

The American Journal of Sports Medicine

<http://ajs.sagepub.com/>

Predictors of Outcome After Nonoperative and Operative Treatment of Adhesive Capsulitis

Brian K. Rill, Cassie M. Fleckenstein, Martin S. Levy, Vinutha Nagesh and Samer S. Hasan

Am J Sports Med 2011 39: 567 originally published online December 15, 2010

DOI: 10.1177/0363546510385403

The online version of this article can be found at:

<http://ajs.sagepub.com/content/39/3/567>

Published by:



<http://www.sagepublications.com>

On behalf of:



American Orthopaedic Society for Sports Medicine

Additional services and information for *The American Journal of Sports Medicine* can be found at:

Email Alerts: <http://ajs.sagepub.com/cgi/alerts>

Subscriptions: <http://ajs.sagepub.com/subscriptions>

Reprints: <http://www.sagepub.com/journalsReprints.nav>

Permissions: <http://www.sagepub.com/journalsPermissions.nav>

>> [Version of Record](#) - Mar 7, 2011

[OnlineFirst Version of Record](#) - Dec 15, 2010

[What is This?](#)

Predictors of Outcome After Nonoperative and Operative Treatment of Adhesive Capsulitis

Brian K. Rill,* MD, Cassie M. Fleckenstein,[†] MS, Martin S. Levy,[‡] PhD, Vinutha Nagesh,[‡] MS, and Samer S. Hasan,^{†§} MD, PhD

Investigation performed at Cincinnati Sports Medicine Research and Education Foundation, Cincinnati, Ohio

Background: Few studies regarding adhesive capsulitis have concurrently evaluated nonoperative and operative treatment.

Purpose: The objectives were to evaluate the efficacy of operative and nonoperative treatment of adhesive capsulitis and to determine predictors of clinical outcome.

Study Design: Cohort study; Level of evidence, 3.

Methods: At minimum 24 months' follow-up, 85 patients underwent self-assessment using the Simple Shoulder Test (SST) and American Shoulder and Elbow Surgeons (ASES) score, including 24 patients treated operatively.

Results: Mean number of yes responses on the SST improved from 4.0 ± 2.7 at initial presentation to 9.9 ± 2.8 at final follow-up ($P < .0001$). Patients who received nonoperative treatment and patients who underwent surgery demonstrated similar improvements on the SST. For the entire cohort, forward elevation and external rotation at the side improved from $119^\circ \pm 20^\circ$ to $152^\circ \pm 15^\circ$ and from $29^\circ \pm 18^\circ$ to $46^\circ \pm 11^\circ$ ($P < .0001$), respectively, between initial presentation and discharge from treatment. Internal rotation to the back improved from the gluteal area to the thoracolumbar junction ($P < .0001$). Improvements in forward elevation and external rotation were greater for patients undergoing surgery. After nonoperative treatment, patients with diabetes had a lower final SST than patients without diabetes ($P < .05$). For the entire cohort, initial SST predicted final SST ($P < .05$), and a shorter duration of symptoms predicted a higher final ASES score ($P < .05$). Younger patients ($P < .001$) and those with a lower initial SST ($P < .05$) were more likely to undergo surgery.

Conclusions: A multimodal nonoperative treatment program is effective for most patients with adhesive capsulitis. Patients who do not improve, including those with diabetes, respond well to manipulation and arthroscopic release. Residual motion deficits at discharge from treatment do not appear to affect longer-term clinical outcome.

Keywords: adhesive capsulitis; frozen shoulder; surgery; nonoperative; outcome; predictors

Adhesive capsulitis or primary frozen shoulder is a painful condition of uncertain origin that results in global loss of motion due to rotator interval contracture and capsular thickening.^{22,34} Adhesive capsulitis typically evolves through 3 phases: a freezing phase, a frozen phase, and a thawing phase.^{21,29} The condition resolves over 1 to 3 years^{6,29} and has been treated with "supervised neglect."⁷

[§]Address correspondence to Samer S. Hasan, MD, PhD, Cincinnati SportsMedicine Research and Education Foundation, 10663 Montgomery Road, First Floor, Cincinnati, OH 45242 (e-mail: cfleckenstein@csmref.org).

*Henry Ford Hospital, Sterling Heights, Michigan.

[†]Cincinnati SportsMedicine Research and Education Foundation, Cincinnati, Ohio.

[‡]University of Cincinnati, Cincinnati, Ohio.

The authors declared that they had no conflicts of interest in their authorship and publication of this contribution.

The American Journal of Sports Medicine, Vol. 39, No. 3

DOI: 10.1177/0363546510385403

© 2011 The Author(s)

However, it is most often treated with a multimodal nonoperative program emphasizing a home exercise program of simple shoulder stretches, with or without supervised physiotherapy.^{4,9,26,32} Intra-articular^{30,33} or oral³ corticosteroids can be effective for short-term pain relief. Residual motion deficits have been described in as many as 30% of patients treated nonoperatively, as far out as 11 years from treatment,³² but the clinical relevance of these deficits is not known.

Operative treatment is usually reserved for patients with phase 2 adhesive capsulitis who have persistent pain and clinically relevant motion deficits despite a lengthy nonoperative program.^{5,24,25} Operative treatment typically encompasses manipulation under anesthesia, with or without arthroscopic capsular release. Several studies have reported on the outcome of nonoperative^{7,9,15,26} and operative¹¹ treatment for adhesive capsulitis. However,

^{||}References 1, 2, 8, 11, 24, 25, 27, 36, 37.

studies are lacking that compare the results of operative and nonoperative treatment in the same cohort of patients with adhesive capsulitis.¹⁵ The objectives of this study were to evaluate the efficacy of nonoperative and operative treatment of adhesive capsulitis in a large group of patients. We hypothesized that certain patient factors, such as sex, age at presentation, duration of symptoms, and diabetes, could predict outcome after treatment for adhesive capsulitis and the need for surgical intervention. In addition, we hypothesized that range of motion after treatment would correlate with longer-term outcome.

