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Analyzing the Neurosurgical Treatment Outcomes for Pediatric Traumatic Brain Injuries and Pediatric Diagnosis Outcomes by CT scan According to A Cross-Section Study from the Department of Neurosurgery

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Abstract: Background: Traumatic brain injury is a disease that causes major mortality and morbidity in children. **Objective:** This study aimed to analyse and assess neurosurgical outcomes related to children with traumatic brain injuries. **Patients and methods:** This study recruited 60 children with traumatic brain injuries, ages 2-14 years. This study collected clinical data for pediatric patients from different hospitals in Iraq, during the period from March 5, 2022, to April 16, 2023. We identified and distributed the CT findings for the type of hemorrhage as well as CT findings showing the severity of the injury. Moreover, our study also recorded data and surgical outcomes of children with TBI who were transferred to the neurosurgical unit, where all of the examinations included blood pressure (systolic and diastolic), heart rate, as well as complication rate, operating time, surgical procedure, blood transfusion, pain rates, and patient's quality of life. After the surgery. **Results:** Our results were enrolled clinical outcomes of surgical treatments for patients with brain injuries, which consists of males was most prevelance with 75% than females with 25%, mechanism of injury included road traffic accident had 30%, falls had 50%, blunt object had 15%, the most type of injuries brains at children were hematomas with 16 patients, concussions with 14 patients, skull fractures with 12 patients, CT scan findings of TBI severity included mild was 50% of patients, moderate was 30% of patients, severe was 20% of patients. According to craniotomy and decompressive craniectomy findings, operation time of surgery more than 3 hours was 36 patients, blood loss was 181.51 ± 119.84 mL, blood transfusion had five patients, systolic blood pressure was 94.63 ± 16.57, diastolic blood pressure was 53.74 ± 4.1, heart rate was 80.82 ± 9.21, hypotension on PICU admission was four patients, hyperglycemia on admission was three patients, length of stay in hospital was 13.67 ±2.25 days, admission PICU stay. Accoording to QOL scores, quality of life, included physical aspect, was 72.01 ± 3.45, psychological aspect was 76.58 ± 4.63, social and emotional aspects were 80.24 ± 2.46, and daily activities was 71.15 ± 5.68. **Conclusion:** This study showed that neurosurgical interventions represent a safe, high-quality, and effective treatment in treating pediatric patients, which contributes positively to a decrease in mortality and morbidity rates.

Keywords: Traumatic brain injury; mortality and morbidity outcomes; craniotomy and decompressive craniectomy surgeries; Postoperative complications.

INTRODUCTION

The most frequent cause of brain damage is that of traumatic origin and is called traumatic brain injury (TBI) [Daoud, H. *et al*., 2014]. It is defined as a physical or functional alteration of any magnitude, mechanism, or severity that is inflicted or suffered by the cranial cavity and its contents, brain mass [Greenberg, J. K . *et al*., 2017]. Cranioencephalic trauma in children continues to be a serious public health problem worldwide, being the leading cause of death and permanent disability in pediatrics. The global incidence varies according to the country, in a range ranging from 47-280 per 100,000 children. In the USA, it is considered as the ninth cause of childhood morbidity and can present irreversible injuries [Wee, J. Z . *et al*., 2016; Araki, T . *et al*., 2017]. [Prasad, M. R . *et al*., 2002] In mild TBI, there are falls, and in severe TBI, the most frequent cause are traffic accidents. It has also been associated with physical abuse at any age. Head trauma can be responsible for one or more injuries of the following characteristics: loss or decrease in the state of consciousness, amnesia, skull fracture, neurological and neuropsychological alterations, development of intracranial lesions, and/or death. Being that cranioencephalic trauma in infants has a

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considerably high incidence globally and can cause permanent disability or death in children, it is necessary that this study had as a general objective to review relevant aspects about cranioencephalic trauma (TBI) in pediatrics. [Wee, J. Z . *et al*., 2016; Prasad, M. R . *et al*., 2002; Filley, C. M. *et al*., 1987; Greenberg, J. K. *et al*., 2017; Koskiniemi, M. *et al*., 1995]

