Canton Kessely *et al.*
*Egyptian Journal of Neurosurgery* (2024) 39:3
https://doi.org/10.1186/s41984-023-00257-2

Egyptian Journal of Neurosurgery

RESEARCH

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# Pediatric traumatic brain injury in chad: about 256 cases

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## Abstract

**Purpose** Pediatric traumatic brain injury (PTBI) is a frequent pathology in the pediatric environment and remains a public health concern in the world. PTBI is the leading cause of death and severe disability in children in countries with limited pediatric trauma legislation. The objective is to report the experience of the management of PTBI in children in Chad.

**Methods** This report is a prospective study of 256 patients admitted for PTBI over a year period.

**Result** The incidence was 19.09%. The mean age was 6.2 years with extremes of 1 day and 15 years. The male represented 68.8% with a ratio of 2.2. The transport of the injured patients to health facilities using other means than ambulances in 87.5%. Initial loss of consciousness (IOL) accounted for 79.1% and coma seizures for 34.37%. Public road accidents accounted for 64.5% of causes. Severe traumatic brain injury (TBI) accounted for 24.2%. The cerebral scanner was performed in 37.9% of cases and had shown the association of craniocerebral lesions in 10.1% of cases. Craniocerebral wound trimming was the most common surgical procedure performed in 21.8% of cases, followed by removal of the depressed fracture of skull in 6.2% of cases. Mortality rate was 9% and sequelae 5.4%.

**Conclusion** PTBI is a frequent neurosurgical pathology in the pediatric setting in Chad. The absence of health insurance in our context makes access to care and radiological examinations very difficult. The prognosis was conditioned by the rapidity of the management and the initial loss of consciousness.

**Keywords** Cranioencephalic trauma, Pediatrics, Chad

## Introduction

Cranio-encephalic trauma refers to any direct or indirect mechanical aggression on the cranium, which may result immediately or later in neurological disorders, leading to diffuse or localized encephalic suffering [1]. PTBI has an anatomical peculiarity due to skeletal and cerebral immaturity, a physiological peculiarity related to cranial disproportion, blood mass, and cerebrospinal fluid (CSF) flow [2]. PTBI is a public health concern. It is the leading cause of death and severe disability in children in countries with limited pediatric trauma legislation [1, 3]. In the USA, PTBI is responsible for approximately 7400 deaths/year and more than 600,000 pediatric emergency room visits each year [4]. The annual incidence in the

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USA is estimated at 1100–1850 cases/100,000 population with a male predominance [5] compared to 7.1% in Niger [6]. The incidence of moderate and severe forms was estimated at 40 cases/100,000 inhabitants [7].

Cerebral CT scan is the prime examination in PTBI because of its best specificity in assessing bone and parenchymal lesions [8]. The challenge managing head injuries in children lies in the severe forms requiring adequate neuro-resuscitation and continuity of care for neuropsychological complications and sequelae [8]. In our practice setting, management is made difficult because of the lack of adequate access to first aid, CT scans and the technical platform. The objective of this work was to help improve the management of PTBI in pediatric settings in Chad.

## Materials and method

This was a prospective observational study with a descriptive and analytical aim over a period of 12 months on TBI in children. The pediatric emergency department of the Mother and Child University Hospital and the neurosurgery unit of the Renaissance University Hospital served as the study sites. The study population consisted of all children aged 0–15 years who had suffered a cranio-encephalic trauma. Any parental consent of a child who had suffered a cranio-encephalic allowed the inclusion of the patient in the study. Children who were lost to follow-up were excluded from the study. Data collection and analysis were performed using Word, Excel, and SPSS. The variables studied were epidemiological, clinical, therapeutic, and evolutionary. The predictive factors of mortality in this study were: coma, severity of the trauma, the notion of initial loss of consciousness greater than 1 h, the association of craniocerebral lesions, the delay of surgical management, the existence of respiratory distress, and circulatory failure.

## Results

We recruited 256 patients admitted for TBI out of 1377 cases, all trauma combined, with a frequency of 18.6%. The mean age of the patients was 6.2 years with extremes of 1 day and 15 years and a standard deviation of 0.524. The age group 0–5 years was the most represented (51.2%), followed by 6–10 years (28.9%) and 11–15 years (19.9%). The predominance was male (68.8%; n = 176) with a sex ratio of 2.2. 21.9% (n = 56) of patients were from rural areas. Hospital admission within the first 6 h was observed in 67.2% (n = 172). 37.1% (n = 95) of the injured were transported to health facilities by two-wheelers (motorcycles), 22.3% (n = 57) by taxis, 17.2% (n = 44) by police vehicles, 12.5% (n = 32) by ambulances, 9.4% (n = 24) by private vehicles, and 1.6% (n = 4) by others means of transportation. The initial clinical symptoms was dominated by a loss of consciousness (LOC) in 79.1% (n = 204) of cases. The duration of the initial loss of consciousness was less than 30 min in 32.4% of cases (n = 84), between 30 and 60 min in 26.3%, and more than 1 h in 20.7%. Road traffic accidents were the leading cause of TBI (Table 1) in children.

