Effect of Adding Interferential Current in an Exercise and Manual Therapy Program for Patients With Unilateral Shoulder Impingement Syndrome: A Randomized Clinical Trial

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Abstract

Objective: The purpose of this study was to measure the additional effect of adding interferential current (IFC) to an exercise and manual therapy program for patients with unilateral shoulder impingement syndrome.

Methods: Forty-five participants were randomly assigned to group 1 (exercise and manual therapy), group 2 (exercise and manual therapy + IFC), or group 3 (exercise and manual therapy + placebo ultrasound). Individuals participated in 16 treatment sessions, twice a week for 8 weeks. The primary outcome of the study was total score of the Shoulder Pain and Disability Index (SPADI). The secondary outcomes were the pain and disability subscales of SPADI, Numeric Rating Scale, and Pain-Related Self-Statement Scale. Adjusted between-group mean differences (MDs) and 95% confidence intervals (CIs) were calculated using linear mixed models.

Results: After 16 treatment sessions, statistically significant but not clinically important differences were identified in favor of the exercise and manual therapy program alone in the SPADI-total (group 1 vs group 2, MD 11.12 points, 95% CI 5.90-16.35; group 1 vs group 3, MD 13.43 points, 95% CI 8.21-18.65). Similar results were identified for secondary outcomes.

Conclusion: The addition of IFC does not generate greater clinical effects in an exercise and manual therapy program for individuals with unilateral shoulder impingement syndrome. (J Manipulative Physiol Ther 2018;41:218-226)

Key Indexing Terms: *Shoulder Pain; Physical Therapy Modalities; Musculoskeletal Pain*

Introduction

Nontraumatic shoulder pain related to the compromise of structures in subacromial space is one of the most common musculoskeletal complaints and is termed shoulder impingement syndrome (SIS).[1] There have been constant updates of this dysfunction over the years in terms of the understanding of its pathobiomechanics.[2-7] Several authors strongly question the terminology of SIS because it refers only to the mechanical mechanism that generates compression in the tendons of the rotator cuff.[8,9] Thus, it is now accepted that there are multiple internal pathophysiological mechanisms that may reduce the potential space for rotator cuff tendons in the subacromial space.[6-10]

In this way, SIS terminology should be considered an umbrella term, not specific, that includes multiple diagnoses, even intrinsic, involving partial tears of rotator cuff tendons, involvement of the long head of biceps, bursal inflammation, and structural abnormalities at the level of the acromial arch,[8] related to alterations in glenohumeral and scapulothoracic kinematics, capsular laxity or tightness, and muscle imbalances of the rotator cuff and scapular muscles.[11-14]

Reported prevalence for shoulder pain in general is contradictory. However, with regard to SIS, the most common figure is 36% among shoulder diseases, being

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Paper submitted April 21, 2017; in revised form August 26, 2017; accepted September 26, 2017.

0161-4754
https://doi.org/10.1016/j.jmpt.2017.09.009

characterized with the most prevalent painful shoulder conditions.[15]

When planning rehabilitation programs involving patients with SIS or shoulder pain, interferential current (IFC) is one of the routinely chosen resources for pain relief.[12,16] It is characterized as an electroanalgesic resource and is based on the application of alternating medium-frequency current (4000 Hz) with amplitude modulated at low frequency (0-250 Hz).[17] As a probable benefit from the use of IFC, the literature highlights the decrease in the impedance offered by the skin during the application and the greater depth reached in the target area of treatment, resulting in a more effective analgesia for the patient.[17,18]

Despite the promising effects conceptually related to the use of IFC, its use alone is not better than placebo or other therapies. However, considering the clinical heterogeneity and populations studied, IFC administration in a multimodal therapeutic approach appears to be more effective in reducing pain than control treatments and more effective than placebo.[17]

Thus, the present study was justified because, despite some recent studies having used IFC to treat shoulder disabilities,[18-22] the results presented by these randomized clinical trials were not fully elucidative in supporting the use of IFC for shoulder disabilities because they did not exhaust all the possibilities on its use for this condition, especially the additional analgesic effect of IFC in an exercise and manual therapy program (ie, in multimodal treatment).[17]

In light of the aforementioned statements, the aim of the present study was to measure the effect of adding IFC in an exercise and manual therapy program for patients with unilateral SIS. The hypothesis of the study was that the insertion of IFC into an exercise and manual therapy program for these patients would be more effective than the isolated use of these therapeutic resources.

