Pediatric Extradural Hematoma: A Report of 34 Cases

Mohamed Hassanein

Department of Neurosurgery, Faculty of Medicine, Suez Canal University, Egypt

Abstract

***Background*: Extradural hematoma (EDH) resembles a potentially life-threatening condition following head injury in children. EDHs are less common in children, with few reports had studied the outcome of such patients. *Aim:* The current analysis presents the etiology, clinical features and management of 34 patients with traumatic EDHs and identifies the possible factors that could predict the outcome. Patients and Methods: Patients with traumatic EDH in the age group (0-18) years, admitted to Suez Canal teaching hospital Between January 2013 and March 2016, were analyzed prospectively. Mode of injury, clinical course, radiological findings and management details were evaluated, and the outcome was measured 3 months after discharge using the pediatric extended Glasgow outcome scale (GOS-E). *Results:* The study included 24 boys and 10 girls, with mean age of 9.7 years. Traffic accident was the commonest mode of injury. The mean Glasgow Coma Scale (GCS) score at presentation was 12.1±2.3, and headache was the most frequent symptom (61.7%). Most patients (65%) were managed conservatively, while 35% were operated upon. Favorable outcome was achieved in 91.1% of patients, and the mortality rate was 5.8%. Univariate analysis demonstrated an association of the final GOS-E score with the initial Glasgow Coma scale (GCS) score, the mode of injury and the presence of pupillary abnormality or intradural injury. *Conclusions:* EDHs can develop following mild head injury in alert children. Favorable outcome was the rule in most children with traumatic EDHs. Traffic accident as a mode of injury, low initial GCS score and the presence of pupillary abnormality or intradural injury are statistically significant factors that were linked to a worse outcome.**

Keywords: Head injury, Glasgow Coma Scale, Extradural hematoma, Children.

Introduction

Traumatic head injury is a frequent cause of acquired physical and cognitive impairments, and results in significant mortality in pediatric population(1). EDH is a life threatening intracranial pathology that occurs in about 2% of all patients with head injury. In children, EDH is less common than in adults with a reported incidence of 1.5 - 4% among hospitalized children with traumatic head injury(2,3). EDHs are commonly developed after skull fractures that injure the middle meningeal vessels or the nearby venous structures (dural sinuses/diploic veins) with subsequent stripping of the dura and hematoma formation. During childhood, the dura is well attached to the inner table of the skull especially at suture lines, and the meningeal vessels are running in shallow grooves without being encased in bone,

Corresponding Author: mhmdhasanin@gmail.com

which makes them easily displaced rather than torn. Therefore, EDHs are less frequent in children than in adults[4]. EDH is potentially remediable if treated early. However, its early diagnosis in pediatric age group is quite challenging due to the different clinical presentation compared to adults. Children with traumatic EDHs are less probable to lose consciousness from the impact of trauma, and their clinical course is more insidious, which could delay the diagnosis and treatment[5]. In the current study, we present the results of 34 consecutive pediatric patients who were admitted and diagnosed as traumatic EDHs, highlighting on mode of injuries, clinical presentation, radiological findings, management details. The final outcome was measured on GOS-E. We also tried to define the relationship between different variables and the final outcome.

Patients and Methods

The present descriptive analysis was conducted prospectively on patients aged <18 years and were managed at our tertiary care hospital for traumatic EDHs during the period between January 2013 and March 2016. Children who were not admitted to hospital and children who died at the scene of injury or at casualty were excluded from the study. At presentation, all children were subjected to first aid measures followed by routine trauma survey unless head trauma was isolated. Patient's data included age, gender, mode of injury, clinical presentation, associated injuries, radiological findings, management given and duration of hospitalization. Neurological examination was focused on evaluation of the level of consciousness on pediatric Glasgow Coma Scale (GCS), and assessment of the motor system and pupils for possible deficits or signs of lateralization respectively. Head CT scan was requested irrespective to the severity of injury, and hemoglobin level was checked periodically. Children were managed either conservatively or surgically based on the guidelines for the management of traumatic brain injury published on 2006[6]. Phenytoin was administered to all children for seizures prophylaxis. Conservative treatment consisted of close neuro-observation, monitoring of vital signs and serial head CT scans. Indications for surgical intervention were one or more of the following; hematoma volume ≥30 ml (using Peterson & Espersen equation; $A \times B \times C/2$), hematoma thickness >15 mm, midline shift >5 mm, clinical/neurological deterioration and findings suggesting brainstem compression, while indications for ICU admission were GCS ≤8 and respiratory or cardiovascular compromise. The final outcome was evaluated three months after discharge based on Pediatric Extended Glasgow Outcome Scale (GOS-E) on outpatient basis[7]. The outcome was defined as "Favorable" with a GOS-E score of 5-8 and was defined as "Poor" with a GOS-E score of 1-4. Univariate analysis using Chi square (x2) and Fisher exact tests was employed to determine any correlation between different clinical or radiological variables and the final outcome scores (GOS-E). A P value ≤ 0.05 was considered statistically significant.

