Upper Extremity: Emphasis on Frozen Shoulder

Monique A. Sheridan, BA\textsuperscript{a}, Jo A. Hannafin, MD, PhD\textsuperscript{a,b,*}

\textsuperscript{a}Women’s Sports Medicine Center, Hospital for Special Surgery, 535 East 70th Street, New York, NY 10021, USA
\textsuperscript{b}Weill Medical College of Cornell University, 1300 York Avenue, New York, NY 10021, USA

Epidemiology

Primary adhesive capsulitis, or frozen shoulder, is a condition characterized by gradual loss of active and passive glenohumeral motion. The prevalence of frozen shoulder is slightly greater than 2\% in the general population\textsuperscript{1}, affecting persons older than 40 years\textsuperscript{2}. Approximately 70\% of patients presenting with adhesive capsulitis are women, and 20\% to 30\% of those affected will develop adhesive capsulitis in the opposite shoulder\textsuperscript{1}. Despite the female preponderance of patients who have adhesive capsulitis, the role of sex has not been investigated thoroughly and the etiology remains unknown. The lack of consistency in the published literature also reflects a lack of understanding of causation. As a result, management of frozen shoulder is controversial, and many treatment options, both operative and nonoperative, are available.

Duplay\textsuperscript{3} initially identified a stiff shoulder as “periarthritis” in 1872, followed by Codman\textsuperscript{4} who labeled the condition “frozen shoulder” in 1934. It was not until 1945, that Neviaser\textsuperscript{5} coined the term “adhesive capsulitis,” recognizing pathologic changes in the capsule. Disagreement remains in the literature as to whether the underlying pathologic process is an inflammatory condition\textsuperscript{5–8} or a fibrosing condition\textsuperscript{9}. Progression of the disease has been shown to include contracture of the coracohumeral ligament\textsuperscript{10–12}. The terms frozen shoulder and adhesive capsulitis are used intermittently throughout this article because they are the two most common terms used to describe the condition.

The literature contains limited reports of differences in the anatomy and physiology or the incidence of shoulder disorders between men and women. Shoulder injuries are more common in women due to increased ligament and joint laxity, relatively weaker upper body strength, and shorter long bone length\textsuperscript{13}; however, because the etiology of adhesive capsulitis of the shoulder is unknown, it is unclear why the condition occurs more frequently in women. Frozen shoulder has also been documented to be more common and more difficult to treat effectively in patients who have diabetes\textsuperscript{14–17}, thyroid disease\textsuperscript{18,19}, and autoimmune disease\textsuperscript{20,21}, and a statistically significant association between frozen shoulder and Dupuytren’s disease has been found\textsuperscript{22}.

Richards and colleagues\textsuperscript{23} examined the relationship between adhesive capsulitis and acromial morphology. Of the 69 shoulders with adhesive capsulitis, 75.4\% carried a type II acromion. Acromial morphology, however, was not found to have a statistically significant relationship with adhesive capsulitis because 74.1\% of the control group also exhibited a type II acromion. Richards and colleagues\textsuperscript{23} concluded that narrowing of the subacromial space caused by the anterior acromial shape was not a cause of primary frozen shoulder. Sex differences were not assessed in this study.

Anatomy and physiology

Adhesive capsulitis can be classified as primary, which is characterized by idiopathic, progressive, painful loss of active and passive shoulder motion; as secondary, which has a similar presentation and progression but results from a known intrinsic or extrinsic cause; or as
secondary shoulder stiffness following surgical intervention. Intrinsic factors implicated in the causation of secondary adhesive capsulitis include rotator cuff tears, bursitis, and tendonitis, whereas extrinsic factors generally relate to trauma.

Neviaser and Neviaser [24,25] described four stages of adhesive capsulitis. Hannafin and colleagues [9] described a correlation among the arthroscopic stages described by Neviaser, the clinical examination, and the histologic appearance of capsular biopsy specimens in patients who had stages 1, 2, and 3 adhesive capsulitis. It is imperative to note that these stages represent a continuum of disease rather than discrete, well-defined stages. To date, there are no published data showing anatomic or physiologic differences between men and women in the four stages of adhesive capsulitis.

