



Evaluation of Common Traffic Accident-Related Injuries Using Radiological Imaging Techniques in Hail Region

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Abstract: Background: Traffic accidents in Saudi Arabia induce severe morbidity, disability, and mortality. Radiologic imaging plays a vital role in the early diagnosis and treatment, and no local data exists on imaging and outcome of injury in Hail or northern Saudi Arabia. The research is the first to estimate the connection between the timing of imaging and the results of trauma in this area. **Objective:** To evaluate injury patterns of victims in road traffic accidents with several radiological imaging modalities and examine the connection between the timeliness of imaging, the extent of injuries, clinical management, and outcomes. **Methods:** A retrospective study involved 1000 traffic accident victims in the tertiary centers in Hail (2021- 2024). Medical and imaging data were analyzed to give demographics, characteristics of the injury, type of imaging, time-to-imaging, and outcomes. Statistical analysis was done with Chi-square and exact probability tests ($p < 0.05$). **Results:** The majority of victims were men (78.0%), and the average age of the victims was 28.9 ± 15.6 . The most frequent modality was CT, particularly in severe injuries ($p = 0.001$). There were more favorable results of early imaging (less than 15 minutes) with reduced ICU admissions and mortality rates ($p = 0.019$). Deaths due to multi-region trauma amounted to 88.9 ($p = 0.008$). **Conclusions:** Fast imaging (CT as well as ultrasound) enhances the survival rates. Road traffic accident morbidity and mortality in Saudi Arabia are minimized through imaging within the first 15 minutes.

Key Words: Traffic Accidents, Radiological Imaging, Injury Patterns, Trauma Assessment, Computed Tomography (CT)

INTRODUCTION

Traffic Injury is a major social problem and has taken the lives of more than 1.3 million people and non-fatal injuries to 20-50 million people within the past years, especially in low and middle-income nations like Saudi Arabia. Increasing motorization, laxity in the implementation of traffic laws, and absence of critical medical services are some of the conditions that have contributed to high trauma rates and severity in these areas. The adult population that is mostly economically productive is high, and thus, there are high economic costs because the young people are the most affected. The pattern of injury depends on such factors as vehicle, collision, restraint, and the level of emergency radiological services.

Early identification is extremely vital in the management of the emergency department (ED) because the early identification of life-threatening injuries (LTIs) can be directly related to the

triage decisions and survival rates. The radiological imaging methods, X-rays, ultrasound (FAST/eFAST), and computed tomography (CT) play a vital role in assessing trauma. Although CT is now the standard technique of whole-body assessment, in cases of inconclusive CT results, MRI is essential to investigate spinal injuries and soft-tissue injuries.

This research seeks to fill the knowledge gap within the area of imaging timing and modality, as far as clinical outcomes are concerned, with particular reference to the Hail region in Saudi Arabia, where trauma frequency has been on the increase owing to high rates of urbanization and traffic flow. The research will analyse the data of 1000 patients by comparing injury patterns according to age and gender, use of imaging according to injury type, and the effect of imaging latency on patients according to injury types. To test the hypothesis, it will be assumed that the earliest CT and ultrasound

done within the first 15 minutes of arrival would greatly enhance morbidity and mortality and result in improved clinical outcomes.

METHODS

Study Design, Setting, and Ethical Considerations

Our cross-sectional retrospective study focused on 1000 patients who were admitted to hospitals in the Hail region, Saudi Arabia, as a result of traffic accidents. Both hospitalized and discharged patients were used, with medical records, imaging systems, and trauma registries used to obtain data, and patient confidentiality was ensured through the anonymity of identifiers. The University of Hail Institutional Review Board (IRB Approval No. H-2025-803) and the Hail Health Cluster (Hospital Approval No. 2025-71) positively endorsed the approval of the study protocol and, accordingly, the informed consent. The IRB allowed the study to be done with ethical sanction and financial backing to ensure that the relevant guidelines were followed.

Study Design and Settings

The patients involved in this study were all aged, and they were taken to the emergency department (ED) following a road traffic accident and had at least one form of radiological examination (X-ray, ultrasound, CT scan, or MRI). Only instances that posted full demographic and clinical data were taken so that a thorough analysis could be done. Patients were not included when they did not have the required data, including imaging time or the severity of injury, or when they were treated as outpatients and did not have imaging. Such requirements allowed a clinically suitable sample to assess the use of imaging and patterns of injuries in the study area.

