ORIGINAL ARTICLE

# Clinicoradiological Features and Early Postoperative Outcome of Depressed Skull Fractures

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## *ABSTRACT*

***Introduction:*** *Skull fractures are frequently associated with head injury, especially in younger children and young adults. Upto 12% of head injury cases are associated with depressed fracture with a variety of clinical and radiological features. Clinical and radiological features of intracranial injuries are the chief determinants of postoperative functional outcome.*

***Objectives:*** *We aimed to study the diverse nature of clinical and radiological features and to determine their impact on the postoperative outcome in patients of depressed skull fractures.*

***Materials and Methods:*** *This is a prospectively conducted case series of a descriptive nature, conducted at the department of Neurosurgery, Hayatabad Medical Complex Peshawar between January 2015 and December 2015. All patients between age 15 years and 65 years, from both genders with the diagnosis of depressed skull fractures due to closed head injury were included. Patients with penetrating nature of trauma such as gunshot wounds or stab wounds were excluded.*

***Results:*** *65 patients with 46 (70.9%) males and 19 (29.2%) females in a ratio of 2.42:1. The most common cause of injury was road traffic accident with a mean age of 25.14 years ± 6.23 SD. Compound fractures were present in 56.9% while the rest were simple. Mean arrival GCS was 11.0 ± 2.29 SD. Mean GCS at discharge was 12.8 ± 3.28 SD and mean GOS was 4.05 ± 1.13 SD. Favourable outcome was recorded in 75.4% of patients while the rest were in unfavourable group. Most common complications were septic which occurred in a total of 15.4% patients and was followed in frequency by CSF leaks postoperatively. There was no mortality.*

***Conclusions:*** *The clinical features such as arrival GCS, pupillary abnormalities, focal deficits and radiological features such as the presence of intracranial and parenchymal lesions predict the outcome in terms of Glasgow outcome score. Most commonly septic complications and CSF leaks occur as complications after surgery.*

***Keywords****: Depressed skull fracture, surgical outcome, clinicoradiological features.*

## INTRODUCTION

Closed head trauma is one of the commonest causes of death and prolonged disability all over the world. There is a grave impact of these injuries in terms of economic losses to individuals, families and societies.[1] Skull fractures are commonly encountered in head injured patients. These fractures result due to direct impact of the injury force to the skull. Though accurate data is lacking about the true incidence of skull fractures, it has been estimated up to 85% of head injuries are associated with some form of skull fractures.[2]

Research has shown that fracture of the skull is a predictor of the force which has caused the head injury and probably an indirect determinant of the final.[3, 4]

More than 20% of severe head injuries present with depressed skull fracture which is a quite high incidence. Open wounds of the scalp, comminution, dural tear, cerebral parenchymal lesions, extradural haematoma, subdural haematoma or other intracranial injuries are frequently associated with depressed skull fractures and directly impact the outcome in these patients. About 55% of depressed skull fractures occur in children and adolescents and 50% of these cases are due to fall from height which is followed by road tra-

ffic accidents and assault. Dural tear and involvement of the cerebral venous sinuses is the determining factor for an intervention and the development of complications. About 48% of cases of depressed skull fractures are associated with tear of the dura matter which is followed by the occurrence of extradural haematoma and cerebral contusion or intracerebral bleed.[5-7]

Mushtaq et al[5] in a prospective case series has shown the incidence of dural tears in 47.9% cases. They have shown that 72.9% of patients recovered with good outcome.[5,7] Scalp laceration and the presence of intracranial mass lesion are the predictors of the severity of trauma and are frequently associated with poor outcome in terms of persistent neurologic deficits and functional disability.[8, 9]

We conducted this study in order to present the clinicoradiological features of patients with depressed skull fractures and their impact on the postoperative outcome. This will help in understanding the correlateion of various preoperative features with the postoperative functional outcome.

