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Dynamic Cervical Stabilization: A Novel, Motion-preserving Alternative to Fusion and Articulating Total Disc Replacement

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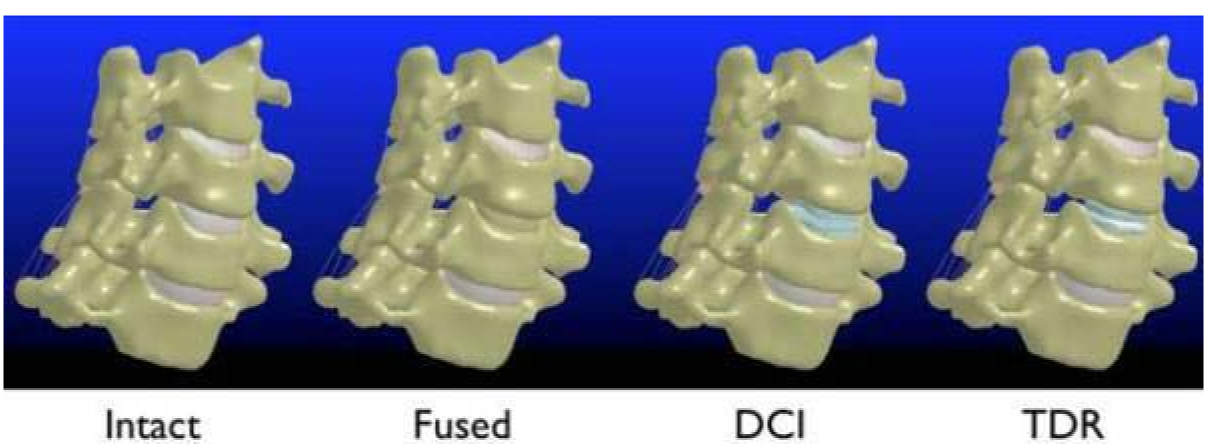
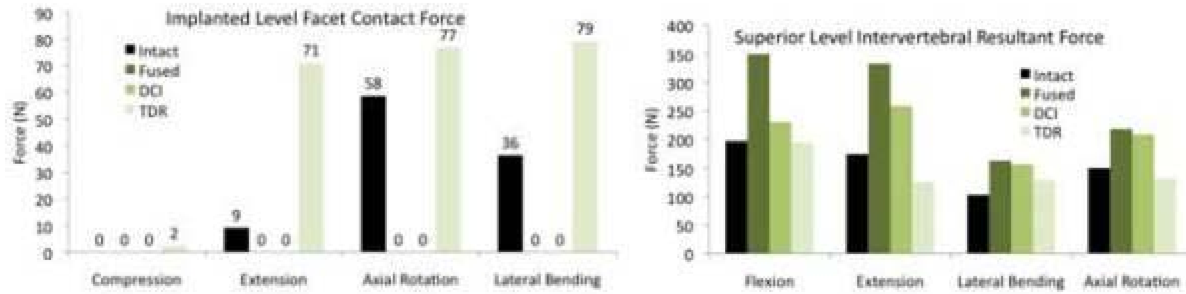
Intro: Fusion may contribute to adjacent segment disc degeneration while motion preserving alternatives, such as total disc replacement(TDR) are associated with index level facet arthrosis. Dynamic cervical stabilization with the Dynamic Cervical Implant (DCI) is a novel motion-preserving concept that facilitates controlled, limited flexion and extension, with restriction of axial rotation and lateral bending motions. The objective of the current study was to evaluate loading at the index and adjacent levels after fusion, TDR, and implantation of the DCI (Paradigm Spine) under both load and displacement control scenarios. We hypothesized that the DCI would reduce or maintain index level facet contact forces compared with the intact condition and TDR, while affording relative protection of the adjacent levels compared with fusion.

Methods: An intact finite element model of C4-C7 was utilized. The C5-C6 level was altered to include an intact spine, ideal fusion, DCI, and TDR(Fig1). Fusion was simulated by setting the disc material properties to match the bony endplate. Models of DCI and TDR devices were virtually implanted at C5-C6. Displacement-controlled hybrid loading was applied to the implanted models. Additionally, a 100 N compressive follower load with 2.5 Nm pure moments in flexion, extension, lateral bending, and axial rotation was applied. Rotational range of motion(RoM), facet contact force, and adjacent segment disc resultant forces were determined.

Results: In general, TDR resulted in increased mobility at the index level during both load and displacement-controlled scenarios. The increased rotational RoM after TDR observed for extension, axial rotation, and lateral bending was associated with increased facet contact loading(Fig2). Conversely, DCI maintained limited RoM at the index level compared with TDR but prevented facet contact in all loading modes. Displacement control indicated increased loading at the adjacent segments for fusion when compared to both DCI and TDR(Fig2).



[Fig1. Images of the 4 FEMs]



[Fig2. Graphs]

Discussion: Our results demonstrate that by providing limited subaxial motion in the sagittal plane (flexion and extension) but limiting axial rotation and lateral bending, the DCI facilitates protection of the index level facet joints, while at the same time protecting the adjacent levels from excessive stresses. We submit that from a biomechanical perspective, the DCI serves as a compromise between rigid fixation with ACDF, and the potential hypermobility demonstrated with TDR. By protecting the facet joints the DCI may serve as an alternative to TDR, and further, may provide a motion-preserving alternative to patients with pre-existing facet arthrosis who are currently contra-indicated for TDR.