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Original Research Paper

Neurosurgery

RISK FACTORS ASSOCIATED WITH MANAGEMENT AND OUTCOMES IN PEDIATRIC EPIDURAL HEMATOMAS: OUR INSTITUTIONAL ANALYSIS

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ABSTRACT **Background:** Pediatric epidural hematomas (EDH) constitute about 2-3% of all head cases and they represent about 2–3% of all head injuries in the pediatric population. They can be managed either surgically or conservatively based on clinical and radiologic evaluation, which can influence the final outcome. **Methods:** We included the cases diagnosed with EDH in the age group between 0-16 years during period of 2020-2021. **Results:** On evaluation of 31 cases from our study. Twenty-one cases have been treated with surgical management and 10 conservatively. Three months after the trauma, the outcome was excellent (mRS 0) in 21/31 (67.7%) cases, mild deficits (mRS 1–2) were present in 6/31 (19.3%), and severe deficits (mRS 3–5) in 1/31 (3.2%) cases. Only a GCS (Glasgow Coma Scale) below 8 at admission was significantly related to the presence of a neurologic deficit at 3 months ($p = 0.043$). **Conclusions:** EDH can be managed with excellent outcomes, by either surgically or conservatively based on clinical and radiologic conditions if intervened within appropriate time period.

KEYWORDS : Head trauma, Glasgow coma scale, Neurological deficits, Craniotomy, Rehabilitation

BACKGROUND

Among neurosurgical emergencies paediatric Epidural hematomas (EDH) account for about 2–3% of all head injuries in the pediatric population and represent 1– 6% of all diagnoses in children hospitalized after traumatic brain injury [1-6]. They are diagnosed radiologically by CT scan of Brain being done as preliminary investigation on arrival.Based on radiological or clinical parameters the EDH can be managed either conservatively or surgically. This study included both the modes of treatment.

AIM

To identify the risk factors associated with outcome in pediatric EDH.

METHODS

This was a single-center, retrospective study conducted in our institution at Osmania General Hospital, Hyderabad with the diagnosis of EDH based on radiological parameters The study was conducted during the period of January 2020 and December 2020.

The inclusion criteria were (a) Age (<16 years) and (b) The child with Cranial EDH.

The parameters that were taken as measure in outcome in management of paediatric EDH were

(a) Age,
(b) Sex,
(c) Mode of injury,
(d) Glasgow Coma Scale (GCS) at admission,
(e) Abnormal pupillary response,
(f) Neurological deficits at the time of admission
(g) Presence of midline shift,
(h) Associated skull fracture,
(i) Mode of management
(j) Duration of hospital stay.
(k) Neurological deficits evaluation at 3 months.
(l) The outcome was assessed using modified Rankin

Scale (mRS): 0 indicate no symptoms , 1 to 2 slight disability, and 3 to 5 indicate moderate to severe disability. A score of 6 indicate death.

On arrival at our institution, the children with poly trauma were triaged and admitted in Neuro trauma centre. The children with other solid organ injuries or orthopediatric injuries were excluded from the study as they may affect in outcome measures All children were admitted and evaluated with surgical profile including CT Scan and monitored.

Based on clinical parameters GCS at the time of admission, pupillary anisocoria, neurological deficit, CT diagnosed EDH with significant volume/skull fracture and midline shift were taken up for surgery.

Based on above parameter, children those who were taken up for surgery with Indications being.

a) GCS at the time of admission
b) Pupillary abnormality
c) Neurological deficit
d) Volume of EDH and midline shift
e) Associated skull fracture.

Children those who were indicated,were taken up for surgery within period of 2h from admission and those who later developed drowsiness/ Loss of conciousness/increase in size of EDH were taken up for surgery immediately.

All children underwent operative treatment with craniotomy and evacuation of EDH with removal of infected skull bone fragments and placement of subgaleal drain and closure of skin with Non-absorbable suture.All operated children underwent post-op CT immediately after surgery.

