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CLINICAL SPECTRUM OF CHILDHOOD TRAUMATIC BRAIN INJURY: SIX-YEAR DATA MINING OF PATIENTS MANAGED AT THE UNIVERSITY OF CALABAR TEACHING HOSPITAL

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ABSTRACT

Background: Injury is one of the most common reasons for hospitalization of young people, with millions worldwide sustaining a traumatic injury requiring hospitalisation each year.

Aim of the study: To study the pattern and quantum of traumatic brain injury managed in our institution.

Patients and Methods: This is a retrospective review of all children aged 0 to 12 years treated for TBI at the UCTH between January, 2016 and December, 2020. Clinico-demographic details of the patients were obtained and analysed.

Results: The mean age of the patients was 58.61±29.36 with male to female ratio of 1.4 to 1.The mean Glasgow Coma Score was 8.63 ±3. Falls, mostly from domestic accident and pedestrian traffic injuries were the most frequent aetiologies (39.77% and 34.09% respectively). Extra-axial bleed was found in 29.55% (26/88) of the patients while cerebral contusion was found in 31.82% (28/88) of the patients. Scalp injury occurred in 27.27% (24/88) patients while 17.05% (15/88) had skull fracture. Operative treatment was carried out in 20.45% of the patients. More than eighteen percent {18.18% (16/88)} had blood transfusion in the course of treatment.

Conclusion: The toddlers and pre-school age children had the highest frequency of traumatic brain injury in this study accounting for 56.82% (50/88) of the total number of patients. Severe traumatic brain injury was the most common type of head injury in this study with a frequency of 44.32%. The recovery rate was high with 98.86% of the patients recovering with a GCS of 14/15 to 15/15 at the time

of discharge from the hospital. Fall mostly from domestic accident was the most common aetiology and responsible for 39.77% of the patients studied.

INTRODUCTION

Head injury (HI) is a leading cause of mortality and permanent disability in children and adolescents.[1, 2, 3] Population-based studies have recently reported that 750 out of 100 000 children will suffer TBI each year. Of these, fewer than half will seek medical care, 10% will be hospitalized and only 7% will sustain significant head injury.[4, 5] An estimate of approximately 3000 children per year acquire significant new neurological disability as a result of TBI.1, 6 When considering adult outcome from such insults, it is frequently assumed that only children with more severe injuries will continue to experience significant long-term sequelae after the insult. Studies on severe head injury showed that the mortality rate was approximately one-third, while residual with another third of children making a good recovery, and the last third exhibiting residual disability, at least in the first few years post-injury.[4, 7]

Injury to the developing brain can alter developmental trajectories, leading to psychosocial, cognitive, emotional and behavioral abnormalities. Importantly, emerging literature suggests that both the response to injury and the path to recovery may be different between male and female infants, children and adolescents.8 Boys are more than twice as likely to suffer a TBI.5 The male preponderance was very clear in younger patients, while in older patients this difference is less pronounced.[19] Traumatic Brain Injury is more common in socially disadvantaged children and in children with pre-existing learning and behavioral deficits.[9, 10, 11] These pre-existing characteristics may increase the young person's risk of experiencing post-injury problems and limit their capacity to access necessary rehabilitation and educational resources, resulting in slower than expected recovery and development and likelihood of residual impairments through childhood and into adulthood.[11]

OBJECTIVES

To study the pattern and quantum of traumatic brain injury managed in our institution.

PATIENTS/METHODS/STUDY DESIGNS

This is an institution-based retrospective study. Patients were identified by a retrospective review of all children aged 0 to 9 years admitted into UCTH with TBI between January, 2016 and December, 2020. Patients' hospital records were studied to obtain clinic-demographic data including age, sex, clinical features, associated non-neurological comorbidities, aetiology, severity of the injury (GCS at presentation), type of management (operative versus non-operative) and immediate outcome at discharge (GCS at discharge). Ideally outcome at discharge should have been measured using GOS or GOSE but because this study was retrospective, this data was difficult to collect. This is the rationale for using GCS.

Exclusion Criteria: All patients treated for childhood traumatic brain injury (between the ages ≤1 to 9 years) at the University of Calabar Teaching Hospital between January, 2016 and December, 2020 and are currently within the ages of 10 and 19 years were recruited into the study.

Exclusion Criteria: All patients between the ages of 1 and 9 years who were treated for childhood traumatic brain injury at the University of Calabar Teaching Hospital between January, 2016 and December, 2020 and are currently above 19 years old were excluded from the study. All patients who were treated for childhood traumatic brain injury between January, 2018 and December, 2020 but died

before the age of 10 years were excluded from the study. All patients with pre-existing neurological disease(s) were excluded from the study. Patients with spinal cord injuries were excluded from the study; Patients who did not do brain computed tomography were excluded.

