J Shoulder Elbow Surg (2010) 19, 1034-1039

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Journal of Shoulder and Elbow Surgery

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SHOULDER

Does slower rehabilitation after arthroscopic rotator cuff repair lead to long-term stiffness?

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Hypothesis: Conservative rehabilitation after arthroscopic rotator cuff repair does not result in long-term stiffness and improves rates of tendon healing.

Materials and methods: We retrospectively evaluated 43 patients with full-thickness rotator cuff tears who underwent a standardized, conservative protocol of full-time sling immobilization without formal therapy for 6 weeks after arthroscopic repair. At 6 to 8 weeks of follow-up, we categorized patients as "stiff" if they demonstrated forward elevation of less than 100° and external rotation of less than 30° passively; all others were designated "nonstiff." Active range of motion in forward elevation, external rotation, and internal rotation was assessed at 3 months, 6 months, and 1 year. American Shoulder and Elbow Surgeons (ASES) and Constant-Murley scores were assessed at 1 year. Follow-up magnetic resonance imaging (MRI) was obtained in all patients to assess tendon healing.

Results: Ten patients (23%) were considered stiff after rotator cuff surgery. At 1 year, there was no difference in mean forward elevation (166° vs 161°, $P = .2$), external rotation (62° vs. 58.4°, $P = .5$), or internal rotation (T7.4 vs T8.2, $P = .07$) between the stiff and nonstiff groups, respectively. There were no differences in final ASES (83 vs 79, $P = .57$) and Constant-Murley scores (77 vs. 74, $P = .5$). Repeat MRI suggested a trend toward a lower retear rate among the stiff patients (70% intact in stiff group vs 36% in nonstiff group, $P = .079$). Two clinically significant cuff retears occurred in the nonstiff cohort.

Discussion: Concerns for recalcitrant stiffness have led some to favor early postoperative therapy. We found that early restriction of motion did not lead to long-term stiffness after arthroscopic rotator cuff repair, even in patients who were clinically stiff in the early postoperative period.

Conclusions: Sling immobilization for 6 weeks after arthroscopic rotator cuff repair does not result in increased long-term stiffness and may improve the rate of tendon healing.

Level of evidence: Level IV, Case Series, Treatment Study.

Keywords: Shoulder; rotator cuff repair; immobilization; healing; rehabilitation; stiffness

Historically, concern about postoperative stiffness after rotator cuff repair has led surgeons to institute early passive motion to improve ultimate motion and clinical outcomes. This may hold especially true in open and minimally-invasive open procedures, where soft tissue dissection may

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1058-2746/$ - see front matter © 2010 Journal of Shoulder and Elbow Surgery Board of Trustees.
doi:10.1016/j.jse.2010.04.006

result in subdeltoid adhesions.[10,11,13] Little data exist regarding the incidence of stiffness after arthroscopic rotator cuff repairs. Some studies have found low rates of stiffness after arthroscopy, which in most cases resolved with therapy.[2,20] Furthermore, multiple studies have demonstrated significant retear rates of between 25% and 90% in arthroscopically-treated rotator cuff tears, especially in larger-sized tears.[1,5,9] Biomechanical studies in animals reported improved structural properties with immobilization.[3,6,18] Other cadaveric studies have found varying levels of tension within the rotator cuff repair when glenohumeral motion was carried out in certain planes.[7,16]

Given concerns over retear rates and the potentially lower likelihood of stiffness after arthroscopy, the idea of delaying rehabilitation and reducing stress at the repair site appears attractive. However, the optimal period of immobilization that balances stiffness with tendon healing has not been clearly defined. The purpose of the current study is to determine whether conservative rehabilitation, consisting of sling immobilization for the first 6 weeks after arthroscopic rotator cuff repair, results in long-term stiffness or has an effect on the final outcome.

Materials and methods

This retrospective review was approved by the Institutional Review Board of the Mount Sinai School of Medicine (Study # GCO 060214). The medical records and radiographic images of these patients were reviewed.

We identified 56 patients with full-thickness rotator cuff tears treated with arthroscopic repair between June 1999 and November 2002. Of these, 43 were evaluated with a postoperative MRI and comprised this retrospective review. All patients except one underwent concomitant subacromial decompression. Additional procedures included biceps tenotomy in 25, distal clavicle excision in 6, superior labrum anteroposterior (SLAP) repair in 1, and biceps tenodesis in 1 patient. Three patients had a subscapularis tendon rupture requiring repair, and the remaining 40 patients had tears classified as being posterosuperior tears. A double-row repair was done in 7 patients (70%) in the stiff group and in 9 patients (27.2%) in the nonstiff group.

