Original Article

Perspective on Paediatric Traumatic Brain Injury

G. O. Igun, C. H. Ihezue, O. B. Lilly-da-tariah, E. S. Isamade*
The Departments of Surgery and Anaesthesia* Jos University Teaching Hospital, Jos.

Abstract

Background: Traumatic brain injury is an important aspect of paediatric trauma because of its contribution to mortality ant post trauma sequelae. Management of traumatic brain injury remains a challenge to surgeons, especially in developing countries. This study aims to determine the pattern of traumatic brain injury among children.

Patients and Methods: A retrospective study of a total of 112 children with severe closed head injury was carried out during a fifteen year period at the Jos University Teaching Hospital to comparatively evaluate the epidemiology, clinical presentation and outcome of 42 children aged (4 months to 6 years) in the pre-school age (PSA) versus 70 others aged (6. – 13 years) in the school age (SA) bracket.

Results: Male to female ratio for PSA was 5:1 versus 4:1 for SA. Road traffic accident (RTA) accounted for a total of 69% of pediatric traumatic brain injury (PTBI). PSA children were less frequently involved in RTA as occupants (15 % versus 56% in SA) but more frequently involved as pedestrians (45% versus 4% respectively). Falls constituted 19% of the total, involving relatively more patients in PSA (36 %t versus 9% in SA). Neck stiffness occurred in a total of 63%, 71% in PSA group versus 59% in SA group. Restlessness was observed in a total of 18%, 29% in PSA compared with 11% in SA. Intracranial hematomas occurred in a total of 29% with sub-dural hematomas predominating in PSA than in SA (32% versus 15%). Coma ranged from 5 weeks in PSA to 3 weeks in SA, with a mean of 4.2 weeks for both groups. A poor outcome (Glasgow outcome score 1, 2,3) was recorded in a total of 20% with a relative majority of patients in PSA (29 % versus 15%).

Conclusion: Road traffic accident was responsible for most of the traumatic brain injury in children, especially among the school age group. Traumatic brain injury is associated with high mortality rate in children.

Keywords: Pediatric, traumatic, brain injury, evaluation.

Introduction

Pediatric traumatic brain injury (PTDBI) has assumed great importance in recent years as reflected by the plethora of literature on the subject and the establishment of pediatric trauma centers in developed countries like the United States of America, Britain and Germany[1, 2]. The diverse contributions by PTBI centre on the epidemiology, management options in the acute phase and the treatment of the resulting complications aimed at improving outcome from PTBI in this special age group. However, controversy still exists regarding the specific age related impact of PTBI on clinical manifestation, complications and survival for injured children in the broad-spectrum age bracket of patients that are less than 13 years23. Our aim in this study was to comparatively evaluate the epidemiology, clinical presentation, effect of different management modalities and outcome of PTBI in two pediatric age-related groups; pre-school age *(less than 6 years)* and school age *(6-13 years)*. It is hoped that such comparative studies will better highlight PTBI in the correct perspective in these two age groups.

Patients and Methods

A retrospective study of 112 children with severe closed head injury (CHI) was carried out at the Jos University Teaching Hospital (JUTH)m between January 1, 1988 and August 30, 2003. In all patients studied, the Glasgow Coma Scale (GCS) was used in assessing the level of consciousness except in children under four years of age in which the Advanced Trauma Life Support modification of the GCS was employed. Following initial resuscitation, all such patients with closed head injury and a GCS of 3-8 underwent burr hole exploration since we do not have Computed Tomography (CT) scan facilities at our centre. All explorations were carried out under general anaesthesia em-

Correspondence and Reprints: Dr. G. O. Igun, Department of Surgery, University Teaching Hospital, P.M.B. 2076, Jos, Nigeria.

ploying endorracheal intubation and hyperventilation. Our outcome measures included a comparative evaluation of demographic data, clinical presentation, complications, management modalities, mortality and morbidity recorded at 2 years in the two age-related groups mentioned, herein referred to for purposes of this communication as PSA – (*preschool age*) and SA (*School age*).

