Biomechanical Evaluation of a Novel Lumbosacral Axial Fixation Device

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Background: Interbody arthrodesis is employed in the lumbar spine to eliminate painful motion and achieve stability through bony fusion. Bone grafts, metal cages, composite spacers, and growth factors are available and can be placed through traditional open techniques or minimally invasively. Whether placed anteriorly, posteriorly, or laterally, insertion of these implants necessitates compromise of the anulus—an inherently destabilizing procedure. A new axial percutaneous approach to the lumbosacral spine has been described. Using this technique, vertical access to the lumbosacral spine is achieved percutaneously via the presacral space. An implant that can be placed across a motion segment without compromise to the anulus avoids surgical destabilization and may be advantageous for interbody arthrodesis. The purpose of this study was to evaluate the in vitro biomechanical performance of the axial fixation rod, an anulus sparing, centrally placed interbody fusion implant for motion segment stabilization. Method of Approach: Twenty-four bovine lumbar motion segments were mechanically tested using an unconstrained flexibility protocol in sagittal and lateral bending, and torsion. Motion segments were also tested in axial compression. Each specimen was tested in an intact state, then drilled (simulating a transaxial approach to the lumbosacral spine), then with one of two axial fixation rods placed in the spine for stabilization. The range of motion, bending stiffness, and axial compressive stiffness were determined for each test condition. Results were compared to those previously reported for femoral ring allografts, bone dowels, BAK and BAK Proximity cages, Ray TFC, Brantigan ALIF and TLIF implants, the InFix Device, Danek TIBFD, single and double Harms cages, and Kaneda, Isola, and University plating systems. Results: While axial drilling of specimens had little effect on stiffness and range of motion, specimens implanted with the axial fixation rod exhibited significant increases in stiffness and decreases in range of motion relative to intact state. When compared to existing anterior, posterior, and interbody instrumentation, lateral and sagittal bending stiffness of the axial fixation rod exceeded that of all other interbody devices, while stiffness in extension and axial compression were comparable to plate and rod constructs. Torsional stiffness was comparable to other interbody constructs and slightly lower than plate and rod constructs. Conclusions: For stabilization of the L_5-S_1 motion segment, axial placement of implants offers potential benefits relative to traditional exposures. The preliminary biomechanical data from this study indicate that the axial fixation rod compares favorably to other devices and may be suitable to reduce pathologic motion at L_5-S_1, thus promoting bony fusion. [DOI: 10.1115/1.2049334]

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