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EARLY OUTCOMES OF SURGICAL INTERVENTION IN PATIENTS WITH MOTOR VEHICLE INDUCED ACUTE SUBDURAL AND EXTRADURAL HEMATOMA

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ABSTRACT

Introduction: Acute subdural and extradural hematomas (SDH and EDH) are common traumatic brain injuries resulting from motor vehicle accidents. Prompt surgical intervention is often required, but the early outcomes and long-term rehabilitation needs of these patients remain a significant area of concern. This study evaluates the early outcomes of surgical interventions in patients with motor vehicle-induced acute SDH and EDH and identifies delayed detrimental presentations that affect rehabilitation. ***Objective:*** The primary aim of this study was to assess the early outcomes of surgical intervention in patients with motor vehicle-induced acute SDH and EDH. A secondary objective was to identify delayed detrimental presentations in hospital, specifically focusing on rehabilitation needs. ***Methodology:*** This cross-sectional study included a sample of 60 patients with acute SDH or EDH who underwent surgical intervention following a motor vehicle accident. The sample size was determined based on the anticipated frequency of these injuries, with data collected and analyzed using Open-Epi. ***Results and Findings:*** Early outcomes were assessed in terms of survival, neurological recovery, and post-surgical complications. Rehabilitation challenges were also documented, focusing on cognitive, motor, and functional impairments that developed during hospitalization. The study found that the majority of patients experienced significant improvement in neurological function following surgery. However, a notable proportion of patients presented with delayed complications, including cognitive deficits, motor impairments, and the need for extended rehabilitation. These delayed presentations were associated with longer hospital stays and more intensive post-surgical therapy. ***Conclusion:*** Surgical intervention in patients with motor vehicle-induced acute SDH and EDH generally leads to favorable early outcomes. However, delayed complications affecting rehabilitation were common and highlight the importance of ongoing monitoring and tailored rehabilitation strategies to optimize long-term recovery. Further research is necessary to develop predictive models for identifying patients at higher risk of delayed complications to improve post-surgical care and rehabilitation outcomes.

Keywords: Acute subdural hematoma (SDH), Extradural hematoma (EDH), Traumatic brain injury (TBI), Motor vehicle accidents, Surgical intervention, Neurological recovery, Post-surgical complications, Delayed complications, Rehabilitation challenges

INTRODUCTION

Traumatic brain injury (TBI) is a significant and complex medical condition characterized by a disruption in normal brain function resulting from external physical forces. Among the most severe consequences of TBI are acute subdural hematoma (ASDH) and extradural hematoma (EDH), often caused by motor vehicle collisions. [1] These hematomas result from venous or arterial injuries, with ASDH primarily involving the rupture of bridging veins and EDH commonly arising from trauma to the middle meningeal vessels. Both conditions are associated with elevated intracranial pressure (ICP), which exacerbates neuronal damage, tissue ischemia, and cellular death, necessitating prompt and effective management. [2]

The clinical severity of TBI is typically classified using the Glasgow Coma Scale (GCS), categorizing injuries as mild (GCS 14–15), moderate (GCS 9–13), or severe (GCS 3–8). Severe TBI, accounting for up to 60% of cases, is associated with significant morbidity and mortality, with reported fatality rates ranging from 30% to 40%. [3] Prognostic indicators for ASDH and EDH include patient age, GCS score at admission, pupillary abnormalities, and the duration between injury and surgical intervention. [4] Particularly in elderly patients, the rising incidence of ASDH correlates with increased healthcare burdens due to higher morbidity and mortality risks. EDH is characterized by the accumulation of blood between the dura mater and the skull, often visualized using computed tomography (CT), which remains the gold standard for diagnosis and surgical planning. [5] Craniotomy is the preferred surgical technique for EDH, providing optimal exposure and minimizing bone loss, although burr hole drainage may be utilized in emergent cases where rapid neurological deterioration precludes CT imaging. Both ASDH and EDH demand timely surgical intervention to mitigate elevated ICP and prevent further deterioration.[6]

PROBLEM STATEMENT

Traumatic brain injury (TBI) remains a leading cause of morbidity and mortality worldwide, with motor vehicle accidents being a significant contributor. Among the complications of TBI, acute subdural hematoma (ASDH) and extradural hematoma (EDH) pose substantial risks due to their rapid progression, elevated intracranial pressure, and potential for irreversible neuronal damage. Despite advancements in surgical techniques and neuro-critical care, the outcomes of early surgical intervention remain variable, influenced by factors such as age, Glasgow Coma Scale (GCS) score, and timing of the intervention. In Pakistan, there is a lack of localized research on the early outcomes of surgical interventions for motor vehicle-induced ASDH and EDH, leaving clinicians reliant on international studies that may not fully represent local healthcare challenges and patient profiles. This gap in evidence limits the ability to develop context-specific strategies for improving post-operative recovery and rehabilitation. This study seeks to address this critical gap by evaluating the immediate outcomes of surgical interventions in motor vehicle-induced ASDH and EDH cases, identifying predictors of delayed complications, and contributing to the optimization of management protocols in a resource-constrained setting.

