ORIGINAL RESEARCH PAPER

Neurosurgery

ANTERIOR SKULL BASE FRACTURE AND ITS MANAGEMENT: AN INSTITUTIONAL EXPERIENCE

KEY WORDS:

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ABSTRACT

Background- Anterior skull base fractures are one of the more difficult fractures to evaluate and treat. These patients often have extensive associated injuries, both extra-cranial and intracranial, which make the management of these patients more challenging. This study aimed to analyze the clinical presentations, management, and outcomes of patients with anterior skull fractures. **Method-** This study was conducted in 38 patients with anterior skull base fractures based on CT scans. All patients were clinically and radiologically evaluated and treated accordingly. In this study, clinical presentation, management, complication, and outcome of these patients were evaluated. **Results-** in this study, the most common patients aged between 16 and 30 years (13 cases), constitute about 34% of the study population. Road traffic accidents were the most common mode of injury in 30 cases (78.94%) of patients and fall in children. The most common clinical finding was periorbital ecchymosis, which was present as bilateral12(31.57%) as well as unilateral 24(63.15%) of the patients respectively, and 10 patients exhibited CSF Leaks. The most common anterior skull base fracture site was the frontal bone, which was fractured in 22 (57.89%) patients. Altered consciousness levels ranging from mild confusion to coma were the most common symptom present in 57.89% (22 cases) of patients followed by headache in 47.36%(18 cases) In 14 patients, anterior cranial fossa fractures were associated with facial fractures. **Conclusion-** Anterior cranial fossa fractures are characterized by a range of clinical features including headache, epistaxis, periorbital ecchymosis, Rhinorrhea, altered consciousness, olfactory disturbance, and coexisting facial fractures. Early recognition and appropriate management are crucial in ensuring favorable patient outcomes. Further studies are needed to explore optimal treatment strategies and long-term prognosis. Study of anterior skull base fracture with associated injury and management; an institutional experience.

INTRODUCTION

Head trauma is one of the most common conditions for visits to the emergency department. Skull base fractures are those fractures that extend through the floor of the anterior, middle, or posterior cranial fossa, occur in an estimated 7% to 16% of nonpenetrating head injuries, and are caused due to a relatively high-velocity trauma, most often seen in high-speed motor vehicle accidents, although motorcycle collisions, falls, pedestrian injuries, and assault are additional associatedcauses(1).Penetrating trauma, particularly gunshot wounds, are seen much less frequently, accounting for less than 10% of cases (2). Skull base injury is often associated with complex facial or orbital fractures. Detection of skull base fractures is a very crucial step because these fractures can be associated with numerous critical complications, including intracranial and orbital injuries, cerebrospinal fluid (CSF) leaks, cranial nerve palsies, and vascular injuries.

The associated risk and extent of complications often depend on the location and pattern of the fracture, which is in turn determined by the mechanism of injury and type of impact.

Normal anatomy

The skull base is made up of 7 bones, the paired temporal and frontal bones, and the unpaired sphenoid, ethmoid, and occipital bones. It is divided into anterior,posterior and central regions, which form the floor of the anterior, posterior and middle cranial fossae.

The anterior skull base, formed by the ethmoid and frontal bones, separates the anterior and inferior frontal lobes and olfactory structures within the anterior cranial fossa from the orbits and the sinonasal cavity. The orbital plate of the frontal bone and the posterior table of the frontal sinus forms the lateral and anterior borders of the anterior cranial fossa. Inferiorly, the floor of the anterior cranial fossa is formed by the cribriform plates and roof of the ethmoid sinuses. The posterior border between the anterior and central skull base is formed by the lesser wing of the sphenoid bone, including the planumsphenoidale and the clinoid process.

The floor of the olfactory groove is formed by the cribriform plates, which are inherently thin, with multiple small foramina through which the small branches of the olfactory nerve pass. In addition to the cribriform plate foramina, the anterior skull base also contains the anterior and posterior ethmoid artery foramina, which should not be confused with fractures; these may represent significant sources of epistaxis if injured.

Classification of Anterior Skull Base Fractures

Direct trauma to the frontal region often results in anterior skull base fractures, so-called frontobasal injuries, with the "frontal" component of fractures involving the upper facial third (superior orbital rim and frontal bone/sinus), and the "basal" component of fracture involving the anterior skull base (ethmoid roofs, cribriform plate, and planum sphenoidale).

