Romanian Neurosurgery (2019) XXXIII (4): pp. 443-448
DOI: 10.33962/roneuro-2019-070
www.journals.lapub.co.uk/index.php/roneurosurgery

Paediatric traumatic brain injury. Study of analysis of outcome predictors

Vibhushankar Parashar, Vivek Kumar Kankane, Gaurav Jaiswal, Tarun Kumar Gupta

Department of Neurosurgery, R.N.T. Medical College & M.B. Groups of Hospital Udaipur (Rajasthan), INDIA

ABSTRACT

Introduction. Traumatic brain injury is a leading cause of death and disability among children, adolescents. Therefore, analysing outcome predictors and initiating preventive policies may contribute to decreased incidence and better prognosis.

Aim. Aim to describe the epidemiologic characteristics, mechanism of injury, radiological findings and also to analyse the determinants of outcome that could help to provide better critical care and also to establish effective preventive policies.

Material and Methods. We conducted a prospective study including patients ≤18 years admitted to our Neuro-intensive care unit at R.N.T. Medical College ,Udaipur, Rajasthan, India from September 2016 to June 2018.Factors including age, gender ,mode of injury, Glasgow coma score(GCS) at admission ,pupillary size-reaction, radiological findings and their relation to outcome was assessed .Patients were divided into mild, moderate and severe head injury according to GCS. Outcome of patients was assessed by Glasgow outcome scale. For statical Analysis used Chisquare test. Statistical Analysis was carried out using Stata 11.0(College station, Texas, USA)

Results. The study comprised of 84 paediatric patients. 44.4%of patients were within 1–5-year age group. The most common cause for trauma was falls and traffic accidents. Patients with mild, moderate and severe head injury were 38.1%, 47.6%and 14.3% respectively. Poor outcome predictors included severity of head injury, pupil size and reaction, midline shift on CT.

Conclusion. This study emphasizes increased burden of paediatric brain injury with assessment of predicting factors for more effective critical care of patients and emerging need for effective fall and traffic accidents prevention strategies.

Keywords
traumatic brain injury,
paediatric,
outcome predictors.

Corresponding author:
Vivek Kumar Kankane

Department of Neurosurgery,
Southern TOHOKU General Hospital,
Koriyama, Fukushima,
Japan

vivekkankane9@gmail.com

ISSN online 2344-4959
© Romanian Society of Neurosurgery

First published
December 2019 by
London Academic Publishing
www.lapub.co.uk

INTRODUCTION

Traumatic brain injury(TBI) is a main cause of functional disability and death in children and adolescents worldwide.[1,2,3] Falls and Road traffic accidents have emerged as the major causes of pediatric head injuries and their prognosis in children differ from adults due to the different mechanisms of head injury and the structures of the skull.[4,5] Infants and young children are more vulnerable to abuse because of their dependency on adults.[6] Pediatric head injuries are critically important because of the risk of high mortality and potential for lifelong neurological disability which could mean dependence on others for

activities of daily living and years of compromised quality of life.

The study aims to describe various factors and determinants of outcome that could help to improve care and make better preventive policies.

Material and methods

This study includes 84 patients of ≤18 years of age who presented with head injury and admitted in Neuro-intensive care unit at R.N.T. Medical College, Udaipur, and Rajasthan, India from September 2016 to June 2018. We further analyzed those 84 patients on the basis of various factors including clinical factors(age, gender), mode of injury, Glasgow coma score (GCS)at admission and Glasgow outcome scale (GOS).Patients were subjected to detailed general physical examination, systemic examination, and central nervous system(CNS) examination including GCS, pupil size and reaction. Based on GCS, 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 plain CT scan head, and CT findings were noted.

After prior stabilization and workup, the patients were managed conservatively or surgically as and when needed. The outcomes of all these patients were assessed by Glasgow Outcome Scale and divided into good (GOS-4,5) and poor (GOS-1,2,3) outcome. Outcome was assessed in relation to age, sex, GCS, pupil size and reaction, Noncontrast computed tomography scan (NCCT Head) features and other associated bodily injuries. For statical Analysis used Chisquare test. Statistical Analysis was carried out using Stata 11.0(College station, Texas, USA).

