

# Traumatic Brain Injury: Neurosurgical and Critical Care Outcomes in Windhoek and Katutura Hospitals, 2020-2024

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**Abstract:** OBJECTIVE: To describe outcomes in patients with traumatic brain injury and document neurosurgical and critical care management. DESIGN: A 4-year retrospective study. SUBJECTS: One hundred and thirty patients with traumatic brain injury admitted between March 2020 and March 2024 for neurosurgical and critical care at Katutura and Windhoek hospitals in Namibia. METHODS: Demographic, clinical, radiological, and injury-mechanism data were recorded at admission and during neurosurgical and intensive care. The primary outcome measure was the Glasgow Outcome Scale. Outcome groups were compared according to age, sex, Glasgow Coma Scale at admission, brain CT findings, ventilation therapy, and neurosurgical procedure. RESULTS: Favorable outcomes were observed in 114 patients, including 91 cases with good recovery (70%). Sixteen patients had an unfavorable outcome; 8 of them died (50%). The 19-34 age group had the highest representation among patients with unfavorable outcomes (9 of 16 cases). Males represented most patients who underwent surgery and neurocritical care (103 of 130 cases, 79%). Assault was present in 84 cases (64%). Seventy-five percent of patients with an unfavorable outcome had a Glasgow Coma Scale score of 8 or less on admission (12 of 16 cases). CT studies showed depressed skull fractures in 52% of patients (68 cases). Eight of the 16 patients with unfavorable outcomes had epidural hematomas (50%). Craniotomy was the most frequent neurosurgical technique (75 cases, 57.69%). Eight of the 16 patients with unfavorable outcomes required mechanical ventilation for more than 8 days. CONCLUSION: Most patients with traumatic brain injury had a favorable outcome on the Glasgow Outcome Scale.

**Key words:** Traumatic brain injury, neurosurgery, neurocritical care, Glasgow Outcome Scale, Glasgow Coma Scale, Namibia.

## 1. Introduction

At present, it is estimated that 50% of patients with traumatic brain injuries have been involved in traffic accidents. Sixty-three percent of them are young adults between the ages of 15 and 24, and 34% are children between the ages of 1 and 4. The existence of adequate legislation addressing risk factors could help reduce the number of deaths and injuries in traffic accidents. Traumatic brain injury is the leading cause of death in these patients, accounting for 50% to 75%

of deaths according to statistics. This is confirmed by the fact that in the United States, for example, mortality from traumatic brain injuries caused by car accidents in the decade from 1982 to 1992 exceeded the number of deaths on the battlefield during that nation's wars. The human factor has been responsible for 90% of these accidents. Injuries caused by traffic accidents (TIR) have increased dramatically and are now a major problem.

Worldwide, they contribute significantly to the burden of deaths and injuries. Sub-Saharan Africa (SSA) is the most affected region globally, with many people suffering injuries and becoming permanently disabled (WHO, 2015a). However, due to the lack of research in the SSA region, there is a significant lack

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of comprehensive understanding of the impact of RTIs on society at the national level, and uncertainty regarding the number of people involved [1-4].

Traumatic brain injury is a disruption of the structure of the brain and its function caused by the application of an external source, manifesting as confusion, loss of consciousness, coma, or convulsion. According to the World Health Organization (WHO) report, RTI is the eighth leading cause of death, with an estimated 1.35 million people dying each year from RTI [2]. Worldwide, TBI is estimated to affect 69 million people each year; low- and middle-income countries (LMICS) have a TBI burden three times higher than high-income countries, according to the WHO report. Internationally, TBI is the leading cause of death and disability. In the United States of America, TBI is the most common cause of mortality and disability. Annually, more than 2.8 million cases of TBI were reported with a mortality rate of 2%.

Among those who survive, most experience various short and long-term impacts throughout their lives, including impaired thinking, physical activity, and loss of senses such as hearing and sight, as well as emotional abnormalities such as depression. In addition, it has also affected the lives of their families and, consequently, their community [5].

Traumatic brain injury (TBI) has been called a “silent global epidemic”, accounting for up to 30% of all trauma-related deaths and is the leading cause of death in young men in developing countries.

This burden is also reported in developed countries [1, 2]. It is considered a double insult comprising primary and secondary processes. The primary injury is the physical or anatomical damage caused at the time of injury, producing vulnerable cells that are further compromised by secondary factors of brain injury [3, 6].

