The Effect of a Single Application of Muscle Energy Technique on Pressure Pain Thresholds in the Lumbar Spine

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Abstract

Background and objectives: Muscle energy technique (MET) is commonly used by osteopaths and other manual therapists in the treatment of spinal and joint pain, but there has been little investigation of its effectiveness on pain reduction, particularly in the lumbar region. The aim of this study was to investigate the immediate effect of a single application of MET on pressure pain thresholds (PPT) in the lumbar spine in an asymptomatic population.

Methods: Fifty-nine asymptomatic volunteers (age = 23 years ± 4.4, 40 female, 19 male) were recruited from the Victoria University student population. The lumbar spinous process reported as most sensitive to manual springing by each subject was marked using a skin pencil. An electronic algometer was used to determine the PPT at this level. Subjects were directed to another room and were randomly assigned to a single application of either a rotational MET or a sham "functional" treatment. Following intervention, subjects returned for re-measurement of PPT by an examiner who was blinded to the treatment intervention.

Results: Following intervention, a small, significant increase in mean PPT was found in the MET group (21.32 kPa, P=0.02), whereas a non-significant decrease in PPT occurred in the sham group (-17.16 kPa). When the difference scores of the two groups were analysed using an independent t-test, a significant difference between the groups was found (P=0.002), and a large between-group effect size (d = 0.85) was calculated.

Conclusion: A single application of rotational MET to the lumbar spine did produce a significant increase in PPT in this asymptomatic population. Caution must be used when interpreting this result because the change in PPT was small and within the error range of the testing equipment. Future research is recommended in symptomatic populations.

Keywords: Muscle energy technique, algometry, pressure pain thresholds, osteopathy

Introduction

Authors of manual therapy have advocated various methods to treat patients with low back pain (LBP), including exercise therapy, massage, ergonomic advice, electrotherapy, short-wave diathermy and spinal manipulative therapy.[1-3] Two commonly advocated forms of manual treatment that differ with respect to the velocity and force applied to the target vertebral joint are manipulation and mobilisation. Muscle energy technique (MET) is a form of mobilisation[4] that is claimed to be effective in treating restrictions of both the spine and extremeties.[5]

Greenman[6] has referred to the use of MET in lengthening a contractured muscle, to strengthen a physiologically weakened muscle or group, to reduce localised oedema and to mobilise an articulation with restricted mobility. MET involves the voluntary contraction of the patient's muscle which is placed on stretch in a precisely controlled direction, at varying levels of intensity, against a distinctly executed counterforce applied by the operator.[6] A typical application of MET involves the dysfunctional joint placed at its restrictive barrier and the patient is asked to perform a gentle, 5-second isometric contraction away from the barrier against the specific counterforce provided by the practitioner. Following a few seconds of relaxation, the restrictive barrier is often perceived to yield, and the joint can be repositioned to a new barrier with the procedure being repeated three to five times.[6,7]

There are few studies available that support the claims of authors who advocate MET for increasing ROM and decreasing spinal pain. Three studies[8-10] have reported an increased ROM in the spinal region following a varied number of MET treatments. While asymptomatic subjects were used, all subjects presented with some restriction in spinal movement. Lenehan et al[9] used a single application of MET in the thoracic region on the side of the rotation restriction which produced a significant improvement (*P*<0.0005) in active trunk rotation but not to the non-restricted side nor within the control group. Earlier studies[8,10] by Schenk and colleagues used a four-week period of MET treatment and found similar increases in range of motion in the treatment, but not control groups. In the study that investigated the cervical spine[8], subjects had multiple restrictions in movement but were treated on the side of the rotation dysfunction. This produced significant improvement only in the range of rotation when compared to the control group. Whereas, subjects in the lumbar study[10] presented with limited lumbar extension and following a rotational MET at L5/S1, the treatment group showed significant improvement in lumbar extension compared to the control.

Only two studies on the effect of MET on spinal pain exist in the reviewed literature, and these studies vary considerably in their design. Cassidy et al[4] reported greater pain relief from acute and chronic patients with unilateral neck pain following a single rotational manipulation compared to MET. Pain intensity was rated on the 101-point numerical rating scale (NRS-101) and was found to be decreased by more than 1.5 times in the manipulated group, although both treatments increased cervical ROM to a similar degree.[4] In a pilot clinical trial, Wilson et al[11] compared the effect of a 4-week period of MET treatment with a control on patients with acute LBP, matched according to their age, gender and initial Oswestry score. On their first and eighth visits, patients completed an Oswestry Disability Index (ODI) for a change of scores and although both groups received comprehensive exercise programs, only the MET group showed improved function and decreased disability as scored on the ODI. Their mean post-treatment Oswestry score was 7% compared to 15% in control group which represented a minimum of 6 out of 10 questions scored as disability without pain.

