THE EFFECT OF CHANGE TO DURATION OF ISOMETRIC CONTRACTION IN MUSCLE ENERGY TECHNIQUE TO THE UPPER CERVICAL SPINE

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ABSTRACT

Muscle Energy Technique (MET) has been advocated for the treatment of restricted range of motion in the upper neck. However, there is little evidence to determine the effectiveness of MET on the optimal duration of isometric contraction during the technique. The aim of this study was to investigate the effect of various durations of MET isometric contractions on active atlanto-axial rotation range of motion.
52 asymptomatic subjects (ages 18-43) who displayed a unilateral active atlanto-axial rotation asymmetry of 4° or more were randomly allocated to either a 5 (n=17) or 20-second (n=18) isometric contraction MET group, or a sham (n=17) treatment control group. Active atlanto-axial end-range measurements were recorded pre and post-intervention, and the examiner was blinded to group allocation. Analysis with a one-way ANOVA revealed significant differences (p=0.04) in the mean change between the 5-second MET group and the control, but not between the 20-second MET group and control. MET using 5-second contractions produced the largest mean increase in rotation, both to the restricted (+6.65°) and non-restricted sides (+0.71°). The 5-second MET produced a large effect size (d=1.01), whereas the 20-second MET (d=0.68) and control (d=0.33) produced medium and small effects. This study failed to demonstrate a significant benefit in the use of a longer (20-second) isometric contraction when treating the upper cervical spine with MET. The use of a 5-second isometric contraction appeared to be more effective than longer contraction durations for increasing cervical range with MET, but further investigation is recommended.

Keywords: Cervical, isometric, muscle energy, range of motion, osteopathy

INTRODUCTION

MET (Muscle Energy Technique) is a technique commonly used by osteopaths and other manual therapists when treating the cervical spine. Authors in the field of osteopathy claim that MET can be used to lengthen shortened musculature and improve joint function and range of motion.[1-3] MET is a method of treatment that involves the voluntary contraction of a subject's muscle(s) in a precisely controlled direction, against a counterforce provided by the operator. Greenman[1] described it as a technique in which the patient contributed corrective muscular force against the practitioner's counteracting resistance. Greenman[1] proposed that MET applied to a restricted atlanto-axial joint may produce improvement in joint range of motion. The clinical benefits of MET have not been well established in the scientific literature and the duration of the isometric contraction used in spinal MET has not been examined in previous research.

The effect of MET – or similar isometric techniques, such as contract-relax and proprioceptive neuromuscular facilitation (PNF) – has been examined on muscle extensibility, particularly the hamstring complex.[4-6] However there have not been many studies looking at the effect of MET to the cervical spine. Schenk *et al.*[7] investigated the effect of MET on cervical flexion, extension, side-bending, and rotation in subjects undergoing seven treatment sessions over a four week time frame. The sessions consisted of three repetitions of MET using approximately 5-second contractions. The researchers found that in each of the six ranges of motion examined in the study, the treatment group demonstrated increased range while the control group showed little or no change, although only a statistically significant increase in cervical range of rotation was found.

A number of studies have examined the effectiveness of HVLA thrust techniques for increasing range of motion (ROM) of the cervical spine.[8-10] Surkitt *et al.*[8] found that manipulation of the atlanto-axial joint significantly increased rotation ROM toward the restricted side. This finding was confirmed in another study by Clements *et al.*[10] who reported that a single HVLA manipulation applied to the atlanto-axial joint reduced the atlanto-axial rotation (8° fixed) asymmetry regardless of whether the manipulation was applied towards or away from the restriction or performed bilaterally.

