## COVER LETTER

This is an original journal article and is not under consideration for publication in another pre-reviewed medium.

I intend to submit this journal article to the Health SA Gesondheid. It should be considered to be published. The study is titled **"The Effectiveness of Chiropractic Manipulation and Ischaemic Compression versus Chiropractic Manipulation and Shockwave therapy on Trapezius Trigger Points".**

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## ETHICAL CLEARANCE

UNIVERSITY OF JOHANNESBURG

# FACULTY OF HEALTH SCIENCES

## RESEARCH ETHICS COMMITTEE

**NHREC Registration no: REC-241112-035**

**1 June 2016**

**TO WHOM IT MAY CONCERN:**

**Student:** LOWE, J
**Student Number:** 201100213

**TITLE OF RESEARCH PROPOSAL:** The Effectiveness of Chiropractic Manipulation and Ischaemic Compression Versus Chiropractic Manipulation and Shockwave Therapy on Trapezius Trigger Points

**DEPARTMENT OR PROGRAMME:** CHIROPRATIC

**SUPERVISOR:** Dr M Moodley **CO-SUPERVISOR:** Dr M Busschau

The Faculty Research Ethics Committee has scrutinised your research proposal and confirm that it complies with the approved ethical standards of the Faculty of Health Sciences; University of Johannesburg.

***The proposal has been awarded a Code 02 – Approved with suggestions without re-submission***. The attached recommendations were made by the Committee which will add value to your proposal.

Please make these amendments to the satisfaction of your supervisor/s and submit a corrected copy of the proposal to the Faculty Research Administrator after which your clearance number will be issued.

The REC would like to extend their best wishes to you with your postgraduate studies.

Yours sincerely,

Marie Poggenpoel

**Prof M Poggenpoel**

**Chair : Faculty of Health Sciences REC**

**The Effectiveness of Chiropractic Manipulation and Ischaemic Compression versus Chiropractic Manipulation and Shockwave therapy on Trapezius Trigger Points**

A dissertation presented to the Faculty of Health Sciences, University of Johannesburg, as partial fulfilment for the Masters Degree in Technology Chiropractic:

By

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**The Effectiveness of Chiropractic Manipulation and Ischaemic Compression versus Chiropractic Manipulation and Shockwave therapy on Trapezius Trigger Points**

**Purpose:** The aim of the study was to compare the effectiveness of a treatment protocol that included Chiropractic manipulation and ischaemic compression against an alternative treatment protocol that involved Chiropractic manipulation and Shockwave therapy. Both protocols were carried out on a target group that presented with an active myofascial trigger point of the upper trapezius muscles.

**Method:** A selection of 30 participants between the ages of 18 and 50 years were recruited for this study, all of which presented with mechanical neck pain that was caused by the presence of an active myofascial trapezius trigger point. Participants were randomly allocated into two groups, with each group containing 15 participants. Group 1 received Chiropractic manipulative therapy to their cervical spine and upper thoracic spine as well as ischaemic compression to the active myofascial trapezius trigger point. Group 2 received Chiropractic manipulative therapy to their cervical spine and upper thoracic spine as well as Shockwave therapy to the active myofascial trigger point present in the trapezius muscle. Each participant received a total of 6 treatments with the seventh and final treatment being a data collection consult only, this was the same for both groups.

**Results:** Both treatment protocols had positive clinical effects on the participants. Subjectively the participants, on average, experienced a decrease in perceived pain. Objectively both the CROM measurements and the Pressure Algometer readings decreased throughout the trial period, this was noted in both groups.

**Conclusion:** In conclusion both treatment protocols had positive effects on participants over the trial, neither treatment protocol had definitive statistical improvements compared to the other in the treatment of mechanical neck pain with associated trapezius myofascial trigger point involvement and thus to conclude, both ischaemic compression therapy and Shockwave therapy in conjunction with cervical and upper thoracic spinal manipulations can be used to effectively treat mechanical neck pain with associated trapezius myofascial trigger point involvement.

**Key Words:** Chiropractic, manipulation, Shockwave therapy, ischaemic compression, neck pain, myofascial.

## INTRODUCTION

Active myofascial trigger points located in the upper trapezius muscle often cause neck pain, which is commonly experienced by the general public. These trigger points can cause mild to intense discomfort resulting in a loss of man-hours and the use of pain medication. According to Hanten, Olsen, Butts & Nowicki (2002) a trigger point is described as a hyperirritable point within a taut band of voluntary skeletal muscle. It is also suggested that a trigger point may be located within muscular tissue or in its associated fascia and that the point is tender on palpation. If the trigger point is active it could elicit characteristic referred pain and autonomic symptoms.

Shockwave therapy being a relatively new technological development is said to be effective in the breakdown and treatment of trigger points and therefore neck pain (Gleitz & Horning, 2012). Chiropractic techniques such as manipulation and soft tissue therapy are often used by chiropractors in the treatment of these trigger points to relieve muscle spasm and to decrease pain. However, soft tissue therapies are time consuming, whereas Shockwave therapy is a relatively simple procedure that can be administered for a short period of time.

### Radial Shockwave Therapy

Shockwave therapy being a relatively new technological development is said to be effective in the treatment of myofascial trigger points and therefore the alleviation of muscle related neck pain. Radial Shockwave Therapy (RSWT) was and still is utilized for the treatment of uroliths in patients, however, in the early 1990's the use of Shockwave therapy was extended to include musculoskeletal disorders (McClure & Dorfmüller, 2004).

Shockwave therapy is a non-invasive and relatively simple treatment method that has recently been effective in the treatment of pain symptoms due to myofascial trigger points (Bauermeister, 2005). It has proved to be effective in promoting angiogenesis, increasing profusion, enhancing cell differentiation, decreasing inflammation and alleviating pain by altering pain signals (Shah, 2008).

Shockwave therapy involves the propagation of a shock wave, which carries energy and can propagate through a medium. Extracorporeal shockwaves are generated outside the body at high pressure and frequency. There are two possible forms of Shockwave therapy, these being: Focused Shockwave therapy, which allows for deep penetration and affects a small, precise area and Radial Shockwave therapy, which targets a more superficial and larger area (Gleitz & Horning, 2012).

## Physiological Effects of Shockwave Therapy

Analgesic effects may result from Radial Shockwave therapy (RSWT) mainly from a reduction in substance P within the target tissue as well as causing a reduced synthesis of substance P in the dorsal root ganglia cells, with selective destruction of unmyelinated nerve fibres within the target zone of the radial shockwaves (Schmitz, 2010).

The suggested treatment protocol for myofascial trigger points is related to the area that is to be treated, its surface area as well as the depth of the muscle in question. The treatment range should always be kept at a medium energy and pulse level. In the case of the trapezius muscle the following settings are deemed appropriate: intensity set at 90 Joules, 2000 pulses and a frequency 16 Hertz, this is according to the Zimmer clinical manual (Appendix F).

## Frequency of Treatments for Shockwave Therapy

The effects elicited by shock waves are seemingly dose dependent, as there appears to be no effect with a low pulse rate and at low energy. However, there is a clinical effect with midrange levels and a destructive effect with high pulse and energy numbers (McClure & Dorfmüller, 2004).

Gerdesmeyer & Weil (2007) performed three studies on chronic pain that was considered therapy-resistant and which was caused by active myofascial trigger points. In these studies neck, shoulder and lower back pain were analysed. A minimum of 6 treatments was necessary in order to establish the effect of Radial Shockwave therapy on symptoms of myofascial trigger point syndrome. It was established that pre- and post-treatment assessment using the visual analogue scale, yielded a 56.6%, 68% and a 62.15% subjective improvement in neck, shoulder and lower back pain respectively.

## Complications Associated with Shockwave Therapy

Certain contra-indications exist for the use of Shockwave therapy and they include: the presence of malignant tumours, conducting Shockwave therapy over pulmonary tissue as well as epiphyseal plates, large vessels and superficial nerves (Gleitz & Horing, 2012). Other contraindications that are listed include the use of Shockwave therapy: over potential vascular thrombi, traditional wound management or in place of stabilization of fractures (Appendix E).

There are complications that may occur with the use of Shockwave therapy, complications such as tissue and organ bleeding, neural damage or a possible pneumothorax. Taking in to consideration the acoustic impedance of lung tissue, much of which will be reflected by the lung tissue. The shockwave changes phase and results in a strong tensile wave, which may cause cavitational effects and lead to disruptive potentials and ultimately damaging the pleural surfaces (McClure & Dorfmüller, 2004). However, serious complications rarely occur during Shockwave therapy, especially if the technique of application is correct and the appropriate settings for the target tissue are used (Gleitz & Horing, 2012).

Less serious complications may occur with the use of Shockwave therapy especially when it is applied to the upper cervical spine region. During the first 1 to 2 days post treatment, local pain may worsen temporarily and development of associated headaches is possible (Gleitz & Horing, 2012).

## Ischaemic Compression

According to Gemmel, Miller & Nordstrom (2008) ischaemic compression is a soft tissue technique that is commonly applied to muscles to alleviate pain resulting from the presence of active myofascial trigger points. The technique involves the application of direct digital pressure to the active myofascial trigger point, with sufficient pressure, that is sustained for a specific period of time, to increase blood supply and relieve the tension within the affected muscle group. A constant pressure is applied to the active myofascial trigger point, applied pressure is then decreased when there is a decrease in tension of the trigger point or if the trigger point is no longer tender (Travell, Simons & Simons, 1999).

A study was conducted to determine the effectiveness of ischaemic compression of latent trapezius myofascial trigger points, that concluded ischaemic compression is effective based on a measurable increase in the pressure pain threshold measured objectively using a pressure algometer (Fryer & Hodgson, 2005).

Ischaemic compression temporarily decreases the blood supply to and within the myofascial trigger point being compressed; in order to eventually increase local blood flow when the applied pressure is decreased. An increase in blood supply to the area results in the removal of waste products as well as increasing local blood oxygen supply, allowing for healing to take place at the affected muscle (Arnau-Masanet, Barrios-Pitarque, Bosch-Morell, Montanez-Aguilera, Pecos-Martin & Valtuena-Gimeno, 2010).

