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Pediatric Traumatic Brain Injury Pattern at the General Hospital, Douala, Cameroon

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Abstract

Traumatic brain injury is the most common injury during childhood comprising 60% to 90% injuries in children. Pediatric traumatic brain injury has peculiarities as compared to adults, such as less severe injuries and better prognosis. The purpose of this work was to study the pattern of pediatric traumatic brain injury at the General Hospital, Douala, Cameroon. This was a retrospective cross-sectional study, from January 1st, 2008 to December 31st, 2017. Included were all complete medical records of children aged 0 to 15 years old treated for traumatic brain injury, and excluded records of obstetric trauma. Data analysis was done by SPSS software version 18.0. One hundred and three cases of pediatric head injuries were recorded during the study period (frequency 10.43%). The mean age was 7.42 ± 5.028 years, and the sex ratio was 2.67 in favor of boys. Road traffic accidents were the most common etiology (44.7%). 83.5% of the patients were transferred to the emergency department of the Douala General Hospital in second intention and by non-medical transport. The traumatic brain injury was mild in 61.20%. The brain computed tomography scan was performed in 99% of the cases and the most observed lesion was cerebral edema (32.74%). Twenty-eight patients underwent surgical operation. 90.28% of patients have recovered fully, and the global mortality was 3.88%. The prevalence of pediatric traumatic brain injuries at the General Hospital, Douala during the last ten years was 10.43%. Most of the patients recovered fully and the mortality was low.

Keywords

Traumatic Brain Injury, Pediatrics, Computed Tomography Scanning, Treatment, Outcome

1. Introduction

Traumatic brain injury (TBI) can be defined as an alteration in brain function resulting from blunt or penetrating force to the head or as a non-congenital assault to the brain caused by mechanical energy to the head from external forces [1] [2] [3]. Pediatric TBI (PTBI) is TBI affecting children. TBI can be classified into mild, moderate or severe (**Table 1**) [4]. There is terminological confusion regarding TBI and specifically mild TBI which has received many definitions from different authorities. The WHO defines mild TBI as acute brain injury resulting from mechanical energy to the brain from external physical forces and which includes one or more of the following: confusion or disorientation; loss of consciousness 30 minutes; post-traumatic amnesia < 24 hours; transient neurological abnormalities, such as focal signs, seizure, intracranial lesion not requiring surgery (GCS 13 - 15 after 30 minutes) [5].

The child's head anatomy and physiology differ from that of the adult: the head to body ratio is greater; skull bones are thinner, elastic and deformable; the brain is less or not fully developed; brain swelling is more frequent and hypovolemic shock can occur from blood loss due to scalp bleeding. Globally, the outcome of pediatric TBI is better compared to adults. Traumatic brain injuries (TBI) are the most frequent injuries during childhood, recorded in 60% to 90% of children with trauma, and TBI is the leading cause of death and disability in children. Hopefully, they are mild in 80% to 90% of the cases [5]. In the USA, pediatric TBI (PTBI) has an annual incidence estimate of 180 cases per 100,000 and is responsible for 2 million emergency department (ED) visits each year, which is underestimated, because not all TBI are present to ED. Also in the USA, PTBI cause 60,000 hospitalizations, 7400 deaths annually, and 125,000 children are living with TBI related disability. Severe PTBI have 20% mortality, 50% unfavorable outcome at six months, and overall life costs are estimated at 60.4 $billions [2] [4]-[11]. In Cameroon, few studies have been done on PTBI. Ndoumbé *et al.* have found a prevalence of 14.81% of PTBI in severe TBI patients admitted at the surgical intensive care unit of the University Teaching Hospital, Yaoundé, between January 2011 and December 2016 [12].

The most frequent modes of injury for PTBI are falls and road traffic accidents (RTA). Most of the studies report a male predominance with no difference concerning the outcome. The diagnosis imaging modality of choice is non-enhanced computed tomography (CT) scanning of the head [6] [8] [9] [13]-[18].

