Combined Use of Diadynamic Currents and Manual Therapy on Myofascial Trigger Points in Patients With Shoulder Impingement Syndrome: A Randomized Controlled Trial

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Abstract

Objective: The purpose of this study was to evaluate the effect of combined manual therapy (MT) and diadynamic (DD) currents on myofascial trigger points of the upper trapezius muscle in individuals with a diagnosis of unilateral shoulder impingement syndrome.

Methods: A randomized clinical trial was conducted involving 60 individuals with shoulder impingement syndrome who were allocated to the following 3 groups: (1) MT and DD currents (MTDD), (2) MT alone, and (3) DD currents alone. The participants were submitted to 16 treatment sessions over an 8-week period and were evaluated using the Numerical Rating Pain Scale as well as the pain and disability subscales of the Shoulder Pain and Disability Index.

Results: Differences in Numerical Rating Pain Scale scores (secondary outcome) between MTDD and MT groups (mean difference 2.25 points, 95% confidence interval 1.07-3.42) and between MTDD and DD groups (mean difference 2.30 points, 95% confidence interval 1.42-3.17) were clinically relevant. No clinical gains were observed in the comparisons between groups of Shoulder Pain and Disability Index scores.

Conclusion: The combination of MT and DD currents on myofascial trigger points was more effective at reducing pain intensity but not disability than each therapy performed individually for patients with unilateral shoulder impingement syndrome. (J Manipulative Physiol Ther 2018;41:475-482)

Key Indexing Terms: *Shoulder Pain; Physical Therapy Modalities; Myofascial Pain Syndromes; Physical and Rehabilitation Medicine*

Introduction

Shoulder impingement syndrome is a condition that causes shoulder pain.[1] With a multifactor etiology, shoulder impingement syndrome is considered a nonspecific term that envelopes different mechanisms and has a broad gamut of diagnoses.[2-4] This condition leads to altered motor control, tightness of muscles and other soft tissue structures around the shoulder, postural deviations, and muscle imbalances.[1]

Muscle involvement in shoulder impingement syndrome[5,6] favors the emergence of myofascial trigger points, especially in the infraspinal and upper trapezius muscles.[7] Myofascial trigger points are palpable nodules located in a taut band of a skeletal muscle and are related to sensory, motor, and autonomic changes with the presence of local pain.[8] Such structures may be active (presence of spontaneous pain or pain reported as familiar through compression) or latent (nonspontaneous and patient reports unknown pain through local compression).[9,10]

A recent review of the literature reports that dry and wet needling, myofascial manipulation, ischemic compression,

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low-level laser therapy, manual muscle stretching, cold application, home exercises, and ergonomic recommendations are among the different treatments for reducing pain, increasing range of motion, and improving shoulder function in individuals with shoulder impingement syndrome and myofascial trigger points.[11] Moreover, positional release and ischemic compression are a part of a set of manual therapies that employ specialized movements of the hands over the myofascial component, both of which are used to reduce pain and improve function.[12,13] Specifically, with regard to myofascial trigger points, these 2 techniques can raise the pressure pain threshold and improve the range of motion of the joint.[14]

The aim of electrophysical agents is to reduce pain and improve function through the administration of a particular amount of energy (electrical, sound, light, or thermal) to target tissues;[12] although, such methods do not have the same quantity and quality of clinical studies in comparison to manual techniques.[15] The present investigation highlights diadynamic (DD) currents (low frequency currents), which promote analgesic effects founded on the gate control theory of pain and the release of endorphins.[16] Such currents can even be employed for chronic conditions, leading to improvements with regard to functional aspects.[17]

Despite the close relationship between myofascial trigger points and shoulder impingement syndrome, the scientific literature offers only a small number of systematic reviews that present evidence for the use of physiotherapeutic resources in these clinical situations, with only dry and wet needling recommended for the short-term and medium-term relief of pain caused by trigger points in the neck and shoulder in comparison to a control group or individuals submitted to sham treatment.[18] Thus, a larger number of randomized clinical trials with due methodological quality will lead to a greater number of resources that are proven effective for use by physiotherapists in the treatment of these clinical conditions.

