Arthroscopic release and repair of concomitant shoulder stiffness and cuff tear

Mohamed G. Morsy, Mohamed A. El-Sheikh

Department of Orthopedics and Traumatology, El-Hadara University Hospital, Alexandria School of Medicine, Alexandria University, Alexandria, Egypt

Correspondence to Mohamed A. El-Sheikh, MD, Department of Orthopedics and Traumatology, El-Hadara University Hospital, Alexandria School of Medicine, Alexandria University, Alexandria, Egypt.
Tel: +20 359 14441;
e-mail: elsheikh74@gmail.com

Received 13 December 2018
Accepted 1 January 2018

The Egyptian Orthopaedic Journal 2018, 53:359–366

Purpose
The aim of this study was to evaluate the results of arthroscopic capsular release and rotator cuff repair as one-stage treatment for cases with concomitant shoulder stiffness and cuff tear.
Patients and methods
One-stage arthroscopic capsular release with rotator cuff repair was performed in 56 patients. All patients were evaluated at a minimum 2-year follow-up with a visual analog scale score for pain, range of motion, and the Constant and University of California at Los Angeles scores for clinical assessment.
Results
At the final follow-up, the mean visual analog scale score improved significantly to 1.7±0.98 points postoperatively ($P<0.01$). Statistically significant improvements were achieved in all motions postoperatively; the mean passive forward flexion was 176° (range: 165°–180°), whereas abduction was 172° (range: 162°–180°). External rotation at the side was 58° (range: 44°–68°), external rotation in 90° abduction was 94° (range: 80°–115°), and internal rotation in 90° abduction was 36° (range: 25°–40°). Furthermore, the Constant and University of California at Los Angeles scores showed statistically significant improvement postoperatively. Overall, 52 (93%) of the 56 shoulders were considered by the patients to be much better or better as a result of the operation.
Conclusion
The arthroscopic tackling of concomitant shoulder stiffness and cuff tear with one-stage capsular release and repair of torn rotator cuff showed satisfactory results and fastened the return to normal activities. Moreover, addition of the L-shaped posterior capsular release improved the postoperative internal rotation range of motion. Level of Evidence: Level III case–control study.

Keywords:
capsular release, cuff repair, rotator cuff tear, shoulder stiffness

Egypt Orthop J 53:359–366

1110-1148

Introduction

Patients with isolated rotator cuff tear are subject to reduced active range of motion (ROM) owing to pain and muscle weakness. In some cases of rotator cuff tears with persistent pain, a stiff shoulder with limited active and passive ROM occurs because of contracture of the capsule that develops progressively over time [1,2]. Traditionally, when a patient had a rotator cuff tear with concomitant stiff shoulder, shoulder stiffness was treated first through nonoperative measures. After the regain of passive ROM, subsequent rotator cuff repair was performed [2,3]. Nonoperative treatment included NSAIDs, corticosteroid injections, rehabilitation, and/or manipulation under anesthesia [4,5]. Unfortunately, however, recent studies have revealed that nonoperative treatment is insufficient to relieve shoulder stiffness because stretching exercises or manipulation improves mainly scapulothoracic motion but does little for glenohumeral joint motion [6–9]. Furthermore, after repair of a rotator cuff tear to the original footprint of the greater tuberosity, the healing process of repair or postoperative adhesion might produce stiffness of the glenohumeral joint [3,4,10]. Recently, a single surgery with concomitant manipulation has been proposed to treat patients with rotator cuff tears and stiff shoulder [1]. In this one-stage procedure, arthroscopic surgical repair of full-thickness rotator cuff tears was performed after manipulation. Although overall good results were achieved, ROM was slow to return, and some patients did not regain full ROM. Moreover, if capsular release was not performed before manipulation, complications of manipulation could include humeral fractures, glenohumeral dislocation, osteochondral defects, rotator cuff tears, anterior labral detachments, superior labral anterior and posterior tears, and radial nerve injury [4,10]. For these reasons, it has remained difficult to propose an ideal protocol for

treatment of rotator cuff tears with shoulder stiffness. Therefore, the aim of our work is to evaluate the results of concomitant arthroscopic capsular release and rotator cuff repair as a one-stage procedure.

