

Arthroscopic Treatment of Partial-thickness Rotator Cuff Tear

Seung-Ho Kim, M.D., Kwon-Ick Ha, M.D., Ph.D.

Department of Orthopaedic Surgery, College of Medicine, Kyun Kwan University,
Samsung Medical Center, Seoul, Korea

Forty-nine partial thickness rotator cuff tears underwent arthroscopic debridement or repair, and were followed up for a minimum of two years. Follow-up evaluations of the results were completed using a detailed functional questionnaire which was comprised of a rating of the UCLA shoulder scale and return to the previous sports activity and job. The average age of the 49 study patients was 46.5 years (range, 14 to 67 years). The patients were divided into four groups on the basis of the onset of the patient's symptoms. Thirty-five patients (72%) had partial tearing only on the articular surface, six (12%) on the bursal surface, and eight (16%) on both surfaces. Group I consisted of 21 patients with an average age of 56.7. Partial tearing in group I was attributed to the impingement syndrome. In group II, partial tearing of the rotator cuff was related to the anterior instability of the shoulder. This group included 9 patients with an average age of 27.9. In group III, all of the 8 patients were overhead athletes with an average age of 21.8. In this group, no isolated instances of significant trauma were related to the development of the shoulder pain. In group IV, 11 patients noted that a significant traumatic event preceded the onset of their pain. The average age of the patients was 34.9. Overall, 82% of the patients demonstrated satisfactory results and 18% revealed unsatisfactory results. The worst UCLA score and rate of return to the prior activity was noted in group III. In conclusion, partial thickness rotator cuff tear can be caused by subacromial impingement, instability, repetitive microtrauma, and macrotrauma. Arthroscopic debridement of partial tear of the rotator cuff provides a favorable outcome except in overhead athletes.

Key Words : Rotator cuff tear, Partial-thickness, Arthroscopic treatment

Rotator cuff lesions are a frequent cause of pain and disability in the shoulder, and a number of publications have contributed to the knowledge about the pathogenesis, diagnosis, and treatment of rotator cuff tears^{4-8,11,13-15,21}. Neer¹⁵ described three stages of rotator cuff lesions. Stage I includes hemorrhage and edema of the tendon, stage II, tendinitis and fibrosis,

and stage III, incomplete or complete tearing of the rotator cuff. This concept of a progressive evolution of the rotator cuff pathology has been widely accepted. Also, the role of mechanical impingement of the tendon under the anterior acromion has been the commonly held view.

However, little information is available on partial-thickness rotator cuff tearing.

※통신저자 : 김 승 호
서울특별시 강남구 일원동 50번지
성균관대학교 의과대학 삼성서울병원 정형외과

This lack of information is due in part to the difficulty of the diagnosis itself. As the majority of partial-thickness tears occur on the articular surface, the tears are not easily visible during open surgical acromioplasty, and in addition, adjunctive imaging such as arthrography, magnetic resonance image, or ultrasonography is often inadequate to detect a small articular surface tearing. Even though arthroscopy has worked most effectively in the diagnosis of partial-thickness tearing, only a few investigators have described the etiologic factors of partial tearing other than Neer's impingement^{3,7}. The purpose of this study was to review our experience with arthroscopically diagnosed partial-thickness rotator cuff tears. The emphasis of this article includes pathomechanisms of different etiologic groups of partial tearing.

MATERIALS AND METHODS

Between October 1994 and June 1996, 54 partial thickness rotator cuff tears were treated at the Samsung Medical Center. Forty-nine of these patients were available for a minimum follow-up of two years. The selection criteria was a thickness rotator cuff tear, either on the articular or bursal surface. Patients who had glenohumeral arthritis, adhesive capsulitis, prior surgery on the shoulder, or previous infection were excluded from this study. The patient's records, including history, physical findings, mechanism of injury, preoperative evaluation and operative treatment were reviewed. Follow-up evaluations of the results were completed using a detailed functional questionnaire which was comprised of a rating on the

Table 1. Grade of Cuff tear

Group(N)	Ellman			Snyder		
I (21)	I	II	III	A	B	AB
	10	6	5	7	6	8
				1A II	3B II	2A I B IV
				3A III	3B III	4A III B II
				3A IV		2A IV B II
II (9)	6	2	1	9		
				3A I		
				2A II		
				3A III		
				1A IV		
III (8)	4	2	2	8		
				4A II		
				3A III		
				3A IV		
IV (11)	4	5	2	8	2	1
				3A II	1B II	1A III B II
				4A III	1B III	
				1A IV		
Total(49)	24	15	10	32	8	9

UCLA shoulder scale and return to the previous sports activity or job.