The management of PTBI is still debated, especially for mild and moderate TBI. For severe PTBI, the controversy is less sharp and its management includes the prescription of CT scan of the head, admission to ICU, intubation and

Table 1. Classification of traumatic brain injury [4].

Classification	GCS	Loss of consciousness	Post-traumatic amnesia
Mild	13 - 15	0 - 30 minutes	<1 day
Moderate	9 - 12	30 minutes - 24 hours	1 - 7 days
Severe	3 - 8	>24 hours	>7 days

GCS: Glasgow coma scale. Severity of TBI is classified based on the highest severity in any column.

mechanical ventilation, at a level I (pediatric) trauma center (having permanent neurosurgical team) [4] [16].

Because of the aforementioned reasons, this study was conducted in order to have a better understanding and to improve the management of PTBI at our institution.

2. Patients and Methods

It was cross-sectional retrospective analysis of 103 cases of PTBI managed at the General Hospital, Douala, (GHD) Cameroon, from the 1st January 2008 to December 31st 2017. The GHD is a tertiary referral hospital with a level I trauma center comprising 3 full-time neurosurgeons with emergency (pediatric and adult), pediatric, surgical and resuscitation departments amongst other. It has a multiple barrettes CT scanner and a 0.4 tesla MRI (Toshiba, Tokyo, Japan). The study was granted ethical committee agreement and informed consent was obtained from patients 'parents and confidentiality of the data gathered was respected. The study involved the medical records of all consecutive cases of PTBI. The inclusion criteria were as follows: patients aged zero to 15 years; all genders; definite diagnosis of TBI associated or not with extra cranial injury; complete medical records. The criteria for non-inclusion were as follows: obstetrical trauma, incomplete files, patients older than 15 years, non-head trauma patients. The sampling method was non-probabilistic consecutive recruitment.

The data concerning age, gender, mode of injury, past medical history, transportation means, complaints, physical examination findings, CT findings, management procedures and the outcome were gathered. The severity of the TBI was determined by the GCS score or the pediatric GCS for patients under 4 years of age (**Table 2**). The TBI was labeled mild TBI for GCS score between 13 and 15, moderate PTBI for GCS score of 9 to 12, and severe PTBI if the GCS score was ≤8. The statistical analysis was done with the software SPSS version 18.0 (Microsoft, Seattle, USA).

3. Results

3.1. Socio Demographic Data

During the study period, 987 cases of TBI were admitted at the emergency department of GHD, 103 cases were children giving a prevalence of 10.43% for PTBI. The PTBI patients comprised 75 boys and 28 girls, sex ratio, 2.67. **Figure 1** gives the age distribution of the patients. The mean age was 7.42 ± 5.028 years (median, 6 years, and range, 1 to 15 years).

3.2. Clinical Data

Table 3 summarizes the general features of the study population. The first mode of injury was the RTA in 44.66% of the cases. The transport from injury site to the hospital was done by non-medical means in most cases. The loss of consciousness at the time of injury was the most frequent clinical manifestation

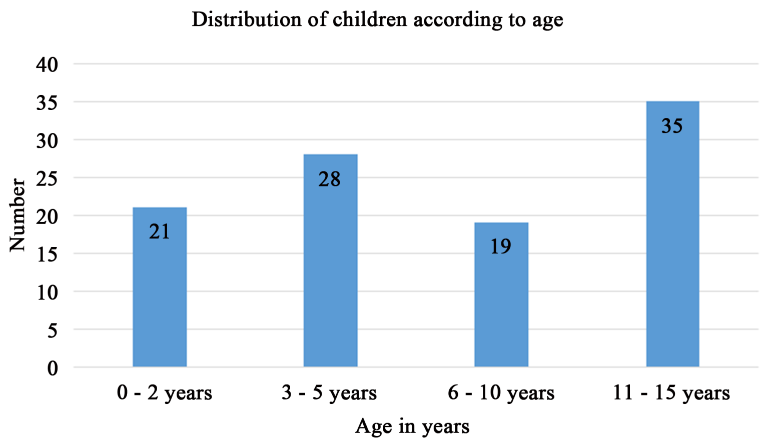


Figure 1. Distribution of patients according to age. Mean age: 07.42 ± 05.028 years. Median, six years. Range, 01 to 15 years. Children between 11 and 15 years of age were the most numerous.

