Cervical Disc Replacement Augmented by an Anterior Polyester Mesh: Biomechanical Evaluation with Two Disc Replacement Devices

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Purpose: Removal of the anterior longitudinal ligament and anterior annulus during cervical total disc replacement (TDR) surgery may lead to hypermobility and instability in some motion planes; potentially contributing to altered facet loading and subsequent degeneration. In this study the effect on spinal kinematics of augmenting cervical TDR with an embroidered polyester mesh (Embrace, NuVasive, Inc., San Diego, CA), in place of the removed soft tissues, was investigated with two ball-and-socket TDRs: (1) CerPass (NuVasive, Inc.) - smaller diameter, ceramic-on-ceramic articulation; (2) PCM (NuVasive, Inc.) - larger diameter, metal-on-UHMWPE articulation.

Methods: Six fresh-frozen cadaveric osteo-ligamentous cervical spines were potted at C2 and T1 (average age 37.8, range 24-52 yrs; 3 male, 3 female). Infra-red motion-tracking markers arrays were mounted at C2, C4, C5, C6, C7 and T1. Specimens were tested using a multi-directional, hybrid protocol. The intact spines were tested in load-control at ±1.5 Nm in flexion-extension, lateral bending and axial rotation. The global ROM (C2-T1) was measured in each direction and applied to all further test conditions, applied at C5-6, which were: (i) CerPass, (ii) CerPass + Embrace mesh, (iii) PCM, and (iv) PCM + Embrace mesh. Intervertebral motion was recorded using an optoelectronic system (Optotrak Certus). Range-of-motion (ROM) and neutral zone (NZ) were determined at the index and adjacent levels.

Results: Flexion-extension ROM at the index level was not significantly altered (p > 0.05) from the intact spine (11.9°) with either CerPass (11.6°) or PCM (10.1°). The primary impact of adding the mesh was seen sagittal plane motion, with a significant reduction in extension ROM for both TDRs (CerPass + mesh: 2.5° decrease; PCM + mesh: 3.0°). Extension NZ (Figure 1) increased with respect to intact for both discs (2.5-3 times greater), however the difference only reached significance with CerPass. Adding the mesh noticeably reduced extension NZ for both discs, returning it closer to intact. In lateral bending and axial rotation, there were no significant differences between the TDRs with or without the mesh, and average ROM and NZ were less than intact in all cases.

Conclusion: While total intact flexion-extension ROM was maintained with both anterior cervical TDRs, extension ROM and extension NZ both increased with respect to intact. ROM and NZ were less than...
intact in lateral bending and axial rotation. The addition of the Embrace anterior polyester mesh had the predominant effect of decreasing extension ROM and extension NZ. Preventing hyperextension with the mesh may protect the facets from overloading, while reducing extension NZ provides more stable and controlled motion. Similar biomechanical behavior has previously been reported when this mesh was applied over anterior lumbar TDRs (Cunningham, Cappuccino, et al., SAS9, 2009).