Results

Mean age was 8.4 years. 44.4% of patients were within 1–5year age group. The male to female ratio was 2.1 to1. It was evident from our series that age and sex had no statistical significance in outcome (p>0.05).For statical Analysis used Chisquare test. [**Table 1]**

	Number of patients	Good outcome	Poor outcome
Gender			
Male	57(67.9 %)	51 (89.5%)	6 (10.5%)
Female	27(32.1 %)	24 (88.9%)	3 (11.1%)
Age (yr)			
<=5	37(44.1%)	34(91.9%)	3(8.1%)
6-12	19(22.6 %)	17(89.5%)	2(10.5%)
13-18	28(33.3 %)	24(85.7%)	4(14.3%)
Total	84(100%)	75(89.3%)	9(10.7%)

Table 1. Correlation of age, gender with the outcome analysis

The most common cause for trauma were falls(51.1%) followed by road traffic accidents(RTAs) (40.5%), assault (2.4%), sports injury (2.4%)and others (3.6%) which include injury by some object on head .RTA had a poor outcome in 14.7%while patients with fall had a poor outcome of 7% . **[Table 2]**

Table 2. Correlation of mode of injury, GCS score, pupil size with outcome analysis

	Number of patients	Good outcome	Poor outcome
Mode of injury			
Falls	43(51.1%)	40(93.0%)	3(7.0%)
Traffic accidents	34(40.5%)	29(85.3%)	5(14.7%)
Assault	2(2.4%)	2(100%)	0(0%)
Sports injury	2(2.4%)	2(100%)	0(0%)
Others (e.g.- fall of heavy objects)	3(3.6%)	2(66.7%)	1(33.3%)
GCS score			
13-15	32(38.1%)	31(96.9%)	1(3.1%)
9-12	40(47.6%)	39(97.5%)	1(2.5%)
<=8	12(14.3%)	5(41.7%)	7(58.3%)
Pupil size			
Normal	74(88.1%)	71(96%)	3(4%)
Fixed and dilated	3(3.6%)	0(0%)	3(100%)
Anisocoria	7(8.3%)	4(57.1%)	3(42.9%)
Total	84(100%)	75(89.3%)	9(10.7%)

The percentage of patients with mild head injury (GCS of 13–15), moderate (GCS of 9-12, and severe (GCS <=8) were 38.1%, 47.6%, and 14.3% respectively. Poor outcome was seen in the category of GCS ≤8 at 58.3%, followed by patients in group GCS 9–12 at 2.5% and group of patients with GCS 13–15 at 3.1%, which was statistically significant (p< 0.05) For statical Analysis used Chisquare test, Statistical Analysis was carried out using Stata 11.0(College station, Texas, USA). **[Table 2]**

Out of the 84 patients, 74(88.1%) patients had normal pupils, 7(8.3%) had anisocoria, and 3(3.6%) patients had fixed dilated pupils. Fixed dilated pupil had poor outcome (100%) followed by anisocoria (42.9%) and normal pupils (4%), which was statistically significant (p< 0.05) For statical Analysis used Chisquare test. **[Table 2]**

CT scan findings were noted as normal in 12 patients(14.3%), isolated skull fracture in 20(23.8%), contusion or hematoma in 20(23.8%), extradural hemorrhage(EDH) in 13 (15.5%),subdural hemorrhage(SDH)in 7(8.3%), brain edema in 7(8.3%), and subarachnoid hemorrhage in2(2.4%), pneumocephalus in 3(3.6%).Among the mode of injury, it is evident that diffuse brain edema had poor outcome in 28.6%, SDH in 28.6%, contusion in 5%, while in EDH it was7.7%. **[Table 3]** From our series, we also concluded that poor outcome was most strongly associated with midline shift (MLS) >3 mm (66.7%) and it was 20% with MLS of<3 mm and it was 7.9% in patients with no MLS (p< 0.05) For statical Analysis used Chisquare test. **[Table 3]**

