Hypothesis: The purpose of this study is to report and compare the outcome of arthroscopic capsular release in patients with shoulder stiffness with post-traumatic, postsurgical, and idiopathic etiologies. We hypothesize that patients with idiopathic or post-traumatic stiffness have better outcomes after arthroscopic capsular release than those with shoulder stiffness with a postsurgical etiology.

Materials and Methods: A retrospective review of 115 patients who underwent arthroscopic capsular release for refractory shoulder stiffness was performed. There were 60 men and 55 women with a mean age of 49 years (range, 27 to 81 years). The patients were divided into 3 groups according to the etiology of stiffness: post-traumatic (26 patients), postsurgical (48 patients), and idiopathic (41 patients). Arthroscopic capsular release was performed in all patients after a mean of 9 months of physical therapy (range, 6 to 13 months).

Results: At a mean follow-up of 46 months (range, 25 to 89 months), the overall subjective shoulder value in all groups improved from 29% to 73% and the age- and gender-adjusted Constant score improved from 35% to 86%. The mean pain score decreased from 7.5 to 1, and mean active forward flexion, external rotation, and internal rotation increased from 97°, 14°, and the L5 vertebral level, respectively, to 135°, 38°, and the T11 vertebral level, respectively (P < .0001). There was no significant difference between the outcomes of idiopathic and post-traumatic stiffness (P = .7). However, the Constant score and subjective shoulder value were significantly lower in the postsurgical group compared with the idiopathic and post-traumatic groups (P = .0001 and P = .006, respectively).

Conclusions: Arthroscopic capsular release is an effective treatment for refractory shoulder stiffness. Patients with idiopathic and post-traumatic shoulder stiffness have better outcomes than patients with postsurgical stiffness.
Stiffness of the shoulder is a common yet poorly understood disorder.  

Multiple etiologies that lead to a stiff shoulder have been reported. A primary idiopathic form, or frozen shoulder, develops with no specific etiology and has a prevalence of approximately 2% in the adult population; it is distinguished from secondary forms of shoulder stiffness that develop after trauma or surgery. Although the idiopathic form is believed to be a self-limiting condition, shoulder stiffness after surgery may remain permanent without a spontaneous tendency to recover. Regardless of the etiology, the initial treatment of choice is always conservative, and physical therapy with or without manipulation under anesthesia is generally effective. However, it has been shown in multiple studies that there is still a group of patients with refractory shoulder stiffness in whom conservative treatment fails and who have long-term residual pain and limitation of motion. These individuals may benefit from operative intervention.

Arthroscopic capsular release has been proposed as a minimally invasive surgical option for patients with refractory shoulder stiffness, with a reliably good outcome especially in the idiopathic type. However, no studies of a large number of patients have validated this treatment approach in the different causes of refractory shoulder stiffness. The purpose of this study is to report the effectiveness of arthroscopic capsular release in 3 different etiologies of refractory shoulder stiffness: the idiopathic, postsurgical, and post-traumatic forms. We hypothesize that patients with idiopathic or post-traumatic stiffness have better outcomes after arthroscopic capsular release than those with shoulder stiffness with a postsurgical etiology.

**Materials and methods**

This study was approved by the IRB of the Massachusetts General Hospital (Protocol # 2009-P-000912).

From 2000 and 2005, 115 consecutive patients (115 stiff shoulders) underwent arthroscopic release for painful shoulder stiffness unresponsive to conservative management. The etiology of stiffness was either post-traumatic, postsurgical, or idiopathic. Patients who were determined to have stiffness due to bony structural abnormalities were excluded from the study. The study was approved by the internal review board of Massachusetts General Hospital, Boston, MA (protocol 2009-P-000912).

There were 60 men and 55 women with a mean age of 49 years (range, 27 to 81 years), with 65 right shoulders and 50 left shoulders (62 dominant shoulders). All patients were treated with a conservative regimen of supervised physical therapy for a mean of 9 months (range, 6 to 13 months) before they underwent arthroscopic capsular release. The indication for surgical treatment was continued pain, inability to sleep, and persistent shoulder stiffness despite therapy.

