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The influence of chronic low back pain on joint kinematics in multi-joint reaching movements with various loads

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Introduction

In previous experiments we have shown that individuals with chronic low back pain reduce lumbar flexion when performing fast –paced full body reaching tasks. The purpose of this study was to determine whether chronic back pain leads to restrictions in lumbar motion when various loads are placed on the reaching limb.

Methods

Forty subjects (20 chronic back pain and 20 matched healthy controls) reached with the right hand for three targets located in a mid-sagittal plane starting from a standing posture. The targets were placed in positions calculated such that the subject (with the elbow fully extended and shoulder flexed to 90 degrees) could, in theory, reach each target by flexing the hips 15, 30, and 60 degrees, respectively, relative to an upright, vertical posture. The target locations were chosen to create a task that progressively challenges the subject with larger excursions of the trunk. While standing on two force plates, subjects performed reaching movements with their right hand at a comfortable pace and were given no instructions on limb segment geometry. For the load conditions they held either a 2lb or 4lb dumbbell. For the no-load condition they held a wooden dowel. Kinematic data was collected using reflective sensors and a 7 camera Vicon system. EMG data was collected from the rectus abdominus, internal and external obliques, multifidus, and erector spinae bilaterally using surface electrodes and Delsys software.

Data Analysis

For each group, the changes in 3-D joint angles (from initial posture to target contact) of the right ankle, knee, hip, spine, shoulder, and elbow were analyzed using mixed-model ANOVAs in which target height and load were the within subject factors and group (low back pain or healthy) was the between subject factor.

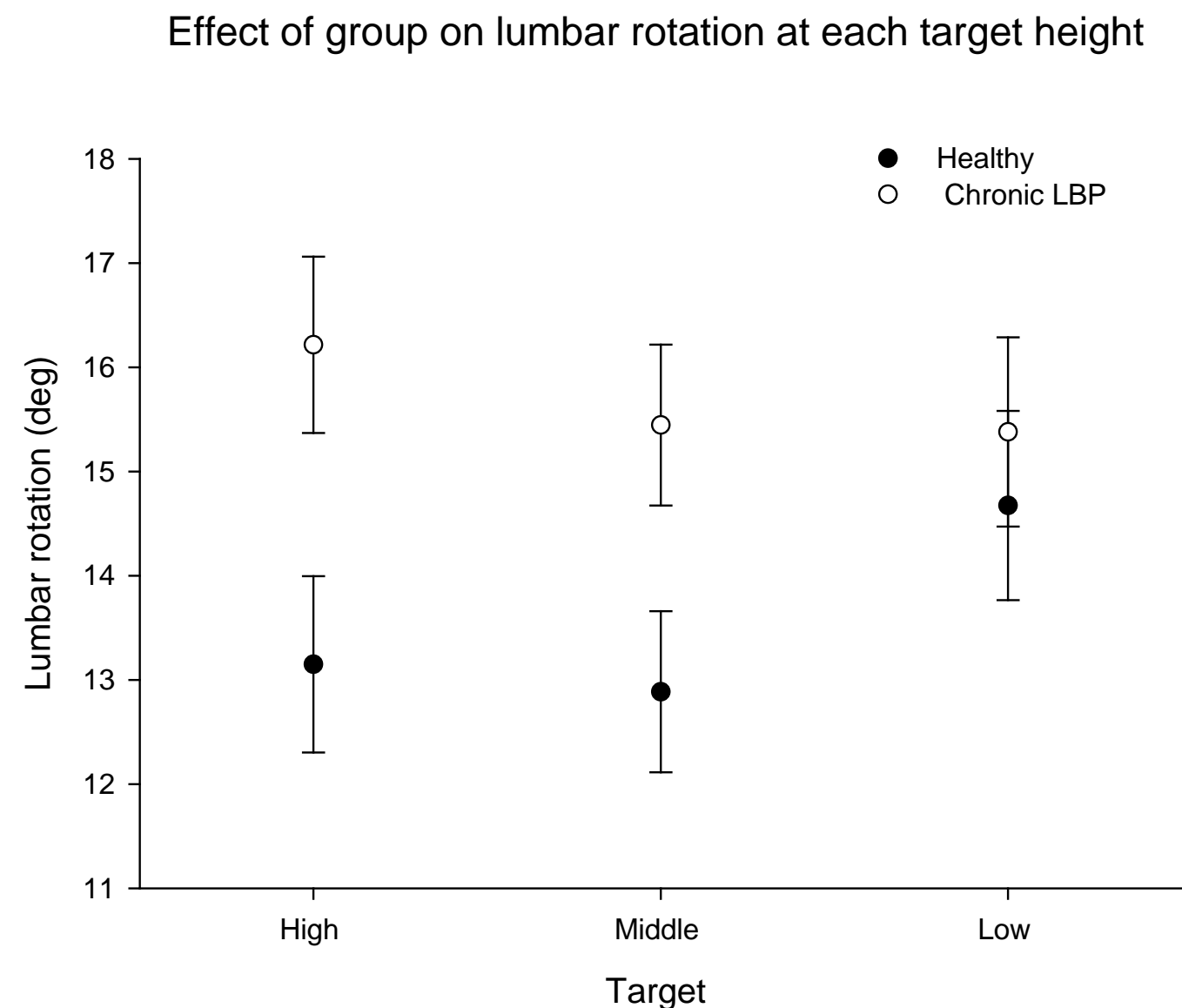


Figure 1. For each target height, subjects with chronic low back pain had larger excursions of lumbar rotation compared to healthy controls ($F=4.51$, $p<.05$).