Sample Size: The sample size was calculated using the fisher's formula. Allowing for an attrition rate of 10%, a minimum of 88 patients were recruited into the study.

Data management and Analysis: Data was analyzed using statistical packages for the social sciences (IBM SPSS statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.). Data collected on proformas (Appendices II, III and IV) was entered into the SPSS spreadsheet using numerical codes.

RESULTS

For descriptive purposes, the age of the patients at the time of the injury (at presentation) were grouped into infancy (≤ 1), pre-school age (2-5) and school age (>5-9) respectively. Patients who were less than a year (≤) were 3.41% (3/88); those between the ages of 2-5 years were 56.82% (50/88) of the total number of patients; and those between the ages of 6-9 were of 39.77% (35/88) of the total number of patients respectively. The real age (absolute age) of every patient was obtained in months with a mean and median age of 58.61±29.36 and 55 months respectively. Table 1&2

Table 1 *(Age Group Distribution.)*

AGE CATEGORY (YEARS)	FREQUENCY (n=88)	PERCENTAGE (%)
Age at trauma		
≤1	3	3.41
2-5	50	56.82
6-9	35	39.77

Table 2 *(Measure of Central Tendency.)*

Measure of central tendency	Age at trauma (Months)
Mean ± SD	58.61 ± 29.36
Median	55.00

Fifty nine percent of the patients were male {59% (52/88)} while 41% (36/88) were females with male female ratio of 1.4:1 (Figure 1).

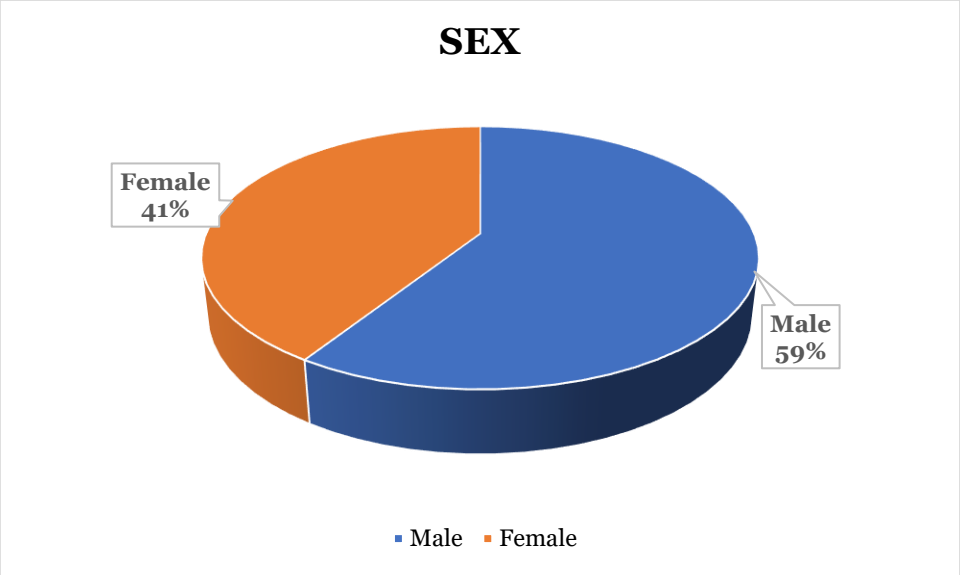

Figure 1 *(Sex Distribution.)*

The Glasgow Coma Score (GCS) was used in this study to measure the severity of injury at presentation and it was categorized into: GCS 3-8 (mild head injury), GCS 9-12 (moderate head injury) and GCS 13-15 (severe head injury) respectively. More than forty four percent {44.32% (39/88)} of the patients had GCS of 3-8 while 40.91% (37/88) and 13.64% (12/88) had GCS of 9-12 (moderate head injury) and GCS of 13-15 (severe head injury) respectively. The data for this study was obtained retrospectively, this precluded the measurement of Glasgow Outcome Scores (GOS or GOSE) and its use for treatment outcome. Therefore, for the purpose of this study the Glasgow Coma Score at the time of discharge was obtained and used as guide to outcome at the time of discharge from the hospital. The GCS at discharge from the hospital was 9-12 (moderate injury) for 1.14% (1/88) patient and 13-15 (mild injury) for 98.86% (87/88) patients respectively. However, no patient was discharge at a GCS of 3-8. The mean GCS at the time of trauma was 8.63 with a standard deviation of ±3 while the mean GCS at the time of discharge from the hospital after successful treatment was 14.58 with a standard deviation of ±0.7. Table 3A&3B

