Frozen Shoulder: Correlation Between the Response to Physical Therapy and Follow-Up Shoulder Arthrography

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ABSTRACT. Mao C-Y, Jaw W-C, Cheng H-C. Frozen shoulder: correlation between the response to physical therapy and follow-up shoulder arthrography. Arch Phys Med Rehabil 1997;78:857-9.

Objective: To study the correlation between improvement of shoulder motion and shoulder joint space capacity determinated by arthrography.

Design: Case series.

Setting: General community hospital.

Patients: Twelve patients with clinically diagnosed frozen shoulder without rotator cuff tear. All subjects were divided as "primary" and "secondary" according to spontaneous onset or not, and "acute" or "chronic" depending on whether duration of disease was less than 2 months or longer.

Interventions: Outpatient rehabilitation programs, including physical modalities, exercise intervention, and regular weekly outpatient clinic follow-up.

Main Outcome Measures: Shoulder range of motion (ROM) and joint space capacity in shoulder arthrography.

Results: In acute patients, the joint space capacity increased significantly after treatment ($t = 2.82$; $p < .05$). Increased joint space capacity was most significantly correlated with improvement in external rotation ($r = .77$, $p < .05$), followed by abduction ($r = .43$, $p > .05$), but was poorly correlated with flexion and internal rotation. In chronic patients, both primary and secondary groups, there was no obvious joint space capacity increase despite significant shoulder motion improvement. Follow-up arthrograms showed the reappearance and/or enlargement of the axillary recess and smoother capular margins in all the patients except one chronic case (disease duration for 1 year). These findings were more obvious in acute than in chronic patients.

Conclusions: For frozen shoulder, generally described as "adhesive capsulitis," the adhesion was reversible in the acute stage. The increase of joint space capacity was significant and was correlated with improvement of external rotation. In chronic patients, ROM restoration occurred independent of change in joint space capacity, which increased slightly. The stretching of other contracted soft tissues around the shoulder, in addition to the adhesive capsule, may contribute to the recovery of chronic frozen shoulder.

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Submitted for publication June 17, 1996. Accepted January 20, 1997.

No commercial party having a direct financial interest in the results of the research supporting this article has or will confer a benefit upon the authors or upon any organization with which the authors are associated.

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0003-9993/97/7808-4067$3.00/0

FROZEN SHOULDER, first described by Neviaser in 1945,[1] is an insidious condition that begins with pain, then gradual restriction of all planes of movement in the shoulder. It is the main cause of shoulder pain and dysfunction in middle aged and elderly populations. The nondominant side is more frequently involved, and more women than men are afflicted with the syndrome.

The etiology is unknown. Lunberg[2] and Helbig et al[3] classified frozen shoulder as primary and secondary. The primary form is idiopathic, usually seen in women older than 45 years of age. Many predisposing factors can lead to secondary frozen shoulder, including upper extremity fracture with immobilization, cervical disc disease, diabetes meliitus, head injury, and stroke. Double contrast shoulder arthrography is the definitive diagnostic test for adhesive capsulitis. Joint capacity, normally 14mL or greater, is usually less than 10mL in adhesive capsulitis.[4,5]

The natural history of frozen shoulder includes three stages as described by Reeves.[6] In stage I, "the freezing stage," shoulder pain is the main problem. During stage II, "frozen stage," the pain gradually subsides, but range of motion (ROM) is limited prominently. In stage III, the "thawing phase," ROM is finally restored. The full course may take 1 to 3 years. The patients experience prolonged disability and muscle wasting. Therefore, aggressive rehabilitation programs are recommended by most authorities.[8-10]

Several treatments have been investigated, including oral nonsteroidal anti-inflammatory drugs (NSAIDs), intraarticular injections, physiotherapy, and manipulation under anesthesia.[11-13] Dacre et al[12] suggested that local steroid injections are as effective as physiotherapy alone or a combination. Lundberg[3] found intensive physical therapy after manipulation increased the rate of restoration and shortened the duration of the disease. Bulgen et al[11] reported, however, that there is little long-term advantage in any treatment regimen. Previous studies have focused on the natural history,[6,7] diagnosis,[4,5] or comparison of different treatments.[11-13] No reports have mentioned the correlation between the improvement of shoulder motion and imaging studies. In this prospective study, our purpose was to correlate the clinical improvement in ROM with follow-up shoulder arthrography to elucidate the possible pathological changes and reversibility of frozen shoulder.