The purpose of the present study was to evaluate the effects of manual therapy (MT) and DD currents on myofascial trigger points of the upper trapezius muscle in individuals with a diagnosis of unilateral shoulder impingement syndrome. The hypothesis is that the combination of these 2 physiotherapeutic resources leads to greater improvements in patients with shoulder impingement syndrome than each resource employed separately.

Methods

Ethical Aspects

Eligible participants were informed beforehand regarding the evaluation procedure that they were to be submitted and signed a statement of informed consent formulated in accordance with Resolution 466/12 of the Brazilian National Health Council and the 1975 Declaration of Helsinki. The procedures of the present study received approval from the Research Ethics Committee of the Nove de Julho University under process number 50917515.3.0000.5511. This study is registered with ClinicalTrials.gov (NCT02735967).

Design

A prospectively registered, three-arm, randomized, controlled trial with a blinded examiner was conducted at a physical therapy clinic in the city of São Paulo, Brazil between January 2016 and July 2016. A researcher who was blinded to the allocation of the participants was in charge of performing the evaluation of the participants to determine their eligibility. This evaluation comprised an interview addressing a detailed medical history and a physical examination of the affected shoulder.

The participants were randomly allocated to 3 treatment groups by means of a scheme generated by computer: MT and DD currents (MMDD), MT alone, or DD alone. Concealed allocation was performed using sequentially numbered, sealed, opaque envelopes. This procedure was conducted by an investigator who was not involved in the recruitment or treatment of the participants.

Three physiotherapists (1 for each group) with at least 2 years of experience were designated to perform the therapeutic procedures. All physiotherapists first underwent a 2-month training period to ensure the standardization of the administration of the DD currents and MT program.

On the first day of treatment, the envelope attributed to the participant was opened by the researcher in charge of the intervention in the respective groups. The participants were informed that they would receive care involving the administration of DD currents, MT, or both. Thus, due to the nature of the interventions, it was not possible to blind the researchers in charge of the procedures or the participants.

Participants

All participants in the present study were on a waiting list at a physical therapy clinic in the city of São Paulo and were formally invited to participate through contact by telephone. The inclusion criteria were age 18 to 59 years; a history of anterolateral, unilateral shoulder pain (minimum intensity of 4 points on the Numerical Rating Pain Scale [NRPS]) for at least 3 months, and a positive result on at least 2 of the 3 orthopedic tests for impingement syndrome: Neer, Hawkins, and Jobe. Moreover, the volunteers needed to have active, unilateral myofascial trigger points in the upper trapezius muscle on the same side as the affected shoulder.[8,19,20]

The diagnosis of myofascial trigger points was performed by a researcher with more than 3 years of experience with this type of evaluation, following the criteria established by Simons et al,[8] as follows: (1) presence of a palpable taut band in a skeletal muscle, (2) presence of a hypersensitive tender spot in the taut band, (3) local twitch response provoked by the snapping palpation of the taut band, and (4) reproduction of the typical referred pain pattern of the trigger points in response to compression.

The physiotherapist used fingertips and a thumb in a snapping palpation to find a taut band within the muscle. A myofascial trigger point was considered active when the volunteer presented spontaneous pain or reported familiar pain during compression[8]. These criteria have acceptable inter-examiner reliability, with kappa values ranging from 0.36 to 0.88.[21]

Individuals with a diagnosis of bilateral shoulder impingement syndrome, fibromyalgia, muscle injury, a history of trauma to the shoulder, other adverse health conditions related to the shoulder, ruptured tendons, ligament laxity, or a sleeping or tingling sensation in the upper limbs were excluded from the study. Those who made use of a corticoid injection in the shoulder or an anti-inflammatory agent and those submitted to surgical treatment or physical therapy for the affected shoulder in the previous 6 months were also excluded.

Intervention

The participants were submitted to 16 treatment sessions over an 8-week period. Treatment was performed individually in a climate-controlled room with adequate light. Three interventions were performed.

