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Results of Surgical Treatment and Prognostic Factors in Patients Operated for Severe Traumatic Brain Injury in Three Referral Hospitals in Yaoundé

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Abstract

Background and Aim: Severe traumatic brain injury (TBI) is a major global health issue associated with high morbidity and mortality. Despite advancements in neurosurgical management, data on surgical outcomes and prognostic factors in resource-limited settings remain scarce. This study aimed to evaluate the surgical outcomes and prognostic indicators in patients undergoing surgery for severe TBI in three referral hospitals in Yaoundé, Cameroon. **Methods and Materials/Patients:** A descriptive and analytical study was conducted with retrospective and prospective data collection from January 2015 to April 2023. Patients diagnosed with severe TBI (Glasgow Coma Scale ≤ 8) who underwent neurosurgical intervention were included. Data on demographic characteristics, clinical presentation, imaging findings, surgical techniques, complications, and long-term functional outcomes were analyzed using IBM SPSS version 26.0. Prognostic factors were assessed using statistical tests, with a significance threshold of $p < 0.05$. **Results:** A total of 129 patients were included, with a male predominance (90%) and a mean age of 37.67 ± 15.63 years. Road traffic accidents accounted for 70% of cases. Craniotomy was the most frequently performed procedure (37.9%), with extradural hematoma being the leading surgical indication (25.6%). The overall postoperative mortality rate was 18.6%. Poor prognostic factors included advanced age (≥60 years, $p < 0.001$), low Glasgow Coma Scale (≤5, $p < 0.001$), bilateral mydriasis ($p = 0.001$), and intraparenchymal hematomas (mortality risk 7.2 times higher). One-year follow-up showed favorable recovery in 81.4% of patients, with progressive improvement on the Glasgow Outcome Scale and Short Form-36 quality of life assessment. **Conclusion:** Severe TBI remains a critical neurosurgical emergency with significant mortality and morbidity. Early surgical intervention, improved prehospital care, and multidisciplinary postoperative management are essential for optimizing outcomes. Strengthening trauma care systems, ensuring rapid transport, and expanding specialized neurosurgical services are necessary to improve survival and long-term functional recovery in resource-limited settings.

Keywords

Traumatic Brain Injury, Prognosis, Surgical Outcomes, Quality of Life

1. Introduction

Severe traumatic brain injury (TBI) is a major public health issue due to its high morbidity, mortality, and socioeconomic burden. It constitutes a significant proportion of neurosurgical emergencies, requiring urgent multidisciplinary care. Primary brain injuries occur at the moment of impact, while secondary injuries result from subsequent biochemical and physiological processes, contributing to further neuronal damage. Timely intervention, including computed tomography (CT) imaging and specialized critical care, plays a crucial role in improving outcomes. Globally, over 10 million people suffer from TBI annually, with road traffic accidents (RTA) being the leading cause. In France, 155,000 cases occur each year, resulting in 8000 deaths and 4000 comas, with 9 percent classified as severe (GCS $\leq$ 8) [1]. In Canada, the incidence of severe TBI is estimated at 9 to 17.1 per 100,000 population [2]. In Africa, RTAs remain the predominant cause of TBI. In Morocco, official statistics from 2013 reported 67,926 accidents, leading to 3832 deaths [3]. In Mali, severe TBI accounted for 51 percent of cases, with mortality rates reaching 30 to 50 percent [4]. In Cameroon, severe TBI mortality rates are as high as 77 percent [5]. Advances in neuroimaging, neuroanesthesia, and neurosurgical equipment and technic have improved management, yet challenges persist, particularly in resource-limited settings. Prognosis is primarily influenced by age, GCS score, pupillary response, intracranial hematomas, and timing of surgery. Despite existing literature on TBI, there is a lack of data on long-term surgical outcomes in Cameroon. This study aims to evaluate the surgical outcomes and prognostic factors in patients with severe TBI undergoing surgery in three referral hospitals in Yaoundé.