A disruption of mechanical nature results with the unlocking of the locked actin-myosin cross-links when ischaemic compression therapy is applied (Perle, Scheider & Seaman, 1999) as well as a subsequent decrease in sensory afferent input of noxious stimuli (Martin, 2008). Pain relief that is experienced after receiving ischaemic compression therapy is linked to an altered spinal reflex mechanism leading to a decrease in pain (Ingber, Kostopoulus, Larkin & Nelson, 2008).

**Cervical Spine Anatomy**

Two segments form part of the cervical spine, these being the upper and lower segments respectively. The occiput, the atlas and the axis form the craniovertebral region and are the components of the upper cervical spine (Worth,1998). Stability is sacrificed for mobility in the region and thus is considered the most mobile region of the spine as a whole. The articulations that provide this mobility are the atlanto-occipital, which allows for 15 – 20° flexion-extension and 10° lateral flexion, and the atlanto-axial joints, considered to be the most mobile joint articulation. This articulation allows for 10° flexion-extension, 5° lateral flexion and 50° rotation (Magee, 2008).

Vertebrae C3 – C7 and its articulations form the lower component of the cervical spine, with mobility in this region occurring as the facet joints glide on each other. This gliding is possible because of the orientation of the facets themselves, the superior facets of the vertebra below are orientated superiorly, posteriorly and medially, while the inferior facets of the vertebra above are orientated inferiorly, anteriorly and laterally, refer to Figure 1. The above mentioned orientation of the facet joints allows for the motion of flexion and extension as well as the coupled motion of rotation and lateral flexion to occur (Magee, 2008).

**The Three Joint Complex**

The three joint complex is formed by the superior and inferior facet joints as well as the intervertebral disc, located between two vertebral bodies. The facet joints are classified as synovial, planar joints and are responsible for the direction and control of movement between the vertebrae. They are also responsible for the loading that the spine experiences, especially during extension and rotation (Cramer & Darby, 2014).

The facet joints are encapsulated posterolaterally by a joint capsule. The outside layer of the capsule is comprised of dense fibroelastic tissue, which differs from the composition of the inner layer, which consists of a synovial membrane. There is also a central vascular layer made up of areolar and loose connective tissues. The ligamentum flavum covers the anterior and medial aspects of the facet joints. This joint capsule is attached to the margins of the opposing superior and inferior facets above and below, and is thin and loose doing little to limit movement but rather to offer some stability during degrees of movement. In this study focus will be on the facet joints as it is these joints that, during chiropractic manipulation, move and cavitate.

**The Muscle Fibre**

Essentially skeletal muscle is formed by a multitude of muscle fibres, which run from origin to insertion. These muscle fibres are bound together by connective tissue and are associated with blood vessels and nerves that may or may not supply that muscle specifically (Martini & Nath, 2009).

Individual muscle fibres are composed of various different components, these being: myofibrils that are orientated lengthwise from the origin to the insertion of the muscle, mitochondria, an extensive smooth endoplasmic reticulum (SER) and numerous nuclei. The muscle fibre originally develops from the fusion of multiple cells, termed myoblasts, which ultimately give rise to the numerous nuclei. The nuclei in conjunction with the mitochondria are located below the plasma membrane, with the SER extending between the myofibrils (Agur & Dalley, 2017).

The striated appearance of a muscle fibre is a result of an alternating pattern between: dark 'A' bands, which are bisected by the 'H' zone located in the centre, which is the 'M' line, light bands and 'I' bands, which are bisected by the 'Z' disc. These bands form myofibrils and are comprised of multiple filaments. Thick filaments have a diameter of ± 15 nm and contain protein myosin. Thin filaments have a diameter of ± 5 nm, being comprised mainly of the protein, actin as well as smaller amounts of troponin and tropomyosin (Martini & Nath, 2009).

**The Anatomy of the Trapezius Muscle**

The trapezius muscle attaches to the pectoral girdle, cranium and vertebral column, which forms a triangular shaped muscle. This shape results in the trapezius muscles covering the superior half of the trunk as well as the posterior aspect of the neck. It assists in suspending the upper limb and is greately influenced by the effects of gravity. It attaches at the medial third of the superior nuchal line, the external occipital protuberance, nuchal ligament and the spinous processes of vertebrae C7 to T12, and inserts on the lateral third of the clavicle, the acromion process and spine of the scapulae. The trapezius muscle is divided into three fibre parts, namely: the superior fibres responsible for elevating the scapulae and thoracic wall, the middle fibres retract the scapulae and the inferior fibres which depress the scapulae resulting in the shoulder being lowered. Thus the varying fibre directions have different actions affecting the physiologic scapulothoracic joint, refer to Figure 2 (Moore & Dalley, 2010).

The spinal accessory nerve (Cranial Nerve XI) supplies the trapezius muscle with motor innervation. The spinal portion of the above mentioned nerve is formed by the first five cervical anterior nerve roots. Via the foramen magnum it enters the cranium and temporarily joins the Vagus nerve (Cranial Nerve X) on its course through the jugular foramen, exiting the cranium. It then descends with the internal carotid artery to pass through and supply the sternocleidomastoid (SCM) muscle. It emerges from the SCM near its posterior border, passing over the superior cervical region to form a plexus under the trapezius muscle that receives contributions from C2 – C4 nerves, which supply sensory innervation to the trapezius muscle, this plexus provides multiple branches to the trapezius muscle (Travell *et al*, 1999).

The dorsal scapular and transverse cervical arteries are the major blood supply to the trapezius muscle, but these also receive minor contributions via the posterior intercostal arteries, which supply the inferior as well as middle fibre portions of the muscle (Garbelotti, Rodrigues, Sgrott & Prates, 2001).

**Biomechanics of the Trapezius Muscle**

Lateral flexion of the head and neck toward one side occurs with unilateral contraction of the upper portion of the trapezius muscle, this action also contributes to extreme rotation of the head toward the opposite side. If the occipital attachment of the muscle is fixed and contraction of the superior portion of the trapezius occurs a resultant elevation of the scapula infers. Thus the scapula is elevated towards the head and neck. The clavicle is also drawn backwards and raised by this portion of the muscle, it results from rotation of the clavicle at the sternoclavicular joint (Travell *et al*, 1999).

Scapula retraction occurs when the spinal attachment of the muscle is fixed and entire muscle contraction occurs, this occurs at the scapulothrocacic joint. The superior and inferior portions of the muscle rotates the scapula superiorly. Scapula depression occurs with contraction of the inferior portion of the muscle (Muscolino, 2010). The primary action of the trapezius muscle is in assisting in maintaining the weight of the upper limb during standing as well as when a weighted object is held in the hand with the arm hanging. Bilateral contraction of the trapezius results in extension of the neck (Travell *et al*, 1999).

**Myofascial Pain Syndrome**

Active trapezius trigger points often cause neck pain, which is commonly experienced by the general public. These trigger points can cause mild to intense discomfort resulting in a loss of man-hours and the use of pain medication (Bron & Dommerholt, 2012).

Active trigger points that are located in anterior border of the upper trapezius, near the mid-portion of the muscle belly, refer pain and tenderness in the following characteristic pattern: unilaterally, along the posterolateral aspect of the neck, behind the ear and to the temple as well as to the back of the orbit (Travell *et al*, 1999).

## Myofascial Trigger Point

According to Hanten, Olsen, Butts & Nowicki (2002) the description of a trigger point is as follows: a hyperirritable point present within a voluntary skeletal muscle, which can be palpated as a taut band. It is also suggested that a trigger point may be located within muscular tissue or in associated fascia and that the point is tender on palpation. If the trigger point is active it could elicit characteristic referred pain and autonomic symptoms, refer to Figure 3.

It was concluded that latent trigger points are more common than active trigger points and that they may cause a restriction in an individual's range of motion as well as result in weakness of the affected muscle. Latent trigger points may remain dormant for years and then suddenly reactivate with minor stretching, overuse or chilling of the muscle harbouring them (Clarkson, 2005). Myofascial trigger points are in fact neuromuscular lesions that develop within a muscle, and not just overly contracted muscle fibres. The central nervous system is affected by the neurological loop that myofascial trigger points form part of (Lucas, Polus & Rich, 2004). Myofascial trigger points occur frequently in most individuals and commonly occur in the trapezius muscle specifically (Travell *et al*, 1999).

## Diagnosis of a Myofascial Trigger Point

The following criteria must be met according to Travell *et al* (1999) to diagnose a myofascial trigger point:

- Previous episodes of pain within the affected muscle that had a rapid onset, this being either during or after an overload of stress, or a gradual onset of pain with more chronic overloading of the muscle that is being affected
- Pain and referral patterns that are characteristic to specific myofascial trigger points in individual muscles
- Restricted motion and associated weakness of the affected muscle
- A palpable, taut band that is present within the individual muscle
- Tenderness of the myofascial trigger point due to digital pressure, within the band of taut fibres
- The occurrence of a local twitch response of the myofascial trigger point as a result of pressure or needling

- Reproduction of the similar type and location of pain experienced by the patient when pressure or needling of the myofascial trigger point takes place
- Relief or reduction of symptoms caused by the trigger point with therapy carried out on the specific muscle

**Referred Pain of Upper Trapezius Muscle Fibres**

The trapezius muscle's upper fibres are particularly prone to developing myofascial trigger points and are frequently overlooked as a source of neck pain and headaches (Travell *et al*, 1999; Von Piekartz, 2007).

The trigger points of the upper trapezius, namely Tp1 and Tp2 being the most prevalent, commonly refer pain to the posterolateral side of the head and neck unilaterally. Pain referral from Tp1 extends upwards along the lateral aspect of the neck, to the temporal region and the orbit of the eye, with less common referral to the angle of the jaw and rarely refers to the lower molar teeth as well as the occiput. Pain referral from trapezius Tp2 occurs slightly posterior in the cervical spine and merges with the referral patterns of Tp1. Active trapezius trigger points may in turn activate satellite trigger points in the temporalis, masseter, sub-occipital, splenius, levator scapulae and rhomboid muscles, causing a larger referral pattern (Lavelle, Lavelle & Susti, 2007).