Results

Between January 2013 and March 2016, 24 boys and 10 girls with traumatic EDHs were included in the present study, their ages ranged between 1.5 and 14 years, and the mean age was 9.7±1.43 years. Nearly half of the patients (47%) were in the age group 11-18 years, with a male/female ratio of 2.4/1. Traffic accident was the most common mode of injury found in 44.1% (n=15), followed by fall from height in 26.4% (n=9), impact with a blunt object in 17.6%

Table 1: Demographic and Clinical characteristics of the Patients (n=34)

Variable	Number (%)
Gender	
Male	24 (71%)
Female	10 (29%)
Age (years)	
0 – 2	3 (8.8%)
3 – 5	5 (14.7%)
6 – 10	10 (29.4%)
11 – 18	16 (47%)
Mode of Injury	
Traffic Accident	15 (44.1%)
Fall	9 (26.4%)
Hit with a Blunt Object	6 (17.6%)
Sport-Related	4 (11.7%)
Severity of Head Injury	
Mild (GCS= 15-13)	22 (64.7%)
Moderate (GCS= 12-9)	7 (20.5%)
Severe (GCS= 8-3)	5 (14.7%)
*Clinical Presentation**	
Headache	
Repeated vomiting	21 (61.7%)
Altered level of con-	19 (55.8%)
sciousness	9 (26.4%)
Scalp swelling	7 (20.5%)
Seizures	4 (11.7%)
Neuro-deficit (limb weak-	2 (5.8%)
ness)	
Location and volume of EDHs	
Temporo-parietal	14 (41.4%)
< 30 CC (n=9)	
> 30 CC (n= 5)	
Frontal	10 (29.4%)
< 30 CC (n=7)	
> 30 CC (n=3)	
Parietal	7 (20.5%)
< 30 CC (n=5)	
> 30 CC (n=2)	
Temporal	2 (5.8%)
< 30 CC (n=1)	
> 30 CC (n=)	
Posterior fossa	1 (2.9%)
< 30 CC (n=1)	
Concomitant CT Findings	
Skull fracture	21 (61.7%)
Cerebral edema	6 (17.6%)
Cerebral contusion	5 (14.7%)
Subdural bleed	1 (2.9%)

* multiple finding could present in one patient

(n=6) and sport-related injury in 11.7% (n=4) of patients (figure 1). Falls were common in children aged below 5 years while traffic accidents were more frequent with increasing age (table 1). However, we did not find a statistically significant correlation between mode of injury and age of the patients in our sample (P=0.308). Most patients (22 patients, 64.7%) presented to casualty with mild head injury (GCS; 13-15), while 7 patients (20.5%) had moderate injury (GCS; 9-12) and 5 patients (14.7%) had severe injury (GCS; ≤ 8). The overall mean GCS score at presentation was 12.1 ± 2.3 and ranged between 5and 15. Headache was the most frequent symptom (61.7%), and was exclusively found in children older than 6 years old, followed by repeated vomiting (55.8%), altered level of consciousness (26.4%) and scalps swelling (20.5%) respectively, with some patients had multiple complaints. Typical lucid interval was reported in only 3 patients (8.8%), seizures occurred in 4 patients (11.7%), and localized limb weakness was elicited in 2 patients (5.8%). Neurological deterioration was documented in 3 children within 12 to 17 hours of injury, two of whom showed hematoma expansion, and the third one developed cerebral edema on follow up head CT scans. Pupillary abnormalities were noted in 7 patients and involved unilateral dilated pupil with sluggish reaction in 3 patients, bilateral dilated pupils with sluggish reaction in 2 patients, and non-reactive pupils in 2 patients. Hemoglobin level was below 10 g/dl in 6 patients and below 8 g/dl in 2 patients (aged 3 and 5 years) who required blood transfusion. Abnormal respiratory pattern was noted in 3 patients, two of them required endotracheal intubation on presentation. Associated injuries were maxillofacial injury in 3 patients, chest trauma in 2 patients, long bone fracture in 4 patients and blunt abdominal trauma in one patient. The most frequent location of EDHs was temporo-parietal region (41.4%), followed by frontal (29.4%), parietal (20.5%), temporal (5.8%) and posterior fossa (2.9%) (table 1). Again, we failed to find any association between location of the hematoma and the outcome (p= 0.642). The thickness of hematomas varied as follow; >15 mm in 10 patients, 10-15mm in 11 patients, and <10 mm in 13 patients along its largest diameter. Midline shift >5 mm was found on initial CT scans of 9 cases, and the volume of EDHs ranged between 18- 65ml with an overall mean volume of 33.7ml (table 1).