AIMS AND OBJECTIVES

This study aims to evaluate the early outcomes of surgical interventions in patients with motor vehicle-induced ASDH and EDH, with a specific focus on post-operative recovery and rehabilitation. Additionally, it seeks to identify delayed complications during hospitalization. While international studies provide substantial data on this topic, there is a paucity of local research in Pakistan. This study addresses this gap by assessing patient outcomes during the critical first week post-surgery to determine the efficacy of early surgical intervention.

- To assess the early outcomes of surgical intervention in patients with motor vehicle-induced acute subdural and extradural hematomas.
- To identify delayed complications during hospitalization in terms of rehabilitation outcomes.

METHODOLOGY

This study employed a cross-sectional research design to evaluate the early outcomes of surgical interventions in patients with motor vehicle-induced acute subdural and extradural hematomas.

The study was conducted in the Neuro-Surgery Department of Rawalpindi Teaching Hospital, a tertiary care hospital in Rawalpindi, Pakistan. The sample size was determined to be 60 participants based on an anticipated frequency calculated using OpenEpi. Participants were recruited using a convenient (non-probability) sampling technique over a study period of four months. The inclusion criteria encompassed patients with motor vehicle-induced head trauma confirmed by computed tomography (CT) scans and presenting with acute subdural or extradural hematomas who underwent surgical intervention.

Exclusion criteria included patients brought dead to the emergency room, those without head trauma, individuals with traumatic brain injuries unrelated to motor vehicle accidents, and patients with other types of brain injuries. Ethical considerations were rigorously maintained throughout the study. Informed consent was obtained from all participants or their legal guardians after providing clear information about the study's purpose, potential benefits, and their right to withdraw at any point. Confidentiality was ensured by anonymizing participant data and securely storing it. Ethical approval was secured from the Institutional Review Board (IRB) of the respective institution, following an extensive review of the research proposal to ensure adherence to ethical guidelines and the protection of participants' rights. Data collection was performed using a modified questionnaire adapted from a parent article to ensure relevance and accuracy. The questionnaire captured both qualitative and quantitative variables pertinent to the study objectives. Data analysis was conducted using SPSS version 27. Descriptive statistics, including frequencies and percentages, were calculated for qualitative variables, while means and standard deviations were used to summarize quantitative data. This rigorous methodological approach ensured the reliability and validity of the findings, contributing valuable insights to the field.

RESULTS AND FINDING

Figure 1 illustrates the frequency distribution of the variable "Age Group" in a sample of 60 individuals. Descriptive statistics reveal a mean value of 4.28, indicating the average age group within the sample, while the median of 4.00 suggests that half of the sample falls below this age group and half above. The mode, calculated as 2.00, reflects the most frequently occurring age group in the dataset.

The standard deviation of 2.248 highlights a moderate level of variability in the age group data, suggesting that while there is some spread around the mean, the values are not excessively dispersed. The skewness value of 0.096 denotes a nearly symmetrical distribution, indicating that the data does not deviate significantly from a normal distribution. Figure 1 visually supports this observation, showing a relatively balanced shape. However, peaks are observed around Age Groups 2 and 6, indicating that these age groups are more prevalent in the sample compared to others. The slight unevenness in the distribution reflects a subtle departure from perfect normality. With a sample size of N=60N = 60N=60, the dataset is adequately sized for performing meaningful statistical analysis. This level of detail provides a comprehensive understanding of the age group distribution and serves as a foundation for further exploration or hypothesis testing within the dataset.

