Short- and Medium-Term Effects of Manual Therapy on Cervical Active Range of Motion and Pressure Pain Sensitivity in Latent Myofascial Pain of the Upper Trapezius Muscle: A Randomized Controlled Trial

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Abstract

Objective: The purpose of this study was to investigate effects of different manual techniques on cervical ranges of motion and pressure pain sensitivity in subjects with latent trigger point of the upper trapezius muscle.

Methods: One hundred seventeen volunteers, with a unilateral latent trigger point on upper trapezius due to computer work, were randomly divided into 5 groups: ischemic compression (IC) group (n = 24); passive stretching group (n = 23); muscle energy technique group (n = 23); and 2 control groups, wait-and-see group (n = 25) and placebo group (n = 22). Cervical spine range of movement was measured using a cervical range of motion instrument as well as pressure pain sensitivity by means of an algometer and a visual analog scale. Outcomes were assessed pretreatment, immediately, and 24 hours after the intervention and 1 week later by a blind researcher. A 4 × 5 mixed repeated-measures analysis of variance was used to examine the effects of the intervention and Cohen *d* coefficient was used.

Results: A group-by-time interaction was detected in all variables ($P < .01$), except contralateral rotation. The immediate effect sizes of the contralateral flexion, ipsilateral rotation, and pressure pain threshold were large for 3 experimental groups. Nevertheless, after 24 hours and 1 week, only IC group maintained the effect size.

Conclusions: Manual techniques on upper trapezius with latent trigger point seemed to improve the cervical range of motion and the pressure pain sensitivity. These effects persist after 1 week in the IC group. (J Manipulative Physiol Ther 2013;xx:1-10)

Key Indexing Terms: *Physical Therapy Modalities; Trigger Points; Range of Motion, Articular; Pain Threshold; Pain Perception*

Myofascial pain syndrome is a common nonarticular musculoskeletal chronic pain.[1] It is one of the main causes of medical consultation, frequently leading to work disability.[2] It is characterized by an intense and deep pain from skeletal muscles and their fascia and by the presence of one or more myofascial trigger points (MTrPs).[1]

An MTrP is described as a hyperirritable spot of a skeletal muscle associated with a hypersensitive palpable nodule of a taut band able to originate specific patterns of pain referral associated with each MTrP, motor dysfunction, restricted range of movement, and producing autonomous phenomena (eg, skin blood flow response).[1,3-5] Myofascial trigger point is clinically classified as active or latent. An active MTrP presents spontaneous pain at rest, during movement and direct compression, whereas latent MTrP, without spontaneous pain, shows only pain and discomfort in response to compression.[1] This clinical distinction has been supported by biochemical data, showing higher levels of nociceptive substances and chemical mediators such as bradykinin, substance P, and serotonin found in active in comparison with latent MTrP or

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regions without MTrP.[5] Nevertheless, there are few data regarding MTrPs physiopathology.[6,7] On the other hand, pressure pain sensitivity is defined as sensitivity to pain's determination using pressure, being extremely used when assessing MTrPs.[1,3-5,8-12] Pressure pain sensitivity can be measured by pressure pain threshold (PPT) or by pressure pain perception (PPP).[8,10-12]

Some studies have demonstrated the potential relevance of latent MTrP. In fact, its presence may cause muscle activation pattern alterations.[13,14] It has been also suggested that latent MTrPs increased nociceptive sensitivity[3,15,16] and sympathetic activity alterations induced by latent MTrP nociceptive stimulation have been investigated.[4,17] However, individuals, even asymptomatic, could have latent MTrP, and high prevalence of MTrPs subsists at cervical and scapular regions.[18]

Furthermore, a diversity of therapeutic interventions consisting of MTrPs inactivation and interruption of the vicious cycle is suggested in literature.[19,20] These interventions are divided into invasive (local injection, acupuncture needles) and noninvasive (manual therapy, electrotherapy, etc).[8,21] Nevertheless, the effectiveness of these different interventions in MTrPs is not yet fully clarified. Acknowledging the diversity of treatment options, this study aimed to determine the short- and medium-term effects of ischemic compression, passive stretching, and muscle energy technique on cervical active range of motion (CAROM) and pressure pain sensitivity in subjects with latent trigger point of the upper trapezius muscle due to computer work.

Methods

This study was a randomized controlled trial using a researcher blinded to group assignment.

Subjects

Volunteer participants were recruited from a university, and the study was advertised via e-mail to the students. At the end, there were 268 positive responses to enter the study. Sample size determination was calculated by the Spanish software (Ene 3.0; Autonoma Barcelona University & Glaxo Smith Kline). The calculations were based on detecting significant clinical differences of 1 kg/cm^2 (>30%) and a SD of 1 kg/cm^2 on PPT levels between groups,[9,22,23] with a level of 0.05 and a desired power of 90%. This generated a sample size of at least 23 participants per group.

Inclusion criteria were 18 years or older, either sex, latent MTrP in the upper trapezius muscle, and average time of computer work of at least 2 hours per day. Exclusion criteria included bilateral MTrPs in the upper trapezius muscle, any pharmacological therapeutic, any treatment at cervical region during the month before this study, any diagnosed health problem, and any history of head and upper trunk surgery or trauma.