The etiology of head trauma (TBI) in pediatrics varies according to age and is related to the degree of psychomotor development of the child. The traumatic mechanism can be very diverse. From the most shocking to the most subtle, without forgetting those that are hidden, for example, those that are the consequence of abuse. Among the main mechanisms of injuries are falls, traffic accidents, direct traumas, and physical abuse. Similarly, it has also been pointed out that within the etiology, accidental falls occupy the first place in frequency in infants and preschoolers, while traffic accidents as passengers or pedestrians make up the first cause of TBI in older children (adolescents) [Prasad, M. R . *et al*., 2002 – Astrand, R. *et al*., 2010]. TBI is considered an important problem due to its high incidence and potential severity [Prasad, M. R . *et al*., 2002, Bruce, D. A, 1990]. It causes a high number of consultations in the emergency services and actions of the health emergency systems. [Koskiniemi, M. *et al*., 1995] It represents an important global health problem with high mortality rates, depending on its severity, and implies a series of consequences for the quality of life of the individual and a considerable expense for States [Chong, S. L. *et al*., 2015 – Heather, N. L. *et al*., 2013]. He reinforces this statement when he argues that pediatric TBI, accidental or not, is a public health problem in the global landscape; it is classified according to its severity by the Glasgow coma scale (ECG) into mild (the most frequent form of presentation, 75-95%), moderate and severe [Moran, L. M. *et al*., 2016 -Taylor, A. *et al*., 2001]. However, injuries considered mild (Glasgow 14 or 15) can have clinically important consequences. this makes it necessary to analyze other data that allow us to make sound decisions about which children should be subjected to further observation or complementary examinations. [Massagli, T. L. *et al*., 1996]

CT scans was presentaed as useful in identifying traumatic brain injuries (TBIs) of pediatric patients as they give precise pictures of the brain's structure, where CT scans can promptly detect anomalies that include skull fractures, hemorrhages, and edema, allowing healthcare practitioners to make educated decisions about the best course of treatment. [Massagli, T. L. *et al*., 1996; Manfiotto, M. *et al*., 2019]

Pediatric patients needed an early and precise diagnosis of TBIs since their brains are still growing, leaving them more vulnerable to long-term problems if not addressed, which CT scans assist healthcare providers in assessing the severity of the damage and determining the appropriate therapy strategy, whether they might involve surgery, medication, or careful monitoring. [Grandhi, R. *et al*., 2014; White, J. R. *et al*., 2001]

Two stages can be identified in TBI; in the first one, there is a primary injury where there is a direct disruption of the cerebral parenchyma, irreversible, and a secondary injury where intracerebral and/or extracerebral events develop [Pillai, S. *et al*., 2001]. Thus, primary brain damage refers to the tissue injury generated by direct trauma; said condition will depend on the injury mechanisms, the intensity and direction of the impact, the resistance of the tissue, and the region affected by said trauma [Woertgen, C. *et al*., 2006]. This same expert points out in relation to secondary brain damage refers to a series of events triggered by the trauma itself at a biochemical level, such as cytotoxicity, oxidative stress, compromise and injury of the perilesional area, release of pro-inflammatory substances, cell death, among others. Also, secondary brain damage favors the appearance of entities such as cerebral edema, intracranial hemorrhages, seizures, etc. In addition, associated injuries such as hemodynamic alterations, anemia, and arterial hypotension may occur [Nirula, R. *et al*., 2014]. These injuries are potentially treatable, predictable, and preventable. Therefore, once the severity of TBI has been recognized and classified, medical management should be aimed at avoiding secondary injuries, mainly including hypoxemia, hypotension, and hyperthermia. [Park, J. H. *et al*., 2014]

PATIENTS AND METHODS

We conducted a cross-sectional study of pediatric patients with traumatic brain injuries, which included 60 patients whose ages ranged between 2-14 years. The patient outcomes methodology was designed and created using the SPSS program, version 22.0, and included patients with brain injuries who were less than 14 years old, while our study excluded data from patients who underwent other surgeries or had serious diseases.

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Demographic and clinical data were collected for patients before, during, and after surgery from different hospitals in Iraq, for a period from March 5, 2022, to April 16, 2023.

This data included age, sex, symptoms, mechanism of injury, type of injury, chronic diseases, and other results. Most of the patients were diagnosed by CT scan, as the results of the CT scan showed the severity of the children's traumatic brain injuries, which were determined by the GCS score, which was distributed into three groups and included mild (14 - 15), moderate (9 - 13), and severe (3 - 8).

Regarding clinical data during surgery, all patients underwent surgery, which included both craniotomy and decompression craniectomy, and underwent sphygmomanometer and heart rate tests. Surgical data included operating time, ventilation time, blood loss, blood transfusion, hypotension on PICU admission, and high Blood sugar on admission, length of stay in the hospital, admission of children to the pediatric intensive care unit, mortality rate, and Glasgow Neurological Scale during the follow-up period.

