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Does adding mobilization to stretching improve outcomes for people with frozen shoulder? A randomized controlled clinical trial

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Abstract

Objective: To assess the effectiveness of joint mobilization combined with stretching exercises in patients with frozen shoulder.
Design: A randomized controlled clinical pilot trial.
Setting: Department of Orthopedics and Traumatology.
Subjects: Thirty patients with frozen shoulder.
Intervention: All participants were randomly assigned to one of two treatment groups: joint mobilization and stretching versus stretching exercises alone. Both groups performed a home exercise program and were treated for six weeks (18 sessions).
Main measures: The primary outcome measures for functional assessment were the Disabilities of the Arm, Shoulder and Hand score and the Constant score. The secondary outcome measures were pain level, as evaluated with a visual analog scale, and range of motion, as measured using a conventional goniometer. Patients were assessed before treatment, at the end of the treatment, and after one year as follow-up.
Results: Two-by-two repeated-measures ANOVA with Bonferroni corrections revealed significant increases in abduction (91.9° [CI: 86.1-96.7] to 172.8° [CI: 169.7-175.5]), external rotation (28.1° [CI: 22.2-34.2] to 77.7° [CI: 70.3-83.0]) and Constant score (39.1 [CI: 35.3-42.6] to 80.5 [75.3-86.6]) at the one-year follow-up in the joint mobilization combined with stretching exercise group, whereas the group performing stretching exercise alone did not show such changes.
Conclusion: In the treatment of patients with frozen shoulder, joint mobilization combined with stretching exercises is better than stretching exercise alone in terms of external rotation, abduction range of motion and function score.

Keywords

Adhesive capsulitis, manual therapy, exercise, shoulder pain, shoulder function

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Introduction

Frozen shoulder, or adhesive capsulitis, is a condition that causes restriction of function and motion in the shoulder joint, affecting many activities of daily living. The prevalence of frozen shoulder is estimated to be two to five percent of the general population and is more prevalent in individuals who are 40 to 65 years of age, female, and have had a previous episode of frozen shoulder in the contralateral arm.[1] The cause of a frozen shoulder is not well understood, and it often occurs for unknown reasons. The pathogenesis of frozen shoulder may be provoked by chronic inflammation in musculotendinous or synovial tissue such as the rotator cuff, biceps tendon or joint capsule.[2] When frozen shoulder develops, the capsule that surrounds the shoulder joint becomes contracted, and the movement of the shoulder becomes painful. Some references indicate that spontaneous recovery may occur an average of two years after the onset of the condition,[3,4] whereas others have reported long-term limitations without spontaneous recovery.[5,6]

The treatment of frozen shoulder is lengthy and difficult for both patients and clinicians. Management of frozen shoulder has been attempted via many strategies, including joint mobilization, which improves tissue extensibility, increases the range of motion, modulates pain, reduces soft tissue swelling and inflammation, increases synovial fluid levels, and stimulates peripheral mechanoreceptors.[1,7] Furthermore, there is growing evidence supporting the effectiveness of joint mobilization techniques in the management of frozen shoulder. Most reports in the literature either compare different mobilization techniques to each other or compare joint mobilization to physical therapy modalities.[1] In addition, some studies have evaluated joint mobilization combined with home exercises or joint mobilization combined with active range of motion exercises.[1] However, no studies have compared joint mobilization combined with manual stretching exercises administered by a physical therapist versus stretching exercises alone in the treatment of frozen shoulder. In addition, a recent study by Page et al.[8] reported that the effects of combinations of manual therapy and exercise are unclear.

Joint mobilization is believed to produce mechanical effects, such as the realignment of collagen tissue, an increase in fiber glide and the dissolution of adhesions, that restore normal glenohumeral movement, decrease pain and improve function.[7] We therefore hypothesized that joint mobilization combined with stretching exercises is more effective for improving range of motion, function and pain levels. In this study, we assessed the effectiveness of joint mobilization combined with stretching exercise in the treatment of frozen shoulder.