From the initial 298 volunteers, 164 were selected after exclusion criteria were applied and selected randomly to 5 groups using closed envelope with the group name: muscle energy technique (MET) group, passive stretching (PS) group, ischemic compression (IC) group, placebo (Pl) control group, and wait-and-see (WS) control group. Only 117 finished the study: 23 in MET group, 23 in PS group, 24 in IC group, 22 in Pl group, and 25 in WS group (Fig 1).

This study is registered with ClinicalTrials.gov number NCT01709357 and was approved by the ethical committee of the University of Porto on March 4, 2010. All subjects signed the informed consent before they were included in the study.

Outcomes

For each subject, the PPT was assessed using an algometer. In a previous study, it was revealed a high algometry's intrarater reliability (intraclass correlation coefficient [ICC $_{2,1}$], 0.91; 95% confidence interval [95% CI, 0.82-0.97]).[24] An electronic pressure algometer FORCE ONE FDIX (Wagner Instruments, Greenwich, CT), a portable equipment with a pointer with a rubber disc extremity, giving a simulation surface of 1 cm^2, was used. Values were displayed in kilograms so measurements were expressed in kilograms per square centimeter.[10] To control the increase of pressure, a standard metronome was used.[11] With the subject seated, the blind researcher placed the pointer on a patterned point of the upper trapezius muscle, at half-away between the midline and lateral border of the acromion[9] with an approximate angle of 90° and an increasing pressure of approximately 1 kg/cm^2 per second.[10] Subjects were told to say "now" whenever the sensation of pressure was replaced by a sensation of pain.[11] The maximum applied pressure was recorded. When PPT increases, the subject tolerates a greater pressure to elicit pain.

For the determination of PPP, the procedure performed was the same as the prior described, but pressure was kept until 2.5 kg/cm^2 and maintained for 5 seconds, whereas the subject had to characterize the level of pain using a 100-mm visual analog scale ruler with 2 extremes: no pain and worst pain ever felt, with no vertical tick marks.[12] In a previous study, it had reported a high visual analog scale's intrarater reliability (ICC, 0.97 [95% CI, 0.96-0.98]).[25] When PPP decreases, the subject felt less pain when using the same pressure.

Moreover, CAROM was also measured: flexion, extension, and ipsilateral and contralateral flexion of latent MTrP as well as ipsilateral and contralateral rotations of latent MTrP with the cervical range of motion instrument (CROM) (OPTP, Plymouth, MN). A previous study had revealed CROM's intrarater reliability with ICC$_{3,1}$ ranging from 0.87 (95% CI, 0.76-0.95) to 0.94 (95% CI, 0.87-0.97).[26] This