Data Collection

For this study, trained research personnel retrospectively retrieved data from hospital electronic medical records, PACS, and trauma registry databases. Collected variables were demographic information (age <10, 10-20 years, 21-30 years, 31-40 years, >40 years, and gender) and accident year (2021-2024). Injury data included the anatomical sites (head, neck, chest, abdomen, face, upper extremity, lower extremity, spine, soft tissue, pelvis, and mixed). Imaging modalities considered were X-ray, CT, ultrasound, and MRI, and time to imaging (<15 min, 15-30 min, 31-60 min, >one h, undocumented) as well as documentation status. Severity of injury was according to the local trauma scoring system (mild, moderate, severe, alive, and fatally injured). Additional variables were operative treatment (yes/no, location) and patient outcome (discharged, admitted, intensive care unit, referral, death, or unknown).

Definitions and Protocols for the Development of Imaging

- **X-ray:** plain radiographs, AP/PA, lateral chest, Abdominal: Plain radiographs taken for suspected fractures, chest, and abdomen assessment.

- **Ultrasound:** FAST/eFAST done by ED physicians or radiology sonographers for the finding of intraperitoneal/pericardial fluid and findings on the chest (pneumothorax/pleural fluid).
- **CT:** CT: non-contrast and contrast [enhanced] CT protocols based on trauma algorithm, including head CT, cervical spine CT, thoracoabdominopelvic CT, and dedicated extremity CT with appropriate indication
- **MRI (Magnetic Resonance Imaging):** Used cautiously in the evaluation of the spinal cord, complex injuries to soft tissues, or neurologic deficit not etiology specific in the CT.

Statistical Analysis

The descriptive statistics were in the format of counts and percentages (categorical variables) and means (SD) (continuous variables). Comparison of beliefs among categorical variables (sex and injury site) was determined through Pearson chi-square tests, and exact probability tests when some were too small. Significance was set at $p < 0.05$. Analysis was done using SPSS version 26.

RESULTS AND ANALYSIS

Study Population

Table 1 presents the demographics of 1,000 victims of a road accident in the Hail Region, comprising patients who were either hospitalized or discharged. The overall age mean was 28.9 years (SD = 15.6), with the majority of the victims being male (78%). The highest proportion was 10-30 years (55.7%), followed by the largest proportion of 10-20 years (31.1%) and 21-30 years (24.6%). The ages of children below 10 years consisted of 5.4, and adults above 40 years constituted 19.4. The gender imbalance is that of increased exposure of males to driving. In 2023 (65.2) and 2024 (33.6), the accident rates were also by far higher than they were in 2021-2022 (1.2%).

Injury Distribution by Region

According to Table 2, gender differences in injury distribution among 1000 road traffic accident survivors reveal a large difference between males and females. The injury of lower limbs was more common among males (43.3% vs. 33.2% had a significant difference of $p = 0.038$) as they are exposed to high- impact activities. Males were more susceptible to head and facial injuries (38.8% and 27.8

Table 1: Surgical Intervention and Clinical Outcomes of Traffic Accident Victims in Hail Region

Items	No	%
Was surgery required?		
Yes	290	29.0
No	710	71.0
Patient outcome from medical record:		
Admitted for observation	399	39.9
Admitted to ICU	129	12.9
Discharged	358	35.8
Referred to surgery	97	9.7
Death in ED/hospital	9	0.9
Unknown	8	0.8

Table 2: Correlation Between Multiple-Region Injuries and Mortality Among Traffic Accident Victims

Injury region	Death				p-value
	Yes		No		
	No	%	No	%	
Multiple regions	8	88.9	443	44.7	0.008*
Single region	1	11.1	548	55.3	

p: Exact Probability test, * $p < 0.05$ (significant)

vs. 35.9% and 22.7), however. Women possessed small percentage differences in chest injuries (35.9% vs. 34.0% and abdominal injuries of 20.5% vs. 19.1%). The difference between the neck, spine, pelvis, and soft tissue injuries did not show any significant gender variation (all $p > 0.05$). The injury severity (13.6 vs. 10.6) and mortality (1.0 vs. 0.5) were greater in males. Specific preventive and treatment interventions against gender are advised.

Age-related Injury Pattern

There is evident age variation in the pattern of injuries in road traffic victims of the Hail Region. The incidence of chest trauma rose with age (24.1% in children under 10 years vs. 44.3% in those over 40 years; $p = 0.048$), probably because of the loss of bone density and elasticity in the thoracic region, which makes them prone to rib injury and intrathoracic injury. The requirement of a larger head-to-body ratio, nonuse of seatbelts and child restraints, and increased exposure to direct impact evidently point to children under 10 years (44.4, $p = 0.036$) as having the highest frequency of facial trauma. The younger groups were also susceptible to head injuries (50.0% in kids and 41.8% in adolescents; $p = 0.324$), which highlights the sustained cranial vulnerability in spite of the insignificance. Even though there were no age changes (all $p > 0.05$) on abdominal, limb, pelvic, and soft-tissue injuries, spinal trauma was more prevalent in older adults (33.0% in >40 years), which is reasonable given degenerative and fragility changes.

