

Cervical Vertebral and Spinal Cord Injuries Remain Overrepresented in Rollover Occupants

Loay Al-Salehi¹, Gunter P. Siegmund², Peter A. Cripton¹

¹Orthopaedic and Injury Biomechanics Group, University of British Columbia, Canada

²MEA Forensic Engineers & Scientists, Inc., USA

Introduction: Rollover crashes persist as a significant public health concern in North America, with the cervical spine emerging as the most frequently injured segment. However, prior analyses primarily focused on identifying risk factors rather than elucidating the nature of cervical spine injuries themselves. Our study aimed to fill this gap by examining the relationship between various types of cervical spine injuries and occupant-related factors in rollovers, compared against non-rollover incidents.

Methods: We used crash and injury data from the National Automotive Sampling System–Crashworthiness Data System (NASS-CDS) for the years 2005 to 2015, complemented with the Crash Investigation Sampling System (CISS) for 2017 to 2022. Using population weighted data, we computed relative risks to assess how occupant characteristics such as sex, seat belt usage, ejection status, and fatal outcomes correlated with the incidence of different cervical spine injuries in both rollovers and non-rollovers.

Results: Among the occupants recorded in the NASS-CDS dataset with cervical spine injuries (weighted N=111,040 cases), approximately 91.5% sustained at least one vertebral injury, while only 11.3% suffered a spinal cord injury, most commonly accompanied by a concurrent fracture. Notably, all categories of cervical spine injuries evaluated were 3.4 to 5.2 times more prevalent in rollovers compared to non-rollover accidents. This elevated risk persisted across both sexes, seat belt usage, ejection status, and non-fatal outcome. While the CISS dataset included fewer occupants with cervical spine injuries (N=42,003), the disparity between rollovers and non-rollovers remained high, with cervical spine injuries being 6.3 to 6.4 times more likely in rollovers despite advancements in vehicle technology.

Discussion: Despite a newer vehicle fleet in the CISS database, the disproportionately high rates of cervical spine and spinal cord injury in rollover occupants and the strong relationship between spinal cord injuries and fractures/dislocations observed in the older NASS database persisted. These findings underscore the ongoing imperative for rollover-specific safety interventions. Moreover, they suggest that targeted efforts aimed at preventing cervical vertebral fractures could effectively mitigate the incidence of most cervical spinal cord injuries. Therefore in addition to this epidemiology study, we will present a novel robotic simulation device to safely expose human subjects to the yaw, trip and roll dynamics of a real-world rollover.