Table 2: Overall outcomes of traumatic EDHs in relation to the GCS scores

Outcome	GCS score			Number (%)
	15-13	12-9	8-3	
Good recovery (GOS-E; 7-8)	22	2	0	24 (70.5%)
Moderate disability (GOS-E; 5-6)	0	5	2	7 (20.5%)
Severe disability (GOS-E; 3-4)	0	0	1	1 (2.9%)
Death (GOS-E; 1)	0	0	2	2 (5.8%)
Total	22	7	5	34 (100%)

Other CT brain findings were skull fractures in 21patients (61.7%), brain edema (either focal or diffuse) in 6 patients (17.6%), parenchymal contusions in 5 patients (14.7%), and concomitant subdural bleed in one patient (2.9%). According to the above-mentioned criteria, twenty-two patients (65%) were managed conservatively, while surgical intervention was performed in 12 patients (35%). The mean time since injury to surgical intervention was 7.6 hours and ranged between 2 and 28 hours. Eleven patients were managed by emergency craniotomy; free bone flap craniotomy and evacuation with fixation of flap using mini-plates and screws was done for 6 patients, and osteoplastic bone flap with evacuation of hematoma was done for 5 patients. In one patient, sub-occipital burr hole was performed to evacuate a liquefied posterior fossa EDH. The source of bleeding was torn middle meningeal artery in 8 patients (23.5%), oozing from fractured bone in 15 (44%) and from dural venous sinuses in 2 (5.8%). In 9 patients (26.4%), the source of bleeding was not identified. Post-operative complications occurred in 4 (11.7%) and comprised recollected EDH that required redo surgery in one patient, craniotomy wound infection in another patient that resolved with antibiotics, and chest infection in 2 patients.

Table 3: Factors associated with children outcome with traumatic EDHs by univariate analysis

Variables	*p* value
Age	0.572
Gender	0.268
Mode of Injury	0.022*
Initial GCS Score	0.008*
Pupillary Abnormality	0.015*
Skull Fracture	0.643
Intradural Injury	0.042*
Volume of Hematoma	0.083
Location of Hematoma	0.742
Midline Shift	0.617

* Statistical significance at $p < 0.05$

The duration of hospital stays ranged between 1 day and 26 days with a mean duration of stay of 4.57 days. Twenty-three patients (67.6%) stayed ≤ 5 days, 9 patients (26.4%) stayed between 6 days and 2 weeks, and two patients (5.8%) stayed > 2 weeks. Three months after discharge, evaluation of the outcome revealed good recovery (GOS-E 8, 7) in 24 patients (70.5%), moderate disability (GOS-E 6, 5) in 7 patients (20.5%) and severe disability

