Relevance to Musculoskeletal Condition: This study investigates effects of posterolateral lumbar fusion and kyphotic deformity on the neighboring motion segments

Introduction: No studies have addressed the in vivo effects of an alignment deformity on neighboring motion segments. The purpose of this in vivo study was to create in-situ as well as kyphotic posterolateral lumbar fusion models and to investigate the biomechanical changes at the adjacent levels in response to the altered biomechanical environment.

Methods: Eighteen mature sheep were equally randomized into three treatment groups (Fig. 1): 1) Surgical control (n=6), 2) In-Situ arthrodesis (n=6), and 3) Kyphotic arthrodesis (n=6). L3-L5 posterolateral fusion was performed using the ISOLA system for both arthrodesis groups, while surgical exposure alone was performed in the control specimens. Following a four month survival period, MRIs (T1, T2) of the fused and adjacent motion segments were performed in the sagittal plane to evaluate degenerative changes of the intervertebral discs. Biomechanical testing of the multi-segmental specimen (L2-6), adjacent levels (L2-3 and L5-6) functional spinal units (FSU’s) and disc body units (DBU’s) quantified biomechanical properties. Surface strain gauges, attached to the right laminae of L2, quantified lamina strain. Statistical significance was determined using a one way ANOVA combined with a Student-Newman-Kuels test or Fisher’s PLSD at 95 % confidence. Animal research permission: Protocol for this in vivo study was approved by the Institutional Animal Care and Use Committee (IACUC).

Results: No obvious differences were detected between the three groups on the MRIs. In flexion-extension, the L2-6 segments as well as L2-3 FSUs of the Kyphosis group showed statistically less range of motion (ROM) than the In Situ and Control groups (p<0.05, Fig. 2). Testing of the L5-6 FSUs and L2-3 and L5-6 DBUs resulted in no significance between the In Situ and Kyphosis groups in all testing modes. Statistically significant difference in posterior element strain was found between three groups under flexion-extension loading (Fig. 3).

Discussion/Conclusion: This in vivo study evaluated the biomechanical effects of kyphotic mal-alignment on the adjacent motion segments. The condition of kyphotic deformity significantly altered the stiffness characteristics of the cranial adjacent FSU and decreased the overall multisegmental ROM in flexion-extension, compared to the in-situ fusion. The increased posterior element strain, exhibited by the in-situ group under flexion/extension, was further increased in the kyphotic group - indicating more load transmission through the posterior column. These mechanical results suggest that kyphotic deformity may lead to facet joint contracture, and serve as the origin of low back pain and long term facet arthritis at the cranial adjacent level.