This study aimed to study the clinical presentations, management, and outcome of such patients of traumatic head injury patients with base of skull fractures.

Radiological imaging techniques are relied upon for inferring the nature of injury in all medico-legal injuries either the presence or absence of skull fracture, simple or grievous [3]. Modern CT scans with bone windows, thin section cuts of up to 1–1.5 mm, and coronal cuts provide improved detection and resolution of even tiny fractures without increased exposure to radiation [4].

MATERIAL AND METHOD

This was a retrospective study, conducted at Neurocare Hospital Jaipur from 2018 to 2021. During this period, 228 cases were admitted with a history of head trauma, among these 38 cases were anterior skull base fractures on CT scans.

A careful and detailed neurological examination was performed for each patient regarding the level of consciousness, arrival GCS and follow-up GCS, pupillary status and cranial nerve function, motor and sensory system involvement when possible, and signs specific for the base of skull fractures including Raccoons eye sign and active CSF leak. Patients were categorized into three categories according to their GCS score – severe head injury (GCS <=8), moderate (GCS 9–12) and mild (GCS 13–15).

CT scan of the head and 3D face was performed using a 64-slice high-resolution CT scan machine.

Follow-up: All patients with anterior skull base fractures, follow up was done in the outpatient department at 1 month, 3 months, and 6 months after discharge. Neurological status of patients, and improvement or deterioration in neurological deficits, if any, was noted. Follow-up CT scans were performed as required and findings were documented.

RESULTS

1. Demographic Data

Thirty-eight patients were included in our study of which 32 were males (84.21%) and 6 were females(15.79%). The youngest and oldest patients were 9 and 67 years old respectively. The mean age was 37 years. There was a preponderance of patients aged between 16 and 30 years (13 cases) who had a base of skull fracture following head trauma, constituting about 34% of the study population. Another 29% (11 cases) of the study population were aged between 31 and 45 years. There was a preponderance of male patients when compared to female patients. Males were 84.21% (32cases) of the study population and the male-to-female ratio was 5.3:1. Road traffic accidents were the most common mode of injury in 78.94% (30 cases) of patients followed by falls from a height that constituted 15.78% (6 cases) of patients as the mode of injury. Their demographic characteristics are summarized in Table 1 and their mode of injury is summarized in Table 2

Table 1

Age Sex	Total	0-15 years	16-30 years	31-45 years	46-60 years	>60 years
Male	32	5	12	8	5	2
Female	6	2	1	3	0	0

TABLE 2	
Mechanism of injury	
Road traffic accident	30(78.94%)
Fall from height	6(15.78%)
Assault	2(5.26%)

2. Symptomatology

The most common clinical finding was periorbital ecchymosis, which was present as bilateral in 12(31.57%) as well as unilateral in 24(63.15%) of the Patients followed by subconjunctival hemorrhage, CSF rhinorrhea, and epistaxis.

Table 3: Clinical findings in 38 patients with anterior skull base fractures

S. No.	Clinical findings	Number of patients (percentage)
1.	Unilateral Periorbital ecchymosis	12 (31.57%)
2.	Bilateral Periorbital ecchymosis	24 (63.15%)
3.	Sub conjunctivalhemorrhage	10 (26.31%)
4.	Epistaxis	5 (13.15%)
5.	Facial nerve palsy	4 (10.52%)
6.	CSF rhinorrhea	8 (21.05%)
7.	Anosmia	4 (10.52%)
8.	Meningitis	2 (5.26%)

Altered consciousness was the most common symptom present in 57.89% (22 cases) of patients followed by headache in 47.36%(18 cases). However, 26.3% (10 cases) of patients did not have any history of symptoms at the time of presentation. clinical findings and symptoms are summarized in Table 4.

Table 4

S. No.	Symptoms	Number of patients (percentage)
1.	Altered consciousness	22 (57.89%)
2.	Headache	18 (47.36%)
3.	Local pain/ lacerated wound	16 (42.10%)
4.	Vomiting	6 (15.78%)
5.	Seizure	6 (15.78%)
6.	Asymptomatic	10 (26.3%)

The patients' neurological presentation varied widely; the mean Glasgow Coma Scale score was 13 (range 3–15). In our study, 7.89% of patients (3 cases) had a severe head injury with a GCS of 8 or less, and 26.31% and 65.78% had moderate (10 cases) and mild (25 cases) head injuries respectively.

