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Forensic Medicine

PATTERNS OF FATAL CRANIO-CEREBRAL INJURIES IN TWO-WHEELER ACCIDENT VICTIMS

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ABSTRACT **Background:** Two-wheeler accidents are a significant cause of fatal cranio-cerebral injuries globally, especially in young adult males. This study investigates the patterns of these injuries, focusing on demographic data, injury types, and outcomes. **Methods:** A cross-sectional descriptive study was conducted at Ravindra Nath Tagore Medical College, Udaipur, involving 100 fatal cases of two-wheeler accidents over one year. Comprehensive data collection from multiple sources was analysed to determine the nature and impact of cranio-cerebral injuries. **Results:** The majority of victims were young males (87%), with the highest incidence in the 21-30 age group (41%). Scalp lacerations (51%) and subdural hematomas (72%) were the most common findings. Skull fractures were also prevalent, with 29% of cases showing comminated fractures. **Conclusion:** The study highlights the urgent need for targeted safety interventions and improved medical responses to reduce fatalities from two-wheeler accidents. Enhanced helmet usage and traffic safety campaigns are recommended to address the high risk faced by this vulnerable population.

KEYWORDS : Two-wheeler accidents, Cranio-cerebral injuries, Fatal injuries, Road traffic accidents, Public health, Helmet usage, Skull fractures, Subdural hematoma

INTRODUCTION

Cranio-cerebral injuries represent a critical public health issue globally, particularly in the context of road traffic accidents (RTAs). Among various vehicular accidents, those involving two-wheelers are disproportionately associated with high morbidity and mortality due to the inherent lack of structural protection compared to four-wheeled vehicles. This study focuses on the patterns of fatal cranio-cerebral injuries sustained in two-wheeler accidents, aiming to delineate the epidemiological characteristics and injury outcomes in this vulnerable road-user group.[1,2]

Two-wheeler users, encompassing motorcycles and scooters, are at a significantly increased risk of severe injuries during RTAs. The dynamics of two-wheeler accidents often result in direct impacts to the rider and pillion, making cranio-cerebral trauma a common and frequently fatal outcome. In many regions, particularly in developing countries where two-wheelers are a primary mode of transport due to their affordability and convenience, the incidence of such injuries is alarmingly high. Despite various safety campaigns and the introduction of mandatory helmet laws, compliance remains inconsistent, and the effectiveness of these measures is a continuous area of research.[3,4]

The cranio-cerebral region is particularly vulnerable in high-energy impacts, which can lead to a range of injuries from minor lacerations to critical skull fractures and intracranial haemorrhages, each contributing differently to the fatality rates. Understanding the specific patterns of these injuries, including the types of skull and brain injuries sustained, is crucial for developing more effective preventive measures and for improving clinical outcomes.[5]

This paper explores several key areas: the age and gender distribution of the victims, the nature and severity of the cranio-cerebral injuries, and the role of protective devices such as helmets in the context of these accidents. By analysing data collected from Ravindra Nath Tagore Medical College, Udaipur, this study provides insights into the demographic and clinical profiles of fatal two-wheeler accident victims, contributing to the broader discourse on road safety and trauma prevention.[6,7]

Through this research, we aim to contribute valuable data to the existing literature on traffic-related injuries, supporting initiatives for better safety regulations and providing a basis for further studies on intervention strategies aimed at reducing the occurrence and severity of cranio-cerebral injuries in two-wheeler users.

MATERIALS AND METHODS

Study Design and Setting

This study is a cross-sectional descriptive analysis conducted over a period of one year, from June 1, 2023, to May 31, 2024. The research was carried out in the Department of Forensic Medicine and Toxicology at Ravindra Nath Tagore Medical College (RNTMC), Udaipur, Rajasthan. RNTMC serves as a primary referral center for forensic examinations in the region, providing a comprehensive setting for the assessment of cranio-cerebral injuries resulting from two-wheeler accidents.

Study Population

A total of 100 fatal cases involving isolated cranio-cerebral injuries sustained in two-wheeler accidents were included in the study. These cases were selected based on their admission to the mortuary of RNTMC during the study period.

Inclusion Criteria

- **Type of Accident:** All fatal cases resulting from two-wheeler road traffic accidents.
- **Injury Type:** Cases with isolated cranio-cerebral injuries.
- **Participants:** Both rider and pillion riders involved in the accidents.
- **Time Frame:** Accidents that occurred and were reported within the one-year study period.

