Journal of Bodywork & Movement Therapies (2012) **16**, 416—423

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CLINICAL METHODS: VISCERAL MANIPULATION

The immediate effects of sigmoid colon manipulation on pressure pain thresholds in the lumbar spine

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Received 31 October 2011; received in revised form 3 February 2012; accepted 4 February 2012

KEYWORDS
Pain;
Fascia;
Visceral;
Manipulation;
Osteopathy;
Manual therapy

Summary Visceral manual therapy is increasingly used by UK osteopaths and manual therapists, but there is a paucity of research investigating its underlying mechanisms, and in particular in relation to hypoalgesia. The aim of this study was to investigate the immediate effects of osteopathic visceral mobilisation on pressure pain thresholds. A single-blinded, randomised, within subjects, repeated measures design was conducted on 15 asymptomatic subjects. Pressure pain thresholds were measured at the L1 paraspinal musculature and 1st dorsal interossei before and after osteopathic visceral mobilisation of the sigmoid colon. The results demonstrated a statistically significant improvement in pressure pain thresholds immediately after the intervention ($P < 0.001$). This effect was not observed to be systemic, affecting only the L1 paraspinal musculature. This novel study provides new experimental evidence that visceral manual therapy can produce immediate hypoalgesia in somatic structures segmentally related to the organ being mobilised, in asymptomatic subjects.

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1360-8592/$ - see front matter © 2012 Published by Elsevier Ltd.
doi:10.1016/j.jbmt.2012.02.004

Introduction

While manual therapy techniques such as high-velocity low-amplitude thrusts (HVLAT) and spinal mobilisations have received much attention in the literature the same cannot be said for visceral manual therapy (VMT). VMT is a treatment approach readily used by osteopaths in the UK (GOsC, 2001) and Australia (Orrock, 2009) but its underlying mechanisms are still unknown. There is a paucity of published research into VMT, and currently the basis for its teaching and application is largely drawn from textbooks and clinical experience. The current model of VMT is based on fascial adhesions that purportedly affect visceral haemodynamics (Finet and Williame, 2000; Barral and Mercier, 2005; Hebgen, 2010; Hedley, 2010; Bove and Chapelle, 2011), viscerospasm due to inflammation, autonomic dysregulation, psychosomatic factors, and visceral ptosis as sources of dysfunction (Barral and Mercier, 2005; Hebgen, 2010). A recent pilot study investigated the effects of an osteopathic treatment protocol which included VMT (Brugman et al., 2010). The results of this study were statistically significant, showing improvements in the outcome measures which included constipation severity, quality of life, and laxative use. However, the authors failed to suggest a putative mechanism for the findings of the investigation. Another study that included VMT (Tarsuslu et al., 2009) also focused strongly on clinical observations with little reference to potential physiological mechanisms. VMT like other manual therapy (MT) approaches demands a body of research evidence to help practitioners take an evidence-informed approach to their practice (Licciardone, 2007; Fryer, 2008) and clinical reasoning (Thomson et al., 2011), so that treatments can be applied safely and most effectively.

There is, however, a growing body of research which may be drawn upon to help understand the mechanisms by which VMT exerts their effects, which could help inform their application in clinical practice. For example contemporary research in the fields of pain and neuroscience have investigated the phenomena of visceral hypersensitivity (VH) (Wesselmann and Lai, 1997; Vergnolle, 2008), referred hyperalgesia (RH) (Giamberardino et al., 2010a,b), visceral cross-sensitisation (VCS) (Brumovsky and Gebhart, 2010), and afferent innervation of the viscera (Robinson and Gebhart, 2008). Viscero-somatic interactions are central to the understanding of these phenomena (Cervero, 2009; Sengupta, 2009) and have also been of great interest to manual therapy researchers. Early osteopathic research helped to develop the concept of the viscero-somatic reflex (Burns, 1907, 1928). The seminal work of Korr (1979), which focused on autonomic spinal reflexes and the implications for osteopathic diagnosis and treatment, helped crystallise the concepts of the viscero-somatic reflex and facilitated segment. These concepts have been further reinforced by the work of Beal (1985, p. 791) who stated that "*somatic manifestation is an integral part of visceral disease*". Experiments have also demonstrated sympathetic nerve discharge (affecting viscera) produced by various types of somatosensory input. These include sympathetic responses to innocuous mechanical stimuli in skeletal muscle (Kaufman and Forster, 1996), synovial joints (Sato et al., 1985) and paraspinal tissue (Sato and Swenson, 1984). As such, a wide range of manual therapies have adopted these concepts into their models of clinical practice. However research is lacking to describe the possible effects of viscerosensory stimuli (possibly produced by manual therapists performing VMT) on somatic tissue such as deep and superficial paraspinal muscle.

