Inclusion of Trigger Point Dry Needling in a Multimodal Physical Therapy Program for Postoperative Shoulder Pain: A Randomized Clinical Trial

José L. Arias-Buría, PT, MSc,[a,b] Raquel Valero-Alcaide, MD, PhD,[c] Joshua Aland Cleland, PT, PhD,[d] Jaime Salom-Moreno, PT, PhD,[b,e] Ricardo Ortega-Santiago, PT, PhD,[b,e] María A. Atín-Arratibel, MD, PhD,[c] and César Fernández-de-las-Peñas, PT, PhD[b,e]

Abstract

Objective: The purpose of this study was to evaluate the effects of including 1 session of trigger point dry needling (TrP-DN) into a multimodal physiotherapy treatment on pain and function in postoperative shoulder pain.

Methods: Twenty patients (5 male; 15 female; age, 58 ± 12 years) with postoperative shoulder pain after either open reduction and internal fixation with Proximal Humeral Internal Locking System plate plate or rotator cuff tear repair were randomly divided into 2 groups: physiotherapy group (n = 10) who received best evidence physical therapy interventions and a physical therapy plus TrP-DN group (n = 10) who received the same intervention plus a single session of TrP-DN targeted at active TrPs. The Constant-Murley score was used to determine pain, activities of daily living, range of motion, and strength, which was captured at baseline and 1 week after by an assessor blinded to group assignment.

Results: Analysis of variance showed that subjects receiving TrP-DN plus physical therapy exhibited greater improvement in the Constant-Murley total score ($P < .001$) and also activities of daily living ($P < .001$) and strength ($P = .019$) subscales than those receiving physical therapy alone. Between-group effect sizes were large in favor of the TrP-DN group ($0.97 < SMD < 1.45$). Both groups experienced similar improvements in pain ($P < .001$) and range of motion ($P < .001$).

Conclusions: Our results suggest that including a single session of TrP-DN in the first week of a multimodal physical therapy approach may assist with faster increases in function in individuals with postoperative shoulder pain.

(J Manipulative Physiol Ther 2015;38:179-187)

Key Indexing Terms: *Trigger Point; Shoulder Pain; Fracture; Rehabilitation*

Fractures of the proximal humerus account for between 5% and 8% off all reported fractures.[1-3] Recently, the incidence of proximal shoulder fractures has increased by approximately 15% per year resulting in substantial personal and economic burden to society.[4,5] The primary goal after a proximal humeral fracture is to eliminate pain and maximize function. It has been reported that around 80% of subjects experiencing a proximal humeral fracture can be treated conservatively; however, the remaining require surgical intervention.[1]

Surgical management strategies for proximal humeral fracture may include the placement of an intramedullary

[a] Clinician, Department of Physical Therapy, Hospital Universitario Gregorio Marañón, Madrid, Spain.

[b] Professor, Cátedra de Investigación y Docencia en Fisioterapia: Terapia Manual y Punción Seca, Universidad Rey Juan Carlos, Alcorcón, Madrid, Spain.

[c] Professor, Department of Physical Therapy, Universidad Complutense de Madrid, Madrid, Spain.

[d] Professor, Department of Physical Therapy, Rehabilitation Services, Concord Hospital, Concord, NH.

[e] Professor, Department of Physical Therapy, Occupational Therapy, Physical Medicine and Rehabilitation of Universidad Rey Juan Carlos, Alcorcón, Madrid, Spain.

Submit requests for reprints to: César Fernández-de-las-Peñas, Departamento de Fisioterapia, Facultad de Ciencias de la Salud, Universidad Rey Juan Carlos, Avenida de Atenas s/n, 28922 Alcorcón, Madrid, Spain.

(e-mail: *cesar.fernandez@urjc.es*, *cesarfdlp@yahoo.es*).

Paper submitted May 21, 2014; in revised form October 16, 2014; accepted November 14, 2014.

0161-4754

http://dx.doi.org/10.1016/j.jmpt.2014.11.007

rod, shoulder arthroplasty, and, more recently, a Proximal Humeral Internal Locking System plate (PHILOS) has been used, which allows for angled stabilization and is attached with surgical screws.[6] Some studies have investigated the clinical results of a surgical intervention using the PHILOS plate after posthumeral fracture; however, not all individuals exhibit good outcomes, and most required postsurgical rehabilitation programs.[7,8]

A recent Cochrane systematic review found that immediate physical therapy resulted in better pain reduction and recovery compared with a group that began physical therapy after 3 weeks in patients with nondisplaced fractures.[9] In our anecdotal clinical experience, patients are usually referred to physical therapy postproximal humeral head fracture and surgical fixation using the PHILOS plate. However, none of the authors of this manuscript or the Cochrane Collaboration[9] could identify any published studies comparing the effects of various physical therapy interventions after such a procedure. Although no studies have examined the effects of physical therapy after surgery in this population, it is well known that many interventions are beneficial for the management of patients with general shoulder pain and function.