MATERIALS AND METHODS

Subjects

We prospectively evaluated 18 patients with a clinical diagnosis of "frozen shoulder." Their ages ranged from 32 to 65 years (average, 52 yrs). The ratio of women to men was 2:1. The disease duration was 2 to 12 months. After physical examinations, all 18 patients met the following criteria: (1) history of pain and stiffness of the shoulder for more than 1 month; (2) shoulder pain elicited at terminal range in all planes of shoulder motion; (3) the ROM of the shoulder limited to flexion of $<140°$, abduction of $<120°$, internal rotation of $<70°$, and external rotation of $<50°$. Six patients were excluded because arthrograms showed rotator cuff tear, making it impossible to

Table 1: Improvement of Frozen Shoulder in Acute and Chronic Patients

	Acute Cases* (n = 7)				Chronic Cases† (n = 5)			
	Before Therapy	After Therapy	t	$p<$	Before Therapy	After Therapy	t	$p<$
Flexion (°)	111 ± 10	153 ± 11	3.52	.01	113 ± 20	148 ± 16	4.04	.01
Abduction (°)	101 ± 18	143 ± 12	3.86	.01	103 ± 25	149 ± 13	3.85	.01
Internal rotation (°)	64 ± 12	83 ± 7	3.24	.01	60 ± 8	86 ± 9	4.21	.01
External rotation (°)	24 ± 8	69 ± 15	4.82	.01	29 ± 11	63 ± 13	4.60	.01
Joint space‡ (mL)	7 ± 2	11 ± 3	2.28	.05	8 ± 3	9 ± 2	1.54	NS

* Acute cases: symptoms and signs lasting 2 months or less.
† Chronic cases: symptoms and signs lasting longer than 2 months.
‡ Joint space determinated by the total volume of contrast agent and air as described in Materials and Methods.

measure joint space capacity. As a result, 12 patients were included in this study.

They were classified as "primary" for spontaneous onset and "secondary" for the existence of some predisposing factors. Chronicity was categorized as acute (less than 2 months) and chronic (more than 2 months), according to the duration of symptoms.

Procedures

Shoulder arthrography was performed by the administration of contrast media (2mL) into joint space, followed by injection of air. Injection was discontinued when resistance was felt. The joint space capacity was defined as the total volume of contrast media and air that could be injected without resistance. All procedures were conducted by the same radiologist to keep measurement reproducible. All studies met at least two of the following criteria: (1) joint space capacity of <10mL; (2) diminished or absent axillary recess; (3) tightness or irregularity of capsular margin.

Oral anti-inflammatory drugs were prescribed for all patients. Intraarticular steroid injection was not performed because its effect on joint capsule is not clear and it could have affected the measurement of joint space. The patients began physical therapy and weekly follow-up at our outpatient clinic. The therapy programs included physical modality and exercise intervention. The regular follow-up included shoulder ROM measurement by the same physiatrist and comparison with the normal range.[14]

The therapist used a combination of physical modalities and exercise to restore motion. The programs were applied twice or three times weekly for 4 to 6 weeks. Heat therapy modality and ultrasound reduced pain and muscle spasm. Six patients received shortwave diathermy (continuous wave, condenser plates application for 20min), and the other six received ultrasound (1MHz applicator, intensity 0.8 to 1.2watts/cm^2 for 8min).

Gentle, passive mobilization reduced pain and guided the limb further into the range without eliciting spasm or a stretch reflex. Stretching and strengthening exercises were gradually introduced after the pain subsided. Home programs were also initiated with active and active-assistive exercises, at least one half hour three times a day. The 12 patients received shoulder arthrography again after the ROM had remained stable for 2 weeks.

Statistical Analysis

The paired Student's t test was used to determine if there was a significant difference of ROM between pretreatment and posttreatment. Linear regression was performed for the correlation between increased joint space capacity and ROM improvement. A significant difference was defined as $p < .05$.

RESULTS

At the initial diagnosis, marked restriction was most common in external rotation (average, 24°, only 27% of normal range), followed by abduction (average, 101°, 56% of normal range) and internal rotation (average, 64°, 71% of normal range).[14] After conservative treatment, the entire ROM, including flexion, abduction, external rotation, and internal rotation, was significantly improved, especially external rotation. There was no difference in ROM improvement between acute and chronic, or primary and secondary, groups (tables 1, 2).

After conservative treatment, both groups demonstrated significant improvement in ROM. In addition, the joint space capacity was found to increase significantly in acute patients (t = 2.82; $p < .05$), but not in chronic patients (table 1).

The increased joint space capacity showed significant correlation with ROM improvement in external rotation in the acute stage ($r = .77, p < .05$) (fig 1), but there was no clear correlation with abduction, flexion, and internal rotation ($p > .05$). In the follow-up arthrograms, all the patients showed reappearance and/or enlargement of the axillary recess and smoother capsular margins, except one chronic patient (disease duration for 1 year). These findings were more obvious in acute patients than in chronic patients.

DISCUSSION

In this prospective study, we followed the improvement of shoulder motion and arthrographic findings in 12 subjects with frozen shoulder before and after physical therapy. External rotation was most restricted at initial diagnosis and improved most

Table 2: Improvement of Frozen Shoulder in Primary and Secondary Patients

	Primary Cases* (n = 6)				Secondary Cases† (n = 6)			
	Before Therapy	After Therapy	t	$p<$	Before Therapy	After Therapy	t	$p<$
Flexion (°)	111 ± 9	155 ± 9	2.88	.05	112 ± 17	149 ± 15	2.12	.05
Abduction (°)	108 ± 19	140 ± 12	3.56	.01	99 ± 22	148 ± 12	4.02	.01
Internal rotation (°)	64 ± 17	80 ± 7	1.64	NS	61 ± 7	87 ± 7	3.84	.01
External rotation (°)	25 ± 7	60 ± 14	2.25	.05	26 ± 11	69 ± 13	2.31	.05
Joint space‡ (mL)	8 ± 3	9 ± 4	1.21	NS	7 ± 3	9 ± 4	1.32	NS

* Primary cases: spontaneous onset.
† Secondary cases: existence of some predisposing factors.
‡ Joint space determinated by the total volume of contrast agent and air as described in Materials and Methods.

