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The Effects of Lumbosacral Fusion on Sacroiliac Joint Biomechanics

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INTRODUCTION:

Clinical studies suggest that many patients with lumbar spine fusions (LSF) develop symptomatic adjacent segmental disease (ASD). Recently ASD pain and subsequent failed back surgery syndrome (FBSS) has been attributed to accelerated sacroiliac (SI) joint degeneration. Normal SI joints are mobile segments adjacent to the lumbosacral spine articulation. It has been hypothesized that LSF alter SI joint biomechanics, increasing the joint forces and cumulative stress. This phenomena has been supported by Ha et al. in a clinical study that found the incidence of SI joint degeneration to be 75% higher in patients with LSF compared to a control group of patients without LSF.[1] In a finite element study, Ivanov et al. concluded increased SI joint motion may be the reason for ASD in these patients.[2] A biomechanical study examining the effects of LSF on the SI joint has not been reported, and is the objective of this study.

METHODS:

Six cadaver pelves including intact lumbosacral spines (L4-sacrum), average age 56.5 years ± 7.74, were harvested and denuded, preserving the iliolumbar, sacrotuberous, sacrospinous, anterior and posterior SI ligaments, the pubic symphysis and the SI joints. Sawbones® proximal femurs were fixed to the pelvis at the hip joints using lag screws to eliminate all motion at these joints. A loading fixture block was mounted to the superior endplate of L4, with PMMA; the loading block was centered and horizontally level on the vertebra, so the vertical compression load would be in line with the gravity load line of the lumbar spine. The specimens were cyclically loaded, with the MTS® to ±8.5 N-m in flexion/extension, and ±7.5 N-m in torsion, both under load control; and to 105 – 1500 N in double leg compression and 60 – 600 N in single leg compression under stroke control. An x-y roller plate was attached to the cross head of the MTS® and used during all testing parameters to allow for free motion and eliminated shear. An 8.5 N·m preload was added to the test specimen in flexion, to induce proper coupled flexion/extension motion, by placing a 60 N (~ 6 kg) weight on a lever arm attached to L4, at a distance of 14.2 cm from the center of the vertebra. A clevis joint was secured to the x-y roller plate and was attached to the extension end of the lever arm at a distance of 10 cm from the center of the L4 vertebra. A schematic diagram of the flexion/extension test set-up is depicted in Figure 1. Four pelvic conditions were tested: 1) intact, 2) post 360º instrumented L4-5 fusion, 3) post 360º instrumented lumbosacral L4-S1 fusion, and 4) post unilateral SI joint fusion. Measurements recorded during this study were load/displacement data through the MTS®, anterior SI joint motion through the MicroStrain® DVRT system and posterior motion between the sacrum and each ilium through the Selspot motion analysis system.