Methods

Ethics

The study was conducted in the integrated health clinic of the Nove de Julho University (São Paulo, SP, Brazil), between January 2016 and January 2017. The study procedures were approved by the Research Ethics Committee of this institution, under protocol number 51675615.3.0000.5511 and registered in ClinicalTrials.gov (NCT029648819). Participants were recruited by means of telephone contact for patients on the same institution's treatment waiting. All individuals included in the study validated their participation by signing an informed consent form.

Study Design

This study was a prospective, 3-arm, randomized, placebo-controlled trial with blinded participants and examiner. Thus, 1 researcher was responsible for recruitment, assessment, and confirmation of the eligibility criteria; a second realized the randomization and concealed allocation; 3 other physiotherapists conducted the application of the treatment programs; and another processed and analyzed the collected data. The researcher responsible for randomization and concealed allocation did not participate of this investigation nor had knowledge about the characteristics of the research.

Individuals were randomly assigned into one of the following groups: group 1 (exercise and manual therapy), group 2 (exercise and manual therapy + IFC), or group 3 (exercise and manual therapy + placebo ultrasound). Concealed allocation of individuals was carried out with opaque envelopes, sealed, sequentially numbered, and randomly assigned by a computer-generated table of random numbers. On the first day of treatment, the envelopes were opened by the physiotherapist responsible for the application of the treatment programs.

Sample

Sample calculation processing was conducted with Ene software, Version 3.0 (Autonomous University of Barcelona, Barcelona, Spain). The sample size was calculated based on a clinical trial conducted by Pekyavas and Baltac.[23] The calculation was performed to detect the difference between groups of 15.93 points in the Shoulder Pain and Disability Index (SPADI), assuming a standard deviation of 13.15 points. The resulting sample size was 12 participants. To compensate for possible sample losses, 15 participants per group were included in this study.

Both men and women between the ages of 18 and 60 years and with a history of anterolateral and unilateral pain in the shoulder for more than 3 months were recruited. In addition, the included participants presented a report issued by the orthopedic doctor confirming the diagnosis, with a minimum score of 4 points on the Numeric Pain Rating Scale (NRS) at rest or during active shoulder movement, and positivity on at least 2 of 3 orthopedic tests for SIS: Neer, Hawkins, and Jobe.[24]

The exclusion criteria adopted in this study were as follows: individuals who presented functional limitation that would make it impossible to carry out fundamental movements for the proposed treatments; signs and symptoms of numbness or tingling in the upper limb; history of shoulder trauma; muscle injury in the upper limb; other diseases related to the shoulder; ruptured tendons; ligamentous laxity; history of shoulder and/or cervical surgery; use of corticosteroid injection in the shoulder or use of analgesic, anti-inflammatory, or muscle relaxants in the last 3 months; performing or having undergone physiotherapeutic treatment in the last 3 months.

Assessment Procedures

The assessments took place before the first treatment session, immediately after the first treatment session (only NRS), after 16 treatment sessions, and 4 weeks after the end of the sessions (only NRS). Thus, 4 weeks after the last session,

follow-up was conducted via telephone. Because this evaluation was performed previously and the NRS is easy to administer, the participants presented no difficulties in responding.

The primary outcomes of the study were shoulder pain and disability (total score) as measured by the SPADI after 16 treatment sessions. The secondary outcomes were SPADI-pain; SPADI-disability; pain intensity, assessed using the NRS; and catastrophizing, assessed by means of Pain-Related Self-Statement Scale (PRSS).

Shoulder Pain and Disability Index

Recognized for its quality, the SPADI is a self-administered questionnaire used to evaluate functional disability caused by shoulder disorders.[25] The questionnaire was applied individually by a single trained examiner familiar with the instrument. The SPADI is composed of 13 items distributed in 2 domains: pain (5 items) and function (8 items). Each item is scored from 0 (no difficulty) to 10 (unable to perform task) points.[26] The values per domain are totaled and the mean of this score is determined. The final values are transformed into percentages ranging from 0 to 100, with higher percentages denoting worse shoulder disorder.[26]

The SPADI has been reported to possess excellent reliability, validity, and responsiveness[25,27] and has been adapted and validated for the Brazilian population.[28] According to Breckenridge and McAuley,[29] the minimum clinically important difference for SPADI is 18 points.