Patients and methods

A total of 56 patients, 21 men and 35 women, with concomitant symptomatic chronic full-thickness rotator cuff tears and shoulder stiffness underwent simultaneous arthroscopic capsular release and cuff repair from February 2010 to October 2011. This study was approved by ethical committee of Alexandria University. In this study, pain during daily activities (60.7%), nocturnal pain (98.2%), weakness of the affected shoulder during the daily activities (76.8%), and/or limitation of ROM (100%) were considered indications for surgical treatment after failure of conservative treatment (medical, intra-articular steroid injection, and physiotherapy) for at least 3 months. Patients with associated biceps tendon pathology, massive rotator cuff tears, subscapularis tendon tears, glenohumeral arthritis, partial cuff tears, symptomatic acromioclavicular arthritis, and previous manipulation under anesthesia were excluded from the study. The mean age of the patients was 57.9±9.89 years (range: 41–73 years). Right shoulder was affected in 40 patients. The time lag before presentation varied between 3 and 11 months, with a mean of 7.16±2.98 months.

Preoperative and postoperative evaluations

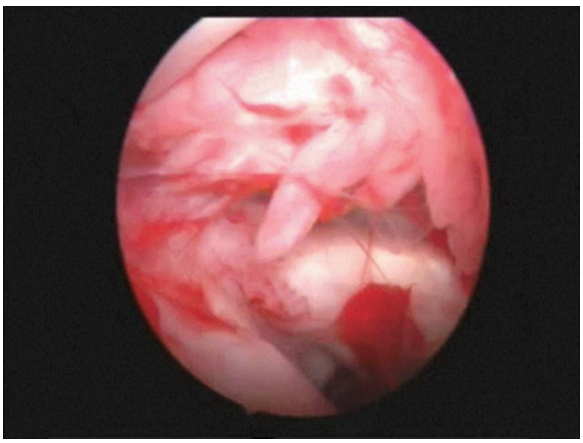
All patients underwent thorough clinical examination followed by radiological evaluation with plain radiography and MRI. Examinations were performed 1 day before the operation, during anesthesia (passive motion), and during the follow-up period. Outcome assessments were standardized and conducted by one blinded and independent examiner. Preoperative and postoperative subjective pain was measured with the visual analog scale (VAS). The VAS was used to measure the patients' pain, with 0 indicating no pain and 10 indicating extremely severe pain. Passive shoulder motion including abduction, forward flexion, external rotation at the side and in 90° of abduction, and internal rotation in 90° of abduction was measured with the patient during anesthesia at 2 weeks, 6 weeks, 3, 6, 12, and 24 months postoperatively, and at the last follow-up. A goniometer was used in the assessment of ROM. Quantitative strength measurements of the rotator cuff were obtained, and active motion and strength were graded throughout the patient's ROM on a scale from 0 to 5 according to the Medical Research Council [9].

Operative techniques

At the time of surgery, arthroscopic capsular release, subacromial decompression, and rotator cuff repair were done. The patients were operated upon under general anesthesia and in semisitting position. The technique started with arthroscopic evaluation of the glenohumeral joint via the posterior portal, and then arthroscopic anterior capsular release was performed through the anterior portal. All rotator interval tissue between the subscapularis and the biceps tendons as well as the anterior and inferior capsule was cleared using the shaver and the radiofrequency ablation device (Mitek J&J) Jhonson and Jhonson (Florida, USA) (Fig. 1). The scope was then placed in the anterior portal where posterior capsular release was performed in L-shaped fashion. The L-shaped release started with a longitudinal limb that begins from the glenoid level down to 6 o'clock position. In addition to the longitudinal release, the hook-tip part of the radiofrequency ablation device was used to do a transverse release in the posterior capsule, starting from the beginning of the longitudinal limb. The transverse limb of the release was performed in a stepwise fashion going step by step laterally but ending before reaching the rotator cuff to avoid any damage of the cuff (Fig. 2). After completion of capsular release, the cuff tear was identified from the joint side (Fig. 3). The scope was then directed upward to the subacromial space where subacromial decompression took place using motorized shaver and bone burr inserted through the lateral portal.