Another form of pain measurement that has been shown to be a reliable and repeatable tool to quantify local pain and tenderness is pressure algometry.[12,13] The pressure-pain threshold (PPT) of an individual is defined as the minimum force that induces pain or discomfort and this is assessed by the calibrated pressure algometer.[14] Algometric measurements have established normal PPT values in asymptomatic individuals as seen by Keating et al[13] who demonstrated a normal regional variance within the spine, with PPT increasing in a caudad direction from cervical to thoracic and lumbar spinous processes. In a pilot reliability study, Keating et al showed that reproducibility of PPTs in the cervical and thoracic levels was excellent (ICC > 0.9) and good at the lumbar level (ICC > 0.75).

Recently, Fryer et al[14] used PPT measurements of the thoracic spine to examine the hypoalgesic effect of mobilisation & manipulation in ninety-six asymptomatic student volunteers. Both a single application of extension mobilisation and high velocity manipulation produced significantly increased PPT in the thoracic spine, whereas the sham control intervention did not. Mobilisation was also found to be more effective for pain reduction and produced greater improvement in PPTs compared to manipulation. While this study[14] supports the efficacy for mobilisation and potentially a preference for applying it in the clinical setting, another form of mobilisation, MET, has had limited research[10,11] supporting its use in the lumbar spine. Yet, osteopaths continue to employ techniques like MET for LBP, which remains a commonly treated condition worldwide. MET has not been previously investigated regarding its efficacy on lumbar spinal pain using PPT. The present study aimed to investigate the effect of MET on PPTs in the lumbar spine in an asymptomatic population.

Methods

Subjects

Fifty-nine asymptomatic volunteers (40 female and 19 male) aged between 18 – 35 years (age=23 ± 4.4 yrs) were recruited from the student population at Victoria University. All participants completed a consent form subsequent to their understanding of the information to participants form. Volunteers were excluded if they were suffering from low back or leg pain, numbness or weakness in the legs or low back, disc injury, low back trauma or surgery, pregnancy, were a long-term corticosteroid user, or if their lumbar spine had been treated with manual therapy in the preceding three days. Testing was performed at Victoria University Osteopathic Medicine Clinic. Ethics approval was received from the Victoria University Human Research Ethics Committee.

Measures

PPT was measured using a hand held electronic pressure algometer (Somedica Algometer Type 2, Sweden) which has been reported by Keating et al[13] to have substantial reproducibility for recording PPTs over lumbar spinous processes. The algometer consisted of a plastic handle, pressure transducer and an LCD screen which showed the amount and rate of pressure applied in kPa/cm^2/second. The algometer was calibrated before each session and a 2cm-rubber probe was used for easier stabilisation over the lumbar spinous processes during measurements. A hand held button was also attached to the algometer which, when activated by the subject, immediately recorded the kPa value at the time.

Pressure pain threshold

Measurement of PPTs was performed using a method similar to that by Keating et al.[13] With the participant lying prone on the plinth, the algometer was positioned perpendicular to the spinous process of the marked vertebrae. Pressure was applied at a steady and constant rate of 40 kPa/second, as displayed on the algometer's LCD, which enabled the force to be applied at a consistent and accurate rate (Figure 1). The probe was stabilised between the researcher's thumb and index finger. Subjects were given a hand held button and were instructed to push the button when the sensation of pressure first changed to pain. The downward force was stopped immediately and the maximal pressure applied with the PPT, recorded. Three PPT measurements were taken, with a break of 10 seconds between each one, with the average being calculated as that subject's PPT. This procedure for PPT measurement was based on the methodology used in studies by both Keating et al[13] and Fryer et al.[14] Previous studies[12,15] have shown that repeated application with the algometer does not result in a change in sensitivity.