Table 3A *(Classification of Injury severity with GCS.)*

GCS CATEGORY	FREQUENCY (n=88)	PERCENTAGE (%)
At Presentation		
3-8	39	44.32
9-12	37	40.91
13-15	12	13.64
At discharge		
9-12	1	1.14
13-15	87	98.86

Table 3B *(Measure of Central Tency for GCS Classification of Injury.)*

Measure of central tendency	GCS at Presentation	GCS at discharge
Mean ± SD	8.63 ± 3.13	14.58 ± 0.72
Median	9	15

Notably, none of the patients had non-neurological co-morbidity such as asthma, sickle cell disease, diabetes mellitus, hypertension or non-neurological congenital malformations. Table 4

Table 4 *(Associated Non-Neurological Comorbidities.)*

Non-Neurological comorbidities	Frequency (n=88)	Percentage (%)
Asthma		
Yes	88	100.00
No	0	0.00
Sickle cell		
Yes	0	0.00
No	88	100.00
Diabetes mellitus		
Yes	0	0.00
No	88	100.00
Hypertension		
Yes	0	0.00
No	88	100.00
Non-neurological congenital malformation		
Yes	0	0.00
No	88	100.00

Non-neurological systemic injuries occurred in most of the patients. Systems affected were musculoskeletal injury {22.73% (20/88)}, chest injury {4.55% (4/88) and abdominal injury {3.41% (3/88)}. Table 5

Table 5 *(Associated Non-Neurological Injuries.)*

Non-Neurological Injuries	Frequency (n=88)	Percentage (%)
Musculoskeletal injury		
Yes	20	22.73
No	68	77.27
Chest Injury		
Yes	4	4.55

No	84	95.45
Abdominal injury		
Yes	3	3.41
No	85	96.59

Falls mostly from domestic accident was responsible for 39.77% (35/88) of the traumatic brain injury in our patients. Pedestrian road traffic accident was second most frequent aetiology and is responsible for 34.09% (30/88) of the traumatic head injury in our patient. The remaining 26.14% (23/88) of the patients had traumatic brain injury caused by vehicular passenger road traffic accident {5.68% (5/88)}, Motor Cycle road traffic accident {7.95% (7/88)}, bicycle fall {1.14% (1/88)}, assault {2.27% (2/88)} and sport injury {9.09% (8/88)}. Table 6.

Table 6 *(Aetiology.)*

Aetiology	Frequency (n=88)	Percentage (%)
Fall	35	39.77
Pedestrian RTA	30	34.09
Vehicular Passenger RTA	5	5.68
Motor Cycle RTA	7	7.95
Bicycle fall	1	1.14
Assault	2	2.27
Sport	8	9.09

All the patients studied had computed tomography scan of the brain done within few days after theinjury with some notable findings. Only 1.14% (1/88) of the patients had features suggestive of axonal injury. Brain stem injury was found in 5.68% (5/88) of the patients. Brain herniation syndrome was found in 6.82% (6/88) of the patients. Among patients with brain herniation syndrome, 66.67% (4/6) had subfalcine herniation while 33.33% (2/6) had trans-tentorial herniation. None of the patients had transforamen magnum herniation. Among 29.55% (26/88) of the patients who had extra-axial bleed, 19.23% (5/26) had subdural haematoma, 30.77% (8/26) had epidural haematoma while the remaining 50% (13/26) had subarachnoid haematoma. Cerebral contusion was seen in 31.82% (28/88) of the patients. Among patients that had cerebral contusion, 64.29% (18/28) had frontal contusion, 28.57% (8/28) had temporal contusion, 3.57% (1/28) had occipital contusion and 3.57% (1/28) had contusion in the posterior fossa. Most of the patients had contusion on the left hemisphere {46.43% (13/28)}, while others had right hemispheric contusion {28.57% (8/28)} or bilateral contusion {25% (7/28)}. Intra-cerebral haemorrhage was seen in 10.23% (9/88) of the patients while midline shift occurred in 22.73% (20/88) patients. Scalp injury occurred in 27.27% (24/88) patients while 17.05% (15/88) had skull fracture.Pneumocephalus was seen in 1.14% (1/88) patient. Table 7.

