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The acute effects of spinal manipulation on neuromuscular function in asymptomatic individuals: A preliminary study

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ABSTRACT

Objectives: To analyse the acute effects of spinal manipulation on neuromuscular function in asymptomatic individuals.
Design: Randomised controlled, cross-over trial.
Settings: Spinal manipulation (SM) is used as therapeutic modality for various neuromuscular disorders and also in sport with asymptomatic individuals to improve range of motion and/or facilitate motor control. Experimental evidence of its effectiveness is lacking.
Participants: 27 asymptomatic participants (15 males and 12 females) [age (mean ± standard deviation) 24 ± 3 years] were exposed to three separate treatments in random order: 1) Spinal Manipulation of the lumbar spine (MAN); 2) Stretching of the Lumbar spine (STR); 3) sham manipulation (SHA).
Main outcome measures: Before (PRE), after (POST) and 15 min after (15_MIN) each treatment, the participants were asked to perform three tasks always in the same order: 1) force fluctuation task; 2) Modified Sörensen's test; 3) sit and reach. Surface EMG was recorded from Gastrocnemius medialis and Erector Spinae muscles using linear arrays during task 1 and 2.
Results: MAN was not shown to determine improvements superior to other treatments in the control of force output and sEMG parameters.
Conclusions: Studies with larger populations are needed in order to ascertain the effectiveness of SM on neuromuscular function.

1. Introduction

Spinal manipulative therapies (Spinal Manipulation [SM] and Spinal Mobilisation [SMob]) have been used over the years as an alternative therapeutic approach to help patients with acute low back pain (LBP), neck pain and other neuromuscular disorders. In particular, SM has also extended to athletes to favour recovery, improve performance and/or as a treatment for acute and chronic muscle pain (George & Delitto, 2002; Haldeman, 1986; Shrier, Macdonald, & Uchacz, 2006). Spinal manipulation is characterised by mechanical inputs applied to tissues in the vertebral column. A cracking or popping sound usually accompanies the manipulation due to the fluid cavitation caused by gapping the joint (Cascioli, Corr, & Till, 2003; Evans, 2002; Haas, 1990). The consequences of this manipulative input are not only mechanical. In fact, some studies have suggested the possibility of acute alterations in motoneuron pool activity following spinal manipulation in asymptomatic individuals (Dishman & Bulbulian, 2000, 2001; Dishman, Greco, & Burke, 2008). Due to the potential for such therapeutic techniques to acutely influence neuromuscular function, most applications have been focused on using it as a non-pharmacological treatment for pain. However, consensus on its effectiveness is controversial and studies directed to improve the understanding of the neurophysiological effects of SM recruiting asymptomatic individuals are lacking.

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To our knowledge, only one study has investigated the influence of SM on voluntary contractions. Keller and Colloca (Keller & Colloca, 2000) assessed the influence of SM on erector spinae's surface EMG (sEMG) during a maximal isometric back extension (MVC) in participants with low back pain. SM determined a mean increase of 21% in sEMG amplitude during MVC, which the authors attributed to an acute increase in the excitability of the alpha motoneuron pool and the inhibition of nociception.

SM has also been suggested to affect neural outputs to muscles related to the manipulated section of the spine due to the acute alterations in motoneuronal excitability caused by the spinal thrust. Suter, McMorland, Herzog, and Bray (1999, 2000) showed that sacroiliac SM determines a decrease in muscle inhibition and increase in knee extensor strength, especially in the leg ipsilateral to SM in patients with anterior knee pain. Grindstaff et al. (Grindstaff, Hertel, Beazell, Magrum, & Ingersoll, 2009) showed a significant increase in quadriceps force immediately following SM in healthy individuals. Smith et al. (Smith, Dainoff, & Smith, 2006) investigated difficulty tasks related to Fitt's law (Fitts, 1992) and concluded that SM can elicit immediate changes in coordinated motor performance in patients with pain. Despite these promising results, recent work has also suggested a lack of evidence for manipulative therapy to enhance exercise performance (Ward, Coats, Ramcharan, Humphries, Tong, & Chu, 2012) and/or improve strength and basketball throws accuracy (Humphries, Ward, Coats, Nobert, Amonette, & Dyess, 2013). Furthermore, there seems to be no acute influence of SM on (Grindstaff et al., 2014) quadriceps spinal reflex excitability in asymptomathic subjects, putting into question some of the neurophysiological mechanisms hypothesised to be responsible for pain reduction with SM.

The use of motor tasks involving the production of constant levels of force has been utilised as a model to study various aspects of motor control (Taylor, Christou, & Enoka, 2003). The extent of the variability in maintaining the force target has been regarded as a measure of unsteadiness in motor control output and related to motor unit activity of the involved muscle groups. Since motor unit activity is controlled by the neural inputs to the α-motoneuron pool in the spinal cord (Taylor et al., 2003; Tracy, Maluf, Stephenson, Hunter, & Enoka, 2005), the potential effect of afferent input to the force fluctuations has been postulated and recent evidence (Yoshitake, Shinohara, Kouzaki, & Fukunaga, 2004) has suggested that Ia afferent inputs contribute to the low-frequency force fluctuations in plantar flexion. Therefore, if SM is capable of acutely altering neuromuscular excitability in muscles affected by the SM procedure one should expect to observe an improvement in controlling force output.