MATERIALS AND METHODS

A retrospective review identified 99 patients (104 shoulders) with adhesive capsulitis who were seen by the senior author between January 2001 and December 2004. Institutional review board approval was waived because the study is a retrospective cohort study using only self-assessed shoulder function at final follow-up. Of these 99 patients, 85 (89 shoulders) completed self-assessment surveys at a minimum of 24 months' follow-up, 3 patients (4 shoulders) were deceased, and 11 declined follow-up or could not be located. The 85 patients (86% follow-up) form the basis for all subsequent analysis. Fifty-six patients were women (59 shoulders) and 29 were men. The mean age was 52 years (range, 34 to 72 years). Figure 1 shows the distribution of patient ages at initial presentation.

All patients underwent careful physical examination by the senior author and radiographic examination using biplanar radiographs. The MRI scans were not routinely obtained but were reviewed when available. All patients met established criteria for adhesive capsulitis,²⁰ including absent or minor shoulder trauma, global loss of active and passive motion, and radiographs demonstrating either osteopenia or no pathologic lesions. None of the patients had undergone prior surgery on the affected shoulder.

The mean duration of symptoms before initial presentation was 8 months (range, 1 to 60 months), and 39 patients had involvement of their dominant shoulder. Twenty-eight patients (30 shoulders) had diabetes, and 16 patients (17 shoulders) reported either a diagnosis of, or an ongoing treatment for, depression or myofascial pain syndrome. Table 1 summarizes the relevant patient demographics for the entire group, as stratified by treatment.

Self-assessed shoulder function was evaluated with the Simple Shoulder Test (SST) at initial presentation and final follow-up and with the American Shoulder and Elbow Surgeons (ASES) score at final follow-up. In addition, shoulder range of motion—comprising passive forward elevation, passive external rotation at the side, and active internal rotation to the back—was recorded at presentation and at discharge from treatment.

All but 3 patients underwent supervised physiotherapy and home exercise in addition to any treatment received elsewhere before their initial presentation. The supervised physiotherapy program emphasizes a 4-quadrant stretching program in forward elevation, external rotation, internal rotation, and cross-body adduction.^{9,19,26} Patients were

also instructed to perform their exercises at home a minimum of 3 times daily. In addition, all patients were offered oral nonsteroidal anti-inflammatory drugs or corticosteroids; in sum, 47 shoulders (53%) received 1 intra-articular corticosteroid injection (37 shoulders) or 2. Patients were offered a corticosteroid injection at initial presentation if pain prevented participation in the stretching program, or at 4 to 6 weeks if the initial treatment was unsuccessful. Patients enrolled in supervised physiotherapy for an average of 9 weeks (range, 3 to 24 weeks) until symptoms improved, in which case they continued with home exercises alone or until symptoms regressed or reached a plateau, in which case surgery was offered.

Twenty-four patients (25 shoulders) underwent operative intervention, including 8 with diabetes (9 shoulders) and 5 men (6 shoulders). In 15 patients, this was at a minimum of 12 weeks after initial presentation (mean, 19.5 weeks; range, 12 to 34 weeks), but 9 patients underwent surgery sooner because they had undergone supervised physical therapy (6 patients) or because they could not tolerate the exercises (3 patients). Twenty-three shoulders underwent manipulation followed by arthroscopic capsular release. Two shoulders recovered range of motion symmetric to the unaffected shoulder after manipulation so that capsular release was not performed. This included 1 patient with bilateral adhesive capsulitis who at surgery underwent manipulation of both shoulders, followed by capsular release for the more symptomatic shoulder.

All patients undergoing operative intervention received a preoperative interscalene block followed by a general anesthetic. Patients underwent gentle manipulation under anesthesia in a supine position, as described previously.^{17,34} For patients undergoing arthroscopic capsular release, a posterior portal was established, the hemarthrosis resulting from the manipulation was evacuated, and a thorough diagnostic arthroscopy was performed. The technique of arthroscopic capsular release employed in this series was similar to that described previously,^{1,11,14,35} and it encompassed a circumferential release of the rotator interval (Figure 2A), the anterior capsule, and the posterior capsule, typically in that order. The capsule was released with a hook-tipped electrocautery device as well as a basket forceps. The axillary pouch was released during the manipulation or with a basket forceps (Figure 2B) but not with electrocautery. An arthroscopic shaver was used for synovectomy and resection of the rotator interval and posterior capsule.

Postoperatively, all patients used a continuous passive motion chair initiated within the first 24 hours and continuing for 1 to 3 weeks after surgery. Patients also resumed supervised physiotherapy with the same stretching protocol used preoperatively. All patients were followed in the office at regular intervals until shoulder range of motion had adequately recovered for functional activities and patients were satisfied with their progress.¹⁵ Mean duration of clinical follow-up averaged 3.4 months (range, 1 to 22 months). The SST and ASES scores were obtained at minimum of 2 years' follow-up (mean, 40 months; range, 24 to 68 months).