The senior author (E.L.F.) performed all of the operative procedures. Exclusion criteria included any patient with a previous fracture of the proximal humerus, partial-thickness rotator cuff repair, radiographic signs of advanced arthritis, follow-up of less than 1 year, and preoperative stiffness defined as passive forward elevation of less than 100° or external rotation of less than 30°.

All patients were treated with a standardized, conservative protocol of sling immobilization for the first 6 weeks after surgery. They were instructed to wear their slings full-time, even while sleeping. No formal physical therapy was instituted. Immediate active motion was allowed in the elbow, wrist, and digits. Patients were evaluated at 2 weeks, 6 weeks, 3 months, 6 months, and 1 year after surgery. They underwent a comprehensive physical examination by 1 of 3 fellowship-trained shoulder surgeons (not the treating surgeon), focusing on range of motion testing. Preoperatively and at 1 year, the American Shoulder and Elbow Surgeons (ASES)[15] and Constant and Murley[4] scores were tabulated. At 1 year, 43 of the original 56 patients underwent a repeat MRI to evaluate the integrity of the tendon healing. These were reviewed by an independent musculoskeletal radiologist and were categorized as torn or intact.

At the 6-week follow-up evaluation (planned for 6 weeks but occurred between 6 and 8 weeks due to patient scheduling variables) postoperatively, patients were specifically tested in passive forward elevation and external rotation in the seated position. We defined a patient as ''stiff'' if passive forward elevation was less than 100° and passive external rotation was less than 30° in the operated-on shoulder. All other patients were defined as ''nonstiff.''

Patients were then started on formal therapy, including stretching and passive range of motion (ROM), beginning with supine forward elevation, external rotation at the side, and pulleys. At 3 months, patients progressed to active-assisted ROM and active ROM. Resistive strengthening was initiated at 3 months. For both patient groups, we recorded the preoperative active ROM, age, gender, hand dominance, intraoperatively determined tear size (< 3 cm or >3 cm), symptom (pain or weakness, or both) duration, 3-, 6-, and 12- month active ROM, pain scores using the visual analog scale (VAS), and ASES and Constant scores.

The data were analyzed using SPSS 16.0 statistical software (SPSS, Chicago, IL). Tests of group differences with respect to categoric outcomes were based on χ^2 and Fisher exact tests. The t test was used to assess group differences for continuous outcomes. All significance tests were two-sided and were conducted at the $P = 0.05$ level.

Results

The study included 19 men and 24 women who were a mean age of 63.8 years (range, 36-86 years). The dominant shoulder was involved in 35 (81%). Patients were reviewed for comorbidities that may affect shoulder stiffness, such as diabetes or thyroid disorders. Two patients in the nonstiff group were diabetic. One each in the stiff and nonstiff groups had a hypothyroid condition.

At the first postoperative evaluation, 33 patients (77%) met the criteria for being nonstiff and 10 (23%) were stiff. We found no statistical difference between the 2 groups for sex, mean age at diagnosis, intraoperatively measured tear size, symptom duration, active preoperative forward elevation and external rotation, preoperative VAS scores, and ASES and Constant scores (Table I). Tear size was documented as less than 3 cm or larger than 3 cm. In the nonstiff group, 58% of patients had a tear size exceeding 3 cm compared with 50% in the stiff group.

The mean active forward elevation at 12 months in the stiff patients was 166° (range, 150°-180°; standard deviation [SD], 9.7°) and 161° (range, 140°-180°; SD, 9.8°) in the nonstiff patients (Fig. 1, *A*). The mean external rotation at 12 months was 62° (range, 40°-80°; SD, 16.2) in the stiff patients and 58.4° (range, 20°-70°; SD, 10.4) in the nonstiff patients (Fig. 1, *B*). The mean internal rotation at 12 months in the stiff patients was T7.4 (range, T10- 6; SD, 1.7 spinal levels) and T8.2 (range, T12-6; SD, 1.7 spinal levels) in the

Table I Preoperative patient demographic and clinical data

Variables*	Stiff patients	Nonstiff patients	$P^{\dagger}$
	(n = 10)	(n = 33)	
Age, y	59.9 ± 12.1	65.1 ± 10.2	.24
Gender			
Male	4	15	.76
Female	6	18	
Symptom duration, mon	17.7 ± 21.3	15.3 ± 41.2	.81
Tear size			
<3 cm	5	14	.73
>3 cm	5	19	
Preoperative motion			
Forward elevation, deg	129 ± 52	150 ± 32	.27
External rotation, deg	61 ± 19	52 ± 20	.24
Preoperative function			
ASES score	45 ± 21	47 ± 23	.79
Constant score	46 ± 21	54 ± 22	.37
Preoperative pain (VAS)	5.8 ± 3.1	5.1 ± 2.7	.82

ASES, American Shoulder and Elbow Surgeons; *VAS,* visual analog scale.

