

Cervical disc prolapse in rear-end automobile collisions: Injury mechanism unique to occupant and head restraint geometry

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Introduction: Anecdotal evidence has subjectively linked rear-end automobile collisions to causation of cervical disc trauma, however the injury mechanism has not been reported. Two case studies of C5/6 disc prolapse following rear-end impacts are presented. A unique combination of occupant and head restraint geometry, and head/neck dynamics resulted in cervical compression/flexion injury mechanism.

Methods: This investigation involved a review of rear-end impact case studies, live human and dummy rear-end head/neck kinematics, and disc injury research using cadaver specimens.

Results: Case One involved a 35 year-old female (160cm 54.5kg) seated in a 1995 Plymouth Voyager passenger van that sustained a rear-end speed change of 16kph. Clinical presentation, EMG, and MRI studies led to a diagnosis of C5/6 disc extrusion. Surgery noted a large, extruded disc fragment. Case Two involved a 30 year-old female (155cm 63.5kg) seated in a 1995 Ford Windstar passenger van that sustained a rear-end speed change of 16kph. Clinical symptoms led to MRI, which demonstrated a large disc extrusion at C5/6. Surgery noted an explosive herniation with fragmented disc material.

Discussion: Military aviators, parachutists, and American football players have sustained acute cervical disc injury following exposure of a flexed spine to compressive loading. This typically occurs as the head flexes forward in a chin-to-chest fashion. Cadaveric studies have established compression/flexion loading causes acute disc prolapse (protrusion, extrusion or herniation). Furthermore, head impacts onto padded surfaces produce large neck forces and more frequent injuries. Cervical spine tolerance has been shown to be lower in females. During rear-end impacts, the head translates rearward relative to the torso, contacting the head restraint which then accelerates the head forward. Therefore, there is no opportunity for significant cervical spine compression. However, the seated height of these two subjects placed the occupants' opisthocranium below the top of the head restraint. Examination revealed the upper lip of the head restraint metal frame protruded forward 3cm. Rear-end occupant dynamics include an upward ramping effect of the torso relative to the seat back as well as straightening of the lordotic and kyphotic curves. In these two cases the head translated rearward pocketing into the padded head restraint, which was then trapped superiorly by the upper lip of the head restraint frame resulting in cervical compression as the torso ramped and the spine straightened. Cervical muscle contraction, shown to occur during the retraction phase, also contributes to compressive loading. Cervical x-ray studies have demonstrated rearward translation causes relative flexion from C2 through C6. Therefore, the resultant injury mechanism was compressive loading to a cervical spine segment already in flexion or compression to a segment that then buckled in flexion resulting in disc prolapse.