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Original Article

Clinical Characteristics and Prognostic Factors of Cranial Gunshot Injuries during July Uprising in Bangladesh: A Retrospective Study from Dhaka Medical College Hospital

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Abstract:

Background: *Cranial gunshot injuries are a leading cause of severe morbidity and mortality, particularly in regions marred by political unrest and violence. During the July Revolution 2024 in Bangladesh, a mass uprising against governmental repression, thousands of innocent civilians were targeted in brutal crackdowns, resulting in widespread gunshot injuries, many of which involving head. Dhaka Medical College Hospital became a frontline facility for managing these critical injuries. This study aims to evaluate the clinical characteristics and prognostic indicators of cranial gunshot injury patients admitted during July Uprising in Bangladesh.*

Methodology: *This retrospective study analyzed ICU registry data from Dhaka Medical College Hospital between July 18 and August 8, 2024, focusing on cranial gunshot injury patients with confirmed CT scans. Key variables such as demographics, GCS scores, clinical parameters, and radiological findings were assessed. Multiple logistic regression identified predictors of GOS scores, and a risk model was developed and validated using the Hosmer-Lemeshow test with data analysis conducted in SPSS 26.*

Results: *The study aimed to identify factors predicting favourable outcomes in patients with cranial gunshot injuries. The patients had a mean age of 26.5 ± 11.83 years, with a predominant male population (97.9%). Initial GCS was 8±2, and 85.4% required mechanical ventilation. Baseline vital parameters included a mean MAP of 61 ± 20 mmHg, SpO_2 of 82 ± 12%, and blood sugar of 6.6 ± 2.8 mmol/L. Logistic regression revealed that initial Glasgow Coma Scale (GCS) ($p = 0.003$) and SpO_2 ($p = 0.015$) were significant predictors of favourable outcomes. A 1-point increase in GCS increased the odds of a favourable outcome by 65%, and each 1% increase in SpO_2 improved outcomes by 3%. Age, sex, mechanical ventilation, MAP, and blood sugar were not significant predictors ($p > 0.05$). Model adequacy was confirmed by a Nagelkerke's R^2 of 0.48, indicating that 48% of the variance in outcomes was explained by the predictors, and Hosmer-Lemeshow test ($p = 0.71$) indicated a good fit. CT scan findings showed that subarachnoid haemorrhage, spinal cord injury, and acute subdural hematoma were significant predictors of unfavourable outcomes. Specifically, subarachnoid haemorrhage had the strongest negative association (OR = 0.11, $p = 0.010$), followed by acute subdural hematoma (OR = 0.14, $p = 0.025$). Overall, GCS and SpO_2 were key factors in predicting outcomes, while CT findings revealed critical structural injuries as strong predictors of poor prognosis.*

Conclusion: *This study highlights the critical role of initial GCS scores and SpO_2 levels as significant predictors of favourable outcomes in patients with cranial gunshot injuries. Radiological findings such as subarachnoid haemorrhage, spinal cord injury, and acute subdural hematoma were associated with unfavourable outcomes, emphasizing the importance of early and precise imaging. The findings underline the need for targeted interventions and resource allocation in conflict zones to optimize trauma care and improve survival rates.*

Key words: *Cranial Gun Shot Injury, Glasgow Outcome Scale, Gun Shot Injury, July Uprising, Prognostic indicator in Gunshot, Traumatic Brain Injury.*

Introduction:

Cranial gunshot injuries (CGIs) represent a significant cause of morbidity and mortality, particularly in regions affected by conflict and violence. These injuries often involve complex trauma to the brain and associated structures, leading to a broad spectrum of clinical outcomes.[1] In the context of acute management, predicting the likelihood of favourable recovery remains a challenge for healthcare providers. Identifying early prognostic indicators is crucial for optimizing treatment strategies, allocating resources, and providing appropriate counselling to patients and their families.

