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Traumatic brain injury in pediatric patients –Clinical manifestations and outcome

Arijit Ghosh[1], Aniruddha Chattopadhyay[2], Jayanta Ghosal[3], Sumanta Sarkar[4]

[1]Post Doctoral Trainee, [2]Assistant Professor, Department of Neurosurgery, [3,4]Assistant Professor, Department of Neuromedicine, Bangur Institute of Neurosciences, Institute of Post-Graduate Medical Education and Research, Kolkata, West Bengal, India

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ABSTRACT

Background: Pediatric traumatic brain injury (TBI) is a global public health concern and is preventable, but there are no approved therapies to treat it definitely until date. Falls are the most frequent mode of injuries followed by road traffic accidents (RTA). Most of the TBIs have favorable outcome, though this is influenced by geographical, environmental, societal, and ethnic differences. **Aims and Objectives:** The aims of this study were to determine the several modes of injury, severity of injury, outcomes, and complications in the Eastern Indian population. **Materials and Methods:** Children-aged <18 years suffering from TBI who were attended to in Bangur Institute of Neurosciences, Institute of Post-Graduate Medical Education and Research, Kolkata, were prospectively studied for 1 year. Detailed history, clinical examinations, assessment of pupillary status, and Glasgow Coma Scale (GCS) score was recorded. Severity of TBI was done based on GCS score for each case. Computed tomography (CT) scan of head without contrast was the initial mode of neuro imaging and findings were recorded diligently. Patients were treated conservatively and surgically as required. Outcome was assessed in relation to age group, gender, initial GCS score, pupillary status, CT findings, intervention, and associated injuries. Simple statistical analysis was done. **Results:** Among the total 150 patients aged 1–18 years, most common mode of injury was fall in 56.66% followed by RTA in 23.33%, assault in 6.66%, and other modes such as sports, hit by object on head, and firearm injury in 13.33%. RTAs had a poor outcome in 14.29% and fall had a poor outcome in 14.12%. Poor outcome was associated with the highest (68%) being midline shift (MLS) >3 mm and it was 12.77% with MLS of <3 mm and it was 10.26% in patients with no MLS. It was noticed that chest, spinal, and multiple injuries were associated with poor outcome. **Conclusion:** The most important prognostic factors regarding pediatric TBI are GCS at presentation, pupillary status, associated injuries, and CT scan findings.

Keywords: Pediatric head injury; Traumatic brain injury; Glasgow outcome score

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INTRODUCTION

Although children and adults are affected by traumatic injuries the problems that are worse in the pediatric group due to the long-term implications of the mortality and morbidity. Measurable deficits occur even after mild-to-moderate head injury, but are markedly greater after severe injury.[1,2] In addition, the presence of an intracranial injury contributes significantly to the mortality resulting from poly trauma.[3,4] Head injuries of varied severity are increasingly being recorded at emergency department in pediatric population in recent times.[5,6] Although the etiology varies with age and geographic location, economic status, road traffic accidents (RTA), falls, and child abuse account for most.[5-8] Dewan et al., incorporated traumatic brain injury (TBI) data from five continents and concluded the global incidence of pediatric TBI to be in between 47 and 280 per 100,000 children; it has a bimodal age distribution with very young children (0–2years) and adolescents (15–18) more commonly injured; and TBI in males is reportedly more common over the age of 3 years.[6] According to the same study, fortunately in most cases, pediatric TBI is mild

Address for Correspondence:
Dr. Aniruddha Chattopadhyay, Assistant Professor, Department of Neurosurgery, Bangur Institute of Neurosciences, Institute of Post-Graduate Medical Education and Research, Kolkata, West Bengal, India. **Mobile:** +91-9836348449. **E-mail:** draniruddhakrishna@gmail.com

in severity, neuroimaging-negative, and could be managed non-surgically and achieve a good clinical outcome at the end. Deciphering the geographical variation in incidence of pediatric TBI, injuries are most commonly reported to occur in Africa, Middle East, and Southeast Asian countries surrounding Indian Ocean.[6,7] Risk stratification and prognostication are essential in the initial emergency management of childhood TBI and includes use of both clinical and neuro imaging findings.[9-14] CT scan of brain is the most commonly employed definitive way to assess the severity of TBI. It helps in decision-making and planning for operative intervention if required.[13-16] Factors determining prognosis are age of the child, clinical indices judging the severity of TBI, and results of CT scan and measurement of intracranial pressure.[17] The authors took up the study to unveil the basic epidemiology of pediatric TBI from a rural-based largest tertiary care setup from Eastern India.

Aims and objectives

To determine the several modes of injury, severity of injury, outcomes and complications in the Eastern Indian population.

