A Prospective Clinical Study of Depressed Skull Fractures with Special Reference to Its Management

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ABSTRACT

BACKGROUND

Depressed skull fractures (DSFs) cause wide range of injuries to the cranium and underlying structures, which influence the morbidity, mortality, and prognosis of the patient. This study was done to obtain a baseline clinical data regarding the management of such patients in Eastern part of our country.

METHODS

This prospective study was conducted in Assam Medical College and Hospital, Dibrugarh, from June 2016 to May 2017. Patients with depressed skull fractures fulfilling inclusion and exclusion criteria were included. After initial clinical evaluation, patients were put in conservative and surgical treatment groups. Surgical procedures were performed as per indication and intra-operative findings were recorded. All the patients were evaluated with regard to clinical findings, treatment provided, complications, outcome and other clinical variables during the hospital stay and follow up period.

RESULTS

A total of 65 patients out of the 1274 patients admitted for head injury were taken up for this study. Most patients were in the age group of 20 - 40 years. Male to female ratio was 5.5:1. The commonest mode of injury was road traffic accident followed by assault and others. Most common presenting symptom was brief loss of consciousness followed by post traumatic amnesia, ENT bleeding, seizures etc. Most commonly involved bone was frontal bone and most were compound fractures. At the time of presentation, 58.5 % of patients had Glasgow Coma Scale (GCS) score of 13 - 15, 33.8 % patients had a GCS score of 9 - 12 and 7.7 % had a GCS score of 3 - 8. Surgical intervention was required in 25 patients and rest received conservative treatment. Two patients expired during hospital stay. At the end of 3 months 78.46 % patients had good recovery, 6.1 % had moderate disability and 6.1 % patients had severe disability.

CONCLUSIONS

DSFs carry specific clinical features and problems which require individualised attention and care. These types of head injuries can be managed with good outcome in a peripheral government centre run by a single neurosurgeon.

KEYWORDS

Head Injury, Traumatic Brain Injury, Depressed Skull Fracture

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BACKGROUND

Depressed skull fractures account for approximately 11 % of the severe head injuries.[1] Usually a small hard impacting object causes depressed skull fracture which may be either closed or open (compound). It carries risk of formation of intracranial hematoma, injury to the dura and brain parenchymal and raised intracranial pressure (ICP). Treatment protocol and outcome depends on multiple factors like local wound condition, type of facture, site of fracture and severity of underlying brain parenchymal lesions etc. There is no nationwide study on DSFs which can provide us a baseline data and management protocol for these patients in our country. This study was carried out in Assam medical College and Hospital which caters to patients from upper Assam and adjacent part of Arunachal Pradesh and Nagaland. From this study we hope to obtain various clinical data (i.e., age / sex distribution, mode of injury, clinical presentation etc.) and their management and outcome in this part of country.

Objectives

- To determine the various clinical variables i.e. incidence, age / sex distribution, mode of injury mode of presentation, severity injury and type of DSFs.
- To assess the various modes of management of depressed skull fractures and their outcome.

METHODS

This prospective study was conducted in general surgery department, Assam Medical College and Hospital, Dibrugarh, Assam where all the neurosurgical patients were admitted and treated by a single neurosurgeon from June, 2016 to May, 2017. We included all admitted patients above the age of 12 years with the diagnosis of DSFs.

All patients underwent plain CT scan of head for confirmation. Patients who could not get a CT scan for any reason, who died before any sort of intervention could be carried out, who had associated major multisystemic injuries were excluded. Approval from the institutional ethics committee (No. AMC / EC / PG / 2153) was undertaken. Written consent was taken from each patient or from a family member or a responsible guardian when the patient was incapable of giving consent. Clinical assessments were done at the time of admission and subsequently in ward and variables like age, sex, clinical presentation, GCS, mode of injury and examination findings were recorded.

