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Study of Forensic Analysis of Injury Patterns in Road Traffic Accidents.

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ABSTRACT

Road traffic accidents (RTAs) are a major public health concern and constitute one of the leading causes of injury-related morbidity and mortality worldwide. Forensic analysis of injury patterns plays a crucial role in understanding the mechanism of trauma, reconstructing accident events, determining the cause of death, and providing valuable medicolegal evidence. Evaluation of injury distribution also contributes to the formulation of preventive road safety strategies. A prospective observational study was conducted in the Department of Forensic Medicine and Toxicology over a period of one year. A total of 40 road traffic accident cases were included based on predefined inclusion and exclusion criteria. Data regarding demographic characteristics, type of road user, accident details, external and internal injuries, fractures, body regions involved, and cause of death were collected using a structured proforma from medico-legal records, hospital case sheets, police reports, and autopsy findings. Statistical analysis was performed using SPSS version 26.0. Descriptive statistics were expressed as frequencies and percentages, while Chi-square and appropriate comparative tests were used to assess associations. A p-value of <0.05 was considered statistically significant. Among the 40 victims, 77.5% were males, and the majority (45%) belonged to the 21–40 years age group. Two-wheeler riders constituted the largest category (42.5%), followed by pedestrians (25%). Abrasions (85%), contusions (70%), fractures (60%), lower limb injuries (65%), and head injuries (45%) were the most frequently observed injury patterns. A statistically significant association was found between the type of road user and injury severity ($p = 0.041$), with pedestrians and two-wheeler riders sustaining more severe injuries than four-wheeler occupants. Young adult males and vulnerable road users are disproportionately affected by road traffic accidents. Abrasions, fractures, and lower limb injuries were the predominant forensic findings. Detailed forensic evaluation of injury patterns is invaluable for accident reconstruction, medicolegal investigations, and judicial proceedings. The findings also reinforce the need for improved road safety measures, strict enforcement of traffic regulations, and enhanced use of protective devices to reduce injury severity and mortality.

Keywords: Road Traffic Accidents, Forensic Injury Pattern, Medicolegal Autopsy.

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INTRODUCTION

Road traffic accidents (RTAs) are a major global public health problem and represent one of the leading causes of morbidity and mortality worldwide [1]. According to the World Health Organization, approximately 1.19 million people die annually due to road traffic injuries, while millions more sustain non-fatal injuries resulting in temporary or permanent disability. India accounts for a substantial proportion of these fatalities because of rapid urbanization, increasing vehicular density, inadequate road safety measures, and variable compliance with traffic regulations [2, 3]. From a forensic medicine perspective, the systematic evaluation of injury patterns in road traffic accident victims is essential for determining the mechanism of injury, reconstruction of accident events, identification of the victim's position within the vehicle, estimation of impact forces, and assessment of the cause and manner of death [4].

The distribution, type, and severity of injuries vary depending on factors such as the category of road user, type of vehicle involved, speed, use of protective devices, and nature of collision. Detailed forensic documentation of external and internal injuries provides valuable medicolegal evidence, assists law enforcement agencies, and supports judicial proceedings. Furthermore, understanding injury patterns contributes to the development of preventive strategies, improvement of trauma care, and formulation of road safety policies [5]. Therefore, the present study aims to analyze the forensic injury patterns observed in road traffic accident victims and correlate these findings with the mechanism and outcome of injury.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Forensic Medicine and Toxicology at a tertiary care teaching hospital over a period of one year after obtaining approval from the Institutional Ethics Committee. A total of **40 consecutive cases** of road traffic accident (RTA) victims were included in the study based on the availability of medico-legal records and autopsy findings. Both fatal and medico-legally examined cases of road traffic accidents involving pedestrians, two-wheeler riders, pillion riders, four-wheeler occupants, and other road users were considered. Cases with incomplete medico-legal documentation, decomposed bodies obscuring injury assessment, burn injuries unrelated to road traffic accidents, and victims with insufficient clinical or autopsy information were excluded. Written permission from the concerned authorities was obtained wherever required, and strict confidentiality of all medico-legal information was maintained throughout the study. The sample size of **40 cases** was determined based on the average annual institutional case load and the feasibility of completing detailed forensic evaluation during the study period.

