CONTRIBUTION OF DRY NEEDLING TO INDIVIDUALIZED PHYSICAL THERAPY TREATMENT OF SHOULDER PAIN: A RANDOMIZED CLINICAL TRIAL.

AUTHORS Sara Pérez-Palomares. PT. [1, 2, 3]
Bárbara Oliván-Blázquez. PhD. [3, 4, 5]
Ana Pérez-Palomares, PhD. [6]
Elena Gaspar-Calvo. PT [1, 3]
Elena López-Lapeña. PT [1, 3]
Marina Pérez-Benito. PT. [1, 3]
De la Torre- Beldarraín ML. PT. [1, 3]
Rosa Magallon-Botaya. Phd. [1, 3,5,7]

1. Primary Care Aragones Health Service (Spain).
2. University San Jorge. Faculty of Health Science. Zaragoza (Spain).
3. Health Research Institute IIS Aragon (Spain).
4. Department of Psychology and Sociology. University of Zaragoza, Spain.
5. Preventative Activities and Health Promotion Network (REDIAPP) (RD06/0018), Health Institute Carlos III (Spain).
6. Department of Statistical Methods. University of Zaragoza, Spain.
7. Department of Medicine and Psychiatry. University of Zaragoza, Spain.

Corresponding author:
Bárbara Oliván-Blázquez
Department of Psychology and Sociology.
University of Zaragoza.
Violante de Hungria 23.
50.009 Zaragoza, Spain
Phone: 34 976 761000 ext 4547
Fax: 34 976 254006
Mail: barbaraolivan@gmail.com

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ABSTRACT

STUDY DESIGN: Multi-center, parallel randomized clinical trial.

BACKGROUND: Myofascial trigger points (MTrP) are implicated in shoulder pain and functional limitations. An intervention intended to treat MTrP is dry needling (DN).

OBJECTIVES: To investigate the effectiveness of dry needling in addition to evidence-based personalized physical therapy treatment in the treatment of shoulder pain.

METHODS AND MEASURES: 120 patients with non-specific shoulder pain were randomly allocated into two parallel groups: 1) personalized, evidence-based physiotherapy treatment; and 2) trigger point dry needling in addition to personalized evidence-based physiotherapy treatment. Patients were assessed at baseline, post-treatment and 3 months follow-up. The primary outcome measure was the pain assessed by visual analog scale (VAS-pain) at 3 months, and secondary variables were joint range-of-motion limitations, Constant-Murley Score for pain and function, and number of active MTrPs. Clinical efficacy was assessed using intention-to-treat analysis.

RESULTS: Of the 120 enrolled patients, 63 were randomly assigned to the control group and 57 to the intervention group. There were no significant differences in outcome between the two treatment groups. Both groups showed improvement over time.

CONCLUSION: Dry needling does not offer benefits in addition to personalized evidence-based physiotherapy treatment for patients with non-specific shoulder pain.

TRIAL REGISTRATION: Retrospectively registered 2009, ISRCTN30907460

LEVEL OF EVIDENCE: Therapy, level 2b

KEY WORDS: Myofascial trigger points, dry needling, personalized physical therapy treatment.

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CONTRIBUTION OF DRY NEEDLING IN PHYSICAL THERAPY TREATMENT OF SHOULDER PAIN: A RANDOMIZED CLINICAL TRIAL.

BACKGROUND

The prevalence of shoulder pain in primary care (PC) is quite high, with almost half of the general population consulting physicians at least once due to shoulder pain. [7,20] It is the third most common cause of musculoskeletal-related PC consultations.[46] Shoulder pain may continue for one year or more in 60% of cases[33] and in 65% of these cases, it requires regular pharmacological treatment over extended periods of time.[20] Extracapsular soft tissue is believed to be implicated in over 90% of shoulder pain.[16] The most prevalent extracapsular soft tissue lesions, both in active and non-active populations, are disorders of the rotator cuff[51] (RC) and related tissues[55] associated with subacromial impingement syndrome (SIS).[6,8,60]

Some studies[3,28] have suggested the existence of myofascial trigger points (MTrPs), as one of causal agents of shoulder pain and functional limitations. Despite the extensive literature on the role of trigger points[9,19,22,23,24,44,62,63] the appropriate diagnostic criteria[4] and, indeed, their very existence remain controversial.[52-53] As there is no confirmatory test to objectify their existence, the diagnosis is exclusively clinical.[62,65] Although there is not considerable knowledge regarding the specific mechanisms involved in the clinical phenomenon of trigger points, a trigger point is considered to be a hypersensitive spot in taut bands of skeletal muscle that is painful upon stimulation and that elicits a referred pain.[44,65]

