Lower Back Pain Associated With CAD Injury: Does it Add Up?

Many authors have reported the incidence of lower back pain associated with cervical acceleration/deceleration (CAD) injury. Accounts vary from a low of 25% by Hildingsson and Toolanen (1) to 57% by Croft and Foreman (2). While this relationship may be obvious to clinical observers, there is a small body of literature that questions its relationship. Banks et al. (3) recently authored one such paper, which suggested that the biomechanical model supporting lower back injury in CAD was lacking. One of the paper’s authors, Howard, has similarly championed the cause against CAD-related TMD over the years (4), based on the results of some of their crash-test data (5). In a nutshell, he claimed to have proved that the TM joint is exposed to forces during a typical CAD trauma scenario that are no more stressful or harmful than everyday flossing. However, his claims were founded on faulty scientific design and engineering application, evidenced by the fact that the subjects were wearing bite plates that were only loosely attached to their mouths during the test. This resulted in non-physiological conditions, with subjects biting down during the test, conditions which cannot be compared with the TM joint of a relaxed, unsuspecting automobile occupant. Additionally, accelerometers were placed far distal to the joint's center of gravity. The conclusions also deny an entire epidemiological literature pointing to the association of TMJ injury in CAD.

To return to the more recent work concerning lower back injury by Banks et. al., Alignment of the Lumbar Vertebrae in a driving posture. The authors attempted to define the anatomical arrangement of the lumbar spine of a human volunteer while in three postures: a driving posture; full flexion; and full extension. X-rays were taken of the lumbar spine of a 33-year-old male subject seated in a comfortable driving posture, another while the subject was postured in full voluntary flexion, and another while in full voluntary extension. Points on the vertebrae were plotted on an x-y coordinate system for each posture. Anterior and posterior disk thicknesses, and the positions of the centers of each vertebra were determined using information from the plots. The arrangement of the lumbar vertebrae resembled that of full voluntary flexion while the subject was in a normal driving posture. The authors indicated that anterior disk thickness was a sensitive indicator of posture, while posterior disk thickness was not. They noted that while seated, the lower back resembled a straight-line that was nearly parallel to the seat back. They indicated that soft tissue elements of the spine can only be damaged by excess tensile forces, and accordingly, since anterior elements of the lumbar spine would be in relative compression they would not be directly threatened in low velocity frontal collisions. In order to sustain tension injury to the anterior lumbar structures as a result of a rear-end collision, the normal driving posture would first have to be reversed. Any compression injury to posterior elements resulting from rear-end collisions would also require reversing the normal pre-impact driving posture.
Critique –
In this study, the authors made some observations of a single male subject seated in a single car seat. They reported that the flexed position and driving positions of the spine are approximately the same. That statement, of course, would only be true for people who cannot bend further while seated. Moreover, their comments about the tolerance and vulnerability to the spine in frontal and rear impact collisions was grotesquely simplistic and seems to assume that only simple bending occurs during this type of trauma. Studies of occupant kinematics (including their own work published in 1993) demonstrate very complex lumbar biomechanics during CAD, which includes a likely flattening of the lumbar spine, followed by compression, ramping, and then tension. The rear impact direction results in a two-phase kinematic, with a pitching forward of the torso in the reentry and torso overspeed phase and, in both phases, shear effects. All of this was omitted from discussion in this current paper. A more egregious omission, however, was the clinical and epidemiological literature that shows lower back complaints in an average of about 45% of CAD cases.

The exact mechanism of lower back injury in rear impact collisions, although not entirely clear, is probably multifactorial. Factors affecting the incidence, nature, and severity of lower back injury in automobile crashes include the following: position of the occupant in vehicle, the use or non-use of seat belts and shoulder harness, deployment of air bag system, (which are designed to deploy only with frontal or side impacts, but may deploy in more severe second collisions), type of restraint system (i.e., conventional restraints vs. restraints with pretensioners), stiffness of the seat back, inclination of the seat back, properties of the seat back padding, degree of ramping, vector and severity of the collision, second collisions inside or outside the occupant's vehicle, snugness of the restraint system, positioning of the restraint system on the occupant, positioning of the restraint system anchors within the vehicle, physical makeup of the occupant, including stature, build, age, and level of fitness, and preparedness for the collision.

Unfortunately, the authors of this article did not make a genuine attempt to come to terms with the issue of CAD-related lower back injury. Their suggestion that the lower back cannot be injured without a flexion/extension mechanism was rather unsophisticated and not supported by the literature. We feel that, while studies of this nature have the potential to be valuable, they become detrimental when erroneous conclusions are generated. Be prepared to face off with medical experts who may refer to studies of this ilk while making their case. The vast majority of CAD literature supports the notion that the lower back is often injured in low speed rear impact collisions, and you should have little problem stemming an attack from someone citing this article.

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