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Original Article

# Surgical Outcomes in Depressed Skull Fractures: An Institutional Experience


## Abstract

**Aims:** The aim is to study the various factors associated with depressed skull fractures (DSFs) and their relationship with outcomes in patients who underwent surgery. **Settings and Design:** This was a cross-sectional study in a hospital setting. **Patients and Methods:** One hundred and fifty patients who underwent surgeries over a period of 6 years at our institute for DSFs were followed up and outcomes were analyzed. Patients having other medical- or trauma-related surgical morbidities were excluded. All age groups were studied. **Statistical Analysis Used:** The statistical analysis was performed using Chi-square test. **Results:** There was a significant relationship between the mode of injury, Glasgow coma scale (GCS) score at admission and discharge, and underlying brain injuries with the outcomes. The variables such as pneumocephalus, dural tears, type of fracture and site of the fracture, and age and sex distribution of the patient were not statistically influencing the outcomes. **Conclusions:** Patients who underwent surgery for DSFs, with good GCS at admission and discharge, with no underlying brain injury, and who did not sustain injuries in a road traffic accident had better outcomes.


**Keywords:** *Depressed skull fractures, outcomes, surgery*


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## Background

Depressed skull fractures (DSFs) constitute a major chunk of head injuries, especially in the Indian setup, where the occurrence of road traffic accidents (RTAs) with nonhelmeted riders is very common. Other modes of injuries commonly causing DSFs are assaults and fall from heights. A DSF is considered when any portion of the outer table is lying below the normal anatomical position of the inner table.[1] Impact of small, hard objects causes depressed fractures. In this case, energy dissipation from the impact results in skull fracture immediately beneath the impacting object. If the impacting force is substantial, all bone under the site of impact is damaged and skull perforation occurs. Due to the focused loading, little or no propagation of the fracture occurs. Depressed fracture carries a high risk of increasing pressure on the brain and damages the normal parenchyma. The outcome of patients with depressed fracture varies and depends on multiple factors. There have been a limited number of previous studies on the significance of these factors on the outcome of depressed fracture of the skull and hence this study.

### Objectives

The main objective is to ascertain various factors related with outcomes of DSFs.

## Patients and Methods

This is an observational cross-sectional study done between July 2012 and July 2018.

All the patients admitted during the study period with depressed fractures of skull who underwent surgery were enrolled in the study after obtaining informed consent. A total of 150 cases were operated and enrolled in the study. All patients with DSFs who underwent surgery were included in the study [Figures 1-4]. Patients having other injuries increasing the morbidity as in a case of polytrauma and patients with other medical comorbidities which may influence the outcome.

A predesigned, semi-structured questionnaire was used which included the following components.

The outcome was measured by the Glasgow outcome scale. Outcome was studied in



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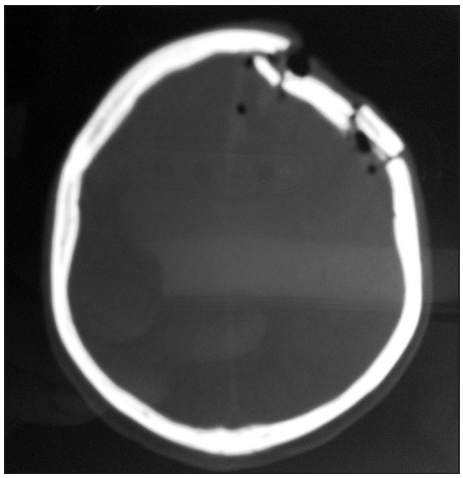

