# Immediate Effects of Ischemic Compression Therapy on Myofascial Trigger Points on Pain, Mobility and Strength in Individuals With Subacromial Impingement Syndrome: A Single-arm Study

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**Research**

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# Abstract

**Background:** The myofascial trigger points (MTPs) may be associated with in shoulder dysfunction.

Objective: To evaluate the immediate effect of ischemic compression therapy (ICT) and to verify the effect of the evaluation protocol on MTPs, pain, mobility and strength of shoulder.

**Methods:** 15 individuals were assessed for the amount of MTPs, pressure pain threshold (PPT), range of motion (ROM), isometric strength of shoulder muscles and pain in performing these tests. The evaluations took place 48 hours before the ICT, immediately before, and after the ICT.

**Results:** There was a reduction in the total amount of MTPs ($p<0.01$; Cliff's $d=0.24$-$0.35$) and an increase in the PPT in the middle deltoid muscle ($p=0.03$) in the comparisons pre and post treatment, while there was no difference in ROMs and strength measures ($p>0.05$). The pain was less during the sagittal elevation ROM ($p<0.01$; $d=0.80$) and internal rotation ($p=0.05$; $d=0.57$), and during the performance of strength in arm elevation and external rotation ($p=0.01$; $d=0.72$ and $d=0.68$). There was generally no difference in the variables assessed between baseline and pre-treatment ($p>0.06$).

**Conclusion:** The ICT immediately reduced the amount of MTPs and pain during mobility and strength. The evaluation protocol did not influence the studied variables.

**Trial registration:** ReBEC (RBR-3DDG2K). Registered in July 5th, 2017 – Retrospectively registered, http://www.ensaiosclinicos.gov.br/rg/RBR-3ddg2k/.


# Introduction

Myofascial trigger points (MTPs) are described as palpable painful nodules within a tense muscle band which generate spontaneous local and referred pain (active MTP) or to digital compression (latent MTP) (1). The presence of MTPs is often related to painful musculoskeletal conditions, which may occur alone or in combination with other pain generators (2).

Studies have shown a high prevalence of muscles containing MTPs in individuals with a non-traumatic painful shoulder (3, 4) and with unilateral Subacromial Impingement Syndrome (SIS) (5). Both the presence of MTPs and SIS have been associated with decreased pressure pain threshold (PPT) (5–8), as well as reducing mobility (1, 9, 10) and strength (9, 11, 12).

Ischemic Compression Therapy (ICT) is one of the commonly used therapeutic modalities among the treatments of MTPs (13). The technique consists of applying sustained pressure over the MPT for a period of 90 seconds (14) and aims to adjust the length of the sarcomeres through digital compression on the MTPs, thus reducing symptoms related to the tense band (15).

ICT has been applied in the treatment of MTPs related to management of several clinical conditions such as plantar fasciitis (16), neck pain (17), pelvic pain (18) and shoulder pain (19–21), being applied alone or associated with other treatments.

There is evidence that ICT reduces pain symptoms (22), increases passive ROM (19) and strength (21, 23) in individuals with non-traumatic painful shoulder conditions; however, these studies have not evaluated the effect of ICT on pain during mobility and the performance of maximum strength. In addition, although these studies have used the mobility and strength variables to assess the effect of treatment on MTPs, it is not yet known how these variables, as well as MTPs, react through their own assessments.

Simons (2004) formulated a hypothesis that the muscle fibers related to MTPs are tensed, even in the resting position, and an increase in local tension due to muscle stretching or contraction could generate increased pain in the muscle with MPT, which could decrease the strength and mobility (1). On the other hand, the isometric strength assessment could act in a positive way, since post-isometric relaxation is attributed to isometric contraction (24). According to the hypothesis of Taylor et al., isometric contraction could also alter muscle viscoelastic properties and passive extensibility, thus improving ROM (15, 25, 26).

Therefore, the present study has two objectives: the first was to evaluate the effects of an ICT session on MTPs and shoulder pain, mobility and strength variables in symptomatic individuals for unilateral SIS; and the second was to verify the reaction of the MTPs and the variables of pain, mobility and strength 48 hours after the evaluation of ROM and maximum isometric strength. Our first hypothesis was that an ICT session could reduce the amount of MTPs, decrease pain and increase ROM and isometric strength. We also hypothesized that the assessments would not lead to an increase in the number of MTPs, nor would it alter shoulder pain, mobility or muscle strength.

## Methods

# Study design

This study is a single-arm study with non-probabilistic recruitment of consecutive cases, developed between May 2017 and October 2018, approved by the Research Ethics Committee of *Universidade Federal do Rio Grande do Norte* (Protocol no. 1,316,438) and registered in the Brazilian Registry of Clinical Trials – ReBEC (RBR-3DDG2K) – Registered in July 5th, 2017 – Retrospectively registered, http://www.ensaiosclinicos.gov.br/rg/RBR-3ddg2k/. All volunteers provided their informed consent after being informed verbally and in writing about the objectives, risks and benefits of the study.

# Participants

Participants were recruited from flyers posted in the community and via social media. The inclusion criteria were: 18–60 years old, history of unilateral shoulder pain lasting at least one month, located in the proximal anterolateral shoulder region (27), or in the C5 or C6 dermatome region (28), and at least three of the following positive tests: Neer (29), Hawkins-Kennedy (30), Jobe (31), painful arch (32), external rotation resistance (33), Gerber and Speed (34). Exclusion criteria were: adhesive capsulitis, history of symptom onset due to trauma, multidirectional or anterior glenohumeral joint instability based on positive sulcus sign test and apprehension test, numbness or tingling in the upper extremity, fibromyalgia or rheumatic disease, previous neck and shoulder surgery, systemic disease, body mass index > 28 $kg/m^2$, injection of

corticosteroids in the last 3 months or use of analgesics or muscle relaxants 72 hours before the procedures, and symptoms of depression with a score ≥ 13 on the Beck's depression Inventory (BDI) (35, 36).

There were 56 individuals interested in participating in the study and were initially evaluated according to the eligibility criteria. However, 41 were excluded from this assessment for the reasons described in the study flowchart (Fig. 1), with only 17 individuals able to participate. Of these, 02 individuals did not attend the second day of assessment; thus, 15 individuals participated in the ICT session. Demographic and pain-related characteristics and shoulder functionality of the participants are shown in Table 1.