The treatment strategy was undertaken according to the clinical and CT scan findings. Conservative and surgical management were undertaken as per indications. All the patients received broad spectrum and one antibiotic with anaerobic coverage was added in compound DSFs. All patients received anti-epileptics (commonly phenytoin, other AEDs like levetiracetam, sodium valproate, clobazam, lacosamide were used as an add on or where hypersensitivity encountered), proton pump inhibitors (PPI) and analgesics. ICU care was provided to patients of both the groups where needed. Surgical management was considered in patients who had DSFs in which depression was greater than 1 cm or greater than the full thickness of the skull, DSFs with associated intracranial injuries that required urgent surgical intervention, Extradural hematoma(EDH), Subdural hematoma(SDH), contusion, Intracerebral haemorrhage (ICH), significant pneumocephalus etc. with mass effect, DSFs with associated focal neurological deficits referable to the DSF, compound DSFs with CSF leak, Dural laceration or brain prolapse. Surgical procedures performed were craniotomy / craniectomy and elevation of DSF with replacement of depressed bone fragments were possible with repair of Dural laceration / removal of small, contaminated bone fragments where needed, removal of EDH / SDH / ICH / devitalized brain and contusion where required. Conservative management was initiated in those patients who had not fulfilled the criteria for surgical management. Conservative management consisted of antibiotics, anti-epileptics, analgesics, local wound care, debridement of the devitalised tissue and irrigation with normal saline where required. Osmotic diuretics (20 % mannitol / furosemide / spironolactone) were used for raised ICP. Patients were regularly evaluated for clinical improvement / deterioration and development of any complications. Patients were discharged when they improved, and all medications converted to oral. Patients were followed up in Outpatient department (OPD) after 1 week, 1 month and 3 months and on emergency basis when necessary. Patients were clinically evaluated, and Glasgow outcome scales score were recorded.

Statistical Analysis

Statistical analysis was done in MS Excel 2010 version using descriptive statistical methods.

RESULTS

Out of the 1274 patients admitted with head injury during the study period, 65 patients had depressed skull fractures i.e., it formed 5.1 % of the total admitted head injury patients in our institute. Age of the patients ranged from 13 years to 71 years. The highest incidence (36.9 %) was found in the age group of 31 - 40 years. (Table 1.1). There were 55 males and 10 females in our study. The male: female ratio was 5.5:1.

Age Group (in Years)	No. of Patients	Percentage
12 - 20	12	18.4 %
21- 30	16	24.6 %
31 - 40	24	36.9 %
41 - 50	9	13.8 %
> 50	4	6.3 %

Table 1.1. Age Distribution in the Present Series

Clinical Symptoms

Brief loss of consciousness in 45 (69.23 %), post traumatic amnesia in 36 (55.38 %), vomiting in 25 (38.46 %), ENT bleeding in 13 (20 %), seizures in 10 (15.38 %),

unconscious on presentation in 5 (7.69 %), neurological deficit was present in 7 (10.77 %) and brain matter prolapse through the open wound in 5 (7.69 %) patients on presentation.

Mode of Injury

Injury due to road traffic accident (RTA) was found in 40 cases (61.5 %), physical assault in 13 cases (20 %), fall from height in 7 cases (10.8 %) and fall of heavy object over the head 5 cases (7.7 %).

Site of DSFs

Out of 65 patients, 53 (81.54 %) patients had DSFs involving single bone. If seen from the perspective of bone involvement then frontal bone was involved in 40 (61.54 %) patients, parietal bone in 25 (38.46 %) patients, temporal bone in 13 (20 %) and occipital in 3 (4.61 %) patients (Table 1.2). Forty-two patients (64.61 %) presented with compound fracture and the rest twenty-three (35.38 %) had closed fractures.

Site of Fracture (Area Wise)		No. of Patients	Percentage
Frontal		30	46.1 %
Parietal		13	20 %
Temporal		7	10.8 %
Occipital		3	4.6 %
Other types	Fronto-parietal	6	9.2 %
	Temporo-parietal	2	3.1 %
	Fronto-temporo-parietal	4	6.2 %

Table 1.2. Different Sites of Fracture

GCS Score on Presentation

Out of 65 patients, 38 (58.46 %) patients had GCS score within 13 - 15, 22 (33.85 %) had GCS score within 9 - 12 and 5 patients were within the GCS score of 3 — 8 (7.69 %).