The distribution of patients by GCS score was as follow: 48.4% (n = 121) had a GCS score between 13 and 15, 28.5% (n = 73) had a score between 9 and 12, and 24.2% (n = 62) had a score less than or equal to 8. Anisocoria was noted in 3.1% of patients. Hyperthermia was observed in 37.8% of patients on admission, polypnea in 10.2% of patients, and 5.9% of patients were bradypneic. Tachycardia was reported in 11.7% and bradycardia in 5.5%. Other neurological signs were respectively: comitiality (34.37%), hemiplegia (2%), paraparesis (1.6%), aphasia (0.8%), deafness (0.8%), tetraplegia (0.4%), and peripheral facial paralysis (0.4%). According to the Master classification, 87 patients (34.1%) were classified as Master 1, 72 patients (28.1%) as Masters 2 and 97 patients (37.8%) as Masters 3. Abdominal trauma injury was associated in 8.9% of cases. Cranioencephalic lesions varied in nature (Fig. 1).

X-rays of the skull were performed in 30 patients, representing 11.7% of total cases. The results showed a depressed fracture in 15 cases (5.8%), a simple fracture line in 5 cases (1.9%) and osteitis in 01 case (0.4%) 0.178 patients were requested to go through brain scan. Of the 178 patients, only 97 (51.1%) have received the brain scan. This represented an overall rate of 37.9% of all patients. But only 97 of them had undergone a rate of 51.1% and 37.9% of all the patients collected. Craniocerebral lesions were reported in 10.1% (n = 26) followed by depressed fracture (see Fig. 2) in 22 cases (Table 2).

Ninety-eight patients (39.2%) had anemia with a hemoglobin level below 10 g/dl. Mild TBI accounted

**Table 1** Distribution of etiologies

| Etiologies | *N* | % |
|---|---|---|
| Public road accident (PRA) | 165 | 64.5 |
| Falls | 38 | 14.8 |
| Obstetrical | 21 | 8.2 |
| Crush syndrome | 13 | 5.1 |
| Races | 6 | 2.3 |
| Playful | 5 | 1.9 |
| Ballistic | 2 | 0.8 |
| Burn | 2 | 0.8 |
| Hoof strike | 2 | 0.8 |
| Shaken Baby Syndrome | 2 | 0.8 |


**Fig. 1** **A** Ballistic right fronto-parietal craniocerebral wound, **B** Scalp detachment, **C** Right parietal depressed fracture

for 47.3% of cases (n = 121), moderate TBI for 28.5%, and severe TBI for 24.2%.

Pre-hospital treatment was administered to 44 patients (17.1%). All patients had received medical treatment. An operative indication was required in 75 patients (29.3%). Craniocerebral wound trimming was the most common procedure performed in 47 patients (21.8%), followed by lifting of depressed fracture in 16 patients (6.2%), craniotomy plus trepanation in 11 (4.3%), and ventriculoperitoneal shunt in 1 case (0.4%). Fifty-three patients were admitted to the intensive care unit (21.2%). The intracranial pressure measurement, the electroencephalogram and the transcranial Doppler untrasonography were not performed during the management. Physical therapy was effective in 14 patients (5.4%) who presented post-traumatic sequelae. The evolution was favorable without sequelae in 206 cases (80.4%). 14 cases (5.4%) have experience sequelae and 23 (9%) cases of death. The causes of death were hypovolemic shock in 2.7% (n = 7), cerebral engagement in 1.9% (n = 5), sepsis in 1.1% (n = 3), and unspecified in 3.1% (n = 8) of cases. The postoperative complications were suppurations (2.7%),