Table 1
Demographic characteristics and pain and functional status of all individuals.

| Variables | Individuals (n = 15) |
|---|---|
| Sex | 6 F (40%) / 9 M (60%) |
| Age (years) | 34.4 ± 10.43[a] |
| Height (m) | 1.68 ± 0.09[a] |
| Weight (kg) | 69.13 ± 11.78[a] |
| BMI (kg/m$^2$) | 24.20 ± 2.18[a] |
| BDI (0/21) | 6.46 ± 3.70[a] |
| Pain at rest | 1.67 (0.18)[b] |
| Number of positive tests | 4.80 ± 1.08[a] |
| Duration of symptoms (months) | 16 (40)[b] |
| Affected Side (D/ND) | 9 D (60%) / 6 ND (40%) |
| Penn Shoulder Score Questionnaire | 74 (25)[b] |

# Evaluation protocol

All individuals included in the study were submitted to the following assessments: 1) pain and general function of the shoulder complex using the Penn Shoulder Score Questionnaire; 2) identification of MTPs; 3) pain assessment, comprising the pressure pain threshold (PPT) and pain during mobility and strength tests, according to the Numerical Pain Rating Scale (NPRS); 4) shoulder mobility; 5) muscle strength of the shoulder complex.

The evaluations were carried out in three moments: a) initial evaluation (baseline); b) 48 hours after the initial assessment and immediately before the ICT session; and c) immediately after the ICT session. The purpose of the baseline was to verify the influence of the evaluation procedures on the variables.

Three evaluators participated in the study, 2 who were in the last year of graduation in Physical Therapy and 1 physiotherapist with 6 years of clinical experience. The physiotherapist performed the screening evaluation of the recruited individuals and performed the ICT session; a second evaluator was responsible for evaluating MTPs and PPT; and the third evaluator was responsible for the other evaluations (mobility, strength and pain due to NPRS). Only the affected side was evaluated.

# Reliability of measures

The two evaluators involved in the MTPs, PPT, mobility and shoulder strength evaluations participated in training with a physiotherapist with six years of experience in musculoskeletal evaluation. The examiners carried out an evaluation of 06 subjects (03 symptomatic and 03 asymptomatic), totaling 5 hours for each evaluator. Next, a test-retest reliability study was conducted with 20 asymptomatic individuals only evaluating the dominant side in order to verify the reliability of the evaluators' measurements. For MTPs, an agreement percentage greater than 70% was verified, being considered acceptable for clinical practice (Bron, Franssen, Wensing, and Oostendorp, 2007). Almost perfect reliability was obtained for the other variables with ICC between 0.91 to 0.98 for the assessments of PPT, ROM and strength, as well as NPRS (ICC: 0.96–0.98).

# MTP evaluation

The evaluated muscles were: upper and lower trapezius, supraspinatus, infraspinatus, pectoralis minor and middle deltoid. The following diagnostic criteria proposed by Simons (38) were monitored: identification of a palpable tense band, if the muscle is accessible; local pain to digital compression of a palpable nodule located in a tense band; recognition of pain referred by the individual as familiar when pressing on the sensitive nodule (to identify active MTP); and jump sign. These criteria have obtained good inter-examiner reliability with moderate to almost perfect reliability (39). The report of spontaneous referred pain, local pain upon palpation and recognition of the pain referred to as familiar in the digital compression was associated with active MTP, while a report of local pain and referred pain which was not familiar to the digital compression was associated with latent MTP (7, 14). If the same muscle had latent and active MTP, that muscle was classified as containing active MTP. The evaluation was performed with the individual in the supine or prone position, with the evaluation order of the muscles being randomized for each individual.

# Pain evaluation

# Pressure Pain Threshold Assessment

The PPT is defined as the minimum amount of pressure that is perceived as painful (40). A digital algometer (Wagner Instruments, model FDX, Greenwich, CT, USA) was used for this assessment, which is a device made up of a 1 $cm^2$ rubber disk connected to a pressure gauge which displays values in $kgf/cm^2$. The individuals were evaluated in the sitting position, and the following muscles were evaluated: lower trapezius (in the muscle belly, halfway between the midpoint of the medial edge of the scapula and the spinous process of the twelfth vertebra), upper trapezius (midway between the spinous process of C7 and the acromion of the scapula), infraspinatus (in the muscular belly below the midpoint of the scapular spine) and middle deltoid (muscle belly, close to the inferolateral insertion) (5, 6).

# Assessment of pain during mobility and maximum isometric strength

Individuals were asked about pain according to NPRS (0–10, with 0 being no pain and 10 being the worst possible pain) after each ROM and strength assessment, with an average of 2 values reported for each test.

# Evaluation of shoulder ROM

The ROM of arm elevation in the sagittal plane, arm elevation in the scapular plane, internal and external rotation of the shoulder were evaluated using a digital inclinometer (Lafayette Instrument Company, model ACU001, Lafayette, IN, USA). The elevation in the sagittal plane of the shoulder was measured with the individuals sitting with their elbow extended, shoulder in neutral rotation and thumb pointing upwards. The internal and medial rotation ROM were measured with the individuals in the supine position, shoulder abducted at 90° in the frontal plane with the humerus supported on the examination table and elbow flexed at 90° (41). Each test was performed twice and the average between the values was calculated (42).

# Isometric strength assessment

The isometric muscle strength test was performed with a manual dynamometer (Lafayette Instrument Company, model 0116, Lafayette, IN, USA) at moments of arm elevation in the scapular plane, medial and external rotation of the shoulder. The individuals were seated in all assessments. The arm was positioned at 90° of elevation in the scapular plane in the neutral rotation with the elbow extended to assess the arm elevation strength (43). Next, the individuals were seated with an arm close to their body, and neutral rotation of the shoulder and elbows flexed at 90° to measure the isometric strength in the medial and external rotation of the shoulder (44). The dynamometer was fixed to the wall and adjusted so that individuals pushed it with the distal part of their forearm. They were instructed to perform maximum isometric contraction for 5 seconds. Each test was performed twice, with an interval of two minutes between attempts, and the average was calculated between the values (45).

# Ischemic Compression Therapy Session

All individuals were submitted to an ICT session applied to all active and latent MTPs identified in the assessment. The therapist intermittently applied digital compression to the identified MTPs. Compression was applied over the MTPs until an increase in muscle resistance was perceived by the therapist (6). At this point the individual felt some degree of discomfort and/or pain, evoking a pattern of referred pain. The pressure was maintained until the therapist felt relief from tension under digital palpation or the individual showed a considerable decline in discomfort and/or pain (22). At that moment the therapist increased the intensity of the compression, trying to find a new parameter of referred pain, following the same process. This procedure was repeated until the individual no longer reported an increase in discomfort or referred pain with progression of the compression, or a maximum time of 90 seconds was reached in the entire process.

