INTRODUCTION

Low back disorders (LBDs) and their prevention are of great importance for companies and their employees. Whole-body vibration (WBV) is thought to be a risk factor for LBDs, but the neuromuscular, biomechanical, and/or physiological mechanisms responsible for this increased risk are unclear. The purpose of this study was to measure the acute effect of seated WBV on the postural control of the trunk during unstable seated balance.

Measures of seated postural sway during unstable seated balance have been used as surrogate measures of trunk postural control (Cholewicki et al, 2000) and have been related to spinal stability (Reeves et al, 2006). Seated WBV was investigated because machine operators are typically exposed to vibration while in a seated posture. It was hypothesized that WBV would impair postural control of the trunk, suggesting a loss of spinal stability and perhaps an increased risk for low back injury.

METHODS AND PROCEDURES

Twenty-one healthy subjects aged 23 ±4 years were tested on a wobble chair (Figure 1) designed to measure trunk postural control. Measurements of kinematic variance and non-linear stability control were based on seat angle before and after 30 minutes of seated whole-body vibration (bandwidth = 2 – 20 Hz, root-mean-squared amplitude =1.15 m/s²). Fourteen of the 21 subjects completed a second experiment during which WBV was replaced with quiet sitting. The goal of this second experiment session was to identify any effects of prolonged sitting on postural control of the trunk.

The wobble chair is designed to provide an unstable seating condition for the subjects to balance upon. A single central pivot point with 4 radially located springs allows for adjustability of the balancing task. Kinematic variance of the seat tilt angle was determined using common measures of postural sway including the 95% ellipse area, root-mean-squared (RMS), and path length. Non-linear stability control measures of the seat tilt angle consisted of Lyapunov exponent, stability diffusion analysis (SDA), and Hurst rescaled range analysis (HRRA).
to allow vertical movement of the chair (approx. ±1”). The shaker was computer controlled using feedback from an accelerometer to maintain the desired RMS amplitude of vibration.

RESULTS

WBV increased all measures of kinematic variance (Table 1). For example, ellipse area increased 35.5% ±50.5%, RMS increased 17.9% ±21.0%, and path length increased 12.2% ±15.1%. WBV also increased all non-linear stability control measures (Table 1). Lyapunov exponent increased 8.78% ±10.9%, SDA increased 1.95% ±2.8%, and HRRA increased 5.2% ±4.0%. Thirty minutes of sitting without WBV (control group) did not affect most measures of kinematic variance or non-linear stability control measures, but the medial/lateral components of RMS and SDA decreased ($P = 0.027$, and $P = 0.019$ respectively) after prolonged sitting.

Spinal stability is maintained through contributions from passive tissue stiffness, active muscular stiffness, and neuromuscular reflexes. The effect of WBV on any of these subsystems could conceivably alter postural control of the trunk, and explain the changes found in the present study.

SUMMARY

In conclusion, WBV impaired postural control of the trunk, which may indicate impaired spinal stability. Future studies are required to further explore the affects of WBV on the subsystems of the neuromusculoskeletal system that control spinal stability, as well as to understand the effects of different vibration characteristics, exposure durations, and recovery time-line.

REFERENCES


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