Furthering this early work, Fryer et al. (2004b, 2005, 2006a,b, 2010), and Fryer and Johnson (2005) have attempted to measure irregularities of segmental tissue texture associated with the somatic dysfunction concept. The results failed to show a correlation between palpable changes and irregular motor activity of deep paraspinal muscles (Fryer et al., 2010). However RH and trophic changes in deep and superficial paraspinal muscles, such as thickening of the subcutis, have been demonstrated in cases of visceral disease and dysfunction (Vecchiet et al., 1990; Giamberardino et al., 2005). The phenomenon of RH in particular may be very relevant to VMT research. Palpation of tenderness is considered a key factor in the diagnosis of somatic dysfunction (Kuchera and Kuchera, 1992), and its quantification could be an effective outcome measure for the investigation of VMT, especially in the treatment of disorders where manual therapy may be indicated such as functional abdominal pain (van Tilburg et al., 2008).

Visceral dysfunctions have been demonstrated to involve significant changes in peripheral and central nociceptive processing (Price et al., 2006; Brumovsky and Gebhart, 2010). These changes, associated with specific referral to somatic structures, VH, RH, reflex patterns with trophic changes, VCS, and potentially from a manual therapy perspective, somatic dysfunction, could be investigated in relation to VMT. The purpose of this study is to investigate immediate hypoalgesic effects of a sigmoid colon mobilisation, locally and systemically, as measured by pressure pain thresholds (PPT) in asymptomatic subjects.

Methodology

Subjects

Sixteen asymptomatic subjects ($N = 16$) were recruited by means of e-mail, social networking, and posters. This cohort was not naive to osteopathic treatment having been taken from years 2 and 3 of an undergraduate osteopathic degree. The basic demographics of the cohort are displayed in Table 1. All volunteers were screened for cautions or contraindications to manual therapy (Barral and Mercier, 2005; Gibbons et al., 2009). Subjects were asked to refrain from strenuous exercise and manual therapy or osteopathic treatment for 3 days prior to each testing session. Before beginning all subjects gave their written informed consent to participate. Ethical approval for the study was granted by the British College of Osteopathic Medicine ethics committee.

Design

The experiment method consisted of a single-blinded, randomised, within subjects, repeated measures design.

Table 1 Descriptive statistics of the basic demographics of the cohort demographics (SD = standard deviation, N = number, BMI = body mass index).

	Age	Height	Weight	BMI
Female	Mean 23.7	Mean 168.7 cm	Mean 59.8 kg	Mean 21.0
$N = 6$	SD 7.5	SD 5.0	SD 6.3	SD 1.8
	Range 20–28	Range 162–175	Range 54–68	Range 19.4–24.1
Male	Mean 27.7	Mean 175.3	Mean 79.4	Mean 25.8
$N = 10$	SD 8.0	SD 9.7	SD 11.2	SD 3.0
	Range 20–42	Range 161–188	Range 62–97	Range 22.3–31.3

The experiment conditions consisted of a visceral osteopathic mobilisation of the sigmoid colon (Barral and Mercier, 2005), a sham intervention of manual contact on the abdomen, and a non-intervention group (control). Each subject received all three interventions on separate occasions, with a minimum of 48 h between each. Researcher and order bias for the delivery of the interventions was avoided by use of the computerised research randomiser (Urbaniak and Plous, 2007) (Fig. 1).

Experiment conditions (independent variable)

All experimental conditions were carried out by a registered osteopath with experience of using VMT in clinical practice (Researcher 1). The visceral manipulation (Fig. 2) was applied to the supine subject by contacting the sigmoid colon laterally, in the left iliac fossa and drawing it superomedially, and then releasing (Barral and Mercier, 2005), for a duration of 1 min. This was repeated at a frequency and amplitude determined appropriate by Researcher 1 (depending on the individual tissue response of each subject), as would occur in clinical practice. The sham intervention consisted of 1 min of light manual contact over the umbilical region, with no position of ease or tissue barrier being engaged (Fig. 3). Each subject was informed that they were receiving an actual functional osteopathic technique frequently used in clinical practice. For the control group Researcher 1 was simply present in the experiment room for the 1 min duration.

