The Effect of a Muscle Energy Stretch on Suboccipital Tenderness.

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ABSTRACT

Background and Objective: Muscle energy technique (MET) is commonly advocated by authors of manual therapy as a means of treating spinal pain and dysfunction, but there is little evidence of its role in pain modulation. This controlled and single blinded study aimed to investigate the effect MET on pressure pain thresholds (PPT) in the suboccipital musculature in an asymptomatic population.

Methods and Measures: Fifty-five participants asymptomatic for neck pain were included in the study. PPT measurements were recorded on a centrally located position in the suboccipital region using an electronic pressure algometer immediately before treatment, and at 5-minutes and 30-minutes post-treatment. Participants were randomly allocated into either the MET group, which received an MET stretch applied to the suboccipital muscles bilaterally, or the control group, which consisted of a 30-second of a sham 'functional' technique.

Results: A split-plot ANOVA (SPANOVA) revealed significant changes in PPT over time ($F_{2,\ 106}$=4.9, *P*=0.01), but not between the groups over time ($F_{2,106}$ = 0.89, *P*=0.42). Further analysis using paired *t*-tests revealed significant differences between the initial and 5-minute post-treatment PPT and between the initial and 30-minute post-treatment PPT for the MET group (*P*<0.01 and *P*<0.03 respectively), but not for the control group at the same intervals (*P*=0.35 and *P*=0.21). Calculation of effect sizes for the MET group revealed a medium effect at both 5 and 30-minutes (d=0.67 and d=0.43), but small effect sizes were calculated for the control group (d=0.19 and d=0.26).

Conclusion: While MET appeared to have some immediate impact on pain threshold, the changes in PPT were not great enough to be significantly different from the sham control. Further studies are recommended to explore the impact of MET on pressure pain thresholds and self-reported pain in symptomatic subjects.

Key Words: Stretching, isometric, algometry, suboccipital, osteopathy.

INTRODUCTION

Muscle energy technique (MET) differs from many manual techniques in that it is an active technique requiring the patient to contribute the corrective force.[1] One author of manual therapy claims that it is one of the most valuable treatment techniques because of the many therapeutic benefits resulting from a single procedure, including lengthening and strengthening muscles, increasing fluid mechanics and decreasing local oedema, and for mobilising a restricted articulation.[1] MET is also claimed to be useful for reducing pain and disability.[2-4]

MET involves the voluntary contraction of patient muscle in a precisely controlled direction, at varying levels of intensity and against a distinctly executed counterforce which is applied by the operator.[1] MET has been advocated as a safer alternative option to high velocity low amplitude (HVLA) techniques.[1, 5, 6] Bourdillion et al[5] warned against the use of HVLA in the upper cervical spine and suggested use of MET as a more gentle approach to treatment in this region. McPartland et al[6] stated that non-thrusting techniques such as MET may better serve areas such as the suboccipital region, cautioning that a poorly executed high velocity thrust may critically damage the suboccipital tissues. Concerns for safety have also been expressed by numerous authors in relation HVLA and the upper cervical spine, as there is potential for such a thrust technique to damage the vertebro-basilar artery.[5-7,8] As such is it imperative to determine the effectiveness of more gentle manual techniques for treating these regions.

With origins of the technique claimed to extend back to the days of A.T Still,[7] who first proposed his philosophy and practice of osteopathy in 1874,[1] and then developed and popularised by Mitchell[1], it is remarkable that research relating to MET is so limited. Of the few studies published to date, most have examined the effect of MET for increasing flexibility and range of motion[9-13]. However, since pain and discomfort are very commonly the symptoms presenting to a manual therapist, it is important to determine the potential of MET for pain relief.

Wilson et al[2] examined the effects of MET in patients with acute low back pain. These researchers examined whether patients with low back pain would demonstrate a greater reduction in disability, as assessed by the Oswestry Disability Index (ODI), after being treated with MET treatment coupled with supervised neuromuscular re-education and resistance training as compared to those treated with supervised neuromuscular re-education and resistance training alone. Wilson et al[2] found that every patient in the MET group had a higher change in ODI scores than patients in the control group, and that the addition of MET improved the ODI scores substantially, with mean percentage change for the MET group being 83%, compared to 65% for the control group. The ODI is one of most frequently used tools in back pain research and consists of 10 sections measuring a variety of activities of daily living as well as pain intensity. [29] The present study aims to determine the effect of MET on pain intensity through the use of an alternative research tool.