## **2. Materials and Methods**

### *2.1 Study Population*

This retrospective study evaluated 147 patients with

traumatic brain injury admitted to the head trauma care unit, acute care unit, or intermediate care unit at Windhoek Central and Katutura hospitals between March 2020 and March 2024.

Patients were included if they were admitted during the study period, had complete medical records, and underwent neurosurgical procedures performed by the author. A total of 130 patients met the inclusion criteria. Seventeen patients were excluded because their records were incomplete or they were outside the study period.

### *2.2 Study Variables*

The dependent variable for this study was the Glasgow Outcome Scale result after traumatic brain injury. Independent variables included age, sex, Glasgow Coma Scale score at admission, mechanism of injury, brain CT findings, neurosurgical procedure, and ventilation therapy.

### *2.3 Operational Definitions and Definition of Terms*

1. GOS-Glasgow Outcome Scale: a multidimensional scale used to assess clinical outcome.

Death (GOS category 1): patients were certified dead.

Vegetative state (GOS category 2): The patient did not exhibit any obvious cortical function.

Severe disability (GOS category 3): patients were conscious but disabled and could not perform activities independently.

Moderate disability (GOS category 4): patients were disabled but independent in daily living; disabilities included varying degrees of dysphasia and hemiparesis.

Good recovery (GOS category 5): resumption of normal activities, although minor neurological or psychological deficits may exist.

Unfavorable outcome: GOS score of 1-3.

Favorable outcome: GOS score of 4 or 5.

### 2. GCS

The Glasgow Coma Scale was used to assess the

neurological status of patients with head trauma at admission.

Mild traumatic brain injury: head injury with a Glasgow Coma Scale score of 13-15.

Moderate traumatic brain injury: head injury with a Glasgow Coma Scale score of 9-12.

Severe traumatic brain injury: head injury with a

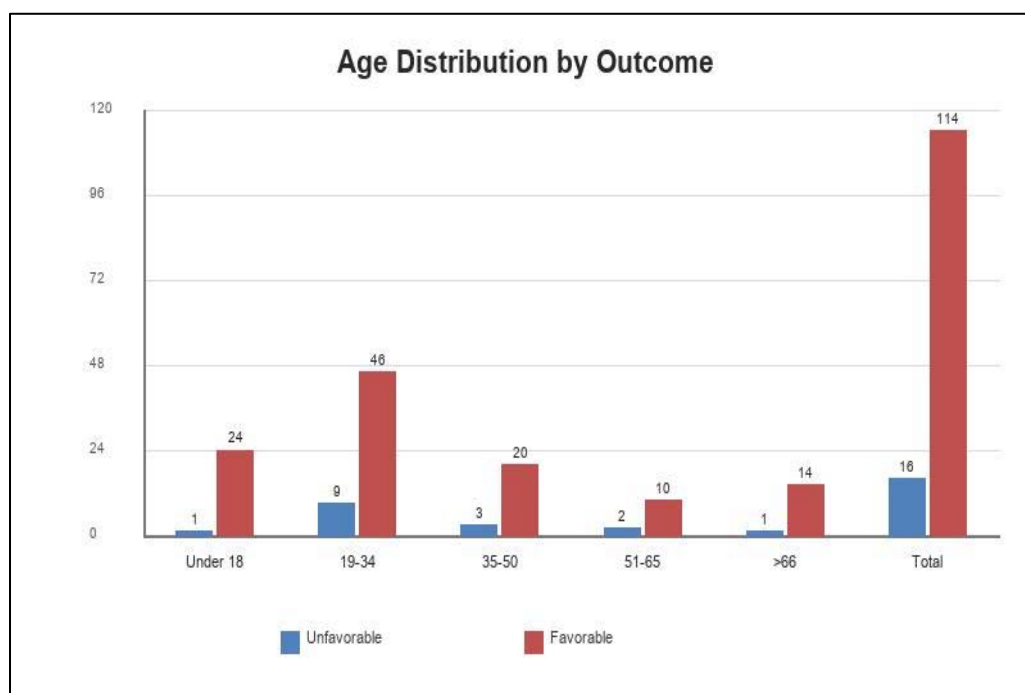
Glasgow Coma Scale score of 8 or less.