Table 2. The pediatric Glasgow coma scale (GCS).

	Eyes opening		
Score	**Age < 1 year**	**Age > 1 year**	
4	Opens eyes spontaneously	Opens eyes spontaneously	
3	Opens to shout	Opens to verbal command	
2	Opens to pain	Opens to pain	
1	No eye opening	No eye opening	
	Motor response		
Score	**Age < 1 year**	**Age > 1 year**	
6	Normal movements	Obeys verbal commands	
5	Localizes to noxious stimuli	Localizes to noxious stimuli	
4	Flexion withdrawal	Flexion withdrawal	
3	Flexion/Decorticate posturing	Flexion/Decorticate posturing	
2	Extension/Decerebrate posturing	Extension/Decerebrate posturing	
1	No response to noxious stimuli	No response to noxious stimuli	
	Verbal response		
Score	**0 - 23 months old**	**2 - 5 years old**	**>5 years old**
5	Smiles/coos/cries appropriately	Appropriate words or phrases	Orientated (normal conversation)
4	Cries/consolable crying/screams	Inappropriate words	Confused$
3	Irritable/inconsolable	Cries/screams	Inappropriate*
2	Grunts/agitated	Grunts	Incomprehensible#
1	None	None	None

To obtain the GCS score, eye opening, verbal and motor responses points are added to each other. Minimum = 3; maximum = 15. $: conversation is possible, but signs of mental confusion are noticed. *: comprehensible words, but conversation is not possible. #: incomprehensible sounds such as grunting.

in 48.54%. Figure 2 is a clinical example of an 11 years old boy who sustained a moderate TBI with a massive depressed skull fracture with sagittal and lambdoid sutures dislocation.

3.3. Radiological Data

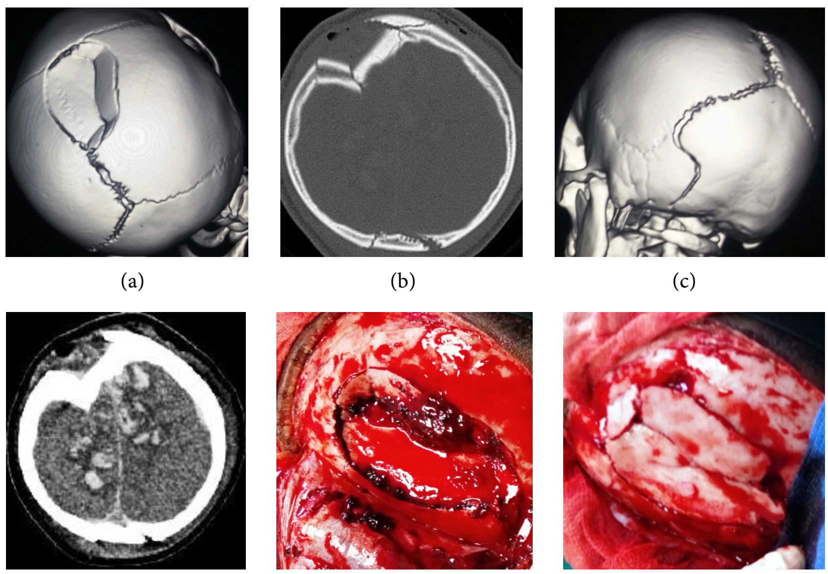
All patients but one had a brain CT scan (99%), five, a skull and two a cervical spine X-ray. Table 3 shows the lesions found on CT. The most radiological finding was post-traumatic cerebral edema.

