In Vivo Changes in Adjacent Segment Kinematics after Lumbar Decompression and Fusion

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Introduction

Background

• Spinal decompression and fusion surgery is a common treatment for degenerative spondylolisthesis (DS)1-4.

• However, the surgery only address DS at the affected levels, so there is an increased long-term risk for developing adjacent segment disease (ASD)5.

• The pathogenesis of ASD is poorly understood, though two theories exist: (1) ASD is an inevitable progression of spinal disease, and (2) ASD develops as a result of altered biomechanics due to fusion.

• Previous in vivo kinematic studies have only assessed changes from static, end-range radiographs (Figure 1), neglecting to consider the mid-range motion that comprise daily activities7-8.

Aim

• Determine the differences in dynamic, in vivo kinematics of the superior adjacent segment relative to the fused segment before (PRE) and 6 months after (POST) spinal decompression and fusion.

Hypothesis

• Flexion and clinical AP translation (slip) of the superior adjacent segment would increase from PRE to POST.

Methods

Data Collection

• Seven patients (5 M, 2 F: age 65±5 years) with symptomatic lumbar DS provided informed consent to participate in this IRB approved study.

• Participants performed two or three trials of continuous torso flexion within a biplane radiograph system (Figure 2) PRE and POST spinal decompression and fusion surgery while skin-based motion capture was also collected (Vicon Vantage).

• CT scans (0.5x0.5x1.25mm) of the lumbar spine were acquired for each participant.

Data Processing

• Bone kinematics of the superior adjacent segment were obtained using a previously validated volumetric model-based tracking system9 (Figure 2).

• Trunk flexion angles were calculated using markers placed on the bilateral shoulder, femoral greater trochanters, and femoral condyles.

• Intervertebral flexion/extension and slip were averaged across all trials at 10° increments of torso flexion for the superior adjacent segment.

Data Analysis

• PRE to POST differences were considered measurable if they were more than twice the validated uncertainty in our measurement system (0.5° for flexion and 0.2 mm for slip).

Results

Intervertebral Flexion

• Two patients had more intervertebral flexion at all body flexion angles POST compared to PRE, while one patient had less at all measured body flexion angles (Figure 3A).

• Two patients had no measurable change in intervertebral flexion, while the remaining two had varying intervertebral flexion change depending on body flexion angle (Figure 3A).

Intervertebral Slip

• Three patients had consistently more slip at all body flexion angles POST compared to PRE whereas two had consistently less slip (Figure 2B).

• The remaining two patients saw varying slip changes depending on body flexion angle (Figure 3B).

Discussion

• There was no consistent trend seen among patients for the change in intervertebral flexion or slip from PRE to POST.

• These findings are similar to previous reports of increased adjacent segment mobility in some patients with decreased mobility in others8.

• Current results suggest a sub-group of patients may be susceptible to change in kinematics at the superior adjacent segment after surgery.

• A strength of this study is that mid-range in vivo kinematics were included to identify changes in intervertebral flexion and slip.

• Limitations of this study include the short-term follow up and a small sample size.

Clinical Significance

• Changes in adjacent segment kinematics after lumbar fusion appear to be patient-specific. Evaluating lumbar kinematics during continuous motion has the potential to identify aberrant midrange kinematics that cannot be seen in static end-range imaging.

References and Acknowledgements


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