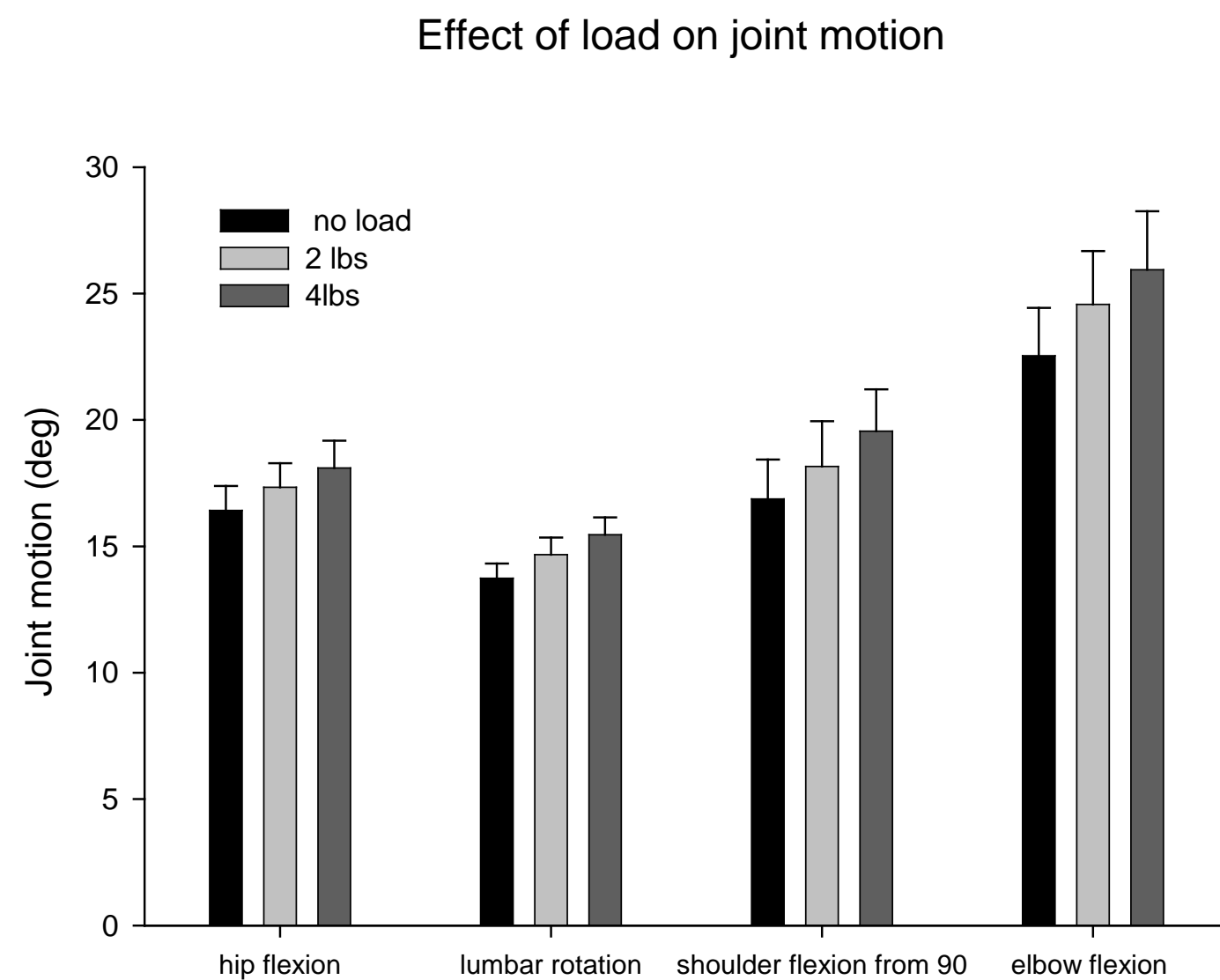


Figure 2. As the load in the reaching hand increased, there was a significant increase in hip flexion, lumbar rotation, shoulder flexion, and elbow flexion.