Chidden who began to improve neurologically were discharged home. The mRS was assessed at the time of discharge and 3 months after discharge.we performed statistical analysis using the SPSS software version 18.0 (SPSS Inc., Chicago, IL, USA). A binary logistic regression analysis was used to identify the influence of single variables on prognosis. Variables included in the analysis were as follows (a) GCS at admission, (b) EDH size, (c) Pupillary anisocoria (d) any associated intracranial lesions, and (e) type of treatment. The significance level was $p < 0.05$.

Among 31 cases admitted duringJanuary 2020-December 2020, 8/31 (25.8%) were girls and 23/31 (74.1%) were boys (Table 1). When we calculated incidence was found 0.52 cases per month. The average age at the admission was 8.8 years (min. 6 months, max. 16 years). 2/31 (6.4%) children were younger than 1year, 7/31 (22.5%) children were between 1 and 4 years of age, 15/31 (48.3%) were between 5 and 10 years of age, and 7/31 (22.5%) were between 10 and 16 years of age (Table 2). The mean follow-up was 12months (min. 3 months, max. 16 months).

When we calculated the time of arrival from the incident, the mean time was <2 hrs with mode of injury being fall 25/31(80%) being most common followed by motor vehicle accident 6/31 (19.3%).

Table 1: Gender data of the pediatric population included in the study

Gender	Total cases	Operated	Non-operated
Male patients	23/31	16/21	7/10
Female patients	8/31	5/21	3/10

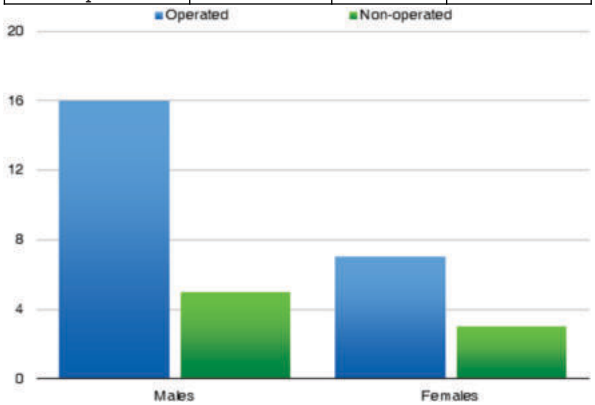
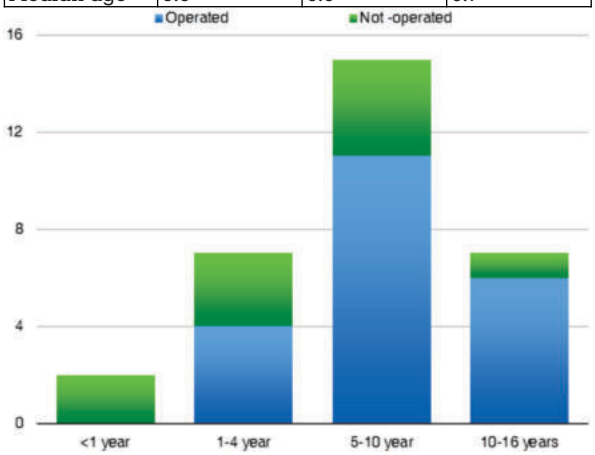


Table 2: Age data of paediatric population in the study

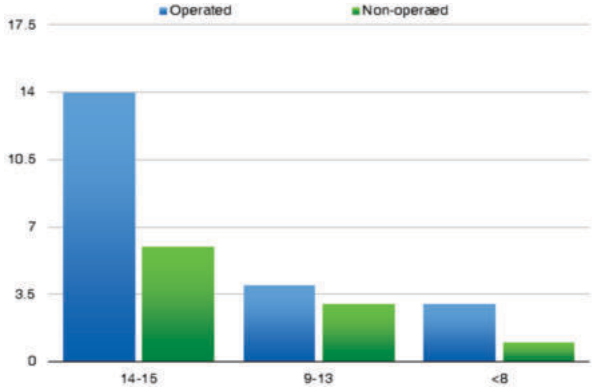
< 1 year	2/31	0/21	2/10
1-4 year	7/31	4/21	3/10
5-10 year	15/31	11/21	4/10
10-16 year	7/31	6/21	1/10
Median age	8.8	6.0	6.7



The GCS at the admission was 14 to 15 in 20/31 (64.5%) cases, 9 to 13 in 7/ 31 (22.5%) cases, and below 8 GCS in 4/31 (12.9%) cases (Table 3). The average GCS at admission was 12.

