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Review Article

Compound elevated skull fractures in adults: A series of five patients and review of literature

Rajeev Sharma [a,*], *Arun Kumar* [b], *Dhananjaya I. Bhat* [c], *B. Indira Devi* [d]

[a] *Senior Resident, Department of Neurosurgery, National Institute of Mental Health and Neurosciences (NIMHANS), Hosur Road, Bangalore 560029, Karnataka, India*

[b] *Junior Resident, Department of Neurosurgery, National Institute of Mental Health and Neurosciences (NIMHANS), Hosur Road, Bangalore 560029, Karnataka, India*

[c] *Associate Professor, Department of Neurosurgery, National Institute of Mental Health and Neurosciences (NIMHANS), Hosur Road, Bangalore 560029, Karnataka, India*

[d] *Professor and Head, Department of Neurosurgery, National Institute of Mental Health and Neurosciences (NIMHANS), Hosur Road, Bangalore 560029, Karnataka, India*

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ABSTRACT

Objective: In view of rarity of elevated skull fractures, this paper was written with aim of making all neurosurgeons familiar with this rare injury, its management and prognosis.
Material and methods: We operated five patients of compound elevated skull fractures over a period of last 5 years. Mode and mechanism of injury, extent of injury, clinical presentation, course of disease and outcome with treatment were studied.
Results: Four out of these five patients improved after surgery without any complications.
Conclusion: Early recognition and appropriate management of compound elevated skull fractures gives good outcome and prevents unnecessary morbidity and mortality.

1. Introduction

Skull fractures are classified based on pattern (linear, diastatic, comminuted, depressed), by anatomic location (convexity, basal) and by type (simple, compound).[1] Compound fracture can be linear, depressed, or sometimes elevated. Elevated skull fracture, although seldom recognized in modern clinical practice, was first described in the oldest scientific and surgical treatise known, the Edwin Smith Surgical Papyrus, over 5000 years ago.[2] It is defined as fracture in which fractured fragment is elevated above the level of the intact skull.[3] In view of its rarity, this paper was written with aim of making neurosurgeons familiar with this rare injury, its management and prognosis. Clinical presentation, mechanism of injury, management, complications, and prognosis are discussed.

* *Corresponding author*. Tel.: +91 9741376769.
E-mail addresses: rajufbd79@rediffmail.com (R. Sharma), arunkumar3002@gmail.com (A. Kumar), dibhat@rediffmail.com (D.I. Bhat), bidevidr@gmail.com (B.I. Devi).
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2. Material and methods

Over a period of last 5 years (2007–2012), we operated five patients (Table 1) of skull fractures in which calvarial fracture fragment was elevated. One of them had mixed calvarial fracture showing both elevated and depressed fracture fragments. Mode and mechanism of injury, extent of injury, clinical presentation, course of disease and outcome with treatment were studied. Complications (post-traumatic seizures, neurological deficit, cerebrospinal fluid (CSF) leak, meningitis, bone flap osteomyelitis, or surgical site infection) were specifically looked for in all 5 patients. All the five patients were haemodynamically stable. All five of them received anti-meningitis treatment.

3. An illustrated case

A 24 years old gentleman presented in altered sensorium following road traffic accident (RTA) under influence of alcohol. There was no history of vomiting, seizures, ear nose and throat (ENT) bleed, or limb weakness. He was drowsy and obeying, pupils were equal and reacting. There were no neurological deficits. There was a right frontoparietal lacerated scalp wound. Computed tomography (CT) head (Fig. 1) 4 h after injury showed right frontoparietal compound elevated fracture, with underlying multiple small specks of right frontoparietal contusions without any mass effect. He underwent wound debridement, thorough wound wash, repair of dural tears. As wound was significantly contaminated, the elevated bone flap was not replaced. Postoperative course was uneventful. CT head showed craniectomy defect, same sized multiple small frontoparietal contusions without any mass effect. Both the cranial and abdominal wounds healed well. He is scheduled for bone flap replacement.

4. Results

All 5 of our patients were male. Out of 5 patients, RTA was the mode of injury in 3 patients and assault by sharp weapon in the remaining 2 patients. "Tangential application of force" was the mechanism of elevation of fracture segment in 3 patients and "lateral pull of the weapon while retrieving it" in the remaining 2 patients. At the time of admission, 3 patients were in altered sensorium and the remaining 2 patients were fully conscious. Only 1 patient who was having mixed elevated depressed fracture (Fig. 3) was having focal neurological deficit (hemiparesis). Head injury was mild in 3, and severe in the remaining 2 patients. All five of them had scalp wound directly overlying the calvarial fracture segment. Scalp wound length range was 5–20 cm. Dural tears were seen in 4 out of 5 patients. Extradural hematoma underneath elevated bone flap was seen in 1 patient only. Brain contusions underneath elevated bone flap were seen in 3 patients but they were small in 2 patients and did not require evacuation of contusion in both of them. One patient who was having mixed elevated depressed fracture was having large contusion immediately beneath fracture fragment which was

Table 1 – Five patients of elevated skull fracture.

