Original Article

Depressed Fractures of Skull: An Institutional Series of 453 Patients and Brief Review of Literature

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Abstract

Background: There has been a substantial increase in the number of cases with head injuries in the past two decades which has simultaneously led to increase in the annual incidence of depressed fractures of skull. Most of these skull fractures are associated with considerable morbidity and mortality of patients and an unavoidable financial burden on the family members. However, many changes have been undertaken directed toward improved management of patients with head injuries and skull fractures in the past 20 years. **Objective:** To study and compare the patterns of occurrence of the depressed fractures of skull and examine the factors which may influence the surgical outcome of patients with reference to similar case series from the past literature. **Patients and Methods:** We reviewed patient records of 453 patients admitted with depressed skull fractures in Department of Neurosurgery, Rajendra Institute of Medical Sciences, Ranchi, India, during the period of March 2004 through July 2009. **Results:** The incidence of depressed skull fracture was highest (56%) in the age group of 16–45 years. There was a predominance of male cases over females with a ratio of 7:1. The most common mode of injury was noted to be alleged assault (36%) and the parietal region (34%) being the most common site. Most cases had mild injury (62%) with Glasgow Coma Scale score of 13–15. The percentage of pure depressed fractures was 57% and the rest 42% were associated with intracranial lesion, of which the most common was contusion (25%). Superficial wound infection was observed in 38% of the patients. Of all the 453 patients, 91% were operated and most of them were operated within 24 h with overall mortality rate of 17%. **Conclusions:** Our study revealed the increased incidence of mortality in the age group of 16–45 years, which can guide our focus of management on them with strategic planning at individual as well as community level. Primary surgical repair of depressed skull fractures is safe, feasible, and associated with good outcomes. There was no significant association between tear in dura and an increase in the complications and, also, no substantial data to support the use of prophylactic antibiotics in patients to reduce chances of infection with it.

Keywords: *Age, depressed skull fracture, mortality, outcome*

Introduction

Although the skull is tough and provides excellent protection to the brain, a severe blow or trauma can cause fracture. Skull fractures are influenced by a number of factors including thickness of vault, mineralization of bones, and the force along with its mechanism of impact. Regarding the view of greater and concentrated force required to cause a depressed fracture, it is commonly associated with an underlying cerebral damage. The brain can be affected either directly by damage to the neurological tissue and its vasculature, or it can be affected indirectly by subdural and/or extradural hematoma which forms under the skull and compresses the underlying brain tissue.[1,2] The arrival of computed tomography (CT) scans and magnetic resonance imaging (MRI) in the late 20th century paves path for significant advancements in the understanding of brain injuries and surgical techniques. Furthermore, the management of head injury in trauma patients has undergone drastic changes after introduction of Advanced Trauma Life Support training.[3,4] However, there have been only a few recent studies analyzing the overall outcomes and association of early complications with skull fractures.

In this study, we have made an attempt to see the patterns of occurrence of depressed fractures of the skull and examine the factors which may be associated with the surgical outcome of patients with depressed

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skull fractures. Our institute is a tertiary patient care center and caters to a population of almost 2 million. This study represents a wide range of cases of depressed fractures in a densely populated area and gives a fair overview of a variety of cases over a period of about 5 years. The recent trends in the incidence, complications, and advances in the management of depressed skull fractures are also reviewed.

Patients and Methods

We retrospectively reviewed case notes of all the patients who were admitted in the Department of Neurosurgery at Rajendra Institute of Medical Sciences, Ranchi, India during the period of March 2004 to July 2009 with the approval of the Institutional Review Board for the study of different patterns in cases with depressed skull fractures and for its publication. The newly admitted patients in the above mentioned period who had one or more fragments depressed by at least more than the thickness of skull were included in the study. Gunshot wounds and linear fractures were excluded from the study.

Data collection and preoperative evaluation

We collected data of depressed skull fractures with relation to age groups, sex ratio, mode of injury, sites of injury, Glasgow Coma Scale (GCS) at admission, pre- and post-operative infections, and mortality. The study was self-funded. The preoperative evaluation included plain radiography of skull and CT scans of head and neck regions.

