Immediate Effects of Spinal Manipulation on Shoulder Motion Range and Pain in Individuals With Shoulder Pain: A Randomized Trial

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ABSTRACT

Objective: The purpose of this study was to investigate the influence of thoracic spinal manipulation (SM) on shoulder pain and ranges of motion in individuals with shoulder pain.

Methods: The sample was composed of 60 individuals, randomly allocated into the manipulation group ($n = 30$), who received the SM, and the placebo group ($n = 30$) who received a placebo manipulation. Pain evaluation was performed using the visual analog scale, and evaluation of shoulder flexion and abduction ranges of motion was assessed using a goniometer pre- and post-intervention. The intervention was performed by either upper thoracic SM or a placebo manipulation.

Results: The manipulation group demonstrated increased flexion and abduction of the painful shoulder ($P < .01$) and increased abduction of the nonpainful shoulder ($P = .03$), but only the abduction of the painful shoulder reached the minimal detectable change. The placebo group showed a post-intervention increase in the flexion ($P = .03$) and abduction ($P < .01$) movement of the painful shoulder. Both groups presented a statistically significant reduction in post-intervention pain ($P < .01$), but not clinically significant.

Conclusion: Although the SM demonstrated a statistically significant difference for shoulder pain, this was not over the clinically meaningful change. Only the abduction of the painful shoulder reached the minimal detectable change. (J Chiropr Med 2019;18:19-26)

Key Indexing Terms: Manipulation, Spinal; Pain; Range of Motion, Articular; Shoulder; Shoulder Pain

INTRODUCTION

Shoulder pain is highly prevalent among musculoskeletal disorders, being the third most frequent reason for medical care in primary care.¹ A study has shown that the 3 most

commonly referenced musculoskeletal conditions for physiotherapeutic treatment at secondary and tertiary levels are low back pain, rotator cuff syndrome, and gonarthrosis.² Thus, regarding complaints of the shoulder complex, the most common pathologies are tendinopathies, especially those of rotator cuff lesion.³

For the treatment of shoulder pain, conservative treatment is initially advocated through physiotherapy interventions.⁴ Some approaches to the treatment of shoulder pain include thoracic spinal manipulation (SM),⁵⁻⁷ which can be defined as a movement of high speed and low amplitude or *thrust* applied directly to any thoracic segment.⁸

The relationship between the thoracic spine and shoulder movements leads to the term *regional interdependence*, which refers to the concept that apparently unrelated deficiencies in an anatomical region may be associated with primary symptoms in other regions that contribute to the patient complaint.⁹ Thus, the rational basis for the clinical use of thoracic manipulation to treat the shoulder is based on this theory.

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Thoracic SM has already been explored in studies of participants with shoulder pain, finding a decrease in shoulder pain immediately after manipulation¹⁰ and improvements in function after thoracic SM.¹¹ On the other hand, other studies did not show immediate changes in the scapular kinematics after thoracic SM⁶ or differences in pressure pain sensitivity,¹¹ added to which improvements were not observed in muscle activity after thoracic manipulation.⁵

Thus, although investigations have been performed in participants with shoulder pain to verify the effects of thoracic manipulation on pain, the pressure pain threshold, muscle activity, and scapular kinematics, no studies were found to verify the immediate effect of thoracic manipulation on the shoulder range of motion (ROM). This investigation is of great importance because patients with shoulder pain tend to present a reduction in ROM, which may lead to a reduction in shoulder function, impairing functional activities.^{12,13} Thus, the preservation of ROM could be an important factor in avoiding disability of the shoulder.

Therefore, this study aimed to investigate the influence of SM on ROM of the shoulder in individuals with shoulder pain. The secondary aim was to investigate the influence of SM on shoulder pain. The hypothesis of the study was that SM would cause an increase in ROM of the shoulder and a decrease in shoulder pain.

METHODS

This investigation was a quasi-experimental study performed at the Clinical School of Physiotherapy of a university and a private clinic. The trial was approved by the ethics and research committee, under the Certificate of Presentation for Ethical Consideration, with the code: 37088014.0.0000.0118. All participants signed the informed consent form to voluntarily participate in the study.