Case no.	Age/ sex	Mode of injury	Mechanism of elevation of fracture	Admission GCS	Scalp wound length (cm)	Dural tears	Associated hematoma or contusion	Bone flap	Trauma – surgery time gap (hours)	Discharge GCS	Follow up (months)
1	24, M	RTA	Tangential force	E3M6V4	8	Present	Small contusions	Not replaced	5.0	E4M6V5	2
2	32, M	Assault by sharp weapon (knife)	Lateral pull of the weapon while retrieving it	E4M6V5	5	Absent	Nil	Not replaced	6	E4M6V5	4
3	25, M	RTA	Tangential force	E1M5V2	20	Present	Small contusions	Repositioned	5.5	E4M6V5	1
4	30, M	Assault by sharp weapon (sword)	Lateral pull of the weapon while retrieving it	E4M6V5	10	Present	Extradural hematoma	Repositioned	6	E4M6V5	60
5	24, M	RTA	Tangential force	E1M5V2 & right hemiparesis	9	Present	Large contusion and intraventricular bleed	Not replaced	21	E2M5V2 & right hemiparesis	2

Abbreviations: GCS – Glassgow coma scale, E – best eye opening, M – best motor response, V – best verbal response, M – male, F – female.

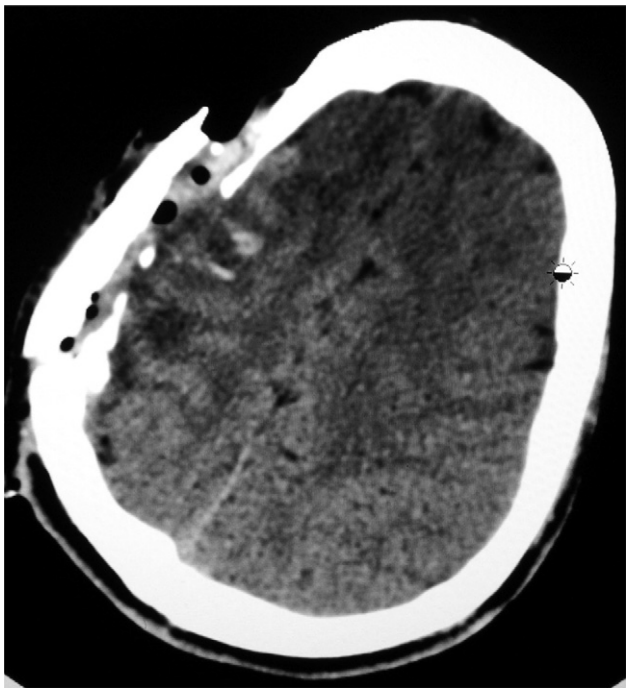

Fig. 1 – Case no. 1 showing right frontoparietal compound elevated fracture.

causing >1 cm midline shift, this patient required evacuation of contusion emergently along with wound debridement and duraplasty. Bone flap was repositioned back in 2 patients but was not replaced in the remaining 3 patients. While repositioning the bone flap, its overriding edges were nibbled. Bone flap was fixed to adjacent normal calvaria using threads passing through bone edge holes. However, bone flap was discarded in 2 patients (Figs. 1 and 2) due to gross wound contamination, and was not replaced in another 1 patient (Fig. 3) who was having mixed calvarial fracture along with large contusion to create space for edematous brain. Out of 5 patients, 4 were operated within 6 h of injury. Fifth patient presented to us 20 h after injury and was operated within 24 h of injury. Out of 3 patients who had came in altered sensorium, 2 patients became conscious and recovered fully after surgery. One patient who had mixed calvarial fracture with large underlying contusion showed only minimal improvement in eye opening and no improvement in hemiparesis after surgery. There were no complications in our series. Overall, 4 out of 5 patients had good outcome with emergent treatment without any morbidity or mortality.

Fig. 2 – Case no. 2 showing left parietal compound elevated fracture.

5. Discussion

Unlike depressed fractures, elevated fractures of the skull are usually externally compound.[2] All five of our patients had scalp injury overlying the elevated fracture fragment. Elevated skull fracture results when an almost tangential penetration of the skull is made by a long sharp-edged heavy object or weapon; and an outward component is imparted by lateral pull of weapon while retrieving it, or by rotation of the head after impact, or while transferring the patient.[2,4,5] They are frequently due to assaults with sharp-edged weapons.[3] In the older literature, such fractures were occasionally recorded as a result of saber wounds of the head.[2]

Extent of injury to brain and its coverings actually depends on the depth of weapon penetration and amount of impact transmitted to brain. Because much of the force is dissipated tangential to the cortical surface and away from it, the degree of scalp and bone injury may be relatively large compared to that of the underlying brain and its coverings.[2] Amount of force transmitted to brain and its coverings is more when force is applied perpendicular to brain's surface in comparison to applying same amount of force tangentially.[2] So, associated injuries to brain and its coverings may be less severe in elevated fractures having tangential impact compared to depressed fractures having perpendicular impact.

Wound contamination may be more in depressed fractures than in elevated fractures because perpendicular direction of force in the former drives more dirt in the wound in comparison to tangential direction of force in the latter one. So, infectious complications commonly associated with depressed fracture may be relatively less common in elevated fracture patients.