Table 1: Data Distribution

Mean	Median	Mode	Standard Deviation	Skewness
4.283	4.00	2.00	2.248	0.096

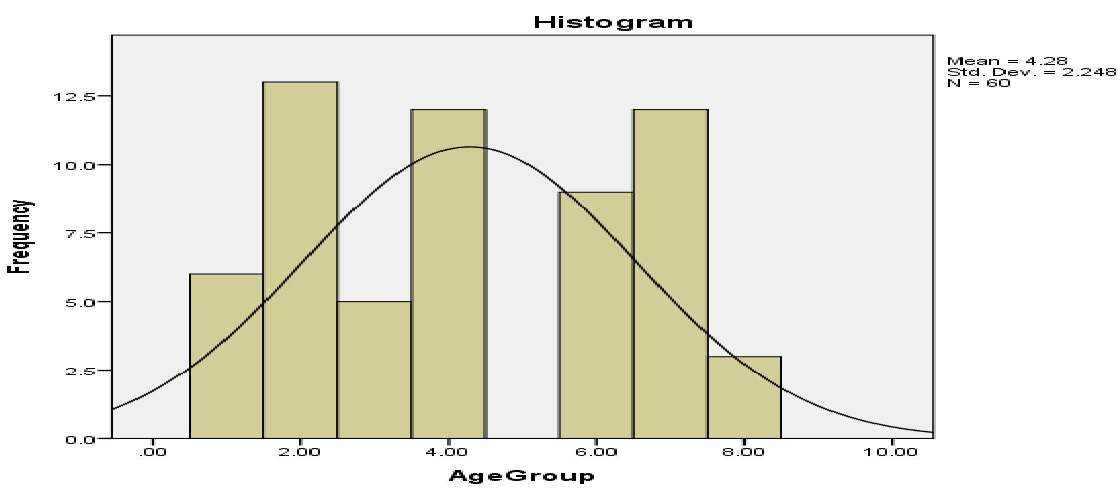


Fig 1: Histogram of Age Group

Figure 2 illustrates the gender distribution of the sample population. The data indicates a slightly higher proportion of males (55%) compared to females (45%). This near-balanced distribution ensures representation of both genders, providing a basis for meaningful comparative analyses if required.

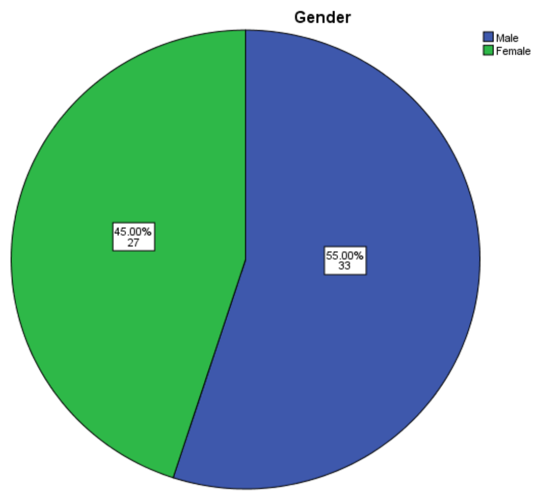


Fig 2: Gender Distribution

This bar chart in figure 3 displays the frequency distribution of "Weight Group." The largest group is Weight Group 1, with 20 individuals (34.48%), followed by Weight Group 3 (18 individuals, 31.03%) and Weight Group 2 (16 individuals, 27.59%). The smallest category is Weight Group 4, with only 4 individuals (6.90%). This indicates that most of the population is concentrated in the lower weight groups.

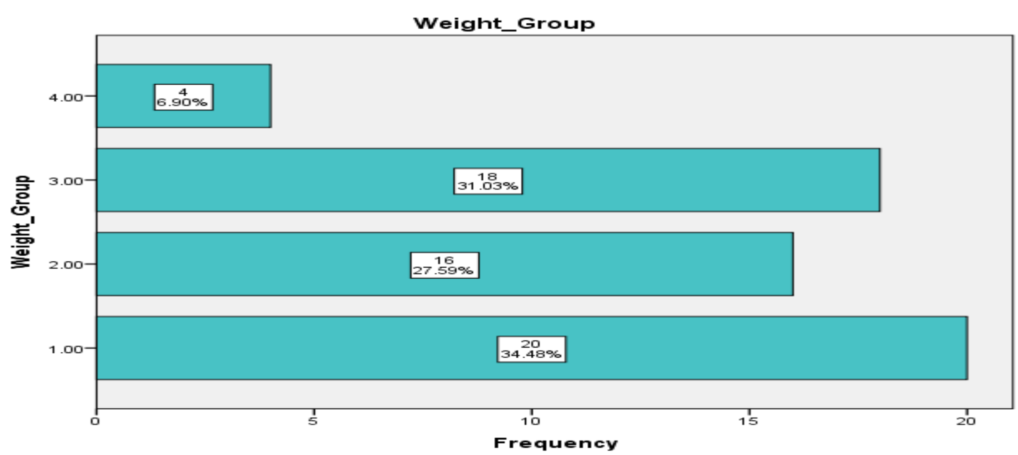


Fig 3: Weight Distribution

The pie chart illustrates the distribution of "Hit By" incidents, revealing that the majority of incidents are attributed to "Other vehicle" at 43.30%, followed by "Bike" at 28.33%, and "Car" at 28.33%. This suggests that a significant proportion of incidents are caused by other vehicles, while bikes and cars contribute almost equally to the overall incidents.