Methods

Subjects

Participants were recruited in the Istanbul area of Turkey and were initially examined by orthopedic surgeons. Radiographic and magnetic resonance imaging results were assessed by the orthopedic surgeons to determine the presence of other pathologies. Subjects who fulfilled the following criteria were included in the study: (1) range of motion in external rotation, abduction and flexion less than 50% in comparison to uninvolved shoulder in one or more of three movement directions (i.e., abduction in the frontal plane, forward flexion, or external rotation at 0° abduction;[9,10] (2) normal radiographic results (anteroposterior and lateral views); (3) duration of complaint of more than three months; (4) ability to complete Disabilities of the Arm, Shoulder and Hand[11] questionnaires in Turkish. Subjects with the following conditions were not included in the study: (1) cervical radiculopathy and radiating pain from either the wrist or hand; (2) diabetes; (3) thoracic outlet syndrome; (4) rheumatological disorders; (5) fractures or tumors of either upper extremity; (6) neurological disorders that cause muscle weakness in the shoulder; (7) corticosteroid injections in the affected shoulder within the previous four weeks; (8) rotator cuff tears.

The sample size and power calculations were performed with the Instat sample size calculator. The calculations were based on a standard deviation of 13 points, a between-group difference of 15

points[12] (which represents the minimal clinically important difference of Disabilities of the Arm, Shoulder and Hand), an alpha level of 0.05, a β level of 20%, and a desired power of 80%. These parameters generated a sample size of at least 12 patients per group. Allowing for a conservative dropout rate, we recruited 30 subjects into the study.

Study protocol

Patients were randomly assigned to two groups using a computer-generated randomized table of numbers created prior to the beginning of the study. Individual, sequentially numbered index cards with the random assignment were prepared. The index cards were folded and placed in sealed opaque envelopes. Each envelope was then opened by a researcher who was blinded to the baseline examination findings, and treatment proceeded according to the group assignment.

Joint mobilization exercises

Join mobilization, specifically glenohumeral joint distraction, glenohumeral joint caudal glide, glenohumeral joint posterior glide, and glenohumeral joint anterior glide, was applied at a rate of two to three oscillations per second for one to two minutes. Every direction was repeated three to four times. For the first two weeks (six sessions), the joint mobilization exercises included grade I or II rhythmic oscillations applied only at the resting position, which is the joint position with the maximum play and in which the joint capsule and ligaments are most relaxed. During the following weeks, restricted positions where joint surfaces are in maximal contact with each other and grade III and IV oscillation techniques were used, depending on the level of tolerance and pain of each patient (supplementary material Appendix 1).[7]

Stretching exercises

The cyclic (intermittent) stretching technique was completed while the patients lay on the bed. Cyclic stretching is a relatively short duration stretch force that is repeatedly, but gradually, applied, released and then reapplied.[13–15] We tested 20-, 30- and 45-second durations for each cycle, but 20 seconds of stretching and 10 seconds of rest was found to be both tolerable and comfortable. Each direction (flexion, scapular plane abduction, external and internal rotation) was applied 10 times. The total stretching exercises lasted 20 minutes. There is no evidence providing a base guideline for the optimal frequency of stretching within a day or week. Our sessions occurred three times a week to minimize post-exercise soreness and tissue healing.

(1) Forward flexion: With the elbow flexed at 90 degrees, one hand was used to stabilize the scapula, and the other hand was placed on the distal arm to force shoulder flexion. (2) Scapular plane abduction: The elbow was flexed at 90 degrees, one hand stabilized the axillary's border of the scapula, and the other hand grasped the distal humerus to force a shoulder abduction. (3) External rotation in the scapular plane: The arm was placed in the scapular plane, and the elbow was flexed at 90 degrees. One hand was placed on the head of the humerus, and the other hand was placed on the mid-forearm to force it into external rotation. (4) While the patient was placed in a half-side lying position, an internal rotation force was applied on the mid-forearm.

Home exercises

Both groups performed the same home exercise program twice per day with 10 repetitions of each movement. We taught the patients how to stretch with a low load, duration and frequency of stretching. The duration and load of the stretching depended on the patients' tolerance and pain. Strengthening exercises for the scapulothoracic and rotator cuff muscles with tubing were performed twice a day, with 10 repetitions of each movement and application of a cold pack for pain. The patients were advised to continue the home exercise program for at least one year after the treatment.

