# Frozen shoulder

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Adhesive capsulitis is a condition that has an unknown etiology and is often marked by an insidious onset of pain and progressive restriction of range of motion. Recent reports suggest that adhesive capsulitis may be caused by biochemical changes in the joint capsule resulting in progressive fibrosis and motion loss. Historically, the diagnosis of adhesive capsulitis has been a clinical one, characterized by loss of active and passive glenohumeral motion. Current research using magnetic resonance imaging and arthrography may provide clinicians with additional data on which to base their diagnoses. Treatment protocols vary from benign neglect to supervised physical therapy, intra-articular corticosteroid administration, and early surgical intervention. Recent advances in the diagnosis and treatment of the frozen shoulder are reviewed. Curr Opin Orthop 2000, 11:271–275 © 2000 Lippincott Williams & Wilkins, Inc.

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**Abbreviations**

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| **MMP** | matrix metalloproteinases |
| **MRI** | magnetic resonance imaging |

Idiopathic adhesive capsulitis is a condition characterized by gradual loss of active and passive shoulder motion. Several factors have been associated with adhesive capsulitis, including female gender [1], age greater than 40 years [2], trauma [2], diabetes [3–5], prolonged immobilization [6], thyroid disease [7,8], cerebral or cardiac infarction [9,10], and the presence of autoimmune disease [11,12]. The etiology of this condition remains elusive, but the increased incidence of adhesive capsulitis in patients treated with protease inhibitors may reflect an alteration in the biochemical properties of the shoulder capsule in frozen shoulder. Treatment options include benign neglect, home and supervised therapy programs, intra-articular and systemic corticosteroids, closed manipulation under regional and general anesthesia, and arthroscopic capsular release.

## Etiology

A review of the literature reveals a multitude of strategies for the treatment of patients with adhesive capsulitis, with extremely variable results provided. The lack of consistency in the published literature reflects a lack of understanding of the stages and etiology of adhesive capsulitis, which play a significant role in diagnosis and treatment. In 1945, Neviaser [10] introduced the term *adhesive capsulitis* and described pathologic changes in the synovium and subsynovium. Disagreement remains in the literature as to whether the underlying pathologic process is an inflammatory condition [13–15] or a fibrosing condition [16]. Significant evidence exists in support of the hypothesis that the underlying pathologic condition in adhesive capsulitis is synovial inflammation with subsequent reactive capsular fibrosis, making adhesive capsulitis an inflammatory and a fibrosing condition, dependent on the stage of the disease. Cytokines have recently been implicated in the inflammation and fibrosis described in adhesive capsulitis. Cytokines are involved in the initiation and termination of repair processes in multiple musculoskeletal tissues, and their sustained production has been shown to result in tissue fibrosis [17,18]. Rodeo *et al.* [14] reported an increase in transforming growth factor-β, platelet-derived growth factor, and hepatocyte growth factor staining in capsular biopsy specimens of patients with primary and secondary adhesive capsulitis and proposed that these cytokines are involved in the inflammatory and fibrotic cascades seen in adhesive capsulitis.

The potential role of matrix metalloproteases in adhesive capsulitis has recently been identified. Matrix metallo-

proteinases (MMP) are zinc-dependent proteinases, which in normal tissues degrade the connective-tissue matrix as part of normal turnover. Tissue Inhibitors of Metalloproteinases (TIMPs) are specific tissue MMP inhibitors that control the activity of MMPs in conjunction with a variety of cytokines and growth factors. New chemotherapeutic agents for cancer and human immunodeficiency have been implicated in several cases of frozen shoulder. Hutchinson *et al.* [19] reported on a series of patients with inoperable gastric carcinoma who were treated with a synthetic MMP inhibitor for more than 1 month. Six of 12 patients developed a frozen shoulder, three of whom also developed a condition resembling Dupuytren disease. In all cases, the frozen shoulder was bilateral. No autopsies were performed and therefore no tissue was available for analysis. The acute symptoms improved when treatment was temporarily discontinued, but regressed when it was recommenced. The authors postulated that the development of frozen shoulder and the Dupuytren-type condition in their patients was due to a decrease in the MMP:TIMP ratio, which caused increased synthesis and deposition of collagen and connective tissue. Although it is not proven that the treatment actually caused these conditions, further research in this area is warranted. If it is possible to manipulate the MMP:TIMP ratio locally or systemically, treatment solutions may evolve from this data.

