Characteristics and Outcome of Paediatric Traumatic Brain Injuries: An Analysis of 163 Patients in Enugu

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Abstract

Background: As with most ailments common to adult and paediatric age groups, studies that describe and characterize paediatric traumatic brain injuries (TBIs) lag those of their adult counterparts. This is more so in the developing countries where national data are not well developed. The development of local clinical guidelines has been shown to positively impact outcomes of paediatric TBI. Data on the characteristics and outcomes of TBI among paediatric age groups will provide a framework for the development of an all-encompassing management guideline. **Methods:** In this study, a retrospective review of demography, mechanism of injury, pattern of presentation, nature of treatment, duration of hospital admission, and outcome of children aged 0–17 years managed for traumatic TBI at the University of Nigeria Teaching Hospital, Enugu-Nigeria was performed. Data were analyzed using SPSS version 21. Relevant test statistics were used to test for associations. A $P = 0.05$ was considered statistically significant. **Results:** A total of 163 patients' medical records were retrieved and analyzed. Of these, 117 (71.8%) were males and 46 (28.2%) were females. Their ages ranged from 6 weeks to 17 years with a mean age of 7.66 ± 5.1 years and peaked at 3–5 years. No difference in mean age between gender ($P = 0.427$). Pedestrian motor vehicular accident was the most common cause of injury. Fall from fruit trees and assault were peculiar to children from suburban/rural areas. TBI severity on admission was mild (44.2%), moderate (38.7%), and severe (17.2%). Other systemic injuries were present in 33.7%, of which long bone fractures were the most common (23/55). Abnormal brain computed tomography findings were seen in 83.2% with skull fracture being the most common finding. Operative procedures were carried out on 19.6% of patients. Conservative measures were the mainstay of management. The mean duration of hospital admission was 14.01 ± 11.8 days was significantly associated with admission Glasgow Coma Scale (GCS) Score ($P < 0.0001$) and Glasgow Outcome Score (GOS) at discharge ($P = 0.03$). The overall outcome was good (GOS 4 and 5) in 92.0% and has a significant association with GCS on admission ($P < 0.0001$). Long-term (Extended GOS) was 8 in 98.2% of those followed up. **Conclusion:** Paediatric TBI is mainly mild to moderate in severity with a male predilection. The main cause is road traffic accidents with most victims being pedestrians. Management is mainly non-operative and the outcome at discharge is good even in a middle-income country and significantly determined by GCS on admission.

Keywords: Characteristics, outcome, paediatric, traumatic brain injuries

Introduction

Paediatric traumatic brain injuries (TBIs), though not as fatal as the adult TBI, remain an important cause of morbidity and mortality in the paediatric population.[1,2] It causes nearly 500,000 emergency department visits and results in more than 2000 deaths/year in the United States.[1] The low- and middle-income countries (LMIC) account for 95% of the global burden of TBI in children, for which 90% of the injuries are non-intentional.[3] Most cases tend to be mild head injuries with better outcomes compared to adult TBI.[2,4] As with most ailments common to adult and paediatric age groups, studies that describe and characterize paediatric TBI lag those of their adult counterparts.[5,6] This is more so in developing countries where national trauma data records are not well developed. The development of evidence-based treatment guideline serves a pivotal role to improve TBI outcomes for the LMIC paediatric population.[3]

This study is aimed at describing the demographic and clinical characteristics as well as the determinants of outcome of TBI

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among paediatric population from a low-income country. This, we believe, will be a good addition to the available database for the development of local treatment guidelines.

Methods

A retrospective review of medical records of children aged 0–17 years who were managed for traumatic head injury by the neurosurgery unit of the University of Nigeria Teaching Hospital, Enugu, was done. Patients' case notes were retrieved from the hospital medical records department, and relevant data on demographics, mechanisms of injury, clinical and treatment profile, as well as early outcomes were extracted. Patients who were not admitted or those who died before resuscitation in the emergency room, and those who had incomplete medical records were excluded from the study.

The outcome was assessed using the Glasgow Outcome Score (GOS) at the point of discharge, while long-term outcome was defined as the outcome at one year or more post-injury. It was assessed using a post-discharge structured interview for Extended GOS (GOS-E) questionnaire.[7] Interviews were made through telephone conversation.

Retrieved data was analyzed with the Statistical Package for the Social Sciences version 20, IBM Corp., and Chicago, Illinois, USA. A $P < 0.05$ was considered significant for statistical tests.