3.4. Management Data

The management (Table 3) has consisted in medical treatment in all cases and surgery in 28. Paracetamol was administered to all but one patients (99%), 3rd generation cephalosporin (mainly ceftriaxone) to 83 (80.60%), and Mannitol infusion to 52 (50.50%).

3.5. Outcome Data

The overall mortality was 3.88% with 4 deaths. Ninety-three (90.28%) patients recovered fully and six (5.82%) had mild to moderate disability. The persisting



(a) (b) (c) (d) (e) (f)

Figure 2. Clinical case of depressed skull fracture. This 11 years-old boy was struck on the head by a falling object. He presented at the emergency department with agitation, consciousness disturbance with left side hemiplegia. The admission Glasgow coma scale (GCS) score was 11. The computed tomography scanning of the head showed a right anterior parietal parasagittal depressed skull fracture crossing the midline ((a), (b)) with dislocation of the posterior half of the sagittal suture and the left part of the lambdoid suture (c); Multiple brain contusion were present under the depressed bone fragments (d); Intraoperative view of the depressed skull fracture before (e) and after elevation of bone fragments (f). The postoperative course was unremarkable. The GCS score returned to 15 three days after surgery and the left hemiplegia was regressing by the time the child was discharged from hospital at day 7 post-surgery.

Table 3. Profile of children with TBI.

Variable	Number	Percent (%)
Mode of injury		
Road traffic accident	46	44.66
Fall	42	40.77
Assault	07	06.80
Domestic accident	04	03.88
Sport accident	04	03.88
Transportation means		
Medical ambulance	10	09.71
Non-medical vehicle	93	90.29
Admission GCS score		
13 - 15 (mild TBI)	63	61.16
09 - 12 (moderate TBI)	34	33.01
≤8 (severe TBI)	06	05.82
Clinical manifestations		
Loss of consciousness	50	48.54
Scalp wound	43	41.74
Periorbital ecchymosis	40	38.83
Vomiting	38	36.89
Headache	31	30.09
Seizures	28	27.18
Time interval*		
0 - 24 hours	49	47.57
24 - 48 hours	05	04.06
>48 hours	49	47.57
Computed tomography findings		
Cerebral edema	37	35.92
Skull fracture (depressed)	35 (15)	33.98 (14.56)
Acute subdural hematoma	19	18.44
Intra cerebral hematoma	10	09.71
Epidural hematoma	08	07.77
Subarachnoid hemorrhage	02	01.94
Management		
Analgesics	102	99.03
Antibiotics	83	80.58
Mannitol	52	50.48
Antiepileptic	22	21.36
Oxygen therapy	13	12.62
Blood transfusion	07	06.79
Craniotomy$	22	21.36
Scalp wound suture	06	05.82
Outcome		
Full recovery	93	90.29
Persisting symptoms#	06	05.82
Death	04	03.88

GCS: Glasgow coma scale. *: time interval between trauma and admission. $: for removal of intracranial hematomas or depressed skull fractures. #: hemiparesis, one case; chronic headaches, five cases. TBI: traumatic brain injury.

disability consisted in hemiparesis in one case and chronic headaches in four. It is only the GCS score at admission which significantly influenced the outcome (Table 4). The time interval between trauma and arrival at the hospital, gender, age, and the treatment modality did not have an impact on the outcome.

4. Discussion

Most findings from this series such as age, gender, cause of trauma, were consistent with data from the literature [1] [3] [4] [5]. The prevalence for pediatric TBI amongst all cases of TBI was 10.43% in this series. This frequency varies depending on the population studied [17] [18].

Table 4. Prognostic factors.

