Presented at 5th Annual Meeting of the Spine Arthroplasty Society, May 4th- 7th, 2005, New York, NY.

Biomechanical Evaluation of the Total Facet Arthroplasty System (TFAS™) Kinematics

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The Total Facet Arthroplasty System (TFAS™, Archus Orthopedics, WA) is designed as an alternative to instrumented fusion to replace the resected facet joints of a lumbar intervertebral joint in order to provide stabilization and to restore physiologic-like kinematics and load-sharing. The system is comprised of articulating bearing surfaces fixed to the cephalad and caudal pedicles. The purpose of this study was to evaluate the ability of the TFAS™ to restore lumbar spine kinematics.

Flexibility tests were conducted on thirteen cadaveric specimens (L3-S1) in the intact and injured conditions, followed by stabilization with the TFAS™ at the L4-L5 level. In six of the specimens, a rigid posterior fixation system (RPFS) was implanted at the L4-L5 level prior to the TFAS™ test. The injury condition involved wide decompressive laminectomy and facetectomy, consisting of removal of all posterior ligaments (L4-L5), the facet joints (L4-L5), and the lamina and spinous process (L4 only). A pure moment of ±10 Nm with a compressive follower preload of 600 N was applied to the specimen in flexion-extension, axial rotation, and lateral bending for three cycles in each test condition. An optoelectronic camera system was used to determine the three-dimensional specimen kinematics. Range of motion (ROM) and helical axis of motion (HAM) were calculated for the L4-L5 segment.

ROMs of the TFAS™ in flexion-extension, axial rotation and lateral bending were 77%, 128% and 88% of the intact ROM, respectively, while ROMs after injury were 151%, 197% and 101%. There were statistically significant differences in ROM between the TFAS™ and the intact status in flexion-extension ($p=0.01$) and axial rotation ($p=0.013$). Compared to the intact, the RPFS constrained the segmental motion significantly in flexion-extension (30%) and lateral bending (47%). There was no significant difference in HAM location or orientation between the TFAS™ and the intact status in any direction except for a significant posterior shift of the HAM location in axial rotation. With the RPFS, the HAM shifted significantly posteriorly in flexion-extension and laterally in axial rotation.

In summary, the TFAS™ allowed considerable motion in all directions tested and it restored intact-like ROM and HAM parameters in several loading modes. Further, the TFAS™ constrained motion to a much lesser extent than the rigid fixation system when compared to the intact condition.