Exclusion Criteria

- **Type of Accident:** Fatalities resulting from road traffic accidents involving vehicles other than two-wheelers.
- **Injury Type:** Fatal cases from two-wheeler accidents that involved injuries other than cranio-cerebral.
- **Non-Fatal Cases:** Any non-fatal injuries sustained in two-wheeler accidents were excluded from the study.

Data Collection

Data were meticulously gathered from multiple sources to ensure comprehensive coverage and accuracy:

- **Police Reports:** Detailed histories and circumstances of the accidents.
- **Relatives' Accounts:** Information provided by family members regarding the victim and the incident.

- **Requisition Letters:** Official documents requesting postmortem examinations.
- **Hospital Case Sheets:** Medical records detailing the victims' conditions prior to death.
- **Postmortem Examination Findings:** Results from thorough autopsies conducted on all subjects.
- **Photographic Evidence:** Images documenting the nature and extent of head injuries sustained.

All collected data were systematically entered into Microsoft Excel spreadsheets for initial organization.

Postmortem Examination

Each body underwent a comprehensive and systematic postmortem examination to accurately identify and categorize cranio-cerebral injuries. The examination focused on:

- **External Injuries:** Including scalp lacerations, abrasions, and other visible trauma.
- **Fracture Analysis:** Detailed assessment of skull vault and base fractures using standardized forensic protocols.
- **Intracranial Injuries:** Identification and classification of intracranial hemorrhages such as Epidural Hematoma (EDH), Subdural Hematoma (SDH), Subarachnoid Haemorrhage (SAH), and other related conditions.
- **Severity Assessment:** Evaluation of injury severity, distinguishing between coup and contrecoup injuries.

Data Analysis

The collected data were entered into Microsoft Excel for organization and subsequently analyzed using SPSS version 21. Statistical analyses included:

- **Descriptive Statistics:** Calculation of frequencies and percentages to summarize demographic variables, injury patterns, and other relevant factors.
- **Correlation Analysis:** Examination of the relationship between the use of safety measures (e.g., helmet usage) and mortality outcomes.

All results were presented in the form of tables and charts to facilitate clear and concise interpretation of the findings.

Ethical Considerations

The study was conducted in accordance with ethical standards for research involving human subjects. Confidentiality of all victims and their families was strictly maintained. Necessary permissions were obtained from relevant authorities, and all data were anonymized to protect personal identities.

Limitations

- Retrospective Design: As a cross-sectional study, it may be subject to inherent biases related to retrospective data collection.
- Data Completeness: Reliance on available records and reports, which may vary in detail and accuracy.
- Generalizability: Findings are specific to the region of Udaipur, Rajasthan, and may not be directly applicable to other geographical areas.

RESULTS

The present study evaluated the demographics, injury types, and outcomes of 100 victims of two-wheeler accidents with fatal cranio-cerebral injuries. The findings are summarized in the following tables and analyses.

Demographic Distribution

The age distribution of the victims showed a predominant impact on the younger population. The majority (41%) of the fatalities occurred in the 21-30 age group, followed by 22% in the 31-40 age group, demonstrating a significant vulnerability among younger adults. Males were overwhelmingly more affected than females, with 87% of the cases being male, which may reflect higher exposure or risk-taking behaviours in this demographic (Table 1).

Nature of Scalp Injuries

Scalp injuries varied widely, with lacerations being the most common type, accounting for 51% of all cases. Combined abrasion and laceration were observed in 14% of the victims, while 12% had only abrasions. Interestingly, 18% of the victims showed no external scalp injuries, which underscores the potential for severe internal injuries without outward signs (Table 2).

Types of Skull Fractures

Analysis of skull fractures revealed that 48% of the victims had no vault fractures, while comminated fractures were the most frequent type among those with fractures, representing 29% of the total. The base of the skull was less frequently fractured, with 69% showing no base fracture. The most common specific fracture was a middle cranial fossa fracture, noted in 13% of the cases (Tables 3A and 3B).

Intracranial Hemorrhage Distribution

Intracranial haemorrhages were predominantly subdural hematomas (SDH), present in 72% of the cases. Other types of haemorrhages included combinations of epidural, subdural, and intracerebral or subarachnoid bleeding, but these were much less common. This indicates that SDH is a critical factor in the lethality of cranio-cerebral injuries in two-wheeler accidents (Table 4).

Overall, the results emphasize the high incidence of severe head injuries among younger males involved in two-wheeler accidents and highlight the critical nature of both external and internal head trauma. These findings suggest an urgent need for targeted interventions to enhance head protection and reduce the frequency and severity of these injuries.