Peyriere *et al.* [20•] reported three cases of frozen shoulder associated with combination therapy for HIV. Two of the three patients developed urinary lithiasis followed by bilateral adhesive capsulitis after starting indinavir. The third patient complained of unilateral shoulder pain 9 months after starting indinavir treatment. In all three patients, shoulder symptoms improved with cessation of indinavir and physical therapy. Three additional cases of acute adhesive capsulitis were also recently reported in patients treated with protease inhibitors for HIV [21].

## Diagnosis

Tamai *et al.* [22] recently reported magnetic resonance imaging (MRI) visualization of thickening of the joint capsule and synovium in patients with frozen shoulder and hypothesized that synovial changes could be quantified or semiquantified by dynamic MRI enhanced with intravenous administration of gadolinium diethylenetriaminepentaacetic acid. Their report describes preliminary results of dynamic MRI on 16 patients with a typical clinical course of frozen shoulder. Frozen shoulder was defined as a painful and stiff shoulder that developed in an otherwise healthy person 40 to 70 years of age, had a duration of more than 1 month prior to examination, and demonstrated loss of passive forward elevation associated with limitation of external and internal rotation. None of the patients had a history of trauma, calcific tendonitis, arthritis, diabetes, cardiopulmonary disease, or thyroid disease. Glenohumeral fluid was present in 6 of 18 pa-

tients, and 5 of 18 showed concomitant subacromial fluid. Dynamic gradient-recalled echo images in all of the patients with frozen shoulder showed obvious enhancement. The values were significantly greater than in images derived from patients with impingement syndrome. The coefficient of enhancement was significantly greater in the region of interest of the glenohumeral joint as compared with the subacromial bursa, although the enhancement in the subacromial bursa was greater in patients with frozen shoulder than impingement. A shorter duration of disease before imaging resulted in a greater coefficient of enhancement in the synovial cavity. Longitudinal study in four shoulders with repeated MRI was notable for no discernible difference in the static images while the dynamic imaging recorded a decrease in enhancement after improvement of symptoms; likewise, there was an increase in enhancement in the shoulder that had progressed clinically. Tamai and Yamamoto [22] theorized that the observed enhancement resulted from increased blood flow in and around the synovial tissue. They concluded that dynamic imaging of the shoulder may become an adjunct for choosing a method of treatment and is a minimally invasive means to quantify the synovial abnormalities in frozen shoulder.

## Treatment

The treatment of patients presenting with adhesive capsulitis is dependent on the stage of the disease and the symptoms. There are many published manuscripts documenting the efficacy of benign neglect, intra-articular corticosteroid administration, manipulation under anesthesia, and operative treatment that will not be reviewed herein. In interpreting the results of the published studies, it is critical to note the stage of adhesive capsulitis being treated, as this can affect efficacy. A summary of several recent publications is presented.

Traditional manipulative treatment of patients with joint contracture relies on forces applied with a long lever arm, risking fracture, especially in osteoporotic patients. Placzek *et al.* [23] reported the long-term effect of translational manipulation on range of motion, pain, and function in patients with adhesive capsulitis. Their technique of translation manipulation uses a static end of range capsular stress or, if needed, a short-amplitude high-velocity thrust. These techniques were performed at the humeral head, minimizing lever arm length while causing a linear translational movement of the humeral head in relationship to the glenoid fossa. The manipulation began with inferior translation; the patient was positioned supine with the cervical spine bent toward the affected extremity to minimize tension on the brachial plexus. An assistant stabilized the scapula while the manipulator abducted the humerus to its end range, externally rotated the limb, and applied lateral traction along the shaft of the humerus. At the same time, with the contralateral hand, the manipulator provided an inferior

