Relationship Between Brain CT Scan Findings, Consciousness Levels, and Outcomes in Brain Trauma Patients: A Cross-Sectional Study

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Abstract

Background: Trauma is the fourth leading cause of mortality worldwide. The Glasgow Coma Scale (GCS) is a crucial tool for evaluating the consciousness levels of trauma patients, serving as a diagnostic instrument for assessing injury severity and the condition of brain trauma patients. Additionally, Computed Tomography (CT) Scans are the most practical and accurate imaging modality for diagnosing the types and locations of lesions in cases of brain trauma in the emergency department. The study was designed to explore the correlation between pathological findings in Brain CT scans and the consciousness levels of brain trauma patients, as assessed by the GCS.

Methods: This cross-sectional descriptive-analytical study investigated 200 brain trauma patients admitted to the emergency department of Khatam Al-Anbia Hospital in Zahedan. Upon arrival, an emergency medicine specialist recorded the patients' consciousness levels based on the GCS criteria. After performing a CT scan and determining the type and location of the lesion, a radiologist, emergency medicine, and neurosurgery specialists determined the continuation of the treatment process. Subsequently, patients requiring admission to the neurosurgery department or intensive care unit were monitored. The final patient status (deceased/survivor) was tracked at the end of the treatment period and added to the checklist. Following data coding and entry into the computer, descriptive statistics, including mean, standard deviation, and confidence intervals, were used for evaluation. Additionally, the Chi-square and independent t-tests, along with SPSS 22, were employed to examine the relationship between consciousness levels and CT scan results.

Results: Three out of 200 patients were excluded from the study due to transfers to other medical facilities during treatment. The mean age of the remaining patients was 27.94 ± 11.25. Results showed that 67.5% of all patients survived, while 32.4% succumbed to injuries. The initial GCS score was 14-15 for 83 patients (42.1%), 9-13 for 69 patients (35%), and 3-8 for 45 patients (22.8%). Brain CT scans of trauma patients predominantly revealed subdural hematomas in 48 patients (24.3%). In the examination of the relationship between the mechanism of brain trauma and mortality, 75% of patients involved in falls and 65.5% in accidents survived, while all patients who experienced other causes of trauma survived. Ultimately, no significant difference was observed between the mechanism of brain trauma and patient mortality (p=0.318). Furthermore, all patients with a GCS score of 14-15 (100%), 85.6% with a GCS score of 9-13, and 35.5% with a GCS score of 3-8 survived. A significant relationship between initial consciousness levels and mortality rates in the emergency department was evident (p=0.001). Statistical analysis indicated that 66.7% of patients with subdural hematomas, 75% with epidural hematomas, 81% with cerebral contusions, 35.3% with intracerebral hemorrhages (ICH), and 92.3% with diffuse axonal injuries (DAI) ultimately survived, signifying a significant relationship between CT scan results and mortality rates (p=0.01). Moreover, the highest mortality rate was observed in patients with ICH, with a frequency of 64.7%.

Conclusions: Simultaneously evaluating consciousness levels using the GCS, along with considering the type of pathology identified in CT scans of brain trauma patients admitted to the emergency department, significantly aids in determining patient mortality rates. Promptly initiating the patient's treatment process can lead to reduced complications from brain trauma and, in some cases, decreased mortality.

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Introduction

Trauma, defined as a tissue injury that occurs due to violence or an accident, triggers responses in the hypothalamic–pituitary–adrenal axis, immunologic, and metabolic systems that aim to restore homeostasis. Trauma can be broadly categorized into three groups: penetrating, blunt, and deceleration trauma [1]. Among various types of trauma, head trauma constitutes a significant portion, playing a pivotal role in the injuries sustained from trauma [2]. Survivors often experience a range of physical disabilities, and treating or mitigating the complications arising from brain lesions can impose a substantial economic burden on society [3].

Various tools are available for assessing the consciousness levels of patients involved in traumatic events, with the Glasgow Coma Scale (GCS) being paramount. The GCS serves as a diagnostic instrument for assessing the severity of injury and the condition of patients with brain trauma. It is widely agreed that the GCS is a valuable tool for evaluating the consciousness levels of individuals facing acute brain issues and can partially estimate their survival rates [4]. The initial GCS score categorizes the extent of brain lesions into three groups: mild (GCS: 14-15), moderate (GCS: 13-9), and severe (GCS: 3-8) [5].

Brain trauma patients can suffer various pathological injuries. When examining the type, location, and volume of potential bleeding, a CT scan proves to be the most accurate imaging tool. It serves as the primary means for diagnosing the types of brain trauma lesions in emergency departments [6]. Swift diagnosis of these brain lesions can expedite the treatment process for patients and reduce the ultimate impact of brain lesion complications on their health. Consequently, the study was designed to investigate the relationship between the pathological findings obtained from brain CT scans and the consciousness levels and outcomes of brain trauma patients who sought care in the emergency department.