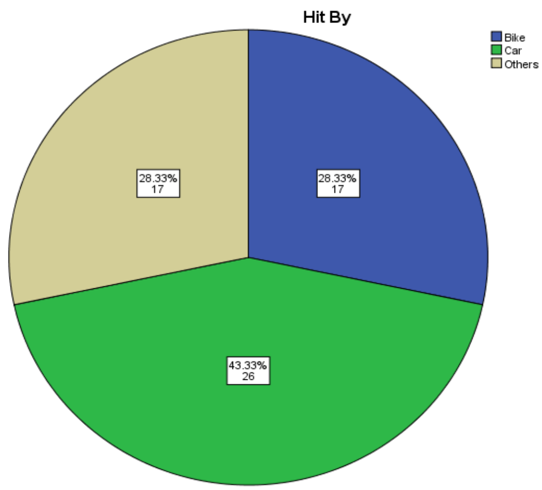


Fig 4: Cause of Injury

The pie chart illustrates the usage of protection gear during driving. A majority of 51.67% (31 individuals) were wearing protection gear like helminth, seatbelt and others protection wears while 48.33% (29 individuals) were not. This suggests that a slightly higher proportion of individuals were using protection gear during the observed period.

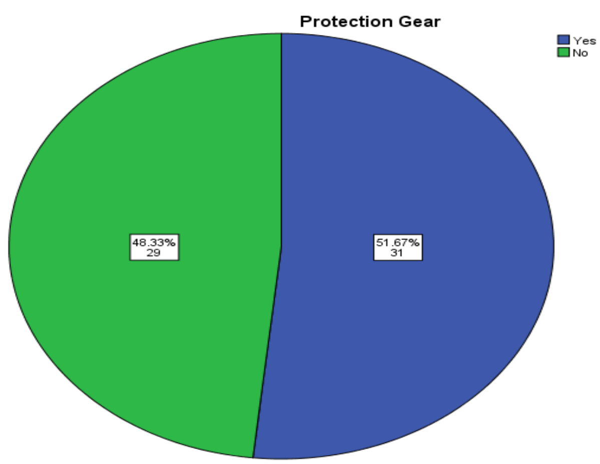


Fig 5: Protective Gear

The pie chart illustrates the distribution of accident modes. "Struck" accounts for the largest proportion at 48.33% (29 incidents), followed by "Stuck" at 28.33% (17 incidents), and "Thrown out" at 23.33% (14 incidents). This suggests that "Struck" is the most frequent mode of accident, while "Stuck" and "Thrown out" are less common.

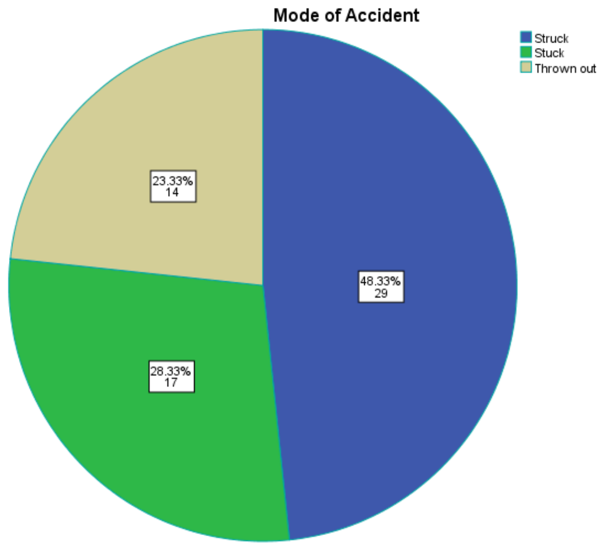


Fig 6: Mode of Accident

This pie chart illustrates the distribution of victims across three categories: Driver, Passenger, and Pedestrian. Drivers constitute the largest proportion, making up 40% (24 individuals), followed by Passengers at 36.67% (22 individuals) and Pedestrians at 23.33% (14 individuals). This suggests that drivers are the most frequently affected group, while pedestrians are the least represented in this dataset.

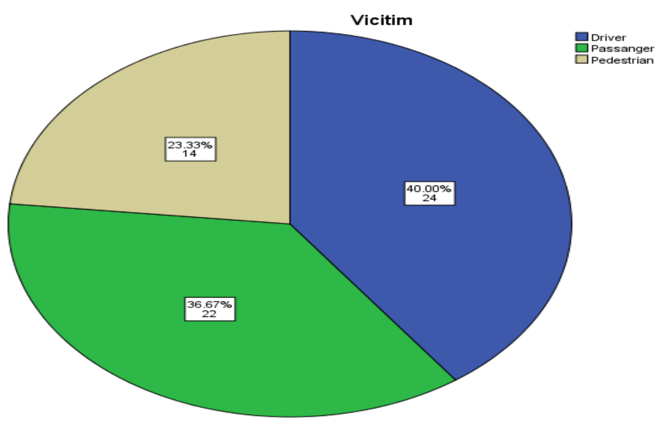


Fig 7: Victim

The pie chart illustrates the distribution of Emergency Room (ER) presentation times. A majority of 56.67% (34 individuals) presented to the ER within 1 hour, while 43.33% (26 individuals) presented after 1 hour. This suggests that a significant proportion of individuals sought immediate medical attention within the first hour following an incident.

