

Treatment of Adhesive Capsulitis (Frozen Shoulder) With Arthrographic Capsular Distension and Rupture

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ABSTRACT. Rizk TE, Gavant ML, Pinals RS. Treatment of adhesive capsulitis (frozen shoulder) with arthrographic capsular distension and rupture. *Arch Phys Med Rehabil* 1994;75:803-7.

• Sixteen patients with adhesive capsulitis of the shoulder were treated in an open trial of capsular distension with intraarticular injection of 30mL of fluid containing 8mL of 1% lidocaine, 2mL of corticosteroid, and 20mL of radiopaque contrast material. A capsular tear during arthrography occurred in all cases. Rupture usually occurred at the subscapular bursa or the subacromial bursa. Rupture at the distal bicipital sheath occurred in two patients and was not associated with pain relief. Thirteen patients experienced immediate pain relief and increased shoulder mobility. This improvement was maintained over a follow-up interval of 6 months. Disruption of the constricted capsule by hydraulic distension seems to be the mechanism for achieving symptomatic relief in adhesive capsulitis.

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Adhesive capsulitis (frozen shoulder) is an insidious, painful condition that results in gradual restriction of movement in the shoulder.¹ Gross pathological changes found during exploratory shoulder surgery include thickening and constriction of the capsule, especially anteroinferiorly with very little synovial fluid in the joint space.^{2,3} Microscopic findings from capsular biopsy showed fibroplasia resembling those seen in Dupuytren's contracture. Electron microscopy confirmed the impression of a more compact than normal arrangement of the collagen fibers.³

Antiinflammatory medications, physical therapy, and corticosteroid injections with local anesthetic have been recommended in management of these cases, but aside from some symptomatic relief, it has been difficult to show long-term benefit. Manipulation under anesthesia and operative capsulectomy are reserved for refractory cases. Distension of the contracted capsule by injecting a large volume of fluid intraarticularly under pressure has been advocated as a treatment for adhesive capsulitis. Dramatic results have been claimed but the mechanism is unclear.⁴⁻¹⁰ This study investigates the mechanism of action and the long-term clinical results of this procedure by performing arthrography before, during, and after the capsular distension.

PATIENTS AND METHODS

In the last 4 years, 179 patients were referred by physicians and outpatient hospital services to our chronic shoulder disorder clinic for shoulder pain evaluation and management. After radiological, laboratory, and clinical examination, 61

patients were diagnosed with rotator cuff tendinitis, 26 with polyarthritis, and 2 with cancer of the prostate with early shoulder pain from metastases. Seven patients had a shoulder-hand syndrome, 5 had polymyalgia rheumatica, 2 had suprascapular nerve entrapment, 14 had shoulder subluxation secondary to hemiparesis of the affected side, and 3 patients had rotator cuff tears.

Fifty-nine patients were clinically diagnosed as having adhesive capsulitis. (There was no arthrography and no magnetic resonance imaging (MRI) performed to confirm or rule out the diagnosis.) Thirty-eight of these patients had neurological diseases (adhesive capsulitis on the hemiplegic side) and 21 patients had no neurological, bony, arthritic condition to explain their shoulder pain and limited range of motion, ie, idiopathic adhesive capsulitis.¹ Eighteen patients in this latter group (13 men, 5 women) agreed to participate in the study. They were admitted with informed consent. These were consecutive patients with certain exclusions. All patients accepted for the study met the following criteria:

- Shoulder pain and stiffness in one or both shoulders for a period of 3 to 6 months, aggravated by resisted abduction and/or internal or external rotation.
- Localization of impaired movement to the glenohumeral joint exclusively, with pain when sleeping on the affected side.
- No history of recent trauma and no previous injection in the involved shoulder.
- No history of allergy to local anesthetics or steroids.
- No medical conditions such as cardiac disease, infection, or coagulation disorders that would significantly increase the risk of local injection.
- A complete physical examination, radiographic examination of the shoulder and chest, and routine hematological tests were performed to rule out specific local or systemic conditions which might lead to development of a painful stiff shoulder. Patients with bony or neurological disorders and patients with polyarthritis were excluded from the study.
- All directions of range of motion (ROM) were less than: Internal rotation, 45° (normal 80°); External rotation,

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Table 1: Percentage of ROM During the Study