There are diverse physiotherapeutic treatments available for the treatment of shoulder pain.[27] Some studies have highlighted the prevalence of MTrPs in different pathologies of shoulder.[3,5,28,31,34] Trigger point dry needling (DN) has become recognized as an intervention targeting the treatment of MTrPs.[26,44,50] The objective of the dry needling intervention (repeated needle insertion) is to deactivate (remove the peripheral source of their persistent nociceptive input) the trigger point via mechanical interruption as a region accumulating multiple sensitized nociceptors,[18] after initially causing a local twitch response.[61,65] Insertion of a needle in the skin and subcutaneous cell layer leads to responses provoked by the very needle insertion,[12] which activate pain control responses at the level of the posterior horn of the spinal cord[50] (also obtained by superficial needling,[1] another method described for the treatment of myofascial pain). Always assuming that a local twitch response is obtained,[32] the mechanical effect as therapy through a connective tissue remodeling, plasticity and decreasing of inflammatory mediators on the MTrP to interrupt its pathogenic mechanisms.[61] There is no evidence to suggest an increased effectiveness with the injection of substances such as local anesthetics in MTrP,[14] as compared to needling with no substance.[59] Clinical trials that have conducted on subjects with shoulder pain up until now, have used conservative techniques and compare the results with those from a control group of wait and see or placebo.[3,28]

The aim of this study was to investigate the effectiveness of DN in addition to personalized, evidence-based physiotherapy treatment versus personalized, evidence-based physiotherapy treatment alone in the treatment of non-specific shoulder pain.

METHODS

Design Overview:

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Multi-center, parallel randomized clinical trial with follow up at three months following treatment completion.

Patients were randomized into two parallel groups: A control group receiving personalized, evidence-based physiotherapy treatment and an intervention group receiving, in addition to personalized treatment, myofascial trigger point DN.

This study is a randomized clinical trial performed according to the Initiative on Methods, Measurement and Pain Assessment in Clinical Trials (IMMPACT),[21] which recommends the inclusion of a set of core outcome domains in clinical trials of pain treatments. The recommendations established by the Consolidated Standards of Reporting Trials (CONSORT) statement[10,47] for randomized controlled trials were also followed. The trail was retrospectively registered in February 2009 with the ISRCTN registry: ID number ISRCTN30907460. Participant recruitment took place from 10/2008 to 08/2010. The protocol of this study has previously been published.[49] Some modifications have been made to the protocol in terms of the number of sessions held in order for the treatment to be as similar as possible, to actual clinical practice carried out in physiotherapy departments of PC centers. There was also a slight decrease in sample size as compared to that published in the protocol, since this size was recalculated based on effectiveness studies with conservative techniques that were published after the publication of the original protocol.[5] Additional measures of outcome were also added.

Setting and Participants

Patients with shoulder pain who visited a general practitioner (GP) in any of 5 primary health care centers in Zaragoza, Spain, were recruited for inclusion in the study. Potential participants were informed and provided consent to participate in the study were considered eligible if they met the following selection criteria**:** age 18 or older; with non-specific shoulder pain considered by the GP to be consistent with RC tendinopathy or SIS; and keeping a range of movement above the 50% of full range (180º) of flexion, abduction or scapular plane elevation, that is, over 90º of range of motion.

Participants were included in the study according to the clinical symptoms that they presented, representing non-specific shoulder pain consistent with clinically suspected RC tendinopathy or SIS, however, 91% of the sample underwent a diagnostic imaging test (ultrasound) and 50% underwent a resonance magnetic image (MRI) in order to confirm the inclusion and exclusion criteria.

The exclusion criteria were the following: prior surgery for subacromial syndrome; disability, pain or sudden loss of strength after an injury that could suggest another condition; glenohumeral instability, symptoms that could indicate a systemic disease; impossibility of attending intervention sessions or refusal to participate; and any illnesses or circumstances that, in the researcher's judgment, could interfere with trial completion or cases in which inclusion in the study could be harmful to the patient.

