INVESTIGATION OF THE LUMBAR SPINE PASSIVE TISSUE RESPONSE TO REPETITIVE LIFTING.

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INTRODUCTION

The time varying changes that occur in the spine can alter both the potential for injury and the injury mechanisms. Conflicting findings from in vitro testing have been reported in the literature, Adams and Dolan (1996) reported decreased stiffness and Callaghan and McGill (2001) reported increased stiffness during repeated flexion protocols. This discrepancy in the literature and a lack of knowledge regarding the in vivo passive tissue response to dynamic flexion prompted this study.

METHODS

Ten male subjects (age 25±2 yrs, height 1.83±0.037 m, mass 84.7±10.69 kg) were recruited from the student population at the University of Guelph. Flexion stiffness was measured on a jig with the subject lying on their right side while the upper body was moved through a full range of flexion. The shoulders, pelvis and legs were restrained with straps. The jig was constructed of a large plexiglass surface upon which nylon ball bearings were set. The cradle supporting the upper body was lined with plexiglass and placed on top of the bearings.

Lumbar spine motion was measured using a 3-SPACE Isotrak system with the magnetic field source secured over the sacrum and the sensor over the spinous process of L1. 3-SPACE output was sampled at 20.5 Hz. A cable fitted with a load cell was attached to the cradle to apply the bending moment. The cable was pulled until the experimenter could no longer move the subject, or the subject expressed discomfort.

To isolate the passive tissues during testing, electrodes were placed over the thoracic (T9) and lumbar (L3) erector spinae groups bilaterally. Maximum voluntary contractions (MVC) were performed for normalization. Throughout testing, trials during which muscle activity exceeded 5% MVC were recollected. EMG and force data were collected at 2048 Hz.

The lifting task required the subject to lift a 4.5 kg weight from the ground over a 55 cm high barrier, turn, walk 1.2 meters and lower the weight back down to the ground over another barrier. Lifting was performed at a rate of 7 times a minute.

Prior to any lifting, an initial stiffness testing session was performed with a minimum of three trials collected to allow subjects to practice the motion without activating the extensor musculature. The subjects then lifted for a thirty-minute interval followed immediately by another session of stiffness testing. This cycle was repeated three times for a total of 1.5 hours lifting, four flexion testing sessions and twelve trials. Typical stiffness vs. angle curves are illustrated in figure 1. Stiffness was calculated using the methods reported by McGill et al. (1994).
Moment at the highest common angle, angle at the highest common moment, and stiffness at 10, 30, 60, and 80% of flexion were compared with repeated measures ANOVAs.

RESULTS AND DISCUSSION

Statistical analysis revealed a significant difference (p<0.05) between trial 1 and trials 2 and 3 (figure 2) potentially due to an initial passive stretching of the tissues.

Analysis also revealed that stiffness in session 2 was significantly lower than that of session 1 (figure 3). The initial decrease in stiffness may be due to creep in the ligaments and intervertebral disc. This decrease in stiffness was followed by a recovery, possibly due to an inflammatory response or increase in the passive stiffness of the musculature.

REFERENCES