Patient No.	Baseline	Next Day	2 Weeks	4th Week	2nd Month	3rd Month	4th Month	5th Month	6th Month
1	45.6%	56.8	65.3	77.3	80.4	84.1	86.2	86.2	89.8
2	44.4	52.6	67.6	85.9	86.2	86.6	88.1	88.3	88.7
3	47.4	55.5	61.1	64.7	65.3	72.9	77.4	78.1	78.4
4	46.0	59.9	60.3	62.7	63.7	68.0	68.2	68.4	69.9
5	49.2	58.8	71.1	78.3	81.4	86.7	89.6	89.9	90.1
6	45.2	51.9	56.2	69.4	75.5	77.3	80.2	80.7	81.3
7	49.6	55.2	74.1	88.2	89.4	89.4	89.5	89.6	91.0
8	47.8	51.4	59.8	59.9	67.1	77.2	80.8	81.1	85.4
9	49.0	—	—	—	—	—	—	—	—
10	48.3	59.9	71.4	85.3	87.4	89.1	89.1	89.1	89.3
11	49.2	49.4	49.4	—	—	—	—	—	—
12	48.3	52.7	58.7	60.1	68.4	70.7	73.8	74.4	76.1
13	49.9	58.3	71.8	86.1	85.3	86.6	89.7	90.1	90.8
14	45.8	56.4	66.2	69.3	69.9	75.4	79.8	86.3	90.1
15	46.4	49.1	56.8	61.6	66.4	70.8	72.2	73.0	73.2
16	49.2	54.3	60.8	66.4	74.6	79.1	80.5	80.5	80.6
17	44.0	—	—	—	—	—	—	—	—
18	48.6	49.9	51.6	55.9	68.3	—	—	—	—

35° (normal 90°); Flexion, 100° (normal 180°); Extension, 35° (normal 60°); Adduction, 35° (normal 45°); Abduction, 80° (normal 180°).

The passive ranges of motion (PROM) in all directions were totalled and expressed in percent of normal (table 1). Mean age of the study group was 55 years, (range 42 to 66 yrs). All patients had shoulder ROM (table 2) and pain severity (table 3) scoring done before the arthrogram and thereafter by the same therapist. Pain severity was evaluated using 1 to 5 pain scale (table 3):

1. No pain on dressing, undressing, or sleeping.
2. Tolerable aches and pain when dressing or undressing not severe enough to disturb sleeping on the affected shoulder.
3. Intolerable pain when dressing or undressing but not severe enough to disturb sleeping on the affected side.
4. Intolerable pain when dressing or undressing severe enough to disturb sleeping on the affected side.
5. Intolerable pain day or night aggravated by arm movement, unable to sleep, irritable, and depressed.

All arthrograms were performed according to the Kaye-Schneider technique.¹¹ The patients were placed supine on a fluoroscopic table with an overhead x-ray tube. Under image-intensified fluoroscopy a lead "O" marker was placed over the glenohumeral joint space at about the junction of its middle and lower third. This point was then marked on the skin with an indelible felt-tipped pen. Using a 25-gauge 5/8in needle the skin beneath the marker was infiltrated with 3mL of 1% lidocaine for local anesthesia. The joint was then punctured by a 20-gauge spinal needle, and its position was checked frequently by fluoroscopy during the procedure.

To definitely confirm the intraarticular location of the needle, a few drops of contrast material were injected. When the needle is within the joint space, the contrast material should flow away from the needle tip, outlining the joint space. Once the intraarticular position of the needle was confirmed, 5 to 8mL of positive contrast agent (60% Renografin^a) were injected. The normal shoulder accommodates up to 12mL of contrast material, while in adhesive capsulitis, approximately only 5mL can be injected.¹²

Table 2: ROM Baseline Measurements

Patient No.	Internal Rotation	External Rotation	Flexion	Extension	Adduction	Abduction	Total	Total % of Normal
1	32	28	90	25	35	80	290	45.6
2	36	26	85	27	33	75	282	44.4
3	40	28	90	30	35	78	301	47.4
4	34	24	90	30	34	80	292	46.0
5	42	30	94	32	35	80	313	49.2
6	33	29	90	28	35	73	288	45.2
7	40	30	95	30	35	75	315	49.6
8	35	30	100	26	33	80	304	47.8
9	45	30	90	35	35	76	311	49.0
10	40	32	89	33	35	78	307	48.3
11	38	30	95	35	34	80	312	49.2
12	45	32	93	30	33	74	307	48.3
13	44	30	98	30	35	80	317	49.9
14	30	30	95	26	32	78	291	45.8
15	40	35	100	30	30	80	295	46.4
16	43	30	98	35	33	73	312	49.2
17	38	28	86	30	28	70	280	44.0
18	45	29	93	32	30	80	309	48.6