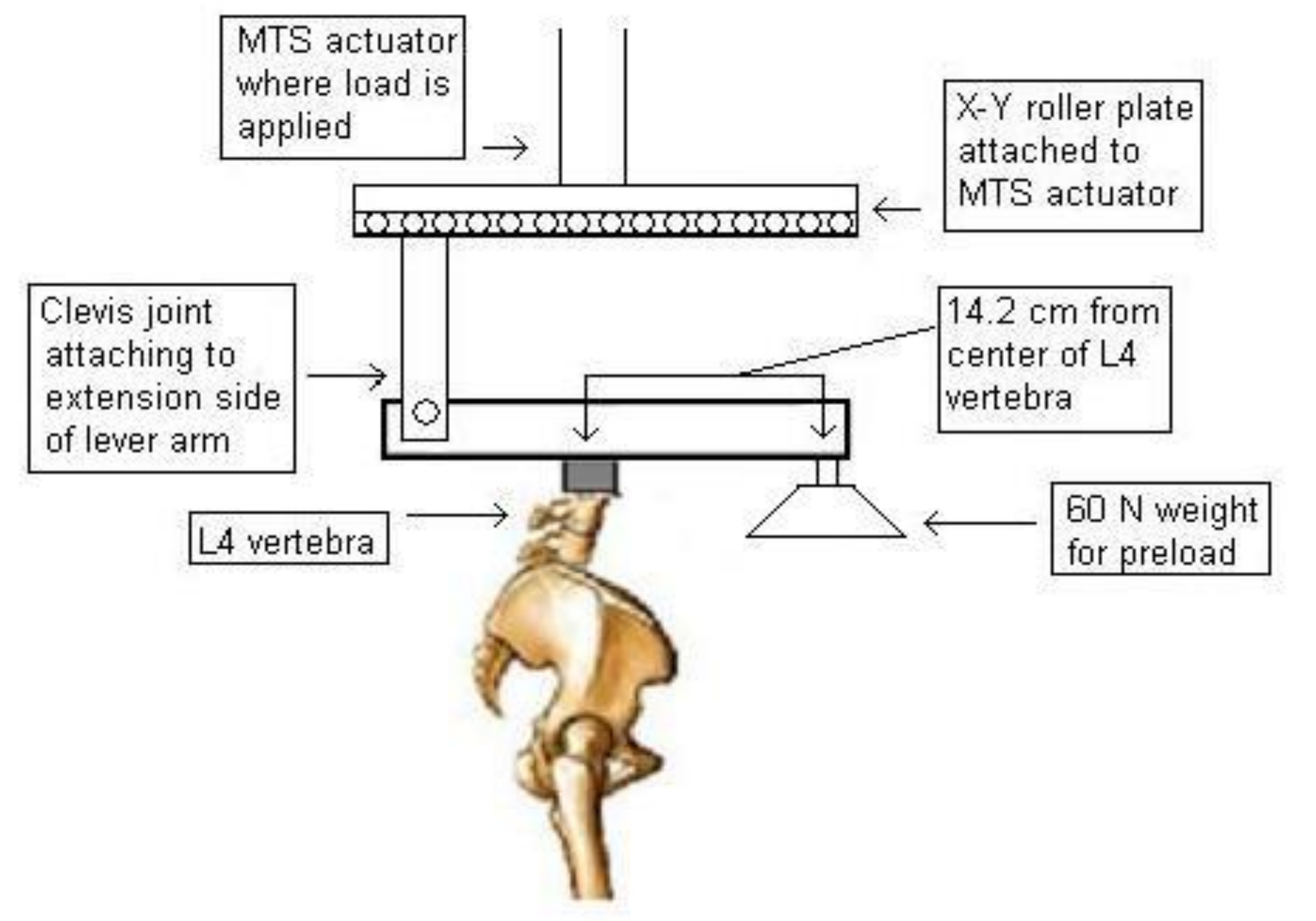

Figure 1: Schematic of flexion/extension test set up.

RESULTS:

Intact specimens in this study demonstrated motion at the SI joints, albeit variable between specimens (range 0.04-1.73mm) and between right and left SI joints (range 0.01-0.2mm) within a single pelvis. During flexion/extension, the SI joints rotated in the sagittal plane. SI joint motion during torsion and axial compression was linear in nature, predominantly in the medial-lateral plane for torsion, and the vertical and anterior-posterior planes during compression. Following fusion (L4-5, L4-S1 and unilateral SI joint) there was a progressive increase in the overall construct stiffness, Figure 2, and a decrease in the neutral zones. Overall increased motion was detected anteriorly at the SI joints during axial compression, Figure 3. The posterior SI joints also demonstrated increased motion, however, this increase was detected in all of the parameters tested (flexion/extension, torsion and axial compression), Figure 4. Due to the small number and variability of specimens tested significance could not be established.