Results

A total of 163 patients' medical records were found and analyzed. Of these, 117 (71.8%) were males, whereas 46 (28.2%) were females translating to a male-to-female ratio of 2.5: 1.0. The ages ranged from 1.8 months to 17 years with a mean age of 7.66 ± 5.1 years. The mean ages for male and female patients were 7.8 ± 5.1 and 7.2 ± 5.1, respectively ($P = 0.427$, Wilcoxon test).

The peak incidence (23.9%) was seen at age 3–5 years. Other age distributions were 0–2 years (17.8%), 6–8 years (17.8%), 9–11 years (12.9%), 12–14 years (12.9%), and 15–17 years (14.7%) (patients aged < 1 year accounted for 3.1%.

Etiology

Motor vehicular accident was the most common cause of pediatric TBI [Table 1]. Aetiology peculiar to the male sex was fall from a tree (4.3%), gunshot injury (1.7%), and driver road traffic accident (5.1%). Paediatric road traffic accidents (RTA) occurred in 67 patients (41.1%), whereas passenger and driver RTA occurred in 38 (23.3%) and 6 (3.9%) patients, respectively.

The causes of injuries in patients from rural locations were MVA (43.4%), MCA (32.3%), and FFH (12.1%). The common causes from urban settings were MVA (40.6%), FFH (35.9%), and MCA (15.6%). All cases of assault and fall from fruit tree were from rural areas.

Clinical presentation and classification of head injuries

Closed head injuries were seen in 149 patients (91.4%), while the remaining 14 (8.6%) had an open head injury.

Table 1: Aetiology of head injury among patients

	Frequency		Total frequency (%)
	Male (%)	Female (%)	
RTA			111 (68.1)
Motor vehicular	44 (37.6)	25 (54.3)	69 (42.3)
Motorcycle	32 (27.4)	10 (21.7)	42 (25.8)
Fall from height	28 (23.9)	7 (15.2)	35 (21.5)
Fruit tree	5 (4.3)	0	5 (3.1)
Story building	17 (14.5)	6 (13.))	23 (14.1)
Low heights <1 m	6 (5.1)	1 (2.2)	7 (4.3)
Assault	5 (4.3)	1 (2.2)	6 (3.7)
Gunshot	2 (1.7)	0	2 (1.2)
Others	3 (2.6)	1 (2.2)	4 (2.5)
Others	8 (6.8)	3 (6.5)	11 (6.7)
Total	117 (71.8)	46 (28.2)	163 (100.0)

RTA: Road traffic accidents

Mild head injuries (Glasgow Coma Scale [GCS] 13–15) were the most common forms of injury in terms of severity (44.2%), moderate (GCS 9–13), and severe head injuries (GCS 3–8) were seen in 38.7% and 17.2% of patients, respectively.

The mean GCS among males ranked higher than that of females, but the difference was not significant ($P = 0.123$, Wilcoxon test).

Posttraumatic seizures were seen in 57 (35%) patients. Of these, seizures were generalized in 48 and focal in nine patients. Seizures occurred in < 1-day posttrauma in 21%, within 1–7 days in 58%, and after seven days in 21% of patients.

Associated injuries were seen in 55 (33.7%) patients: long bone fractures, 23 (14.1%), ophthalmological injuries, 15 (9.2%) patients; ENT injuries, nine (9.2%) patient; maxillofacial injuries, five (3.1%) patients; spinal injuries, two (1.2%); and pelvic injury, one (0.6%) patient.

Brain computed tomography (CT) scan was done in 125 patients (74.7%). The CT findings were normal in 16.8%, but abnormal findings were seen in 83.2% (104/125) of patients. Skull fracture was the most common abnormal CT finding [Figure 1].

Management and outcome

Non-operative treatment was employed in the care of 131 (80.4%) patients. The remaining 32 (19.6%) patients had some form of operative care. The surgical procedures performed on the patients were: scalp laceration repair, 17 (10.4%); elevation of depressed skull fracture, 8 (4.9%) patients; craniotomy, 5 (3.1%) patients; and burr hole, 4 (2.5%) patients.

The mean duration of hospital admission was 14.01 ± 11.8 days. The admission duration was significantly longer among those with lower admission GCS and is associated with poor GOS [Table 2].