Informed consent was obtained from participants before they were aware of their group assignment and before any assessment. Before giving their consent, patients were offered a general overview of the aims and characteristics of the study and interventions. They were informed that they would be participating voluntarily and that they could withdraw at any time with the guarantee that they would continue to receive the treatment considered most appropriate by their doctor. Data gathering involved no risks for the subjects participating in the study. A patient was considered to have withdrawn from the trial if he or

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she withdrew their informed consent, if the researcher felt that he or she should withdraw from the study for safety reasons or if the researcher felt it to be in the best interest of the patient.

The study was conducted in accordance with Helsinki Convention norms. The Study Protocol was approved by the Clinical Research Ethics Committee of Aragon (01/2008).

Role of the Funding Source

The study was funded by a grant from the Spanish government's Ministry of Health (Grand Number PI07/90924). The role of the financing source was to verify that the study was conducted as requested and in compliance with regulations for research and the obtaining of public funding as well as with legislation regarding ethical aspects in the study implementation.

Sample size

We calculated the sample size based on the clinically important improvement of VAS-pain of 1.5 points,[38] on a scale of 0-10, with a standard deviation of 2 points. Assuming a 95% confidence interval and power of 90%, the resulting sample size was 38 participants per group, for a total of 76 individuals. Based on previous studies, an attrition rate of 10% may be expected, therefore, the required number of patients for recruitment was 86. We aimed to exceed this sample size and recruiting 132 subjects (66 randomized in each treatment group) to ensure the reliability of the study.[49] The protocol did not include any interim analyses or stopping rules.

Randomization

Patients were admitted by general practitioners of the primary care centers and verification of the inclusion and exclusion criteria was carried out by physical therapists from the involved physical therapy units.

Each patient was assigned to one of the two groups using a computer-generated random number sequence with no restrictions. The information for the random allocation sequence was implemented by phone, from an independent researcher, who said the type of treatment assigned for each new patient. The sequence was concealed throughout the study. Group assignment was carried out by the independent researcher.

Due to the nature of the study, it was impossible to maintain the blinding on both sides (physical therapist and patient). All of the assessments were performed by an evaluator blinded to group allocation.

Interventions

The interventions were as follows:

Control group: All participants underwent a clinical examination process, by the treating physiotherapist beginning with a thorough background history, followed by a physical examination of the shoulder girdle[43,57,58] and shoulder joints.[37] All joints were manually assessed with active movements and with a translatory test according to Kaltenborn therapy[37]

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(Online Only Appendix 1). Personalized physiotherapy treatment based on the most appropriate manual therapy techniques, after physical evaluation of the patient. This consisted of manual therapy treatment based on articular gliding or restoration of the glenohumeral[37] and scapula-thoracic[43] translatory joint movement, stretching of the shortened periarticular muscle tissue directly or indirectly involved in the shoulder joint movement,[57,58] isometric exercises, exercises for proprioceptive re-education and scapular control,[43,48] range-of-motion stretching at home and postural recommendations for everyday activities[25,27,29,58] (Online Only Appendix 1). All of these therapies were applied in an individualized manner based on patient state.[40,41] Training sessions were held with the research group to standardize the protocol, as well a written procedural manual was used, where the applied techniques, the number of sessions and the content thereof were recorded (Online Only Appendix 1). Ten personalized physical therapy treatment sessions were conducted, consisting of 30 minutes per session and distributed twice weekly.

Treatment group: Participants assigned to this intervention group all received the physiotherapy treatment described above, as well as DN of active MTrPs identified by the treating physiotherapists in the participants' supraspinatus, infraspinatus, subscapularis (lateral, superior and inferior), teres minor, and deltoid (anterior, medial and posterior) muscles. Needling was performed using the Hong technique[32] ("fast-in, fast-off"), accompanied by the subsequent application of cold spray to diminish the post-needling pain sensation.[45,65] Acupuncture needles measuring 0.25 x 25 mm, 0.30 x 50 mm and 0.30 x 75 mm with guide tube were used**.** A total of three needling sessions were conducted, distributed over the 1st, 4th and 7th sessions respectively**,** in order to have eight days between each dry needling,[17] and needling the active MTrPs once in each session.

Outcomes and Measurements

Baseline assessment

Sociodemographic variables were collected at baseline (age, gender and occupation) as well as history of pain, timing of clinical evolution, background history, prior treatments, medication (drug type, time administered and evolution with medication).

