuted posterior table fracture, dural tear along with persistent cerebrospinal fluid leak.

The etiology of all the patients with frontal sinus injuries were predominantly automobile accidents as cited in the literature in which 11 out of 15 cases had isolated anterior wall fractures and 4 with anterior and posterior table fractures. Anterior wall fractures were approached through existing lacerations and one case operated through bicoronal approach as there was an associated malar and orbital injury.

There is no consensus regarding the timing of surgical repair, and it is still an unsettled controversy. Rohrick and Hollier in their experience have shown that surgery done immediately after the incident reduces the morbidity.<sup>[4]</sup> In our experience, we feel that morbidity or extended stay in the hospital was determined by factors such as getting neurosurgical clearance, other body injuries, and insurance approval for some patients than the delay in performing surgery. Patients with cranioencephalic complication were managed conservatively with a neurosurgical opinion.<sup>[11-13]</sup> We also did not encounter complicated lesions such as cerebrospinal fistulas, lesions



**Figure 1:** (a) Frontal sinus repair via existing laceration using mesh fixation preoperative frontal profile. (b) Three-dimensional computed tomography scan showing severe comminuted anterior table frontal sinus fracture. (c) Surgical exposure through an existing laceration. (d) A mesh was used to treat a large frontal sinus fracture. (e) Postoperative frontal view of the patient



**Figure 2:** (a) Axial computed tomography scan showing a displaced both anterior and posterior table frontal sinus fracture. (b) Intraoperative view with an application of gel foam. (c) Stabilization and fixation with titanium plates and screws. (d) Postoperative frontal view





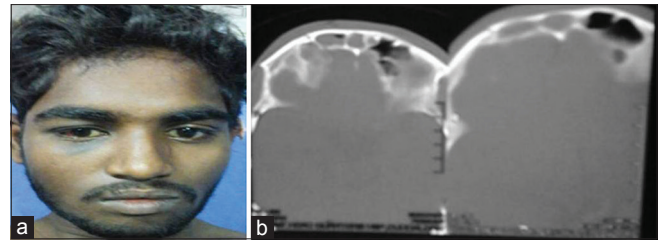
**Figure 3:** (a) Frontal sinus repair via coronal incision clinical view of a patient who sustained blunt trauma from a motor vehicle accident. (b) Three-dimensional computed tomography scan showing a displaced anterior table frontal sinus fracture. (c) Surgical exposure through a coronal incision exposing the entire forehead and frontonasal complex with open reduction and internal fixation of the anterior table, in addition to repair of the nasoorbitoethmoid fracture and zygomatic arch fracture, using titanium plates and screws. (d) Frontal view of the patient postoperatively

in the orbital cone and optic nerve, meningitis, fracture of cribriform plate of ethmoid, and permanent anosmia.

Another unsettled controversy in a surgical approach to the frontal sinus fracture was to approach the fracture through the existing laceration or by bicoronal incision. In most of our cases, we used existing lacerations, and sometimes, we extended it alongside of tension. One case was approached through bicoronal approach as there was an associated zygomatic arch and lateral orbital rim injury. There are reports in the literature which cite persistent glabellar and frontal hyperesthesia because of injury to supraorbital nerves however we did not encounter such complications.

Compound or displaced fracture treated by intraosseous wiring done until 80s are no longer practiced though they provide good cosmetic and functional results.<sup>[4]</sup> We used titanium miniplates for fixation in nine cases after getting good reduction which will give a better facial appearance. In one case, with gross comminution of bone fragments, we used a titanium mesh.

Aggressive techniques such as packing, obliteration, and cranialization of the frontal sinus is not preferred by many surgeons.<sup>[14-19]</sup> Literature review shows different approaches ranging from conservative till aggressive surgery especially in cases with intracranial and orbital complications.<sup>[12,13-19]</sup> Some protocols such as total nasal mucosa excresis,<sup>[20-22]</sup> frontonasal duct obliteration, and sinus packing with autogenous fat inducing osteogenesis are very well debated.<sup>[16]</sup> All these procedures bear advantage over conservative measures.<sup>[23]</sup> From our experience, we suggest that conservative approaches should prevail over aggressive approaches. In our series



**Figure 4:** (a) Patient with undisplaced frontal sinus fracture for observation. (b) Computed tomography scan showing undisplaced anterior table frontal sinus fracture

of 15 patients, five patients were managed conservatively; one underwent sinus obliteration with gel foam others with reduction and fixation with miniplates. None of our patients had a postoperative complication in both the way of treatment surgical and conservative.

## CONCLUSION

We conclude that decision-making regarding the best time to treat, the surgical approach and the technique depends on the severity and the extent of the fracture and associated complications. Mainly our protocol was to observation and follow up in undisplaced frontal bone alone fracture and to operate displaced frontal bone anterior wall fracture. If there was involvement of posterior frontal wall fracture treatment can be planned along with neurosurgical consultation and to operate depending on the associated complications.

## Declaration of patient consent

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

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## Conflicts of interest

There are no conflicts of interest.

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