### 3. Results and Analysis

In Table 1 and Fig. 1, 42.31% of patients were in the 19-34 age group (55 cases). This age group also had the highest representation among patients with unfavorable outcomes (9 of 16 cases, 56.25%).

**Table 1 Age distribution by GOS outcome.**

Age group	Favorable		Favorable		Total	
	No.	%	No.	%	No.	%
Under 18	1	6.25	24	21.05	25	19.23
19-34	9	56.25	46	40.35	55	42.31
35-50	3	18.75	20	17.54	23	17.69
51-65	2	12.50	10	8.77	12	9.23
More than 66	1	6.25	14	12.28	15	11.54
Total	16	100.00	114	100.00	130	100.00

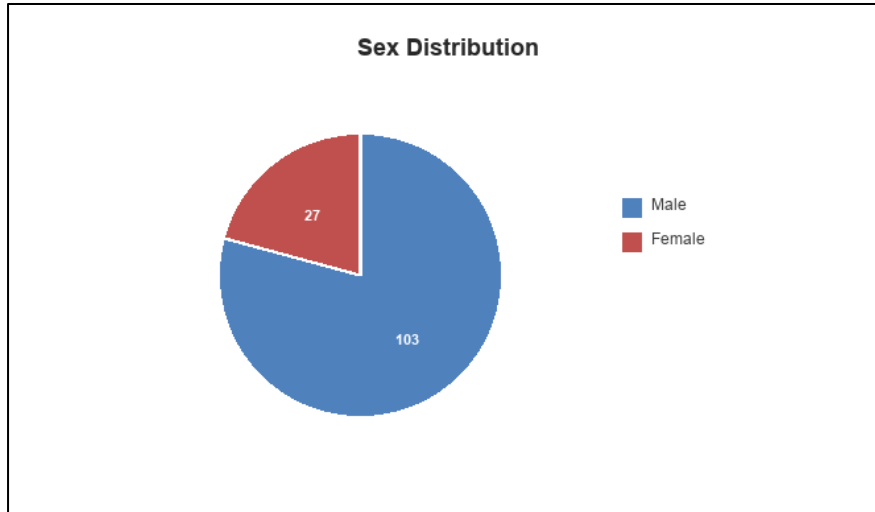


**Fig. 1 Age distribution by GOS outcome.**

**Table 2 Sex distribution by GOS outcome.**

Sex	Glasgow Coma Scale					
	Unfavorable		Favorable outcome		Total	
	No.	%	No.	%	No.	%
Male	14	87.50	89	78.07	103	79.23
Female	2	12.50	25	21.93	27	20.77
Total	16	100.00	114	100.00	130	100.00

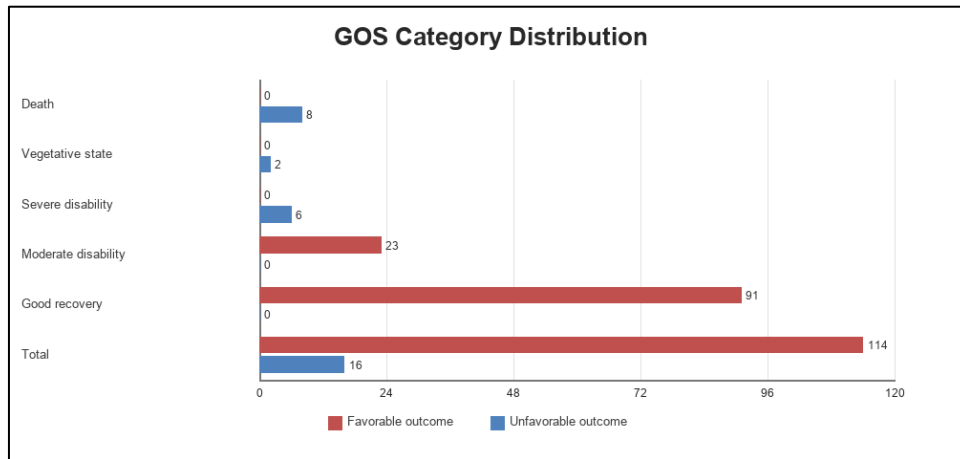
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**Fig. 2 Sex distribution by GOS outcome.**

