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Original Article

Traumatic brain injuries in children: A hospital-based study in Nigeria

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ABSTRACT

Background: Traumatic Brain Injury (TBI) is a significant cause of morbidity and mortality worldwide. Our previous studies showed a high frequency of motor vehicle accidents among neurosurgical patients. However, there is a dearth of data on head injuries in children in Nigeria. **Aims:** To determine the epidemiology of paediatric traumatic brain injuries. **Setting and Design:** This is a prospective analysis of paediatric head trauma at the University of Benin Teaching Hospital, a major referral centre for all traumatic brain injuries in Nigeria between October 2006 and September 2011. **Materials and Methods:** We studied the demographic, clinical and radiological data and treatment outcomes. Data was analysed using statistical package for the social sciences (SPSS) 16.0. **Results:** We managed 127 cases of paediatric head injuries, 65 boys and 62 girls representing 13% of all head injuries managed over the 5-year period. They were aged 3 months to 17 years. The mean age was 7.4 years (median 7 years) with peak incidence occurring at 6-8 years i.e. 31 (24.4%) cases. Motor vehicle accidents resulted in 67.7%, falls 14% and violence 7%. The most frequent computed tomography finding was intracerebral haemorrhage. Mean duration of hospitalization was 18 days (median 11 days). Eleven patients died, mortality correlating well with severity and the presence of intracerebral haematoma. **Conclusion:** Head injuries in children are due to motor vehicle and motor vehicle-related accidents. Hence, rational priorities for prevention of head injuries in children should include prevention of vehicular, especially pedestrian, accidents in developing countries.

Key words: Children, head injuries, pedestrian, prevention, and road traffic accidents

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INTRODUCTION

Traumatic brain injury (TBI) is devastating in children, being the single most common cause of death and because of its influence on key developmental processes such as emotion, awareness and social functioning.[1,2] Its incidence varies in different geographical regions; however our previous studies showed there is increasing incidence across all age groups, including children, in Nigeria.[3,4] Implementable priorities for preventing childhood head injuries should emphasize both vehicular and, especially in developing countries, pedestrian injuries.

We present in this study the trends of paediatric brain trauma, relating the demographic, clinical and radiological patterns to treatment outcomes, at our institution, a major referral centre in the Midwest and south of Nigeria.

MATERIALS AND METHODS

Our institution, located at the confluence of several interstate highways linking all the geopolitical zones of the country, is a 700-bed teaching hospital setting and a major referral centre for victims of motor vehicle accidents and other forms of trauma. Neurosurgical care commenced in 2006.

Data on demography, source of injury and clinical management and outcome on all paediatric patients with traumatic brain injury who presented to our institution were collected. This excluded patients who succumbed during initial resuscitation after admission into the emergency unit and patients with mild traumatic brain injuries who were neuro-radiologically normal. The latter group were subsequently discharged to out-patient clinic from the A and E after a short period of observation. All the patients were admitted through the A and E and came from the scene of the accident or on referral from private and general hospitals or other tertiary institutions. Initial reviews and resuscitation by the trauma unit was followed by referral to neurological surgery unit for evaluation before admission for neurosurgical care. Significant brain trauma requiring referral was determined by the severity of injury using the Glasgow coma score (GCS). Patients with moderate and severe injuries were admitted and referred to the neurosurgical unit (NSU) while those with mild injuries (GCS $\geq$13) were also referred if the following were present: Focal neurological deficits, cranial nerve palsies, raised intracranial pressure, seizures, calvarial fracture or an aerocoele on skull radiographs or clinical signs of basal skull fracture (such as rhinorrhoea, otorrhoa, subconjuctival haemorrhage and periorbital or retroauricular ecchymoses). Mild head injuries that do not meet the admission criteria in the hospital were discharged home.

All patients referred to NSU had non-contrast CT with bone window. Severe TBI and patients with brain stem involvement (clinically or radiologically) and /or acute respiratory insufficiencies were admitted into the intensive care unit. The patients had both surgical and non-surgical management depending on the clinical decision of the NSU team.

Data was analysed using SPSS 16.0

RESULTS

One hundred and twenty seven children were managed for head injuries between October 2006 and December 2011. This accounted for 13% of all head injuries managed in our facility during the five-year period. The ages ranged from 3months to 17 years with a mean of 7.4 years (median 7 years). Head injuries were commonest in children aged 7 to 10 years, accounting for 34 patients i.e. 27% then decreasing to a minimum in children $\leq$6 months and 17 years. Severe head injuries were the commonest type (51 i.e. 40%) especially between 7 to 10 years in both sexes [Table 1]. The male to female ratio was approximately 1, though severe head injuries in girls occurred more frequently than all other forms of head injuries in children [Table 1].