The duration of the isometric contraction in MET has received little attention in previous research. Various authors and researchers have suggested different durations for the muscular contraction for MET and similar techniques. Greenman[1] suggested 3 repetitions of 3-7 second resisted contractions for adequate therapeutic effect. Schmitt *et al.*[11] used 5 and 12-second isometric contraction durations in their research, in both groups there were 5 subjects each. Ferber *et al.*[12] used repetitions of 20-second isometric contractions in their study of knee-joint ROM on a sample of 32 volunteers, with a mean power value for comparisons being 85%. In the cervical MET study by Schenk *et al.*,[7] eighteen volunteers were randomly assigned into either control or MET group. The MET group performed three repetitions of approximately 5-second contractions were and produced statistically significant increases in cervical range of motion.

In a recent study that examined the relationship between durations of sub-maximal isometric contraction on hamstring flexibility, Schmitt *et al.*[11] compared the effects of 6 and 12-seconds isometric contraction phase in PNF techniques. Both groups produced increases in ROM, but showed no significant differences between one another. But only a small number (n=10) volunteers were used for the study.

Mehta and Hatton[4] treated asymptomatic subjects with hamstring MET using a 5-second contraction, and after a fourteen-day period treated them again using a 20-second sub-maximal contraction MET. They found a significant increase in the passive range of motion following *both* the 5-second and 20-second contractions, but no significant difference between the two treatments. The authors concluded that using a 5-second MET was as equally effective as a 20-second MET. Whereas different researchers have used varying contraction times in their studies, no study has yet determined the optimal contraction duration or found a significant difference when testing different durations of contractions. No study has yet addressed this variable for MET applied to the spine, which may have great clinical significance, especially in the field of osteopathy.

Active cervical range of motion has been used by many researchers.[7,13-14] The Cervical ROM (CROM) device has been demonstrated to reliably measure active cervical range of

motion.[15-17] This instrument contains several inclinometers to measure sagittal and coronal plane motions, but uses a compass goniometer to measure axial rotation. [15-17] The present study examined the effect of a specific rotational MET on atlanto-axial joint motion using a compass goniometer with an adjustable head-piece, and aimed to establish if there was increased benefit in using longer isometric contractions when applying MET.

MATERIALS AND METHODS

Subjects

Volunteers were recruited from university students enrolled at Victoria University, Melbourne. Sixty-three male and female volunteers (age 18-43 [23.27 ± 4.24]) presented for preliminary goniometric assessment. Suitable subjects had no historical features of cervical pathology or substantial trauma, were receiving no form of manual treatment to the cervical spine, and were pain free on days of testing. Of the 63 volunteers tested, 52 exhibited the minimum 4° unilateral atlanto-axial (AA) rotation asymmetry necessary for inclusion in the study. The Victoria University Human Research Ethics Committee approved the study, and all subjects provided written consent prior to participation and were free to withdraw from the study at any stage.

Several researchers have examined the effect of manipulation on the cervical spine using asymptomatic subjects displaying a rotational asymmetry of 8° or more.[7,8,10] In the present study a more conservative figure of 4° was used, as our primary objective was to observe changes in range of movement, and not just asymmetry. In a study of six cadarval cervical spines, it was found that asymmetrical atlanto-axial joint geometry was common and causes asymmetrical joint dynamics.[18] It is questionable whether fixed asymmetry represents dysfunction or simply anatomical asymmetry, which would not likely respond to manual therapy more than in subjects with lesser asymmetries.

Goniometric measurement

The experimental design used measurement of AA rotation because it appears possible to reliably measure motion contributed mostly by this segment. It has been proposed that AA joint rotation can be isolated when the neck is flexed to approximately 45°.[19] This

effectively locks the lower cervical segments (below C2) and limits their ability to participate in further rotation. If rotation is introduced from this flexed position, the movement is deemed to occur between the occiput and C2. Because it has been reported that only 1° of rotation occurs at the occipito-atlanto segment,[20] this position effectively produces only rotation at the AA joint, and serves as an ideal testing position to examine the effect of a joint specific technique.[19]