Another common surgical treatment used for the management of shoulder pain, particularly shoulder impingement, is a rotator cuff repair.[10] Rotator cuff repairs have an incidence ranging from 2.6 to 4.7 per 100 000 habitants[11,12] with an increase of 235% in the last decade.[13] Similar to a fracture repair with PHILOS surgical plate, rehabilitation programs are needed after rotator cuff repair surgery.[14] A Cochrane review found that physical therapy programs including mobilization combined with exercise are beneficial in the management of individuals with rotator cuff disease.[15] However, it also notes that more research is needed. More recent reviews concluded that there is no consensus for the optimal protocol for rotator cuff postsurgery rehabilitation.[16,17]

Because of either surgical procedure, soft tissues surrounding the shoulder area can be damaged. Surgery can be 1 potential mechanism for developing myofascial trigger points (TrPs).[18] Trigger points comprise hypersensitive spots in taut bands of skeletal muscles painful on stimulation and elicit a referred pain.[19] If they are active, TrPs cause spontaneous pain, and the elicited referred pain reproduces the symptoms experienced by patients. If they are latent, TrPs do not cause spontaneous symptoms, and the elicited referred pain reproduces none of the patient's symptoms.[19] We do not know the contribution of referred pain elicited by myofascial TrPs in postoperative shoulder pain and how early and management of the muscle TrPs would influence the clinical outcomes of these patients.

Using TrP dry needling (TrP-DN) has gained popularity in physical therapist practice for the management of several chronic pain conditions.[20,21] Recent evidence supporting the use of TrP-DN in various patient populations has increased. A recent meta-analysis by Kietrys et al[22] found that there is evidence for the effectiveness of TrP-DN for individuals with upper quadrant pain syndromes. However, it is not known if similar results would occur for patients' status postsurgical fixation of humeral fractures using the PHILOS plate or rotator cuff tear repair.

Early rehabilitation is usually claimed after shoulder surgery for preventing postoperative pain and stiffness; however, scientific evidence is conflicting.[23] The presence of active muscle TrPs in individuals with postoperative shoulder pain may delay proper rehabilitation outcomes in postoperative patients. Potentially, TrP-DN could help for better outcomes at the beginning of the therapeutic process and therefore lead to faster recovery.[24] Therefore, the purpose of this clinical trial was to compare the effects of including 1 session of TrP-DN in the first week of a multimodal physical therapy treatment on pain and function in individuals who experienced postoperative shoulder pain after a PHILOS procedure for proximal humeral fixation or rotator cuff tear repair to a group that did not receive TrP-DN. We hypothesized that individuals receiving TrP-DN into their first sessions of postsurgery rehabilitation program would exhibit greater improvements in pain and function than those patients receiving only conventional postsurgery physical therapy.

Methods

Participants

A randomized clinical trial was conducted (trial registered at ClinicalTrials.gov, NCT02122315). Patients with postoperative shoulder pain presenting to rehabilitation from September 2012 to March 2013 were eligible to participate in the study. Patients with proximal humeral fracture who underwent open reduction and internal fixation with PHILOS plate (Synthes, Switzerland) or with rotator cuff tear who underwent surgical repair were evaluated for eligibility criteria. All patients should experience their first attack of shoulder pain after the surgery and were naive to any treatment for postoperative shoulder pain. They were excluded if they exhibited any of the following: (1) no active TrPs were found; (2) multiple fractures; (3) previous surgery; (4) cervical radiculopathy/myelopathy; (5) diagnosis of fibromyalgia[25]; (6) having undergone any physical therapy intervention in the year before the shoulder surgery; (7) fear of needles; or (8) contraindication for DN, for example, anticoagulants or psychiatric disorders. The study protocol was approved by the local Human Research Committee of the Hospital General Universitario Gregorio Marañon (Madrid, Spain). All subjects signed an informed consent before inclusion in the study.

Trigger Point Diagnosis

Trigger point diagnosis was determined when all the following criteria were present[19]: (1) presence of a hypersensitive spot in a palpable taut band, (2) palpable

or visible local twitch on snapping palpation; or (3) reproduction of referred pain elicited by palpation of the sensitive spot. These criteria have been shown to exhibit good interexaminer reliability (κ, 0.84-0.88), when applied by an experienced clinician.[26] Trigger points were active, when the referred pain elicited by their palpation reproduced the neck symptoms, and the patients recognized the pain as their familiar symptoms.[19]

Subjects were examined for active TrPs in the upper trapezius, infraspinatus, supraspinatus, and medium deltoid muscles by a clinician with more than 10 years of experience in the management of TrPs.[27]

Outcome Measures

The main outcome measure for this study was the Constant-Murley score, which includes both self-rated and performance-based components.[28] It was assessed before and 1 week after the intervention by an assessor blinded to the treatment allocation group in a standardized fashion.[29]

The Constant-Murley score is a 100-point scoring system divided into 4 main subscales: pain (15 points), activities of daily living (20 points), range of motion (40 points), and strength (25 points). Higher score represents better function. The pain and activities of daily living subscales are self-reported by the patient. The pain score is graded as none, 15 points; mild, 10 points; moderate, 5 points; and severe, 0 point. The activities of daily living score are divided into sleep problems (2 points), work and recreational activities (4 points each), and ability to position hand in space (10 points).[28] Range of motion is evaluated as active pain-free elevation in the flexion, abduction, external, and internal rotation of the shoulder (10 points each). Shoulder flexion and abduction are measured in a seated position with a goniometer. Scoring for shoulder flexion and abduction is 0° to 30°, 0 points; 31° to 60°, 2 points; 61° to 90°, 4 points; 91° to 120°, 6 points; 121° to 150°, 8 points; and 151° to 180°, 10 points.[28] Shoulder external rotation is evaluated by assigning 2 points for each of the following separate unassisted maneuvers: (1) hand to the back of the head with the elbow forward; (2) hand to the back of the head with the elbow back; (3) hand to the top of the head with the elbow forward, and (4) hand to the top of the head with the elbow back.[27] Shoulder internal rotation is measured during unassisted movement by the thumb as a pointer, behind the buttock, 2 points; behind the sacroiliac joint, 4 points; behind the waist, 6 points; behind T12, 8 points; and interscapular, 10 points.[28] Finally, strength testing was measured at 90° of abduction in the scapular plane and the forearm in pronation using a dynamometer. The score given for normal strength is 25 points because a healthy man resists 25 pounds. Strength is scored as the maximum of 3 repetitions. Patients who cannot achieve the test position of 90° of abduction are assigned a score of 0.[28]