**Table 3 GOS category distribution.**

GOS category	Glasgow Coma Scale					
	Unfavorable		Favorable outcome		Total	
	No.	%	No.	%	No.	%
Death	8	50.00	0	0.00	8	6.15
Vegetative estate	2	12.50	0	0.00	2	1.54
Severe disability	6	37.50	0	0.00	6	4.62
Moderate disability	0	0.00	23	20.18	23	17.69
Good	0	0.00	91	79.82	91	70.00
Total	16	100.00	114	100.00	130	100.00



**Fig. 3 GOS category distribution.**

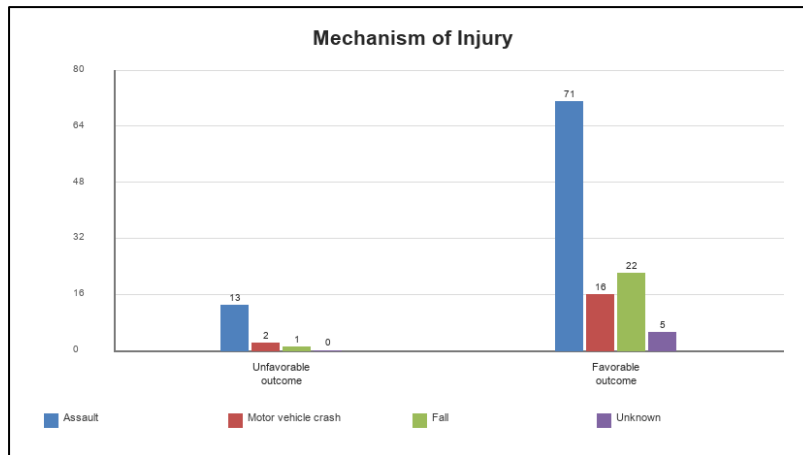
In Table 2 and Fig. 2, Males accounted for the majority of patients who underwent surgery and received neurocritical care: 103 of the 130 cases (79%). The male-to-female ratio of those who died after an unfavorable outcome was 7 to 1.

In Table 3 and Fig. 3, Eighty-seven percent of patients

with traumatic brain injury who underwent surgery and received neurocritical care had a favorable outcome, with 23 having moderate disability and 91 having good recovery, representing 17.6 percent and 70 percent, respectively. Eight of the 16 patients with an unfavorable outcome died, representing 50 percent.

**Table 4 Mechanism of injury distribution.**

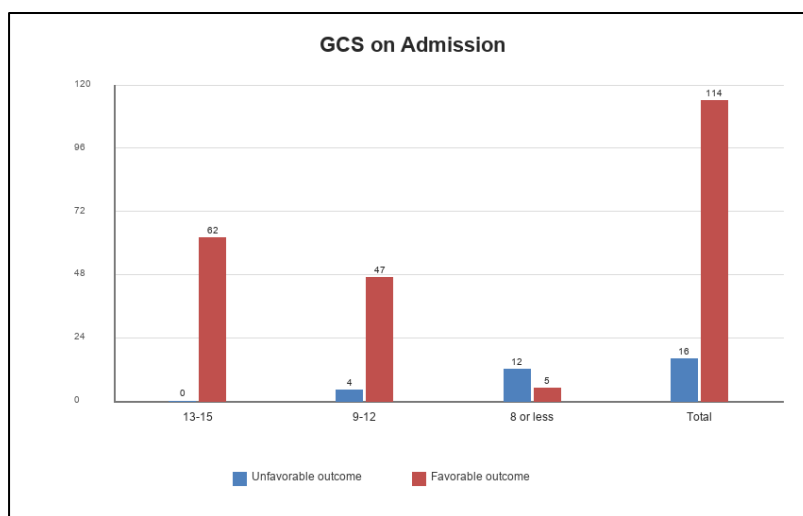
Mechanism of injury	Glasgow Coma Scale					
	Outcome unfavorable		Outcome favorable		Total	
	No.	%	No.	%	No.	%
Assault	13	81.25	71	62.28	84	64.62
Motor vehicle crash	2	12.50	16	14.04	18	13.85
Fall	1	6.25	22	19.30	23	17.69
Unknown	0	0.00	5	4.39	5	3.85
<b>Total</b>	<b>16</b>	<b>100.00</b>	<b>114</b>	<b>100.00</b>	<b>130</b>	<b>100.00</b>



