Does a single thrust manipulation of the upper thoracic spine increase neck range of motion?

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Declaration

Name of candidate: *Lyndal Sharples*

This Research Project is submitted in partial fulfilment for the requirements for the Unitec degree of Masters of Osteopathy

Candidate's Declaration

I confirm that:

- This Research Project represents my own work;
- The contribution of supervisors and others to this work was consistent with the Unitec Regulations and Policies.
- Research for this work has been conducted in accordance with the Unitec Research Ethics Committee Policy and Procedures, and has fulfilled any requirements set for this project by the Unitec Research Ethics Committee.

  Research Ethics Committee Approval Number: 2009.964

Candidate Signature: Date:

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Preface

This research project is divided into three sections. Section 1 consists of a Literature Review that firstly examines the importance of neck range of motion and the influence of somatic dysfunction in regards to cervical mobility. The biomechanical link between thoracic and cervical spine and literature supporting the methods used in the current study is then presented. Section 2 is a manuscript for a research report that has been formatted in accordance with *Manual Therapy* submission requirements. Note the manuscript uses the *Manual Therapy* style of referencing as stipulated by the publisher. Section 3 of the dissertation is an appendix containing tables and figures not included in the journal manuscript as well as the documentation of ethics approval.

Section 1: Literature Review

Introduction

Neck pain is a common condition affecting as much as two-thirds or more of the general population at one point during their life (Fejer, Kyvik, & Hartvigsen, 2004). Patients with mechanical neck pain[1] frequently present in manual therapy practices as it is the most common cause of neck pain and the second most common reason for which patients seek manual medical treatment (Fejer, Kyvik, & Hartvigsen, 2006).

Somatic dysfunctions of the upper thoracic spine may be a cause or contributor to mechanical neck pain. Somatic dysfunction is defined as an impaired or altered function to tissues of the musculoskeletal system and related vascular and neurological components, amenable to osteopathic manipulation (Stone, 1999; Ward, 2003). Somatic dysfunction of the cervical region of the spine often results in increased muscle tension, sensitivity changes, asymmetry, and restriction of range of motion (Burns & Wells, 2006). Early research investigated that reduced mobility at the cervical-thoracic junction has been shown to be a risk factor for neck pain (Norlander, Aste-Norlander, Nordgren, & Sahlstedt, 1996; Norlander, Gustavsson, Lindell, & Nordgren, 1997). Following on from these early studies, evidence has recently begun to emerge for the use of manual techniques concentrated at thoracic spine somatic dysfunctions for patients with mechanical neck pain (Cleland, 2007a; Cleland, Childs, McRae, Palmer, & Stowell, 2005; Cleland, Flynn, Child, & Eberhart, 2007b; Cleland, 2007c; Fernandez, Fernandez-Carnero, Fernandez, Lomas-Vega, & Miangolarra-Page, 2004; Fernández, Palomeque-del-Cerro, Rodríguez-Blanco, Gómez-Conesa, & Miangolarra-Page, 2007; Gonza´ lez-Iglesias et al., 2008; González-Iglesias, Fernández-de-las-Peñas, Cleland, &

[1] Mechanical neck pain may be 'non-specific' neck pain including minor injuries or sprains to muscles or ligaments in the neck. (N Bogduk, 1984)

Gutiérrez-Vega, 2009; Krauss, Creighton, Jonathan, & Podlewska-Ely, 2008). These studies have focused on the biomechanical relationship between the thoracic and cervical spine, considering both anatomical and neural connections to increase evidence to support thoracic thrust techniques.

For patients with neck complaints it is common practice for manual medicine practitioners to use manipulative treatment, including spinal joint thrust manipulation, to treat somatic dysfunction. The aim of manipulation is typically to reduce pain and increase cervical mobility (Flynn, Wainner, Whitman, & Childs, 2004; Gross, 2002; Howing, 2001). Based on these early studies, it is likely that a high velocity/low amplitude (HVLA) directed at thoracic spine somatic dysfunctions may have beneficial biomechanical effects on the cervical spine by decreasing mechanical stress and consequently increasing range of motion.

The purpose of this review is to highlight current knowledge of: somatic dysfunction evaluation; neck range of motion; the anatomical relationship between upper thoracic and cervical spine; and to present findings from thoracic spinal thrust manipulation studies.

Literature search

A review of literature was completed that investigated outcome measures and interventions similar to this study. A comprehensive literature search using electronic databases including Science Direct, Ebsco, PEDro, Scopus, Academic Search Premier and the Medline databases was undertaken to identify literature relating to neck range of motion, thoracic manipulation, and somatic dysfunction. Results and discussions from these studies are presented below.

Neck Pain

Anatomical borders

A description of the anatomical regions and borders of neck pain are as follows: "Neck pain or cervical pain is perceived as arising from an area bounded superiorly by the superior nuchal line, inferiorly by the tip of the spinous process of the first thoracic vertebrae, and laterally by the lateral borders of the neck". Cervical pain has been further subdivided in upper cervical, lower cervical and suboccipital pain (Merskey & Bogduk, 1994).

Definition

Neck pain (or cervicalgia) is a common problem, with two-thirds of the population having neck pain at some point in their lives. The International Association for the Study of Pain (IASP) defines pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage". This often quoted definition was first published in 1979 by IASP (Pain, 1979), but is derived from a definition of pain given earlier by pain specialist Professor Harold Merskey: "An unpleasant experience that we primarily associate with tissue damage or describe in terms of tissue damage or both"(Merskey, 1964; Merskey & Bogduk, 1994).

Mechanical neck pain was defined as nonspecific pain including minor injuries or sprains to muscles or ligaments in the neck that is exacerbated by neck movements (Bogduk, 1984; Childs, Whitman, Fritz, Piva, & Young, 2003)

Pain is a perception, and a sensation; it involves sensitivity to chemical changes in the tissues and then interpretation that such changes are harmful. Pain is also said to be subjective, which arises because each individual learns the sensation of pain through their own experiences related to injuries in earlier life. Injuries have been associated with unpleasant experiences and therefore are also emotional (Merskey & Bogduk, 1994).

Causes

Conditions to cause neck pain may comprise those of an inflammatory, infectious, neoplastic, degenerative, vascular or endocrinal nature. Dysfunctions that may cause neck pain may involve zygapophysial joint irritation, traumatic injuries to the cervical spine and cervical disc disease such as disc herniation, which may irritate the nerve root by mechanical and biochemical stimuli (Binder, 2007; Bogduk, 1984, 2000). Nerve fibers and endings can be found in cervical structures including ligaments, muscles, vertebrae periosteum and even deep in the annulus fibrosus and nucleus. All of these structures offer a possible mechanism for nociception pulposus (Freemont et al., 1997)

Prevalence

The six month prevalence for neck or back pain in New Zealand from 755,100 participants was 24.2% (95% Confidence Interval = 23.2 to 25.2: Males 23.1%, 21.6 to 24.6%; and females 21.3%, 20.3 to 22.4%) (New Zealand Ministry of Health, 2008). The New Zealand statistic is similar to estimates of the world mean six month neck pain prevalence of 29.8% of the general population (Fejer et al., 2006). Another six month study was completed by Coté, Cassidy et al., in 1998 that reported 66% of adults experienced neck pain at some point in their lifetimes, with 54% in the recent six month period. This study was a large population-specific study of 1133 people in Canada with the conclusion of a reported point prevalence of neck pain that varies between 9.5–35%(Coté, Cassidy, & Carroll, 1998). Also in Canada, research completed in 1994 found 30% of chiropractic referrals were for neck pain (Waalen, White, & Waalen, 1994). Additionally a 12-month prevalence for neck pain ranges from 30–

50% of the general population (Hogg-Johnson, Van der Velde, & Carroll, 2008). In comparison a short two week survey was conducted more recently (Fejer & Hartvigsen, 2008) and reported that of the 4146 people aged 20-71 examined from Denmark, 35.5% females and 26% suffered neck pain. After lumbar spine-related diagnoses at 19%, cervical spine diagnoses were the second most common reason for referral at 16% in a US study on outpatient physical therapy (Boissonnault, 1999). These estimates demonstrate that neck pain is a constant problem for a substantial portion of the population.