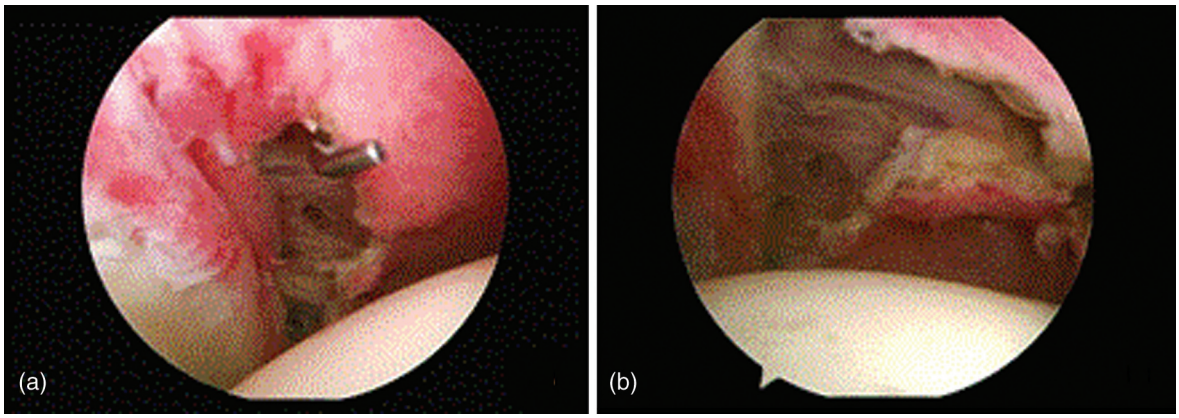
Manipulation of the shoulder was then performed followed by dealing with the full-thickness tear through the following steps: preparation of the footprint, bone anchor insertion into the footprint (5 mm, Mitek Jhonson and Jhonson (Florida, USA)) double-loaded with No.2 Orthocord or Ultrabraid

Figure 1



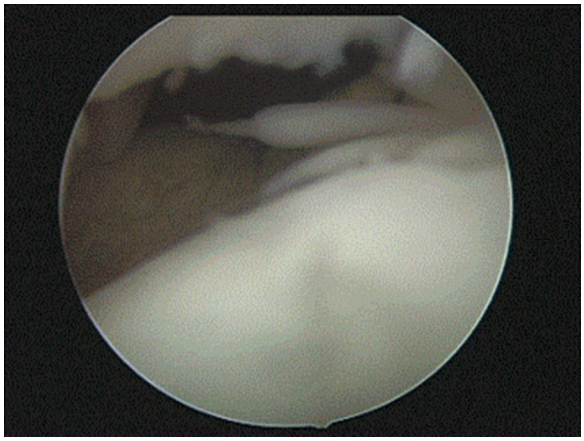
Inflamed adhesive rotator interval tissue.

Figure 2



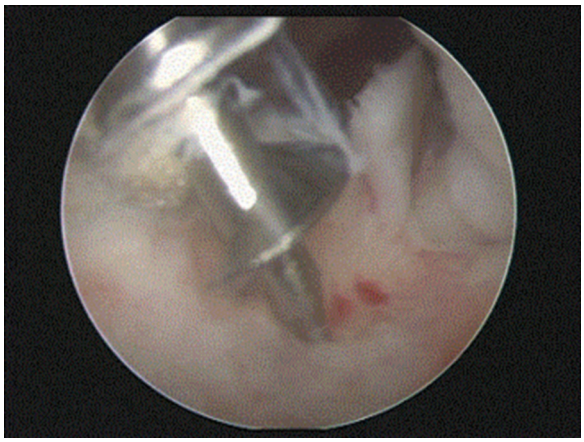
L-shaped posterior capsular release (a, b).

Figure 3



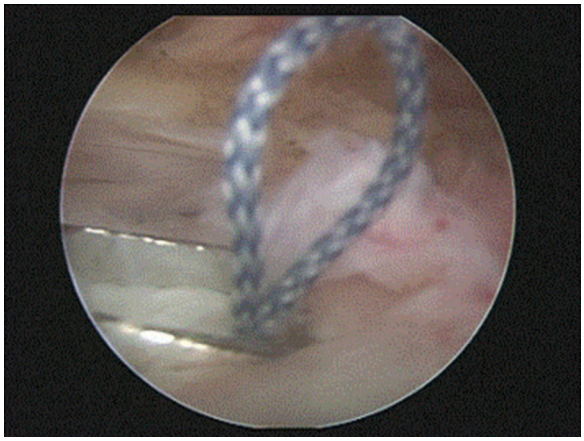
Intraarticular visualization of the cuff tear.

Figure 4



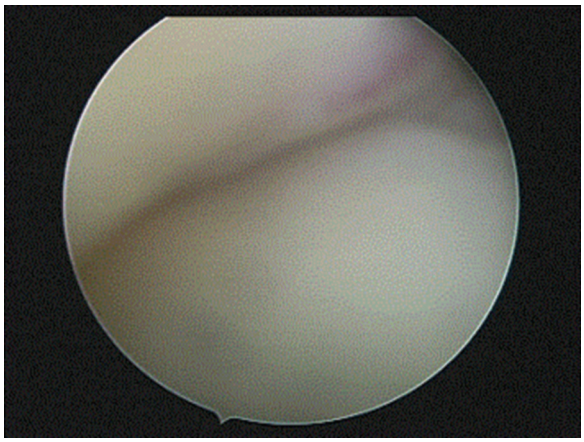
Bone anchor insertion into the footprint.