Results

During the fifteen-year period under study, 1.530 children with severe closed head injury were admitted into JUTH. One hundred and twelve (7%) of these were cases of severe PTBI in children less than thirteen years while 1.318 (93%) represented adult cases. There were 42 patients in the PSA group, 35 were males and 7 females (M:F 5:1), while in the SA age group there were 70 patients made up of 52 males and 18 females (M:F= 4:1). The mean age of presentation for PSA was 4.5 years (*range: 4 months to 6 years*) versus 12 (*range: 6.2 to 13 years*) for SA. Seventy-seven of a total of 112 patients (69 %) with severe PTBI were due to road traffic accidents (RTAs), 19% due to falls and 13% due to assaults. There was no appreciable difference between children in PSA and SA groups with severe traumatic brain injury due to RTA (60% versus 73%), Table 1. Less occupants of vehicles were more frequently involved in SA than in PSA (45% versus 14%). In 3% of cases motorcyclists were involved but exclusively in the SA group. More children in PSA than in SA were involved in falls (36% versus 9%), including falls from stairs

Table 1: Causes of PTBI: JUTH: 1988 – 2003

Causes	PSA(n = 42)	%	SA(n = 70)	%	Total(n = 112)	%
R. T. A.	25	60	52	73	77	69
Occupants	6	15	40	56	46	41
Pedestians	19	45	10	14	29	26
Motorcyclist	0	0	2	3	2	2
FALLS	15	36	6	9	21	19
Stairs	7	17	2	3	9	9
Back	6	14	0	0	6	5
Trees	2	5	4	6	6	5
ASAULTS	2	4	12	18	14	13

PTBI - *Pediatric Traumatic Brain Injury*
RTA - *Road Traffic Accident*

TABLE 2: Clinical presentation of PTBI patients at JUTH 1988 – 2003

Causes	PSA(n = 42)	%	SA(n = 70)	%	Total(n = 112)	%
G.C.S.	7	100	8	100	8	100
Restlessness	12	29	8	11	20	18
Pedestians	12	20	6	9	18	16
Seizures	3	7	10	14	13	12
Vault Fracture	7	17	3	4	10	9
Nerve deficit	3	7	2	3	5	3
Pupillary abnormality	2	5	1	1	3	3
Reunal haemorrhage	30	71	11	59	71	63
Neck stiffness	2	5	5	7	7	6
Hemiplegia	4	10	2	3	6	5
Hypertonia	6	15	4	6	10	9
AIS 3	0	0	3	4	3	3
Chest	3	7	2	3	5	4
Spleen	1	2	3	4	4	4

AIS - *abbreviated Injury Score*

TABLE 3: Intracranial Complications of PTBI. JUTH 1988 – 2003

Causes	PSA(n = 42)	%	SA(n = 70)	%	Total(n = 112)	%
Hematoma	15	36	18	26	33	29
Extradural	2	4	7	10	11	10
Sub-dural	13	32	11	15	22	20
Magroguaosis	6	12	2	3	8	7
Subdural Abscess	2	4	5	7	7	6

TABLE 4: Management modalityin P'TBI. JUTH 1988 – 2003

Causes	PSA(n = 42)	%	SA(n = 70)	%	Total(n = 112)	%
Negative exploration	25	60	41	51	66	60
Decompression	8	19	42	60	50	45
Hyperventilation	10	24	12	17	22	20
Manitol	27	64	55	79	82	73
Anti-convulsants	12	29	6	9	18	16
Thoracostomy	0	0	3	4	3	3
Spleenoraphy	3	7	2	3	4	4
Skin Traction	1	2	3	4	4	4

(17%) and from the back of house-helps (14%). Among the PSA children, 5% were involved in falls from trees compared with 6% in the SA group. Assault was higher in the SA group than in the PSA children (18% versus 4%).