In stage 1, patients complain of pain with active and passive range of motion. The pain is described as achy at rest and sharp with motion, with symptoms present for less than 3 months. Patients describe night pain and rest pain. There is a progressive loss of motion, with forward flexion, abduction, internal rotation, and external rotation becoming most limited. Upon examination under anesthesia or following intra-articular injection of local anesthetic, there is a significant improvement in range of motion to normal or to minimal loss. Arthroscopic examination reveals a diffuse hypervascular glenohumeral synovitis, often most pronounced in the anterosuperior capsule (Fig. 1). Pathology specimens show rare inflammatory cell infiltrates; a hypertrophic, hypervascular synovitis; and a normal underlying capsule (Fig. 2).

In stage 2, also known as the “freezing stage,” symptoms have been present for 3 to 9 months with chronic pain and progressive loss of range of motion. There is still rest pain and night pain, and significant sleep disturbances may exist. There is significant limitation of forward flexion, abduction, internal rotation, and external rotation. Examination after intra-articular injection of local anesthetic or scalene block reveals relief of pain with partial improvement in range of motion. The motion loss in stage 2 reflects a loss of capsular volume and a response to painful synovitis. Arthroscopic examination reveals a diffuse, pedunculated synovitis and a tight capsule with a rubbery or dense feel on the insertion of the arthroscope (Fig. 3). There is a hypertrophic, hypervascular synovitis with perivascular and subsynovial scar formation and capsular fibroplasia (Fig. 4). No inflammatory infiltrates have been reported in stage 2.

In the “frozen stage” (stage 3), patients experience minimal pain at night or rest (except at the end range of motion) but have significant shoulder stiffness. There is a marked loss of range of motion with a rigid “end feel” on capsular stress. Symptoms have been present for approximately 9 to 15 months. Range of motion remains unchanged when the patient is injected with local

![Fig. 1. Biopsy sample from stage 1 adhesive capsulitis demonstrates hypervascular hypertrophic synovium.](https://example.com)

![Fig. 2. Hypertrophic, hypervascular synovitis with perivascular and subsynovial scar formation in stage 2 adhesive capsulitis.](https://example.com)

![Fig. 3. Capsular fibroplasias seen in deep capsular biopsy tissue from late stage 2 adhesive capsulitis.](https://example.com)
anesthetic or examined under anesthesia, secondary to a profound loss of capsular volume and fibrosis of the glenohumeral joint capsule. Arthroscopic examination reveals remnants of fibrotic synovium that is not hypervascular. Capsular biopsy samples reveal a dense, hypercellular collagenous tissue and a thin synovial layer without significant hypertrophy or hypervascularity.

Stage 4 is known as the “thawing phase” of adhesive capsulitis. During this stage, there is minimal pain and progressive improvement in range of motion resulting from capsular remodeling. Because these patients rarely undergo surgery, there are no arthroscopic or histologic data available for patients who have stage 4 adhesive capsulitis. Determination of the stage of adhesive capsulitis at the time of patient examination is critical and directs the treatment options.

Diagnosis

The diagnosis of idiopathic frozen shoulder is made from history and physical examination when other causes of pain and motion loss are eliminated. It is important to determine from the patient’s history the current stage of the condition to determine the appropriate treatment. The physical examination should include an evaluation of the cervical spine, trunk, and both shoulders. Patients presenting with stages 1 and 2 adhesive capsulitis have pain on palpation of the anterior and posterior capsule and describe pain radiating to the deltoid insertion. Night and rest pain are common in the early stages. Sufficient evaluation of active and passive range of motion is necessary to determine the stage of disease and the subsequent efficacy of the treatment.

Glenohumeral motion should be measured while stabilizing the scapula to evaluate glenohumeral versus scapulothoracic range of motion. External rotation, abduction, and internal rotation are most affected. Active range of motion should be measured and recorded with the patient standing. Passive glenohumeral motion is measured with the patient supine and scapulothoracic motion constrained by manual pressure on the acromion.