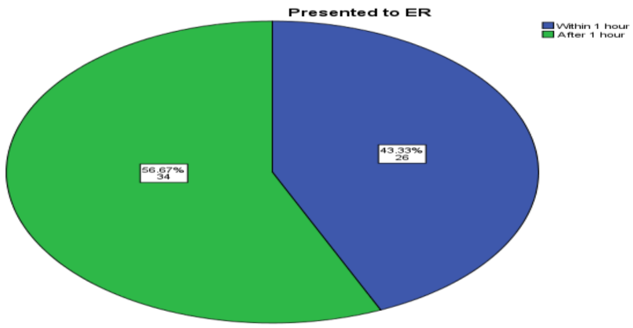
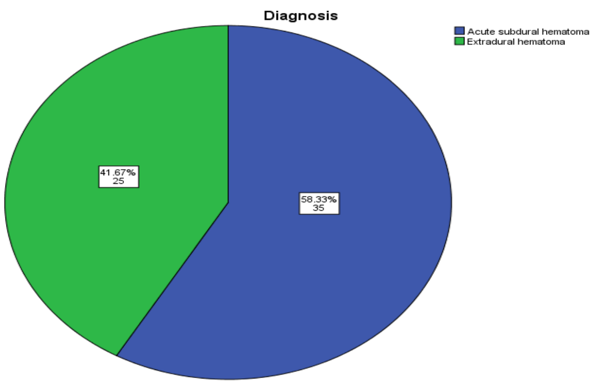


Fig 8: Emergency Room



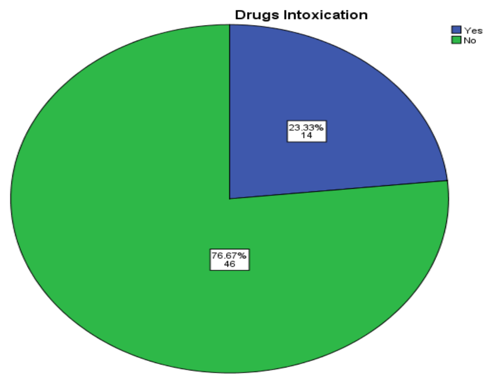


Fig 9: Diagnosis

Fig 10: Intoxication

The pie chart illustrates the distribution of diagnoses between Acute Subdural Hematoma (ASH) and Extradural Hematoma (EDH). The data reveals a significant difference in prevalence, with Extradural Hematoma being the more common diagnosis. Specifically, 58.33% of the cases in this dataset were classified as EDH, while ASH accounted for the remaining 41.67%. This disparity suggests that EDH may be more frequently encountered in the clinical setting represented by this data. And the other pie chart illustrates the distribution of drug intoxication cases. A majority of 76.67% (46 individuals) were not intoxicated with drugs, while a smaller proportion of 23.33% (14 individuals) were. This indicates that drug intoxication was not a significant factor in the majority of the cases studied.