Biomechanical connection of Thoracic and Cervical spine

Neck pain, although felt in the neck, can be caused by numerous other spinal issues. Neck pain may arise due to muscular tightness in either the neck and upper back, or pinching of the nerves originating from the cervical vertebrae or commonly from joint disruption in the upper back (Binder, 2007; Bogduk, 2000; Bogduk & Teasell, 2000). The head is supported by the lower neck and upper back, and it is these areas that commonly cause neck pain.

The cervical spine can be divided into four units, each with a unique morphology that determines its kinematics and its contribution to the functions of the complete cervical spine. In anatomical terms the units are the atlas, the axis, the C2–3 junction, and the remaining, typical cervical vertebra (C4-7). In metaphorical functional terms these can be perceived as the cradle, the axis, the root, and the column (Bogduk , 2000). The top three joints in the neck allow for most movements of the neck and head. The lower joints in the neck and those of the upper back create a supportive structure for the head to sit. If this support system is affected adversely then the muscles in the area may be impaired, leading to neck pain (Bogduk, 1984; Bogduk , 2000; Ward, 2003).

The vertebral bodies of T1-T4 are similar to that of the cervical vertebra, specifically T1, being broad transversely, its upper surface concave, and lipped on either side (Pal, Routal, & Sagom, 2001; Panjabi et al., 1993). The spinous processes are also similar to the cervical spine because they are thick and long and almost horizontal compared to rest of the thoracic spinous process that are directed obliquely and inferiorly. The orientation of the articular facets of the zygapophyseal joints at the cervical and upper thoracic region are very similar and from C4/5 facet joint to T3/4 facet joint the orientation of the superior articular facets face posterolateral in relation to the sagittal plane (Pal et al., 2001; Panjabi et al., 1993). The similarity in anatomical structure between the cervical and upper thoracic spine implies that the functions subserved are similar.

There are a variety of opinions on what constitutes normal movement and satisfactory posture and how activity and movement varies in parts of the body affect the function and structure of other parts (Bogduk , 2000; Stone, 1999; Triano, 2001). Due to the strong biomechanical, anatomical and nerve connection between the cervical and thoracic spine the presence of somatic dysfunctions and decreased mobility of the thoracic spine may impair and limit the function of the cervical spine and may be associated with the development of mechanical neck pain (Greenman, 1996; Maitland, Hengeveld, Banks, 2000). For these reasons it is likely that the thrust manipulation treatment focused on the thoracic spine will have a clinically beneficial biomechanical effect on the cervical spine (Fernandez-de-la-Peñas , 2004; Fernández-de-las-Peñas , 2007; Norlander , 1996; Norlander et al., 1997).

Range of motion

Cervical motion measures provide substantial information regarding the severity of motion limitation and level of effort in neck disability patients. Clinical evaluation of range of motion is a fundamental diagnostic procedure in all forms of manual medicine. Range of motion is the distance and direction of movement of a joint or series of joints (Bogduk, 2000; Ferrario, Sforza, Serrao, Grassi, & Mossi, 2002). Limited range of motion describes a specific joint or body part that cannot move through its normal range of motion. This motion may be limited by a mechanical problem within the joint, by swelling of tissue around the joint, by stiffness of the muscles or by pain (Stone, 1999; Ward, 2003). Passive range of motion is where another person, such as a caregiver or therapist moves the joint whereas active (or manual) range of motion involves the individual moving the joint themselves.

Measurement of cervical motion is probably the most commonly applied functional outcome measure in assessing the status of patients with cervical pathology. Several authors advocate the importance of adequate range of motion within the spine and joints throughout the body for prevention of pain and injury (Bogduk , 2000; Fernández et al., 2007; Krauss et al., 2008; Stone, 1999; Ward, 1996). Multiple techniques and instruments have been used for assessing cervical range of motion. These techniques were associated with a wide variety of parameters relating to accuracy, reproducibility, and validity. Measurement systems enable recording, processing, and documentation of cervical range of motion with a high degree of precision (Tamara & Zeevi, 2008). Used in conjunction with muscle pain charts, ROM evaluation allows a clinician to distinguish overlapping pain patterns, locate areas of musculoskeletal dysfunction, and differentiate between symptoms in individual muscles (Fernández-de-las-Peñas , 2007). Active and passive cervical motion provide important findings for the manual therapists regarding the patient’s condition and is also used as a pre- and post-test clinically to assess treatment outcomes.

Definition and diagnosis of somatic dysfunction

Cervical-thoracic and upper thoracic somatic dysfunctions have commonly been associated with neck pain and restricted neck range of motion. Somatic dysfunctions have been described as "impaired or altered function of related components of the somatic (body framework) system: skeletal, arthrodial, and myofascial structures, and related vascular, lymphatic, and neural elements, amenable to osteopathic manipulation" (Ward, 2003). It has been theorised that spinal segmental somatic dysfunction can create or maintain a symptomatic reaction from an adjacent restricted spinal segment (Kaltenborn, 1993). It is theorised this could be due to the strong biomechanical connection between the cervical and thoracic spine, considering both the anatomical and neural connections (Greenman, 1996; Maitland et al., 2000)

Manual therapy manipulative medicine expands differential diagnoses by allowing the physician to consider somatic dysfunction. Physical examination of patients is usually completed in relation to the osteopathic model of somatic dysfunction (Bogduk, 1984;Dinnar, Goodridge, Johnston, Karni, Mitchell et al., 1982; Dinnar , Goodridge, Johnston, Karni , Mitchell et al. , 1980; Greenman, 1996; Kuchera & Kappler, 2002; Stone, 1999). These diagnostic criteria for somatic dysfunction include a focus on tissue texture abnormalities such as changes in stability, laxity, effusions and tone; asymmetry and misalignment of bony landmarks; restriction of and change in ROM or contractures; and temperature changes, tenderness, pain and soreness in the anatomical regions (Stone, 1999; Ward, 2003; Ward, 1996).

Establishing reliable[2] palpatory tests for assessment of somatic dysfunctions continues to be a critical, yet elusive, step in osteopathic medical research and evidence-based clinical practice. Because various kinds of palpatory tests are used in patient care within the osteopathic and allopathic medical professions, as well as in chiropractic care and physical therapy, reliability is an important issue for healthcare professionals. For palpatory tests, two forms of reliability are routinely studied: intraobserver reliability and interobserver reliability. Intraobserver reliability assesses the ability of a healthcare professional to obtain the same finding when serially evaluating a patient. This form of reliability has been criticized as lacking in credibility, mostly because of the difficulties in blinding an examiner between examinations (Degenhodt, Snider, Snider, & Johnson, 2005; Haas, 1991). Interobserver reliability, the degree to which multiple examiners reach the same conclusion, is considered more relevant than intraobserver reliability in assessing practitioner skill (Degenhodt et al., 2005; Haas, 1991).

Joint thrust manipulations of somatic dysfunction findings are often included in the management of neck complaints by several manual therapists for pain relief and increasing cervical mobility (Gross, 2002; Howing, 2001). Thrust manipulation of the somatic dysfunctions found can influence patients through pain reduction; increased ROM; enhanced ability of ease of movement; increased blood flow; and may also improve neurovascular and lymphatic function (Bogduk, 2000; Stone, 1999; Ward, 1996).