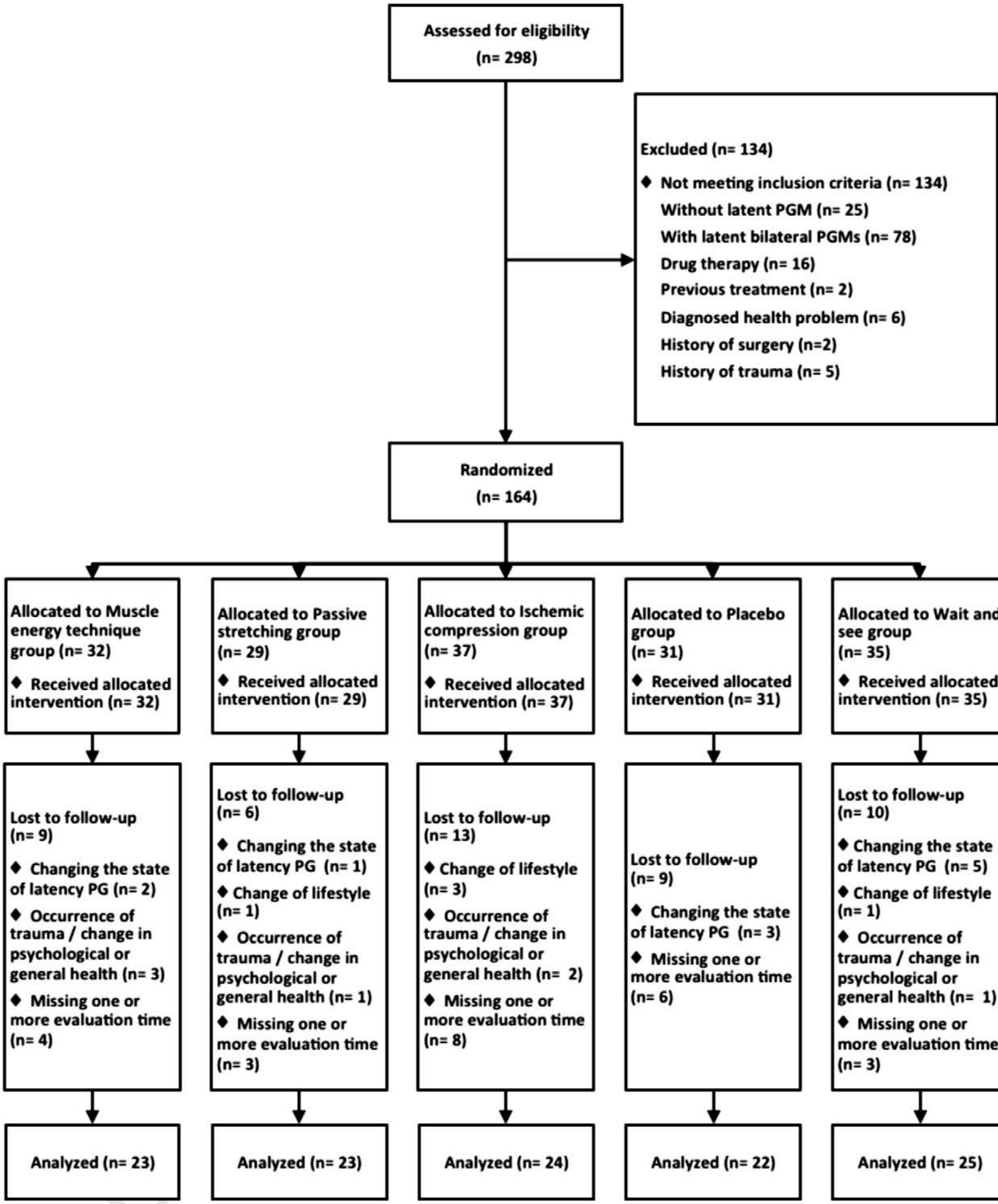

Fig 1. *Flowchart for study.* ~~*PG, placebo group.*~~

equipment with inclinometers and magnets had adjusted to the occipital region. Subjects were asked to seat correctly with relaxed shoulders.[27] Each subject performed each active cervical movement until the end of available range.

Three repetitions were performed with 30-second intervals for each variable under study (CAROM, PPT, and PPP) and their average registered.

Interventions

All interventions were performed with the subject in the supine position.

Muscle Energy Technique Group. The researcher, with one hand on the occipital region and the other stabilizing the shoulder, performed a passive contralateral flexion to the muscle, taking the subject's head until an end-feel point

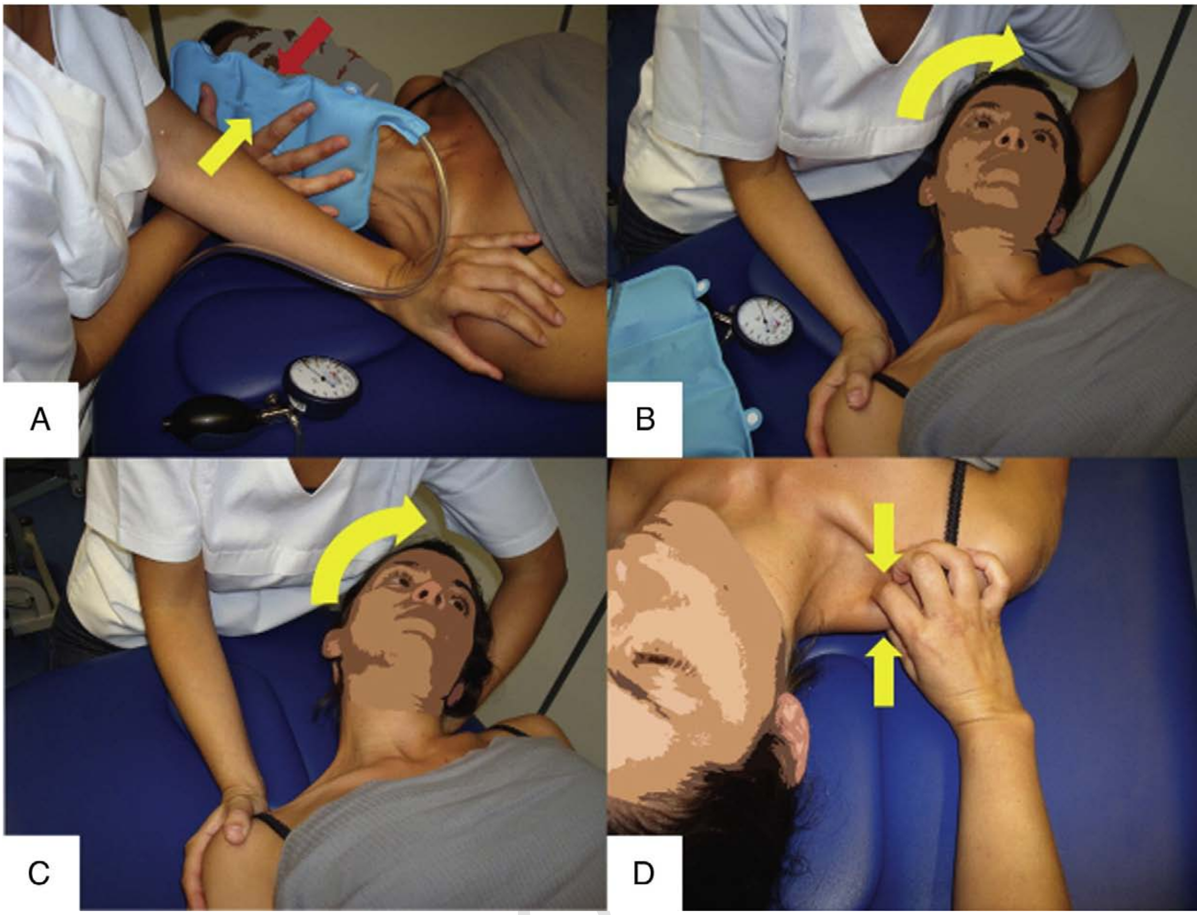

Fig 2. *Interventions. A, Muscle energy technique of right upper trapezius (contraction phase). Red arrow, Direction of contraction performed by the subject. Yellow arrow, Direction of resistance offered by the therapist. B, Muscle energy technique of right upper trapezius (stretching phase). Yellow arrow, Direction of stretch performed by the therapist. C, Passive stretching of right upper trapezius. Yellow arrow, Direction of stretch performed by the therapist. D, Ischemic compression technique of MTrP of right upper trapezius. Yellow arrows, Direction of compression performed by the therapist. (Color version of figure is available online.)*

