

Restrained Children's Spinal Injury Causation Scenarios in Motor Vehicle Crashes

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Abstract

Objective: *To determine common injury causation scenarios that result in significant spinal injuries to restrained children in motor vehicle crashes.*

Pertinent Problem: *Spinal injuries are among the most disabling of all motor vehicle crash-related injuries, and prior research has focused on injury epidemiology using general trauma. This study aims to describe the specific injury causation scenarios for spinal injuries in child occupants.*

Methods and Data: *The Crash Injury Research and Engineering Network (CIREN) database was queried as the data source. Cases were included if they met the following criteria: case occupant <18 years old with at least one spinal injury of severity 2 or greater on the Abbreviated Injury Scale (AIS), vehicle model year 1990 or newer, and no rollover during the crash. Of the resultant cases, those in which the case occupant was not using the shoulder portion of the belt, was not using the belt at all, or was grossly misusing a child restraint seat were excluded. Cases were also excluded if the occupant had a pre-existing condition contributing to spinal injury, or if there was limited injury information available. The remaining cases were individually reviewed by a multidisciplinary team of physicians and engineers in order to determine injury causation scenarios (ICSs). Additionally, crash conditions, occupant and restraint characteristics, and injuries were summarized.*

Results: *Applying all inclusion and exclusion criteria produced 51 occupants for the study, together sustaining 108 AIS 2+ spinal injuries. The most common crash direction was frontal (63%), and the spinal-injured occupants were most frequently in passenger cars (67%). The mean delta-V across the crashes was 52.1 ± 19.8 km/h. The occupant population was primarily 16-17 year olds (49%), followed by 3-5 year olds (19%) and 13-15 year olds (14%), and the seating distribution was as follows: 31% right-front passengers, 29% drivers, 22% rear (rows 2 and 3) left, 14% rear right, 4% rear center. Eighty-seven percent of restrained spinal-injured occupants were wearing a lap and shoulder belt. Of the 108 spinal injuries, 52 were to the lumbar spine, 33 to the cervical spine, and 23 to the thoracic spine. Spinal injuries were most commonly classified as vertebral fracture with or without dislocation (N=83), followed by dislocations without fracture (N=11), and spinal cord contusions or lacerations (N=9). AIS 2+ head injuries (N=62) and lower extremity injuries (N=61) were most often associated with the spinal injuries.*

Conclusions: *In the CIREN database, spinal injuries in restrained children are most often caused by flexion or lateral bending over the lap and/or shoulder belt or child restraint harness,*

compression by the occupant's seat back, and axial loading through the seat pan. Teenagers and right front passengers experience the most spinal injuries, and of spinal injuries, the most common is a vertebral fracture to the lumbar spine resulting from flexion over the lap belt. This knowledge can be utilized by engineers when developing new safety measures, by public educators when teaching parents how to properly fasten their children, and even by first responders when attempting to identify potential spinal injuries.