Measurements were performed using a goniometric device with an adjustable head-piece and a firmly attached compass at its apex. Magnetic south was selected as the goniometer's 'neutral position' for cervical rotation neutral or mid-point, which acted as a reliable starting position. The chair was placed and locked into the position of magnetic south. Once seated and securely fastened in the chair that was slanted back to 45°, the subject was asked to flex their head 45° to a vertical position. The goniometric device (Fig 1) was placed on the subject's head, with the operator checking that the subject's head was in a vertical position, and that the goniometer's neutral was accurately facing magnetic south. Each subject was asked to perform three active rotations left (as far as was comfortable) and then to do three active rotations right (again, as far as was comfortable). After each rotation, the subject held the position for a few seconds so that the operator could record the goniometric reading (Fig 2). The mean of these recordings was later calculated and used for analysis. Subjects were not informed of the direction of rotation restriction.

Procedure

The design of this study was based on the methodology of Lenehan *et al*, who examined the effect of MET on active trunk rotation.[21] Once ROM testing was completed, subjects were given a card with their side of restriction written down, and then took this to the treatment operator in a separate room. Subjects were randomly allocated by lottery draw into one of the three treatment groups. The testing operator was blinded to group allocation. Even grouping was ensured as an even amount of cards (n=20) for each group had been placed in a hat, for random lottery selection.

An experienced registered osteopath delivered all the treatment for this study. The three treatment groups were as follows:

1. **Control group**: This group (n=17) received a 'sham-functional' technique, where the treatment operator's hands were simply placed on the subject's neck, without taking it to, or away, from the reported restriction. The practitioner placed his hands under the patient's head for a period of 30 seconds. A period of 30 seconds was used to give the participant the illusion that a proper technique was being done, however conscious effort was made not to instill any soft-tissue change to the neck, to use it as a "sham"-control group. Subjects were informed they were being treated with an osteopathic functional technique[22]. This 'sham' technique was used instead of a non-treatment 'control', so that subject bias and motivation would not influence re-testing.

2. **5-second MET group**: Subjects allocated to this group (n=17) received MET treatment to the direction of restriction, with each isometric contraction limited to 5 seconds. Subjects lay supine on a treatment table, with the practitioner present at the head of the table. The practitioner flexed the subject's head and neck to 45° and applied a MET technique to the restricted side by rotating the head until a perceived barrier was palpated.[1] For the MET technique the subject was instructed to gently push into the practitioner's hand for the allocated time (i.e. 5 seconds). Three contractions were performed with a 5-second break between each contraction (Fig. 4).

3. **20-second MET**: Subjects allocated to this group (n=18) received MET treatment to the direction of restriction, with each isometric contraction limited to 20 seconds. Subjects lay supine on a treatment table, with the practitioner present at the head of the table. The practitioner flexed the subject's head and neck to 45° and applied a MET technique to the restricted side by rotating the head until a perceived barrier was palpated.[1] For the MET technique the subject was instructed to gently push into the practitioner's hand for the allocated time (i.e. 20 seconds). Three contractions to each side were performed with a 5-second break between each contraction.

Following treatment, subjects immediately returned to the testing room for re-measurement using the same procedure as before. The examiner was blinded to the group allocation of all subjects.

Statistical Methods:

All calculations were performed on SPSS for Windows, version 10. Calculations were performed and reported as means with standard deviations. A one-way ANOVA was used to analyse the results of change to both the restricted and non-restricted sides between all groups. Significance was set at $p \leq 0.05$. A Tukey post-hoc test was utilized, and effect size (Cohen's *d*) was calculated. To assess the reliability of the compass goniometer, the intra-class coefficient (ICC, based on a one-way ANOVA) was calculated for the three pre-test readings of left and right rotation in each subject.

RESULTS

The ICC calculations revealed for left rotation, the average measure ICC= 0.9467 (F=18.76, sig. + 0.00, 95% C.I. : lower = 0.9157, upper = 0.9676), and for right rotation the ICC = 0.9040 (F= 10.41, sig. 0.00, 95% C.I. : lower = 0.8481, upper = 0.9416). The ICCs indicate a very high reliability for this measurement procedure.

