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Immediate effects of ischemic compression therapy on shoulder myofascial trigger points

Efeitos imediatos da terapia de compressão isquêmica nos pontos-gatilho miofasciais do ombro

Efectos inmediatos de la terapia de compresión isquémica en los puntos gatillo miofasciales del hombro

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José Diego Sales do Nascimento
ORCID: https://orcid.org/0000-0003-0609-8865
Universidade Federal do Rio Grande do Norte, Brasil
E-mail: fisioterapiamanualjd@gmail.com
Francisco Alburquerque-Sendín
ORCID: https://orcid.org/0000-0002-3892-8440
Universidade de Córdoba, Espanha
E-mail: pacoalbur@hotmail.com
Laysla Carla de Castro Ferreira
ORCID: https://orcid.org/0000-0002-4337-6118
Universidade Federal do Rio Grande do Norte, Brasil
E-mail: layslacf@gmail.com
Catarina de Oliveira Sousa
ORCID: https://orcid.org/0000-0002-2818-3596
Universidade Federal do Rio Grande do Norte, Brasil
E-mail: sousa.catarinaoliveira@gmail.com

Abstract

Objective**:** To primarily evaluate the immediate effect of ischemic compression therapy (ICT) on pain, mobility and strength of shoulder muscles in individuals with Subacromial Impingement Syndrome (SIS). Secondly, to assess whether the strength and mobility assessment protocol influences the amount of MTPs. Methods**:** A single-arm study with a total of 15 individuals (6 women and 9 men, 34.4±10.43 years; 24.20±2.18 kg/m^2) with clinical symptoms of unilateral SIS. All individuals were assessed for the amount of MTPs in the upper

trapezius, lower trapezius, supraspinatus, infraspinatus, pectoralis minor and middle deltoid muscles; pressure pain threshold (PPT) in the upper trapezius, lower trapezius, infraspinatus and middle deltoid muscles; range of motion (ROM) of the shoulder; and isometric strength of shoulder muscles. Results: There was a reduction in the total amount of MTPs ($p<0.01$) and an increase in the PPT in the middle deltoid muscle ($p=0.03$) in the comparisons between pre and post treatment, while there was no difference in ROMs ($p>0.05$) and strength measures ($p>0.24$); however, the pain was less during the sagittal elevation ROM ($p<0.01$) and internal rotation ($p=0.04$), and during the performance of strength in arm elevation and external rotation ($p=0.01$). 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, but did not change the PPT, ROM or strength variables. The evaluation of mobility and strength did not have a negative effect on the evaluated variables.
Keywords: Myofascial pain; Pressure pain threshold; Shoulder pain.

Resumo

Objetivo: Primeiramente, avaliar o efeito imediato da terapia de compressão isquêmica (TCI) na dor, mobilidade e força dos músculos do ombro em indivíduos com Síndrome do Impacto Subacromial (SIS). Em segundo lugar, verificar se o protocolo de avaliação de força e mobilidade influencia a quantidade de pontos-gatilho miofasciais (PGMs). Métodos: Estudo de braço único com um total de 15 indivíduos (6 mulheres e 9 homens, 34,4±10,43 anos; 24,20±2,18 kg/m2) com sintomas clínicos de SIS unilateral. Todos os indivíduos foram avaliados quanto à quantidade de PGMs nos músculos trapézio superior, trapézio inferior, supraespinhal, infraespinal, peitoral menor e deltóide médio; limiar de dor à pressão (LDP) nos músculos trapézio superior, trapézio inferior, infraespinhal e deltóide médio; amplitude de movimento (ADM) do ombro; e força isométrica dos músculos do ombro. Resultados: Houve redução da quantidade total de PMGs ($p<0,01$) e aumento do LDP no músculo deltóide médio (p 0,03) nas comparações entre pré e pós-tratamento, enquanto não houve diferença nas ADMs ($p>0,05$) e medidas de força ($p>0,24$); entretanto, a dor foi menor durante a ADM de elevação sagital ($p<0,01$) e rotação interna ($p=0,04$), e durante a realização de força em elevação do braço e rotação externa ($p=0,01$). Em geral, não houve diferença nas variáveis avaliadas entre a linha de base e o pré-tratamento ($p>0,06$). Conclusão: A TCI reduziu imediatamente a quantidade de PGMs e a dor durante a mobilidade e força, mas não alterou as variáveis LDP, ADM ou força. A avaliação da mobilidade e força não interferiu negativamente nas variáveis avaliadas.
Palavras-chave: Dor miofascial; Limiar de dor por pressão; Dor no ombro.

