D12 Biomechanics of Spinal Injury

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After attending this presentation, attendees will better understand the forces and accelerations required to produce "whiplash" cervical soft tissue injuries.

The presentation will impact the forensic science community by quantifying a method to assess the potential for spinal soft tissue injuries based on the known scientific literature on the strength of the affected biological materials.

Over the years, there has been considerable argument over the occurrence of soft tissue injuries during low-speed collisions. Although a variety of ailments have been claimed during these low-speed impacts, only cervical soft tissue injuries are addressed in this presentation. Some of the most common unrelated injuries claimed include rotator cuff injuries, carpal tunnel injuries, Temporomandibular Joint Injuries (TMJ), Anterior Cruciate Ligament (ACL) injuries, and thoracic and lumbar spine injuries. Cervical soft tissue injuries are commonly referred to as "whiplash." The range of complaints for this type of injury includes headaches, numbing and tingling of the arms, pain, and loss of range of motion.

In this presentation, the other types of injury claims are disregarded simply because they have no merit in low-speed rear-end collisions because a biomechanical effect cannot be attributed to them. Cause and effect must be established in order to proceed with biomechanical calculations. In this context, several researchers have studied the "whiplash" phenomenon. Clemens and Burrow determined that there are three areas of the spine susceptible to injury, at the base of the cranium and C1, the region of C3 and C4, and the region of C6 and C7. Their tests in the range of 17 miles per hour and decelerations of 30gs correlated to serious injury involving 90% of ruptures and 30% of fractures. They found that the limit of vulnerability to injury to be 13mph and 13gs. Damask places the vulnerability to injury between 13mph and 16mph and 13gs to 15gs to include isolated fissures of discs without injury to the ligaments or bones. The known scientific literature indicates a high probability of cervical soft tissue injury at accelerations of 17gs or greater.

From tests performed on biological materials, Yamada determined the lowest value of the ultimate strength of discs to vary from 0.20 Kg/mm^2 to 0.24Kg/mm^2. Calculations can be performed on the number of discs, a variation in the size of the disc structures, the weight of the individual affected, and various speed changes to determine the probability of injury to the cervical spine. This type of parametric analysis lends itself well to asses and correlate potential injuries to the work of other researchers that have established well-recognized limits on vulnerability to injury. Charts and graphs will be presented to show the analysis and the underlying basic equations used to formulate the problem.

Whiplash, Biomechanics, Spinal Injuries