# Statistical analysis

The sample size was calculated using the G* Power 3.1 software program (46) adopting an α of 0.05 and power of 0.80% for paired comparison analysis, with pain as the main outcome variables. The calculated

sample size was 12 individuals considering a difference between means of 2.05 and standard deviation of 2.30 in NPRS (47); while the calculated sample size was 10 individuals considering the PPT variable with a difference between the averages of 1 kg/cm² (48, 49) and standard deviation of 1 kg/cm² (50). Thus, we considered the calculation with the largest number (n = 12) and added 25% of this value, totaling 15 individuals.

The data were statistically analyzed in a descriptive and inferential manner using the SPSS 20.0 statistical package (SPSS Inc., Chicago, IL, USA). The sample distribution was assessed using the Shapiro Wilk test. Mean and standard deviation (SD) were calculated for each variable, and the median and interquartile range were also calculated for non-parametric variables.

The Wilcoxon test was used to compare the number of MTPs between baseline and pre-treatment assessments in order to verify the influence of the assessment on the number of MTPs and other variables, and between pre and post-treatment assessments in order to to assess the effect of the ICT session. The paired t-test was used to compare the other variables between baseline and pre-treatment assessments, as well as pre- and post-treatment.

The effect size was then calculated from the differences between the evaluations using the Cohen's d coefficient in the G* Power software program (51) for parametric variables. An effect size greater than 0.8 was considered large, around 0.5 moderate, and less than 0.2 small (52). A moderate effect size is considered to be clinically important (53). Delta Cliff was used to evaluate the effect size for non-parametric variables (MTPs) using a VBA/Excel calculator, considering 0.43 large, around 0.28 moderate and less than 0.11 small (10).

## Results

# Myofascial trigger points

Table 2 shows the number of MTPs (active and latent) for each muscle in each evaluation, the percentage change in the number of MTPs between evaluations, the result of the comparisons and the effect sizes.

Table 2
Number of Myofascial Trigger Points (MTrPs) in baseline, pre-intervention and post intervention evaluations.

| MTrPs | Baseline | Pre intervention | Post intervention | Baseline/Pre intervention | | Pre intervention/Post intervention | |
|---|---|---|---|---|---|---|---|
| | | | | P value | Delta Cliff | P value | Delta Cliff |
| **MTrPs per muscle (number, median, interquartile range)** | 12 (1; 0–2) | 12 (1.40; 0–3) | 7 (0.80; 0–2) | 0.99 | 0 | 0.02 | 0.24 |
| Upper Trapezius | 6 (0.00; 0–1) | 9 (0.80; 0–3) | 5 (0.46; 0–2) | 0.31 | -0.05 | 0.15 | 0.15 |
| Active MTrPs | 18 (1.2; 0–2) | 21 (1.4; 0–3) | 12 (0.80; 0–2) | 0.36 | -0.09 | 0.01 | 0.37 |
| Latente MTrPs | | | | | | | |
| Total | | | | | | | |
| Lower Trapezius | 8 (0.00; 0–3) | 14 (0.93; 0–3) | 8 (0.53; 0–2) | 0.22 | -0.14 | 0.06 | 0.14 |
| Active MTrPs | 2 (0.00; 0–1) | 3 (0; 0–2) | 2 (0; 0–1) | 0.70 | -0.01 | 0.56 | 0.01 |
| Latente MTrPs | 10 (0.66; 0–3) | 17 (1.13; 0–3) | 10 (0.66; 0–2) | 0.15 | -0.20 | 0.30 | 0.21 |
| Total | | | | | | | |
| Infraspinatus | 5 (1; 0–1) | 9 (0.60; 0–2) | 6 (0.40; 0–2) | 0.15 | -0.13 | 0.18 | 0.11 |
| Active MTrPs | 6 (0.00; 0–2) | 5 (0.60; 0–2 | 2 (0.33; 0–1) | 0.70 | 0.06 | 0.18 | 0.14 |
| Latente MTrPs | 11 (0.73; 0–2) | 14 (0.93; 0–2) | 8 (0.53; 0–2) | 0.36 | -0.22 | 0.03 | 0.28 |
| Total | | | | | | | |
| Supraspinatus | 8 (1; 0–2) | 11 (0.73; 0–2) | 6 (0.40; 0–2) | 0.70 | 0.01 | 0.09 | 0.23 |
| Active MTrPs | 4 (0.00; 0–1) | 2 (0.13; 0–1) | 1 (0.06; 0–1) | 0.31 | 0.13 | 0.31 | 0.07 |
| Latente MTrPs | 12 (0.80; 0–2) | 13 (0.80; 0–2) | 7 (0.46; 0–2) | 0.99 | -0.07 | 0.09 | 0.23 |
| Total | | | | | | | |

| MTrPs | Baseline | Pre intervention | Post intervention | Baseline/Pre intervention | | Pre intervention/Post intervention | |
|---|---|---|---|---|---|---|---|
| | | | | P value | Delta Cliff | P value | Delta Cliff |
| Minor Pectoralis | 3 (0.00; 0–1) | 6 (0.4; 0–2) | 6 (0.4; 0–2) | 0.18 | -0.15 | 0.99 | 0.04 |
| Active MTrPs | 7 (0.00; 0–2) | 5 (0.33; 0–2) | 2 (1.33; 0–1) | 0.48 | 0.16 | 0.25 | 0.08 |
| Latente MTrPs | 10 (0.66; 0–2) | 9 (0.73; 0–3) | 6 (0.53; 0–2) | 0.70 | 0.01 | 0.08 | 0.09 |
| Total | | | | | | | |

Table 2
Number of Myofascial Trigger Points (MTrPs) in baseline, pre-intervention and post intervention evaluations (Continued).