Figure 5



Retrieval of the suture threads of the anchor through the cuff tendon.

Figure 6

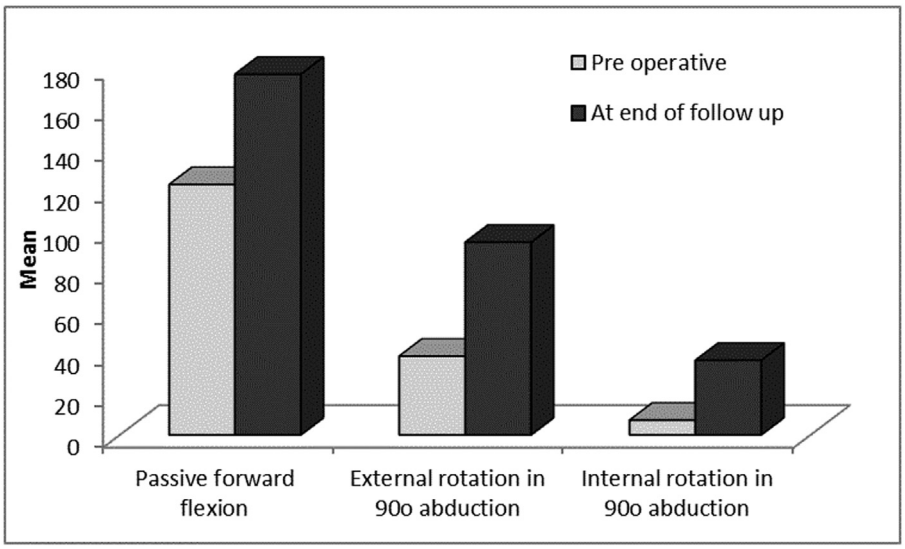


Arthroscopic closure of the defect.

suture threads (Fig. 4), retrieval of the suture threads of the anchor through the cuff tendon and back again into the lateral portal using a suture passer instrument (Mitek, Jhonson and Jhonson (Florida USA)) (Fig. 5), and finally arthroscopic knot tying and closure of the defect (Fig. 6). One to three bone anchors were used depending on the size of the tear.

Postoperatively, a sling or an abduction pillow was applied for all patients depending on the size of the

Figure 7



Gain of range of motion at last follow-up.

tear, quality of the tissue, and security of the repair. Three-phase rehabilitation program was then started: 6 weeks passive exercises, 6 weeks active assisted exercises, and 4 weeks strengthening exercises.

Postoperative rehabilitation

The sling was worn full time for 6 weeks, except when patients were showering or eating. The patients mainly performed home rehabilitation self-exercises. On the first postoperative day, they were instructed to perform passive stretching including forward elevation by table sliding, external rotation with a cane out to 45°, and internal rotation. From the first postoperative day to 6 weeks, this gentle passive stretching program was performed for 15 min every day. At 6 weeks from the date of surgery, patients discontinued the use of the sling. At this time, aggressive stretching with forward elevation by door sliding and external and internal rotation using a door was begun. At 6 weeks, strengthening with pushups using a wall was also begun. Progression to using light weights was based on the patient's progress. The return to full, unrestricted activities usually occurred at 3–6 months postoperatively and was based on the initial size of the tear, the strength of the repair, and the patient's rehabilitation progress.

Statistical analysis

The data were collected and entered into the personal computer. Statistical analysis was done using statistical package for social sciences (version 20) software (SPSS Inc., Chicago, Illinois, USA).

The statistical test used was as follows: arithmetic mean, SD. *t*-Test was used to compare between the mean values of measurement before and after treatment. The level of significance was 0.05.