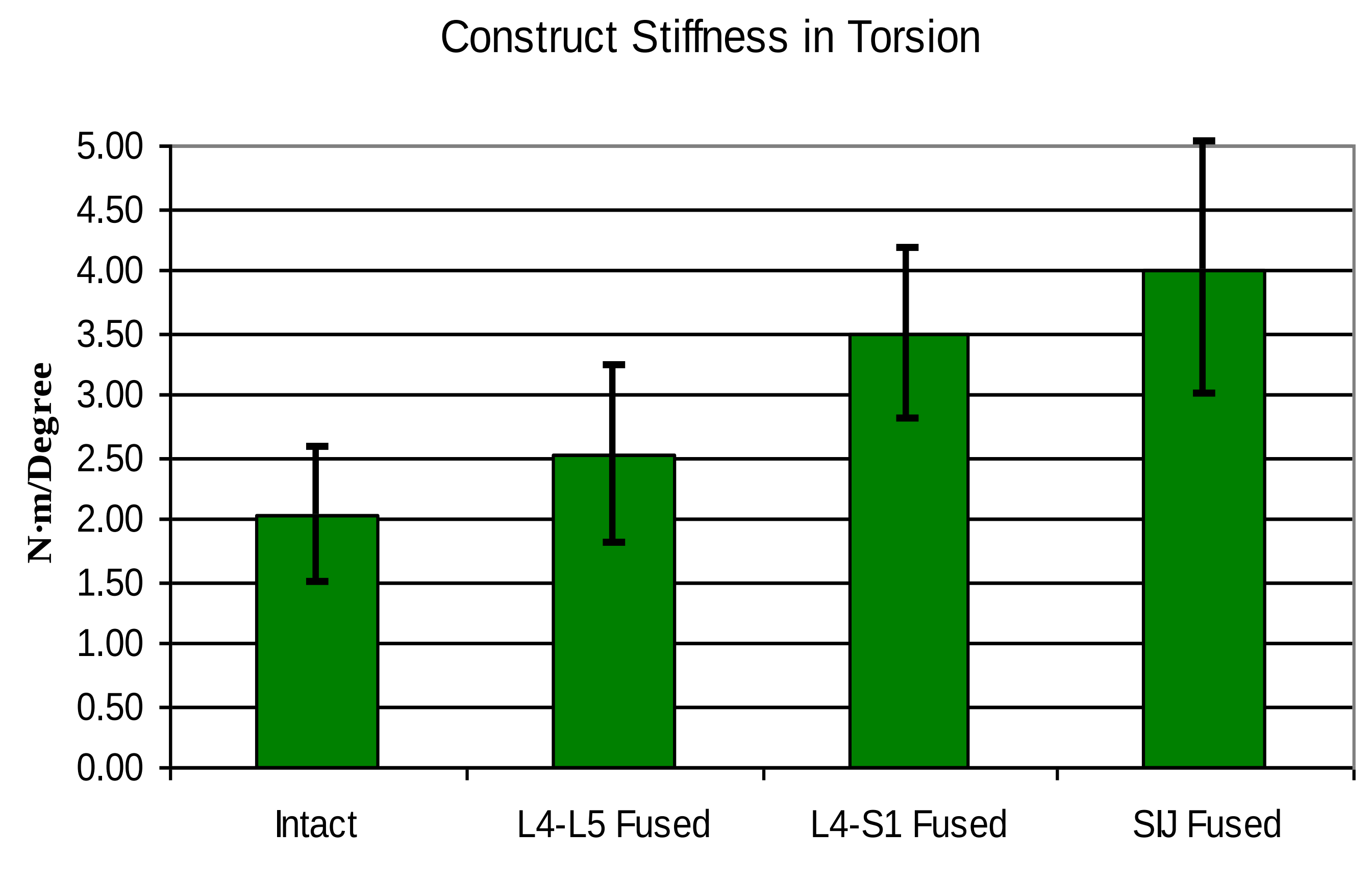

Figure 2: Construct stiffness in torsion.