TABLE 3. Correlation of Radiological findings on CT and assessment of midline shift with outcome analysis

	Number of patients	Good outcome	Poor outcome
Radiological-CT findings			
Fracture	20(23.8%)	19(95%)	1(5%)
EDH	13(15.5%)	12(92.3%)	1(7.7%)
SDH	7(8.3%)	5(71.4%)	2(28.6%)
SAH	2(2.4%)	2(100%)	0(0)
Contusion/hematoma	20(23.8%)	19(95%)	1(5%)
Edema	7(8.3%)	5(71.4%)	2(28.6%)
Pneumocephalus	3(3.6%)	2(66.7%)	1(33.3%)
Normal	12(14.3%)	11(91.7)	1(8.3%)
Midline shift(MLS)			
No	76(90.5%)	70(92.1%)	6(7.9%)
Yes<3mm	5(5.9%)	4(80%)	1(20%)
Yes >3mm	3(3.6%)	1(33.3%)	2(66.7%)
Total	84(100%)	75(89.3%)	9(10.7%)

On analysis for associated injuries, fractures of face were noted in 10(10.7%), limb fractures in 6(7.1%), abdominal trauma in 4(4.8%), spinal trauma in 2(2.4%), chest trauma in 2(2.4%), multiple traumas in 2(2.4%), and isolated head trauma in 59(70.2%). It was noticed that chest, spinal, and multiple injuries were associated with a poor outcome (p< 0.05). **[Table -4].** Outcome of patients was assessed by Glasgow outcome scale **[Table -5].**

TABLE 4. Correlation of associated other bodily injuries with outcome analysis

	No of patients	Good outcome	Poor outcome
Associated injury			
No injury(head trauma only)	59(70.2%)	57(96.6%)	2(3.4%)
Fracture-facial bones	9(10.7%)	7(77.8%)	2(22.2%)
Abdominal organ injury	4(4.8%)	3(75%)	1(25%)
Fracture – limbs	6(7.1%)	5(83.3%)	1(16.7%)
Injury to chest	2(2.4%)	1(50%)	1(50%)
spinal injury	2(2.4%)	1(50%)	1(50%)
Multiple injuries	2(2.4%)	1(50%)	1(50%)
Total	84(100%)	75(89.3%)	9(10.7%)

TABLE 5. Glasgow Outcome Scale in the study group

Glasgow outcome scale	Functional status	No. of patients	Outcome
5	Resumption of normal life, there may be minor neurological and or psychological deficit	5 (6%)	Poor
4	Able to work in a shattered environment and travel by public transportation	2 (2.4%)	Poor
3	Dependent for daily support by reason of mental or physical disability or both	2 (2.4%)	Poor
2	Unresponsive for weeks or months or until death	6 (7.1%)	Good
1	Death	69 (82.1%)	Good

Out of the 84 patients, 58(69.1%) were managed conservatively and 26 (30.9%) patients were managed surgically. The various surgical procedures performed in patients include fracture debridement and elevation in 12 (46.2%), hematoma removal with fracture debridement in 3 (11.5%), and hematoma (EDH, Acute SDH, Hematoma removal with Decompressive craniotomy in 8 (30.8%)) Decompressive craniotomy alone (for cerebral edema with midline shift of more than 5 mm)) in 3 (3.57%), We followed up our patients for a week to maximum of 12 months.

DISCUSSION

Pediatric TBI remains an important public health concern worldwide, but with the advent of state of art - Intensive Care Unit and incorporation of multidisciplinary approach in developed countries, the outcome of the TBI patients has improved. Yet, it still continues to be a major challenge in our part of the world, which further necessitates the adoption and implementation of strict prevention strategies. Rivara et al. reported that boys have double the rate of brain injuries when compared with female counterparts. [7] In our study, 67.9% of the patients were boys. Although gender differences were important in the rate of injury, they did not appear to adversely affect neurological outcome.