**Symptoms of Active Upper Trapezius Myofascial Trigger Points**

Active trapezius Tp1 will cause an individual to experience constant posterolateral neck pain and commonly an associated unilateral temporal headache. Active trapezius Tp2 results in similar neck pain as Tp1 but without the headache component. When upper trapezius trigger points are present, full rotation of the head to a side results in the trapezius muscle on the same side of rotation being in its most short and contracted position. Active trigger points that are present within that contracted muscle will cause pain (Travell *et al*, 1999).

An individual will experience a "stiff neck" if trigger points were present and may also experience associated symptoms of dizziness or vertigo. The dizziness may be a direct result of the trapezius trigger point as this muscle functions to position the head in space and contains proprioceptors that convey the spatial orientation of the head. It may also be a result of reflex stimulation of active trigger points in the clavicular division of the sternocleidomastoid muscle that acts as a synergist (Travell *et al*, 1999).

## Management of a Myofascial Trigger Point

Myofascial trigger point therapy involves the interruption of specific reverberating neural circuits, which are responsible for self-perpetuation of the pain-spasm-pain cycle (Stephens, 2010). Various techniques exist to inactivate myofascial trigger points; they include ischaemic compression, chiropractic spinal manipulation, dry needling and drugs such as analgesics and muscle relaxants. Other therapeutic modalities include: interferential current therapy (IFC), ultrasound therapy, low-level laser therapy and Shockwave therapy (Travell *et al*, 1999). In this study both ischaemic compression and Shockwave therapy will be used as treatment methods.

## Chiropractic Spinal Manipulation

Chiropractic techniques such as manipulation and soft tissue therapy are often used by Chiropractors in the treatment of these trigger points to relieve muscle spasm and to decrease pain (Cramer, Ross, Pocius, Cantu, Laptook, Fergus, Gregerson, Selby & Raju, 2011).

Chiropractic spinal manipulation is a manual treatment utilising controlled force, leverage, amplitude and velocity. It is applied utilising parts of the vertebra and other contiguous structures as levers to correct spinal restrictions of movement (Vizniak, 2010). Chiropractic spinal manipulation is a proven technique that is considered to be more effective than a wide variety of treatments for neck and associated muscle pain (Haas, Bronfort & Evans, 2006). The effects of Chiropractic manipulation have been shown to include: increased range of motion, relief of musculoskeletal pain, increased pain tolerance and increased muscle strength (Meeker & Haldeman, 2002).

## Cervical Facet Syndrome

Pain was described by Redwood (1997) as an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage. Neck pain can be defined as pain either in the occipito-cervico and cervico-thoracic junctions. Haldeman, Chapman-Smith & Peterson (1993) defined cervical facet syndrome as a joint or multiple joint dysfunctions, which results in decreased joint motion, requires joint manipulation. Pain can however, be produced by all structures but it is most frequently caused by the components of the three joint complex, namely the facet joints and the intervertebral disc.

**Existing studies on Chiropractic manipulations and the effect on Myofascial Trigger Points**

A study conducted by Gross, Miller, D'Sylva, Burnie, Goldsmith, Graham, Haines, Brønfort & Hoving (2010) illustrated the following treatment protocol: a group of volunteers underwent Chiropractic manipulation over a three to four week period, with a total of six treatments being carried out. This study was carried out to identify the effect of Chiropractic manipulation to the cervical spine as well as thoracic spine to assess the effects on patient satisfaction, pain and function. Treatment times were standardised to 15 – 20 minutes each, with the majority of patients responding positively with the six-treatment protocol.

Cassidy, Lopes & Yonh-Hing (1992) conducted a trial in which one hundred patients with unilateral neck pain with associated referral to the trapezius muscle were either manipulated or mobilised. It was revealed that immediately post Chiropractic manipulation, 85 percent of the manipulation group noticed pain improvement. While 69 percent of the patients that received a mobilisation technique noticed a decrease in pain. The pain reduction was 1.5 times more in the group that received manipulations compared to the group that received a mobilisation technique.

**Effect of Age on the Cervical Spine**

As men and women age their head posture changes to a more anterior position. This can be a result of alterations in the mechanoreceptor activity of the upper cervical joints; this mechanoreceptor activity plays a significant role in the postural and kinaesthetic awareness of the head and neck in space (Kendall, Kendall & Boynton 1970). Thus, degenerative changes in the cervical spine due to the aging process may adversely affect this mechanoreceptor activity and contribute to the change of head posture (Wyke, 1979).

As a result of this anterior head carriage, there is an associated increase in extension of the cervical spine, which may cause shortening of the various tissues and muscles that connect to the suboccipital region. If muscles and the associated tissues are maintained in a shortened position for a substantial amount of time, it may result in a decrease in range of motion and an increased stretch resistance (Gutmann & Hanzlikova, 1972).

It may be hypothesised, based on a review of the effects of aging on intervertebral tissues, that intrinsic tissue changes, such as extensibility loss of collagenous tissue, dehydration of the intervertebral disc, the formation of vertebral and facet joint osteophytes as well as weakening and atrophy of muscles may cause a decreased antero-posterior range of motion of the cervical spine (Fenlin, 1971).

## MATERIAL AND METHODS

Participants who met the following criteria were allowed to participate in the study:

- Participants were between the ages of 18 – 50 years old, this limited the possibility of degenerative change within the participant, often seen in older age groups (Kelly, Groarke, Butler, Poynton & O'Byrne, 2011).
- Both male and female participants were included in the study.
- Participants presented with mechanical neck pain with myofascial involvement caused by active trigger points of the upper trapezius muscles, which were on either the left or right side or presented bilaterally. These were identified by flat palpation carried out by the researcher. The researcher palpated for a taut, palpable band that elicited tenderness, within the trapezius muscle (Hanten *et al*, 2006).
- The participants had the following criteria associated with joint dysfunction in one or more joints in the cervical and upper thoracic spine (Peterson & Bergmann, 2002):
    - Facet joint dysfunction determined by the examiner using motion palpation, indicated by a decreased range of motion
    - Altered end feel on motion palpation
- Understanding of the information form (Appendix B) and signing the consent form (Appendix C).

Participants who presented with the following could not participate in this study:

- Participants who presented with any contra-indications to spinal manipulative therapy (Appendix D) of the cervical and thoracic spine.

- Participants who presented with contra-indications to Shockwave therapy (Appendix E).
- Participants who had received any form of treatment to the cervical and thoracic spine or active trapezius trigger points in the past month, prior to the study.
- Neck pain that was caused by other conditions other than that of active trapezius trigger points.
- Participants may not have received any other forms of treatment that may have interfered with the results of the study, including manual therapy such as massage, physiotherapy or the use of medications such as analgesics, muscle relaxants or non-steroidal anti-inflammatory drugs.

**Methodolgy**

**First and Follow-up Consultations**

The following occurred at the first consultation:

- The researcher explained how the study was to be performed and what was required from the participant during the study.
- The information form (Appendix B) and consent form (Appendix C) were read and signed respectively.
- The researcher conducted a sufficient patient case history, physical examination and cervical spine regional.
- Before treatment, participants were assessed for subjective data using the Visual Analogue Scale (VAS) (Appendix G) as well as for objective data using a pressure algometer (Appendix H) and Cervical Range of Motion (CROM) device (Appendix I).
- All information gathered was written in the personal evaluation form.
- At the first and follow-up consultations, Group 1 received the following:
    - Participants received Chiropractic manipulative therapy, in the form of diversified Chiropractic technique, to restricted cervical and upper thoracic spine segments as well as ischaemic compression therapy, the researcher applied direct digital pressure to the active trapezius myofascial trigger point, with sufficient pressure, that was sustained for a specific period of time.

Treatment protocol was carried out twice a week for 3 weeks for a total of 6 treatments.

  - Measurements were taken during visits 4 and 7.
  - On the seventh consultation only data collection was done, there was no treatment.

- At the first and follow-up consultations, Group 2 received the following:
  - Participants received Chiropractic manipulative therapy, in the form of diversified Chiropractic technique, to restricted cervical and thoracic spine segments as well as Shockwave therapy to the active trapezius myofascial trigger points. Shockwave therapy was carried out in the following manner: The participant was asked to lie prone on the treatment bed. The researcher then exposed the area of treatment and located the most active trapezius trigger point, in case more than one trigger point was found. The location of the active trigger point was noted on the SOAP note. This ensured that the same trigger point was treated throughout the study period. Coupling gel was then be applied to the area of treatment to ensure acoustic wave efficiency. The correct settings (intensity between 90 Joules; 2000 pulses; frequency 16 Hertz) were entered into the shockwave unit according to the Zimmer clinical manual (Appendix F) and treatment took approximately take 5 minutes to complete. Treatment occurred twice a week for 3 weeks for a total of 6 treatments.
- Measurements were taken during visits 4 and 7.
- On the seventh consultation only data collection was done, there was no treatment.

**Subjective Data**

**Visual Analogue Scale (VAS)**

The VAS was conducted to ascertain the participant's perception of their level of pain. The VAS (Appendix G) consists of a 100mm uninterrupted line. The number 0, indicating "no pain" was placed at one end, with the number 10, indicating the "worst pain ever experienced", placed at the other end of the line (Farrar, Pritchett, Robinson & Chappell, 2010). The VAS is considered reliable and valid by Breivik, Borchgrevink, Allen, Rosseland, Romundstad, Kvarstein & Stubhaug (2008).

## Objective Data

## Cervical Range of Motion (CROM)

Objective data included measurements of the participant's cervical range of motion through the CROM device. The CROM device consists of two pendulum goniometers to measure the cervical range of motion in the sagittal and frontal planes (flexion, extension and lateral flexion) and a single magnetic goniometer to measure rotation in the seated position. The advantage of the CROM device is that it does not have to be moved to measure movement in another plane and has been proven to be a valid device in the measuring of cervical spine range of motion (Clarkson, 2005).

Measurements were taken on the first, fourth and seventh consultations. The participant had the device appropriately fitted to their heads and were then asked to go through all ranges of cervical motion, these being flexion, extension, left and right lateral flexion as well as left and right rotation. The participants went to their end ranges of motion or as far as they were able to move. Each range of motion was recorded off the CROM device by the clinician and noted. Readings were taken and recorded in table format (Appendix I) on the first, fourth and seventh consultations.

