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Comparison of the outcomes of two different exercise programs on frozen shoulder

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Objectives: The aim of the study was to compare the effects of two different exercise programs on pain, range of motion (ROM), and functional results in frozen shoulder.

Methods: Twenty-two female and 7 male patients [mean age 52.1 years (range 38-65 years)] were randomly allocated into two groups: 14 in the first group and 15 in the second group. The patients were treated for 6 weeks (30 sessions) at hospital under the supervison of physical therapist. Both groups were treated with transcutaneous electrical nerve stimulation, cold pack, and nonsteroidal antiinflammatory drugs; and were given glenohumeral ROM exercises. The scapulothoracic exercises were performed only by the second group. Functional results were assessed using the modified Constant score, pain was assessed using visual analog scale (VAS), and ROM was measured with a goniometer. Assesments were performed before treatment and repeated at 6 and 12 weeks of treatment.

Results: In both groups, the Constant score and ROM were increased, and VAS was decreased at the end of 6 and 12 weeks. The modified Constant score was not significantly different between the groups before and after treatment. VAS score was better in the second group at 6 weeks ($p<0.01$). Improvement in ROM was significantly better in the second group at 12 weeks ($p=0.005$).

Conclusion: In addition to glenohumeal ROM exercises, scapulothoracic exercises contribute to decreasing pain and increasing ROM in patients with frozen shoulder.

Key words: Frozen shouder; joint stiffness; pain; scapulothoracic exercises.

Frozen shoulder, also known as adhesive capsulitis, is a disease of unknown etiology, which is characterized by pain and decreased active and passive range of motion (ROM). The clinical findings, course, and prognosis of this disease are well-known. Frozen shoulder may be primary or secondary. Primary frozen shoulder is idiopathic, whereas secondary frozen shoulder has a known cause, such as immobilization, rotator cuff disease, biceps tendinitis, trauma, myocardial infarction, or psychologic disturbances.

Capsular adhesions, soft tissue contractures, and adhesions in axillary space contribute to the pathogenesis of the frozen shoulder.[1] According to Cyriax,[1] the thickening of the joint capsule results in partial restriction of the joint movements, particularly by affecting external rotation and abduction. The disease has 3 phases of clinical presentation. The characteristic feature of the first phase is pain. During the second phase, there is a decrease in pain and ROM. The third phase is characterized by only decreased ROM.[2]

The treatment of the frozen shoulder may be either conservative or surgical. Conservative treat-

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ment includes various exercise methods and physical therapy modalities such as hot-cold therapy,[3] transcutaneous electrical nerve stimulation (TENS), ultrasound (US), acupuncture,[4,5] and laser.[6] Exercise programs consist of active and passive ROM exercises, stretching exercises guided by a physiotherapist, self-stretching, manipulation and mobilization techniques, strengthening exercises, patient education, and home exercises.[7] Intra-articular injections and capsular and arthrographic distension[8] are also methods used in conservative treatment. In patients without complete recovery after conservative treatment, surgical procedures such as manipulation and arthroscopic or open capsular release can be performed under general anesthesia.[9]

In most exercise programs, the goals are to relieve pain and to improve the decreased glenohumeral ROM resulting from capsular contracture. However, it is also known that limited glenohumeral movement leads to an increase in scapulothoracic movement.[10] During the 3-dimensional kinematic analysis of scapular movements in frozen shoulder, increased external rotation and protraction of the scapula have been noted.[11,12] The kinematic analysis of an another study showed that there was significant impairment of humeral movements in patients with frozen shoulder in comparison to the control group.[13] Such kinematic alterations cause a disruption in normal scapulothoracic rhythm.

Until recently there was no exercise program proven effective for impaired scapular movement in conservative management of frozen shoulder. In this study, as we restored impaired scapulothoracic motion by scapulothoracic strengthening, mobilization, and stretching exercises, we investigated the effects of this program on pain, ROM, and functional status.

