

**Original article****Surgical Outcome of EDH in Children: Our Observation in DMCH**Das S<sup>1</sup>, Rashid MM<sup>2</sup>, Hasanuzzaman M<sup>3</sup>, Sarker ac<sup>4</sup>, Ansari A<sup>5</sup>, Ghosh D<sup>6</sup>, Bhuiyan S<sup>7</sup>.**Abstract**

**Background:** Epidural hematoma (EDH) is accumulation of blood between the inner table of the skull and the dural membrane due to trauma and predominantly consists of venous blood in case of children. Children with extradural hematoma (EDH) present differently than adults and outcome would also be different. **Methods and Materials:** This is a prospective interventional study done in the Department of Neurosurgery, Dhaka Medical College and Hospital (DMCH) in between period of January 2016 to December 2019. Children of both sex below 12 years of age with EDH were included after fulfilling inclusion and exclusion criteria. Follow up period was 1 month after surgery. **Results:** Among 90 patients, 73.3% were male and 26.7% were female. Age 5 - 12 years is most commonly affected among all age groups, attributing to 58.9%, fall from height was the most common cause (58.9%) followed by road traffic accident (32.2%), fall of heavy object over head (7.8%) etc. The most common symptom was vomiting which was present in 85.6% of patients followed by altered consciousness in 72.2%, headache in 60% and scalp swelling in 25.6% of patients. The follow-up of our patients was 1 month after surgery. Most of our patients made good recovery. Among them 73 patients (81.1%) were neurologically intact (GOS 5), 10 (11.1%) patients had some deficit but could do their daily activity independently (GOS 4), 03 patients (3.3%) was dependant on other for daily activity with cognitive deficit (GOS 3) and 4 patients (4.4%) died. **Conclusion:** EDH in children can be managed by surgery with good outcomes. Even in the presence of poor initial clinical and radiologic conditions, timely intervention can lead to a good recovery.

**Keywords:** EDH; Head injury; Children; GCS; GOS; etc.

Bangladesh Journal of Medical Science Vol. 21 No. 04 October'22 Page : 865-874  
DOI: <https://doi.org/10.3329/bjms.v21i4.60288>

**Introduction**

Extra Dural Hematoma (EDH) is a unique type of neurotrauma which is potentially lethal, yet easily remediable if diagnosed early and treated timely<sup>1</sup>. Epidural hematomas (EDH) account for about 2–3%

of all head injuries in children and represent 1–6% of all diagnoses in paediatric patients hospitalized after traumatic brain injury<sup>2</sup>. The impact response of the infant head depends not only on its unique geometry, but also on the age-dependent mechanical properties

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of the skull and sutures. The paediatric skull differs markedly from the adult skull in geometry, structure and material properties<sup>3</sup>. The skull of a neonate is a loose aggregate of thin plates of pliable bone connected by sutures. The compliant structure is capable of substantial deformation during childbirth, as well as during traumatic impact loading. At birth, the cranial bones are thin, flexible, and contain no diploe. As the child grows, the cranial bone differentiates into inner and outer layers of compact bone that enclose a middle layer of cancellous bone. As cranial sutures develop during infancy, cranial adjustment to the expanding brain takes place by bone deposition at the sutural margins. Mature sutures are highly interdigitated and capable of absorbing energy during impact loading<sup>4</sup>.

It is recognized that EDH in children differs from EDH in adults in that the hematoma may follow a trivial injury, the symptoms are different, the course is more insidious, associated skull fracture is infrequent, and prognosis is better<sup>5</sup>. The Brain Trauma Foundation (BTF) has produced informative guidance on the management of EDH. The criteria laid out for conservative management consists of patients who are non-comatose, lack of focal neurological deficit, have EDH volumes of less than 30 ml, thickness of less than 15mm and an associated midline shift of less than 5 mm. The BTF recommends that all patients with an EDH volume of greater than 30 cc should undergo surgical evacuation regardless of Glasgow Coma Scale (GCS)<sup>6,7</sup>. It is strongly recommended that patients with an acute EDH and GCS<9 and anisocoria undergo surgical evacuation as soon as possible<sup>1</sup>.