A structured proforma was used to collect demographic details, accident-related information, and forensic findings from medico-legal records, police inquest reports, hospital case sheets, radiological investigations, and autopsy reports. Variables studied included age, sex, type of road user, type of vehicle involved, mode of collision, time and place of accident, use of safety devices (helmet/seat belt), external injuries (abrasions, contusions, lacerations, incised wounds), fractures, internal organ injuries, body regions involved, Injury Severity Score (where applicable), cause of death, and survival interval. Injuries were classified according to standard forensic medicine guidelines and correlated with the mechanism of injury. Data were entered into Microsoft Excel and analyzed using **SPSS version 26.0**. Descriptive statistics were expressed as frequency, percentage, mean, and standard deviation. Associations between categorical variables were assessed using the Chi-square test or Fisher's exact test, while continuous variables were analyzed using Student's *t*-test or Mann-Whitney *U* test as appropriate. A **p-value <0.05** was considered statistically significant.

RESULTS

Table 1. Demographic Profile and Accident Characteristics of Study Participants (n = 40)

Variable	Category	Frequency (n)	Percentage (%)
Age Group (years)	<20	4	10.0
	21-40	18	45.0
	41-60	12	30.0
	>60	6	15.0

Sex	Male	31	77.5
	Female	9	22.5
Road User	Two-wheeler rider	17	42.5
	Pedestrian	10	25.0
	Four-wheeler occupant	8	20.0
	Pillion rider	5	12.5
Type of Collision	Vehicle vs Vehicle	18	45.0
	Vehicle vs Pedestrian	10	25.0
	Self-skid/Fall	8	20.0
	Other	4	10.0

Table 2. Distribution of Injury Patterns among Road Traffic Accident Victims (n = 40)

Injury Pattern	Number of Cases (n)	Percentage (%)
Abrasions	34	85.0
Contusions	28	70.0
Lacerations	23	57.5
Fractures	24	60.0
Head Injury	18	45.0
Thoracic Injury	15	37.5
Abdominal Injury	10	25.0
Upper Limb Injury	19	47.5
Lower Limb Injury	26	65.0
Multiple Injuries	22	55.0

Table 3. Association Between Type of Road User and Severity of Injury (n = 40)

Road User	Minor Injury n (%)	Moderate Injury n (%)	Severe/Fatal Injury n (%)	Total	p-value
Two-wheeler Rider (n=17)	4 (23.5)	6 (35.3)	7 (41.2)	17	
Pedestrian (n=10)	1 (10.0)	3 (30.0)	6 (60.0)	10	
Four-wheeler Occupant (n=8)	3 (37.5)	4 (50.0)	1 (12.5)	8	
Pillion Rider (n=5)	1 (20.0)	2 (40.0)	2 (40.0)	5	
Total	9 (22.5)	15 (37.5)	16 (40.0)	40	0.041*

*Chi-square test; $p < 0.05$ indicates a statistically significant association between type of road user and injury severity.

DISCUSSION

Road traffic accidents (RTAs) remain one of the leading causes of unnatural morbidity and mortality, particularly in developing countries where rapid urbanization, increasing vehicle density, and inadequate road safety measures contribute substantially to the burden of injury. The present study analyzed the forensic injury patterns among 40 road traffic accident victims and demonstrated that young adult males constituted the majority of victims. This finding is consistent with numerous forensic and epidemiological studies, which report that males aged 21–40 years are at the highest risk because they represent the most economically productive population, travel more frequently, and are more likely to engage in high-speed driving and occupational commuting. The predominance of male victims also reflects greater exposure to road traffic environments compared with females [6-8].

In the present study, two-wheeler riders formed the largest group of victims, followed by pedestrians. Similar observations have been reported in several Indian studies where motorcycles remain the most commonly used mode of transport. Two-wheeler riders are particularly vulnerable because they lack the structural protection available to occupants of enclosed vehicles. Poor helmet compliance, excessive speed, alcohol consumption, distracted driving, and non-adherence to traffic regulations further increase the likelihood of severe injuries. Pedestrians were also found to sustain severe injuries,

emphasizing their vulnerability in mixed traffic conditions where dedicated pedestrian pathways and safe crossing facilities are often inadequate [9].