Paediatric head injuries by age

In the youngest children, aged 3 months to 22months, there were sixteen (16) cases of traumatic brain injuries: 4 cases aged 3 to 6months, 8 aged 7months to 1 year and 4 aged 15 to 22months [Figure 1].

Injuries were caused by motor vehicle accidents which accounted for 86 cases, (68%): 50.4% were pedestrians 17.3% were occupants in vehicles.

The other causes were falls 19 (i.e. 15%), violence/ assault 13 (7%), including 2 gunshot wounds and 2 stab wounds, falling objects 4, miscellaneous 2 and unknown aetiology 3 [Table 2].

The interval between injury and admission ranged between 10 mins and 11 days with an average of 1.94 days.

Most children, who suffered head injuries, 18 (14%), had a GCS of 15 at the time of admission; 15 cases had a GCS of 10 and 15 cases had a GCS of 7. Based on severity of injury, most paediatric injuries i.e. 51(40%) presented with severe TBI [Figure 2].

Skull fractures were found in 39 patients (linear calvarial 13, depressed calvarial 23 and basal 3). Intracranial haematomas were found in 72 (extradural 14, subdural 6, intracerebral 47, subarachnoid and intraventricular 5), marked cerebral oedema 12, diffuse axonal injury 12 and normal CTs in 4.

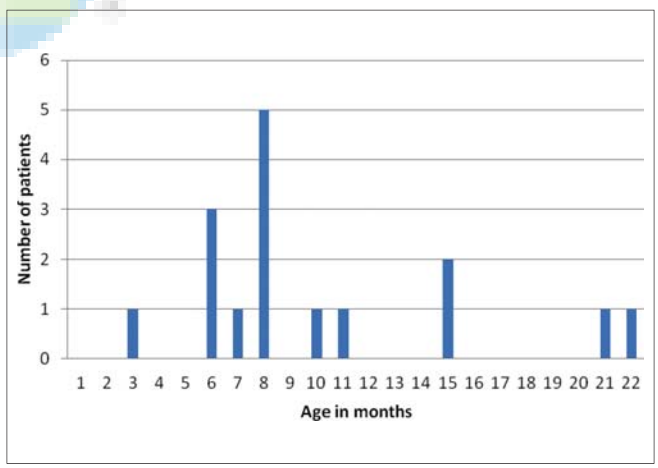

Figure 1: Head injuries in children under 2 years

Table 1: Age and sex distribution of head injuries in children

Age group	Male				Female				
	Mild	Moderate	Severe	Total	Mild	Moderate	Severe	Total	Grand total
0-3	6	4	5	15	7	6	8	21	36
4-6	4	4	3	11	3	3	5	11	22
7-10	3	6	8	17	3	3	11	17	34
11-16	6	6	6	18	3	4	5	12	30
>16	2	2	0	4	0	1	0	1	5
Total	21	22	22	65	16	17	29	62	127

CT findings in fatal cases were multiple/extensive intracerebral haemorrhages in 8, diffuse axonal injury (DAI) 2, brain stem haemorrhage 1.

One hundred children, i.e. 79%, were managed non-operatively while 27, i.e. 21%, underwent various surgical operations in the acute period. Most operated patients, 9 of 27 (i.e. 33%), were aged 7 to 10 years. Two operated patients died.

The operations were for EDH (12), open brain wound/depressed skull fracture (11) missile brain wound (4).

Average duration of hospitalization was 18 days (median 11 days). Prolonged hospitalization (≥ 28days) was associated with severe TBI.

In patients who died, the average duration of hospitalization was 18.87days (median 7 days). Both patients with diffuse axonal injury (DAI) died after 50 days and 120 days of brain stem failure and sepsis respectively [Figure 3].

One hundred and sixteen (116) patients, i.e. 91% of children, survived head injuries despite the high frequency of severe TBI. GCS in survivors were: GCS 15 (93), GCS 14 (17), GCS 13 (3), GCS 9, 10 and 12 (1 each) Figure 4.

Eleven (11) patients died i.e. 8.66% of children who suffered head injuries died. Five (5) of these i.e. 50% were aged 7 years. Two were perioperative deaths. The GCS range in those who died was 4-8; most patients who died had GCS 6 and 7 i.e. 4 cases each. Mean GCS in fatal cases was 6.

DISCUSSION

Traumatic brain injuries (TBI) in children at our centre, as this study showed, peaks between 0 to 3 years and between 7 to 10 years; TBI is rare in children above the age of 16 years. Though, there was no clear sex predilection, severe head injuries in girls and pedestrian accidents predominated over the other types and causes of TBI in children.