The inclusion criteria were men and women, aged between 20 and 70 years, presenting shoulder pain for at least 6 months, with clinical signs of rotator cuff tendinopathy as presented by positive results in 3 of 5 clinical tests indicating signs of rotator cuff tear¹⁴ (1: positive Hawkins test, 2: Neer positive test, 3: pain during active arm elevation less than 60° in relation to the plane of the scapula or sagittal plane, 4: Jobe positive test [empty can] to evaluate pain or weakness, 5: pain or weakness with external rotation of the resisted shoulder with the arm at the side of the body). Additional inclusion criteria included agreeing to kinetic-functional evaluation or presenting a medical diagnosis or imaging of the rotator cuff injury, not having taken medication containing beta-blockers or anti-inflammatories for at least 1 month, not being in physical therapy treatment, and having pain with an intensity higher than 3 on the visual analog scale (VAS).¹⁵

Exclusion criteria were clinical signs of complete rotator cuff tear (drop arm test positive),⁵ a history of shoulder surgery, any absolute contraindication to SM indicated by

red flags (history of cancer, osteoporosis, acute inflammatory process, and fracture),¹⁶ spinal pain complaints (thoracic region), heart transplant, pacemaker, a history of surgery or trauma to the spine, pregnant women, presenting a neurological disease, and visual or hearing impairment.

Participants were intentionally recruited from the general population through informal invitation or pamphlets. Initially, 75 participants were invited. However, 12 did not meet the inclusion criteria (6 aged above 70 years, 2 aged less than 20 years, 3 were in physiotherapeutic treatment, 1 used anti-inflammatories 1 week before the study); 2 did not agree to participate in the study; and 1 had experienced a stroke in the previous year. Finally, 60 participants participated in the study and were randomized into 2 groups: manipulation group (MG) ($n = 30$), which received the manipulation; and placebo group (PG) ($n = 30$), which received a placebo manipulation (Fig 1).

Participants were randomly divided into groups by an independent evaluator (A). This randomization was of the simple type. Thus, the participants selected an envelope containing a piece of colored paper (30 orange and 30 blue) cut into even rectangular shapes. The orange paper corresponded to the manipulation group, and the blue paper corresponded to the placebo manipulation. In this way, each volunteer removed 1 piece of colored paper from the envelope, handing it to the independent evaluator, who in turn showed it to the physiotherapist (B), who assigned the individual to the randomly selected manipulation. Only the therapist who administered the therapy (B) knew the color of each intervention because it was physiotherapist B who applied the intervention, as blinding was impossible. The volunteers knew that there was a placebo group but were blind to the intervention groups. Evaluation of the participants and application of the interventions were performed by the same physiotherapist (B).

Initially, an evaluation form was applied, composed of identification data of each participant and questions pertinent to the research such as age, sex, and details of shoulder pain. Subsequently, the evaluation was performed by a physiotherapist who had 6 years of clinical experience to verify the inclusion and exclusion criteria.

Participants were assessed for pain using the VAS, which consists of a scale to assess the level of pain, comprising a horizontal line of 10 cm extended from 0 to 10, on which 0 corresponds to no pain and 10 to maximum pain.¹⁵ Thus, the individuals drew a vertical line on the horizontal line to demarcate their current level of pain. To assess pain, the examiner measured the position of the line drawn by the individual with a standard ruler. This evaluation was performed before (pre) and after (post) the intervention. For the participants, the minimal clinically important difference on the VAS was 1.4 cm.¹⁵

The ROM verification of the flexion and abduction movements of both shoulders was also performed before and after intervention. The ROM evaluation was performed using

Fig 1. Flowchart for admitting patients and group composition.

a Carci brand universal goniometer. The reliability of goniometry for flexion and abduction of the shoulder was performed by the same examiner (with 6 years of experience with this measure) and between-days before data collection, evaluating 10 individuals who did not present a pain complaint or limitation of shoulder ROM. The reliability analysis was performed using the intraclass correlation coefficient considering the means of ROM values (mean of 3 trials) of flexion and abduction and adopting a 95% CI. An intraclass correlation coefficient value of 0.96 was obtained with 95% CI (0.92-0.99). According to the protocol, this value was considered excellent.¹⁷ The calculation of the standard error of the measurement (SEM) was 4° for shoulder flexion and 5.3° for abduction. The minimal detectable change (MDC) was calculated using the formula $MDC = \text{the standard error of the measurement} \times \sqrt{2}$,⁶ resulting in 5.64° for flexion and 7.47° for abduction.