[2] Reliability is defined as the reproducibility of findings when a test is repeated to evaluate an unchanged attribute (Haas, 1991)

Thoracic spinal thrust manipulations

The thoracic spine is the most often manipulated region of the spine clincally and therefore an important area to investigate (Kjellman, Skargren, & Oberg, 1999). Even though the HVLA technique is accepted and widely used in practice by manual therapist for neck pain there is a lack of enough sufficient evidence to support therapeutic benefit for clinical use (Hoving et al., 2001; Kjellman et al., 1999).

In one clinical practice approximately 37% (n=118) of manual medical practitioners commonly use manipulation and/or mobilization treatments to the cervical spine in patients with neck pain (Hurley, Yardley, Gross, Hendry, & McLaughlin, 2002). The effectiveness of these treatments in patients with neck pain has been supported by a number of randomized clinical trials (Bronfort et al., 2001b; Cassidy, Lopes, & Yong-Hing, 1992; Hoving et al., 2001; Martínez-Segura, 2006), and systematic reviews (Bronfort, Assendelft, Evans, Haas, & Bouter, 2001a; Gross et al., 2002a; Gross et al., 2002b) indicating both manipulation and mobilisation are effective forms of treatments. However the benefits of treatments directed to the cervical spine must be considered in the context of potential risks: i.e. serious complications such as vertebrobasilar artery occlusion, which can possibly lead to brain stem, cerebellar ischemia and infarction (DiFabio, 1999; DiFabio & Bolssonnault, 1998; Haldeman, Kohlbeck, & McGregor, 1999; Haldeman, Kohlbeck, & McGregor, 2002a, 2002b). Additonally, studies have failed to substantiate the ability of currently available screening procedures to identify at-risk patients prior to treatment (DiFabio, 1999). In one survey of physical therapists in Canada, 88% of 118 respondents agreed that all available screening tests should be completed prior to cervical manipulation (Hurley et al., 2002), highlighting the reality that manual medical practitioners are concerned about the potential risks. Experienced practitioners have suggested that a thorough examination of the thoracic spine be included in the evaluation of patients with primary complaints of neck pain (Greenman, 1996; Porterfield & DeRosa, 1995). Considering these concerns the use of thoracic spine manipulation interventions instead of direct manipulation of the cervical spine, may avoid these risks while achieving similar therapeutic benefits (Erhard & Piva, 2000).

Thoracic spinal “thrust technique” is a direct method of a manipulation treatment that uses high velocity/low amplitude (HVLA) activation to move a joint that is exhibiting somatic dysfunction through its restrictive barrier so that when the joint resets itself, appropriate physiologic motion is restored (Greenman, 1996; Ward, 2003). An HVLA manipulation involves a quick thrust over a short distance through what is termed a pathologic barrier. The movement is within a joint's normal ROM and does not exceed the anatomic barrier or ROM. With proper positioning of the patient, HVLA requires very little force and can be specifically targeted to spinal segments. The goal of the treatment is restoration of joint play or a desirable gap between articulating surfaces (Stone, 1999; Ward, 2003; Ward, 1996).

This technique is an effective method of restoring joint motion with minimal risk of symptom exacerbation (Kuchera & Kappler, 2002; Ward, 2003). There are various theories of how a thrust manipulation will create an effect. Ledermam (1997) proposes a physiological model for the effects of manipulation. This model can be adapted to provide three categories of indications for the use of HVLA: biomechanical, neurological, psychological. The biomechanical influence of a manipulation is to improve the plasticity and elasticity of shortened and thickened soft tissue. Additionally biomechanically it improves fluid dynamic such as blood, lymph and synovial fluid. Following this the neurological model aims at diminishing muscle tone and modulating pain (Lederman, 1997). Studies have also demonstrated that manipulation of joints remote to the patient's pain (neck) results in an immediate hypoalgesic effect, and it has been suggested that the pain relief occurs through the stimulation of descending inhibitory mechanisms within the central nervous system (Paungmali, O'Leary, Souvlis, & Vicenzino, 2003; Skyba, Radhakrishnan, Rohlwing, Wright, & Sluka, 2003; Vicenzino, Collins, Benson, & Wright, 1998).

A number of studies have reported that HVLA techniques are associated with a temporary increase in the range of spinal motion. (Cleland, 2007a; Cleland et al., 2005; Cleland et al., 2007b; Fernández et al., 2007; Gonza´ lez-Iglesias et al., 2008; González-Iglesias et al., 2009; Krauss et al., 2008). Longer term effects of HVLA techniques have also been reported (González-Iglesias et al., 2009; Whittingham & Nilsson, 2001). These studies have used outcome measures such as the Neck Disability Index, the Visual Analoge Scale, the Numeric Pain Rating Scale, and the Global Rating of Change Scale (Cleland, 2007a; Cleland J, 2005). The common conclusion from these studies is that high-velocity manipulation directed to the thoracic spine decreases participants complaints of neck pain and disability. This outcome is occurres regardless of how many cavitations[3] occur or whether the cavitations are specific towards segmental dysfunction (Ross, Bereznick, & McGill, 2004). Refer to Table one for the details (participants, intervention, outcome measure and results) of three distinctly similar studies motivating and resembling this study.

[3] Cavitations are 'audible' and defined by the characteristic 'click' or 'pop' that commonly occurs with thrust manipulation (Cleland JA, 2007)

Table 1: Summary of previous studies investigating thoracic spine thrust manipulation

	Study Design	Participants	Intervention	Outcome Measures	Results/Effects
Krauss, J Creighton, D Ely, JD Podlewske, J 2008	RCT	32 patients EG: n= 22 CG: n= 10 Symptomatic: Mechanical Neck pain	EG: Thoracic HVLA CG: No intervention	I Neck ROM: Inclinometer Neck Pain : FPS	*Active Cervical ROM*: EG: Mean increase of 8.23 for rotation right & 7.09 for rotation left, post intervention. CG: Mean decrease of -0.1 for rotation right & -0.6 for rotation left, post intervention. *Faces Pain Scale:* EG CG Rotation Right 1.50 -.100 Rotation Left .688 -.667
Cleland, J Glynn, P, Whitman, J Eberhart, S MacDonald, C Childs, J 2007	RCT	60 patients (18-60 yrs) EG: n=30 CG: n=30 Symptomatic: Neck pain	EG: Thoracic thrust Manipulation/ Mobilisation CG: Non thrust mobilization/ manipulation	Self reported: NDI NPRS Pain Diagram FABQ	EG: Thrust CG: Non-thrust NDI 33.5(11.2) 29.6(12.6) NPRS 5.3(1.4) 4.5(2.1) FABQ 11.5(4.9) 11.2(5.0)
Cleland, JA Childs, J.D McRae, M. 2005	RCT	36 patients (18-60 yrs) EG: n= 19 CG: n= 17 Symptomatic: Neck pain	EG: Thoracic thrust Manipulation CG: Placebo, no Thrust (sham)	VAS NDI	Mean changes displayed from pre to post Intervention. VAS Pre Post Change NDI EG 41.6 26.1 15.5mm decrease 28.4 CG 47.7 43.5 4.2mm decrease 33.6
Cleland, J Flynn, T.W Child, M Eberhart, ST 2007	RCT	78 patients (18-60) Symptomatic: Neck pain	All pts received 6 thrust manipulations and CROM exercises	NDI NPRS FABQ CROM	*Mean (SD)* measured at baseline then results grouped by different amount of cavitations All subjects ≤3 cavitations ≥3 cavitations n=78 n=27 n=57 NDI 34.9(1.01) 35.6(12.6) 34.5(8.7) NPRS 4.7(1.8) 4.5(1.8) 4.8(1.8) FABQ 12.6(4.1) 12.9(4.6) 12.5(3.8) CROM- *no substantial change in CROM measurements*

Notes:

EG	Experimental group
CG	Control group
RCT	Randomized clinical trials
NDI	Neck disability index : is scored from 0-50 with higher scores corresponding to greater disability. The score is then multiplied by two and expressed as a percentage. NDI is only collected at baseline to assess disability between groups.
NPRS	Neck pain rating scale
FABQ	Fear avoidance belief questionnaire
VAS	Visual analogue scale
FPS	9-point Faces Pain Scale : uses nine different faces depicting various severities of pain. Face 0=happy, face 5=neutral, face 10=pain.