Primary outcome variable

The primary outcome variable was patient-reported pain perception, assessed using the Pain Visual Analogical Scale (VAS-pain). The VAS-pain was designed to permit a thorough and understandable subjective assessment of pain. The visual analogue scale typically consists of a 10-cm horizontal line, with perpendicular lines on the edges, defined as the extreme limits of the pain experience. Anchor points at each edge are characterized by verbal expressions, such as ''no pain'' (accompanied by the number 0) at one end and ''maximum pain ever experienced'' (accompanied by the number 10) at the other end. Higher scores indicate greater pain**.** In the study, patients were asked to evaluate the overall pain that was the cause of their visit. The psychometric usefulness of VAS in pain measurement has been widely demonstrated.[64] Clinically important improvement of VAS-pain is considered to be 1.5 points.[38]

Secondary outcome variables

Secondary efficacy variables were: joint range-of-motion limitations, Constant-Murley Score for pain and function, and number of active MTrPs. They were measured as follows:

Active articular limitation of the glenohumeral joint in degrees, via digital inclinometers for flexion and abduction movements (AcumarTM Digital Inclinometer, © 2006 Lafayette Instrument Co). For internal and external rotation, the subscale from functional

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Constant-Murley Score measure was used to determine rotation based on functional movement (Online Only Appendix 1).

Functionality was measured with the Constant-Murley Score.[2,39] This test scores from 0 to 100 and includes subscales for subjective pain (0 to 15 points), everyday activities (from 0 to 20 points), and objective subscales on mobility (40 points) and strength (25 points). The greater the score is the greater the functionality. This test has revealed good reliability[13,56] and is one of the most frequently used in clinics.[13,56]

Existence of active MTrPs. Supraspinatus, infraspinatus, subscapularis (lateral, superior and inferior), teres minor and deltoid (anterior, medial and posterior) muscles were evaluated. All of these localizations were based on the nomenclature and localization of Travell & Simons.[65] Diagnosis was made according to updated Travell JG & Simons[3] diagnostic criteria: presence of a hypersensitive spot in a palpable taut band, palpable or visible local twitch response on palpatory stimulus and reproduction of referred pain elicited by palpation.[44,65]

Additional outcomes

One additional outcome measure, not specified in the trail registration or published protocol, was added. This was nocturnal pain (determined according to the following nomenclature: Yes/no).

Reassessment periods

Patients were assessed at 3 time points: baseline, post-treatment and 3 months follow-up. Follow-up assessments (post-treatment and follow up at 3 months) were conducted by an evaluator blinded to group allocation. The treating physical therapists as well as the evaluators were physical therapists with over 5 years prior experience in the physiotherapeutic diagnosis and treatment, including the treatment of the MTrP. They also underwent an additional 4 sessions of protocol standardization with an expert in DN treatment. Furthermore, they were provided with a telephone contact to make any necessary consultations regarding doubts or incidents that may arise during the study period.

Statistical analysis

Clinical efficacy was assessed using intention-to-treat analysis. The worst observation carried forward (WOCF) method was used to handle missing data. Baseline comparison of key variables was made between the groups after randomization to establish baseline comparability. For each group, the improvement at the end of the treatment and 3 months later was analyzed using a paired sample t-test for quantitative variables. We used the McNemar test for the binary outcome of nocturnal pain. Differences between both groups at the end of the treatment and 3 months later were analyzed using ANCOVA. Thus, for the primary outcome variable and for each pre-specified secondary outcome variable in each time point (post treatment and 3 months later) we adjusted a linear model in which the type of treatment and the corresponding outcome measure at baseline were the independent variables. For nocturnal pain, in order to compare between the groups, we considered the patients whose nocturnal pain had improved, (changed from yes to no) and the rest of patients (whose nocturnal pain did not change or even got worse). We compared the frequencies of these categories between both groups with the Chi-squared test at the end of the treatment and 3 months later.

Statistical analyses were performed with the SPSS 22.0 statistical software package. *P* values below 0.05 were considered to be statistically significant.

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RESULTS

Participant flow and compliance

Figure **1** illustrates the flow of participants during the trial. 142 potential patients were assessed for inclusion in the study, all of whom had pain and shoulder limitations. They were sequentially included in the study between October 2008 and August 2010. There were 22 exclusions.