Pilot reliability study

Before commencement of the present study, a pilot study was performed to determine the repeatability of the PPT measurement procedure. Twenty volunteers were recruited from the student population and were measured for PPT using the same procedure as for the main study. The participant was then instructed to leave the treatment room and return in approximately 1 minute to re-measure the PPT values. The mean difference between the first and second values was 5.83 kPa ± 44.21, and the error range of the procedure (mean difference ± SD of difference scores) was:

38.38 kPa – 50.04 kPa. The average Intraclass Correlation Coefficient of the two trials was found to be ICC = 0.94, suggesting excellent repeatability.

Procedure

Subjects undressed and removed upper torso clothing to expose their lumbar spines and were offered open-backed gowns. The subject lay prone on the treatment table with the lumbar spine exposed. Researcher 1 used manual springing (two applications of postero-anterior pressure) on each lumbar spinous process and the subject reported the segment that was most sensitive. This procedure took between 10 to 15 seconds to perform. The spinous process that was most sensitive to pressure was then marked with a skin pencil for assessment of PPT. Researcher 1 then left the room which allowed Researcher 2 to enter and record the PPT of the marked spinous process. The participant was then directed to the room of Researcher 3 room which was less than 5-metres away. Researcher 3, a registered osteopath, randomly allocated the participant into an intervention group: MET (n=29) or a "functional"/sham treatment (n=30) via a similar method to lottery draw but the drawn tickets were replaced into the box after each selection to ensure each draw was truly random. The appropriate intervention was then performed and the participant was directed back to the initial room where Researcher 2 re-measured the PPT on the marked level as previously detailed. Participants were allowed to walk from one room to another as it was a very short distance and it was not considered that this activity may dampen the post-treatment change in PPT. If such a change was to occur due to movement, then the treatment change would likely be so transient as to be clinically irrelevant. Both Researchers 1 and 2 were blinded to the treatment allocation of the subjects.

Treatment intervention

Muscle Energy Technique

Researcher 3 applied a rotational MET, with a similar set-up to an osteopathic thrust manipulation technique[5] to the marked lumbar segment with the subject side-lying on the right and then left side. After the rotational motion barriers were engaged (as perceived by Researcher 3), the patient was instructed “to gently unwind” themselves using a moderately strong 5-second isometric contraction which may be estimated at 70% of a voluntary contraction by the patient (Figure 2). This rotation effort was resisted by the operator, and, following two seconds of relaxation, a new rotation barrier was engaged. This procedure was performed three times.

Sham technique (placebo)

To minimise subject bias in the control group, a sham treatment (‘functional’ technique) was used. The majority of participants were osteopathic students and knowledgeable of osteopathic techniques, but due to the subtle leverages involved in functional technique, subjects would have difficulty in determining whether it was performed incorrectly. The participant lay prone on the treatment table whilst Researcher 3 manoeuvred their lower limb into slight hip extension, to engage the ‘barrier’ (Figure 3). No restrictive barriers were engaged during the 30-second performance of the sham functional technique, which was followed by the patient’s breath exhalation. Because functional technique involves subtle leverages,[6,7] participants were informed that they should feel little movement and that if they experienced any pain to report this to the researcher.

Statistical Methods

Data was recorded by Researcher 2 and it was then collated using Microsoft Excel and analysed using SPSS, version 12.0. Pre- and post-intervention PPT measurements were analysed for within-group changes for the two groups using paired t-tests. An independent t-test was used to determine if differences existed between the changes produced by the two interventions. Statistical significance was set at the alpha 0.05 level. As several dependent t-tests were being performed, a *Bonferroni Correction* was chosen to reduce the risk of making a Type I error.[17-19] Effect sizes (Cohen's d) were also calculated within the groups (pre – post) and between the groups.

Results

Analysis of pre- and post- intervention PPT values (kPa) showed that there was a small increase in PPT in the MET group (21.32 ± 45.07) and a decline in PPT for participants in the functional/placebo group (-17.16 ± 45.02). Paired t-tests indicated that there was a significant change for both groups – MET ($t = -2.548$, $P = 0.017$) had a significant increase in mean PPT whereas the placebo group ($t = 2.087$, $P = 0.046$) had a significant decrease in mean PPT. However, when the *Bonferroni Correction* was applied[18-19] by lowering the alpha level to $P < 0.025$, only the MET group displayed a significant change in mean PPT. The MET group was found to have a medium pre-post effect size ($d = 0.47$), whereas the control group had a small to medium effect size ($d = 0.38$). When the different scores of the two groups were analysed with an independent t-test, a significant difference between the groups was found ($t = 3.280$, $P = 0.002$). The effect size between MET and the functional/placebo group was also large ($d = 0.85$) (Table 1).