Results

Of over 16,000 patients admitted in our department over a span of about 5 years, information for all the patients with depressed skull fracture having sufficient data was retrieved from the records. The count came to 453 (2.83%). Their data were then analyzed retrospectively.

Age and sex

In our case series of 453 patients, maximum incidence was found to be in the age groups of 16–30 years (30%, *n* = 136) and 31–45 years (26%, *n* = 119) as shown in Figure 1. When we examined the distribution of cases according to sex, 69.5% (*n* = 315) were male and 30.5% (*n* = 138) were female. There was a predominance of depressed skull fractures in young and adult male patients between the age group of 16–45 years in this study with male to female ratio of 7:1.

Mode of injury and site of injury

Alleged assault was the most common cause of depressed skull fractures with occurrence rate of 36.42% (*n* = 165) cases followed by road traffic accidents (RTAs) which were 18.98% (*n* = 86) of the total cases [Figure 2]. The most common site of injury was parietal region found in 34.65% cases (*n* = 157), followed by frontoparietal in

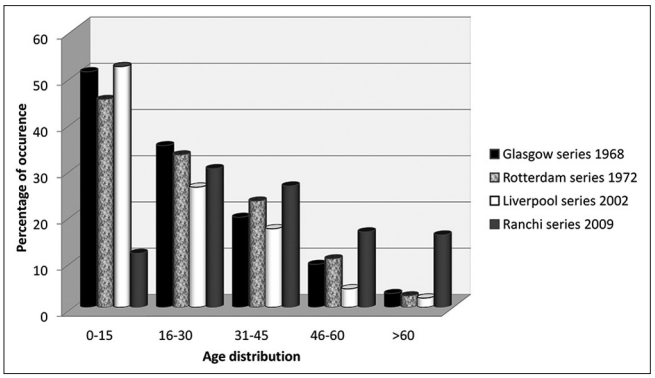

Figure 1: Occurrence of depressed skull fractures with age

25.16% (*n* = 114) and frontal in 18.98% (*n* = 86) cases. Temporoparietal, occipital, and isolated temporal site injuries were very few in numbers. About 5% (*n* = 20) patients had fractures in more than two regions [Figure 3]. It was particularly emphasized by Miller and Jennett[5] that serious sequelae are mostly associated with parietal injuries.

Severity of injury and radiographic evaluation

Initial GCS score at admission was 13–15 in 63% (*n* = 283) patients, 9–12 in 23% (*n* = 103) patients, and <8 in 15% (*n* = 67) patients. Out of 453 cases, 58% (*n* = 261) of the cases had pure depressed fracture with no evidence of intracranial lesions. All the other cases (*n* = 192) had associated intracranial lesions, of them contusion (59%, *n* = 113) was the most common followed by extradural hemorrhage in 25% (*n* = 47). Acute subdural hemorrhage and diffuse axonal injury were noted in a minority of cases. Venous sinuses were involved in 16.3% (*n* = 74), of which 46 were sagittal and 28 were transverse. Thirty-one patients with venous sinus involvement had actual tear, of which 22 were sagittal and nine transverses. About 88.5% (*n* = 401) patients had compound fractures and 11.5% (*n* = 52) had closed fractures [Figure 4]. The dura was intact in 43% (*n* = 194) and torn in 57% (*n* = 259).

Surgical approach

In 90.72% (*n* = 411) cases, operative management was done, of which all the compound fractures were operated within 24 h of admission and the rest 42 patients underwent wound debridement only. A total of six patients left against medical advice. In all the other cases of compound fractures, patients underwent wound debridement and elevation of depressed fragment either to relieve pressure over eloquent areas of brain or to remove fragments piercing the dura and damaging the brain or for cosmetic purposes. About 90% of the patients had the bone fragments replaced onto the fracture site. In 46 patients, bone was discarded because wound was contaminated with or without associated pus formation. These patients were later admitted for cranioplasty after 6 months. In cases of closed depressed fractures, fracture elevation was done for