translational force to the humeral head adjacent to the joint line and parallel to the glenoid. The second stage of the procedure consisted of posterior manipulation. The affected arm was flexed to roughly 80 degrees and horizontally adducted to its end of range. The scapula was stabilized against the thorax with the right hand while the left hand provided lateral traction and a posterior translational force that was directed along the long axis of the humerus. Placzek *et al.* [23] reported on 31 patients who underwent brachial plexus block followed by manipulation. All nondiabetic patients started a 6-day medrol dose-pack the day before the manipulation. Range of motion and pain were assessed before and after manipulation under anesthesia, early follow-up (2–8 weeks), and long term (7–21 months). Passive range of motion increased, visual analogue pain scores decreased, and Wolfgang criteria score increased. The degree of improvement in range of motion was independent of the number of physical therapy visits before manipulation and after. Their technique may limit the trauma inflicted on periarticular soft tissue, thereby hastening the recovery process. Translational manipulation, they concluded, is a safe, effective treatment option and possibly should be offered as an alternative much earlier. It should be noted, however, that the authors used both translational manipulation and oral corticosteroids in the treatment of these patients. It remains unclear based on these results which treatment factor is responsible for the observed improvement in range of motion. Reichmeister recently reported on the results of a retrospective study evaluating long-term functional results after manipulation of the frozen shoulder. Ninety-seven percent of the patients had relief of pain and recovery of "near complete" range of motion at an average follow-up of 58 months, although 8% required a second manipulation to obtain a successful result. Of note, these patients had all failed a course of conservative treatment, including physical therapy, nonsteroidal anti-inflammatory drugs, and intra-articular injection with corticosteroid. Following manipulation under general anesthesia, an intra-articular injection of decadron and lidocaine was also given, which may have favorably altered the response to manipulation [24•].

There is extensive information regarding the efficacy of intra-articular corticosteroids in the treatment of adhesive capsulitis [23,24•,25–29]. In interpreting the results of published studies, it is critical to note the stage of adhesive capsulitis being treated. Bulgen *et al.* [25] randomized patients to treatment with corticosteroids, physical therapy, ice, or benign neglect. The initial response to treatment was most marked in patients treated with corticosteroids; however, no significant difference in final long-term outcome was reported when treatment groups were compared. Hazelman [30] summarized numerous studies on the use of intra-articular corticosteroids and reported that the success of treatment is dependent on the duration of symptoms. Patients treated

within 3 months of the onset of symptoms reported a significant improvement in symptoms, whereas those patients treated after 5 or more months had a more delayed recovery. The time necessary for full recovery was reported to be dependent on the duration of symptoms. Patients treated within 1 month of onset of symptoms recovered in an average of 1.5 months. Patients treated within 2 to 5 months of onset of symptoms recovered in 8.1 months; patients treated 6 to 12 months after onset of symptoms required an average of 14 months for full recovery. The authors have observed a similar pattern in the treatment of patients with adhesive capsulitis at their institution. Patients treated with intra-articular corticosteroids during stage 1 (0–3 months) had a rapid and striking recovery of a pain-free shoulder within 6 weeks. Patients treated during stage 2 demonstrated a significant improvement in night pain and pain at rest, with the time necessary for recovery of range of motion dependent on the duration of symptoms before treatment.

Gam *et al.* [31] performed a randomized clinical trial comparing the effects of intra-articular distension with lidocaine and triamcinolone versus distension with lidocaine alone on range of motion and pain in patients with frozen shoulder. Inclusion criteria consisted of duration of more than 6 weeks, passive range of motion less than 50% of that of the opposite shoulder, lack of effusion, normal radiographic findings, absence of trauma or diabetes, and lack treatment except analgesics during the study period. Patients were randomized by the envelope method. Distension was achieved with 19 mL of 0.5% lidocaine with or without 20 mg of triamcinolone. Ultrasonography was utilized to confirm intra-articular placement of the injection. The treatment was repeated once a week for a maximum of 6 weeks or until the patient was asymptomatic. Patients reported pain at rest and on function using a visual analogue scale as well as daily analgesic usage. At inclusion, and at 3-week intervals up to 12 weeks, the patients were examined by an impartial, blinded physician who judged the severity of the disorder on a scale of 1 to 3 and the passive range of motion compared with the opposite shoulder. Twenty patients completed the study over 2 years; there was no statistical difference between the groups in terms of pain relief, although there was a tendency in favor of less pain in the group treated with distension and corticosteroids. Range of motion and analgesic usage were improved in the group treated with distension and corticosteroids. A small subject number resulting from the strict inclusion criteria limited this study.