* Continuous data are given as mean ± standard deviation; categoric data as number.

† No statistically significant differences were found between the stiff and nonstiff patients in any of the preoperative variables that were examined. *P* was determined from χ^2 analysis for categoric variables and 2-sample *t*-test analysis for continuous variables.

nonstiff patients (Fig 1, *C*). There were no statistically significant differences in the mean values between the 2 groups in forward elevation ($P = .18$), external rotation ($P = .53$), and internal rotation ($P = .07$).

There were 2 clinical failures of cuff repair. One patient who had 150° of passive forward elevation only had limited active forward elevation to 70°. A second patient only had active external rotation to −10° and had a significant external rotation lag. Both patients belonged to the nonstiff group. No patient underwent a subsequent surgery related to a stiff shoulder.

Pain scores improved from 5.8 to 2.0 amongst stiff patients ($P = .59$) and from 5.1 to 1.7 amongst the nonstiff patients ($P = .82$). The mean 1-year ASES score was 83 amongst the stiff patients and 79 for the nonstiff patients. The mean Constant score at the same time point was 77 for the stiff patients and 74 for the nonstiff patients. There was no statistical difference between the 2 patient groups. Both groups, however, demonstrated significant improvements compared with their preoperative scores. The ASES score for the stiff patients improved from 45 to 83 ($P = .0008$) and the Constant score improved from 46 to 77 ($P = .003$). Amongst the nonstiff patients, the ASES score improved from 47 to 79 ($P < .0001$) and the Constant score from 54 to 74 ($P < .0001$; Fig. 2).

A 56% retear rate was documented in the 43 patients who underwent a repeat MRI at 1 year. In the stiff patient group, 70% of the repaired tendons were intact compared with 36% in the nonstiff group. The difference, although not statistically significant, trended towards significance ($P = .079$). Tears exceeding 3 cm in widest dimension, as measured intraoperatively, were associated with a significantly higher retear rate than smaller tears ($P = .00075$).

Discussion

The use of passive motion in the early postoperative period has been advocated as a means of maintaining motion while reducing the potential for adhesion formation after rotator cuff surgery.[2,8,12-14,20] Although open shoulder surgery has traditionally been associated with postoperative stiffness,[10,11,13] some recent studies have also reported stiffness after arthroscopic procedures.[1,2,20] Early motion may help decrease stiffness, but some studies have demonstrated a potential benefit of a period of immobilization on tissue healing.[6,18]

Brislin et al[2] found that postoperative stiffness developed in 23 of 268 consecutive patients (8.6%) undergoing arthroscopic rotator cuff repair, the most common complication in their study. They applied a definition of "stiff" as external rotation of less than 10° or forward flexion of less than 100° that persisted beyond 90 days. All but 2 patients responded to aggressive physical therapy. Unlike in our series, patients were started on passive motion on postoperative day 1, and formal therapy beginning on postoperative day 5. In a comprehensive review of the literature, Weber et al[20] reported an incidence of stiffness after arthroscopic shoulder surgery of up to 15%. They stated that most patients could be treated conservatively with therapy, with a small number requiring operative release.

We used our own standardized definition of early stiffness after arthroscopic rotator cuff repair (<100° passive