Consensus on the clinical effectiveness of SM is far from being defined. Michaleff, Lin, Maher, & van Tulder (2012) suggested SM to be a cost-effective treatment to manage spinal pain and recent work suggested beneficial effects larger than conventional anti-inflammatory therapy (Von Heymann, Schloemer, Timm, & Muehlbauer, 2012). This despite systematic reviews suggesting some beneficial effects (Goertz, Pohlman, Vining, Brantingham, & Long, 2012) of SM on pain. The uncertainty over the clinical effectiveness of SM is accompanied by a paucity of well-controlled studies on the acute and chronic physiological consequences of this therapeutic modality.

Hence, the aim of this preliminary study was to analyse, in healthy asymptomatic participants, the acute effects of SM on: 1) force fluctuation and muscle activation of the leg neurologically related to the site of SM; 2) spine and lower limbs range of motion (ROM). It was hypothesised that SM could acutely improve muscle activation, reduce the variability in producing force in an isometric task and improve ROM.

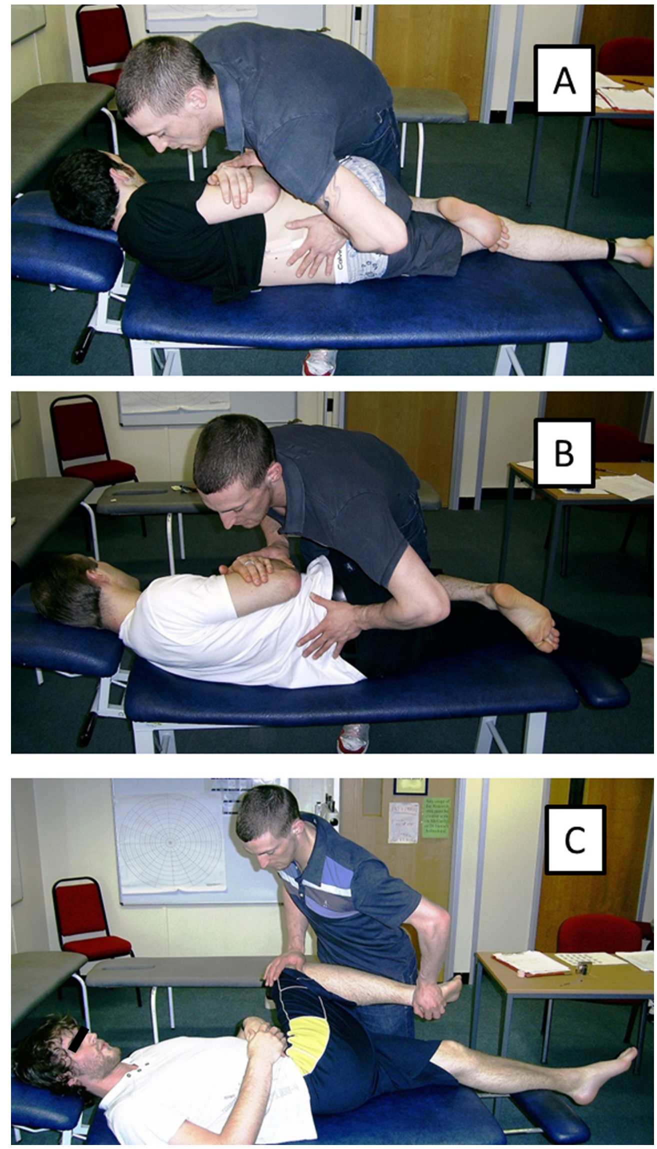

Fig. 1. Picture of the 3 treatments employed in the study. A = Spinal Manipulation [SM]; B = Sham [SHA]; C = Stretching [STR].

2. Methods

2.1. Study design

A randomised controlled-cross over design was adopted. 27 participants (15 males and 12 females) [age (mean ± standard deviation) 24 ± 3 years, BMI 23.6 ± 2.5 kg/m] were recruited and voluntarily participated in the study signing an informed consent. Sample size was determined based on repeatability data from Rainoldi, Galardi, Maderna, Comi, Lo Conte, & Merletti (1999) and assuming a medium effect size (f = 0.25), a power of 0.90 and $\alpha = 0.05$. The study was approved by the Harrow Ethics Committee (reference number: 09/H0709/16). The participants were asked to report to the laboratory on four separate occasions: the first time for a familiarisation trial of the plantar flexion procedure and the three subsequent times to undergo the three different treatments in a randomised order. The three treatments were: 1) Spinal Manipulation of the lumbar spine (MAN); 2) Stretching of the Lumbar spine (STR); 3) sham manipulation (SHA). All treatments