without creating discomfort. At this point, subjects were asked to perform an isometric contraction of 25% of their maximum force, which had been previously measured by a sphygmomanometer. For this purpose, an inflatable pouch was placed between the researcher's hand and the subject's face and the subject accomplished an ipsilateral flexion of the MTrP affected muscle for 5 seconds, while the researcher offered manual resistance (Fig 2A). Afterwards, the subject relaxed in this position during 5 seconds. Contralateral flexion was now increased until a new end-feel point was reached (Fig 2B).[28]

Passive Stretching Group. The researcher implemented the same initial contact points as described previously. A contralateral flexion of the muscle was performed taking the subject's head passively to the maximum available range of motion, without creating discomfort, while subjects were asked to breathe steadily (Fig 2C). During the breathing phase, the researcher increased the range of motion maintaining this position. This procedure was repeated during 30 seconds.[29,30]

Ischemic Compression Group. The researcher applied gradual pressure on upper trapezius muscle latent MTrP (Fig 2D). Subjects had been previously asked to say when pain was "moderate but bearable" corresponding to a level 7 in a 1 to 10 level scale of pain (1, no pain; 10, unbearable pain). At this point, pressure was maintained until pain levels were reduced to level 3. The researcher increased once more the pressure until the level of pain was 7 again. This procedure was repeated during 90 seconds.[31,32]

Placebo Technique Control Group. The researcher implemented the same contact points as the ones described for PS group, without executing any movement, for 30 seconds.

Wait-and-See Control Group. Subjects were in the supine position for 30 seconds.

Procedure

The aim of this study was explained by the researcher during the first appointment. Subsequently, the diagnosis of the latent MTrPs was performed according to the scientific

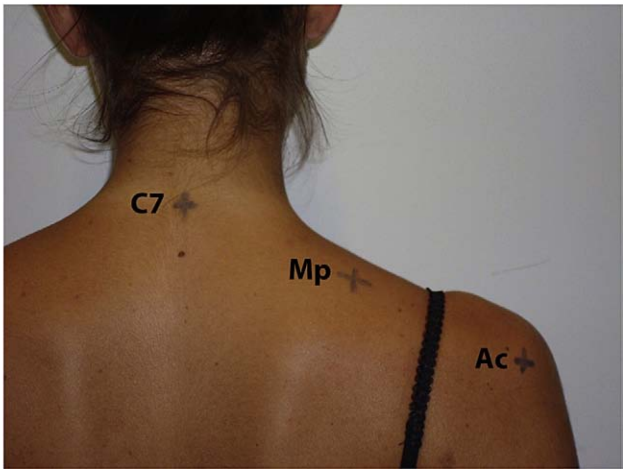

Fig 3. *Identification of anatomical references. C7, spinous process of the seventh cervical vertebra; Ac, acromion; Mp, midpoint between C7 and Ac. (Color version of figure is available online.)*

committee recommendations: (*a*) presence of a palpable taut band in a skeletal muscle, (*b*) presence of a hypersensitive tender spot within the taut band, (*c*) local twitch response elicited by the snapping palpation of the taut band, and (*d*) reproduction of referred pain in response to MTrP compression.[1,33] These criteria, when applied by a trained researcher, have shown a good interexaminer reliability (κ, 0.84-0.88).[33] This procedure was performed by the researcher with 7 years of professional experience in the diagnosis and treatment of MTrPs and with 13 years of professional experience in clinical practice of manual therapy. When MTrPs were present in both upper trapezius muscles, subjects were excluded. A questionnaire was performed afterwards to gather general information about the subjects. At the end, maximum cervical ipsilateral flexion of the MTrP muscle isometric force was measured using pressure values.[34] In fact, muscle force was measured with subjects lying down, while the researcher offered manual resistance, subjects were asked to take their head toward the shoulder on the side of the latent MTrP. The average of 3 measurements was calculated, and 25% of this mean value was registered.[28]

On the following week, before intervention, the researcher identified latent MTrP by palpation and made skin marks on the spinous process of the seventh cervical vertebra, posterolateral edge of the acromion, and the medial point between the last 2 identified points (Fig 3). Then, the blinded researcher executed the evaluation before the intervention (Pre) of CAROM, PPT, and PPP. After the intervention performed by the researcher, subjects were assessed, under the same conditions, 10 minutes after preintervention evaluation (Post1), 24 hours after (Post2) and 1 week later (Post3). Time between evaluations was equal for each group.

