Are Delayed Operations Effective for Patients With Rotator Cuff Tears and Concomitant Stiffness? An Analysis of Immediate Versus Delayed Surgery on Outcomes

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Purpose: The purpose of this study was to compare the clinical outcomes of immediate rotator cuff repair with capsular release and those of rotator cuff repair after the stiffness was treated with rehabilitative therapy. Methods: Between June 2007 and December 2010, we recruited 63 patients with rotator cuff tears and stiffness. In 33 patients arthroscopic rotator cuff repair was performed with capsular release simultaneously (group I). In 30 patients arthroscopic rotator cuff repair was performed after 6 months of preoperative rehabilitation for stiffness (group II). The American Shoulder and Elbow Surgeons score, Simple Shoulder Test score, Constant score, and visual analog scale score for pain and range of motion (ROM) were assessed at the start of the study; at 3, 6, and 12 months; and at the last visit. The postoperative cuff tendon integrity was assessed between 6 and 12 months using magnetic resonance or ultrasound images. Results: There were no significant differences in preoperative demographic data between the groups (P > .05). The mean follow-up period was 21.54 months. After treatment, there was significant improvement in ROM and functional scores in both groups, as measured at the last follow-up (P < .05). No statistical differences were found in clinical scores and ROM at the last follow-up (P > .05). On assessment of the magnetic resonance or ultrasound images taken 6 to 12 months postoperatively, the retear rate for the repaired cuff tendon in each group was 12.1% in group I and 13.4% in group II. Conclusions: In the treatment of rotator cuff tears with stiffness, satisfactory results can be achieved either by repairing the tear with simultaneous capsular release or by waiting to perform the repair after preoperative rehabilitation for stiffness. Because a delayed rotator cuff repair after improving ROM offered no clear advantage over an immediate operation, we recommend surgically treating rotator cuff tears with concomitant stiffness early using a simultaneous capsular release method to save time and to avoid unnecessary rehabilitation. Level of Evidence: Level II, prospective comparative study.

For many patients with rotator cuff tears, they not only have pain but they also have decreased range of motion (ROM) of the shoulder, which inhibits their function in daily life.1-5 Many factors can lead to this shoulder stiffness in patients with rotator cuff tears.6

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Often, the pain from the injury results in joint disuse, and contracture of the joint capsule or secondary muscular weakness may facilitate the joint stiffness. In addition, secondary adhesive capsulitis, which is precipitated by inflammation from the rotator cuff tear, can be a contributor to joint stiffness.5

Unfortunately, treating rotator cuff tears with concomitant stiffness can be paradoxical. Protection and immobilization are necessary for proper healing of the repaired tendon, yet constant ROM exercise is needed to prevent stiffness. In addition, the actual repair of the rotator cuff tear may lead to the progression of stiffness because the repair is a joint-tightening procedure, and again, postoperative immobilization is important for healing the repaired tendon.7-9 Because of these factors, the traditional concept of recovering joint motion before the surgical rotator cuff repair has been in practice for a long time.7-9

Recently, these practices have come under investigation. According to recent studies, nonoperative
treatments such as stretching, exercise, or manipulation are less effective at improving glenohumeral joint motion but rather improve scapulothoracic motion. Another approach involves resolving stiffness by manipulation under anesthesia before the rotator cuff repair. However, undesirable trauma including fracture, dislocation, or other injuries within the shoulder joint has persisted after forceful manipulation. Because of these results, we are forced to consider other approaches for treating rotator cuff tears with stiffness.

One viable option is to perform arthroscopic capsular release with the rotator cuff repair. With advances in arthroscopic techniques, arthroscopic capsular release has been an effective treatment method for the recalcitrant frozen shoulder. Capsular release performed with the rotator cuff repair not only treats isolated stiffness but also allows a rapid recovery time and improvements in ROM. In addition, this approach offers advantages, including allowing visual control of the release and yielding fewer potential complications than the traumatic manipulation method. However, there are few reports focusing on the treatment of rotator cuff tears associated specifically with shoulder stiffness. In these studies the incidence, stiffness severity, and treatment protocols were not clearly presented, and it was also unclear how the preoperative stiffness affected the postoperative results. To our knowledge, no reports have been published comparing the results of the traditional method, which is delayed repair of rotator cuff injuries after the recovery of ROM, versus the results of immediate rotator cuff repair with concomitant capsular release of the capsule. Therefore the purpose of this study was to compare the clinical outcomes of immediate rotator cuff repair with capsular release and those of delayed rotator cuff repair after preoperative treatment of stiffness. The hypothesis of the study was that simultaneous capsular release with rotator cuff repair would show better clinical results than the delayed rotator cuff repair after preoperative treatment of stiffness.