Table 1: Age Distribution Of Victims

Age Group	Male	Female	Total	Percentage (%)
10-20	7	0	7	7%
21-30	36	5	41	41%
31-40	18	4	22	22%
41-50	12	1	13	13%
51-60	9	3	12	12%
>60	5	0	5	5%
Total	87	13	100	100%

Table 2: Types Of Scalp Injuries Observed

Scalp Injury Type	Number of Patients	Percentage (%)
Abrasion	12	12%
Abrasion & Laceration	14	14%
Laceration	51	51%
Laceration & Crushed Injury	5	5%
No External Injury	18	18%
Total	100	100%

Table 3: Distribution Of Skull Fractures

A. Skull Vault Fractures

Fracture Type	Number of Patients	Percentage (%)
Comminated Fracture	29	29%
Depressed Fracture	1	1%
Depressed & Comminated Fracture	4	4%
Diastatic & Fissured Fracture	1	1%
Fissured Fracture	13	13%
Fissured & Comminated Fracture	4	4%
No Vault Fracture	48	48%
Total	100	100%

B. Skull Base Fractures

Fracture Type	Number of Patients	Percentage (%)
Anterior Cranial Fossa (ACF)	11	11%
ACF & Middle Cranial Fossa (MCF)	2	2%
ACF, MCF & Posterior Cranial Fossa (PCF)	2	2%
Middle Cranial Fossa (MCF)	13	13%
Posterior Cranial Fossa (PCF)	2	2%
PCF & MCF	1	1%
No Base Fracture (NBF)	69	69%
Total	100	100%

Table 4: Types Of Intracranial Hemorrhages

Intracranial Injury	Number of Patients	Percentage (%)
Epidural Hematoma (EDH)	1	1%
EDH & Subdural Hematoma (SDH)	8	8%
EDH, SDH & Intracerebral Haemorrhage	3	3%

EDH, SDH & Subarachnoid Haemorrhage	1	1%
Subarachnoid Haemorrhage (SAH)	4	4%
SAH & SDH	11	11%
Subdural Hematoma (SDH)	72	72%
Total	100	100%

DISCUSSION

The study presented here provides an important insight into the epidemiological and clinical nature of fatal cranio-cerebral injuries in two-wheeler accident victims. The demographic distribution highlights a significant predisposition among young males, which is consistent with previous studies indicating higher risk behaviours and exposure among this group. Notably, the 21-30 age group exhibited the highest incidence of fatal injuries, suggesting a target demographic for intensified preventive strategies.[8]

The findings also underscore the severity of injuries that two-wheeler accidents can inflict. Scalp injuries, particularly lacerations, were predominant, serving as a potential indicator of the force involved during impact. The high percentage of victims with no external scalp injuries yet fatal outcomes calls for a revaluation of emergency response protocols and initial medical assessments at accident scenes.[9,10]

Skull fractures, both at the vault and the base, add another layer of complexity to the injury patterns observed. The predominance of comminated vault fractures reflects the intense impact forces typically experienced in two-wheeler crashes, which often lack the mitigating barriers seen in automobile accidents. The relatively lower frequency of base fractures compared to vault fractures may relate to the point of impact and the mechanics of the accidents involved.[11]

Intracranial haemorrhages, particularly subdural hematomas, were the most common and lethal findings, emphasizing the need for rapid and precise medical intervention. The data clearly demonstrate that subdural hematomas are a major contributor to the high fatality rates associated with cranio-cerebral trauma in two-wheeler accidents. This finding aligns with the literature which supports that timely surgical intervention can be life-saving in cases of significant subdural hematoma.[12,13]

Overall, the data not only delineate the types and severity of injuries but also highlight critical areas for intervention.[14] These include public health campaigns focused on helmet use, enforcement of traffic laws, and possibly the introduction of new technologies in helmet design to reduce the impact of such injuries. Furthermore, urban planning and policy reforms aimed at improving road safety for two-wheeler users could significantly mitigate risks.

CONCLUSION

This study provides compelling evidence that young males are particularly susceptible to fatal cranio-cerebral injuries from two-wheeler accidents. The high incidence of subdural hematomas and severe skull fractures calls for enhanced preventive measures, improved emergency medical response, and heightened public awareness about the importance of helmet use. Targeted interventions that address both behavioural and safety standards are crucial for reducing the mortality and morbidity associated with two-wheeler accidents. The findings underscore the necessity for multi-faceted approaches to improve road safety and ultimately save lives.

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