Table 2: Aetiology of head injuries in children

Aetiology	Frequency	%
Pedestrian Accidents	64	50.4
Motor Vehicle Accidents	22	17.3
Violence/Assault	9	7.1
Falls	19	15
Falling objects	4	3
Stab Injuries	2	1.6
Gun Shot Injuries	2	1.6
Miscellaneous	2	1.6
Missing/Unknown	3	2.4
Total	127	

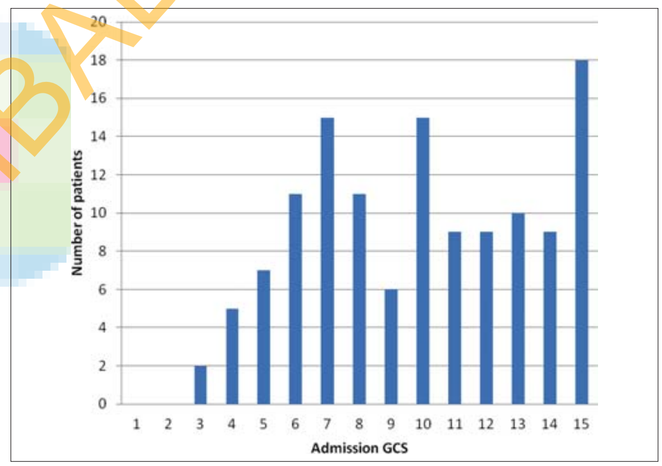

Figure 2: Admission glasgow coma score in all 127 patients

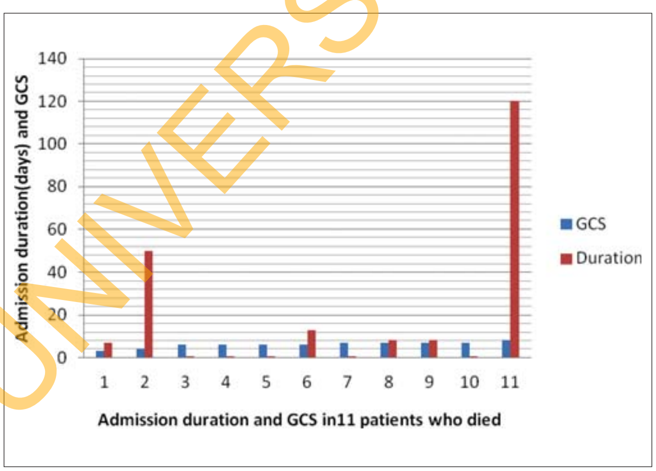

Figure 3: Admission duration and glasgow coma score in 11 patients who died

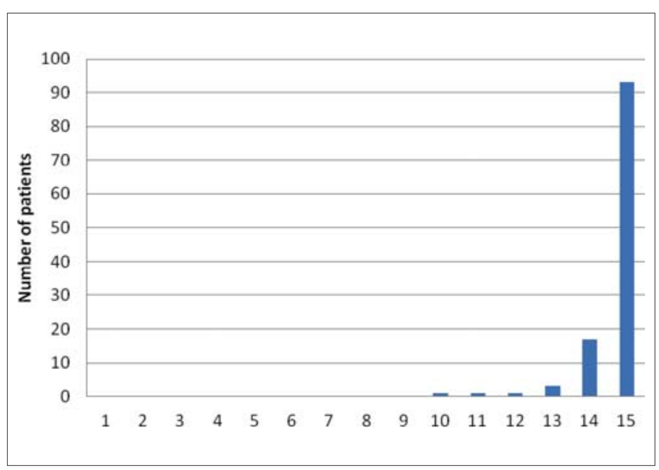

Figure 4: Discharge glasgow coma score in survivors

Minor trauma, which may not warrant any form of treatment, is common in the paediatric age group, but more severe injuries may result in death and permanent disability.[2] Though this study showed no significant difference in occurrence of head injury among boys and girls, other studies showed that TBI is commoner among boys.[5,6] The greater willingness of the male child to undertake risky adventures can explain the latter. In this study, however, the commonest source of head trauma is pedestrian road traffic accidents, an involuntary occurrence, which probably explains the gender ratio.