Resumen

Objetivo: Primero, evaluar el efecto inmediato de la terapia isquémica compresiva (TIC) sobre el dolor, la movilidad y la fuerza de los músculos del hombro en individuos con síndrome de impacto subacromial (SIS). En segundo lugar, verificar si el protocolo de evaluación de la fuerza y la movilidad influye en la cantidad de puntos gatillo miofasciales (PGM). Métodos: Estudio de grupo único con un total de 15 personas (6 mujeres y 9 hombres, 34,4±10,43 años; 24,20±2,18 Kg/m^2) con síntomas clínicos de SIS unilateral. Todos los individuos fueron evaluados respecto al número de PGM en los músculos trapecio superior, trapecio inferior, supraespinoso, infraespinoso, pectoral menor y deltoides medio; umbral de dolor a la presión (LDP) en el trapecio superior, trapecio inferior, infraespinoso y deltoides medio; rango de movimiento (ROM) del hombro; fuerza isométrica de los músculos del hombro. Resultados: Hubo una reducción en la cantidad total de PMG ($p<0.01$) y un aumento del LDP en el músculo deltoides medio ($p=0,03$) en las comparaciones entre pre y postratamiento, mientras que no hubo diferencia en los ROM ($p>0,05$) y medidas de fuerza ($p>0,24$); sin embargo, el dolor fue menor durante el ROM de elevación sagital ($p<0,01$) y rotación interna ($p=0,04$), y durante la realización de elevación del brazo y fuerza de rotación externa ($p=0,01$). En general, no hubo diferencia en las variables evaluadas entre la línea de base y el pretratamiento ($p>0,06$). Conclusión: La TIC redujo inmediatamente la cantidad de PGM y el dolor durante la movilidad y la fuerza, pero no cambió las variables LDP, ROM o fuerza. La valoración de la movilidad y la fuerza no afectó negativamente a las variables evaluadas.

Palabras clave: Dolor miofascial; Umbral de dolor a la presión; Dolor en el hombro.

1. Introduction

Studies have shown a high prevalence of muscles containing MTPs in individuals with a non-traumatic painful shoulder (Bron, Dommerholt, Stegenga, Wensing, & Oostendorp, 2011; Ge, Fernández-de-las-Peñas, Madeleine, & Arendt-Nielsen, 2008) and with unilateral Subacromial Impingement Syndrome (SIS) (Alburquerque-Sendín, Camargo, Vieira, & Salvini, 2013). Both the presence of MTPs and SIS have been associated with decreased pressure pain threshold (PPT) (Hidalgo-Lozano et al., 2010, 2011), as well as reducing mobility (Celik & Mutlu, 2013; Fernández-de-las-Peñas & Dommerholt, 2018) and strength (Celik & Mutlu, 2013; Ge, Arendt-Nielsen, & Madeleine, 2012).

Among the treatments of MTPs, the Ischemic Compression Therapy (ICT) aims to adjust the length of the sarcomeres through digital compression on the MTPs, thus reducing symptoms related to the tense band (Simons, 2002). There is evidence that ICT reduces pain symptoms (Bron, De Gast, et al., 2011), increases passive ROM (Akbaba et al., 2019) and strength (Cagnie et al., 2013; Hains, Descarreaux, & Hains, 2010) 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 MPTs, which could decrease the strength and mobility. On the other hand, the isometric strength assessment could act in a positive way, since post-isometric relaxation is attributed to isometric contraction (Lewit & Simons, 1984), or could also alter muscle viscoelastic properties and passive extensibility, thus improving ROM (Taylor, Brooks, & Ryan, 1997).