**Methods**

**Inclusion and Exclusion Criteria**

From June 2007 to December 2010, a total of 80 consecutive patients who met our inclusion criteria were enrolled. Patients were required to have a small- or medium-sized (tear size <3 cm) full-thickness rotator cuff tear confirmed by magnetic resonance imaging (MRI) before surgery along with concomitant shoulder joint stiffness. Stiffness was determined to be present when the patient had forward flexion of less than 100° (maximum of 150°; forward flexion is glenohumeral motion without scapulohumeral rhythm), external rotation of less than 45° (maximum of 90°), or internal rotation of a level where the thumb reaches lower than the first lumbar spine junction (maximum of T7 level).

Patients were also required to have no evident trauma history. Patients who had large or massive rotator cuff tears, a history of shoulder surgery, or concomitant shoulder lesions such as arthritis in the glenohumeral joint or labral lesions were excluded. Patients with a symptomatic acromioclavicular joint lesion or confirmed to have acromioclavicular joint arthritis on either radiographs or MRI studies were also excluded. A total of 80 patients were selected for the study. Because 8 patients refused to participate, the study comprised 72 patients. This study was approved by our institutional review board.

**Baseline Characteristics**

Patients were allocated to 2 groups: group I underwent an immediate rotator cuff tear operation with concomitant capsular release, and group II underwent a delayed rotator cuff tear operation after 6 months of preoperative treatment for shoulder stiffness, with simultaneous capsular release in 14 patients. Assignment of patients to each group was achieved by computer-generated blocked-randomization numbers. After confirmation that the patient met the inclusion and exclusion criteria, the treatment method was determined by a random number taken from a sealed envelope. All of the patients were blinded at the time of allocation and informed about the advantages and disadvantages of both treatments before allocation. Three patients in group I were lost during the follow-up period, and 6 patients in group II refused to undergo the operation. Therefore 33 patients were enrolled in group I and 30 patients were enrolled in group II (Fig 1). The baseline characteristics of the enrolled patients are shown in Table 1.

**Preoperative Management**

Preoperative management for the recovery of ROM was performed in group II only. The exercise protocol was modified from that in the study by Griggs et al. All patients were treated with the same home-based rehabilitation exercise protocol, and the patients were provided with instructions for the exercises. Exercises included pendulum circumduction, passive shoulder stretching in forward flexion, external rotation, horizontal adduction, and internal rotation. Pulley exercises were also included for the accelerated recovery of forward flexion. Patients were instructed to stretch the shoulder to the point of tolerable discomfort and hold the position for at least 3 seconds. Patients were recommended to perform 3 sessions every day and instructed that each exercise session should last at least 15 minutes. Patients were prescribed nonsteroidal anti-inflammatory drugs and muscle relaxants to be taken when necessary. All exercise programs were continued...
for at least 6 months before surgery. All patients were recommended to visit the hospital once each month for regular checkups. No additional management was performed for group I between the diagnosis of the rotator cuff tear and surgery. All patients in group I underwent surgery within 2 weeks of the diagnosis.

Operative Techniques

One senior surgeon (Y-S.K.) conducted all surgical procedures, and the same procedure was applied in both groups for arthroscopic repair of the rotator cuff tear. Patients were positioned in the lateral decubitus position, and all arthroscopic surgical procedures were performed with patients under general anesthesia. A standard posterior portal was used for visualization. An anterior portal in the rotator interval capsule and a lateral portal were used as the working portals. For small (<1 cm) rotator cuff tears, a single-row repair was performed, and for medium-sized (1 to 3 cm) tears, a transosseous-equivalent repair (suture bridge technique) was applied. The selection of the surgical method was based on the location and shape of the torn tendon.