**Figure 1: Axial computed tomography (bone window) of a depressed skull fracture**


**Figure 2: Axial computed tomography (parenchymal window) showing depressed fracture with underlying contusion**

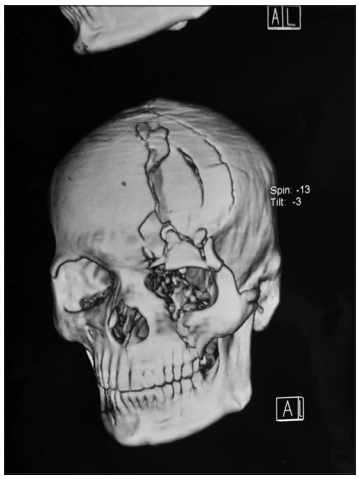


**Figure 3: Three-dimensional view of facial bones showing the depressed skull fracture**

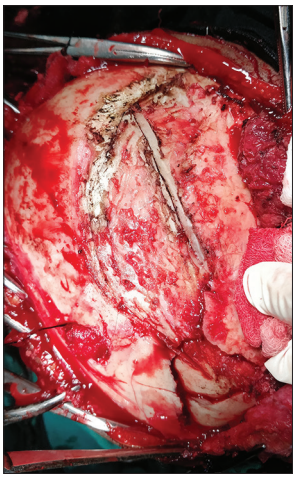

**Figure 4: Intraoperative image of a depressed skull fracture**

relation to the following variables: age, sex, mode of injury, site and side of fracture, type of depressed fracture (simple or compound), associated brain trauma and additional components of head injury, Glasgow coma scale (GCS) at admission, dural tear, GCS at discharge, and Glasgow outcome scale.

The data were collected and analyzed using MS Excel and Open Epi (Emory University, Atlanta, GA, USA). Descriptive statistics were calculated and statistical tests of significance such as Chi-square was applied wherever required.

Ethical clearance was obtained from the Institutional Ethics Committee before the start of the study.

## Results

A total of 150 patients underwent surgical intervention during the study period [Tables 1 and 2]. A total of 127 patients, i.e., 84.7% of study participants had a Glasgow outcome scale score of 5 and 23 patients (15.4%) had a Glasgow outcome score of <5. All these patients were assessed with respect to the different variables mentioned above and the results obtained were analyzed to draw conclusions.

1. Age and sex distribution and relation with outcome: Around 26% of study participants were <20 years of age and 58.7% in the age group of 20–40 years and 15.3% were >40 years of age. The mean age of the study participants was 27.9 ± 12.9 years. Around 13.3% of the study participants were female and 86.7% were male. No significant correlation was found between age and Glasgow outcome score and no statistical association ($P > 0.05$) was found between gender and Glasgow outcome score for depressed fractures
2. Mode of injury: The most common mode of injury was a RTA, accounting for 66.7% of total depressed fractures. Other modes of injuries such as fall from height, assaults, and railway accidents were grouped as non-RTA group and they accounted for 33.3%. A significant association was found between mode of injury and the outcome score (Using Chi-square,