Therefore, the present study has two objectives: to evaluate the effects of an ICT session on MTPs and shoulder pain, mobility and strength variables in symptomatic individuals for unilateral SIS and 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 hypothesis is 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.

2. Methods

Study design

This is a single arm study evaluating the effects of ICT in individuals with unilateral SIS who were evaluated in three stages: 1) initial evaluation (baseline), 2) 48 hours after the initial evaluation and immediately before the ICT session, and 3) immediately after an ICT session. This study was developed between May 2017 and October 2018, approved by the Research Ethics Committee of *Universidade Federal do Rio Grande do Norte* (protocol number 1,316,438) and registered in the Brazilian Registry of Clinical Trials – ReBEC (RBR-

3DDG2K). All volunteers gave their written and informed consent after being informed verbally and in writing about the objectives, risks and benefits of the study.

Participants

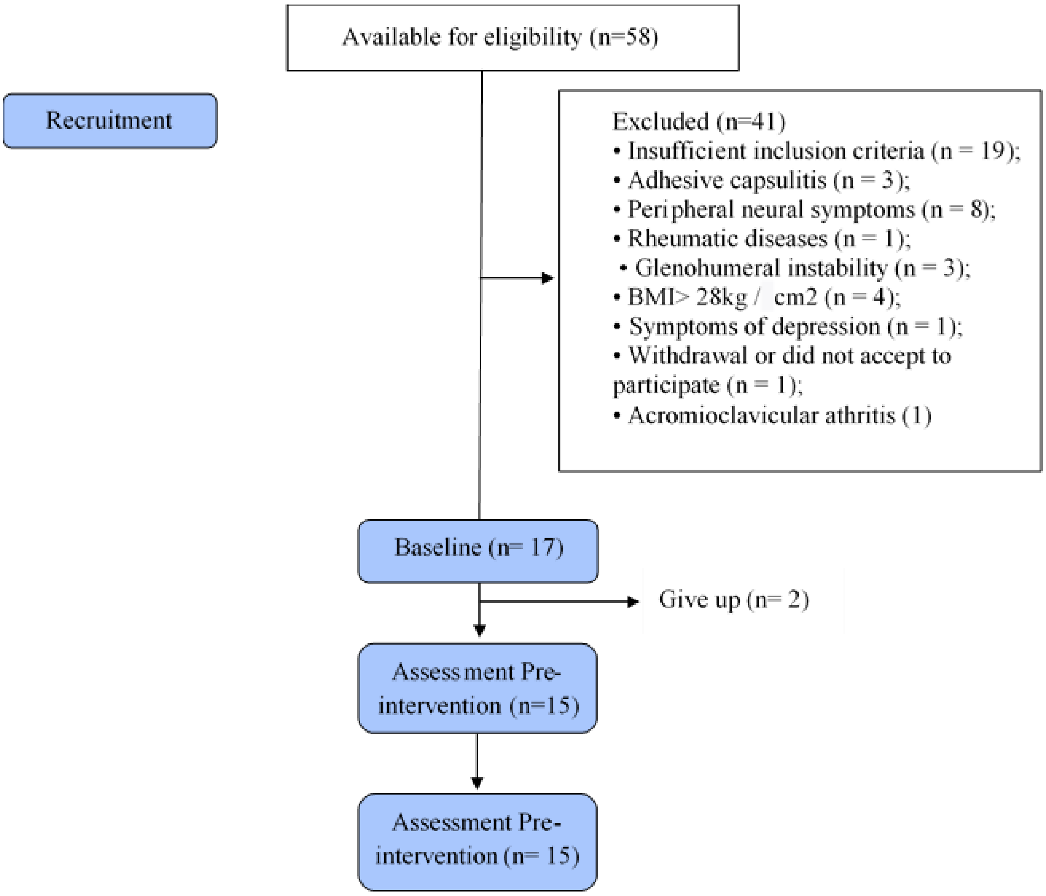
Participants were recruited from flyers posted in the community and via social media. The inclusion criteria were: 18 – 60 years old, history of unilateral shoulder pain lasting at least one month, located in the proximal anterolateral shoulder region (Lin, Chen, Chen, & Tsauo, 2010), or in the C5 or C6 dermatome region (McClure, Michener, & Karduna, 2006), and at least three of the following positive tests: Neer (Neer, 1972), Hawkins-Kennedy (Hung, Jan, Lin, Wang, & Lin, 2010), Jobe (Jobe & Jobe, 1983), painful arch (L. a. Michener, Walsworth, Doukas, & Murphy, 2009), external rotation resistance (Diercks et al., 2014), Gerber and Speed (Camargo, Ávila, Asso, & Salvini, 2010).