Statistical Analysis

Statistical analysis was conducted with the SPSS 16.0 package (SPSS, Chicago, IL). Central tendance measures were used as mean, SE, and 95% CIs. Kolmogorov-Smirnov test showed a normal distribution of quantitative data ($P > .05$). For each dependent variable (CAROM, PPT, and PPP), a 4 × 5 mixed model analysis of variance (ANOVA) with main effects of time (Pre, Post1, Post2, and Post3) as the repeated factor and group (WS, Pl, IC, PS, and MET) as the independent factor was used. Interactions of time and group were of interest. The Mauchly's test was used to measure sphericity. The Huynh-Feldt Epsilon correction and the Bonferroni test for post hoc analysis were used when necessary. $P < .05$ was considered significant. Within-group effect size was calculated using Cohen *d* coefficient. An effect size greater than 0.8 was considered large; around 0.5, moderate; and less than 0.2, small.[35]

Results

The study sample was composed by young adults with normal body mass index, being female the most predominant sex (n = 85). General data from the study sample are presented on Table 1. No significant differences were found between groups concerning sex ($\chi^2 = 2.41$; $P = .66$), age ($F = 0.25$; $P = .91$), body mass ($F = 2.00$; $P = .1$), height ($F = 1.28$; $P = .22$), or dominant upper member side ($\chi^2 = 2.08$; $P = .72$).

Cervical Active Range of Motion

By ANOVA test, a significant group-by-time interaction ($F = 6.93$; $P < .01$) in flexion was revealed (Table 2). After intergroup analysis before the intervention, significant differences were identified between WS and IC groups ($P = .02$) and WS and PS groups ($P < .01$), not allowing interpret the postintervention comparisons. The within-group analysis revealed that IC group has shown significant increase between Pre and the 3 postintervention ($P < .01$), with small effect sizes. Passive stretching group has shown significant increase between Pre with Post1 and Post2 ($P < .01$), with a moderate and small effect size, respectively, and disappeared after 1 week. Muscle energy technique group accomplished results similar to the PS group, but with a lower immediate effect size ($d = 0.27$) (Table 2).

Although a significant interaction was shown by ANOVA test ($F = 3.79$; $P < .01$), extension was the movement, which induced the less changes when compared with the other cervical movements (Table 2). No intergroup significant differences were found at any moment of assessment. However, a within-group significant increase was observed immediately after the intervention in the 3 experimental groups ($P \leq .01$). Nevertheless, this change t1.1 **Table 1.** *Characteristics of the subjects*

		WS group (n = 25)	Pl group (n = 22)	IC group (n = 24)	PS group (n = 23)	MET group (n = 23)
t1.4	Sex (male/female)	7/18	8/14	4/20	6/17	7/16
t1.5	Age (y)	20.44 ± 2.08 (19.58-21.3)	20.23 ± 1.57 (18.53-20.92)	20.08 ± 1.21 (19.57-20.6)	20.6 ± 1.93 (19.73-21.4)	20.35 ± 2.14 (19.42-21.28)
t1.6	Weight (kg)	60.4 ± 10.35 (56.14-64.66)	67.27 ± 11.52 (62.17-72.38)	59.33 ± 8.57 (55.72-62.95)	63.96 ± 11.72 (58.89-69.02)	63.0 ± 10.86 (58.3-67.7)
t1.7	Height (m)	1.66 ± 0.09 (1.62-1.69)	1.71 ± 0.1 (1.67-1.76)	1.66 ± 0.1 (1.62-1.71)	1.69 ± 0.1 (1.64-1.73)	1.69 ± 0.1 (1.66-1.74)
t1.8	Latent MTrP side (right/left)	25/0	21/1	23/1	22/1	22/1
t1.9	Dominant side (right/left)	24/1	21/1	24/0	22/1	23/0

t1.10 *IC*, ischemic compression; *MET*, muscle energy technique; *Pl*, placebo; *PS*, passive stretching; *WS*, wait and see.
t1.11 Data are expressed as mean ± SD (95% CI).
t1.12 No differences were identified between groups ($P > .05$).