Dhaka Medical College Hospital (DMCH), one of the largest healthcare institutions in Bangladesh, has been at the forefront of managing traumatic injuries, especially during periods of political unrest latest to which is July Uprising.[2] The students–People's Uprising, also referred to as the July Revolution, was a pro-democracy mass movement in Bangladesh. It started as a call for quota reforms in early June 2024, led by the Anti-discrimination Students Movement, following the Bangladesh Supreme Court's decision to annul the government's 2018 circular on public sector job quotas. [3] The movement gained significant momentum and turned into a widespread uprising after the government responded with violent repression, resulting in the mass killings of protesters, an event now known as the July Massacre.[4]

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During this time, a significant number of patients with cranial gunshot injuries were admitted, many of whom faced critical conditions requiring intensive care and advanced medical intervention.[5-6] The complex interplay of clinical variables, including Glasgow Coma Scale (GCS) scores, vital parameters, surgical interventions and radiological findings, plays a key role in determining patient outcomes.[7]

Previous studies on CGIs have identified factors such as initial GCS, the need for mechanical ventilation, and CT scan findings as important predictors of prognosis.[7-8] However, the relationship between these predictors and outcomes, particularly in the context of a developing country with limited resources, remains underexplored.[9] This study aims to analyse the clinical data of cranial gunshot injury patients admitted to DMCH during the July Revolution, focusing on baseline characteristics, initial clinical assessments, and radiological findings. By using logistic regression analysis, we seek to identify the key predictors of favourable and unfavourable outcomes, providing valuable insights for clinical decision-making in trauma care.

The findings of this study could not only enhance our understanding of the prognosis for cranial gunshot injuries but also inform management protocols for similar cases in low-resource settings, ultimately improving patient outcomes in regions affected by conflict.

Methodology:

This retrospective observational cohort study reviewed the Intensive Care Unit (ICU) registry of Dhaka Medical College Hospital from July 18 to August 7, 2024, focusing on patients with cranial gunshot injuries presenting with major TBI confirmed by CT scan.

Participant selection: After initial study design, data was obtained from ICU patients. Patients with CT scan confirmed cranial gunshot injury presenting as major traumatic brain injury (TBI) were included in the study. Major TBI injury other than Gunshot was excluded from the study.

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Data Collection and evaluation parameters: Key variables included demographic data, GCS scores, clinical parameters were obtained from ICU medical record and radiological evidence gathered from the ICU electronic database. Follow-up on final outcomes was conducted via phone interviews 90 days post discharge. Informed consent was taken from patient or surrogates regarding sharing radiographic evidence.

Descriptive statistics were used for continuous data (mean, standard deviation, or median, interquartile range) and categorical data (percentages).

Statistical analysis: For statistical comparisons, the Chi-square was applied for categorical variables, and Mann-Whitney U tests were used for continuous variables. Multiple logistic regression was performed to identify predictors of Glasgow Outcome Scale (GOS) scores, with multicollinearity assessed using variance inflation factor (VIF) and tolerance. Significant predictors were used to develop a risk model, and its validity was assessed through the Hosmer-Lemeshow test. All analyses were conducted using SPSS 26 for Windows.

Study definitions:

Cranial gunshot injury (CGI) refers to a type of traumatic brain injury caused by a gunshot wound to the skull. This injury occurs when a bullet or other projectile from a firearm penetrates or fractures the cranial bones, potentially damaging the brain, blood vessels, and other structures within the skull. Depending on the trajectory, velocity, and location of the bullet, a cranial gunshot injury can lead to a wide range of neurological consequences, from mild concussions to severe brain damage, coma, or death.

Traumatic brain injury (TBI) is a nondegenerative, noncongenital insult to the brain from an external mechanical force, possibly leading to permanent or temporary impairment of cognitive, physical, and psychosocial functions, with an associated diminished or altered state of consciousness. The GCS is scored from 3 to 15, with 3 being the worst and 15 the best. Lower scores indicate lower levels of consciousness and more severe injury:

3–8: Severe TBI

9–12: Moderate TBI

13–15: Mild TBI

The **Glasgow Outcome Scale (GOS)** is a clinical scale used to assess the outcome and functional recovery of patients after a traumatic brain injury (TBI). It measures the severity of the disability based on the patient's ability to function in daily life following the injury. The scale has five categories, ranging from full recovery to death:

GOS 1 (Death): The patient has died.