(GOS-E 4) in one patient (2.9%). None of our patient developed persistent vegetative state, while 2 patients (5.8%) had died (table 2). One mortality occurred in a patient with severe head injury who undergone urgent craniotomy for evacuation of large frontal EDH and died 3 days after admission. The other one had a non-surgical EDH and associated retroperitoneal hematoma that required urgent laparotomy. Both patients were victims of traffic accidents, and their GCS scores were <8 at presentation. Univariate analysis was used to assess the relation between different variables and the final outcome score and revealed that the initial neurological state (GCS score) was strongly linked to the outcome (p=0.008). Mode of injury (traffic accident Vs non-traffic accident) was also correlated with a poor outcome (p=0.022). Similarly, the presence of pupillary abnormalities or intradural injuries were significantly associated with a poor outcome (p=0.015 and 0.042 respectively). However, univariate analysis failed to find a statistically significant relationship of the final outcome score with other different variables like age of the patient (p=0.572), gender (p=0.268), location and volume of the hematoma (p=0.742 and 0.083 respectively) or the presence of skull fracture (p=0.643).

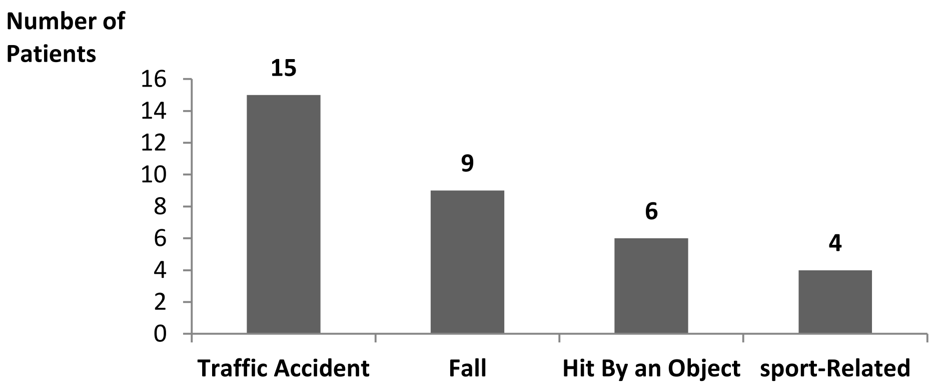

Figure 1: Distribution of Mode of Injury

Discussion

Review of literature revealed a limited number of articles addressing traumatic EDH in children prospectively. EDH following head injury is less common in children compared to adults, with an incidence ranges between 2.5% and 4% [2,8], and is far uncommon during infancy and early childhood with an incidence of 1.5-2% among hospitalized children[9]. Although EDH resembles a small ratio of the overall pediatric head injuries, it has a highly favorable outcome compared to other pediatric head injuries if managed promptly. The present study comprised 34 patients with traumatic EDHs. The age of the patients ranged between 1.5 and 15 years with a mean age of 8.74 years which is comparable to previous reports[5,10]. Sixteen patients (47%) were older than 11 years, while the least number of patients was observed in the 0-2 year old subgroup (3 patients, 8.8%), followed by the 3-5 year old subgroup (5patients, 14.7%) which is also consistent with previously reported series[11,12], and proves the direct proportion of incidence of EDH to age. This has been attributed to the firm attachment between the dura and the inner skull[13], and the resilient skull bones that are less likely to have a fracture associated with development of an EDH during infancy and early childhood[14,15]. Furthermore, the high-velocity trauma mechanisms (e.g. Traffic accidents) that cause EDHs are more frequent in older children like adults[13]. Our results demonstrate a male predominance (71% males *vs.* 29% females) with a male / female ratio of 2.4/1 which is in keep with most series on pediatric EDH[5,16], and emphasizes the natural behavioral tendency of boys to participate in drastic activities that increase exposure to trauma[1]. In the present analysis, we failed to find any significant association between age and the outcome (p=0.572), or between gender and the outcome (p=0.268). Traffic accidents represent the predominant mode of injury in our series found in 44.1 % of patients, which is close to the recent rates reported by Umerani et al in a case series of 72 children with EDH, and by Kandregula et al in an analysis comprised 201 children with traumatic EDH[17,18]. But the rate of traffic accidents in our study is quite high relative to the rates reported in some previous studies (11-33%)[5,19]. Next to traffic accidents, falls were observed in 26.4% of patients as the underlying mode of injury, and there was a statistically significant correlation between mode of injury and the outcome (p=0.022). Many previous reports have considered falls as the most common mode of injury causing EDHs in children[5,20,21]