The home exercises were as follows: (1) self-stretching: shoulder flexion on the table; (2) self-stretching: shoulder abduction on the table; (3) self-stretching: internal rotation of the shoulder (sleeper stretch); (4) posterior capsule stretching;

(5) scapular retraction with tubing; (6) external rotation with tubing; (7) extension with tubing; (8) wall and table push-ups; (9) scapular adduction in prone position.

The stretching and joint mobilization group, who received joint mobilization and stretching exercise, were treated by the same physical therapist, who had seven years of experience in joint mobilization techniques. The patients in the stretching and joint mobilization group were treated with 30 minutes of joint mobilization and 20 minutes of stretching exercises per session. The patients in the stretching group received manual stretching administered by a physical therapist. All subjects received treatment at the clinic three times per week (18 sessions).

Outcome measures

The primary outcomes were the Disabilities of the Arm, Shoulder and Hand[16] and the Constant[17] score. The Disabilities of the Arm, Shoulder and Hand[16] questionnaire is a 30-item scale of disability symptoms used to assess a patient's health status. The scores obtained from all items are then used to calculate a score ranging from 0 (no disability) to 100 (most severe disability). The Constant[17] scale is a widely used numerical scale to assess overall shoulder functionality and comprises pain, activities of daily living, active range of motion and abduction strength measurement subscales. The total Constant score ranges from 0 to 100, with higher scores indicating healthier function.

The secondary outcomes were range of motion assessment and pain. The passive range of motion of each subject, including abduction in the frontal plane, forward flexion, external and internal rotation in 30° abduction, was measured as described by Clarkson et al.[18] with a conventional goniometry. Levels of pain were assessed using the visual analog scale, in which a patient is asked to indicate his/her perceived pain during the daily living activities. Pain intensity is measured from left to right, with 0 indicating no pain and 100 indicating severe pain.

Assessments were made by another therapist without knowledge of the study groups or the procedures. Outcomes were measured at baseline, at the end of treatment (six weeks), and at a one-year follow-up.

Statistical analyses

The data were evaluated using the Statistical Package for the Social Sciences 20.0 program for Windows and by analyzing descriptive statistics (frequency, mean and standard deviation). Before the statistical analysis, a Kolmogorov–Smirnov Test was used to assess the distribution of data. Our data were found to be normally distributed, so a parametric test was used for statistical analysis. Demographic comparisons of the two groups were conducted using a Chi-square analysis for categorical variables and independent t-tests for continuous variables. For continuous variables, the mean outcome and their 95% confidence intervals were calculated at baseline and follow-up. The primary analyses, 2×2 repeated-measures ANOVA and 3×2 repeated-measures ANOVA with time (baseline and end of treatment and baseline, end of treatment, and one-year follow-up, respectively) as the within-subjects variable and group (stretching, stretching and joint mobilization) as the between-subjects variable, were used to examine the effects of interventions on range of motion values, pain and functional outcomes using Bonferroni equality at an alpha level of 0.05. The between-group effect sizes were calculated using partial eta squared. An effect size of 0.2 was considered small, 0.5 moderate and 0.8 large. *P* values lower than 0.05 were considered as statistically for all analysis. The study protocol complied with Helsinki rules on human research and was approved by the Ethics Committee in Istanbul University, Istanbul, Turkey.

Results

Forty-two consecutive patients were screened for possible inclusion. Of these, 12 did not meet the inclusion criteria, resulting in a total of 30 patients included in the study; 15 were randomized to the intervention group and 15 to the control group. Four of them discontinued treatment; therefore, 26 subjects were analyzed at six weeks and at the one-year follow-up; please refer to the CONSORT