Analysis of injury patterns revealed that abrasions were the most common external injury, followed by contusions, fractures, lacerations, and multiple injuries. Abrasions generally result from friction between the body and road surface during sliding after impact and therefore represent an important forensic indicator of the mechanism of injury. Fractures and lacerations were frequently associated with high-energy collisions and direct impact with vehicles or surrounding objects. Lower limb injuries were observed more commonly than upper limb injuries, reflecting the biomechanics of road traffic accidents where the lower extremities are usually the first body parts struck, particularly in pedestrian and motorcycle collisions. Head injuries were also common and remain a major determinant of mortality in road traffic accidents, highlighting the importance of appropriate helmet use and early trauma management [10].

The present study also demonstrated a statistically significant association between the type of road user and injury severity. Pedestrians and two-wheeler riders sustained severe or fatal injuries more frequently than four-wheeler occupants. This observation is supported by existing forensic literature, which consistently shows that vulnerable road users experience greater kinetic energy transfer during collisions because they lack external protective structures such as vehicle frames, airbags, and seat belts. Conversely, occupants of four-wheeled vehicles generally sustain relatively less severe injuries due to improved crash protection systems [11, 12].

From a forensic perspective, systematic documentation of injury distribution provides valuable information for reconstructing accident events, determining the direction and magnitude of impact, identifying the position of victims during collision, and correlating injuries with the alleged mechanism of accident. Such analyses also assist investigating agencies, insurance authorities, and courts in establishing medicolegal facts. Furthermore, understanding characteristic injury patterns helps emergency physicians anticipate associated internal injuries and prioritize trauma management.

CONCLUSION

The findings of the present study emphasize the need for strengthening road safety measures, improving helmet and seat belt compliance, enhancing pedestrian protection, enforcing traffic regulations, and promoting public awareness regarding safe driving practices. Although the study was limited by a relatively small sample size and its single-center design, it provides useful forensic evidence regarding injury characteristics among road traffic accident victims. Larger multicentric studies involving diverse populations and detailed biomechanical analysis are recommended to further improve forensic interpretation and contribute to evidence-based road safety policies.

REFERENCES

- [1] Jha N, Srinivas DK, Roy G, Jagdish S. Epidemiological study of road traffic cases: A study from south India. *Indian Journal of Community Medicine*. 2004;29:20–4.
- [2] Azmani W, Rusli MA, Ismail AA, Hashim M. Factors and road accidents during festive seasons in Kelantan. *NCD Malaysia*. 2005;4:24–7.
- [3] Aygencel G, Mahamet K, Mahamet E, Telatar G. Review of traffic accident cases presenting to an adult emergency service Turkey. *Journal Forensic & Legal Medicine*. 2008;15:1–6.
- [4] Menon A, Pai VK, Rajeev A. Pattern of fatal head injuries due to vehicular accidents in Mangalore. *Journal Forensic & Legal Medicine*. 2008;15:75–7.
- [5] Montazeri A. Road traffic related mortality in Iran: a descriptive study. *Public Health*. 2004;118:110–3.
- [6] Harish D, Sharma BR, Kumar S, Vij K. Analysis of pelvic fractures in fatal vehicular accidents. *Journal of Forensic Medicine & Toxicology*. 2004;21:30–3.
- [7] Bansal YS, Dikshit PC. Pattern of chest injuries in fatal vehicular accidents in central Delhi. *International Journal of Medical Toxicology & Legal Medicine*. 2001;4:21–6.
- [8] Chaudhary BL, Singh D, Tirpude BH, Sharma RK, Veena M. Profile of road traffic accident cases in Kasturba Hospital of M.G.I.M.S., Sevagram, Wardha, Maharashtra. *Medico-Legal Update*. 2005;5:127–33.



- [9] Singh YN, Bairagi KK, Das KC. Epidemiological Study of road traffic accidents victims in medico-legal autopsies. *Journal of Indian Academy of Forensic Medicine*. 2005;27:166-9
- [10] Sharma BR, Dasari H, Sharma V, Vij K. Road traffic accidents - a demographic and topographic analysis. *Medicine Science & Law*. 2001;41:266-74.
- [11] Salgado MSL, Colombage SM. Analysis of fatalities in road accidents. *Forensic Science International*. 1988;36:91-6.
- [12] Henriksson E, Ostrom M, Erikson A. Preventability of vehicle-related fatalities. *Accident Analysis Prevention*. 2001;33:467-75.