

Pattern of Limb Injuries in Fatal Road Traffic Accidents: A Hospital-Based Study in Tripura, India

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Abstract:**Background:** The expansion of motorization and road networks in India has led to an increase in road traffic accidents (RTAs), causing substantial mortality and morbidity. This study aims to evaluate the pattern of limb injuries in fatal RTA cases in the north eastern state of Tripura.**Methods:** A hospital-based observational study was conducted at the Department of Forensic Medicine and Toxicology, Agartala Government Medical College (AGMC) and GBP Hospital from December 7, 2022, to May 6, 2024. All RTA fatalities undergoing medico-legal autopsy were included, except decomposed bodies. Data were collected from relatives of the deceased and analyzed using SPSS version 15.0.**Results:** Out of 1,361 autopsies conducted during the study period, 290 (21.3%) were RTA-related deaths. After applying exclusion criteria, 240 cases were included. Most victims were males (90.8%) and belonged to the 21–40 age group (43.8%). Two-wheeler accidents were predominant. Abrasions were the most common external limb injury, with lower limbs affected more frequently than upper limbs. External and internal injuries of head, neck, and face were prevalent, with head injury being the most common cause of death (63.3%).**Conclusion:** The study highlights the prevalence of limb and head injuries in fatal RTA cases, underscoring the importance of detailed forensic analysis for legal and public health measures.

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This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.**Introduction**

Road traffic accidents (RTAs) remain a major global public health concern, contributing significantly to trauma-related morbidity and mortality. While much attention has been given to life-threatening injuries such as those involving the head and thorax, injuries to the limbs particularly fractures of long bones are among the most frequently sustained and can have long-term physical, social, and economic consequences. Limb injuries, especially in the upper and lower extremities, are common in both fatal and non-fatal RTAs. These injuries can reflect the mechanism and severity of the impact, the type of collision, and the position of the victim during the accident. In fatal cases, the presence and pattern of limb injuries provide crucial forensic evidence that assists in reconstructing the event and determining the circumstances of death. Furthermore, understanding these injury patterns is essential for clinicians, emergency responders, and forensic experts to develop targeted preventive and management strategies. Despite the high incidence

of limb injuries in RTA victims, limited research has been conducted on the detailed pattern of these injuries in fatal cases, particularly in the north eastern region of India. Tripura, one of the North Eastern states, has shown a consistent burden of road traffic fatalities with 575 accidents in 2022, secured second place among NE states.[1] But yet the forensic documentation and analysis of limb injuries remain sparse. Therefore, the present study was undertaken to analyze the pattern and distribution of limb injuries among road traffic accident victims brought for medico-legal autopsy at AGMC & GBP Hospital in Tripura. The findings aim to bridge the knowledge gap and contribute to forensic documentation, public safety strategies, and medico-legal proceedings.

Methodology**Study Design:** This was a prospective, hospital-based observational study.

Study Setting: The study was conducted in the Department of Forensic Medicine and Toxicology (FM&T) at Agartala Government Medical College (AGMC) and GBP Hospital, Tripura.

Study Period: The study was carried out over a period of 17 months, from December 7, 2022, to May 6, 2024.

Study Population: All deceased individuals from road traffic accidents (RTAs) brought to the mortuary of the Department of FM&T, AGMC and GBP Hospital for medico-legal autopsy during the study period were considered for inclusion.

Inclusion Criteria: The inclusion criteria for the study comprised deceased individuals who were confirmed cases of road traffic accidents. Only those who were brought for medico-legal autopsy during the study period were considered. Additionally, inclusion in the study required that consent was obtained from the relatives or legal guardians of the deceased.

Exclusion Criteria: The study excluded decomposed (putrefied) bodies and cases where consent could not be obtained from the relatives or legal guardians of the deceased.

Data Collection: Data were collected through interviews conducted with the relatives, guardians, or close associates of the deceased individuals. A pre-designed and pre-tested proforma was utilized to systematically document information, including demographic details, circumstances surrounding the accident, and the pattern of injuries observed.