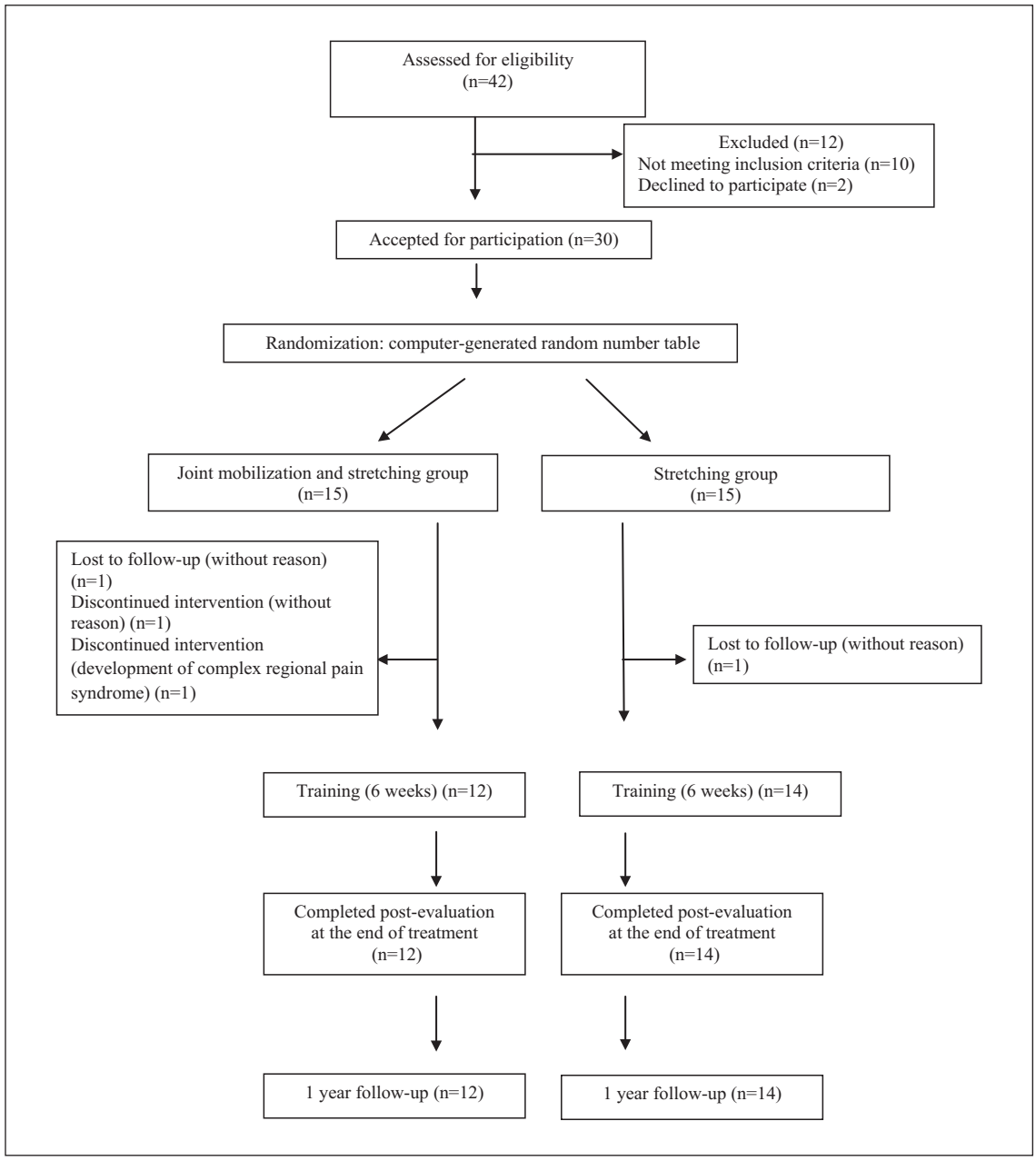

Figure 1. Design of the study (CONSORT flow diagram).

flow diagram (Figure 1). The mean duration of the symptoms was 15.7 (14-21) weeks. The demographic data of the participants are presented in Table 1.

Significant differences were analyzed, with the abduction range of motion (P=0.001, F=14.290), external rotation range of motion (P=0.02, F=6.052) and Constant score (P=0.04, F=4.686)

Table I. Demographic Features.

	Stretching and joint mobilization	Stretching	*P* value
Age, years (mean±SD)	54.2±7.9	54.8±6.4	.71*
Duration of the symptoms	16±2.2	15.4±2.0	.49*
Female/Male	9/3	9/5	.43†
Dominant side R/L	8/4	13/1	.23†
Involved dominant/non-dominant	8/4	9/5	.61†

Values are expressed as the mean±SD or n.
R: Right, L: Left.
*Independent t-tests for between-group comparison.
†Chi-square test for between-group comparison.

increasing significantly from baseline to the end of treatment. This increase continued from baseline to the one-year follow-up (Table 2).

