Biomechanical Effects of Sequential Facet Resection on Lumbar Spine Mechanics
K. Sedacki1, M. Campos2, B.P. Kelly1, R. Cardenas2, D.J. Diangelo1
1The University of Tennessee Health Science Center, Department of Biomedical Engineering and Imaging, Memphis, TN, United States, 2The University of Tennessee Health Science Center, Department of Neurosurgery, Memphis, TN, United States

Introduction: Lumbar facetectomy is one of the most commonly performed spinal surgeries. Whether it's performed for foraminal stenosis or other pathologies, there is always the concern of iatrogenic spine destabilization. Minimally invasive techniques (MIS) have been developed to preserve the joint and ligamentous structures in the area of interest. Despite these advancements, controversy of whether or not one has destabilized the spine after performing a lumbar facetectomy remains. The objective was to investigate the effects of sequential facet resection by comparing the biomechanical stability of four different spine conditions: harvested, after an MIS partial unilateral facetectomy (UF), after an MIS bilateral facetectomy via unilateral approach (BF) and after a traditional laminectomy (TL).

Materials and methods: Eight fresh human cadaveric lumbar spinal segments (four L1-L2, two L2-3 and two L4-5) were tested with three different protocols using a multi-axis robotic testing platform. They included the pure moment method (PM) and two novel testing techniques: a combined load and moment protocol (CLM) and a coupled eccentric loading protocol (CEL). The CLM protocol introduces to the PM an anterior-posterior (A-P) displacement to the flexion-extension (F-E) modes of testing through application of shear and compressive loads, and the CEL protocol introduces the coupling of F-E or lateral bending (LB) with active left and right axial rotation (AR). The purpose of these protocols was to simulate a more physiological mode of testing in vitro. All rotational data were analyzed at an 8Nm end limit for F-E and 6Nm for LB and AR. A non-parametric one-way repeated-measure ANOVA on ranks (Friedman's test) was employed to analyze the rotational data (p< 0.05). If there a statistical difference was detected, a Student-Neuman Keuls comparison test was then applied.

Results: For both PM and CLM, the UF caused a reduction in motion during flexion and extension (Figure 1). Further facet resection, namely BF and TL, resulted in a significant increase in rotation during flexion and extension compared to the UF condition. During LB tests (using the PM protocol), the UF caused a reduction in rotation for movement towards the surgical side (left) and an increase in rotation during LB away from the surgical side (right). Further facet resection through BF or TL resulted in significant increases in lateral rotation. The inclusion of active axial rotation coupled with F-E or LB in the CEL protocol did not produce any new findings compared to the other two modes of testing.

Conclusions: Unilateral facetectomy was associated with an increase in stability highlighting the efficacy of this surgical procedure. However, the overall biomechanical stability of the spine significantly decreased following subsequent BF and TL surgical resections, indicating the possible need for surgical stabilization.
[Figure 1. Graph depicting segmental rotations of a]