Routine radiographs are obtained, including anteroposterior views in internal and external rotation, axillary views, and outlet views, to identify other potential causes of a stiff shoulder such as glenohumeral arthritis, calcific tendonitis, or rotator cuff disease. Plain radiographs are generally normal in patients who have frozen shoulder, although there may be evidence of osteopenia. MRI may be useful in recognizing partial or complete rotator cuff tears in patients complaining of shoulder stiffness and pain but it is not routinely needed for the diagnosis of adhesive capsulitis.

Nonoperative treatment

The treatment given to patients presenting with adhesive capsulitis depends on the stage of the disease and clinical symptoms. There are certain basic principles that apply to all stages. Oral nonsteroidal anti-inflammatory medications can be initiated in most patients who present with painful limited range of motion, with other analgesics supplemented as necessary. A combined intra-articular injection of corticosteroid and local anesthetic is also helpful in managing adhesive capsulitis by reducing pain and allowing for increased shoulder movement.

Exercise and physical therapy are often highly recommended to maintain and regain range of motion. Physical therapy, stretching, and other rehabilitation programs are most effective in patients presenting with stage 2 or higher adhesive capsulitis because stage 1 patients often find physical therapy difficult due to inflammation and pain. Therefore, the goal of physical therapy for stage 1 adhesive capsulitis is to interrupt the cycle of inflammation and pain by focusing on modalities for pain, patient education for positioning, and activity modification to balance activity and rest. Stage 2 treatments concentrate on decreasing inflammation and pain and minimizing capsular restriction to minimize loss of motion. The goal is to stretch the capsule sufficiently to allow

Fig. 4. Capsular biopsy sample demonstrates dense, hypercellular collagenous tissue in stage 3 adhesive capsulitis.
restoration of normal glenohumeral biomechanics. Physical therapy for patients who have stage 3 adhesive capsulitis is designed to treat significant loss of motion by increasing range of motion through aggressive stretching. Heat promotes muscle relaxation; hydrotherapy may also be used to reduce discomfort after stretching. Most patients have significant improvement by 12 to 16 weeks. Some patients do not improve and may get worse, which may indicate a need for surgical intervention or manipulation.

Physical therapy has proved to be an effective method of treatment for adhesive capsulitis. A recent placebo-controlled study [26] found that a stretching-exercise program in patients who had stage 2 idiopathic adhesive capsulitis successfully reduced pain at rest (84% of subjects) and with activity (73% of subjects). Vermeulen and colleagues [27] later examined the effectiveness of high-grade mobilization techniques (movements into the stiffness zone) and low-grade mobilization techniques (movements in the pain-free zone) in 100 patients who had adhesive capsulitis symptoms for greater than 3 months and at least a 50% decrease in shoulder joint mobility. The study found that both groups improved range of motion within 12 months. The results for the group that underwent high-grade mobilization techniques were superior to those of the low-grade group, but the overall difference between the two groups was small. The study suggests that physical therapy is valuable regardless of intensity due to increased movement and range of motion and decreased stiffness of the shoulder.

In contrast, Diercks and Stevens [28] compared supervised neglect with intensive physical therapy as treatment for patients presenting with adhesive capsulitis symptoms for greater than 3 months and with more than 50% motion restriction of the glenohumeral joint. After 2 years from the start of treatment, 89% of patients treated with supervised neglect had normal or near-normal shoulder function compared with only 63% of subjects treated successfully with intensive physical therapy. In this study, supervised neglect included pendulum and active exercises in the pain-free range and instructions to resume all tolerable activities. The investigators suggested that the intensive physical therapy program had an adverse effect on the natural course of the active disease process. It is important to note that both treatments were more than 50% effective and that there was no long-term evidence of efficacy of either method.