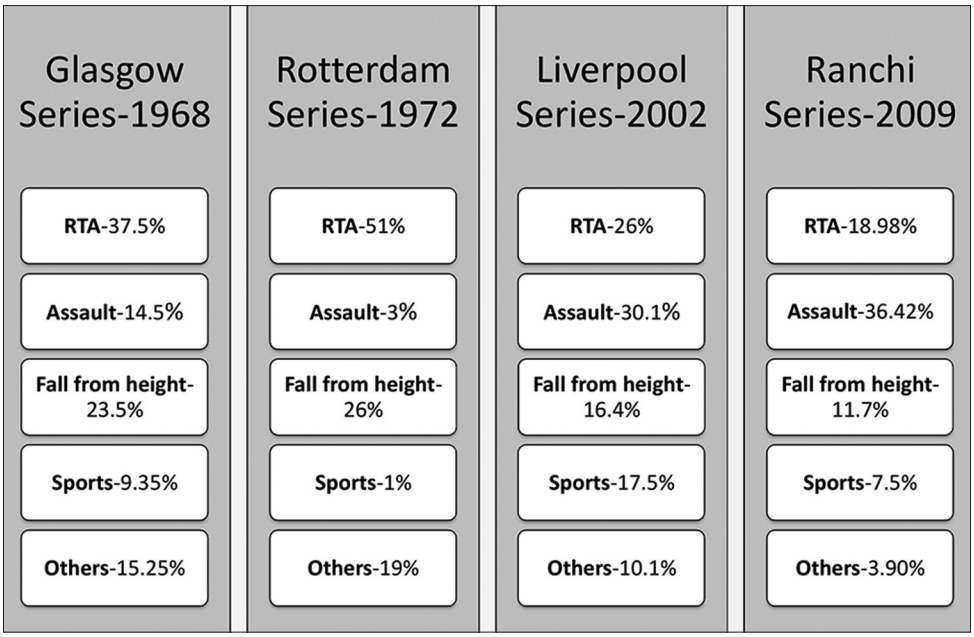

Figure 2: Etiology of depressed skull fractures

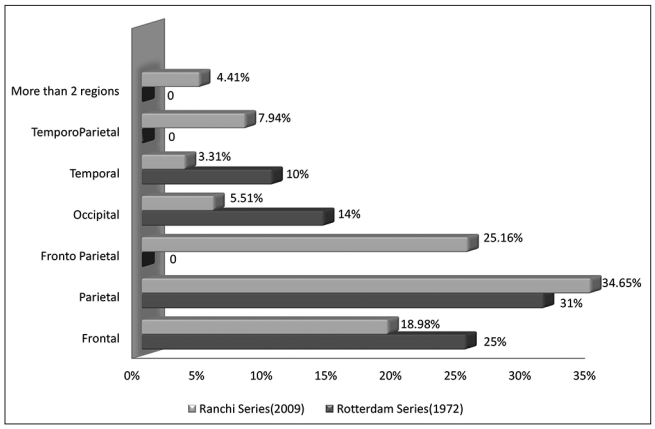

Figure 3: Site of depressed skull fractures

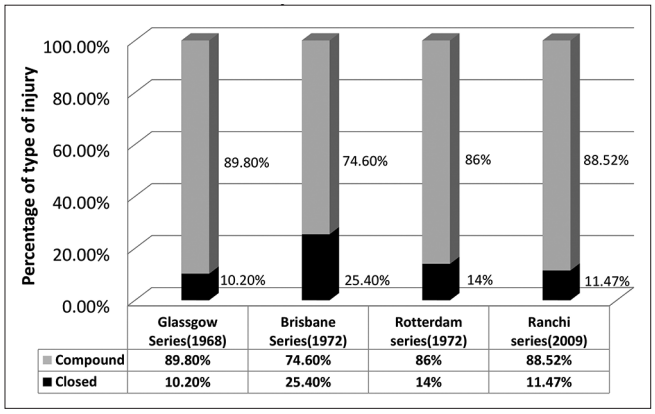

Figure 4: Incidence of compound and closed fractures

cosmetic reasons or to relieve pressure over eloquent areas of brain. In cases of dural injury, water tight duroplasty was done.