Associated Minor Injuries

A total of 26 (40 %) patients had minor faciomaxillary injury and 27 (41.54 %) patients had minor orthopaedic injury.

Associated Intracranial Injuries

EDH was found in 25 (38.5 %), contusion in 22 (33.8 %), pneumocephalus in 19 (29.2 %), SDH in 6 (9.2 %), Subarachnoid haemorrhage (SAH) in 7 (10.8 %) and driven bone fragments in 3 (4.6 %) patients.

Indications for Surgical Intervention

Out of the 65 patients, 25 (38.5 %) patients underwent operative interventions as per standard indication. (Table 1.3).

Operative Procedure Performed

Craniotomy or craniectomy and elevation of depressed skull fracture and removal of small bone fragments were done where required. Evacuation of EDH / SDH / ICH, removal of devitalized brain / foreign body, contusectomy and dural repair was also done where indicated. (Table 1.4).

Operative Indications		No. of Patients	%
Depression of fractured fragments more than inner table (by approx. 1 cm or more) without underlying intracranial injuries	Closed wound	2	8 %
	Clean	3	12 %
	With heavy wound contamination	4	16 %
Depression of fragments more than inner table (by approx. 1 cm or more)	With intracranial injuries	2	8 %
	With intracranial injury and in driven bone fragment	3	12 %
	With intracranial injury and brain prolapse	5	20 %
	Impacted foreign body with underlying intracranial injuries	2	8 %
	Intracranial injury and heavy wound contamination	2	8 %
Minimal DSF associated intracranial injuries with mass effect		2	8 %

Table 1.3. Various Operative Indications in the Operated Patients

Operative Procedures		No. of Patients	%
Elevation with complete replacement of fragments		7	28 %
Elevation with partial removal of small bone fragments		15	60 %
Elevation with complete removal of fragments		3	12 %
Other procedures	Duroplasty	8	32 %
	Neurorrhaphy	3	12 %
	Evacuation of EDH	6	24 %
	Evacuation of SDH	2	8 %
	Contusectomy	4	16 %
	Removal of prolapsed / devitalised brain	5	20 %
	Removal of foreign body	2	8 %

Table 1.4. Operative Procedures Performed in Operated Cases

Complications

Wound infection was the most common complication seen in this study (in 15.8 % patients) followed by seizures, neurological deficits (all had deficits at presentation), pneumonitis, electrolyte imbalances and sepsis. (Table 1.5)

Complications	Operative (25 Patients)	Conservative (40 Patients)	Total (65 Patients)
Wound infections	3 (12 %)	7 (17.5 %)	10 (15.8 %)
Seizures	5 (20 %)	4 (10 %)	9 (13.8 %)
Neurological deficits	5 (20 %)	2 (5 %)	7 (10.8 %)
Pneumonitis	3 (12 %)	2 (5 %)	5 (7.7 %)
Electrolyte imbalance	3 (12 %)	0	3 (4.6 %)
Sepsis	1 (4 %)	0	1 (1.5 %)

Table 1.5. Complications

Mortality

Two patients had died during the hospital stay, both due to pulmonary complications.