Capsular release was performed in all the participants in group I. In group II, capsular release was performed for the patients whose ROM was below the ROM defined by the inclusion criteria after 6 months of preoperative rehabilitation. The capsular release began with the rotator interval and middle glenohumeral ligament using a 3.0-mm 90° electrocautery device (ArthroCare, Sunnyvale, CA) through the anterior portal. The anterior capsule release began below the biceps origin, preserving the glenoid labrum. Without release of the subscapularis tendon, the capsular release was carried down to the 7:30 clock-face position involving both the anterior and posterior bands of the inferior glenohumeral ligament. To avoid axillary nerve damage, the capsular release was performed just off the glenoid rim without violation of the glenoid labrum. In addition, electrical stimulation of electrocautery was helpful in detecting the nearby axillary nerve before direct injury. Because the effect of posterior capsular release is controversial, the posterior capsule remained intact.22 Acromioplasty was performed for all type II and III acromions, along with the removal of subacromial spurs. For type I acromions, the acromial undersurface was smothered.

Postoperative Rehabilitation

All patients were fitted with an abduction brace directly after the operation. The abduction brace was worn for 4 weeks postoperatively, and the same standardized rehabilitation protocols were prescribed in both groups. Daily sessions of controlled, early passive motion exercises for forward flexion were conducted under the supervision of a therapist for the first 4 weeks after the operation. After being weaned from using the brace, the patients were asked to undergo home-based active-assisted shoulder exercises 3 times a day, with
each session lasting for at least 20 minutes. Muscle strengthening was initiated 2 months after the operation, and all sports activities were permitted after 6 months. During the time of home-based exercise, patients were asked to visit the clinic every month for regular checkups.

Outcome Evaluation

ROM of the shoulder and functional scores, including the visual analog scale score for pain, American Shoulder and Elbow Surgeons (ASES) score,24 Constant score, and Simple Shoulder Test score, were evaluated before surgery; at 3, 6, and 12 months after surgery; and again at the final follow-up. For measurements of ROM, forward flexion and external rotation were evaluated with a goniometer when patients were in the supine position, excluding scapulohumeral motion. Internal rotation, which was measured in the seated position, was evaluated by the tip of the thumb reaching the vertebral level. Internal rotation up to the level of the sacrum was designated as 0 points, and 1 point was added for each level above this. All the assessment data were prospectively collected by a clinician who was blinded to this study. The postoperative cuff tendon integrity was assessed between 6 and 12 months after the operation using MRI. For patients who could not participate in MRI evaluation, ultrasound was recommended. The images were blindly interpreted by one of the authors (H-J.L.)

Table 1. Baseline Data

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th>Group II</th>
<th>P Value</th>
</tr>
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<tbody>
<tr>
<td>No. of patients</td>
<td>33</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Age, yr, mean (range)</td>
<td>61.24 (45-76)</td>
<td>62.14 (44-76)</td>
<td>.12</td>
</tr>
<tr>
<td>Sex</td>
<td>13 male and 20 female</td>
<td>12 male and 18 female</td>
<td>.08</td>
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<tr>
<td>Mean follow-up period, mo</td>
<td>20.58</td>
<td>22.61</td>
<td>.11</td>
</tr>
<tr>
<td>Duration of symptoms, mo</td>
<td>4.6</td>
<td>5.2</td>
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<td>Underlying disease, n</td>
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<tr>
<td>Diabetes mellitus</td>
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<td>4 of 30</td>
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<td>2 of 33</td>
<td>1 of 30</td>
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<td>Previous treatment, n</td>
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<tr>
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<td>22 of 33</td>
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<td>7 of 30</td>
<td>.35</td>
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<td>Injection</td>
<td>9 of 33</td>
<td>9 of 30</td>
<td>.08</td>
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<td>Tear size of rotator cuff in medial to lateral dimension, mm</td>
<td>12.43 ± 0.68</td>
<td>11.29 ± 1.21</td>
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<td>Initial ROM</td>
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<td>FF, °</td>
<td>124.19 ± 15.55</td>
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<td>67.69 ± 10.04</td>
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<tr>
<td>ER at 90° of abduction, °</td>
<td>73.51 ± 8.45</td>
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<tr>
<td>IR</td>
<td>L2</td>
<td>L2</td>
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<td>Initial clinical score, points</td>
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<td></td>
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<tr>
<td>VAS for pain</td>
<td>5.34 ± 1.23</td>
<td>5.38 ± 1.12</td>
<td>.32</td>
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<tr>
<td>ASES</td>
<td>48.61 ± 5.57</td>
<td>44.80 ± 6.09</td>
<td>.70</td>
</tr>
<tr>
<td>SST</td>
<td>30.95 ± 4.12</td>
<td>34.51 ± 5.07</td>
<td>.33</td>
</tr>
<tr>
<td>Constant</td>
<td>57.35 ± 7.56</td>
<td>61.33 ± 6.19</td>
<td>.11</td>
</tr>
</tbody>
</table>