Subsequently, the evaluation of shoulder ROM was performed with the participants in a sitting position. Evaluation of the movement of the active shoulder flexion was carried out

in the sagittal plane. The fulcrum of the goniometer was positioned lateral and inferior to the acromion process, the fixed arm parallel to the trunk, and the mobile arm parallel to the longitudinal axis of the humerus toward the lateral epicondyle.¹⁸

For abduction of the active shoulder, the participants remained in the same position, but the measurement was performed in the coronal plane. The participants were instructed to perform the movement with the thumb pointing up toward the ceiling. The fulcrum was positioned at the midpoint of the posterior aspect of the glenohumeral joint, the fixed arm parallel to the trunk, and the mobile arm parallel to the longitudinal axis of the humerus.¹⁸ To perform the abduction, the participants maintained elbow extension, associated with shoulder external rotation (with the thumb pointed up). Three repetitions of each movement were performed and the average was used for analysis. Because it has already been shown that there is an improvement in scapular upward rotation during active flexion shoulder, independent of shoulder symptoms after

Fig 2. Spinal manipulation in the prone position.

thoracic manipulation,¹⁰ the contralateral limb was also evaluated following the same procedures. The maximum active ROM was determined by self-report of the participant.¹⁹ The examiner was not blinded to group assignment.

Spinal manipulation was performed on the upper thoracic spine (between the fourth and fifth thoracic vertebrae [T4-T5] segments). The proposed technique for manipulation is designated prone position (or patient lying prone) (Fig 2). Two manipulations were carried out on the T4-T5 segment, performed by a physiotherapist with formation in manipulative physiotherapy, with 6 years of experience in the area.

For spinal manipulation, participants were lying in a prone position on a low stretcher and the therapist performed a low-amplitude, high-velocity thrust applied at the end of the available spinal movement in the posterior-anterior direction after the patient exhaled. For this, the therapist positioned the hypothenar eminence of his hands on the transverse processes of the thoracic vertebrae. The therapist then requested the patient to inhale completely and exhale completely. The therapist followed the patient through the exhalation and applied downward pressure to remove the slack from the soft tissue. At the end of expiration, the therapist applied a low-amplitude, high-velocity thrust to achieve manipulation.⁶

For placebo manipulation, the same position was adopted, although at the end of the expiration no thrust on the vertebrae was performed; instead, the therapist maintained physical contact with minimum pressure.^{5,6} This placebo manipulation was validated as an active treatment.²⁰

Initially, it was intended that the statistical analysis would be performed according to intention to treat (expectation maximization imputation method)²¹ using the Statistical Package for Social Sciences (SPSS) data package version 20.0 (IBM Corp, Armonk, New York). However, as there was no loss of data or sample, there was no need for this to be performed. Thus, the statistical analysis was performed using the same data package (SPSS). Descriptive statistics were used for means and standard deviation. The dependent variables were pain and ROM. To verify the normality of the data, a Shapiro-Wilk test and skewness values were applied.

To indicate a normally distributed variable by skewness values, the scores must be within the range of -1.0 to 1.0.^{22,23} The *t* independent test was used to analyze differences in baseline variables between manipulation and placebo groups for continuous data (height, age, weight, ROM, and pain). Because the data were normally distributed, for pain, a 2-way mixed-model analysis of variance was performed for comparisons within and between the groups, considering time (pre and post) and groups (manipulation and placebo). For ROM, a 3-way mixed-model analysis of variance was performed considering time (pre and post), groups (manipulation and placebo), and affected side (painful and nonpainful shoulder). The Bonferroni post hoc test was used when necessary. A significance level of 5% was adopted for all analyses. The effect size was calculated using Cohen's *d* coefficient, considered small (<0.2), moderate (0.5), or large (> 0.8).²⁴

RESULTS

Sixty participants participated in this study, randomly allocated into 2 groups of 30 individuals. There were no differences between groups for all baseline variables. The anthropometric characteristics are shown in Table 1.