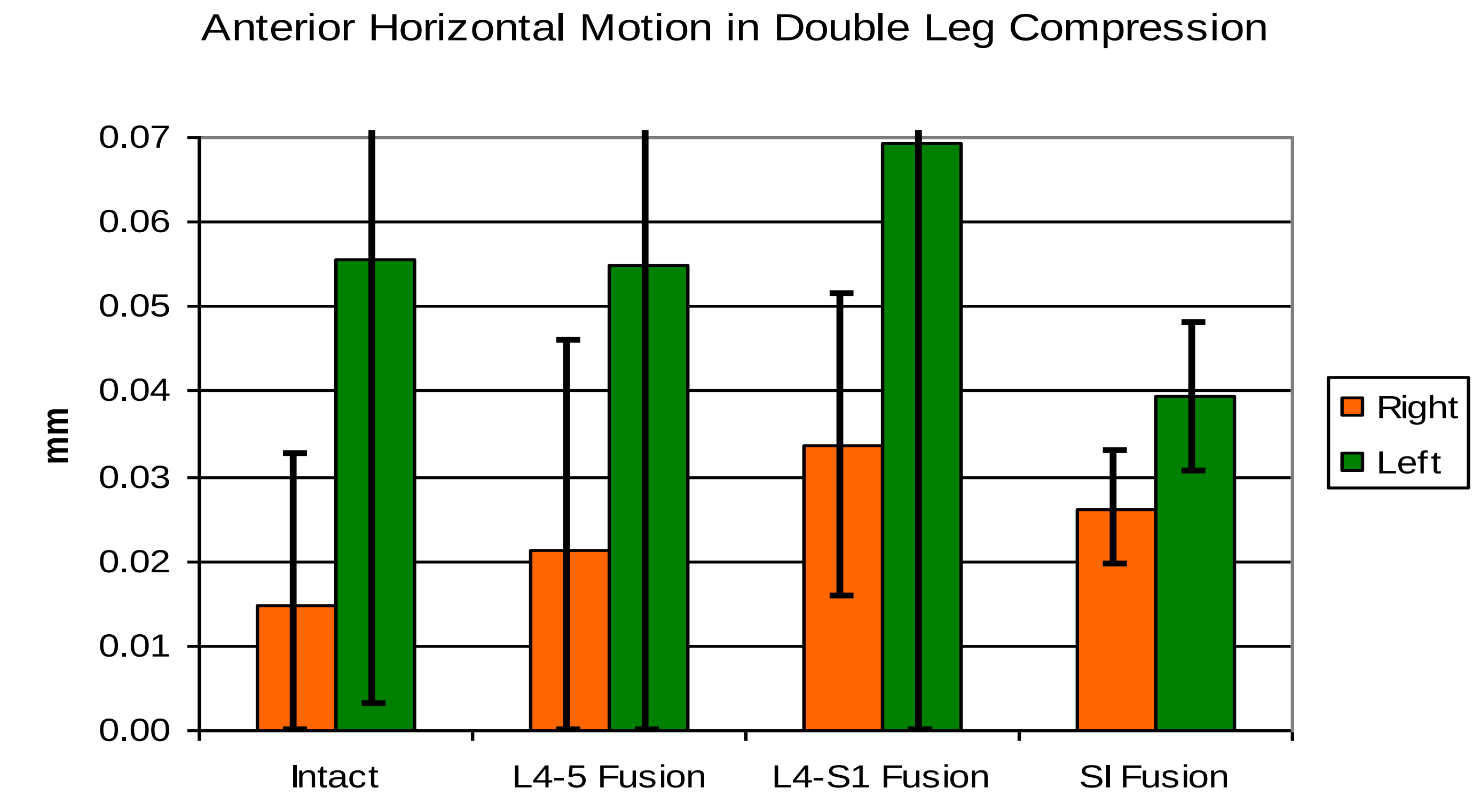

Figure 3: Anterior horizontal motion in double leg compression.