MATERIALS AND METHODS

One hundred and fifty cases of pediatric TBI (≤18 years) were evaluated (on basis of pretested, predetermined proforma) and treated in the Department of Neurosurgery, Bangur Institute of Neurosciences, Kolkata, West Bengal, India for 20 months from February 2021to February 2022, which were enrolled in this prospective observational study. Detailed history regarding demographic profile and mode of injury were recorded. All of them had undergone a detailed general survey, systemic examination followed by neurological examination especially Glasgow Coma Scale (GCS) score, pupil size, and reaction to light. Based on GCS, the severity of head injury of the patients were divided into mild head injury (GCS 13–15), moderate head injury (GCS 9–12), and severe head injury (GCS ≤8) categories. All the patients were subjected to CT scan of head without contrast and findings were documented. After initial resuscitation and rapid investigations, the patients were managed either conservatively or surgically as per indications. The relevant data were tabulated and percentage values calculated in this observational study. The outcomes of all these patients were assessed by Glasgow outcome scale (GOS) and divided into good (normal and moderate disability) and poor (severe, vegetative, and death) outcome. Outcome was assessed in relation to age, gender, GCS, pupil size and reaction, features on CT scan, modes of intervention, and presence of associated injuries.

RESULTS

One hundred and fifty patients aged between 1 day and 18 years were included in the study comprising 66.67% males and 33.33% females (Table 1). The most common modes of injury were fall 56.67% followed by RTAs 23.33%, assault 6.67%, and others 13.33% which include sports injury, hit by some object on head, and firearm injury. RTAs had a poor outcome in 14.29%, while patients with fall had a poor outcome of 14.12% (Table 1). Majority of our patients had a GCS of 13–15 (mild head injury), 74.66% followed by 9–12 (moderate), 18%, and 8 or less (severe head injury) 7.33%. In group of patients in the category of GCS ≤8, poor outcome was seen in 63.64% (Table 1). Out of the 150 patients, 80% patients had normal pupils, 14.67% had anisocoria, and 5.33% patients had fixed dilated pupils. Fixed dilated pupil had poor outcome (100%) followed by anisocoria (20%) and normal pupils (20%), which was statistically significant. CT scan findings were noted as normal in 12% patients, isolated skull fracture in 16%, contusion or haematoma in 32%, extradural haemorrhage (EDH) in 10.67%, subdural haemorrhage (SDH) in 10%, pneumocephalus in 8%, brain oedema in 6%, and subarachnoid haemorrhage in 5.33%. Among the mode of injury, it is evident that diffuse brain oedema had poor outcome in 44.45%, SDH in 20%, and contusion in 14.59%, while, in EDH, it was18.75% (Table 2). We inferred that poor outcome was associated with the highest (68%) being midline shift (MLS) >3 mm and it was 12.77% with MLS of <3 mm and it was 10.26% in patients with no MLS (Table 2). Out of the 150 patients,62%were managed

Table 1: Relationship of age, gender, mode of trauma, and Glasgow Coma Scale score with outcome

Variables	Good outcome (%)	Pooroutcome (%)	Total (%)
Age group (years)			
≤5	55 (78.57)	15 (21.43)	70 (46.67)
6–12	30 (75)	10 (25)	40 (26.67)
13–18	25 (62.5)	15 (37.5)	40 (26.66)
Gender			
Male	88 (88)	12 (12)	100 (66.67)
Female	40 (80)	10 (20)	50 (33.33)
Mode of trauma			
Fall	73 (85.88)	12 (14.12)	85 (56.67)
RTA	30 (85.71)	5 (14.29)	35 (23.33)
Assault	7 (70)	3 (30)	10 (6.67)
Others	15 (75)	5 (25)	20 (13.33)
GCS			
13–15 (mild)	104 (92.85)	8 (7.15)	112 (74.66)
9–12 (moderate)	22 (81.48)	5 (18.52)	27 (18)
≤8 (severe)	4 (36.36)	7 (63.64)	11 (7.33)

RTA: Road traffic accidents; GCS: Glasgow Coma Scale; Others (i.e., sports related injuries, hit by an object on head, and firearm injury)

conservatively and the rest were managed surgically. The various surgical procedures performed in patients include fracture debridement and elevation in 20%, haematoma or contusion removal in 10.67%), and decompressive craniectomy in 7.33% (Table 3). Other associated injuries included facial bone fracture in 14%, abdominal organ injury in 4%, limb fracture in 7.33%, spinal injury in 3.33%, chest injury in 4.67%, and multiple injuries in 9.33% (Table 4), Glasgow coma scale was evaluated as shown in Table 5.

