Data Article

Effects of diaphragm muscle treatment in shoulder pain and mobility in subjects with rotator cuff injuries: A dataset derived from a pilot clinical trial

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A B S T R A C T

The rotator cuff inflammatory or degenerative pathology is the main cause of shoulder pain. The shoulder and diaphragm muscle have a clear relation through innervation and the connection through myofascial tissue.

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A prospective, randomized, controlled, single-blind (assessor) pilot clinical trial was performed with a sample size of 27 subjects with rotator cuff injuries and with clinical diagnosis of myofascial pain syndrome at shoulder. The sample were divided into 3 groups of treatment (9 subjects per group):

1. A direct treatment over the shoulder by ischemic compression of myofascial trigger points (MTP) (control / rotator cuff group).
2. Diaphragm manual therapy techniques (diaphragm group).
3. Active diaphragm mobilization by breathing exercises (breathing exercises group).

The pain and range of shoulder motion were assessed before and after treatment in all the participants by inclinometry, NRS of pain in shoulder movements and pressure algometry. Methodology and full data analyzing the effect of the three interventions are presented in this article.

These data could give a basis for further experiments on revealing the underlying mechanism of action of the visceral manual therapy in reducing the symptoms of shoulder pain.

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Specifications Table

| Subject                      | Physical Therapy and Rehabilitation |
|------------------------------|-------------------------------------|
| Specific subject area        | The influence of treatment on the diaphragm in shoulder pain |
| Type of data                 | Table                                |
|                              | Figure                               |
| How data were acquired       | Shoulder and diaphragm physical treatment through manual therapy and active breathing exercises and its relation to the shoulder pain and mobility using Numeric Pain Rating Scale (NPRS) [1], inclinometry [2,3] and pressure algometry [4] assessment. |
| Data format                  | Raw                                  |
|                              | Analyzed                             |
| Parameters for data collection | Subjects between the age of 18–65 diagnosed with rotator cuff pathology by ultrasound and / or magnetic resonance imaging and with pain in flexion / abduction movements of the shoulder. |
| Description of data collection | Assessment of active shoulder range of motion (ROM) on flexion, abduction and external rotation movements, using a digital inclinometer and recorded in degrees. Perceived shoulder pain (0–10) assessed by NPRS on flexion, abduction, external rotation and shoulder extension movements. Algometry assessment of pressure pain thresholds (PPT) in the supraspinatus tendon, xiphoid process and spinous process of C4. |
| Data source location         | Institution: Radiology, Rehabilitation and Physical Therapy Department. Facultad de Medicina. Universidad Complutense de Madrid. City/Town/Region: Madrid Country: Spain |

(continued on next page)
Data accessibility

Data have been uploaded to a Mendeley repository. Reference and link to the data:
Fernández-López, Isidro; Peña-Otero, David; Atín-Arratibel, María de los Ángeles; Eguillor-Mutiloa, María; Bravo-Llatas, Carmen; Genovés-Crespo, Marta; Callejas-González, Francisco Javier (2021). “Fernandez-Lopez Results spreadsheet diaaphragm treatment and shoulder ”, Mendeley Data, V1, doi: 10.17632/r93nz95zc7.1
http://dx.doi.org/10.17632/r93nz95zc7.1
A figure is presented with the article (Fig. 1. Consort flow diagram).

Value of the Data

- These data provide the immediate effectiveness of each of the three intervention groups in shoulder ROM and pain in subjects with rotator cuff injuries.
- These data allow for researchers and physical therapists to understand the possible impact that diaphragm muscle could have in shoulder pain.
- These data could give a basis for further experiments on revealing the underlying mechanism of action of the visceral manual therapy in reducing the symptoms of shoulder pain.
- These data allow to compare two different diaaphragm muscle treatments through manual therapy and active breathing exercises and its relation to the shoulder pain and ROM.

1. Data Description

This dataset (available on Mendeley) summarises in 16 tables the effectiveness of each of the three intervention groups in shoulder ROM and pain, extracted from 27 subjects with rotator cuff injuries that met the inclusion criteria for the pilot clinical trial.