The ROM changes for the subjects allocated to the control group (n=17), 5-second MET (n=17), 20-second MET (n=18) are seen in Table 1. There was a mean increase into both directions (restricted and non-restricted) following MET treatment, which was largest for the 5-second MET group (6.65^0). In the control group, there was a small increase to the side of restriction, and a drop in range of motion away from the restriction post-treatment. In each group, the difference in range of motion toward the side of restriction was markedly greater than away from the restriction.

Insert Table 1 near here

Insert Table 2 near hear

Analysis of mean changes with a one-way ANOVA demonstrated a statistically significant p value of 0.04 when comparing the results between the three groups ($F_{(2,52)}$=3.438) (Table 2). A Post-hoc Tukey comparison revealed significant differences between the control group and the 5-second MET was found (p=0.031), but only toward the side of restriction (Table 3). No significant differences were found when comparing the control group and the 20-second MET, both toward and away from the side of restriction. There were also no significant differences between the 5-second MET and 20-second MET, either toward or away from the side of restriction. Effect sizes post-hoc were small in the control group (d=0.33), large in 5-second MET (d=1.009), and moderate-large in the 20-second MET (d=0.684), (table 4)

Insert Table 3 near here

Insert Table 4 near here

DISCUSSION

The results of this study showed that MET applied to the AA joint did significantly increase range of motion toward the side of restriction. The greatest change was found in the 5-second MET group (mean increase 6.65°, p=0.031). The 20-second MET group also experienced a mean increase in range of motion (4.34°), but this was not significantly different from the control group change. Effect size calculations show that the 5-second MET produced a large effect (d=1.019), the 20-second MET a medium-large effect (d=0.68), and the control group a small effect (d=0.33). Contrary to the expectation of the researchers, MET using a 5-second isometric contraction appeared to be more effective for increasing AA range than with a 20-second contraction. It is interesting to note that the increased range in the direction of restriction was not made at the expense of the non-restricted range, which also made slight increases.

The results of the present study support the study conducted by Schenk *et al.*,[7] who also used 5-second MET contractions to produce significant changes to cervical ranges of motion. However there were many differences between these two studies, Schenk *et al.*[7]

collected data over a four-week time frame and retested subjects one day after their last treatment session, whereas the present study examined only the immediate effects to the AA joint.

Mehta and Hatton[4] investigated the effect of 5-second sub-maximal contraction MET to the left hamstring muscle, followed by 20-second contraction MET fourteen days later, Their study did not include a control group, but compared the 5 and 20-second isometric contraction techniques directly against one another. They found no significant differences between the two groups, and like the present study, no benefit in lengthening the duration of the MET. The methodology of the present study outlined immediate change whereas Mehta and Hutton evaluated change after 14 days, so a direct correlation can not be made. But where Mehta and Hutton[4] found no benefit between the two groups, the present study suggests benefits of using 5-second MET over the longer contraction.

The present study measured cervical range using active rotation, in contrast to some other studies that have used passive cervical range.[8-10] Measurement of active cervical rotation has previously been demonstrated to be reliable.[19] The current study used a different method for evaluating cervical ROM but ICC results (ICC=0.90, 0.94) suggest the compass goniometer is a reliable measuring tool in this instance. Active ROM overcomes the uncertainty of applying equal passive torque to right and left sides, however, subject motivation can potentially affect active measurements. For this reason a sham technique was used as the control. It was uncertain how naive the subjects (all osteopathic students) were to the sham procedure because no follow-up study assessed this, but given the subtle nature of functional technique and the explanation of it given to subjects in this group, the authors expect the subjects were largely naive to the sham. In addition, all subjects were informed there was a fourth no-treatment control group, which would reinforce the belief that the functional technique was genuine.