The Constant-Murley score has exhibited good psychometric properties because it correlates strongly (>0.70) with shoulder-specific questionnaires, had excellent intratester ($0.94 < r < 0.96$) and intertester ($0.89 < r < 0.91$) reliability, and is responsive (effect sizes and standardized response mean, >0.8) for detecting clinical improvements after intervention in subjects with different shoulder pathologies.[30] However, there are no current data that state the minimal clinically important difference for the Constant score. Clinical practice considers a change of approximately 15 points to be clinically important.

Randomization

After the baseline examination, patients were randomly assigned to the physical therapy plus TrP-DN or physical therapy group. Concealed allocation was performed using a computer-generated randomized table of numbers created before the start of data collection by a researcher not involved in the recruitment and/or treatment of patients. Individual and sequentially numbered index cards with the random assignment were prepared. The index cards were folded and placed in sealed opaque envelopes. A second therapist, blinded to baseline examination findings, opened the envelope and proceeded with treatment according to the group assignment.

Both groups were treated by a clinician with more than 10 years of experience in the management of postoperative shoulder pain. All participants attended a physical therapy clinic daily for 1 week (5 sessions). Patients were unaware of the objective of the study because they were aware of the ethical implications without revealing the real intervention being evaluated. All subjects were informed of the true nature of the study at the end of the trial.

Intervention

The rehabilitation process of a patient after shoulder surgery should time biological healing of the repaired tissues according to surgical intervention[31] and usually requires longer periods of treatment including daily sessions. Therefore, in the current study, we investigated the inclusion of early TrP-DN into the common daily clinical practice in patients who experienced their first attack of pain after the surgery.

Both groups received 5 sessions of best evidence physical therapy intervention for postoperative shoulder rehabilitation. All participants received passive mobilization interventions of the glenohumeral (Fig 1) and scapular (Fig 2) regions, soft tissue massage of the shoulder muscles (Fig 3), and scar tissue mobilization (Fig 4) on a daily basis. Within the last 2 sessions, patients started with pain-free proprioceptive and strengthening exercises of the shoulder musculature.[32]

Trigger Point Dry Needling

Trigger point dry needling was applied once within the first treatment session into those active TrPs found within the examined muscles by a clinician with more than 8 years

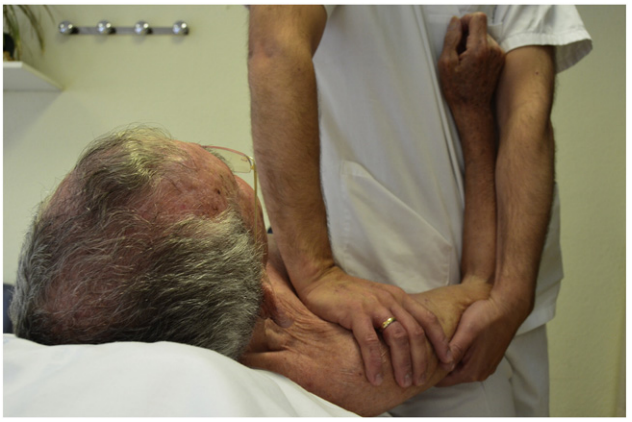

Fig 1. *Passive mobilization intervention of the glenohumeral joint. (Color version of figure is available online.)*

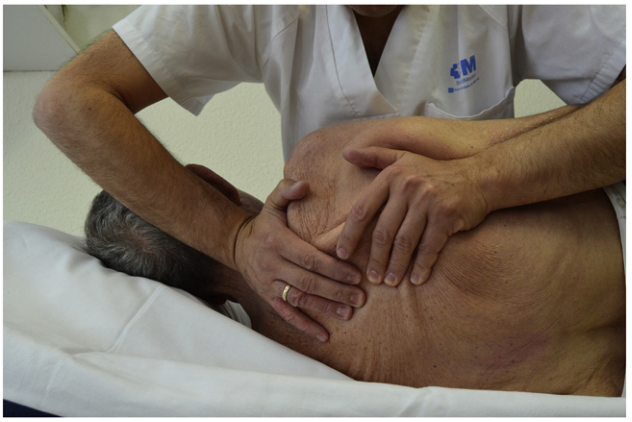

Fig 2. *Passive mobilization intervention of the scapula bone. (Color version of figure is available online.)*