Non-contrast CT head is the investigation of choice because it demonstrates bony abnormalities as well as associated hematoma or parenchymal injuries.[5–7] The surgical principles of management are identical to those of compound depressed fractures with the elevated bone segments being replaced into position after evacuation of hematoma, thorough wash, and proper closure of the dura.[3,6–8] Presence of intact dura in some of these patients reduces the occurrence of postoperative infectious complications.[9] Bone segment can either be removed or repositioned depending on degree of contamination, quality of debridement, and brain bulge.[3,5,7] A

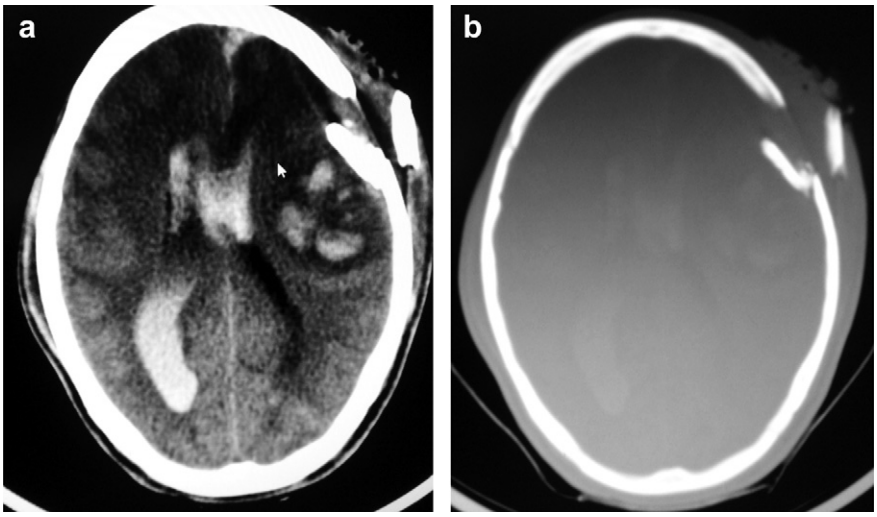

Fig. 3 – a: Case no. 5 showing left frontoparietal comminuted mixed elevated depressed fracture with underlying large frontotemporal contusions and intraventricular hemorrhage. b: Bone window showing the corresponding calvarial fracture.

grossly contaminated bone segment can be removed, thoroughly cleaned and preserved in bone bank for cranioplasty later.[7] If appropriately managed in time, these injuries have a somewhat more favorable prognosis than open depressed fractures.[2] However, delay or failure to operate may be complicated by intracranial sepsis like meningitis or abscess formation, or CSF fistula.[3,5,7,8]

There are very few references of elevated skull fracture in literature (largest series of 4 patients is by Adeolu et al[8]). We compared our patients with other published reports. Exclusive male gender involvement is related to their involvement in outdoor activities more than females. Modes of injury in Adeolu et al[8] series were assault, domestic accident, and road traffic accident. Mode of injury was RTA in 3 patients and assault with sharp weapon in remaining 2 patients of our series. Mode of injury in our third patient was nearly similar to that of the patient described by Borkar et al.[7] Mechanism of injury seems to be application of tangential force in 2 patients and lateral pull of the weapon while retrieving it in 3 patients of our series, and is similar to that described in literature. External scalp injury in all 5 (100%) of our patients is similar to that described in literature, but overlying scalp can rarely be intact as in one patient reported by Chhiber et al.[5] As in 4 out of 5 of our patients, dural breech is often seen in patients with elevated skull fractures. However, dura can sometimes be intact as in our second patient. It has also been reported by Borkar et al.[7] Good outcome in our series is comparable to that of other reports. Small or no contusions in the underlying brain and good recovery after surgery in 4 patients are probably related to lesser amount of force getting transmitted to brain parenchyma because direction of application of force was tangential. However, 1 patient of severe head injury who was having mixed elevated depressed fracture did not showed significant improvement after surgery. Large underlying contusion and depressed fracture segment in this patient suggest that large amount of force was transmitted to the brain perpendicularly. Our surgical techniques and decision making were nearly similar to that described by other authors.

There were no complications in our series. One of four patients of Adeolu et al[8] series who had presented 4 weeks after injury has developed brain abscess, whereas none of our patients got infected probably because four of them presented and got operated within 6 h of injury. Mortality was 0% in our series but was 50% in Adeolu et al[8] series. Good debridement especially thorough wound wash at the earliest possible seems to be the key to good outcome in this dirty wound surgery series. Factors affecting outcome are amount of contamination, presence or absence of dural breech, trauma to surgery time gap, quality of wound debridement, and appropriate anti-meningitis therapy.

6. Conclusion

Elevated skull fracture although rare, should be included in the pattern wise classification of skull fractures as has been suggested by many other authors. Early recognition and appropriate management of this skull fracture subgroup will prevent unnecessary morbidity and mortality.

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Conflicts of interest

All authors have none to declare.

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Dr Praveen Saligowda contributed equally to this paper.

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