Table 3: GCS data of the paediatric population at the time of admission

	All cases	operated	Non-operated
14-15 GCS	20/31	14/21	6/10
9-13 GCS	7/31	4/21	3/10
< 8 GCS	4/31	3/21	1/10
Median GCS	12	12	13.5



Decline in the neurological status was observed in 3/31 (9.6%) patients. The clinical condition has worsened early in 2 cases, with lucidity interval. while in 1 cases, the deterioration was later.Pupillary abnormality was seen in 6/31 (19.3%) of patients with a unilateral fixed pupil.

Table 4: General data of pupillary abnormality

Unilateral fixed pupil	6/31	6/21	0/10
Early and late clinical deterioration	3/21	3/21	0/10

In all patients after getting CT scan. The location of the EDH was as follows (Table 5): 14/31 (45.1%) were parietotemporal (Fig.1), 6/31 (19.3%) were temporal,11/31 (35.4%) were frontotemporal (Fig. 2). The mean size of EDH was 40 mm (min. 20 mm, max. 70mm), and a midline shift was present in 17/31 (54%) cases with mean value of around 8mm.

Table 5 Radiological data of EDH in the study.

		All cases	operated	Non-operated
EDH Location	Parieto-temporal	14/31	9/21	5/10
	Temporal	6/31	5/21	1/10
	Fronto-temporal	11/31	7/21	4/10
Mean EDH thickness		40mm	30mm	20mm
Midline shift		17/31	17/21	0/10

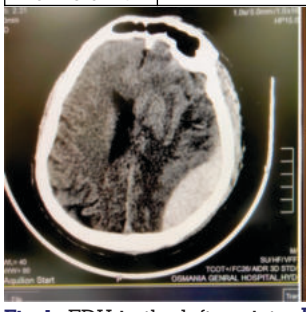


Fig 1: EDH in the left parieto-occipital region.

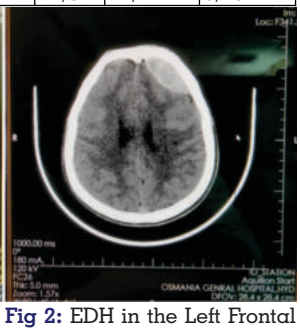


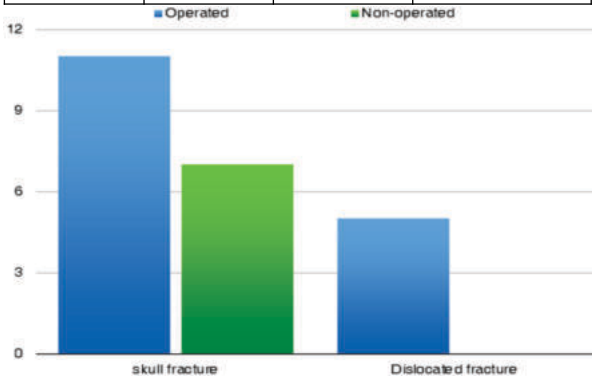
Fig 2: EDH in the Left Frontal region

A skull fracture was present in 18/31 (58%) patients (Fig. 3). In which 6/31 (19.3%) patients, fracture was located at the cranial vault, in 2/31 (6.4%) at the skull base, in 1/31 (3.2%) at the zygomatic arch, and in 9/31 (29%) at the orbital floor.

Fig 3: undisplaced linear fracture in the Right parieto-temporal region.