NOTE. Data are presented as mean ± SD unless otherwise indicated.

ASES, American Shoulder and Elbow Surgeons; ER, external rotation; FF, forward flexion; IR, internal rotation; SST, Simple Shoulder Test; VAS, visual analog scale.

Statistical Methods

Sample sizes were calculated based on finding a significant difference in the ASES score, with a mean difference of 8 points and an SD of 12 points. The ASES score has been validated and widely used for the evaluation of outcome after arthroscopic rotator cuff repair.24-26 A sample size of 28 patients in each group was required for a power of 70% at a type I error level of .05. There would have been a lower chance of a type II error with a higher power (e.g., 80%), but a previous Level III study by Snow et al.19 presented results with an even lower power value of 50%. Statistical analysis was performed with SPSS software, version 12.0 (SPSS, Chicago, IL). The Student t test was used to compare the differences between the outcomes of the 2 groups, and a paired t test was used to compare the differences in functional evaluation scores before and after surgery for each group. In addition, repeated-measures analysis of variance (ANOVA) was performed to evaluate the time effect and the interaction between group and time. P < .05 was considered significant.

Results

Overall, there were no significant differences in demographic data between the 2 groups (P > .05). The mean follow-up period was 21.54 months. In group II, after 6 months of rehabilitation, there were no significant improvements in ROM except for flexion.
Rotator Cuff Tear with Concomitant Stiffness

(121.22° ± 9.34° to 141.53° ± 8.79°, \( P = .029 \)) and internal rotation (L2 to T11, \( P = .014 \)) before surgery. Among the functional scores, no significant changes were shown except in the visual analog scale score for pain (5.3 ± 0.2 points to 4.1 ± 0.4 points, \( P = .021 \)) and the ASES score (44.84 ± 3.92 points to 61.91 ± 2.81 points, \( P = .002 \)) after rehabilitation. In group II arthroscopic capsular release was performed in patients whose ROM was still below the ROM defined by the inclusion criteria after 6 months of preoperative rehabilitation. Among the 30 patients in group II, 14 underwent arthroscopic capsular release.

Both groups showed significantly improved ROM and functional scores after the operation, which was measured at the last follow-up visit. In addition, internal rotation at 3 and 6 months postoperatively was significantly different between the groups, with group II showing improved ROM over group I (\( P = .031 \) and \( P = .025 \), respectively). However, there were no significant differences between the 2 groups in functional scores, including the ASES score, at any time point (\( P > .05 \)) (Fig 2). In addition, there was no significant difference in ROM between the 2 groups at any other time point (\( P > .05 \)) (Fig 3).

These measures were evaluated once more using repeated-measures ANOVA. There were significant changes in all measures of ROM over time regardless of the group (\( P < .05 \)). In flexion and external rotation, there were no significant differences between the groups when we considered the interaction between group and time (\( P > .05 \)). However, when revising the effect of the time course, we found a significant difference between the 2 groups in internal rotation (\( P = .007 \)). There were significant changes in all functional scores over time and no significant differences between the groups when analyzed by repeated-measures ANOVA.