Pressure pain thresholds (dependent variable)

Algometry has been widely used to assess hypoalgesia associated with manual therapy treatment procedures (Sterling et al., 2001; Vicenzino et al., 2001; Paungmali et al., 2003b; Fryer et al., 2004a; Thomson et al., 2009) and in the study of referred visceral pain and hypersensitivity (Arendt-Nielsen, 1997; Giamberardino et al., 2010b). Numerous methods are available for testing response to electrically and chemically induced pain (Giamberardino et al., 2005) and for testing pain using verbal, numerical, visual, and written scales (Triano et al., 1993; Von Korff et al., 2000). The use of pressure algometry offers an economical and practical method for measuring mechanical pain thresholds and has been shown to have excellent intra-observer reliability (Vanderweeen et al., 1996; Potter et al., 2006).

Pressure pain threshold (PPT) was measured using a hand-held manual digital pressure algometer (Wagner FPX 25) calibrated by the manufacturer, and with a 1 cm^2 rubber tip.

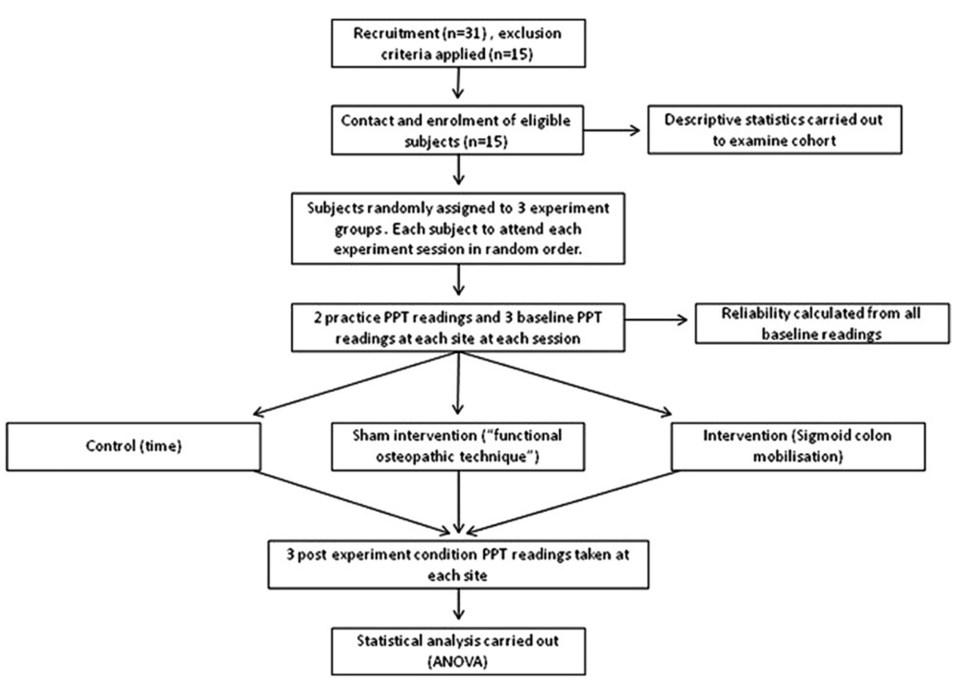

Figure 1 Summary of the experiment procedure.