The group-by-time interaction for the 3×2 repeated-measures ANOVA was statistically significant for the abduction range of motion ($F = 9.129$, $P=0.02$), external rotation range of motion ($F = 4.695$, $P=0.02$) and Constant score ($F = 6.439$, $P=0.001$). Patients receiving the combination of stretching and joint mobilization intervention demonstrated a greater increase in abduction and external rotation range of motion and greater increase in Constant score compared to those receiving the only stretching exercise group. Between-group effect sizes were small and moderate for significantly improved outcomes (Table 2).

Discussion

Based on this study, it appears that joint mobilization combined with stretching exercise is more effective than stretching exercises alone in improving abduction range of motion, external rotation range of motion, and Constant score at the end of treatment and at one-year follow-up. The data from the present study indicate that the improvements were based on the effect of joint mobilization. However, the magnitude of effect sizes ranged from small to moderate.

Joint mobilization has received considerable attention in the management of frozen shoulder in recent years.[19,20] In their systematic review covering the years 1985–2014, Page et al.[8] discuss 22 studies related to joint mobilization or manipulation methods in frozen shoulder. There is no consensus or advice on which type of joint mobilization should be used in the management of frozen shoulder.[24] Although some studies have compared different types of joint mobilization, others often compared mobilization with home exercises, active exercise or supervised exercises for the treatment of frozen shoulder.[21–27] Vermeulen et al.[21] found that high-grade mobilization was effective to improve passive abduction at a one-year follow-up, but Yang et al.[22] reported that end-range mobilization or mobilization with movement is effective to improve arm elevation, humeral external and internal rotation and scapulohumeral rhythm at 12 weeks of follow-up. Johnson et al.[23] found that posterior glide joint mobilization was superior to anterior glide joint mobilization for external rotation. Nicholsan et al.[25] and Maricar et al.[26,27] used mobilization combined with active exercises in addition to their mobilization techniques. Both of those studies found that joint mobilization was more effective when combined with active exercises to increase range of motion and function. To date, however, no study has compared joint mobilization combined with stretching exercises versus only stretching exercises. We used joint mobilization techniques from the aforementioned studies but also added stretching exercises to our program and found significant increases in passive external rotation and abduction range of motion in our study at the one-year follow-up, similar to the results of previous studies.[21–23,25–27] However, due to positive effects of adding stretching exercises, our achievements in range of motion were better than those reported in the literature.

Table 2. A comparison of passive range of motion, visual analog scale, Constant score and Disabilities of the Arm, Shoulder and Hand between groups.

Assessment	Group	Baseline	End of treatment	Repeated-measures ANOVA		1 year follow-up	Repeated measure ANOVA		Effect sizes
		Mean (95% CI)	Mean (95% CI)	F	P[a]	Mean (95% CI)	F	P[b]	
Flexion	**Str-Mob**	126.6 (107.7–141.1)	172.0 (167.8–175.4)	0.914	0.14	177.1 (174.9–178.5)	2.310	0.12	0.16
	Str	129.4 (116.8–140.8)	159.9 (153.6–166.5)			168.9 (164.1–173.6)			
Abduction	**Str-Mob**	91.9 (86.1–96.7)	154.1 (141.6–164.2)	14.290	**0.001**	172.8 (169.7–175.5)	9.129	**0.001**	0.44
	Str	99.2 (83.1–115.3)	139.8 (125.5–154.4)			159.2 (145.0–173.4)			
External-rotation	**Str-Mob**	28.1 (22.2–34.2)	70.5 (61.8–76.9)	6.052	**0.02**	77.7 (70.3–83.0)	4.695	**0.02**	0.29
	Str	35.7 (27.6–44.2)	66.2 (57.8–73.9)			72.2 (64.4–79.5)			
Internal-rotation	**Str-Mob**	35.1 (29.2–41.2)	71.1 (65.4–76.9)	0.888	0.09	82.7 (79.2–86.4)	1.734	0.19	0.13
	Str	45.1 (34.1–55.4)	71.2 (63.8–77.6)			82.0 (76.3–87.1)			
Visual Analog Scale	**Str-Mob**	5.3 (3.8–6.8)	0.4 (0.08–0.8)	0.271	0.60	0.2 (0.0–0.5)	1.719	0.20	0.13
	Str	5.3 (4.3–6.2)	0.9 (0.5–1.4)			0.4 (0.1–0.6)			
Constant Score	**Str-Mob**	39.1 (35.3–42.6)	80.5 (75.3–86.6)	4.686	**0.04**	92.4 (88.2–96.2)	6.439	**0.006**	0.35
	Str	34.6 (30.8–38.5)	64.7 (56.9–72.9)			75.2 (69.7–80.9)			
Disabilities of the Arm, Shoulder and Hand Score	**Str-Mob**	50.7 (37.5–63.4)	14.4 (10.2–19.2)	0.364	0.55	5.1 (3.1–7.5)	0.411	0.66	0.03
	Str	54.3 (43.8–63.5)	22.3 (17.0–27.6)			11.5 (7.5–15.3)			