t2.1 **Table 2.** *Outcomes of all groups and evaluations*

		Group					
t2.3		WS group	Pl group	IC group	PS group	MET group	*P*
t2.5	Flexion (°)						
t2.6	Pre	64.5 ± 12.0	59.4 ± 7.6	55.6 ± 10.9	53.8 ± 8.4	57.4 ± 9.5	**<.01**
t2.7	Post1	64.1 ± 12.3	58.8 ± 7.5	59.5 ± 9.6	57.8 ± 8.1	59.9 ± 9.5	
t2.8	Post2	64.1 ± 12.4	58.9 ± 7.3	59.1 ± 10.1	56.8 ± 7.6	59.8 ± 9.6	
t2.9	Post3	63.9 ± 12.1	58.8 ± 7.3	58.6 ± 10.3	54.1 ± 8.6	58.7 ± 8.2	
t2.10	Extension (°)						
t2.11	Pre	67.8 ± 8.6	70.9 ± 9.1	64.7 ± 12.2	67.1 ± 10.4	65.8 ± 8.3	**<.01**
t2.12	Post1	67.6 ± 8.5	70.8 ± 9.2	68.6 ± 11.0	68.5 ± 9.6	68.1 ± 8.4	
t2.13	Post2	67.7 ± 8.7	70.6 ± 8.8	66.9 ± 10.8	68.1 ± 9.6	69.0 ± 7.5	
t2.14	Post3	67.6 ± 8.7	70.4 ± 9.0	66.7 ± 10.7	67.3 ± 9.9	66.7 ± 10.0	
t2.15	Ipsilateral flexion (°)						
t2.16	Pre	45.0 ± 5.3	46.8 ± 5.8	46.1 ± 4.6	42.9 ± 4.6	45.0 ± 5.1	**<.01**
t2.17	Post1	44.7 ± 5.4	45.9 ± 5.2	47.4 ± 5.4	43.2 ± 5.2	47.2 ± 4.9	
t2.18	Post2	44.5 ± 5.2	45.3 ± 5.3	46.2 ± 4.5	43.3 ± 5.2	46.8 ± 4.8	
t2.19	Post3	44.5 ± 5.6	45.5 ± 4.9	45.7 ± 4.0	43.0 ± 5.0	45.7 ± 5.0	
t2.20	Contralateral flexion (°)						
t2.21	Pre	37.5 ± 4.9	40.2 ± 7.2	39.8 ± 5.1	37.6 ± 5.1	39.8 ± 4.6	**<.01**
t2.22	Post1	37.6 ± 5.0	39.7 ± 7.2	46.0 ± 5.8	46.8 ± 4.9	48.1 ± 4.0	
t2.23	Post2	37.4 ± 4.6	39.7 ± 6.4	46.6 ± 5.4	43.8 ± 6.0	46.2 ± 4.3	
t2.24	Post3	37.2 ± 4.6	39.2 ± 6.4	46.8 ± 5.4	41.7 ± 6.4	45.2 ± 4.7	
t2.25	Ipsilateral rotation (°)						
t2.26	Pre	71.3 ± 5.2	71.1 ± 5.6	71.2 ± 5.7	70.6 ± 6.4	70.4 ± 5.7	**<.01**
t2.27	Post1	71.3 ± 5.1	70.5 ± 5.5	76.3 ± 4.5	75.0 ± 5.5	74.3 ± 5.4	
t2.28	Post2	70.6 ± 5.1	70.4 ± 6.3	77.2 ± 4.0	73.6 ± 5.4	73.4 ± 5.7	
t2.29	Post3	71.0 ± 5.1	70.8 ± 6.2	76.5 ± 6.7	72.4 ± 6.1	73.4 ± 5.1	
t2.30	Contralateral rotation (°)						
t2.31	Pre	80.3 ± 5.7	78.5 ± 4.7	77.3 ± 4.3	77.3 ± 5.2	75.5 ± 5.0	.7
t2.32	Post1	80.2 ± 5.5	78.2 ± 4.4	78.4 ± 3.7	77.1 ± 5.1	76.1 ± 4.6	
t2.33	Post2	80.6 ± 5.4	78.5 ± 4.6	78.8 ± 3.6	77.0 ± 5.6	75.9 ± 3.8	
t2.34	Post3	80.2 ± 5.9	78.7 ± 4.8	79.3 ± 4.3	77.8 ± 4.9	75.5 ± 3.7	
t2.35	PPT (kg/cm^2)						
t2.36	Pre	2.2 ± 0.4	2.2 ± 0.4	1.7 ± 0.3	1.9 ± 0.4	1.8 ± 0.4	**<.01**
t2.37	Post1	2.0 ± 0.4	2.0 ± 0.4	2.8 ± 0.4	2.5 ± 0.4	2.6 ± 0.5	
t2.38	Post2	2.2 ± 0.4	2.1 ± 0.4	2.8 ± 0.4	2.2 ± 0.4	2.4 ± 0.4	
t2.39	Post3	2.1 ± 0.4	2.2 ± 0.3	2.9 ± 0.4	2.2 ± 0.3	2.3 ± 0.4	
t2.40	PPP (mm)						
t2.41	Pre	29.8 ± 16.1	34.3 ± 18.1	31.3 ± 21.0	34.9 ± 19.2	43.2 ± 20.0	**<.01**
t2.42	Post1	32.9 ± 15.2	27.0 ± 14.2	22.7 ± 15.9	25.6 ± 19.3	28.6 ± 18.2	
t2.43	Post2	30.7 ± 15.8	33.3 ± 17.5	25.1 ± 14.9	28.1 ± 17.2	34.1 ± 17.5	
t2.44	Post3	31.2 ± 13.5	32.6 ± 16.3	22.2 ± 16.3	31.3 ± 19.4	31.9 ± 16.2	

t2.45 *IC*, ischemic compression; *MET*, muscle energy technique; *Pl*, placebo; *PS*, passive stretching; *WS*, wait and see.
t2.46 Data are expressed as mean ± SD. Values in bold are statistically significant difference ($P < .05$).

was only maintained after 1 week in IC group (P = .03). However, the effect sizes were small or almost inexistent revealing that the range of movement after intervention is very close to the value of preintervention (Table 2).

A significant group-by-time interaction that was found in ipsilateral flexion assessment was revealed (F = 2.97; P = .01), without any intergroup differences (Table 2). In IC group, an immediate significant increase (P = .01), with a small effect size and inexistent after 1 week, was observed. An immediate significant increase (P < .01) was maintained 24 hours later (P = .01) in MET group; however, ipsilateral flexion was significantly loss after 1 week (Post2-Post3, P = .04). Although an increase of range with moderate effect size was seen at Pre-Post1 (d = 0.49), range values showed values close to Pre after 1 week (d = 0.14) (Tables 2).

A significant group-by-time interaction was shown in contralateral flexion (F = 24.17; P < .01) (Table 2). Contralateral flexion increased significantly, immediately after intervention, in the 3 experimental groups when compared with 2 control groups (P < .01), which were sustained for 1 week (P ≤ .01), except PS group that only improved for 24 hours when compared with WS group. Significant differences were found in IC, MET, and PS groups between Pre and all postintervention time moments of assessment (P < .01). In fact, large effect sizes demonstrated that contralateral flexion range of motion increased over time; they were more steadily sustained in IC group, followed by MET and with a higher loss for PS group (Tables 2 and 3).