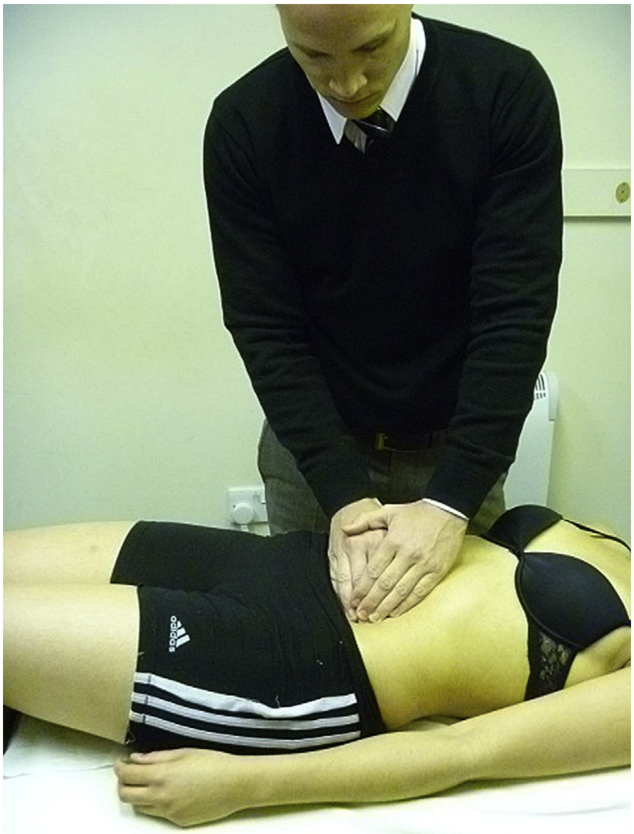

Figure 2 Experimental technique — visceral manipulation to the sigmoid colon.

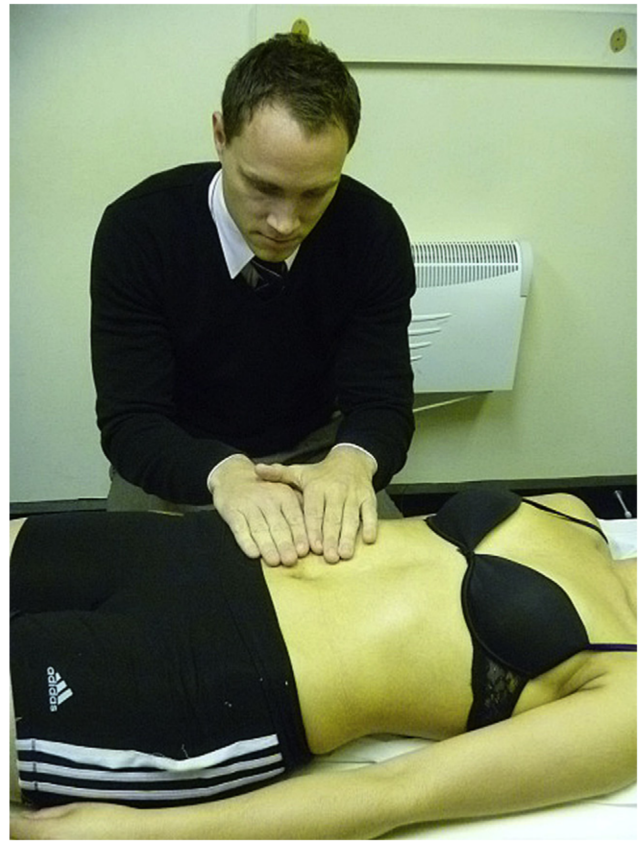

Figure 3 Sham 'functional technique', involving light touch over the abdomen.

The algometer was applied perpendicular to the skin at a gradually increasing pressure of $5\ \mathrm{N\,s^{-1}}$. Subjects were instructed to say 'now' immediately when the sensation of pressure changed to one of pain. This protocol was based on that developed by Fischer (1987). All PPT readings were taken by a researcher (Researcher 2) with over 5 h practice time using the PPT algometer.

At each experiment session two landmarks were identified and marked with a skin pencil. The paraspinal muscle 1 cm left-lateral to the L1 spinous process (Fig. 4) was chosen as it has been shown to be a segmental level for autonomic innervation of the colon (Jänig and McLachlan, 1987) and its paraspinal muscle is associated with referred hyperalgesia, via colonic referral (Giamberardino et al., 2010b). A distal site was chosen to monitor any systemic response to the interventions (Fig. 5). The 1st dorsal interossei on the right hand was used as it is easily accessible and a large amount of data is available for comparison (Vanderweeen et al., 1996; Chesterton et al., 2003).

Data

Microsoft Excel (2003) was used to record the data and calculate descriptive statistics for the PPT and demographic data. The means of the 3 PPT readings before and after at each site were calculated. SigmaPlot 11.0 (Systat Inc.) was used for further analysis. A two-way repeated measures ANOVA was used for the data from each site, with the Holm—Sidak method employed for the lumbar spine data. The two dependent variables were PPT measurement site and time (pre- and post-). The independent variable was the experiment condition (intervention, sham, control). Percentage change in mean PPT's pre and post for the two sites were also calculated. Significance levels were set at $P < 0.05$ (Altman, 1991). Interclass correlation coefficient (ICC) was used to measure intra-observer reliability.

Figure 4 PPT measurement of the left paravertebral soft tissue at L1.