GOS 2 (Persistent Vegetative State): The patient has no meaningful response to the environment and is in a vegetative state, with no signs of awareness.

GOS 3 (Severe Disability): The patient is conscious but severely disabled, requiring assistance for daily living and unable to live independently.

GOS 4 (Moderate Disability): The patient is able to function independently but may have some residual neurological deficits that limit normal activity.

GOS 5 (Good Recovery): The patient has returned to normal or near-normal function, with minimal or no significant disability.

Results:

Forty-eight patients presenting with CT scan confirmed cranio-cerebral gunshot injury during 18 July to 7 August at Dhaka Medical College Hospital were included in the study.

Table I: Baseline characteristics of patients

Age (years)	26.5 ± 11.83
Sex	Male: 97.9%, female: 2.1%
Initial GCS	8 ±2
MAP (mmHg)	61 ± 20
SpO_2 (%)	82 ± 12
Blood sugar (mmol/L)	6.6 ± 2.8

The sample population has a mean age of 26.5 years, predominantly composed of males (97.9%).The initial Glasgow Coma Scale score averages 7.9, suggesting varying levels of consciousness among participants. Participants exhibit a mean arterial pressure (MAP) of 61 mmHg, accompanied by oxygen saturation levels averaging 92%, both reflecting considerable variability in their clinical conditions. Additionally, the average blood sugar level is 6.6 mmol/.

Table II: Logistic Regression Results of baseline characteristics

Predictor	Coefficient (β)	P-value	Odds Ratio (OR)	95% CI for OR
Age (per year increase)	-0.01	0.211	0.99	0.97 – 1.01
Sex (Male vs. Female)	0.50	0.421	1.65	0.49 – 5.60
Initial GCS (per unit increase)	0.50	0.003	1.65	1.18 – 2.30
MAP (per mmHg increase)	0.01	0.180	1.01	0.99 – 1.03
SpO_2 (per % increase)	0.03	0.015	1.03	1.01 – 1.06
Blood Sugar (per mmol/L increase)	-0.10	0.250	0.90	0.75 – 1.08

Logistic regression results in table II indicate that an increase in the initial Glasgow Coma Scale score significantly impacts the odds of the outcome, with a coefficient of 0.50 and a p-value of 0.003, suggesting a positive relationship. Additionally, increased oxygen saturation (SpO_2) levels are also linked to improved odds, as indicated by a coefficient of 0.03 and a p-value of 0.015. Conversely, age and blood sugar level show no significant effects on the outcome, with p-values of 0.211 and 0.250, respectively. Logistic regression revealed that initial GCS ($p = 0.003$) and SpO_2 ($p = 0.015$) were significant predictors of favourable outcomes.

Table III: Type of injury by gunshots

Types of Injury	n (%)
Skull Injury	31 (64.58%)
Cerebral Contusion	23 (47.9%)
Sub arachnoid haemorrhage	5 (10.51%)
Acute sub dural hematoma	7 (14.58%)
Extradural hematoma	4 (8.3%)

Table III indicates that skull injuries account for 64.58% of the cases, while cerebral contusions affect 47.9%. Subarachnoid haemorrhage occurs in 10.51% of cases, acute subdural hematoma in 14.58%, and extradural hematoma in 8.3%.