In literature, there has been discrepancy regarding outcome in the pediatric age group. In our study, 37 (44.1%) were less than 5 year of age. One group of reports has indicated that outcome tends to be better in children under10 years of age[8,9]while others report that children under five have a higher mortality rate.[10]Although in our series there was no difference in poor outcome in children below5 years or above 5 years as was reported by Suresh et al.[11]

Falls and traffic accidents account for the majority of injuries in pediatric head trauma.[11,12]Fall from height is the most common cause of injury in our study(51.1%) similar to study by Garget al.[12]Motor vehicle accidents accounted for nearly 40.5% of cases. In 2.4%of patients, assault was the cause of trauma. As age increased, the incidence of falls decreased but that of traffic accidents increased greatly. This is in contrast to the reports in which high-velocity trauma is the most common mode. [13]

Many studies show that the initial GCS is an excellent predictor of mortality [12,14] However, we observed that the classification of head injury into mild, moderate, and severe on the basis of initial GCS is a good prognostic factor for predicting chances of mortality.[12,15]Suresh et al. reported poor outcome in the group of GCS 3–5 as 58.5%, GCS 6–8 had 35.2%, GCS 9–12 had 11.4%, and GCS 13–15 had1.3%.[11] Beca et al. Found that the initial GCS score was the single most important factor affecting outcome.[16]
In our study, we found abnormal pupillary response being the strongest predictor of outcome. Poor outcome in patients with normal pupils was 4%, patients with anisocoric pupils were 42.9%, and with fixed dilated pupils was 100%. Astrand et al. reported 100% poor outcome in dilated pupils unresponsive to light. [17]

We found isolated skull fracture in 20 (23.8%) patients with good outcome in 95% and poor outcome in 5%. Suresh etal.had17% patients with isolated skull fracture with good outcome in 94.1% and poor outcome in 5.9%.[11]Astrand et al.reported 48% of patients of EDH with good outcome in 98% and poor outcome in 2%.[17]Extradural hematoma is significantly less common in children than in adults and is even more rare in infants.[18]

The outcome of patients with SDH is significantly

worse than that of patients with EDH, mainly because of the underlying brain damage accompanying SDH and the resultant increased intracranial pressure. In our series, SDH was seen in 7 (8.3%) patients and out of those poor outcomes was noted in 2(28.6%) patients.

In our study, diffuse brain edema was observed in 7(8.3%) with poor outcome in 2 (28.6%) patients. Suresh et al. reported the incidence of diffuse brain edema as 30% with poor outcome in 25%. [11]

Quattrocchi et al. found prognostic significance of the presence or absence of Midline shift(MLS)on the basis of CT findings.[19] In our study, we found major prognostic significance of Midline shift and strong predictor of poor outcome. Athiappan et al. found the prognostic value of MLS to be more important in patients with single contusions or Intracerebral hematoma than for those with multiple lesions and extra axial or subdural hematoma. [20]

In our study, we found that 70.2% of patients had only head trauma, 10.7% had facial trauma, 7.1% had limb fractures, 4.8% had abdominal solid organ injury, 2.4% had spinal injuries, 2.4% had chest trauma, and 2.4% had multiple injuries. Paret et al. reported chest trauma in 62%, limb fracture in 32%, facial fractures in 29%, abdominal solid organ lesions in 20%, spinal cord injuries in 5% and multiple in 67%.[21]This difference is because we included all patients irrespective of severity of injury.

The overall outcome of our series of patients revealed a mortality of 6% and good outcome of 82.1% with 7.1% patients have moderate disability and 4.8% patients being completely dependent for their day-to-day activities. **[Table5]**

Conclusion

RTAs are more common in school children and adolescents, and falls are commoner in toddlers and preschool children. Poor outcome was seen in the category of GCS ≤8 patients had fixed dilated pupils had poor outcome followed by anisocoria. From our series, we also concluded that poor outcome was most strongly associated with midline shift (MLS) >3, there is an emerging need for effective fall and traffic accidents prevention strategies for children which includes educating about traffic rules and enforcement of road safety. Prompt and accurate assessment of the severity of injury may lead to early initiation with better critical care which may prevent mortality in these patients.