Relation between time interval & admission GCS	Mild to moderate TBI (GCS 9 to 15)	Severe TBI (GCS ≤ 8)	Total	Chi-square	DDL	P value
Delay < 24 h	46	3	49			
Delay > 24 h	51	3	54	0.167	1	0.683 (NS)
Total	97	6	103			
Outcome & the GCS						
Full recovery	90	3	93			
Disability*	05	1	06	14.96	1	**0.001**
Death	02	2	04			
Total	97	6	103			
Outcome & gender	**Survivors**	**Deceased**	**Total**			
Boys	72	3	75			
Girls	27	1	28	0.01	1	0.92 (NS)
Total	99	4	103			
Outcome & age	**Survivors**	**Deceased**	**Total**			
0 - 2	21	0	21			
3 - 5	25	2	27			
6 - 10	19	1	20	1.92	3	0.955 (NS)
11 - 15	34	1	35			
Total	99	4	103			
Outcome & treatment	**Survivors**	**Deceased**	**Total**			
Non-operated	72	3	75			
Operated	22	1	28	0.003	1	0.955 (NS)
Total	99	4	103			

GCS: Glasgow coma scale, TBI: traumatic brain injury, h: hour, NS: non-significant. *: one hemiparesis & five chronic headaches. The only significant prognostic factor was the GCS at admission. The mortality for mild and moderate TBI was 2.06% (2 deaths out of 97 children), while that of severe TBI was 33.33% (2 deaths out of 6 patients); the prevalence of persisting disability was 5.26% in the survivors with mild and moderate TBI (5/95), and 25% in survivors with severe TBI (1/4). Time interval between trauma & admission, gender, age, and treatment modality had no impact on the outcome.

4.1. Age Distribution

The age distribution of children who sustained TBI varies amongst series. In the present series, children aged between 0 and 5 years were the most involved, followed by those between 11 and 15 years of age. This finding is similar to data reported by other authors [1] [4] [7] [17] [18].

4.2. Gender

The male predominance for TBI even in children is unanimously reported from the literature suggesting that males and hence boys, are more exposed to activities at risk for TBI [1] [6] [7] [10] [12] [13] [14] [17] [18]. In the present series, boys represented 73% of children who sustained a TBI.

4.3. The Cause of TBI

The falls are the 1st mode of injury for pediatric TBI, mainly before six years of age, followed by road traffic accidents [1] [6] [10] [12] [17] [18]. In this series, the RTA was the first mechanism of injury accounting for 44.7% of PTBI and falls were second with 40.8%. The motorcycles were involved in most of the RTA because motorcycles are the main mean of transport in the Douala city area.

4.4. Clinical Aspect

Most TBI are mild both in children and adults. This is consistent with findings from this series in which 61.20% of PTBI were mild (GCS 13 to 15). The predominance of mild and moderate TBI in children can be explain by many factors: in children up to two years of age, the skull is deformable and can absorb shock better than adult skull; most accidents occur at home and are therefore low-energy injuries; parents may be more worried even in cases of light blow and may be more prone to bring children to the hospital [16].

Concerning the clinical findings, the initial loss of consciousness was the most common symptom observed in 50 (48.50%) children, and this finding was consistent with reported data [12] [13] [14]. Vomiting was observed in 36.90% of cases from this series. Vomiting is frequent in pediatric TBI but, in the presence of consciousness alteration, it can cause inhalation and lead to inhalation pneumonia which can worsen the prognosis. Seizures' frequency (27.20%) in this series was higher compared to data from other authors. Headaches are common in TBI and can persist long after the injury and spoil the child life. Its frequency varies from 9% to 72% according to [5] [18] [19]. Headaches were found in 31 (30.10%) of our children and four of them were disabled by chronic persisting headaches. The scalp wounds are also frequent in TBI. They can range from pin-point wound to huge scalp avulsions. Their frequency varies amongst series. Forty-three (41.70%) children of this series had a wound of the scalp. The time interval between the TBI and admission at the emergency department of GHD was more than 48 hours in 47.6% (48) of the cases. This reflects the fact that the General Hospital, Douala is a tertiary referral health institution and therefore, children were transported primarily to other health facilities. This was corroborated by the fact that 83.5% of children of this series were referred to GHD in second intention. But, this did not have a significant impact on the outcome.