**Table 1: Distribution of the study population according to their clinical profile**

| Variable | Number of cases (*n*=150), *n* (%) | Good outcome (outcome score=4, 5), *n* (%) | Poor outcome (outcome score 1, 2, 3), *n* (%) |
|---|---|---|---|
| Age group (years) | | | |
| <20 | 39 (26) | 39 (100) | Nil |
| 20-40 | 88 (58.7) | 80 (90.9) | 8 (9.1) |
| >40 | 23 (15.3) | 23 (100) | Nil |
| Sex | | | |
| Male | 130 (86.7) | 121 (93) | 9 (7) |
| Female | 20 (13.3) | 20 (100) | Nil |
| Mode of injury | | | |
| RTA | 100 (66.7) | 92 (92) | 8 (8) |
| Non-RTA | 50 (33.3) | 49 (98) | 1 (2) |
| GCS at admission | | | |
| 13-15 | 111 (74) | 110 (99) | 1 (1) |
| 9-12 | 21 (14) | 20 (95.2) | 1 (4.8) |
| <9 | 18 (12) | 11 (61.1) | 7 (38.9) |
| Site of fracture | | | |
| Frontal | 89 (59.4) | 84 (94.4) | 5 (5.6) |
| Temporal | 8 (5.3) | 8 (100) | Nil |
| Parietal | 31 (20.7) | 30 (96.7) | 1 (3.3) |
| Frontotemporal | 3 (2) | 3 (100) | Nil |
| Temporoparietal | 5 (3.3) | 5 (100) | Nil |
| Parietooccipital | 5 (3.3) | 4 (80) | 1 (20) |
| Frontoparietal | 4 (2.6) | 2 (50) | 2 (50) |
| Occipital | 5 (3.3) | 5 (100) | Nil |
| Associated brain injuries | | | |
| Contusion | 45 (30) | 39 (86.7) | 6 (13.3) |
| EDH | 26 (17.3) | 24 (92.3) | 2 (7.7) |
| SDH | 2 (1.3) | 2 (100) | Nil |
| SAH | 6 (4) | 6 (100) | Nil |
| Type of fracture | | | |
| Simple | 22 (14.7) | 21 (95.4) | 1 (4.6) |
| Compound | 128 (85.3) | 120 (93.7) | 8 (6.3) |
| Dural tear | | | |
| Present | 83 (55.3) | 78 (93.9) | 5 (6.1) |
| Absent | 67 (44.7) | 63 (94) | 4 (6) |
| Pneumocephalus | | | |
| Present | 28 (18.7) | 26 (92.8) | 2 (7.2) |
| Absent | 122 (81.3) | 115 (94.2) | 7 (5.8) |
| GCS at discharge | | | |
| 13-15 | 141 (94) | 140 (99.2) | 1 (0.8) |
| 9-12 | 7 (4.7) | 4 (57.2) | 3 (42.8) |
| <9 | 2 (1.3) | Nil | 2 (100) |

RTA – Road traffic accident; EDH – Epidural hematoma; SDH – Subdural hematoma; SAH – Subarachnoid hemorrhage; GCS – Glasgow coma scale

$P < 0.05$). RTAs causing DSFs had poor outcome when compared to those with other modes of injury

3. GCS score at admission: Around 74% of the study participants had a GCS of 13–15, and 14% had a GCS score of 9–12 and 12% had a GCS score <9 at admission. A moderately positive correlation (+0.5) was found between GCS score at admission and Glasgow outcome score. Better GCS score at admission was found to be correlated statistically with better outcome
4. Site of fracture: A total of 59.4% cases had a fracture of frontal bone; 5.3% – temporal bone; 20.7% – parietal bone; 2% – frontotemporal; 2.7% – frontoparietal; and 3.3% each of temporoparietal, parietooccipital, and occipital bone. There was no significant correlation between site of fracture and outcome score in our study. Frontal bone was the most common bone to be fractured in our study
5. Associated brain injuries: Thirty percent of cases had underlying contusion, and 17.3% had epidural

**Table 2: Relationship between factors and Glasgow outcome scale scores**

| Variables | Outcome score=5 (%) | Outcome score <5 (%) | Total (%) | *P* |
|---|---|---|---|---|
| Male | 109 (83.8) | 21 (16.2) | 130 (100) | 0.4 |
| Female | 18 (90) | 2 (10) | 20 (100) | |
| RTA | 77 (78.5) | 21 (21.5) | 98 (100) | 0.004* |
| Non-RTA | 50 (96.2) | 2 (3.8) | 52 (100) | |
| Simple[#] | 21 (95.4) | 1 (4.6) | 22 (100) | 0.1 |
| Compound[#] | 106 (82.8) | 22 (17.2) | 128 (100) | |
| Dural tear | 69 (83.1) | 14 (16.9) | 83 (100) | 0.5 |
| No dural tear | 58 (86.6) | 9 (13.4) | 67 (100) | |
| Pneumocephalus | 25 (89.3) | 3 (10.7) | 28 (100) | 0.4 |
| No pneumocephalus | 102 (83.6) | 20 (16.4) | 122 (100) | |
| Internal bleed present | 59 (77.6) | 17 (22.4) | 76 (100) | 0.005* |
| Internal bleed absent | 68 (91.8) | 6 (8.2) | 74 (100) | |
| Total | 127 (84.6) | 23 (15.4) | 150 (100) | |