Several studies that incorporated the effects on the neck from thoracic manipulations have not been included in the table for dissimilar distinctions and limitations. Fernández et al. (2007) was not a randomized clinical trial (RCT), it was a case series and limited to only seven subjects. A series of studies by Gonza´ lez-Iglesias et al. (2008 & 2009 were randomized controlled trials. However their patients had an inclusion criteria of acute mechanical neck pain, and their intervention included an electro-therapy/thermal program which could be perceived as leading away from the practical clinical relevance the study was attempting to influence. Cleland has been an influence on this study and a large involvement in all the studies cited above that included a thoracic manipulation in relation to its effect on the neck. All three of his studies have been included in the table, however it should be noted that two of these studies did not include cervical spine range of motion in their outcome measure (Cleland, 2007a; Cleland et al., 2005). The other two studies presented in table one both measured active cervical range of motion with an electrogoniometer, which is why these studies are the strongest correlating studies to this one.

It should be noted that to date no controlled randomized studies have explicitly investigated the effects of active cervical range of motion following a thoracic manipulation on asymptomatic participants. The previously mentioned studies focused on neck pain or disability as primary outcome measures and then would briefly incorporate ROM assessment. This study sought to determine if a thoracic spinal thrust manipulation would have an effect on active cervical range of motion (measured by an electrogoniometer) when applied to the upper thoracic region.

Conclusion & Aims

As discussed several studies have used symptomatic participants, but to date there has been no investigation into cervical spine range of motion in asymptomatic participants that received a manual intervention technique to the thoracic region. Asymptomatic participants help determine if somatic dysfunctions leads to decreased neck range through structural and functional limitations. Therefore, the aim of the current study was to evaluate cervical spine range of motion (flexion-extension, rotation left and right) before and after a thoracic spinal thrust manipulation (HVLA) in asymptomatic subjects.

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Section 2: Manuscript

Note

This manuscript has been prepared in accordance with the Instructions for Authors for *Manual Therapy*

Does a single thrust manipulation of the upper thoracic spine increase neck range of motion?

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Abstract

This study examined the effect of thrust manipulation (HVLA, high velocity low amplitude manipulation) of the upper thoracic spine (T1-T4 segments) on active cervical spine range of motion (CROM). Cervical flexion-extension, rotation right and left range of motion was measured pre- and post intervention using an electrogoniometer. Asymptomatic participants (n=22; n=10 males; n=12 females) were recruited using convenience sampling. Eleven participants were randomly assigned to the experimental group (EG) and eleven to the control group (CG). Prior to receiving the allocated intervention the cervical and upper thoracic spine of each participant was examined for the presence of somatic dysfunction by a registered osteopath. The EG received an upper thoracic manipulation and the CG received a "sham wind up" to the same region (T1 –T4). Paired *t*-tests were used to analyze within-group changes in cervical rotation, flexion and extension. Increased cervical rotation in one direction (right), and flexion was observed following a thoracic thrust manipulation for the EG, demonstrating mean (SD) increase in right rotation of 7.09 degrees (a 'moderate' effect) and 4.30 degrees (a 'moderate' effect) for flexion. This study supports the view that spinal thrust manipulation applied to the upper thoracic spine (T1-T4) may alter C ROM in asymptomatic participants.

Keywords: Neck Pain, Range of Motion, Thoracic Spine, Spinal Thrust Manipulation

1. Introduction

Cervical-thoracic and upper thoracic somatic dysfunctions have been associated with mechanical neck pain and restricted cervical range of motion (CROM). Somatic dysfunction has been defined as "impaired or altered function of related components of the somatic (body framework) system: skeletal, arthrodial, and myofascial structures, and related vascular, lymphatic, and neural elements, amenable to osteopathic manipulation" (Ward, 2003). It is believed that spinal segmental somatic dysfunction can create or maintain a symptomatic reaction from adjoining restricted spinal segments (Greenman, 1996; Kaltenborn, 1993). It has been theorised this could be due to the biomechanical, anatomical and neural connections of the cervical spine with the upper thoracic region and thoracic spine (Greenman, 1996; Maitland, Hengeveld, Banks, 2000).

Osteopaths and other manual medicine practitioners commonly use manipulative treatment, including spinal joint thrust manipulation, to treat somatic dysfunction. The aim of manipulation is typically to reduce pain and increase cervical mobility (Association, 2009; Gross et al., 2002a; Gross et al., 2002b; Howing & Gasner, 2001). Evidence has recently begun to emerge for the use of manual techniques at the thoracic spine for patients with mechanical neck pain (Cleland, 2007a; Cleland, Childs, McRae, Palmer, & Stowell, 2005; Fernandez, Fernandez-Carnero, Fernandez, Lomas-Vega, & Miangolarra-Page, 2004; Fernández, Palomeque-del-Cerro, Rodríguez-Blanco, Gómez-Conesa, & Miangolarra-Page, 2007; González-Iglesias, Fernández-de-las-Peñas, Cleland, & Gutiérrez-Vega, 2009; Krauss, Creighton, Jonathan, & Podlewska-Ely, 2008).

Cervical manipulation is contraindicated in patients presenting with risk factors such as those who show signs of vertebrobasilar insufficiency (VBI). A serious potential complication of cervical manipulation is vertebrobasilar artery occlusion and injury, which can lead to brain stem and cerebellar ischemia and infarction (DiFabio, 1999; Haldeman, Kohlbeck, & McGregor, 1999; Haldeman, Kohlbeck, & McGregor, 2002a; b). In light of this risk, the use of thoracic spine manipulation rather than direct manipulation of the cervical spine, may potentially avoid these risks of injury while achieving similar therapeutic benefits. Vertebrobasilar injury has not been associated with thoracic spine manipulation.

There are a variety of opinions on what constitutes normal movement and satisfactory posture and how activity and movement in various parts of the body affect the function and structure of other parts (Bogduk , 2000; Stone, 1999; Triano, 2001). According to Norlander et al (1996; 1997), reduced mobility at the cervical-thoracic junction has been shown to be a risk factor for neck pain. Studies have also demonstrated that manipulation of joints remote to the patient's pain results in immediate hypoalgesic effects, and it has been suggested that pain relief occurs through the stimulation of descending inhibitory mechanism within the central nervous system (Skyba, Radhakrishnan, Rohlwing, Wright, & Sluka, 2003; Vicenzino, Collins, Benson, & Wright, 1998). Based on these early studies, it is likely that therapeutic interventions directed at thoracic spine somatic dysfunction may have beneficial biomechanical effects on the cervical spine by decreasing mechanical stress and consequently increasing CROM. Active and passive cervical motion provide important findings for the manual therapist regarding the patient's condition and is also used as a pre- and post-treatment test to clinically assess treatment outcomes (Fernández et al., 2007). An underlying premise in osteopathy is that restoration of normal CROM may be associated with improved symptomatic status.

