ISSN 1413-3555
Rev Bras Fisioter, São Carlos, v. 12, n. 4, p. 298-303, jul./aug. 2008
Revista Brasileira de Fisioterapia©

The influence of joint mobilization on tendinopathy of the biceps brachii and supraspinatus muscles

A influência da mobilização articular nas tendinopatias dos músculos bíceps braquial e supra-espinal

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Abstract

The most common causes of shoulder pain are related to degeneration of the tendons of the rotator cuff muscles. **Objective:** To investigate the influence of joint mobilization by means of accessory movements of the shoulder during the early rehabilitation of 14 patients with chronic tendinopathy of the supraspinatus and/or biceps brachii muscles. **Methods:** Two treatment protocols were compared: application of therapeutic ultrasound over the affected tendon area and eccentric training of the musculature involved, with or without joint mobilization maneuvers. The Constant and DASH (Disabilities of the Arm, Shoulder and Hand) questionnaires were used as the assessment method, before and after the treatment. **Results:** The results showed that both treatment protocols were effective for patient rehabilitation, since better functional results were obtained at the end of the treatment, in comparison with the beginning ($p<0.001$). The patients who underwent joint mobilization in association with therapeutic ultrasound and eccentric training achieved better mean scores in the questionnaires. There was a statistically significant difference in the final scores between the two groups, for both questionnaires ($p<0.05$). **Conclusions:** Thus, both treatment protocols were effective for treating chronic tendinopathy of the shoulder, although their use in association with joint mobilization seems to provide better functional results.

Key words: exercise therapy; tendinopathy; shoulder; rotator cuff; Physical Therapy; joint mobilization.

Resumo

As causas mais comuns de dor no ombro estão relacionadas às degenerações dos tendões da musculatura do manguito rotador. **Objetivo:** Verificar a influência da mobilização articular por meio dos movimentos acessórios do ombro na recuperação inicial de 14 pacientes com tendinopatia crônica dos mm. supra-espinal e/ou bíceps braquial. **Métodos:** Foram comparados dois protocolos de tratamento, compostos da aplicação de ultra-som terapêutico na área do tendão afetado e de treinamento excêntrico na musculatura envolvida, acompanhados ou não de manobras de mobilização articular. Como métodos de avaliação foram utilizados os questionários de Constant e Disabilities of the Arm, Shoulder and Hand (DASH), no início e ao final do tratamento. **Resultados:** Os resultados encontrados demonstraram que ambos os protocolos de tratamento foram eficazes na reabilitação dos pacientes, pois se obtiveram melhores resultados funcionais na aplicação dos questionários quando comparados o final com o início do tratamento para os pacientes ($p<0,001$). Os pacientes que foram submetidos à mobilização articular associada ao ultra-som terapêutico e o treinamento excêntrico obtiveram em média melhores escores para os questionários, ocorrendo diferença estatística significante entre os escores finais nos dois grupos para os dois questionários ($p<0,05$). **Conclusões:** Assim ambos os protocolos de tratamento foram eficazes no tratamento da tendinopatia crônica do ombro, sendo que, o uso associado da mobilização articular parece oferecer melhores resultados funcionais.

Palavras-chave: terapia por exercício; tendinopatia; ombro; manguito rotador; Fisioterapia; mobilização articular.

Received: 27/06/07 – **Revised:** 04/12/07 – **Accepted:** 10/06/08

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Introduction

Studies have reported that the estimated predominance of shoulder pain within populations is between 11.7 and 16%[1,2], reaching 21% in geriatric hospital populations[1]. The incidence of shoulder pain complaints in general health service practice is 11.2 cases for every 1.000 treated patients (1.12%)[3]. This pathological condition, which is more frequent with aging and the practicing of certain occupations or sports[4,5], appears mainly in the forms of pain, movement and strength restrictions, and decreased shoulder functionality[4].

Thus, shoulder pain can be a persistent and frequently incapacitating condition[2,6]. Its incidence in cases of professional incapacities remains unknown. Only approximate data are available, such as the data provided by the Biomechanical Institute of Valencia (BIV), which calculated that 50% of medically certified sick leave patients are due to muscle or joint complaints in the shoulder or neck[4].