Cassidy et al[14] investigated the effects of MET and HVLA manipulation of the cervical spine in subjects with neck pain on both pain and cervical range of motion. The researchers used a 101-point numerical rating scale to measure pain and found that both treatments reduced pain; however, the change was larger in the manipulation group. This study demonstrates the potential of MET for pain relief in the cervical spine and therefore justifies the need for continuing research into non-thrusting techniques to ensure safe and effective practice of manual therapists.

One region of particular clinical importance when assessing and treating the cervical spine is the suboccipital region, which includes the atlanto-occipital joint and the suboccipital muscles.[15-17] Various authors have implicated the suboccipital muscles not only as a cause of upper cervical pain, but also as a cause of chronic headaches.[5,15-17] The suboccipital muscles extend from C1 and C2 to the occiput, including rectus capitis posterior major, rectus capitis posterior minor, obliquus capitis superior and obliquus capitis inferior. Their actions include extension of the head on C1, or rotation the head on C1 and C2.[18]

McPartland et al[5] reviewed the clinical importance of the rectus capitis posterior minor (RCPMn) muscle in balance and pain. These authors suggested that the high density of muscle spindles found in the RCPMn may indicate that the value of these muscles lies not only in their motor function, but also in their role as “proprioceptive monitors” of the head and cervical spine. McPartland et al[5] proposed that dysfunction of this muscle may disrupt its role in proprioception and therefore may be clinically significant. Dysfunction in the suboccipital muscles has been claimed to arise from any trauma that causes sudden or extreme movement of the head, or simply from chronic postural stresses, such as those occurring during slouching and the typical "chin poking" posture.[5] Hallgren et al[15] examined patients with chronic headaches and neck pain using MRI and found that some individuals exhibited replacement of suboccipital skeletal muscle with fatty tissue. Hallgren et al[15] hypothesised that this may result in a decrease of muscle spindle and Golgi tendon organ density, with a decrease in proprioceptive information transmitted to the central nervous system (CNS), which may result in postural destabilisation.[15] While cervical proprioception is recognised as an essential component in maintaining balance[5], adequate treatment of the region is imperative, especially when treating the elderly community.

Both Hallgren et al[15] and McPartland et al[5] also recognised the possible importance of the spinal gate theory of pain with relationship to suboccipital atrophy and chronic pain. According to the spinal gate theory, mechanoreceptor input entering the dorsal horn cells in the spinal cord may act as a "gate" that can modulate and inhibit incoming nociceptive information.[5,15] A substantial decrease in the proportion of proprioceptive activity from the affected muscles may therefore result in greater perception of pain by the patient.[15] As such it would seem that the effect of MET in the suboccipital region may be superior to many other techniques as it can strengthen atrophied muscles resulting in greater proprioception while also modulating excessive pain signals. Further testing into the effects of MET on pain is therefore imperative.

Accurate measurement and analysis of pain levels in individuals can often be difficult due to the subjective nature of the sensation. The visual analogue scale and pain and disability questionnaires, such as the McGill and Oswestry surveys, are commonly used and validated research tools implemented as a means of monitoring patient progress.[19,20] An alternative method of evaluating pain and tenderness lies in the use of pressure algometry. Used by many researchers,[21-26] the algometer works as a pressure gauge that quantifies the amount of pressure required to produce pain by giving a value to the pressure-pain threshold (PPT) in an individual. The PPT refers to the point at which the force being applied first causes a change in sensation from pressure to pain.[21-26]

The reliability of measuring PPTs on bony landmarks and muscles has been verified by numerous researchers.[21-26] Nussbaum et al[21] reported almost perfect reliability for measurement of PPT within and across 3 days when assessing for PPTs in the biceps brachii muscle. Nussbaum et at[21] also concluded that reliability was enhanced when all measurements were taken by one examiner. Similarly, Keating et al[22] reported that reproducibility of PPTs in the cervical and thoracic levels were excellent (ICC>0.9) and good at the level of the lumbar spine (ICC=0.84), but standard deviations were relatively large. Keating et al[22] compared PPTs between different spinal regions and found that the mid-thoracic segments were less tender than the cervical segments, but more tender than lumbar segments.