Outcome as per Glasgow Outcome Scale

At the time of discharge 6 patients had severe disability, 9 patients had moderate disability and 48 patients had good recovery. At the end of 3 months, 51 patients had good recovery, 4 patients had moderate disability and 4 patients had severe disability. 4 patients didn't come for 3rd follow up at the end of 3 months. (Table 1.6)

Follow Up	At D / A	1 Week	1 Month	3 Months
Death	0	0	0	0
Vegetative state	0	0	0	0
Severe disability	6	5	5	4
Moderate disability	9	9	5	4
Good recovery	48	48	52	51

Table 1.6. Outcome of the Patients as per GOS

DISCUSSION

Traumatic brain injury (TBI) is one of the leading causes of death and disability despite advances in management protocol and efforts of preventive measures. Depressed skull fractures form a major portion of head injuries. Incidence of DSF varies from (2.0 - 6.0 %).[2,3,4,5] Various studies showed that younger and male patients are most commonly involved in DSFs.[6,7,8,9] In our study depressed skull fracture patients formed 5.1 % of the total admitted head injured patients. The male: female ratio was 5.5:1. The highest distribution was seen in the age group of 21 - 40 years (61.54 %). Younger patients were affected most commonly which can be explained by the fact that these group of people are most commonly involved with outdoor activities, RTA and physical work. Recent trends showed RTAs as the most common cause followed by physical assault, fall from height, sports related injuries etc. 10, 11, 12 The most common mode of injury we found was Road traffic accident (61.5 %) followed by physical assault (20 %) and others. This is mainly due to increased number of vehicles on the road coupled with decreased awareness regarding traffic rules, use of safety measures while driving and increased incidence of drunk driving.

Many patients with DSFs experienced initial loss of consciousness and subsequent neurological recovery.[5] History of brief unconsciousness and post traumatic amnesia were the common symptoms. Other symptoms were vomiting, seizures, ENT bleeding etc.[10,8] We found brief loss of consciousness (69.23 %) as the most common symptom followed by post traumatic amnesia (55.38 %), vomiting (in 38. 46 %), ENT bleeding (in 20 %), seizures (in 15.38 %) and others. One striking finding we found at presentation was brain matter prolapse through the open wound in 5 (7.69 %) patients. Some investigators had found initial GCS score 13 - 15 as most common[13,7] and others had found GCS score 9 - 12 as the most common presentation. In almost all studies lowest percentage of patients found in GCS score 3 — 8 group. In our study, 58. 5 % of the patients had GCS score between 13 to 15, 33. 8 % had GCS score between 9 to 12 and 7.7 % patients had GCS score between 3 to 8.

Depressed fractures results from higher velocity and more concentrated force[14,15,16,17,18,19] which is the reason why impact force at the contact point is more severe as compared to linear fractures.[20] Following trauma overhead, there is in-bending of skull which ultimately leads to the fracture which creates a bevelled, displaced bone at the impact site, that along with secondary and tertiary fractures compresses and injures the underlying structures.[14,15,16,19,21] Parietal region was the most commonly involved part in DSFs in previous reports[6,22] But newer reports showed frontal region as common site of DSFs.[8,9] We found frontal bone as the the most commonly involved bone for the DSFs (61.5 %) followed by parietal (38.5 %) and temporal (20 %). One striking finding was that in 18.46 % cases, more than one bone was involved in the fracture and compound fractures were found in 64.61 % patients. This is due to the fact that road traffic accidents are now becoming the most common causes of these fractures.

These patients present with a history of trauma, wound over scalp of varying severity ranging from mere swelling over region or depression over scalp to open lacerated wound with clearly visible depressed bone fragments along with brain matter / CSF coming out through it. DSFs may present with intracranial injuries which in turn influences the morbidity, mortality and prognosis. Common associated intracranial injuries are EDH, SDH, ICH, Dural laceration, contusions etc.[11,7,8,9] In our study, 67.69 % patient had some sort of associated intracranial injury detected on plain CT scan of head and EDH was the most common finding.

Majority of the open DSFs requires operative intervention and majority of closed DSFs requires management.[4,7] Indications for operative interventions are grossly contaminated wounds, Dural laceration, neurological deficits referable to the DSF, depression more than 1 cm or more then the thickness of the skull, brain matter prolapsed through the wound, penetrating depressed bone fragment, underlying intracranial hematoma or contusion causing mass effect etc.[10,7] Operative intervention should be undertaken as early as possible to reduce the risk of infection.