Patients and methods

Twenty-two female and 7 male patients (mean age 52.1 years, range 38-65 years) were included in this study. Patients were examined for the first time by different orthopedists from İstanbul Faculty of Medicine, Department of Orthopedics and Traumatology who are specialized in shoulder. The radiographic and magnetic resonance imaging (MRI) findings of the patients were evaluated as well.

Inclusion criteria were: 1) ROM in external rotation, abduction, and flexion less than 50% in comparison to the other shoulder; 2) normal radiography (anteroposterior, lateral); 3) secondary frozen shoulder diagnosis with MRI showing a small rotator cuff tear; and 4) secondary frozen shoulder with type II subacromial impingement syndrome on physical examination and MRI. Exclusion criteria were: 1) radiculopathy, 2) thoracic outlet syndrome, 3) rheumatologic disorders, 4) fractures and tumors of the upper extremity, and 5) neurological disorders causing muscle weakness in the shoulder. The patients provided written informed consent.

The patients were divided randomly into two groups. The exercise programs of the groups were as follows:

Group I: Glenohumeral ROM exercises.

Group II: Glenohumeral ROM and scapulothoracic exercises.

The results of the treatment were evaluated with modified Constant score and visual analogue scale (VAS) before the beginning of the treatment and at 6 and 12 weeks; ROM (flexion and internal and external rotation) was measured with a goniometer passively at the same intervals. Since the patients had limited movement and abduction <90° in shoulder before the treatment, the strength parameter could not be assessed; hence the modified Constant score was used.[14]

The clinical phase of frozen shoulder was determined for each patient, and a 6-week (30 sessions) treatment approach was planned accordingly.

The intensity of scapulothoracic exercises was gradually increased according to the pain and muscle strength of the patient. Exercises were as follows:

1. Scapular retraction with exercise band (Fig. 1)
2. Extension with exercise band (Fig. 2)
3. Scapular adduction and elevation (Fig. 3)
4. Wall, table, and floor push-ups (Fig. 4)
5. Scapular stabilization with exercise ball in upright standing position (Fig. 5)
6. Scapular adduction in prone position
7. Extension in prone position
8. Scapular protraction in supine position
9. Push-up in sitting position
10. Scapular abduction in upright standing position

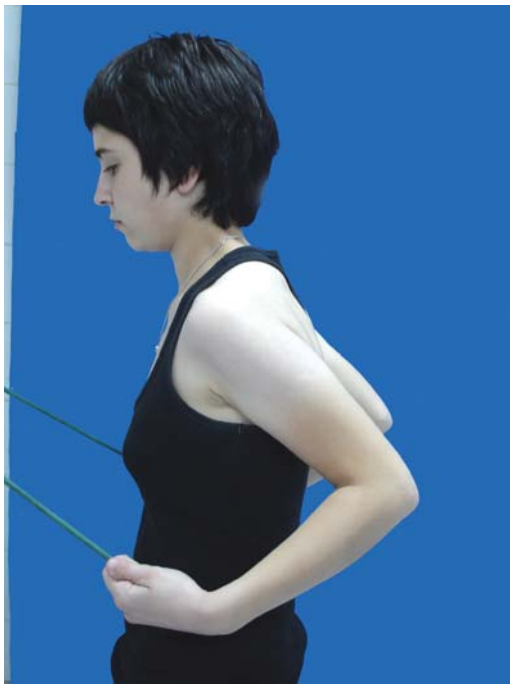

Fig. 1. Scapular retraction with exercise band.