The average pain period reported by the participants was 3.75 years. The MG reported a mean period of 3.21 years and the PG 4.3 years. The right shoulder was the most commonly affected, corresponding to 70% in the MG and 63.33% in the PG.

Regarding the practice of physical exercise, most individuals in both groups did not practice any physical exercise (53.33% MG and 70% in PG). A minority in both groups were smokers (MG = 23.33%, PG = 3.33%).

For both flexion and abduction ROM, there was no interaction of time $\times$ side $\times$ group ($P = .69$, $F = 0.15$; $P = .79$, $F = 0.06$, respectively). However, for both, there was a main effect of time $\times$ side ($P = .01$, $F = 6.95$ for flexion; $P < .01$, $F = 18.54$ for abduction). After the intervention, there was a statistically significant increase in the flexion and abduction ROM of the painful shoulder in the MG (effect size = 0.12 and 0.27, respectively). There was also a significant increase in abduction of the nonpainful shoulder

Table 1. Characteristics of the 2 Groups (Mean and Standard Deviation)

Characteristics	Manipulation Group (n = 30)	Placebo Group (n = 30)	P Value
Sex (women/men)	22/08	19/11	-
Age (y)	46.06 (16.11)	44.46 (12.14)	.66
Height (m)	1.65 (0.09)	1.65 (0.09)	.94
Weight (kg)	69.75 (12.85)	78.7 (15.13)	.17

Table 2. Values of Range of Motion (in Degrees) Pre- and Post-Intervention Within Each Group

Range of Motion	Within Groups	
	MG	PG
Flexion (painful)		
Mean pre	122.63 (29.43)	113.26 (29.53)
Mean post	126.15 (28.36)	115.77 (29.70)
<i>P</i> value	< .01 ^a	.03 ^a
MDC	3.52	2.51
Abduction (painful)		
Mean pre	111.84 (29.58)	101.99 (36.26)
Mean post	119.86 (29.70)	108.44 (35.81)
<i>P</i> value	< .01 ^a	< .01 ^a
MDC	8.02 ^b	6.45
Flexion (nonpainful)		
Mean pre	143.03 (23.18)	133.05 (26.35)
Mean post	143.50 (22.78)	133.42 (27.68)
<i>P</i> value	.28	.21
MDC	0.47	0.37
Abduction (nonpainful)		
Mean pre	139.38 (25.71)	127.55 (32.83)
Mean post	141.41 (26.11)	128.70 (31.93)
<i>P</i> value	.03 ^a	.41
MDC	2.03	1.15

MDC, minimal detectable change; MG, manipulation group; PG, placebo group. Data presented as mean, standard deviation, and *P* values.

^a Significant difference ($P < .05$).

^b Minimal detectable change.

(effect size = 0.07). The PG showed a statistically significant increase for ROM of flexion in the painful shoulder (effect size = 0.08). The same result was observed for abduction only in the painful shoulder (effect size = 0.17) (Table 2). Analysis between groups showed no significant differences.

Pain improvements after the intervention were not different between groups; there was no time interaction $\times$ group ($P = .38$; $F = 0.75$) or main effect of group. However, there was a main effect of time ($P < .01$; $F = 23.02$) with a statistically significant reduction in shoulder pain in both groups after the intervention (Table 3) (mean difference of 0.53 cm and effect size = 0.36 for MG; mean difference of 0.37 cm and effect size = 0.14 for PG).

DISCUSSION

The results of the present study demonstrated that there were no differences between the groups for ROM and pain. The MG demonstrated increased flexion and abduction of the painful shoulder and increased abduction of the non-painful shoulder after the intervention. However, only abduction of the painful shoulder in the MG reached the MDC. The PG also showed a post-intervention increase in flexion movement and abduction of the painful shoulder and a statistically significant reduction in post-intervention pain, but this did not reach the MDC. In addition, both groups showed a statistically significant reduction in post-intervention pain, but not clinically significant. Thus, there were no differences between groups.