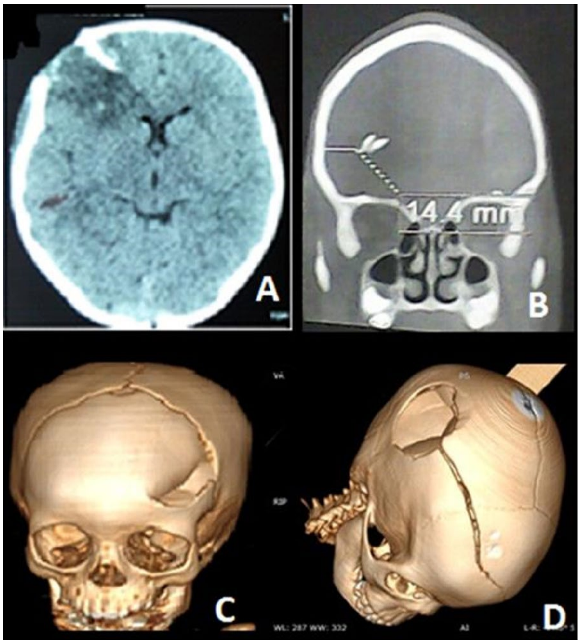


**Fig. 2** **A** Axial section brain CT showing a right frontal depressed fracture, **B** Coronal reconstruction CT showing an intracranial bone fragment, **C** 3D reconstruction CT showing a left frontal depressed fracture, **D** 3D reconstruction CT showing a right parieto-occipital depressed fracture + a right fronto-parietal linear fracture

**Table 2** Distribution by brain scan result

| Scan results | n | % |
|---|---|---|
| Associations | 26 | 10.1 |
| Depressed fracture | 22 | 8.6 |
| Cerebral edema | 12 | 4.7 |
| Acute epidural hematoma (AEH) | 10 | 3.9 |
| Cerebral contusion | 8 | 3.1 |
| Simple fracture | 4 | 1.6 |
| Pneumencephaly | 4 | 1.4 |
| Normal | 4 | 1.4 |
| Acute subdural hematoma | 2 | 0.8 |
| Progressive fracture | 2 | 0.8 |
| Subdural hygroma | 1 | 0.4 |
| Osteitis | 1 | 0.4 |
| Hydrocephalus | 1 | 0.4 |

meningitis (1.9%), bedsores (0.7%), osteitis (0.3%) and post-traumatic hydrocephalus (3%) (Fig. 3).

The average length of hospitalization was 6.26 days with extremes of one day to 64 days. The posttraumatic sequelae reported were hemiplegia (1.8%), comitial seizures (1.1%), headache (0.7%), aphasia (0.4%), deafness (0.4%), tetraplegia (0.4%), and peripheral facial paralysis (0.4%).

The correlation between mortality and time to admission (Chi-square = 8.869 and p = 0.12), mortality and gender (Chi-square = 0.147 and p = 0.702) were not statistically significant. LOC longer than 1 h was correlated with mortality (Chi-square = 96.710 and p = 0.000). All patients who died (100%) had an initial loss of consciousness greater than 1 h.

Bradypnea was a factor associated with death (Chi 2 = 155.533 and P = 0.000). Coma (GCS < 8) was a predictor of mortality (Chi 2 = 79.02 and P = 0.000).

Mortality was associated with delayed surgical management and pupillary abnormality (see Table 3).

## Discussion

Cranio-encephalic trauma is a frequent neurosurgical pathology in the pediatric setting and represented 18.6% of traumatic pathologies in children. This result is similar to that of Tomta et al. [9] in Cotonou in 2014 who found 14.7%. This high frequency of TBI in pediatric settings remains a real public health problem. The mean age was 6.2 years with the extremes of one day and 15 years, comparable to Hassen et al. [10] in 2012 with 5.6 years as the mean age. The age range of 0–5 years was the most represented (51.2%) similar to the work of Long et al. [11], who found this age range in 51% of cases. The lack of adequate supervision of small children and their indifference to danger could justify this high rate of TBI before the age of 5 years. We report a male predominance (68.8%) with a sex ratio of 2.2. Long et al. [11] found a male predominance in 61% of cases. TBI is more predominant in males; this predominance is probably justified by the fact that little boys are more agitated and attracted by dangerous games than girls who are more protected at this age in this setting. The transport of the injured to the health facilities was carried out in 87.5% of cases by own means (motorcycle, cab, private vehicle, pedestrians). Hassen et al. [10] found that 90.6% of patients were transported by their own means. This high rates could be explained by the absence of medical means of emergency transport (Emergency Medical Service) and by the lack of rapid transport of the traumatized child to a hospital structure. Initial loss of consciousness was reported in 79.1%; this is similar to the result of Hodé et al. [12] who found Initial loss of consciousness in 78.9%. Seizures were reported in 34.37% of cases. This result is higher than that reported by Hode et al. [12] of 18.6%. Comatic seizures are of particular semiological interest because of the increase in intracranial pressure leading to cerebral ischemia by increasing cerebral metabolic demand, releasing of cytotoxic neurotransmitters and hypoxia. The Glasgow score between 13 and 15 represented 48.4% of cases. This result is similar to that of Herrera et al. with 50.4% [13]. Neurovegetative disorders (hyperthermia in 37.8%, polypnea