Considering the cause of EDH in Children; Fall is the most common. Road Traffic Accidents Caused more commonly in older age groups. Age 5yr to 12yr is most commonly affected among children<sup>8</sup>. The fracture in the skull was more common in children Less than two years of age than older but fracture did not affect the outcome. Children aged less than 5 years had a better outcome than older age group. Low GCS at admission did not always accurately predict the outcome for EDH in children. Patients with less than 20 ml usually not require surgery unless there is anisocoria or gross neuro deficit, cases with volume

20-30 ml required surgery based on assessment on serial neuro evaluation and cases more than 30ml required surgery. Patients with Posterior Fossa EDH more than 15 ml required surgery<sup>9</sup>.

### Methods and Materials

This current study was a prospective interventional study carried out in between the period of January 2016 to December 2019. Children (up to 12 years) with extradural hematoma attending in the Department of Neurosurgery, Dhaka Medical College and Hospital, Dhaka. Diagnosed case of traumatic EDH (with or without skull fracture) underwent surgical intervention, aged up to 12 years of both sex were included in this study. Patients above 12-year-old age, EDH with diffuse axonal injury, subdural hematoma or brain contusion or polytrauma (Major Chest/ Blunt abdominal trauma/ major trauma to limb and pelvis) were excluded from this study. Clinico-radiological findings at admission with preoperative GCS, pre and post-operative CT findings, time interval to surgery since trauma are vital parameters. Patients were followed-up for a total of 1 month post-operatively. Follow-up of the patients were done on indoor basis up to discharge and on OPD at 1 month. During follow up the patients were assessed using the post-operative GCS, check CT on first postoperative day. Postoperative data of Day 1, 3 and discharging date were recorded. Outcome was measured by using Glasgow Outcome Scale (GOS) during discharge and after 1 month.

**Ethical clearance:** Ethical clearance was taken from Ethical Review Committee of Dhaka Medical College.

### Result

Table I shows 90 patients were included in this study; they were divided into 3 groups. Age range was 0 to 12 year. It was observed that, majority 53(58.9%) patients were 5-12 years of age followed by 28(31.1%) in 2-5 years, 09(10.0%) in below 2 years of age group. This table also shows sex distribution of the study patients. In the study, male predominance was observed. Majority 66(71.1%) patients were male and 24 (28.9%) patients were female. Male-female ratio was 2.8:1.

**Table I: Age and sex distribution of the study subjects according (N=90)**

Variable	Frequency(n)	Percentage (%)
<b>Age distribution</b>		
< 2 year	09	10.0%
2 years – 5 years	28	31.1%
5 years – 12 years	53	58.9%
<b>Sex distribution</b>		
Male	66	73.3%
Female	24	26.7%

**Table II: Distribution of the study patients according to mode of injury (N=90)**

Table II shows the distribution of the study patients by mode of injury. Among all the cases, majority cause identified was fall from height 53(58.9%) followed by road traffic accident 29 (32.2%).

Mode of injury	Frequency(n)	Percentage (%)
Fall from height	53	58.9%
Road traffic accident	29	32.2%
Fall of heavy object over head	07	7.8%
Assault	01	1.1%
Total	90	100.0%

**Table III: Distribution of the study patients by pre-operative clinical presentation (N=90)**

Table III shows distribution of clinical presentation in the study population. It was observed that, most of the patients had multiple clinical presentations. Majority patients presented with vomiting 77(85.6%) and altered consciousness 65 (72.2%). Other results are shown in the table below.

Pre-operative Clinical presentation	Frequency(n)	Percentage (%)
Altered consciousness	65	72.2%
Vomiting	77	85.6%
Headache	54	60.0%
Convulsion	04	4.4%
Scalp swelling	23	25.6%
Multiple response*		

**Table IV: Distribution of the study population by preoperative neurological status (N=90)**

Table IV shows the preoperative neurological status of the study population. It was observed that, 27(30.0%) patients had bilaterally equally reacting normal pupil, 59(65.6%) had unilateral dilated pupil and 04(4.4%) had bilateral dilated pupil. 48(53.3%) patient had no focal deficit, 29(32.2%) were hemiparetic or hemiplegic, 11(12.2%) presented with seizure and 2(2.2%) presented with aphasia.