The average age of the 49 study patients was 46.5 years (range, 14 to 67 years). Eleven patients were female and 38 male. The dominant arm was involved in 35 patients and the nondominant arm in 14. The patients were followed up for a minimum of 2 years with the average follow-up being 30.1 months (range 24 to 44 months). The duration of symptoms averaged 39.4 months (range, 6 to 192 months). Thirty-five patients (72%) had partial tearing only on the articular surface, six (12%) on the bursal surface, and eight (16%) on both surfaces. The degree of involvement was classified using the Ellman's and Snyder's grading system and summarized in Table 1. Treatment of the partial-thickness tear was either arthro-

scopic debridement of the torn cuff tendon or arthroscopic repair of the large flap of the tendon depending on the size of the tear. All grade I lesions in the Ellman's system were debrided and grade II lesions were debrided when the flap had frayed and fibrillated, or repaired arthroscopically if the lesion had a significant large flap. All grade III tears were repaired arthroscopically.

The patients were divided into four groups on the basis of the onset of their symptoms. Group I consisted of 21 patients. The etiology of the partial tearing of group I attributed to the impingement syndrome. The average age of the group I patients was 56.7 years (range 37 to 67 years), consisting of 13 males and 8 females. In group II patients, partial tearing of the rotator cuff was related to the anterior instability of the shoulder. This group included 9 patients, consisting of 8 males and 1 female. The average age of the patients was 27.9 years (range, 18 to 38 years). In group III, all of the 8 patients were overhead athletes, either at the professional or collegiate level. All patients were male with an average age of 21.8 years (range, 18 to 24 years). Four patients were professional baseball players, including two pitchers. One patient was a professional badminton player and three were collegiate tennis players. In this group, no isolated instances of significant trauma were related with the development of the shoulder pain. In group IV, all patients noted that a significant traumatic event preceded the onset of their pain. This group consisted of 11 patients with 9 males and 2 females. The average age of the patients was 34.9 years (range, 14 to 59 years). Two of these patients

were actively involved in athletic activities at a recreational level. One was a ski coach and the other, a water skier. The other 9 patients were not involved in athletics on any regular basis.

SURGICAL TECHNIQUES

After the induction of general anesthesia, the patient was placed on the operating table in the lateral decubitus position. Standard arthroscopic portals were made and a complete diagnostic examination was performed. Viewing from the posterior portal, partial thickness tears were debrided by using a full radius synovial resector which was introduced through the anterior portal. When the partial-thickness tear of the articular surface had a large flap, only the margin of the flap was debrided, and then arthroscopic repair was performed. Viewing from the posterior portal, an additional anteroinferior portal was made just proximal to the subscapularis tendon. An 18-gauge spinal needle was inserted into the supraspinatus tendon, just lateral to the anterior acromion, so as to pierce the intact tendon and the torn flap. A Shuttle-Relay (Linvatec, Zimmer) was introduced through the spinal needle and the end of the Shuttle-Relay was retrieved from the joint out of the anteroinferior portal. A nonabsorbable suture (No 2 Ethibond) was loaded in the eyelet of the Shuttle-Relay, and the other end of the Shuttle-Relay was pulled with the suture. A second 18-gauge spinal needle was inserted about 1 cm apart from the first needle in order to pierce the intact tendon and the flap. Then, a second Shuttle-Relay was introduced and retrieved out of the anteroinfe-

rior portal. The other end of the nonabsorbable suture at the anteroinferior portal, was loaded into the eyelet of the Shuttle-Relay, and the Shuttle-Relay was pulled back out of the skin just lateral to the anterior acromion. Subacromial bursectomy was performed and the nonabsorbable suture was tied using the slip knot technique. When the subacromial bursa was inflamed, arthroscopic bursectomy and anterior acromioplasty were performed. Viewing from the posterior subacromial portal, an electrocautery was introduced through the lateral portal, thickened soft tissue on the under surface of the anterior acromion and coracoacromial ligament were morcellated. A 5-mm cylindrical burr (Vortex, Linvatec) was introduced through the lateral subacromial portal and the lateral margin of the anterior one-third of the acromion was thinned. A trough about 1mm deep, was created from the posterior end of the acromioclavicular joint to the lateral margin of the acromion and was used as a reference line for the following procedure. An arthroscope was inserted through the lateral portal, and the burr through the posterior portal. Beginning from the reference trough, the undersurface of the anterior acromion was resected. The thickness of resection was checked using the tip of the burr. When osteophytes on the undersurface of the distal clavicle were noted, partial resection of the distal 1cm of the clavicle was performed concurrently. Any fraying or tearing on the bursal surface of the rotator cuff was debrided. After skin closure and dressing, an arm sling with pillow (Ultrasling, DonJoy) was applied.