MTDD group. Positional release was first performed. With the physiotherapist positioning 1 hand on the occipital region and the other stabilizing the shoulder, lateral inclination of the cervical spine toward the affected shoulder was performed with maximum movement, without causing discomfort. The participant was then instructed to inhale and exhale deeply. Due exhalation, the physiotherapist performed maximum range of motion of ipsilateral inclination of the cervical spine combined with elevation of the shoulder, maintaining this position for 90 seconds with slight manual contact on myofascial trigger points and repeating the procedure 3 times.[14] The physiotherapist then performed ischemic compression over myofascial trigger points. Ideal pressure was considered to be when the participant reported a sensation of moderate but supportable pressure. If this sensation reduced during compression, greater force was applied until reaching the sensation of moderate, but supportable pressure again. Compression was maintained for 90 seconds, and the procedure was repeated 3 times.[14]

Diadynamic currents were administered immediately following MT. For such, an electrotherapy device was employed (Quark, Diapulsi 990, Piracicaba, São Paulo, Brazil). The negative electrode (7 x 7 cm) was positioned over the myofascial trigger points in the upper trapezius muscle, and the positive electrode (7 x 7 cm) was positioned between the scapulas. The fixed biphasic modality was performed for 4 minutes, followed by 4 minutes of long periods and 4 minutes of short periods. The first and second intensity was at the sensory threshold, and the third was at the motor threshold; both thresholds were based on the participant's report of what was supportable.

MT group. Manual therapy was employed with the same procedures and application times described previously.

DD group. Diadynamic currents were performed with the same electrotherapeutic modalities, electrode placement, and application times described previously.

Outcome Measures

Shoulder disability was the primary outcome and was based on the pain and disability subscales of the Shoulder Pain and Disability Index (SPADI). Pain intensity assessed using the NRPS was the secondary outcome. The evaluations were performed before and after treatment sessions.

The SPADI is a self-administered questionnaire used to evaluate functional disability due to shoulder disorders. This questionnaire is comprised 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.[22] 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.[22] The Brazilian version was validated by Martins et al.[23] According to Breckenridge and McAuley,[24] the minimum clinically important difference for SPADI is 18 points.

The NRPS is a simple, easily administered scale used to evaluate the perceived intensity of pain on an 11-point scale ranging from 0 (no pain) to 10 (worst possible pain). Participants were asked to report the level of pain intensity based on the previous 7 days.[25] Kelly[26] reported minimum clinically important difference of 1.5 points.

Sample Size Calculation

The sample size was determined with the aid of the Ene program, version 3.0 (Autonomous University of Barcelona, Barcelona, Spain) and was calculated based on a study conducted by Pekyavas and Baltaci.[27] Shoulder Pain and Disability Index was the outcome variable. The detection of a difference of 13.30 points and a standard deviation (SD) of 14.25 points among the groups was considered for the sample size calculation. Considering an 80% statistical power and 5% alpha, a group size of 20 volunteers per group was determined.