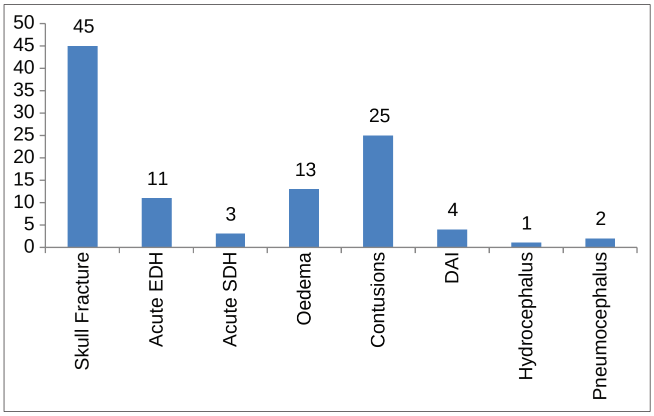

Figure 1: Abnormal brain computed tomography findings

Table 2: Multivariate analysis of duration of hospital admission

	Mean duration of admission	*P*
Admission GCS		
13-15	9.61±6.0	0.000, Kruskal-Wallis test
9-12	14.75±12.2	
3-8	22.71±16.2	
Treatment		
Operative	16.59±13.8	0.621, Wilcoxon test
Nonoperative	13.37±11.3	
GOS		
4-5	12.94±10.4	0.03, *t*-test
1-3	26.31±19.4	

GCS: Glasgow Coma Scale, GOS: Glasgow outcome score

The GOS at discharge was five in 134 (82.2%) patients; four in 16 (9.8%) patients, three in seven (4.3%) patients; two in five (3.1%) patients; and one in one (0.6%) patient. The admission GCS was also significant between and within the respective GOS (*P* = 0.000, Kruskal–Wallis test).

A total of 142 patients were at least one-year post-discharge but only 57 patients (40.1%) were successfully contacted through their parents. The follow-up duration among contacted patients ranged from two to six years (mean of 4 ± 1.5). Out of the 57 patients, 56 (98.2%) had a GOS-E of eight and all of them had a GOS of five at discharge. The remaining one patient had a GOS-E of three at follow up and had a GOS of two at discharge.

Among the 57 followed up patients, 15 (26.3%) had a history of post-traumatic seizure, while on admission but none was reported to be having seizures on follow-up.

Discussion

We observed a male preponderance (2.5 times that of females) among our cohorts and a general peak age of 3–5 years. The mean age in relation to gender was similar (*P* = 0.427, Wilcoxon test). The male predilection concurred with findings from various studies across the globe, and a plausible explanation has been the adventurous and aggressive tendencies of boys.[5,6,8-10] This explanation could also explain why we found that fall from fruit trees and gunshot injuries to be peculiar to the male child.

The most common causes of injury observed were RTA (68.1%) and falls (21.5%). This is similar to reports by Udoh and Adeyemo from Nigeria and Abdelquadir *et al*. from Uganda.[6,11] Motor vehicular accident was the most common cause of injury (42.2%) and remained so irrespective of gender and patient location [Table 1]. Motorcycle crash was the second most common cause of injury from our findings (25.3%), and it was more common in rural/suburban areas compared to urban areas (33.2% vs. 15.6%). It is more common than falls in rural areas and less common in urban areas. In this study, the majority of falls from heights were from a building/story building and is consistent with findings of Kihiko and his coworkers from Kenya.[12]

The use of a motorcycle as means of commercial transport with attendant accident-proneness is a well-known phenomenon in Nigeria.[13] Of 96 patients with motorcycle-related TBI studied by Nnadi *et al*. in Calabar, Nigeria, only one patient had a head helmet.[14] Chinda *et al*. also identified motorcycle accidents as an important cause of pediatric TBI among their cohorts.[8] The difference in the incidence of motorcycle-related accidents in our studies between urban and nonurban areas could be explained by the ban placed by the government on the use of motorcycles within the metropolis of the study location. Most of the victims of RTA in this study were pedestrians (61.3%). This corroborated with other published findings.[8,15,16] A probable explanation for high pedestrian accidents in developing countries is the burgeoning development of motorization and transportation systems with no commensurate available safety infrastructures. Consequently, children are more vulnerable to traumatic injuries and TBIs, especially as pedestrians."[3] Rider motorcycle injuries were seen in six (3.7%) patients. All were boys within the age range of 15–17 years. This underscores the adventurous nature of boys and the poor enforcement of the legislation against underage driving.