## Pressure Algometer

The Pressure algometer was used in order to determine the minimum pressure that caused pain in each participant. Minimum pressure threshold was measured using a pressure threshold algometer, which quantifies this tenderness. The reliability and validity of the pressure algometer was researched and confirmed by Kinser, Sands and Stone (2009). Each participant's readings were inserted into table format (Appendix H).

The algometer consists of a force gauge fitted with a rubber disc with a surface area of $1cm^2$. Pressure was applied to a defined area, that being the most active myofascial trigger point palpated, which generally elicits the most tenderness, through the rubber disc. The gauge of the algometer had a range of 0 – 10 kilograms and was calibrated in $kg/cm^2$. The algometer itself consists of a body and gauge attached to a metal rod with a rubber disc at the end. The pressure exerted on the rubber disc and rod moved the indicator to a figure on the gauge, which was recorded by the researcher.

The following procedure was followed to ascertain the pain pressure threshold readings of each participant: the procedure of measuring was explained to each participant. With the participant in a seated position, the researcher palpated the upper trapezius muscle for the most active myofascial trigger point. This point was marked with a marker to ensure that repeated measurements were done on the same point, making the readings accurate. The rubber disc at the end of the metal rod was placed onto this myofascial trigger point and pressure was applied in $kg/cm^2$ per second. When a level of tenderness or discomfort was produced in the muscle the participant verbally communicated such. An average of three readings were taken and recorded in table format (Appendix H) on the first, fourth and seventh consultations.

### Data Analysis

The researcher collected subjective and objective data during the study period. The data was analysed by statisticians at STATKON (located at the University of Johannesburg Kingsway Campus). The statistician used frequencies and descriptives to interpret the data as well as cross tabulation between genders was conducted, Chi-Square Tests and the Fisher's Exact Test was used to do this. The Shapiro-Wilk Test was also used to determine normality per group. Intra-group analysis (comparison within a group) was performed using the Friedman Test, which measures the same sample at three or more points in time. If there was a statistically significant difference, a post-hoc test was carried out, in order to establish specifically where the differences occured, the Wilcoxon Signed Rank Test was used to do this. Inter-group analysis (comparison between groups) was performed using non-parametric tests, in which the Mann-Whitney U Test was conducted, this test compares the medians of two groups (Pallant, 2007).

## RESULTS

The probability level or p-value represents the statistical significance of the results. The p-value was set at $\mathbf{p \leq 0.05}$. When the p-value was less than or equal to 0.05 ($\mathbf{p \leq 0.05}$) it indicated a significant difference, however, if the p-value was greater than 0.05 ($\mathbf{p > 0.05}$) then findings were considered to not be statistically significant, although they can still be considered to have clinical relevance.

## Demographic Data Analysis

### Age and Gender Distribution

Participants in Group 1 ranged in age between 22 and 33 years with a mean age of **25.53** (standard deviation = 2.72). Participants in Group 2 ranged in age between 23 and 49 years with a mean age of **26.13** (standard deviation = 6.54). Group 1 consisted of 8 females (53.33%) and 7 males (46.67%). Group 2 consisted of 6 females (40%) and 9 males (60%). Across the two groups there was a distribution of 14 females (46.67%) and 16 males (53.33%), refer to Table 1.

## Subjective Data Analysis

### VAS Intra-group Analysis

Group 1 yielded the following results for subjective data using the VAS, visit 1 resulted in a mean value of **5.46** (standard deviation = 1.59), visit 4 resulted in a mean value of **3.40** (standard deviation = 0.98) and visit 7 resulted in a mean value of **1.93** (standard deviation = 0.88). This resulted in a difference of the mean values at visit 1 and between visit 7 as being 3.53, thus a percentage change of 64.64% occurred, refer to Table 2.

Further intra-group analysis resulted in a p-value of **0.00** for Group 1; this was calculated using the Friedman Test. The value of **0.00** is **≤ 0.05**, which indicates there was a significant statistical change over time. Comparing the Mean Rank for the three tested consults showed a decrease from **2.93** for visit 1 to **1.07** for visit 7.

Group 2 yielded the following results for subjective data using the VAS, visit 1 resulted in a mean value of **5.40** (standard deviation = 1.05), visit 4 had a mean value of **3.20** (standard deviation = 0.94) and visit 7 resulted in a mean value of **0.93** (standard deviation = 0.96). The difference between the mean values at visit 1 and visit 7 was recorded at 4.46 thus a percentage change of 82.72% occurred, refer to Table 3.

Further intra-group analysis resulted in a p-value of **0.00** for Group 2; this was calculated using the Friedman Test. The value of **0.00** is **≤ 0.05**, which indicates there was a significant statistical change over time. Comparing the Mean Rank for the three tested consults showed a decrease from **2.93** for visit 1 to **1.00** for visit 7.

Post-Hoc tests, in which the Wilcoxon Signed Rank Test was performed, established that if there were differences over time, where did they occur. Group 1 produced a p-value of **0.00** between visit 1 and visit 4 and a p-value of **0.00** between visit 1 and visit 7. Group 2 produced a p-value of **0.00** between visit 1 and visit 4 and a p-value of **0.00** between visit 1 and visit 7. In both Group 1 and Group 2 between visits 1 and 4 and visits 1 and 7 the p-values were **≤ 0.05**, indicating there was a significant statistical change over time.

**VAS Inter-group Analysis**

Inter-group analysis between both groups was conducted using the Man-Whitney U Test, which yielded the following p-values: visit 1 resulted in a p-value of 0.74, visit 4 resulted in a p-value of 0.51 and visit 7 resulted in a p-value of **0.00**. For visits 1 and 4 the p-values were **> 0.05** it can then be assumed that the variance for these two visits were equal and the result is not significant. However, for visit 7 the p-value was **≤ 0.05** indicating there was a significant difference between the groups on the final visit.

**Objective Data Analysis**

**Cervical Range of Motion: Flexion**

The Shapiro-Wilk Test was performed to ascertain if the data was normally distributed across both Group 1 and Group 2. Results for Group 1: visit 1 yielded a p-value of 0.09, visit 4 yielded a p-value of 0.20 and visit 7 yielded a p-value of 0.25. Results for Group 2: visit 1 yielded a p-value of 0.34, visit 4 yielded a p-value of 0.31 and visit 7 yielded a p-value of 0.08. Thus across all three recorded visits and in both groups the p-values were **> 0.05**, and thus no statistically significant change occurred.

**Intra-group Analysis of Flexion**

The Friedman Test was used for comparative intra-group analysis. Descriptive statistics for Flexion ROM produced the following results: Group 1 had a 4.67° improvement from the initial visit, which had a recorded mean value of **61.60°** (standard deviation = 10.66), to the seventh visit, which had a recorded mean value of **66.27°** (standard deviation = 7.63). Group 2 improved by 6.13° from the first visit, which had a recorded mean value of **66.00** (standard deviation = 11.00) to the seventh visit, which had a recorded mean value of **72.13°** (standard deviation = 9.36), refer to Table 4.

The Friedman Test indicated that for Group 1 there was a p-value of 0.15, which is **> 0.05** suggesting that there was no statistically significant difference over time. Group 2 had a p-value of **0.01**, which is **≤ 0.05**. This suggests that there was a statistically significant difference over time for this group.

A comparison of the values recorded at the first and the fourth visits as well as a comparison between the first and seventh visits is shown by using the Wilcoxon Signed Rank Test. P-values for Group 2 were recorded as follows: comparison between the first and the fourth visits yielded a value of 0.70, thus no statistically significant difference was found. Comparison between the first and seventh visits yielded a p-value of **0.03**, which is **≤ 0.05**, thus it indicates a statistically significant difference.

**Inter-group Analysis of Flexion**

The Mann-Whitney U Test indicated that both Group 1 and Group 2 were comparable at all three data recording visits. At visit 1, a p-value of 0.29 was recorded, at visit 4 a p-value of 0.38 was recorded and at visit 7 a p-value of 0.10 was recorded. Thus all three visits yielded a p-value of **> 0.05**. As seen Table 4 there was a greater improvement of flexion for Group 2 (6.13°) compared to that of Group 1 (4.67°) over the course of the trial.

**Cervical Range of Motion: Extension**

The Shapiro-Wilk Test was performed to ascertain if the data was normally distributed across both Group 1 and Group 2. Results for Group 1: visit 1 yielded a p-value of 0.13, visit 4 yielded a p-value of 0.83 and visit 7 yielded a p-value of 0.52. Results for Group 2: visit 1 yielded a p-value of 0.95, visit 4 yielded a p-value of 0.61 and visit 7 yielded a p-value of 0.32. Thus across all three recorded visits the p-values were **> 0.05**, and thus no statistically significant change occurred.

**Intra-group Analysis of Extension**

Comparative intra-group analysis was performed using the Friedman Test. Descriptive statistics for Extension ROM produced the following results: Group 1 had 0.86° improvement from the initial visit, which had a mean result of **62.60**° (standard deviation = 9.94) to the seventh visit which had a mean result of **63.46**° (standard deviation = 8.60). Group 2 improved by 7.33° from the first visit, which had a mean result of **61.20**° (standard deviation = 14.77) to the seventh visit which had a mean result of **68.53**° (standard deviation = 9.89), refer to Table 5.

The Friedman Test indicated that for Group 1 there was a p-value of 0.42, Group 2 had a p-value of 0.09, which is **> 0.05** suggesting that there was no statistically significant difference over time for both groups.

**Inter-group Analysis of Extension**

The Mann-Whitney U Test indicated that both Group 1 and Group 2 were comparable at all three data recording visits. Visit 1 yielded a p-value of 0.58, visit 4 yielded a p-value of 0.38 and visit 7 yielded a p-value of 0.21. As seen in Table 5 there was a greater improvement of extension for Group 2 (7.33°) compared to that of Group 1 (0.86°) over the course of the trial.

**Cervical Range of Motion: Right Lateral Flexion**

The Shapiro-Wilk Test was performed to ascertain if the data was normally distributed across both Group 1 and Group 2. The following p-values were calculated for Group 1: visit 1 yielded a p-value of 0.59, visit 4 yielded a p-value of 0.65 and visit 7 yielded a p-value of 0.32 and for Group 2 the following p-values resulted: visit 1 yielded a p-value of 0.70, visit 4 yielded a p-value of 0.32 and visit 7 yielded a p-value of 0.61. Thus across all three recorded visits the p-values were **> 0.05**, and thus no statistically significant change occurred.

