Comprehensive Biomechanical Analysis of Three Reconstruction Techniques Following Total Sacrectomy - An In-Vitro Human Cadaveric Model

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Introduction

The objective of this study is to compare the biomechanical stability of three distinct techniques for sacral reconstruction in vitro.

Methods

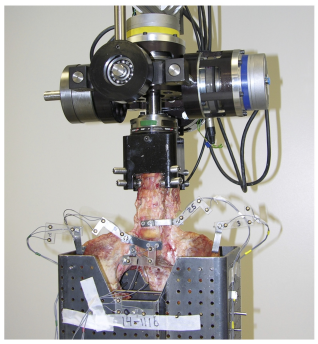
Eight intact human lumbo-pelvic specimens (L1 – pelvis) were tested for flexion-extension, lateral bending, axial rotation, and axial compression including segmental translation about the ±Y axis and ±Z axis. Following intact analysis, each specimen underwent total sacrectomy and reconstruction as follows: segmental pedicular instrumentation of the lumbar spine plus bilateral spinal rods anchored with iliac screws (Model 1), addition of a transiliac rod (Model 2), and addition of two spinal rods and two S2 screws (Model 3).

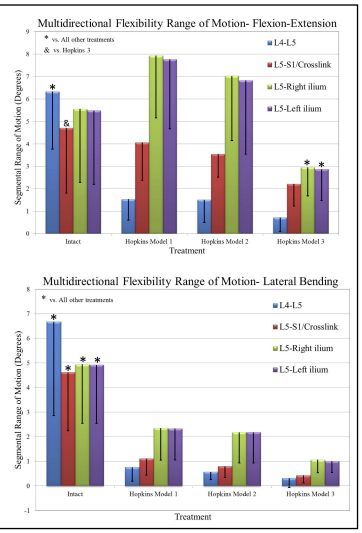
Results

The flexion-extension range of motion at L4-L5 in Model 1 (1.54 ± 0.94), Model 2 (1.51 ± 1.01), and Model 3 (0.72 ± 0.62) were significantly lower than the intact condition (6.34±2.57). For the Model 3 treatment, the mean range of motion at both the L5-Right ilium (2.95 ± 1.27) and L5-Left ilium (2.87 ± 1.40) were significantly less than all other treatments at the same level. Under lateral bending loading, the mean range of motion for the intact condition at L5-S1 (4.62 ± 2.37), L4-L5 (6.68 ± 3.81), L5-Right ilium (4.95 ± 2.41), and L5-Left ilium (4.92 ± 2.37) were significantly greater than all three subsequent reconstruction groups.

The axial rotation range of motion at L4-L5 for Model 1 (2.01 ± 1.39), Model 2 (2.00 ± 1.52), and Model 3 (1.15 ± 0.80) were significantly lower than the intact condition (5.02 ± 2.90) ($p<0.05$).

Figure: Intact specimen undergoing testing in a 6 degree-of-freedom testing machine





Conclusions

The current biomechanical study demonstrates a definitive kinematic advantage of Model 3 reconstruction method with regard to lumbopelvic range of motion. From a biomechanical standpoint, implementation of four iliac screws and four rods results in greater stability than bilateral rods and iliac screws, with or without transverse iliac fixation.

Learning Objectives

1. Know the biomechanical differences of three reconstruction techniques following total sacrectomy

References

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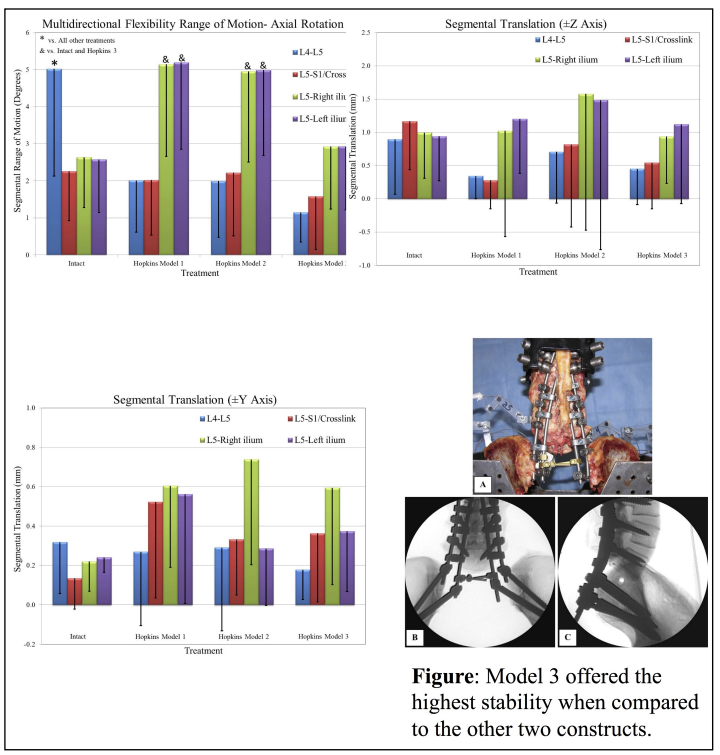

Figure: Model 3 offered the highest stability when compared to the other two constructs.