Function is the most important outcome of treatment. However, various outcome measurements are used in the literature to assess function in frozen shoulder, including the Shoulder Rating Questionnaire,[21] the Flexi-level Scale of Shoulder Function,[22] and the Shoulder Pain and Disability Index,[26] making it difficult to compare our results with the literature. Regardless, all of the studies reported that function was improved with treatment. We used the Constant score and the Disabilities of the Arm, Shoulder and Hand questionnaire for functional assessment. The Constant scores were significantly better in the group that received joint mobilization combined with stretching exercise, but we did not find a similar improvement for the Disabilities of the Arm, Shoulder and Hand questionnaire. This discrepancy may be due to the content of the outcome measure, as the Disabilities of the Arm, Shoulder and Hand questionnaire assesses mostly daily activities and does not depend on improved range of motion.

Clinically, frozen shoulder is generally treated with glenohumeral stretching exercises; however, there are differing opinions regarding the appropriate intensity and degree of these exercises. Starring et al.[28] reported that cyclic stretching was more comfortable than a prolonged static stretch because it is applied at a slow velocity, in a controlled manner and at relatively low intensity, thus resulting in optimal rates of range of motion impairment without injuring the tissue.[29] In our study, we applied the cyclic stretching program in accordance with the pain threshold of each patient. During our study, each subject received 20 minutes of stretching by a physiotherapist during each session.

One of the keys to the success of the treatment of approach is to gain neuromuscular dynamic control over the newly gained range of motion and function. Therefore, the patients must perform some stretching and strengthening exercises at home to maintain the gained range of motion. For this purpose, we selected certain exercises as a home program and encouraged the patients to perform these exercises. The patients were asked at each session whether they had done the exercises and were encouraged to participate in the home exercise program. Our results showed that the patients in both groups demonstrated improvement in all of the outcomes measured from the end of the treatment to the one-year follow-up, perhaps due to their participation in the home program.

This study has certain limitations. First, our sample size was diminished due to the 13.3% dropout rate of the patients. Second, though we encouraged the patients to conduct the home exercise program and followed up with them, we cannot be sure that they performed the program correctly. Third, although we required the patients to not take any analgesics during the treatment, except for two weeks of taking NSAIDs, we simply accepted their declarations that they complied with this requirement. Fourth, we did not assess the patients between the six weeks of treatment and the one-year follow up, and the results of the treatments may have been achieved prior to the one-year follow-up. Fifth, joint mobilization may require skilled therapy and experience and is a time-consuming application; therefore, it may not be suitable for every clinician. Sixth, joint mobilization is a very expensive technique compared to conventional treatment. The strength of the present study is that we followed up with our patients at one year because recovery from frozen shoulder requires a long time. Nevertheless, except for the study by Vermullen et al.,[21] the literature reports short-term results for these patients.

This study found that joint mobilization in addition to stretching exercises has a significant impact for increasing the abduction and external rotation range of motion and Constant score for patients with frozen shoulder. Although the subjects improved significantly with either treatment intervention, the functional results were better in the group that received joint mobilization combined with stretching exercises. Future studies are needed to compare stretching exercises performed by a physical therapist to joint mobilization exercises alone.

Clinical message

- In patients with frozen shoulder, adding active mobilization exercises to a program of stretching carried out over six weeks leads to an immediate improvement in pain and function. The beneficial effects remain evident one year later.

Conflict of interest

The authors declare that there is no conflict of interest.

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