Variables Collected: The variables collected encompassed socio-demographic characteristics such as age, gender, and place of residence. Accident-related information was also recorded, including the type of vehicle involved, the location and time of the accident, and the survival period following the incident. Additionally, data on the type and distribution of both external and internal injuries, as well as the location and frequency of fractures in the upper and lower limbs, were gathered.

Ethical Considerations: Prior informed consent was obtained from the relatives or legal guardians of the deceased before inclusion in the study. The confidentiality and anonymity of all participants were strictly maintained throughout the research process. Ethical clearance for the study was obtained from the Institutional Ethics Committee of AGMC vide no.F.4(6-13)/AGMC/Medical Education/IEC Approval/2022/19991, Dated 06.12.2022.

Statistical Analysis: The collected data were entered and analyzed using SPSS software version 15.0. [2] Descriptive statistics such as frequencies, percentages, and mean \pm standard deviation (SD) were used to summarize the findings. The results

were presented in both tabular and graphical formats, as appropriate.

Results

During the study period, a total of 1,361 medico-legal autopsies were performed at the mortuary of AGMC & GBP Hospital. Of these, 290 (21.3%) cases were due to road traffic accidents. After applying the exclusion criteria, which eliminated 50 cases (mainly due to putrefaction), a total of 240 deceased individuals were included in the final analysis. The majority of the deceased (43.8%) were in the productive age group of 21–40 years, with a mean age of 39.87 ± 16.3 years. Males accounted for 218 (90.8%) of the victims, indicating a significant male predominance. Most accidents occurred in urban areas (58.8%) and on pucca (paved) roads (70.8%). Two-wheeler vehicles were the most commonly involved in fatal RTAs. In terms of time distribution, accidents were almost equally distributed between 6:00 AM and 12:00 PM, while the lowest incidence was recorded during the midnight hours. With respect to survival period, 21.7% of the deceased were brought dead following the accident, while 38.7% died within 24 hours of hospital admission. The remaining victims succumbed after a longer period of hospitalization. Injury analysis revealed that external injuries were present in 216 (90%) individuals on the upper limbs and in 226 (94.2%) individuals on the lower limbs. Abrasions were the most common type of external injury on both upper and lower limbs. In the upper limbs, abrasions alone were most frequent, followed by a combination of abrasion and laceration. In the lower limbs, lacerations were the second most common injury type after abrasions. Fractures were more commonly observed in the lower limbs, with 15.8% of the study population sustaining lower limb fractures, out of which 03.33% had compound open fracture of the lower limbs. Crush injuries were present in 02 (0.83%) individuals. Head, neck, and face were the most frequently injured regions outside the limbs. External injuries in these areas were observed in 53.8% of cases, while internal injuries involving the same region were present in 63.3% of cases. Among the internal injuries, fracture of the skull bone, cranio-cerebral hemorrhage, and extravasation of blood into body cavities were most common. Head injury was identified as the leading cause of death, accounting for 152 (63.3%) of the cases. These findings highlight the high frequency and forensic importance of limb and cranial injuries in fatal RTA cases.

Discussion

Limb injuries are among the most frequently sustained physical traumas in road traffic accidents (RTAs), and their evaluation holds considerable importance in forensic, clinical, and public health domains. In the present hospital-based prospective