Imaging Modality Utilization and Injury Severity

The analysis demonstrated a substantial relation between the severity of the injury and the use of the imaging modalities among the patients of the traffic accidents in the Hail Region ($p = 0.001$). The usage of CT was higher in the cases of injury severity, 76.7% in mild, 95.9% in moderate, and 100% in severe and fatal cases. X-ray (87-100%) was a beneficial assay with many results focusing on the initial examination of traumas. In the severe cases, ultrasound (FAST/eFAST) was more prevalent with 77.8 in fatal cases with a greater emphasis that it can be used to detect internal bleeding. MRI was used in 3-4% of cases. Outcomes were also associated with the severity where increasing ICU admissions (56.1%) and ‘[]’;reducing the discharge rates (3.3) were observed in severe cases.

Time-to-Imaging and Clinical Outcomes

Time to imaging and injury severity ($p = 0.001$) and patient outcome ($p = 0.019$) have a significant correlation. Majority of all trauma patients (without severity distinction) received

preliminary imaging within 15 min of arrival (mild: 73.7%, moderate: 78.2%, severe: 79.5). But in severe cases, there were delays delivered with 44.4% undergoing imaging 15-30 min which could be a limiting factor. Patients that were discharged (76.3), those that were admitted to observation (76.7), had common early imaging (less than 15 minutes), which was an indication of a better prognosis. Conversely, delays (15-30 minutes) caused more ICU admissions and mortality, and thus there is a need to speed up the imaging process when managing trauma care in order to enhance survival and the dependence on ICU.

Clinical Outcomes and Surgical Interventions

A breakdown of clinical outcomes and surgical procedures of 1000 victims of road accidents in the Hail Region (quantified in the supplementary section) shows that 29% ($n = 290$) were subjected to surgery and 71% ($n = 710$) treated with conservative therapy. Though most of the injuries turned out to be non-life threatening, a high surgical burden was witnessed, with 39.9, 35.8 and 12.9 cases observed, discharged and transferred to ICU respectively. The mortality rate was 0.9 which shows that it was stabilized. Figure 4 indicates that there was an uneven number of surgeries by the location of injuries with abdominal injury (45.9) and lower extremity injury (45.0) being the most frequently used. The rate of surgery done on polytrauma patients was 40.5 percent and facial injuries was 36.7 percent. These findings emphasize the significance of imaging and diagnosis in a timely manner as a form of guiding surgical procedures towards the best treatment results.

Multiple-Region Injuries and Mortality

Shifted to supplementary section shows that there is a significant association between multi- region injuries and mortality among the victims of the traffic accidents ($p = 0.008$), with 88.9% cases resulting in death caused by polytrauma, and 11.1% of the mortality caused by single-region injuries. This underscores the high mortality rates linked with polytrauma, and especially when the critical organs and regions of the body, including those of the head, chest, and abdomen, are involved. A combination of these injuries causes a rapid degenerative process of the physiological unit, necessitating high-resolution medical imaging methods and surgery. These results highlight the importance of effective trauma workflow and imaging pre-triage systems in emergency rooms, especially in the Hail Region.

DISCUSSION

The analysis of 1000 traffic accident victims in the Hail region indicates important information on the distribution of injuries, imaging modalities, and clinical outcomes. Most victims were young men with an average age of 28.9 ± 15.6 years with more than half in the 10-30 age group which highlights that such victims are a heavy burden in terms of the socioeconomic aspect of the most economically active

group of the population. The injuries to lower limbs were most common, then the head and chest injuries and the workload of the orthopedic surgeons was with lower limb injuries (45% of the cases). Besides, there were more head injuries in younger victims, and it is necessary to wear the helmets, as well as to receive the neuroimaging as soon as possible. The incidence of chest injuries in victims older than 40 years was higher which contributed to the even bigger age difference in terms of compliance of the chest wall. These results indicate that safety programs should be age tailored, especially to young drivers and other susceptible people including the children and the elderly.

When compared to imaging, CT scans were crucial, as it was used in a thinly veiled majority of 76.7 percent to 100 percent in mild and severe injuries respectively. Early imaging especially in the first 15 minutes was highly linked with a positive patient outcome, such as, faster discharge and less time on observations. Any delays (more than 15-30 minutes) in imaging led to poor outcomes, and expedited imaging to reduce diagnostic intervals was important (especially in polytrauma patients). The findings support the importance of effective management of trauma by the use of timely imaging and multidisciplinary management to maximize patient survival and recovery.