[#]Symbol denotes fracture. **P*<0.05 - statistical significance - using Chi-square test. In any cell with value <5 - Yates correction was applied and *P* value was calculated. RTA – Road traffic accident

hematoma (EDH), 1.3% cases had subdural hematoma (SDH), and 4% cases had subarachnoid hemorrhage (SAH). There was a significant association between outcome score and fractures associated with brain injuries (Using Chi-square, $P < 0.05$). DSFs which had underlying brain injury had a poor outcome when compared to the fractures which had no underlying brain injury

6. Type of fracture: Around 14.6% of fractures were simple fractures and 85.4% were compound fractures in the present study. There was no statistical association between type of fracture and Glasgow outcome score in our study (Using Chi-square, $P > 0.05$)
7. Dural tear: In the present study, around 55.3% of the study participants had dural tear. There was no statistical association with dural tear and outcome score (Using Chi-square, $P > 0.05$)
8. Pneumocephalus: Only 18.6% of cases had pneumocephalus. There was no statistical association with pneumocephalus and outcome score (Using Chi-square, $P > 0.05$)
9. GCS score at discharge: There was strong positive correlation (+0.77) between GCS at discharge and Glasgow outcome score. Better GCS score at discharge indicates better outcome.

## Discussion

Head injury is a major contributor to the mortality and morbidity in patients sustaining trauma. Nonhelmeted riding on two-wheelers is a deep-rooted practice in Indian public scenario in spite of many rules and regulations prohibiting the same. The number of RTAs is increasing each year. Driving under the influence of alcohol is a major factor contributing to this rise in incidence. DSFs is one of the commonly seen head injuries. In DSFs, the outer table of one or more of the fracture edges lies below the normal anatomical level of the inner table as determined by the surrounding intact skull.[2] Patients give a classical history of trauma to the head, RTAs being the most common followed by accidental falls, assaults, and railway accidents among others. Various coexisting scenarios arise along with DSFs, namely, underlying bleeds such as EDHs, SDHs, dural tears, and contusions. Computed tomography (CT) scan is helpful in the diagnosis of skull fracture and associated intracranial lesion. CT is more useful in demonstrating depressed fractures except when they are at the vertex.[3] Heary *et al*. suggested that injuries were roughly equal between assault and RTAs.[4] Depending on the segment of depression and cosmetic considerations, either surgical or conservative approaches, can be employed. We have considered 150 cases of depressed fractures who underwent surgeries at our institute. Hossain *et al*.,[5] Jagger *et al*.,[6] Jamieson and Yelland,[7] Mumtaz *et al*.,[8] and Satardey *et al*.[9] conducted similar studies.

Various factors such as age, sex, GCS score on presentation, site of DSF, associated CT findings like the presence of contusions, EDHs, SDHs, and SAHs in the brain, dural tears and pneumocephalus, and GCS scores at discharge were studied which may influence the outcome of the patients with DSFs.

In our study, the mean age of presentation was 27.9 ± 12.9 years. Maximum patients (58.7%) were in the age group of 20–40 years. RTAs were found to be the most common mode of injury (66.7%). As most of these patients belonged to the working class which requires commuting daily, hence involved in RTAs more frequently. A study by Jagger *et al*.[6] concluded that outcome became worse with increase in age. In our study, there was no correlation between age and outcome. However, better outcome was observed in the study participants who were <20 years and >40 years of age. This can be attributed to the fact that their injuries were of a milder nature. Jamieson and Yelland[7] studied the mechanisms of injury in depressed fractures.

In our study, only 13.3% were females, and all of them had good outcome. There was no significant association between gender and outcome scores. This finding was similar to a study by Mumtaz *et al*.,[8] wherein 35.71% cases were female and 64.28% were male.