Table 6 Radiological data of skull fracture in the study

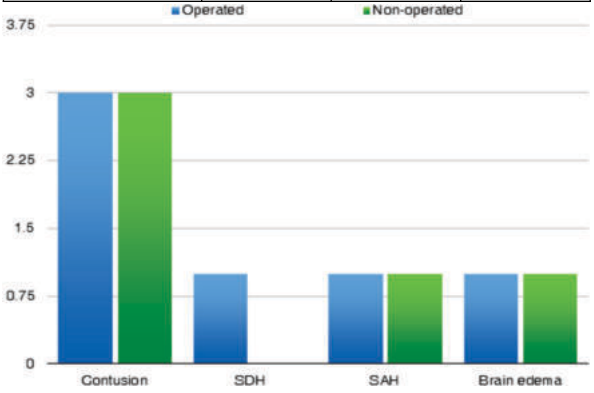
	ALL CASES	OPERATED	NON-OPERATED
Skull fracture	18/31(58%)	11/21(52.3%)	7/10(70%)
Dislocated fracture	5/31(16.1%)	5/21(23.8%)	0/10(0%)



In 15/31 (48.38%) cases, the EDH represented an isolated intracranial injury, on the other side 16/31 (51.6%) patients had at least one associated intracranial injuries, contusion in11/31 (35.4%) cases, a subdural hematoma (SDH) in 1/31 (3.2%), a subarachnoid hemorrhage (SAH) in 2/31 (6.4%), and cerebral edema in 2/31 (6.4%) cases(Table 7).

Table 7: Radiological data of intracranial injury in the study.

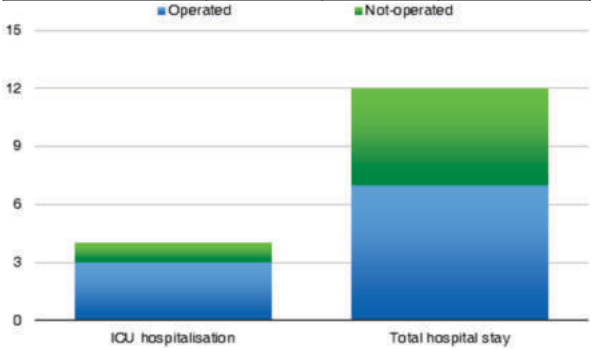
Associated intracranial injuries	ALL CASES	OPERATED	NON-OPERATED
Contusion	11/31(35.4%)	8/21(38%)	3/10(30%)
SDH	1/31(3.2%)	1/21(4.7%)	0/10(0%)
SAH	2/31(6.4%)	1/21(4.7%)	1/10(10%)
Brain edema	2/31(6.4%)	1/21(4.7%)	1/10(10%)



The average length of hospitalization in the ICU was 3 days, while the average length of hospitalization for children with EDH was 7 days (min. 5 day, max. 10 days) (Table 8).

Table 8: Time of ICU hospitalization and total hospital stay of the children included in the study

	All cases	operated	Non-operated
ICU hospitalisation	3days	3days	1days
Total hospital stay	7days	7days	5days



The overall outcome at the discharge from the hospital was as follows: mRS 0 in 22/31 (70.9%) patients, mRS 1–2 in 6/31 (19.3%), and mRS 3–5 in 1/31 (3.2%) patients. Mortality (mRS 6) was 2/31 (6.4%).

Three months after the trauma, the outcome was the following: mRS 0 in 24/29(82.7%) cases, mRS 1–2 in 4/29 (13.7%) cases, and mRS 3–5 in 1/29 (3.4%) cases. The GCS below 8 at admission was significantly related to a bad outcome (mRS 1–5) ($p = 0.048$).

EDH size ($p = 0.28$), unilateral fixed pupil ($p = 0.56$), associated intracranial lesions ($p = 0.498$), and type of treatment ($p = 0.21$) were not significantly related to a bad outcome.