Of the 120 enrolled patients, 57 were randomly assigned to the dry needling group and 63 were randomly assigned to the control group. All patients received the allocated intervention and all were analyzed using intention-to-treat (ITT) analyses. Attrition was low: of the 120 subjects who began the study, 117 (97.5%) completed the treatment and the 3 month follow-up was filled out by 109 subjects (90.8%). The attrition rate in the two treatment groups was quite similar: 2 out of 63 (3.17%) patients in the PT group and 1 out of 57 (1.75%) patients in PT+DN group abandoned treatment over 10 treatment sessions. Considering the 3 month follow-up, the total attrition rate was 11 subjects, 6 out of 63 (9.52%) in the PT group and 5 out of 57 (8.77%) in PT+DN group. Due to the low dropout rate, predictors of dropout were not subjected to further analysis, and WOCF was considered an adequate method for dealing with missing data for ITT analysis.

Group baseline characteristics

TABLE 1 displays the baseline characteristics of the two study groups. There were no important differences between groups in any sociodemographic or clinical variable**,** neither in the diagnosed pathology via US/MRI, indicating that the two groups were equivalent in regards to the measured variables.

Primary outcome variable

TABLE 2 displays the data for the assessment of the principal and secondary variables at baseline, post-treatment and 3 month follow-up for the personalized treatment and personalized treatment plus dry needling groups. Participants in both groups showed significant improvement at the end of the treatment period and after 3 months in pain**.** The patients assigned to the personalized treatment plus dry needling group showed a slight improvement (0.86 is the difference estimate with a C.I (0.06, 1.67)) in pain at the end of the treatment period whereas this difference was not revealed at 3 months follow-up.

Secondary and additional outcomes

Participants in both groups showed significant improvement at the end of the treatment period and after 3 months, in regards to internal rotation range of motion, functionality and number of active trigger points. The patients assigned to the personalized treatment group showed improvement in external rotation range of motion whereas this difference was not revealed in the personalized treatment plus dry needling group. Comparing both groups, similar effects were found between the two treatments for all pre-specified secondary outcome variables, at the end of the treatment period and at 3 months follow-up.

Results for the additional variable not specified *a priori* are reported in Online Only Appendix 2. The changes in nocturnal pain (a NO value at baseline and a YES value after the treatment or a YES at baseline and a NO after treatment) indicated improvements in nocturnal pain in both groups following treatment and at the 3 month follow-up. The results indicated a slight between group difference in nocturnal pain improvement at post treatment favoring the

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personalized treatment + DN group (odds ratio equals 0.41 with a C.I. (0.17, 0.99)), but not at 3 month follow-up.

DISCUSSION

This is the first clinical trial assessing the effectiveness of dry needling when added to a personalized treatment of shoulder pain, compared with personalized treatment only. There were no clinically or statistically significant differences in the results between the intervention groups, in terms of pain or in range of motion, or in terms of functioning or in a decreased number of MTrPs at 3 month follow-up. The only statistically significant difference found at post treatment was in pain. This comparison showed a difference estimate of 0.86 and a confidence interval equals (0.06, 1.67), on VAS-pain. This, according to a-priori defined minimum difference of 1.5 on VAS-pain, is not a clinically relevant improvement.

We highlight the improvement in pain that was perceived in both treatment groups, both at the time of post-treatment as well as three months later. This change is clinically relevant, with a decrease in the VAS-pain scale of more than 2 points[38] and at 3 months, a decrease by more than 3 points (the mean for pain at three months is less than half of the initial level for the PT with DN group). While we are unable to attribute this improvement in pain to the administered treatments, given that our study lacked a control group, it has been established in studies in which control groups have been included that manual therapy may with or without supervised exercises be superior to physician advice, as shown by Kachingwe,[36] or no intervention as shown by Dickens.[15] Nevertheless, a study with a control group should be conducted in order to confirm these results.

As for function; changes in the total Constant-Murley Score,[30] although statistically significant, did not exceed the minimum clinically important change of 17 points in either of the two treatments. Virtually no changes were observed for range of motion. Significant improvement was only observed in a similar manner in internal rotation for both groups, as well as a significant improvement in external rotation in only the group treated with PT. It is possible to say that there is little capacity for improvement given the fact that the limitation level in general is not very high; the mean degree in flexion and abduction is over 75%, in external rotation it is over 70% and in internal rotation it is somewhat less, but it is over 60% in overall movement. These results may be consistent with those from other studies in which manual therapy was assessed for shoulder pain,[35] finding few and varied changes in the different ranges of motion,[11] and whose increase may be related to the initial level of restriction[42] and the range in which the joint movement is carried out.[11]

We chose to use a non-standardized physiotherapy treatment protocol in both because physical therapists generally use a multimodal treatment approach.[27] Manual therapy, stretching and/or proprioceptive re-education and control exercises have also been described to inactivate myofascial trigger points.[44,54,65] This may possibly be the reason for similar decrease for both groups in our study, as the manual therapy may have indirectly benefitted the MTrPs. The treatment of shoulder pain through the inactivation of MTrPs has been previously studied by Bron[5] and Hains,[28] who found significant improvements in pain and function following conservative treatment as compared to a control group, thereby associating the improvement to the treatment of the MTrPs.