REHABILITATION

When the patient was seen for the first time in the outpatient clinic, conservative treatment initiated. Conservative treatment included nonsteroidal anti-inflammatory medication, local steroid injection into the subacromial space, and a home-therapy rehabilitation kit, or a regular basis hospital cuff rehabilitation program. Conservative treatment was continued for at least 6 months, before consideration of operative intervention. When symptoms persisted after the adequate period of conservative treatment, arthroscopic treatment was planned. After the arthroscopic debridement or repair, an immediate rehabilitation program was initiated, which included cold pack massage during operation day, passive range of motion from the second day, and progressive strengthening of the rotator cuff muscle. The patient was educated on how to use the home-therapy-kit preoperatively and encouraged to use the kit daily. When the patient had severe resting pain, especially at night, and motion limitation, PCA (patient-control-anesthesia) was induced in the recovery room after the operation. These patients felt comfortable during the early period after the operation and could initiate the regular rehabilitation program with minimal pain.

When the partial-thickness tears were repaired, only gentle pendulum and passive motion exercises with rope and pulley were permitted for 3 weeks after the operation. Gentle strengthening exercises were added from the fourth week for the internal and external rotation of the arm at the side position. Athletic activities

such as throwing and serving a ball was started 6 months after the operation.

STATISTICS

Statistical analyses were performed with the SPSS software package (SPSS for windows Release 7.51, SPSS Inc USA). Duncan's multiple range test was performed to determine the differences in results between each group. Pearson's rank correlation coefficient was calculated to determine the relationship between the final result and the various parameters, such as patient group, grade of partial-thickness tear, severity of trauma, age of patient, sex, sports activity, selection of treatment, dominance of arm and type of acromion. All analyses were set at 95% confidence interval for statistical significance.

RATING SYSTEM

The UCLA shoulder rating system was used to evaluate the final results of the patients. The rating system evaluates the pain, function, active forward flexion, strength of forward flexion, and satisfaction of the patient. The maximum score on the rating system is 35 points. Excellent (34-35) or good (28-33) scores are deemed as satisfactory and fair (21-27) or poor (0-20) are rated as unsatisfactory. The pain score was also graded using the analog scale from 0 to 10. Return to the previous job or level of athletic activity was evaluated using four grades. Grade 0 represented no limitation of athletic activities and a complete return to prior job. Grade I was mild limitation in athletic activities and return to prior job. Grade II was rated when the patient had mod-

erate to severe limitation of their athletic activities or moderate limitation to the job even though the patient continued prior job or sports activities. Grade III represented complete inability to return to prior athletic activities or previous job. Grade 0 and I were classified as favorable returns, while grade II and III were classified as unfavorable returns. We put an emphasis on the grade of returning to prior job or athletic activity for the evaluation of the final results. After all, because the return to the prior level of job or activities reflects a more functional condition of the patients after the treatment and is also a goal of the treatment itself.

RESULTS

Clinical findings

In group I, all of the twenty-one patients revealed clinical findings consistent with the impingement syndrome. The average age of the patients was 56.7 years with the range being 37 to 67. There were 13 males and 8 females. Using the Ellman's grading system for this group, there were included 10 grade I's, 6 grade II's, and 5 grade III's. History of minor trauma was recalled in 11 of the patients. But the traumas in these patients were not associated with the onset of the symptoms. No trauma was discovered in the remaining 10 patients. The dominant arm was involved in 13 patients while the nondominant arm was involved in 8. Seven patients demonstrated only an articular surface tear (one AII lesion, 3 AIII lesions, 3 AIV lesions), 8 patients demonstrated partial tearing on both the articular and bursal surfaces (2 A