Infections and mortality

About 15% (n = 68) patients developed infection, of which 38% (n = 26) of these cases had superficial wound infection, 25% (n = 17) had meningitis, and 19% (n = 13) had osteomyelitis. Localized brain abscesses and subdural empyema were noted in few cases. All cases of infection were treated with appropriate antibiotics after culture and sensitivity testing. The overall mortality was 16.77% (n = 76) in our series [Figure 5].

Discussion

Head injury is the leading cause of morbidity and mortality not only in the developed countries but also in developing countries[6] and accounts for almost half of all the deaths from trauma.[7] Incidence of skull fractures is 44/100,000 person/years.[8] The majority of skull fractures are simple (53%), whereas depressed and compound fractures account for 16% and 12%, respectively.[8]

There is a wide divergence between the age group most commonly affected by depressed skull fractures in our (Ranchi) series and the Glasgow (1968),[5] Brisbane (1972),[9] Rotterdam (1972),[10] and Liverpool (2002)[11] series. The most common age group affected in our series was between 16–45 years which included 56.29% (n = 225) patients. In all the other three series, there was a preponderance of pediatric population (<16 years) which consisted of almost 50% of the total patients. The difference in our series could be attributed to the fact that this age group is more involved in outdoor activities. Hence, they are more prone to assault and RTAs. However, in agreement with the previous studies, there was a predominance of the male

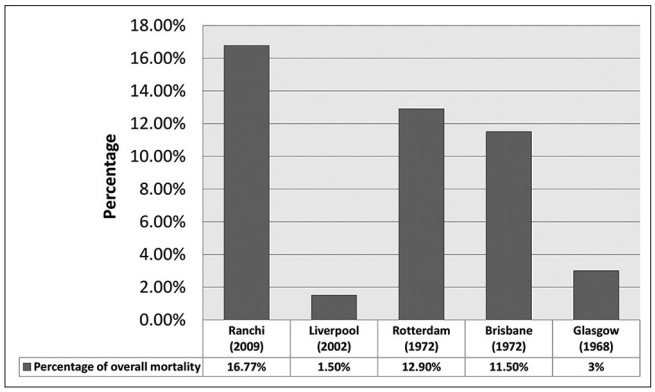

Figure 5: Association of mortality with depressed skull fractures

cases (6.94:1) as compared to females. The male:female ratio in Glasgow, Brisbane, Rotterdam, and Liverpool series was 4.99:1, 4.04:1, 6.14:1, and 9:1, respectively.[5,9,10,11] The higher ratio in males could be explained due to thicker and stronger skull in males which can absorb the impact force. Hence, males are more likely to get depressed fracture while females are more prone to linear fractures.[12] The most common mode of injury was noted to be alleged assault (36.42%) followed by RTA (18.98%). This is comparable to the recent study of Liverpool series in 2002 which also reported alleged assault (30.1%) to be the most common and RTA (26%) as the next important cause. However, RTA was found to be the leading cause in other studies which were performed more than four decades back. RTAs have been attributed to about 37% cases in the Glasgow series and 51% in both Brisbane and Rotterdam series. This could be attributed to the stringent traffic regulations in recent years which have led to significant reduction in RTAs. The maximum number of fractures was observed in parietal region (35%) which is parallel to the observation in Rotterdam series (31%).

The incidence of severe head injury (GCS < or = 8) and moderate injury (GCS score 9–12) is 15% and 23% which are slightly higher than findings in Liverpool series. This notable percentage of severe and moderate injury may be due to initial neglect of injury and lower or difficult access to medical facilities causing delay in seeking medical care in developing countries like ours, resulting in conversion of mild head injury into moderate head injury. This could be supported by the observation that there is simultaneous decrease in mild cases with GCS score13–15 (62.47%) as compared to 72% in Liverpool series.

The incidence of compound fractures in our series is 89% which is in agreement with the Glasgow series (90%), Brisbane series (75%), and Rotterdam series (86%). The higher incidence of compound fractures may be a consequence of increased number of cases of alleged assault. During alleged assault, the force is higher and delivered over a concentrated area of skull, thereby, is more likely to cause a depressed and compound fracture. Similarly, in RTA, the force of impact is usually very high, predisposing to higher chances of sustaining a compound fracture as found in our series.