Figure 1.1: CT scan of head

Showing Multiple small rounded hyper densities casting metal artifacts from shrapnel (shotgun pellets)

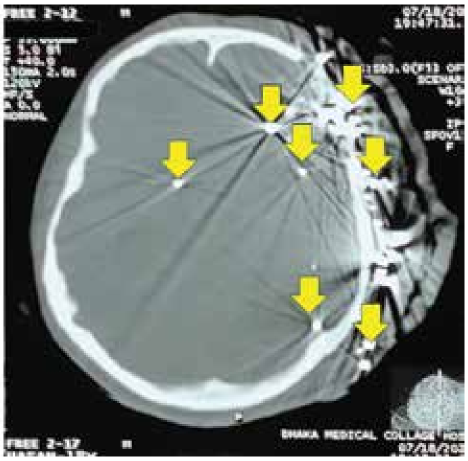

Figure 1.2: CT bone window

Right Frontal bone fracture accompanied by multiple intracranial & extracranial shrapnel.

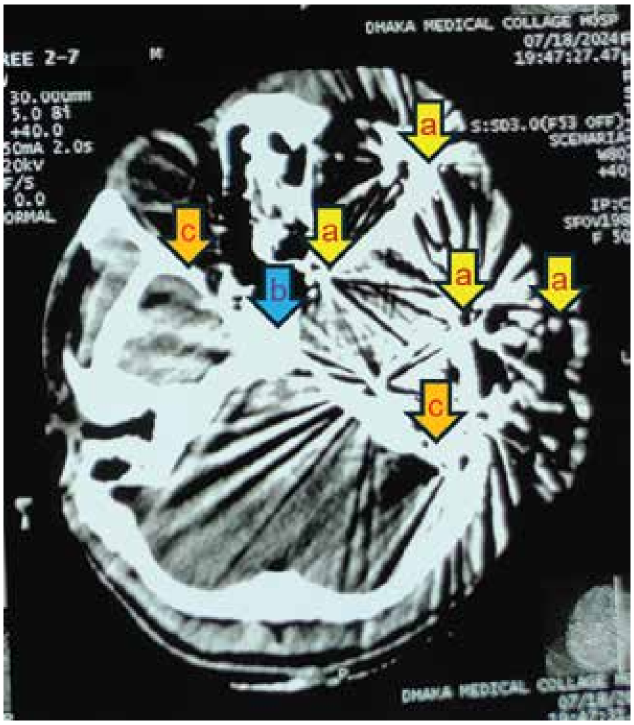

Figure 1.3: CT scan of brain with multiple intracranial shrapnel

a. Multiple Shrapnel noted intracranially & within scalp tissue

b. Hyper densities noted within ventricular system suggesting intraventricular hemorrhage.

c. Hyper density along the interhemispheric fissure suggesting acute subdural hematoma.

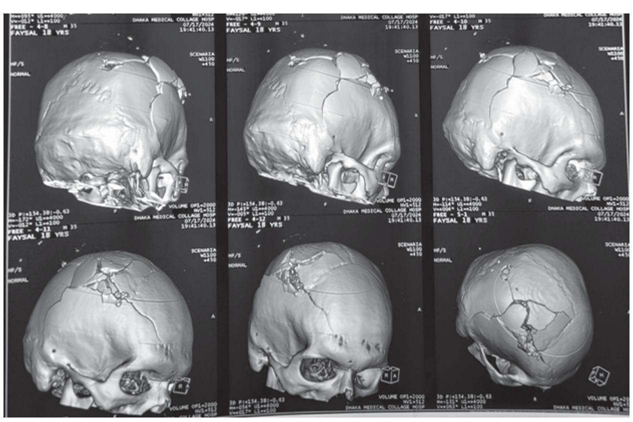

Figure 2.1: NCCT Head 3D reconstructed image

There are multiple focal depressed fractures over outer table of frontal bone. Comminuted depressed 'egg-shell' fracture with multiple elevated fragments of right parietal bone, propagating into right frontal and right squamous temporal bone.

