Journal of Bodywork & Movement Therapies 21 (2017) 495–502

Contents lists available at ScienceDirect

Journal of Bodywork & Movement Therapies

journal homepage: www.elsevier.com/jbmt

EXPERIMENTAL, RANDOMIZED CROSS-OVER STUDY

# Acute electromyographic responses of deep thoracic paraspinal muscles to spinal manual therapy interventions. An experimental, randomized cross-over study

Gary Fryer, B.Sc(Osteopathy), PhD. Associate Professor [a, b, *], Michael Bird, PhD. [c], Barry Robbins, D.O. [d], Jane C. Johnson, M.A. [a]

[a] *A.T. Still Research Institute, A.T. Still University, Kirksville, MO, USA*
[b] *College of Health and Biomedicine, Victoria University, Melbourne, Australia*
[c] *Department of Health and Exercise Sciences, Truman State University, Kirksville, MO, USA*
[d] *Department of Neurobehavioral Sciences, Kirksville College of Osteopathic Medicine, A.T. Still University, Kirksville, MO, USA*

ARTICLE INFO

*Article history:*
Received 16 November 2016
Received in revised form
24 April 2017
Accepted 25 April 2017

*Keywords:*
Electromyographic
Spinal manipulation
Paraspinal muscles

ABSTRACT

This single group, randomized, cross-over study explored whether manual therapy alters motor tone of deep thoracic back muscles by examining resting electromyographic activity (EMG) after 2 types of manual therapy and a sham control intervention. Twenty-two participants with thoracic spinal pain (15 females, 7 males, mean age 28.1 ± 6.4 years) had dual fine-wire, intramuscular electrodes inserted into deep transversospinalis muscles at a thoracic level where tissues appeared abnormal to palpation (AbP) and at 2 sites above and below normal and non-tender to palpation (NT). A surface electrode was on the contralateral paraspinal mass at the level of AbP. EMG signals were recorded for resting prone, two 3-s free neck extension efforts, two 3-s resisted maximal voluntary isometric contractions (MVIC), and resting prone before the intervention. Randomized spinal manipulation, counterstrain, or sham manipulation was delivered and EMG re-measured. Participants returned 1 and 2 weeks later for the remaining 2 treatments. Reductions in resting EMG followed counterstrain in AbP (median decrease 3.3%, $P = 0.01$) and NT sites (median decrease 1.0%, $P = 0.05$) and for the surface electrode site (median decrease 2.0%, $P = 0.009$). Reduction in EMG following counterstrain during free neck extension was found for the surface electrode site (median decrease 2.7%, $P < 0.01$). Spinal manipulation produced no change in EMG, whereas counterstrain technique produced small significant reductions in paraspinal muscle activity during prone resting and free neck extension conditions. The clinical relevance of these changes is unclear.



## 1. Background

For practitioners of manual medicine, palpation of soft tissue texture, subtle joint motion, and tissue tenderness are important components for the assessment of spinal segmental joint dysfunction (Greenman, 2003). Further, the tissue texture abnormality of spinal segmental dysfunction has been claimed to be palpable as hypertonicity in the deep muscles of the medial, paravertebral groove or ‘gutter’ (Chaitow, 2003; Greenman, 2003; Isaacs and Bookhout, 2001). The cause of this palpable tissue texture change in these deep tissues has been proposed as abnormal contraction of the deep fourth layer paraspinal muscles, particularly rotatores and multifidus muscles (Chaitow, 2003; Greenman, 2003; Isaacs and Bookhout, 2001). Abnormal contraction of these deep muscles is also claimed to disturb motion at that segment (Chaitow, 2003; Denslow et al., 1947; Greenman, 2003; Isaacs and Bookhout, 2001).

In the 1940s, Denslow, Korr, and colleagues investigated paraspinal muscles using needle electromyography (EMG) and reported increased segmental muscle activity at spinal levels associated with clinically detected segmental dysfunctions (Denslow and Clough, 1941; Denslow et al., 1947). Although the concept of muscle contraction as a cause of paraspinal tissue hardness remains

* Corresponding author. College of Health and Biomedicine, Victoria University, PO Box 14428 MCMC, Melbourne, 8001. Australia.
*E-mail addresses:* gary.fryer@vu.edu.au (G. Fryer), mbird@truman.edu (M. Bird), grobbins@atsu.edu (B. Robbins), jjohnson@atsu.edu (J.C. Johnson).

http://dx.doi.org/10.1016/j.jbmt.2017.04.011
1360-8592/

popular, recent research using intramuscular fine-wire EMG of the deep thoracic paraspinal muscles failed to find evidence of abnormal activity in regions detected as tender and abnormal to palpation within the paravertebral gutter (Fryer et al., 2010a). Low-level resting EMG activity of the deep musculature appears to be highly variable between individuals.

Manual therapy techniques, such as spinal manipulation, have been proposed to 'reset' the resting tone of muscles associated with palpable tissue texture and tenderness (Korr, 1975). Spinal manipulation is one of a large range of manual techniques commonly used by osteopaths, chiropractors and other manual therapists to treat musculoskeletal conditions involving tissue texture tenderness and palpable abnormalities (Fryer et al 2009, 2010b). It involves the use of a high-velocity, low-amplitude thrust to mobilize and cavitate a spinal joint, often producing an audible click or pop (Gibbons and Tehan, 2008; Greenman, 2003). Counterstrain is a commonly used non-thrust manual technique which involves passively shortening a tissue until pain and palpated tenderness are reduced and holding that position for 90 s or until tissue relaxation (Friedman et al., 2000).