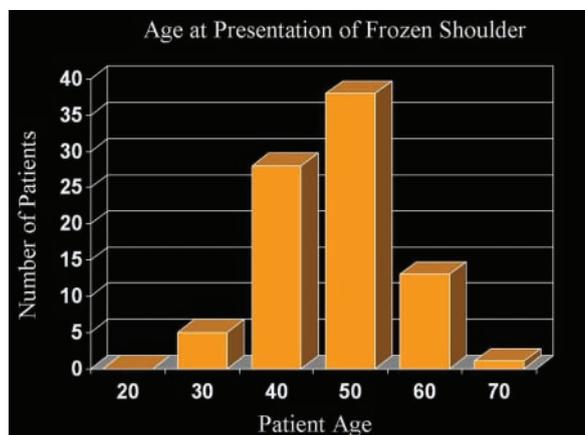


Figure 1. Distribution of patient ages at initial presentation.

TABLE 1
Patient Demographics

	Cohort	Nonoperative	Surgery
n	85	61	24
Mean age, range	52.0 (34-72)	53.4 (36-72)	47.3 (34-65) ^a
Sex: F, M	56, 29	38, 23	18, 6
Depression ^b	17	12	5
Diabetes	28	19	9
Duration symptoms, mos (range)	8.0 (1-60)	8.0 (1-48)	7.9 (1-60)

^a $P < .005$, compared with nonoperative group.

^bPatients who reported a diagnosis of treatment for depression and/or myofascial syndrome.

Ranges of motion—as consistently measured by the senior author at initial presentation and follow-up—included forward elevation, external rotation at the side, and internal rotation to the back. Internal rotation to the back was recorded as the highest bony landmark reached with the extended thumb. This was subsequently transformed to a value between 0 and 10 according to the Constant score³⁰ to facilitate statistical analysis (Table 2).

STATISTICAL METHODS

Statistical analyses were conducted using Microsoft Excel and SAS 9.1, as appropriate. Significance testing included parametric and nonparametric methods comparing initial and final range of motion and SST. These methods were repeated for range of motion and SST as stratified by treatment (surgery or nonoperative treatment) and by demographic factors, such as sex and diabetes. Analyses of correlations between various outcome measures were carried out with the Spearman correlation. Although 4 patients underwent treatment of bilateral frozen shoulders, the 89 shoulders were treated as independent observations for all statistical analyses.

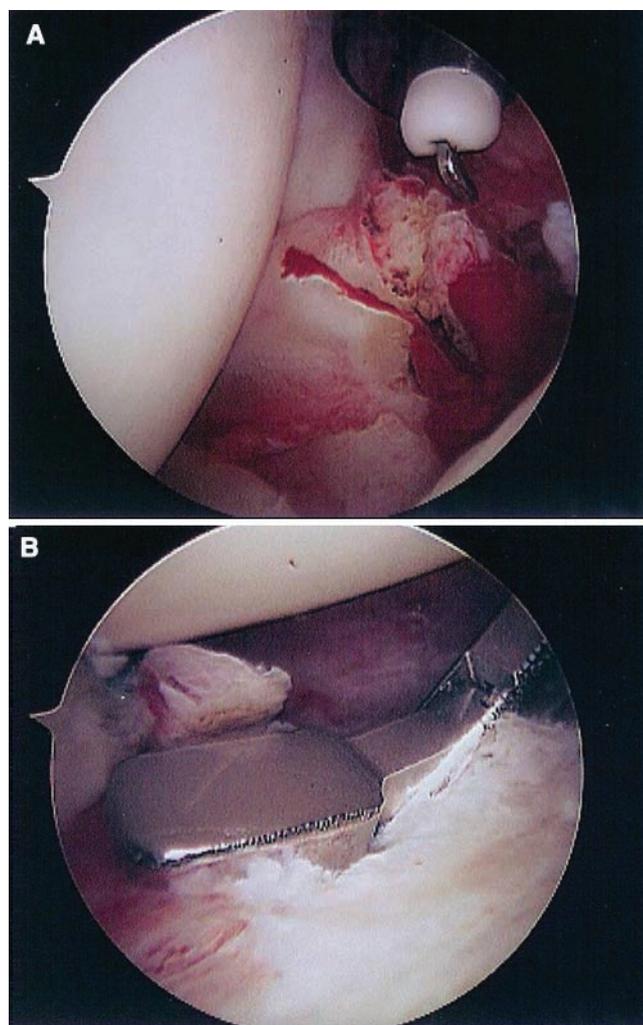


Figure 2. Intraoperative images illustrating arthroscopic release of the rotator interval (A) and axillary pouch (B). Note the use of basket forceps in lieu of electrocautery for axillary pouch release.

Linear regression analyses were performed for initial and follow-up SST and ASES scores, as were logistic regression analyses for dichotomous variables, such as the need for surgery. The predictors that were explored consisted of the initial SST and range of motion measurements, as well as demographic variables such as age, sex, duration of symptoms, diabetes, and clinical depression or myofascial pain syndrome. For both types of regressions, both stepwise exploration and one-at-a-time analyses were performed to identify collections of significant predictors (in the former case) and significant individual predictors (in the latter).

Stepwise procedures sort through possible predictors in a systematic fashion to retain those variables that contribute to the predictive statistical model, discarding the less useful variables, according to criteria based on significance probabilities (P values). We set initial P value thresholds of .10 instead of .05 for entry and retention of variables into

TABLE 2
Internal Rotation to the Back Transformed
for Constant Score

	Bony Landmark				
	Thigh ^a	Buttock ^b	L/S ^c	T12 ^c	T7 ^c
Constant score	2	4	6	8	10

^aGreater trochanter.

^bIschial tuberosity.