The thoracic spine is clinically the most often manipulated region of the spine, and is therefore an important target for research investigation (Kjellman, Skargren, & Oberg, 1999). To date, no studies have specifically investigated the effects of thoracic thrust manipulation on active CROM in asymptomatic participants. Osteopaths do not tend to focus on symptomatic joints they tend to focus on symptomatic function, and using range of motion appears to be one of the most important examination procedures in clinical practice. Examining active CROM forms an important part of physical evaluation (Dvorak, Antinnes, Panjabi, Loustalot, & Bonomo, 1992) and has been studied in primary research into work related neck and upper limb disorders (Bronfort et al., 2001b; Fredriksson et al., 2002). Consequently the aim of this study was to determine if a single thoracic thrust manipulation would have an effect on CROM in asymptomatic participants when applied to somatic dysfunction identified in the upper thoracic region (T1-T4).

2. Methods and Materials

This study was a randomised, controlled experimental design with immediate post-intervention follow up. Figure 1 illustrates the flow of experimental procedures.

2.1 Participants

Participants were recruited from a university population and surrounding region using poster advertisements. A questionnaire was completed by participants to identify inclusion and exclusion criteria. Inclusion criteria were: aged between 18–50 years; a score of zero on both the McGill short form Pain Questionnaire (SF-MPQ) (Melzack, 1987) and the Neck Disability Index (NDI) questionnaire (Vernon & Mior, 1991). Patients were excluded if they exhibited any of the following: any contraindication to manipulation, a previous history of a whiplash injury, history of head or neck surgery, known serious spinal pathology (eg inflammatory arthropathy, infection, tumours, osteoporosis or spinal fracture), diagnosis of cervical radiculopathy or myelopathy, head or neck pain within the year preceding the study or evidence of vertebrobasilar insufficiency. The practitioner who performed both interventions (experimental and sham techniques) was a registered osteopath with over 25 years clinical experience. All participants received an information sheet and signed a consent form prior to participating in the study. Ethical approval for this study was granted by the Unitec Research Ethics Committee.

2.2 Outcome measures

Measurement of participants' CROM in the sagittal and horizontal planes was the only outcome measure of interest in this study.

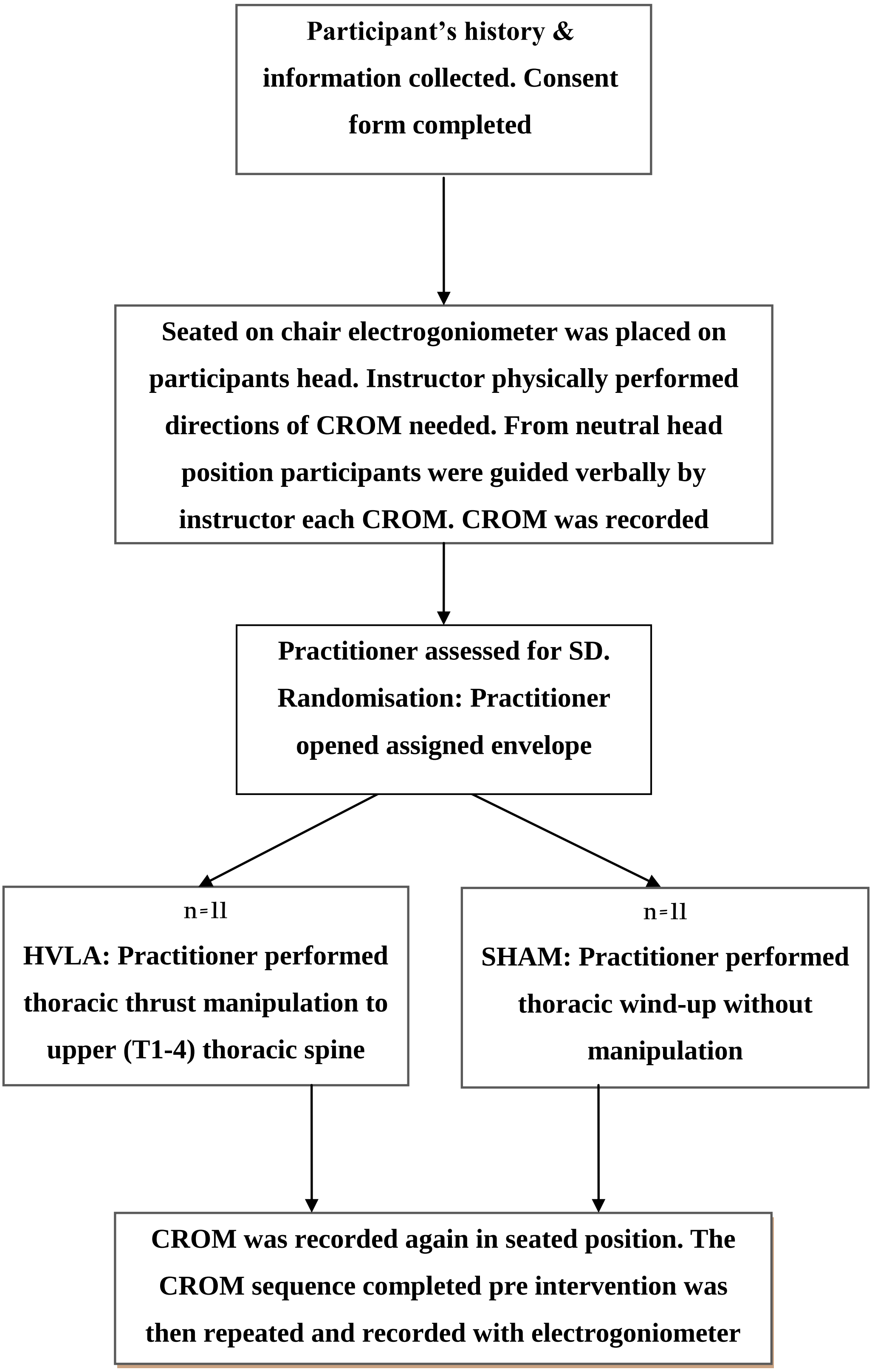

Figure 1: Flowchart of procedures and experimental design

2.3 Measuring device

Cervical range of motion was measured before the intervention and immediately following the intervention using a Triaxial 3DM- GX1 Gyro Enhanced Orientation Sensor (Microstrain Inc., Williston, USA) interfaced with a notebook computer running custom designed data acquisition and display software (Lab View, National Instruments Corp. Austin, TX). The orientation sensor was attached to custom designed, size adjustable head gear and securely fitted to the head with a chin strap (Rowe, 2008). The sensor operates over 360 degrees of angular motion on three axes and provides a fast response for range of movements while eliminating drift and then provides output in digital format. The sequence of cervical movements was flexion, extension, rotation right, and rotation left. In between each movement the participant paused in the neutral head position. This sequence was recorded three times for both pre- and post-measurements.

2.4 Procedure

All procedures for each participant were completed in one room over a 15 to 20 minute period. Each participant completed demographic information, medical history information, SF-MPQ and the NDI questionnaires. Each participant sat in a chair allocated for electrogoniometer measurement and pre-measurements. The participant then moved to an adjacent treatment table, which was positioned in the middle of the room. One investigator (LS) measured CROM for every participant and after each pre-intervention measurement session left the room and the practitioner entered the room and commenced assessment of somatic dysfunction, before delivery of the appropriate intervention. After intervention the practitioner left the room and the investigator re-entered the room remaining blinded to the patients' group assignment and completed post intervention CROM measures with the participant in the seated position. Post-intervention measurement was performed within two minutes of receiving the intervention.