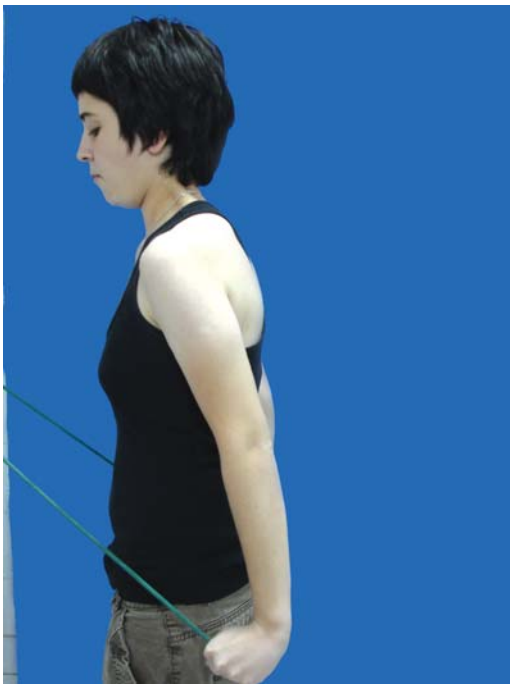

Fig. 2. Extension with exercise band.

Both groups were given passive or active assistive ROM and pulley exercises led by physiotherapists at minimum pain level. After exercises and 20 min of TENS, a cold pack was applied in the clinic. Depending on the pain status of the patient, active assistive ROM exercises were given as home program, and cold application was added to the home program in periods of 15 min 3 times a day. Patients were also given nonsteroidal antiinflammatory drugs (NSAIDs).

The intensity of the exercises was increased gradually, depending on the functional and pain status of the patients. In addition to the exercises in the clinic, the patients were also given self-stick exercises, posterior and inferior capsule stretching exercises, flexion, scapular elevation, and internal and external rotation exercises. Besides manual stretching exercises, proprioceptive neuromuscular facilitation (PNF), and phase I gliding exercises were assisted by physiotherapists, and stick exercises and self-stretching exercises were given as home program. TENS and cold applications were continued.

In addition to the exercises given to group I, the second group received additional exercises such as scapulothoracic strengthening (serratus anterior, middle and lower trapezius, latissimus dorsi), upper trapezius stretching, and postural exercises.

From the beginning of the 5th week of the treatment, the dose of the stretching exercises was increased in both groups considering pain levels of the patients. TENS and NSAID were terminated. Cold pack was applied only when the patient had pain. The frequency and intensity of the scapulothoracic exercises for group II were increased.

The exercises were carried out once a day and 5 times a week in the clinic under the supervision of a physiotherapist. In addition patients followed the exercise program at home twice daily with 20 repeats. Comparison between groups was made using the Mann-Whitney test, and the Wilcoxon signed rank test was used to evaluate the groups separately.

Results

Group I consisted of 5 male and 9 female patients (mean age 54.78 years, range 42-65 years), and group II consisted of 2 male and 13 female patients (mean age 49.6 years, range 38-62 years).

In the first group, there were 9 patients with right-sided frozen shoulder and 5 with left-sided frozen

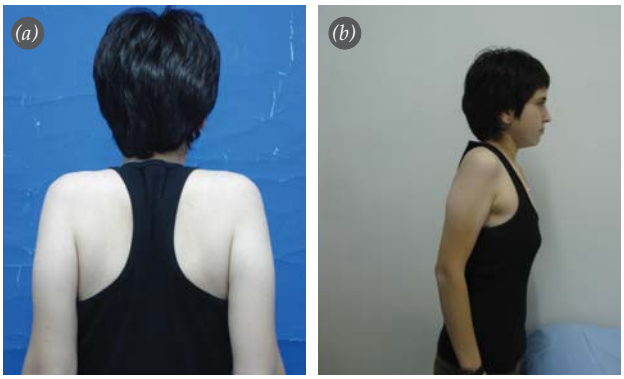

Fig. 3. (a, b) Scapular elevation and adduction (posture exercise).

Fig. 4. (a, b) Wall, table, and floor push-ups.

shoulder. In 10 of the patients, the affected side was the dominant shoulder. Only 5 patients had secondary frozen shoulder in the first group. Two patients in this group had diabetes, and 1 had thyroid disease.

The second group consisted of 3 patients with right-sided frozen shoulder and 12 with left-sided frozen shoulder. In 4 of the patients, the affected side was the dominant shoulder. Ten of the cases were secondary frozen shoulder; 2 patients in group II were diagnosed with diabetes (Table 1).