Table 2 lists the clinical features of PTBI in all patients in this study who presented with a mean Glasgow Coma Scale (GCS) of 8. The most common presentations were neck stiffness in 71 of 112 patients (63%), restlessness (18%), early seizures (16%) and cranial vault closed fractures (12%). Neck stiffness was commoner in PSA than in SA (71% versus 59%). Other presentations in the PSA and SA included restlessness (29% versus 11), seizures (29% versus 9%), respectively. Cranial vault fractures occurred more frequently in SA (14%), compared with 7% in PSA. Cranial nerve deficits were recorded in a total of 9% of children with PTBI, and were more preponderant in PSA (17% versus 4 percent). Hemiplegia occurred in a total of 6 patients with almost equal frequency in both groups, 5% in PSA versus 7% in SA. Hypertonia occurred in a total of 5%, but was commoner in PSA (10%) than in the SA group (3%). Pupillary abnormalities in the form of asymmetry in size and bilateral retinal haemorrhages were each observed in a total of about 3% of patients and were commoner in PSA. Pupillary abnormality was

TABLE 5: Average duration of coma (ADC) and outcome in PTBI: JUTH 1988 – 2003

Causes	PSA(n = 42)	%	SA(n = 70)	%	Total(n = 112)	%
ADC *(Weeks)*	5	100	3	100	42	100
Glasgow outcome Scale						
1	5	12	6	9	11	10
2	2	5	0	0	2	2
3	5	12	4	6	9	8
4	3	7	5	7	8	7
5	27	64	35	79	82	73
Vegetative	2	5	0	0	2	3
Emotional Liability	3	7	3	4	6	5
Hemiplegia	2	5	1	1	3	3
Headache	2	5	1	1	3	3
Amnesia	1	2	1	1	2	2

noted in 7% in PSA and 3% in SA, while haemorrhages occurred in 5% of PSA and 1% of SA. An abbreviated injury score (AIS) of 3, defined as multi-traumatized patients with injuries in at least 2 body regions was recorded in a total of 9% of patients and the number was skewed in favour of PSA (15% versus 6%), with most of the injuries involving the spleen and long bones. Intracranial complications due to PTBI occurred as hematomas in 29% and postoperative exuberant macroglial scar in 7% (Table 3). The incidence of subdural hematoma was 32% in PSA and 15% in SA, while extradural hematomas occurred more in SA than in PSA (10% versus 4%). Subdural abscesses occurred in a total of 6 of patients, 7% in SA and 4% in PSA. A negative burr hole exploration was recorded in 60% of all patients, with equal frequency of 60% in both PSA and SA (Table 4). Hyperventilation in form of intermittent positive pressure ventilation (IPPV) was employed for reduction of increased intracranial pressure in 45% of patients, predominantly in PSA (24% versus 17%). Associated injuries in both groups were appropriately managed before definitive burr hole explorations were carried out.

The prognostic indices and outcome in PTBI are shown on Table 5. The average duration of coma (ADC) in both groups combined was 4.2 weeks; coma was more prolonged in PSA, 5 weeks versus 3 weeks for SA. When the Glasgow outcome scale (GOS) was considered, a total of 11 of 112 children (10%) were dead within thirty days of admission (GOS 1). Four of these (4%) had primary brain stem injuries, 2 (2%) had retinal haemorrhage and 9 (9%) were placed on IPPV. Hospital mortality was 12% in the PSA and 9% in SA. A total 2% of all patients, all of them in the PSA group (5%) scored a GOS of 2, which is defined as a permanent vegetative state. A total of 8% of all patients, 12% of the PSA group and 6% of the SA group were recorded as having a GOS of 3. In the PSA group, emotional liability occurred in 7% compared with 4% in SA group. Hemiplegia was observed in 5% and 1% in PSA and SA, respectively. A poor outcome defined as (GOS1, 2, 3) was therefore recorded in a total of 20% of all patients with a predominance of patients in PSA (29% in PSA versus 15% in SA). Moderately disabled patients that were capable of independent existence, GOS 4, were recorded overall in 7%with equal distribution between both groups. Headache occurred in a total of 3% and was especially noticeable in PSA (5% in PSA versus 1% in SA). Post-traumatic amnesia occurred in a total of 2% of all patients with equal frequency of about 2% in both groups. At 3 years, all neurological complications recorded in both groups had disappeared except for 2 patients (5%) in PSA who complained of headache and 1 (1%) in SA group with spastic hemiplegia.