3. Locations of anterior skull base fractures

The most common anterior skull base fracture site was the frontal sinus, which was fractured in 28 (73.68%) patients followed by involvement of the ethmoid cribriform plate in 18 patients (47.36%). Associated facial fractures were present in nearly 26 patients (68.42%). Amongst zygoma fractures were the most common constituting 52.63% of(20 cases) cases followed by orbital wall fracture seen in 42.10%(16 cases) of cases followed by maxilla and mandible fractures in 6 cases(15.78%) and 4 cases(10.52%) respectively.

4. Intracranial pathology associated with anterior skull base fractures

The most common intracranial pathology was pneumo cephalus, which was found in 23 patients (60.52%). The remaining intracranial pathological findings were frontal contusion, EDH, Acute SDH, and ICH seen in 26.31%(10 cases), 23.68%(9 cases), 15.78%(6 cases), and 7.89%(3 cases) of patients. However, 15.78% of patients (6 cases) had no associated intracranial findings despite having a base of skull fracture.

Management And Outcome

There are two methods for skull base repair
(1) Conservative (2) Surgical
Treatment decisions were individualized based on the severity of injury, clinical presentation, and presence of complications. In our study,16 patients were managed conservatively and 22 patients were surgically managed.

Conservative Management

Indications

(1) patients who showed only anterior frontal sinus fracture but no radiological signs of displacement and deformity.
(2) patients with linear or slightly displaced fracture (<2 mm) of the posterior wall of the frontal sinus, with no signs of pneumocephalus and/or rhinorrhea.

They were treated with bed rest, clinical observation, and symptomatic analgesic /antibiotic therapy. The median overall hospital stay was 8 days ranging from 6 to 12 days.

Outcome - 16 patients managed conservatively. One patient died during treatment due to meningitis

Follow-up 2 patients had CSF rhinorrhea, which was managed by lumbar drain insertion.

In conservative management, at the time of follow-up (6 months), 75% (12 out of 16) of the patients had good recovery with a GCS of 13 or more, 18.75 % (3 out of 16) of the patients had moderate recovery with GCS 9 or more and mortality was 6.25% (1out of 16)

Surgical Management

Indications

(1) Fracture of the posterior wall of the frontal sinus with evidence of one or more findings such as pneumo cephalus, Rhinorrhea, displaced and comminuted fracture.
(2) Skull base fracture with acute subdural hemorrhage, ICH, EDH, contusions, etc.

The average time from admission to surgery was 12 to 24 hours and the type of surgery described in Table 5.

Complications and Outcome

The postoperative course of 2 patients was complicated by meningitis, the infections were treated successfully with intravenous antibiotic therapy.

Local wound infection occurred in 1 patient and 1 patient developed wound dehiscence which was treated by closure of the skull scalp defect.

Five (22.72%) of the 22 patients developed CSF leaks after surgical repair. All 5 patients underwent the CSF Diversion method and got relief. (Figure 1)

No patients had postoperative neurological deterioration. Two patients died; this was on postoperative day 7 and day 16. (pre-operative patient GCS were < 8 with thick SDH with multiple injuries)

The mean follow-up time was 6 months. In surgical management, at the time of follow-up (6 months), 77.27% (17 out of 22) of the patients had good recovery with a GCS of 13 or more, 13.63 % (3 out of 22) of the patients had moderate recovery with GCS 9 or more. mortality was 9% (2 out of 22)

Table 5 Distribution of patients according to surgical procedure

S. No.	Type of surgery	Number of patients (percentage)
1.	Craniotomy and evacuation of hematoma	3 (7.89%)
2.	Decompressivehemicraniectomy	2 (5.26%)
3.	Craniotomy with contusectomy/lobectomy	8 (21.05%)
4.	ACF Base repair (Bilateral frontal craniotomy with removed of depressed fracture)	10 (26.3%)
5.	Endoscopic repair	4 (10.52%)

DISCUSSION-

The description of skull fracture including the base of the skull has been described in literature as early as the 11th century [5]. Traumatic brain injury is a major public health problem in the world, especially in India with 100,000 lives lost every year due to traumatic brain injury [6]. This suggests the importance of public health education and awareness among the population. The incidence of base of skull fracture in head injuries has been reported to be 3.5–24.0% [7,8]. Most of these patients had associated major intracranial injuries requiring surgical treatment. Based on this condition, there is a need for quicker and more accurate diagnosis of head injuries with base of skull fractures so that appropriate and emergency management of such patients can be done and survival can be improved.

