## D14 Relationship of Risk Factors and Specific Tissues at Risk in Rear-Impact Collisions

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After attending this presentation, attendees will understand the most pertinent and valid risk factors associated with injury in motor vehicle occupants subjected to collinear rear-impact collisions. This presentation will address four common mechanisms which alter the biomechanical loading capacity of the cervical spine and one mechanism which is unique to rear impacts. For each mechanism, the presenters will describe what tissues or structures are placed at risk and how the pain of injury to these structures is expressed.

This presentation will impact the forensic science community by elucidating common factors which increase the risk of injury in rear-impact collisions. This will enable biomechanical experts to better understand and analyze the mechanisms of injury in these collisions and aid care providers in assigning prognoses to patients recovering from these events. This presentation will help illuminate a field which has been fraught with bias due to the lack of understanding of the true injury mechanism and interaction between human, vehicle, and collision factors which can increase injury risk and lower long-term prognosis for recovery.

The risk factors most commonly identified in motor vehicle collision testing include: (1) Gender — females are more likely to be injured in rear-end collisions than males.[1,2] The female anatomy and physiology is less conducive to withstand impact loads, shear, compression, tension, torsion or jolt injuries as sustained in a rear-end collision; (2) Stature — persons with smaller frames and smaller neck circumferences are more likely to be injured in rear-end collisions.[3] Tissues with smaller circumference or geometrical size are less able to withstand trauma; (3) Occupant Position — studies have found that when the head is rotated from ideal position, neck strain becomes more common.[4] Additionally, multiple injuries and more severe injuries occurred with increased frequency.[5] When an occupant is not seated in ideal position, structures are less likely to be in an optimal load tolerance state and likelihood of injury is increased; (4) Unpreparedness— it has been shown that unprepared occupants are more likely to sustain multiple injuries and more severe injuries.[1,5] When an occupant is hit unaware, he or she is unable to brace for impact, which increases risk of deep spinal injuries and lowers prognosis for recovery; and, (5) Rear-Impact Unique Loading Event — when struck from the rear, a motor vehicle occupant experiences an S-shaped curve in the cervical spine, which produces a loading event unlike daily activities, sports, or other traumatic events.[6,7] This event combines a pre-loading level of compression that decreases the load tolerance of the pain-sensitive structures of the upper quarter. This compression is immediately followed by a shear-torsion mechanism causing differential loading between the lower and upper cervical spine, concentrating forces and increasing the risk of injury of deep and superficial pain-sensitive spinal structures.

Forensic analysis and medical examination are further complicated by intrinsic links between these factors. For example, females are typically smaller than males and are more likely to have a smaller stature and automobile seats often do not accommodate persons of smaller stature, making it difficult or impossible for them to sit in ideal occupant position or brace effectively for collision. This presentation will discuss how the interplay of these factors affects likelihood of injury and prognosis for recovery of individuals involved in rear-impact collisions.

There is a confluence of evidence from international sources including independent and institutional researchers which consistently documents increased injury risk when these factors are present. This evidence comes from a variety of sources, including cadaver and human volunteer studies, autopsy studies, provocative injections, palliative injections, and long-term population studies. The data provided by each of these sources will be discussed as it relates to cervical injuries in rear-impact collisions.

**References:**

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**Injury Risk, Cervical Spine, Rear Impact**