II BIV lesions, 4 AIII BII lesions, 2 AIV BII lesion). And 6 patients had only bursal surface tears (3BII, 3BIII). All patients had a positive impingement sign. In all of the group I patient, subacromial space revealed severe thickening of the inflamed bursa and multiple osteophytes in the undersurface of the anterior acromion and acromioclavicular joint. Additional findings included a type I superior labral anterior to posterior (SLAP) lesion in 3 patients, and a type II SLAP lesion in 3 patients. None of the patients were involved in any rigorous sports activity. No patient revealed more than a grade I anterior translation under general anesthesia. Radiographs of the shoulder revealed curved anterior acromion in 11 patients, a hook-like anterior acromion in 8 patients, and a flat acromion in 2. Arthroscopic subacromial decompression was performed in all patients. Fifteen patients underwent arthroscopic debridement for the tear, and 6 patients received arthroscopic repair to the torn flap of the rotator cuff.

In group II, all of the nine patients, 8 males and 1 female, had recurrent anterior instability of the shoulder. The average patient age was 27.9 years (range, 18 to 38 years). The dominant arm was involved in 7 patients. In this group, the partial tear occurred on the articular surface in all patients. According to Ellman's classification of the tears, there were 6 grade I's, 2 grade II's, and 1 grade III lesion. In Snyder's classification system, there were 3 AI's, 2 AII's, 3 AIII's, and 1 AIV lesion. All but one patient recalled a significant traumatic event in the initial dislocation of the shoulder. All patients revealed a Bankart lesion and

one patient had a type II SLAP lesion. Impingement sign I was positive in 4 patients while negative in 5. The subacromial space revealed a normal bursa, except in 2 patients with mild inflammation of the bursal tissue. No patient had a significant spur on the undersurface of the anterior acromion. Radiographs demonstrated flat acromion in 6 patients and curved acromion in 3 patients. There was no hook-like anterior acromion. Arthroscopic Bankart repair was performed on all patients using the suture anchor technique. Arthroscopic debridement of the tear was performed in 8 of the patients, and arthroscopic repair of AIV lesion in 1 patient. No patient underwent subacromial decompression. In this group, 3 patients had been involved in athletic activities. These included tennis, basketball, and soccer, but at the recreational level.

Group III included 8 male patients with an average age of 21.8 years (range, 18 to 24 years). All patients were overhead athletes, either at the professional or collegiate level. Four patients were professional baseball players, including two pitchers. One patient was a professional badminton player and three were collegiate tennis players. No isolated instances of significant trauma was recorded for this group. Although one of the patients demonstrated a minor traumatic event, the onset of the pain was not associated with this traumatic event. Most of their shoulder pain developed while either serving or throwing a ball. The average period of participation of overhead athletic activity for these patients was 11 years (range, 7 to 16 years). These patients revealed a grade I lesion in 4, grade II lesion in 2, and a

Table 3. Return to Activity

Group(N)	Grade 0	I	II	III
I (21)	14(67%)	4(19%)	2(9%)	1(5%)
II (9)	6(67%)	3(33%)		
III (8)		2(25%)	4(50%)	2(25%)
IV (11)	4(36%)	4(36%)	2(18%)	1(9%)
Total(49)	24(49%)	13(27%)	8(16%)	4(8%)

Duncan's multiple range test revealed that the percentage of unsatisfactory results was greater in group III than the other group ($p=0.18$).

RETURN TO ACTIVITY

In 49 patients, 24(49%) returned to their prior jobs or sports activities with no limitations related to the shoulder(grade 0), while 25(51%) had some limitation returning their prior job or sports. Thirteen(27%) out of 25 patients revealed some mild limitation(grade I). Eight patients(16%) showed moderate to severe limitations in returning to the prior level even although there was no change in job or sports. Four patients(8%) failed to return to the prior job or sports due to the shoulder pain. Overall, 76% of the patients demonstrated a favorable return and 24% an unfavorable return. The best returns was recorded in group II patients, while the worst returns were in group III patients. Six(75%) out of 8 patients in group III demonstrated unfavorable return. Return to the prior job and sports are summarized in Table 3.

No patient had returned completely to the prior level. Only two patients in group III had a grade I return to the their prior level of sports activities. These two patients were collegiate tennis players who had Ellman's grade I tear in the

supraspinatus tendon, and were rated as having excellent and good results on the UCLA scoring system respectively.