Operated group of patients

21/31(67.7%) children with EDH have been treated surgically. The average age in the operated group was 8.8 years (min. 6 months, max. 16 years). There were 16/21 (76.1%) boys and 5/21 (23.8%) girl(Table 1). Among the operated children, 0/21 (0) were younger than 1 year, 4/21 (19%) were between 1 and 4 years of age,11/21 (52.3%) were between 5 and 10 years of age, and 6/21 (28.5%) were between 10 and 16 years of age (Table 2).

The GCS at the admission in the emergency department was 14 to 15 in 14/21 (66.6%) cases, 9 to 13 GCS in 4/21 (19%) cases, and below 8 GCS in 3/21 (14.2%) cases (Table 3). The average GCS at the admission among the operated children was 12.

6/21 (28.5%) operated children had preoperatively a unilateral fixed pupil. The deterioration of the level of consciousness during the observation occurred in 3/21 (14.2%) cases. In all 3 of them, the time from trauma to the clinical deterioration was short (< 2 h) and it was related to an active bleeding and to EDH enlargement . All children have been operated early, within 3 h from admission.

The EDH was parietotemporal in 9/21 (42.3%) cases, frontotemporal in 7/21 (33.3%) cases, and temporal in 5/21 (23.8%) cases (Table 5). In operated group mean size of EDH noted was 30mm (min. 20mm, max. 40 mm), and a midline shift was present in 17/21 (80.9%) patients with mean midline shift was 8 mm.

A skull fracture was detected in 11/21 (52.3%) cases, and 5/21 (23.8%) fractures were dislocated (Table 6). Among the operated children, the EDH was associated with another intracranial lesion in 6/21 (28.5%) cases. The initial CT scan showed contusions in 3/21 (14.2%) patients, a SDH in 1/21 (4.7%) patients, and a SAH in 1/21 (4.7%) patients. The control CT showed brain edema in 1/21 (4.7%) cases.

The average length of the ICU stay was 3days, and the average length of hospitalization among the operated children was 7 days (min. 5 days, max. 12 days) (Table 8).

The outcome at the discharge from the hospital was as follows: mRS 0 in 15/21 (71.4%) cases, mRS 1–2 in 3/21 (14.2%) cases (2 cases of cognitive impairment and 1 case of hemiparesis), and mRS 3–5 in 1/21 (4.7%) cases. Three months after the trauma, the outcome did not differ (Table 6).

Among the operated children, mortality was 2/21 (9.5%) no surgery related morbidity was observed. none of the cases had EDH recurrence.

Not operated group of patients

10/31 (32.2%) cases of EDH have been treated conservatively. The average age within this group was 7 years (min. 2 years, max. 12 years).

There were 3/10 (30%) girls and 7/10 (70%) boys(Table 1).2/10 (20%) were <1 years of age 3/10 (30%) children were between 1 and 4 years of age, 4/10 (40%) between 5 and 10 years of age, and 1/10 (10%) between 10 and 16 years of age (Table 2).

The GCS at the admission in the emergency department was 14 to 15 in 6/10 (60%) cases, 9 to 13 GCS in 3/10 (30%) cases, and below 8 GCS in 1/10 (10%) cases (Table 3). The average GCS at the admission among the not operated patients was 13.

None of the children had a unilateral fixed pupil at admission, and a delayed deterioration of the level of consciousness occurred in 1/10 (10%) patients (Table 2), in whom the GCS fell from 13 to 10 during the 3rd day of hospitalization as a result of brain edema.

The location of the EDH was temporal in 1/10 (10%) cases , frontotemporal in 4/10 (40%) cases, parietotemporal in 5/10 (50%) cases.

The mean size of the EDH was 6.8 mm (min. 3 mm, max. 8 mm), and none of the cases had midline shift (Table 5).

A skull fracture was noticed in 7/10 (70%) cases, none of which was dislocated (Table 6). Among the operated children, the EDH was associated with another intracranial lesion in 5/10 (50%) cases. There was a contusion in 3/10 (30%) cases, a SAH in 1/10 (10%) cases, a and brain edema in 1/ 10 (10%) cases at the initial CT scan, while the control imaging revealed brain edema in 2/10 (20%) other cases(Table 7).