Numeric Rating Pain Scale

The NRS is a simple, easily administered scale used to evaluate the perceived intensity of pain. It consists of a sequence of numbers from 0 (no pain) to 10 (worst possible pain).[30] The NRS has high test-retest reliability for shoulder disorders, with an intraclass correlation coefficient of 0.74.[31] Kelly et al[32] reported a minimum clinically important difference of 1.5 points.

Pain-Related Self-Statement Scale

The PRSS is a scale that evaluates catastrophic thoughts based on cognitive concepts and automatic thoughts present in individuals with chronic pain.[33] Validated for the Brazilian population by Sardá Junior et al,[34] the PRSS is composed of 9 items with a sequence of numbers from 0 to 5 points, corresponding to ”almost never” and ”almost always,” respectively. The total score is the sum of items divided by the number of items answered.

Treatment Programs

Individuals participated in 16 treatment sessions, twice a week for 8 weeks. The sessions were individual, conducted in a reserved room with proper lighting and temperature, with an average duration of 2 hours. Three physiotherapists (1 for each group) in charge of the therapeutic procedures had 3 years of experience in physical therapy clinic and had undergone a 2-month training period for the use of the electrotherapy equipment and execution of the therapeutics exercises and manual therapy.

Group I (Exercise and Manual Therapy)

The exercise and manual therapy program consisted of techniques that form conventional treatment used in physical therapy clinics. Thus, individuals were submitted to the following program:

1. Cervical traction performed by manual contact of the physiotherapist, in three 1-minute series, with 30-second rests between series.[35,36]
2. Myofascial release of the upper trapezius performed by manual contact of the physiotherapist, in three 1-minute series for each muscle.[36]
3. Sleeper’s stretch in 3 series of 30 seconds, with 30-second rests between series: participant lying on the side to be stretched, with knees bent, elevating the humerus to 90° on the support surface, then passively internally rotating the humerus with the opposite arm.[37]
4. Punch exercise during 3 series of 10 repetitions, with 30-second rests between series: participant, in supine position, with the arm flexed to 90° and the elbow extended, punched the ceiling, protracted, and retracted the scapula.[38]
5. Activation of the inferior trapezius muscle: using the overhead arm lift, participant in prone position, with the arm 120° elevated (in line with the lower trapezius) with a pillow under the chest, scapula in neutral. Patient lifted his/her hand with scapular movement and held it 3-5 cm above the horizontal. If the patient could not reach this position as a result of pain or muscle weakness, the patient could let the arm hang from the examining table and just needed to raise the upper arm (elbow flexed) in 120° of elevation.[39,40]
6. Activation of the middle trapezius muscle: participant in same position as for the lower trapezius, but now the abducted the arm at 90°, elbow flexed (hand to the floor), scapula in neutral. Patient pulled the scapula in toward the midline of the spine. The upper arm could still be supported by the bed. Activation of the middle and lower trapezius was performed during 3 series of 10 repetitions, with 30-second rests between series, using elastic-band resistance for movement realizations.[39,40]
7. Rotator cuff exercise (internal rotation and external exercise), arm internal/external rotation at 90° elevation in scapular plane with elastic-band resistance during 3 series of 10 for each rotation, with 30-second rests between series.[38]
8. Rotation on the wall using a ball (internal rotation and external rotation): individual moved the hand of the