With respect to the nocturnal pain variable, our study found that the number of participants with improved nocturnal pain was slightly higher for the DN group after treatment. This comparison showed an odds ratio of 0.41 with a confidence interval (0.17, 0.99) which does not reveal important differences with respect to this variable. Moreover, we

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are unable to assess the clinical meaningfulness of this small improvement due to the nature of the variable used (yes/no), and no significant difference existed at 3 month follow-up. This outcome was not a primary or secondary outcome for this study, therefore should not be considered of consequence; it may have been a chance finding, given no other outcomes showed important significant differences**.**

The main strength of this study is that it is the first clinical study to assess the effectiveness of dry needling when added to personalized physiotherapy treatment in primary care, with appropriate sample size and representativeness. Furthermore, a follow up at 3 months following treatment completion was conducted, allowing us to analyze patient evolution after the treatment. But there are several limitations to this study. One of these is the inclusion based on diagnosis by the family physician based on clinical symptoms (although a large percentage of the subjects had their pathology confirmed via US or MRI). Finally, the follow-up period may be considered rather short; longer follow-up periods may be necessary to confirm the long-term stability of the improvements. Finally, although previous studies have shown individualized manual therapy and exercise therapy to be superior to a no-physiotherapy control,[15,36] larger, higher quality studies are necessary to definitively establish the effectiveness of physical therapy management of non-specific shoulder pain, RC disorders or SIS.[11]

CONCLUSIONS

Dry needling does not offer benefits to personalized treatment in terms of shoulder pain, with regard to pain, self-reported function, range of motion, or reduction in active MTrPs.

Conflicts of interest

The authors have declared that they have no conflicts of interest.

Authors' contributions

SP, BO, and RM, are the principal researchers and developed the original idea for the study. The study design was further developed by SP, LR, EG, EL, and MP. AP developed the statistical methods. All authors have read and corrected draft versions and approved the final version.

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Key Points

Findings: Dry needling did not offer benefits in addition to personalized physiotherapy treatment, in patients with non-specific shoulder pain, with regard to pain, self-reported function, range of motion, or reduction in active MTrPs.

Implications: Dry needling is not justified as an adjunct to the management of pain in shoulder pain by personalized evidence-based physiotherapy treatment.

Caution**:** In the primary care setting of this study, the inclusion of the participants was based on clinical diagnosis of non-specific shoulder pain considered by the family physician to be consistent with RC tendinopathy or SIS; and who also had impaired movement of less than 50% of the expected normal range of motion. Although a large percentage of the subjects had their pathology confirmed via US or MRI, the shoulder pain diagnosis was non-specific. The evidence-based physiotherapy treatment, although similar between the groups, was individualized and therefore not exactly replicable.