2. Methods and Materials/Patients

This study is a descriptive and analytical investigation with both retrospective and prospective data collection. It was conducted in three referral hospitals in Yaoundé:

Yaoundé General Hospital, Yaoundé Central Hospital, and the Military Hospital. The study was conducted over six months, from December 2023 to June 2024, while patient recruitment covered nine years and three months, from January 2015 to April 2023. The target population included all patients admitted to emergency and neurosurgery departments. The source population consisted of a retrospective component involving medical records of patients diagnosed with severe traumatic brain injury (TBI) who underwent neurosurgical treatment and a prospective component involving direct patient interviews through outpatient consultations or telephone follow-ups.

The inclusion criteria were patients diagnosed with severe TBI (Glasgow Coma Scale ≤ 8 and/or evolving cerebral lesions) after stabilization of hemodynamic and respiratory status who underwent neurosurgical treatment, patients alive at the time of data collection (at least one-year post-surgery), and patients aged 10 years and above. The exclusion criteria were patients younger than 10 years, patients with incomplete medical records, patients who died before receiving medical care, and patients with mild or moderate TBI from admission to discharge. A consecutive, non-exhaustive sampling method was used.

The study variables included sociodemographic data (age, sex, occupation, mode of transport, time to surgery), clinical data (neurological status including GCS on admission, pupil response, sensory-motor deficits, seizures, signs of intracranial hypertension; hemodynamic status including heart rate, blood pressure, respiratory rate, oxygen saturation, urine output; general examination including temperature, scalp or facial injuries, otorrhea/rhinorrhea, associated injuries), paraclinical data (imaging findings, biological test results), therapeutic data (treatment modalities, type of surgical intervention, surgical indications), and prognostic factors (evolution and outcomes).

Data were collected using a structured questionnaire and entered into Microsoft Word 2016, while analysis was performed using IBM SPSS version 26.0. Categorical variables were presented as frequencies and percentages. Chi-square (χ^2) tests were used for statistical comparisons, with a p-value < 0.05 considered statistically significant. Graphical representations were created using Microsoft Excel 2016. The study was conducted strictly for scientific purposes, with no financial or material incentives offered for participation. Access to collected data was restricted to the research team.

3. Results

A total of 129 patients who underwent surgical treatment for severe traumatic brain injury (TBI) were included in the study.

Sociodemographic Profile

The mean age of the patients was 37.67 ± 15.63 years, ranging from 10 to 80 years. The majority of patients (34.9%) were aged between 30 and 40 years (**Figure 1**). The study population was predominantly male, with 116 men (90%) and 13 women (10%), resulting in a male-to-female ratio of 8.92 (**Figure 2**).

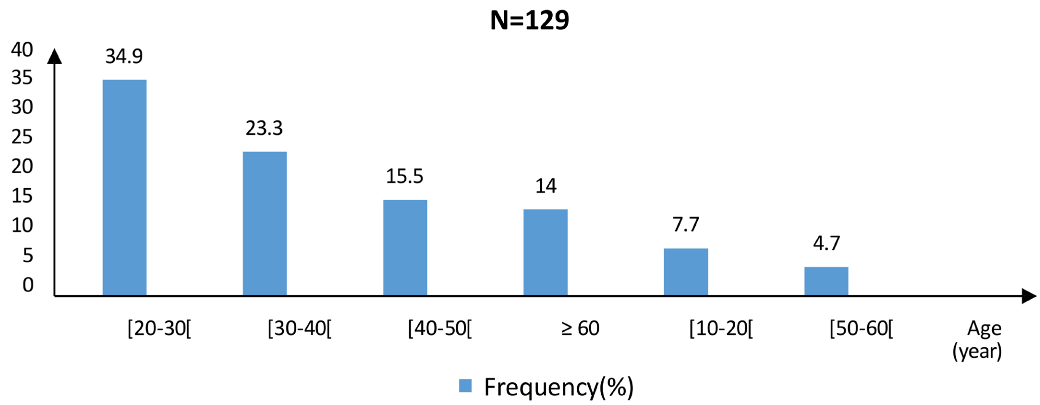

Figure 1. Age distribution of study population.