In relation to shoulder ROM, flexion and abduction increased in the painful shoulder and abduction in the non-painful shoulder in the MG. However, only abduction in the painful shoulder reached the MDC, with a small effect size. In the PG, the same movements increased only in the painful shoulder, with a small effect size. In this context, 1 study also used a placebo group in individuals with subacromial impact syndrome and found that placebo manipulation had the same benefits as true manipulation but did not show changes in shoulder ROM for internal rotation and flexion.²⁵ On the other hand, the present study demonstrated an increase in shoulder ROM after both upper thoracic SM and placebo manipulation procedures for

Table 3. Mean Value of Pain Pre- and Post-Intervention in Both Intervention Groups

Groups	Mean Pre VAS ^a	Mean Post VAS ^a	Mean Difference/CI 95% ^b	<i>P</i> Value
Manipulation group (n = 30)	4.90 (1.56)	4.30 (1.43)	-0.53 (-1.2, 0.4)	.38
Placebo group (n = 30)	5.27 (1.73)	4.90 (1.74)	-0.37 (-0.48, 1.2)	.38
Main effect of time	5.08 (0.21)	4.63 (0.20)	-0.45 (0.263, 0.640)	<.01 ^c

CI, confidence interval; VAS, visual analog scale.

^a Values are mean $\pm$ SD.

^b Values represent the 95% CI.

^c Significant difference ($P < .05$).

flexion and abduction. The participants in the present study were symptomatic, different than the study by Michener,²⁵ which involved only participants without shoulder pain.

The study of Strunce et al²⁶ verified the immediate effects of thoracic spine and rib manipulation in patients with primary complaints of shoulder pain, noting pain reduction and increased ROM flexion, abduction, and internal and external shoulder rotations. However, this study presented important methodological limitations, such as the absence of randomization of the participants, different types of manipulation in different positions, and the absence of a sham group, preventing establishment of a cause-and-effect relationship.

Because there were no differences between the groups in relation to the analyzed variables, the hypothesis of the study was refuted. Thus, a study suggests that this improvement can occur independently of the use of impulse for manipulation.¹¹

One of the factors that may have contributed to this is the stimulation of joint mechanoreceptors. This stimulation may have occurred because both interventions used pressure and manual contact over the upper thoracic region, possibly stimulating pressure mechanoreceptors (Golgi-Mazzoni corpuscles and Pacini's corpuscles).^{27,28} The mechanical deformation information captured by these receptors tends to follow the spinal cord, reaching the bulb, thalamus, and sensory cortex where the information is deciphered.²⁹ Generally, manual stimulation tends to trigger body relaxation,³⁰ a fact that may have contributed to the reduction in the painful complaint and consequent increase in shoulder ROM.

The mechanical force (pressure) used for the intervention was assigned to a single vertebral level (T4-T5). Despite this, studies show that even directing this to a single vertebral segment, several levels can be simultaneously affected,^{31,32} which may justify the increase in ROM in both shoulders in the MG group. This may have occurred as a result of bilateral mechanical stimulation of the spinal thrust, which could be responsible for bilateral afferent stimulation in the spinal cord, translating to shoulder ROM.⁸

The present study also demonstrated a reduction in pain after the intervention in both the manipulation and placebo groups. This result was also reported in a systematic review in which thrust manipulation was investigated as a treatment option for nonsurgical shoulder conditions, verifying that there was a reduction in pain, although active and sham treatments were comparable.³³ Similar to this result, the study of Kardouni et al,¹¹ who evaluated patients with shoulder impingement syndrome after thoracic manipulation, found that both the manipulation group and the placebo group presented a reduction in pain. Two other studies obtained the same outcome as those of the present study for pain, verifying a decrease after manipulation in participants with shoulder impingement syndrome, both in the manipulation group and placebo group.^{5,6} As in the present study, this decrease was statistically significant, but not clinically significant.