## MATERIAL AND METHODS

This is a prospective case series between January 2015 to December 2015 conducted at the department of neurosurgery, Hayatabad Medical Complex Peshawar. Patients with a diagnosis of depressed skull fracture which were listed for operative elevation were included. Patients between age 15 to 65 years of age were included irrespective of their gender. Patients with penetrating head injuries and skull fractures other than DSF were excluded. Patients with minimal depression who were operated for other intracranial traumatic lesions were also excluded.

Data was collected on a predesigned digital chart about the identity of patient like name, age, gender, address, admission number, mode of admission, admission GCS, location of fracture, and operative findings of the dural tear. Moreover, data was also collected about the presence of intracranial traumatic lesions such as epidural, subdural haematoma, contusions, and intracerebral haemorrhage. Outcome was assessed according to Glasgow outcome score. Favourable outcome group was of GOS 4 and 5 while GOS 1, 2 and 3 comprised Unfavourable group.

All Patients who needed surgery were operated under general anaesthesia using scalp incision which included the fracture, followed by raising a scalp flap. A burrhole was made along the edge of the fracture and the fracture was elevated using a blunt instrument such as a McDonald dissector or a periosteal elevator. Fractures which were comminuted or which were associated with dural tear underwent formal craniotomy. Moreover, patients who required craniotomy for evacuation of intracranial haematoma were operated according to the clinical judgment of the operating neurosurgeon. Patients were followed up till discharge and up to one month postoperatively. The outcome was measured in terms of Glasgow outcome score at the end of follow-up period, occurrence of complications, especially those which needed a readmission or reoperation and neurological sequelae such as focal deficits or motor dysfunction of the cranial nerves.

Statistical Package for Social Sciences (SPSS version 22.0) was used to enter and analyse the data. Descriptive statistics like mean and standard deviations were calculated for quantitative variables like age and initial GCS. Frequency/percentage were calculated for categorical variables like gender, presence or absence of dural tear.Outcomewas stratified among age gender initial GCS and Dural tear. Post-stratification significance was analysed using the chi-square test keeping P Value less than or equal to 0.05.The results were presented using charts and graphs.

## RESULTS

There were 46 (70.8%) males and 19 (29.2%) females among the 65 patients who presented with the diagnosis of depressed skull fracture.In 28 (43.1%) cases the fractures were simple, while in 37 (56.9%) the fractures were compound. Injuries were most commonly (n = 50, 76.9%) caused by road traffic accidents (RTAs) **(Table 1).**

Mean age was 25.14 ± 6.23 SD. Mean GCS at presentation was 11.0 ± 2.29 SD, while the mean time to presentation was 6.25 hours ± 3.04 SD.

Loss of consciousness (LoC) was reported in 70.8% (n = 20) of patients, vomiting in 30.8% (n = 20), seizures in 43.1% (n = 28), hemiparesis in 27.7% (n = 18), cranial nerves deficits in 6.2% (n = 4), CSF leaks in 26.2% (n = 17) and pupillary abnormalities were recorded in 16.9% (n = 11) at the time of presentation. There were 24 (36.9%) cases of frontal fracture, 10 (15.4%) fractures of temporal bone, and 31 (47.7%) cases of parietal bone.

In 19 (29.2%) cases, there was a concomitant cerebral parenchymal injury in the form of intracerebral hemorrhage (23.7%), contusion (43.1%) or superficial laceration (33.2%) with dural tear. Intracerebral haematoma was present in 11 (16.9%) of cases.

Postoperatively, the mean GCS at discharge was recorded to be 12.8 ± 3.28 SD while mean GOS at the end of follow-up was 4.05 ± 1.14 SD. Favourable outcome was recorded in 75.4% (n = 49) patients while unfavourable outcome was recorded in 24.9% (n = 16) patients (**Table 3**). The commonest postoperative complication was postoperative CSF leak which was recorded in 12.3% (n = 8) cases. It was followed by wound infection in 6 (9.2%) and progressive neurologic deficit in 6 (9.2%) cases. Meningitis occurred in 4 (6.2%) cases. There was no mortality (**Table 2**).

On Chi-square analysis pupillary abnormalities, trauma to other systems, presence of intracranial haematoma and parenchymal injury in the form of intracerebral haemorrhage or contusion was strongly associated with unfavourable postoperative outcome (**Table 1**).