There are few evaluation methods for measuring the functional activity of the upper limbs. Among these are the DASH index (Disabilities of the Arm, Shoulder and Hand)[7] and the Constant questionnaire[8]. The DASH functional incapacity index is composed of a series of questions, from a minimum of 30 to a maximum of 38, relating to upper limb functions and symptoms (pain, pins and needles and weakness). These questions have a range of possible responses with scores from 1 to 5, in which the minimum score (1) represents functions with the highest degree of satisfaction. For the overall calculated value, which may be between 0 and 100, after the normalization of the results, the lower the index is, the better is the function of the limb in question[7].

In turn, the Constant questionnaire is based on a maximum score of 100, and evaluates four individual parameters: pain (15 points), daily activities (20 points), range of movement (40 points) and strength (25 points). The higher the score is, the most satisfactory is the function of the shoulder in question. The subjective pain evaluation is made using a visual analog scale. The daily activities are measured subjectively according to the influences of an individuals' occupational and recreational dysfunction and their sleep quality (10 points), and objectively through performing specific movements (10 points). The range of movement is measured objectively for the lateral and medial rotation movements of the upper limbs and by goniometry for other shoulder movements. Finally, muscular strength is measured according to bear the weight of barbells. Thus, the questionnaire items correspond to certain functions related to daily activities, such as pain and the quality of movements performed that influence the final score[8].

Tendinopathy (rotator cuff tendon degeneration) is the most common cause of shoulder pain[1,3], and 29% of the patients register such complaints[3]. The tendons most frequently involved in shoulder tendinopathy are those of the supraspinatus and biceps brachii muscles[1]. The long head of the latter is closely related to the shoulder complex, because of its origin. It is an important stabilizer for this joint[9], even though it does not form part of the rotator cuff. According to Norkin and Levangie[10], the biceps brachii has more relevance in dysfunction than in functioning of the shoulder.

Historically, there have been two major theories for the etiology of tendinopathy and consequently for tendon ruptures: one is mechanical and the other, vascular. According to the mechanical theory, it is said that repeated loading, even within the normal physiological oscillation range of a tendon, causes fatigue and may lead to tendon failure because there is an accumulation of damage to the collagen or of other components of the collagen matrix through repeated tensions, even within the physiological stress limits[1]. Tendons are metabolically active tissues and need vascular support. Thus, in the vascular theory, it is said that certain tendons, including the tendon of the supraspinatus muscle, or at least some of their segments, have deficient blood provision, thereby making them more susceptible to degeneration[1].

Comparative studies between normal and degenerated human tendons have shown notable differences in collagen matrix composition, changes in collagen fiber distribution (with increases in type III collagen relative to type I collagen) and, in some lesions, fibrovascular proliferation and focal expression of type II collagen, representing fibrocartilaginous substitutions[11].

In a recent review on tendinopathy treatment, Rees, Wilson and Wolman[1] cited the treatments most frequently described in the existing literature, which included therapeutic ultrasound, eccentric training and manual therapy techniques.

According to Robertson and Baker[12] and van der Windt, van der Heijden and van der Berg[13], therapeutic ultrasound is the electrophysical resource most frequently used in physical therapy practice. It widely used in many countries, such as Canada, United States, United Kingdom, Australia, Denmark, Finland, New Zealand and Switzerland. However, there is currently little evidence regarding the clinical effectiveness of therapeutic ultrasound, as used by physical therapists for treating pain and musculoskeletal damage and for promoting the healing of superficial tissues[1,11,12,14,15].

Ultrasound is applied at frequencies of between 0.75 and 3MHz, and most machines are set at frequencies of 1 or 3MHz. At a frequency of 1MHz, ultrasound is primarily absorbed by tissues at depths of 3 to 5cm and is therefore recommended for deep injuries or for patients with greater quantities of subcutaneous tissue. The frequency of 3MHz is recommended for injuries to tissues that are more superficial, at depths of 1 to 2cm[11].

Ultrasound can induce thermal and non-thermal physical effects on tissue and non-thermal effects may occur with or without accompanying thermal effects[11,14]. The thermal effects of ultrasound on tissues include locally increased blood flow, reduced muscle spasms, increased collagen fiber extensibility and increased pro-inflammatory response. However, when in excess, these effects may cause tissue damage, through stationary wave formation. Thus, it may be necessary to use pulsed waves and continuous movement of the transducer during the treatment, to minimize this phenomenon[11].