Table 3: Pain Score in Each Patient

Patient No.	Baseline	Next Day	2 Weeks	4th Week	2nd Month	3rd Month	4th Month	5th Month	6th Month
1	5	3	2	2	2	1	1	1	1
2	4	2	2	2	2	2	1	1	1
3	4	3	2	2	1	1	1	1	1
4	5	4	4	3	3	2	2	2	2
5	5	2	2	2	2	2	1	1	1
6	5	2	2	2	2	2	2	1	1
7	4	4	3	2	1	1	1	1	1
8	4	2	2	1	1	1	1	1	1
9	3	—	—	—	—	—	—	—	—
10	5	2	2	2	2	2	1	1	1
11	4	4	4	—	—	—	—	—	—
12	4	3	2	2	2	2	1	1	1
13	5	2	2	2	2	1	1	1	1
14	5	4	4	1	1	1	1	1	1
15	5	3	3	2	2	2	2	1	1
16	5	4	3	2	2	1	1	1	1
17	3	—	—	—	—	—	—	—	—
18	4	4	4	4	3	—	—	—	—

Patient 9 and 17 were excluded (Arthrogram showed minor capsular tear in patient 17 whereas patient 9 arthrogram was normal). Patient 11 and 18 did not show up for follow-up for various reasons.

Roentgenograms were made in the anteroposterior projection, in internal and external rotation, as well as in axillary and bicipital groove views. If the findings were consistent with adhesive capsulitis, (small volume joint space, synovial irregularities and serrations, nonfill of the bicipital tendon sheath or obliteration of the subscapular or axillary recesses), then a 30mL mixture including 80mg methylprednisolone (2mL), 1% lidocaine (8mL), and 20mL water-soluble contrast material were injected under pressure. Again, multiple radiological views were taken. At that time, entry of contrast material into the subacromial or subscapular bursae was assumed to indicate an iatrogenic capsular tear.

All patients were instructed to sleep with the affected shoulder in abduction and external rotation for 1 week after the injection. No strong analgesics or narcotics were given; however, patients were allowed to take simple analgesics, eg, acetaminophen or aspirin. All patients were instructed and urged to do the same therapeutic exercise program at home (Codman's sign, wall climbing, and using wand exercises) three times daily for 30 minutes. Measurements were done before initiating the injection procedures, the following day, 2 weeks later, and monthly thereafter during the follow-up visits up to 6 months. Patients were asked to mark the pain score form before the injection and before the ROM measurement at each follow-up visit (table 3).

RESULTS

Shoulder arthrography showed that 16 patients had the typical radiographic appearance of adhesive capsulitis (fig 1). There were restrictions of joint volume, serration of the bursal attachments, failure to fill the biceps tendon sheath, and partial obliteration of subscapular and axillary recesses.¹¹ One patient's radiographic appearance showed normal findings (patient 9), and in another case there was a possible small capsular tear (patient 17). No further injections were given to these two patients and they were discharged from the study.

After injection of the 30mL therapeutic mixture all 16 patients showed iatrogenic capsular tears, at the subscapular

bursa in 8 patients, at the subacromial bursa in 6, and at the distal bicipital sheath in 2. In the latter instance, contrast material may be shown in soft tissues, extending to the level of the midhumerus. A typical example of a subscapular capsular tear is illustrated in figs 2-4. Capsular rupture occurred after injection of 12mL of fluid in this case, and in other cases after from 11 to 20mL. However, all patients received the total 30mL therapeutic mixture. All patients reported an increase of pain during the first 10 to 20mL injection, 13 described marked sudden pain relief towards the end of the 30mL injection, and 3 did not. It seems most likely that the time of sudden pain relief is the time of capsular rupture. No radiological changes of ruptures were noticed before the sudden pain relief. Of the 3 patients who did not experience pain relief, 2 had distal bicipital sheath rupture and 1 had subscapular rupture. There were no adverse affects of the procedure. Pain score on the day after the injection showed

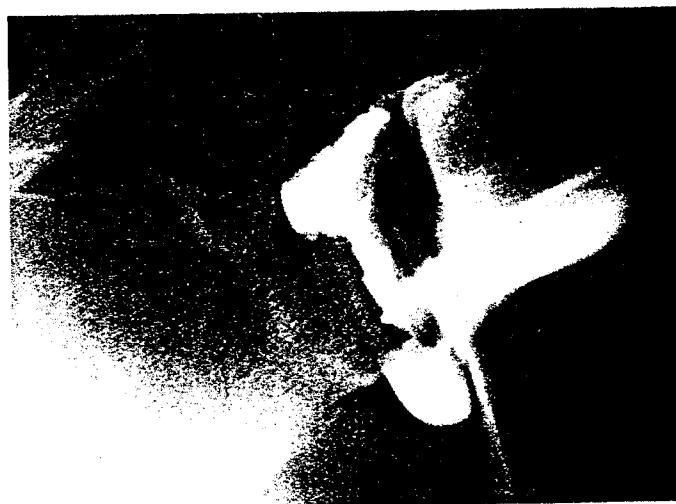


Fig 1—Arthrogram of adhesive capsulitis: restriction of joint volume, failure to fill the biceps tendon sheath, and partial obliteration of subscapular and axillary recesses.