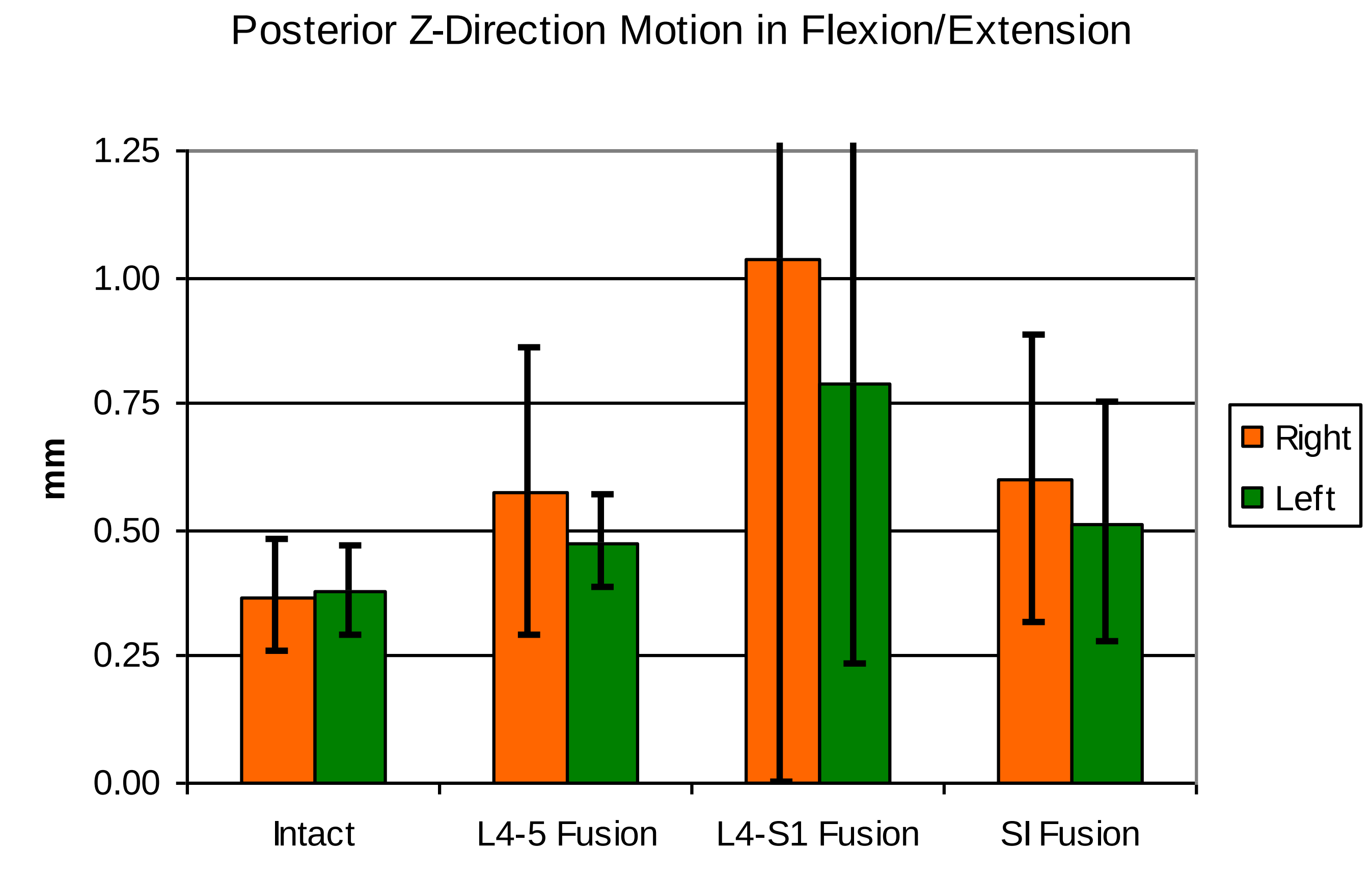

Figure 4: Posterior motion in the z-direction for flexion/extension.

DISCUSSION:

This study demonstrates that SI joint motion increases following LSF. Moreover, this motion increased with mulitilevel vs. single level LSF. These changes in SI joint biomechanics may account for the clinical reports of ASD and FBSS in patients .

REFERENCES:

1. Ha KY, Lee JS, Kim KW. Degeneration of Sacroiliac Joint After Instrumented Lumbar or Lumbosacral Fusion. Spine. 2008;33:1192-1198.
2. Ivanov AA, Kiapour A, et al. Lumbar Fusion Leads to Increases in Angular Motion and Stress Across Sacroiliac Joint. Spine. 2009;34(5):E162-E169.

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