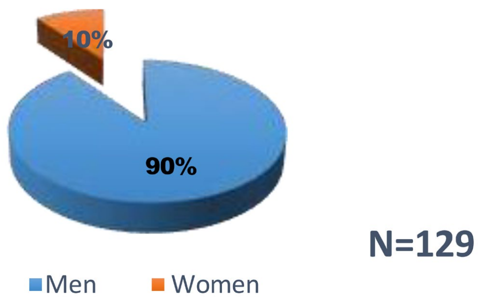

Figure 2. Breakdown of study population by gender.

In terms of occupation, 64.3% of patients belonged to the low-income class, with students (18.6%) and traders (16.3%) being the most represented. Road traffic accidents accounted for 70% of cases. Non-medicalized transport was the most common mode of patient transport, used in 91.5% of cases.

Clinical Characteristics

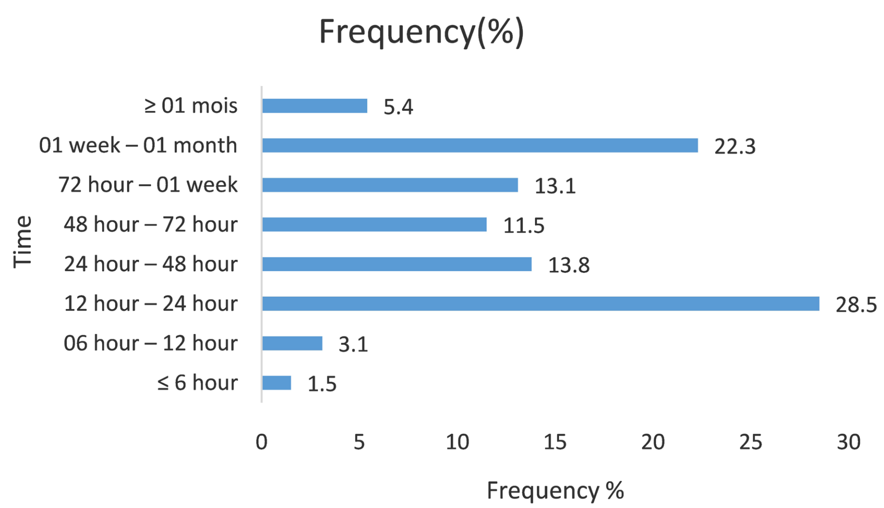

Figure 3. Distribution of study population by time from incident to surgery.

The time interval between the incident and neurosurgical intervention was 12

- 24 hours in 28.5% of cases (**Figure 3**).

Initial loss of consciousness was reported in 56.6% of patients. At admission, 90% of patients had a Glasgow Coma Scale (GCS) score between 6 and 8. Signs of intracranial hypertension were observed in 73% of cases. Mydriasis was present in 19.4% of patients, and hypertension was the most common comorbidity, found in 3.9% of cases.

Imaging Characteristics

Computed tomography (CT) findings revealed that intracranial lesions were the most frequent, accounting for 66.8% of cases. Extradural hematoma (28%), acute subdural hematoma (22.5%), and skull fractures (25.6%), including depressed fractures (20.1%), were the most common findings. The predominant location of intracranial hematomas was the temporoparietal region (38.4%), followed by the parietal region (32.5%).

Neurosurgical Indications and Techniques

The most common surgical indication was the evacuation of extradural hematoma (25.6%), followed by acute subdural hematoma evacuation (21.7%), depressed skull fractures (20.1%), and chronic subdural hematoma evacuation (16.3%). Craniotomy was the most frequently performed neurosurgical procedure (37.9%), followed by burr hole trephination (29.5%). Most patients were discharged within two to three weeks postoperatively. **Figures 4(A)-(F)**