DISCUSSION

Management of pediatric TBI in neurosurgical units has much scope for modification and renovation. Good prognosis in most cases is usual in childhood head-trauma cases.[6] Injuries are mostly sustained as a part of polytrauma and seldom in isolation and are approached in a similar fashion as done in cases of adulthood poly trauma.[6,8,18-21] No real difference in outcome in age groups above and below 5 years has been demonstrated by recent study by Wani et al., and Suresh et al.[8,22] The age has been described as a definite factor for determination of morbidity/mortality by few old studies[23,24] and these results perhaps had been derived from comparison between adults and children with TBI. It has been evident that fall followed by RTA has been the most common two modes of pediatric TBI as reported in series.[6,8,22] Poor outcome was seen in patients with low GCS (<8) and good outcome in patients presenting with initial GCS >9. Initial GCS score has been shown to be the most statistically important clinical factor predicting outcome.[25,26] Delayed presentations to the emergency and utterly inadequate pre-hospital care are likely two main culprits for poorer prognosis in countries like India. Pupillary response is another strong predictor of final outcome in cases of pediatric TBI.[8] Invariably poor outcome is seen in cases with dilated and fixed pupils.[6,8,22,27,28] In this series of paediatric TBI, outcome was strongly related to pupillary size and reaction. Brain oedema followed by evidence of SDH and SAH on CT scan of brain had poorer outcome compared to evidences of EDH, pneumocephalus, fracture, and contusion on initial brain imaging. This has been found in many studies.[6,8,22,29,30] EDH is rare in paediatric head trauma and can occur without skull fracture, compared to adults.[29] Diffuse cerebral oedema was associated with poorer outcome in our series like in the previous studies.[6,8,22,28-30] Poor outcome was seen in patients with MLS >3mm on CT brain as found in other studies.[6,8,22] Final outcome, as assessed by GOS scale, revealed death in only 10.66% cases and completely normal outcome in 60% cases and 12% had severe disability.

Table 2: Relationship of pupillary status, CT findings and midline shift with outcome

Clinical features and imaging	Good outcome (%)	Poor outcome (%)	Total (%)
Pupils			
Normal	96 (80)	24 (20)	120 (80)
Fixed and dilated	0 (0)	10 (100)	10 (5.33)
Anisocoria	16 (80)	4 (20)	20 (14.67)
Findings on CT brain			
SDH	12 (80)	3 (20)	15 (10)
Contusion	41 (85.41)	7 (14.59)	48 (32)
EDH	13 (81.25)	3 (18.75)	16 (10.67)
Brain edema	5 (55.55)	4 (44.45)	9 (6)
Normal	18 (100)	0 (0)	18 (12)
SAH	6 (75)	2 (25)	8 (5.33)
Fracture	18 (75)	3 (25)	24 (16)
Pneumocephalus	12 (100)	0 (0)	12 (8)
Midline shift			
No	70 (89.74)	8 (10.26)	78 (52)
Yes <3mm	41 (87.23)	6 (12.77)	47 (31.33)
Yes >3mm	8 (32)	17 (68)	25 (16.67)

CT: Computedtomography, SDH: Subduralhematoma, EDH: Extraduralhemorrhage, SAH: Subarachnoid hemorrhage

Table 3: Relationship of mode of treatment with outcome

Intervention employed	Good outcome (%)	Poor outcome (%)	Total (%)
Decompressive craniectomy	8 (72.72)	3 (27.28)	11 (7.33)
Fracture debridement andelevation	22 (73.33)	8 (26.67)	30 (20)
EDH evacuation	13 (81.25)	3 (18.75)	16 (10.67)
Conservative	80 (86.02)	13 (13.98)	93 (62)
Total	123	27	150

Table 4: Relationship of associated injuries with outcome

Associated injuries	Good outcome (%)	Poor outcome (%)	Total (%)
None	73 (84.88)	13 (15.12)	86 (57.33)
Facial bone(s) fracture(s)	17 (80.95)	4 (19.05)	21 (14)
Abdominal organ injuries	4 (66.66)	2 (33.34)	6 (4)
Limb fracture(s)	9 (81.81)	2 (18.19)	11 (7.33)
Spinal injuries	5 (100)	0 (0)	5 (3.33)
Chest injuries	6 (85.71)	1 (14.29)	7 (4.67)
Multiple injuries	11 (78.57)	3 (21.43)	14 (9.33)
Total	125	25	150

Table 5: GOS in the study group

GOS score	n (%)
5 (Normal)	90 (60)
4 (Moderate disability)	21 (14)
3 (Severe disability)	18 (12)
2 (Vegetative state)	5 (3.33)
1 (Death)	16 (10.66)

GOS: Glasgow outcome scale

Limitations of the study

Sample size was less and thus did not represent the entire population. Pre-hospital care was not included in this study. Long term follow up could not be done.

CONCLUSION

The most important prognostic factors regarding paediatric TBI are GCS at presentation, pupillary status, associated injuries, and CT scan findings. Outcome would have been better had presentation of patients would have been early along with proper prehospital management. Diffuse cerebral oedema has resulted in poor outcome.

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AG- Concept and design of the study, prepared first draft of manuscript; **JG, SS-** Interpreted the results; reviewed the literature and manuscript preparation; **AC-** Concept, coordination, statistical analysis and interpretation, preparation of manuscript.

Work attributed to:
Institute of Post-Graduate Medical Education and Research and SSKM Hospital, Kolkata - 700 020, West Bengal, India.

Orcid ID:
Dr. Arijit Ghosh - https://orcid.org/0000-0002-4849-0403
Dr. Aniruddha Chattopadhyay - https://orcid.org/0000-0002-4000-7181
Dr. Jayanta Ghosal - https://orcid.org/0000-0002-5716-7552
Dr. Sumanta Sarkar - https://orcid.org/0000-0002-5777-845X

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