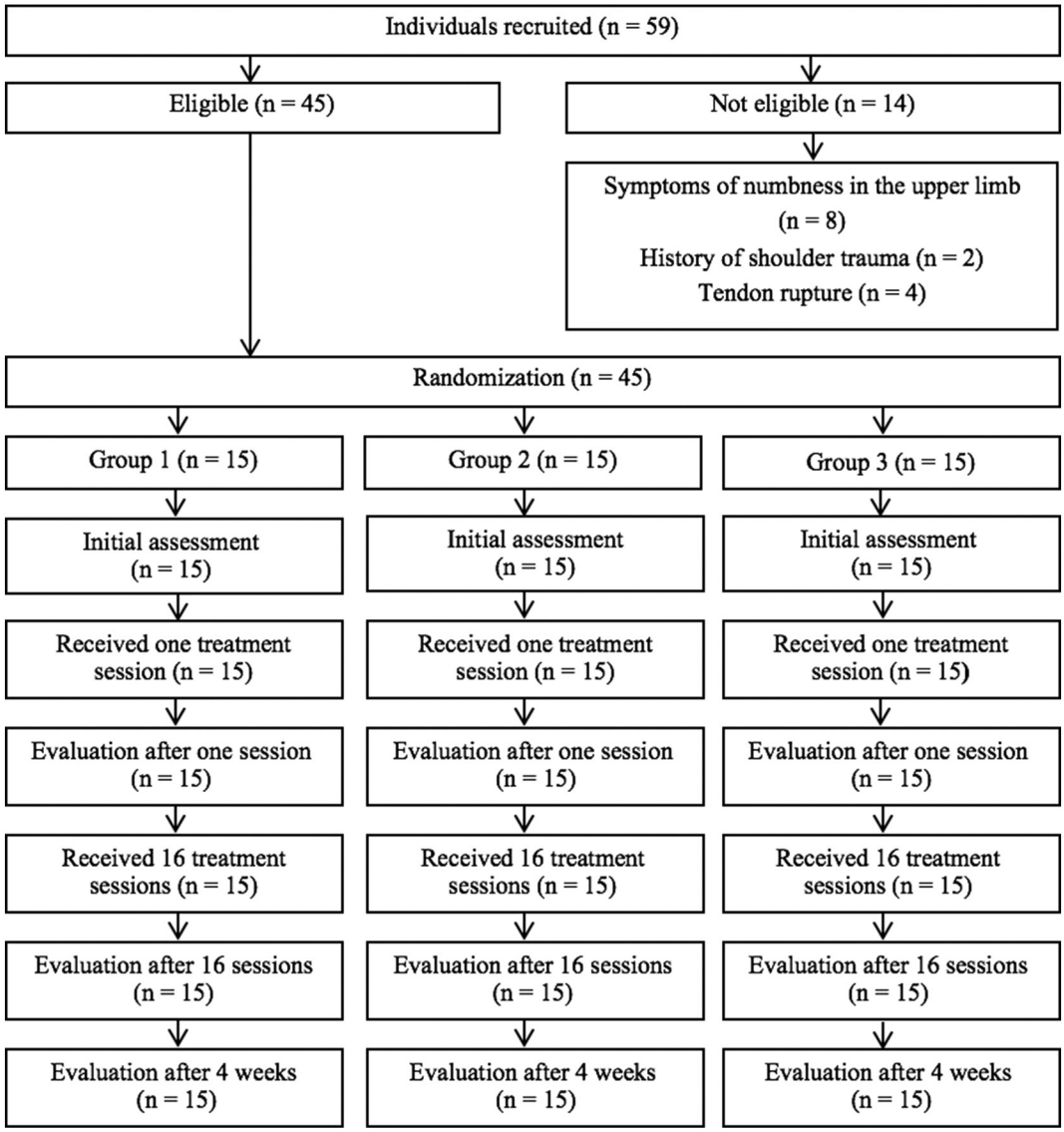

Fig 1. *CONSORT flowchart.*

affected side on the wall using a ball, during 3 series of 10 for each rotation, with 30-second rests between series.[41]

For the standardization of the exercise performed with an elastic band, resistance was determined based on 10 repetitions of the exercise without pain and was also individualized. The resistance was reevaluated at the end of each week and necessary adjustments were made.

Group 2 (Exercise and Manual Therapy + IFC)

In addition to the same exercise and manual therapy program used in group 1, group 2 received IFC generated by Endophasys equipment (KLD, Amparo, SP, Brazil) with 2 channels (4 self-adhesive electrodes, 50 × 90 mm) over the area of pain with the following parameters: carrier frequency of 4 kHz, amplitude-modulated frequency of 100 Hz, sweep frequency of 50 Hz, and swing pattern 1:1, for 50 minutes.[42,43] The physiotherapist responsible for the procedures of this group followed the therapy at all times, being responsible for ensuring the maintenance of the intensity according to the participant's report of "strong but comfortable tingling."[43]

Group 3 (Exercise and Manual Therapy + Placebo Ultrasound)

In addition to the same exercise and manual therapy program used in group 1, group 3 received placebo ultrasound therapeutic generated by Sonophasys equipment (KLD, Amparo, SP, Brazil) for 10 minutes. Circular and slow movements were performed using the transducer head over the painful region of the shoulder. The ultrasound device was

Table 1. *Characteristics of the Individuals in the Present Study According to the Allocation Groups*

