# The Effect of Mobilisation on Pressure Pain Thresholds in the Thoracic Spine

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## Abstract

Mobilisation is a commonly used technique by osteopaths however there is little evidence to support its efficacy in the treatment of the thoracic spine. This study examined the effect of a single mobilisation (seated extension articulation) intervention in an asymptomatic population. Volunteers were randomly allocated into either a treatment group or a control group (sham laser acupuncture) and pre-intervention pain pressure threshold (PPT) measurements were taken using a pressure electronic algometer on a single thoracic segment. The treatment group received a single application of mobilisation (thirty seconds) and post intervention PPT measurements recorded. Mobilisation applied to the thoracic spine produced a statistically significant increase in PPT while the control group demonstrated no change in PPT. This study supports previous studies that have reported hypoalgesic affects following mobilisation on the cervical and lumbar spine.


**Key words**: osteopathy, mobilisation, pain pressure threshold, thoracic spine

## Introduction

Mobilisation, or articulation as it is known in osteopathy, is a commonly used technique in the treatment of musculoskeletal pain of spinal origin. It involves passive rhythmic and repetitive movements within a range of motion or against a restrictive barrier, intending to reduce the barrier and improve physiological motion of a joint. It is an extension of motion testing and can be regionally applied to a single articulation or a group of spinal segments. Mobilisation is a technique that is claimed to be useful in a wide variety of conditions[1]. It is a gentle technique where the force and amplitude can be controlled depending on the response of the tissues and the severity of the condition being treated.

Research on the effect of manual therapy on pain tolerance has focused primarily on the treatment of lumbar pain and cervical pain. Studies so far have examined the effects of manipulation[2,3,4], compared the effects of mobilisation and manipulation[5], while only few studies have investigated the effects of mobilisation alone[6,7,8]. Clinical trials by Sterling[7], Wright and Vicenzino[8] demonstrated increases in pain thresholds in symptomatic and asymptomatic subjects respectively following posterioranterior mobilisation applied to the cervical spine. Sterling reported increases in pain measures in the order of 23% while Wright and Vicenzino reported improvement in pain measures ranging from 15% to 25%. Vicenzino[9] also discovered increases in pain thresholds occurring at sites remote from the application of mobilisation. Subjects with lateral epicondylitis were treated with mobilisation at the level of C5/6 and measurements taken at the head of the radius resulted in an increase in PPT of up 25%.

Similar results were found in the evaluation of mobilisation in the lumbar spine. Goodsell[6] observed an improvement in pain levels following posterioranterior mobilisation applied at the spinal level for three one-minute repetitions on symptomatic subjects. However, the treatment failed to produce any objective measurable change in the mechanical behaviour of the lumbar spine (posterioranterior response and range of movement) and the authors suggested that improvement in pain levels may be due to a placebo effect.

No studies have investigated the hypoalgesic effects of mobilisation on the thoracic spine, however Schiller[10], Terret and Vernon[11] have investigated the effects of manipulation on the thoracic spine. Terret and Vernon reported an immediate increase in pain thresholds that were maintained for up to ten minutes. These post manipulative effects were statistically significant ($p<0.0001$) demonstrating a 40-55% increase in pain tolerance levels. Schiller also reported a lasting increase in pain threshold after a six-week treatment period of manipulation. Subjects receiving the manipulation demonstrated statistically significant improvement ($p=0.025$) between the first and final treatment and later maintained this level in a one month follow-up consultation.

The exact mechanism by which joint mobilisation exerts its pain relieving effects on spinal pain has not been elucidated, however several theories have been postulated. The gate control theory by Melzack and Wall proposed mobilisation to produce pain relief by activating the spinal component of the gate control mechanism. Wright[12] proposed activation of descending pain inhibitory systems via the dorsal periaqueductal grey as a mechanism of pain relief.

Pressure algometry has been demonstrated to be a reliable and repeatable tool to quantify local pain and tenderness over muscles and bony prominences[13-19]. Fischer[13] studied the reliability of the algometer in muscles of an asymptomatic population and concluded that PPT was reproducible and proposed a range of standard values. Hogweg[16] agreed with Fischer who demonstrated highly correlating values ($r > 0.74$) between the left and the right sides of the body. Reeves[17] demonstrated reliability in the detection of myofascial trigger points while Kosek[18] compared PPT values measured over bone with those measured over muscle and found no difference. In the spine, PPT measurements were found to increase in a caudal direction where the tissues in the cervical spine displayed greater sensitivity to pain compared to those in the lumbar spine[13-19]. Keating et al[19] reported normal PPT values in the thoracic spine at the levels of T4 (324 $kPa/cm^2$) and T6 (302 $kPa/cm^2$).