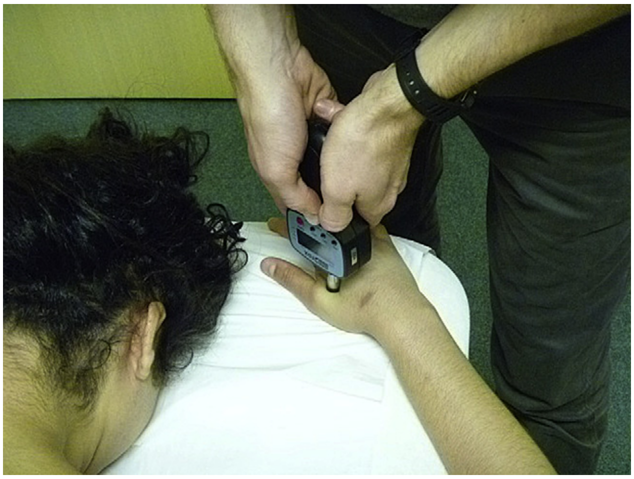

Figure 5 PPT measurement of the first dorsal interossei.

Results

One subject was excluded due to surgery they underwent before the conclusion of the study. All of the remaining subjects completed the study with no adverse effects from the interventions or pressure pain algometry. Following a two-way repeated measure ANOVA the Holm–Sidak method was used for lumbar spine PPT's. This showed a statistically significant difference for pre- and post-intervention PPT's in the lumbar spine ($P < 0.0001$). No statistical difference was shown for pre and post sham ($P = 0.647$) or control ($P = 0.877$) PPT's. No significant interaction was seen between groups at baseline ($P = 0.459$) or between groups pre and post ($P = 0.319$) in the right hand.

The percentage change in mean PPT pre- and post-intervention was 18.4% in the lumbar spine. Table 2 summarises the mean pre and post change in Newtons (N), and percent change for each site and each intervention.

Intra-rater reliability was determined for baseline readings taken at the hand and lumbar spine sites for all experimental conditions. The ICC was calculated as 0.95 for the hand and 0.92 at the lumbar spine. 95% confidence intervals were calculated at 0.92–0.97 for the hand and 0.87–0.95 for the lumbar spine. These results indicated good (ICC > 0.75) reproducibility of PPT measurements.

Discussion

While many studies have demonstrated hypoalgesia after MT interventions (Vicenzino et al., 2001; Paungmali et al., 2003a; Nielsen et al., 2009; Krouwel et al., 2010; Willett et al., 2010), this was the first study of its kind to investigate the hypoalgesic effect of a visceral osteopathic mobilisation. It provides preliminary evidence that mobilisation of the sigmoid colon can produce hypoalgesia in somatic tissue with segmentally related innervation. This induced hypoalgesic effect, quantified by increased PPT values ($P < 0.001$) in paraspinal soft tissue lateral to the L1 spinous process, was demonstrated in asymptomatic subjects. The effects were not observed to be systemic.

An increase in mean PPT of 18.4% above baseline was recorded in the lumbar paraspinal soft tissue after mobilisation of the sigmoid colon. No other notable change occurred in either the hand or lumbar spine for the control or sham groups. This is summarised in Table 2. Moss et al. (2007) suggest a change of at least 15% in PPT values is needed to be considered clinically significant. This however is based on recordings from symptomatic subjects and relates to peripheral joint mobilisation. As for hypoalgesia after spinal mobilisation, figures of 23–30% have been considered significant in symptomatic subjects (Vicenzino et al., 1996). Therefore, a larger percentage change may have been observed if symptomatic subjects were used in the investigation, and would provide the basis for further research.

Given the novelty of this experiment no model exists in VMT research through which to discuss these results. Models of the mechanical and neurophysiological mechanisms of manipulation induced hypoalgesia (MIH) have been proposed (Vernon, 2000; Pickar, 2002; Zusman, 2004; Bialosky et al., 2009). In the interpretation of the results of this study it may be worth noting some of these recent opinions in MT research. It has been suggested that the biomechanical effects associated with MT are non-specific (Reggars and Pollard, 1995; Herzog et al., 2001; Ross et al., 2004; Bolton et al., 2007; Huijbregts, 2007) unrelated to the choice of technique (Chiradejnant et al., 2003; Haas et al., 2003; Kent et al., 2005; Kanlayanaphotporn et al., 2009), and without lasting structural changes (Tullberg et al., 1998; Hsieh et al., 2002). Bialosky et al. (2009) suggest that the mechanical force applied during manual therapy may simply be the provocative factor for

Table 2 Mean Newtons (N) pre experiment condition, mean Newtons post experiment condition, change in Newtons and mean percentage (%) changes.