| | Baseline | Pre intervention | Post intervention | Baseline/Pre intervention | | Pre intervention/Post intervention | |
|---|---|---|---|---|---|---|---|
| | | | | P value | Delta Cliff | P value | Delta Cliff |
| **MTrPs per muscle (number, median, Interquartile range)** | 1 (0.00; 0–1) | 3 (0.2; 0–1) | 4 (0.26; 0–2) | 0.31 | -0.13 | 0.31 | -0.01 |
| Middle Deltoid | 1 (0.00; 0–1) | 3 (0.06; 0–1) | 0 | 0.15 | 0.16 | 0.08 | 0.08 |
| Active MTrPs | 2 (0.13; 0–1) | 8 (0.40; 0–2) | 6 (0.26; 0–2) | 0.15 | -0.13 | 0.15 | 0.12 |
| Latente MTrPs | | | | | | | |
| Total | | | | | | | |
| **MTrPs Total (number, median, Interquartile range)** | 37 (2.46; 0–6) | 54 (3.60; 0–12) | 37 (2.26; 0–10) | 0.07 | -0.15 | 0.01 | 0.24 |
| Active MTrPs | 25 (1.66; 0–4) | 27 (1.8; 0–8) | 12 (0.8; 0–3) | 0.19 | 0.22 | 0.11 | 0.21 |
| Latente MTrPs | 62 (4.13; 1–10) | 81 (5.4; 1–14) | 49 (3.26; 0–10) | 0.17 | -0.15 | 0.00 | 0.35 |
| Total | | | | | | | |

No differences were found in the number of MTPs between baseline and pre-intervention assessments. Considering all muscles in comparisons between pre and post-intervention, there was a reduction in the total amount of MTPs (active and latent) ($p < 0.01$) with an effect size between moderate and large (Cliff's $d = 0.35$) and a reduction in active MTP ($p < 0.01$) with an effect size close to moderate ($d = 0.24$). Regarding muscle observation, there was a significant reduction in the total number of MTPs in the upper trapezius ($p = 0.01$; Cliff's $d = 0.37$) and in the infraspinatus ($p = 0.03$; Cliff's $d = 0.28$), as well as in the number of active MTPs in the upper trapezius ($p = 0.02$; Cliff's $d = 0.24$).

# Pressure pain threshold

Table 3 presents the results of the comparisons between the assessments for the PPT in the investigated muscles. There was no significant difference between baseline and pre-intervention measures ($p \geq 0.09$). Regarding the pre and post intervention comparisons, there only was an increase in the PPT in the middle deltoid muscle ($p = 0.03$) with a small effect size ($d = -0.20$).

Table 3
Pressure pain threshold in shoulder muscles in baseline, pre-intervention and post intervention evaluations.

| Pressure Pain Threshold ($kg/cm^2$) | Baseline | Pre intervention | Post intervention | Baseline/Pre intervention | | Pre intervention /Post intervention | |
|---|---|---|---|---|---|---|---|
| | | | | Mean difference (p value) | Cohen's d | Mean difference (p value) | Cohen's d |
| **Upper Trapezius** | 3.07 ± 0.89 | 2.52 ± 0.23 | 2.62 ± 0.24 | 0.09 | 0.31 | 0.14 | -0.08 |
| **Lower Trapezius** | 3.60 ± 0.44 | 3.18 ± 0.27 | 3.30 ± 0.29 | 0.20 | 0.21 | 0.38 | -0.08 |
| **Infraspinatus** | 3.89 ± 0.40 | 3.70 ± 0.32 | 3.69 ± 0.24 | 0.42 | 0.09 | 0.94 | 0.01 |
| **Middle Deltoid** | 3.02 ± 0.32 | 2.93 ± 0.22 | 3.21 ± 0.29 | 0.63 | 0.06 | 0.03 | -0.20 |

# ROM and pain during ROM

Table 4 shows the results of ROM and pain during ROM. No difference was generally found between baseline and pre-intervention assessments for any ROM or pain during ROM ($p \geq 0.10$), with an effect size between 0.04 and 0.31 (low effect size). Only pain during internal rotation was lower in the pre-intervention assessment compared to baseline ($p < 0.01$) with a strong effect size ($d = 0.96$), and pain during external rotation, which despite not having changed statistically, showed a moderate effect size ($d = 0.45$) indicating a reduction in pain. Regarding the comparison between the pre and post-intervention assessments, there was no difference in ROM; however, the pain was less during elevation in the sagittal plane ($p < 0.01$) and internal rotation ($p = 0.04$), with an effect size between strong and moderate ($d = 0.80$ and 0.57, respectively).

Table 4
Results of pain, mobility and strength in baseline, pre-intervention and post intervention evaluations.

| | Baseline | Pre intervention | Post intervention | Baseline/Pre intervention | | Pre intervention/Post intervention | |
|---|---|---|---|---|---|---|---|
| | | | | Mean difference (p value) | Cohen's d | Mean difference (p value) | Cohen's d |
| **ROM (°)** | 159.90 ± 11.14 | 156.70 ± 10.96 | 152.36 ± 21.68 | 3.20 (0.25) | 0.29 | -4.34 (0.44) | 0.20 |
| Sagittal Elevation | 158.90 ± 13.06 | 155.70 ± 14.79 | 156.13 ± 13.37 | 3.20 (0.25) | 0.30 | 0.43 (0.61) | 0.08 |
| Scapular Elevation | 65.60 ± 8.06 | 63.43 ± 8.22 | 72.23 ± 29.88 | 2.16 (0.32) | 0.26 | 8.8 (0.34) | 0.29 |
| Internal Rotation | 85.77 ± 14.71 | 83.70 ± 16.76 | 83 ± 16.88 | 2.03 (0.53) | 0.16 | -0.70 (0.81) | 0.06 |
| External Rotation | | | | | | | |
| **Pain in ROM (0–10)** | 4.66 ± 2.28 | 4.80 ± 1.71 | 3.40 ± 1.49 | 0.14 (0.81) | 0.06 | -1.40 (< 0.01) | 0.80 |
| | 4.30 ± 2.02 | 4.23 ± 1.97 | 3.40 ± 1.64 | -1.24 (0.86) | 0.04 | -0.83 (0.09) | 0.45 |
| Sagittal Elevation | 4.30 ± 1.61 | 3.06 ± 1.98 | 2.20 ± 1.54 | -1.24 (< 0.01) | 0.96 | -0.86 (0.04) | 0.57 |
| Scapular Elevation | 4.30 ± 2.08 | 3.50 ± 2.11 | 3.13 ± 2.15 | -0.80 (0.10) | 0.45 | -0.37 (0.55) | 0.16 |
| Internal Rotation | | | | | | | |
| External Rotation | | | | | | | |
| **Strength (N)** | 76.17 ± 27.93 | 75.20 ± 31.72 | 72.36 ± 30.80 | 0.97 (0.79) | 0.09 | -2.84 (0.09) | 0.44 |
| | 103.86 ± 44.42 | 110.21 ± 51.23 | 113.93 ± 57.92 | -6.35 (0.25) | 0.29 | 3.71(0.28) | 0.29 |
| Scapular Elevation | 84.27 ± 27.79 | 85.52 ± 28.25 | 87.27 ± 31.54 | -0.86 (0.72) | 0.12 | 1.75 (0.41) | 0.21 |
| Internal Rotation | | | | | | | |
| External Rotation | | | | | | | |