The predominance of severe over mild and moderate head injuries in our population may be due partly to the fact that more severe cases are likely to be referred to this centre. However, some other studies report mild head injuries to be commonest type in children.[7] Like adults, head trauma in children (>4 years old) is often motor vehicle-related, but the percentage of motor vehicle and motor vehicle-related accidents also increases with increasing age: 20% in children 0 to 4 years of age and up to 66% in adolescents.[8] Studies show that the 6 to 10 year age group had the peak incidence in involvement in pedestrian road traffic accidents.[9] This age bracket is also the school age group and its association with pedestrian road traffic accidents may be due to multiple factors: Many African urban children commute to school on foot, prevalence of street hawking by children in urban cities in many developing countries and a preponderance of street side shops.[10] Risky behaviour in children and apparent lack of inhibition which may be related to immaturity of the cognitive function, inaccurate sensory and physical coordination could also contribute to pedestrian road traffic accidents.[11-13] Low socioeconomic status (SES) has also been identified as a factor in pedestrian road traffic accident.[14] Children from a low SES background are more likely to be street hawkers, walk and play at roadsides or man roadside shops. Such children may also lack adequate adult supervision in potentially risky areas like the open markets common in many parts of Africa. In developed countries pedestrians road traffic accidents are not rare either, though the incidence may be declining; reports suggest that in the absence of active intervention measures, pedestrian road traffic accidents are high in the inner cities especially in the summer months when more people are probably walking outdoors.[9] Though this study showed pedestrian accidents thrice outnumber vehicular collisions, there may be variations in the ratio of pedestrian injuries and those due to vehicular collisions even within the same country.[15,16] This may highlight differences in highway infrastructure and SES in the same country.

TBI can be grouped into categories depending on the mechanism of injury: Focal versus diffuse injuries, closed head versus penetrating injures and primary versus secondary injuries. Diffuse injuries are more common in children than focal injuries.[8] Because of the uniqueness of the immature brain and its response to injury, it is important to understand the role that the overall difference of age and development play both in the acute setting following a head injury and during the chronic period of recovery; it is also important to differentiate the mechanism of injury and physiologic responses in children as a group compared to adults, and the differing responses in children at different stages of maturity.[17]

More than 90% of CT scans obtained in the alert child after mild head injuries are negative suggesting that this modality is overused.[18] The use of CT, skull radiographs or MRI is not recommended for initial evaluation and management of the child with minor closed head injury and no loss consciousness; observation in the hospital or at home under the care of a competent care giver will suffice.[19] Children with loss of consciousness, amnesias, headache or vomiting at the time of evaluation, have up to 7% prevalence of intracranial injury on CT scans; up to 5% of may require neurosurgical intervention.[20-23]

Children < 2 years especially infants are at higher risk for intracranial injury and skull fractures after blunt head trauma, because of their thinner more pliable skulls; this is especially true for parietal and temporal, than frontal skull fracture.[18,24] Nevertheless, intracranial haematomas are said to be a less common complication than in adults, even though more occur without fracture.[25-27]

Since there is little literature that primarily involves children, much of the treatment modalities used for the child after severe TBI have been extrapolated from adult data.[17] Differences of age and development affect recovery and outcome following head injury and children as a group, have better outcome than adults; however, factors such as mechanism of injury, severity, multisystem trauma, secondary insults also impact on the final outcome.[17] Many of the poor outcomes observed are best prevented by preventing either the initial impact or the secondary insults that typically occur following TBI to minimize the severity of injury;[17] interestingly, very young and pre -school children have worse outcomes both in mortality and long-term disability than older children and adolescents.[17]

Measurable deficits occur even after mild to moderate head injury but are markedly greater after severe injury. They include chronic headaches, impaired memory and cognition, language difficulties, motor impairments, disruption of attention and information processing, and psychiatric disturbances.[17,18,28]

Those patients with initial GCS >8 have very good long-term outcomes; those with initial GCS<8 have high morbidity and mortality.[18,28] Any child whose GCS <14 on presentation should be referred for neurocognitive assessment.[8,28] In cases of severe head injury, children whose coma lasts less than 2 weeks have considerably better neurocognitive outcomes and fewer developmental and behavioral sequelae than those children whose coma lasts more than 2 weeks.[18,28] In children who die from head injuries, motor vehicle accidents have been implicated in 71% in some studies, skull fractures are present in 72%, large intracranial haematomas, especially intracerebral, in 34%, and diffuse axonal injury in 22%; 84% of deaths are those who did not talk after injury and median survival after injury was <48 hours, indicating severity.[29] Age itself, even within the pediatric age range, is a major independent factor affecting the mortality rate in head-injured patients.[2]

Because the consequences of head injury are severe, patients should be counselled about preventive strategies, children should always be supervised and should use safety equipment during activities that could result in head injury; safety equipment includes car seats, seat belts, bicycle helmets, and other protective gear during sports as foot ball, base ball (during bathing), hockey, horseback riding, skateboarding, wrestling and skiing.[18,28]

Initiatives aimed at reducing pedestrian injury through education of children have been shown to be effective; these can be combined with enforcement of other traffic and environmental rules to reduce pediatric TBI due to pedestrian road traffic accidents.[30] Ensuring the use of these preventive devices and appropriate child restraint devices will contribute to reduction of morbidity and mortality due to pediatric TBI.

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