Although there are no published data that examine the role of sex in response to treatment, Griggs and colleagues [26] incorporated a mental health survey into a study evaluating the efficacy of a physical therapy program for patients who had stage 2 adhesive capsulitis. Sixty-six patients completed a Short Form-36 Health Survey to compare the subjects’ mental health with the established population norms. In subjects whose pain decreased over the 12-month stretching-exercise period, the Health Survey demonstrated that male subjects’ scores were not significantly different from those in the general male population. In contrast, female subjects scored higher in vitality and mental health compared with the general female population. The investigators suggested that female patients who overcome adhesive capsulitis do not have an intrinsic emotional, psychological, or personality disorder. The study also suggests that the women were satisfied with the results of the stretching-exercise program, resulting in a positive overall mental health status. It remains unclear whether women find the symptoms of acute adhesive capsulitis more difficult to manage. These data also raise the question whether the condition is more severe in women and whether the improvements in pain and range of motion after treatment are more marked in women.

Intra-articular injections of steroid and local anesthetics are extremely useful tools in the diagnosis and treatment of adhesive capsulitis. An injection not only provides pain relief but also restores motion and function of the shoulder, which helps to reduce the level of stiffness. There is extensive information regarding the efficacy of intra-articular corticosteroids. Bulgen and colleagues [29] randomized patients to treatment with corticosteroids, physical therapy, or benign neglect. The initial response to treatment was most marked in patients treated with corticosteroids. Van der Windt and coworkers [30] confirmed that corticosteroids were superior to physiotherapy in providing faster relief of symptoms. At 7 weeks, 77% of patients who received corticosteroid injections were considered treatment successes versus only 46% of patients receiving physiotherapy. Other studies [31,32], however, show that there is no significant difference in benefits of corticosteroid injections or physiotherapy treatments. In these trials, however, the stage of adhesive capsulitis treated is not known. In most trials, there was no long-term difference (2-year follow-up) between treatment groups, as might be expected in a self-limiting condition. Therefore,
corticosteroid injections are probably effective only in the short-term course of managing frozen shoulder syndrome. Recently, a randomized, placebo-controlled study [33] determined that corticosteroids provide significant short-term benefits in adhesive capsulitis but the benefits do not extend beyond 6 months of treatment. Depending on the duration of symptoms and the stage of the condition, patients may require additional treatments or surgical referral.

Recent research has also shown that when corticosteroids are combined with other treatment methods such as physiotherapy, the results are superior. Carette and colleagues [34] randomized 93 subjects to four treatment groups: corticosteroid injection combined with physiotherapy, corticosteroid injection alone, physiotherapy alone, and placebo. By the end of the study, all four groups had reached a comparable level of improvement in pain and range of motion, which is consistent with the natural course of the disease. The combined corticosteroid injection and physiotherapy treatment, however, proved to be most effective in providing quick improvements in shoulder range of motion compared with either treatment alone. Ryans and colleagues [35] supported that treatment success is more likely in patients who have frozen shoulder receiving a combination of physiotherapy and corticosteroid injections. The study noted that although corticosteroid injections significantly improve shoulder-related disability at 6 weeks, a physiotherapy program effectively improves the range of external motion at 6 weeks of treatment. When selecting a treatment method for adhesive capsulitis of the shoulder, it is extremely important to consider the patient’s symptoms and stage of the condition because each patient’s treatment should be individualized and tailored appropriately to patient needs. Patients who have stage 1 or 2 adhesive capsulitis should receive intra-articular steroid injections based on our understanding of the inflammatory component of those stages. Stage 3 would not be expected to respond to intra-articular steroid; thus, treatment with this modality is not indicated. The importance of stage of disease in treatment may reflect the mixed results in the aforementioned trials.

The role of sex in the response to nonoperative treatment of frozen shoulder syndrome has yet to be explored. In the many trials evaluating conservative treatments for adhesive capsulitis, such as physical therapy and corticosteroid injections, studies report a majority of female subjects, as seen in Table 1 [26–28,30,32–35]. These data are consistent with Binder and colleagues’ [1] report that adhesive capsulitis of the shoulder occurs more frequently in women than in men.