Participants were randomly assigned to either an experimental group (EG) or control group (CG). Randomization was performed using a random number generator (http://www.random.org) to assign a numbered and sealed envelope containing a slip of paper indicating group assignment as either 'experimental' or 'control'. The envelope was provided to the osteopath in the room upon participant arrival. Envelope numbers were recorded by the osteopath on all data collection forms and on a master sheet containing both envelope numbers and group assignment. This master sheet was then stored in a locked container. The researcher was therefore blind to the group allocation until after the measurement and experimental procedures were completed. Following both interventions and post measurements each participant was informed about the existence of a real and sham group and asked "do you believe you were in the manipulation group?" by the researcher recording the CROM, and their answers were noted.

Participants were positioned in an upright chair with lumbar support with both feet flat on the floor, with knees and elbows positioned at 90° angles, and buttocks positioned against the back of the chair. The investigator physically demonstrated the procedure for sitting in the chair and how to complete full CROM for the participants before they began. The electrogoniometer was positioned securely at the top of the head. Refer to Figure 2 for an illustration of the setup used to evaluate range of motion using the electrogoniometer. The head device and setup protocol was originally developed by Rowe (2008). The participants assumed a neutral head-neck position before being asked to move their head as far as possible in each direction (flexion-extension, rotation left and right). For the purpose of this study, 'neutral head-neck position' was operationally defined as being in the comfortable midline and for ease of understanding was described to the participants as "looking straight ahead". Three repetitions of this sequence were recorded for each direction of movement, and the mean ranges were calculated for data analysis.

Figure 2. Experimental setup for the evaluation of range of motion using an electro-goniometer.

Notes: Note the upright position of the trunk, buttocks to the back of the chair, the strap around the waist for lumbar support and feet flat on the floor. *Photo kindly reproduced with permission from Philip Rowe (Rowe, 2008).*

2.5 Diagnosing somatic dysfunction

Before performing the intervention the practitioner examined each participant in the seated position for somatic dysfunction of the thoracic and cervical spine (see Fig 3.). The practitioner's examining methods involved evaluating full passive CROM and thoracic ROM assessment in flexion, extension, rotation left and rotation right while palpating for the mobility of each spinal segment. The practitioner also palpated for tissue texture and tissue tenderness, while observing symmetry of the spinal movement. The results were recorded on a data collection sheet with either a tick in the cervical spine column or thoracic spine column, or both.

Figure 3. Thoracic spine examination used by the practitioner in evaluating somatic dysfunction.

Notes: This was performed with the participant seated on the treatment table with their arms folded across their chest and hands on opposite shoulders. The practitioner palpated with the index finger at the interspinous space (in between each vertebrae) of the upper thoracic segments. The remainder of the palpating hand supported the segment below the segment being tested. The practitioners other arm wrapped around the practitioner's trunk over their crossed arms allowing for contact to move the practitioner through each range of flexion, extension, rotation right and left, side bending right and left.

2.6 Interventions

Eleven participants were randomly assigned to the experimental group (EG) and eleven to the control group (CG). The intervention was a single thoracic thrust manipulation (high velocity-low amplitude) and the 'sham' intervention for the CG received a thoracic 'wind up' without the HVLA thrust. The CG received a sham thoracic spine manipulation. The participants in the CG were placed in the identical set up position as those in the EG with the exception of hand positioning. An "open hand" was placed over the inferior part of the upper thoracic vertebrae (see Figure 4), and once a pre-manipulative position (thoracic 'wind up') was achieved the participant was instructed to take a deep breath and then exhale. No HVLA thrust technique was performed during the exhalation.

2.7 Thoracic spine thrust manipulations

Thoracic spinal "thrust technique" is a direct method of a manipulation treatment that uses HVLA activation to move a joint that is exhibiting somatic dysfunction through its restrictive barrier so that when the joint resets itself, appropriate physiologic motion is restored" (Greenman, 1996; Ward, 2003). If audible cavitation was not observed on the first manipulation attempt the practitioner did not deliver a second attempt. All participants in the experimental group (EG) received, as far as possible, an identical HVLA manipulation regardless of the clinical presentation or somatic dysfunction identified.

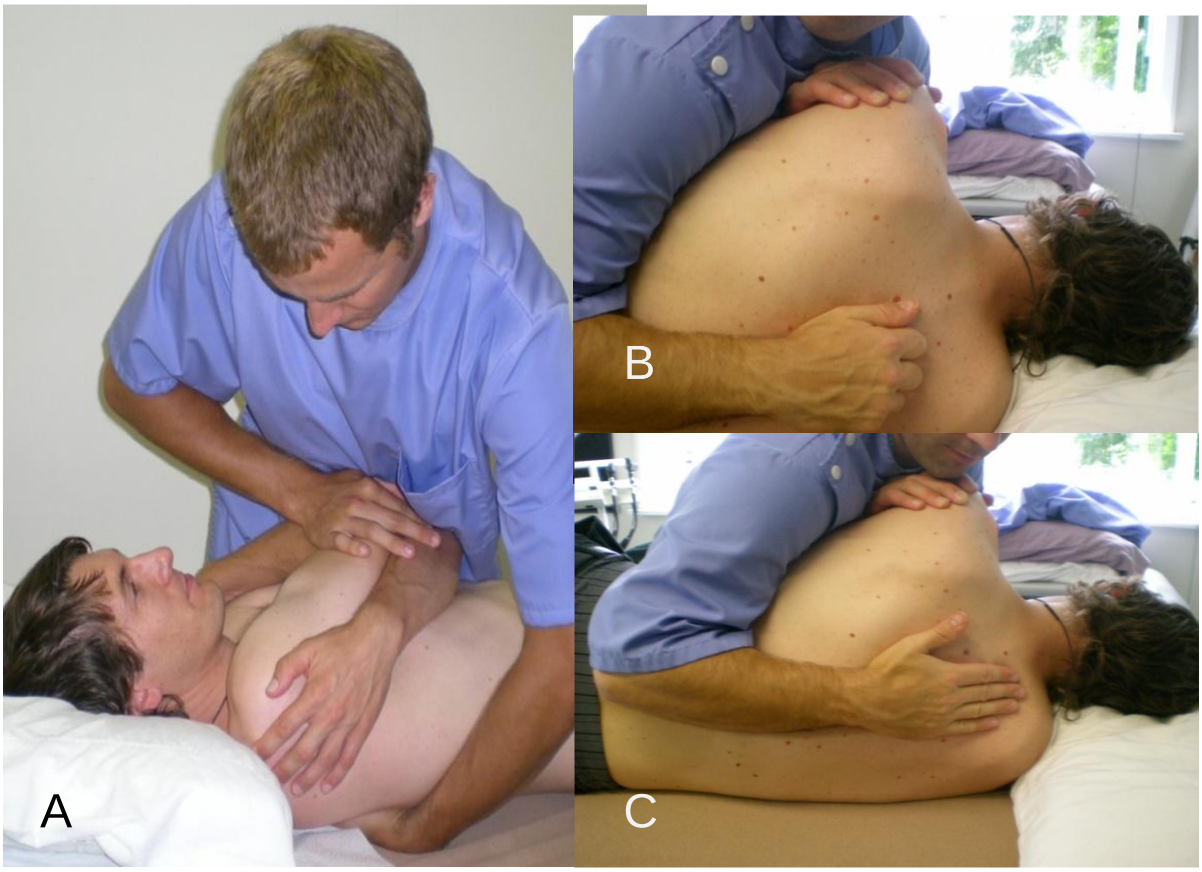

Figure 4. Thoracic spinal thrust manipulation used in this study.