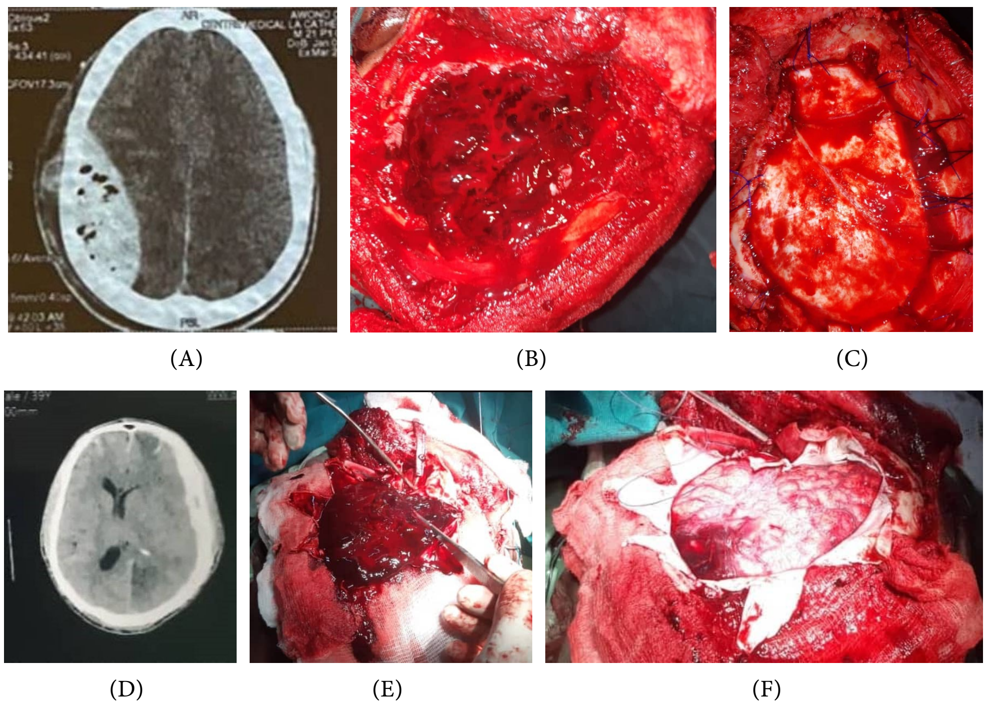

Figure 4. Illustrative cases: (A) Axial Brain CT scan showed right parietal extradural hematoma; (B) Per operative image of extradural hematoma; (C) Evacuation of extradural hematoma and suspension of dura-mater; (D) Axial Brain CT scan showed Left hemispheric acute subdural hematoma with important ventricular mass effect; (E) Decompressed craniotomy and opening of dura-mater; (F) Evacuation of subdural hematoma.

Prognostic Factors

Older age was associated with increased mortality, with patients aged ≥ 60 years at higher risk ($p < 0.001$). Mydriasis was significantly correlated with mortality ($p = 0.001$). Patients with a GCS score between 3 and 5 had a 17.5-fold increased risk of postoperative mortality ($p < 0.001$). Intracerebral hematomas increased mortality risk by 7.2 times, while acute subdural hematomas increased the risk by 2.6 times. No significant associations were found between independent factors and mortality. The delay in surgical management was not significantly associated with mortality (Table 1).

Table 1. Prognostic factors.