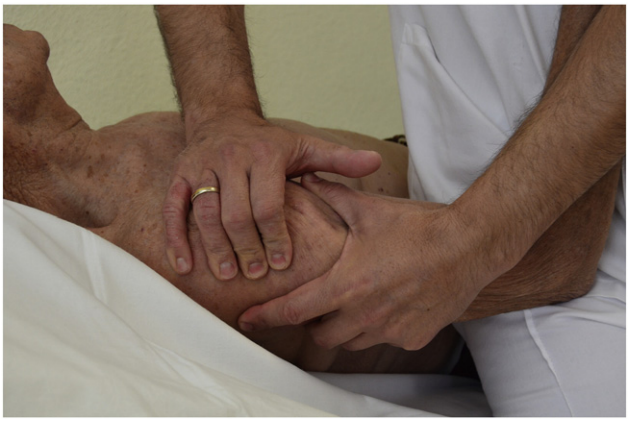

Fig 3. *Soft tissue massage of the deltoid muscle. (Color version of figure is available online.)*

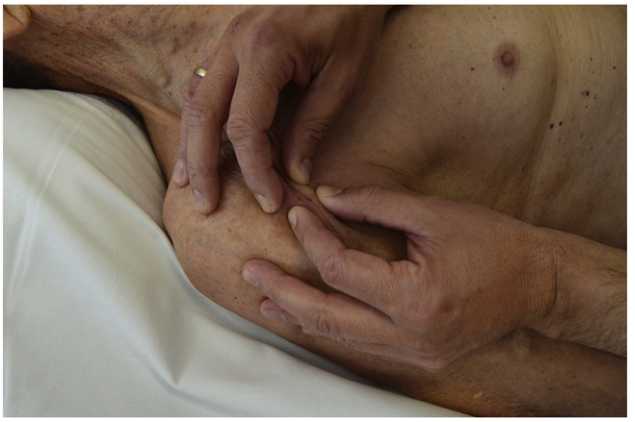

Fig 4. *Scar tissue mobilization. (Color version of figure is available online.)*

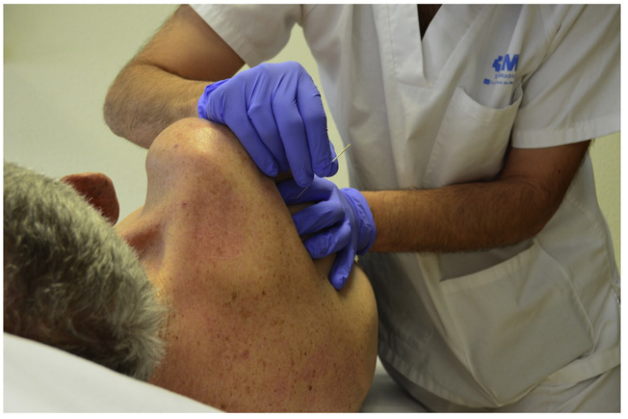

Fig 5. *Trigger point dry needling applied over active TrPs in the infraspinatus muscle. (Color version of figure is available online.)*

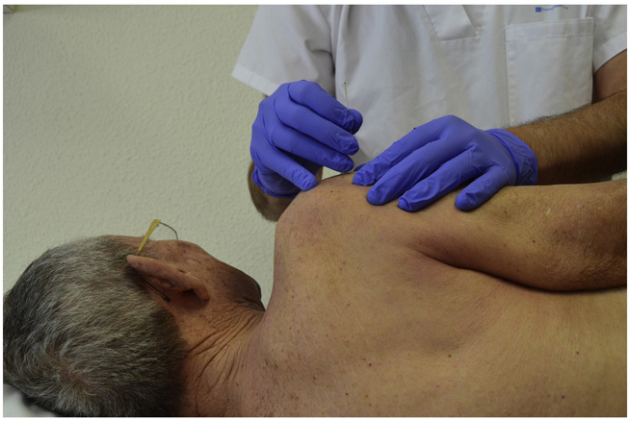

Fig 6. *Trigger point dry needling applied over active TrPs in the medium deltoid muscle. (Color version of figure is available online.)*

Participants received TrP-DN with disposable stainless steel needles (0.3 × 30 mm, Novasan, Madrid, Spain) that were inserted into the skin over the TrP area. In this study, the fast-in and fast-out technique described by Hong[33] was applied. Once the active TrP was located, the overlying skin was cleaned with alcohol. The needle was inserted, penetrating the skin 10 to 15 mm into the TrP, until the first local twitch of experience in TrPs management with this technique.