**Intra-group Analysis of Right Lateral Flexion**

Comparative intra-group analysis was performed using the Friedman Test. Descriptive statistics for Right Lateral Flexion ROM produced the following results: Group 1 had 3.93° improvement from the initial visit which had a mean result of **43.53**° (standard deviation = 8.96) to the seventh visit which had a mean result of **47.46°** (standard deviation = 6.69). Group 2 improved by 6.80° from the first visit which had a mean result of **48.13**° (standard deviation = 7.87) to the seventh visit which had a mean result of **54.93**° (standard deviation = 7.04), refer to Table 6.

The Friedman Test indicated that for Group 1 there was a p-value of 0.13, which is **> 0.05** suggesting that there was no statistically significant difference over time. Group 2 had a p-value of **0.00**, which is **≤ 0.05**. This suggests that there was a statistically significant difference over time for this group.

**Inter-group Analysis of Right Lateral Flexion**

The Mann-Whitney U Test was used to compare the two groups at specific time intervals, thus the following p-values were calculated at visits 1, 4 and 7. Visit 1 had a p-value of 0.14, visit 4 had a p-value of **0.00** and visit 7 had a p-value of **0.01**. As seen in Table 4.6 there was a greater improvement of right lateral flexion for Group 2 (6.80°) compared to that of Group 1 (3.93°) over the course of the trial.

**Cervical Range of Motion: Left Lateral Flexion**

The Shapiro-Wilk Test was performed to ascertain if the data was normally distributed across both Group 1 and Group 2 for Left Lateral Flexion. The following p-values were calculated for Group 1: visit 1 yielded a p-value of 0.22, visit 4 yielded a p-value of 0.83 and visit 7 yielded a p-value of 0.360 and for Group 2: visit 1 yielded a p-value of 0.219, visit 4 yielded a p-value of 0.160 and visit 7 yielded a p-value of 0.372. Thus across all three recorded visits the p-values were **> 0.05**.

**Intra-group Analysis of Left Lateral Flexion**

Comparative intra-group analysis was performed using the Friedman Test. Descriptive statistics for Left Lateral Flexion ROM produced the following results: Group 1 had 3.93° improvement from the initial visit which had a mean result of **43.93°** (standard deviation = 10.55) to the seventh visit which had a mean result of **47.86°** (standard deviation = 7.53). Group 2 improved by 7.07° from the first visit which had a mean result of **45.73°** (standard deviation = 7.16) to the seventh visit which had a mean result of **52.80°** (standard deviation = 7.39), refer to Table 7.

The Friedman Test indicated that for Group 1 there was a p-value of **0.03**, which is **≤ 0.05** suggesting that there was a statistically significant difference over time. Group 2 had a p-value of **0.00**, which is **≤ 0.05**. This suggests that there was a statistically significant difference over time for this group.

**Inter-group Analysis of Left Lateral Flexion**

The Mann-Whitney U Test was used to compare the two groups at specific time intervals, thus the following p-values were calculated at visits 1, 4 and 7. Visit 1 had a p-value of 0.69, visit 4 had a p-value of **0.01** and visit 7 had a p-value of 0.08. As seen in Table 4.7 there was a greater improvement of left lateral flexion for Group 2 (7.07°) compared to that of Group 1 (3.93°) over the course of the trial.

**Cervical Range of Motion: Right Rotation**

The Shapiro-Wilk Test was performed to ascertain if the data was normally distributed across both Group 1 and Group 2. Group 1: visit 1 yielded a p-value of 0.55, visit 4 yielded a p-value of 0.98 and visit 7 yielded a p-value of 0.79 and for Group 2: visit 1 yielded a p-value of 0.19, visit 4 = 0.74 and visit 7 yielded a p-value of 0.80. Thus across all three recorded visits the p-values were **> 0.05**.

**Intra-group Analysis of Right Rotation**

Comparative intra-group analysis was performed using the Friedman Test. Descriptive statistics for Right Rotation ROM produced the following results: Group 1 had 0.13° improvement from the initial visit which had a mean result of **68.00**° (standard deviation = 6.80) to the seventh visit which had a mean result of **68.13**° (standard deviation = 7.72). Group 2 improved by 3.20° from the first visit which had a mean result of **66.26**° (standard deviation = 8.31) to the seventh visit which had a mean result of **69.46**° (standard deviation = 6.82), refer to Table 8.

The Friedman Test indicated that for group 1 there was a p-value of 0.60, which is **> 0.05**. Group 2 had a p-value of 0.11, which is **> 0.05**. This suggests that there was no statistically significant difference over time for both groups.

**Inter-group Analysis of Right Rotation**

The Mann-Whitney U Test was used to compare the two groups at specific time intervals, thus the following p-values were calculated at visits 1, 4 and 7. Visit 1 yielded a p-value of 0.58, visit 4 yielded a p-value of 0.75 and visit 7 yielded a p-value of 0.73. As seen in Table 4.8 there was a greater improvement of right rotation for Group 2 (3.20°) compared to that of Group 1 (0.13°) over the course of the trial.

**Cervical Range of Motion: Left Rotation**

The Shapiro-Wilk Test was performed to ascertain if the data was normally distributed across both Group 1 and Group 2. Group 1: at visit 1 a p-value of 0.56 was recorded, at visit 4 a p-value of 0.66 was recorded and at visit 7 a p-value of 0.97 was recorded. For Group 2 at visit 1 a p-value of 0.72 was recorded, at visit 4 a p-value of 0.98 was recorded and at visit 7 a p-value of 0.58 was recorded. Thus across all three recorded visits the p-values were **> 0.05**.

**Intra-group Analysis of Left Rotation**

Comparative intra-group analysis was performed using the Friedman Test. Descriptive statistics for Left Rotation ROM produced the following results: Group 1 had 3.67°

improvement from the initial visit which had a mean result of **63.93°** (standard deviation = 7.82) to the seventh visit which had a mean result of **67.60°** (standard deviation = 6.28). Group 2 improved by 4.40° from the first visit which had a mean result of **63.86°** (standard deviation = 7.30) to the seventh visit which had a mean result of **68.26°** (standard deviation = 8.37), refer to Table 9.

The Friedman Test indicated that for Group 1 there was a p-value of **0.03**, which is **≤ 0.05** suggesting that there was a statistically significant difference over time. Group 2 had a p-value of 0.19, which is **> 0.05**. This suggests that there was no statistically significant difference over time for this group.

**Inter-group Analysis of Left Rotation**

The Mann-Whitney U Test was used to compare the two groups at specific time intervals, thus the following p-values were calculated at visits 1, 4 and 7. Visit 1 had a p-value of 0.73, visit 4 had a p-value of 0.35 and visit 7 had a p-value of 0.67. As seen in Table 4.9 there was a greater improvement of left rotation for Group 2 (4.40°) compared to that of Group 1 (3.67°) over the course of the trial.

**Intra-group Analysis of Pressure Algometer Measurements**

Descriptive statistics in the form of pressure algometer readings were recorded as follows for group 1: visit 1 resulted in a mean value of **2.86** $kg/cm^2$ (standard deviation = 0.83), visit 4 resulted in a mean value of **3.19** $kg/cm^2$ (standard deviation = 0.71) and visit 7 resulted in a mean value of **3.38** $kg/cm^2$ (standard deviation = 0.62). The difference between the first visit and the seventh visit was 0.52 $kg/cm^2$ resulting in a percentage increase of 18.39% seen in Table 10.

The Friedman Test further indicated that there was a p-value of **0.00** for Group 1, this being **≤ 0.05**. Thus there was a statistically significant change over time.

The following results were recorded for Group 2: visit 1 resulted in a mean value of **2.78** $kg/cm^2$ (standard deviation = 0.58), visit 4 resulted in a mean value of **3.11** $kg/cm^2$ (standard deviation = 0.60) and visit 7 resulted in a mean value of **3.62** $kg/cm^2$ (standard deviation = 0.80). The difference between the first visit and the seventh visit was 0.84 $kg/cm^2$ resulting in a percentage increase of 30.25% seen in Table 11.

The Friedman Test further indicated that there was a p-value of **0.00** for Group 2, this being **≤ 0.05**. Thus there was a statistically significant change over time.

The Wilcoxon Signed Rank Test was performed as a Post-Hoc test to establish where differences occurred over time. Group 1 produced a p-value of **0.03** between visit 1 and visit 4 and **0.00** between visit 1 and visit 7. Group 2 produced a p-value of 0.06 between visit 1 and visit 4 and **0.00** between visit 1 and visit 7. For Group 1 between visits 1 and 4 and visits 1 and 7 the p-values were **≤ 0.05**, indicating there was a statistically significant change over time. However, in Group 2 between visits 1 and 4 the p-value was 0.06, which is **> 0.05**, suggesting that there was no statistically significant change over time but between visits 1 and 7 the p-value was, **0.00**, which is **≤ 0.05**, indicating there was a statistically significant change over time for this period.

### Inter-group Analysis of Pressure Algometer Measurements

Inter-group analysis for both groups was conducted using the Mann-Whitney U Test, which yielded the following p-values: visit 1 yielded a p-value of 0.91, visit 4 yielded a p-value of 0.95 and visit 7 yielded a p-value of 0.49. For visits 1, 4 and 7 the p-values were **> 0.05** it can then be assumed that the variance for all three visits were equal. This suggests that there was no statistically significant difference between the two groups and thus statistically no treatment intervention was superior with regards to pain pressure threshold.

## DISCUSSION

### Demographic Data

The demographic data reflected no statistically significant difference in terms of age and gender and were therefore comparable. Participants in Group 1 ranged in age between 22 and 33 years of age, resulting in a mean age of **25.53.** The ages of participants in Group 2 ranged between 23 and 49 years, resulting in a mean age of **26.13.** Each group had a total of 15 participants, with Group 1 consisted of 8 females (53.33%) and 7 males (46.67%). Group 2 consisted of 6 females (40%) and 9 males (60%). Across the two groups there was a distribution of 14 females (46.67%) and 16 males (53.33%), refer to Table 4.1.