Characteristics	Group 1 (n = 15)	Group 2 (n = 15)	Group 3 (n = 15)
Sex, [a] female	13 (86.66)	13 (86.66)	14 (93.33)
Age, [b] y	48.20 (7.42)	48.26 (7.10)	47.66 (6.98)
Mass, [b] kg	75.00 (8.94)	75.20 (6.81)	75.93 (4.74)
Height, [b] m	1.69 (0.08)	1.71 (0.07)	1.70 (0.07)
Body mass index, [b] kg/m^2	26.05 (2.61)	25.60 (2.00)	26.21 (2.16)
Affected side, [a] right	13 (86.66)	14 (93.33)	14 (93.33)

Group 1: exercise and manual therapy; group 2: exercise and manual therapy + interferential current; group 3: exercise and manual therapy + placebo ultrasound.
[a] Values shown in number (percentage). No significant difference in comparisons between groups (χ^2 test, $P > .05$).
[b] Values shown in mean (standard deviation). No significant difference in comparisons between groups (1-way analysis of variance, $P > .05$).

Table 2. *Variation of Pain Intensity Over Time According to the Applied Physiotherapeutic Intervention*

Outcome	Group	P0	P1	P16	F4
NRS score	1	7.46 (0.91)	7.33 (0.97)	3.06 (1.27)[a,b]	3.46 (1.40)[a,b]
	2	7.13 (1.24)	2.60 (1.05)[a]	4.00 (0.65)[a,b]	4.13 (1.06)[a,b]
	3	7.13 (1.06)	5.93 (1.27)[a]	3.60 (0.73)[a,b]	3.66 (0.81)[a,b]

NRS, Numeric Rating Scale.
Values shown in mean (standard deviation). Group 1: exercise and manual therapy; group 2: exercise and manual therapy + interferential current; group 3: exercise and manual therapy + placebo ultrasound; P0: before the intervention; P1: after 1 session; P16: after 16 sessions; F4: 4 weeks after the end of the sessions.
[a] Differs significantly from P0 ($P < .05$).
[b] Differs significantly from P1 ($P < .05$).

Table 3. *Variation of Pain, Disability, and Catastrophizing Over Time According to the Instituted Physiotherapeutic Intervention*

Outcome	Group	P0	P16
SPADI-pain score	1	73.33 (4.99)	31.66 (6.49)[a]
	2	68.00 (7.01)	37.86 (7.68)[a]
	3	68.93 (5.11)	41.73 (11.28)[a]
SPADI-disability score	1	72.50 (5.91)	34.33 (6.26)[a]
	2	66.49 (6.07)	38.91 (6.52)[a]
	3	68.41 (5.65)	43.41 (11.32)[a]
SPADI-total score	1	72.82 (5.22)	33.53 (5.56)[a]
	2	67.07 (5.93)	38.92 (5.89)[a]
	3	68.61 (5.12)	42.76 (10.88)[a]
PRSS score	1	3.19 (0.73)	2.21 (0.37)[a]
	2	3.11 (0.29)	2.35 (0.14)[a]
	3	3.40 (0.40)	2.28 (0.28)[a]

PRSS, Pain-Related Self-Statement Scale; *SPADI,* Shoulder Pain and Disability Index.
Values shown in mean (standard deviation). Group 1: exercise and manual therapy; group 2: exercise and manual therapy + interferential current; group 3: exercise and manual therapy + placebo ultrasound; P0: before the intervention; P16: after 16 sessions.
[a] Differs significantly from P0 ($P < .05$).

switched on and it was possible for the participant to hear a beep at the beginning of the therapy; however, the device had zeroed parameters and the instrument panel that indicated the treatment parameters were out of sight of the participant.[44]

Statistical Analysis

Participants were analyzed in the groups to which they were randomly allocated (intention-to-treat analysis). Histograms were created to test data normality and all outcomes had normal distributions. The data were expressed as mean and standard deviation values. Moreover, adjusted between-group mean differences (MD) and 95% confidence intervals (CI) were calculated using linear mixed models by using group, time, and group-by-time interaction terms. The SPSS program, Version 17.0 (SPSS Inc, Chicago, Illinois) was used for the statistical analyses, with a 5% significance level established for all comparisons.