The data are ordered into seven sections. Section 1 contains Table 1 with the raw data of each measure of each variable with a list of abbreviations.

Section 2 presents the Shapiro-Wilk test to assess the normality of continuous data (Supplementary Table 2).

Section 3 (Supplementary Tables 3–5) summarises the data of the immediate effectiveness of all three interventions on improving ROM during shoulder flexion, abduction and external rotation using an inclinometry assessment.

Section 4 (Supplementary Tables 6–8) summarises the data of the immediate effectiveness of all three interventions on improving pain during shoulder flexion, abduction, external rotation and extension using Numeric Pain Rating Scale (NPRS).

Section 5 (Supplementary Tables 9–11) summarises the data of the immediate effectiveness of all three interventions on improving PPT in the supraspinatus tendon, xiphoid process and spinous process of C4 using an algometry assessment.

Section 6 contains the between-groups comparisons (Supplementary Tables 12–14).

Section 7 (Supplementary Tables 15 and 16) contains the data of the demographic and anthropometric characteristics of subjects in each group regarding mean age and mean weight.

2. Experimental Design, Materials and Methods

a. Eligibility criteria
Subjects were included if they met the following inclusion criteria:
- Subjects with symptoms in the shoulder region, with a clinical diagnosis of rotator cuff pathology using ultrasound and / or magnetic resonance imaging.
- Being in an age range between 18 and 65 years.
- Having symptoms in active mobility in flexion and / or abduction of the shoulder.
- Not having had any episode of dislocation or subluxation or Bankart injury in the labrum.
- Not having received physical therapy treatment in the last week.
- Not having undergone any type of thoracic or shoulder surgery.
- Not having taken analgesic, anti-inflammatory and / or muscle relaxant medication during the 72 h before the study.
- Diabetic patients, people with a diagnosed neurological pathology, or with a diagnosed mental health problem, or inability to understand and sign the informed consent and information sheet, have not been included.

b. Methods

A prospective, single-blind (evaluator), randomized and controlled pilot clinical trial was determined with a sample size of 27 subjects (9 subjects per group) with rotator cuff injuries and a clinical diagnosis of myofascial pain syndrome in the shoulder.

Each subject signed an informed consent statement before participating in the study. The pilot clinical trial has followed the same protocol as that registered for the final clinical trial, registered at www.clinicaltrials.gov under number NCT03293329.

Control group or rotator cuff group consisted of a protocol of two ischemic compression techniques [7,8] of supraspinatus and infraspinatus myofascial trigger points applied by a physiotherapist with more than 15 years of experience. The most painful myofascial trigger point on palpation was located in each of the muscles according to the criteria proposed by Simons, Travell and Simons [9]. Ischemic compression of the MTPs consisted of pressing each muscle to the point of resistance, within the comfort zone, and then gently and gradually increasing pressure was applied to the MTP until the finger encountered a definite increase in pressure tissue, resistance or barrier. The pressure was gradually increased until the subject experienced his greatest tolerable pain [5]. The pressure was maintained until a decrease in tension was perceived with the sensing finger. At this time, the finger increased the pressure enough to reach a new barrier, until the patient felt no pain from the pressure and the therapist felt a release of tension under his fingers.

Group 1 or diaphragm group consisted of a protocol of 3 diaphragm manual therapy techniques applied by the same physiotherapist, these techniques were as follows:

- A manual stretching technique of the diaphragm as described previously by Chaitow et al. [6], where each subject was positioned seated erect. The patient was instructed to breathe deeply and let the air out; while the patient exhaled, the therapist contacted the patient’s lower ribs and costal margins with his hands, deepening the tissue with each respiratory cycle, staying between 5 and 7 min.
- A diaphragm release technique as described previously by Ward [7], where each participant was asked to lie supine with relaxed limbs. The patient was instructed to breathe deeply and let the air out; while the patient exhaled, the movement of the diaphragm was followed by pressing with the thumbs back towards the table, holding while the patient took a deep breath again and proceeding with a greater progressive cephalic movement. This technique was repeated for 5 respiratory cycles.
- A diaphragm stretching technique as described previously by Ricard [8], where each subject was positioned on the healthy side, and the affected shoulder in a relaxed position [8]: The therapist contacted his hands in the internal area of the costal cartilages and ribs, and pulled using the weight of the body obliquely in the direction of the shoulder on that same side during the subject’s inspiration; on expiration, the therapist maintained sufficient force so that the costal cartilages did not descend. 15 respiratory cycles were performed.