| | Baseline | Pre intervention | Post intervention | Baseline/Pre intervention | | Pre intervention/Post intervention | |
|---|---|---|---|---|---|---|---|
| | | | | Mean difference (p value) | Cohen's d | Mean difference (p value) | Cohen's d |
| **Pain in Strength (0–10)** | 3.93 ± 2.40 | 4.40 ± 2.24 | 3.23 ± 2.25 | 0.46 (0.32) | 0.26 | -1.16 (0.01) | 0.72 |
| Scapular Elevation | 3.66 ± 2.42 | 3.10 ± 2.62 | 2.30 ± 1.59 | 0.56 (0.27) | 0.29 | -0.80 (0.15) | 0.38 |
| Internal Rotation | 4.26 ± 2.17 | 3.76 ± 1.70 | 2.93 ± 1.49 | 0.50 (0.24) | 0.31 | -0.83 (0.01) | 0.68 |
| External Rotation | | | | | | | |

# Isometric strength and pain during contraction

Table 4 shows the strength and pain results during the isometric strength. There was generally no difference in strength measurements between baseline and pre-intervention ($p \geq 0.25$) assessments with small effect size ($d \leq 0.29$), nor between pre and post intervention ($p \geq 0.09$), despite the effect size being between moderate and large ($d = 0.21–0.44$). There was also no change in pain during isometric strength between baseline and pre-intervention assessments ($p \geq 0.24$), and the effect size was between small and moderate ($d = 0.26–0.31$). There was only a reduction in pain during isometric strength in the arm elevation and external rotation ($p = 0.01$) between the pre and post-intervention evaluations, with a moderate effect size ($d = 0.72$ and $d = 0.68$, respectively).

# Discussion

As hypothesized, the results of the present study show that the ICT session was able to decrease the amount of MTPs (active and latent) and decrease pain during the range of motion and in performing the maximum isometric strength contraction. However, there was no improvement in ROMs, strength, or PPT, except for the middle deltoid. In addition, the study design made it possible to verify that the evaluation protocol did not negatively influence the number of MTPs and the variables of pain, mobility and strength, also as hypothesized. Thus, the study presents clinicians with the immediate effects of ICT in treating myofascial pain, as well as demonstrating the safety of performing maximum ROM tests and maximum strength in symptomatic individuals.

According to Simons (2004), the presence of MTPs could decrease the ROM and strength of individuals with myofascial pain, and some studies which relate the presence of MTPs with the change in muscle activation pattern (54–56) seem to support this hypothesis. Thus, the reduced number of MTPs would be accompanied by an increase in strength and mobility. However, the effect of improving strength and mobility was not seen after the ICT session, even though it was effective in reducing the number of MTPs, both active and latent. One factor to consider is that changes in strength and mobility may not happen immediately, but

as a result of longer treatment, as already observed in studies which investigated effects of ICT on mobility and strength variables (21), self-reported function (22) and pain-free ROM (19).

It is worth noting that the positive effect in reducing the amount of MTPs and pain in performing ROM and strength is an important result, considering that the decrease in discomfort will enable an increment of therapies and better clinical prognosis (57). However, it is also important to highlight that these pain improvement results should be interpreted with caution, because even with a statistical difference with moderate to large effect size, the differences between the means did not reach the least clinically important difference (58) or the responsiveness values of the measure (47).

The same can be seen in PPT, where the ICT session was only effective in the middle deltoid muscle for which an increase in PPT was observed. However, the effect size was small and the difference did not reach the slightest clinically important difference (48, 50). A probable explanation for not having seen an increase in PPT after the ICT session is the possibility that individuals with persistent pain may develop a sensitization phenomenon (59), where the painful reference is not associated with nociceptive pain, but rather a change in central nervous system processing in facing a non-painful stimulus (60).

We can generally say that the ICT session proved to be effective in reducing MTPs and improving pain in performing ROM and strength, even in a single session. This study brings a new approach which aimed to fill limitations of previous studies such as: evaluating the effects of an isolated intervention; the performance of the intervention in several muscles of the shoulder region, and application of a protocol for maximum ROM and isometric strength tests, which can be similar to the functional needs of work demands or daily life. However, further studies which assess the relationship between MTPs and clinical variables of mobility and strength are still needed in individuals with pain, given that much of what involves clinical diagnosis, related signs and symptoms and treatment is still a source of disagreement and uncertainty in the scientific community (61, 62).

In addition to the results of the intervention, this study brings an important result related to the clinical evaluation of individuals with pain. It was found that the evaluation of the ROM and maximum isometric strength variables did not negatively influence the studied variables, thus contrasting the hypothesis by Simons (2004), and therefore being considered safe even in individuals with pain and can be used in clinical evaluations as they do not cause greater discomfort.

Despite the important clinical findings, we assume that this study has limitations related to the absence of a control group and post-session follow-up between 24 and 48 hours in order to verify the duration of the results and possible adverse effects of ICT. Future studies are needed to fill these gaps.

# Conclusion

A single session of ICT is able to decrease the amount of MTPs and reduce pain during mobility and strength in individuals with unilateral shoulder pain, although it does not improve ROM and strength or increase PPT. The mobility and maximum isometric strength assessments had no effect on the evaluated variables.

# Declarations

## Ethics approval and consent to participate

The study was approved by the Research Ethics Committee of *Universidade Federal do Rio Grande do Norte* (Protocol no. 1.316.438) and registered in the Brazilian Registry of Clinical Trials – ReBEC (RBR-3DDG2K) – Registered in July 5th, 2017 – Retrospectively registered, http://www.ensaiosclinicos.gov.br/rg/RBR-3ddg2k/.

## Consent for publication

Not applicable

## Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Competing interests

The authors declare that they have no competing interests.


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## Authors' contributions

José Diego Sales do Nascimento conceived and designed the study, collected the data, performed and interpreted the analysis, and wrote the manuscript.

Francisco Alburquerque-Sedín conceived and designed the study, interpreted the analysis and wrote the manuscript.

Laysla Carla de Castro Ferreira collected the data and helped to perform the analysis.