Table 4. *Comparisons of the Outcomes of the Present Study Between the Groups According to the Evaluations Performed*

Outcome	Time	Group 1–Group 2	Group 1–Group 3	Group 2–Group 3
NRS score	P0-P1	–4.40 (–5.19, –3.60) [a]	–1.06 (–1.85, –0.27) [a]	3.33 (2.54, 4.12) [a]
	P0-P16	1.26 (0.47, 2.05) [a]	0.86 (0.07, 1.65) [a]	–0.40 (–1.19, 0.39)
	P0-F4	1.00 (0.20, 1.79) [a]	0.53 (–0.25, 1.32)	–0.46 (–1.25, 0.32)
SPADI-pain score	P0-P16	11.53 (5.26, 17.80) [a]	14.46 (8.19, 20.73) [a]	2.93 (–3.33, 9.20)
SPADI-disability score	P0-P16	10.58 (5.12, 16.04) [a]	13.16 (7.70, 18.62) [a]	2.58 (–2.87, 8.04)
SPADI-total score	P0-P16	11.12 (5.90, 16.35) [a]	13.43 (8.21, 18.65) [a]	2.30 (–2.91, 7.53)
PRSS score	P0-P16	0.22 (–0.11, 0.55)	–0.14 (–0.47, 0.19)	–0.36 (–0.66, –0.02) [a]

NRS, Numeric Rating Scale; *PRSS,* Pain-Related Self-Statement Scale; *SPADI,* Shoulder Pain and Disability Index.
Values shown in adjusted mean differences (95% confidence interval of the differences). Group 1: exercise and manual therapy; group 2: exercise and manual therapy + interferential current; group 3: exercise and manual therapy + placebo ultrasound; P0: before the intervention; P1: after 1 session; P16: after 16 sessions; F4: 4 weeks after the end of the sessions.
[a] Significant difference ($P < .05$).

Results

A total of 59 individuals were recruited for the present study. Of these, 14 were excluded for several reasons, as shown in Figure 1. Therefore, 45 individuals were included in the study and were randomly allocated to 3 different groups. The adherence to the 16 sessions of physiotherapeutic intervention proposed was 100% in all groups, with no sample loss or discontinuity. None of these 45 individuals received intervention outside the study during the study period.

The demographic characteristics of the individuals in the present study are described in Table 1. Thus, it was noted that the majority of the study participants were women, were young adults, and were slightly overweight. In addition, the groups were comparable in terms of the baseline, this being the result of randomization and concealed allocation.

In comparisons over time, there was a significant reduction of pain, catastrophizing, and disability in all groups, as shown in Tables 2 and 3. Regarding the most important analyses of the present study—that is, the between-groups analysis (Table 4)—immediately after the first treatment session it was noted that group 2 was more effective in reducing the NRS score compared with group 1 (MD –4.40 points, 95% CI –5.19 to –3.60), as well as group 3 compared with group 1 (MD –1.06 point, 95% CI –1.85 to –0.27). However, after 16 treatment sessions, these therapeutic effects were not maintained, and so group 1 was more effective in reducing pain intensity than group 2 (MD 1.26 point, 95% CI 0.47-2.05) and group 3 (MD 0.86 point, 95% CI 0.07-1.65). However, these differences between the groups were not clinically relevant (ie, they were <1.5 points).[32] Four weeks after the end of the treatment sessions, group 1 remained more effective in reducing the NRS score than group 2 (MD 1.00 point, 95% CI 0.20-1.79), but without clinical significance. Comparing the remaining groups, group 2 was more effective in reducing pain intensity than group 3 (MD 3.33 points, 95% CI 2.54-4.12) only immediately after the first treatment session.

With regard to SPADI (Table 4), reduction of the SPADI-pain score was identified after 16 sessions of the treatment applied in group 1 compared with group 2 (MD 11.53 points, 95% CI 5.26-17.80) and with group 3 (MD 14.46 points, 95% CI 8.19-20.73). A similar result was identified for SPADI-disability, with reduction in the scores after 16 sessions of treatment applied in group 1 compared with group 2 (MD 10.58 points, 95% CI 5.12-16.04) and with group 3 (MD 13.16 points, 95% CI 7.70-18.62), as well as for SPADI-total, with reduction in the scores after 16 sessions of treatment applied in group 1 compared with group 2 (MD 11.12 points, 95% CI 5.90-16.35) and with group 3 (MD 13.43 points, 95% CI 8.21-18.65). However, although the results reported here are statistically significant, they are not clinically relevant because the differences between the groups are less than the clinically important minimum difference of 18 points.[29]

Regarding the PRSS, it was noted that the 16 treatment sessions applied in group 3 were more effective in reducing catastrophizing pain compared with group 2 (MD –0.36 point, 95% CI –0.66 to –0.02), but, like the other outcomes of the present study, likely without clinical relevance, given that the improvement reported here was less than 10%.