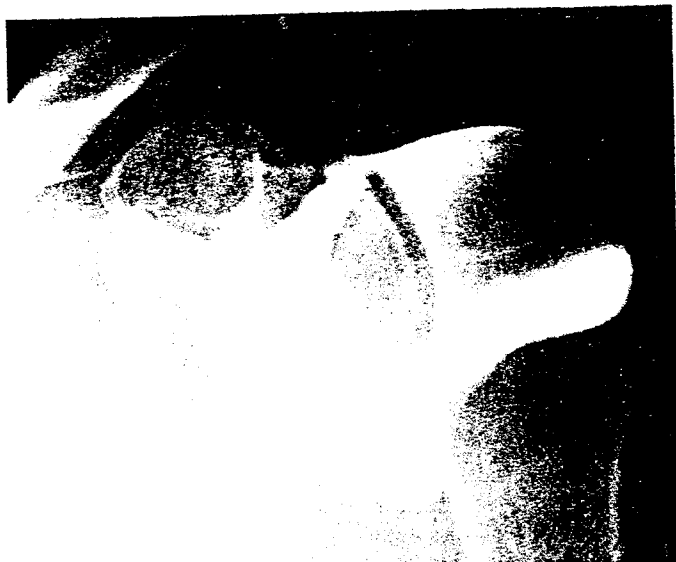


Fig 2—Arthrogram following 12mL injection: contrast material started to leak out at the subscapular area.

4 patients scored 3 levels, 4 patients scored 2 levels, and 5 patients scored 1 level less than initial scoring whereas 3 patients scored the same. Two of the latter had the rupture at the bicipital sheath and the other one at the subacromial bursae.

On follow-up examination 2 weeks after capsular distension and rupture, 12 patients reported considerable improvement in pain and function. Only four were still unable to sleep on the affected side. Two patients were lost to follow-up after that (patients 11 and 18). Four weeks after the procedure, 11 patients were functioning well with tolerable pain. Two had improved considerably but reported pain at the extremes of shoulder motion, one had only fair relief, and another had no relief. After 6 months, 13 patients were pain free, able to sleep on the involved shoulder and perform



Fig 3—Arthrogram following 20mL injection: contrast material seen at the subacromial-subscapular area.

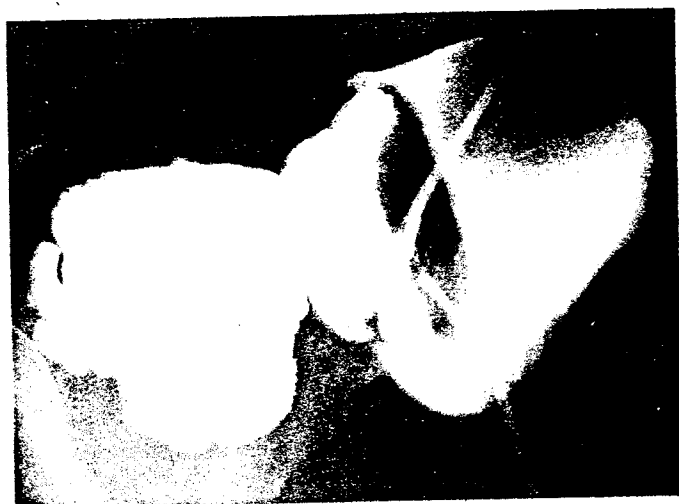


Fig 4—Arthrogram following 30mL injection: contrast material filling the subscapular area.

all activities of daily living. Only one patient reported tolerable aches on dressing and undressing. Shoulder ROM showed 10.7% to 25% improvement from the base line by the end of the second week. However, one patient (11) showed no improvement in ROM at all. ROM continued to show steady increase in all the others (table 1). By the end of the study, patients achieved 69.9% to 90% of the normal ROM.