When the groups were evaluated separately, both groups showed significant improvement at the end of the 6 and 12 weeks of treatment according to the modified Constant score, VAS, and ROM findings.

When the groups were compared, there was no statistically significant difference in modified Constant score at weeks 0, 6, or 12. VAS was improved at 6 weeks in group II; the difference was statistically significant (p=0.05) (Table 2). At 12 weeks, group II showed improved ROM of flexion compared with group I; this difference was also statistically significant (p=0.005) (Table 3).

Discussion

Both groups showed improvements in VAS, modified Constant score, and ROM. Using scapulothoracic exercises in addition to glenohumeral ROM exercises in the second group resulted in significant improvements in VAS at 6 weeks and flexion ROM at 12 weeks.

Pain management is the primary concern in treatment during the first phase of frozen shoulder; improvement in ROM is the goal of the second and third phase. In addition, a careful history to distinguish between primary and secondary frozen shoulder is important in planning treatment. In this study there were 10 patients with primary frozen shoulder and 4 patients with secondary frozen shoulder in group I, and 5 patients with primary frozen shoulder and 10 patients with secondary frozen shoulder in group II.

Fig. 5. (a, b) Scapular stabilization with exercise ball in upright standing position.

There are many treatment options for treatment of frozen shoulder. It has been shown that cold pack, NSAIDs, TENS, corticosteroids and intra-articular injections to reduce synovial inflammation are effective in the early phase of pain management of frozen shoulder.[15-17] In our study, cold packs, NSAIDs, and TENS were used for pain control.

When pain was reduced in the second phase, the goal was to achive increasing ROM and muscle strength. There are many methods of increasing ROM. Callinan et al.[18] studied the effectiveness of hydroplasty and therapeutic exercises and concluded that they were effective when used together. In another study with a 4-week rehabilitation program, pain was diminished and muscle strength was increased.[19] In our study, pain was reduced and ROM was improved in both groups at 6 and 12 weeks. Muscle strength was not evaluated before treatment because of pain; it was therefore not assessed at 6 and 12 weeks.

Table 1

Age, primary and secondary frozen shoulder, diabetes, and thyroid disease distribution of the groups (mean or n)

	Group I	Group II
Age (years)	54.78	49.60
Primary frozen shoulder	10	5
Secondary frozen shoulder	4	10
Diabetes mellitus	2	2
Thyroid disease	1	0

In the second phase of treatment, pain was moderately improved, and the purpose of the treatment was to increase ROM. For this reason, stretching, propri-

Table 2

Change in VAS, modified Constant score, and range of motion with time (mean±SD)

	Group I	p value	Group II	p value
VAS				
0-6 week	-5.0±2.8	0.002	-6.0±2.3	0.001
0-12 week	-5.5±2.5	0.002	-6.0±2.1	0.001
6-12 week	-1±1.2	0.222	0.0±1.8	0.609
Modified Constant score				
0-6 week	26.0±15.6	0.002	29.0 ±12.6	0.001
0-12 week	38.5±16.5	0.001	44.0±14.0	0.001
6-12 week	12.0±9.4	0.002	13.0±7.1	0.001
Elevation ROM				
0-6 week	20.7±18.4	0.001	24.8±10.2	<0.001
0-12 week	27.6±18.8	<0.001	36.6±12.3	<0.001
6-12 week	-6.8±4.5	<0.001	11.8±11.4	0.001
ER ROM				
0-6 week	22.0±12.5	0.001	28.0 ±13.9	0.001
0-12 week	33.0±14.9	0.001	35.0±13.8	0.001
6-12 week	5.0±8.9	0.030	11.5±6.7	0.001
IR ROM				
0-6 week	19.0±15.5	0.001	23.0 ±13.2	0.001
0-12 week	22.5±16.4	0.001	35.0±14.5	0.001
6-12 week	50.4±6.7	0.003	12.0±8.9	0.003

VAS: Visual analogue scale, ER: External rotation, IR: Internal rotation, ROM: Range of motion.