Neurological Status	Frequency(n)	Percentage (%)
<b>Pupillary changes</b>		
Equal normal pupil (3-4 mm)	27	30.0%
<b>Dilated pupil (&gt; 4 mm)</b>		
Bilateral	04	4.4%
Unilateral	59	65.6%
<b>Focal neurological deficit</b>		
No deficit	48	53.3%
Hemiparesis / Hemiplegia	29	32.2%
Seizure	11	12.2%
Aphasia	02	2.2%

**Table V: Location of hematoma by preoperative Computed Tomography (CT) scan (N=90)**

Table V shows the involved cerebral lobe or lobes of the study patients. It was observed that, majority 29(32.2%) patients had parietal lobe involvement followed by 21(23.3%) frontal lobe involvement. Other results are shown in the table.

Hematoma location	Frequency(n)	Percentage (%)
Temporoparietal	14	15.6%
Frontal	21	23.3%
Parietal	29	32.2%
Frontoparietal	09	10.0%
Temporal	12	13.3%
Occipital	02	2.2%
Post. fossa	03	3.3%
Total	90	100.0%

**Table VI: Pre-operative GCS among the cases (N=90)**

Table VI shows pre-operative GCS which reveals most patients 49 (54.4%) are between GCS 14 to 15.

Pre-operative GCS	Frequency (n)	Percentage (%)	Mean ± SD
3-8	18	20.0%	11.12 ± 3.34
9-13	23	45.5%	
14-15	49	54.4%	

**Table VII: Preoperative Computed Tomography (CT) scan findings of study population (N=90)**

Table VII shows the distribution of the study patients according to pre-operative CT scan finding. It was observed that, 59(65.5%) had more than 30 ml and 24(26.7%) patients had hematoma volume in the range of 20-30 ml. Regarding thickness of hematoma, 68(75.6%) were more than 15 mm thick and 17(18.9%) were 11-15 mm thick. 66(73.3%) patients had more than 5mm midline shift and 16(17.8%) had less than 5mm midline shift. 31(34.5%) patients had skull fracture and ventricular effacement was present in 61(67.8%) patient.

CT Scan Findings	Frequency(n)	Percentage (%)
<b>Hematoma Volume</b>		
<20 mL	07	7.8%
20-30 mL	24	26.7%
>30 mL	59	65.5%
<b>Thickness of Hematoma</b>		
<10 mm	05	5.6%
11-15 mm	17	18.9%
>15 mm	68	75.6%
<b>Midline shift</b>		
No shift	08	8.9%
<5 mm	16	17.8%
>5 mm	66	73.3%
<b>Skull Fracture</b>		
Present	31	34.5%
Absent	59	65.5%
<b>Ventricular effacement</b>		
Present	61	67.8%
Absent	29	32.2%

**Table VIII: Post-operative Computed Tomography (CT) scan findings of study population (N=90)**

Table VIII shows Post-operative CT scan findings of study population shows 78(86.7%) patients had no hematoma. Other findings are mentioned below.

CT Scan Findings	Frequency(n)	Percentage (%)
<b>Hematoma Volume</b>		
No hematoma	78	86.7%
Small residual	12	13.3%
<b>Midline shift</b>		
No shift	82	91.1%
<5 mm	6	6.7%
>5 mm	2	2.2%
<b>Ventricular effacement</b>		
Present	11	12.3%
Absent	79	87.7%

**Table IX: Preoperative distribution of the study population by timing of surgery since trauma (N=90)**

Table IX shows, 55(61.1%) patients had time interval between trauma and operation was 12-24 hours. 24(26.7%) had time interval more than 24 hours and only 11(12.2%) had time interval of less than 12 hours.