Control	Mean pressure pre (N)	Mean pressure post (N)	Change in pressure (N)	% change
L1 paraspinal	60.1	60.5	0.4	0.7
1st dorsal interossei	25.5	23.8	−1.7	6.7
Sham intervention				
L1 paraspinal	55.5	56.7	1.2	2.2
1st dorsal interossei	23	22.1	−0.9	3.9
Visceral intervention				
L1 paraspinal	53.7	63.6	9.9*	18.4
1st dorsal interossei	24.0	25.3	1.3	5.4

* = The statistically significant change ($P < 0.0001$).

a series of neurophysiological events which cause the outcomes observed following manual therapy treatment. This could apply to VMT, where, similar to MT, the techniques are likely to be imprecise and incapable of causing lasting structural changes, but have the potential to influence nociceptive processing at either peripheral, spinal, or central levels. Beyond effects on nociception alone, somato-visceral interactions could hypothetically be involved. The connection between the autonomic innervation of viscera and segmentally related somatic tissue investigated by Sato (Sato et al., 1985; Sato and Swenson, 1984), among others, may help provide an explanation for the results of this study. Visceral techniques may be inherently imprecise due to the proximity of other organs and adnexal attachments, particularly if adhesions are present (Hedley, 2010) and thus may act primarily through neurophysiological mechanisms. This does not however rule out effects on adhesions or fluid dynamics (Bove and Chapelle, 2011).

This study provides an opportunity to assess whether experimental designs that are well established in MT research are applicable for the assessment of the hypoalgesic effects of VMT. It was demonstrated to be a practical and cost-effective approach. Due to the use of asymptomatic subjects, the clinical relevance of this study is difficult to ascertain, and no extrapolation of these findings in relation to central or peripheral sensitisation can be made. Future research should investigate VMT induced hypoalgesia in the segmentally related somatic tissue within a symptomatic population, and explore avenues such as whether the effects are dose-dependent, and induce durable long term hypoalgesia. This would allow for a more clinically relevant quantification of PPT reduction after visceral manipulation. An appropriate symptomatic population which could be further explored might include patients suffering functional visceral dysfunction and the associated referred pain pattern. PPT values would be employed as the primary outcome measure as a means of assessing the hypothetical effect of VMT on somatic dysfunction.

While pressure algometry has been shown to be a reliable measure of pain (Vanderweeen et al., 1996; Potter et al., 2006), there are reported methodological flaws (Kosek et al., 1993; Vanderweeen et al., 1996; Vaughan et al., 2007). This study in particular may have suffered from the lack of a means by which to control the rate of pressure increase during PPT measurement, and the absence of a subject controlled switch, which would avoid reliance on tester reaction time. Pressure algometry is part of a range of quantitative sensory testing (QST) measures (Siao and Cros, 2003), and the inclusion of other measurements such as thermal pain threshold and vibration thresholds may well illuminate the mechanisms by which VMT exerts a hypoalgesic effect.

Time and resource constraints resulted in a small sample size and this may limit the significance of the results. The believability of the sham could also be brought into question as the cohort was drawn from a student population in an osteopathic institute in which the teaching includes VMT and functional osteopathic techniques. However, the majority of the subjects ($N = 11$) were taken from a stage in their studies where they had not yet formally encountered such techniques. It may have been beneficial to carry out a follow up study to gauge the level of awareness of the sham intervention. Additionally, only the immediate hypoalgesic effect of sigmoid colon mobilisation was demonstrated and future research could include a wider timeframe to identify any lasting effects minutes or hours after intervention.

Conclusion

Visceral mobilisation of the sigmoid colon was found to produce immediate hypoalgesia in segmentally related somatic tissue. The study suggested a novel approach to investigating the mechanisms of VMT, however it is difficult to ascertain the clinical relevance. Further research into VMT is required to examine whether these changes are durable and dependent on dose and type of treatment technique. Moreover, future studies should explore the hypoalgesic effects in larger, symptomatic cohorts using a variety of QST methods, so that a more complete understanding of the mechanisms of VMT may be obtained, thereby helping to inform its application in clinical practice.

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