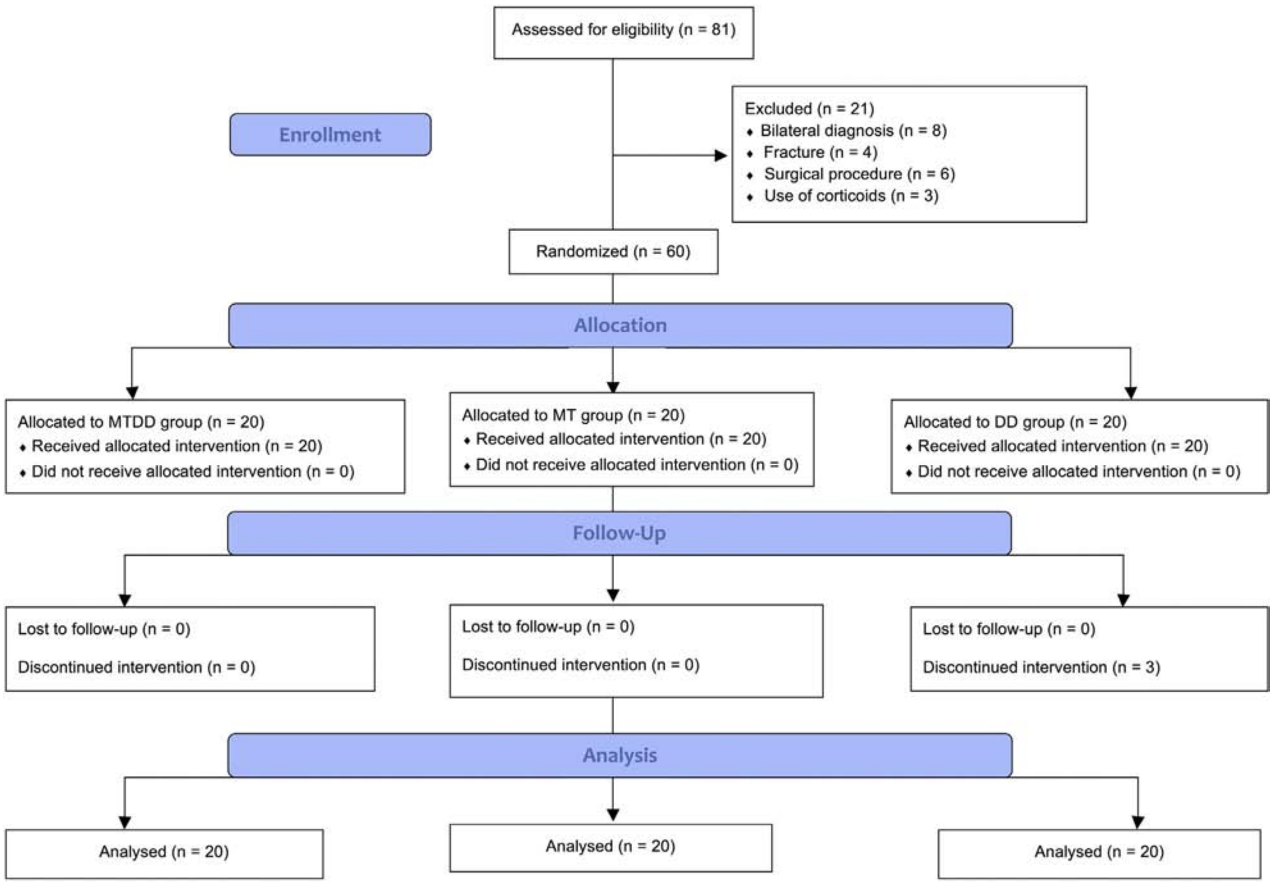

Fig 1. *CONSORT flowchart.* CONSORT, *consolidated standards of reporting trials;* DD, *diadynamic;* MT, *manual therapy;* MTDD, *manual therapy and diadynamic currents.*

Statistical Analysis

Intention-to-treat analysis was employed in this study. Either the Kolmogorov-Smirnov test was performed or histograms were created to determine the distribution (normal or non-normal) of the data. Two-way repeated measures analysis of variance was performed followed by the Bonferroni test; 2 factors were considered: time (before and after the physiotherapeutic interventions) and group (MTDD, MT, and DD). Mauchly's sphericity test with the Greenhouse-Geisser correction was considered in this analysis. The data were expressed as mean, SD, mean differences (MD), and 95% confidence intervals (CI). 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.

Results

Eighty-one individuals were recruited for the present study, 21 of whom were excluded for the reasons listed in Figure 1. Among the 60 remaining individuals, only 3 were not evaluated after the interventions (5% dropout rate). Patient adherence was considered satisfactory: mean of 10 sessions (SD = 0) in the MTDD group, 10 sessions (SD = 0) in the MT group, and 8.50 sessions (SD = 3.66) in the DD group. Table 1 displays the demographic characteristics of the patients. The baseline values of the outcome measures are presented in the second column of Table 2.

Significant group vs time interactions were found for the NRPS ($F = 17.52$, $P < .001$), SPADI-disability ($F = 14.352$, $P < .001$), and SPADI-pain ($F = 25.195$, $P < .001$) scores. Significant improvements in all outcomes were found in all 3 groups over time (Table 2). Considering the effects of the interventions proposed, which are presented in Table 3, the combination of MT and DD currents was statistically more effective ($P < .05$) than these 2 therapies were separately with regard to the NRPS, SPADI-disability, and SPADI-pain scores. However, only the differences in NRPS values between MTDD and MT groups (MD 2.25 points, 95% CI 1.07-3.42) and between MTDD and DD groups (MD 2.30 points, 95% CI 1.42-3.17) were clinically relevant, according to the study conducted by Kelly.[26]

Table 1. *Anthropometric and Clinical Characteristics of Patients With Shoulder Impingement Syndrome in Groups Submitted to Different Forms of Treatment* [a]