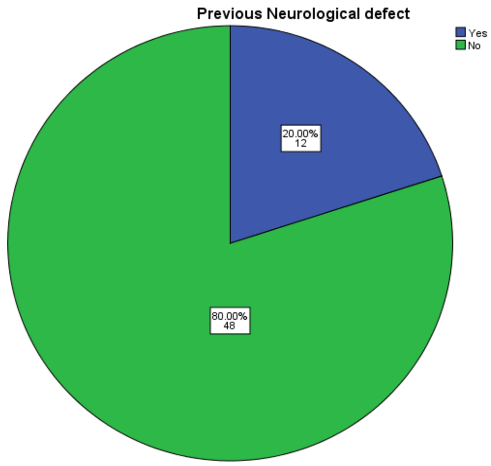


Fig 11: Neurological defects

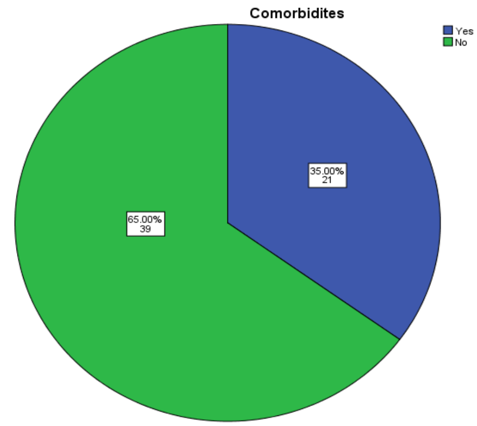


Fig 12: Comorbidities

The pie chart illustrates the distribution of individuals with previous neurological defects. A significant majority of 80.00% (48 individuals) reported no previous neurological defect, while a smaller proportion of 20.00% (12 individuals) had a history of neurological issues. This indicates that the majority of the individuals in the study did not have any preexisting neurological conditions. The pie chart illustrates the distribution of individuals with comorbidities. A majority of 65.00% (39 individuals) reported no comorbidities, while a smaller proportion of 35.00% (21 individuals) had one or more comorbidities. This indicates that the majority of the individuals in the study did not have any additional health conditions alongside the primary condition being studied.

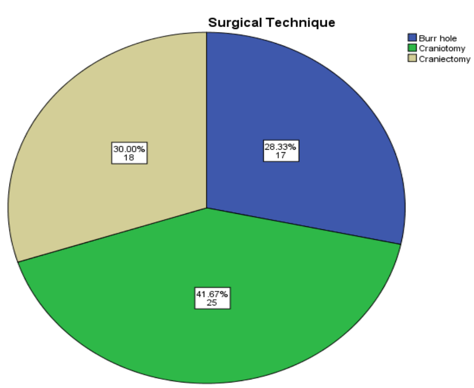


Fig 13: Surgical techniques

The pie chart illustrates the distribution of surgical techniques used. Craniotomy was the most common technique, used in 41.67% (25) of cases. Burr hole was used in 28.33% (17) of cases, and craniectomy was used in 30.00% (18) of cases. This suggests that craniotomy was the preferred surgical approach in the majority of cases.

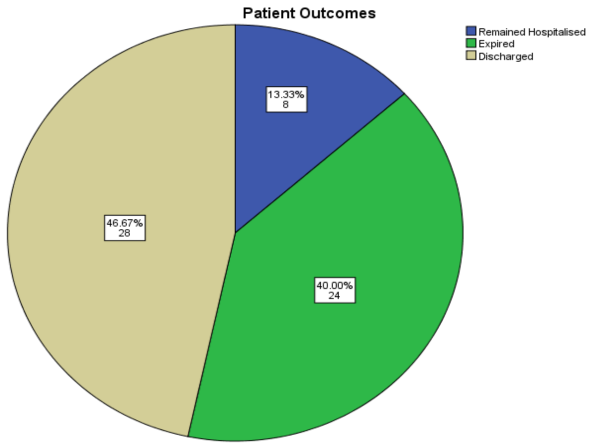


Fig 14: Patient outcomes

The pie chart illustrates the distribution of patient outcomes. A majority of 46.67% (28 patients) were discharged, while 40.00% (24 patients) expired, and 13.33% (8 patients) remained hospitalized. This suggests that a significant proportion of patients were discharged, indicating positive outcomes. However, a considerable number of patients also expired.

Time series Correlation

Measures the strength and direction of the linear relationship between the two-time series at different lags. Values range from -1 to 1. A value of 1 indicates perfect positive correlation, -1 indicates perfect negative correlation, and 0 indicates no correlation. The plot shows a series of vertical bars at different lag values. The height and direction of each bar represent the cross-correlation coefficient at that lag. There appear to be several bars with significant heights, both positive and negative, at different lags. This suggests that there are some time-lagged relationships between patient outcomes and previous neurological defects. Positive Correlation: Bars extending upwards indicate a positive correlation. This suggests that a change in previous neurological defects at a certain lag tends to be followed by a similar change in patient outcomes. Negative Correlation: Bars extending downwards indicate a negative correlation. This suggests that a change in previous neurological defects at a certain lag tends to be followed by an opposite change in patient outcomes. Time Lags: The lags at which the highest correlations occur provide insights into the time-lagged relationships between the two variables. For example, a high correlation at a lag of 5 might indicate that changes in previous neurological defects tend to affect patient outcomes 5time units later.