Time interval	Frequency (n)	Percentage (%)
Within 12 Hours	11	12.2%
12-24 Hours	55	61.1%
>24 Hours	24	26.7%
<b>Total</b>	<b>90</b>	<b>100.0%</b>

**Table X: Distribution of the study populations by post-operative GCS (N=90)**

Table X shows distribution of post-operative GCS in the study patients. GCS is an important predictor of outcome. GCS 14-15 were found in 41 (45.6%) cases in 1st POD, 57(63.3%) cases in 3rd POD and 77(85.6%) during discharge. The mean GCS was 11.52±3.47 in the 1st pod and 13.47±3.05 was during

discharge.

Post-operative GCS	Frequency of GCS score		Mean ±SD
	n	%	
<b>1<sup>st</sup> POD</b>			11.52±3.47
3-8	14	15.5%	
9-13	35	38.9%	
14-15	41	45.6%	
<b>Total</b>	<b>90</b>	<b>100%</b>	
<b>3<sup>rd</sup> POD</b>			12.79±3.17
3-8	08	8.9%	
9-13	25	27.8%	
14-15	57	63.3%	
<b>Total</b>	<b>90</b>	<b>100%</b>	
<b>During discharge</b>			13.47±3.05
3-8	05	5.5%	
9-13	08	8.9%	
14-15	77	85.6%	
<b>Total</b>	<b>90</b>	<b>100%</b>	

**Table XI: Glasgow Outcome of patients with preoperative GCS (Glasgow Coma Score) after 1 month follow up (N=90)**

Table XI shows unfavourable outcome found 7 patients. Among them 5 patients (27.8%) of pre-operative GCS 3-8 and 2 patient (8.7%) with GCS 9-13.

Pre-operative GCS	Glasgow outcome			
	Favorable outcome (N=83)		Unfavorable outcome (N=07)	
	n	%	n	%
3-8	13	72.2%	05	27.8%
9-13	21	91.3%	02	8.7%
14-15	49	100%	00	0.0%

**Table XII: Glasgow Outcome in relation to preoperative hematoma volume after 1 month follow up (N=90)**

Table XII shows unfavourable outcome patients had pre-operative hematoma volume >30 ml in 6 (10.2%) patients and 20-30 ml in 1(4.2%) patient. This study is statistically significant (p-value <0.05).

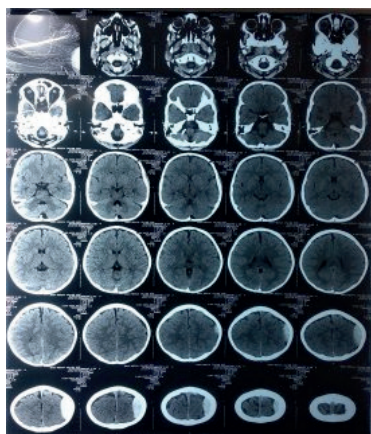
Preoperative Hematoma Volume	Glasgow outcome				P-value
	Favourable outcome (n=83)		Unfavourable outcome (n=07)		
	N	%	N	%	
<20 ml	07	100%	00	0.0%	0.018*
20-30 ml	23	95.8%	01	4.2%	
>30 ml	53	89.8%	06	10.2%	

\*P-value determined by Chi-square test

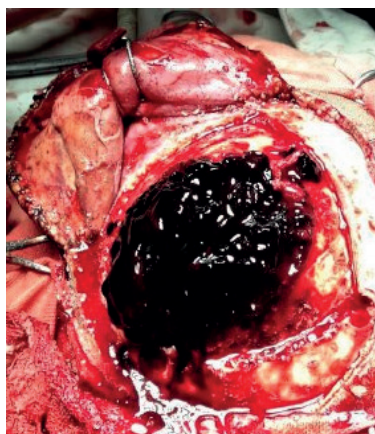
**Table XIII: Estimation of postoperative outcome by using GOS (Glasgow Outcome Scale) at discharge and 1 month (N=90)**

Table XIII shows that at discharge 81(90.0%) and 1 months follow up; 83(92.2%) patients had favourable outcome. At discharge; 63 patients (70.0%) had GOS 5, 18 patients (20.0%) had GOS 4. In other hand at 1 month follow up; 73 patients (81.1%) had GOS 5, 10 patients (11.1%) had GOS 4.