References

1. Mazurek A. Pediatric injury patterns. Int Anesthesiol Clin1994;32:11–25.
2. Jagannathan J,Okonkwo DO, Yeoh HK, Dumont AS, Saulle D, Haizlip J, etal.Long-term outcomes and prognostic factors in pediatric patients with severe traumatic brain injury and elevated intracranial pressure. J NeurosurgPaediatr 2008;2:237-9.
3. Rodriguez JG. Childhood injuries in the United States. A priority issue. Am J Dis Child1990;144:625–6.
4. Keenan HT,Bratton SL. Epidemiology and outcomes of pediatric traumatic brain injury. Dev Neurosci2006;28:256-263.
5. Margulies SS, Thibault KL. Infant skull and suture properties: measurements and implications for mechanisms of pediatric brain injury. J BiomechEng2000;122:364-371.
6. Kumar R, Mahapatra AK. The changing "epidemiology" of pediatric head injury and its impact on the daily clinical practice. Childs Nerv Syst2009;25:813-23.
7. Rivara FP, Bergman AB, LoGerfo JP, Weiss NS. Epidemiology of childhood injuries. II. Sex differences in injury rates. Am J Dis Child1982;136:502-6.
8. Carlsson CA, von Essen C, Lofgren J. Factors affecting the clinical course of patients with severe head injuries. Part 1: Influence of biological factors. Part 2: Significance of posttraumatic coma. J Neurosurg1968;29:242-51.
9. Comninos SC. Early prognosis of severe head injuries in children. Acta Neurochir Suppl1979;28:144-7.
10. Raimondi AJ, Hirschauer J. Head injury in the infant and toddler. Coma scoring and outcome scale. Childs Brain1984;11:12-35.
11. Suresh HS, Praharaj SS, Indira Devi B, Shukla D, Sastry Kolluri VR. Prognosis in children with head injury: An analysis of 340 patients. Neurol India2003;51:16-8.
12. Garg K, Sharma R, Gupta D, Sinha S, Satyarthee GD, Agarwal D,Kale SS, Sharma BS, Mahapatra AK.Outcome predictors in pediatric head trauma: A study of clinicoradiological factors. J PediatrNeurosci2017;12:149-53
13. Kokoska ER, Smith GS, Pittman T, Weber TR. Early hypotension worsens neurological outcome in pediatric patients with moderately severe head trauma. J Pediatr Surg1998;33:333-8.
14. Levin HS, Aldrich EF, Saydjari C, Eisenberg HM, Foulkes MA, Bellefleur M, et al. Severe head injury in children: Experience of the Traumatic Coma Data Bank. Neurosurgery1992;31:435-43.
15. Chesnut RM, Marshall LF, Klauber MR, Blunt BA, Baldwin N, Eisenberg HM, et al. The role of secondary brain injury in determining outcome from severe head injury. J Trauma1993;34:216-22.
16. Beca J, Cox PN, Taylor MJ, Bohn D, Butt W, Logan WJ, et al. Somatosensory evoked potentials for prediction of outcome in acute severe brain injury. J Pediatr1995;126:44-9.
17. Astrand R, Undén J, Hesselgard K, Reinstrup P, Romner B.

Clinical factors associated with intracranial complications after pediatric traumatic head injury: An observational study of children submitted to a neurosurgical referral unit.PediatrNeurosurg2010;46:101-9.
18. Choux M, Grisoli F, Peragut JC. Extradural hematomas in children 104 cases. Childs Brain1975;1:337-47.
19. Quattrocchi KB, Prasad P, Willits NH, Wagner FC Jr. Quantification of midline shift as a predictor of poor outcome following head injury. Surg Neurol1991;35:183-8.
20. Athiappan S, Muthukumar N, Srinivasan US. Influence of basal cisterns, midline shift and pathology on outcome in head injury. Ann Acad Med Singapore1993;22:452-5.
21. Paret G, Ben Abraham R, Berman S, Vardi A, Harel R, Manisterski Y, et al. Head injuries in children – Clinical characteristics as prognostic factors1999;136:677-81.