**Fig. 4 Mechanism of injury distribution.**

**Table 5 Distribution by Glasgow Coma Scale score on admission.**

Glasgow Coma Scale on admission	Glasgow Coma Scale					
	Unfavorable outcome		Favorable outcome		Total	
	No.	%	No.	%	No.	%
13-15	0	0.00	62	54.39	62	47.69
9-12	4	25.00	47	41.23	51	39.23
8 or less	12	75.00	5	4.39	17	13.08
<b>Total</b>	<b>16</b>	<b>100.00</b>	<b>114</b>	<b>100.00</b>	<b>130</b>	<b>100.00</b>

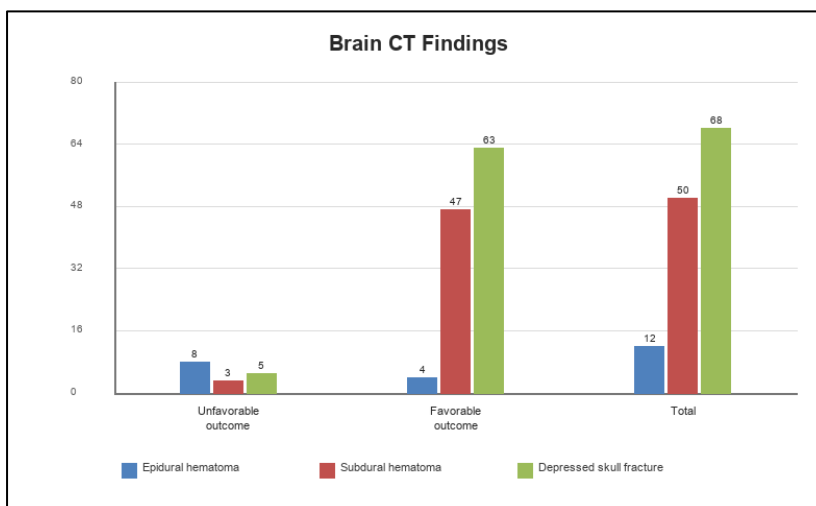


**Fig. 5 List of patients by Glasgow Coma Outcome Scale on admission.**

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**Table 6 Brain CT scan results.**

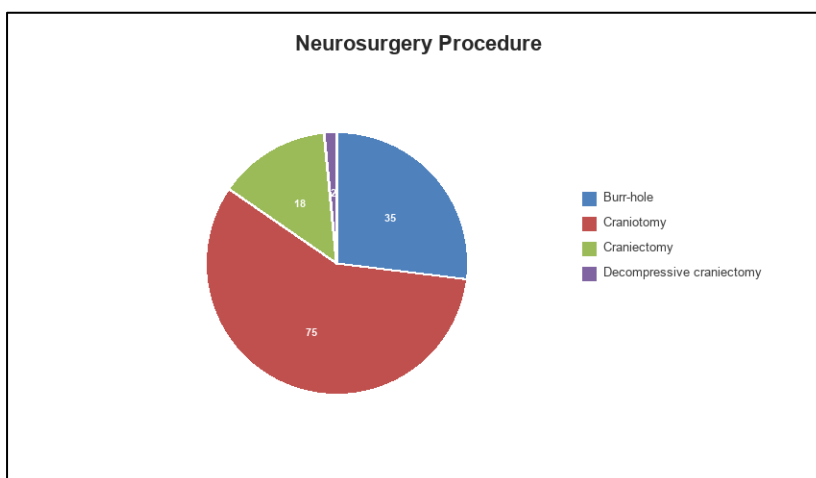
Brain CT scan	Glasgow Coma Scale					
	Unfavorable		Favorable		Total	
	No.	%	No.	%	No.	%
Epidural hematoma	8	50.00	4	3.51	12	9.23
Subdural hematoma	3	18.75	47	41.23	50	38.46
Depressed skull fracture	5	31.25	63	55.26	68	52.31
Total	16	100.00	114	100.00	130	100.00