Patient demographic information, including age at surgery, side of surgery, arm dominance, duration of symptoms, mean follow-up, preoperative physical examination findings, and associated surgeries, is shown in Tables I and II. Subjective and objective data, which had been collected prospectively, were reviewed retrospectively. Outcome measures included clinical examination, subjective shoulder value (SSV), Constant score (CS), and pain level. To determine the SSV, patients were asked to subjectively estimate the value of their treated shoulder as a percentage of the value of an entirely normal shoulder. The CS was calculated both as an absolute numeric value and as a percentage of an age- and gender-matched normal score (relative CS). Pain was measured by use of a visual analog scale ranging from 0 (no pain) to 10 (severe pain).

Preoperatively, the SSV was 29.3% (range, 0% to 70%) and the adjusted CS was 35.7% (range, 14% to 51%). The mean pain level was 7.4 (range, 4 to 10), mean forward elevation was 97° (range, 30° to 120°), mean external rotation was 14° (range, −20° to 20°), and mean internal rotation was to the sacrum level (range, greater trochanter to third lumbar level).

**Patient data according to specific etiology**

Patients with idiopathic frozen shoulders had marked restriction of passive glenohumeral joint motion. No history of trauma was recorded. Of the patients, 41 (25 women and 16 men) met these criteria. Their mean age at the time of capsular release was 52 years (range, 36 to 81 years). The dominant arm was affected in 21 patients and the nondominant arm in 20. Of the 41 patients, 16 (39%) had diabetes mellitus and 2 (4.8%) had hypothyroidism. Operative intervention was performed after at least 9 months of conservative treatment (mean, 11 months; range, 9 to 13 months). The mean SSV was 26% (range, 0% to 50%), and the mean age- and gender-adjusted CS was 36.8% (range, 26% to 47%). The mean pain level was 7.6 (range, 4 to 10) (with 0 points indicating no pain and 10 points indicating most severe possible pain), mean forward elevation was 100° (range, 40° to 120°), mean external rotation was 14° (range, −10° to 20°), and mean internal rotation was to the fifth lumbar level (range, greater trochanter to third lumbar level).

Forty-eight patients had postsurgical shoulder stiffness. The mean age at the time of capsular release was 44 years...
The dominant arm was affected in 28 patients and the nondominant arm in 20. Operative intervention was performed after at least 6 months of conservative treatment (mean, 7 months; range, 6 to 8 months). The 48 patients had 56 previous surgeries: 17 patients had undergone 20 rotator cuff repairs (14 open and 4 arthroscopic with 2 revisions), 12 patients had 16 Bankart operations (8 arthroscopic and 8 open), 6 patients had arthroscopic subacromial decompression, 5 patients had an arthroscopic superior labrum repair (2 isolated, 2 with a Bankart operation, and 1 with a rotator cuff repair), 1 patient had a hemiarthroplasty, 1 patient had a total shoulder replacement (after hemiarthroplasty), 2 patients had HemiCAP implantation (Arthrosurface, Franklin, MA) (one after rotator cuff repair and the other after Bankart operation), and there were 4 other operations. The mean SSV was 32.5% (range, 10% to 70%), and the mean gender-adjusted CS was 36% (range, 14% to 51%). The mean pain level was 7.4 (range, 4 to 10) (with 0 points indicating no pain and 10 points indicating most severe possible pain), mean forward elevation was 94° (range, 30° to 110°), mean external rotation was 11° (range, −20° to 25°), and mean internal rotation was to the sacrum level (range, greater trochanter to fourth lumbar level).