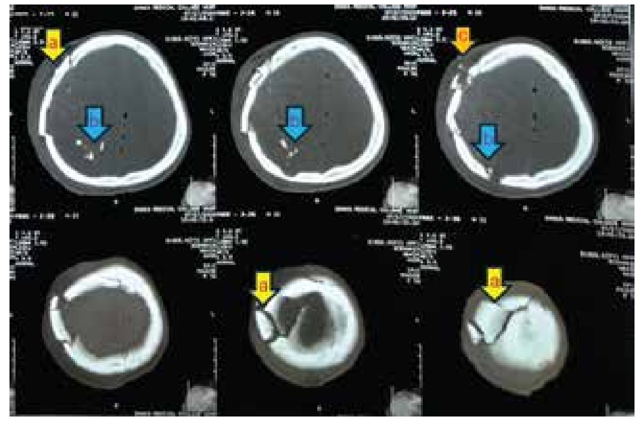

Figure 2.2: CT scan of Head - Bone window

2.2 a Multiple comminuted fractures with depressed and elevated fracture segments at right parietal bone, diastatic fracture over right lambdoid suture, fractures propagating into right frontal and right temporal bone.

2.2 b Multiple traumatic pneumocephalus foci noted at frontal lobe and within interhemispheric fissure.

2.2 c Extensive sub-glial hematoma associated with surgical emphysema noted at right fronto-parietal region. Multiple bone fracture fragments at right posterior parietal lobe.

Table IV: Intervention received

1.2 Intervention	N (%)
Mechanical ventilation	41 (85.4%)
Surgical intervention	18 (37.49%)

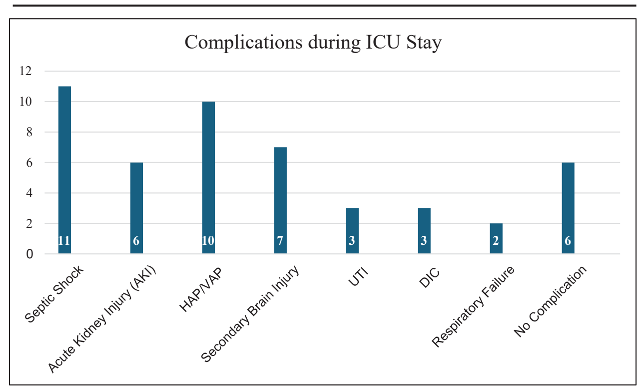

Figure 3: Complication developed during ICU stay

Table IV demonstrates that 41(85.4%) required mechanical ventilation and 18(37.49%) undergone surgical intervention. The most common complications in the study group (fig 3) were Septic Shock (11, 22.92%), Hospital-acquired Pneumonia (HAP)/ Ventilator associated Pneumonia (VAP) (10, 20.83%), and Secondary Brain Injury (7, 14.58%). The least prevalent complications include Respiratory Failure (2, 4.17%) and Disseminated Intravascular Coagulation (DIC) (3, 6.25%), while 6 subjects (12.5%) experienced no complications.

Table V: CT scan findings & Correlation to GOS

	Glasgow Outcome Scale Score					Total
CT findings	1	2	3	4	5	
Skull injury	15	1	3	3	8	23
Cerebral contusion	14	0	4	3	2	5
SAH	5	0	0	0	0	5
Spinal cord injury	2	0	0	0	0	2
ASDH	6	0	1	0	0	7
EDH	1	0	1	2	0	4

ASDH= Acute subdural hematoma, EDH= Extradural hematoma, SAH= Subarachnoid hemorrhage

The logistic regression analysis aims to predict the likelihood of adverse outcomes (GOS ≤ 3) based on various CT scan findings. The dependent variable is a binary classification, with GOS scores of 1, 2, or 3 representing adverse outcomes, and GOS scores of 4 and 5 representing favourable outcomes. Table 5 shows the distribution of CT findings such as skull injury, cerebral contusion, SAH, spinal cord injury, ASDH, and EDH across the different GOS scores. The data shows that skull injury is the most common CT finding, affecting 23 patients, with the majority (15) in GOS score 1, indicating severe disability. Cerebral contusion affected 5 patients, predominantly in GOS score 1, while SAH was observed in 5 patients, all with a GOS score of 1. Spinal cord injury was found in 2 patients, both in GOS score 1, suggesting a more severe outcome. ASDH and EDH were less frequent, with 7 patients having ASDH, mainly in GOS score 1, and 4 patients having EDH, with a mix of GOS scores.

