VARIATION OF REPOSITION SENSE OF LUMBAR SPINE WITH TORSO FLEXION AND MOMENT LOAD

Venkata K. Gade and Sara E. Wilson

Mechanical Engineering
University of Kansas
Lawrence, Kansas

INTRODUCTION

Low back pain is a significant health problem that affects 80% of the general population at some point in their lifetime (1). Incidence of low back injuries are reported to be high for industrial workers operating in flexed postures (2). Low back injuries are believed to be associated with insufficient low back stabilization (3). In order to maintain joint stability sufficient proprioception is necessary (4). A decrease in proprioceptive feedback leads to inefficient muscle responses, leading to increased risk of injury and low back pain (5). A previous study has shown that reposition sense error, a measure of proprioception, increased with increased torso flexion (6). In flexion tasks, both geometry and moment load change. The increase in reposition sense error could be a result of either the increase in the moment load, the change in geometry, or a combination of the two leading to altered proprioception. The objective of current study was to investigate reposition sense of lumbar spine as a function of moment load and torso flexion, independently.

METHODS

Thirteen adults (10 men and 3 women) between the ages of 20 and 32 years with no history of low back pain or musculoskeletal disorder participated in the study. The study was approved from the University of Kansas, Human Subjects Committee.

An electromagnetic motion analysis system (Motion Star, Ascension Tech., VT) was used to collect data. Three markers, one over the T-10 spinous process, one over the L5/S1 spinous process and one on manubrium were placed on the participant as shown in figure1.

Lordosis was defined as the angle between the markers over the T-10 and L5/S1 spinous process as shown in figure2.1. Torso flexion was defined as the angle between the vertical and a plane containing the three sensors as shown in figure 2.2.

Each participant performed a reposition sense protocol for 4 conditions (all combinations of the flexion angles of 0 or 45 degrees and moment loads 0 or M). A moment equal to the moment generated about feet by the weight of the upper body at 45 degrees of torso flexion (M) was applied in moment condition. A rope carrying a load at one end and going over a pulley was attached to the chest harness worn by participant to apply moment.

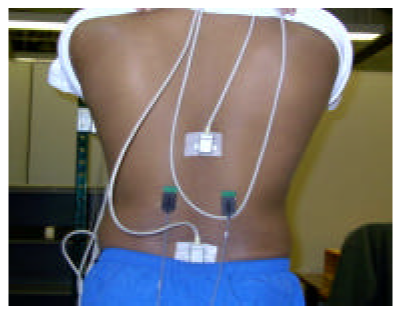

Figure 1.Participant with markers and EMG electrodes. The EMG electrodes were placed over the erector spinae muscle group at L2/L3 level of lumbar spine.

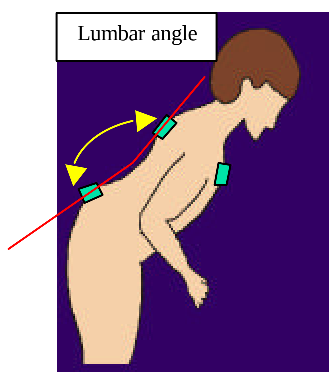

Figure 2.1. Lumbar angle is the difference in angle of the T10 and S1 markers.

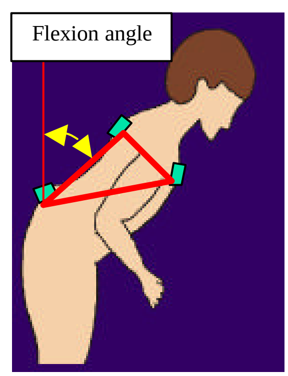

Figure 2.2. Flexion angle is the angle of whole torso relative to vertical.

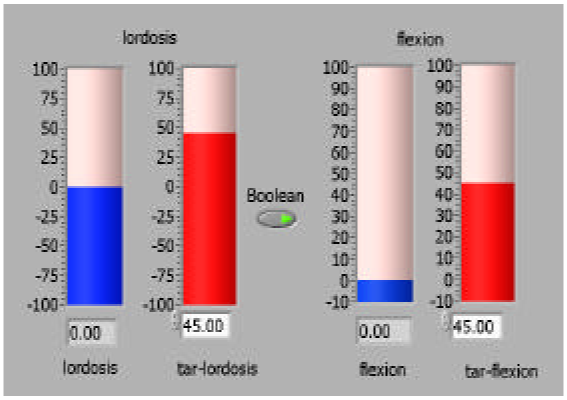

Figure 3. Visual display on computer screen. The set of bars on right side provides feedback for torso flexion. The set of bars on left side provides feedback for lumbar curvature. In each set of display the bar on the right indicates the target to be reached and the left bar shows the corresponding real time value.