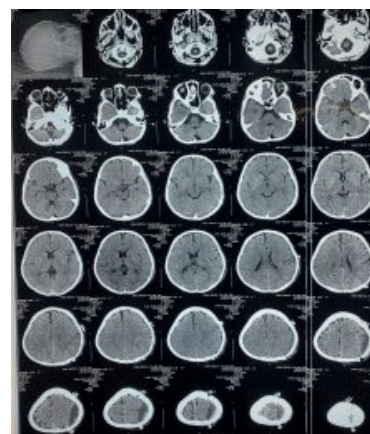
GOS score	Frequency		Favourable/ unfavourable	Outcome	Percentage
	n	%		n	%
<b>During discharge</b>					
1	04	4.4%	Unfavourable GOS (1-3)	09	10.0%
2	00	0.0%			
3	05	5.6%			
4	18	20.0%	Favourable GOS (4-5)	81	90.0%
5	63	70.0%			
<b>At 01 months follow up</b>					
1	04	4.4%	Unfavourable GOS (1-3)	07	7.8%
2	00	0.0%			
3	03	3.3%			
4	10	11.1%	Favourable GOS (4-5)	83	92.2%
5	73	81.1%			



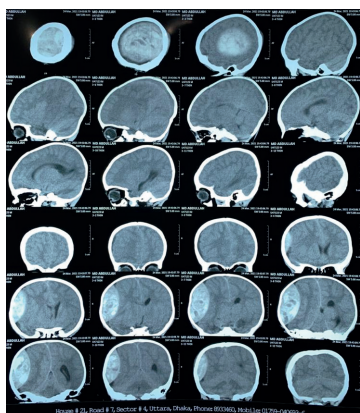
**Figure 1a:** Pre-operative CT scan of head



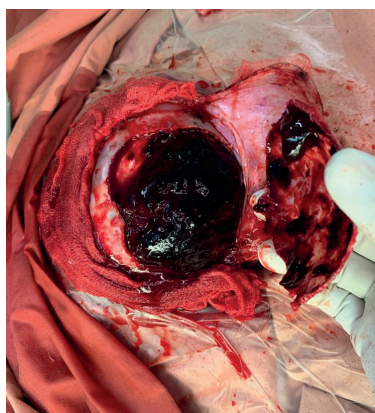
**Figure 1b:** Per-operative image showing EDH



**Figure 1c:** Post-operative CT scan of head showing no hematoma



**Figure 2a:** Pre-operative CT scan of head



**Figure 2b:** Per-operative image showing EDH



**Figure 2c:** Post-operative patient condition on 1<sup>st</sup> POD

## Discussion

Extradural hematoma (EDH) in children is a potentially life-threatening complication resulting from head injuries. These intracranial lesions in children represent 2 to 3% of all head injury complications<sup>4</sup>. Though EDH in children is an acute neurosurgical emergency and potentially life-threatening condition, it can be managed with excellent outcomes as a consequence of access to modern imaging modalities to neurosurgical and ICU treatment<sup>10</sup>. The prognosis of patients with EDH depends upon a number of factors. The Glasgow Coma Scale at presentation is the most important factor which determines the prognosis<sup>11</sup>. The present study was carried out to identify the factors associated post-operative clinical improvement of children with extradural hematoma.

In our series, the age of the patients ranged from 0 year to 12 years. Our analysis has identified that

EDH is more frequent among children of 5-12 years 53(58.9%). These data are correlated with other reported series of EDH in children<sup>8</sup>.

There were 66(73.3%) males and 24 (26.7%) female patients; the ratio between them was 2.8:1. It is similar to other reported series of EDH in children<sup>12-14</sup>. It was reflecting the natural tendency of males to expose to outside world.

In our study, fall from height were the predominant mode of injury 53 (58.9%) followed by road traffic accidents 29 (32.2%), fall of heavy object over head 7(7.8%) and assault in 1(1.1%) cases. Similar results have been reported by other authors<sup>18-20</sup> but other study found that 64% patients with EDH had been involved RTA and other causes had occurred less frequently<sup>12,16</sup>.