study, we observed that injuries to the both upper and lower limbs were highly prevalent among fatal RTA victims, with 90% and 94.2% of deceased individuals sustaining external injuries to the upper and lower limbs, respectively. These findings underscore the vulnerability of extremities during vehicular collisions, particularly in two-wheeler users, who formed the majority of the cases in our study. The high prevalence of abrasions, followed by lacerations and contusions in both upper and lower limbs, aligns with the nature of injuries typically seen in high-velocity impacts. Abrasions, often caused by friction with the road surface, are indicative of sliding or skidding mechanisms, while lacerations suggest direct impact with hard or sharp surfaces. Fractures, more commonly observed in the lower limbs (15.8% of cases), often reflect transmission of force from vehicle parts, road surfaces, or structural collapse. This anatomical susceptibility of the lower limbs can be attributed to their position during impact particularly in two-wheeler riders, where the legs are more exposed to collision forces. Our findings are consistent with those of Mehta et al [3]. (New Delhi), who also reported lower limb fractures as the most common skeletal injury in fatal RTA victims. Similarly, Rao et al. [4] found lower limbs to be more frequently affected than upper limbs, emphasizing the role of biomechanical exposure. The predominance of limb injuries in younger adults (21–40 years) in our study also raises socioeconomic concerns, as this is the most productive age group contributing to the workforce. Fatal or disabling injuries in this demographic have a profound impact on families, healthcare systems, and national productivity. From a forensic standpoint, detailed documentation of limb injuries can provide valuable insight into the dynamics of the crash, including the type of vehicle involved, the position of the victim, and the nature of impact. For example, patterned abrasions or specific fracture configurations may indicate being struck by a vehicle versus being a passenger or rider. These insights are especially useful during legal proceedings, insurance claims, and determination of culpability. Crush injuries and compartment syndrome are critical complications of limb trauma in road traffic accidents, often leading to severe morbidity or amputation. Crush injuries cause muscle necrosis and systemic issues, while compartment syndrome involves increased pressure within muscle compartments, threatening limb viability. Prompt recognition and early surgical intervention are vital for favourable outcomes. [5,6] Limb injuries from road traffic accidents often result in permanent disability due to severe musculoskeletal and neurovascular damage. Early intervention is crucial to prevent long-term functional loss. [7] Fat embolism is a serious complication of long bone fractures in road traffic accidents, potentially leading to fat embolism

syndrome with respiratory distress, neurological impairment, and petechial rash. Early recognition and supportive care are essential to reduce morbidity and mortality. [8]

Despite their high frequency, limb injuries are often underemphasized in trauma care, where life-threatening injuries naturally take precedence. However, in non-fatal cases, such injuries may lead to permanent disability, long-term rehabilitation, or amputation there by stressing the need for preventive strategies that prioritize limb protection.

Several measures can significantly reduce the incidence and severity of limb injuries in RTAs:

1. **Use of Protective Gear:** The consistent use of certified protective gear such as knee guards, elbow pads, reinforced riding jackets, gloves, and riding boots has been shown to substantially reduce both soft tissue and skeletal injuries in motorcyclists. Unfortunately, their usage remains suboptimal in many parts of India, including Tripura, due to lack of awareness, cost, and weak enforcement.
2. **Vehicle Design Modifications:** Incorporating crash-absorbing structures and protective barriers in two-wheelers and cars (such as leg guards and side airbags) can help absorb kinetic energy during impact, thereby reducing the force transmitted to the limbs.
3. **Infrastructure Improvements:** Road quality, lighting, and traffic calming measures (e.g., speed breakers, pedestrian zones, protected bike lanes) play a significant role in both preventing crashes and minimizing injury severity. Urban planning that prioritizes safe, segregated traffic flow can reduce high-impact collisions.
4. **Policy and Regulation:** Strict enforcement of traffic safety rules, including mandatory helmet and protective gear laws, speed regulations, and zero-tolerance policies for drunk driving, can lower the incidence of high-velocity impacts that often result in severe limb injuries.
5. **Public Awareness Campaigns:** Educating road users, especially young riders, about the importance of protective gear and safe driving practices can foster behavioural change. Community-based interventions, school programs, and mass media efforts are effective tools in spreading this awareness.
6. **Emergency Response and Trauma Systems:** Early and efficient pre-hospital care, including splinting and stabilization of limb fractures, can reduce complications and long-term disability in survivors. Improved coordination among police, ambulance services, and trauma centres is crucial.

Conclusion

This study provides a comprehensive assessment of limb injury patterns among fatal road traffic accident victims in Tripura, a region where such data has been scarce. Our findings reveal that injuries to the upper and lower limbs are not only highly prevalent but also hold significant forensic and clinical value. Abrasions were the most common type of external injury, while lower limb fractures were notably more frequent than upper limb fractures, particularly among two-wheeler users. By documenting the type, location, and frequency of limb injuries, this study contributes to a better understanding of trauma patterns in fatal RTAs and highlights the need for improved protective strategies and enforcement of safety regulations. Importantly, these findings can assist forensic experts during medico-legal examinations and court proceedings, as well as guide public health policymakers in designing targeted interventions.

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