A PROPOSED MECHANISM OF SAGITTAL MOTION INDUCED BY MANUAL POSTERIOR TO ANTERIOR MOBILIZATION: ASSESSMENT OF LUMBAR SPINE KINEMATICS USING DYNAMIC MRI

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INTRODUCTION

Posterior to anterior (PA) mobilization is frequently employed to assess spinal mobility, and involves a manual application of a force to a single spinous process with the individual lying in the prone position. It is still unclear how this manual technique influences inter-vertebral motion of the lumbar spine. An in vivo study, using an apparatus to deliver a PA force to the L4 spinous process (Lee et al 1997), identified bidirectional sagittal intervertebral motions at all segments with maximal extension at L2-L3. A mathematical model, of force application to L3, predicted linear posterior-anterior displacement, and only minimal sagittal rotation (Keller et al .2003). Considering the morphology of the lumbar vertebrae and their structural relationship, neither of the two studies appears to present a comprehensive model. The purpose of this study was to 1) describe the segmental motion of the lumbar spine during a PA mobilization procedure using dynamic imaging techniques and 2) to propose a mechanism of the lumbar spine’s motion as a result of a PA force to a lumbar spinous process. We postulated that the unique structure of the lumbar spine would dictate the intervertebral responses to a PA force on a single spinous process.

METHODS

Twenty healthy individuals (12 male and 8 female) between the ages of 22 to 43 and with no history of back pain participated.

Dynamic imaging of the lumbar spine was performed using a vertical MRI system (0.5 Tesla, Signa SP, General Electric Medical Systems, Milwaukee, WI) with an opening that allowed the examiner access to the subject during testing. Sagittal plane imaging of the spine was performed using a flexible receive-only surface coil. Imaging parameters were: TR 200ms; TE 18 ms; matrix: 256 x 256; FOV: 28 x 21 cm; and a 7 mm section thickness with an interslice spacing of 1 mm.

The manual force was aimed at reaching the end range of vertebral motion and was comparable in magnitude to that of a “grade IV” (Maitland, 2001). Forces were applied at each subject’s vertebrae starting at L5 and moving to L1.

Figure 1: Sagittal images taken during a PA force applied to L4 spinous process.

The intervertebral angle, defined as the angle formed by lines delineating adjacent
vertebral endplates, was measured (Figure 1). Segmental motion was defined as the difference between the intervertebral angles as measured from the resting and the end-range images. An increase in intervertebral angle between those positions was indicative of segmental extension. The superior vertebra was used to define the target segment.

RESULTS AND DISCUSSION

The results of this study revealed a consistent pattern of lumbar spine motion during a PA mobilization procedure. Specifically, motion at the targeted and adjacent segments always was directed towards extension (Figure 2, Figure 3 top).

A theoretical explanation for this pattern of segmental motion can be proposed based on the morphology of the lumbar spine. For example, when a PA force is applied to the spinous processes of L3, the facet of the tested (L3) vertebra approximates the facet joint of the adjacent caudal (L4) vertebra and imposes motion to it (Figure 3, bottom). It is conceivable that this approximation would result in the L3 facet “pushing” on its L4 counterpart (bone on bone contact), causing a bending moment rotating L4 away from L3 (Figure 3, bottom). The facet of L3 moves away from the facet of L2 causing tension in the joint capsule, which in turn also results in a bending moment of L2 on L3 into extension, but of lesser magnitude.

Figure 2: Mean motion at each lumbar segment during a PA force on L3.

Figure 3: Segmental motion as a result of PA at L3 represented graphically (top) Artist’s conception of the proposed mechanisms of intervertebral motion resulting from PA force on L3 (bottom).

SUMMARY

The findings suggest that a PA force at one spinous process causes motion at the target vertebra and the neighboring vertebrae. Secondly, we propose a mechanism by which a PA force applied to a spinous process propagates motion caudally and cranially.

REFERENCES


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