All patients with open DSFs should receive broad spectrum antibiotics. Advocated operative intervention includes elevation of depressed fragments and primary replacement of depressed fragments wherever possible along with contusectomy / removal of devitalized brain / evacuation of intracranial hematoma / repair of dura / removal of grossly contaminated bone / removal of in driven fragment and debridement of wound margin whenever necessary[6,23,8,9] We performed elevation and partial replacement of the depressed fragments in 15 cases, elevation and complete replacement of depressed fragments in 7 cases and elevation with complete removal of depressed fragments in 3 cases. Duroplasty was done in 8 cases and neurorrhaphy in 3 cases.

Out of 25 operated cases, evacuation of intracranial hematoma was done in 8 cases, removal of prolapsed brain / necrotic brain in 5 cases and contusectomy in 4 cases. In two cases of minimally DSFs surgical intervention was undertaken for evacuation of underlying hematoma (one EDH and one SDH with mass effect). In our study mostly primary replacement of depressed fragments was performed which has been recommended in previous studies.[23] Those patients with large skull defect following complete removal / partial removal of bone were called after 4 to 8 weeks for cranioplasty. Non-operatively managed open DSFs required irrigation, debridement and closure of scalp wound.[7] Conservative treatment includes administration of antibiotics, analgesics, PPI and anticonvulsant in all cases. Diuretics (20 % mannitol, furosemide) and other supportive measures were given as per requirements.

Complications in cases of DSFs are surgical site infection, CSF leak, meningitis, osteomyelitis, localized brain abscess, empyema, seizures, neurological deficit, skin defect, pulmonary complications, dyselectrolytemia, sepsis and nutritional deficiencies.[12,9,18,13,24] Surgical site infection rate in DSFs ranges from 5.35 to 15 %. which is higher as compared to other type head injuries[18,13,12,9,18,25]

Incidence of post traumatic seizures is also higher in this type of head injuries (4 % to 60 %) which is mainly due to

higher incidence of underlying cortical injuries. The risk of subsequent seizures is higher in patients with early post traumatic seizures, post traumatic amnesia more than 24 hours, dural tear or focal neurological deficit and cortical injuries.[12,26] During hospital stay we found surgical site infection as the most common complication followed by seizures, neurological deficit, pulmonary complications, electrolyte imbalance and sepsis. During follow up, persistent motor deficit was found in 7 patients out of which, 3 had Lower motor neuron (LMN) facial palsy (gradually improving, all had associated temporal bone fracture), 4 patients had motor weakness in limbs, persistent motor aphasia in 2 patients, persistent altered higher mental function in 4 patients, seizures in 2 patients where addition of other AEDs required. We also found phenytoin sensitivity in 2 patients during follow up where phenytoin was stopped, other AEDs were started.

Risk factors for bad outcome were Old age, male sex, poor GCS at presentation, compound DSF, dural tear, associated intracranial injury, involvement of more than two skull bones, presence of infection, seizures etc.[13,7,27] In our study, at the time of discharge, 6 (9.2 %) patients had severe disability, 9 (13.8 %) had moderate disability and 48 (73.8 %) patients had good recovery. All patients came for first two reviews, 4 patients did not come for review at 3 month. At the end of 3 months, 51 (78.46 %) patients had good recovery, 4 (6.1 %) patients had moderate disability and 4 (6.1 %) patients had severe disability. There were 2 deaths during the hospital stay (mortality rate of 3.08 %) both due to pulmonary complications.

CONCLUSIONS

In this study, males, predominantly belonging to the age group of 21 - 40 years, formed the bulk of the patients with road traffic accidents being the most common mode of injury. DSFs carry specific clinical features and problems which require individualised attention and care. These can be managed with good outcome in a peripheral government centre run by a single neurosurgeon. Apart from treatment at hospital, we also need to focus on prevention of this type of injury by increasing the awareness with regard to traffic rules, use of safety measures while driving / travelling, improving the road condition and healthcare facility. We should also look into the causes of increased incidence of violence in society and try to prevent it.

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