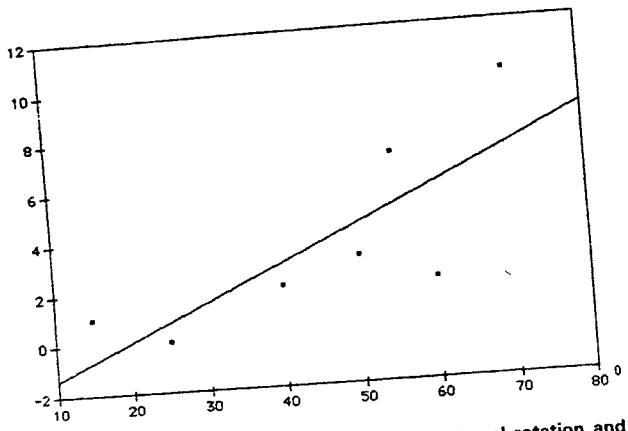

Fig 1. Correlation between the improvement of external rotation and increase of joint capacity in acute cases: coefficient of correlation, .77; standard error of estimate, 13.7; $p < .05$.

prominently after conservative management. Significant correlation was noted between improvement of external rotation and increase of joint space capacity in the acute stage.

In 1986, Wadsworth[8] observed that the motion restriction in frozen shoulder was most obvious in external rotation. Shaffer et al[7] and Rizk et al[9] also mentioned this finding. The subscapular bursa and axillary fold tended to be adhesive and obliterated in arthrographic studies,[6,15] which correlated with the limitation of ROM in external rotation and abduction. After ROM improved, reappearance of the axillary recess and subscapular bursa were noted.[6] In our study, we also found that the adhesion was reversible and that joint space capacity reexpanded with early treatment of frozen shoulder by aggressive therapy.

The joint space capacity, measured before treatment, was reduced to only 5 to 10mL, which was significantly less than the normal shoulder capacity (more than 14mL).[2,15] This is consistent with the adhesive nature of frozen shoulder in an arthroscopic study by Neviaser.[16] Although after conservative treatment both groups demonstrated significant improvement in ROM, the joint space did not completely return to the normal range (table 1, 2). We also found that there was a good correlation between improvement of ROM in external rotation and an increased joint space capacity in the acute stage, which indicated that the improvement in ROM was linked with some structural restoration.

Through arthroscopic study, Neviaser[16] found four identifiable stages in frozen shoulder. First, in the preadhesive stage, there is erythematous fibrinous pannus over the synovium, best seen in and around the dependent fold. In stage II, acute adhesive synovitis, there is a proliferative synovitis and early adhesion formation. The increased joint capacity after treatment in acute subjects may be related to the earlier pathological change with potential of reversibility.

For the third stage described by Neviaser,[16] the stage of maturation with loss of the axillary fold, the synovitis subsides. In stage IV, the chronic stage, adhesions are fully mature and markedly restrictive. In chronic patients, although follow-up arthrograms showed no significant increase in joint space capacity, ROM improved. This indicates that, in addition to stretching of the adhesive capsule, there are other mechanisms by which treatment programs contribute to the recovery of chronic frozen shoulder. However, since we did not perform invasive arthroscopy at the same time in our patients, no definite conclusion can be drawn in this respect.

One of the limitations of this prospective study was that there was no nontreatment control group. This makes it difficult to state with certainty that the physical therapy interventions caused the clinical and radiographic improvement. The other consideration is the fact that arthrography itself might cause some improvement of shoulder motion.[17,18] To avoid this confounding factor, shoulder arthrography was performed by the same radiologist. Two-milliliter contrast agent followed by air was injected into the joint capsule slowly and smoothly without resistance to avoid creating the potential space artificially. The total amount injected in our study was only approximately 5 to 14mL, much less than the amount used for therapeutic purpose, 30 to 40mL.[17,18]

In chronic frozen shoulder, we suggest that, besides the adhesive capsule, other soft tissues around the shoulder, including muscles, tendons, and ligaments, may also become contracted because of the prolonged shortening position and joint motion limitation. These connective tissues show plastic elongation when subjected to prolonged mild tension,[19] and can be stretched during aggressive physical therapy programs. The restoration of these soft tissues' lengths also plays a role in ROM improvement and may contribute to the improvement of chronic frozen shoulder. Further study is needed to confirm this hypothesis.

Acknowledgment: We thank Paul Corcoran, MD, for his valuable suggestions and assistance in the preparation of this manuscript.

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