

Clinical Study

Occupant and crash characteristics in thoracic and lumbar spine injuries resulting from motor vehicle collisions

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Abstract

BACKGROUND CONTEXT: Motor vehicle collisions (MVC) are a leading cause of thoracic and lumbar (T and L) spine injuries. Mechanisms of injury in vehicular crashes that result in thoracic and lumbar fractures and the spectrum of injury in these occupants have not been extensively studied in the literature.

PURPOSE: The objective was to investigate the patterns of T and L spine injuries after MVC; correlate these patterns with restraint use, crash characteristics, and demographic variables; and study the associations of these injuries with general injury morbidity and fatality.

STUDY DESIGN/SETTING: The study design is a retrospective study of a prospectively gathered database.

PATIENT SAMPLE: Six hundred thirty-one occupants with T and L (T1–L5) spine injuries from 4,572 occupants included in the Crash Injury Research and Engineering Network (CIREN) database between 1996 and 2011 were included in this study.

OUTCOME MEASURES: No clinical outcome measures were evaluated in this study.

METHODS: The CIREN database includes moderate to severely injured occupants from MVC involving vehicles manufactured recently. Demographic, injury, and crash data from each patient were analyzed for correlations between patterns of T and L spine injuries, associated extraspinal injuries and overall injury severity score (ISS), type and use of seat belts, and other crash characteristics. T and L spine injuries patterns were categorized using a modified Denis' classification to include extension injuries as a separate entity.

RESULTS: T and L spine injuries were identified in 631 of 4,572 vehicle occupants, of whom 299 sustained major injuries (including 21 extension injuries) and 332 sustained minor injuries. Flexion-distraction injuries were more prevalent in children and young adults and extension injuries in older adults (mean age, 65.7 years). Occupants with extension injuries had a mean body mass index of 36.0 and a fatality rate of 23.8%, much higher than the fatality rate for the entire cohort (10.9%). The most frequent extraspinal injuries (Abbreviated Injury Scale Grade 2 or more) associated with T and L spine injuries involved the chest (seen in 65.6% of 631 occupants). In contrast to occupants with major T and L spine injuries, those with minor T and L spine injuries showed a strikingly greater association with pelvic and abdominal injuries. Occupants with minor T and L spine injuries had a higher mean ISS (27.1) than those with major T and L spine injuries (25.6). Among occupants wearing a three-point seat belt, 35.3% sustained T and L spine injuries, whereas only 11.6% of the unbelted occupants sustained T and L spine injuries. Three-point belted

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individuals were more likely to sustain burst fractures, whereas two-point belted occupants sustained flexion-distraction injuries most often and unbelted occupants had a predilection for fracture-dislocations of the T and L spines. Three-point seat belts were protective against neurologic injury, higher ISS, and fatality.

CONCLUSIONS: T and L spine fracture patterns are influenced by the age of occupant and type and use of seat belts. Despite a reduction in overall injury severity and mortality, seat belt use is associated with an increased incidence of T and L spine fractures. Minor T and L spine fractures were associated with an increased likelihood of pelvic and abdominal injuries and higher ISSs, demonstrating their importance in predicting overall injury severity. Extension injuries occurred in older obese individuals and were associated with a high fatality rate. Future advancements in automobile safety engineering should address the need to reduce T and L spine injuries in belted occupants. Published by Elsevier Inc.

Keywords:

Motor vehicle collision; CIREN; Spinal column injury; Automobile safety; Spine trauma; Spine fracture

Introduction

Motor vehicle collisions (MVC) are a common cause of thoracic and lumbar (T and L) spine injuries, accounting for between 22.5% and 51% of all T and L spine injuries in different series [1–3]. T and L spine fractures generally do not directly result in mortality but can result in substantial morbidity, especially when associated with neurologic deficit and deformity. Engineering analyses of vehicle crash mechanisms have resulted in numerous vehicular safety improvements and a substantial reduction in the incidence of fatal and nonfatal occupant injuries from car crashes over the last two decades [4]. There has, however, been little effort in characterizing the mechanisms of injury in vehicular crashes that result in thoracic and lumbar fractures and the spectrum of injury in these occupants.

A single database that provides comprehensive data on the crash characteristics, occupant demographics, and clinical details of the injuries sustained has not been previously studied in relation to T and L spine injuries. A study reported in 1989 on T and L injuries after motor vehicle crashes included older vehicles and did not consider advances in safety technologies such as air bags [5]. Other studies on T and L spine injuries from MVC have been restricted in their scope by studying thoracolumbar junctional injuries alone [6], injuries from frontal impact collisions alone [7–9], or front seat occupants alone [8]. Limitations in other studies include single hospital reported data [6,7], absence of correlation with air bag deployment [6,8], small numbers [10], or the use of databases with insufficient data to provide accurate correlation of clinicoradiographic findings with crash characteristics [8,11].

In the present study, we reviewed a multicenter national database of motor vehicle accidents, providing comprehensive crash and occupant information in a large number of moderate to severely injured occupants presenting at Level 1 Trauma Centers. The objectives of this study were to determine the types of injuries sustained to the thoracic and lumbar spines in motor vehicle crash occupants and study the associated morbidity incurred by occupants with these fractures of the spines. Clinical and imaging data were analyzed, and fracture patterns were correlated with demographic and

crash data. As a result of these findings, modifications have been proposed to the three-column injury classification system to accommodate for patterns of spinal injury that do not fit well into the current classification systems.

Materials and methods

The Crash Injury Research and Engineering Network (CIREN) database is a prospectively gathered database of MVC maintained by the National Highway Traffic Safety Administration. The database contains information on the specifics of the vehicular crash and from the medical records of the occupants of the involved vehicles, gathered currently from six centers across the United States. Motorcycle, bicycle, and pedestrian accidents are excluded. Currently, crashes involving vehicles manufactured more than 5 years before the year of accident are excluded. Only those occupants sustaining systemic injuries with an Abbreviated Injury Score (AIS) of 3 or more [12], irrespective of region of injury, or AIS of 2 in at least two different regions of the body are included in the database. The database maintains deidentified clinical information on injuries, obtained from hospital medical records. Impact and engineering data related to the vehicular crash is input by specially trained engineers after vehicle inspection and road and physical environs of the collision. Clinical information is entered by clinical coordinators at individual centers. Additional information can be found on the CIREN database (<http://www.nhtsa.gov/CIREN>). The database was specifically queried for injuries to the thoracic and lumbar spines, between 1996 and 2011. Occupants of all ages were included.

A total of 4,572 occupants in MVC were registered in the CIREN database between 1996 and November 2011. Of these, 631 occupants were identified with 2,626 thoracic and lumbar spine injuries. The CIREN files for all 631 individuals were reviewed for demographic, injury, and crash data. Subject demographics recorded included age, sex, body weight, height, and body mass index (BMI). Specific information on the thoracic and lumbar injuries included the type and level of spinal column injury and

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