Exclusion criteria were: adhesive capsulitis, history of symptom onset due to trauma, multidirectional or anterior glenohumeral joint instability, numbness or tingling in the upper extremity, fibromyalgia or rheumatic disease, previous neck and shoulder surgery, systemic disease, body mass index > 28kg/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 (Altindag, Gur, & Altindag, 2008; Furlanetto, Mendlowicz, & Romildo Bueno, 2005).

There were 56 individuals interested in participating in the study. However, only 15 individuals participated in the ICT session, as described in the study flowchart (Figure 1).

Demographic and pain-related characteristics and shoulder functionality of the participants are shown in Table 1. Individuals were young with age mean around 30 years old, BMI classified as normal (<25 kg/m^2) (Nuttall, 2015), with low score for depression (<9) (Çelik & Mutlu, 2012), low level of pain (<2) (McClure & Michener, 2014), chronic pain (time of pain > 3 months) (Martinez-Calderon, Struyf, Meeus, Morales-Ascencio, & Luque-Suarez, 2017), and moderate score for shoulder function (<75) (Leggin et al., 2006).

Figure1. Study flowchart.



Source: Authors.

All individuals were submitted to: pain and general function of the shoulder complex using the Penn Shoulder Score Questionnaire; identification of MTPs; pain assessment, comprising the PPT and pain during mobility and strength tests, according to the Numerical Pain Rating Scale (NPRS); shoulder mobility; and muscle strength of the shoulder complex.

Evaluations were carried in two days: initial evaluation (baseline) and 48 hours after that. In the second day, individuals were evaluated immediately before and after an ICT session (pre intervention and post intervention, respectively). The purpose of the baseline was to verify the influence of the evaluation procedures on the variables.

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]

Note: Values expressed as frequency (sex, affected side), mean and standard deviations[a], and median and interquartile range[b]. Legend: M = male; F = female; BMI = Body Mass Index; BDI = Beck Depression Inventory; D = dominant; ND = non-dominant. Source: Research data.

One physiotherapist with 6 years of clinical experience performed the screening evaluation of the recruited individuals and performed the ICT session, and two others evaluators, in last year of graduation in Physical Therapy, were responsible for evaluations. Only the affected side was evaluated.

Reliability of measures

The two evaluators involved in the evaluations participated in training with the physiotherapist with 6 years of experience and assessed 3 symptomatic and 3 asymptomatic subjects. Next, a test-retest reliability study was conducted with 20 asymptomatic individuals 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 for the assessments of PPT, ROM, strength and NPRS (ICC: 0.91-0.98).

Evaluation Protocol

The evaluated muscles were: upper and lower trapezius, supraspinatus, infraspinatus, pectoralis minor and middle deltoid. The following diagnostic criteria proposed by Simons (Bailón-Cerezo & Torres-Lacomba, 2013) were monitored: identification of a palpable tense band; 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; and jump sign.

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 (Hidalgo-Lozano et al., 2010). If the same muscle had latent and active MTP, that muscle was classified as containing active MTP.

The PPT is defined as the minimum amount of pressure that is perceived as painful (Fischer, 1986). A digital algometer (Wagner Instruments, model FDX, Greenwich, USA) was used for this assessment.

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) (Alburquerque-Sendín et al., 2013; Hidalgo-Lozano et al., 2011).

The ROM of arm elevation in the sagittal and scapular plane, internal and external rotation of the shoulder were evaluated using a digital inclinometer (Lafayette Instrument Company, model ACU001, IN, USA). The elevation in the sagittal plane of the shoulder was measured with the individuals sitting with their elbow (Michener, Kardouni, Sousa, & Ely, 2015) 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°.