^cSpinous process.

TABLE 3
Preoperative Range of Motion, Stratified by Patient
Demographics: Mean \pm SD

	Men	Women
Forward elevation, deg	121 \pm 21	118 \pm 21
External rotation at the side, deg	30 \pm 20	30 \pm 17
Internal rotation to the back ^a	4.7 \pm 2.1	4.9 \pm 1.7
	Diabetic	Nondiabetic
Forward elevation, deg	116 \pm 20	120 \pm 21
External rotation at the side, deg	29 \pm 15	30 \pm 19
Internal rotation to the back	4.6 \pm 2.1	5.0 \pm 1.7
	Surgery	Nonoperative
Forward elevation, deg	116 \pm 24	120 \pm 18
External rotation at the side, deg	23 \pm 22	32 \pm 16 ^b
Internal rotation to the back	4.2 \pm 1.8	5.1 \pm 1.8 ^b
	Depression	No Depression
Forward elevation, deg	119 \pm 20	118 \pm 21
External rotation at the side, deg	30 \pm 12	30 \pm 19
Internal rotation to the back	5.4 \pm 1.9	4.7 \pm 1.8

^aTransformed. See Table 2 for transformation of landmarks to Constant score (0 to 10).

^b $P < .05$.

the predictive model, because our aim was to allow for a more thorough exploration of the contribution of potential predictors. Setting too high a threshold would result in models including too many marginal variables, whereas too low a threshold might exclude potentially meaningful variables. However, all final models reported here contained only predictors at the $P = .05$ level of significance.

RESULTS

At initial presentation, men and women, as well as patients with and without diabetes, had similarly restricted range of motion, as shown in Table 3. However, patients who eventually underwent surgical intervention had significantly greater deficits in external rotation ($23^\circ \pm 22^\circ$ versus

$32^\circ \pm 16^\circ$, $P < .05$) and internal rotation ($P < .05$) compared with patients who did not undergo surgery.

Overall, patients responded favorably to treatment for adhesive capsulitis. At the time of discharge from treatment, mean forward elevation had improved from $119^\circ \pm 20^\circ$ to $152^\circ \pm 15^\circ$ ($P < .0001$), external rotation at the side had improved from $29^\circ \pm 18^\circ$ to $46^\circ \pm 11^\circ$ ($P < .0001$), and internal rotation to the back had improved from the gluteal area to the T12 spinous process ($P < .0001$). Table 4 presents initial and final shoulder range of motion for the entire group, as stratified by treatment. Only 5 shoulders demonstrated decreased mobility in 1 or more plane. Spearman correlation analyses revealed that postoperative range of motion and preoperative range of motion were significantly correlated, as shown in Table 5 for the entire group and as stratified by treatment.

No intraoperative or major postoperative complication was observed in the group undergoing manipulation and arthroscopic capsular release. One patient underwent revision arthroscopic capsular release and manipulation for persistent stiffness, but at 41 months' follow-up, SST and ASES scores had improved to 8 and 75, respectively.

Postoperative forward elevation, external rotation at the side, and internal rotation to the back were similar for nonoperatively and operatively treated patients (Table 4), and with the numbers available, there were no significant differences between the 2 groups. However, range of motion gains were greater in patients who underwent surgery compared with those who underwent nonoperative treatment. Forward elevation improved by a mean $41^\circ \pm 22^\circ$ in patients who underwent surgery, compared with $31^\circ \pm 19^\circ$ in those who did not ($P < .05$), and external rotation improved by a mean $25^\circ \pm 15^\circ$ in patients who underwent surgery, compared with $16^\circ \pm 17^\circ$ in those who did not ($P < .05$). With the numbers available, the mean improvement in internal rotation to the back was similar for both treatment groups.

Self-assessed shoulder function also improved for the entire group. The mean number of *yes* responses on the SST improved from 4.0 ± 2.7 (range, 0 to 11) to 9.9 ± 2.8 (range, 0 to 12) ($P < .0001$). The number of *yes* responses increased after treatment in 83 shoulders, remained the same in 3 shoulders (2 patients), and decreased by 2 responses in 3 shoulders. Of the 6 shoulders that did not improve (per SST), 2 had undergone operative treatment. None of the 6 shoulders were among the 5 that demonstrated a diminished range of motion in at least one plane. Mean ASES scores at final follow-up were 84.6 ± 12.6 out of 100 (range, 43.3 to 98.3).

Comparing nonoperative and operative treatment groups revealed that SST and ASES scores at final follow-up were similar for both groups. For patients undergoing nonoperative treatment, mean SST improved from 4.4 ± 2.7 to 10.0 ± 2.8 ; for patients undergoing surgery, mean SST improved from 3.0 ± 2.3 to 9.7 ± 2.9 . Mean ASES scores at final follow-up for patients undergoing nonoperative treatment and surgery were 85.5 ± 12.7 and 82.2 ± 12.4 , respectively. Patients who underwent surgery had a significantly lower number of *yes* responses on the initial SST than those who did not ($P < .05$).

TABLE 4
Range of Motion Before and After Treatment: Mean \pm SD^a

	Initial	Posttreatment
Cohort		
Forward elevation, deg	119 \pm 20	152 \pm 15
External rotation at the side, deg	29 \pm 18	46 \pm 11
Internal rotation to the back	Gluteal (thigh \pm L3) ^b	T12 (L3 \pm T9)
Nonoperative		
Forward elevation, deg	120 \pm 18	150 \pm 14
External rotation at the side, deg	32 \pm 16	46 \pm 10
Internal rotation to the back	Gluteal ^c (gluteal \pm L3)	T12 (L3 \pm T10)
Surgery		
Forward elevation, deg	116 \pm 24	156 \pm 15
External rotation at the side, deg	23 \pm 22	46 \pm 13
Internal rotation to the back	Gluteal (thigh \pm sacrum)	T12 (L3 \pm T9)

^aAll rows, $P < .0001$.