The retear rate after rotator cuff repair was 12.1% (4 of 33 patients) in group I and 13.3% (4 of 30 patients) in group II as measured by follow-up MRI studies and ultrasounds performed, on average, at 10.52 months postoperatively (\( P = .13 \)). Magnetic resonance images were obtained for 29 patients in group I and 27 patients in group II. We evaluated 4 patients in group I and 3 patients in group II by ultrasound.

Discussion

In this study we saw significant improvements in ROM and functional scores after rotator cuff repair regardless of whether the patient participated in preoperative rehabilitation for stiffness. At the end of the study, there were no significant differences in ROM or functional outcome measures between the 2 groups.

Many studies have identified contributing factors or treatments for isolated shoulder stiffness, but in the case of rotator cuff tears with concomitant stiffness, the

![Fig 2](https://example.com/fig2.png)

Fig 2. Functional scores (pain visual analog scale [VAS], American Shoulder and Elbow Surgeons [ASES], Constant, and Simple Shoulder Test [SST]) improved after surgery in both groups. No significant differences between groups were seen at any time point.
Predisposing factors have yet to be determined, which creates controversy when choosing the optimal treatment. Currently, many investigators think that any significant preoperative stiffness should be fully restored before rotator cuff repair to avoid severe postoperative stiffness.\(^5,\,8\) To evaluate the validity of this protocol, we assigned 6 months of nonoperative rehabilitation to be completed before rotator cuff repair in group II and compared the outcomes with group I, which underwent surgical repair immediately. In this study, small- to medium-sized rotator cuff tears were included because large or massive rotator cuff tears tend to yield greater functional deficits, in addition to more pain and stiffness, before and even after surgical treatment, along with higher retear rates. In addition, there may be multiple variations in surgical techniques used to treat larger tears that may affect the outcome.

In contrast to previous studies that showed successful outcomes with nonoperative treatment of adhesive capsulitis,\(^23,\,27\) we found no significant improvement in external rotation, Simple Shoulder Test scores, or Constant scores after the rehabilitation period in group II and compared the outcomes with group I, which underwent surgical repair immediately. In this study, small- to medium-sized rotator cuff tears were included because large or massive rotator cuff tears tend to yield greater functional deficits, in addition to more pain and stiffness, before and even after surgical treatment, along with higher retear rates. In addition, there may be multiple variations in surgical techniques used to treat larger tears that may affect the outcome.

In contrast to previous studies that showed successful outcomes with nonoperative treatment of adhesive capsulitis,\(^23,\,27\) we found no significant improvement in external rotation, Simple Shoulder Test scores, or Constant scores after the rehabilitation period in group II. In contrast to idiopathic adhesive capsulitis, the treatment for rotator cuff tears with concomitant stiffness remains controversial, with various outcomes. Either the rotator cuff repair has a negative influence on the treatment of stiffness, or vice versa.\(^7,\,9,\,11,\,17,\,28\) In addition, 16.7% of the patients enrolled in group II (6 of 36 patients) declined to follow through with the operation during the study period. Among the 6 patients who declined to proceed, 4 showed satisfactory results after the preoperative rehabilitation and refused to undergo rotator cuff repair. The decisions were merely subjective, and the functional outcomes with ROM were not available at the time of resignation. The other 2 patients refused to tolerate the remaining rehabilitation period. In our study the unsatisfactory results of preoperative rehabilitation with a high dropout rate can be explained by lack of supervision with the home-based program with a relatively long period of treatment. However, generally, nonoperative treatment for stiffness can be problematic because it is time-consuming and the results may vary according to patient compliance. Enduring the often long and painful process of rehabilitation can be challenging for many patients, especially those who may not reach their target ROM. In addition, inappropriate exercise leading to fatigue accumulation in the damaged tendon or forceful manipulation before rotator cuff repair may actually worsen the rotator cuff injury.\(^7,\,11,\,28,\,29\)