Catarina de Oliveira Sousa conceived and designed the study, interpreted the analysis, and wrote the manuscript.

All authors discussed the results, performed a critical revision and approved the final version of the manuscript.


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# References


1. Fernández-de-las-Peñas C, Dommerholt J. International Consensus on Diagnostic Criteria and Clinical Considerations of Myofascial Trigger Points: A Delphi Study. Pain Med. 2018 Jan;19(1)(1):142–50.
2. Gerwin RD. Diagnosis of Myofascial Pain Syndrome. Phys Med Rehabil Clin N Am. 2014;25(2):341–55.
3. Bron C, Dommerholt J, Stegenga B, Wensing M, Oostendorp R. a B. High prevalence of shoulder girdle muscles with myofascial trigger points in patients with shoulder pain. BMC Musculoskelet Disord. 2011;12(1):139.
4. Ge HY, Fernández-de-las-Peñas C, Madeleine P, Arendt-Nielsen L. Topographical mapping and mechanical pain sensitivity of myofascial trigger points in the infraspinatus muscle. Eur J Pain. 2008;12(7):859–65.
5. Alburquerque-Sendín F, Camargo PR, Vieira A, Salvini TF. Bilateral Myofascial Trigger Points and Pressure Pain Thresholds in the Shoulder Muscles in Patients With Unilateral Shoulder Impingement Syndrome. Clin J Pain. 2013 Jun;29(6):478–86.
6. Hidalgo-Lozano A, Fernández-de-las-Peñas C, Díaz-Rodríguez L, González-Iglesias J, Palacios-Ceña D, Arroyo-Morales M. Changes in pain and pressure pain sensitivity after manual treatment of active trigger points in patients with unilateral shoulder impingement: A case series. J Bodyw Mov Ther. 2011;15(4):399–404.
7. Hidalgo-Lozano A, Fernández-de-las-Peñas C, Alonso-Blanco C, Ge H-Y, Arendt-Nielsen L, Arroyo-Morales M. Muscle trigger points and pressure pain hyperalgesia in the shoulder muscles in patients with unilateral shoulder impingement: a blinded, controlled study. Exp Brain Res. 2010 May 26;202(4):915–25.
8. Wytrążek M, Huber J, Lipiec J, Kulczyk A. Evaluation of palpation, pressure algometry, and electromyography for monitoring trigger points in young participants. J Manipulative Physiol Ther. 2015;38(3):232–43.
9. Celik D, Mutlu EK. Clinical implication of latent myofascial trigger point. Curr Pain Headache Rep. 2013;17(8):353.
10. Simons DG. Review of enigmatic MTrPs as a common cause of enigmatic musculoskeletal pain and dysfunction. J Electromyogr Kinesiol [Internet]. 2004 Feb [cited 2012 Jul 13];14(1):95–107. Available from: http://www.ncbi.nlm.nih.gov/pubmed/14759755.
11. Ge HY, Arendt-Nielsen L, Madeleine P. Accelerated muscle fatigability of latent myofascial trigger points in humans. Pain Med (United States). 2012;13(7):957–64.
12. Simons DG. Review of enigmatic MTrPs as a common cause of enigmatic musculoskeletal pain and dysfunction. J Electromyogr Kinesiol. 2004 Feb;14(1):95–107.
13. Shah JP, Thaker N, Heimur J, Aredo JV, Sikdar S, Gerber L. Myofascial Trigger Points Then and Now: A Historical and Scientific Perspective. PM&R. 2015;7(7):746–61.
14. Simons DG, Travell JG, Simons LS. Myofascial Pain and Dysfunction: The Trigger Point Manual: Volume 1. 2nd ed. Baltimore: Lippincott Williams & Wilkins; 1999. 628 p.

15. Simons DG. Understanding effective treatments of myofascial trigger points. J Bodyw Mov Ther. 2002;6(2):81–8.
16. Hains G, Boucher PB, Lamy A-M. Ischemic compression and joint mobilisation for the treatment of nonspecific myofascial foot pain: findings from two quasi-experimental before-and-after studies. J Can Chiropr Assoc [Internet]. 2015 Mar;59(1):72–83. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25729088.
17. Cagnie B, Castelein B, Pollie F, Steelant L, Verhoeyen H, Cools A. Evidence for the Use of Ischemic Compression and Dry Needling in the Management of Trigger Points of the Upper Trapezius in Patients with Neck Pain: A Systematic Review. Am J Phys Med Rehabil. 2015 Jul;94(7):573–83.
18. Montenegro MLLS, Braz CA, Rosa-e-Silva JC, Candido-dos-Reis FJ, Nogueira AA, Poli-Neto OB. Anaesthetic injection versus ischemic compression for the pain relief of abdominal wall trigger points in women with chronic pelvic pain. BMC Anesthesiol. 2015 Dec 1;15:175.
19. Akbaba YA, Mutlu EK, Altun S, Turkmen E, Birinci T, Celik D. The effectiveness of trigger point treatment in rotator cuff pathology: A randomized controlled double-blind study. J Back Musculoskelet Rehabil. 2019;32(3):519–27.
20. Bron C, Wensing M, Franssen JL, Oostendorp RA. Treatment of myofascial trigger points in common shoulder disorders by physical therapy: A randomized controlled trial. BMC Musculoskelet Disord. 2007 Dec 5;8(1):107.
21. Cagnie B, Dewitte V, Coppieters I, Van Oosterwijck J, Cools A, Danneels L. Effect of ischemic compression on trigger points in the neck and shoulder muscles in office workers: A cohort study. J Manipulative Physiol Ther. 2013;36(8):482–9.
22. Bron C, De Gast A, Dommerholt J, Stegenga B, Wensing M, Oostendorp RA. Treatment of myofascial trigger points in patients with chronic shoulder pain: a randomized, controlled trial. BMC Med. 2011 Dec;24(1):8. 9(.
23. Hains G, Descarreaux M, Hains F. Chronic Shoulder Pain of Myofascial Origin: A Randomized Clinical Trial Using Ischemic Compression Therapy. J Manipulative Physiol Ther. 2010;33(5):362–9.
24. Lewit K, Simons DG. Myofascial pain: relief by post-isometric relaxation. Arch Phys Med Rehabil. 1984 Aug;65(8):452–6.
25. Faqih AI, Bedekar N, Shyam A, Sancheti P. Effects of muscle energy technique on pain, range of motion and function in patients with post-surgical elbow stiffness: A randomized controlled trial. Hong Kong Physiother J. 2019;39(1):25–33.
26. Taylor DC, Brooks DE, Ryan JB. Viscoelastic characteristics of muscle: passive stretching versus muscular contractions. Med Sci Sports Exerc. 1997;29(12):1619–24.
27. Lin J, Chen W-H, Chen P-Q, Tsauo J-Y. Alteration in Shoulder Kinematics and Associated Muscle Activity in People With Idiopathic Scoliosis. Spine (Phila Pa 1976). 2010;35(11):1151–7.
28. Struyf F, Nijs J, Baeyens J-P, Mottram S, Meeusen R. Scapular positioning and movement in unimpaired shoulders, shoulder impingement syndrome, and glenohumeral instability. Scand J Med Sci Sports. 2011 Jun;21(3):352–8.