Characteristics	MTDD Group	MT Group	DD Group
Age (y)	40.45 (6.54)	38.45 (4.95)	35.55 (5.81)
Sex			
Male	4 (20%)	4 (20%)	6 (30%)
Female	16 (80%)	16 (80%)	14 (70%)
Weight (kg)	75.26 (7.40)	73.20 (6.33)	76.00 (7.04)
Height (m)	1.73 (0.07)	1.72 (0.07)	1.75 (0.07)
Body mass index (kg/m^2)	24.88 (1.82)	24.56 (2.03)	24.94 (1.95)
Affected side			
Right	17 (85%)	17 (85%)	16 (80%)
Left	3 (15%)	3 (15%)	4 (20%)

DD, diadynamic; *MT,* manual therapy; *MTDD,* manual therapy and diadynamic currents.

[a] Data expressed as mean (standard deviation) or number (percentage).

Discussion

Based on the results of the present study, greater reductions in pain intensity (secondary outcome) occurred in the group submitted to a combination of MT and DD currents in comparison to the groups that only received 1 of these therapies. However, we did not identify clinically important differences between groups in disability and pain assessed by SPADI (primary outcomes).

Because of the physiopathologic and clinical complexity of shoulder impingement syndrome, researchers have employed physiotherapeutic resources with the aim of reducing the signs and symptoms of this disorder. In a systematic review of the literature, Goldgrub et al[28] found little evidence to support that multimodal care provides superior effectiveness in comparison to individual interventions for the management of subacromial impingement syndrome or nonspecific shoulder pain. However, Tefner et al[29] reported reductions in pain and disability among patients with chronic shoulder pain treated with exercise, transcutaneous electrical nerve stimulation (TENS), and balneotherapy in comparison to a group submitted to only exercise and TENS. Kaya et al[30] found no differences between Kinesio Taping with exercise and MT with exercise, as both methods achieved similar results in reducing pain and disability in subacromial impingement after 6 weeks of treatment.

Considering the use of physical agents on patients with shoulder impingement syndrome, Galace de Freitas et al[31] found that patients treated with exercises and a pulsed electromagnetic field experienced increases in both muscle strength and function as well as a greater reduction in pain intensity when compared to a group submitted to exercises and sham pulsed electromagnetic field (machine switched off). Yavuz et al[32] compared the effects of therapeutic laser and ultrasound in patients with subacromial impingement syndrome and found that both treatments led to reductions in pain and functional disability. In this context, the present investigation was a pioneering study conducted to evaluate the effects of DD currents on this population and found reductions in pain intensity when this resource was combined with MT.

Both MT and DD currents were directed at myofascial trigger points located in the upper trapezius muscle on the same side as the affected shoulder. This decision was based on previous studies. Hidalgo-Lozano et al[33] found that patients with shoulder impingement showed widespread pressure hypersensitivity and active myofascial trigger points in the shoulder muscles, which reproduce clinical pain symptoms. According to Alburquerque-Sendín et al,[34] myofascial trigger points can alter the motor pattern, thereby leading to abnormal muscle activation and biomechanical dysfunction. Moreover, the greater number of myofascial trigger points in patients with shoulder impingement syndrome in comparison to controls underscores the relevance of myofascial pain in the physiopathology of this condition, which can pave the way for new hypotheses and possibilities for recovering normal muscle and joint function through the treatment of these trigger points.

In the present study, ischemic compression and positional release were employed as the MT techniques, both of which were directed at myofascial trigger points. In a systematic review, Cagnie et al[35] recommend ischemic compression to resolve pain caused by trigger points in the upper trapezius muscle. The literature offers a fewer number of studies on positional release, which is also known as the strain counterstrain technique. In a systematic review, Wong et al[36] state that, despite the low-quality evidence, calculated meta-analysis suggests that positional release reduces pain upon the palpation of tension points. In the present investigation, the MT program alone reduced pain and disability in the analysis performed over time, but with no significant differences in comparison to the group submitted to DD currents and with less effectiveness in comparison to the group submitted to the combination of modalities.