In the group 2, a protocol of active breathing exercises was applied in two different positions, standing (exercise 1) and standing with the trunk inclined about 45° above the hips (exercise 2) as described previously by Caufriez [9]. In both postures, the subject was asked to self-lengthen, bringing the elbows outwards in the direction of the longitudinal axis of the arm, through an active contraction of the serratus anterior muscle, while the hands remained at the level of the
iliac crests. In addition, he was instructed to take a lower costal inspiration, so as to raise the lower ribs and subsequently a total expiration, preserving self-elongation. Finally, he performed a blockage of breathing (expiratory apnea) with a closed glottis, accentuating the abduction of the shoulder blades, self-lengthening and the elevation of the lower ribs. Each posture was held for 25 s, repeating each exercise 3 times, with a rest period of about 20 s between exercises [9] and making sure that none of the subjects presented pain in the shoulder during the execution of the postures.

All three interventions were carried out by the same researcher.

The examiner performed the ROM evaluation [2,3] in degrees and in the supine position using a Baseline Digital Inclinometer (Fabrication Enterprises Inc., White Plains, New York U.S.A.). A repetition of the movement to be evaluated was performed passively, as suggested by Kolber and Hanney [2], led by the examiner prior to the ROM assessment, with the purpose for the subject to become familiar with the movement. Active shoulder movements were then evaluated in this order and with 30-s rest intervals between each movement: flexion, abduction, and external rotation with the shoulder positioned at a 90° abduction. For each active repetition, the participants were required to move their arm to the final range that pain or limited mobility allowed, and maintain the position while the angle was assessed with the inclinometer, which was set in the “peak”; function hold when reaching the final position, so that the maximum value taken is recorded. Once the measurement was obtained, the participants returned their arm to the neutral position of 0° [2]. Three measurements were made in each of the movements and the resulting mean was obtained [3].

The measurement position in each of the movements was as follows:

a. Shoulder flexion: the arm was found located along the trunk and supported on the stretcher. An active flexion movement in a strictly sagittal plane with the palm facing down was requested while the measurement was recorded. The inclinometer was placed in the distal part of the humerus proximal to the elbow [2].

b. Shoulder abduction: the arm was found located along the trunk and supported on the stretcher. An active lifting movement in a strictly coronal plane with the thumb up was requested to allow the necessary external rotation to avoid impingement of the greater tuberosity with the acromion [2]. Once the final joint range was achieved, the measurement was documented. The inclinometer was placed in the distal part of the humerus and proximal to the elbow [2].

c. External rotation with shoulder abduction: the references of Green et al. [10] were used to examine this movement. The patient was placed in a supine position with the shoulder abducted 90°, with the elbow supported, also fixed at 90° of flexion, and the forearm in the prone position. Towels were used under a stable surface, as necessary, under the arm to bring the humerus to the level of the coronal plane in the initial position [11]. The inclinometer was placed along the axis of the radius, perpendicular to the plane of motion. The subject was asked to perform an external rotation movement of the shoulder, bringing his hand back and to the ground.

The reference values of Muir et al. [11] were adopted to detect a minimal clinical difference after the intervention and for a single evaluator in the case of patients with shoulder pathology. This minimal clinical difference was for the active shoulder flexion movement: 11°, for the shoulder abduction movement: 16°, and for the external rotation movement with the shoulder abducted 90°: 14°.