^bBony landmarks in parentheses represent mean level \pm 1 standard deviation.

^cMidway between gluteal and sacrum.

TABLE 5
Correlations Between Preoperative and Postoperative Range of Motion

	Rho ^a	P
Entire cohort		
Forward elevation	.32	.003
External rotation at the side	.40	.001
Internal rotation to the back	.33	.006
Nonoperative		
Forward elevation	.30	.021
External rotation at the side	.33	.029
Internal rotation to the back	.34	.014
Surgery		
Forward elevation	.49	.022
External rotation at the side	.63	.002
Internal rotation to the back	.26	.300

^aSpearman correlation coefficient.

Univariate logistic regression models revealed that younger age ($P < .005$) and lower initial SST ($P < .05$) at presentation were the strongest predictors of the need for surgery. Stepwise logistic regression revealed that younger age ($P < .01$) and greater initial internal rotation deficits ($P < .05$) most strongly predicted the need for surgery. With the numbers available, other demographic variables—including diabetes ($P = .646$) and depression ($P = .327$)—did not predict the need for surgery.

For the entire cohort, a higher initial SST and the absence of diabetes predicted a higher final SST ($P < .05$), and a shorter duration of symptoms predicted a higher final ASES score ($P < .05$) but not a higher SST. After nonoperative treatment, patients with diabetes had a lower mean final SST than patients without diabetes (8.8 ± 3.4 vs 10.6 ± 2.3 , $P < .05$), but after surgery these were identical (9.7). Absence of diabetes ($P < .005$) and young age ($P < .01$) predicted a higher final SST, and a shorter duration of symptoms ($P < .0001$) predicted a higher final ASES score for patients undergoing nonoperative treatment.

At initial presentation, men had a higher mean initial SST than women (5.1 ± 2.6 vs 3.4 ± 2.5 , $P < .01$), but male and female patients had a similar mean final SST (10.3 ± 2.6 vs 9.7 ± 2.9). With the numbers available, men and women had similar ASES scores. Furthermore, no statistically significant sex-related differences in final SST or ASES scores were observed when these were stratified by treatment.

Analysis of correlations between range of motion at time of discharge and self-assessed outcome at final follow-up revealed no statistically significant correlations between forward elevation, external rotation at the side, or internal rotation to the back and SST or ASES scores for either the entire cohort or the 2 treatment groups, except for internal rotation to the back and SST for patients undergoing surgery ($\rho = 0.226$, $P < .05$). In addition, SST and ASES scores were highly correlated for the entire cohort ($\rho = 0.662$, $P < .0001$) as well as for the nonoperative ($\rho = 0.587$, $P < .0001$) and surgery ($\rho = 0.807$, $P < .0001$) groups.

DISCUSSION

Our study demonstrates that both nonoperative treatment and operative treatment for adhesive capsulitis effectively improve shoulder range of motion and function. Of 89 shoulders, 83 had improved function at final follow-up. Our findings compare favorably with other current reports on the outcomes of nonoperative treatment. Griggs and colleagues⁹ reported on a series of 75 patients (77 shoulders) who underwent a 4-quadrant home-based stretching program for adhesive capsulitis. The mean SST improved from 4.1 to 10.7 ($P < .0001$), and the mean forward elevation improved 43° . Levine and colleagues¹⁵ followed 98 patients (105 shoulders) with adhesive capsulitis until resolution or surgery. All patients were offered nonsteroidal anti-inflammatory medications, and 37% of shoulders received at least 1 intra-articular corticosteroid injection. Mean forward elevation improved from 118° to 164° , and mean external rotation at the side improved from 26° to 59° .

Our study found that patients undergoing surgery had significantly less external and internal rotation at presentation than patients who were treated nonoperatively. In contrast, range of motion at presentation did not appear to be influenced by sex or diabetes.

Our study demonstrated persistent residual motion deficits in most patients at short-term clinical follow-up. Griggs and colleagues⁹ found that residual deficits remained in all motion arcs at a mean follow-up of 22 months, despite the fact that 90% of patients were subjectively satisfied with their result. Shaffer and colleagues³² retrospectively studied 62 patients treated nonoperatively at a mean follow-up of 7 years and determined that whereas most patients reported no symptoms after treatment, 60% had measurable motion deficits.

Our study also demonstrated that range of motion at initial presentation correlated with range of motion at discharge from treatment. The correlations were strongest for forward elevation and external rotation in the surgery group. Initial and postoperative internal rotation to the back did not correlate in the surgery group, but this may relate to (1) the observation that internal rotation often recovers more slowly than other movements and (2) our measurement of range of motion at discharge from treatment rather than at longer-term follow-up. For example, Griggs and colleagues⁹ found that mean passive internal rotation improved from the L4 spinous process to the L1 spinous process at 6 to 12 weeks after initiation of the stretching program but to the T8 spinous process at final follow-up. Levine and colleagues,¹⁵ who also recorded range of motion at discharge from treatment, found that mean internal rotation improved from L4 to T10 for patients treated nonoperatively, but with the numbers available, this improvement was not statistically significant.