Significant group-by-time interaction was also revealed in ipsilateral rotation (F = 9.99; P < .01) (Table 2). In an intergroup comparison, ipsilateral rotation increased significantly only in IC group when compared with control groups maintaining the improvement for 1 week (P ≤ .01). Ischemic compression technique revealed a within-group large effect size over time (P < .01; d ≥ 0.8). A similar behavior of increase was seen in PS and MET groups showing large immediate effect size (P < .01; PS: d = 0.74/ MET: d = 0.70), but there was a decrease in time, more relevant in PS group (PS: Pre-Post3, P = .26; d = 0.29/ MET: Pre-Post3, P < .01; d = 0.54) (Tables 2 and 3).

In contralateral rotation, no group-by-time interaction was observed (F = 1.67; P = .07), supported by small or almost inexistent effect sizes revealing an absence or very low range of motion changes after interventions.

Pain Measures

Analysis of variance tests revealed a significant group-by-time interaction in PPT (F = 42.58; P < .01) (Table 2). After intergroup analysis, PS group revealed a significant postimmediate increase in PPT when compared with Pl groups (P < .01). Within-group analysis verified a significant decrease of PPT on WS and Pl groups, immediately after the intervention (WS: P < .01/Pl: P = .03), with values returning to initial values after 24 hours and 1 week. Muscle energy technique and PS groups had immediate increase of PPT with large effect sizes (PS: P < .01; d = 1.61/MET: P < .01; d = 1.92), which were significantly decreased 24 hours and 1 week later (P < .01 in all cases), maintaining the large effects (PS: d = 0.87/ MET: d = 1.32). Nevertheless, IC procedure was the one that shown bigger differences between Pre and all postintervention moments (P < .01). In fact, this group has shown an increase of PPT values with large effect sizes over time, without loss of immediate effect after 1 week (Pre-Post1: d = 3,28; Pre-Post2: d = 3,42; Pre-Post3: d = 3,59) (Tables 2 and 3).

A significant group-by-time interaction was found in PPP (F = 3.59; P < .01) (Table 2). No intergroup significant differences were found at any moment of assessment. Nevertheless, in a within-group analysis, Pl group revealed a significant decrease at Pre-Post1 comparison (P = .04), which was lost after 24 hours. Ischemic compression and MET groups had similar immediate behavior (IC: P < .01; d = −0.47/MET: P < .01; d = −0.76) that was maintained for 1 week (IC: P < .01; d = −0.49/MET: P < .01; d =

Table 3. *Moderate and high intragroup effect size for contralateral flexion, ipsilateral rotation, PPT, and PPP variables*

	IC group	PS group	MET group
Contralateral flexion			
Pre-Post1	1.13	1.83	1.96
Pre-Post2	1.29	1.11	1.45
Pre-Post3	1.32	0.72	1.77
Post1-Post2	–	−0.55	−0.48
Post1-Post3	–	−0.89	−0.67
Post2-Post3	–	–	–
Ipsilateral rotation			
Pre-Post1	0.99	0.74	0.70
Pre-Post2	1.23	0.52	0.51
Pre-Post3	0.85	–	0.54
Post1-Post2	–	–	–
Post1-Post3	–	−0.44	–
Post2-Post3	–	–	–
PPT			
Pre-Post1	3.28	1.61	1.92
Pre-Post2	3.42	0.78	1.57
Pre-Post3	3.59	0.87	1.32
Post1-Post2	–	−0.81	−0.55
Post1-Post3	–	−0.82	−0.67
Post2-Post3	–	0.04	–
PPP			
Pre-Post1	−0.47	−0.48	−0.76
Pre-Post2	−0.35	−0.37	−0.48
Pre-Post3	−0.49	–	−0.62
Post1-Post2	–	–	–
Post1-Post3	–	–	–
Post2-Post3	–	–	–

IC, ischemic compression; *MET*, muscle energy technique; *PPP*, pressure pain perception; *PPT*, pressure pain threshold; *PS*, passive stretching.
Results are expressed as Cohen index (d).
Empty cells refer to nonexistent to small effect sizes.

−0.62). Passive stretching group only showed an immediate decrease in pain ($P < .01$; $d = -0.48$) (Tables 2 and 3).

In summary, there were improvements on contralateral flexion for IC and MET groups and on ipsilateral rotation for IC group, in comparison with control groups. In addition, IC and MET techniques presented large effect sizes on PPT and PPP, respectively. There was a tendency to decrease the observed effects over time, obtained sometimes values close to the preintervention. Nevertheless, IC group presented larger effect size of contralateral flexion and PPT after 24 hours and 1 week (Tables 2 and 3).

Discussion

A single IC, PS, or MET treatment on an MTrP's upper trapezius muscle leads to an increase in contralateral flexion and ipsilateral rotation, PPT increase, and a PPP decrease. Moreover, the IC technique showed an effect on PPT, whereas the other techniques have shown to be more effective on contralateral flexion range acquisition, persisting during a week. Although the achieved effect sizes were large, both MET and PS technique showed moderate to large loss of immediate effect on contralateral flexion range and PPT. The IC technique increased gradually with a higher effect level regarding postimmediate measures.