The isometric muscle strength test was performed with a manual dynamometer (Lafayette Instrument Company, model 0116, 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 (Michener et al., 2016). 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 (Saccol, Almeida, & de Souza, 2016). 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.

Individuals were asked about pain according to NPRS after each ROM and strength assessment. All measurements were performed twice and the average between them was calculated.

Ischemic Compression Therapy Session

All individuals were submitted to an ICT session applied to all MTPs identified in the assessment. Compression was applied over the MTPs until an increase in muscle resistance was perceived by the therapist (Hidalgo-Lozano et al., 2011).

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.

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 (Faul, Erdfelder, Buchner, & Lang, 2009) 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 (Chien, Bagraith, Khan, Deen, & Strong, 2013). We added 25% of this value, totaling 15 individuals.

The data were 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 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 (Faul, Erdfelder, & Buchener, 2007) for parametric variables. An effect size greater than 0.8 was considered large, around 0.5 moderate, and less than 0.2 small (Cohen, 1988).

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 (Goedhart, 2016).

3. Results

Table 2 shows the number of MTPs for each muscle in each evaluation and the percentage change in the number of MTPs between evaluations.

It is important to note that 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 ($p<0.01$) 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 (Cliff's $d=0.24$). 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 $d=0.24$).

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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)							
Upper Trapezius	12 (1; 0 – 2)	12 (1.40; 0 – 3)	7 (0.80; 0 – 2)	0.99	0	0.02	0.24
Active MTrPs	6 (0.00; 0 – 1)	9 (0.80; 0 – 3)	5 (0.46; 0 – 2)	0.31	-0.05	0.15	0.15
Latente MTrPs	18 (1.2; 0 – 2)	21 (1.4; 0 – 3)	12 (0.80; 0 – 2)	0.36	-0.09	0.01	0.37
Total							
Lower Trapezius							
Active MTrPs	8 (0.00; 0 – 3)	14 (0.93; 0 – 3)	8 (0.53; 0 – 2)	0.22	-0.14	0.06	0.14
Latente MTrPs	2 (0.00; 0 – 1)	3 (0; 0 – 2)	2 (0; 0 – 1)	0.70	-0.01	0.56	0.01
Total	10 (0.66; 0 – 3)	17 (1.13; 0 – 3)	10 (0.66; 0 – 2)	0.15	-0.20	0.30	0.21
Infraspinatus							
Active MTrPs	5 (1; 0 – 1)	9 (0.60; 0 – 2)	6 (0.40; 0 – 2)	0.15	-0.13	0.18	0.11
Latente MTrPs	6 (0.00; 0 – 2)	5 (0.60; 0 – 2	2 (0.33; 0 – 1)	0.70	0.06	0.18	0.14
Total	11 (0.73; 0 – 2)	14 (0.93; 0 – 2)	8 (0.53; 0 – 2)	0.36	-0.22	0.03	0.28
Supraspinatus							
Active MTrPs	8 (1; 0 – 2)	11 (0.73; 0 – 2)	6 (0.40; 0 – 2)	0.70	0.01	0.09	0.23
Latente MTrPs	4 (0.00; 0 – 1)	2 (0.13; 0 – 1)	1 (0.06; 0 – 1)	0.31	0.13	0.31	0.07
Total	12 (0.80; 0 – 2)	13 (0.80; 0 – 2)	7 (0.46; 0 – 2)	0.99	-0.07	0.09	0.23
Minor Pectoralis							
Active MTrPs	3 (0.00; 0 – 1)	6 (0.4; 0 – 2)	6 (0.4; 0 – 2)	0.18	-0.15	0.99	0.04
Latente MTrPs	7 (0.00; 0 – 2)	5 (0.33; 0 – 2)	2 (1.33; 0 – 1)	0.48	0.16	0.25	0.08
Total	10 (0.66; 0 – 2)	9 (0.73; 0 – 3)	6 (0.53; 0 – 2)	0.70	0.01	0.08	0.09

Note: Values expressed as number, median and interquartile range. Legend: MTrPs = myofascial trigger points. Source: Authors.

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

Note: Values expressed as number, median and interquartile range. Legend: MTrPs = myofascial trigger points. Source: Authors.

