Mechanism of cervical spinal cord injury during bilateral facet dislocation

Paul C. Ivancic[1], Adam M. Pearson[1], Yasuhiro Tominaga[1], Andrew K. Simpson[1], James J. Yue[1], and Manohar M. Panjabi[1]

[1]Yale University

ABSTRACT

Objectives: *The objectives were to: quantify dynamic canal pinch diameter (CPD) narrowing during simulated bilateral facet dislocation of a cervical functional spinal unit model with muscle force replication, determine if peak dynamic CPD narrowing exceeded that observed post-trauma, and evaluate dynamic cord compression.*

Outline of the problem: *Previous biomechanical models are limited to quasi-static loading or manual ligament transection. No studies have comprehensively analyzed dynamic CPD narrowing during simulated dislocation.*

Methodology: *Bilateral facet dislocation was simulated using 10 cervical functional spinal units (C3/4: n=4; C5/6: n=3; C7/T1: n=3) with muscle force replication by frontal impact of the lower vertebra. Rigid body transformation of kinematic data recorded optically was used to compute the CPD in neutral posture (prior to dislocation), during dynamic impact (peak during dislocation), and post-impact (flexion rotation = 0 degrees). Peak dynamic impact and post-impact CPD narrowing were statistically compared.*

Data: *Average peak dynamic impact CPD narrowing significantly exceeded ($P<0.05$) post-impact narrowing and occurred as early as 71.0 ms following impact. The greatest dynamic impact narrowing of 7.2 mm was observed at C3/4, followed by 6.4 mm at C5/6, and 5.1 mm at C7/T1, with average occurrence times ranging between 71.0 ms at C7/T1 and 97.0 ms at C5/6.*

Summary: *Extrapolation of the present results indicated dynamic spinal cord compression of up to 88% in those with stenotic canals and 35% in those with normal canal diameters. These results are consistent with the wide range of neurological injury severity observed clinically due to bilateral facet dislocation.*