It is estimated that 45%-54% of the population have been affected by mechanical cervical spine pain, at some point in their lives. There is a possibility that within this percentile, some individuals may progress further to develop a disability. For any one individual the prevalence of developing idiopathic cervical spine pain in their lifetime is estimated at 67%-71%, indicating that two-thirds of the population will, at some point in their life, develop mechanical cervical spine pain (De Las Penas, Cuadrado, Simons & Pareja, 2007).

It has been reported than myofascial trigger points can result in or influence the development of mechanical cervical spine pain. Patients presenting with cervical spine pain commonly have active myofascial trigger points associated with their spinal dysfunction, this is generally not associated with healthy individuals with no type of cervical spine pain. Thus, it is essential that patients presenting with mechanical cervical spine pain be concurrently assessed for myofascial trigger point involvement (De Las Penas, Cuadrado, Arendt-Nielsen, Simons & Pareja, 2007).

A study was performed in 2001 in order to determine the incidence of, and association to episodic cervical spine pain over a one-year period. The result of this study indicated that the incidence of cervical spine pain fluctuated minimally between age groups partaking in the study. The participants' ages amply represent a portion of the population known to show minimal fluctuation regarding their age and incidence of mechanical cervical spine pain (Croft, Jayson, Lewis, Macfarlane, Papageorgiou, Silman & Thomas, 2001).

An occupation-related musculoskeletal disorder study discovered that 94% of the participants that took part presented with myofascial trigger points, 70% of which had trapezius myofascial trigger points (Gerwin, 2001). Mechanical cervical spine dysfunction symptoms have been linked to occupations that involve the following: work that is highly repetitive, static work postures and work that require movements and maintained positions above the shoulder level. This study was conducted at the University of Johannesburg Chiropractic Day Clinic based at the Doorfontein campus. As a result of the location of the research trials, majority of the participants were students or individuals who are involved with static work postures (Balogh, Ektor-Andersen, Hanson, Isacsson, Isacsson, Orbaek, Onstergren & Winkel, 2005).

**Subjective Data**

**Visual Analogue Scale**

A statistical analysis study was conducted by Tashjian, Deloach, Porucznik & Powell (2009), suggesting the minimal clinical important difference for VAS, measuring pressure pain threshold was 1.4 out of 10. Thus, Group 2 showed a clinically significant difference over the period of the trial. It is also clinically significant that both groups showed percentage changes of **64.64%** and **82.72%** respectively, as it is suggested that any change greater than **14%** is of statistical significance (Tashjian *et al*, 2009).

The results from the trial can also be compared to a study carried out by Ji *et al* (2012). In the study, 4 sessions of Shockwave therapy were performed on the trapezius muscle that showed symptoms of myofascial pain syndrome. The sessions were conducted over a two-week period. The study used a VAS for subjective readings and showed that the treatment group had a pre-test mean score of **4.91** and post-test mean score of **2.27** which resulted in a **26.4%** reduction in perceived pain levels (Ji *et al*, 2012).

Group 1 showed a decrease in perceived pain over time, based on the subjective data obtained from the trial. Ischaemic compression is defined as the application of pressure applied to a target tissue; with the pressure being maintained until the tissue resistance barrier releases and thus reduces the pain caused by the myofascial trigger point. The associated taut band is also disrupted and released (Ingber *et al*, 2008). Ischaemic compression when administered creates a disruption, which is mechanical in nature, of the locked actin-myosin myofibril cross links within the skeletal muscle fibre (Perle *et al*, 1999), resulting in the brain receiving decreased noxious stimuli via sensory afferent input. This mechanism occurs via the pain gate theory (Martin, 2008). Pain relief and decreased muscle spasm from ischaemic compression therapy has been linked with altered spinal reflex mechanisms (Ingber *et al*, 2008). Stimulation of relevant brain centres results in activation of the descending efferent fibres. These efferent fibres have the ability, at the initial synaptic level, to influence the afferent fibres, this being based on the pain gate theory (Melzack & Wall, 1965).

Initially blood supply is decreased temporarily when ischaemic compression is applied to the myofascial trigger point, this is in order to eventually increase local blood flow to the area. This in turn leads to the elimination of waste products, increasing local oxygen supply and ultimately allowing affected tissue to heal. This explains the mechanism whereby ischaemic compression reduces pain, thus substantiating the statistically significant improvement shown in Group 1 over the trial period (Arnau-Masanet *et al*, 2010).

The greater perceived pain decrease shown by Group 2 compared to that of Group 1 could be based on the different degrees of pressure demonstrated between that of ischaemic compression and Shockwave therapy. According to the pain gate theory, a greater applied pressure, produced by the shockwave, produces a greater pressure stimulus, offering an explanation for the greater clinical improvement seen in Group 2.
The greater applied by pressure from the shockwaves has a greater effect on the pain gate mechanism, which suggests that pressure receptors are more thickly myelinated and are notably longer when compared to pain receptors and pain fibres. Thus, pressure receptors have the ability to transmit pressure stimuli at a far more rapid rate than pain receptors are able to do so, thus closure of the gate to pain stimuli is facilitated (Tsao, 2007).

A study conducted by Sukubo, Tibalt, Respizzi, Locati & d'Agostino (2015) illustrated the effects of Shockwave therapy on macrophages and inflammation, with a focus on tissue regeneration and remodeling. In the study, classic macrophages (M1), which release pro-inflammatory cytokines and proteinase causing tissue damage and pain, are prevalent during the initial phase of inflammation. The Shockwave therapy inhibited these classic macrophages. Shockwave therapy was also described to have a synergistic effect on alternative macrophages (M2), which produce anti-inflammatory cytokines and interleukins that promote tissue healing and reduce pain, suggesting that Shockwave therapy may have a biological effect on myofascial trigger points and substantiates the greater decrease in perceived pressure pain of Group 2 compared to that of Group 1 (Sukubo *et al*, 2015).

Reduction of perceived pain levels, muscle spasm and tenderness of trapezius myofascial trigger points are due to the biological effects of Shockwave therapy. Angiogenesis and the elimination of excessive levels of calcium ions at the musculotendinous junction are caused by the energy crisis and local tissue ischaemia, which is promoted by the shockwave in the target tissue (Dommerholt & Huijbregts, 2010; Gerdesmeyer & Weil, 2007).

Spinal manipulative therapy is known to have biomechanical effects, resulting in a reduction of pain and associated muscle spasm produced by myofascial trigger points, this is known as the reflexogenic effect (Herzog, 2010). In a study by Herzog, Scheele & Conway (1999), spinal manipulative therapy affected the electromyography (EMG) activity of skeletal muscles in the underlying treatment area, suggesting spinal manipulation causes a reflex response. Hypotonic muscles relaxed and EMG activity decreased post spinal manipulation resulting in a decrease in pain (Herzog *et al*, 1999).

Both ischaemic compression therapy (Arnau-Masanet *et* al, 2010) and Shockwave therapy (Sukubo *et al*, 2015) in combination with spinal manipulation have the ability to increase local microcirculation to improve oxygen supply to the hypoxic cells. This can account for the statistical improvements obtained over time for both Group 1 and Group 2 with regards to perceived pain.

**Objective Data**

**Cervical Range of Motion**

The presence of an active myofascial trigger point in the upper trapezius muscle restricts range of motion and primarily restricts muscular stretching as a result of muscle tension due to a taut palpable band and essentially shortening and contraction of the muscle itself. Pain also causes a restriction of movement due to sensitised nociceptors found within the active myofascial trigger point. Increasing tension and passively stretching a functionally shortened muscle, generally results in pain (Travell *et al*, 1999).

Structural and functional alterations to cervical spine musculature may have adverse effects on the ability of these muscles to function optimally with regards to generating and sustaining cervical spine movements. Patients experiencing cervical spine pain that is mechanical in nature will at some point demonstrate altered neural control of surrounding cervical musculature. This altered neural control results in patients demonstrating restructuring of the muscle functioning patterns. Thus, in the presence of pain, redistribution of loads and forces between antagonistic and synergistic muscles must occur in order to compensate for altered neural control and the subsequent effects (Elliot & O'Leary, 2009).

Group 1 as well as Group 2 showed improved active cervical spine Flexion, clinically over the course of the study. The primary function of the trapezius muscle is to extend the cervical spine and the thoracic spine against resistance, this occurs when the muscle functions bilaterally. A stretch of the muscle is created when movement opposite to that of the defined action and function of a muscle occurs. By inactivating the active trapezius myofascial trigger point the taut palpable band was broken down and allowed for non-painful stretching (Travell *et al*, 1999).

The application of ischaemic compression and Shockwave therapy initiates a disruption of a mechanical nature to the locked actin-myosin myofibril cross-links present within a myofascial trigger point (Perle *et al*, 1999). Manual therapies such as ischaemic compression and Shockwave therapy attempt to restore full stretch length to the targeted muscle and will subsequently decrease the interaction of actin and myosin. This leads to decreased contractile activity, decreased metabolic demand and increased metabolic supply (Travell *et al*, 1999). However, even though both therapies have a commonality, it was Group 2 that had greater cervical spine Flexion and Extension improvements over the course of the study.

A study, in which the effects of ischaemic compression therapy on upper trapezius myofascial trigger points were investigated, concluded that ischaemic compression therapy demonstrated clinical and statistical improvements at a faster rate with more short-term improvements. This therefore supports the results reported on in this study with regards to the greater clinical and statistical improvement seen between the first and the fourth consultations for Group 1 with regards to Flexion (Shacksnovis, 2005).

In addition to the actions of Flexion and Extension, Hyuk, Choi, Park & Yoon (2007) reported that anatomically, the upper trapezius muscle produces the actions of Lateral Flexion to the homolateral side of contraction and contralateral Rotation, so after release of the myofascial trigger points of the trapezius muscle, neck Flexion, Lateral Flexion and Rotation ROM can be increased with relatively little effect upon extension. Active contraction and stretching of the trapezius muscle will improve when inactivation of the active trapezius myofascial trigger point occurs (Travell *et al*, 1999).