So far, the literature has reported that mobilisation may produce analgesic effects on the cervical and lumbar spine, yet it has not been determined if similar beneficial effects occur within the thoracic region. This study examined whether mobilisation of the thoracic spine would have an immediate effect on the thoracic PPT measurements.

# Materials and Methods

## Participants

Ninety-six (96) asymptomatic volunteers (39 male, 57 female) were recruited for this study from an osteopathy student population after completing a consent form and a questionnaire to exclude thoracic pathology. Subjects were excluded if their history indicated that they were suffering from any back pathology, spinal neurological condition or any vascular disorders; had been manipulated/mobilised in the three days prior; history of long-term corticosteroid use, or were unable to be positioned for application of intervention. Testing was performed in the Victoria University Osteopathy Clinic. The Victoria University Human Research Ethics Committee granted ethics approval for the study. This study was performed in conjunction with a study investigating the effects of manipulation on PPT in the thoracic spine.

## Materials

Pre- and post- intervention PPT testing required the use of a SOMEDIC electronic Algometer Type II, which comprised of a plastic handle, built-in pressure transducer and a LCD screen (Figure 1). This study used the same instrument and PPT procedure as Keating et al[19]. A probe with a surface area of 2 cm was used instead of a 1 cm as used by Keating, as this was found to improve the stability of the algometer on the spinous process, allowing for greater control when taking the measurements. The instrument was calibrated in accordance with the manufacturers instructions using a standard brass weight. A Laser pointer (Laserex LP2000) was used as the sham control intervention. Osteopathic treatment tables were used for the application of intervention technique and measuring the PPT.

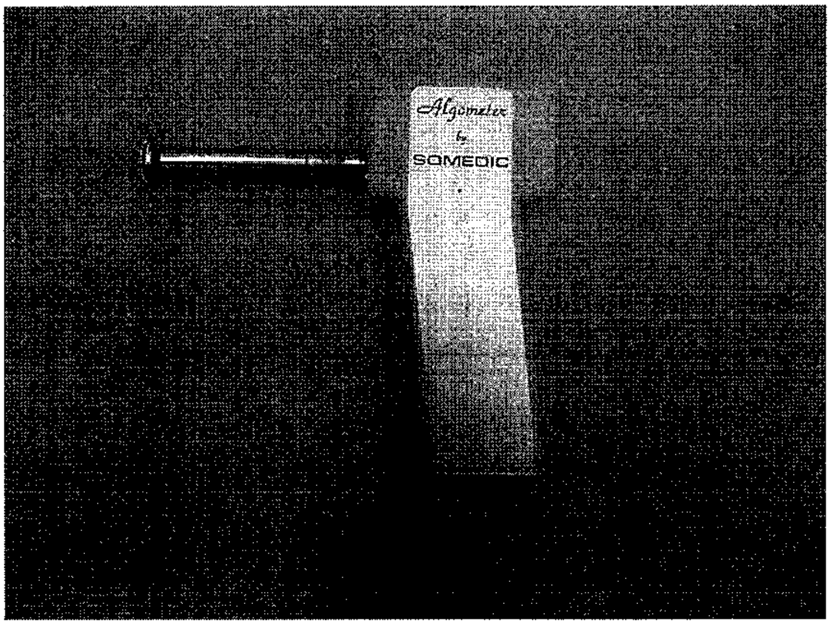


**Figure 1.** SOMEDIC electronic Algometer Type II

**PPT Measurements**

A standard treatment bench was used to position the patient prone exposing their thoracic spine. The algometer was placed perpendicular to the spinous process of a marked vertebra and pressure was applied at a steady and consistent rate of 30 kPa/second (Figure 2). The LCD screen displayed the rate of applied pressure (the pressure and slope). The pressure tip was stabilised between the Researcher's thumb and index finger. Participants were instructed to say 'now' as soon as they felt the sensation of pressure change to a sensation of pain and the downward force immediately ceased. This instantaneously froze the pressure reading, which the researcher recorded. Three measurements were taken at the marked thoracic level with a break of 20 seconds between each reading. The average of the three readings was calculated.