Table 7 *(Radiological Findings.)*

Radiological findings	Frequency (n=88)	Percentage
Diffuse axonal injury		
Yes	1	1.14
No	88	98.86
Brain stem injury		
Yes	5	5.68
No	83	94.32
Herniation syndrome		
Yes	6	6.82
No	82	93.18
Type of herniation		
Subfacine	4	4.55
Transtentorial	2	2.27
Transforamen magnum	0	0.00
No	82	93.18
Subdural haematoma		
Yes	5	5.68
No	83	94.32
Subarachnoid haemorrhage		
Yes	13	14.77
No	75	85.23
Contusion location		
Frontal	18	20.45
Temporal	8	9.09
Occipital	1	1.14
Posterior fossa	1	1.14
No	60	68.18
Side of contusion		
Right	8	9.09
Left	13	14.77
Bilateral	7	7.95
None	60	68.18
Intracerebral haemorrhage		
Yes	9	10.23
No	79	89.77
Midline shift		
Yes	20	22.73
No	68	77.27
Scalp injury		
Yes	24	27.27
No	64	72.73
Skull fractures		
Yes	15	17.05
No	73	82.95
Epidural haematoma		
Yes	8	9.09

No	80	90.91
Pneumocephalus		
Yes	1	1.14
No	87	98.86

Operative treatment was carried out in 20.45% (18/88) of the patients while the remaining 79.55% (70/88) patients had only non-operative treatment. More than eighteen percent {18.18% (16/88)} had blood transfusion in the course of treatment and equal number of patients {18.18% (16/88)} had Intensive Care Unit admission. Table 8.

Table 8: (*Management.)*

Type of management	Frequency (n=88)	Percentage (%)
Treatment		
Operative	18	20.45
Non-operative	70	79.55
Blood transfusion		
Yes	16	18.18
No	72	81.82
ICU admission		
Yes	16	18.18
No	72	81.82

DISCUSSION

Findings from previous studies have shown that traumatic brain injury (TBI) is relatively common amongst children.8, 13, 14 This is also proven from our result which showed that 56.82% of the patients were between the ages of 2-5 years compared to 39.77% that are between the ages of 6-9 years. However, our result showed relative rarity of traumatic brain injury among infants who accounted for just 3.41% of our patients. Our study showed a male to female ratio of 1.4: This male preponderance is seen in other studies.15, 16, 17, This high frequency of head injury among male patients could be due to the fact that male children are more adventurous.[18]

The severity of traumatic brain injury at presentation was measured using the Glasgow Coma Score which classifies traumatic brain injury into mild (GCS 13- 15), moderate (GCS 9-12) and severe (GCS 3-8). Studies have shown that mild traumatic brain injury is the most common type of traumatic brain injury.19 However, severe traumatic brain injury was the most common type in this study with a frequency of 44.32% closely followed by moderate traumatic brain injury with a frequency of 40.91% while mild traumatic brain injury had the least frequency in our study (13.64%). Similarly, studies showed that in the UK, severe TBI was most frequent with approximately 3000 children acquiring significant new neurological disability as a result of severe TBI.[19, 20]

It has been found in a similar study that the sequelae of TBI in children may remain constant or deteriorate.20 However, the recovery rate of the patients in our study seems high with 98.86% of the patients recovering with a GCS of 14/15 to 15/15 at the time of discharge from the hospital. None of

the patients studied had a non-neurological co-morbidity such as asthma, sickle cell disease, diabetes mellitus, hypertension or non-neurological deformity either prior to or after the traumatic brain injury. The absence of these non-neurological comorbidities could be due to their rarity among children and adolescents. However, development of chronic medical comorbidities after TBI could complicate the course of recovery and increase health care costs and mortality.21-23A number of studies have demonstrated increased risk of cardiovascular and metabolic disorders as well as epilepsy, stroke and depression in the chronic phase of TBI recovery. However, most of these studies were based on self-report and focused on older age groups.[24, 25, 26]

Non-neurological systemic injuries occurred in some of the patients studied, 22.73% had musculoskeletal injury, 4.55% had chest injury and 3.14% had abdominal injury. The presence of other non-neurological systemic injury in patients with traumatic brain injury is associated with higher mortality rate.21 When associated with lung contusion mortality rate could be as high as 80%.[21]