Shockwave therapy produces analgesic effects mainly due to a reduction in substance P within the target tissue as well as by causing a reduced synthesis of substance P in the dorsal root ganglia cells. This results from selective destruction of unmyelinated nerve fibres within the target zone of the radial shockwaves (Schmitz, 2010). This offers an explanation for the improvement seen in both groups during Right and Left Lateral Flexion of the cervical spine. However, it was Group 2 that showed a greater clinical improvement for both Right (6.80° improvement) and Left (7.07° improvement) Lateral Flexion compared to that of Group 1, which showed a 3.93° improvement for Right Lateral Flexion and 3.93° for Left Lateral Flexion.

If no other myofascial trigger points of the surrounding cervical spine musculature present with active myofascial trigger points but there is active upper trapezius myofascial trigger points presenting, there will be minimal restriction to rotational movements of the cervical spine. Both Group 1 as well as Group 2 showed a clinical improvement with regards to cervical spine Rotation, with Group 2 demonstrating a greater improvement. As stated above, there is usually minimal restriction of cervical spine Rotation and therefore the results obtained could be of little clinical significance.

Although a greater clinical improvement was obtained overall for active cervical spine range of motion with Shockwave therapy, a lack of statistical intra-group differences occurred during active cervical spine Extension and Rotation. Had a larger sample size been used or had more treatments been included in this study, the possibility for statistically significant values could have been more significant.

Statistical differences were lacking between the two groups (inter-group) for cervical ranges of motion in for: Flexion, Extension and Rotation. This may have resulted, as both treatment protocols are seemingly effective in the breakdown of myofascial trigger points due to their specific mechanisms. Both treatment protocols equally inactivating the myofascial trigger point. A small sample size may also result in no clear statistical difference between the two groups, thus no treatment protocol was seen to be statistically significant when compared to the other.

Further concepts need to be considered to account for the deficiency of statistically significant differences seen in both groups with active cervical spine range of motion. The following needs to be considered: cervical spine musculature and its influence on range of motion of the cervical spine (Penning, 1978), cervical spine movements and its normal ranges (Magee, 2008), postural effects on range of motion (Gerwin, 2001) as well as similar evidence-based findings, when considering a lack of statistical differences (Eyadeh, Khamees, Kondeva & Hussein, 2004).

The arrangement of the cervical spine musculature is of particular importance. Muscles located in the upper cervical spine region are arranged independently and are in a specific, ordered direction, whereas cervical spine muscles that are situated in the lower aspects, are arranged in a somewhat interconnected manner. Thus, specific movements occur as a result of the actions of the upper cervical spine musculature while united and uniformly combined movements occur due to the lower cervical spine musculature, implying that upon activation this musculature action has the ability to move multiple segments (Penning, 1978).

Effective and efficient function of a muscle is deterred when a muscle that has a myofascial trigger point present within it. This exists due to the fact that the associated taut band restricts the muscles ability to stretch, ultimately decreasing the range of motion (Gerwin, 2001).

Mechanical cervical spine pain may be a result of either cervical spine or shoulder musculature containing myofascial trigger points. Myofascial trigger points that cause mechanical cervical spine pain as a result of postural stresses is of particular interest. An individual presenting with anterior head carriage and a rounded shoulder posture is exposed to postural stresses (Gerwin, 2001). Cervical spine range of motion is significantly influenced by posture, as the individual's initial posture has an effect on the three-dimensional biomechanics of the cervical spine (Edmondston, Henne, Ostvold & Loh, 2005). Participants were seated when cervical spine range of motion was assessed with the CROM goniometer it needs to be considered that postural alterations mentioned above may account for lack of statistically significant differences seen in cervical range of motion.

A study performed by Moussavi (1997), found that although increases in cervical spine active ranges of motion occurred with treatment of upper trapezius myofascial trigger points, none of the values were statistically significant. In concluding, Moussavi determined that only myofascial trigger points of the upper trapezius muscle were treated and cervical spine range of motion was limited prior to and post treatment. Eyadeh *et al* (2004) stated that pain is generally caused by active myofascial trigger points while the presence of latent myofascial trigger points restricts active range of motion, as well as causes muscle weakness. Based on this statement, cervical spine musculature, other than the upper trapezius muscle, which presented with a latent myofascial trigger point may have prevented the improvement of cervical spine range of motion seen in Group 1.

Spinal manipulation therapy when applied to the cervical spine and cervico-thoracic junction levels, or any restricted joint segment, reduces pain as well as improves range of motion and restores joint mobility. The intervertebral foraminal spaces are increased during spinal manipulation, therefore reducing pressure on nerve roots, resulting in improved nerve supply and neurological function to the skeletal muscle, in this case the trapezius muscle (Bergman & Peterson, 2011; Gatterman, 2005).

Clinical results indicate that both treatment protocols with the addition of Chiropractic manipulations are effective in improving range of motion. A study conducted by Martinez-Segura, Fernadez-de-las-penas, Ruiz-saez, Lopez-Jimenez & Rodriguez-Blanco (2006) supports this, in which mechanical neck pain and active range of motion were assessed. The immediate effects following a single cervical high-velocity, low-amplitude manipulation were investigated. Results of the study showed significant improvement in neck pain as well as increased cervical spine Flexion, Extension, bilateral Lateral Flexion and bilateral Rotation post manipulation. Capsular mechanoreceptors, muscle tone and the pain gate mechanism are affected by Chiropractic manipulation (Murphy, 2000). Chiropractic manipulation involves the application of a high velocity thrust, applied to a restricted joint motion segment; this manoeuver activates Golgi tendon organs, which inhibit muscle activity reducing muscle spasm (Gatterman, 2005).

**Pressure Algometer**

A pressure algometer can be utilised as a means of quantitatively assessing the presence of myofascial trigger points and the associated pressure pain threshold of that individual (De Las Penas, Campo, Carnero & Miangolarra-Page, 2005). Pressure pain threshold is the minimal pressure value that causes pain (Ylinen, 2007). As shown by the subjective data results from this trial, both ischaemic compression therapy and Shockwave therapy proved to be effective with regards to perceived pain relief.

Clinical improvements were noted on both the treated side as well as the non-treated side and seen in both groups. Active myofascial trigger points may lead to peripheral sensitisation of surrounding muscle nociceptors primarily due to increased levels of algogenic substances and decreased pH levels both of which are unique to active myofascial trigger points (De Las Penas *et al*, 2007).

A functionally related myofascial trigger point may develop in the contralateral upper trapezius muscle as a result of an active myofascial trigger point on the symptomatic side. Treatment of the active upper trapezius myofascial trigger point leads to the inactivation of the satellite myofascial trigger point (Travell *et al*, 1999). Clinical improvements noted on the treated side as well as on the non-treated side in both groups can account for this.

A 2005 study by Shacksnovis compared myofascial manipulation and ischaemic compression of upper trapezius myofascial trigger points. In the study it was concluded that myofascial manipulation was a better treatment option when compared to ischaemic compression, with regards to increasing pressure pain threshold. This result occurred as ischaemic compression requires a slow sustained stretch, which may lead to irritation of the active myofascial trigger point prior to resolution of symptoms. Ischaemic compression requires applied pressure at a tolerable pain limit in order to avoid producing excessive pain, which would ultimately affect the pressure pain threshold (Kannan, 2012).

A pilot study performed by De Las Penas, Alonso-Blanco, Fernandez-Carnero & Miangolarra-Page (2006) was carried out to determine the effect of ischaemic compression on the tenderness of active myofascial trigger points. Improvements in the pressure pain threshold of the participants were noted and it was concluded that ischaemic compression was an effective form of therapy to reduce the pain experienced by individuals as a result of active myofascial trigger points. In 2008, a study was conducted by Gemmel, Miller & Nordstrom, to investigate the short-term effect of ischaemic compression when applied to active upper trapezius myofascial trigger points, in this study it was concluded that clinically, ischaemic compression effectively increased pressure pain threshold.

Intra-group analysis showed statistically significant improvements suggesting that ischaemic compression and Shockwave therapy are effective manual therapies for increasing pressure pain threshold of study participants. Both therapies have various effects and advantages. In both groups pressure was applied to the active trapezius myofascial trigger point, as seen in Group 1 via the use of applied thumb pressure and in Group 2 via the Shockwave applicator.

Essentially an explanation for the lack of a statistically significant difference during the inter-group analysis for Pressure Algometer readings can be attributed to the fact that both ischaemic compression and Shockwave therapy are clinically effective in increasing the pain threshold over a treated active trapezius myofascial trigger point. Varying degrees of pressure when applied, as in ischaemic compression and Shockwave therapy and with taking the pain gate theory into account, has the ability to influence the pain gate mechanism. Pressure receptors transmit pressure stimuli more rapidly than that of pain receptors, facilitating the closure of the gate to pain stimuli (Tsao, 2007). Applying pressure to the surface of the skin overlying the active trapezius myofascial trigger point as done in both Group 1 and Group 2, accounts for a clinical improvement seen in both groups.

## CONCLUSION

Subjective data readings in the form of the VAS indicated that on average participants in both groups had reductions in subjective pain levels. However, it was the Shockwave therapy group that yielded a greater improvement in terms of subjective pain levels over the course of the trial.

Objective data analysis was also conducted, this being done with use the use of a CROM device and a pressure algometer. Data analysis revealed that statistically in both groups participants had improvements in all ranges of motion. With regards to pressure algometer readings, again statistically both groups showed an improvement over the course of the trial, with participant's pain pressure thresholds decreasing and thus pain tolerance improving. There was no significant difference between the two groups and thus statistically no treatment intervention was superior with regards to pain pressure threshold.

Both treatment protocols had positive clinical effects on the participants. Subjectively the participants, on average, experienced a decrease in perceived pain. Objectively both the CROM measurements and the Pressure Algometer readings decreased throughout the trial period, this was noted in both groups. This suggests that although both treatment protocols had positive effects on participants over the trial, neither treatment protocol had definitive statistical improvements compared to the other in the treatment of mechanical neck pain with associated trapezius myofascial trigger point involvement. Thus to conclude, both ischaemic compression therapy and Shockwave therapy in conjunction with cervical and upper thoracic spinal manipulations can be used to effectively treat mechanical neck pain with associated trapezius myofascial trigger point involvement.