Age range (Years)	Deceased		OR (IC à 95%)	P-value
	Yes	No		
	N = 24; n (18.6%)	N = 105; n (81.4%)		
[10 - 20[	2 (8.3)	8 (7.6)	0.281 (0.046 - 1.534)	0.712
[20 - 30[	4 (16.7)	41 (39)	0.053 (0.01 - 0.265)	0.04
[30 - 40[	2 (8.3)	28 (26.7)	-	0.05
[40 - 50[	7 (29.1)	13 (12.3)	0.334 (0.78 - 1.425)	0.138
[50 - 60[	1 (0.4)	5 (1.2)	0.78 (0.06 - 1.538)	0.98
≥60	8 (33.3)	10 (9.5)		**0.00**
Pupil condition				
Mydriasis	12 (50)	13 (12.3)	-	**0.001**
Myosis	2 (8.3)	13 (12.3)	0.00	0.999
Anisocoria	-	2 (2)	1.00 (0.196 - 5.108)	1.00
Normal	10 (41.7)	65 (62)	6.00 (2.144 - 15.79)	0.06
State of consciousness on admission				
3 - 5	7 (29.2)	5 (4.7)	**17.52 (3.727 - 78.014)**	**0.00**
6 - 8	17 (70.8)	100 (95.3)	-	0.8
Intracranial lesions				
Extradural hematoma	5 (20.8)	36 (34.3)	-	0.557
Acute subdural hematoma	9 (37.5)	25 (23.8)	2.592 (0.778 - 8.661)	0.122
Chronic subdural hematoma	3 (12.5)	19 (18.1)	1.137 (0.245 - 5.279)	0.870
Intraparenchymal hematoma	3 (12.5)	3 (2.8)	**7.20 (1.128 - 45.958)**	0.037
Embarrassment	3 (12.5)	11 (10.5)	1.964 (0.403 - 9.558)	0.403
Skull base fracture	0	5 (4.7)	0.000	0.999
Meningeal hemorrhage	1 (4.2)	5 (4.7)	1.440 (0.138 - 14.97)	0.760

Postoperative Evolution

Patients was seen 1, 6, and 12 months after discharged.

At short-term follow-up, 81.4% of patients had a favorable postoperative course, while the overall mortality rate was 18.6%. The most common postoperative complications were status epilepticus (8.5%) and pulmonary infections (5.4%).

At long-term follow-up, most patients were reviewed two years after surgery (31.4%). The Glasgow Outcome Scale (GOS) showed a progressive improvement in recovery over time (Figure 5), with 88.5% of patients achieving good recovery at one year.

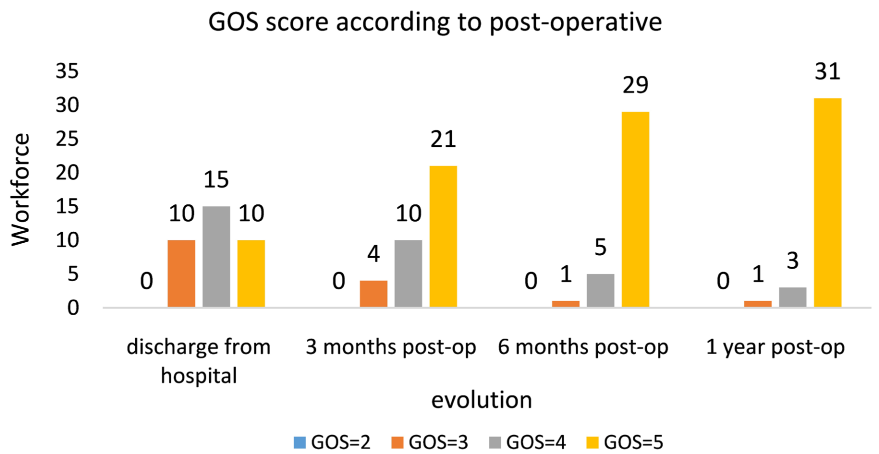

Figure 5. Distribution of GOS score according to postoperative course.

A higher initial GCS score correlated with better recovery outcomes (Figure 6, Figure 7).

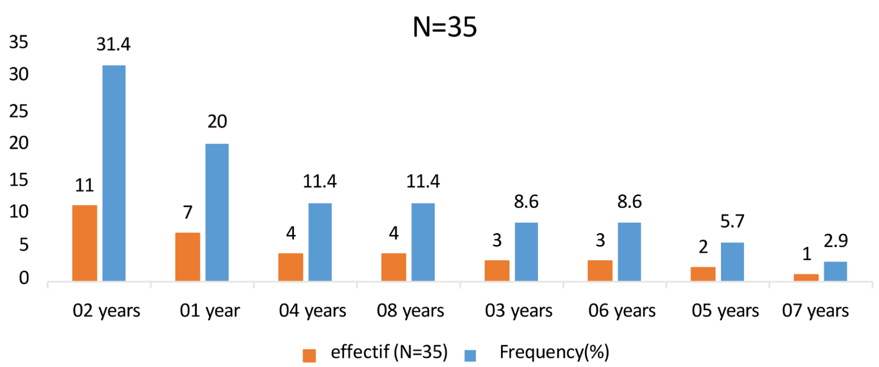

Figure 6. Distribution according to years of postoperative follow-up.