Table 3 shows the results for PPT between baseline and pre-intervention assessments and between pre-intervention and post-intervention assessments. 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 4 shows the results of ROM, strength, and pain during ROM and strength. No difference was generally found between baseline and pre-intervention assessments for any ROM or pain during ROM ($p \geq 0.10$), with low effect size (d=0.04-0.31). 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 ($p=0.04$) (d=0.80 and 0.57, respectively).

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 moderate and large effect size (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).

4. Discussion

Our study investigated the immediate effects of one ICT session on pain, mobility and pain in subjects with shoulder pain. 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.

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

Note: Values are expressed as mean and standard deviation. Source: Authors.

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 (°)							
Sagittal Elevation	159.90±11.14	156.70±10.96	152.36±21.68	3.20 (0.25)	0.29	-4.34 (0.44)	0.20
Scapular 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
Internal Rotation	65.60±8.06	63.43±8.22	72.23±29.88	2.16 (0.32)	0.26	8.8 (0.34)	0.29
External Rotation	85.77±14.71	83.70±16.76	83±16.88	2.03 (0.53)	0.16	-0.70 (0.81)	0.06
Pain in ROM (0-10)							
Sagittal Elevation	4.66±2.28	4.80±1.71	3.40±1.49	0.14 (0.81)	0.06	-1.40 (<0.01)	0.80
Scapular Elevation	4.30±2.02	4.23±1.97	3.40±1.64	-1.24 (0.86)	0.04	-0.83 (0.09)	0.45
Internal Rotation	4.30±1.61	3.06±1.98	2.20±1.54	-1.24 (<0.01)	0.96	-0.86 (0.04)	0.57
External Rotation	4.30±2.08	3.50±2.11	3.13±2.15	-0.80 (0.10)	0.45	-0.37 (0.55)	0.16
Strength (N)							
Scapular Elevation	76.17±27.93	75.20±31.72	72.36±30.80	0.97 (0.79)	0.09	-2.84 (0.09)	0.44
Internal Rotation	103.86±44.42	110.21±51.23	113.93±57.92	-6.35 (0.25)	0.29	3.71(0.28)	0.29
External Rotation	84.27±27.79	85.52±28.25	87.27±31.54	-0.86 (0.72)	0.12	1.75 (0.41)	0.21
Pain in Strength (0-10)							
Scapular Elevation	3.93±2.40	4.40±2.24	3.23±2.25	0.46 (0.32)	0.26	-1.16 (0.01)	0.72
Internal Rotation	3.66±2.42	3.10±2.62	2.30±1.59	0.56 (0.27)	0.29	-0.80 (0.15)	0.38
External 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

Note: Values are expressed as mean and standard deviation.
Legend: ROM = range of motion.
Source: Authors.

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 (Ge, Monterde, Graven-Nielsen, & Arendt-Nielsen, 2014; Lucas, Rich, & Polus, 2010; Struyf et al., 2014) 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 observed in studies which investigated effects of ICT on mobility and strength variables (Cagnie et al., 2013), self-reported function (Bron, De Gast, et al., 2011) and pain-free ROM (Akbaba et al., 2019).

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 (McClure & Michener, 2014). 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 (Hao et al., 2019) or the responsiveness values of the measure (Chien et al., 2013).

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 clinically important difference (Prushansky, Dvir, & Defrin-assa, 2004; Walton et al., 2011). 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 (Borstad & Woeste, 2015), 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 (Trouvin & Perrot, 2019).

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.

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.

Implications of physiotherapy practice

In addition to the results of the immediate effects of ICT in treating myofascial pain, this study presents clinicians 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, and therefore being considered safe even in individuals with pain and can be used in clinical evaluations as they do not cause greater discomfort.

5. 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. The present study opens the perspective for future studies to evaluate the effect of ICT in the medium and long term on pain, mobility and strength.

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Porcentagem de contribuição de cada autor no manuscrito

José Diego Sales do Nascimento – 35%

Francisco Alburquerque-Sendín – 20%

Laysla Carla de Castro Ferreira – 20%

Catarina de Oliveira Sousa – 25%