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Comparison of surface electromyographic activity of erector spinae before and after the application of central posteroanterior mobilisation on the lumbar spine

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Abstract

Lumbar spine accessory movements, used by therapists in the treatment of patients with low back pain, is thought to decrease paravertebral muscular activity; however there is little research to support this suggestion. This study investigated the effects of lumbar spine accessory movements on surface electromyography (sEMG) activity of erector spinae.

A condition randomised, placebo controlled, repeated measures design was used. sEMG measurements were recorded from 36 asymptomatic subjects following a control, placebo and central posteroanterior (PA) mobilisation to L3 each for 2 min. The therapist stood on a force platform while applying the PA mobilisation to quantify the force used. The PA mobilisation applied to each subject had a mean maximum force of 103.3 N, mean amplitude of force oscillation of 41.1 N, and a frequency of 1.2 Hz. Surface electromyographic data were recorded from the musculature adjacent to L3, L5 and T10.

There were statistically significant reductions of 15.5% (95% CI: 8.0–22.5%) and 17.8% (95% CI: 12.9–22.4%) in mean sEMG values following mobilisation compared with the control and placebo, respectively.

This study demonstrates that a central PA mobilisation to L3 results in a statistically significant decrease in the sEMG activity of erector spinae of an asymptomatic population.

Keywords: Mobilisation; Erector spinae; Electromyography; EMG

1. Introduction

Patients with low back pain often present with reduced lumbar spine mobility and this may be associated with increased paraspinal muscle activity (Chen et al., 1998; Chiou et al., 1999; Lariviere et al., 2000; Lehman, 2002; Lofland et al., 2000; Mannion et al., 1997). During clinical examination of these patients, therapists' perception of increased lumbar posteroanterior (PA) stiffness (Latimer et al., 1996) may be due to this increase in paraspinal muscle activity (Colloca and Keller, 2001; Lee et al., 1993; Shirley, 2004; Shirley et al., 1999). Therapists may treat PA stiffness by manually applying rhythmical oscillatory forces to the spinous processes of the lumbar spine.

The effect of an oscillatory PA force to the lumbar spinous process has been shown to produce a generalised extension movement (Lee et al., 1994; Lee and Evans, 1997) as far as T8 (Lee and Svensson, 1993). All the neuromusculoskeletal tissues in the region will therefore be affected by the oscillatory force; there will be movement of the interbody and zygapophyseal joints and their accompanying periarticular tissues, as well as local musculature and neural tissues. Because of this, PA mobilisation treatment is

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likely to have widespread effects in a number of tissues. One suggested effect is reduced paraspinal muscle activity (Maitland et al., 2005; Zusman, 1986).

There is support in the literature that oscillatory joint movement influences muscle activity; but it is still unclear in what direction. Some studies have found a reduction in spinal motor excitability in the lower limb (Cheng et al., 1995; Freeman and Wyke, 1967) while in the upper limb one study found an increase in corticomotor activity (Lewis et al., 2001) and one a decrease (Edwards et al., 2002).

While there have been a large number of studies investigating the effect of a spinal manipulative thrust on local muscle activity (for example DeVocht et al., 2005; Dishman and Burke, 2003; Ritvanen et al., 2007), there have been only two studies that have specifically explored the effect of oscillatory joint mobilisation on local muscle activity; one study on the temporomandibular region and the other on the cervical spine (Sterling et al., 2001; Taylor et al., 1994). Both these studies used surface electromyography (sEMG) to measure a change in muscle activity. While there are limitations of sEMG to isolate particular muscles (Basmajian and DeLuca, 1985; DeLuca, 1997; Ferdjallah and Wertsch, 1998; Wolf et al., 1991), it has been demonstrated to accurately record signals from the erector spinae (Stokes et al., 2003; Wolf et al., 1991).

The sEMG activity of the masseter muscle before and after oscillatory grade IV distraction mobilisations over the lower molar teeth was used with 15 subjects with temporomandibular pain and dysfunction (Taylor et al., 1994). The application of the mobilisation lasted for 3 min (three repetitions of 1 min duration with 10 s intervals). Following mobilisation there was a statistically significant ($p < 0.05$) decrease in resting and clenched masseter sEMG immediately and after 15 min, compared with a placebo treatment.