Analysis of patient outcomes according to the GOS indicated that all patients were discharged home after surgery (Table 2).

Table 2. Patient place of residence according to GOS score.

GOS	GOS = 2	GOS = 3	GOS = 4	GOS = 5
At home	0	1	3	31
Institution	0	0	0	0
Hospital	0	0	0	0

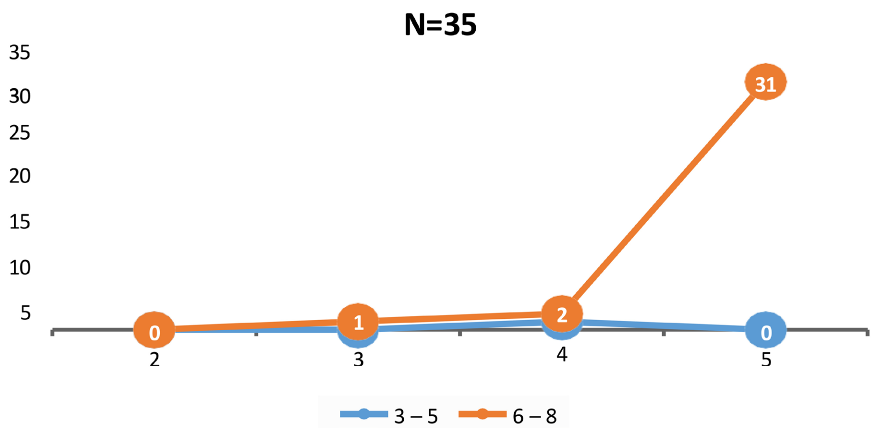

Figure 7. Distribution Glasgow score in the initial phase of care according to the GOS score.

Those with persistent disabilities required additional assistance (Table 3), and return to professional activity was significantly influenced by the degree of disability (Table 4). Changes in social or external activities were significantly associated with GOS classification, whereas depression and relationship problems were not (Table 5).

Table 3. Need for help according to GOS score.

GOS	2	3	4	5
Need for help				
Yes	0	1	2	0
No	0	0	1	31
Total	0	1	3	31

Table 4. Return to work according to GOS score.

GOS	2	3	4	5
Professional activity				
Yes	0	0	0	28
No	0	1	3	3

P < 0.001.

Table 5. Existence of a change in outdoor or social activities according to the GOS score.

GOS	2	3	4	5	P
External change	0	1	3	2	**0.00**
Relational	0	1	2	1	0.02
Depression	0	1	3	7	0.07

Quality of Life Assessment (SF-36)

The mean SF-36 scores across different dimensions were analyzed at one year postoperatively (Table 6). There were no significant differences between the general population and patients with a GOS score of 5 (Table 7).

Table 6. Mean and standard deviation of the SF-36 score by dimension at 01-year post-surgery.

Dimensions	Mean/standard deviation
Physical activity (PF)	82.61 ± 18.62
Limitations due to physical condition (RP)	73.29 ± 35.93
Physical pain (BP)	73.35 ± 30.56
Perceived health (GH)	74.09 ± 15.98
Vitality (VT)	58.49 ± 17.97
Life and relationships with others (SF)	77.86 ± 21.12
Limitations due to mental state (RE)	78.22 ± 32.44
Mental health (MH)	78.06 ± 12.99

Table 7. Mean and standard deviation of the SF-36 score by dimension at 01-year post-surgery compare to general population.