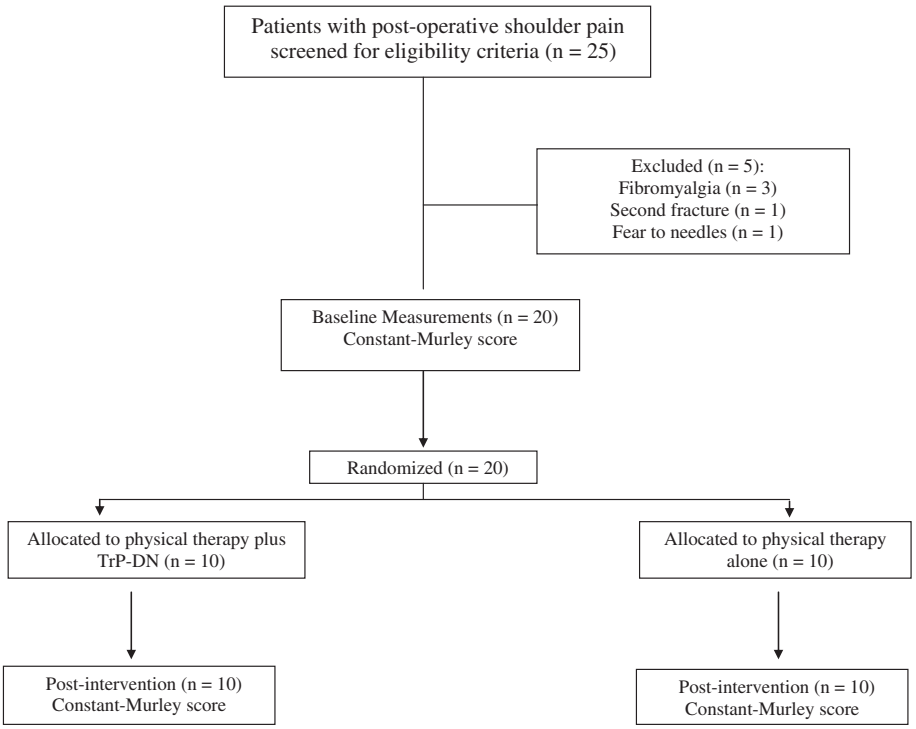

Fig 7. *Flow diagram of patients throughout the course of the study. TrP-DN, trigger point dry needling.*

response was obtained (Figs 5 and 6). Local twitch responses should be elicited during TrP-DN for a proper and successful technique.[33] Once the first local twitch response was obtained, the needle was moved up and down (2-3 mm vertical motions with no rotations) at approximately 1 Hz for 25 to 30 seconds. Because subjects with postoperative shoulder pain could exhibit active TrPs in multiple muscles, we decided not to apply TrP-DN on over 3 muscles in the single session.

Treatment Side Effects

Patients were asked to report any adverse event they experienced after either intervention or during the follow-up period. In this study, an *adverse event* was defined as sequelae of medium term in duration with any symptom perceived as distressing and unacceptable to the patient and requiring further treatment.[34] Adverse effects were self-reported by the patients and collected by a clinician not involved in the study. Because TrP-DN sometimes induces posttreatment soreness, subjects were advised to report any increase in their symptoms after this procedure.

Statistical Analysis

Statistical analysis was conducted with the SPSS 18.0 package (SPSS, Chicago, IL). Mean, SDs, or 95% confidence intervals (CIs) were calculated. The Kolmogorov-Smirnov test showed a normal distribution of quantitative data ($P > .05$). Differences within baseline demographic variables were compared between both groups using independent Student *t* tests for continuous data and χ^2 tests of independence for categorical data. Separate 2 × 2 repeated-measures analysis of variance with time (baseline and posttreatment) as within-subject variable and group (TrP-DN or physical therapy) as the between-subject variable were used to examine the effects of interventions on the total Constant-Murley score and the score on each domain (pain, activities of daily living, range of motion, and strength). The main hypothesis of interest was the group × time interaction. To enable comparison of effect sizes, standardized mean differences (SMDs) were calculated by dividing mean score differences between TrP-DN and the comparison (physical therapy) groups by the pooled SD. *P* values lower than 0.05 were considered as statistically significant for all analyses.

Results

Twenty-five consecutive patients with postoperative shoulder pain were screened for eligibility criteria. Twenty patients, aged 51 to 64 years (mean ± SD, 58 ± 3 years; 75% female) satisfied the eligibility criteria, agreed to participate, and were randomized into physical therapy alone (n = 10) or physical therapy plus TrP-DN (n = 10). The reasons for ineligibility can be found in Figure 7, which provides a flow diagram of patient recruitment and retention. Baseline features between both groups were similar for all variables (Table 1).

Table 1. *Baseline Demographics for Both Groups*

	Physical Therapy + DN Group	Physical Therapy Group
Clinical features		
Sex (male/female)	3/7	2/8
Age (y)	58 ± 15	57 ± 11
Height (cm)	162 ± 12	161 ± 7
Weight (kg)	73 ± 7	77 ± 8
Months with pain after surgery	5.8 ± 5.2	5.4 ± 8.5
Affected side (right/left)	7/3	6/4
Type of surgery (PHILOS/rotator repair)	8/2	7/3
Constant-Murley score		
Pain subscale (0-15)	6.0 ± 3.9	5.0 ± 4.1
Activities of daily living subscale (0-20)	8.0 ± 1.6	8.3 ± 1.3
Range of motion subscale (0-40)	11.0 ± 3.1	11.8 ± 2.9
Strength subscale (0-25)	4.5 ± 3.7	5.5 ± 3.6
Total score (0-100)	29.5 ± 6.7	30.6 ± 5.6

DN, dry needling; *PHILOS*, proximal humeral internal locking system.

The 2 × 2 mixed model analysis of variance revealed a significant group × time interaction for the Constant-Murley total score ($F = 15.887$, $P < .001$) and activities of daily living ($F = 21.260$, $P < .001$) and strength ($F = 6.688$, $P = .019$) subscale: patients receiving TrP-DN plus physical therapy experienced greater improvements in the total score and these 2 subscales than those receiving physical therapy alone (Table 2). Between-group effect sizes were large ($0.97 < SMD < 1.45$) in favor of the TrP-DN plus physical therapy group.

