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CASE REPORT

Elevated fracture of skull in pediatric age group: A series of five patients with review of literature

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ABSTRACT

Elevated fractures of skull in pediatric age group are rarely reported in the literature. In view of rarity, we present a series of five cases of elevated skull fracture in pediatric age group. Over a period of 1-year, we operated on five such cases. In this article, we have discussed the mode, mechanism and extent of injury, its clinico-radiological findings, course of the disease, and the management outcome. Four out of five cases improved after surgery and did not suffer any complications. Early recognition and appropriate management of compound elevated fracture in pediatric age group comes with good outcome and prevents unwanted morbidity and mortality.

Key words: Elevated skull fracture, ped compound elevated fracture, pediatric skull fracture

Introduction

Elevated fracture of skull was first described in the renowned surgical treatise "the Edwin Smith surgical papyrus" over 5000 years ago.[1] Elevated fractures have been reported infrequently in the medical literature. Most of the cases reported in English language medical literature were adults[1-9] except for two cases[10] and all were a result of either road traffic accident and assault. We present five cases of pediatric elevated skull fracture which have unique features. First, all cases belong to the pediatrics age group; second, mechanisms of injury in two cases were fall in the well and attack by alcoholic father by a sword respectively; third, all are cases of simple elevated fracture with one patient having delayed neurological deterioration. In this article, we have also discussed the mode, mechanism and extent of the injury, clinico-radiological findings, course of the disease, and its management outcome along with complications.

Materials and Methods

Over a period of 1-year, (2012–2013) we operated on five cases of elevated skull fracture of pediatric age group. Mode, mechanism of injury, extent of injury, clinico-radiological findings, course, and management outcome of disease were studied. Postoperative complications, such as seizures, neurological deficit, cerebrospinal fluid (CSF) leak, meningitis, bone flap osteomyelitis, and surgical site infection were specially looked for in all the patients. Four out of five patients were hemodynamically stable and one was in shock at the time of presentation. All five of them received antibiotics and antiepileptic drugs.

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Results

All of our patients were male. Non-contrast computed tomography (CT) scan of brain and skull findings and mode of injury are discussed in Table 1. Tangential application of force was the mechanism of elevation of fracture fragment in four patients and lateral pull of weapon while retrieving it, in one patient. At the time of presentation, three patients had severe head injury (Glasgow coma scale score [GCS] ≤8), one had moderate head injury (GCS >8 but ≤11 and one patient had mild head injury (GCS >11 but ≤15). In one patient (case no. 3), in primary health care center, the GCS was 15/15 and he presented to our institute after 36 h with a of GCS 8/15.

Of the five patients, external scalp wound was seen in four patients and one patient had intact overlying scalp with scalp hematoma. Length of scalp wound ranged from 4 cm to 14 cm. Extradural hematoma (EDH) underlying elevated bone segment was seen in three patients. Of the patients with EDH underlying the elevated fracture, one had contusion [Figure 1a] and another had small double EDH [Figure 2a]. Two patients had only contusion [Figures 3, 3a, 4, and 4a]. Dural tear was present in two out of five patients. Bone flap was replaced in two patients. In three patients, bone flap was not replaced because of grossly contaminated wounds

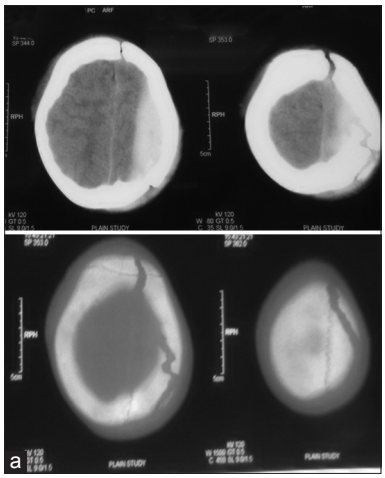

Figure 1: Left frontal elevated fracture with underlying extradural hematoma (a) bone window

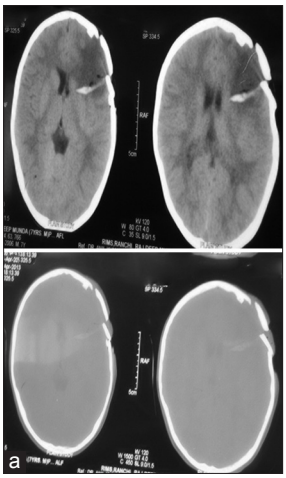

Figure 2: Left parietal elevated fracture with small double extradural hematoma (a) bone window

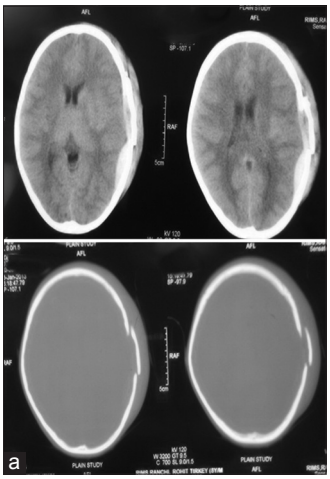

Figure 3: Left fontal elevated fracture with underlying contusion (a) bone window