Materials ad Methods

Research Design

The present study was an analytical cross-sectional investigation conducted at Khatam Al-Anbia Hospital in Zahedan in 2021. The study received approval from Zahedan University of Medical Sciences (IR.ZAUMS.REC.1396.285) and adhered to ethical considerations. Consent was obtained from patients or their legal guardians.

Statistical Population

The study focused on brain trauma patients who presented at the emergency department of Khatam Al-Anbia Hospital in Zahedan for one year in 2021. Inclusion criteria encompassed individuals aged 20 to 50 years, absence of abdominal bleeding and internal organ or limb rupture, absence of diabetes, no history of seizures, no neuropsychiatric disorders, no poisoning from neuropsychiatric drugs, anticonvulsants, hypnotics, or alcohol, and no history of substance addiction. Exclusion criteria included patients who passed away prior to undergoing a brain CT scan or patients or their legal guardians refusing further treatment or transfer to another healthcare facility. The sample size was set at 200, determined by considering the study's duration and similar research employing simple random sampling on brain trauma patients admitted to the emergency department.

Data Collection

A checklist was used to record demographic information, including the patient's age, gender, mechanism of trauma (e.g., fall, accident), and consciousness level assessed using the GCS. This data was collected from brain trauma patients upon their admission to the emergency department at Khatam Al-Anbia Hospital in Zahedan, concurrently with the administration of necessary treatment measures. Subsequently, a radiologist performed a CT scan, reporting the type and location of any lesions, which was then documented in the checklist. Patients requiring admission to the neurosurgery department or intensive care unit were followed up, and the final status (alive/deceased) after the treatment period was determined by a team of neurosurgeons and subsequently recorded.

Statistical Analysis

Descriptive statistics were used to summarize the data, including mean and standard deviation, frequency, and percentages. Chi-square and independent t-tests were employed to ascertain the relationship between demographic findings, consciousness level, brain CT scan results, and patient mortality. A significance level of $P<0.05$ was adopted.

Results

The study aimed to investigate the relationship between brain CT scan results, the level of consciousness upon arrival, and mortality in patients

with brain trauma. Out of 200 patients, three were excluded from the study due to their transfer to other medical centers during treatment. Of the remaining 197 patients, 178 were male (90.4%), and 19 were female (9.6%), with a mean age of 27.94 ± 11.25. The results showed that 67.5% of all patients survived, while 32.4% succumbed. Furthermore, 19 patients (8.2%) suffered from brain trauma due to falls, 173 (87.7%) due to accidents, and 8 (4%) due to other causes. The initial Glasgow Coma Scale (GCS) scores were as follows: 14-15 in 83 patients (42.1%), 9-13 in 69 patients (35%), and 3-8 in 45 patients (22.8%).

Based on the observations made by the emergency medicine specialists and the reports of radiologists regarding the brain CT scans of the 197 brain trauma patients admitted to the emergency department, the majority of patients had subdural hematomas (48 patients, 24.3%), followed by cerebral contusions (42 patients, 21.3%), epidural hematomas (32 patients, 16.2%), intracerebral hemorrhages (ICH) (34 patients, 17.2%), and diffuse axonal injuries (DAI) (26 patients, 13.1%). Other brain CT scan findings were noted in 15 patients, accounting for a relatively high frequency (7.6%).

The Chi-square test was used by the authors to establish relationships within the data. Ultimately, 67.8% of the 178 male patients and 13 (68.4%) of the 19 female patients survived, with no significant difference found between the genders of the patients and mortality rates (p=0.946). In terms of the mechanism of brain trauma and its relationship to mortality, 75% of the patients who experienced falls and 65.5% of those involved in accidents survived. Among the patients with other causes of trauma, all survived, and no significant difference was found in the mechanism of brain trauma and patient mortality (p=0.318).

Furthermore, all the patients with initial consciousness levels of 14-15 (100%) survived. Of those with consciousness levels of 9-13, 85.6% survived, while 35.5% with GCS scores of 3-8 survived. Conversely, 64.5% of the patients with consciousness levels of 3-8 and 14.4% with consciousness levels of 9-13 did not survive (Table 3). Therefore, a significant relationship was identified between the initial consciousness level of the patients in the emergency department and their mortality rates (p=0.001).

According to statistical data analysis, 66.7% of patients with subdural hematomas on brain trauma CT scans, 75% with epidural hematomas, 81% with cerebral contusions, 35.3% with ICH, and 92.3% with DAI ultimately survived. This indicates a significant relationship between CT scan findings and mortality rates with a p-value of 0.01.