While these findings suggest the positive effects of the shorter 5-second contraction in the treatment of the upper cervical spine, caution should be exercised when attempting to extrapolate these findings into the clinical setting. The MET treatment was applied to

asymptomatic volunteers with only goniometric asymmetry obtained, and no attempt was made to diagnose specific upper cervical dysfunctions. Further studies should be performed to gain further knowledge about isometric contraction times in MET using symptomatic subjects, as well as using a longer period of follow-up. Larger subject numbers would be helpful, because 50 subjects would be needed to achieve 80% power (based on the medium effect size of the 20-second MET group and analysis with ANOVA).[23]

CONCLUSION

This study suggests that a MET using 5 seconds of isometric contraction produced a significant increase in range of restricted active rotation at the AA joint. The application of MET using a 20-second contraction appeared to be less effective, and was not significantly different from the control group. The increased range in the direction of restriction was not made at the expense of the non-restricted direction, which made small, non-significant increases. This study failed to demonstrate a benefit in the use of a longer isometric contraction when using MET to increase the range of upper cervical rotation.

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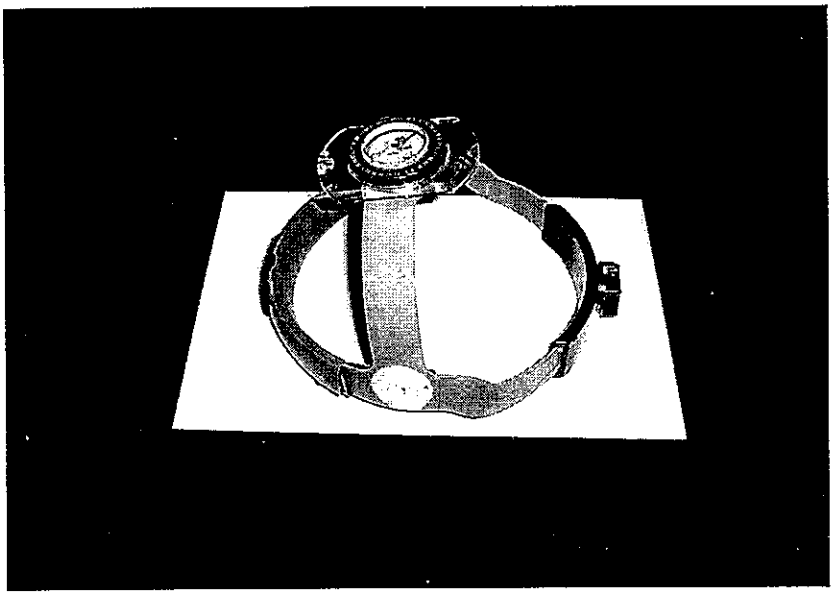