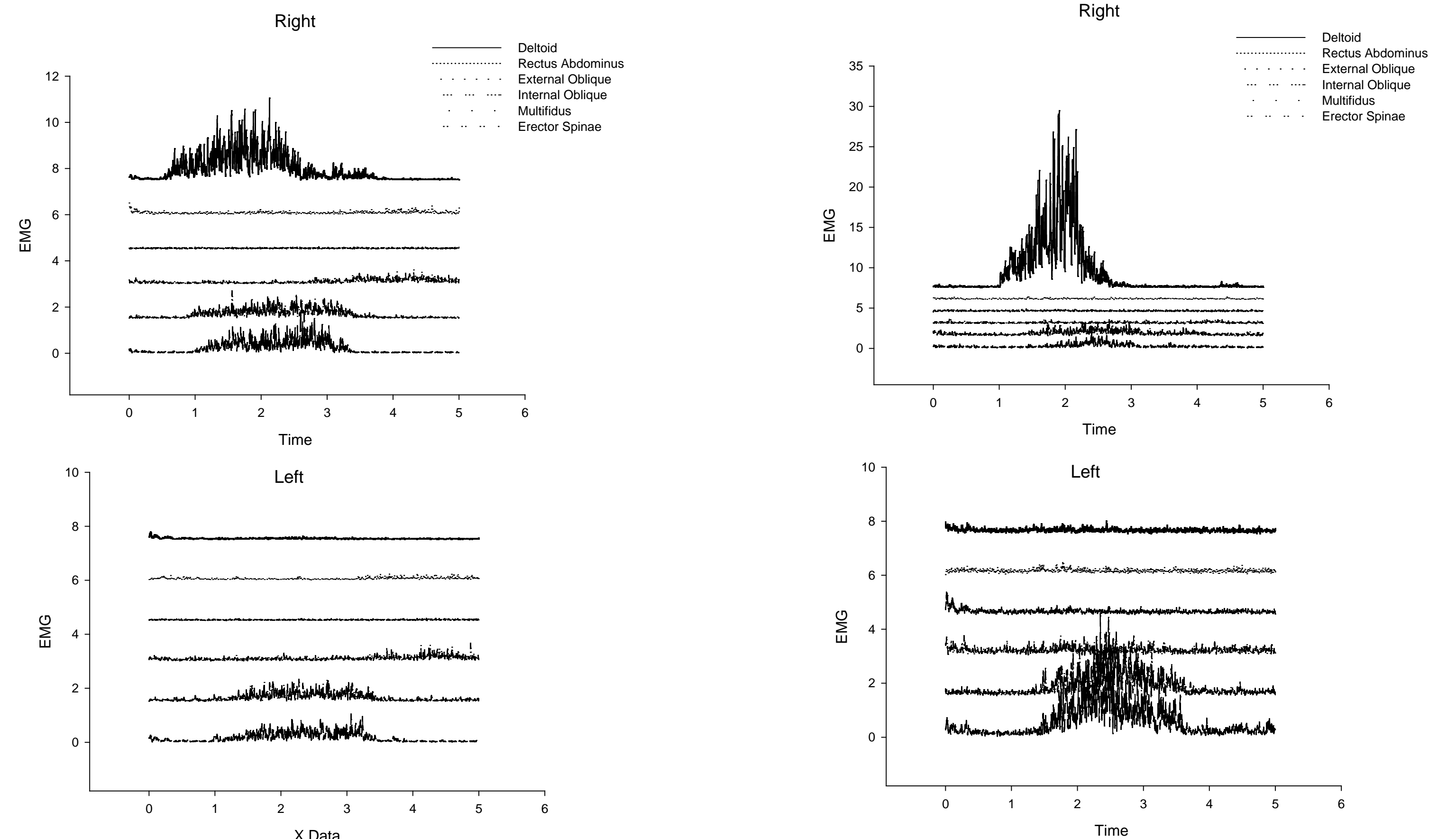


Figure 3

Results

There was no effect of group on any sagittal plane joint excursions of right leg or right arm joints. There was also no significant effect of group on either lumbar flexion or lumbar lateral flexion. However, there was a significant effect of group on lumbar rotation ($F=4.51$, $p<.05$). Figure 1 illustrates that for each target height, participants with chronic low back pain had larger excursions of lumbar rotation compared to healthy controls, especially at the high target. Because the target was located in the midline, increased lumbar rotation allows the subject to reach the target with decreased flexion. As the load in the reaching hand increased, there was a significant increase in hip flexion ($F=7.25$, $p<.05$), lumbar rotation ($F=13.6$, $p<.05$), shoulder flexion ($F=11.0$, $p<.05$), and elbow flexion ($F=4.8$, $p<.05$) (see Figure 2). Subjects chose to use increased excursion at the shoulder, elbow, and hip in order to reach the target without increasing lumbar flexion. Lumbar flexion with increased loads would create increased torque on the low back, therefore subjects move in such a way that lumbar flexion can be avoided. As the load increases the subject uses more compensatory movements to reach the target.

Conclusions

The increase in joint motions may have been a result of an overshoot error in planning the movement task. However, we expected that lumbar flexion and rotation would be reduced as the load in the reaching hand increased in order to reduce peak loads on the lumbar spine. Nonetheless, our data indicate that individuals with chronic back pain actually use greater lumbar rotation to perform these multi-joint reaching tasks. Rotation of the lumbar region increases stress on lumbar discs and is a known risk factor for low back pain. The increase in lumbar rotation may result from poor trunk control or greater overshoot error and could be a contributing factor in persistence of low back pain.

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