Our study found that base of skull fracture was more common in the 2nd & 3rd decade of life constituting 34 % of all the cases.Naidu et al. (9) and Rupani et al.(10) found the incidence of the base of skull fracture to be higher in the 3rd and 5th decade of life respectively.

That means most of the cases in our study group were younger adolescents and young adults who had accidents while traveling in a two-wheeler, thus the incidence was higher in this age group. The Indian Head Injury Foundation reveals that road traffic accidents are the leading cause of head trauma in India in 60% of the cases. Rupani et al.reported vehicle accidents to be the cause of head injury with base of skull fracture in 70% of the cases [10].

Thangaraj et al. reported road traffic accidents and falls from height as the etiological factors in 32% and 36% respectively [11]. Naidu et al reported road traffic accidents were the main cause of head injury and base of skull fractures in 79% of the cases. In our study, 78.94 % of cases were due to RTA. Hence this is necessary to concentrate on educating the general population regarding safety precautions during travel.

In the present study loss of consciousness was the most common presenting complaint in 57.89% of the study population followed by headache (47.36%), pain, swelling, or wound at the site of injury (42.10%), seizure and vomiting (15.78%). 26.3% of patients had no symptoms at the time of presentation.

When classified according to the GCS, in our study,7.89% of patients had severe head injury. Mild and moderate head injury was seen in 65.78% and 26.3% of patients respectively. Patel et al. in their study found their study population to have mild, moderate, and severe head injury in 50%, 26%, and 24% cases respectively[12]. In our study, the Olfactory nerve was most commonly injured in 10.52% of cases.

The most common anterior skull base fracture site was the frontal sinus, part of the frontal bone, which was fractured in 28 (73.68%) patients followed by involvement of the ethmoid cribriform plate in 18 patients (47.36%). In our study, CSF leak was found in 21% of patients in contrast to the Naidu et al study which described the incidence of CSF leak to be 10.34%.

Anterior skull base fracture is commonly associated with facial bone fracture. In our study zygoma fractures were the most common constituting 52.63% of(20) cases followed by orbital wall fractures seen in 42.10%(16) of cases Most of the cases required surgical fixation.

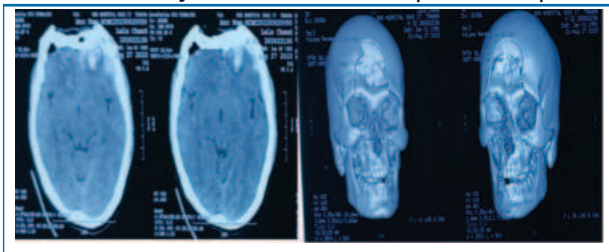
The majority of the patients were treated surgically (57.89%) and 42.11% of patients were treated conservatively.The base of the skull fracture itself was not a primary indication for emergency surgery. The most common indication for surgery was acute subdural hemorrhage followed by contusion.

CONCLUSION-

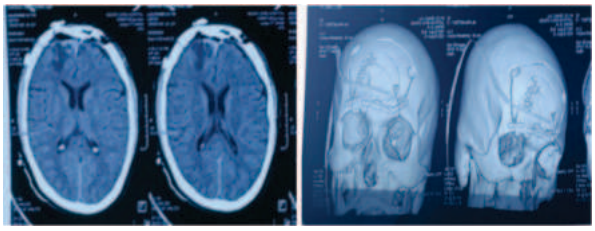
Skull base fractures are a common complication of high-impact trauma, and are associated with, epistaxis, periorbital ecchymosis, Rhinorrhea, altered consciousness, olfactory disturbance, and coexisting facial fractures.

Even relatively linear non-displaced fractures may be associated with significant intracranial complications, including CSF leak; therefore, their detection is very important.

Early and aggressive surgical repair of anterior skull base fractures is an essential step for patients in whom conservative management has failed and for those who present with meningitis or extensive depressed or comminuted fractures and the best result obtained by a team including plastic surgeon, neurosurgeon, and ENT surgeon.



A. Pre Op. CT Scan **B. Pre Op. 3D CT Scan**



C. Post Op. CT Scan **D. Post Op. 3D CT Scan using multiple plate**

Figure 1: A & B suggestive of midline depressed fracture of frontal bone with involvement of frontal sinus and C& D suggestive of post operative scan using multiple plate & screw for better alignment.

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