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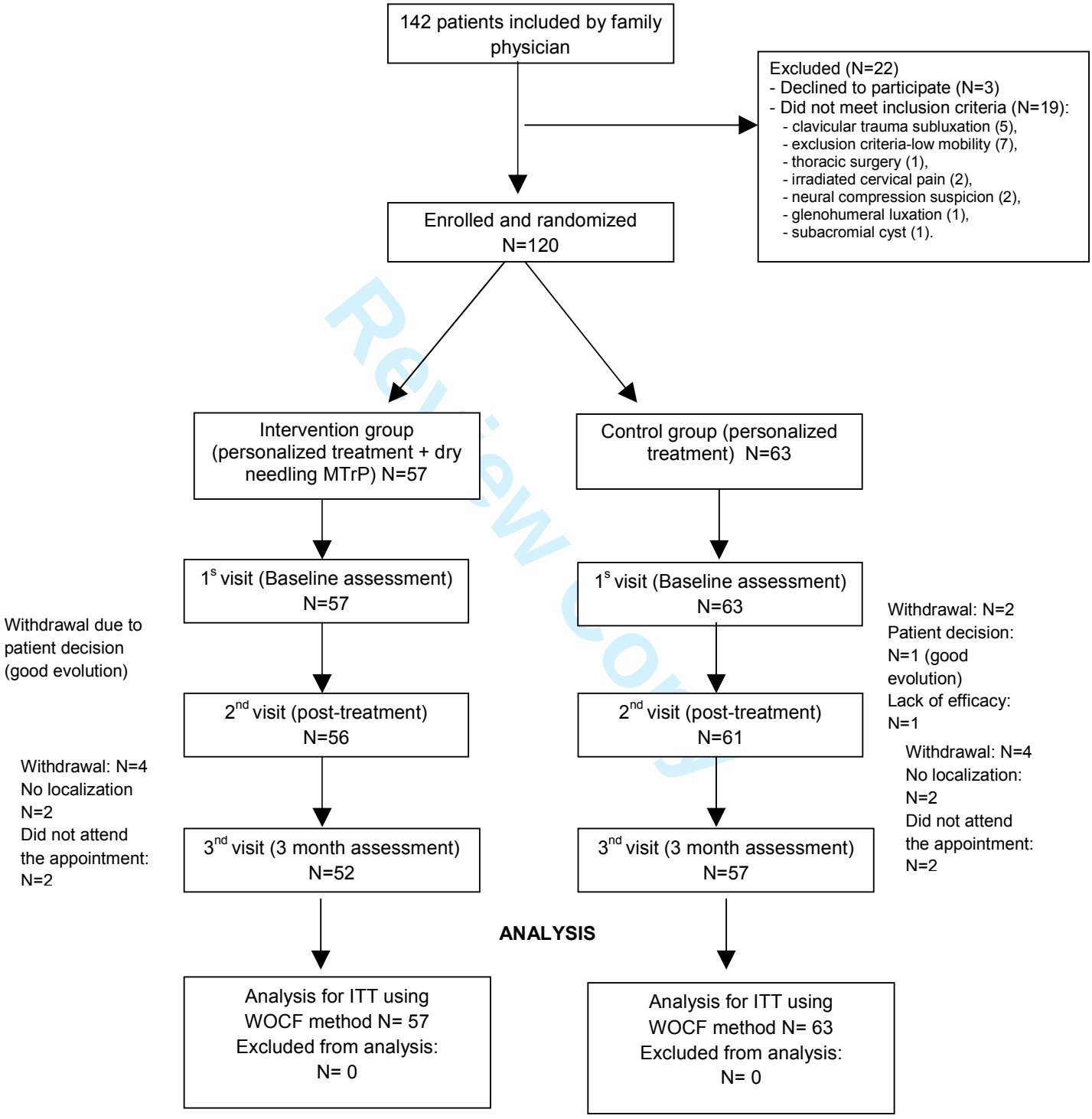

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TABLES

Table 1. Baseline sociodemographic and clinical characteristics of the sample (N= 120)

VARIABLES	Personalized treatment (N=63)	Personalized treatment + Dry needling (N=57)
SOCIODEMOGRAPHIC VARIABLES		
Gender (M/F)	28/35	17/40
Age	54.32 (11.45)	52.74 (11.81)
PAIN (VAS)	6.75 (1.5)	6.58 (1.52)
GLENOHUMERAL ACTIVE ROM (degrees)		
Flexion	136.09 (16.42)	135.97 (20.40)
Abduction	141.74 (27.87)	150.02 (26.03)
External rotation	7.08 (2.96)	7.82 (2.46)
Internal rotation	6.37 (2.67)	6.21 (2.71)
FUNCTIONALITY (CONSTANT-MURLEY SCORE)	47,6 (11.53)	50.3 (11.75)
NOCTURNAL PAIN (NO/YES)	22/41	16/41
NUMBER OF ACTIVE TRIGGER POINTS	4.82 (1.75)	5.07 (1.86)
PATHOLOGY		
TOTAL/PARTIAL TEAR (NO/YES)	51/6	48/4
TENDINOPATHY (NO/YES)	37/20	39/13
ARTHROSIS (NO/YES)	35/22	38/14
BURSITIS (NO/YES)	43/14	46/6
INJURY (NO/YES)	23/34	27/25

Other than gender and pathology, all values are means (SD)

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Table 2: Outcome data at baseline, post-treatment and 3 month follow-up.