Twenty-six patients had shoulder stiffness due to trauma. Of the 26 patients, 7 had shoulder stiffness after a fracture (6 patients had a minimally displaced 2-part fracture of the proximal humerus and 1 patient had fracture dislocation resulting in avascular necrosis of the humeral head with no significant head collapse). None of these had a significant osseous deformity creating a bony block to motion. The remaining 19 patients had shoulder stiffness after a particular trauma without fracture (10 patients had a post-traumatic rotator cuff tear, 3 patients had a post-traumatic superior labral tear, 1 patient had a shoulder dislocation with severe stiffness, and the remaining 5 patients had a loss of shoulder motion with a documented injury). The mean age of these patients at the time of capsular release was 55 years (range, 42 to 74 years). The dominant arm was affected in 13 patients and the nondominant arm in 13. Operative intervention was performed after a mean of 7 months of conservative treatment (minimum, 6 months). The mean SSV was 28.6% (range, 29% to 40%), and the mean gender-adjusted CS was 33.3% (range, 21% to 43%). The mean pain level was 7 (range, 4 to 8) (with 0 points indicating no pain and 10 points indicating most severe possible pain), mean forward elevation was 96° (range, 30° to 140°), mean external rotation was 17° (range, 0° to 40°), and mean internal rotation was to the sacrum level (range, greater trochanter to seventh thoracic level).

### Table I  Demographic data of patients who had arthroscopic capsular release

<table>
<thead>
<tr>
<th></th>
<th>Idiopathic</th>
<th>Postsurgical</th>
<th>Post-traumatic</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>41</td>
<td>48</td>
<td>26</td>
<td>115</td>
</tr>
<tr>
<td>Age [mean (range)] (y)</td>
<td>52 (36 to 81)</td>
<td>44 (24 to 65)</td>
<td>55 (49 to 74)</td>
<td>49 (24 to 81)</td>
</tr>
<tr>
<td>Gender (M/F)</td>
<td>16/25</td>
<td>27/21</td>
<td>17/9</td>
<td>60/65</td>
</tr>
<tr>
<td>Dominant side</td>
<td>52%</td>
<td>58%</td>
<td>50%</td>
<td>54%</td>
</tr>
<tr>
<td>Diabetes</td>
<td>16/41 (39%)</td>
<td>—</td>
<td>—</td>
<td>39%</td>
</tr>
<tr>
<td>Previous operations</td>
<td>4</td>
<td>58</td>
<td>2</td>
<td>64</td>
</tr>
<tr>
<td>Follow-up [mean (range)] (mo)</td>
<td>49 (26 to 75)</td>
<td>43 (27 to 89)</td>
<td>46 (25 to 84)</td>
<td>46 (25 to 89)</td>
</tr>
</tbody>
</table>

### Table II  Operations performed in patients associated with arthroscopic capsular release

<table>
<thead>
<tr>
<th>Operation</th>
<th>Idiopathic</th>
<th>Postsurgical</th>
<th>Post-traumatic</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACR</td>
<td>41</td>
<td>48</td>
<td>26</td>
<td>115</td>
</tr>
<tr>
<td>ASAD</td>
<td>36</td>
<td>35</td>
<td>18</td>
<td>89</td>
</tr>
<tr>
<td>BT tenotomy</td>
<td>2</td>
<td>1</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>BT tenodesis</td>
<td>1</td>
<td>4</td>
<td>—</td>
<td>9</td>
</tr>
<tr>
<td>ACJ resection</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Superior labrum repair</td>
<td>—</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>RC repair</td>
<td>—</td>
<td>1</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Subcoracoid decompression</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>1</td>
</tr>
</tbody>
</table>

ACR = Arthroscopic cuff repair; ASAD = arthroscopic subacromial decompression; BT = biceps tenodesis; ACJ = aromio-cavicular joint; RC = rotator cuff.

Surgical technique

The operation was performed as previously described by the senior surgeon in 1997 with a few technical modifications added after the original description. All patients
were operated on in the beach-chair position. After positioning of the patient in the operating room, while under anesthesia, passive range of motion was documented. The entire upper extremity was then prepared in a sterile fashion, and a mechanical arm holder was used to maintain the position of the arm. An 18-gauge spinal needle was inserted into the joint from the posterior arthroscopic portal, which was slightly higher (0.5 cm) than the usual placement, and sterile saline solution was introduced into the contracted intra-articular space. Typically, 10 to 15 mL of saline solution was injected to fill the contracted joint space, increasing hydrostatic pressure and thus distracting the articular surfaces from each other. This allowed for confirmation of proper placement of the arthroscope as fluid would flow out of an open port when the arthroscope was introduced into the joint. An incision was then made, and the arthroscope was inserted in the same orientation of the spinal needle, with the surgeon carefully guiding it over the humeral head. An 18-gauge spinal needle was introduced into the joint just underneath the biceps, and a 6-mm cannula was introduced into the superior joint. Release of the rotator interval region was first performed, and then the remainder of the contracted anterior capsule was released followed by the posterior capsule.