Discussion

Seven percent of a total of 1,530 patients with severe closed head injuries recorded in this study were children under 13 years of age. Relatively more males in PSA group sustained severe PTBI than in the SA group. When analyzing the three most common causes of PTBI in this study, it was found that in cases due to RTA, more SA children were involved as occupants and motorcyclists than in PSA. However, the PSA group was more frequently involved as pedestrians in RTA. Similar studies from other centers have corroborated these findings ascribing these results to the increased pressure especially in present day Nigeria for mothers to join the workforce[4]. Early training in traffic safety for children might decrease the frequency of PTBI in this group of trauma patients[3]. When falls were considered, more PSA children were involved especially in falls from stairs and the back of house-helps. Assaults as a cause of PTBI were however more frequent in the SA group as a result of the recent upsurge in civilian violence in the Jos-Plateau area and there was no single case of the shaken impact syndrome (*battered baby syndrome*).

The most common clinical findings at presentation were neck stiffness, restlessness and seizures, which were commoner in the PSA group. Cranial vault fractures were however commoner in the SA group due to the decreased moulding characteristics of the cranium in this age group. Other features like III and VII cranial nerve palsies, hypertonia, pupillary abnormalities and retinal abnormalities were still more frequently observed in PSA compared to SA except for hemiplegia which occurred with about equal frequency in both groups. Although not a dominant sign in the initial phase of severe head injury in this study, dysautonomic abnormalities like hypertonia were more frequently observed in most other studies and intrathecal Baclopher therapy has been recommended for its control[5]. It has also been observed that sixty-six percent of children with bilateral retinal haemorrhages may suffer a fatal outcome and so retinal haemorrhages may be considered as an important clinical prognostic index[6]. Associated injuries to the spleen and long bones were again

more frequently seen in PSA group and this agrees favourably with the finding that in all age groups, injuries to the head and legs were most common as a result of RTA[3].

Intracranial complications subdural hematomas were again more frequently observed in PSA than SA group. This finding correlated well with the observation that the triad of neck stiffness, restlessness and seizures noted in this study were more predominant in the PSA group. Meningeal irritation from blood in the subdural space could result in all three signs mentioned and seizures are traditionally regarded as the prototype of brain contusions and lacerations in all age groups[7]. Epdeural hematommas and subdural abscesses on the other hand were more common in SA group due probably to associated cranial vault fractures, which although closed, might be associated with occult abrasions on the scalp which serve as a nidus for spread of infection through communicating diploic veins. We would want to draw particular attention to the development of exuberant macrogliosis which again was more frequently observed in PSA. These were cauliflower-like masses which develop at the sites of injudicious attempts at burr hole exploration with iatrogenic injury and infection to the leptomeninges and underlying brain tissues. Simple excision nearly always results in recurrence. These lesions could be likened to type IV growing skull fractures and treatment should ideally be aimed at adequate craniectomy, excision, dural inlay graft and skull reconstruction. A negative burr hole exploration for intracranial collections of 60 percent was recorded in both groups due to the absence of imaging facilities at our centre. The availability of computed tomography scan should reduce our negative exploration rate[8]. Hyperventilation was employed predominantly in PSA children. In one respect, this should be kept in mind, such as when considering the comparate mortality in both groups since early use of aggressive hyperventilation may be associated with a worse outcome in this group of patients[9].

Children in PSA group exhibited a more prolonged phase of coma than those in the SA group. A total hospital mortality of 10 percent was recorded for both groups mostly in PSA, involving children with primary brain stem lesions, retinal haemorrhages[6] and those receiving IPPV. More children in PSA also suffered a poor outcome as patients in vegetative state and others who were emotionally and physically handicapped. Diffuse headaches were more frequently recorded in this group and no cases of migrainous or chronic progressive daily headaches[10] were recorded in this series. Most of the complications recorded, however, tended to improve with time. In the final appraisal, therefore, children in the PSA group were more frequently involved in RTA as pedestrians, presented with more bizarre, prolonged comatous clinical picture, suffered more from sub-dural haematomas and emerged from PTBI with a worse outcome than those in SA.

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