Venous sinuses were involved in 16.3% of cases in our series which was slightly more compared to the series of Rotterdam with 11.5% of patient. In both series, sagittal sinuses were affected more than transverse. Disruption of dura was seen in 43% of cases which is lesser than Glasgow series (49.2%), Brisbane series (54.9%), Rotterdam series (51%), and Liverpool series (49.3%). The rate of infection in our series ranged from 0.6% having subdural empyema to 5.7% with superficial wound infection. This is not very different from the rates of infection reported in Glasgow (4.9%) and Rotterdam series (3.5%) but is slightly lower than in the Liverpool series which reported 8.2% infection rate. Thus, we have no concluding evidence to prove that tear in dura increases the chances of infection and/or the early use of antibiotics can prevent it. This is similar to the findings evidenced in other literatures where the benefit of prophylactic antibiotics could not be proved.[13-15]

The management of depressed skull fractures is guided by the various factors discussed earlier. Most patients had compound depressed skull fracture. The approach varies according to the protocol followed by different neurosurgeons. A great proportion of neurosurgeons in developing countries still follow the classical method of management, in which if the compound injury is not clean, the bone fragments are removed and are not replaced. If the dura mater is torn, watertight closure is tried to achieve.[10] This surgery is followed by cranioplasty after few months. If the wounds are clean, the bone fragments are tried to be replaced in the same operation. Closed depressed fracture can be followed up with conservative approach or approached surgically depending on the extent of depression, compression effects, or for cosmetic purpose. The depressed fractures overlying venous sinuses are left undisturbed to avoid hemorrhage.[10] In our institution, we apply the newer approach. Nearly 88.8% (n = 365) of surgically managed patients (n = 411) had their bone fragments replaced in the surgery. Only 46 patients had severely infected wound, for which the bone was removed, followed by management of infection and finally cranioplasty was performed. Of these, only 11 patients had closed wound. It was comparable to the approach in Rotterdam series, in which 73% underwent surgical approach.[10]

Mortality is much higher in our series (16.77%) than Glasgow series (3%), Rotterdam (12.9%), and Liverpool series (1.4%). This could be explained because of a higher percentage of aged patients who have coexisting medical illnesses and delay in seeking treatment in many cases. The provision of advanced care to trauma patients is not readily available. Imaging modalities such as CT scans and MRI are also not easily accessible. The associated intracranial lesions and higher rate of infections could also be a significant cause of increased mortality.

Limitations of the study

In our series, we have just seen the pattern of injuries in a large sample of the patient population. However, our study does not establish a relation between these factors and the surgical outcome of these patients. Furthermore, many patients left against medical advice, so we could not follow up with such patients.

Conclusions

Higher mortality rate in developing country such as ours concerns us to establish more efficient protocols in the management of cases with depressed skull fractures. The need of management not only includes the efforts in hospital environment but also should aim at creating awareness and strategies for an individual as well as society to avoid such incidents such as strictness toward following traffic rules, better management of comorbidity, and a harmonious neighborhood to reduce cases of assault. Age can be of aid to us to determine our focus in bringing out reforms. Our series helps us concentrate on the adult age group which suffers more from the causative factors such as assault and RTA along with their associated morbidity. Nevertheless, from perspective of health-care provider to treat such cases, conservative approaches can be adopted in a large number of cases with good outcome,[4] the primary rationale for attempting early single stage reconstruction of compound depressed skull fracture, and some closed depressed fracture serves potential benefit to functional, aesthetic, and psychological outcome. Although there is no convincing evidence that early use of antibiotics prevents or decreases the risk of infection with or without dural involvement, it is appropriate to do early debridement of wound and provide antibiotic cover in case of "dirty" wounds. Thus, taking into consideration the different strata of management and providing health care, a more holistic approach toward treating and avoiding such incidence of depressed skull fracture, we can bring significant reduction in mortality and morbidity caused by it and has better outcomes.

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Conflicts of interest

There are no conflicts of interest.

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