It has been suggested that the non-thermal effects of ultrasound, especially cavitations, tissue fluid pressure changes and acoustic chains (unidirectional movement of fluids along the cell membranes), are more important in treating superficial tissue injuries than are the thermal effects[11]. This is because the non-thermal effects are believed to promote changes in cell permeability and metabolism[14], through interactions with one or more of the inflammation components and optimizing the process, and ultimately forming denser collagen fibers and increased tissue resistance to traction[11].

Interest in the use of eccentric exercise training for treating degenerative tendon diseases has recently been renewed[1]. Eccentric exercise involves active stretching of the muscle tendon unit[1].

After three months of eccentric training, its effects on injured tissue have been reported to result in statistically significant reductions in tendon thickening[1,16] and intra-tendon signals[16], thus suggesting that improved healing with collagen deposition is occurring[1]. Öhberg and Alfredson[17] using Doppler examinations, found that neovascularization of the tissue was involved in the eccentric exercise response.

These results were obtained by applying the Alfredson protocol[1,17,18], which consists of three series of 15 repetitions done twice a day, for 12 weeks. Even though this protocol is adequate, it becomes unviable when applied to outpatient care.

Among the manual therapy techniques used for managing tendinopathy, the most common are deep transversal massage and superficial tissue mobilization massage, which produce positive results and pain relief[1]. However, joint mobilization for accessory movements has physiological effects that may be beneficial with regard to these dysfunctions[18,19]. Three factors enabling the use of manipulations via rhythmic or oscillatory techniques for tissue reorganization have been identified: manipulation facilitates the repair process, influences the structure and mechanical behavior of tissues and affects the fluid dynamics[18].

According to Maitland[19], there are five classification grades for the different ways of applying manipulations and their physiological effects: grade I is characterized by micro-movements at the beginning of the arc of movement, with the physiological effect of inputing neurological information through mechanoreceptors, by activating the spinal gating; grade II show large movements in the middle of the arc that, besides activating spinal gating, stimulate venous and lymphatic return, thereby causing joint clearance; grade III show movements over the whole arc, causing the same effects as in grade II, plus stress in the shortened tissue due to adherences; grade IV demonstrate micro-movements at the end of the arc that promote tissue stress capable of moving fibrotic tissue slightly. These four grades are classified as joint mobilizations; grade V relates to joint manipulation, demonstrates minuscule high-speed movement in the middle of the arc that promotes the breakage of adherences, activate Golgi tendon organs and may drastically alter the condition of the tissues surrounding the joint.

Therefore, joint mobilizations of grades II and III have the aims of directing the tissue remodeling process, reducing the proliferation of fibrosis tissue and decreasing the formation of crossed collagen bridges and tendon adhesions to tissues that surround it. This also influences the fluid dynamics, which help to decrease the accumulation of inflammation by-products and thus modulate the pain processes[18,19].

However, studies attempting to investigate the influences of this manual therapy technique on degenerative tendon diseases are scarce[1]. Thus, the objectives of this study were to investigate the influences of joint mobilization through accessory movements of the shoulder, on the initial recovery of patients with chronic tendinopathy of the supraspinatus and/or biceps brachii muscles, by comparing two treatment protocols composed of applications of therapeutic ultrasound to the affected tendon areas and eccentric training for these muscles, with or without accompanying joint mobilization maneuvers.

Materials and methods

This study was developed in the Physical Therapy Section of Hospital das Clínicas, Ribeirão Preto School of Medicine, University of São Paulo (HC/FMRP-USP), with approval from the ethics committee of this hospital under procedure number 12043/2006.

Subjects

Patients referred for physical therapy by the orthopedics clinic of HCFMRP-USP, with a diagnosis of tendinopathy of the supraspinatus and/or biceps brachii muscles, were preselected for this study. They then underwent screening to determine whether they could be included within the study protocol. All patients signed an informed consent statement. Thus, 14 patients of both genders and a mean age 46.14±7.62 years were used. They were randomly selected to participate in one of the treatment protocols (A or B). After randomization, a physical therapy evaluation was performed. Group A was composed of seven patients (three men and four women) with a of mean age 43.57±7.59 years and group B was made up of seven patients (two men and five women) with a mean age 48.71±7.27 years.