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**FIGURES**

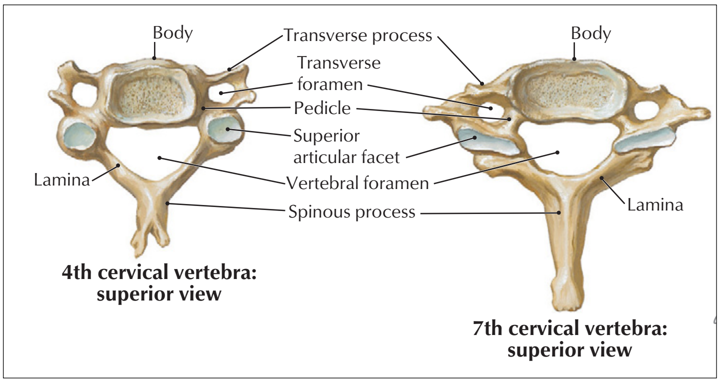


**Figure 1: Representation of the 4th and 7th Cervical Vertebrae (Netter, 2011)**

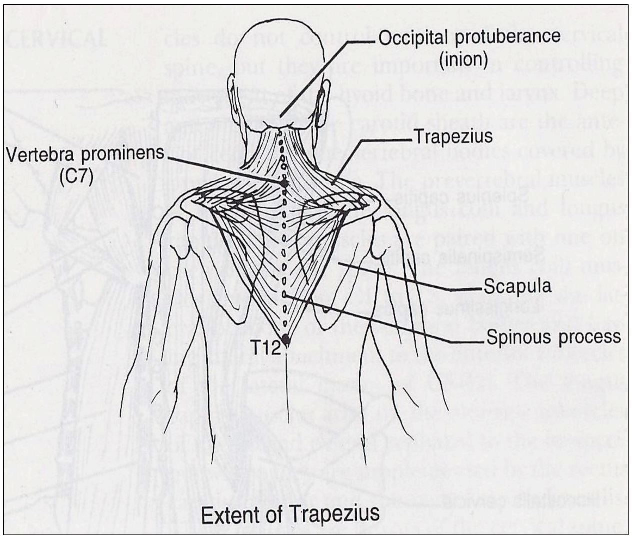


**Figure 2: Trapezius Muscle (Boeinstein, Wiesel & Bodein, 1996)**

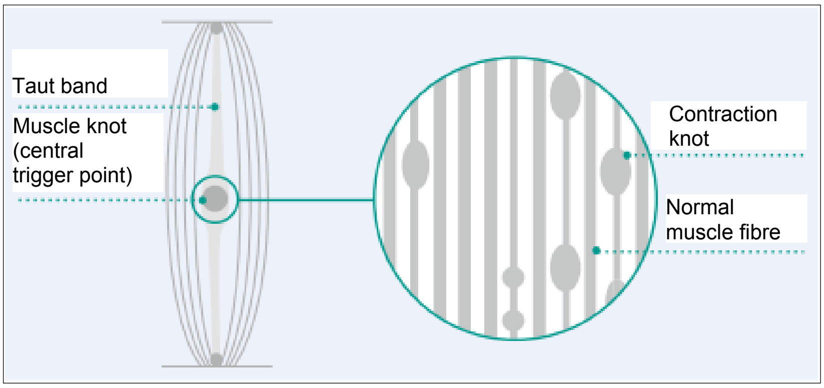


**Figure 3: Trigger point complex located in a section of muscle fibre (Travell *et al*, 1999 (Modified))**

**TABLES**

Table 1: Demographic Data for Groups 1 and 2

| | Gender Percentage (%) | | Age Demographic | | |
|---|---|---|---|---|---|
| | **Female** | **Male** | **Minimum** | **Maximum** | **Mean** |
| **Group 1** | 53.33 | 46.67 | 22 | 33 | 25.53 |
| **Group 2** | 40 | 60 | 23 | 49 | 26.13 |

Table 2: Demonstrates Intra-group Analysis of VAS Readings for Group 1

| Visit | Minimum | Maximum | Mean | Percentage Change (%) |
|---|---|---|---|---|
| 1 | 2 | 5 | 5.46 | 0 |
| 4 | 2 | 5 | 3.40 | 37.81 |
| 7 | 1 | 3 | 1.93 | 64.64 |

Table 3: Demonstrates Intra-group Analysis of VAS Readings for Group 2

| Visit | Minimum | Maximum | Mean | Percentage (%) |
|---|---|---|---|---|
| 1 | 4 | 7 | 5.40 | 0 |
| 4 | 2 | 5 | 3.20 | 40.74 |
| 7 | 0 | 3 | 0.93 | 82.72 |

Table 4: Demonstrates Data Analysis of Cervical Range of Motion in Flexion

| | | Group 1 | Group 2 |
|---|---|---|---|
| **Visit 1** | Mean (°) | 61.60 | 66.00 |
| | Standard Deviation | 10.66 | 11.00 |
| **Visit 4** | Mean (°) | 63.73 | 67.20 |
| | Standard Deviation | 10.87 | 8.51 |
| **Visit 7** | Mean (°) | 66.26 | 72.13 |
| | Standard Deviation | 7.63 | 9.36 |

Table 5: Demonstrates Data Analysis of Cervical Range of Motion in Extension

| | | **Group 1** | **Group 2** |
|---|---|---|---|
| **Visit 1** | Mean (°) | 62.60 | 61.20 |
| | Standard Deviation | 9.94 | 14.77 |
| **Visit 4** | Mean (°) | 62.40 | 65.86 |
| | Standard Deviation | 9.20 | 11.50 |
| **Visit 7** | Mean (°) | 63.46 | 68.53 |
| | Standard Deviation | 8.60 | 9.89 |

Table 6: Demonstrates Data Analysis of Cervical Range of Motion in Right Lateral Flexion

| | | **Group 1** | **Group 2** |
|---|---|---|---|
| **Visit 1** | Mean (°) | 43.53 | 48.13 |
| | Standard Deviation | 8.96 | 7.78 |
| **Visit 4** | Mean (°) | 43.20 | 52.13 |
| | Standard Deviation | 5.89 | 6.16 |
| **Visit 7** | Mean (°) | 47.46 | 54.93 |
| | Standard Deviation | 6.69 | 7.04 |

Table 7: Demonstrates Data Analysis of Cervical Range of Motion in Left Lateral Flexion

| | | **Group 1** | **Group 2** |
|---|---|---|---|
| **Visit 1** | Mean (°) | 43.93 | 45.73 |
| | Standard Deviation | 10.55 | 7.16 |
| **Visit 4** | Mean (°) | 44.93 | 51.46 |
| | Standard Deviation | 7.08 | 7.98 |
| **Visit 7** | Mean (°) | 47.86 | 52.80 |
| | Standard Deviation | 7.53 | 7.39 |

Table 8: Demonstrates Data Analysis of Cervical Range of Motion in Right Rotation

| | | Group 1 | Group 2 |
|---|---|---|---|
| **Visit 1** | Mean (°) | 68.00 | 66.26 |
| | Standard Deviation | 6.80 | 8.31 |
| **Visit 4** | Mean (°) | 67.06 | 67.73 |
| | Standard Deviation | 7.99 | 7.66 |
| **Visit 7** | Mean (°) | 68.13 | 69.46 |
| | Standard Deviation | 7.72 | 6.82 |

Table 9: Demonstrates Data Analysis of Cervical Range of Motion in Left Rotation

| | | Group 1 | Group 2 |
|---|---|---|---|
| **Visit 1** | Mean (°) | 63.93 | 63.86 |
| | Standard Deviation | 7.82 | 7.30 |
| **Visit 4** | Mean (°) | 67.06 | 65.06 |
| | Standard Deviation | 5.94 | 7.74 |
| **Visit 7** | Mean (°) | 67.60 | 68.26 |
| | Standard Deviation | 6.28 | 8.37 |

Table 10: Demonstrates Intra-group Analysis of Pressure Algometer results for Group 1

| Visit | Minimum ($kg/cm^2$) | Maximum ($kg/cm^2$) | Mean ($kg/cm^2$) | Percentage (%) |
|---|---|---|---|---|
| 1 | 2 | 5 | 2.86 | 0 |
| 4 | 2 | 5 | 3.19 | 11.78 |
| 7 | 2 | 5 | 3.38 | 18.39 |

Table 11: Demonstrates Intra-group Analysis of Pressure Algometer results for Group 2

| Visit | Minimum ($kg/cm^2$) | Maximum ($kg/cm^2$) | Mean ($kg/cm^2$) | Percentage (%) |
|---|---|---|---|---|
| 1 | 2 | 4 | 2.78 | 0 |

| | | | | |
|---|---|---|---|---|
| 4 | 2 | 4 | 3.11 | 12.17 |
| 7 | 2 | 5 | 3.62 | 30.25 |

**AUTHOR DECLARATION**

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome. We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

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**Author Agreement**

I, Malany Moodley, the corresponding author, certify that all authors have seen and approved the manuscript being submitted.

The article submitted is the authors' original work, has not received prior publication and is not under consideration for publication elsewhere.

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**100 WORD ABSTRACT**

**Purpose:** The aim of the study was to compare the effectiveness of Chiropractic manipulation and ischaemic compression against Chiropractic manipulation and Shockwave therapy.

**Method:** 30 participants between the ages of 18 – 50 years were recruited for this study, all presenting with mechanical neck pain caused by an active myofascial trapezius trigger point.. Group 1 received Chiropractic manipulative therapy and ischaemic compression. Group 2 received Chiropractic manipulative therapy and Shockwave therapy.

**Results:** Both treatment protocols had positive clinical effects on the participants. Subjectively the participants experienced a decrease in perceived pain. Objectively data readings decreased throughout the trial period in both groups.

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**Full Title: The Effectiveness of Chiropractic Manipulation and Ischaemic Compression versus Chiropractic Manipulation and Shockwave therapy on Trapezius Trigger Points**

**8 Word Title: Ischaemic Compression vs. Shockwave therapy on Trapezius Trigger Points**


**Key Words: Chiropractic, manipulation, Shockwave therapy, ischaemic compression, neck pain, myofascial**