BIOMECHANICAL EVALUATION OF MEDIALLY AND LATERALLY PLACED UNILATERAL PEDICLE SCREW FIXATION OF THE SPINE WITH POSTERIOR OBLIQUE LUMBAR INTERBODY FUSION

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Introduction: Internal fixation of the spine reduces motion and increases stiffness of functional spine units. The degree of stiffness needed for fusion has not been defined. It is argued extremely stiff constructs may shield the bone from the stresses needed to produce fusion or produce degeneration at an adjacent level, while less stiff constructs may produce inferior rates of arthrodesis. A unilateral pedicle screw system may supply an intermediate level of stiffness. This study compared medial and lateral placements of unilateral pedicle screw system. Each unilateral construct was placed with a posterio-laterally implanted cage.

Methods: Six L3-L4 fresh-frozen calf spines were examined for their range of motion under ±6Nm in flexion/extension, lateral bending then axial rotation. Each spine was tested in 3 conditions: intact; a single cage (BAK, Centerpulse Spine-Tech, Minneapolis, MN, USA) placed obliquely from a posterior unilateral transforaminal approach plus unilateral pedicle screws (ST360, Centerpulse Spine-Tech) placed on the same side as cage insertion with the posterior rod placed either medially (3 spines randomized) or laterally (3 spines) from the screws; finally the rod was reset to be in the other position (medially or laterally).

The spines were tested on an 858 Mini Bionix® (MTS Systems Corporation, Eden Prairie, Minnesota, USA) configured with 2 rotary actuators with integral rotary potentiometers in addition to its existing bi-axial actuator (Figure 1). These rotary degrees of freedom were mounted onto glide tables to create a six degree-of-freedom configuration that could apply moments about the x-, y-, and z-axes without constraining translations along the axes and no axial preload. The range-of-motion was calculated based on optoelectronic photometric (Optotrak 3020, Northern Digital Inc., Waterloo, Ontario, Canada) measurements taken at the maximum applied moments. The ranges of motion were compared with a matched pairs t-test (Sigma Stat 2.03, SPSS Inc., ) to determine statistical difference (p<0.05) between groups.

Results: In flexion/extension, the posterior instrumentation placed medially had 14% of the intact range of motion (representing a 86% reduction from intact); the laterally placed instrumentation was 9%. In lateral bending the medial placement was 10% and lateral placement was 13%. For axial rotation, medial and lateral placements were 73% and 78%, respectively. Statistically, there was no difference between medial and lateral placement in flexion/extension (p=0.329), lateral bending (p=0.844), or axial rotation (p=0.438).

Discussion: Previous study has shown unilateral pedicle screw constructs to have greater stiffness than a single posterio-lateral cage and less stiffness than bilateral pedicle screw constructs with a cage implanted posterio-laterally. Therefore, these unilateral rod placements may provide more surgical options when an intermediate stiffness is preferred. The unilateral placement of a pedicles screw system with a cage placed obliquely from a posterior unilateral transforaminal approach is a less invasive approach to attain an intermediate level of stiffness of the functional spinal unit. The less invasive approach decreases patient morbidity. Furthermore, this approach is more cost effective. Clinical application research is needed, but this technique may be a viable option in surgical cases requiring more support than stand-alone cages while minimizing potential degeneration of adjacent segments and stress shielding of stiffer constructs such as bilateral pedicle screws with an interbody fusion device.

Conclusion: Both unilateral constructs decreased the range of motion significantly from the intact spine. There was no statistical difference between the medial and lateral rod placements in flexion/extension, lateral bending or axial rotation.