Most patients presented with mild (44.2%) and moderate (38.7%) injuries. Severe TBI was the least common (17.2%) type of head injury. There was no difference between the mean GCS in males and females (*P* = 0.123) [Figure 2]. A high incidence of mild head injuries has been reported to be common with pediatric TBI.[5,15,17] However, some local studies from Nigeria have reported a higher incidence of severe head injuries of 35.6% (Chinda *et al*.) and 40% (Udoh and Adeyemo).[6,8] Udoh and Adeyemo attributed the high severe head injuries to the fact that a good number of patients were referred.[6] Although 30.1% of our patients were referred from other states, the low incidence of severe head injuries which correlates with international data may show a paradigm shift in health-seeking behavior, in which even those with mild/moderate head injuries are referred for neurosurgical assessment.

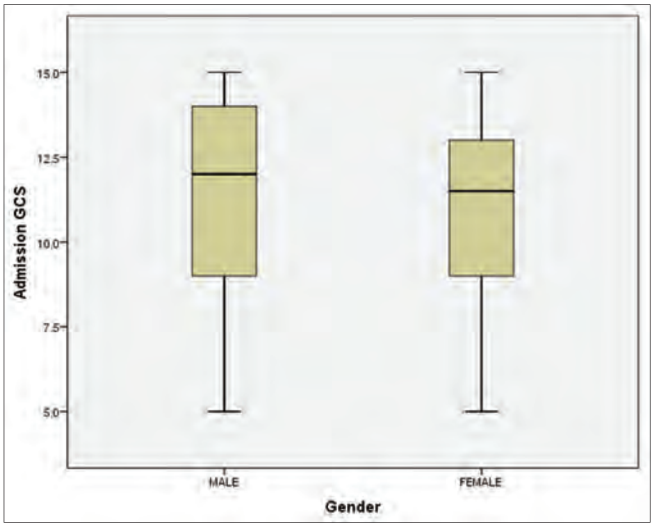

Figure 2: Plot of admission Glasgow Coma Scale by patient gender

Posttraumatic seizures were seen in 57 (35%) of our patients. Seizures were classified as immediate, when they occurred within 24 h posttrauma 12 (7.4%); early if within 1–7 days 33 (20.2%); and late if it occurred after seven days, 12 (7.4%). Trauma has been recognized as an important cause of epilepsy, and the rate in this series is within the range described for posttraumatic seizures.[18-21] However, of the 57 patients who were followed up, all were seizure-free despite 15 (26.3%) of them having a record of posttraumatic seizure while on admission. Keret *et al*. found no correlation between immediate posttraumatic seizure and the development of posttraumatic epilepsy.[22] Although seizures appeared to have resolved among our patients, it is however worth noting that, in 14.3% of patients, the first episode of posttraumatic epilepsy could occur after two years posttrauma.[19] Hence, the need for further follow-up and investigation. Other associated systemic injuries were seen in 55 (33.7%) patients, of which long bone fractures were the most common 23 (14.1%). A detailed systemic evaluation of patients with TBI is therefore necessary in order to pick up these associated injuries. The presence of associated injuries did not significantly affect the admitting GCS or GOS at discharge [Table 3].

CT scan is the investigation of choice,[23] and in our series, the CT findings were normal in 21 (16.8%) of the 125 patients who had a brain scan, and abnormal findings were seen in 83.2%. The presence of abnormality in the CT scan was not significantly different with respect to the severity of head injury ($P = 0.3446$), presence of seizures $P = 0.2627$), and outcome ($P = 0.5487$) as seen in Table 4. Skull fractures and contusions were the most common abnormal CT findings [Figure 1]. In a review of cranial CT scan findings in head trauma patients, Ohaegbulam *et al*. found that, in 19.9% of cases, CT was unremarkable, whereas 80.1% of cases had abnormal CT findings.[24] The most common CT abnormality in our findings was similar to other documented reviews in the literature.[15]

Nonoperative treatment was employed in the care of 131 (80.4%) patients. The remaining 32 (19.6%) patients had some form of operative care. Nonoperative management has been highlighted by most authors as the predominant form of treatment in pediatric TBI.[8,10,15,17] Repair of scalp lacerations and elevation of depressed skull fractures were the most common operative procedures we performed among our patients.