These data and others present in the literature support the hypothesis that adhesive capsulitis is an inflammatory and fibrotic condition [13–16,19,22,27]. In the early stages, a hypervascular synovial hyperplasia is present that results in eventual fibrosis of the subsynovium and capsule. Early treatment with intra-articular corticoste-

roids may provide a chemical ablation of the synovitis, thus limiting the subsequent development of fibrosis and shortening the natural history of the disease. The self-limiting nature of adhesive capsulitis also supports the role of the synovium in initiation and regulation of the fibrotic process in the capsule. With resolution of the synovitis and loss of the cytokine stimulus to the capsular fibroblasts, capsular remodeling and recovery of range of motion take place. It remains to be defined whether the use of specific cytokine inhibitors will shorten this syndrome's natural history or whether the use of inhibitors of collagen synthesis will be helpful in decreasing capsular fibrosis.

### Arthroscopic treatment of frozen shoulder

Historically, arthroscopy was reported to be of little diagnostic and therapeutic value in patients with adhesive capsulitis of the shoulder. However, there is evidence in the orthopedic literature to support the use of the arthroscopy in delineation of disorders, documentation of the results of closed manipulation, and treatment of concomitant intra-articular and subacromial disease [32–37]. For this reason, the authors are prepared to perform arthroscopy, capsular release, and manipulation if there are no suspected extra-articular factors contributing to the motion loss. Arthroscopic intervention permits evaluation of glenohumeral or subacromial disease, synovectomy in stage 2 adhesive capsulitis, and facilitates a precise capsular release. Furthermore, the force of manual manipulation required to regain motion is greatly reduced by arthroscopic capsular release before manipulation [35]. The timing of arthroscopy and manipulation remains controversial. Some surgeons prefer to manipulate the shoulder first and follow with the arthroscopic evaluation; however, rupture of the capsule with manipulation will greatly increase the risk of fluid extravasation in the soft tissues surrounding the shoulder joint. The senior author prefers to perform a diagnostic arthroscopy and synovectomy before manipulation of the shoulder to minimize fluid extravasation into the soft tissue [38•].

Andersen *et al.* [32] recently reported on 24 patients treated with arthroscopy, manipulation under anesthesia, and early passive range of motion. The male-to-female ratio was unusual, with 11 men and 13 women and a mean age of 46 years. The patients on average had 8 months of symptoms prior to surgery and all had either corticosteroid injections or physiotherapy previously with mild or no improvement. Fifty percent of the cases were idiopathic, 25% diabetic, and 25% secondary frozen shoulder related to subacromial impingement or cervical radiculopathy. All patients underwent arthroscopy under general anesthesia with passive motion determined at the outset. Initial findings at arthroscopy were a reduced intra-articular volume and diffuse synovitis. In patients who described symptoms of subacromial impingement

prior to onset of adhesive capsulitis, subacromial decompression was done at time of arthroscopy. The arthroscopy after manipulation revealed that 79% of cases had a rupture of the capsule adjacent to the anterior inferior rim. Following surgical treatment, an epidural catheter was guided into the subacromial space and connected to a bupivacaine pump for 48 hours. The postoperative protocol consisted of immediate institution of continuous passive motion twice daily for 4 hours supplemented by continuous passive exercises supervised by a physiotherapist. Pain treatment lasted for 5 days and the mean hospital stay was 6 days. Physical therapy was required on an outpatient basis for 3 to 6 weeks. At 12 months' follow-up, 75% of patients had satisfactory results, with no significant difference in outcome between patients with primary and secondary adhesive capsulitis, including those patients with diabetes.

### Conclusions

Frozen shoulder is a condition that has traditionally been diagnosed clinically and allowed to resolve over time. Although an increased incidence had been noted in certain populations, the reasons behind this phenomenon remain unclear. Recent case reports implicating an alteration in MMP activity may open new areas of investigation into the etiology and potential pharmacologic treatment of adhesive capsulitis. The treatment of patients with frozen shoulder remains varied, with positive improvement in patient function noted with home-based physical therapy [39•] in addition to intra-articular corticosteroid treatment and surgical intervention. New techniques for manipulation promise to lessen the risk of fracture, and the development of improvements in postmanipulation pain control, such as catheters for continuous local anesthesia, may improve patient outcome. There remain significant gaps in our understanding of the etiology of frozen shoulder, which must be answered to best provide appropriate and efficacious treatment for these patients.

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