Fryer et al[23] adopted the use of pressure algometry as a tool for measuring the efficacy of mobilisation and manipulation in the thoracic spine in asymptomatic subjects. These researchers found that both procedures increased the PPT readings; however mobilisation produced a greater immediate improvement in PPT.

Although MET is commonly advocated by authors of manual therapy for treatment of somatic dysfunction and muscle pain, there remains little research into the effects of MET on pain and tenderness.[2-6] Previous studies have measured PPTs as a means of investigating the efficacy of manual techniques in the lumbar and thoracic spine in asymptomatic groups.[2, 23] The present study aimed to determine the effect of MET applied to the suboccipital muscles on PPTs in the suboccipital region.

METHOD

Subjects

Fifty-five asymptomatic volunteers were recruited from a population of student osteopaths at the Victoria University (mean age 23 ± 5 including 16 males and 39 females). Testing was performed in the Victoria University Osteopathic Clinic.

Participants were screened and excluded if they suffered from any cervical pathology or a current neck complaint which was determined by administration of treatment for a neck complaint in the three days prior to this testing. All participants were informed of the nature of the study, procedures to be used and any risks that may occur throughout the study and signed a consent form. This study received approval from the Victoria University Human Research Ethics Committee.

Measurement of Pressure Pain Thresholds

An electric algometer (Somedic Algometer II, Sweden) with a built-in pressure transducer with a display screen, that displayed the rate and amount of pressure applied, was used to measure PPTs (Figure 1). The algometer was calibrated prior to testing and the same researcher took all PPT measurements. The algometer was fitted with a 1cm2 rubber tip to allow easy stabilisation of the probe in the suboccipital region.

Figure 1: The algometer

The procedure for measurement of the PPTs was identical to the methods used by Keating et al[22] and Fryer et al[23] except for the location of the measurement. The participant was positioned prone on the treatment table and the head of the table was adjusted slightly to introduce some cervical flexion, reducing the lordotic curve of the region and allowing for greater access to the upper cervical spine. The probe of the algometer was angled at 90° to the cervical spine and the tip was placed on a central point located in suboccipital region found to be most sensitive to palpation (Figure 2). Pressure was applied at a steady and consistent rate of 30kPa/second, as displayed on the screen. Participants were instructed to press a hand-held button when they perceived the sensation first change from pressure to discomfort, and this pressure reading was recorded as the PPT. Three measurements were taken on the same location with an interval of 20 seconds between each reading. The PPT was calculated according to PPT calculations conducted in studies by Keating et al[22] and Fryer et al[23], where the PPT measurement used in the analysis was the mean of three trials.

Figure 2: Measurement of pressure pain threshold using the algometer

Pilot Reliability Study

In order to determine the reliability of PPT measurement of the suboccipital region, a pilot study was conducted involving 20 participants. PPT measurements were performed as previously described. PPT measurements were recorded on 20 participants, and repeated 5 minutes and 30 minutes later. The mean differences from the initial PPT measurement to the 5-minute and 30-minute PPT measurements were small (7kPa, SD=43 and 11kPa, SD=52 respectively). The measurement procedure appeared to be highly reliable, producing an average measure ICC = 0.96. The error range of the measurement procedure (mean difference and SD) was calculated to be 50kPa (5-minutes) and 63kPa (30-minutes).

Procedure

A brief demonstration of the PPT measurement was conducted on the participant's forearm, and they were instructed to push the button when the pressure first became a discomfort. The participant then lay prone on the treatment table with the cervical region exposed. Researcher 1 identified sensitive area located centrally in the suboccipital region and performed measurement of the PPT using the algometer.

Researcher 2 recorded the PPT readings and calculated the mean from the 3 measurements.

Following the initial PPT readings, participants were directed to another room where they were allocated into the treatment or control group by lottery draw by researcher 3 (a registered osteopath), who performed all treatments. On completion of the treatment, participants returned to the measurement room for re-testing of the PPT. Movement of participants between testing was part of the procedure that was adopted by each group in order to reduce the influence it may have in creating error. However it was also considered that if walking a short distance between treatment rooms could have such an influence on the effectiveness of a technique, then application in the clinical setting seems redundant if the effects would have worn off by the time the patient walked to the reception area.