Table 1 Demographic and clinical data of the studied patients

	N=56 [*n* (%)]
Sex	
Male	21 (37.5)
Female	35 (62.5)
Age (years)	
Range	41–73
Mean±SD	57.9±9.89
Follow-up period (months)	
Range	24–38
Mean±SD	29.2±3.48
Side affected	
Right	40 (71.4)
Left	16 (28.6)
Time lag before presentation (months)	
Range	3–11
Mean±SD	7.16±2.98
Size of tear	
Small	20 (35.7)
Medium	22 (39.3)
Large	14 (25.0)

Results

Preoperative patient demographics evaluation

The preoperative patient demographics are listed in Table 1. According to the classification of DeOrio and Cofield, the extent of the tear was determined intraoperatively under direct arthroscopic visualization after debridement of the degenerated tendon edges [7]. Arthroscopic findings included small tears in 20 (35.7%) patients, medium-sized tears in 22 (39.3%) patients, and large tears in 14

(25.0%) patients. The mean follow-up period was 29.2 months (range: 24–38 months). The mean duration of symptoms before surgery was 7.16 months (range: 3–11 months).

Pain

At the final follow-up, the mean VAS score improved significantly from 7.9±2.01 points preoperatively (range: 5–9) to 1.7±0.98 points postoperatively (range: 0–3) ($P<0.01$).

Range of motion

At the last follow-up, the passive forward flexion was 176° (range: 165°–180°), whereas abduction was 172° (range: 162°–180°). External rotation at the side was 58° (range: 4°–68°), external rotation in 90° abduction was 94° (range: 80°–115°), and internal rotation in 90° abduction was 36° (range: 25°–40°). Statistically significant improvements were achieved in all motions [P=0.0012 (passive forward flexion), 0.001 (abduction), 0.0025 (external rotation at side), 0.0015 (external rotation in 90° abduction), and 0.001 (internal rotation in 90° abduction)] (Table 2).

Muscle strength

At the last follow-up, statistically significant improvement in the mean muscle strength (range: 0–5) of patients during abduction, external rotation, and internal rotation was measured as 4.4, 4.6, and 4.7, respectively (Figure 7).

Clinical assessment

The Constant score at the last follow-up improved significantly from a mean of 44.35 points preoperatively (range: 30–62) to a mean of 93.3 ±3.98 points postoperatively (range: 81–97 points) ($P<0.001$). Moreover, the Shoulder Rating Scale of the University of California at Los Angeles at the last follow-up improved significantly from a mean of 14.5 ±2.91 points preoperatively (range: 10–18) to a mean of 32.8 points postoperatively (range: 30–34 points) ($P<0.001$) (Table 2).

Of the 56 shoulders, 52 (93%) were considered by the patients to be much better or better as a result of the operation.

Recovery patterns of range of motion

Forward flexion

Patients had gradual recovery of forward flexion: 160.8° at 2 weeks postoperatively, 161.9° at 6 weeks, 162.5° at 3 months, 167.9° at 6 months, and 176.5° at 2 years (Fig. 8).

Table 2 Comparison between preoperative and postoperative results

	Preoperative	Postoperative	*P*
VAS			
Range	5–9	0–3	0.001*
Mean±SD	7.9±2.01	1.70±0.98	
Passive forward flexion			
Range	92–130	165–180	0.0012*
Mean±SD	122.5±7.68	176.5±6.85	
Passive abduction			
Range	95–130	162–180	0.001*
Mean±SD	122.6±18.6	172.1±6.98	
External rotation at side			0.0025*
Range	15–35	44–68	
Mean±SD	28.2±6.22	58.5±5.65	
External rotation in 90° abduction			0.0015*
Range	20–50	80–115	
Mean±SD	38.6±5.65	94.2±4.25	
Internal rotation in 90° abduction			0.001*
Range	0–15	25–40	
Mean±SD	7.22±3.01	36.5±3.85	
Muscle Strength			
Abduction		4.4	
External rotation		4.6	
Internal rotation		4.7	
Constant score			
Range	30–62	81–97	0.0001*
Mean±SD	44.35±7.33	93.3±3.98	
UCLA			
Range	10–18	30–34	0.013*
Mean±SD	14.5±2.91	32.8±3.98	

VAS, visual analog scale; UCLA, University of California at Los Angeles. *Significant *P* value.

External rotation in 90°of abduction

Patients had gradual recovery of external rotation in 90° of abduction: 83.4° at 2 weeks postoperatively, 85.8° at 6 weeks, 91.0° at 3 months, 92.0° at 6 months, and 94.2° at 2 years (Fig. 8).