Whether to preoperatively rehabilitate the shoulder before surgery is a major consideration, but there are also concerns when choosing the surgical approach. Two surgical options, manipulation and capsular release, have been reported for shoulder stiffness.\(^7,\,9,\,17,\,30\) Cho and Rhee\(^6\) recently reported successful results of an
arthroscopic rotator cuff repair with concomitant manipulation for stiffness. Even though the overall results were satisfactory with a single operation, the recovery of ROM took longer in patients who underwent manipulation for stiffness than in patients without stiffness who did not require manipulation. In contrast, Chuang et al.17 showed rapid recovery of ROM with a single arthroscopic rotator cuff repair with concomitant manipulation and capsular release. When choosing between manipulation and capsular release, there is much information to consider. For example, because manipulation risks tearing the glenohumeral ligament, patients with preoperative shoulder stiffness often have recurrence because the torn ligament may develop fibrosis and adhesions.9,10,12 Moreover, manipulation has a high risk of other complications such as humeral fracture, glenohumeral dislocation, osteochondral injury, rotator cuff tear, labral injury, or radial nerve injury.7,9 However, because of improvements in arthroscopic techniques, arthroscopic capsular release has been a more recent, popular option for the treatment of shoulder stiffness, and it has many advantages over forceful manipulation.31 Visual control of the release allows the surgeon to selectively address the main pathology, avoiding many potential complications that may occur with traumatic manipulation. In addition, it allows the treatment of associated lesions and better control of possible hemarthrosis.9,10,14,18,32,33 Capsular release was performed from the anterior capsule to the posterior band of the inferior glenohumeral ligament. The superior and posterior capsule was left intact. The effect of posterior capsular release has been controversial. Recent studies have shown that the additional posterior capsular release was not associated with any significant difference in the outcome when compared with anterior capsular release.19,22,34

As mentioned earlier, regardless of preoperative rehabilitation for stiffness, patients in both groups showed similar improvements in ROM and functional scores by the end of the study period. Because of these similar overall results, we conclude that there seems to be no benefit in enduring a prolonged period of painful rehabilitation before surgery. A single, simultaneous arthroscopic rotator cuff repair with capsular release is sufficient for improving overall ROM and functional scores in the treatment of rotator cuff tears with accompanying stiffness.

Limitations

When one is analyzing the results of this study, several limitations should be noted. First, it is important to acknowledge our relatively small study population. Moreover, intention-to-treat analysis was omitted for the 6 patients who did not participate in the surgical treatment in group II. These facts led to a decrease in the power of the study. Second, the mean follow-up period is relatively short. Our study showed improved results in every category after 6 months postoperatively, and the effect was maintained until 12 months postoperatively. It is unlikely that this effect would deteriorate with a longer observation time. Third, we were not able to clearly distinguish the cause of the stiffness at the time of enrollment. Even though the target of the study was aimed at patients with rotator cuff tears that evolved toward stiffness, there was still a chance of involving patients with primary or secondary stiffness with concomitant rotator cuff tears. However, the purpose of this study was to determine the optimal treatments for patients with both rotator cuff tears and stiffness by comparing the clinical outcomes of 2 different treatment modalities regardless of the cause of the stiffness. Fourth, because the rehabilitation was based on a home exercise program, careful monitoring was insufficient regarding adherence. Despite the weakness regarding monitoring, it has been proved that self-exercise in the home setting is a more important factor than the session frequency of joint mobilization in the hospital setting in rehabilitation for limited glenohumeral joint mobility.35 Fifth, the 6-month preoperative rehabilitation period seemed too long. Earlier assessment of rehabilitation may have decreased the dropout rate. Lastly, homogenization of the repair methods was not successful. Two surgical methods were used for rotator cuff repair according to the shape and location of the rotator cuff tear. In group II, because 16 patients recovered their ROM after preoperative rehabilitation, a single rotator cuff repair was necessary. However, the other 14 patients who did not show successful results on rehabilitation underwent both capsular release and rotator cuff repair.

Conclusions

In the treatment of rotator cuff tears with stiffness, satisfactory results can be achieved either by repairing the tear with simultaneous capsular release or by waiting to perform the repair after preoperative rehabilitation for stiffness. Because a delayed rotator cuff repair after improving ROM offered no clear advantage over an immediate operation, we recommend surgically treating rotator cuff tears with concomitant stiffness early using a simultaneous capsular release method to save time and to avoid unnecessary rehabilitation.

References