Figure 1: Cervical goniometer

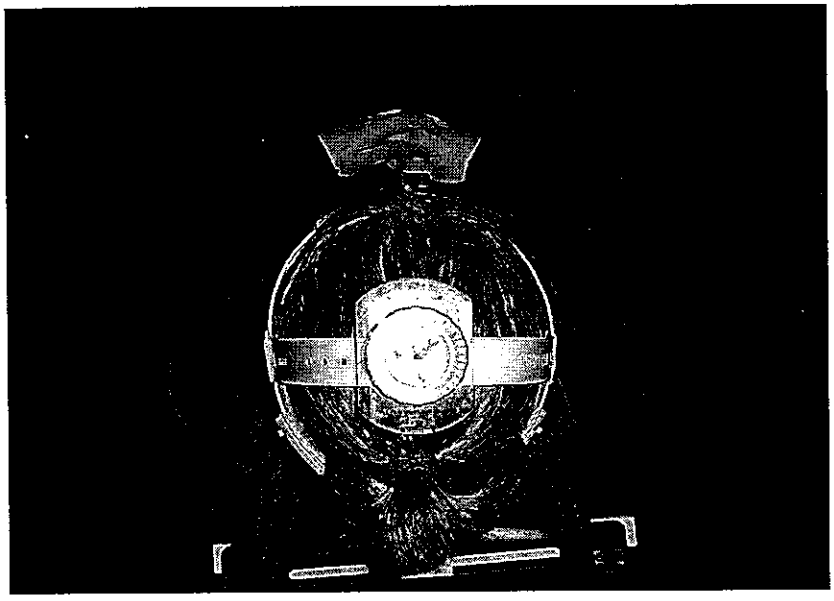

Figure 2: Cervical goniometer

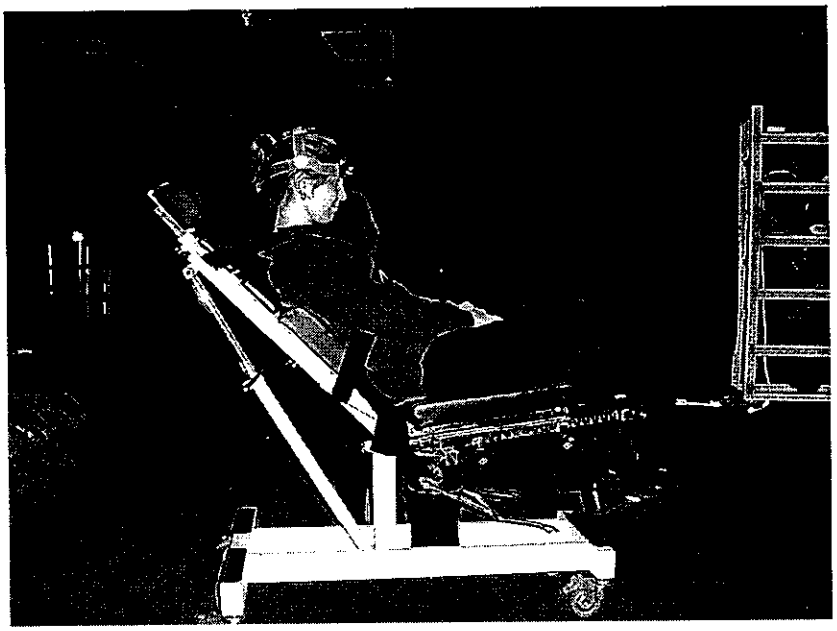

Figure 3: Biodex chair

Figure 4: Cervical MET

	Pre TTx		Post TTx			
	Restricted Side	Non-restriced side	Restricted side	Non-restriced side	Change to restriced side	Change to non-restricted side
Control Group	44.11 (8.61)	57.29 (8.45)	49.05 (9.30)	56.11 (8.03)	+1.41 (4.27)	-1.12 (6.95)
5-second MET group	52.41 (8.28)	60.24 (8.44)	59.06 (12.07)	60.95 (10.48)	+6.65 (6.59)	+0.71 (5.77)
20-second MET group	51.22 (10.61)	60.05 (10.26)	55.56 (9.97)	60.39 (9.45)	+4.34 (6.33)	+0.33 (6.86)

Table 1: Mean change (in degrees) for all groups (standard deviations in brackets)

	F	Sig.
Change to restricted side	3.438	.040
Change to non-restricted side	.444	.644

Table 2: ANOVA analysis of mean changes between groups

Dependent Variable	(I) groups	(J) groups	Mean Difference (I-J)	Sig.
Change to restricted side	Control	MET5	-5.24	.031*
		MET20	-2.92	.309
	MET5	Control	5.24	.031*
		MET20	2.31	.475
	MET20	Control	2.92	.309
		MET5	-2.31	.475

Table 3. Post-hoc Tukey comparisons between groups

* The mean difference is significant at the .05 level.

Group	Effect Size
Control	0.33
5-Second MET	1.01
20-Second MET	0.68

Table 4: Effect size calculations for within-group effect (Cohen's d)