Table 1: Demographics findings in patients with brain trauma

Factor	Data frequency	Frequency percentage
	Gender	
Female	19	9.6%
Male	178	90.4%
	GCS	
3-8	45	22.8%
13-9	69	35%
14-15	83	42.1%
	The final status of the patient	
Dead	64	32.4%
Alive	133	67.5%
	Mechanism of trauma	
Fall	16	8.2%
Accident	173	87.8%
Other	8	4%

Table 2: Frequency of types of brain lesions in patients with brain trauma

Type of brain lesion	Data frequency	Frequency percentage
Subdural hematoma	48	24.3%
Epidural hematoma	3	16.2%
Contusion	42	21.3%
ICH	34	17.2%
Other	15	7.6%

Table 3: Correlation between demographic findings in patients with brain trauma in final status

Gender	Final status		P-value
	Dead	Alive	
Male Frequency	57	121	0.946
Frequency percentage	32.2%	67.8%	
Female Frequency	6	13	
Frequency percentage	31.6%	68.4%	
Mechanism	Final status		0.318
	Dead	Alive	
Fall Frequency	4	12	
Frequency percentage	25%	75%	
Accident Frequency	60	113	
Frequency percentage	34.5%	65.5%	
Other Frequency	0	8	
Frequency percentage	0%	100%	
Consciousness level (GCS)	Final status		0.001
	Dead	Alive	
Level 14-15 Frequency	0	83	
Frequency percentage	0%	100%	
Level 9-13 Frequency	10	59	
Frequency percentage	14.4%	85.6%	
Level 3-8 Frequency	29	16	
Frequency percentage	64.5%	35.5%	

Table 4: Correlation between types of brain lesions in patients with brain trauma in final status

Type of brain lesion	Final status		P-value
	Dead	Alive	
Subdural hematoma Frequency	16	32	0.01
Frequency percentage	33.3%	66.7%	
Epidural hematoma Frequency	8	24	
Frequency percentage	25%	75%	
Contusion Frequency	8	34	
Frequency percentage	19%	81%	
ICH Frequency	22	12	
Frequency percentage	64.7%	35.3%	
DAI Frequency	2	24	
Frequency percentage	7.7%	92.3%	
Other Frequency	8	7	
Frequency percentage	53.3%	46.6%	

Furthermore, the authors observed the highest mortality rate in ICH patients, with a frequency percentage of 64.7%. In contrast, the lowest mortality rate was observed in DAI patients, with a frequency percentage of 92.3% (Table 4).

Discussion

The current study explored the correlation between brain CT scan findings, initial consciousness levels upon arrival, and mortality rates in patients with brain trauma. Notably, this investigation revealed no substantial association between patient gender, age, or the mechanism of trauma and their respective mortality rates. However, a meaningful connection emerged between the patients' consciousness levels, the specific lesion types identified in their CT scans, and their mortality rates.

In terms of the significant relationship observed between consciousness levels and patient mortality, research findings align with those of Mena's study, which included an extensive cohort of 60,428 brain trauma patients studied between 1996 and 2007 [5]. Similarly, Jiang's study, involving 7,145 brain trauma patients, explored factors such as gender, age, and intracranial pressure (ICP) levels yet yielded results consistent with the study, indicating no substantial relationship between patient age, gender, and mortality rates [8].

Numerous studies have underscored the influence of brain CT scan-identified lesion types on patient mortality, with midline shift emerging as a particularly significant lesion category [9]. Additionally, other studies have highlighted the impact of brain lesions, including subdural hematomas, identified through CT scans on patient mortality, a finding echoed by the study [10].

While various studies have identified additional factors such as systolic and diastolic blood pressure, pupil size, and specific patient assessments as predictors of mortality in brain trauma patients, these factors were not measured in the study [11]. Notably, Nayebaghayee's study conducted in Tehran with a cohort of 200 brain trauma patients concluded that assessing the initial consciousness level alone is insufficient to gauge the severity of head trauma. Hence, the results of brain CT scans should be taken into account.

However, it is worth noting that Nayebaghayee's study covered a broad age range, including children, which might account for the inconsistency with the findings. Consequently, further supplementary studies, primarily involving pediatric patients, are warranted [7].

Conclusion

Among the variables examined in this study, both the initial consciousness level determined by the GCS and the results of brain CT scans had a substantial influence on the prognosis of patients with brain trauma. Consequently, brain CT scans and appropriate treatment must be promptly administered to individuals presenting with brain trauma in a hospital setting to mitigate the extent of brain injury.

Simultaneously, assessing the patient's consciousness level using the GCS and considering the specific pathology identified in the CT scan of brain trauma patients admitted to the emergency department significantly enhances the ability to predict patient mortality rates.

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