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Biomechanical Comparison of Multi-level Cervical Disc Arthroplasty versus Fusion: ProDisc-C versus Prestige-LP

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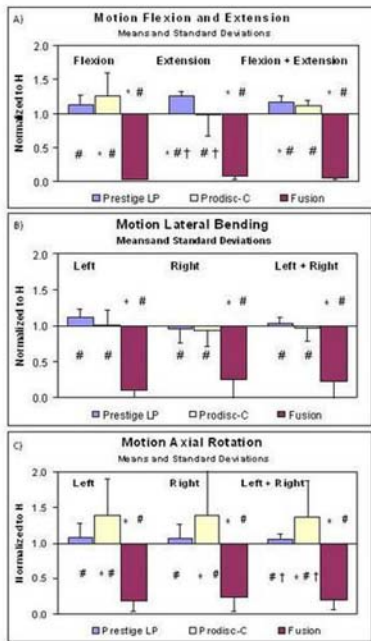
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Introduction: Although cervical fusion is an acceptable surgery for cervical spondylosis or other spinal disc diseases, an increase in adjacent segment degeneration has been reported that increases with the number of levels fused. Multi-level disc replacement is an alternative approach to multi-level fusion surgery that may address these issues. The purpose of this study was to compare the *in vitro* biomechanics of a more constrained ball-and-socket design (ProDisc-C, Synthes Spine) and a less constrained design (Prestige-LP, Medtronic) in a two level instrumented model. The biomechanical performance of the two-level disc prostheses were compared to a two-level fused condition.

Methods: Fourteen human cadaveric cervical spines (C2-T1) were procured. The specimens were tested in a programmable apparatus in flexion, extension, lateral bending, and axial rotation. The implanted spine underwent an anterior discectomy and insertion of the disc prostheses as per manufacturer's instructions. Fusion was simulated by attaching custom designed screws and clamps to the C5, C6, and C7 vertebrae. Four different conditions were evaluated: harvested spine (n=14), spine with C5-C6 and C6-C7 disc replacements using the ProDisc-C prosthesis (n=8), spine with C5-C6 and C6-C7 disc replacements using the Prestige-LP prosthesis (n=6), and two-level (C5-C7) fused spine condition (n=14). The spines were tested to a target moment of 3Nm. Measurements included individual vertebral motions, total spine rotation, and applied loads. The contribution of motion at the instrumented (C5-C7) level of the altered spines was normalized to their contribution in the harvested condition and compared with a one-way ANOVA and S-N-K test with p=0.05.

Results: Normalized motion of the altered spine conditions is shown in Figure 1. The only significant differences between the ProDisc-C and the Prestige-LP were in extension (99±38% vs. 126±21%), and combined left+right axial rotation (136±51% vs. 105±8%). ProDisc-C was significantly different from harvested in flexion (117±18% of H), left axial rotation (122±24% of H), and combined left+right axial rotation (123±37% of H). Significant differences between Prestige-LP and harvested included flexion (114±14% of H), extension (126±21% of H), and combined flexion+extension (117±7% of H). As expected, fusion significantly decreased normalized motion in all loading conditions as well as combined flexion/extension, left/right lateral bending, and left/right axial rotation as compared to the harvested condition and both instrumented conditions for modes of all loading.

Discussion: Issues pertaining to adjacent segment disease (ASD) with multi-level fusion were supported by the increase motion at multiple adjacent segments. However, two-level disc arthroplasty eliminated any significant increase and may prevent ASD. Both the constrained and semi-constrained cervical disc prostheses in a two-level application did not limit the overall biomechanical integrity of the cervical spine. From a biomechanical point of view, two-level cervical arthroplasty yielded a spine that was much closer to the baseline (unoperated) state than did fusion.



Normalized motion in A) Flexion and extension, B) Lateral Bending, and C) Axial Rotation. † Signifies significant difference between the Prestige-LP and ProDisc-C conditions. * Signifies significant difference from the harvested (H) condition. # Signifies significant difference between fusion and Prestige-LP and ProDisc-C.

[Figure 1: Normalized Motion]