The reposition sense test included 8 trials with 3 training trials followed by alternation of assessment and training trials. A visual display of flexion and lumbar curvature (Figure3) was provided on a computer screen for the trials. In assessment trials only flexion was displayed. In training trials both flexion and curvature were displayed. In training trials the participants were instructed to match the target flexion and lumbar curvature using the feedback from the displays. Once both the targets were reached, participant was instructed to maintain this position for 5 seconds during which the data was collected. The participants were instructed to remember the position. The reposition sense was then assessed in the assessment trials as the ability to reproduce the target position after the lumbar display was removed.

Reposition sense error was defined as the absolute difference between the target curvature and the actual measured curvature. Errors were assessed during both training and assessment trials. A two-way ANOVA used the reposition sense error for the assessment trials for each of the conditions to study the effect of moment load and flexion.

RESULTS

Reposition sense error during the training trials was small (0.97 ± 0.11 degrees). No significant difference was observed in the training error across the different conditions. The error increased significantly in assessment trials to a mean error of 4.17 ± 1.07 degrees.

Two-way ANOVA for the reposition sense errors under the different conditions showed that the reposition sense error decreased with moment load but this decrease was not significant ($p=0.49$). The reposition sense error increased significantly with torso flexion ($p<0.05$).

DISCUSSION

Reposition sense error was found to increase significantly with the torso flexion and not moment load. The increase in reposition sense error with flexion suggest that the increase in risk of injury associated with the flexed postures may be due to loss of proprioception due to the changes in the geometric configuration of the body. The trend of decreasing error in moment conditions indicates that moment load might actually improve reposition sense.

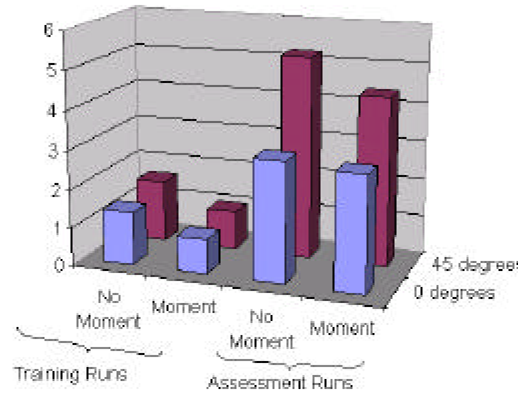

Figure 4. Reposition sense error with flexion and applied moment. During the training runs (curvature displayed) error was small and did not increase significantly with flexion. During the assessment run (curvature display removed) error increased with a significantly greater error seen in the 45 degree flexed postures.

The results of the study demonstrate that in the workplace tasks involving flexed posture should be avoided, as they are likely to increase the risk of low back injuries, even when loading is supported by external means. This research explains why some studies have found increased risk in flexion tasks, even when these tasks do not involve excessive moment loads on the low back [7]. Future studies must be undertaken to understand exactly how changes in reposition sense alter the overall stabilization of the spine and methods by which such effects could be reduced.

REFERENCES

[1] Kelsey JL, White AA 3rd. Epidemiology and impact of low-back pain.

[2] Marras WS, Lavender SA, Leurgans SE, et al. Biomechanical risk factors for occupationally related low back disorders.

[3] Cholewicki J, Panjabi MM, Stabilizing function of trunk flexor-extensor muscles around a neutral spine posture.

[4] Panjabi MM. The stabilizing system of the spine: Part 1. Function, disfunction, adaptation and enhancement.

[5] Hides JA, Richardson CA, Jull GA. Multifidus muscle recovery is not automatic after resolution of acute, first-episode low back pain.

[6] Wilson SE, Granata KP. Reposition sense of lumbar curvature with flexed and asymmetric lifting postures.

[7] Punnett, L, et al. Back disorders and non-neutral trunk postures of automobile assembly workers.