Dimensions	GOS 5	General population	P
Physical activity (PF)	82.61 ± 18.62	84.45 ± 21.19	0.58
Limitations due to physical condition (RP)	78.70 ± 25.94	81.21 ± 32.20	0.98
Physical pain (BP)	69.48 ± 23.65	73.39 ± 23.73	0.49
Perceived health (GH)	62.74 ± 18.43	69.13 ± 18.57	0.58
Vitality (VT)	58.82 ± 17.65	59.96 ± 18.05	0.35
Life and relationships with others (SF)	81.54 ± 18.94	81.55 ± 21.41	0.20
Limitations due to mental state (RE)	81.90 ± 29.76	82.13 ± 32.15	0.39
Mental health (MH)	80.12 ± 10.76	82.13 ± 17.62	0.34

4. Discussion

Sociodemographic Characteristics

The high male predominance (90%) observed aligns with studies by Assamadi *et al.* (84.9%) [3] and Tanapo *et al.* (87%) [6], reflecting the fact that men, particularly young adults, are more likely to engage in high-risk activities such as driving motorcycles or working in labor-intensive jobs. The mean age of 37 years is consistent with Eyenga *et al.* (36.88 years) [4] and Aguémon *et al.* (32 years) [7], further supporting the notion that the most economically active demographic is also the most exposed to severe trauma.

The socioeconomic distribution of our study participants, where 64.3% belonged to low-income groups, also reflects a common pattern in low-resource settings. Similar findings were reported by Njall Pouth *et al.* in Douala, where students and informal workers represented a large proportion of TBI cases [8]. Limited access to safety regulations, lower rates of helmet and seatbelt use, and the need for daily mobility in precarious environments may contribute to this trend.

Mechanism of Injury and Prehospital Transport

Road traffic accidents (RTAs) accounted for 70% of cases, consistent with findings from Assamadi *et al.* (84%) [3] and Tanapo *et al.* (74.5%) [6]. This high prevalence may be attributed to rapid urbanization, poor road infrastructure, and non-compliance with traffic regulations. The significant proportion of firearm-related TBIs (17%) suggests an increase in interpersonal violence and insecurity in certain urban areas, a trend also reported in other African settings [9].

Non-medicalized transport was used in 91.5% of cases, similar to the findings of Razafindraibe *et al.* (95.2%) [10] and Aguémon *et al.* (91%) [7]. The limited availability of emergency medical services (EMS) in Cameroon and other low-resource settings contributes to this problem, with most patients being transported by relatives or bystanders. The lack of prehospital stabilization may worsen secondary brain injury due to delayed airway protection, hypotension, or hypoxia, negatively impacting patient prognosis [11].

Time to Surgery and Initial Clinical Presentation

Delayed surgical intervention was a major concern, with 28.5% of patients admitted between 12 - 24 hours post-injury. Motah *et al.* found that 22.2% of cases were admitted within a similar timeframe [9], while studies in Benin reported mean delays of up to 120 hours [11]. These delays may result from long travel distances, financial constraints, and inefficiencies in hospital referral systems. Early surgical intervention is crucial for reducing intracranial pressure (ICP) and preventing further neurological deterioration. The observed delays in our setting likely contributed to poorer outcomes compared to high-income countries, where most severe TBI cases undergo surgery within the first six hours post-injury [12].

At admission, 90% of patients had a Glasgow Coma Scale (GCS) score of 6 - 8, with 10% scoring 3 - 5. Similar distributions were reported by Benhayoun *et al.* and Khalil *et al.* [12]. The predominance of moderate-to-severe TBI at presentation suggests that only the most critical cases reach neurosurgical centers, as milder cases may be managed in general hospitals or remain unreported.

Radiological Findings and Surgical Indications

Intracranial lesions were the most common pathology (70.7%), with extradural hematomas (28%) and subdural hematomas (22.5%) being the leading indications for surgery. This aligns with Khalil *et al.* (26.6% extradural hematomas) [12]. The temporoparietal region was the most affected, as reported in studies from Madagascar [13]. The predominance of extradural hematomas is expected, given that they often result from high-impact trauma and require surgical evacuation to prevent brain herniation.

The choice of surgical technique depended on the severity of the injury and lesion type. Craniotomy (37.9%) was the most performed procedure, followed by trepanation (29.5%). This preference is in line with studies that advocate craniotomy for decompression in cases of space-occupying hematomas, while trepanation is often reserved for less extensive lesions [12]. However, the high use of trepanation in our study suggests that some cases may have been managed with less invasive techniques due to resource constraints.