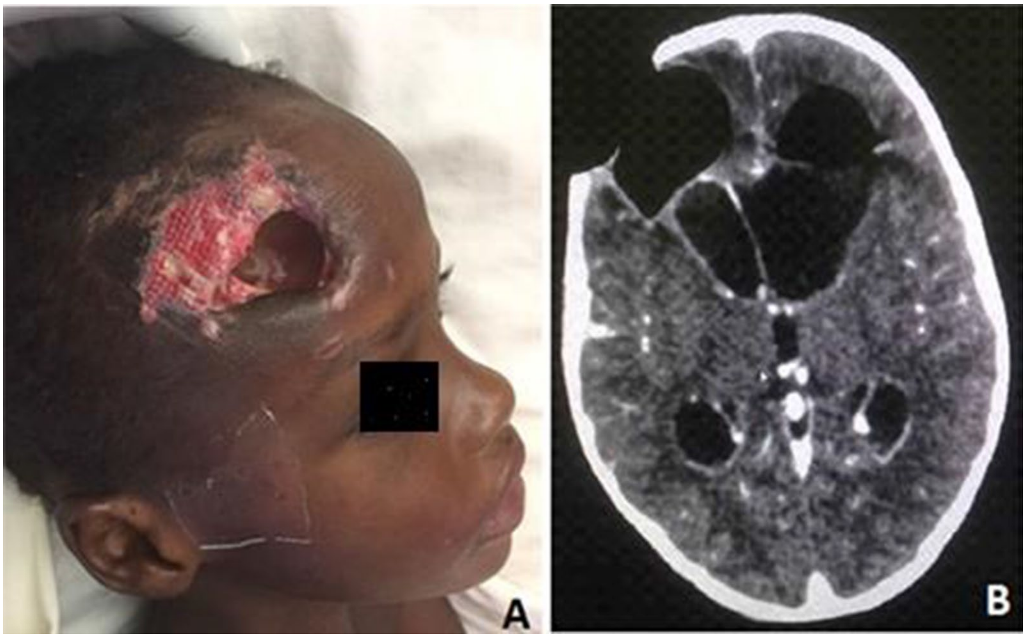


**Fig. 3** **A** Infected craniocerebral wound **B** Cerebral scan in axial section showing right frontal bone loss, an aerial cavity opposite and ependymitis + meningitis

**Table 3** Distribution of patients by predictive factors for death

| Variables | OR | IC 95% OR | P |
|---|---|---|---|
| Convulsions | 2.760 | [0.285–26.701] | 0.381 |
| Agitations | 0.134 | [0. 2–9. 921] | 0.360 |
| Abnormal pupils | 14.928 | [1.064–209.391] | 0.045 |
| Associated lesions | 0.229 | [0.018–2.951] | 0.258 |
| Severe TBI | 0.284 | [0–8, 285] | 1.000 |
| Late surgical treatment | 32.978 | [1.980–549.156] | 0.015 |
| Age (6–10 ans) versus others | 3.851 | [0.393–37.751] | 0.247 |

P: Probability; OR: Odds ratio; CI: Confidence intervals

in 10.2%, bradypnea in 5.9%, in 11.7% and bradycardia in 5.5%) were poor prognostic factors, 64.5% of TBI in this report was due to road traffic accidents; this is similar to the finding made by Bahloul et al. [14] with 69.4% of cases. These results are largely superior to those of Ciurea et al. in 2011 [15] and Shao et al. in 2012 in China [16] who had found 23.7% and 14%, respectively. The population growth, the increase traffic and cars, the insufficient road infrastructure and the lack of respect and knowledge of traffic regulations may seem to be the major risk factors of RTA in poor and developing countries.

X-rays of the skull were performed in 11.7% of cases. It helped in the diagnosis of bone lesions without providing information on the cerebral parenchyma. Though, not very much used nowadays, in our context, x-ray was considered as an alternative to the diagnosis of bone lesions in patients who do not have the financial means to pay for a cerebral CT scan. Cerebral CT was performed in 37.9% of cases. This result is lower than that of Gerritsen et al. [17] who reported 50.6%. The indication for CT scanning was established according to the master's criteria in 178 patients with a low rate of completion (51.1%). Cerebral CT is the gold standard in the evaluation of craniocerebral traumatic injuries, but the low rate of implementation in this context is linked to its very high cost ($130–180 USD), which is equivalent to almost twice the minimum wage in Chad.