Participants were then asked to perform 2 repetitions of active shoulder flexion, abduction, external rotation with the shoulder positioned at a 90° abduction, and extension movements in a standing position, until pain or limited mobility allows, and reported their pain intensity using an 11-point NPRS from 0 to 10 [11]. Pain during movements was assessed at baseline and immediately after intervention by a blinded assessor. Previous work has reported the minimal clinically important difference (MCID) of the NPRS in patients with shoulder pain to be 1.1 points [12].
Pressure algometry evaluation [4] was performed according to the following protocol for measuring pressure pain thresholds (PPTs) with a Baseline push-pull Force Gauge algometer (Fabrication Enterprises Inc., White Plains, New York U.S.A.): all participants were assessed and in the same order the PPT on supraspinatus tendon, the distal part of xiphoid process in supine position, and spinous process of C4 in prone position. PPT was measured three times at 15 s intervals [14,15], and the mean of the 3 measurements was calculated. The force value in kg/cm² was registered. Participants were trained to warn when their sensation changed from pressure to pain. The evaluator positioned the head of the algometer perpendicular to the marked point and with the viewfinder in the opposite direction, in order not to be influenced by the measurement. Participants were asked to notify when the pressure stimulus began to become painful [16].

The detailed measurement of the PPT by algometry was carried out in this way:

a. Supraspinatus tendon on the head of the humerus: in anterior and lateral area to the acromion. The tendon of supraspinatus palpation technique is accurate despite being performed indirectly through the anterior deltoid muscle [13]. The supraspinatus tendon was located and marked with a dermal pencil by the evaluator in the supine position with the affected arm at rest along the trunk. The algometer was positioned perpendicular to the insertional fibers of this tendon.

b. Distal part of the xiphoid process of the sternum. Corresponds to the area where most strongly inserts and most visible is the distal portion of the pectoral fascia [14] and one of the insertion points of the diaphragm muscle [15]. The evaluator located this area and marked it with a dermal pencil in the supine position. The algometer was positioned perpendicular to the distal and anterior area of the xiphoid process.
c. Posterior part of the spinous process of the C4 vertebra: with the patient in the prone position, with the subject’s back uncovered, the head in a centered position and the arms along the trunk. The spinous process of C4 was located and marked with a dermal pencil. The C4 vertebra was chosen as it corresponds to the most significant medullary level for the phrenic nerve [16]. The algometer was positioned perpendicular to the posterior end of the spinous process of C4.

Previous work has reported a clinically significant post-intervention result of the algometry assessment of 15% improvement according to the references of Moss et al. [17].

The data obtained were analyzed with the Statistical Package for the Social Sciences (SPSS), version 25.0 (IBM, Armonk, NY, USA). Descriptive statistics were presented as the mean ± standard deviation, minimum and maximum values, median and quartiles (Q1 and Q3) for continuous variables. The Shapiro-Wilk test to assess the normality of continuous data was performed before statistical analysis. With respect to normal data, the t-test for paired samples was used to compare the evaluation results before and after treatment. Wilcoxon’s signed rank test was used for non-parametric data. For normal data, an analysis of variance (ANOVA) with Scheffé post-hoc test was used to compare the evaluation results between the three groups before and after treatment in case of homocedasticity; or the robust Welch ANOVA with Tamhane T2 post-hoc tests in the case of heterocedasticity. Levene test was applied to assess homocedasticity. For non-normal data, a Kruskal-Wallis non-parametric test followed by posterior multiple comparisons with Bonferroni correction was applied. Statistical analysis was performed with a confidence level of 95%.

Ethics Statement

Approval for the study was obtained from Ethics Committee of the Hospital Clínico San Carlos de Madrid, Spain (ID number C.I. 17/380-E); according to minutes 11.1 / 17, of November 24, 2017.

CRediT Author Statement

Isidro Fernández-López: Conceptualization, Investigation, Methodology, Data curation, Writing original draft; David Peña-Otero: Methodology, Data curation, Writing - Reviewing and Editing; María de los Ángeles Atín-Arratibel: Visualization, Supervision; María Eguillo-Mutiloa: Writing - Reviewing and Editing; Carmen Bravo-Llatas: Software, Formal analysis; Marta Genovés-Crespo: Project administration, Funding acquisition; Francisco Javier Callejas-González: Project administration, Funding acquisition.