No statistically significant group × time interaction for pain ($F = 2.598$, $P = .124$) and range of motion ($F = 3.358$, $P = .083$) subscales was observed, but there was a main effect for time with both groups experiencing similar improvements in pain ($F = 15.323$, $P < .001$) and range of motion ($F = 25.80$, $P < .001$). Within-group effect sizes were large for both groups (SMD, >2.1), and between-group effect sizes were medium (SMD, <0.51) Table 2 provides before and after intervention and within-group and between-group differences with their associated 95% CI for the total score and all subscales of the Constant-Murley total score.

In our study, 6 patients assigned to the TrP-DN + physical therapy group (60%) experienced muscle soreness after treatment but experienced no increase in their symptoms. Trigger point dry needling posttreatment soreness resolved spontaneously within 24 to 36 hours with no intervention.

Discussion

The results of this randomized clinical trial suggest that including a single session of TrP-DN into the first session of a multimodal physical therapy treatment approach may assist for faster improving in the outcomes in patients with postoperative shoulder pain who have received open reduction and internal fixation with PHILOS plate or rotator cuff tear surgical repair.

It is common knowledge that individuals often experience postoperative chronic pain.[35] The transition from acute to chronic pain is likely associated with alterations in nociceptive pain modulation. A recent study found that central sensitization, specifically, temporal summation of suprathreshold heat pain responses, is predictive of postoperative pain and disability in individuals with shoulder pain.[36] Therefore, it would be essential to identify therapeutic methods to minimize the impact of central sensitization on pain and function in this population.

To date, the mechanisms regarding the physiologic effects of TrP-DN remain to be elucidated. However, there is speculation that TrP-DN might include both segmental and central involvement.[37,38] Trigger point dry needling posttreatment has shown to reduce the calcitonin gene–related peptide and substance P in TrPs.[39] Furthermore, stimulation of the Aδ fibers, which activate noradrenergic inhibitory systems, may be also stimulated with TrP-DN.[40] In addition, it is also plausible that TrP-DN might increase microcirculation reducing chemical mediators.[41] Despite the mechanism in action, we have identified that adding a single session of TrP-DN into the first session of a multimodal physical therapy program results in greater improvements in function when compared with physical therapy alone in patients with postoperative shoulder pain.

Different systematic reviews suggested that manual physical therapy (including joint mobilization) plus exercise results in improved outcomes in patients with shoulder pain.[15-17] None had identified TrP-DN as an effective intervention for shoulder pain, not because there was evidence against it, but, rather, there was a lack of studies on the topic. The current study is the first one investigating the additional benefit of a single session of TrP-DN to a multimodal therapy approach including mobilization interventions and exercise for the management of postoperative shoulder pain.

Physical therapy practice using multimodal approaches falls within clinical practice. One recent approach appears to be the combination of manual therapy (joint mobilization and manipulation) with TrP-DN. A case series by González-Iglesias et al[42] described the outcomes of 9 rock climbers with lateral epicondylalgia who were treated with manual therapy directed at the cervical spine, elbow, and wrist combined with TrP-DN of the wrist extensor muscles. All patients in the case series experienced significant and clinically meaningful improvements in function and pain pressure thresholds after the multimodal intervention and at a 2-month follow-up. In a more recent case series,[43] after treatment including the combination of manual therapy and TrP-DN, 15 patients with temporomandibular pain experienced significant and clinically important reduction in pain and improvements in function

Table 2. *Baseline, Final Treatment Session, and Change Scores for the Constant-Murley Score*

Outcome Group	Baseline	End of Treatment	Within-Group Change Scores	Between-Group Difference in Change Scores
Pain subscale (0-15)				
Physical therapy + TrP-DN	6.0 ± 3.9	10.8 ± 2.7	4.8 ± 4.2	2.8 (0.8, 4.8)
Physical therapy	5.0 ± 4.1	7.0 ± 2.6	2.0 ± 3.5	
Activities of daily living subscale (0-20) [a]				
Physical therapy + TrP-DN	8.0 ± 1.6	15.5 ± 1.1	7.5 ± 1.8	3.3 (1.8, 5.7)
Physical therapy	8.3 ± 1.3	12.5 ± 1.7	4.2 ± 1.1	
Range of motion subscale (0-40)				
Physical therapy + TrP-DN	11.0 ± 3.1	20.2 ± 2.0	9.2 ± 2.1	2.0 (0.2, 3.8)
Physical therapy	11.8 ± 2.9	19.0 ± 2.7	7.2 ± 2.7	
Strength subscale (0-25) [a]				
Physical therapy + TrP-DN	4.5 ± 3.7	11.5 ± 4.8	7.0 ± 4.2	4.5 (0.8, 8.2)
Physical therapy	5.5 ± 3.6	8.0 ± 4.9	2.5 ± 3.5	
Constant-Murley score total score (0-100) [a]				
Physical therapy + TrP-DN	29.5 ± 6.7	58.0 ± 8.1	28.5 ± 8.9	12.6 (5.9, 19.2)
Physical therapy	30.6 ± 5.6	46.5 ± 7.8	15.9 ± 4.8	

TrP-DN, trigger point dry needling.
Values are expressed as mean ± SD for baseline and final means and as mean (95% CI) for within- and between-group change scores (higher values indicate greater function and lower levels of pain).
[a] Statistically significant Group × Time interaction ($P < 0.05$).

and range of motion. However, future randomized clinical trials are needed to truly determine the effects of a multimodal program including manual therapies and TrP-DN.