The average length of hospitalization in the ICU among the conservatively treated children was 1 days, and the time of hospitalization was 5 days (min. 1 day, max. 7 days) (Table 8).

The outcome at the discharge from the hospital was as follows: mRS 0 in 7/10 (70%) cases and mRS 1–2 in 3/10 (30%) cases (1 cases of mild hemiparesis). Three months after the trauma, 1 children with hemiparesis recovered completely and the outcome was as follows: mRS 0 in 10/10 (100%) cases

DISCUSSION

EDH is a potentially life threatening condition in children which can be managed either by surgical tretament or conservative by proper clinical, radiological assessment and Ronitoring in ICU.

In our study fall being the most common cause of EDH followed by Road traffic accidents. Most of the children present with headache, vomiting, altered concious states without neurological defecits also[12].

There was male preponderance in our study constituted around 74.2%, which also corresponded in the literalure [3,9,13] . Most common cause noted being the middle meningeal artery rupture, caused by skull fracture and was present in 70% of our cases.Other series reported between 58-70% of skull fracture being the cause for EDH.

EDH may express three-phasic clinical manifestation with an initial loss of consciousness followed by a lucidity interval and second loss of consciousness, with unilateral mydriasis. Pasaoglu et al. reported this lucidity interval in 32% of their pediatric patients[11], while we observed it in 3/31 (9.6%) cases. Sometimes we see clinical deterioration after 3 days of trauma defined as late . While an early deterioration is caused by an EDH enlargement, the delayed deterioration is due to secondary brain edema and prolonged mass effect. A delayed deterioration was ob- served in 1/31 (3.2%) cases in our series, and patient underwent surgical evacuation of EDH. Factors that determining the surgical treatment of EDH include volume > 30 mL, thickness > 15–18 mm, and shift > 5 mm[16]. Whereas conservative treatment is indicated in case of thickness < 2 cm, antero-posterior diameter < 3 cm with absence of midline shift and neurologic deficits[17-19]. Balmer et al. described a series of children with EDH larger than 1 cm treated conservatively which showed that size does not represent only indication for surgical treatment [7]. Surgical indications depends mainly on EDH thickness, on GCS,neurological deficits and presence of midline shift and depressed fracture.

Surgeon decision will play role in a group of children presenting with unspecific signs and symptoms in EDH thickness between 10 and 20 mm, no shift, and GCS between 12 and 14. Bejjani et al. termed this as intermediate- size EDH, suggested a careful and individualized clinical management [15].

No significant relationship was found between type of treatment and final outcome(p = 0,231).

Surgical evacuation is safe also for the intermediate-size EDH as there may be possibility of late deterioration [7],which was seen in 1/31 (3.2%) cases in our series. Although conservative management can be done in an hospitals where ICU care with close monitoring is possible also for craniotomy at any time [7, 10].

Poor prognostic factors associated in EDH may be described as bradycardia [17, 20], seizures, focal neurological deficits [14], age [21], mydriasis [8, 14, 17, 20], presence of associated brain contusions.

The only prognostic factor neurological deficits at 3 months (mRS 1–5) was a GCS below 8 at admission. The mortality of EDH in literature was observed to range from 0 to 12% [2, 9, 14, 17, 20, 22, 23]. In our series, one mortality was documented.

Operative treatment did not produce any morbidity or complications, which can also be seen in other reports[24].The final outcome was worse in the operated group (76.4% of mRS 0) compared to the conservatively managed group (92.3% of mRS 0) and there was no significance statistically. This can be attributed to poor initial neurological condition.Overall, 82.7% of all EDH had an excellent outcome (mRS 0) 3 months after the discharge. These results are similar to other reports treated both surgically and conservatively [7, 9].

CONCLUSIONS

Fall being the most frequent cause of EDH in our series. Eventhough EDH can be managed with good outcome.The primary focus should be on prevention of the cause.

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