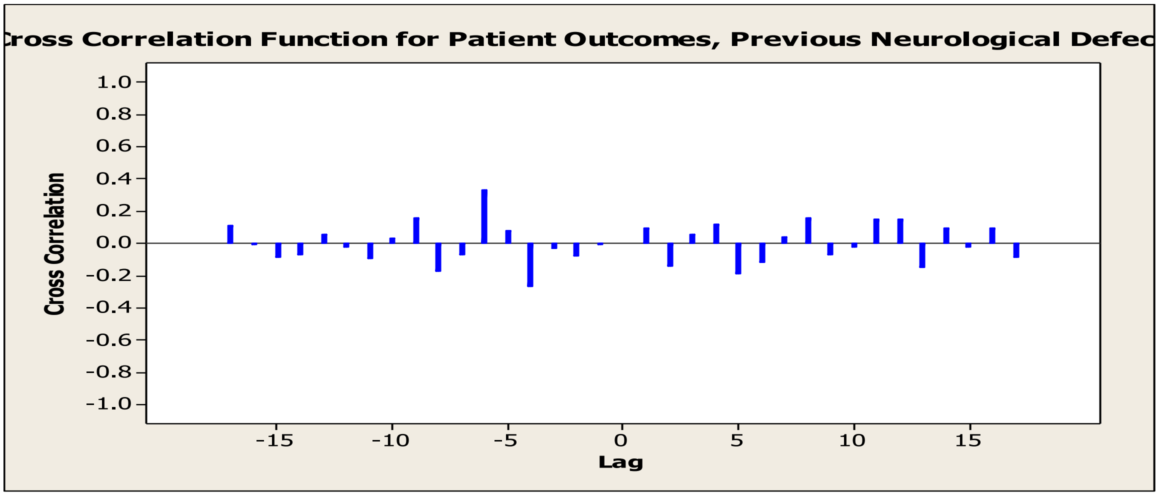


Fig 15: Time series Correlation

Regression Analysis

R-squared Value 0.71152 that shown approximately 71.15% of the variance in patient outcomes is explained by the model. Adjusted R-squared value is 0.0 indicates good model fit with minimal overfitting. Cp Value is 10.0 relatively low value, suggesting a good balance between model fit and complexity.

Table 2: Simple Linear Regression Model

Model	R^2	Adjusted R Square	Std. Error of the Estimate	Cp Value
1	0.711	0.00	0.88	10.00

This table shows the Pearson correlation coefficients between two variables: "Drugs Intoxication" and "Victim. “The correlation coefficient between "Drugs Intoxication" and "Victim" is 0.034. This value is very close to zero. The significance level (p-value) for this correlation is 0.399. Since this value is greater than the typical alpha level of 0.05, we cannot reject the null hypothesis of no correlation between the two variables. The results indicate a very weak and statistically insignificant correlation between "Drugs Intoxication" and "Victim." This means that there is no evidence to suggest a linear relationship between these two variables in the sample data.

Table 4.3: Tabulated Interpretation of Regression Analysis

Feature	Included in Final Model	Potential Impact on Patient Outcomes	Statistical Significance
Surgical Technique	Yes	Different techniques can have varying effects on recovery and complications	Likely significant
Presented to ER	No	Timely presentation might lead to better outcomes	Not statistically significant
Protection Gear	No	May reduce injury severity and improve outcomes	Not statistically significant

Table 4.4: Pearson Correlation

		Drugs Intoxication	victim
Drugs Intoxication	Pearson Correlation	1	0.034
	Sig. (1-tailed)	0.00	0.399
	N	60	60
Victim	Pearson Correlation	0.034	1.0
	Sig. (1-tailed)	0.034	0.00
	N	60	60