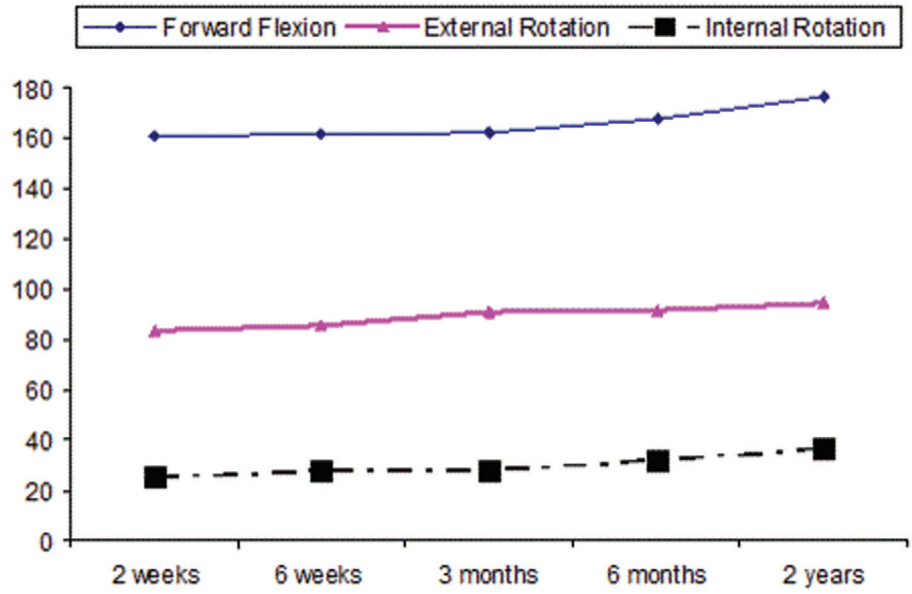
Internal rotation in 90° of abduction

Patients had gradual recovery of internal rotation in 90° of abduction: 25.4° at 2 weeks postoperatively, 28.0° at 6 weeks, 27.9° at 3 months, 31.6° at 6 months, and 36.5° at 2 years (Figure 7).

Range of motion for affected shoulders and contralateral unaffected shoulders

At the last follow-up, the contralateral shoulders had passive ROM (177.4° of forward flexion, 95.4° of external rotation in 90° of abduction, 34.8° of internal rotation in 90° of abduction, and abduction of 173.65°) that was similar to that in the shoulders after surgery (176.5° of forward flexion, 94.2° of external rotation in 90° of abduction, 36.5° of internal rotation in 90° of abduction, and

Figure 8



Range of motion.

abduction of 172.1°); the difference was not significant.

Complication

Two had a superficial wound infection at the surgical incision after the operation, which resolved after using oral antibiotic for 10 days. No patient required reoperation or remanipulation.

Discussion

Shoulder stiffness is caused by soft-tissue contracture, which can be intra-articular (capsular contracture or tendon shortening) or extra-articular (subacromial or subdeltoid scarring or scarring of the subscapularis-conjoined tendon region) [11]. These factors may occur in isolation or in combination. To date, there have been many studies on several factors leading to shoulder stiffness, but few have focused on the treatment of rotator cuff tears associated with shoulder stiffness [2,12–16].

Shoulder stiffness can occur after rotator cuff repairs, but it is not rare to see associated stiffness even before repairs. In some cases, full-thickness rotator cuff tears reduce active ROM while preserving passive ROM. In other cases, rotator cuff tears accompany severe pain as well as contracture and atrophy of the rotator cuff, which could introduce loss of motion. It is possible that capsulitis is precipitated by inflammation from a rotator cuff tear, limiting ranges of passive forward flexion, internal rotation, and cross-body adduction.

It is also unclear how preoperative shoulder stiffness can affect postoperative outcomes. Diabetes has been associated commonly with adhesive capsulitis and postoperative stiffness after rotator cuff repair. Tauro [2] has analyzed total preoperative passive ROM of 72 arthroscopic rotator cuff repairs. He observed that more than 40% of his patients had at least 25° total ROM deficit, indicating frequent development of preoperative stiffness. Moreover, 50% of the patients with more than 70° total ROM deficit had insulin-dependent diabetes mellitus.

The ideal treatment for rotator cuff tears with shoulder stiffness remains controversial [1–3]. The priority of treatment for either rotator cuff tear or shoulder stiffness is sometimes considered to present a paradox. Generally, protection or immobilization is needed after repair of the rotator cuff, and stretching exercise or movement is needed for recovery of shoulder stiffness. If the rotator cuff is repaired without attention to prevention of shoulder stiffness, the progression of shoulder stiffness can be predicted owing to the healing process of cuff repair and the postoperative adhesions [3,4,10]. In contrast, if shoulder stiffness is managed before repairing the rotator cuff, additional injury of the rotator cuff will be noted during manipulation or stretching exercise in a shoulder with an impingement syndrome [4,7,17]. In the literature, there have been many studies on the treatment of isolated shoulder stiffness, isolated rotator cuff tears, or shoulder stiffness after rotator cuff repair [2,11,18–22]. Few reports have focused on the

treatment of rotator cuff tears associated with shoulder stiffness [1,2].