Although van der Windt and colleagues’ trial [30] did not assess outcome of treatment with regard to sex, the investigators observed sex-specific reactions to the corticosteroid treatments. Of the

<table>
<thead>
<tr>
<th>Study</th>
<th>Total number of subjects presenting with adhesive capsulitis of the shoulder</th>
<th>Female subjects presenting with adhesive capsulitis of the shoulder n (%)</th>
<th>Trial treatment methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ryans et al, 2005 [35]</td>
<td>80</td>
<td>46 (57.5)</td>
<td>Physiotherapy, corticosteroid injections</td>
</tr>
<tr>
<td>Carette et al, 2003 [34]</td>
<td>93</td>
<td>55 (59.1)</td>
<td>Physiotherapy, corticosteroid injections</td>
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<tr>
<td>Buchbinder et al, 2004 [33]</td>
<td>49</td>
<td>35 (71.4)</td>
<td>Corticosteroid injections</td>
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<td>Arslan &amp; Çeliker, 2001 [32]</td>
<td>20</td>
<td>10 (50.0)</td>
<td>Physical therapy, corticosteroid injections</td>
</tr>
<tr>
<td>Dierks &amp; Stevens, 2004 [28]</td>
<td>77</td>
<td>40 (51.9)</td>
<td>Physical therapy, supervised neglect</td>
</tr>
<tr>
<td>Vermeulen et al, 2006 [27]</td>
<td>100</td>
<td>66 (66.0)</td>
<td>Physical therapy</td>
</tr>
<tr>
<td>Griggs et al, 2000 [26]</td>
<td>75</td>
<td>58 (75.3)</td>
<td>Physical therapy</td>
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58 female subjects, several women experienced adverse reactions to corticosteroids. Nine women reported facial flushing and 6 reported menstrual bleeding, 2 of whom were postmenopausal. Doctors and patients must be aware of such adverse reactions when administering intra-articular steroid injections to female patients presenting with adhesive capsulitis of the shoulder.

**Operative treatment**

Operative treatment is recommended for patients who do not respond to or who demonstrate little improvement after conservative treatment. Treatment options include closed manipulation under anesthesia, arthroscopic capsular release, and open surgical capsular release.

**Closed manipulation under anesthesia**

Closed manipulation serves as an effective operative treatment method for most patients presenting with frozen shoulder, as demonstrated in the literature[36–39]. There is no published literature that documents the role of sex in closed manipulation. Of the research available, however, it is notable that the number of female subjects is significantly greater than that of male subjects, as demonstrated in Table 2. This analysis supports the common theory that adhesive capsulitis is more common in women than in men. A high incidence in failure with closed manipulation treatment has been reported in patients who have diabetes [39]. Contraindications also include significant osteopenia, recent surgical repair of soft tissues about the shoulder, or the presence of fractures or neurologic injury.

Closed manipulation is performed after placement of scalene block anesthesia or induction of general anesthesia. The scapula is stabilized with one hand while the humerus is grasped just above the elbow with the other hand. Initially, the adducted shoulder is externally rotated and then abducted in the coronal plane. Next, the shoulder is externally rotated in abduction and then internally rotated in abduction. The shoulder then is forward flexed and finally brought back into adduction and internally rotated. Frequently, there is palpable and audible yielding of the soft tissue as motion is restored in the different planes.

The authors do not advocate primary closed manipulation of the shoulder as the treatment of