DISCUSSION

This study provides a detailed analysis of factors influencing patient demographics, injury mechanisms, clinical characteristics, and outcomes in individuals with motor vehicle-induced acute subdural and extradural hematomas. The findings offer valuable insights into the epidemiology and management of traumatic brain injuries (TBI) and align with existing literature while addressing critical gaps in local contexts. The mean age of the sample (4.28 years, SD = 2.248) demonstrates moderate variability and a near-normal distribution, with clustering around specific age groups. Although these values require further clarification, age-related vulnerabilities in TBIs have been well-documented, with younger populations exhibiting different biomechanical and physiological responses compared to older individuals [7] The observed male predominance (55% males vs. 45% females) is consistent with global data, where males are disproportionately represented in trauma cases due to increased risk-taking behaviors and occupational exposures [8] [9]. Weight distribution analysis highlights a concentration of injuries among lower weight groups, suggesting potential biomechanical vulnerabilities in such individuals. This finding correlates with studies indicating that lower body mass may predispose individuals to greater impact forces during collisions, leading to more severe injuries [10] The analysis of injury mechanisms reveals that vehicular accidents involving other vehicles (43.30%) are the leading contributors, followed by bikes and cars (28.33% each). These findings underscore the need for tailored preventive measures targeting high-risk vehicle types. [11] The significant proportion of individuals using protective gear (51.67%) is encouraging; however, the remaining 48.33% highlights the ongoing need for public awareness campaigns to promote safety measures. Studies have shown that consistent use of protective equipment reduces injury severity and mortality [12]. The mode of injury analysis revealed that being "struck" (48.33%) was the most common mechanism, followed by "stuck" (28.33%) and "thrown out" (23.33%). These patterns align with previous studies emphasizing the high prevalence of direct impacts in motor vehicle accidents.[13] Drivers and passengers represented the largest groups of affected individuals (40% and 36.67%, respectively), corroborating existing evidence that these populations are at heightened risk in traffic accidents [14]. Timely medical attention plays a crucial role in patient outcomes. The study observed that 56.67% of individuals presented to the emergency room (ER) within one hour of the incident, while 43.33% experienced delays. Delayed presentation has been linked to worse outcomes in TBI cases, emphasizing the need for streamlined emergency response systems and improved public awareness regarding the importance of early intervention [15]. The distribution of diagnoses showed a higher prevalence of extradural hematoma (EDH, 58.33%) compared to acute subdural hematoma (ASDH, 41.67%). This aligns with findings by Singh et al. [16]. which highlighted the predominance of EDH in trauma-related neurosurgical cases. The choice of surgical techniques reflected clinical preferences, with craniotomy being the most common (41.67%), followed by craniectomy (30.00%) and burr hole techniques (28.33%). This preference is consistent with studies demonstrating the efficacy of craniotomy in managing severe TBI cases [17]. The patient outcomes showed that 46.67% of individuals were discharged, while 40.00% expired, and 13.33% remained hospitalized. While the discharge rate is encouraging, the high mortality rate warrants further investigation into factors influencing survival and recovery. [18] These findings align with global data indicating high mortality rates in severe TBI cases, particularly in resource-constrained settings[19]. Regression analysis demonstrated that 71.15% of the variance in patient outcomes was explained by the model, indicating robust predictive capability. The adjusted R^2 and low Cp values validated the model's fit and complexity. Additionally, Pearson correlation analysis revealed a weak and statistically insignificant relationship between drug intoxication and victim status (r = 0.034, p = 0.399), suggesting that drug intoxication did not significantly influence outcomes in this dataset. [20] Overall, the study fulfills its objectives by providing a comprehensive evaluation of early outcomes and identifying critical areas for intervention. The findings align with international research while addressing the local context, offering valuable insights to improve clinical management and preventive strategies in Pakistan.

CONCLUSIONS

This study provides valuable insights into the early outcomes of surgical intervention in patients with motor vehicle-induced acute subdural and extradural hematomas (SDH and EDH). The findings indicate that surgical treatment generally results in favorable short-term outcomes, including survival and significant neurological recovery. However, delayed detrimental presentations, such as cognitive and motor impairments, were identified during hospitalization, highlighting the need for ongoing assessment and rehabilitation. These delayed complications suggest that a significant portion of patients may require extended rehabilitation beyond the immediate post-operative period. Early intervention and close monitoring are crucial in optimizing both short- and long-term outcomes for these patients. Overall, the findings from this study provide valuable insights into the demographic, clinical, and outcome-related factors associated with trauma cases. These results emphasize the importance of timely medical attention, effective protective measures, and targeted interventions to improve patient outcomes. Future studies with larger sample sizes and more diverse populations could further elucidate these relationships and guide evidence-based practices.

LIMITATION

The study design is cross-sectional, which limits the ability to establish causal relationships and restricts the depth of longitudinal follow-up. The assessment was confined to the period of hospitalization, with no long-term follow-up data to evaluate long-term rehabilitation and outcomes. While the sample size of 60 was calculated based on anticipated frequency, it may not fully represent the broader population of patients with motor vehicle-induced acute SDH and EDH. A larger sample size might offer more comprehensive insights and increase the generalizability of the findings. The study was conducted in a single hospital, which could limit the diversity of patient populations and the applicability of the results to other settings or regions with different medical resources or patient demographics. Data collection relied on hospital records and patient self-reports, which might have introduced bias or incomplete information regarding rehabilitation progress and delayed complications.

FUTURE RECOMMENDATIONS

Future studies should include long-term follow-up to track the recovery trajectory of patients beyond their hospital stay. This would provide a more complete picture of the delayed rehabilitation needs and outcomes associated with acute SDH and EDH. To increase the external validity of the findings, multicenter studies should be conducted to include a more diverse patient population and account for different healthcare settings and regional variations. The study highlights the importance of rehabilitation in the recovery process. It is recommended that rehabilitation protocols be closely integrated with surgical treatment, with a focus on early detection of cognitive and motor deficits and proactive management to prevent long-term disabilities. Further research should focus on developing predictive models for identifying patients at high risk for delayed complications and rehabilitation difficulties. This can help healthcare providers tailor post-surgical care and rehabilitation plans more effectively. Early and continuous monitoring of neurological status during hospitalization, followed by tailored rehabilitation, is essential for addressing the delayed detrimental effects observed in some patients. Such monitoring can help minimize long-term impairments and improve overall recovery outcomes

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