We found a mean duration of admission of 14.01 ± 11.8 days. The duration of admission was longer with an increase in severity of TBI ($P = 0.000$), and the longer the duration of admission, the poorer the GOS at discharge ($P = 0.03$). This average length of admission compares with that reported by Udoh and Adeyemo also from Nigeria.[6]

Table 3: Multivariate analysis of other injuries in pediatric traumatic brain injuries

	Other injuries		Total (%)	*P*
	Yes (%)	No (%)		
Etiology				
RTA	41 (36.9)	70 (63.1)	111 (100.0)	0.1724, 1.8623
Non-RTA	14 (26.9)	38 (73.1)	52 (100.0)	
Total	55 (33.7)	108 (66.3)	163 (100.0)	
GCS on admission				
3-8	10 (35.7)	18 (64.3)	28 (100.0)	0.9507
9-15	45 (33.3)	90 (66.7)	135 (100.0)	
Total	55 (33.7)	108 (66.3)	163 (100.0)	
GOS at discharge				
Good GOS	52 (34.7)	98 (65.3)	150 (100.0)	0.379, 0.7736
Poor GOS	3 (27.1)	10 (72.9)	13 (100.0)	
Total	55 (33.7)	108 (66.3)	163 (100.0)	

RTA: Road traffic accidents, GCS: Glasgow Coma Scale, GOS: Glasgow outcome score

Table 4: Multivariate analysis of brain computed tomography findings among study population

	CT findings		Total (%)	*P*
	Normal (%)	Abnormal (%)		
Etiology				
RTA	10 (12.7)	69 (87.3)	79 (100.0)	0.1045
Non-RTA	11 (23.9)	35 (76.1)	46 (100.0)	
Total	21 (16.8)	104 (83.2)	125 (100.0)	
Seizures				
Present	5 (11.6)	38 (88.4)	43 (100.0)	0.2627
Absent	16 (19.5)	66 (80.5)	82 (100.0)	
Total	21 (16.8)	104 (83.2)	125 (100.0)	
GCS on admission				
3-8	2 (8.0)	23 (92.0)	25 (100.0)	0.3446
9-12	7 (16.3)	36 (83.7)	43 (100.0)	
13-15	12 (21.1)	45 (78.9)	57 (100.0)	
Total	21 (16.8)	104 (83.2)	125 (100.0)	
GOS at discharge				
Good GOS	20 (17.4)	95 (82.6)	115 (100.0)	0.5487
Poor GOS	1 (10.0)	9 (72.9)	10 (90.0)	
Total	21 (16.8)	104 (83.2)	125 (100.0)	

RTA: Road traffic accidents, GCS: Glasgow Coma Scale, GOS: Glasgow outcome score, CT: Computed tomography

There was no difference in length of admission between operated and non-operated patients [Table 2]. The outcome of management was good (GOS of 4 and 5) in 91% of cases with only one mortality (0.6%). There was a significant association between GCS on admission and the GOS (P = 0.000). This is in line with the general reports on paediatric TBI which is good.[2,4,5,15] Similarly, admitting GCS has also been shown to be a significant determinant of outcome both in children and adults.[10,25-27] In view of the good outcome, no child should be denied the opportunity to receive treatment, as the result could be way beyond expected.

Follow-up rate was 40.1% despite using mobile telephone lines specified in the medical records. This very low rate was partly attributable to the fact that some phone numbers were for relatives who do not live with the discharged patients and had no significant idea of their well-being. Other factors we noted include poor network connectivity, reluctance to share clinical details through the phone despite proper introduction, and in some instances, lack of a phone number to call. Only one patient (1.8%) had a poor GOS-E (GOS-E 3) and that patient had a poor GOS of 2 at discharge. Overwhelming majority (98.2%) had upper good recovery (GOS-E of 8) and were said to be doing well. Consequently, while GOS at discharge is not usually relied upon due to the fact that patients are still recovering, a good GOS at discharge appears to be a reliable predictor of long-term functional outcome. This corroborates with the study by Oliveira *et al*. who found the GOS at discharge to be a reliable prognosticator of recovery among patients with severe TBI.[28]

Conclusion

Paediatric TBIs are mainly mild to moderate in severity. A road traffic accident is the main cause, followed by falls predominantly from story buildings. The significant number of pedestrian accidents begets a clarion call to protect children by instituting and enforcing appropriate traffic regulations. Similarly, the need to put child protection measures when building story buildings has also been underscored by this study. Irrespective of the severity of injury, a pragmatic approach of adequate resuscitation and institution of appropriate treatment measures yields rewarding outcomes.

The study is limited by the inability to capture patients who died in the emergency room before admission and those who were not admitted at all. Capturing these groups of patients in subsequent studies will give a more complete picture of the spectrum of pediatric TBI.

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Conflicts of interest

There are no conflicts of interest.

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