There are several limitations to the current study that should be considered. First, the sample size was small. Second, we only collected data after applying 5 consecutive treatments and 1 week after the last intervention. Future studies including a larger sample size and longer follow-up periods are now needed. Third, there was no control group; therefore, we cannot be certain if all the improvements observed in both groups can be attributed to the passage of time; however, this is unlikely because our patients exhibited pain from 5 months before the start of the intervention. Because all patients were naive related to any therapeutic approach for their postoperative shoulder pain, it is probably that the improvements were related to the interventions. It would be useful for future trials to include a control or placebo group. Finally, the same clinician treated all patients on each group respectively, which might limit the generalizability of the results.

Conclusion

Current results suggest that including a single session of TrP-DN in the first week of a multimodal physical therapy approach may assist with faster increasing in function in individuals with postoperative shoulder pain who had received open reduction and internal fixation with PHILOS plate or rotator cuff tear repair. Future trials with long-term follow-ups are needed to examine the effects of TrP-DN in the chronic stage of postoperative shoulder pain.

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

Practical Applications

- This study suggests that the inclusion of a single session of TrP-DN in the first week of a multimodal physical therapy approach may assist with faster increasing in function in individuals with postoperative shoulder pain.
- Patients with postoperative shoulder pain who received DN experienced higher improvement in function and range of motion than those who did not received DN.
- Future studies should determine the long-term effects of the inclusion of TrP-DN into multimodal treatments.

References

1. Lind T, Krøner K, Jensen J. The epidemiology of fractures of the proximal humerus. Arch Orthop Trauma Surg 1989;108:285-7.
2. Nayak NK, Schickendantz MS, Regan WD, Hawkins RJ. Operative treatment of nonunion of surgical neck fractures of the humerus. Clin Orthop Relat Res 1995;313:200-5.
3. Volgas DA, Stannard JP, Alonso JE. Nonunions of the humerus. Clin Orthop Relat Res 2004;419:46-50.
4. Kannus P, Palvanen M, Niemi S, Parkkari J, Järvinen M, Vuori I. Osteoporotic fractures of the proximal humerus in elderly Finnish persons: sharp increase in 1970-1998 and alarming projections for the new millennium. Acta Orthop Scand 2000;71:465-70.
5. Giannoudis PV, Xypnitos FN, Dimitriou R, Manidakis N, Hackney R. Internal fixation of proximal humeral fractures using the Polarus intramedullary nail: our institutional experience and review of the literature. J Orthop Surg Res 2012;7:39.
6. Charalambous CP, Siddique I, Valluripalli K, Kovacevic M, Panose P, Srinivasan M, Marynissen H. Proximal humeral internal locking system (PHILOS) for the treatment of proximal humeral fractures. Arch Orthop Trauma Surg 2007;127:205-10.
7. Korkmaz MF, Aksu N, Göğüş A, Debre M, Kara AN, Işiklar ZU. The results of internal fixation of proximal humeral fractures with the PHILOS locking plate. Acta Orthop Traumatol Turc 2008;42:97-105.
8. Geiger EV, Maier M, Kelm A, Wutzler S, Seebach C, Marzi I. Functional outcome and complications following PHILOS plate fixation in proximal humeral fractures. Acta Orthop Traumatol Turc 2010;44:1-6.
9. Handoll HH, Ollivere BJ, Rollins KE. Interventions for treating proximal humeral fractures in adults. Cochrane Database Syst Rev 2012;12:CD000434.
10. Jain NB, Higgins LD, Losina E, Collins J, Blazar PE, Katz JN. Epidemiology of musculoskeletal upper extremity ambulatory surgery in the United States. BMC Musculoskelet Disord 2014;15:4.
11. Judge A, Murphy RJ, Maxwell R, Arden NK, Carr AJ. Temporal trends and geographical variation in the use of subacromial decompression and rotator cuff repair of the shoulder in England. Bone Joint J 2014;96B:70-4.
12. Tashjian RZ. Epidemiology, natural history, and indications for treatment of rotator cuff tears. Clin Sports Med 2012;31:589-604.
13. Ensor KL, Kwon YW, Dibeneditto MR, Zuckerman JD, Rokito AS. The rising incidence of rotator cuff repairs. J Shoulder Elbow Surg 2013;22:1628-32.
14. Ross D, Maerz T, Lynch J, Norris S, Baker K, Anderson K. Rehabilitation following arthroscopic rotator cuff repair: a review of current literature. J Am Acad Orthop Surg 2014;22:1-9.
15. Green S, Buchbinder R, Hetrick S. Physiotherapy interventions for shoulder pain. Cochrane Database Syst Rev 2003;2:CD004258.
16. Baumgarten KM, Vidal AF, Wright RW. Rotator cuff repair rehabilitation: a level I and II systematic review. Sports Health 2009;1:125-30.
17. Huisstede BM, Koes BW, Gebremariam L, Keijsers E, Verhaar JA. Current evidence for effectiveness of interventions to treat rotator cuff tears. Man Ther 2011;16:217-30.
18. Simons DG. Review of enigmatic MTrPs as a common cause of enigmatic musculoskeletal pain and dysfunction. J Electromyogr Kinesiol 2004;14:95-107.
19. Simons DG, Travell J, Simons LS. Myofascial pain and dysfunction. The trigger point manual, 2nd edition, volume 1. Baltimore: Williams & Wilkins; 1999.
20. Dommerholt J, Mayoral O, Gröbli C. Trigger point dry needling. J Man Manipulative Ther 2006;14:E70-87.
21. Dommerholt J, Fernandez-de-las Peñas C. Trigger point dry needling: an evidence and clinical-based approach. 1st ed. London: Churchill Livingstone: Elsevier; 2013.
22. Kietrys DM, Palombaro KM, Azzaretto E, Hubler R, Schaller B, Schlussel JM, Tucker M. Effectiveness of dry needling for upper quarter myofascial pain: a systematic review and meta-analysis. J Orthop Sports Phys Ther 2013;43:620-34.
23. Kim YS, Chung SW, Kim JY, Ok JH, Park I, Oh JH. Is early passive motion exercise necessary after arthroscopic rotator cuff repair? Am J Sports Med 2012;40:815-21.
24. Mejuto-Vázquez MJ, Salom-Moreno J, Ortega-Santiago R, Truyols-Domínguez S, Fernández-de-Las-Peñas C. Short-term changes in neck pain, widespread pressure pain sensitivity, and cervical range of motion after the application of trigger point dry needling in patients with acute mechanical neck pain: a randomized clinical trial. J Orthop Sports Phys Ther 2014;44:252-60.
25. Wolfe F, Smythe HA, Yunus MB, Bennett RM, Bombardier C, Goldenberg DL, et al. The American College of Rheumatology 1990 criteria for classification of fibromyalgia: report of the multi-center criteria committee. Arthritis Rheum 1990;33:160-70.
26. Gerwin RD, Shanon S, Hong CZ, Hubbard D, Gevirtz R. Interrater reliability in myofascial trigger point examination. Pain 1997;69:65-7.
27. Bron C, Dommerholt J, Stegenga B, Wensing M, Oostendorp R. High prevalence of shoulder girdle muscles with myofascial trigger points in patients with shoulder pain. BMC Musculoskelet Disord 2011;12:139.
28. Constant CR, Murley A. A clinical method of functional assessment of the shoulder. Clin Orthop Relat Res 1987;160–4.
29. Blonna D, Scelsi M, Marini E, et al. Can we improve the reliability of the Constant-Murley score? J Shoulder Elbow Surg 2012;21:4-12.
30. Roy JS, MacDermid JC, Woodhouse LJ. A systematic review of the psychometric properties of the Constant-Murley score. J Shoulder Elbow Surg 2010;19:157-64.
31. Ross D, Maerz T, Lynch J, Norris S, Baker K, Anderson K. Rehabilitation following following arthroscopic rotator cuff repair: a review of current literature. J Am Acad Orthop Surg 2014;22:1-9.
32. Conti M, Garofalo R, Delle Rose G, Massazza G, Vinci E, Randelli M, Castagna A. Post-operative rehabilitation