29. Neer CS. Anterior acromioplasty for the chronic impingement syndrome in the shoulder: a preliminary report. J Bone Joint Surg Am. 1972;54(1):41–50.
30. Hung CJ, Jan MH, Lin YF, Wang TQ, Lin JJ. Scapular kinematics and impairment features for classifying patients with subacromial impingement syndrome. Man Ther. 2010;15(6):547–51.
31. Jobe FW, Jobe CM. Painful athletic injuries of the shoulder. Clin Orthop Relat Res. 1983;(173):117–24.
32. Michener L, Walsworth MK, Doukas WC, Murphy KP. Reliability and Diagnostic Accuracy of 5 Physical Examination Tests and Combination of Tests for Subacromial Impingement. Arch Phys Med Rehabil. 2009;90(11):1898–903.
33. Diercks R, Bron C, Dorrestijn O, Meskers C, Naber R, de Ruiter T, et al. Guideline for diagnosis and treatment of subacromial pain syndrome. Acta Orthop. 2014;85(3):314–22.
34. Camargo PR, Ávila MA, Asso NA, Salvini TF. Muscle performance during isokinetic concentric and eccentric abduction in subjects with subacromial impingement syndrome. Eur J Appl Physiol. 2010;109(3):389–95.
35. Altindag O, Gur A, Altindag A. The relationship between clinical parameters and depression level in patients with myofascial pain syndrome. Pain Med. 2008;9(2):161–5.
36. Furlanetto LM, Mendlowicz MV, Romildo Bueno J. The validity of the Beck Depression Inventory-Short Form as a screening and diagnostic instrument for moderate and severe depression in medical inpatients. J Affect Disord. 2005;86(1):87–91.
37. Bron C, Franssen J, Wensing M, Oostendorp RAB. Interrater Reliability of Palpation of Myofascial Trigger Points in Three Shoulder Muscles. J Man Manip Ther. 2007;15(4):203–15.
38. Bailón-Cerezo J, Torres-Lacomba M. Presencia de puntos gatillo miofasciales y discinesia escapular en nadadores de competición con y sin dolor de hombro: estudio piloto transversal. Fisioterapia. 2013;36(6):266–73.
39. Nascimento JDSdo, Alburquerque-Sendín F, Vigolvino LP, Oliveira WF de, Sousa C de. O. Inter- and Intraexaminer Reliability in Identifying and Classifying Myofascial Trigger Points in Shoulder Muscles. Arch Phys Med Rehabil. 2018 Jan;99(1):49–56.
40. Fischer AA. Pressure threshold meter: its use for quantification of tender spots. Arch Phys Med Rehabil. 1986;67(11):836–8.
41. 10.1016/j.math.2014.08.008
Michener LA, Kardouni JR, Sousa CO, Ely JM. Validation of a sham comparator for thoracic spinal manipulation in patients with shoulder pain. Man Ther [Internet]. 2015;20(1):171–5. Available from: http://dx.doi.org/10.1016/j.math.2014.08.008.
42. Kolber MJ, Vega F, Widmayer K, Cheng MSS. The reliability and minimal detectable change of shoulder mobility measurements using a digital inclinometer. Physiother Theory Pract. 2011;27(2):176–84.
43. 10.1016/j.jse.2016.04.010
Michener LA, Sharma S, Cools AM, Timmons MK. Relative scapular muscle activity ratios are altered in subacromial pain syndrome. J Shoulder Elb Surg [Internet]. 2016;25(11):1861–7. Available from: http://dx.doi.org/10.1016/j.jse.2016.04.010.
44. 10.1016/j.jelekin.2015.08.003