Despite the physiological effects promoted by DD currents,[16] studies that have employed this electrotherapeutic technique are scarce in the literature. Two studies stand out among the few articles published. Bolel et al[37] found that DD currents administered to the stellar ganglion (in combination with medicinal treatment, hot pack and cold pack treatment, whirlpool, TENS, and exercise) led to a reduction in sympathetic activity in patients with reflex sympathetic dystrophy. Ratajczak et al[17] found that DD currents have an analgesic impact on patients with low back

Table 2. *Comparison of Outcomes Over Time and Clinical Effect Size in Different Groups*

Outcomes	Preintervention [a]	Postintervention [a]	Within-Group Differences [b]
NRPS (score, 0-10)			
MTDD group	7.20 (1.39)	3.35 (0.98)	3.85 (3.16, 4.53) [c]
MT group	6.85 (1.18)	5.25 (1.01)	1.60 (0.86, 2.33) [c]
DD group	6.65 (1.30)	5.10 (1.44)	1.55 (1.01, 2.08) [c]
SPADI-disability (score, 0-100)			
MTDD group	69.71 (4.30)	46.75 (8.52)	22.96 (19.35, 26.57) [c]
MT group	67.87 (3.24)	53.93 (2.87)	13.93 (12.11, 15.76) [c]
DD group	69.62 (4.17)	56.12 (5.57)	13.50 (10.37, 16.62) [c]
SPADI-pain (score, 0-100)			
MTDD group	70.50 (4.44)	43.60 (8.01)	26.90 (23.13, 30.66) [c]
MT group	67.40 (4.40)	51.90 (2.71)	15.50 (13.98, 17.01) [c]
DD group	68.60 (6.19)	55.40 (5.35)	13.20 (9.88, 16.51) [c]

DD, diadynamic; *MT,* manual therapy; *MTDD,* manual therapy and diadynamic currents; *NRPS,* Numerical Rating Pain Scale; *SPADI,* Shoulder Pain and Disability Index.

[a] Data expressed as mean (standard deviation).

[b] Data expressed as difference between means (95% confidence interval).

[c] Significant difference ($P < .05$).

Table 3. *Comparison of Outcomes Between Groups as Function of Physiotherapeutic Resources Employed*

	Between-Group Differences		
Outcomes	MTDD - MT	MTDD - DD	MT - DD
NRPS (score, 0-10)	2.25 (1.07, 3.42) [a]	2.30 (1.42, 3.17) [a]	0.05 (-0.96, 1.06)
SPADI-disability (score, 0-100)	9.02 (5.79, 12.25) [a]	9.46 (5.74, 13.17) [a]	0.43 (-2.94, 3.81)
SPADI-pain (score, 0-100)	11.40 (7.61, 15.18) [a]	13.70 (9.69, 17.70) [a]	2.30 (-1.81, 6.41)

DD, diadynamic; *MT,* manual therapy; *MTDD,* manual therapy and diadynamic currents; *NRPS,* Numerical Rating Pain Scale; *SPADI,* Shoulder Pain and Disability Index. Data expressed as difference between means (95% confidence interval).

[a] Significant difference ($P < .05$).

discopathy and lead to an improvement in functional fitness, but with no significant differences when compared to patients treated with TENS. In the present study, the combination of DD currents, ischemic compression, and positional release was the most effective treatment strategy for treatment of myofascial trigger points in patients with shoulder impingement syndrome only in reducing the intensity of pain.

Limitations

The pressure pain threshold over the myofascial trigger points was not measured because only pain intensity and disability were evaluated. The patients included in the present study were evaluated before and after the treatment sessions. As such, it is not possible to ascertain how long the clinical improvements were maintained. Thus, future studies should evaluate patients 1, 3, or 6 months after the conclusion of treatment. Moreover, passive treatment modalities were employed. Thus, future studies should investigate the combination of these modalities with exercise, as a systematic review conducted by Abdulla et al[38] highlights the importance of this form of treatment in such patients.

Conclusion

The combination of MT and DD currents on myofascial trigger points was more effective at reducing pain intensity, but not disability, than each therapy performed in a separate fashion for patients with unilateral shoulder impingement syndrome.

Funding Sources and 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): F.P., T.d.O.G., D.A.B.-G.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): C.A.F.d.P.G., F.P.
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., F.P., T.d.O.G., D.A.B.-G.
Writing (responsible for writing a substantive part of the manuscript): C.A.F.d.P.G., A.V.D.-F., F.P., T.d.O.G., D.A.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 Applications

- Greater reductions in pain intensity occurred in the group submitted to a combination of manual therapy and diadynamic currents in comparison to the groups that only received 1 of these therapies.
- We did not identify clinically important differences between groups in disability and pain assessed by SPADI.