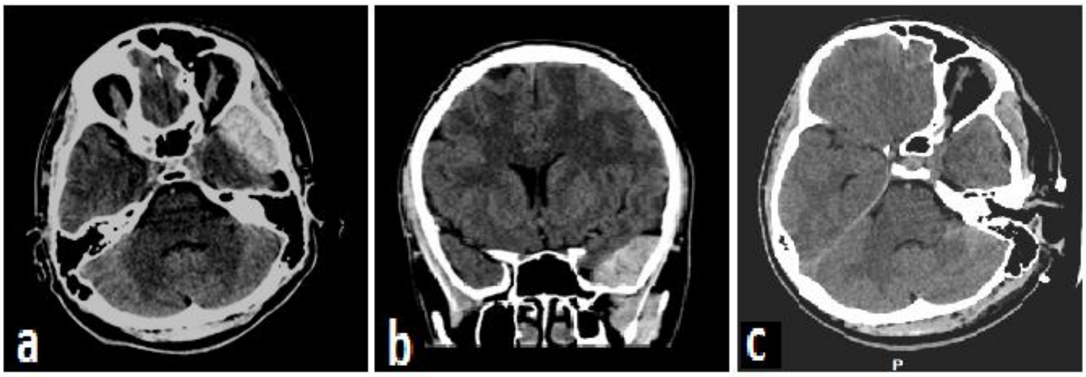

Figure 2: Preoperative (a-b) and post operative (c) Head CT images of a 11 years old boy with left temporal EDH

The discrepancy of our results could be explained by smaller sample size of the present study, but it also reflects the challenging conditions in developing countries where children are more vulnerable to traffic accidents due to increasing road traffic and lack of traffic regulations or safety measures in roads[1,3]. In our study, 64.7% of patients had mild head injury with a GCS score of 13-15 while 20.5% had moderate injury with a GCS score of 9-12, and 14.7% were comatosed and had a severe injury with a GCS score ≤8, and there were a strong relation between the initial GCS score and the outcome (p=0.008). All patients with mild as well as moderate head injury achieved a favorable outcome, while only 40% of patients with severe head injury (GCS ≤8) achieved a favorable outcome and the 2 deceased patients had a GCS score ≤8. Headache was the most common presenting symptom observed in 61.7% of our patients, followed by repeated vomiting in 55.8%, which is consistent with other literature[2]. Headache and vomiting are non-specific symptoms for intracranial injury following head trauma. However, if both persist or progress, this can point towards the diagnosis of EDH especially in a child[17].

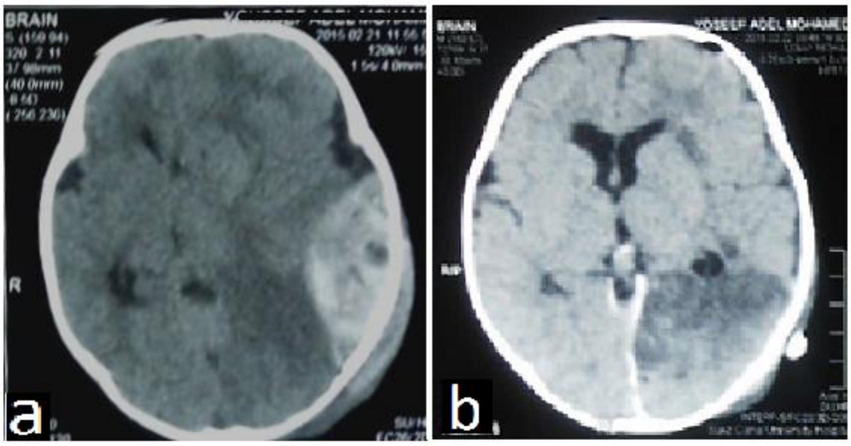

Figure 3: Preoperative (a) and postoperative (b) CT images of a 7 years old girl with huge left temporoparietal EDH following a traffic accident