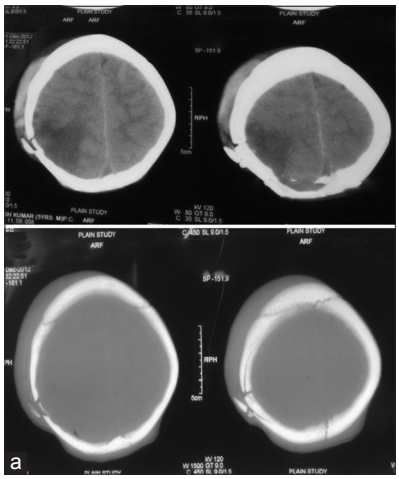

Figure 4: Right parietal elevated fracture with underlying contusion (a) bone window

in two patients and massive brain swelling in one patient. Of five patients, four were operated within 6 h of injury and one after 36 h of injury. Of the three patients who had GCS ≤8, one recovered fully with Glasgow Outcome Scale at Hospital Discharge (GOS-HD) of 15/15 at the time of discharge and one recovered fully (GCS 15/15) after 4 months of follow-up and one patient attained GCS 11/15 after 1-month of follow-up. Other two patients with GCS 11 and 15 at the time of admission recovered fully (GOS-HD 15/15). There were no complications in our series. Overall, out of five patients, four patients had a good outcome with emergent treatment, without much morbidity and no mortality.

Discussion

Skull fractures are classified on the basis of type, pattern, and anatomic location of the fracture. On the basis of type, it may be simple or compound. On the basis of pattern, it may be linear, diastatic, comminuted or depressed.[11] Compound fracture may be linear, depressed or sometimes elevated. Fracture of skull bones following trauma is common. In neurosurgical practice, we commonly come across depressed fractures. In some cases, the bone fragment is elevated above the intact skull bone and is known as elevated fracture of the skull. Elevated fractures are rare and are scantly reported in English medical literature.

The mechanism of elevation of intact skull bones may be injury made by a sharp heavy objects or weapons which elevate the skull fracture by lateral pull of object or weapon, elevation of free segment while retrieving the weapon,[1,3,10] tangential force acting on the intact calvarium in association with rotation of head.[2,9] The amount of force transmitted to the brain and its overlying structures is more when applied force is perpendicular to the brain's surface in comparison to when the force is applied tangentially.[1] Thus, injury to brain and associated structures may be less severe in elevated fracture having tangential impact compared to depressed fractures having a perpendicular impact.[1] Depressed fracture of skull may be more contaminated than the elevated fracture of skull

Table 1: Summary of pediatric cases operated for elevated skull fractures

Age/sex	Mode of injury	Mechanism of injury	Admission GCS and clinical history	Time of Neurolog-ical deteriora-tion	Scalp wound	Dura	Associated CT-Scan findings	Bone flap replaced ?	Trauma to surgery time gap	Follow up outcome
3-y/M	Fall in well	Lateral pull	E2V2 M3	Acute	R frontal wound 3 cm×1 cm and large abrasion in l occipital region	Intact	R frontal contusion and l parieto- occipital elevated fracture with underlying large EDH	No	6- h	E3V3 M6 at four months
8-year/M	Fall from tree	Lateral pull	E2V3M6	Acute	Lacerated wound in left parietal region 4 cm×2 cm	Intact	L parietal elevated fracture with underlying small double EDH	Yes	-h	E4V5M6 at four months
5-year/M	Fall from height	Lateral pull	GCS at primary health care center E4V5M6. GCS at time of admission E2V2M4 H/o one episode of seizure	Delayed	Right fronto-temporo- parietal scalp hematoma	Torn	Right parietal elevate fracture with underlying contusion	Not replaced	36-hours	E4V5M6 at two months
8-year/M	Fall from roof	Lateral pull	E4V5M6	No neurologi cal deficit		Intact	Right temporo-parietal elevated fracture with underlying EDH	Replaced	6-hours	E4V5M6 at two months
7-year/M	Assault	Lateral pull while retrieving the weapon	E2V1M5	Acute	Right frontal multiple lacerated wound 7 cm×4 cm	Torn	Right frontal elevate fracture with underlying contusion	Not replaced.	5-hours	E4V2M5 at one month

GCS – Glasgow coma scale score; EDH – Extradural hematoma

because the perpendicular direction of force drives more dirt in the wound than the tangential direction of the force. Hence, patients of depressed fractures are more prone for infectious complications than those with elevated fractures. Pediatric patients are more susceptible for the secondary insult of brain from low oxygen saturation, fluid imbalances, electrolyte disturbances, fever, and seizures requiring special care.

Noncontrast CT Scan of head is the investigation of choice in all age groups of elevated skull fracture patients because it reveals bony abnormality as well as any underlying hematoma and brain parenchymal lesions.[5,6,10] Compound elevated fractures should be managed as compound depressed fracture with extensive debridement of wound, elevated bones fragment repositioned or remove after the evacuation of hematoma or contusion, with proper wash and closure of dura.[2,4,5] Intact dura reduces the chance of postoperative infections.[8] Removal or repositioning of the elevated bone segment depends on the degree of contamination, quality of wound debridement, and brain bulge.[4,5,10] Grossly contaminated bone fragments are generally removed.[5] Delayed surgery or failure to operate may be complicated by meningitis, brain abscess, or CSF fistula formation.[2,4,5,10] Timely interventions result into more favorable prognosis.