**Anterior capsular release**

The first and key step in all cases was to release the rotator interval region, which was represented as contracted capsule between the anterior edge of the supraspinatus and the superior border of the subscapularis (Figure 1). This region is the part of the capsule limiting external rotation with the arm at the side, and its release also permits the humeral head to move inferiorly and laterally away from the glenoid so that the contracted anterior capsule may then be released.28,29 The capsular scar inferior to the biceps tendon is released by use of a radiofrequency device with a hook-tip arthroscopic instrument and a motorized shaver. The endpoint of this stage of the release is exposure of the upper edge of the subscapularis tendon. Because the capsular scar may be very thick in this region, release to the base of the coracoid process with exposure of the conjoined tendon may be necessary in some patients.

The next step is to divide the anterior capsule deep to the subscapularis tendon (Figure 2). This is facilitated by using the radiofrequency device to cut through the scarred capsule until one sees the muscle fibers of the subscapularis. Progressive external rotation of the arm by use of the arm-holder device allows one to confirm that the subscapularis tendon is free to move without any capsular scar tethering it into the subscapularis fossa. Partial release of the subscapularis tendon was not necessary in any patient. Whereas the normal capsule is only a few millimeters thick, in our patients the capsule was usually up to 5 to 8 mm in thickness. The release was continued down to the 6-o’clock position. As long as the muscle of the subscapularis is visible, the axillary nerve is not at risk because of its proximity to the radiofrequency device.

**Posterior capsular release**

After release of the entire anterior capsule, a posterior capsular release was performed for persistent loss of internal rotation even after anterior capsular release.

The arthroscope was first placed through the anterior cannula with inflow switched to that cannula. The arthroscopic sheath was removed over a switching stick and replaced with a 6-mm arthroscopic cannula. The posterior capsule was then released by use of the radiofrequency device. This portion of the capsular release was performed along the glenoid rim because this region allows one to visualize the muscle of the infraspinatus as the endpoint of capsular release (Figure 3). The release was continued from just behind the biceps tendon down to approximately the 8-o’clock position on the glenoid. The posterior capsule in all patients was noted to be thickened to 4 to 8 mm compared with the normal lax posterior capsule, which has a thickness of 1 to 2 mm (Figure 4). The inferior capsule was released fully if it was found to be thick in patients with limited flexion/abduction. This situation was mostly encountered in patients with post-traumatic shoulder stiffness.

After the arthroscopic release, gentle manipulation of the shoulder was performed. In all cases minimal or no
force was required to restore supple range of motion to the shoulder.

We routinely performed a subacromial bursectomy to determine whether there was an associated component of subacromial bursitis. Most patients were found to have at least an inflamed, thickened bursa, which was removed. We believed that this was consistent with the mechanism of non-outlet impingement, where shoulder stiffness caused mechanical compression between the rotator cuff and the acromion. The finding of an inflamed subacromial bursa was observed in virtually all patients with post-traumatic and postsurgical stiffness.

Aftercare

All patients had interscalene anesthesia with an indwelling interscalene catheter. They received a bolus of 30 to 40 mL of a combination of 1.5% mepivacaine and 0.5% bupivacaine, usually in a combination of 20 mL each. Then, the infusion was run with 0.1% bupivacaine at a variable rate ranging from 10 to 20 mL/h, depending on the individual patient’s degree of pain.

Patients were admitted to the hospital for 48 hours to undergo immediate physical therapy, which consisted of passive range of motion performed twice daily. A cryotherapy device was used during this early phase of treatment to reduce pain and swelling.

In the recovery room, once awake, all patients were shown their postoperative passive range of motion as their arm was painlessly manipulated for them. We found that this helped them appreciate what they had gained and then actively and optimistically participate in their subsequent physical therapy.