Declaration of Competing Interest

We have no conflicts of interest to disclose.

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Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi: 10.1016/j.dib.2021.106867.

References

[1] S.J. Ahlers, L. van Gulik, A.M. van der Veen, H.P. van Dongen, P. Bruins, S.V. Belitser, et al., Comparison of different pain scoring systems in critically ill patients in a general ICU. Crit. Care 12 (1) (2008) R15.
[2] M.J. Kolber, W.J. Hanney, The reliability and concurrent validity of shoulder measurements using a digital inclinometer and goniometer: a technical report. Int. J. Sports Phys. Ther. 7 (3) (2012) 306.
[3] A.M. Cools, L. De Wilde, A. Van Tongel, C. Ceyssens, R. Ryckwaert, D.C. Cambier, Measuring shoulder external and internal rotation strength and range of motion: comprehensive intra-rater and inter-rater reliability study of several testing protocols. J. Shoulder Elbow Surg. 23 (10) (2014) 1454–1461.
[4] A. De Groef, M. Van Kampen, N. Vervloesem, E. Clabau, M.-. Christiaens, P. Neven, et al., Inter-rater reliability of shoulder scoring measurements in middle-aged women, Physiotherapy 103 (2) (2017) 222–230.
[5] B. Cagnie, V. Dewitte, I. Coppierers, J. Van Oosterwijck, A. Cools, L. Danneels, Effect of ischemic compression on trigger points in the neck and shoulder muscles in office workers: a cohort study, J. Manip. Physiol. Ther. 36 (8) (2013) 482–489.
[6] L. Chaitow, D. Bradley, C. Gilbert, Multidisciplinary Approaches to Breathing Pattern Disorders, Churchill Livingstone, London, 2002.
[7] R. Ward, Foundations for Osteopathic Medicine, Lippincott Williams & Wilkins, 2003.
[8] F Ricard, Tratado de Osteopatía visceral y Medicina Interna, Sistema Cardiorespiratorio., Médica Panamericana, Madrid, 1994.
[9] M. Caufriez, Gymnastique Abdominale Hypopressive, M.C. Editions, Bruselas, 1997.
[10] S. Green, R. Buchbinder, A. Forbes, N. Bellamy, A standardized protocol for measurement of range of movement of the shoulder using the Plurimeter-V inclinometer and assessment of its intrarater and interrater reliability, Arthritis Care Res. 11 (1) (1998) 43–52.
[11] S.W. Muir, C.L. Corea, L. Beaupre, Evaluating change in clinical status: reliability and measures of agreement for the assessment of glenohumeral range of motion, N. Am. J. Sports Phys. Ther. 5 (3) (2010) 98–110.
[12] P.E. Mintken, P. Glynn, J.A. Cleland, Psychometric properties of the shortened disabilities of the arm, shoulder, and hand questionnaire (QuickDASH) and numeric pain rating scale in patients with shoulder pain, J. Shoulder Elbow Surg. 18 (6) (2009) 920–926.
[13] E.M. Wolf, V. Agrawal, Transdeltoid palpation (the rent test) in the diagnosis of rotator cuff tears, J. Shoulder Elbow Surg. 10 (5) (2001) 470–473.
[14] D.M. Panicek, C.B. Benson, R.H. Gottlieb, E.R. Heitzman, The diaphragm: anatomic, pathologic, and radiologic considerations, Radiographics 8 (3) (1988) 385–425.
[15] R. Putz, R. Pabst, Sobotta: Atlas de Anatomia Humana (t. ii): Tronco, Visceras y Miembro Inferior, 22nd ed., Medica Panamericana, 2006.
[16] S. Dayal, M. Ky, The variations in the root of origin of theaphragm nerve, J. Mahatma Gandhi Inst. Med. Sci. 14 (n. ii) (2009) 24–27.
[17] P. Moss, K. Sluka, A. Wright, The initial effects of knee joint mobilization on osteoarthritic hyperalgesia, Man. Ther. 12 (2) (2007) 109–118.