An independent t-test was run to determine the difference of means for the continuous variables such as age, GCS at arrival, time since injury and GCS at discharge, on the basis of outcome groups according to GOS. It was observed that GCS at arrival, time since injury and GCS at discharge had statistically significant mean difference between the outcome groups as shown in **Table 4**.

## DISCUSSION

Skull fracture is a very common occurrence in closed head injury patients and depressed skull fracture is the result of a more focussed force with a low cross-sectional area.[10] The outcome in skull fracture patients

**Table 1:** *Clinicoradiological features and their association with outcome groups.*

| Variable | Favourable Outcome (n = 49) | Unfavourable Outcome (n = 16) | Significance (P value) |
|---|---|---|---|
| | Frequency (%) | Frequency (%) | |
| **Gender** | | | 0.83 |
| *Male* | 35 (71.4%) | 11 (68.8%) | |
| *Female* | 14 (21.5%) | 05 (31.3%) | |
| **Parenchymal Injury** | 3 (6.1%) | 16 (100%) | < 0.001 |
| **Fracture type** | | | 0.52 |
| *Simple* | 20 (40.8%) | 8 (50.0%) | |
| *Compound* | 29 (59.2%) | 8 (50.0%) | |
| **Haematoma** | 3 (6.1%) | 8 (50.0%) | < 0.001 |
| **Pupillary abnormalities** | 3 (6.1%) | 8 (50.0%) | < 0.001 |
| **Seizures** | 19 (38.8%) | 9 (56.3%) | 0.22 |

**Table 2:** *Postoperative complications for outcome groups.*

| Complication | Favourable Outcome (n = 49) | | Unfavourable Outcome (n = 16) | |
|---|---|---|---|---|
| | Frequency | Percent | Frequency | Percent |
| Progressive neurological deterioration | – | – | 6 | 37.5% |
| Meningitis | – | – | 4 | 25.0% |
| CSF leak | 2 | 4.1% | 6 | 37.5% |
| Wound infection | 4 | 8.2% | 2 | 12.5% |

is primarily related to the nature of intracerebral injury at the time of the application of force or secondary brain damage resulting as its consequence. [11] Direct mechanical brain injury such as parenchymal haemorrhage, contusions or superficial laceration of the brain surface are chiefly the determinant of presenting features as well postoperative outcome after skull fracture elevation.[9,12]

Penetration of the dura by fragmented bone[13], elevates the chances of infective complications, CSF leaks and intracerebral haemorrhage. This is the tationale of emergency intervention for contaminated fractures in compound type and to alleviate the raising ICP due to depression of large segment of bone inwardly.[14]

**Table 3:** *GOS scores at the end of follow-up.*

| Glasgow Outcome Score | Frequency | Percent |
|---|---|---|
| **1** | – | – |
| **2** | 6 | 9.3% |
| **3** | 10 | 15.4% |
| **4** | 20 | 30.8% |
| **5** | 29 | 44.6% |

**Table 4:** *Difference of means for the two outcome groups with their 95% CI.*

| | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|
| | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% CI of the Difference | |
| | | | | | | Lower | Upper |
| **Patient Age** | 0.840 | 63 | 0.40 | 1.510 | 1.797 | -2.081 | 5.102 |
| **GCS at Arrival** | 6.411 | 63 | < 0.001 | 3.316 | 0.517 | 2.283 | 4.350 |
| **Time Since Injury** | -6.208 | 63 | < 0.001 | -4.316 | 0.695 | -5.706 | -2.927 |
| **GCS at Discharge** | 14.310 | 63 | < 0.001 | 6.616 | 0.462 | 5.692 | 7.540 |

In the current study we evaluated the presenting clinical and radiological features of patients with depressed skull fractures as well as their postoperative outcome during the initial thirty days after discharge. The demographic characteristics of our patients were similar to other studies as mostly younger age patients were involved with a high number of road traffic accident victims which were followed in frequency by falls and assaults. Younger age male patients are highly active members of our society and together with lower rates of traffic safety rules, low public awareness of traffic rules and the aggressive attitudes of these young adults pose a higher risk for head injury. Rehman L et al,[12] in 2007 conducted a prospective observational study, including 56 patients with male predominance and average age of 21.7 years. They described fall as the commonest cause of DSF in their patients. Nnadi MO et al[9]has described RTA as the commonest mode of injury while Al-Haddad AS et al[15] observed assault as the commonest mode. These studies show that DSF mechanism of injury varies across various studies.