Table 3
Intergroup VAS, modifed Constant score, ROM values (mean±SD)

	Group I	Group II	p value
VAS			
Week 0	6.00±2.0	7.20±2.4	0.286
6th week	1.50± 1.4	0.00±1.6	0.050
12th week	1.00±0.9	0.00±0.7	0.125
Modified Constant Score			
Week 0	28.50±9.5	27.00±10.7	0.662
6th week	53.00± 7.9	60.00±13.3	0.407
12th week	59.00±5.9	68.00±10.7	0.230
Elevation ROM			
Week 0	132.28±26.1	135.46±12.6	0.676
6th week	153.07± 13.0	160.33±14.7	0.173
12th week	159.92±13.1	172.13±7.4	0.005
ER ROM			
Week 0	41.50±9.5	30.00±10.3	0.482
6th week	61.50±7.9	60.00±14.7	0.827
12th week	67.50±5.6	70.00±12.5	0.442
IR ROM			
Week 0	46.5±22.2	50.0±10.7	0.982
6th week	70.00±3.3	70.00±9.2	0.810
12th week	78.00±3.9	78.00±8.4	0.210

VAS: Visual analogue scale, ER: External rotation, IR: Internal rotation, ROM: Range of motion.

oceptive neuromuscular facilitation, and glide I exercises were given to group I, and scapulothoracic strengthening and stretching exercises were given to group II to regulate scapulothoracic rhythm.

Even though scapular alterations have been assessed in patients with frozen shoulder in some studies, treatment programs were focused on pain relief and improvement in ROM. Scapulothoracic exercises were not included in any of these programs, but decreased glenohumeral ROM caused increased or compensatory scapulothoracic motions. According to Nicholson,[20] during humeral elevation, increased upper rotation has been reported in patients with frozen shoulder. In another study, early and increased external rotation was noted to compensate the ability of flexion and scapular and frontal plane abduction of glonohumeral joint.[11] Fayad et al.[12] performed early scapular external rotation during humeral elevation using a 3-dimentional kinematic analysis system.

The purpose of our study was to provide normal scapulothoracic rhythm while enhancing glenohumeral ROM. Usually, the scapulothoracic rhythm rate is 2:1; it is 4:1 at the 30-60° glenohumeral flexion; and it is 5:1 above 60° of flexion.[21] In frozen shoulder, these rates increase in favor of scapulothoracic joint. Glenohumeral joint mobility decreases with scapular adhesions; this prevents external rotation of humeral head, and the humeral head slides below the acromion during humeral elevation.[11] Throughout humeral elevation, the scapula reaches to the end of the range earlier than humerus because of glenohumeral impingement or restricted glenohumeral motion. In our study, we gave scapulothracic strengthening and mobilization exercises to the patients in group II to restore increased scapular

protraction, external rotation, and stretching exercises for the shorthened and contracted muscles, especially the upper trapezius. Flexion ROM was found better in the second group, who received scapulothoracic exercises. It can be hypothesized that scapulothoracic strengthening exercises restored normal scapulathoracic rhythm. In addition, the degree of pain was found significantly lower in the second group than that in the first group. In frozen shoulder, patients elevate the shoulder because of pain. This posture causes scapulothoracic muscle imbalance and usually shortening or contraction of upper trapezius and weakening of lower trapezius. This muscle imbalance leads to development of myofascial trigger points on the scapular muscles, particularly the upper trapezius muscles.[22,23] This may cause pain to be felt more than usual. Myofascial pain is relieved by performing scapulothoracic strenghtening, mobilization, and stretching exercises; this is likely the reason that the pain level in group II was signficantly better than that in group I.

There are some limitations in this study. Scapular alterations or dyskinesis was analyzed visually, but not with 3-dimentional motion analysis, which could give much more specific information.

In conclusion, scapulathoracic exercises in addition to glenohumeral exercises can be effective in decreasing pain and increasing glenohumeral ROM by fixing scapulohumeral rhythm. In future studies, scapulothoracic dyskinesis should be assessed, and myofascial trigger points and muscle imbalance should be considered a result of shoulder pain in planning and assessing treatment programs.

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