4.5. CT Scan Findings

The CT scanning of the head is the imaging tool of 1st intention for patients with TBI [5] [10] [12] [13] [14]. The CT scanning of the head was done in 99% (102/103) of the cases in this series. The most common findings were cerebral edema, linear and depressed skull fractures, and the acute subdural hematomas.

4.6. Management

In this series, 22 patients (21.36%) needed a craniotomy for intracranial hematomas or depressed skull fractures and six had sutured scalp wounds. Therefore, the prevalence for post-traumatic intracranial lesions requiring surgery was 13.59% (14 children). In the series from O'Lynnger *et al.* 20 to 32% of children with severe TBI needed a neurosurgical operation [11]. In 2009, Kuppermann *et al.* [20] have found that, for 42,412 children admitted in hospitals in the USA, 0.9% had significant post-traumatic intracranial lesions and only 0.1% were operated. This discrepancy with our results can be explained by a selection bias from our series since its study population was withdrawn from head trauma patients and not from global pediatric admissions.

4.7. Outcome

TBI can be detrimental on a developing brain with a negative impact on school performance and family functioning with a high economic cost, and this is particularly true for severe TBI in which mortality can reach 20% with 50% unfavorable outcome at six-month [6]. Long-term neurocognitive assessment of children who sustained a TBI has shown cognitive, emotional and behavioral impairment in a significant number [5] [8] [9] [15] [16] [21]. Nevertheless, most children who have sustained a TBI will recover fully (**Table 4**). This was consistent with this series where 90.28% of children recovered fully. One child was moderated disabled (hemiparesis) and four complained of chronic headaches. The mortality was also low and consistent with data from the literature [1] [6] [8] [9] [10] [15] [16] [19] [21]. Age, gender, treatment modality (surgery or not), and time interval between trauma and admission to the hospital did not influence the outcome, but the admission GCS score (trauma severity) did. In the present series, the mortality and persisting disabilities were significantly higher in children with severe TBI than those with mild or moderate TBI. The mortality for mild and moderate TBI was 2.06% (2 deaths out of 97 children), while that of severe TBI was 33.33% (2 deaths out of 6 patients); the prevalence of persisting disability was 5.26% in the survivors with mild and moderate TBI (5/95), and 25% in survivors with severe TBI (1/4), p value = 0.001. But it is established that the time elapsed from trauma to treatment favors secondary brain insults and influence the outcome, but this was not the case in this pediatric series. The good prognosis in this series can also be explain by the high proportion of mild and moderate PTBI (97; 94.17%) compared to severe ones (6; 05.82%).

5. Conclusion

In conclusion, the frequency of pediatric TBI amongst patients admitted for TBI at the General Hospital, Douala, Cameroon for the last ten years was 10.43%. The pediatric TBI was more frequent in boys than in girls and affected most often early childhood and pre-adolescent children. The road traffic accident was the first mode of injury and implicated motorcycles most of the time, and falls were second after RTA. Most of the patients were transferred at the GHD in second intention by non-medical transport. Almost two-third of pediatric TBI was mild and the loss of consciousness was the most frequent symptom. The CT scan of the head was systematically done and it has revealed most often post-traumatic cerebral edema. The mortality was low and full recovery was the rule. The main limitation of the study was its retrospective aspect. For that reason, some medical files had incomplete data and we could analyze only data which were gathered.

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Conflicts of Interest

None.

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Abbreviations Used in This Article

CT: Computed Tomography. PTBI: Pediatric Traumatic Brain Injury. TBI: Traumatic Brain Injury. EDH: Epidural or Extradural Hematoma. GCS: Glasgow Coma Scale. GHD: General Hospital, Douala. ICU: Intensive Care Unit. LOC: Loss of Consciousness. SAH: Subarachnoid Hemorrhage. WHO: World Health Organization.