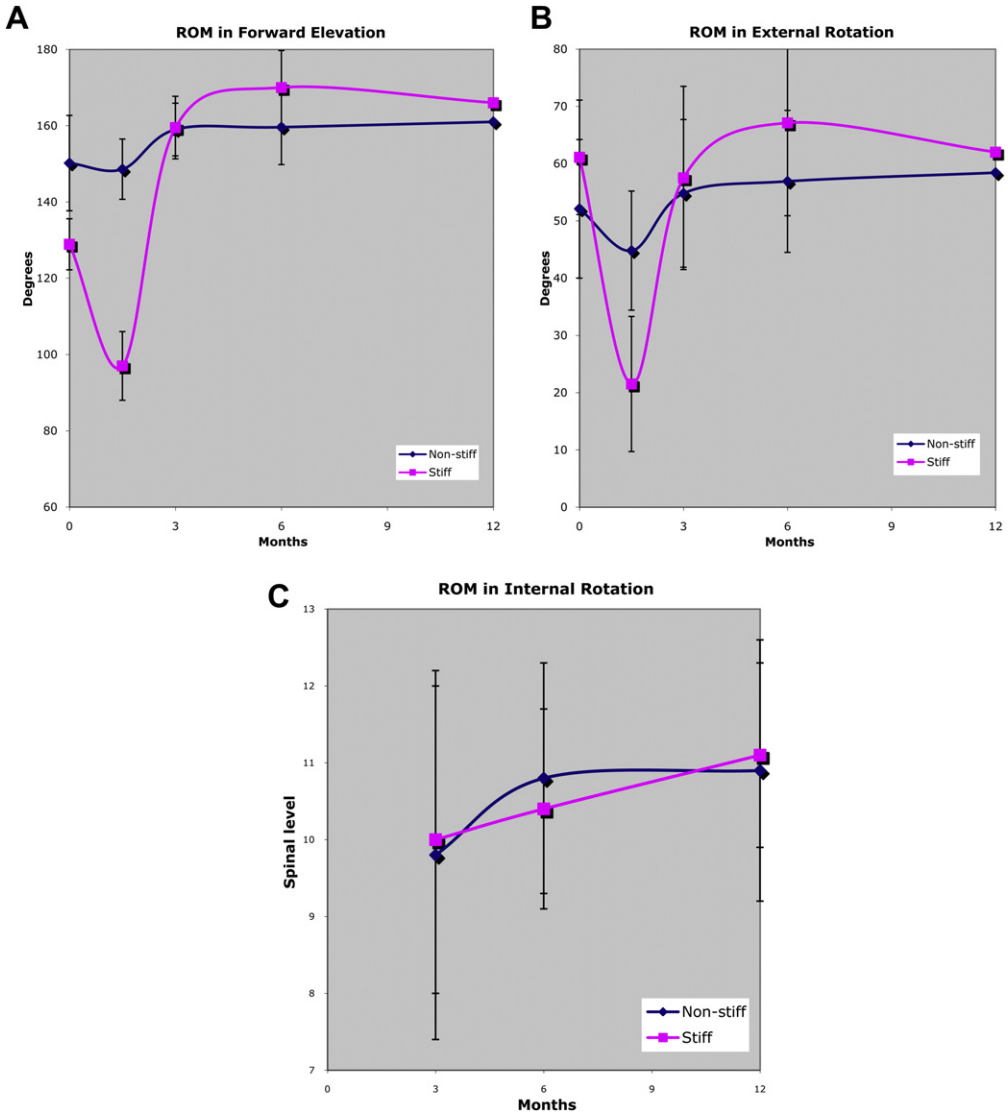

Figure 1 Active range of motion in **(A)** forward elevation, **(B)** external rotation, and **(C)** internal rotation in stiff (squares) and nonstiff (circles) patients. At the final follow-up, no significant difference in forward elevation, external rotation, or internal rotation was noted between those patients categorized as stiff vs nonstiff. Note internal rotation is not reported for 6 weeks because this is not assessed as part of the motion profile until 3 months.

forward elevation and <30° external rotation) and found 23% of our patients met these criteria. This definition is slightly more rigid that that proposed by Brislin et al[2] but was chosen because we thought these limits were more clinically appropriate. We believed less than 30° external rotation should be considered as stiffness because in the senior author's practice, these patients may go on to require additional treatment for this decreased ROM. In our total group of 56 patients, no patient required a release for recalcitrant stiffness, despite these more conservative expectations for ROM.

At the 12-month follow-up, we found no significant difference in forward elevation, external rotation, or internal rotation between the patients categorized as stiff or nonstiff according to their initial postoperative ROM at 6 to 8 weeks of follow-up. The mean forward elevation was 166° in the stiff patients and 161° in the nonstiff patients. Mean external rotation was 62° in the stiff patients and 58° in the nonstiff patients. Mean internal rotation was T7.4 in the stiff patients and T8.2 in the nonstiff patients. These results support the notion that special treatment beyond formal therapy may not be necessary in a patient with early restricted passive ROM after arthroscopic rotator cuff repair.