In two-stage treatment of adhesive capsulitis with rotator cuff tear, typically as recommended in anterior cruciate ligament reconstruction surgery of the knee, ROM of the shoulder must be restored before rotator cuff repair [3]; however, in patients with stiff shoulder and rotator cuff tear, care must be undertaken during the program of stretching or manipulation for treatment of stiffness. In an ultrasound study, after the shoulder had been manipulated for adhesive capsulitis, a 10% incidence of rotator cuff tear was reported [5]. Patients with preoperative shoulder stiffness have a risk of recurrence after manipulation owing to adhesion of a torn glenohumeral ligament caused by manipulation. Moreover, manipulation has improved mainly scapulothoracic motion but resulted in little improvement of glenohumeral joint motion in previous studies. Furthermore, some patients may withdraw from rehabilitation because of severe pain during stretching exercises, as the pain may be not only from adhesive capsulitis but also from bursitis caused by impingement [6,8,9].

Recently, a single arthroscopic surgery with concomitant manipulation for patients with full-thickness rotator cuff tears and stiffness of the shoulder was proposed by Cho and Rhee [1], and overall good results were achieved. Although final outcomes were as good as those in patients without stiffness, the return of ROM took longer in those patients who underwent manipulation for stiffness of the shoulder. In the last follow-up of the group with stiffness in this study, forward flexion was 166.7° and external rotation at the side was 48.8°. In the study by Cho and Rhee [1], capsular release was not performed, and full ROM was still not achieved at the last follow-up. When manipulation has been performed without capsular release, complications of humeral fracture, glenohumeral dislocation, osteochondral defect, rotator cuff tears, and labral detachments have been noted in the literature [4,10]. In addition, forward elevation and abduction can be significantly improved with manipulation, but restricted internal rotation has been a persisting problem. Fracture risk has been greatest during this part of the manipulation because bone is weakest in torsion [6,23].

For treatment of refractory adhesive capsulitis, arthroscopic capsular release has become popular [22]. Arthroscopic capsular release allows a visually controlled release of the capsule and ligaments, with fewer potential complications than one might have with a more traumatic manipulation [19,20,23]. Arthroscopic release also allows a different direction of capsular release, control of any potential hemarthrosis, and treatment of any associated injuries [6,24].

In this study, a modified arthroscopic L-shaped posterior capsular release was performed aiming at improving the postoperative internal rotation ROM as well as decreasing the incidence of recurrent shoulder stiffness. In this study, 56 patients with concomitant shoulder stiffness and cuff tear were subjected to one-stage arthroscopic capsular release and rotator cuff repair with a mean of 29 months of follow-up. At the final follow-up, 93% of cases were satisfied by the operation, Modified University of California at Los Angeles score improved significantly from a mean of 20.35 points preoperatively to a mean of 45.29 postoperatively, and the VAS score improved significantly from 7.6 points preoperatively to 1.7 points postoperatively. The ROM showed significant postoperative improvement and was comparable to the contralateral normal shoulder.

Direct comparison with the studies by Tauro and Cho and Rhee might be difficult, but perhaps the patients with stiffness in our series showed good ROM at the last follow-up owing to the performance of capsular release before rotator cuff repairs on those patients with severely limited ROM. In contrast, Tauro did notperform manipulation and Cho and Rhee did not perform capsular release. Nevertheless, a secure repair of the rotator cuff should be fundamental to immediate postoperative stretching exercises, and this might spare the patient a prolonged recovery of ROM [1,4].

Chung *et al*. [25] compared functional outcomes with and without capsular release in arthroscopic treatment of rotator cuff tears with a stiff shoulder and concluded that the overall satisfactory results could be achieved by either method, whereas rapid recovery and improvement of ROM could be achieved by using a single arthroscopic repair and concomitant release for patients with rotator cuff tears with stiff shoulder.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1 Cho NS, Rhee YG. Functional outcome of arthroscopic repair with concomitant manipulation in rotator cuff tears with stiff shoulder. Am J Sports Med 2009; 36:1323–1329.

2 Tauro JC. Stiffness and rotator cuff tears: incidence, arthroscopic findings, and treatment results. Arthroscopy 2006; 22:581–586.