Furthermore, our study reported emergency department clinical outcomes and postoperative management outcomes of children with TBI, which included hypothermia, hyperthermia, hypotension, hypoxia, bradycardia, tachycardia, and outcomes of initial respiratory support. Also, the rate of complications among patients was recorded during the follow-up period, and our results also showed the patients' pain and nerve assessments using each of the VAS scales, ranging from 0 to 10, where 0 represents no pain, 10 represents the presence of severe pain, and the GOS scale ranges from 1 to 8, where 1 represents Death, 8 represents a good recovery, and the quality of life scale, which ranges from 0 to 100, represents the highest degrees of recovery, and 0 represents the lowest degrees of recovery.

The quality-of-life measures included the physical, psychological, emotional, and social aspects and daily activity, for which evaluations and examinations were conducted during the follow-up period, which It lasted for 12 months.

RESULTS

Table 1: Demographic and clinical outcomes of patients

Characteristics	Number of patients [60]	Percentage [%]
Age		
2 – 5	9	15%
6 – 9	27	45%
10 - 14	24	40%
Sex		
Male	45	75%
Female	15	25%
Symptoms		
Headache	15	25.0%
Nausea and vomiting	9	15.0%
Trouble with balance	4	6.67%
Dizziness	8	13.33%
Blurred vision	9	15.0%
Sensitivity to light	3	5.0%
Memory problems	6	10.0%
Changes in sleep patterns	6	10.0%
Mechanism of injury		
Road traffic accident	18	30.0%
Fall	30	50.0%
Blunt object	9	15.0%
Other	3	5.0%
Type of injury		
Extradural hemorrhage	30	50.0%
Subdural hemorrhage	18	30.0%
Subarachnoid hemorrhage	12	20.0%

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Chronic illness		
No	36	60.0%
Hypertension	9	15.0%
Diabetes	6	10.0%
HIV	5	8.33%
Others	4	6.67%
Pupil size (mm)		
< 3	48	80.0%
> 3	12	20.0%
Pupil dilation		
Unilateral	45	75.0%
Bilateral	15	25.0%
Type of injuries in the brains at children		
Concussions	14	23.33%
Contusions	12	20.0%
Diffuse axonal injuries	6	10.0%
Hematomas	16	26.67%
EDH	8	13.33%
SDH	5	8.33%
ICH	3	5.0%
Skull fractures	12	20.0%

Table 2: CT scan findings of TBI severity based on mild, moderate, and severe

GCS score	Number of patients [60]	Percentage [%]
Mild [14–15]	30	50.0%
Moderate [9–13]	18	30.0%
Severe [3–8]	12	20.0%

Table 3: Surgical outcomes of children who undergoing craniotomy and decompressive craniectomy

Variables	Number of patients [60]	Percentage [%]
Operation time, hrs, n (%)		
≤ 3	24	40.0%
> 3	36	60.0%
length of ventilation, days, Mean±SD	10.85 ± 1.23	
Blood loss, mL, Mean±SD	181.51 ± 119.84	
Blood transfusion, n (%)	5	8.33%
Blood pressure		
Systolic blood pressure	94.63 ± 16.57	
Diastolic blood pressure	53.74 ± 4.1	
Heart rate	80.82 ± 9.21	
Hypotension on PICU admission		
Yes	4	6.67%
No	56	93.33%
Hyperglycemia on admission		
Yes	3	5.0%
No	57	95.0%
Length of stay in hospital, days, Mean±SD	13.67 ±2.25	
Admission PICU stay, n (%)	7	11.67%
Mortality rate, n (%)		
Death	3	5%
Alive	57	95%
Glasgow Outcome Scale at discharge	2 [1 – 6], n = 3 (death)	
Median GOS at four months	6 [2 – 8], n = 57	
GOS at 12 months	7.5 [2 – 8], n = 10	

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Table 4: Clinical outcomes of the emergency department in association with the management of children's TBI after surgery

Variables	Number of patients [60]	Percentage [%]
Hypothermia	7	11.67%
Hyperthermia	4	6.67%
Hypotension	3	5.0%
Hypoxia	2	3.33%
Bradycardia	2	3.33%
Tachycardia	7	11.67%
Initial respiratory support		
None	2	3.33%
Loss of Consciousness	2	3.33%
Bag-valve mask	0	0%
ED endotracheal intubation	1	1.67%
Supplemental oxygen	15	25.0%

