Biomechanical Comparison of Anterior and Direct Lateral Interbody Fusion with Supplemental Instrumentation

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INTRODUCTION:

Direct lateral interbody fusion (DLIF) is less invasive than traditional methods, such as anterior lumbar interbody fusion (ALIF). While the direct lateral approach is safer for a variety of clinical reasons, immobilization of motion segments is crucial for complete bony union, regardless of approach. Therefore, biomechanical assessment is necessary to determine if the DLIF approach is a viable alternative to standard procedures, such as ALIF.

The goal of this cadaveric biomechanical study was to compare the immediate postoperative stability of DLIF and ALIF. Further, any additional stiffness imparted by supplemental instrumentation was quantified. We hypothesized that the two approaches would be biomechanically equivalent, and that supplemental instrumentation would be comparably beneficial for both techniques.

MATERIALS AND METHODS:

The study used eight fresh-frozen human lumbosacral segments (L1-sacrum) with a mean age of 68 years (range 50-89). Criteria for inclusion were: adequate disc height; no previous lumbar trauma, intervention, or pathology; and sufficient bone-mineral density (DXA). Specimen ends were then potted in urethane resin to facilitate mechanical testing.

Using a custom loading fixture in conjunction with a servo-hydraulic linear actuator (MTS), pure moments were applied to impose flexion, extension, lateral bending, and axial rotation. Testing order was randomized to account for effects of stress relaxation. Spines were preconditioned then loaded maximally to 6Nm (8Nm for flexion) in 2-Nm increments. Vertebral kinematic response at each increment was tracked with an optoelectronic motion-capture system (Northern Digital). Vertebral rotation was quantified in terms of Euler angles relative to adjacent vertebrae.

After testing intact, the L2/3 and L4/5 levels were randomized to ALIFs (Cougar ALIF cage) or DLIFs (Cougar LS cage). A single surgeon performed all fusions according to manufacturer’s recommendations. Specimens were tested in four configurations in random order: stand-alone cage, cage with AEGIS stabilizing plate, cage with unilateral pedicle screw fixation (PSF), and cage with bilateral PSF. Plates following DLIF were applied laterally and those following ALIF were applied anteriorly. All devices were manufactured by DePuy Spine.

Range of motion (ROM) was calculated as the rotation of motion segments at the highest applied moment, relative to a neutral posture. Stiffness was calculated as the inverse slope of a trend line applied to the extensible region of the moment-response curve. Values were compared to the control conditions within groups using Wilcoxon signed-rank test (non-parametric, repeated-measures). Comparison between the ALIF and DLIF groups was conducted using Wilcoxon rank-sum test (non-parametric, independent). Statistical significance was set at p ≤ 0.05.

RESULTS:

Compared to the intact state, stand-alone DLIF tended to reduce ROM in all directions more than standalone ALIF, although these differences did not reach statistical significance (p>0.05; Fig. 1).

In flexion, fused segments from both groups were significantly stiffer when supplemented with bilateral PSF than when were segments from the same group supplemented by other techniques (p<0.05; Fig. 2). Only significant differences were observed in flexion, yet performing bilateral PSF tended to increase stiffness in all loading modes. No significant differences were observed between ALIF and DLIF after bilateral PSF.

The stabilizing plate had different effects on motion segment stiffness depending on the displacement direction and surgical approach.

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