**Fig. 6 Brain CT scan results.**

**Table 7 Neurosurgery procedure distribution.**

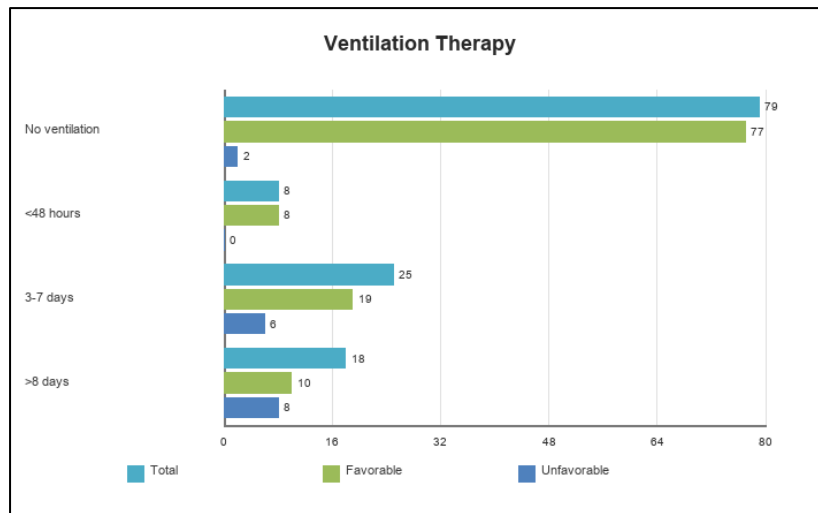
Neurosurgery procedure	Glasgow Coma Scale	
	No.	%
Burr-hole procedure	35	26.92
Craniotomy	75	57.69
Craniectomy	18	13.85
Decompressive craniectomy	2	1.54
Total	130	100.00



**Fig. 7 Neurosurgery procedure distribution.**

**Table 8 Ventilation therapy distribution.**

Ventilation therapy	Glasgow Coma Scale					
	Unfavorable		Favorable		Total	
	No.	%	No.	%	No.	%
No ventilation	2	12.50	77	67.54	79	60.77
Ventilation < 48 hours	0	0.00	8	7.02	8	6.15
Ventilation 3-7 days	6	37.50	19	16.67	25	19.23
Ventilation > 8 days	8	50.00	10	8.77	18	13.85
<b>Total</b>	<b>16</b>	<b>100.00</b>	<b>114</b>	<b>100.00</b>	<b>130</b>	<b>100.00</b>



**Fig. 8 Ventilation therapy distribution.**

In Table 4 and Fig. 4, assault was the most frequent mechanism of injury, occurring in 84 of 130 patients (64.62%). Among patients with an unfavorable outcome, assault accounted for 13 of 16 cases (81.25%).

In Table 5 and Fig. 5, 75% of patients with an unfavorable outcome had a Glasgow Coma Scale score of 8 or less at admission (12 of 16 cases).

In Table 6 and Fig. 6, depressed skull fractures were present in 68 patients (52.31%). Eight of the 16 patients with an unfavorable outcome had epidural hematoma (50%).

In Table 7 and Fig. 7, craniotomy was the most frequent neurosurgical technique (75 cases, 57.69%), followed by burr-hole procedures (35 cases, 26.92%).

In Table 8 and Fig. 8, 51 patients (39.23%) required mechanical ventilation. Among patients with an unfavorable outcome, 8 of 16 cases (50%) required ventilation for more than 8 days.

#### 4. Discussion

TBI was predominant in people under the age of 45, with males accounting for the highest number of cases. This is consistent with the international literature consulted, which states that it is the leading cause of death in patients in this age group and accounts for a large number of deaths and sequelae in those who survive this event, thus attributing a considerable cost in hospital care and rehabilitation. [1] On the other hand, mild TBI, with a GCS between 14 and 15 points, represents 75% to 88% of all TBIs. [2] It should be noted that in a considerable percentage of patients with a GCS of 14 or 15 points, linear fractures, depressed fractures, juxtadural hematomas, and even small cerebral contusions, which changes the therapeutic approach and makes them moderate TBI. The predominant injuries were linear fractures, followed by contusions without mass effect and HSDs, the majority of which were chronic. This would

explain the high incidence of Marshall II (interhemispheric fissure displacement less than 5 mm, focal lesions of less than 25 mm<sup>3</sup> in volume) since linear fractures accounted for the highest number of cases, followed by contusions without mass effect, which were followed by Marshall grade IV (interhemispheric fissure displacement greater than 5 mm, focal lesions of less than 25 mm<sup>3</sup> in volume may coexist), which would be explained by the considerable number of patients with juxtadural hematomas and contusions with mass effect, both of which tend to displace the cerebral midline. Intracranial pressure measurement provides two types of information: the numerical value of ICP (baseline height) and the state of cerebral distensibility (presence of pathological waves). It is tolerated as ICP.