The lack of health insurance coverage caused victim's family members to bear all the medical expenses related to the care of the patient. This is a real obstacle for an adequate care of the patients. The association of craniocerebral lesions (depressed fracture, cerebral contusions, meningeal hemorrhage, pneumencephaly, hygroma, AEH) was observed in 10.1% of cases. The association of lesions would be a source of neurological deficit because 33.33% of patients with associated craniocerebral lesions had presented a neurological deficit. The risk factors for the occurrence of seizures are closely related to the existence of associated craniocerebral lesions [2].

All patients had received medical treatment. 29.3% of cases required surgery. The surgeries were dominated by the trimming of a craniocerebral wound in 21.8% of cases, followed by the removal of an depressed fracture in 6.2% of cases. Neurosurgical indications for TBI in children are not uncommon and are generally of an extremely urgent nature. Some authors estimate that only half of the brain lesions identified requires neurosurgical management. These brain lesions, which are said to be clinically significant in the literature, only concern less than 1% of minor CTs [18–20].

Neuro-resuscitation was performed in 21.2% of cases. The criteria for admission to the intensive care unit were essentially based on the severity of the trauma with a pediatric Glasgow score of less than 8. The aim of this resuscitation was to prevent the occurrence of Secondary Brain Attacks of Systemic Origin (SBASO), to well guide the Therapy and to bring prognostic arguments [21–23]. No patient benefited from the intracranial pressure measurement, or Electroencephalogram or the transcranial Doppler untrasonography in ICU management due to unavailability. For Takashi et al. [24], the use of intraparenchymal intracranial pressure (ICP) is the only scientifically proven method for early detection of increased ICP in children with severe TBI. The improvement was favorable in 80.4% of cases. This finding is similar to the work of Ntsambi et al. [25] who found a favorable outcome in 67.7% of cases. The mortality rate in our context was 9%. This rate is close to that of Shein et al. in 2011 [26] who reported a mortality of 14.3%. For Alali et al. [27], the use of ICP monitoring was associated with reduced in-hospital deaths of children with severe TBI. We believe that this would reduce the mortality in our study. The application of 2019 Consensus and Guidelines-Based Algorithm [28] would significantly improve the prognosis of TBI. This is not the case in our report due to the lack of adequate infrastructures. The prognosis of patients who have survived moderate and severe TBI was poor and constituted a real public health problem because these sequelae (neuropsychological, cognitive and behavioral) are disabling and require specialized long-term care [29].

## Conclusions

TBI is a very common neurosurgical pathology in the pediatric setting in Chad. The absence of health insurance in our context makes access to care and radiological examinations (CT scan) very difficult. The prognosis is conditioned by the rapidity of care and the duration of the initial loss of consciousness.

**Abbreviations**

| | |
|---|---|
| AEH | Acute Epidural hematoma |
| CI | Confidence intervals |
| GCS | Glasgow Coma Scale |
| ICP | Intracranial pressure |
| LOC | Loss of consciousness |
| PTBI | Pediatric traumatic brain injury |
| OR | Odds ratio |
| P | Probability |
| PRA | Public road accident |
| SBASO | Secondary Brain Attacks of Systemic Origin |
| TBI | Traumatic Brain Injury |

**Acknowledgements**
Not applicable.

**Author contributions**
YCK and OS wrote the manuscript. YCK and NN translated the manuscript in English. ON Momar Codé BA and KRB corrected the manuscript. YCK, OS, FT, OO, MCB made the surgery. KN made the anesthesia for all the surgical intervention Brahim Soukaya Made all CT scan for the patients.

**Funding**
We receive any fund.

**Availability of data and materials**
Yes.

## Declarations

**Ethics approval and consent to participate**
The name of this committee is 'Comité National de Bio-ethique du Tchad', under the supervision of the faculty of human health sciences.

**Consent for publication**
The two consents, the first one for the study signed by the patient's parent, and the second one for the surgery signed by the patient's parent, mentioning his or her national identity number, the parent's age, the relationship with the patient and the parent's signature.

**Competing interests**
We don't have any competing interests.

Received: 19 January 2023 Accepted: 21 March 2023
Published online: 23 January 2024

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