References

1. Millar AL, Lasheway PA, Eaton W, Christensen F. A retrospective, descriptive study of shoulder outcomes in outpatient physical therapy. *J Orthop Sports Phys Ther.* 2006;36:403-414.
2. Seitz AL, McClure PW, Finucane S, Boardman 3rd ND, Michener LA. Mechanisms of rotator cuff tendinopathy: intrinsic, extrinsic, or both? *Clin Biomech (Bristol, Avon).* 2011;26(1):1-12.
3. Braman JP, Zhao KD, Lawrence RL, Harrison AK, Ludewig PM. Shoulder impingement revisited: evolution of diagnostic understanding in orthopedic surgery and physical therapy. *Med Biol Eng Comput.* 2014;52(3):211-219.
4. Phadke V, Makhija M, Singh H. The use of evidence-based practices for the management of shoulder impingement syndrome among Indian physical therapists: a cross-sectional survey. *Braz J Phys Ther.* 2015;19(6):473-481.
5. Moraes GF, Faria CD, Teixeira-Salmela LF. Scapular muscle recruitment patterns and isokinetic strength ratios of the shoulder rotator muscles in individuals with and without impingement syndrome. *J Shoulder Elb Surg.* 2008;17(1 Suppl): 48S-53S.
6. Ludewig PM, Braman JP. Shoulder impingement: biomechanical considerations in rehabilitation. *Man Ther.* 2011;16(1): 33-39.
7. Bron C, Dommerholt J, Stegenga B, Wensing M, Oostendorp RA. High prevalence of shoulder girdle muscles with myofascial trigger points in patients with shoulder pain. *BMC Musculoskelet Disord.* 2011;12:139.
8. Simons DG, Travell J, Simons LS. *Myofascial Pain and Dysfunction: The Trigger Point Manual: Volume 1*. 2nd ed. Baltimore, MD: Lippincott Williams & Wilkins; 1999.
9. Ge HY, Arendt-Nielsen L. Latent myofascial trigger points. *Curr Pain Headache Rep.* 2011;15(5):386-392.
10. Bron C, Dommerholt JD. Etiology of myofascial trigger points. *Curr Pain Headache Rep.* 2012;16(5):439-444.
11. Sergienko S, Kalichman L. Myofascial origin of shoulder pain: a literature review. *J Bodyw Mov Ther.* 2015;19(1):91-101.
12. Page MJ, Green S, Kramer S, et al. Manual therapy and exercise for adhesive capsulitis (frozen shoulder). *Cochrane Database Syst Rev.* 2014;8:CD011275.
13. Childs JD, Cleland JA, Elliott JM, et al. Neck pain: clinical practice guidelines linked to the International Classification of Functioning, Disability, and Health from the Orthopedic Section of the American Physical Therapy Association. *J Orthop Sports Phys Ther.* 2008;38(9):A1-A34.
14. Oliveira-Campelo NM, de Melo CA, Alburquerque-Sendín F, Machado JP. Short- and medium-term effects of manual therapy on cervical active range of motion and pressure pain sensitivity in latent myofascial pain of the upper trapezius muscle: a randomized controlled trial. *J Manipulative Physiol Ther.* 2013;36(5):300-309.
15. Kroeling P, Gross A, Goldsmith CH, et al. Electrotherapy for neck pain. *Cochrane Database Syst Rev.* 2009;4:CD004251.
16. Artioli DP, Nascimento ES, Santos JC, et al. The use of polarized current in physical therapy. *Rev Bras Clin Med.* 2011;9(6):428-431.
17. Ratajczak B, Hawrylak A, Demidaś A, Kuciel-Lewandowska J, Boerner E. Effectiveness of diadynamic currents and transcutaneous electrical nerve stimulation in disc disease lumbar part of spine. *J Back Musculoskelet Rehabil.* 2011;24(3): 155-159.
18. Liu L, Huang QM, Liu QG, et al. Effectiveness of dry needling for myofascial trigger points associated with neck and shoulder pain: a systematic review and meta-analysis. *Arch Phys Med Rehabil.* 2015;96(5):944-955.
19. Tsai CT, Hsieh LF, Kuan TS, Kao MJ, Chou LW, Hong CZ. Remote effects of dry needling on the irritability of the myofascial trigger point in the upper trapezius muscle. *Am J Phys Med Rehabil.* 2010;89(2):133-140.
20. Andersen LL, Hansen K, Mortensen OS, Zebis MK. Prevalence and anatomical location of muscle tenderness in