Although the present study found a statistically significant reduction in shoulder pain, there was no clinically significant improvement, without differences between groups. The pain improvements could not be considered as a real improvement because the improvements after the interventions were about 0.4 points (0-10). One study showed that for individuals with rotator cuff tendinopathy to consider an MDC, there should be a reduction in VAS of approximately 1.4 cm.¹⁵ However, in the MG this reduction was 0.53 cm and in the PG it was 0.37 cm post-intervention. Thus, the possibility of the placebo effect (or placebo response)³⁴ cannot be ruled out. The placebo effect is related to the perception that the actual therapy is being administered,³⁴⁻³⁶ resulting in benefits.

Some studies mention that other factors may influence whether these changes were similar in both groups. Added to the placebo effect, interaction with a professional, time before and after, and beneficial contributions associated with manual touch⁶ are facts that could contribute satisfactorily to the therapy.^{37,38}

In this context, Michener et al²⁵ carried out a study in which they verified that a placebo-like thoracic vertebral manipulation was considered to be an active treatment and presented benefits to the patients, but the sample consisted only of healthy individuals. Possibly, this same manipulation was also seen by the symptomatic participants as an active treatment, which would explain the changes found.

Although the study did not investigate the individuals' expectations before the intervention or the benefits they expected, there are reports in the literature that these factors may contribute to the placebo effect.³⁸⁻⁴⁰ Based on this concept, in this work, all individuals received the same information regarding the procedures that would be performed as well as the same instructions, thus avoiding possible expectations associated with the results of the intervention to be applied.

Another factor that may justify the nonoccurrence of differences between the groups is that sample recruitment was intentional. All participants in the study sought the researchers for care of shoulder pain. Therefore, that the sample is actively seeking treatment for shoulder pain may have contributed to the results found. This possibility has already been approached in another study.⁶

After the intervention, the participants were informally questioned about whether they believed they had received the manipulation or placebo, and most believed they had received the manipulation. Therefore, the individuals' knowledge of the existence of a placebo group did not influence the outcome variables because both groups demonstrated a reduction in pain and increased ROM of the painful shoulder. Finally, the results of this research are applied only under the conditions described (short-term effects).

Limitations

The analyses were performed with a specific technique of manipulation and thus it is not possible to predict whether

using another thoracic manipulation technique would vary the results in this sample. However, the choice of the manipulation technique of the present study was due to the positioning of the affected upper limb because for other types of manipulations patients reported pain or discomfort, which did not occur in our work.

Another limitation was that the manipulation was performed by the same examiner who evaluated shoulder pain and ROM. In addition, there was no evaluation of whether the participants presented restrictions in thoracic vertebral movements, which could have interfered with the results. An important limitation of the study is the possibility of large variability in the measures (ROM) because the reliability of the measure in patients with pain was not performed, only without pain. Finally, the absence of a functional questionnaire and the fact that participant recruitment was performed intentionally could be a source of study bias.

For future studies, it is important to include a control group, long-term evaluation to address long-term effects, a blind examiner, and verification of the presence of restriction in thoracic vertebral movements to ensure individuals receive specific adjustment according to their restriction.

CONCLUSION

This study showed that both thoracic vertebral manipulation and a placebo manipulation provided statistically significant but nonclinically significant decreases in pain. Meanwhile, both resulted in increased shoulder ROM in individuals with shoulder pain in both groups; however, only abduction in the painful shoulder in the manipulation group reached the MDC. We suggest that the alterations found may have occurred owing to the placebo effect, possible expectations of the patients, and stimulation of the mechanoreceptors.

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CONTRIBUTORSHIP INFORMATION

Concept development (provided idea for the research): A.C.d.S.

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Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): A.C.d.S., G.M.S., C.M.d.G.M.

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Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): C.M.d.G.M., J.L.B.M.

Practical Applications

- This study found that SM including placebo treatment decreased pain but was not clinically significant.
- Spinal manipulation and placebo provided increased ROM of the painful shoulder.
- Only the abduction of the painful shoulder reached the MDC.
- Other factors may be involved for the changes encountered, such as placebo effect, patient expectations, or mechanoreceptor stimulation.

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