The mean gains in range of motion after nonoperative treatment reported in our study of 31° in forward elevation and 16° in external rotation are somewhat lower than those reported elsewhere,^{9,15} but this may be confounded by differences in patient selection, range of motion assessment, duration of clinical follow-up, and criteria for discharge from care. For example, other studies have reported on passive motion,⁹ but we report on active internal rotation to the back because passive motion testing in this plane is often painful and active motion is more clinically relevant. Finally, the range of motion results reported by Levine and colleagues¹⁵ are most comparable with those reported here because in both studies range of motion was measured only until discharge from treatment.

Our study also found that short-term range of motion gains after treatment did not predict longer-term self-assessed outcome, as measured with the SST or ASES score. Consequently, any residual motion deficits at discharge from treatment do not appear to affect longer-term clinical outcome. Patients were transitioned to a home-based stretching program as soon as shoulder range of motion had recovered adequately for functional activities and patients had demonstrated an ability to continue independently with their stretches. Shoulder range of motion has been reported to improve after treatment for 6 months or longer,³² so in some patients, range of

motion may have continued to improve beyond their discharge from treatment.

Manipulation and arthroscopic capsular release has been shown to be effective for adhesive capsulitis that is refractory to nonoperative treatment.^{11,23-25,27,36} In addition to documenting less internal and external rotation in patients undergoing surgery, our study found that patients undergoing surgery for adhesive capsulitis had worse initial function by SST than those who did not undergo surgery. This reinforces our selection for surgery patients who were more debilitated by the condition and who were failing or were expected to fail nonoperative treatment.

Other studies have demonstrated similar results after arthroscopic capsular release. Nicholson²³ evaluated the results in 68 stiff shoulders classified into 5 subgroups, including 8 diabetic and 15 idiopathic, and concluded that the etiologic factors did not influence outcome or time to recovery. Mean number of *yes* responses on the SST improved from 4 to 11 in the idiopathic group and from 2.5 to 9.0 in the diabetic group. Baums and colleagues¹ prospectively studied 30 patients treated with arthroscopic release and found that the mean number of *yes* responses on the SST increased significantly from 4 to 10. These compare favorably with the improvement in our series, from 4.0 to 9.8. The mean final ASES score of 82 reported here is lower than the 88 and 94 reported by Nicholson²³ for diabetic and idiopathic groups and lower than the 91 reported by Baums and colleagues¹ but higher than the 77 recently reported by Liem and colleagues.¹⁶

Many reports on the treatment of adhesive capsulitis describe the results after either operative or nonoperative treatment but not both. In our series, many patients improved with nonoperative treatment alone, but 24 patients who did not improve underwent subsequent manipulation and arthroscopic capsular release. At follow-up, patients undergoing operative treatment for refractory adhesive capsulitis had an outcome comparable with those undergoing nonoperative treatment. Improvements in forward elevation and external rotation were significantly greater after surgery, but there was no difference in final range of motion in all 3 planes evaluated after either nonoperative treatment or surgery.

Thirty percent of our patients had diabetes, which is higher than the 11% in the study by Griggs and colleagues⁹ or the 18% in the study by Levine and colleagues.¹⁵ Multiple studies have reported that patients with diabetes respond less readily and less consistently to nonoperative treatment for adhesive capsulitis compared with patients without diabetes³² so that surgery is more often necessary in this group.^{9,13,18,31} However, our study found that with the numbers available, diabetes did not predict the need for surgery. Similarly, Levine and colleagues¹⁵ found that patients with diabetes were not more likely to require surgery.

After nonoperative treatment, our study demonstrated that patients with diabetes had a lower mean final SST than those without diabetes. This may reflect differences in pathomechanics³⁸ that render the diabetic frozen shoulder more resistant to nonoperative treatment.²⁵ However, this may also reflect the influence of comorbid conditions,

including diabetes, on self-assessed pain and dysfunction in patients with adhesive capsulitis.³⁸ Although the ASES score and SST correlated highly overall, with the numbers available the ASES scores were not significantly lower in patients with diabetes.

In contrast to diabetic patients undergoing nonoperative treatment, those undergoing capsular release had a mean SST that was identical to that for patients without diabetes. Nicholson²³ demonstrated similar improvements in SST after capsular release in patients with and without diabetes, and Harryman and colleagues¹¹ reported similar final SST for patients with and without diabetes. However, other reports describe inferior results after arthroscopic capsular release in patients with diabetes.^{9,24,28} On the basis of our results, patients with diabetic frozen shoulder can be counseled that arthroscopic capsular release is just as effective as in patients without diabetes. Manipulation under anesthesia in isolation was not performed routinely and not considered in patients with systemic confounders such as diabetes, because studies have demonstrated that those with diabetes who fail nonoperative treatment do not respond adequately to manipulation alone.^{10,13}

Consensus is lacking over the influence of other patient demographic factors on the outcome after nonoperative treatment of adhesive capsulitis. In general, comorbidity has been shown to strongly influence self-assessed shoulder function in patients with adhesive capsulitis.³⁸ Previous studies have analyzed, with conflicting results, such confounders as age, sex, hand dominance, specific comorbidities, duration of symptoms, and workers' compensation status.^{9,29,32,36,38} Some studies have shown that male sex predicts an inferior outcome,^{9,32} but our study and at least 1 other¹⁵ have not. In addition, we found that for patients undergoing nonoperative treatment, as well as for the entire cohort, a shorter duration of symptoms before presentation predicted a better outcome, as measured by the ASES score, which suggests that early initiation of nonoperative treatment may improve shoulder function.