adults with nonspecific neck/shoulder pain. *BMC Musculoskelet Disord.* 2011;12:169.
21. Gerwin RD, Shannon S, Hong CZ, Hubbard D, Gevirtz R. Interrater reliability in myofascial trigger point examination. *Pain.* 1997;69(1-2):65-73.
22. Roach KE, Budiman-Mak E, Songsiridej N, Lertratanakul Y. Development of a shoulder pain and disability index. *Arthritis Care Res.* 1991;4(4):143-149.
23. Martins J, Napoles BV, Hoffman CB, Oliveira AS. The Brazilian version of Shoulder Pain and Disability Index - translation, cultural adaptation and reliability. *Rev Bras Fisioter.* 2010;14(6):527-536.
24. Breckenridge JD, McAuley JH. Shoulder Pain and Disability Index (SPADI). *J Physiother.* 2011;57(3):197.
25. Ferreira-Valente MA, Pais-Ribeiro JL, Jensen MP. Validity of four pain intensity rating scales. *Pain.* 2011;152(10):2399-2404.
26. Kelly AM. The minimum clinically significant difference in visual analogue scale pain score does not differ with severity of pain. *Emerg Med J.* 2001;18(3):205-207.
27. Pekyavas NO, Baltaci G. Short-term effects of high-intensity laser therapy, manual therapy, and Kinesio taping in patients with subacromial impingement syndrome. *Lasers Med Sci.* 2016;31(6):1133-1141.
28. Goldgrub R, Côté P, Sutton D, et al. The effectiveness of multimodal care for the management of soft tissue injuries of the shoulder: a systematic review by the Ontario protocol for traffic injury management (OPTIMa) collaboration. *J Manipulative Physiol Ther.* 2016;39:121-139.e1.
29. Tefner IK, Kovács C, Gaál R, et al. The effect of balneotherapy on chronic shoulder pain. A randomized, controlled, single-blind follow-up trial. A pilot study. *Clin Rheumatol.* 2015;34(6):1097-1108.
30. Kaya DO, Baltaci G, Toprak U, Atay AO. The clinical and sonographic effects of kinesiotaping and exercise in comparison with manual therapy and exercise for patients with subacromial impingement syndrome: a preliminary trial. *J Manipulative Physiol Ther.* 2014;37(6):422-432.
31. Galace de Freitas D, Marcondes FB, Monteiro RL, Rosa SG, Maria de Moraes Barros Fucs P, Fukuda TY. Pulsed electromagnetic field and exercises in patients with shoulder impingement syndrome: a randomized, double-blind, placebo-controlled clinical trial. *Arch Phys Med Rehabil.* 2014;95(2):345-352.
32. Yavuz F, Duman I, Taskaynatan MA, Tan AK. Low-level laser therapy versus ultrasound therapy in the treatment of subacromial impingement syndrome: a randomized clinical trial. *J Back Musculoskelet Rehabil.* 2014;27(3):315-320.
33. Hidalgo-Lozano A, Fernández-de-las-Peñas C, Alonso-Blanco C, Ge HY, 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;202(4):915-925.
34. 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: a blinded, controlled study. *Clin J Pain.* 2013;29(6):478-486.
35. 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;94(7):573-583.
36. Wong CK, Abraham T, Karimi P, Ow-Wing C. Strain counterstrain technique to decrease tender point palpation pain compared to control conditions: a systematic review with meta-analysis. *J Bodyw Mov Ther.* 2014;18(2):165-173.
37. Bolel K, Hizmetli S, Akyüz A. Sympathetic skin responses in reflex sympathetic dystrophy. *Rheumatol Int.* 2006;26(9):788-791.
38. Abdulla SY, Southerst D, Côté P, et al. Is exercise effective for the management of subacromial impingement syndrome and other soft tissue injuries of the shoulder? A systematic review by the Ontario protocol for traffic injury management (OPTIMa) collaboration. *Man Ther.* 2015;20(5):646-656.