Regarding range of motion, the interventions done on the upper trapezius muscle increased significantly both contralateral flexion and ipsilateral rotation on different times. Despite its cervical tridimensional action, results were expected to be more prominent in movements with opposite direction to its function when contracted unilaterally.[1] The fact that the other movements did not improve could be a consequence of the presence of measures' ceiling effect at baseline.

Ischemic compression technique has shown significant immediate effect levels on contralateral flexion and ipsilateral rotation that remained for 1 week, agreeing with Aguilera et al.[27] These authors with similar sample and procedures had the same effect in contralateral flexion, the only movement studied. The results can be explain by Simons' hypothesis,[20] suggesting that local pressure may equalize the length of treated MTrP sarcomeres.

Passive stretching technique also had significant immediate contralateral flexion increase, keeping it for a week. These improvements could be explained as PS intervention targets the overshortened muscle fibers increasing then the cervical movements. On the other hand and according to Simons,[7] the use of slow, relaxed passive stretching with a gradual increase in range of motion during expiratory phase, as used in the present study, appears to inhibit alpha motor neurons response and consequent inhibition of muscle shortening when stretched,[36] so sarcomeres remain relaxed allowing an increase in length.[37] Even with lack of evidence about the effect of PS of an affected muscle with an MTrP, Hou et al[8] and Majlesi and Unalan[38] had shown a range of motion improvement with stretching associated with other types of interventions, in presence of MTrP, but it was impossible to determine the single contribution of the stretching on the improvement.

Muscle energy technique group revealed a significant immediate increase of contralateral flexion range that was maintained during 1 week. Muscle energy technique efficiency in increasing range of motion is due to an isometric contraction of the affected muscle leading to postisometric relaxation by inhibition of the motor activity through Golgi tendon organs.[39] Furthermore, viscoelastic properties and plastic alterations of myofascial conjunctive tissue elements are a possible explanation for an increase in muscle length.[40-42] On the other hand, Lewit[43] considers that the results obtained with postisometric relaxing technique are due to the fact that the minimum amount of force used in an isometric contraction leads to an activation of some muscle fibers while inhibiting fibers involved in the taut band of the MTrP as well as avoiding a stretching reflex during passive stretching of the affected muscle. There is reduced evidence about the effect of MET on CROM with the presence of MTrP. However, some evidence about range of motion increase after MET but related to shoulder[44] and hip[45] was found.

Concerning mechanical pain sensitivity, an immediate significant PPT increase in PS group was observed and which had decreased over time. Some authors established that an active stretching program leads to a PPT improvement at the active MTrP.[30,46,47] On the other hand, Somprasong et al[48] have not detected PPT improvement at postimmediate or at 24 hours after a single PS technique, perhaps, because the authors produced a stretching with moderate pain that could cause muscle contraction through activation of muscle spindle and its reflex and thus increase the sensitivity of MTrP. In addition, studies have shown that the conjugation PS with a mechanical intervention at the MTrP leads to better pain sensitivity outcomes.[46,47] In fact, it would be expected that direct treatment at the MTrP would inactivate the MTrP and stretch would increase sarcomeres' length through fuse gamma inhibition, leading to muscle relaxation and, consequently, pain reduction, increasing pain threshold.[1]

Ischemic compression group had shown an immediate large effect sizes in PPT during 1 week. These results are similar to Aguilera et al[27] and Fernández-de-las-Peñas et al [32] who have shown, in similar studies, an immediate improvement over pressure sensitivity of the upper trapezius MTrP after IC technique. The increase in PPT by IC technique is explained by Hou et al[8] as a consequence of MTrP's reactive hyperemia or a spinal reflex mechanism for the release of muscle contraction.

Muscle energy technique had positive effects on PPT over time but also in PPP in the immediate. Considering the upper trapezius MTrPs, Nagrale et al[49] have shown PPP improvement after 4 weeks of MET program and have not been evaluated changes in the postimmediate, 24 hours, and

1 week. In addition, an immediate reduction in PPT was determined when there is no MTrP region.[50,51] So, the increase range of motion due to mechanism of voluntary contraction followed by a passive stretching may possibly reduce pain.[28] Nevertheless, muscle contraction can increase the sensitivity of MTrP and so reduce the magnitude of improvement in pain.

Limitations

For this study, subjects were asymptomatic and, therefore, not representative of the population often seen in clinics, which was a limitation of the study. The study of the effects of a single session had limited the direct comparison with other studies. Closer to clinical practice, future studies need to explore the cumulative effect of several sessions of different techniques and also the combination of these to discern if the individual effect of each technique is complemented by the others. On the other hand, longitudinal epidemiological studies, which allow the study of appearance and conversion of latent MTrPs into active ones, are necessary as these could then appraise the relevance of preventive therapy on latent MTrPs.

Conclusion

Ischemic compression, passive stretching, and muscle energy techniques' single application on upper trapezius with latent MTrP leads to an increase on contralateral flexion and ipsilateral rotation range of motion as well as on the pain threshold immediately after session. All 3 techniques maintained improvements after 1 week; however, ischemic compression resulted in the most stable improvement.

Practical Applications

- Manual therapy techniques improved CROM and PPT on upper trapezius with latent trigger points.
- The effects of manual therapy on cervical spine were not bilateral.
- Ischemic compression technique showed large effects on upper trapezius with latent trigger points.
- Ischemic compression technique showed effects that increased gradually after a single application after 1 week.

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No funding sources or conflicts of interest were reported for this study.

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