Patients were discharged on the afternoon of the second postoperative day without a sling and were instructed to begin immediate physical therapy and to try to use their shoulder for activities of daily living. Supervised physical therapy was performed 5 days per week for the first 2 weeks and then usually 3 days per week for the next 2 weeks. Afterward, therapy was individualized to each patient’s needs. Water therapy was also used whenever possible.

Statistical analysis

To determine the statistical significance between the different groups, a 1-way analysis of variance test was used. When significant, a Tukey test was performed to identify differences between groups. The level of statistical significance was set at $P = .05$.

Results

At a mean follow-up of 46 months (range, 24 to 89 months), the mean pain score decreased from 7.5 (range, 4 to 10) to 1 (range, 0 to 8) ($P < .0001$) in all patients (Table III). Of the 115 patients, 72 (63%) reported no pain, 24 (21%) reported mild pain, 14 (12%) reported moderate pain, and 5 (4%) reported severe pain. All patients with severe pain after surgery had a similar level of pain before surgery. None of the patients had worsening pain after surgery. The mean SSV increased from 29% (range, 10% to 50%) to 73% (range, 25% to 100%) ($P < .0001$). Mean active forward flexion, external rotation, and internal rotation increased from 97° (range, 30° to 140°), 14° (range, −20° to 50°), and the L5 vertebral level (range, trochanter to T7), respectively, to 135° (range, 60° to 160°), 38° (range, 0° to 60°), and the T11 vertebral level (trochanter to T3), respectively ($P < .0001$). The mean CS (normalized) increased from 35% (range, 17% to 54%) to 86% (range, 34% to 100%) ($P < .0001$). Seven patients required a revision arthroscopic capsular release.

Results according to etiology

When the demographic data of the groups were compared, the mean age of the patients in the postsurgical stiffness
The outcomes after treatment of idiopathic stiffness were better than the outcomes after treatment of postsurgical stiffness in terms of pain relief ($P = .01$), forward flexion ($P = .02$), and SSV ($P = .0001$). There was no significant difference between the outcomes of the idiopathic stiffness and post-traumatic stiffness groups, but shoulders with post-traumatic stiffness had better postoperative SSV scores than shoulders with postsurgical stiffness ($P = .006$).

### Discussion

Management of shoulder stiffness continues to be challenging. Although physical therapy is generally effective in the management of the stiff shoulder due to adhesive capsulitis, it may not be as effective in patients in whom stiffness develops after surgery or trauma. Patients in whom there is a failure to progress after a compliant commitment to conservative treatment and who continue to have not only shoulder stiffness but also pain may benefit from operative intervention. It has been shown that 5% to 20% of patients who have persistent loss of shoulder motion remain functionally disabled. Operative options have historically included manipulation under anesthesia with or without arthroscopy or surgical release, either open or arthroscopic. Arthroscopic capsular release has been shown to lead to a similar rate of earlier relief of pain and resolution of stiffness compared with open release but with an added advantage of a less invasive approach.
approach. Many authors have validated arthroscopic capsular release.\(^1,8,12,13,15,17,22,25\) However, their studies were relatively small and did not consider the potential influence of the etiology of the stiffness on the outcome.

The original technique of arthroscopic capsular release was reported by Ogilvie-Harris and colleagues\(^1,8,19\) and subsequent modifications were reported by both the senior author (J.J.P.W.) and colleagues\(^28\) and Harryman.\(^11\) Since these original articles, several authors have reported on the outcome of arthroscopic capsular release for stiff shoulder.\(^1,17,18,28\) Yamaguchi et al.\(^31\) reported on the outcome of capsular release in 23 patients with adhesive capsulitis who had severe pain and in whom there was a failure to progress with a physical therapy protocol. An intra-articular pain catheter was placed in all patients, which helped to eliminate the postoperative pain and assisted in range-of-motion exercises. Of the patients, 95% achieved nearly complete range of motion without pain.