The effect of cervical spine mobilisation on sEMG of sternocleidomastoid in 30 subjects with chronic (3 months or more) mid to lower cervical spine pain was investigated by Sterling et al. (2001). sEMG activity of the superficial neck flexor muscles during the cranio-cervical flexion test was measured before and after an oscillatory Grade III unilateral posteroanterior mobilisation to the articular pillar of C5/6 on the subject's symptomatic side. The mobilisation lasted 3 min (three repetitions of 1 min duration, with I minute rest period between the applications of pressure). Following mobilisation, there was a statistically significant ($p < 0.0002$) decrease in sEMG of both left and right neck flexor muscles compared to control or placebo conditions.

To further elucidate the effect of spinal joint mobilisation on muscle activity, this study investigated the effect of lumbar PA mobilisation on paraspinal sEMG of asymptomatic subjects. The lack of information in the literature concerning the effect of central lumbar posteroanterior mobilisation on the surrounding musculature led to the a non-directional experimental hypothesis (Hicks, 1995; Jenkins et al., 1998) that there would be a change in the magnitude of resting sEMG activity in standing before and after the application of central lumbar posteroanterior pressures.

2. Methods

A condition randomised, placebo controlled, repeated measures design was used to identify the differences in the magnitude of sEMG activity of the lumbar and thoracic section of the erector spinae musculature of healthy subjects after applying central posteroanterior (PA) mobilisation to L3. The L3 level was selected because of its approximate central position in the lumbar lordosis which suggests that a posteroanteriorly directed force would mainly translate the vertebra anteriorly (Harms and Bader, 1997; Lee et al., 1990). Ethical approval was obtained from the University of Brighton Ethics Committee and all subjects gave informed consent.

2.1. Subjects

Thirty-six subjects, 10 male and 26 female aged between 18 and 48 years (mean 26.8 SD 7.1) participated in the study. Subjects were included if they were non-disabled, had a body mass index (BMI) less than 28 kg/m^2 and their age was between 18 and 65 years. The BMI limit was chosen to obtain comparable thickness of subcutaneous tissues between subjects (Lariviere et al., 2000) in order to enhance the accuracy of sEMG amplitude recordings (DeLuca, 1997; Ferdjallah and Wertsch, 1998). The upper age limit was chosen because of the decrease in skin conductivity with age (Hodges and Bui, 1996), which may have interfered with sEMG recordings. Exclusion criteria were history of low back pain within 6 months prior of the study, history of lumbar spine surgery, osteoporosis, rheumatoid arthritis, lower limb neurological signs and spondylolisthesis.

2.2. Instrumentation, procedure and measurements

With the subject lying prone on an adjustable plinth the researcher palpated and marked the spinous process of L5, L3 and T10. In an attempt to enhance the reliability and validity of palpation (Binkley et al., 1995; McKenzie and Taylor, 1997; Newton and Waddell, 1991), levels were cross-checked in three different ways: finding T12 by following the last rib, finding L4 from the level of the iliac crests and finding L5 by following the sacrum (Oliver and Middleditch, 1991).

The area to the left of each of the marked locations was cleaned with isopropyl alcohol and shaved if necessary, in preparation for the electrode attachment. The active bipolar electrodes (Biometrics SX-230, Biometrics Ltd., Gwent) were attached longitudinally to the skin overlying the belly of the left erector spinae, 3.5 cm laterally of the midline next to the marked levels (Stokes et al., 2003; Wolf et al., 1991). The ground-reference electrode was placed around the subject's left hand. Since the sEMG amplitude is not significantly different between left and right sides on healthy individuals (Lariviere et al., 2000; Mannion et al., 1997) and because the vertebrae move mainly in the sagittal plane during central posteroanterior mobilisation (Lee and Evans, 1997; Powers et al., 2003), it was not deemed necessary to apply electrodes bilaterally.

Electrodes were placed at L5, L3 and T10 to sample sEMG of erector spinae. Altered muscle activity was expected to occur at