Depressed fractures usually occur along with overlying laceration (compound type) and various studies have analysed the impact of compound or simple fracture types on the incidence of infective complications. In our study we did not observe a correlation between the occurrence of infection, meningitis or unfavourable outcome for either fracture type. Studies by Rehman L et al,[12] Hossain MZ et al[2] and Ersahin Y et al,[16] have shown that compound fractures are commonest which are in agreement with our results.

In our study there was a positive correlation between arrival GCS and final functional outcome. As shown in table, patients with an unfavourable outcome presented with a mean GCS of 9.04 ± 2.34 SD while in the favourable outcome group, the mean GCS at arrival was 11.55 ± 1.79 SD (mean difference: 2.51, $p < 0.001$). These findings are concurrent with the study of Ersahin Y et al.[16] Many authors have shown that GCS is a good predictor of postoperative outcome in terms of GOS.[11,15,17,18] Both of these are good tools to assess the initial neurological status and final outcome.

Ali M and Ali L[19] in a seven – year review of 98 cases of depressed fractures have recorded focal deficits in 14%, CSF leaks in 9%, extradural haematoma

in 7% and gross skull deformation in 15% of patients. These clinical and radiological features have also been described as the indications for emergent surgical elevation of depressed skull fractures. We also observed similar indications as are described above. In most cases the patients GCS, persistently raised ICP due either to localised intracranial or parenchymal lesion or diffuse brain oedema. Urgent exploration, debridement and elevation of the depressed fracture is desirable due to several reasons and these are surgical debridement of the contaminated wound, elevation of depressed bony segment of the skull, evacuation of an acute extradural or subdural haematoma or resection of a contusion, dura repair in cases where there is presence of dural tear due to bony impingement, and lastly gross cosmetic deformity.

Wylen EL et al,[20] has shown that replacement of bony fragments in a DSF does not elevate the risk of infective complications. Similar is our practice in replacing the depressed fragments which include washing of the bone fragments with pyodine and hydrogen peroxide and replacing it during the same operation. A study by Nadell J and associates[21] have also shown that infective complications are not increased due to replacement of bone fragments in compound DSF, rather it is beneficial to avoid an additional procedure such as cranioplasty with its added complications and risks.

In our results of the clinical features, it was observed that the presence of pupillary abnormalities was associated with unfavourable outcome. These findings were also described by Ersahin Y and co-workers[16] in a large retrospective outcome analysis who have also shown that compound fractures are associated with worse outcomes.[16]

In our study approximately 75.4% patients achieved a favourable postoperative outcome whereas the rest were classified as having an unfavourable outcome in terms of GOS. Complications after surgical management of DSF include septic complications such as meningitis, wound infection, brain or scalp abscess formation or generalised sepsis. We encountered meningitis and wound infection in a total of 15.4% of patients. This complication rate after surgical management of DSF is similar to other studies such as by Van den Heever et al[22], who reported septic complications rate of 8%. This rate of complications as stated by Van den Heever et al,[22] is good when the septic status of the compound fractures is considered.[22]

## CONCLUSIONS

Depressed fractures frequently present with moderate traumatic brain injury and in a variety of patients it is associated with intracranial lesions such haematomas, contusion and intracerebral haemorrhage. The clinical features such as arrival GCS, pupillary abnormalities, focal deficits and radiological features such as the presence of intracranial and parenchymal lesions predict the outcome in terms of Glasgow outcome score. Most commonly septic complications and CSF leaks occur as complications after surgery.

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