One collegiate tennis player who had an excellent UCLA score complained of occasional pain during the serving motion. In 2 pitchers, the one who had Ellman's grade II tear revealed a fair score and a grade II return to the activity, while the one who displayed an Ellman's grade III tear revealed a poor result and a grade III return to pitching. The other two baseball players who had an Ellman's grade I and II tears showed a fair UCLA score and a grade II and III return to baseball respectively. One collegiate tennis player who had an Ellman's grade I tear and a good UCLA score, and one professional badminton player who had a grade III tear and a poor score, revealed grade II returns to the their respective sports activities.

CORRELATION OF UCLA SCORE AND FUNCTIONAL RETURN WITH VARIOUS FACTORS

The multiple linear regression method was used to evaluate the difference between the final results for the different groups. Group III patients demonstrated a significantly lower UCLA score and functional return compared to the other groups. Pearson's correlation coefficient for the patient group was highest in several various factors. The type of acromion sex, selection of treatment, associate SLAP lesion, stability, and arm dominance had less of an influence on the final UCLA score and functional return than did the differences of the groups of the patients.

In group III, the UCLA score and functional return were related to the Ellman's grade of rotator cuff tear. Patients with large cuff tears demonstrated lower UCLA scores and functional returns. In the other group, there was no significant correlation between the size of the cuff tear and UCLA score or functional return.

DISCUSSION

Since Neer's description of rotator cuff disease, three stages of this extrinsic mechanical impingement of the rotator cuff under the anterior acromion has been accepted as the primary cause of cuff tearing. Subacromial decompression of the impinging area, either open or arthroscopically, provides a promising result and has been well proven by biomechanical rationale.

However, most of the literature to date had been addressing the full thickness rotator cuff tear or the bursal surface tear. With the increased application of arthroscope in shoulder surgery, increased numbers of partial thickness rotator cuff tears in the articular surface has been recorded. Recently, other mechanisms for the rotator cuff tear have been postulated. Walch et al.²² described impingement of the posterior superior glenoid rim against the articular surface of the rotator cuff during the abducted and externally rotated positions of the shoulder. This internal impingement plays a role of partial thickness rotator cuff tear on the articular surface.

Instability of the glenohumeral joint is also associated with an articular surface partial tear. Increased glenohumeral

translation causes elongation of the rotator cuff tendon beyond the physiologic limits and results in tendon failure.

Repetitive overhead athletes are prone to overuse and fatigue of the rotator cuff. Eccentric overloading during the throwing mechanism may result in intrinsic failure of the tendon fiber of the cuff, which compromise the function of the cuff to hold the humeral head centered in the glenoid, resulting in secondary impingement and further cuff injury. Also, acute trauma may also cause rotator cuff tear in the younger population.

The results of arthroscopic treatment of partial thickness rotator cuff varied according to the authors. Various factors, such as patient population, arthroscopic technique, and the size of the partial tear may influence the results of the treatment. Most of the literature exclude these factors. Recently Gartsman et al.⁷ evaluated articular surface partial-thickness rotator cuff tears, in which they separated the patients into three different groups based on the primary cause of the cuff tear. The impingement group comprised the largest portion of these patients, and were older in age than the other groups. Overall, 88% of the patients had satisfactory results after the average follow-up of 32.3 months. In their series, no difference could be found among the three patient subgroups. This result is contradictory to our present study. The partial thickness rotator cuff tear in the present study was caused by four different etiologies. They were impingement, instability, tension overload, and trauma. The tension overload group scored the worst final results in the UCLA score and return to activity. These patients were young athletes who

were involved in repetitive overhead motion. In Gartsman's series, the information about the patient's activity in the subgroups is lacking⁷.

The UCLA scores were similar for the impingement, instability, and trauma groups. However, return to activity was observed best in the instability group (100%), followed by the impingement group (86% satisfactory return), and then the trauma group (72% satisfactory return).

The final results of the UCLA score and functional return within the subgroup were related to the size of cuff tear. Although we could not calculate the statistical difference due to the small numbers for each grade of cuff tear, the patient with the larger size of tear revealed a poorer outcome.

In conclusion, partial-thickness rotator cuff tear occur most commonly as an impingement of the rotator cuff into the anterior acromion. Cuff failure also occurs in relation to glenohumeral instability, significant trauma of the shoulder, and tensile overload from repetitive overhead athletic activity. Arthroscopic debridement or repair of the partial tear provides favorable results except in the tension overload group. In this group, the majority of the patients proved to have unfavorable outcomes.

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