Some studies have suggested that spinal manipulation produces a decrease in resting paraspinal EMG activity (Lehman, 2012), but the evidence is inconclusive because of conflicting results, lack of controls, or poorly described methods and data (Fryer et al., 2004a). Most studies examining the effect of manipulation on EMG have used surface EMG techniques. Surface EMG is non-invasive and suitable to examine superficial muscles, but not the deeper musculature. Few studies have examined the response of deeper paraspinal muscles to spinal manipulation or other manual techniques using needle or indwelling electrodes.

The current study was designed to determine whether there were immediate changes in EMG activity of deep thoracic paraspinal muscles following spinal manipulation during resting and active conditions. Evidence of muscle relaxation following manipulation would implicate the deep paraspinal muscles as having a role in the reported changes to segmental tissue texture and motion following manual therapy. Additionally, this study aimed to compare the effect of spinal manipulation with a non-thrust manual technique, counterstrain. It is possible that different manual techniques have different effects on the resting tone of paraspinal muscles. The paraspinal sites chosen for investigation were based on palpatory findings, because authors of manual therapy texts (Chaitow, 2003; Greenman, 2003; Isaacs and Bookhout, 2001) claim that abnormally hard, tense, and tender tissues represent contracted deep muscles and some studies reported relaxation when areas of superficial tense musculature were investigated (Lehman, 2012). The change in activity at the palpated target site was compared to changes at normal to palpation sites above and below the target site. Both spinal manipulation and counterstrain technique were hypothesized to produce a reduction of EMG activity in the deep thoracic paraspinal muscles at rest and the change in EMG would be greatest at the target site compared to adjacent sites.

## 2. Methods

### 2.1. Participants

The current study was a single group, randomized, cross-over design. Participants were recruited from the student and employee population at A.T. Still University and Truman State University in Kirksville, Missouri, USA, over a 3-month period. There was little evidence available on which to base the calculation of effect sizes and power and study samples for this study. Due to the expense and invasiveness of intramuscular procedures, studies that have examined the multifidus muscle using intramuscular electrodes have used small sample sizes (Andersson et al., 2002; Hodges et al., 2003; Hodges and Richardson, 1997; Moseley et al., 2002). Based on a medium effect size, $\alpha$ at 0.05, within-subject correlation of at least 0.60, and analysis with ANOVA or non-parametric equivalent, 25 participants would provide 80% power for the study.

Participants were included if they presented with pain in the thoracic region (>3 on a numerical scale of 0–10), had pain for 5 of 7 days during the preceding 2 weeks, had a site in the thoracic region that was tender and abnormal to palpation, had a body mass index less than 30, and were aged between 18 and 50 years. Symptomatic participants were included for better generalisability to patients seen in practice and provided a greater likelihood that the palpatory findings may be clinically relevant.

Participants were excluded if the examiner could not identify an abnormal site, the participant received thoracic spinal manipulation in the last 7 days, or there were medical conditions prohibiting fine-wire EMG testing, such as abnormal blood pressure, postural hypotension, medical blood disorders, needle phobia, syncopal attacks, pregnancy, or skin conditions and sensitivity to adhesives. Participants over 50 years were excluded to avoid the possible influence of spinal degenerative joint disease.

Procedures were approved by the A.T. Still University-Kirksville Institutional Review Board and all participants provided informed consent. The research was conducted on the A.T. Still University-Kirksville campus.

### 2.2. Electromyography

Disposable, paired hook-wire electrodes (44 gauge, insulated nickel alloy wire, Viasys, Neurocare, USA) were used for intramuscular EMG data. Electrodes were inserted using 30 mm (27 gauge) and 50 mm (25 gauge) hypodermic needles by a medical practitioner with extensive experience in EMG and insertion of intramuscular electrodes (B.R.). Wires were stripped of insulation for 2 mm at their terminal ends; 2 mm of one wire and 5 mm of the other extended from the tip of the needle. During preliminary testing before the main study, the optimal site of needle insertion and orientation was determined by varying the insertion site medially and laterally, and the needle placement within the deep transversospinalis musculature was confirmed using diagnostic ultrasound (Phillips iU22, Netherlands). Using a medial insertion location approximately 2 cm lateral to the midline spinous process and directing the needle anteriorly and slightly medially (Chiodo et al., 2006; Kim et al., 2005), the needle was inserted in the deep transversospinalis muscles (multifidus and rotatores). The deep thoracic multifidus and rotatores cannot be distinguished by ultrasonography, so activity was likely recorded from both muscles (Lee et al., 2005).

The skin around the marked regions (see below) of each participant was swabbed with alcohol, and surface electrode sites were abraded and swabbed. Electrodes were inserted at marked sites until the needle met the resistance of the lamina. The needle was withdrawn, leaving the electrode in situ. Spring-coil connector leads were attached to the free wires, and the leads were taped to the participant's back, keeping a loop of approximately 5 cm free for movement. The skin was abraded and swabbed with alcohol for attachment of the adhesive dual surface electrodes (Ag/AgCl, Noraxon, USA). A surface reference electrode was connected to the participant's acromion process on the same side as the other electrodes (Fig. 1).

EMG data was collected at 2000 Hz using a TeleMyo 2400G2 wireless telemetry EMG system with pre-amplified leads (Noraxon, USA) and was processed using MyoResearch XP Master Edition