Notes: *Panel A:* The participant lay supine on the treatment table with crossed arms so their hands were on opposite shoulders and their elbows met in the middle. The participant's arms were drawn inferiorly to create spinal flexion down to the upper thoracic spine. The practitioner's right hand was placed under the vertebra of the targeted motion segment and used as a fulcrum, and his body applied force through the participants' arms to produce a high velocity, low-amplitude thrust by momentarily dropping his body weight with sudden flexion of the knees. *Panel B:* Note the practitioners' right hand which is closed for the manipulation intervention in comparison to picture. *Panel C:* where the practitioners hand is open in order not to manipulate the segment for the sham intervention

2.8 Data Analysis

Baseline measures of CROM were compared with measures recorded post intervention. The intervention (thoracic HVLA) served as the independent variable and the dependant variable was the active cervical range of motion measurements. Raw data were explored for normality using descriptive statistics, P-P and Q-Q plots and the Shapiro-Wilk statistic. For normally distributed variables, paired sample *t*-tests were used to compare pre- and post- measurements. Non-normal variables were contrasted using Wilcoxon signed rank test. Effect sizes and confidence intervals were calculated to aid interpretation of the results and interpreted according to the criteria of (Hopkins, 2008). Statistical analysis was performed using SPSS v17 (SPSS Inc, Chicago, IL). All figures are presented as mean±SD.

3 Results

Twenty-two subjects participated in this study (n=11 females; n=11 males) with 11 (n=4 females; 7=y males) randomly allocated to the experimental group and 11 (n=7 females; n=4 males) in the control group. The mean age of participants was 28.3± 6.8 years. Descriptive statistics in terms of pre- and post- intervention comparison data for each outcome in both groups is displayed in Table 1.

'Trivial' to 'small' effects for within-group changes were observed in flexion (d=0.44), extension (d=0.14), left rotation (d=0.18) and right rotation (d=0.17) in the control group. An increase in range of motion from pre to post HVLA thrust manipulation was observed in the experimental group (mean increase of 7.09° ±5.83°; d = 0.78 'moderate'; p = 0.01) for rotation right range of motion, and for flexion range of motion (mean increase of 4.30°±3.27°; d=0.60 'moderate'; p= 0.98).

Although participants in this study were asymptomatic, the presence of somatic dysfunction was noted in many participants. The practitioner recorded that 7 out of 11 participants from the EG and 5 out of 11 participants from the CG were found to have at least one site of cervical spine somatic dysfunction. All of the participants examined by the practitioner were identified as having at least one site of thoracic somatic dysfunction.

In the post-study follow up, all of the participants in both groups believed they had been manipulated, with the exception of two participants from the control group (sham) who did accurately report what group they were allocated to, this indicates that blinding was effective. Concerning the experimental group, all of the thoracic spinal thrust manipulations were delivered successfully with an audible cavitation occurring.

Table 1. Results from the paired-sample t test distributed Pre and Post inclinometer; treatment and sham group data and from Wilcoxon signed ranks test for non-normal Pre and Post inclinometer; treatment and sham group data.

		Mean Pre	**Pre SD**	**Mean Post**	**Post SD**	**Mean difference**	**95% CI Difference**		**P-value**	**Effect Size (r)**	**Descriptor[b]**
							Lower	Upper			
Extension	Tx	59.11	12.82	60.81	13.29	1.71	-6.18	2.77	.416	0.13	'trivial'
	Control	52.17	5.99	52.27	6.75	0.89	-2.61	4.39	.583	0.14	'trivial'
Flexion	Tx	52.24	4.51	56.55	8.25	4.30	-9.55	.94	.098	0.60	'moderate''
	Control	59.16	4.51	57.08	5.22	2.08	-1.52	5.68	.228	0.44	'small''
Rotation R	Tx	75.34	8.36	82.43	9.69	7.09	-	-	.010	0.78	'moderate'
	Control	70.73	8.33	69.37	8.33	1.36	-2.60	5.32	.463	0.17	'trivial'
Rotation L	Tx	67.76	6.14	71.03	9.06	3.27	-	-	.091	0.51	'small' '
	Control	63.04	7.01	64.49	9.63	1.46	-4.52	1.61	.316	0.18	'trivial''

Notes

a. Effect size (r) for non-parametric data were calculated using $r= Z/\sqrt{N}$, (N=11)s. Effect sizes for parametric data were calculated using the Cohen statistic.
b. Descriptors for magnitudes of effect are based on those described by Hopkins, (2007). Indicates that these variables are non-normally distributed. p-values were calculated using Wilcoxon signed rank test.

The symbol '– ' indicates no confidence interval could be calculated because the data was non- normally distributed.
SD = standard deviation; CI confidence interval; r = effect size; Tx = treatment group

4 Discussion

The aim of this study was to evaluate CROM before and after thrust manipulation of the upper thoracic spine in a sample of asymptomatic participants. The results indicate that thoracic HVLA moderately increased both cervical flexion and cervical rotation in one direction (right) in the experimental group.

There are several orthopaedic manual physical therapy interventions that can be used for treatment of cervical spine complaints; this study demonstrated that the application of HVLA to the upper thoracic segments may be a useful approach for the treatment of restricted range of motion of the cervical spine. All participants except for one in the EG demonstrated moderate, but clinically relevant, increases in post-intervention active cervical rotation right. The mean improvement in cervical rotation right that followed thoracic spinal manipulation was approximately seven degrees.

In clinical practice assessing active and passive range of motion is a commonly used examination procedure and is routinely used by manual therapists. CROM measures provide important findings for manual medicine practitioners regarding a patient's condition and is also used as a pre- and post-test procedure to assess response to treatment. Several authors advocate the importance of adequate range of motion within the spine and joints throughout the body for prevention of pain and injury (Bogduk, 2000; Fernández et al., 2007; Krauss et al., 2008; Stone, 1999; Ward, 1996). Used in conjunction with muscle pain charts, ROM evaluation allows practitioners to distinguish overlapping pain patterns, locate areas of musculoskeletal dysfunction, and differentiate between symptoms in individual muscles (Fernández et al., 2007). Clinical evaluation of range of motion is a fundamental diagnostic procedure in all forms of manual medicine. It is not clear whether the 7° degree change in range of motion observed in this study is detectable by a practitioner using motion palpation, however, it seems plausible that a change of range of this magnitude might be detectable given that the total range of motion for rotation is a range between 40-55 degrees (Ferrario, Sforza, Serrao, Grassi, & Mossi, 2002; Krauss et al., 2008; Won & Duk, 2009) therefore a seven degree change represents at least a 17% change. In 2008, Fletcher et al., conducted a study measuring active CROM in persons with and without neck pain and stated in the conclusion "…changes [in range] between 5° and 10° are needed to feel confident that a real change in spine mobility has occurred"(Fletcher & Bandy, 2008). Further study into minimum detectable change of neck range using motion palpation would help to clarify the clinical relevance of this change.

The head is supported by the lower joints in the neck and upper back, and these areas are known to commonly cause neck pain. If this support system is affected adversely, then the muscles in the area may be impaired, leading to neck pain (Bogduk, 1984; Bogduk N, 2000; Ward, 2003). In both biomechanical and anatomical terms the cervical spine is functionally related to the upper thoracic spine. The vertebral bodies of T1-T4 are like those of the cervical vertebra, specifically T1, being broad transversely, its upper surface concave, and lipped on either side (Pal, Routal, & Sagom, 2001; Panjabi et al., 1993). The spinous processes are also similar to the cervical spine, they are thick and long and almost horizontal compared to the thoracic spinous processes which are directed obliquely and inferiorly. The orientations of the articular facets of the zygapophyseal joints at the cervical and upper thoracic region are similar. From approximately the level of the C4/5 facet joint to the T3/4 facet joint the orientation of the superior articular facets are facing posterolateral in relation to the sagittal plane (Pal et al., 2001; Panjabi et al., 1993). The similarity in anatomical structure between the cervical and upper thoracic spine implies that the functions subserved are similar.