Discussion

A recent study has confirmed that LBP amongst Australian adults is a common condition of mainly low-intensity pain with low associated disability, but over 10% of the sampled 3000 participants had been significantly disabled by pain in the past 6 months.[16] LBP is a commonly treated complaint by osteopaths and other manual practitioners using techniques like MET, despite limited research supporting its efficacy[10,11].

The results of the present study appeared to indicate MET did significantly reduce pressure pain sensitivity in the lumbar spines of an asymptomatic population, relative to baseline measures and the changes in the sham control group. MET appeared to be slightly more effective for PPT reduction with a mean increase of 21.32 kPa and a medium effect size (d = 0.47) compared to the sham control which had a decrease of 17.16 kPa and a small to medium effect size (d = 0.38). The differences in PPT between the groups were significant (P = 0.002), and a large effect size (d = 0.85) was observed. Despite these statistically significant results, the changes in kPa were small and within the error range of the measurement procedure (50 kPa), making these significant changes of little meaning.

Previous studies on MET in the lumbar region have suggested that this technique may reduce spinal pain[11] and improve ROM[10]. Unfortunately, no previous study which has examined the effect of manual treatment on PPT has reported the error range (38.38 kPa – 50.04 kPa in the present study) associated with the use of a pressure algometer, which makes interpretation of the clinical significance of these studies difficult. This present study failed to demonstrate any meaningful changes on PPT in the lumbar spine in an asymptomatic population using MET.

The lack of a significant change to PPT may be due to a number of factors. Although the subjects were asymptomatic, the spinal segment which was most sensitive to manual pressure was chosen, using the method adopted by Fryer et al[14]. The authors believed that this segment may be more responsive to treatment. The selection of a relatively sensitive segment may possibly explain the large difference in pre-treatment PPT with previously reported normative values.[13] Keating et al[13] reported a mean PPT value of 504 kPa (± 182) at the level of L4, whereas the present study had a mean value of 270 kPa (± 112). It is difficult to directly compare the mean PPT values between these studies, because the present study examined variable lumbar levels (L1 to L5) which had been chosen based on the individual's perception of tenderness and as such were not recorded, as opposed to the pre-determined L4 segment of Keating's study.

This study had a relatively large error range of 38.38 kPa – 50.04 kPa in the PPT measurement procedure that was due to the comparatively large variation in repeated measures and resultant standard deviations (Table 1). The sensation of pain is subjective and this fact may have contributed to the large standard deviations. However, the relatively large standard deviation (112 kPa) was comparable to – and smaller than – that of Keating et al[13] (182 kPa). It is likely that any study which uses PPT measurement will have large standard deviations, and will need to produce large changes in PPT in order to demonstrate a significant treatment effect.

In addition, subjects walked between testing rooms while this study was being performed, and it is therefore possible that this activity may have also had an influence on the PPT recordings. However, if walking from one room to another did dampen the post-treatment change in PPT, then this change was so transitory as to be clinically irrelevant. But future studies must take this into consideration and should restrict the amount of subject spinal movement between PPT measurements.

The present study examined asymptomatic subjects, and it is possible that symptomatic patients may present with lower PPT values which may provide a greater range for improvement, and result in a more meaningful change in pain perception post-treatment. Previous MET studies[4,11] that have used symptomatic patients to examine its hypoalgesic effects on spinal pain have had conflicting findings. While both these studies examined symptomatic patients, major differences existed in the selection of spinal regions, the number of MET treatments, and in the measurement of pain. Cassidy et al[4] compared the effect of a single rotational manipulation with MET on pain and ROM in the cervical region. Both groups had a similar improvement in pain and ROM, but the decrease in pain intensity as scored on the NRS-101 was greater than 1.5 times only in the manipulated group. In patients with acute LBP, Wilson et al[11] found that applications of MET treatment over a 4-week period (twice a week) combined with the use of an exercise program produced a greater improvement in ODI score compared to the control group. This study was more similar in both its design and outcome to Cassidy et al[4] than Wilson et al[11] in that a single application of a rotational MET to the spine produced an effect on pain that needed to be interpretated with some caution. It is important to continue with future research on the potential hypoalgesic effects of MET, despite the lack of definitive findings in the present study.