Inclusion criteria

The patients selected were adults who had shoulder pain and/or dysfunctions for over six months, but did not have a diagnosis of a frozen shoulder. They demonstrated pain on palpation of the supraspinatus and/or biceps brachii muscle tendons and were positive in one or more special tests for detecting dysfunctions in the supraspinatus muscle tendon (like the Jobe[20] test) and biceps brachii muscle tendon (like the Speed test and Yergason[21] test).

Exclusion criterion

Patients were excluded who, during a previous evaluation, showed a diagnosis of total rupture of one or more tendons of the rotator cuff, or closed calcified tendinopathy diagnosed by imaging.

Physical therapy evaluation

The physical therapy evaluation was based on both objective and subjective methods. A physical-functional evaluation was performed, including anamnesis, physical examination and goniometry of the whole upper limb in question. The presence of local edema or visual abnormalities in the shoulder area; pain on palpation or movement of the glenohumeral, acromioclavicular and sternoclavicular joints; and pain on palpation of muscle, tendon and bone prominences of the shoulder region, were investigated and the Yergason, Speed, Jobe special tests were performed. In addition, two methods for measuring the functional capacity of the upper limbs (the DASH[7] and Constant[8] questionnaires) were applied.

Intervention procedures

As mentioned earlier, two treatment protocols were performed: A and B. Group A received intervention with the use of therapeutic ultrasound, eccentric muscle training and joint mobilization for the accessory movements of the shoulder; while group B only received therapeutic ultrasound and eccentric training.

Both protocols had duration of ten sessions (three sessions per week) and, at the end, the patients were reevaluated using the same evaluation criteria and the interventions were concluded within four weeks.

The Sonacel Dual® therapeutic ultrasound equipment (Bioset®) was used, set at a frequency of 3MHz[11], with a SATA dosage of 1.0W/cm^2 and a pulsed exit of 1:1 (50%). Ultrasound was applied for three minutes to the supraspinatus muscle tendon or for four minutes to the tendon of the long head of the biceps brachii muscle, over areas of approximately 10.5 or 14cm^2, respectively to the supraspinatus or biceps brachii muscle. With this equipment, the effective radiation area of the transducer (ERA) was 3.5cm^2. Thus, the total emitted energy was 900 or 1600J, resulting in emitted energy densities of 60 J/cm^2 in both cases[22]. The dosage was applied by direct contact, using the contact medium of ultrasound transmission gel prepared within the Pharmacy Section of HCFMRP-USP, with continuous movement of the transducer[11].

The eccentric training was done by means of the "empty can" movement (the patient performs abduction movements of the shoulder in the scapular plane, with medial rotation), when treating the supraspinatus muscle[20,23], or the "right curl" movement (the patient flexes his elbow, with the arm abducted beside the body) when treating biceps brachii dysfunctions[24]. Movement resistance was offered manually, always by the same researcher and respecting the patient's pain limit. Three series of 20 repetitions were done in every treatment session.

Joint mobilization for group A patients was done in relation to the accessory movements of the shoulder: front, back, lower longitudinal and lateral relaxations of the glenohumeral joint, anteroposterior movements of the acromioclavicular (squeeze) joint and anteroposterior, inferior-superior and superior-inferior movements of the sternoclavicular joint[19]. During the treatment, the following series was applied twice every session: one minute of mobilization for each movement (two to three cycles per second)[19], and one minute of active free abduction movement in the scapular plane, over the arc of movement without pain.

Statistical analyses

For statistical investigation of the data obtained from the applied questionnaires, a linear model of mixed effects (random and fixed effects) was used. This analysis of the data was such that the responses from a single individual were grouped, and the supposition of independence between observations within the same group was inadequate[25,26]. The fixed effects were considered to be the group, time and questionnaire; the individual was the random effect. For this model to be used, it was necessary for its residuals to have normal distributions with zero mean and constant variance[25-27].

Results

In regard to group A, the DASH and Constant questionnaires were used in an initial evaluation, obtaining mean scores of 47.88±9.05 and 62.86±9.39, respectively. After applying the treatment protocol, the individuals were re-evaluated and scores of 7.31±4.79 for DASH and 84.43±6.97 for Constant were obtained, thus resulting in statistically significant differences ($p<0.001$) between the beginning and end of the treatment (Figures 1 and 2).