Table 5: Postoperative complications outcomes

Complications	Number of patients [60]	Percentage [%]
Infection	4	6.67%
Hemorrhage	2	3.33%
Hydrocephalus	0	0%
Seizures	1	1.67%
Cognitive impairment	2	3.33%
Motor dysfunction	2	3.33%
Behavioural changes	1	1.67%

Table 6: Assessment of pain scores of patients during follow–up time

Follow–up time (months)	Pain score (Mean ± SD)
Three months	6.78 ± 0.67
Six months	4.34 ± 0.10
Nine months	2.12 ± 0.001
12 months	1.01 ± 0.012

Table 7: Assessment of quality of life for patients after surgery during follow–up time

Items	QOL (Mean ± SD)
Physical aspect	72.01 ± 3.45
Psychological aspect	76.58 ± 4.63
Social and emotional aspects	80.24 ± 2.46
Daily activities	71.15 ± 5.68

DISCUSSION

Our results were enrolled demographic and clinical outcomes which consists of age where patients who aged (6 - 9) were highest with 45% of children, followed by children who aged (10 - 14) years with 40%, males was most prevelance with 75% than females with 25%, most common symptoms spread on children were headache included 15 children, nausea and vomiting had 9 children, blurred vision had 9 children, dizziness was 8 children, mechanism of injury included road traffic accident had 30%, fall had 50%, blunt object had 15%, types of injuries found that extradural hemorrhage who have 30 patients, subdural hemorrhage had 18 patients, subarachnoid hemorrhage had 12 patients, most common chronic illiness affected on patients included hypertension with 15%, diabetes included 10%, pupil dilation conists of unilateral was 45 children and bilateral was 15 children, the most type of injuries brains at children were hematomas with 16 patients, concussions with 14 patients, skull fractures with 12 patients.

In addition, our data were conducted diagnoses of children by CT scan, which promote to CT findings of TBI severity, where mild was 50% of patients, moderate was 30% of patients, and severe was 20% of patients. Based to intraoperative findings, we conducted records of surgical outcomes of children who undergoing craniotomy

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and decompressive craniectomy, which found all data surgical outcomes included operation time of surgery less than 3 hours was 24 patients and operation time of surgery more than 3 hours was 36 patients; blood loss was 181.51 ± 119.84 mL, blood transfusion had five patients, systolic blood pressure was 94.63 ± 16.57, diastolic blood pressure was 53.74 ± 4.1, heart rate was 80.82 ± 9.21, hypotension on PICU admission was four patients, hyperglycaemia on admission was three patients, length of stay in hospital was 13.67 ±2.25 days, admission PICU stay was seven patients, death cases was three patients, hypothermia was seven patients, tachycardia was seven patients, hyperthermia was four patients, supplemental oxygen was 15 cases, postoperative complications included infection was four patients, hemorrhage was two patients, motor dysfunction was two patients. Also, we conducted an assessment of all pain scores of patients during follow–up time, where we found pain score at three months was 6.78 ± 0.67, at six months was 4.34 ± 0.10, at nine months was 2.12 ± 0.001, and at 12 months was 1.01 ± 0.012, quality of life included physical aspect was 72.01 ± 3.45, psychological aspect was 76.58 ± 4.63, social and emotional aspects were 80.24 ± 2.46, daily activities were 71.15 ± 5.68.

Recent studies have agreed that the impact of neurosurgical treatment with traumatic brain injury (TBI) in children is critical due to the severity and possible long-term effects associated with these injuries and that neurosurgical interventions play an important role in managing TBI to children by addressing various issues including intracranial bleeding, swelling, and pressure in the brain. [Bor-Seng-Shu, E. *et al*., 2015 – Hu, Y. *et al*., 2015]

An American study found that early neurosurgical intervention for children with TBI may significantly lower mortality rates, reduce long-term disabilities, and enhance overall quality of life, allowing for rapid along with precise treatment of potentially life-threatening complications, including intracranial hemorrhage, that can lead to secondary brain injury if not treated promptly. [Lee, J. J. *et al*., 2018]

CONCLUSION

This study indicates that traumatic brain injuries negatively and significantly affect children's quality of life in terms of both the physical, cognitive, and social aspects. However, our study found that surgical intervention represents the safest and most effective treatment in reducing the severity of these injuries, complications, and pain, as well as the mortality rate, which highlights improvements in the clinical outcomes and quality of life of children in the long term.

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