Comparative Analysis

This study has a greater injury burden, imaging use, and clinical severity than the previous literature. Al-Orf *et al.* [13] found a lower number of severe/polytrauma with pan-CT in Saudi Arabia and almost every severe/fatal involved the use of CT, and 88.9% of deaths were observed to be related to multi-region trauma. The study by Alkhateeb *et al.* [14] found a younger demographic of trauma and did not provide a specific analysis of lower limb and head injury but used lower levels of CT in comparison with our results (76.7% in mild cases, almost universal in severe cases). It implies higher the intensity of trauma and use of CT to diagnose in Hail. Kithinji *et al.* [15] demonstrated that handheld eFAST is effective in hemothorax, but with lower usage and diagnostic performance than our study, where ultrasound should be used as a complement to the CT in the majority of patients with moderately and severely injured. Willett *et al.* [16] emphasized on insufficient imaging facilities but in our paper an established imaging workflow was noted with 74-80% of patients being imaged within 15 minutes, which demonstrates a more efficient trauma system. Our findings indicate increased compounds of CT use and severity as compared to international data. The lower diagnostic utility was reported in Ishii *et al.* [17] and Fathi *et al.* [18], but in our study, high utilization and severity of CT were described. Huber-Wagner *et al.* proposed prompt integration of imaging [19], and our results are consistent with them with early imaging (<15 min) associated with desirable results. These descriptions highlight the valuable contribution of our study to the imaging of trauma in Saudi Arabia.

Clinical Implications and Recommendations

Early and synchronized imaging plays a major role in the incidence of trauma care and the early imaging process has a close relationship with better patient outcomes. Formalizing traumatic procedures, such as faster CT-imaging, and the implementation of the eFAST-trained staff is essential in the early identification of occult trauma and avoiding misdiagnoses. High-risk patients or those with unclear mechanisms of injury should be subjected to an exclusive use of pan-CT, which will improve the accuracy of the diagnosis. Moreover, effective emergency, radiology, and surgical team communication systems should be in place with the end result being timely interpretation and response. Concerning the healthcare systems, it is crucial to make sure that the services of radiology, surgery, and anesthesia could be available all the time. Such preventive strategies as helmet use and seatbelts, restricting speed and educating young drivers are vital to the reduction of morbidity and mortality that is associated with the vehicle-related trauma. Collaboration between health institutions and traffic safety analyst will strategize the both clinical outcomes and safety programs at the state level.

Strengths, Limitations and Areas of Future Research

The main advantage of this study is the fact that the sample of 1000 participants is a sufficient amount of data to guarantee a thorough and generalized assessment of trauma injury epidemiology in the area of Hail. The provision of descriptive imaging, and clinical outcome data enables sound correlations of imaging techniques, degree of injury, and patient outcome, with potential implications in enhancing the effectiveness of diagnostic processes and patient care in the emergency room.

Nevertheless, the research has shortcomings. The generalizability of the results to other regions possibly having dissimilar trauma systems is limited due to the retrospective design and a regional bias of the study. The absence of pre-hospital data regarding safety device use and the absence of long-term recovery outcomes are significant limitations that make it more difficult to draw causal conclusions and evaluate the long-term effects of quality of life of patients.

Prospective time-motion studies should also be incorporated into future research to reveal the inefficiencies in the workflow and investigate how pre-hospital care affects imaging timeliness and patient outcomes. Furthermore, economic analyses between imaging modalities in resource constrained environments, and longitudinal analyses of functional recovery are also required. The interventional trials of fast-track imaging protocols and system-level reforms would help gain evidence that would reduce morbidity and mortality in the trauma care.

CONCLUSION

This is a large retrospective study in the Hail area which indicates that the victims of traffic accidents are mainly young males with most injuries affecting the lower limbs, head, chest, and spine. Most common imaging applications include CT and ultrasound imaging, which are important in contemporary trauma care but could not be applied in milder cases, with initial imaging (less than 15 minutes) being associated with increased success and reduced mortality. The presentation of the problem was mainly

the abdominal and lower extremity injuries that required surgical treatment, and the predictor of in-hospital death was the multi-region trauma. The findings highlight the importance of casino where the use by young drivers: fast track pathways, imaging accessibility, clinician training, and public health measures targeting young drivers. Future studies within the field should concern when the imaging interventions are carried out to improve survival and recovery.

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