IN VITRO BIOMECHANICS OF LUMBAR DISC ARTHROPLASTY WITH THE PRODISC TOTAL DISC IMPLANT

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INTRODUCTION

An alternative approach to lumbar fusion surgery is to restore motion to the diseased segment with a disc prosthesis. The goal of the disc prosthesis is to replace the diseased disc while preserving and/or restoring the motion at the operated spinal level. The purpose of this study was to determine the ability of the PRODISC\textsuperscript{R} (Spine Solutions Inc., Paoli, PA) disc prosthesis to restore lumbar spine motion and compare this motion to that of the harvested and fused spines.

METHODS

Six fresh human cadaveric lumbar spines (L1-Sacrum) were procured and screened with anteroposterior (AP) and lateral radiographs to exclude those with osteopenia. The specimens were mounted in a programmable testing apparatus and tested in flexion, extension, lateral bending, and axial rotation under displacement control. Three different conditions were evaluated: the harvested spine, spine with L5-S1 lumbar disc replacement using the PRODISC, and L5-S1 pedicle screw fixation (Synthes Spine). The instrumented spine underwent an anterior discectomy at L5-S1 and insertion of the disc prosthesis as per manufacturer’s instructions. A previously developed in vitro testing protocol was adopted; i.e., a target moment of 8Nm with limit checks of 25 degrees total spine rotation, maximum bending moment of 10Nm, or 200 N actuator load. For axial rotational tests, a 100 N compressive load was applied to the spinal construct. Measurements included individual vertebral motions, total spine rotation, and applied loads. Motion patterns were analyzed by comparing the percent contribution of the rotation at the implanted level (L5-S1) relative to overall total rotation (L1-Sacrum) for the disc, fused, and harvested conditions at a common end limit of global (L1-Sacrum) moment (8Nm). Motion and flexibility data were analyzed with a one-way ANOVA and S-N-K test were used with significance set at $p = 0.05$.

![Figure 1: PRODISC Lumbar Spine Prosthesis.](image)

The implant consists of two forged cobalt-chrome alloy endplates and an ultra-high molecular weight polyethylene inlay element.
RESULTS

The normalized motion data are shown in Figure 2. There were no significant differences in the normalized motion responses at the implanted level for the PRODISC spines compared to the harvested spines, except for left axial rotation and extension, although the PRODISC did provide up to 72% ± 17% of the harvested limit in extension. Significant differences existed between the fused condition and both the harvested and disc spine conditions for all modes of loading. The mean relative MSU rotations for the three different spine conditions are shown in Figure 3 for flexion and extension loading. Application of the fusion hardware reduced the motion at the operated level as illustrated in Figure 3.

DISCUSSION

In contrast to the spines with pedicle fixation, the PRODISC implants maintained a natural range of lumbar mobility and stability during flexion, extension and lateral bending, and adequate motion in combined (left+right) axial rotation (66% of harvested). Use of a prosthetic total disc replacement device, such as the PRODISC, to treat symptomatic degenerative lumbar disc disease may minimize or alleviate the adjacent segment disease associated with pedicle fixation.

REFERENCES