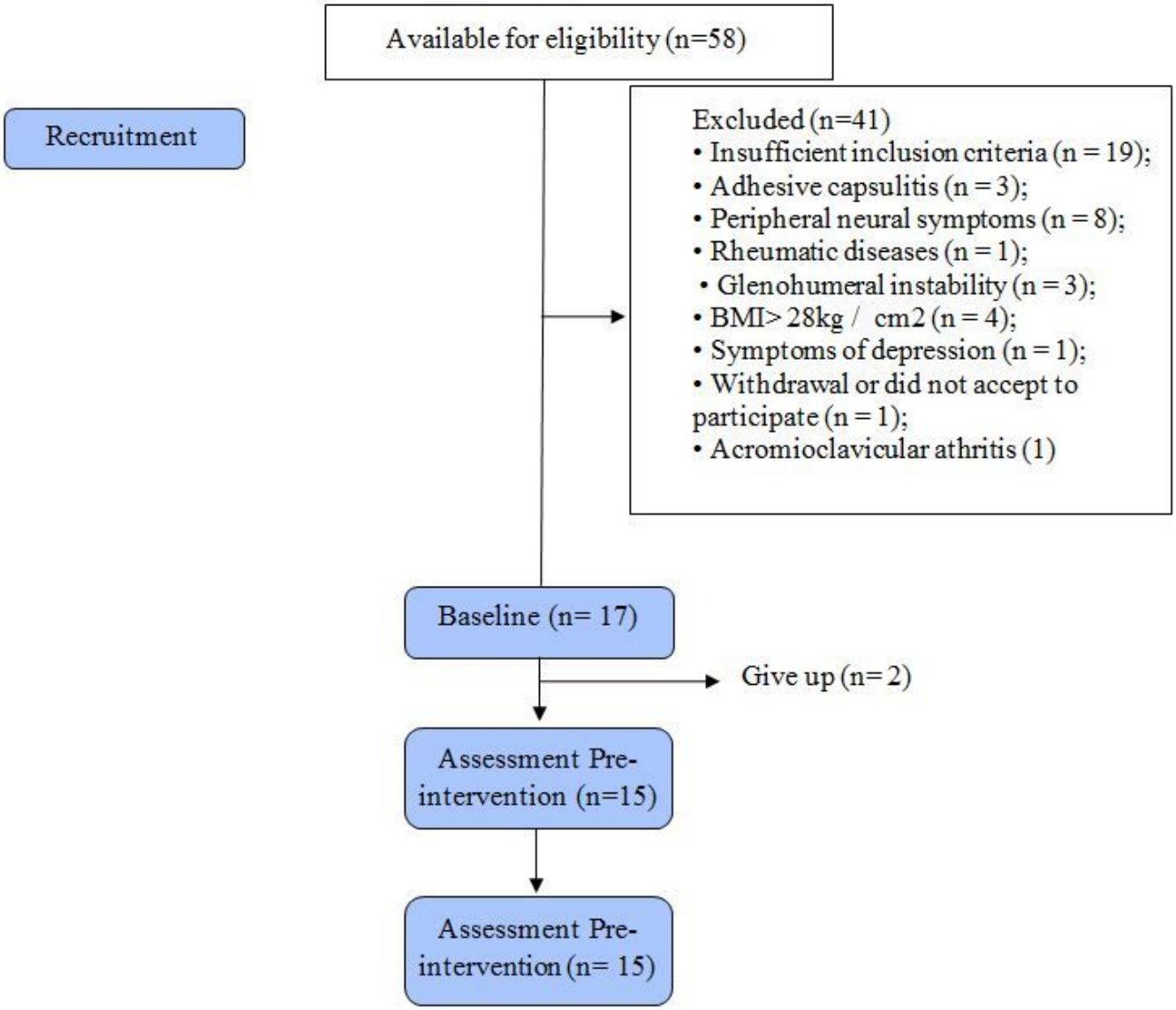
Saccol MF, Almeida GPL, de Souza VL. Anatomical glenohumeral internal rotation deficit and symmetric rotational strength in male and female young beach volleyball players. J Electromyogr Kinesiol [Internet]. 2016 Aug;29:121–5. Available from: http://dx.doi.org/10.1016/j.jelekin.2015.08.003.

45. Kolber MJ, Beekhuizen K, Cheng MSS, Fiebert IM. The reliability of hand-held dynamometry in measuring isometric strength of the shoulder internal and external rotator musculature using a stabilization device. Physiother Theory Pract. 2007;23(2):119–24.
46. Faul F, Erdfelder E, Buchner A, Lang A-G. Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. Behav Res Methods [Internet]. 2009 Nov;41(4):1149–60. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19897823.
47. 10.1016/j.jpain.2013.08.006
Chien C, Bagraith KS, Khan A, Deen M, Strong J. Comparative Responsiveness of Verbal and Numerical Rating Scales to Measure Pain Intensity in Patients With Chronic Pain. J Pain [Internet]. 2013;14(12):1653–62. Available from: http://dx.doi.org/10.1016/j.jpain.2013.08.006.
48. Walton DM, Macdermid JC, Nielson W, Teasell RW, Chiasson M, Brown L. Reliability, standard error, and minimum detectable change of clinical pressure pain threshold testing in people with and without acute neck pain. J Orthop Sports Phys Ther. 2011;41(9):644–50.
49. Ylinen J, Nykänen M, Kautiainen H, Häkkinen A. Evaluation of repeatability of pressure algometry on the neck muscles for clinical use. Man Ther. 2007;12(2):192–7.
50. Prushansky T, Dvir Z, Defrin-assa R. Reproducibility Indices Applied to Cervical Pressure Pain Threshold Measurements in Healthy Subjects. 2004;20(5):341–7.
51. Faul F, Erdfelder E, Buchener A-GL. and A. G * Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 2007;39(2):175–91.
52. Cohen J. The concepts of power analysis. In: Cohen J, editor. Statistical Power Analysis for the Behavioral Sciences. New Jersey: Academic Press; 1988. pp. 1–17.
53. Armijo-Olivo S, Warren S, Fuentes J, Magee DJ. Clinical relevance vs. statistical significance: Using neck outcomes in patients with temporomandibular disorders as an example. Man Ther. 2011 Dec;16(6):563–72.
54. Ge HY, Monterde S, Graven-Nielsen T, Arendt-Nielsen L. Latent myofascial trigger points are associated with an increased intramuscular electromyographic activity during synergistic muscle activation. J Pain. 2014;15(2):181–7.
55. Lucas KR, Rich P, Polus BI. Muscle activation patterns in the scapular positioning muscles during loaded scapular plane elevation: The effects of Latent Myofascial Trigger Points. Clin Biomech. 2010;25(8):765–70.
56. Struyf F, Cagnie B, Cools A, Baert I, Brempt J, Van, Struyf P, et al. Scapulothoracic muscle activity and recruitment timing in patients with shoulder impingement symptoms and glenohumeral instability. J Electromyogr Kinesiol. 2014;24(2):277–84.
57. McClure PW, Michener LA. Staged Approach for Rehabilitation Classification: Shoulder Disorders (STAR-Shoulder). Phys Ther. 2014;95(5):791–800.
58. 10.1136/bmjopen-2018-028777

Hao Q, Devji T, Zeraatkar D, Wang Y, Qasim A, Siemieniuk RAC, et al. Minimal important differences for improvement in shoulder condition patient-reported outcomes: a systematic review to inform a BMJ Rapid Recommendation. BMJ Open [Internet]. 2019 Feb 20;9(2):e028777. Available from: http://bmjopen.bmj.com/lookup/doi/10.1136/bmjopen-2018-028777.

59. Borstad J, Woeste C. The role of sensitization in musculoskeletal shoulder pain. Brazilian J Phys Ther. 2015;19(4):251–6.
60. 10.1016/j.berh.2019.04.007
Trouvin A, Perrot S. New concepts of pain. Best Pract Res Clin Rheumatol [Internet]. 2019;33(3):101415. Available from: https://doi.org/10.1016/j.berh.2019.04.007.
61. Kim SA, Oh KY, Choi WH, Kim IK. Ischemic compression after trigger point injection affect the treatment of myofascial trigger points. Ann Rehabil Med. 2013;37(4):541–6.
62. Dommerholt J, Hooks T, Chou L-W, Finnegan M. A critical overview of the current myofascial pain literature – January 2018. J Bodyw Mov Ther. 2018 Jan;22(1):184–91.

# Figures




## Figure 1

Study flowchart.