after surgical repair of the rotator cuff. Chir Organi Mov 2009; 93:S55-63.
33. Hong CZ. Lidocaine injection versus dry needling to myofascial trigger point: the importance of the local twitch response. Am J Phys Med Rehabil 1994;73:256-63.
34. Carlesso LC, Macdermid JC, Santaguida LP. Standardization of adverse event terminology and reporting in orthopaedic physical therapy: application to the cervical spine. J Orthop Sports Phys Ther 2010;40:455-63.
35. Macrae WA. Chronic post-surgical pain: 10 years on. Br J Anaesth 2008;101:77-86.
36. Valencia C, Fillingim RB, Bishop M, Wu SS, Wright TW, Moser M, et al. Investigation of central pain processing in post-operative shoulder pain and disability. Clin J Pain 2014;30:775-86.
37. Hsieh YL, Yang SA, Yang CC, Chou LW. Dry needling at myofascial trigger spots of rabbit skeletal muscles modulates the biochemicals associated with pain, inflammation, and hypoxia. Evid Based Complement Alternat Med 2012;2012:342165.
38. Cagnie B, Dewitte V, Barbe T, Timmermans F, Delrue N, Meeus M. Physiologic effects of dry needling. Curr Pain Headache Rep 2013;17:348.
39. Shah JP, Danoff JV, Desai MJ, Parikh S, Nakamura LY, Phillips TM, Gerber LH, et al. Biochemicals associated with pain and inflammation are elevated in sites near to and remote from active myofascial trigger points. Arch Phys Med Rehabil 2008;89:16-23.
40. Baldry PE. Acupuncture, trigger points and musculoskeletal pain. Edinburgh: Churchill Livingstone; 2005.
41. Cagnie B, Barbe T, De Ridder E, Van Oosterwijck J, Cools A, Danneels L. The influence of dry needling of the trapezius muscle on muscle blood flow and oxygenation. J Manipulative Physiol Ther 2012;35:685-91.
42. González-Iglesias J, Cleland JA, del Rosario Gutierrez-Vega M, Fernández-de-las-Peñas C. Multimodal management of lateral epicondylalgia in rock climbers: a prospective case series. J Manipulative Physiol Ther 2011;34:635-42.
43. González-Iglesias J, Cleland JA, Neto F, Hall T, Fernández-de-las-Peñas C. Mobilization with movement, thoracic spine manipulation, and dry needling for the management of temporomandibular disorder: a prospective case series. Physiother Theory Pract 2013;29:586-95.