	P.T.*	P.T.+D.N.*	Between-group differences**
PAIN (VAS)			
Baseline	6.75 (1.50)	6.58 (1.52)	
Post-treatment	4.71 (2.28)	3.81 (2.20)	0.86 (0.06, 1.67)
After 3 months	3.59 (2.61)	3.00 (2.44)	0.52 (-0.37,1.42)
Within group improvement from baseline+			
Post-treatment	2.04 (1.44, 2.63)§§	2.77 (2.08, 3.46)§§	
After 3 months	3.16(2.55, 3.77)§§	3.58 (2.82, 4.34)§§	
GLENOHUMERAL ACTIVE ROM (degrees)			
FLEXION			
Baseline	136.09 (16.42)	135.97 (20.40)	
Post-treatment	136.17 (18.90)	140.53 (15.47)	4.41 (-1.29,10.10)
After 3 months	141.08 (16.49)	139.32 (17.61)	-1.71(-7.34, 3.92)
Within group improvement from baseline+			
Post-treatment	0.08 (-4.58, 4.75)	4.56 (-0.67, 9.79)	
After 3 months	4.99 (0.44, 9.53)	3.35 (-2.06, 8.77)	
ABDUCTION			
Baseline	141.74 (27.87)	150.02 (26.03)	
Post-treatment	149.23 (25.18)	151.17 (25.64)	-0.98 (-9.64,7.68)
After 3 months	148.12 (25.65)	149.89 (25.18)	-0.60 (-9.51, 8.31)
Within group improvement from baseline+			
Post-treatment	7.49 (-0.02, 14.99)	1.15 (-6.48, 8.79)	
After 3 months	6.37 (-1.34, 14.09)	-0.13 (-8.43, 8.17)	
EXTERNAL ROTATION			
Baseline	7.08 (2.96)	7.82 (2.46)	
Post-treatment	8.44 (2.20)	8.53 (2.31)	-0.09 (-0.89, 0.69)
After 3 months	8.54 (2.52)	8.53 (2.41)	-0.24 (-1.09, 0.62)
Within group improvement from baseline+			
Post-treatment	1.36 (0.64, 2.09)§§	0.70 (-0.12, 1.53)	
After 3 months	1.46 (0.75, 2.17)§§	0.70 (-0.15, 1.55)	
INTERNAL ROTATION			
Baseline	6.37 (2.67)	6.21 (2.71)	
Post-treatment	7.21 (2.86)	7.86 (2.13)	0.74 (0.02, 1.46)
After 3 months	7.73 (2.37)	8.00 (2.14)	0.34 (-0.36, 1.04)
Within group improvement from baseline+			
Post-treatment	0.84 (0.33, 1.35)§	1.65 (0.99, 2.31)§§	
After 3 months	1.36 (0.75, 1.98)§§	1.79 (1.14, 2.44)§§	
FUNCTIONALITY (CONSTANT-MURLEY SCORE)			
Baseline	47.39 (11.53)	50.30 (11.75)	
Post-treatment	57.29 (13.74)	61.44 (12.00)	3.04 (-1.36, 7.44)

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After 3 months	61.77 (16.18)	62.89 (12.91)	-0.07 (-5.19, 5.04)
Within group improvement from baseline[++]			
Post-treatment	9.68 (6.55,12.81)[§§]	11.14(7.10,15.18)[§§]	
After 3 months	14.39 (10.55,18.22)[§§]	12.60 (8.36, 16.83)[§§]	
NUMBER OF ACTIVE TRIGGER POINTS			
Baseline	4.82 (1.75)	5.07 (1.86)	
Post-treatment	3.97 (1.71)	4.17 (2.01)	-0.001 (-0.39, 0.38)
After 3 months	3.75 (1.94)	4.05 (2.12)	0.10 (-0.39, 0.59)
Within group improvement from baseline[+]			
Post-treatment	0.86 (0.61, 1.10)[§§]	0.89 (0.57, 1.21)[§§]	
After 3 months	1.08 (0.73, 1.43)[§§]	1.02 (0.65, 1.38)[§§]	

Abbreviations: PT, personalized treatment; DN, dry needling.

+ Improvement calculated as the reduction of the variable.

++Improvement calculated as the increment of the variable.

**For each variable and time point, the first three rows are mean (SD) and the last two rows are mean differences (95% confidence interval).*

*** For each variable and time point, values are mean differences (95% confidence interval) between both treatments by using ANCOVA (outcome score at different time points is the dependent variable and the corresponding variable at baseline is the covariable).*

§ Statistically significant differences with p-values<0.01.

§§ Statistically significant differences with p-values<0.001.

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