In the present study, there was significantly poor outcome in the RTA group when compared with the non-RTA group ($P < 0.05$). Similar findings were observed in the study conducted by Jagger *et al*.[6] and Jamieson and Yelland[7] where RTA was the most frequent mechanism of injury in compound depressed fractures. These findings differed with a study by Swann *et al*., in which assault was the principle mode of injury.[10] A similar study done by Al-Derazi *et al*. shows that an accidental heavy object fall on the head was the cause of injury in 30% of patients, which occurred mainly during industrial work or building constructions.[1]

The patients with GCS score of 13–15 (74%) at the time of admission fared well with better long-term outcome as against those with GCS score below it. There were 111 patients between 13 and 15 GCS score, of which 110 had good outcome. Twenty-one patients were noted in the 9–12 GCS group and 20 of them had good outcome. Eighteen patients fell in the below 9 GCS score group and only 11 of them had good outcome. There was moderately strong correlation (+0.5) between GCS at admission and final outcome score. GCS score at discharge was also considered. One hundred and forty-one (94%) patients fell under the group of 13–15 GCS score at discharge. Seven patients were noted in the group of 9–12 GCS score and only two patients had GCS score <9. Four patients out of the former group had good outcome, whereas both the patients in the latter had poor outcome. There was a very strong correlation (+0.77) between GCS score at discharge and final outcome score. Hence, it can be emphasized that GCS score both at admission and at discharge had a significant role in predicting the final outcome. In a similar study by Hossain *et al*., patients with preoperative GCS in the range of 13–15 were 50%, 9–12 were 31%, and those who presented with GCS of 8 or lower were 19%.

In the present study, the most common site of fracture is the frontal bone (59.33%) followed by the parietal bone (20.66%) and temporal bone (5.33%). More than two bones were less frequently involved. There was no statistical association between the site of injury and outcome score. The present study findings were concurrent with a study by Al-Derazi *et al*., where the sites for DSF were frontal (32%), parietal (44%), temporal (18%), and occipital (6%).[1]

In this study, 85.33% were compound fractures, which were similar to a study by Al-Derazi *et al*., where 72% patients had compound DSF.[1]

Associated brain injuries are another important factor in predicting the outcome in patients with DSFs. In our study, 30% of cases had contusions, 17.33% – EDH, 1.33% – SDH, and 4% – SAH. All the cases having SDH and SAH had good outcome. Most cases with poor outcome had contusions. Statistically, the association between underlying bleeds with depressed fracture was significant and was having relatively poor outcome ($P < 0.05$). These findings were similar to a study by Hossain *et al*., findings where EDH – 22%, brain contusions – 31%, dural tear – 25%, and in-driven bone fragment – 13%.[5] Other coexisting conditions such as dural tears and pneumocephalus were not related to the outcomes in our study. There were three cases which had a Glasgow outcome score of 1, i.e., death in our study. All these three patients were from the age group of 20 to 40 years and had underlying hematomas and all three were compound fractures.

Dural tear, site, and type of fracture were not related to outcomes in our study. This conclusion is slightly in contrast with Satardey *et al*.[9] which had poor outcomes even in cases with dural tear and a statistically significant relation with type of fracture (simple fractures had better outcomes in their study) which was not observed in our study. In a study by Lee *et al*.,[11] seizures were more common when the GCS was low. In our study, a similar association was noticed.

## Conclusions

Our study comprised 150 cases of DSFs which were operated over a period of 6 years and followed up for at least 6 months. There was positive correlation between GCS at presentation and discharge. There was statistical significant association between RTAs and poorer outcome. Underlying brain trauma had poor outcomes in general and was statistically significant association was also found. Other factors such as sex, age, pneumocephalus, dural tear, site, and type of fracture were not related to outcomes in our study. Hence, from this study, it can be concluded that depressed fractures not resulting from RTAs, with good GCS score at presentation and at discharge with no underlying brain injuries had good outcomes.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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