Researchers 1 and 2 were blinded to the group allocation of all participants. Participants were asked to remain in the clinic for the final measurement that was conducted at 30-minutes post treatment.

Treatment Interventions

Muscle Energy Technique

Those participants allocated to the MET treatment group were requested to lie supine on the treatment table. With the practitioner standing at the head of the table, an MET stretch was applied to the suboccipital and trapezius muscles on both the left and right sides. Hand contact was made with the base of the occiput with one hand, while the other hand stabilised the shoulder (Figure 3). The head and neck were positioned in flexion and slight side bending to the opposite side until the participant perceived a stretch in the suboccipital region. The participant was instructed to gently push their head back against the practitioners' resistance as if to lay their head back on the pillow.[27] Contraction was held for around 3-5 seconds and was followed by a period of relaxation. When the tissues relaxed, the practitioner then took up the slack to the new point of resistance. This was performed randomly 3 times on each side.

Sham Functional Technique (Control)

The control group received a modified version of a functional technique. Correctly applied, this indirect technique involves taking the joint away from a barrier to a position of ease and waiting for a release in the surrounding tissues.[1] For the purpose of this study, the practitioner introduced minimal positioning and did not engage any barrier or position of ease. A neutral position was maintained for 30 seconds.

Figure 3: MET stretch applied to the suboccipital muscle

Statistical Methods

Data was collated using Microsoft Excel and analysed using SPSS Version 11. Changes in PPT over time and between the groups were analysed with a split-plot ANOVA (SPANOVA). Within-group changes between pre-, 5-minutes post and 30-minutes post MET were also analysed using paired *t*-tests. Within-group effect sizes were calculated using Cohen's *d*. Effect sizes can be interpreted as small when d=0.2, medium when d =0.5 and large when d =0.8.[28]

RESULTS

Mean PPT values shown in Table 1 indicate that the greatest change occurred in the MET group between the initial and 5-minute post treatment readings (42.03kPa), with a relatively large change also occurring from initial to 30-minutes post treatment (30kPa). When analysed with SPANOVA, there was a significant difference over time ($F_{2, 106}$=4.86, P=0.01), though not between the groups over time (F=$_{2,106}$ = 0.89, P=0.42). Furthermore a very small between group effect size was calculated (Partial Eta Squared = 0.00). Statistical analysis using paired t-tests demonstrated that there was a statistically significant improvement in PPT values after 5 minutes and 30 minutes where P=0.01 and P=0.03 respectively, however these results become irrelevant as values were within the measurement error range of 50kPa (5-minutes) and 63kPa (30-minutes). Medium pre-post effect sizes were calculated for both intervals (*d*=0.67 and *d*=0.43).

A small increase in PPT was observed in the control group between both the initial and 5 minute and the initial and 30 minute groups with mean changes of 15.88kPa and 16.12kPa respectively, however again changes were well within the error range of the measurement procedure. There was not significant difference at either interval (*P*=0.35 and *P*=0.21) and small effect sizes were calculated for both (*d*=0.19 and *d*=0.26).

***Table 1*: Mean (SD) PPT values (kPa)**

	Pre	Post 5-minutes	Post 30-minutes
MET	340.63 (166.94)	382.67 (158.29)	370.63 (182.17)
Control	352.56 (155.76)	368.44 (208.16)	368.68 (192.62)

Table 2: Mean differences, (SD), P values (t-tests) and Effect sizes (Cohen's d)

	Mean differences	*P*	Effect Size (d)
preMET - MET-5	-42.03 (62.37)	0.001*	0.67†
preMET - MET-30	-30.00 (69.53)	0.025*	0.43†
MET-5 – MET-30	12.03 (74.74)	0.39	0.16
preControl - Control-5	-15.88 (83.62)	0.35	0.19
preControl - Control-30	-16.12 (62.49)	0.21	0.26
Control-5 - Control-30	-0.24 (81.55)	0.99	0.01

*Significance at $P \leq 0.05$
†Indicates medium effect size

DISCUSSION

Wilson et al[2] and Cassidy et al[14] suggested that MET can reduce pain levels in the lumbar and cervical spine, yet these authors are among the very few that have investigated the topic. The results of the present study found that there were no significant differences in the change in PPT between MET and the sham control, when analysed using a SPANOVA. However, MET produced the greatest increase in PPT, the pre-post change was significant when analysed using the less robust t-test, and the pre-post change produced medium effect sizes, all of which lend cautious support to the possibility that MET may produce a change in PPT. However, it should be noted that the mean changes in PPT after 5-minutes and after 30-minutes were within the error range determined by the pilot reliability study (50kPa and 63kPa respectively) and therefore it cannot be concluded that MET was effective in reducing pain levels in this asymptomatic group tested.