Discussion

In the present study, the addition of IFC to an exercise and manual therapy program for individuals with unilateral SIS was not effective in reducing pain, disability, and catastrophizing compared with a group that received only exercise and with a group that received exercise and placebo ultrasound.

The results reported here indicate an important consideration regarding the use of IFC for pain relief, its main clinical implication. Despite being widely used by rehabilitation professionals as a treatment for patients with SIS,[45]

no previously published randomized controlled trial has investigated the clinical effects of the use of IFC on SIS. Therefore, with the results of this study we hope to offer alternatives for the reality of clinical practice and also to contribute to the growing evidence base in the management of SIS.

In this context, Suriya-amarit et al[19] conducted a study using IFC in patients with hemiplegic shoulder pain and identified an immediate reduction of pain intensity compared with a placebo group. Similarly, our study identified a reduction in NRS scores in the group submitted to exercise and manual therapy associated with IFC. However, the effects of this combination were not clinically superior to the isolated use of exercises and manual therapy or exercises and manual therapy associated with placebo ultrasound after 16 sessions. These results confirm the immediate effectiveness of IFC in reducing shoulder pain, which is not clinically important because of the chronicity that is common in the disorders addressed in both studies.

Understanding the limitations of the use of IFC alone and bringing the scientific context closer to what is in fact commonly practiced in specialized rehabilitation centers for shoulder disorders treatment,[45] our study and some other reports investigated the addition of IFC to the multimodal treatments for this population.[20-22]

Thus, a study conducted by Van Der Heijden et al[20] compared the effects of IFC, ultrasound therapy, and their respective placebos associated with exercises and educational interventions to improve mobility and pain in patients with unspecified shoulder soft tissue disorders. In a similar way to our study, these authors identified the lack of effective clinical gains from the addition of IFC to a multimodal program.

In another common shoulder dysfunction, Taskaynatan et al[21] investigated the effects of the use of IFC compared with the application of steroid iontophoresis, both associated with hot packs, ultrasound, and exercises, in patients with bicipital tendinitis. The group that received IFC presented lower clinical benefits, corroborating the results of our study. On the other hand, Cheing et al[22] reported that the use of electroacupuncture or IFC in combination with shoulder exercises is effective in treating patients with frozen shoulder. However, the use of IFC was no better than the use of electroacupuncture.

Limitations

First, the small number of individuals included in this study is a limitation. Although the present study presents a priori sample calculation based on a previous study (but with values below minimum clinically important difference for SPADI), future investigations should consider larger sample sizes. In addition, the follow-up period considered was 4 weeks. Thus, it would be appropriate to observe the behavior of pain and disability over a longer period. Third, the formation of SIS subgroups, such as typical impingement and subsequent internal impingement, was not carried out. Because of this characteristic, the results cannot be extrapolated to specific groups. Fourth, the outcome measures used in the study are not specific for SIS but rather for general shoulder pain processes. Finally, it is important to highlight that IFC is a modality within the field of electrotherapy and future studies should consider the additional effects of other therapeutic modalities in exercise and manual therapy programs for patients with SIS.

Conclusion

The addition of IFC does not generate greater clinical effects in an exercise and manual therapy program for individuals with unilateral SIS than the isolated use of these therapeutics resources.

Funding Sources and Potential Conflicts of Interest

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

Contributorship Information

Concept development (provided idea for the research): C.A.F.d.P.G., A.V.D.-F.
Design (planned the methods to generate the results): C.A.F.d.P.G., A.V.D.-F.
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): C.A.F.d.P.G.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): C.A.F.d.P.G., W.A.M., S.Q.R., E.S.S., A.C.B.G.
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): C.A.F.d.P.G., A.V.D.-F.
Literature search (performed the literature search): C.A.F.d.P.G., A.V.D.-F., W.A.M., S.Q.R., E.S.S., A.C.B.G.
Writing (responsible for writing a substantive part of the manuscript): C.A.F.d.P.G., A.V.D.-F., W.A.M., S.Q.R., E.S.S., A.C.B.G.
Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): C.A.F.d.P.G., A.V.D.-F.

Practical Application

- The addition of IFC in an exercise and manual therapy program for individuals with unilateral SIS was not effective in reducing pain, disability, and catastrophizing when comparing a group that received only exercise and manual therapy and with a group that received exercise, manual therapy, and placebo ultrasound.

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