ICP values of up to 20 mmHg in the supine position, in the absence of drugs or pharmacological measures that could reduce ICP, are considered normal. Values above 20 mmHg maintained for more than 20 minutes are considered intracranial hypertension. ICP wave recordings allow visualization of the cerebral pulse wave, which consists of four components called P1, P2, P3, and P4 [4-8]. The P1 wave is related to systolic arterial expansion, while the other waves are related to retrograde venous pulsations. When ICP rises, the P2 wave increases and, to a lesser extent, the P3 wave also increases, with minimal changes in P1. This gives the cerebral pulse curve a rounded appearance. If ICP continues to rise, the waves disappear and the pulse curve shows a pyramidal morphology corresponding to a large P2.

When cerebral distensibility is altered, the ICP tracing may show pathological waves. Lundberg A waves, or plateau waves, are rapid and significant ICP elevations to 50-100 mmHg that remain constant for 5 to 20 minutes and then decrease rapidly. They occur in patients with very low cerebral compliance, in whom small volume changes produce substantial ICP increases. B waves are cyclical ICP increases with a

frequency of approximately 0.5-2 per minute and an amplitude usually between 10 and 30 mmHg. They usually occur in states of low intracranial compliance. C waves are passive ICP variations with low amplitude and a frequency of 4-5 per minute and are thought to be caused by cyclic blood-pressure variations related to systemic waves [9-11]. The management of traumatic brain injury and complex neurosurgical pathology therefore requires specialized care and intensive therapy.

Monitoring hemoglobin oxygen saturation in the internal jugular bulb can be used to indirectly estimate cerebral oxygen balance and cerebral blood flow. This measure helps determine whether cerebral blood flow is adequate, excessive, or insufficient to meet oxygen metabolic demand [12, 13]. Becker, Ward, and colleagues [14] showed that early diagnosis and intensive management can improve outcomes in severe head injury, while Narayan and colleagues [15] emphasized that neurotrauma patients benefit from experienced, high-quality neurocritical care systems. Decompressive craniectomy (DC) has historically been used to treat intracranial hypertension refractory to medical treatment. Kocher [16] and Cushing [17] were among the first to report surgical decompression techniques aimed at controlling intracranial pressure. This procedure remains controversial because published studies have reported variable effects on survival and functional outcome [18, 19]. Sahuquillo and Arikian [20] concluded in their 2006 Cochrane review that evidence was insufficient at that time to confirm or refute decompressive craniectomy in adults. Subsequent randomized studies, including DECRA, evaluated decompressive craniectomy in patients with severe traumatic brain injury and refractory intracranial hypertension [21].

In DECRA, bifrontotemporoparietal decompressive craniectomy reduced intracranial pressure and ICU length of stay, but was associated with worse functional outcomes at 6 months [21]. Guidelines for the surgical management of traumatic brain injury by

Bullock and colleagues [22] describe decompressive procedures, including subtemporal decompression, temporal lobectomy, and hemispheric decompressive craniectomy, as management options in selected patients with intracranial hypertension and diffuse parenchymal injury with clinical and imaging evidence of impending herniation [22, 23]. Later evidence, including the RESCUEicp trial and updated Cochrane review, suggests that decompressive craniectomy can reduce mortality in selected patients, but the balance between survival and long-term disability remains controversial [24, 25].

## 5. Conclusions

1. The most frequent favorable outcome for patients with traumatic brain injury was good recovery, observed in 91 cases (70%). The 19-34 age group accounted for 9 of 16 unfavorable outcomes (56.25%).

2. Males accounted for the majority of patients who underwent surgery and neurocritical care (103 out of 130, or 79%).

3. Assault was present in 84 cases (64.62%) and accounted for 13 of 16 unfavorable outcomes (81.25%).

4. Seventy-five percent of patients with an unfavorable outcome had a Glasgow Coma Scale score of 8 or less at admission (12 of 16 cases).

5. Tomographic studies revealed depressed skull fractures in 52% (68 cases).

6. Eight of the 16 patients with an unfavorable outcome had epidural hematoma (50%). Craniotomy as a neurosurgical technique was performed in more than 50% (75 cases).

7. Fifty-one patients (39.23%) who underwent surgery with neurocritical care required mechanical ventilation.

8. Patients requiring ventilation for more than 8 days accounted for 50% of unfavorable outcomes (8 of 16 cases).

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