Altered level of consciousness was considered by some authors as the most significant sign of EDH in children[5,12]. It was reported in 26.4% of our patients, although most patients were conscious at presentation. The typical lucid interval was not so obvious in the present study, unlike in adults[21], and was reported in only 5.8% of patients which is comparable to the result of Khan et al[3]. Of the 34 patients, 5 patients (14.7%) showed no manifestations of head injury at presentation (2 patients were <2 years old, and 3 patient were <5 years old). Such patients might be easily overlooked unless head CT scans were done. The clinical course of EDH may be more insidious in infants rather than older children owing to the open sutures and fontanelles, and the larger extracerebral spaces and cisterns that improve the tolerance to the increased ICP, and results in fewer symptoms and signs[15,22]. Therefore, head CT scan should be considered for almost all children following non-trivial head injury, even if the injury was mild. But this is not a viable option everywhere, especially in developing countries, and should be weighed against the hazards of CT scanning including radiation or the possible need for sedation[23,24]. Pupillary abnormalities were noted in 20.5% of patients. However, anisocoria was evident in only 4 patient and was also linked to a poor outcome (p=0.015). In the present study, temporo-parietal region was the most frequent location showing EDHs (38.3%), followed by frontal and parietal regions. Temporal EDH was found in only 2 patients, and both were older than 10 years. Paucity of pure temporal hematoma during infancy and early childhood have been reported in the literature and was explained by the lake of indentation of the middle meningeal artery in the temporal bone[13]. Similarly, posterior fossa location was reported in one patient (2.9%), which is less than the rate previous literature (4.2)[17], and have been attributed to the more firm attachment between dura and posterior cranial fossa compared to anterior and middle fossae[25]. Associated skull fractures were observed in 61.7% of our patients. Pediatric skull bones possess higher resiliency against fracture compared to adults[15]. However, previous reports showed the presence of skull fracture along with EDH in about 48% up to 95% of pediatric patients[26,27].The influence of skull fracture on outcome is controversial[5]. Kuday et al found a strong relation between skull fractures and poor outcome in an analysis comprised 115 patients with EDHs[28]. Moreover, Quayle et al reported a fourfold increase in the relative risk for intracranial injury in the presence of a skull fracture[29]. In contrary, Rivas et al observed a better outcome in terms of function and mortality rate in patients with cranial vault fractures, and explained this by the possible leakage of blood into the sub-galeal space through the fracture with subsequent reduction of the intracranial pressure[18]. In the present study, we found no association between presence of skull fractures and the outcome on final follow up (p=0.643), which is consistent with Zhong et al in a series comprised 269 children with traumatic EDH[2]. The overall rate of concomitant intradural injuries in the present study was 35.2% which is comparable to other literature[5]. Brain edema represented the most common finding reported (17.6%) followed by brain contusions (14.75), which is in keep with previous series reported brain edema as the commonest concomitant intradural injury in children with traumatic EDH[21,27]. Presence of intradural injury is considered as a poor prognostic factor that lowers the chance for good recovery following head injury[12]. In our study, We found a correlation between presence of concomitant intradural injuries and the outcome (p= 0.042). Of the 34 cases, surgical intervention was indicated in 12 patients (35.2%) and involved emergency craniotomy in 11 patients and sub-occipital burr hole in one patient. The mean volume of EDHs in the surgical group was 43.2 ml, and the mean thickness of the hematoma was 18.4 mm. Selection between conservative treatment and surgical evacuation of pediatric EDHs is still debatable. Nevertheless, review of literature and recent guidelines reported that EDH with volume ≥ 30 ml, hematoma thickness ≥15 mm, and midline shift≥5 mm should be surgically treated[30,31]. Review of the outcome in different series on pediatric EDH showed complete recovery in about 70-95% of patients[17]. In the present study, 70.5% of cases showed good recovery on pediatric GOS-E, and the overall outcome was favorable in 91.1% of patients, while poor outcome was demonstrated in 8.8% of patients. The mortality following traumatic EDHs varied in literature between 0% and 12%[5,16,32]. The mortality rate in our study was 5.8% which is comparable to the mortality rates reported by Hanci et al (5.5%) and by Nath et al (7.6%)[10,12], and was exclusive in male victims whom sustained high velocity traffic accidents and had a severe head injury

Conclusions

Extradural hematoma can develop in alert children and should be suspected following traffic accidents or falls irrespective to the severity of head injury. Head CT scan is crucial for early diagnosis of EDHs in children considering their non-specific presentation. Traffic accident as a mode of injury, low initial GCS score and the presence of pupillary abnormality or intradural injury are statistically significant factors that were linked to a worse outcome.

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