We attempted to study the influence of depression or depressive symptoms on outcome because patients undergoing extensive rehabilitation for musculoskeletal disorders have been shown to have high rates of psychiatric comorbidities.¹² We are unaware of any previous study on adhesive capsulitis that has investigated a possible interaction with depressive symptoms. In a study on the influence of comorbidity on self-assessment instruments, Wolf and Green³⁸ identified 10 patients out of 100 with depressive symptoms, but the influence of individual comorbidities on patient outcome was not studied specifically. We identified 16 patients with depression or depressive symptoms, but with the numbers available we could not demonstrate a relationship between depression and outcome. Employing a depression inventory at initial presentation instead of a retrospective chart review of comorbidities might have altered this result.

Self-assessed function at initial presentation predicted self-assessed function at final follow-up, as measured by the SST. These findings agree with those reported by

Griggs and colleagues.⁹ Our regression analysis also revealed that younger patients had better outcome scores than older patients after nonoperative treatment. Because younger patients were also more likely to undergo surgery than older patients, we recognize that our treatment recommendations were biased in favor of surgery for younger patients. This bias may simply reflect our reactions to patient demands and expectations. Interestingly, Levine and colleagues¹⁵ also found that the mean age of 10 patients undergoing surgery for failed nonoperative treatment was significantly younger (51 years) than the mean age of patients treated without surgery (56 years).

The current study has some strengths and limitations. It included nearly 100 consecutive patients with adhesive capsulitis, and only 11% were lost to follow-up for reasons other than death. Meaningful comparisons between operative and nonoperative groups were carried out, in part, because a relatively large number of patients underwent surgery. In addition, both range of motion and shoulder-specific outcome instruments were used to measure outcome and to facilitate comparisons not only between treatment groups but with previous studies. Finally, the senior author performed all initial and follow-up examinations and all surgeries.

The limitations of this study are that it is a retrospective study lacking in initial ASES scores. Another limitation is that the operative treatment group is composed of those patients who failed initial nonoperative treatment. Consequently, the outcome of the nonoperative group is overestimated because those patients undergoing surgery after failing nonoperative treatment are excluded from the analysis. Avoiding this selection bias would require that a group of patients undergo immediate surgical intervention for adhesive capsulitis, which is inconsistent with clinical practice and ethical standards.

Other limitations include missing data points that precluded an evaluation of other motions such as abduction. Compliance with the home exercise program was not monitored specifically, and range of motion was measured at discharge from treatment but not at final follow-up so that only short-term changes in range of motion were observed.

The high proportion of shoulders undergoing operative intervention (25 of 89, or 28%) merits further discussion and raises questions about the indications for surgery. The rate of surgical intervention is higher than the 10% reported by Levine and colleagues¹⁵ or the 7% reported by Griggs and colleagues.⁹ Furthermore, the statistical analysis revealed a bias toward surgery in younger patients. However, all patients in this study were offered surgery only after failing to respond to an often-prolonged trial of nonoperative treatment and only as an alternative to continued nonoperative treatment. It is possible that differences in criteria for consideration of surgery, patient compliance with home exercise and physiotherapy, and patient demographics (including specific referral patterns to the senior author) contributed to the rate of operative intervention observed in this study.

CONCLUSION

This study demonstrates that the majority of patients with adhesive capsulitis respond to a nonoperative treatment program emphasizing supervised physiotherapy combined with home exercises. In addition, manipulation and capsular release are effective for refractory cases such that both nonoperative treatment and operative treatment improve shoulder mobility and self-assessed function. Our findings support previous reports that most patients report satisfactory shoulder function despite some range of motion deficits. Patients with diabetes should still be offered a trial of nonoperative treatment, even though surgery for those with persistent motion deficits is just as successful as in patients without diabetes. Compared with older patients, younger patients respond better to nonoperative treatment, but they are also more likely to undergo surgery.

