Biomechanical Evaluation of Interbody Fusion Construct Stability: Contribution of Lateral-Approach Cage Footprint Size and Comparison with TLIF Constructs

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INTRODUCTION:
The lateral trans-psoas approach for lumbar interbody spinal fusion (XLIF®) allows for placement of a large footprint interbody cage while maintaining the anterior and posterior longitudinal ligaments and annulus. Previous biomechanical testing has demonstrated the stability of the 18 mm anterior-posterior width XLIF interbody cage, predominantly due to the large interbody implant size and retention of anatomical stabilizing structures [1]. Larger footprint XLIF cages have been developed to provide additional stability as well as subsidence resistance in osteoporotic patients.

This study compared the stability of the 18 mm XLIF cage with a 26 mm XLIF cage. As a control, a TLIF group was included. All groups were tested with supplemental pedicle screw fixation (unilateral or bilateral constructs), however the cage alone was also evaluated to assess the baseline stability offered by the cage (note: interbody cages not FDA-cleared without supplemental fixation).

METHODS:
Twenty-four L2-3 functional spinal units (FSUs) were dissected from fresh-frozen human spines. Specimens were radiographed to exclude deformity/degeneration. DEXA scans provided bone mineral density of each specimen. The FSUs were divided into 3 BMD-matched groups, each with different interbody grafts:

- XLIF 18 mm anterior-posterior (A-P) width cage,
- XLIF 26 mm A-P width cage, or
- TLIF 11 mm A-P width cage.

Each FSU was subjected to multidirectional non-destructive flexibility testing using a custom 6 degree-of-freedom spine test system. Specimens were tested in flexion-extension, lateral bending and axial rotation for 3 cycles to ±7.5 Nm under the following conditions:

1. intact,
2. intact disc with bilateral pedicle screws (PS),
3. interbody cage alone,
4. cage + unilateral PS,
5. cage + bilateral PS.

Range of motion (ROM) was measured using an Optotrak system with infrared LED marker arrays in the L2 and L3 vertebral bodies. ROM from the third cycle was normalized to the intact condition (percent intact ROM) and differences were examined using ANOVA and post hoc comparisons.

RESULTS:
The XLIF cages without supplemental fixation reduced ROM with respect to intact in all directions. The TLIF cage alone condition allowed ROM similar to intact in flexion-extension (Figure 2, top), and greater than intact in lateral bending (Figure 2, middle), and axial rotation (Figure 2, bottom). The 26 mm XLIF cage was more stable than the 18 mm XLIF cage and the TLIF cage under all supplemental fixation conditions.

In flexion-extension, lateral bending and axial rotation, the 26 mm XLIF cage without supplemental fixation provided a larger reduction in ROM than the TLIF cage with bilateral pedicle screws. The narrower 18 mm XLIF cage with unilateral PS provided comparable or greater stability than TLIF with bilateral PS.

DISCUSSION:
Both XLIF cages (18 mm and 26 mm A-P width) provided better stability than the TLIF cage. The wider 26 mm XLIF cage also reduced ROM to a greater extent than the narrower XLIF cage. These biomechanical results suggest that the baseline stability provided by the XLIF cages, with adequate cage height sizing and good bone quality, may allow for less supplemental fixation than a more destabilizing approach such as TLIF.

Improved TLIF stability may be possible using different cage designs or insertion techniques. Clinical considerations for using wider XLIF cages include larger psoas exposure and need for appropriate neuromonitoring.

SIGNIFICANCE:
The trans-psoas lateral approach is an evolving technique in minimally invasive spine surgery. Development of new implants for specific patient groups and/or indications should be evaluated appropriately to ensure intended benefits, such as biomechanical stabilization, are realized.

REFERENCES: