VIBRATION ALTERS PROPRIOCEPTION AND DYNAMIC LOW BACK STABILITY

[1] Maneesha Arashanapalli and [1]Sara E. Wilson
[1]Mechanical Engineering, University of Kansas, email: sewilson@ku.edu

INTRODUCTION

Whole body vibration has long been shown to be a risk factor for low back disorders. Vibration is associated with 1.5-39.5 fold increase in low back injury risk [1]. Vibration has been associated with a higher incidence of low back disorders in occupations such as pilots, tractor drivers and heavy equipment operators [2]. Although a number of investigators have studied the transmissibility of vibration, the mechanism by which vibration results in low back injury is not understood. One potential mechanism by which vibration may lead to low back injury is through changes in the dynamic stabilization of the spine. Muscle and muscle-tendon vibrations of 20 to 120 Hz are known to result in proprioceptive illusions in the extremities due to the stimulation of the muscle spindle organs [3]. After removal of vibration from the muscle, proprioceptive changes have been shown to persist [4]. In this experiment it was hypothesized that vibration-induced proprioceptive changes in the muscle both during and after vibration will correspond to changes in the dynamic stabilization of the low back.

METHODS

Seven healthy subjects were recruited for the study, which was approved by the Human Subjects Committee, University of Kansas. Electromagnetic sensors were placed over the manubrium and the T10, T12, C7 and the S1 spinous processes. Lumbar curvature was defined as the angle between the T10 and S1 markers. Electromyographic sensors were placed on 8 trunk muscles (RA/ES/IO/EO) to measure their activity. The reposition sense protocol consisted of training trials followed by assessment trials. In the training trials, subjects were asked to match their current lumbar curvature with a target lumbar curvature. In the assessment trials, the subjects were asked to reproduce the target lumbar curvature without visual feedback. After two training trials, training and assessment trials were alternated. Reposition Sense Error (RSE) was defined as the absolute difference between the actual curvature assumed and the target lumbar curvature during the assessment trials. Directional error (DE) was defined as the difference between the actual curvature assumed and the target lumbar curvature during the assessment trials. In the sudden loading protocol, the subject wore a harness, which applied a small sudden forward impulse through a dropped weight mechanism. The time from impulse load to peak muscle response was assessed from the EMG data for the erector spinae muscle groups. Both the reposition sense test and sudden loading test were conducted before, during, immediately after, 15 minutes after, and 30 minutes after vibration.

RESULTS AND DISCUSSION

In this experiment, two different effects were observed. First during vibration, kinesthetic illusions were observed resulting in increases in reposition sense error and directional error (Figure 2). Subjects tended to assume more lordotic postures during vibration, which is consistent with previous evidence of muscle lengthening kinesthetic illusions. After vibration, the reposition sense error remained increased while directional error returned to zero suggesting a habituation mechanism for altered position sense. Both during and after vibration, delay in muscle response during dynamic low back stabilization was increased suggesting that proprioceptive changes may indeed be a mechanism for altered low back stability and increased injury risk (Figure 1).

REFERENCES

1. Bernard, B.P., ed. Musculoskeletal disorders and workplace factor. 1997, U.S. D.H.H.S.: Washington, D.C., 94-213.
2. M. L. Magnusson, et al., Spine, **21**, 710-7, 1996.
3. Roll J.P. and J.P.Vedel, Exp Brain Res. **47**(2), 177-90, 1982.
4. Wierzbicka, MM, et al., J Nuerophysiol. **79**, 143-50, 1998.

ACKNOWLEDGEMENTS

This publication was made possible by support from the National Institute for Occupational Safety and Health (1R03 OH007995-01).

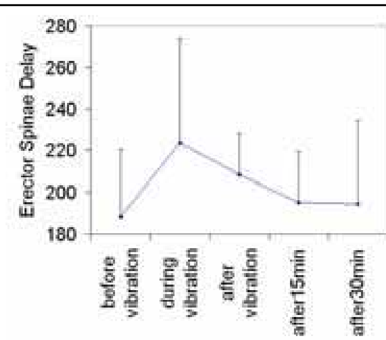

Figure 1: The delay between perturbation and peak initial muscle response was found to increase both during and after vibration returning to baseline after 15 minutes.

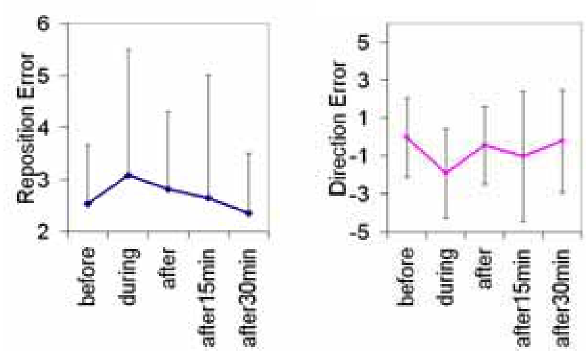

Figure 2: Reposition error was found to increase both during and after vibration, returning to baseline after 30 minutes. Directional error was found to be near zero except during vibration.