Introduction: With the appropriate device design, maintaining the form and function of a compromised disc would potentially enable biomechanical attributes for the entire functional spinal unit (FSU) to be preserved. In order to gage the efficacy of hydrogel augmented nucleus pulposus relying on the otherwise plenary intervertebral disc, tests isolating the performance of the treatments were conducted. The biomechanical flexibility or stability of the functional spinal units (FSU) was established with in vitro human lumbar FSU specimen. Additionally, each FSU was modified through posterior column resection in order to quantify and compare the anterior column kinematic contributions with and without nucleus augmentation.

Materials and methods: Sixteen fresh frozen human lumbar cadaveric specimens were processed with the intent of sparing the native osteoligamentous structures. Based on the radiographic grading of each level by the surgeon, severely degenerated FSU were excluded, leaving 25 qualified levels. Each of the lumbar segments was separated into individual FSU and then subjected to ±5.0Nm for flexion extension, lateral bending, and axial torsion. Each FSU was tested sequentially in the intact condition, with posterior column removed and with a polymer augmented nucleus. An analysis of variance (ANOVA) statistical model was used to detect differences amongst the treatment groups with a Bonferroni post hoc test to specify the different treatment groups.

Results: The mean±stddev ROM, shown in the figure, for the intact flexion extension bending was 9.30°±2.33°, 13.40°±4.28°, and 12.00°±6.58° for the intact, posterior column removed and nucleus augmented treatments. The mean ROM for lateral bending was 8.03°±2.57°, 8.85°±3.37° and 7.92°±3.42° for the same treatment order. Similarly, for axial torsion, the mean ROM was 4.03°±2.70°, 8.23°±5.01°, and 7.13°±5.35°. The ROM was statistically greater with the posterior column removed in flexion extension bending and axial torsion modes (p< 0.001 for both comparisons). Similarly, the treated anterior column was statistically lower in ROM for the axial torsion mode (p=0.022).
Discussion: Clearly, removal of the posterior facets destabilized the FSU in flexion extension as measured by the ROM. The role of the facets cannot be underestimated particularly in this mode of loading. In order to capture the contributions specifically from the intervertebral disc, the FSU should be dissected to only include the vertebral bodies and the corresponding intervertebral disc. Interestingly no differences existed in any of the treated specimens in lateral bending. However, axial torsion demonstrated the greatest number of differences between the treatment groups with the posterior element removal exhibiting the largest ROM and the nucleus augmentation of the anterior column of the FSU have a statistically significantly reduced ROM. In conclusion, nucleus augmentation may have a significant effect on the intervertebral disc and the corresponding vertebral bodies, particularly in the axial torsion mode of loading.