The aetiology of traumatic brain injury varies with geographical location. A study in Bauchi, Nigeria demonstrated that over 50% of TBI were due to motor vehicular transport related injury, 40% due to motorcycle-related injury while 11% was pedestrian related.[22] These findings were similar to a report by Chandra and colleagues in a study where about two-third of road traffic related injuries were motor-vehicular related and one-third were pedestrians related.23. It is not enough to blame children, parents, caregivers, motorists and illiteracy for the high rate of RTA. Most of the roads in Nigeria were constructed without shoulders or walk way for pedestrians and with no street lights. These factors contribute to the high incidence of road traffic accidents in Nigeria.[23] Fall from heights was the second leading cause of head injury in this study from Bauchi in Northern Nigeria. However, this finding is at variance with the result from studies that are reported in developed countries which showed that fall is the leading cause of head injury.[27, 28] This difference could be explained by lack of enforcement of traffic rules and poor road network that had worsened the incidences of road traffic accidents, thus relegating head injury due to fall to second place in developing countries.[29] It should be emphasized that some studies have reported assault as the second most common cause of head injury.[22, 30] The fall into depth is also common in some places especially in the northern Nigeria where fall into dug-wells is a commonplace.[22, 31, 32] In this study, fall mostly from domestic accident was the most common aetiology and responsible for 39.77% of the patients studied. Pedestrian road traffic accident was responsible for 34.09% of the head injury in this study and second most common aetiology. Pedestrian road traffic accident usually occurs while children are trying to cross the road especially during school closing time especially in sub-urban regions where motor cycles are used as a commercial means of mass movement. Passenger motor vehicular crash accounted for 26.14% of the patients, it is common due to lack of strict enforcement of seatbelts, child carriers and speed limits. Motor Cycle road traffic accident accounted for 7.95% of our patients. Overall, road traffic crash was a significant aetiology in this environment. In a study carried out in Sokoto, none of the patients in that study (both riders and passengers) used a safety helmet despite the pivotal role of safety helmets in preventing head injuries to riders and passengers of motorcycles crashes.[21, 33] A similar finding was noted in a study from Ilorin, Nigeria.[32]

Computed tomography scan is an indispensable, lifesaving diagnostic tool in the management of traumatic brain injury.33,34 However, social inequalities determine the subset of patients undergoing this test.35 In industrialized countries where health insurance is functional, patients from disadvantaged areas are more likely to have greater accesses to CT scan.[35] Whereas, in developing countries like Nigeria, where a health insurance scheme is either nonfunctional or unavailable, out-of-

pocket spending remains the dominant source of health care financing.[36] In a study conducted in Sokoto, Nigeria 15.2% of the patients could not afford to do brain CT scans that are required to urgently take clinical decisions needed for their care.[33] Similarly, very large subset of the patients managed during the study period where excluded from this study on account of their inability to do brain computed tomography scan due to lack of fund. These excluded patients would have contributed positively in improving the power of this study. Among traumatic brain injury patients who carried out brain CT scans and met inclusion criteria, 39.1% showed no intracranial abnormalities, a similar study carried out in Ibadan, Nigeria also found majority of the patients having normal CT findings.[37] However, in a study carried out in Enugu, only 19.9% showed normal brain on CT scan.38 Expectantly in this study, patients with mild head injury had the highest frequency of normal CT scan (37.5%), followed by patients with moderate head injury (34.7%), while patients with severe head injury had the least frequency of normal CT results (27.8%).35 It is known, however, that having normal findings on CT scan does not necessarily mean lack of intracranial pathology.35 Infact, normal CT scan in a patient with clinical evidence of severe head injury is possible.26, 39 This scenario was seen in 27.8% of a study in the Northern Nigeria with normal CT scan but with clinical diagnosis of severe head injury.[33] In a related study of 46 head injured patients who had brain CT scan, 41.3% had acute subdural hematomas, 23.9% had contusions, 21.7% had diffuse brain edema, 10.9% had epidural hematomas, and 2.2% had hemorrhagic brain contusion.33 However, in another related study hemorrhagic contusion was the most frequent CT finding (16.3%), while extradural hematoma was the most frequent extra-axial bleed (10.9%).[33]. In this study cerebral contusion was seen in 31.82% of the patients and the most frequent computed tomography finding in our study, which is consistent with the result from the latter study.[33]

Operative treatment in traumatic brain injury is associated with a lower mortality, increased survival rate compared to non-operative treatment.40 However, a higher rate of severely impaired patients according to the early GOS was observed in the operative group.40 In a study carried out in Enugu, operative procedures were carried out on 19.6% of patients which is very similar to the finding from our study in which operative treatment was carried out in 20.45% of the patients while the remaining 79.55% patients had only non-operative treatment.[15]

CONCLUSION

The toddlers and pre-school age children had the highest frequency of traumatic brain injury in this study (56.82%) with relative rarity among infants (3.41%). Severe traumatic brain injury was the most common with a frequency of 44.32%. The recovery rate of the patients in our study was high with 98.86% of the patients recovering with a GCS of 14/15 to 15/15 at the time of discharge from the hospital. Fall mostly from domestic accident was the most common aetiology (39.77%). Operative treatment was carried out in 20.45% of the patients while the remaining 79.55% patients had only non-operative treatment.

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