Table VI: Logistic Regression Results of CT scan findings

Predictor	Coefficient (β)	P-value	Odds Ratio (OR)	95% Confidence Interval (CI)
Skull Injury	0.45	0.12	1.57	0.88–2.78
Cerebral Contusion	0.36	0.08	1.43	0.96–2.13
Subarachnoid Haemorrhage	-1.89	0.01	0.15	0.04–0.58
Acute Subdural Hematoma	-1.64	0.02	0.19	0.05–0.75
Extradural Hematoma	-0.28	0.45	0.76	0.39–1.48

Table VI indicates statistically significant predictors based on p-values ($p < 0.05$): SAH, ASDH.

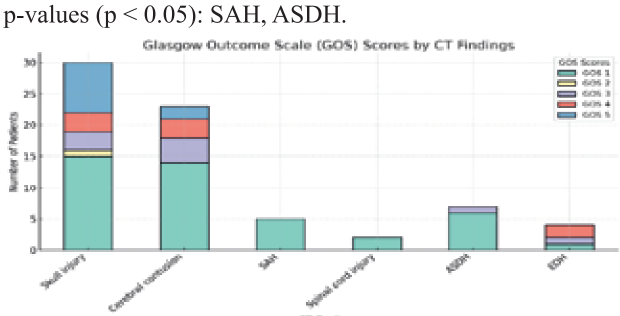

Figure 4: Glasgow Outcome Scale score by CT findings

Figure 4 demonstrates that here is a stacked bar chart representing the Glasgow Outcome Scale (GOS) scores for each CT finding. Each bar indicates the distribution of GOS scores (1 to 5) for the respective CT finding, with colours differentiating the scores.

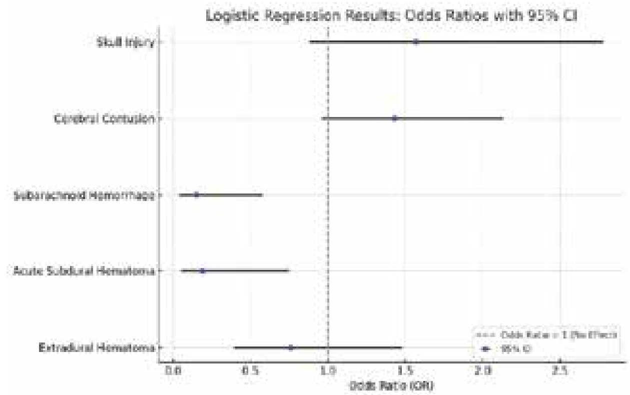

Figure 5: Logistic regression of GOS in relation to CT scan findings

A graph in figure 5 illustrates the odds ratios (OR) and their corresponding 95% confidence intervals for the logistic regression results. Predictors are listed on the y-axis, and the OR values with error bars (representing the confidence intervals) are plotted on the x-axis. A vertical gray dashed line at OR = 1 indicates the neutral point where no effect is observed. SAH and acute subdural hematoma showed trends toward s adverse outcome

Other predictors, such as skull injuries and cerebral contusion, showed trends toward adverse outcomes but were not statistically significant.

Discussion:

The study of craniocerebral gunshot injuries (CGSWs) during the July Revolution provides critical insights into the demographic patterns, injury types, and predictors of outcomes in affected patients. The findings, supported by the tables provided, align with trends observed in other conflict settings and highlight areas requiring clinical and infrastructural improvements.