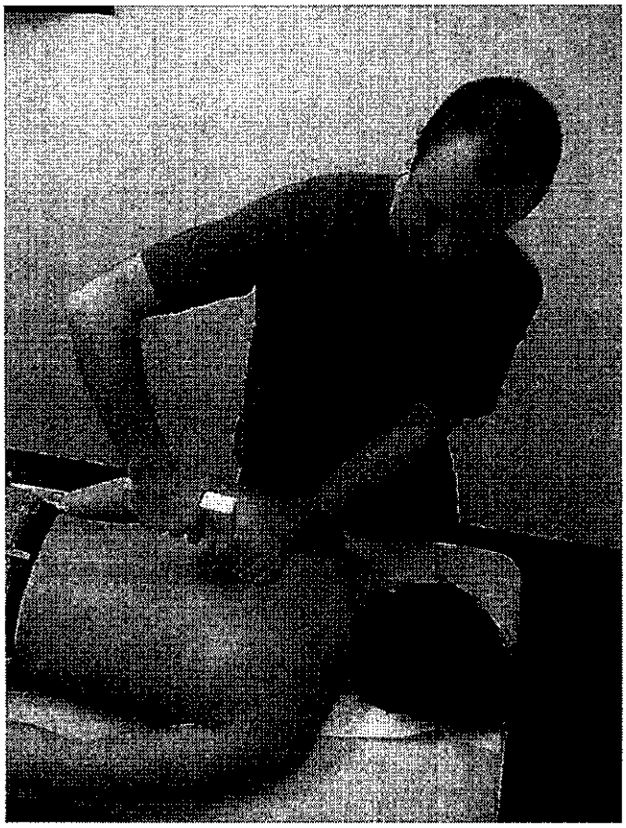

**Figure 2.** Algometer measurement

**Procedures**

Outlined below is the procedure that was performed in conjunction with a study that investigated the effects of manipulation on PPT in the thoracic spine.

The participant undressed to expose the spine and was positioned prone on a treatment bench. Researcher 1 applied a gentle spring (posterior-anterior) to each thoracic vertebra in a cranial to caudal direction. The participant was instructed to identify the most tender spinal level and the relevant vertebral segment was marked with a pen. Researcher 2 carried out the PPT measurements using the Somedic pressure algometer. The participants (n=96) were then randomly allocated via a lottery draw into two intervention groups: manipulation (n=32), mobilisation (n=32) and a control (n=32) group. They were directed to the another room for the intervention. Researcher 3, an experienced Osteopath, administered the intervention to each participant at the indicated thoracic level. The treatment groups received either manipulation or mobilisation. Participants in the manipulation group were given a single standard osteopathic manipulation as outlined by Gibbons and Tehan[20]. Participants in the mobilisation group were treated with a seated extension mobilisation technique as described by Tucker and Deora[21] (Figure 3). This technique was modified slightly if the marked vertebral level was in the upper thoracic region (Figure 4).

**Figure 3.** Mobilisation of the middle and lower thoracic spine.

**Figure 4.** Mobilisation of the upper thoracic spine.

The control group received thirty seconds of a sham treatment intervention consisting of non-operational laser acupuncture. Those in the control group were treated no differently and with the same enthusiasm as those in the experimental groups. A sham treatment was considered to be more desirable than no treatment, as the expectation of a treatment effect may have influence on pain perception during the recording of PPT.

Immediately following intervention, participants returned to the testing room and PPT measurements were recorded at the marked level in the same manner as outlined above. The researcher recording the PPT measurements was blinded to the treatment allocation of the participants.

## Statistical Methods

All data was collated and analysed using the statistical package SPSS Version 11.0 Pre- and post- intervention PPT measurements were analysed for the three groups using paired t-tests. Statistical significance was set at the alpha <0.05 level, and effect size was calculated for all treatment and control groups. A one-way ANOVA on the mean difference values was conducted to determine any differences that existed between the three intervention groups.

## Results

The means and standard deviations of pain pressure thresholds for the control group and the treatment groups are given in Table 1. A paired t-test was used to compare the mean pre- and post- intervention PPT values for the control and treatment groups. Results are presented in Table 2. A one-way ANOVA was used to evaluate PPT mean differences, which revealed significant differences between the experimental conditions. A post hoc analysis was performed using a Scheffe test. Results are presented in Table 3. The level of significance chosen for this study was $P<0.05$.

| | Mobilisation | Manipulation | Control |
|---|---|---|---|
| Pre-intervention | 218.70 (82.91) | 204.63 (85.52) | 243.70 (95.22) |
| Post-intervention | 247.12 (96.86) | 216.51 (90.50) | 244.63 (91.59) |
| Difference | 28.41 (39.67) | 11.87 (31.82) | 0.94 (35.00) |

**Table 1:** Paired samples statistics: Group means pre- and post- intervention for treatment and control groups (kPa/cm$^2$).

An increase in PPT was demonstrated in both the mobilisation (28.41, SD 39.67) and manipulation (11.87, SD 31.82) treatment groups whereas the PPT for control group remained relatively unchanged (0.94, SD 35.00).

| | Mean (SD) | t value | d value | 95% CI | Sig (2-tailed) |
|---|---|---|---|---|---|
| Mobilisation | 25.41(39.67) | 4.05 | 0.64 | (42.72, 14.11) | 0.000* |
| Manipulation | 11.87(31.82) | 2.11 | 0.37 | (23.35, 0.400) | 0.043* |
| Control | 0.94 (35.00) | 0.15 | 0.02 | (13.60, 11.70) | 0.881 |

