FACET LAXITY ZONE: A NEW CONCEPT THAT DESCRIBES FACET JOINT CONTACT IN THE LUMBAR SPINE

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INTRODUCTION

During axial rotation of the lumbar spine, the facet joints are in contact during some of the range of motion. For example, left axial rotation causes the right facet joint to be compressed, while right axial rotation causes compression of the left facet joint. Despite this rather elementary concept of facet joint function, there is little information on the relation between compression in the facet joint and kinematic behavior. The neutral zone (NZ) has been widely used in spine biomechanics[1], but there is no study to explore facet joint contact within the NZ. In this study, we introduce the facet laxity zone (FLZ), defined as a range of motion in which there is no compressive load in the facet joint and we hypothesize that it is linked to the kinematic NZ. This in vitro study was designed to document this relationship and to analyze the effect of a follower compressive preload on FLZ.

METHODS

Six cadaveric specimens (L3-S1) were used. Ten uniaxial strain gauges (Tokyo Sokki Kenkyujo, Tokyo, Japan) were bonded to the posterior aspect of the left and right inferior facet of L4[2-3]. A pure moment (±10Nm) in axial rotation was applied to each specimen with and without 600N follower preload, respectively. The positions of the L4 and L5 vertebra were monitored using an optoelectronic camera system (Optotrak 3020, Northern Digital, ON). Neutral zone (NZ) and range of motion (ROM) were calculated [1]. The L5 superior facets were removed after flexibility test. For calibration of facet load, a known force was applied to the L4 inferior surface of facet joint and the corresponding strains were recorded to determine the facet forces based on the recorded strains during the flexibility test [4]. From the facet forces, a facet laxity zone (FLZ) was defined as segmental motion that occurred with very small facet contact load, defined at 5N in this study (Figure 1). Paired Student's t-test was used to determine the difference between the FLZ and NZ, and effect of follower load on the FLZ and NZ. Pearson correlation between FLZ and NZ was analyzed. The significance level was set at 0.05.

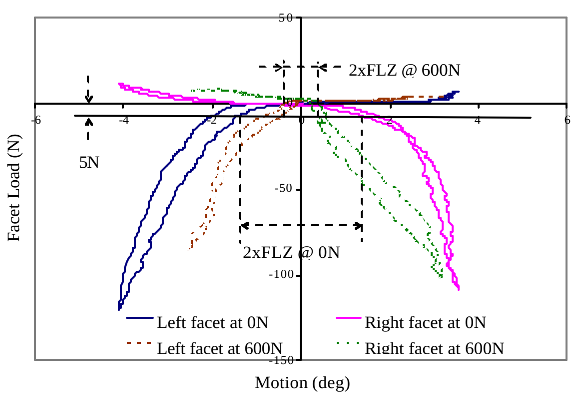

Figure 1. Facet laxity zones are defined on the curve of facet loads of L4-L5 segment in axial rotation at 10Nm moment with and without 600N follower preload, respectively.

RESULTS

Axial rotation at 10Nm led to 76.2±38.3N compression in the contralateral facet joint (Figure 1). There was no significant difference of facet loads between two sides. FLZ and NZ were, on average, 1.7°±1.3° and 0.6°±0.4° for 0N preload, and 0.7°±0.6° and 0.2°±0.0° for preload, respectively. FLZ decreased significantly with 600N preload, as did NZ (Figure 2-3). FLZ was significantly greater than NZ (Figure 3) and significantly correlated to NZ in axial rotation without preload (Figure 4).

ACKNOWLEDGEMENTS

The support in the form of a research grant from Archus Orthopaedics Inc., Seattle WA, USA, is gratefully acknowledged.

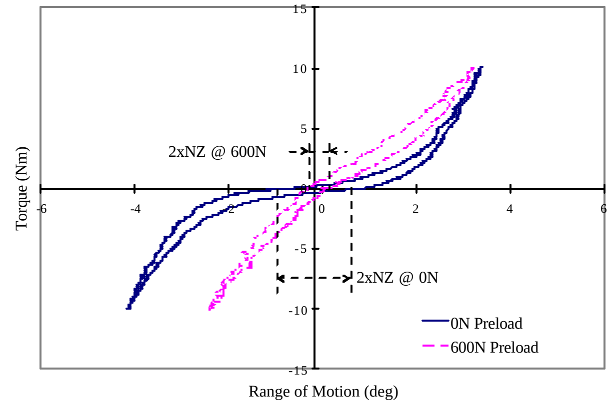

Figure 2. Neutral zone of L4-L5 segmental motion in axial rotation at 10Nm moment with and without follower preload, respectively.

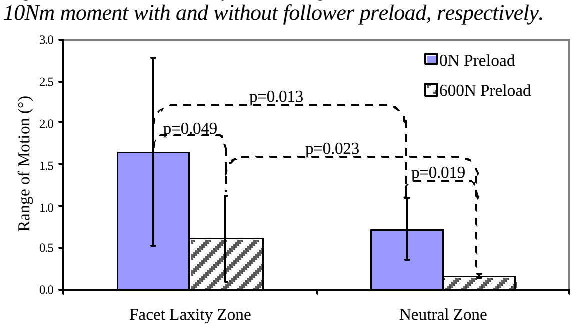

Figure 3. Facet laxity zone and neutral zone in axial rotation.

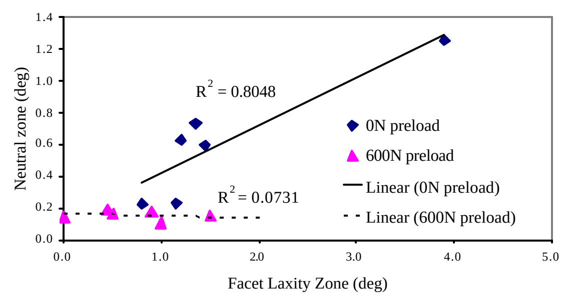

Figure 4. Correlation between facet laxity zone and neutral zone in axial rotation.

DISCUSSION

We introduce facet laxity zone to describe the facet joint contact of lumbar spine in axial rotation. The result suggested that facet joint contact occurred at motion beyond the FLZ, but not within NZ. Follower preload lowered the disc height and led to facet joint contact at less axial rotation. Further study should be done to expand FLZ to segmental motion in flexion-extension and lateral bending.

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