Although the changes in PPT were small and within the error range of 38.38 kPa – 50.04 kPa of the measurement procedure, the significant changes and the medium effect size found in the present study suggest that MET may have the potential to influence PPT, despite only having used a single application on asymptomatic subjects. It is possible that future MET studies may have a stronger effect through the use of more than one treatment. Previous studies by Schenk and colleagues on the cervical[8] and lumbar[9] regions in asymptomatic populations corroborated how the repeated use of MET (twice weekly over a 4-week interval) significantly improved the range of spinal motion. Also, the study by Wilson et al[11] on symptomatic subjects with LBP, supported the effectiveness of MET applied over a longer treatment period. These patients had a lower mean Oswestry score which represented a minimum of 6 out of 10 questions scored as "no pain" compared to the control group. Examination of the effect of MET using symptomatic subjects is recommended for future research.

In private practice, osteopaths identify areas of dysfunction using the T.A.R.T[6,7] acronym (A=asymmetry, R= range of motion, T= tissue texture and tenderness). While this study used tenderness over the lumbar spinous process as a diagnostic tool, previous MET research on the spine has used both asymmetry and range of motion testing in both asymptomatic subjects[8-10] and symptomatic patients[4,11]. The use of diagnosing a segmental dysfunction in these earlier studies[4,8-11] may also explain the stronger effect post-treatment, with significant improvements in spinal range of motion[4,8-11] and improvement in spinal pain[4,11]. Future research which applies MET to an identified spinal dysfunction is recommended.

The pilot reliability study suggested the measurement procedure had excellent repeatability (ICC = 0.94), so it was surprising to find a small decrease in the PPT values of the sham functional group post-intervention. However, this small change in kPa that occurred for the sham control became insignificant when using a *Bonferroni Correction* to reduce the risk of a false positive being declared.[17] The electronic algometer used was chosen for its reliability, ease-of-control in the application of the rate of pressure and its reproducibility and reliability were well established.[12,13] Because the decrease in PPT value was less than the error range of the present study, the result may not be meaningful or it may have been the effect of an increased subject awareness of the specified spinal level. This asymptomatic population of student osteopaths possessed a certain amount of manual therapy knowledge so the decision was made to use a sham treatment rather than a control to account for the placebo effect. The sham functional technique consisted of constant light palpation over the spinous process and subtle leverages to that level for 30 seconds. As expected, there appeared to be no therapeutic effect of this sham treatment, with the small change in kPa being less than the error range. Future studies may benefit from the inclusion of both a sham treatment and a control group for comparison against the MET group, a follow up study to observe how many subjects were naïve to the sham and a population naïve to manual therapy.

Conclusion

Application of a single of rotational MET to the lumbar spine did produce a significant increase in PPT in this asymptomatic population. However, caution must be used when interpreting this result. Despite demonstrating statistically significant changes in PPT in the MET group and between the treatment groups, the changes in kPa were small and within the error range of the measurement procedure. Failure of the study to reveal any meaningful changes to PPT using MET may possibly be attributed to the use of an asymptomatic population, screening only for tenderness (rather than for signs of intervertebral dysfunction), a single application of the treatment intervention, lack of a control group and the reliability of the algometer. The effectiveness of MET as a therapeutic technique remains under investigated, with further research required to determine its hypoalgesic qualities. Important considerations for future research include the use of a symptomatic population, application of techniques to a pre-determined dysfunctional segment (using the T.A.R.T. criteria) and the addition of a control group.

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Fig. 1. PPT measurement using the algometer.

Fig. 2. MET of the lumbar spine.

Fig. 3. Sham ‘functional’ technique.

Table 1

PPT means (± SD), mean differences (± SD), *P* values (dependent *t*-test) and pre-post effect sizes

Group	Pre-intervention	Post-intervention	Difference	*P* value	Effect size (Cohen's d)
MET	270.18 ± 112.22	291.51 ± 115.14	21.32 ± 45.07	0.017*/**	0.47
Functional	297.81 ± 113.14	280.66 ± 103.24	-17.16 ± 45.02	0.046*	0.38

* indicates a significant value when $P < 0.05$

** indicates a significant value when $P < 0.025$, using Bonferroni Correction

[a] Values for PPT means and mean differences in kPa