Postoperative Complications and Prognostic Factors

Postoperative complications included status epilepticus (8.5%) and pneumonia (5.4%), consistent with previous studies where respiratory infections remain a leading cause of in-hospital morbidity after TBI [12]. The mortality rate of 18.6% was similar to findings from Motah *et al.* [9] but lower than some reports from sub-Saharan Africa, where rates range from 30% - 50% [7]. The relatively lower mortality in our study may be attributed to the inclusion of patients who had access to neurosurgical care, as opposed to those who succumbed before reaching a specialized center.

Several prognostic factors were identified. Advanced age (≥60 years) was strongly associated with mortality ($p < 0.001$), in agreement with Errai *et al.* [14]. This could be explained by age-related cerebral atrophy, reduced neuroplasticity, and higher rates of comorbidities. Pupil abnormalities, particularly bilateral mydriasis, were also linked to poor outcomes ($p = 0.001$), as they indicate brainstem dysfunction and impending herniation [15]. The GCS score at admission remained a key predictor, with patients scoring 3 - 5 having significantly higher mortality ($p < 0.001$), as reported in similar studies [12]. Intraparenchymal hematomas had the highest mortality risk (7.2 times higher), followed by acute subdural hematomas (2.6 times higher), reflecting the destructive nature of deep brain injuries [14].

Long-Term Outcomes and Quality of Life

At one year postoperative, the Glasgow Outcome Scale (GOS) showed progressive recovery, with 80% of patients in GOS category 5 returning to work. This finding is consistent with literature emphasizing that functional outcomes improve over time, particularly in patients with initial GCS scores above 6 [16] [17]. However, residual neurological deficits and cognitive impairments remain a concern, particularly for those with diffuse axonal injury.

Quality of life assessment using SF-36 indicated that while physical and mental health domains remained relatively preserved, patients experienced a slight but non-significant decline compared to pre-injury levels. These findings align with studies demonstrating that despite functional recovery, post-TBI patients often report fatigue, headaches, and emotional disturbances [18] [19].

5. Conclusion

Severe traumatic brain injury remains a significant public health issue, with high morbidity and mortality rates. Timely surgical intervention, improved pre-hospital care, and multidisciplinary postoperative management are essential to optimizing patient outcomes. This study highlights the need for structured trauma management strategies, particularly in resource-limited settings. Moving forward, targeted efforts are necessary to strengthen trauma care systems and preventive measures. Authorities should improve road infrastructure, enhance public awareness of road safety, strengthen safety regulations, promote standardized TBI management protocols, and optimize patient evacuation and emergency response strategies. Healthcare professionals should receive continuous training in TBI management, be provided with optimal working conditions, strengthen emergency medical services, and develop functional rehabilitation programs to enhance patient autonomy. Medical practitioners should educate the public on trauma prevention, foster interdisciplinary collaboration, participate in continuous medical education on neurosurgical trauma care, and ensure rapid and effective treatment of TBI. The general population should adhere to traffic regulations and road safety measures and promptly alert emergency services in cases of road traffic accidents. Strengthening preventive strategies, optimizing acute management, and improving long-term rehabilitation are crucial steps toward reducing the burden of traumatic brain injuries. Future research should focus on refining treatment protocols and addressing systemic challenges in trauma care.

Study Limitations

This study had several limitations. The small sample size, a common challenge in severe TBI research, may have affected statistical power. The retrospective nature of part of the study led to the exclusion of incomplete medical records, while the prospective component was limited due to difficulties in patient follow-up. Additionally, the lack of standardized post-discharge monitoring may have introduced bias in long-term outcome assessment.

Author's Contributions

Methodology, data collection and writing: Djoubairou Ben ousmanou, Bello Figuim, Donguim Maxime, Haman Nassourou.

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Analysis Interpretation of data: Djoubairou Ben ousmanou, Bello figuim, Donguim Maxime.

Drafting the article, Reviewing submitted version of manuscript, Approving the final version of the manuscript: all authors.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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