In regard to group B, the mean scores of 42.28±8.49 for DASH and 59.57±6.83 for Constant were obtained in the initial evaluation, and 22.31±8.40 and 74.14±5.18 in the reevaluation for each of the questionnaires, which also demonstrated statistically significant differences ($p<0.001$) between the beginning and end of treatment (Figures 1 and 2).

Comparisons between the treated groups showed that there were no significant differences between the initial treatment scores for the two questionnaires. However, there were statistical differences ($p=0.021$ and $p=0.004$) between the final scores from the Constant and DASH questionnaires, respectively.

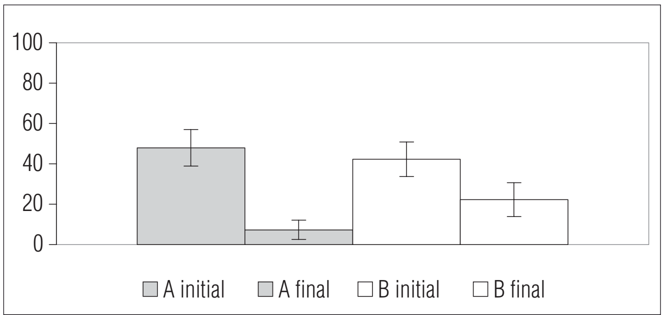

Figure 1. Comparisons between Disabilities of the Arm, Shoulder and Hand (DASH) index scores for the two groups, from assessments before and after the treatment.

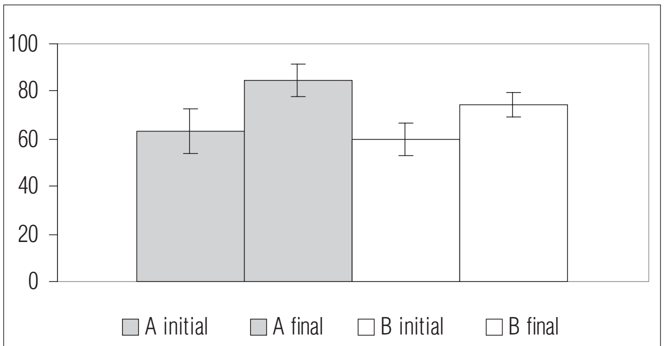

Figure 2. Comparisons between Constant questionnaire scores for the two groups, from assessments before and after the treatment.

Discussion

In the present study, the results showed that the proposed treatments were effective, comparing the initial and final scores from the questionnaires applied to the two treatment groups (A and B). There is controversy in the literature regarding the beneficial effects from therapeutic ultrasound on degenerative injuries of the shoulder[11-13] and the effectiveness of eccentric training for shoulder complex tendon dysfunctions[28]. However, the present study showed that the associations of the two techniques (protocol B), under clinical supervision, was effective for functional improvement among the patients treated. Statistical differences ($p<0.001$) could be seen between the initial and final scores of the two applied protocols.

Supervision of the eccentric training on an outpatient basis was advantages regarding the patients' assiduity and commitment, considering that none of them gave up during the treatment. On the other hand, only 56% of patients who began the 12 weeks of home treatment proposed in Alfredson's protocol[1,15,16,28] for supraspinatus muscle dysfunction[28] reached the end of the treatment. Notably, the present protocol was briefer, was concluded in four weeks, and was less tiring for the patients, which therefore made it more effective.

When joint mobilization techniques were added to the treatment (protocol A), the functional gains were even more significant, with statistically significant differences between the final scores for both applied questionnaires, between the two groups. The use of joint mobilization enables the physiological effects of neurological information input through mechanoreceptors, thereby activating spinal gating, stimulating the venous and lymphatic return, placing stress on shortened tissue through adherences, allowing breakages of adherences and drastically changing the condition of the tissues surrounding the joint[19].

Thus, in the sample studied, both of the treatment protocols were effective in the initial treatment (pain relief, gain of range of motion, improvement in shoulder function in daily life activities and strength gain) on chronic shoulder tendinopathy. The associated use of joint mobilization seemed to offer better functional results. However, new studies with the same methodology and larger samples will be useful to reinforce the results.

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