Similar to our findings, Trenerry et al[19] reported that patients with restricted ROM at 6 weeks after arthroscopic evaluation and open decompression with rotator cuff repair were no different in flexion and only 9° deficient in external rotation compared with their nonstiff cohorts by 76 weeks after surgery.[19] In that study, sling immobilization was encouraged for 2 days, and a 3-month home program was begun, with extra therapy at the patient's discretion. No

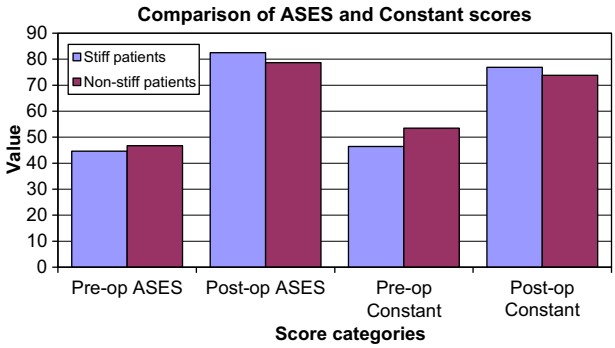

Figure 2 Comparison of preoperative and postoperative American Shoulder and Elbow Surgeons *(ASES)* and Constant scores. No differences were found between the 2 groups in the preoperative and postoperative ASES and Constant scores. However, both groups demonstrated a significant improvement in ASES and Constant scores from baseline.

mention was made of the rotator cuff integrity, and a standardized definition for postoperative stiffness was not used.

Recent animal studies would also seem to corroborate these clinical results. Soslowsky et al[17] demonstrated that joint stiffness after repair and immobilization of the rat rotator cuff tendon was transient and was not significantly different from the nonimmobilized study animals in the long-term. Further studies have shown demonstrated superior histologic characteristics[18] and biomechanical properties[6] of the repaired supraspinatus tendon in a rat model testing the effects of immobilization vs early motion. Therefore, a benefit of delayed motion may be increased healing of the rotator cuff repair.

We were able to obtain an MRI study at 1 year in 43 patients. Our findings of a 56% retear rate are consistent with prior studies,[1,5] especially in larger tears. Among the stiff patients, 70% of the tendons were intact, compared with 36% for the nonstiff patients. This difference approached, but did not reach, statistical significance ($P = .079$). Tears exceeding 3 cm had a statistically higher incidence of retear at the 1-year follow-up, a finding consistent with previous reports.[5,9] Although our protocol of prolonged postoperative immobilization trended towards improved tendon healing, larger patient numbers with longer follow-up are needed.

This study adds to the understanding of rehabilitation after rotator cuff repair. However, the study has some limitations. As is typical of rotator cuff repair, additional procedures were performed, some which may affect postoperative stiffness. Concomitant SLAP repair or a subscapularis repair may increase the patient's risk for postoperative stiffness. Only 1 patient underwent concomitant SLAP repair, and this patient was in the stiff group; however, the 3 subscapularis repairs were in the nonstiff group. In addition, 70% of the stiff patients had a double-row repair compared with only 27% of the nonstiff patients, which could affect the healing rates and potentially the postoperative ROM of these patients. An additional factor may be that some of these double-row repairs were performed during the learning curve for this technique.

Another potential weakness of our study includes the retrospective nature of the data collection. However, our patients were monitored closely in the postoperative period, standardized examination techniques were performed by a single examiner, and data forms were collected.

Further, we cannot vouch for the compliance of our study patients in wearing the sling full-time. No prescription for formal therapy was given to any patient until the 6-week follow-up examination. Finally, no control group of early passive ROM was used in this study. This is the subject of a prospective trial at the senior author's institution.

It is particularly important to recognize that the study had a small number of patients, and the conclusions drawn from these groups (particularly the stiff group with only 10 patients) should be interpreted as such. However, it remains an important finding that no patient in any group required additional procedures to address stiffness, despite undergoing a slower rehabilitation program.

Conclusions

We believe that delayed rehabilitation after arthroscopic rotator cuff repair may be justified. We found that early restriction of ROM does not lead to long-term stiffness after arthroscopic rotator cuff repair, even in patients who are clinically stiff in the early postoperative period. Further, we found a trend toward improved tendon healing in patients observed to have early stiffness. Therefore, this may suggest that stiffness at 6 weeks after arthroscopic rotator cuff repair should not be a cause for alarm, does not require any special treatment, and may be an indication of rotator cuff healing. Further prospective studies are needed to better elucidate the relationship between slower rehabilitation, the development of stiffness, and healing of the repaired tendon.

Acknowledgments

We would like to thank Michael K. Parides, PhD, for his assistance with statistical analysis.

Disclaimer

The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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