**Table 2:** Summary table for paired samples t-test
* Significant at $p<0.05$

The t-tests demonstrated a statistically significant increase in PPT following mobilisation (p=0.000) and manipulation (p=0.043). Pain pressure threshold increased following mobilisation and manipulation. Mobilisation demonstrated a medium to large pre-post effect size (d=0.64), while manipulation demonstrated a small effect size (d= 0.37). The control group failed to reveal statistically significant differences in PPT demonstrating a small effect size (d=0.02).

| | | Mean difference | Sig |
|---|---|---|---|
| Manipulation | Control | 10.93 | 0.474 |
| | Mobilisation | 16.54 | 0.185 |
| Control | Manipulation | 10.93 | 0.474 |
| | Mobilisation | 27.47* | 0.011 |
| Mobilisation | Manipulation | 16.54 | 0.185 |
| | Control | 27.47* | 0.011 |

**Table 3:** One way ANOVA: Scheffe Post hoc-analysis of between group differences
* Significant at p>0.05

The one-way ANOVA demonstrated a significant effect of treatment with post-hoc analysis revealing a significant difference between the mobilisation treatment and control group (p=0.011). No significant difference was found between the manipulation treatment and control group (p=0.185).

## Discussion

The data revealed a statistically significant increase in PPT in the thoracic spine following mobilisation, demonstrating a mean increase of 25.41 (SD 39.67 $kPa/cm^2$) while the control treatment group revealed no significant change in PPT. The mean increase in PPT resulted in a medium to large effect size (d=0.64) providing strong evidence of its clinical effectiveness. This study is the first to examine the effects of mobilisation on pain thresholds in the thoracic spine and the findings are in accordance with studies that have investigated the effects of mobilisation on the lumbar and cervical spine [6,7,8].

The instrument and PPT procedure used in this study was the same one used by Keating et al[19] who demonstrated excellent algometer reliability and repeatability in the thoracic spine (ICC > 0.90). The variability in the measurements taken pre- and post- intervention resulting in relatively large standard deviations may be due to the variability in a subject's ability in perceiving differences between pressure and pain. Furthermore, the standard deviations were of a similar magnitude to those reported by Keating et al[19].

A laser pointer was used in this study as the placebo treatment. Although participants in this group were treated no differently than those in the experimental group, we cannot be certain that participants were entirely naive to the placebo treatment. Participants in the control group were informed that laser is a commonly used modality by medical acupuncturists. It was the third researcher's opinion that most participants accepted it as a genuine treatment, however a follow up was not conducted to confirm this. Failure to produce the necessary provisions as a 'real' treatment may have undue influence on the participants' perception of pain. The volunteers were derived from Victoria University Osteopathic Medicine course and it is possible that they may be less naïve than the general population.

Mobilisation applied in this study was for the duration of thirty seconds that resulted in an immediate improvement in pain measures. In clinical practice, the grade and duration of mobilisation on the thoracic spine is usually dependent on the condition being treated and tissue response as monitored by the practitioner. Thoracic mobilisation is often applied on more than one occasion over period of time, therefore further research should not only be directed at investigating the longer term effects of a single mobilisation but also the effects of multiple doses over a given period of time. Although it was shown that there was an immediate improvement in the participants pain threshold, the therapeutic aim of mobilisation is for long-term pain relief. A follow up period of three to six months or more is recommended to provide some indication of the benefits of treatment. Whilst this study demonstrated a relative increase in pain threshold in an asymptomatic population, future studies should investigate the possible differences in a varied symptomatic population to highlight the clinical relevance of mobilisation in the management of acute and chronic thoracic pain.

Several studies have compared the effects of mobilisation and manipulation on the cervical and lumbar spine, however there have been no studies to compare the effects of any manual therapy techniques on the thoracic spine. Despite many techniques available to the practitioner commonly used to treat thoracic pain, clinical trials have yet to establish the efficacy of these techniques. Future studies should also compare the immediate and long-term effects of mobilisation with other techniques used in manual therapy.

The mechanism by which mobilisation exerts pain relieving effects is not certain, but the search for an explanation persists. Continued research to further examine the models proposed so far and investigations into other possible mechanisms will further our understanding of the effects of mobilisation. Thoracic spinal pain is associated with varying levels of impairment and disability and deserves the same attention that has been given previously to cervical and lumbar spinal pain.

## Conclusion

Mobilisation technique was shown to be effective in increasing the pain pressure threshold in the thoracic spin of asymptomatic subjects. The treatment group demonstrated a statistically significant increase in pain thresholds while the control group demonstrated no significant change. These results support the use of mobilisation in increasing pain thresholds in the thoracic region, supporting findings of previous cervical and lumbar spine mobilisation studies [6,7,8]. Evaluation of pain pressure threshold with a pressure algometer has proven to be a useful measure in evaluating the effect intervention and it is recommended that future studies investigate the long-term effects and benefits on a symptomatic population.

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