REFERENCES

- Baums MH, Spahn G, Nozaki M, Steckel H, Schultz W, Klinger HM. Functional outcome and general health status in patients after arthroscopic release in adhesive capsulitis. *Knee Surg Sports Traumatol Arthrosc.* 2007;15:638-644.
- Berghs BM, Sole-Molins X, Bunker TD. Arthroscopic release of adhesive capsulitis. *J Shoulder Elbow Surg.* 2004;13:180-185.
- Buchbinder R, Hoving JL, Green S, Hall S, Forbes A, Nash P. Short course prednisolone for adhesive capsulitis (frozen shoulder or stiff painful shoulder): a randomized, double blind, placebo controlled trial. *Ann Rheum Dis.* 2004;63:1460-1469.
- Bunker TD, Anthony PP. The pathology of frozen shoulder: a Dupuytren-like disease. *J Bone Joint Surg Br.* 1995;77:677-683.
- Chambler AF, Carr AJ. The role of surgery in frozen shoulder. *J Bone Joint Surg Br.* 2003;85:789-795.
- Codman EA. *The Shoulder: Rupture of the Supraspinatus Tendon and Other Lesions in or About the Subacromial Bursa.* Boston, MA: Thomas Todd; 1934:216-224.
- Diercks RL, Stevens M. Gentle thawing of the frozen shoulder: a prospective study of supervised neglect versus intensive physical therapy in seventy-seven patients with frozen shoulder syndrome followed up for two years. *J Shoulder Elbow Surg.* 2004;13:499-502.
- Diwan DB, Murrell GA. An evaluation of the effects of the extent of capsular release and of postoperative therapy on the temporal outcomes of adhesive capsulitis. *Arthroscopy.* 2005;21:1105-1113.
- Griggs SM, Ahn A, Green A. Idiopathic adhesive capsulitis: a prospective functional outcome study of nonoperative treatment. *J Bone Joint Surg Am.* 2000;82:1398-1407.
- Hamdan TA, Al-Essa KA. Manipulation under anaesthesia for the treatment of frozen shoulder. *Int Orthop.* 2003;27:107-109.
- Harryman DT 2nd, Matsen FA 3rd, Sidles JA. Arthroscopic management of refractory shoulder stiffness. *Arthroscopy.* 1997;13:133-147.
- Härter M, Reuter K, Weisser B, Schretzmann B, Aschenbrenner A, Bengel J. A descriptive study of psychiatric disorders and psychosocial burden in rehabilitation patients with musculoskeletal diseases. *Arch Phys Med Rehabil.* 2002;83:461-468.
- Janda DH, Hawkins RJ. Shoulder manipulation in patients with adhesive capsulitis and diabetes mellitus: a clinical note. *J Shoulder Elbow Surg.* 1993;2:36-38.
- Jerosch J. 360 degrees arthroscopic capsular release in patients with adhesive capsulitis of the glenohumeral joint: indications, surgical technique, results. *Knee Surg Sports Traumatol Arthrosc.* 2001;9:178-186.
- Levine WN, Kashyap CP, Bak SF, Ahmad CS, Blaine TA, Bigliani LU. Nonoperative management of idiopathic adhesive capsulitis. *J Shoulder Elbow Surg.* 2007;16(5):569-573.
- Liem D, Meier F, Thorwesten L, Marquardt B, Steinbeck J, Poetzel W. The influence of arthroscopic subscapularis tendon and capsule release on internal rotation strength in treatment of frozen shoulder. *Am J Sports Med.* 2008;36:921-926.
- Loew M, Heichel TO, Lehner B. Intra-articular lesions in primary frozen shoulder after manipulation under general anesthesia. *J Shoulder Elbow Surg.* 2005;14:16-21.
- Massoud SN, Pearse EO, Levy O, Copeland SA. Operative management of the frozen shoulder in patients with diabetes. *J Shoulder Elbow Surg.* 2002;11:609-613.
- Matsen FA, Lippitt SB. Surgical release of the stiff shoulder. In: *Shoulder Surgery: Principles and Procedures.* Philadelphia, PA: WB Saunders; 2004:65-79.
- Matsen FA 3rd, Lippitt SB, Sidles JA, Harryman DT 2nd. *Practical Evaluation and Management of the Shoulder.* Philadelphia, PA: WB Saunders; 1994.
- Murnaghan JP. Adhesive capsulitis of the shoulder: current concepts and treatment. *Orthopedics.* 1988;11:153-158.
- Neviaser JS. Adhesive capsulitis of the shoulder: a study of the pathological findings in periartthritis of the shoulder. *J Bone Joint Surg Am.* 1945;27:211-222.
- Nicholson GP. Arthroscopic capsular release for stiff shoulders: effect of etiology on outcomes. *Arthroscopy.* 2003;19:40-49.
- Ogilvie-Harris DJ, Biggs DJ, Fitsialos DP, MacKay M. The resistant frozen shoulder: manipulation versus arthroscopic release. *Clin Orthop Relat Res.* 1995;319:238-248.
- Ogilvie-Harris DJ, Myerthall S. The diabetic frozen shoulder: arthroscopic release. *Arthroscopy.* 1997;13:1-8.
- O'Kane JW, Jackins S, Sidles JA, Smith KL, Matsen FA 3rd. Simple home program for frozen shoulder to improve patients' assessment of shoulder function and health status. *J Am Board Fam Pract.* 1999;12:270-277.
- Pearsall AW 4th, Osbahr DC, Speer KP. An arthroscopic technique for treating patients with frozen shoulder. *Arthroscopy.* 1999;15:2-11.
- Pollock RG, Duralde XA, Flatow EL, Bigliani LU. The use of arthroscopy in the treatment of resistant frozen shoulder. *Clin Orthop Relat Res.* 1994;304:30-36.
- Reeves B. The natural history of the frozen shoulder syndrome. *Scand J Rheumatol.* 1975;4:193-196.
- Ryans I, Montgomery A, Galway R, Kernohan WG, McKane R. A randomized controlled trial of intra-articular triamcinolone and/or physiotherapy in shoulder capsulitis. *Rheumatology (Oxford).* 2005;44:529-535.
- Scarlat M, Harryman DT 2nd. Management of the diabetic stiff shoulder. *Inst Course Lect.* 2000;49:283-294.
- Shaffer B, Tibone JE, Kerlan RK. Frozen shoulder: a long-term follow-up. *J Bone Joint Surg Am.* 1992;74:738-746.
- Sheridan MA, Hannafin JA. Upper extremity: emphasis on frozen shoulder. *Orthop Clin North Am.* 2006;37:531-539.
- Smith AM. Frozen shoulder. In: *Orthopaedic Knowledge Update: Shoulder and Elbow.* 3rd ed. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2008:577-583.
- Snyder SJ. *Shoulder Arthroscopy.* 2nd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2003:66-73.
- Warner JJP. Frozen shoulder: diagnosis and management. *J Am Acad Orthop Surg.* 1997;5:130-140.
- Watson L, Dalziel R, Story I. Frozen shoulder: a 12-month clinical outcome trial. *J Shoulder Elbow Surg.* 2000;9:16-22.
- Wolf JM, Green A. Influence of comorbidity on self-assessment instrument scores of patients with idiopathic adhesive capsulitis. *J Bone Joint Surg Am.* 2002;84:1167-1173.