Warner et al\(^28\) reported on 23 patients who underwent arthroscopic capsular release for refractory frozen shoulder. The patients all received an interscalene infusion of analgesia via a catheter postoperatively. All patients reported a significant reduction of their pain, and the postoperative range of motion was within 7° of the contralateral normal shoulder in all planes. In another study Warner et al\(^29\) reported on 18 patients who underwent arthroscopic capsular release performed for postoperative stiffness. Successful restoration of motion was reported in 16 patients, whereas 2 patients required open release because of subscapularis tightness.

Gerber et al\(^8\) reported on the results of arthroscopic capsular release in 45 patients with shoulder stiffness in whom conservative treatment had failed. They divided the patients according to the etiology of stiffness into 3 groups: idiopathic (9 patients), postoperative (21 patients), and post-traumatic (15 patients). Improvement in pain and range of motion was shown in all groups; however, the outcome was better after arthroscopic capsular release of frozen shoulder compared with postoperative and postsurgical stiffness. Patients with post-traumatic stiffness had the least improvement compared with the idiopathic and postsurgical stiffness patients.

Nicholson\(^17\) reported on the results of arthroscopic capsular release in 68 patients with stiff shoulder. He divided patients into 5 groups depending on the etiology of stiffness: idiopathic (17), postsurgical (20), post-traumatic (15), diabetic (8), and due to impingement syndrome (8). Significant improvement in pain, range of motion, and function was seen in all groups, with no major differences between the groups except for a tendency toward less improvement in the diabetic group.

The overall outcome of capsular release for refractory shoulder stiffness in our study is similar to the other reported studies.\(^3,8,18,28,29\) We reported significant improvement in range of motion, pain, function, and CS in all groups. However, there were differences in outcome between the different groups. The results in patients with idiopathic and post-traumatic stiffness were similar to or better than those in patients with postsurgical stiffness. This differs from the results reported by Gerber et al\(^8\) and Nicholson.\(^17\) In the series of Gerber et al, the idiopathic group fared better than the postoperative group, and both of those groups had better results than the post-traumatic group. This could be related to the fact that most post-traumatic patients in their series had dislocations or fracture whereas patients in our series more commonly had stiffness from soft-tissue trauma.

In the series of Nicholson,\(^17\) the outcomes in all groups were similar. This difference between his results and ours might be related to the smaller number of patients and different types of surgeries leading to postoperative stiffness in his patients. Most of the cases of postoperative stiffness in his series were the result of arthroscopic subacromial decompression and rotator cuff repair. In our series, only half of the patients had postoperative stiffness after rotator cuff repair or arthroscopic subacromial decompression, and the rest of the patients had Bankart repair, labral repair, or shoulder arthroplasty.

The reported outcome of arthroscopic capsular release in patients with diabetes varied in the literature.\(^1,17,18,22,28,31\) Some reviews reported a higher recurrence rate after arthroscopic capsular release in diabetic patients, whereas others did not find a differences in the outcome between diabetic patients and nondiabetic patients. In our series, we did not find a statistical difference in the outcome in patients with diabetes compared with nondiabetic patients.

Reported complications after arthroscopic capsular release include recurrence of contracture (up to 11%).\(^30\) axillary nerve palsy,\(^11\) and anterior dislocation immediately postoperatively.\(^28\) In this series, among all patients, 7 of 115 (6%) had recurrence of stiffness requiring revision surgery. None of the patients had either axillary nerve palsy or instability after surgery.

The limitations of this study include its retrospective nature. In addition, all patients with post-traumatic stiffness were placed in the same group regardless of the type of trauma. The same method of grouping was performed in the postsurgical patients. Despite the adequate number of patients reported in each category in this study, the numbers were still not large enough to be able to divide the patients and compare their outcomes according to type of surgery or trauma that resulted in their stiffness.

**Conclusions**

Arthroscopic capsular release is a reliable treatment option for patients with idiopathic, post-traumatic, and postsurgical shoulder stiffness. It was found to reliable not only in restoring motion but also in eliminating pain. Patients with idiopathic or post-traumatic shoulder stiffness have better outcomes than those with postsurgical stiffness. Diabetic involvement did not affect the outcome of surgical treatment.
Disclaimer

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References