Extensive medical literature search by our group shows that almost all reported cases of elevated skull fracture report adults[1-8] except for Chhiber *et. al.*,[3] who reported two cases of elevated fractures in pediatrics age group. We compare our findings with other published English language reports in medical literature. All the patients reported in our series were males. Modes of injury of elevated fracture reported by Adeolu *et al*.,[1] Chhiber *et al*.,[3] and Sharma *et al*.,[6] were assault, domestic violence, road accident, fall from height, and animal bite. In our series, the mode of injury was fall from height (fall in well, fall from tree, fall from roof) in four patients, and assault by sharp weapon (sword) in one patient. Tangential impact to the skull associated with rotation when the head hits to some elevated surface seems to be the probable mechanism in four cases and lateral pull of weapon while retrieving it was the mechanism of injury in one case. External scalp injury was seen in four patients while one patient had intact overlying scalp with scalp hematoma [Figures 2 and 2a] which is rarely seen. One such case of intact overlying scalp was described by Chhiber *et al*.[3] Dural breach often accompanies elevated fractures. Two out of five of our patients had a dural tear and in the remaining three patients dura was found to be intact. Intact dura in cases of elevated fractures has also been reported by Borkar *et al*.[2] Good outcome in our series is comparable to that of the others reports. Mechanism of injury in four patients was lateral pull, the direction of applied force being tangential causing less amount of energy being transmitted to brain parenchyma, being the probable cause of good recovery in four patients. Elevated skull

fracture when accompanies a large EDH [Figures 1 and 1a] or contusion, acts as spontaneous decompression and protects the patient from sudden deterioration. All the cases reported in the literature had maximum neurological deterioration at the time of presentation except in the case described by Chhiber *et al*.[3] in which neurological deterioration occurred 48 h after injury. In our series, in case no. 3, [Figures 4 and 4a] neurological deterioration occurred after 36 h of injury, which is not explained by any associated injury. Improvement of the neurological condition may be explained by improvement in local blood supply around the herniated brain tissue after surgery and diuretic therapy. In one patient, mechanism of injury was retrieving of sharp edge weapon (sword) in which direction of applied force was perpendicular causing more amount of energy transmitted to brain parenchyma leading to poor outcome in that patient. Decision-making and surgical technique were nearly similar to that described by others authors.

There were no complications in our series because four patients were operated within 6 h of injury except for one patient. In contrast to 50% mortality reported by Adeolu *et al*.,[1] there was 0% mortality in our series. Factors affecting the good outcome are amount of contamination, presence or absence of dural breach, trauma-surgery time gap, quality of wound debridement and appropriate and timely antibiotic and antiepileptic medication.

Conclusions

Early recognition and appropriate management of elevated skull fracture may prevent unnecessary morbidity and mortality. Pediatric age group patients are more prone to secondary brain insult, requiring better attention and timely intervention. In view of rarity of its incidence, elevated fracture should be included in pattern wise classification of skull fractures as has been suggested by many others authors.

References

1. Adeolu AA, Shokunbi MT, Malomo AO, Komolafe EO, Olateju SO, Amusa YB. Compound elevated skull fracture: A forgotten type of skull fracture. Surg Neurol 2006;65:503-5.
2. Borkar SA, Sinha S, Sharma BS. Post- traumatic compound elevated fracture of skull simulating a formal craniotomy. Turk Neurosurg 2009;19:103-5.
3. Chhiber SS, Wani MA, Kirmani AR, Ramzan AU, Malik NK, Wani AA, *et al.* Elevated skull fractures in pediatric age group: Report of two cases. Turk Neurosurg 2011;21:418-20.
4. Garg N, Devi BI, Maste P. Elevated skull fracture. Indian J Neurotrauma 2007;4:133.
5. Mohindra S, Singh H, Savardekar A. Importance of an intact dura in management of compound elevated fractures; a short series and literature review. Brain Inj 2012;26:194-8.
6. Sharma R, Kumar A, Bhai DI, Devi BI. Compound elevated fracture in adult: A series of five patients and review of literature. Indian J Neurotrauma 2012;9:112-6.
7. Ralston BL. Compound elevated fractures of the skull. J Neurosurg 1976;44:77-9.
8. Abu Talha K, Selvapandian S, Asaduzzaman K, Selina F, Rahman M, Riad M. Compound elevated skull fracture with occlusion of the superior sagittal sinus. A case report. Kobe J Med Sci 2009;54:E260-3.
9. Verdura J, White RJ. Letter: Compound elevated skull fractures. J Neurosurg 1976;45:245.
10. Bhaskar S. Compound "elevated" fracture of the cranium. Neurol India 2010;58:149-51.
11. Balasubramaniam S, Tyagi DK, Savant HV. Everted skull fracture. World Neurosurg 2011;76:479.e1-3.

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