3 Matsen FA III, Lippitt SB, Sidles JA, Harryman DT II. Practical evaluation and management of the shoulder. Philadelphia, PA: WB Saunders; 1994. pp. 145–148.

4 Iannotti JP, Williams GR. Disorders of the shoulder: diagnosis and management. Philadelphia, PA: Lippincott Williams & Wilkins; 2006. pp. 541–562.

5 Weber M, Prim J, Bugglin R, Michel BA, Gerber H. Long term follow-up of patients with frozen shoulder after mobilization under anesthesia with special reference to the rotator cuff. Clin Rheumatol 1995; 14:686–691.

6 Hill JJ Jr, Bogumill H. Manipulation in the treatment of frozen shoulder. Orthopedics 1988; 11:1255–1260.

7 Loew M, Heichel TO, Lehner B. Intraarticular lesions in primary frozen shoulder after manipulation under general anesthesia. J Shoulder Elbow Surg 2005; 14:16–21.

8 Neviaser RJ, Neviaser TJ. The frozen shoulder: diagnosis and management. Clin Orthop Relat Res 1987; 223:59–64.

9 Parker RD, Froimson AI, Winsberg DD, Arsham NZ. Frozen shoulder, part II: treatment by manipulation under anesthesia. Orthopedics 1989; 12:989–990.

10 Weber SC, Abrams JS, Nottage WM. Complications associated with arthroscopic shoulder surgery. Arthroscopy 2002; 18:88–95.

11 Warner JJ, Greis PE. The treatment of stiffness of the shoulder after repair of the rotator cuff. Instr Course Lect 1998; 47:67–75.

12 Gerber C, Espinosa N, Perren TG. Arthroscopic treatment of shoulder stiffness. Clin Orthop Relat Res 2001; 390:119–128.

13 Goldberg BA, Scarlat MM, Harryman DT II. Management of the stiff shoulder. J Orthop Sci 1999; 4:462–471.

14 Moren-Hybbinette I, Moritz U, Schersten B. The clinical picture of the painful diabetic shoulder: natural history, social consequences and analysis of concomitant hand syndrome. Acta Med Scand 1987; 221:73–82.

15 Nicholson GP. Arthroscopic capsular release for stiff shoulders: effect of etiology on outcomes. Arthroscopy 2003; 19:40–49.

16 Ozaki J, Nakagawa Y, Sakurai G, Tamai S. Recalcitrant chronic adhesive capsulitis of the shoulder: role of contracture of the coracohumeral ligament and rotator interval in pathogenesis and treatment. J Bone Joint Surg Am 1989; 71:1511–1515.

17 Lundberg BJ. The frozen shoulder: clinical and radiographical observations: the effect of manipulation under general anesthesia: structure and glycosaminoglycan content of the joint capsule. Acta Orthop Scand Suppl 1969; 119 (Suppl):1–59.

18 Andersen NH, Sojbjerg JO, Johannsen HV, Sneppen O. Frozen shoulder: arthroscopy and manipulation under general anesthesia and early passive motion. J Shoulder Elbow Surg 1998; 7:218–222.

19 Harryman DT II, Matsen FA III, Sidles JA. Arthroscopic management of refractory shoulder stiffness. Arthroscopy 1997; 13:133–147.

20 Holloway GB, Schenk T, Williams GR, Ramsey ML, Iannotti JP. Arthroscopic capsular release for the treatment of refractory postoperative or post-fracture shoulder stiffness. J Bone Joint Surg Am 2001; 83:1682–1687.

21 Florence JM, Pandya S, King WM. Intrarater reliability of manual muscle test (Medical Research Council Scale) grades in Duchenne's muscular dystrophy. Phys Ther 1992; 72:115–122.

22 Warner JJ, Allen AA, Marks PH, Wong P. Arthroscopic release for chronic refractory adhesive capsulitis of the shoulder. J Bone Joint Surg Am 1996; 78:1808–1816.

23 Snow M, Boutros I, Funk L. Posterior arthroscopic capsular release in frozen shoulder. Arthroscopy 2009; 25:19–23.

24 Jerosch J. 360 degree arthroscopic capsular release in patients with adhesive capsulitis of the glenohumeral joint – indication, surgical technique, results. Knee Surg Sports Traumatol Arthrosc 2001; 9:178–186.

25 Chuang TY, Ho WP, Chen CH, Lee CH, Liau JJ, Huang CH. Arthroscopic treatment of rotator cuff tears with shoulder stiffness: a comparison of functional outcomes with and without capsular release. Am J Sports Med 2012; 40:2121–2127.