In this study, we observed that most of the patients had multiple clinical presentation. Vomiting 77(85.6%) as the commonest presenting feature followed by

altered consciousness 65(72.2%) similar to other studies<sup>12,14,16,18</sup>.

Pupillary changes were found in 63 patients (70.0%) in which 4(4.4%) had bilateral dilated pupil, 59 patients (65.6%) had unilateral dilated pupil. Cheung et al. (2007) found almost similar pupillary changes<sup>19</sup>.

Most of the patients presented to us with Glasgow coma scale (GCS) in between 14 and 15. GCS on pre-operative stage ranged between 14 to 15 in 49(54.4%) cases, 9 -13 in 23 (45.5%) cases, and 3-8 in 18 (20%) cases. Mean admission GCS was 11.12±3.34. Other study results almost consistent with the current study<sup>20,21</sup>.

This study shows GCS is an important predictor of outcome. In our series progressive unfavorable outcome was found 5 patients (27.8%) with initial GCS 3-8 and 2 patients (8.7%) with GCS 9-13. Other authors also observed this finding<sup>22,23</sup>.

Hematoma volume is a good prognostic factor in EDH patients. Hematoma volume >30ml need surgical intervention, volume 20-30ml required surgery in rapidly deteriorate patients in serial neuro assessment and volume <20ml required surgery in case of posterior fossa EDH or with anisocoria or focal neuro deficit. In patients with pre-operative hematoma volume more than 30ml showed 53(89.8%) favorable outcome while 20-30 ml hematoma volume patients had 23(95.8%) favorable outcome. Among unfavourable outcome patients, pre-operative hematoma volume >30 ml in 6 (10.2%) patients and 20-30 ml in 1 (4.2%) patient. This study showed statistically significant value (p-value=0.018). Hematoma volume correlated well both with the clinical presentation and with the outcome<sup>24-26</sup>.

In this study, even patients present with pre-operative poor GCS (3-8); out of 18 patients, 13(72.2%) recovered with favourable outcome. Also, for initial hematoma volume more than 30ml; among 59 patients, 53(89.8%) patients recovered with favourable outcome. Outcome is much better than of adult patients<sup>27,28</sup>.

In this series, the parietal region 29 (32.2%) was the commonest site for hematoma followed by frontal region 21(23.3%). Other study also revealed similar

result of hematoma location<sup>14,15</sup>.

Skull fractures are relatively uncommon in childhood. In younger children skull bones are relatively elastic and differences in the elastic coefficient between the dura and bone cause dural detachment during impact. This lead to formation of EDH without a fracture. In the present series 34.5% of children with EDH has skull fracture in compared to adult<sup>29</sup>.

Majority patients 55(61.1%) underwent surgery within 12-24 hours to trauma followed by 11(12.2%) within 12 hours and 24(26.7%) more than 24 hours after trauma. Timing of surgery has a clear influence on clinical deterioration<sup>30</sup>.

The outcome of children is distinctly better when compared to their adult counterpart with similar GCS score at surgery<sup>29</sup>. In the present series favorable outcome is 92.2% and unfavorable outcome is 7.8%. Themortality is 4(4.4%) in our study. Narasimhan et al. also found good outcome in 97% cases and mortality in 3% cases<sup>16</sup>.

### Conclusion

EDH in children can be managed by surgery with good outcomes. Even in the presence of poor initial clinical (low GCS, poor neurological status) and radiologic conditions (large hematoma volume, midline shift) timely intervention can lead to a good recovery because of the elasticity of brain, pliability of the skull of the children and opening of the fontanelle in case of children below 2 years.

**Source of fund:** Not funded by any institute or any group.

**Conflict of interest:** There is no conflict of interest to this paper to disclose.

### Authors's contribution:

**Data gathering and idea owner of this study:**

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**Editing and approval of final draft:** Assoc Prof. Dr. Ayub Ansari, Dr. Sharif Bhuiyan



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