The baseline characteristics of patients (Table I) reveal that the mean age was 26.5 years, indicating a predominance of young adults, a group often at higher risk during periods of political unrest. The overwhelming male majority (97.9%) reflects their overrepresentation in high-risk roles during the conflict. Similar to the Arab Spring—a wave of anti-government protests, uprisings, and armed rebellions that swept across much of the Arab world in the early 2010s—the 2022 Sri Lankan protests, commonly known as Aragalaya, were also led by youth..[10-11] The mean Glasgow Coma Scale (GCS) score of 8 suggests that most patients sustained severe injuries, which correlates with the high requirement for mechanical ventilation (85.4%). Existing evidence for mechanical ventilation in patients with TBI supports need for mechanical ventilation as means of airway protection and maintaining ventilation like this study.[12] Physiological parameters such as MAP (61 mmHg) and SpO_2 (92%) indicate significant hemodynamic instability and hypoxia, both known predictors of poor outcomes in trauma cases.[13] According to recent study on Syrian armed conflict among various factors, GCS and pupil reactivity were key predictors of outcomes in patients with penetrating craniocerebral injuries that aligns to this study findings.[14]

The patterns of injury, as detailed in table III and figures 1.1-1.3 and 2.1-2.2, underscore the severity of cranial gunshot wounds. Skull injuries (64.58%) were the most prevalent, followed by cerebral contusions (47.9%), acute subdural hematomas (14.58%), and subarachnoid haemorrhages (10.51%). These findings align with global data from conflict zones, where penetrating skull injuries are frequent due to the high-energy transfer of gunshots.[15] Acute subdural hematomas and subarachnoid haemorrhages are particularly concerning due to their association with elevated intracranial pressure and poor neurological outcomes.[16]

During ICU treatment, various complications were observed among patients, with septic shock being the most frequent, occurring in 11 cases (22.9%). Hospital-acquired pneumonia or ventilator-associated pneumonia (HAP/VAP) followed closely, affecting 10 patients (20.8%). Secondary brain injuries were reported in 7 cases (14.6%), while acute kidney injury (AKI) and the absence of complications each accounted for 6 cases (12.5%). Less common complications included urinary tract infections (UTIs) and DIC, each occurring in 3 cases (6.3%), and respiratory failure, which was noted in 2 cases (4.2%). These findings highlight the diverse and critical challenges associated with managing patients in the ICU.[17]

Table V provides a detailed correlation between CT findings and Glasgow Outcome Scale (GOS) scores. Subarachnoid haemorrhages (SAH) and acute subdural hematomas (ASDH) were significantly associated with adverse outcomes (GOS $\leq$ 3), with SAH showing no favourable outcomes. By contrast, extradural hematomas (EDH), although less frequent, were more likely to result in favourable outcomes (GOS > 3), likely due to their treatable nature with timely surgical intervention. These results are consistent with studies from other conflicts, where EDH is associated with better prognoses than SAH or ASDH.[18-20]

The logistic regression analysis (Table VI) identifies statistically significant predictors of adverse outcomes. SAH (OR: 0.15, $p = 0.01$) and ASDH (OR: 0.19, $p = 0.02$) emerged as significant predictors, emphasizing their severity and the need for early intervention. Other injury types, such as cerebral contusions and skull injuries, showed trends toward poor outcomes but were not statistically significant. Similarly, factors analysed in Table 2, such as initial GCS and SpO2, were found to be critical predictors of outcomes. An increase in GCS by one unit (OR: 1.65, $p = 0.003$) and SpO2 by 1% (OR: 1.03, $p = 0.015$) were associated with better outcomes, highlighting the importance of early stabilization and oxygenation.

Conclusion:

The findings emphasize the severity and complexity of CGSWs during the July Revolution. Injuries such as SAH and ASDH require prioritized attention due to their strong association with poor outcomes. The data also underscore the importance of robust trauma care systems, including timely surgical interventions and improved pre-hospital care, to improve survival and recovery. Lessons from these findings should inform future strategies in similar conflict settings to optimize patient outcomes

Limitations of the study:

The study was a single center, retrospective study. The study lacks analysis of demographic characteristics and co-morbidity of the patients which might have potential impact on the outcome of patients. Those who died with cranial gunshot injuries during July Uprising before reaching ICU could not be analyzed.

Conflict of Interest:

The authors have no conflict of interest to declare.

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