Significant pre- post change in the MET group was found through the use of *t*-tests and the mean PPT change at 5-minutes and 30-minutes produced a medium effect sizes. While this gives an indication that MET has potential to produce changes in pain thresholds, Wilson et al[2] demonstrated the long term benefit of MET in a clinical setting. These researchers found that in patients with acute low back pain, MET combined with neuromuscular re-education and resistance training was more effective than the re-education and training alone for reducing pain levels over a period of 8 weeks. In this study, the participants received 2 MET treatments weekly for a period of 4 weeks. Although the present study is useful for examining and comparing the effects of individual techniques, it does not accurately represent treatment in a clinical setting, and researchers could improve this by using a symptomatic population and including multiple treatments in future studies.

In the control group, small increases in PPT occurred over time (15.88kPa at 5minutes and 16.12kPa at 30minutes) and, despite the fact that these increases were not significant, these changes may be the result of a minor placebo effect or may be attributed an adaptation of pain fibre signals. No treatment effect was expected from the sham functional technique, because the researcher did not engage any perceived 'position of ease', but assessed this position and then moved the head back to the neutral position. While it was expected that most participants believed the sham functional treatment to be a legitimate technique because of the subtle leverages involved, no follow up study was conducted to determine this. The participants in this study were recruited from a population of student osteopaths, and despite the subtle nature of the technique, it is possible that they may have been more aware of the functional technique being a sham than if the population was from the general public. However, over half of those assigned to the control group were junior students untrained in the use of functional technique, and therefore would not know what to expect of the technique. One explanation for the change maybe associated with the error range of the measurement procedure. Calculated at 50kPa at 5-minutes and 63kPa at 30-minutes, this suggests that unless the difference in PPT is greater than these values, the changes that do occur are most likely associated with the measurement procedure rather than due to the effects of the technique. This may have been more clearly indicated with the addition of a no-treatment group.

When assessing pain levels, a certain amount of variability between individuals should be expected due to the subjective nature of the sensation. Some large variations between the 3 PPT readings in the present study produced standard deviations of mean values ranging from 60-75kPa. In comparison to research by Keating et al[22] and Fryer et al[23], standard deviations in the present study were quite low. Keating et al[22] reported a standard deviation of 150kPa in a repeatability study of PPT measurement in the cervical spine, and still the algometer readings were reported to be highly reliable based on ICC and coefficient of variance (CV). Similarly, Fryer et al[23] reported standard deviations ranging from 83-97kPa when testing PPTs in the thoracic spine. Again the measurement procedure using the algometer was reported as reliable (ICC=0.93). A reliability study conducted prior to the beginning of this study produced an average measure ICC=0.96, and therefore supports previous studies which have shown that measurements of PPT can be highly repeatable in individuals without pain, despite the large standard deviations.[22, 23]

The present study measured PPTs on an asymptomatic population and therefore it must be determined whether testing the effects of MET on symptomatic subjects would better reflect the potential of MET for pain reduction, as has been indicated in studies conducted by Wilson et al.[2] It would appear from results of the present study that MET has little effect on pain levels after one treatment, however in the clinical setting most treatments are applied more than once. Wilson et al[2] demonstrated this incorporating multiple applications of MET in people suffering low back pain. Further studies must therefore investigate whether significant results would be found when testing a longer regimen of therapy and follow-up. The therapeutic goal of manual treatment is long-term relief and thus future research testing other osteopathic techniques such as counterstrain, functional, articulation and cranial for treating suboccipital tenderness and chronic headaches would be beneficial.

CONCLUSION

While MET appeared to have some immediate impact on pain threshold, no significant differences between the changes in PPT were found between the two groups, and the changes were within the error range of the measurement procedure. One recommendation for future research is continued investigation into the effects of MET on pain levels particularly in a symptomatic population. Researchers should also seek to determine the lasting effects of MET and other manual techniques in order to establish the most efficacious combination of techniques to adequately inform clinical practice.

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