DISCUSSION

The term "frozen shoulder" is a medical colloquialism rather than a diagnosis. It is usually used as a clinical description with pathogenetic inferences, as suggested by the alternative designations of periarthritis, pericapsulitis, obliterative bursitis, and adhesive capsulitis.¹

The term "adhesive capsulitis" was reported by Neviasser in 1945 during surgery.² The shoulder capsule peeled from the head much as adhesive tape peels from skin, but there were no actual structural intraarticular adhesions shown during open shoulder or arthroscopic surgery.² Generalized capsular thickening, little synovial fluid, normal articular cartilage and little synovial cell hyperplasia were reported. Microscopic studies showed mainly fibroplasia resembling that seen in Dupuytren's contracture³ and a more compact arrangement of collagen fibers.

Radiological and laboratory testing help to rule out other shoulder pathology (arthritis, tumors, infection, fractures, etc). However, it does not confirm or rule out the diagnosis of adhesive capsulitis. Arthrography is the standard diagnostic technique for showing adhesive capsulitis and rotator cuff and capsular tear.

The pathogenesis of adhesive capsulitis is not clearly understood. However, trauma (and internal shoulder derangement), immobilization, suprascapular compression neuropathy, immune mechanisms, psychogenic disorders, and autonomic neuropathy have been suggested and reported by different authors as possible causes.¹

In the last 26 years, several authors have recommended hydraulic distension as a treatment of adhesive capsulitis,

but the mechanism has not been clearly defined. Simon⁵ used a procedure he called "infiltration brisement" under general anesthesia, postulating that the hydrostatic pressure of injected fluid would dissect the capsule from the underlying glenoid and humerus, and with increasing pressure might actually rupture the capsule at its tightest point. In recent years, corticosteroids have usually been included in the injection mixture. Kozin⁴ described excellent responses with injection of procaine and corticosteroid in 50mL of saline. Recently, Fareed and Callivan⁹ reported good results from shoulder distension with 40mL of saline and steroids. The procedures were performed as office procedures without arthrography. Our study investigates the mechanism of action and long-term value of this procedure.

In this uncontrolled trial of capsular distension and rupture, sustained symptomatic improvement was shown in most patients.

There are five possible causes of the improvement: capsular rupture, joint space distension, corticosteroids, local anesthetic, or radiological contrast material. The enhancement of shoulder motion exceeded in both rate and degree that which was observed in our controlled studies of physical therapy with shoulder stretching¹² and multiple corticosteroid and local anesthetic injections.¹³ Therefore, it is unlikely that the corticosteroid, local anesthetic and the contrast medium were responsible for the dramatic and sustained benefit. The other two possibilities are capsular rupture and capsular distension.

It is possible that distension of the capsule by the volume of material injected might be the factor that caused freeing of the joint by peeling back the capsule from the head and releasing the adhesive affect. That would lead to an increase of the volume of the joint space, disappearance of the synovial irregularities, and serrations as well as filling of the subscapular or axillary recesses. However, the fact that the joint space volume was the same size before and after the 30mL injection and there was no disappearance of synovial serrations as seen by the arthrography makes it unlikely that capsular distension occurred or might be the factor that caused shoulder improvement. The general belief that capsular distension might cause release of adhesions is absolutely wrong. There are no structural intracapsular or extracapsular adhesions found in adhesive capsulitis.

All 16 patients with capsular constriction documented by arthrography had capsular rupture after distension with 30mL of fluid. In the two patients with distal bicipital sheath rupture, there was no improvement, but 13 of 14 with subscapular or subacromial bursa rupture experienced fast relief. This suggests that interruption of the constricted capsule at particular locations is required to achieve a favorable pain response. One might speculate that reduced capsular tension

results in decreased stimulation of pain receptors in the capsule or its periosteal attachments. The improvement of ROM is clearly related to the capsular release allowing unrestricted motion.

The mechanism of pain relief with capsular rupture may be similar to that of manipulation under anesthesia. With manipulation, clinical improvement occurs soon after the procedure and is maintained on prolonged follow-up.^{14,15} Capsular rupture may be presumed to occur, although arthrography has not been performed after manipulation. Because of concerns about brachial plexus injury, or fracture and dislocation, manipulation is generally regarded as a late therapy for refractory cases. In a recent orthopedic series, only 15 of 118 patients required manipulation.¹⁵

Distension arthrography seems to be a promising treatment for adhesive capsulitis. This is an office procedure that is less expensive than surgery or manipulation under anesthesia. The appropriate timing of distension arthrography remains to be defined. It is our experience, however, that it should be considered for cases not responding to other conservative treatment for more than 3 months.

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