There are various theoretical reasons why thoracic spine thrust manipulation may beneficially effect patients with neck complaints. This study focused primarily on the functional biomechanical link between the cervical and thoracic spine that was described by Norlander et al. (1996, 1997) and Pal et al. (2001) regarding similar facet orientation, vertebral body and spinous process shape. There are numerous non-biomechanical explanations that account for the effects of spinal manipulative therapy. In addition to studies that investigate functional and anatomical linkage between cervical and thoracic spine, it could also be that thrust manipulation decreases pain and spasm while increasing mobility through increased inter-segmental joint play (Cassidy, Lopes, & Yong-Hing, 1992; Norlander et al., 1997; Norlander & Nordgren, 1998). Additionally, thrust manipulation techniques may induce segmental inhibitory mechanisms, or activation of descending inhibitory pathways and this would explain the decreased cervical symptoms after the application of a manipulation in another region (Fernández et al., 2007; Skyba et al., 2003; Vicenzino et al., 1998).

In a recently published similar study, Krauss et al. (2008) investigated an upper thoracic spinal thrust manipulation with active cervical range of motion also recorded by an electrogoniometer. These authors reported an increase of approximately eight degrees in right rotation which is similar to the change in range observed in the current study. However, the current study did not observe the substantial effects reported by Krauss for rotation left. Krauss et al's result for left rotation was approximately a seven degree increase in comparison to approximately three degree increase from pre to post intervention in this current study.

It is unclear why right rotation was associated with a larger increase in range than left rotation. Left rotation may have been affected by the setup with the investigator seated behind and to the left of the participant while instructing the participant. This setup resulted in the participant being face-to-face with the instructor on full range of left rotation, which may have inhibited the participant in completing the full range of rotation because of personal proximity to the investigator.

During data collection the investigator observed that participants tended to move their heads faster in later repetitions. Future studies should randomise the sequence of neck movements in order to decrease the tendency to increase speed of movement with repetitive patterns. Furthermore the sequence of movements required left rotation as the final movement in the sequence and in the participants desire to finish may have resulted in not completing the full range of left rotation. These points may or may not have an influence; however, further consideration in future work would be worthwhile. Rotation right may have had additional increase simply because there may have been more somatic dysfunction on the right in this sample. However, detailed data about characteristics and location of observed somatic dysfunction was not collected in this study.

Another limitation for this study includes the small sample size. Based on the observed effect of 0.7 and a sample size of 11 participants per group, a post-hoc power analysis reveals the observed power in the study was 0.55. To achieve a minimum power of

0.8, a minimum of 19 participants per group would be required. This study was therefore underpowered and there is a risk of making a Type II error.

Participants were all asymptomatic and of a similar age therefore contributing to the homogeneity of the sample. Homogeneity in a sample strengthens internal validity (Harmon & Morgan, 1999), however, the narrow age range is unlikely to represent the diversity of the wider population (Alreck & Settle, 1995) and therefore the extent to which these findings may be generalised to wider age groups is limited.

The participants' emotional disposition, mood and motivation at the time of data collection may have some influence on the results, for example if participants were tired, excited or distracted this may compromise their concentration and be reflected in the experimental data. However it was apparent from observation during data collection that this was not a strong factor in this study.

Evidence has begun to emerge in support of thoracic thrust manipulation as an intervention for the treatment of mechanical neck pain. However, to build a strong recommendation for a clinical technique it is necessary to have multiple studies with convergent findings. In this study there were interesting changes in rotation, but this needs to be replicated in further studies, and expanded to include the use of other manual therapy approaches. As most manual therapists use a combination of modalities for the management of neck complaints (eg soft tissue, articulation, mobilizations, muscle energy) rather than only thoracic manipulations, a recommendation is that additional clinical trials incorporate other interventions or a combination of treatment techniques with the thrust manipulation to determine which is most efficacious.

A further limitation of this study includes the use of only immediate short term measurements, only comparing pre and post with no follow up being completed. Future studies should seek to investigate the longer term changes of thoracic spinal manipulations on neck range of motion. A seven day follow up period would be appropriate because of the practical clinical relevance, as it is common for manual therapists to follow up with patients on a weekly basis.

Upon completing the procedure, 9 out of 11 participants included in the control group and all 11 in the experimental group reported they thought they received the manipulation. Therefore the argument that the ‘cracking’ sound associated with thrust manipulation creating a placebo effect does not apply in this study.

5 Conclusion

The findings of the present study indicate a ‘moderate’ increase in only cervical flexion and cervical rotation right range of motion after a single thoracic spinal thrust manipulation in asymptomatic participants. Further studies are required to examine the longer term effects of thoracic thrust manipulation in asymptomatic participants as well as those with acute mechanical neck pain.

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Section 3: Appendices

Appendix A: Confirmation letter of ethical approval for this study was granted by the Unitec Research Ethics Committee.

Lyndal Sharples
57 Alverston Street
Waterview
Auckland

25 June 2009

Dear Lyndal

Your file number for this application: 2009.964
Title: **What is the short-term effect of thoracic spine manipulations on active range of motion in the cervical spine?**
Your application for ethics approval has been reviewed by the Unitec Research Ethics Committee (UREC) and has been **approved** for the following period:

Start date: 24 June 2009
Finish date: 24 June 2010

Please note that:

1. the above dates must be referred to on the information AND consent forms given to all participants
2. you must inform UREC, in advance, of any ethically-relevant deviation in the project. This may require additional approval.

You may now commence your research according to the protocols approved by UREC. We wish you every success with your project.

Yours sincerely

Deborah Rolland
Deputy Chair, UREC

CC: Cynthia Almeida
Rob Moran

Appendix C: Guidelines for submission to Manual Therapy

Guide for Authors

The journal editors, Ann Moore and Gwen Jull, welcome the submission of papers for publication.

Submission to this journal proceeds totally online at http://ees.elsevier.com/ymath.
Use the following guidelines to prepare your article.
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Masterclass 4000 words
Letters to the Editors 500 words
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•you should give a maximum of four **degrees/qualifications** for each author and the current relevant appointment

•name and address of the department or institution to which the work should be attributed

•name, address, telephone and fax numbers, and e-mail address of the author responsible for correspondence and to whom requests for offprints should be sent.

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•The Case Report should be between 1500 - 2000 words in length excluding references and illustrations. Longer studies will be considered by the Editorial Committee if of an exceptional quality.

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•The method of presentation to the treating practitioner should be detailed along with the symptoms and their behaviour. A body chart illustrating the symptoms is considered essential.

•The history (present and past) should be reported. Relevant work and leisure activities should also be presented in this section.

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•The Case Report should conclude with a brief summary.

•Three copies of the Case Report are required.

For further details on the Case Report section please contact: Jeffrey D. Boyling, Jeffrey Boyling Associates, Broadway Chambers, Hammersmith Broadway, LONDON, W6 7AF, UK. Tel: +44 (0) 20 8748 6878 Fax: +44 (0) 20 8748 4519 E-mail: jeffboyling@yahoo.co.uk

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For further details and full instructions for authors for the Masterclass section please contact: Karen Beeton, Department of Physiotherapy, University of Hertfordshire, College Lane, HATFIELD, Herts, AL10 9AB, UK. Tel: +44 (0)1707 284114 Fax: +44 (0)1707 284977 E-mail: k.s.beeton@herts.ac.uk

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