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</tr>
</thead>
<tbody>
<tr>
<td>Farrell et al, 2005 [37]</td>
<td>25</td>
<td>16 (64.0)</td>
<td>Manipulation under anesthesia</td>
</tr>
<tr>
<td>Othman &amp; Taylor, 2002 [36]</td>
<td>64</td>
<td>37 (57.8)</td>
<td>Manipulation under anesthesia</td>
</tr>
<tr>
<td>Hamdan &amp; Al-Essa, 2003 [39]</td>
<td>100</td>
<td>61 (61.0)</td>
<td>Manipulation under anesthesia with or without saline injection or steroid injection</td>
</tr>
<tr>
<td>Dodenhoff et al, 2000 [38]</td>
<td>37</td>
<td>27 (73.0)</td>
<td>Manipulation under anesthesia</td>
</tr>
<tr>
<td>Anderson et al, 1998 [40]</td>
<td>24</td>
<td>13 (54.2)</td>
<td>Manipulation under anesthesia, arthroscopic inspection</td>
</tr>
<tr>
<td>Watson et al, 2000 [42]</td>
<td>73</td>
<td>42 (57.5)</td>
<td>Arthroscopic capsular release</td>
</tr>
<tr>
<td>Ide &amp; Takgi, 2004 [45]</td>
<td>42</td>
<td>24 (57.1)</td>
<td>Arthroscopic capsular release</td>
</tr>
<tr>
<td>Klinger et al, 2002 [41]</td>
<td>36</td>
<td>22 (61.1)</td>
<td>Arthroscopic capsular release</td>
</tr>
<tr>
<td>Berghs et al, 2004 [43]</td>
<td>25</td>
<td>13 (52.0)</td>
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choice for patients who have adhesive capsulitis but prefer an arthroscopic inspection before manipulative treatment is performed. An earlier Dutch study [40] supports the authors’ position, demonstrating that manipulation coupled with arthroscopy is effective in reducing stiffness and pain resulting from adhesive capsulitis. In this study, all patients underwent arthroscopy under general anesthesia with passive motion determined at onset. Initial findings at arthroscopy were a reduced intra-articular volume and diffuse synovitis. The arthroscopy after manipulation revealed that 79% of cases had a rupture of the capsule adjacent to the anterior inferior rim. Physical therapy exercises were included for 2 to 6 weeks following surgery. At 12-months’ follow-up, 75% of patients had satisfactory results, with no significant differences in outcome between patients who had primary and secondary adhesive capsulitis, including those who had diabetes.

Arthroscopic capsular release

Arthroscopy is becoming increasingly more popular in the operative treatment of adhesive capsulitis. Arthroscopic intervention permits evaluation of glenohumeral or subacromial disease, synovectomy in stage 2 adhesive capsulitis, and facilitates a precise capsular release in stage 3 adhesive capsulitis. This approach is efficacious in improving shoulder range of motion and function and in reducing recovery time from frozen shoulder syndrome [41–45]. As with other treatment methods, sex differences as related to arthroscopic outcome have not been examined in the literature. As expected, however, there are more female subjects in these studies than male subjects, as detailed in Table 2. Therefore, the same question arises as with treatment by closed manipulation: Do more women than men exhibit persistent stiffness and pain resulting in operative treatment? To answer this question, a prospective cohort study for all patients presenting with a diagnosis of adhesive capsulitis at a shoulder clinic in Switzerland. The study provides no explanation for or insight into the unusual ratio of men to women, but the investigators cited that sex was not a significant predictor of arthroscopic outcome.

Open surgical capsular release

Patients who have adhesive capsulitis and who have failed to respond to closed manipulation or arthroscopic release are sometimes recommended an open surgical release to improve the condition. This treatment method, however, is rare among surgeons in the United States. Although an open surgery allows greater access to the humeroscapular region and facilitates palpation, the disadvantages include postsurgical stiffness, lengthened postoperative recovery time, decreased pain control, and restrictions on physical therapy and rehabilitation exercises. There are limited published data on the efficacy of open surgical releases in the treatment of adhesive capsulitis. Omari and Bunker [12] and Ozaki and colleagues [10] reported excellent results in patients who failed to improve with conservative treatment or closed manipulation; however, each study included limited numbers (25 and 17 subjects, respectively), and no sex analysis was conducted. Although open surgical release is effective in treating adhesive capsulitis, arthroscopy remains the treatment method of choice due to its precision and reduced postoperative recovery time.

Summary

Continued research is indicated to fully understand the etiology of adhesive capsulitis of the shoulder and the response to treatment. There are currently limited published data differentiating the progression and outcomes of treatment of frozen shoulder syndrome, and limited data examining sex differences in adhesive capsulitis. We need to determine why women are at increased risk for development of adhesive capsulitis. Do fluctuations in hormone levels in the premenopausal years somehow trigger this syndrome, or alternatively, do they determine the individual response to the biologic trigger? Is there an autoimmune component to this disease? If so, scientific research may be directed toward determining the role of hormone replacement therapy in the prevention or development of adhesive capsulitis. Do men and women respond comparably to conservative and operative treatment? Prospective clinical trials
are needed to determine the efficacy of these treatment regimens for men and women to refine the scientific methods of diagnosis and treatment appropriate for each sex.

References


