Articular surface partial-thickness rotator cuff tears

Gary M. Gartsman, MD, and Joseph C. Milne, MD, *Houston, Tex.*

Between 1987 and 1992, one hundred eleven articular surface partial-thickness rotator cuff tears were diagnosed in 106 patients; 90 were men, and 16 were women. The average age was 42.5 years. Average follow-up was 32.3 months, ranging from 26 to 84 months. Patients were separated into three groups. Group 1 consisted of 85 shoulders in which impingement was believed to be the primary cause; these shoulders were treated with debridement of the tear and arthroscopic subacromial decompression. Group 2 consisted of 14 shoulders with instability treated with debridement of the partial tear and anterior reconstruction (n = 10) or debridement and rehabilitation (n = 4). Group 3 contained 12 shoulders with tearing caused by trauma that were managed with debridement and open repair, if necessary. In 98 of 111 cases (88%), the patients had a satisfactory result. Five patients required open rotator cuff repair at a later date because of continued symptoms. Complications included significant postoperative stiffness in four shoulders, which required open release. (J SHOULDER ELBOW SURG 1995;4:409-15.)

Neer[18] originally described three gradations of rotator cuff lesions: stage I denotes hemorrhage and edema of the tendon; stage II, tendinitis and fibrosis; and stage III, incomplete or complete tearing of the rotator cuff. Most orthopaedic literature is devoted to the diagnosis and management of either stage II disease or complete tears. Little has been written regarding partial-thickness rotator cuff tears.[10, 21] Two factors seem to be responsible for this deficiency. First, the majority of partial-thickness tears occur on the articular surface.[12, 15] These tears are not visualized during open surgical acromioplasty for stage II impingement, and they may not be seen well even if the tendon is split in line with its fibers. Second, when partial tears were noted, they did not fit into Neer's classification because they represent more damage than a stage II lesion, yet they are not well categorized in stage III disease.

With the advent and increased use of shoulder arthroscopy, partial articular surface tears have been frequently described.[1, 2, 5-10, 12, 23, 27, 29] The articular surface of the rotator cuff is well visualized arthroscopically, and tears can be precisely measured. Various classification systems have been devised to categorize these lesions.[6, 24, 29] The classification system used in this article was described by Ellman and Gartsman,[6] who classified partial-thickness tears according to the depth of the lesion and the anatomic site. Tears are noted to be present on the articular surface, the bursal surface, or both. Grade 1 lesions demonstrate definite disruption of the tendon fibers but are less than one fourth of the tendon thickness (<3 mm). Grade 2 lesions are less than half of the tendon thickness and are 3 to 6 mm in depth. Grade 3 lesions are more than half the tendon thickness and are more than 6 mm deep.

The purpose of this article is to review our experience with arthroscopically diagnosed articular surface partial-thickness rotator cuff tears (ASPRCT).

PATIENTS AND METHODS

The criterion for inclusion in this study was arthroscopic confirmation of an ASPRCT. Tears were diagnosed as partial thickness if the tendon fibers were disrupted but no full-thickness tear was noted visually or by palpation with a probe or arthroscopic instrument. Fraying, roughening, abrasions, or discoloration of the synovial lining or tendon surface was not classified as a partial-thickness tear. Patients with partial tears on the bursal surface, with or

From the Texas Orthopedic Hospital, Houston.

Reprint requests: Gary M. Gartsman, MD, 7401 S. Main St., Houston, TX 77030.

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Table I Activities of daily living

Activity	Group 1 Preoperative	Group 1 Postoperative	Group 2 Preoperative	Group 2 Postoperative	Group 3 Preoperative	Group 3 Postoperative
Put on a coat	1.4	2.7	1.5	2.7	1.5	2.6
Sleep on painful side	0.8	2.6	1.2	2.7	1.4	2.7
Wash back/fasten bra	1.1	2.2	1.5	2.8	1.4	2.6
Manage toileting	2.6	2.9	2.7	2.9	2.7	2.8
Comb hair	1.3	2.5	1.9	2.8	2.2	2.6
Reach high shelf	0.8	2.2	2.0	2.6	2.1	2.7
Lift 10 lb above shoulder	0.6	2.1	1.6	2.4	1.8	2.5
Throw ball overhead	0.7	1.9	0.8	2.4	0.6	2.3
Do usual work	1.3	2.6	0.4	2.2	0.7	2.5
Do usual sport	1.4	2.5	0.8	2.3	1.1	2.6

Function is rated by patients from 0 to 3, with 0 representing inability to perform the activity and 3 no shoulder pain when activity is performed.

without an articular surface partial tear, were excluded from this study.

One hundred eleven shoulders in 106 patients formed the study group. The average age of the 106 study patients was 42.5 years (range, 16 to 67 years). Ninety patients were men and 16 were women. The patients were followed up for a minimum of 2 years. Average follow-up was 32.3 months (range, 26 to 84 months).

Patients were rated before and after surgery according to the system of the American Shoulder and Elbow Surgeons.[3, 26] The amount of pain was rated by the patient on an analog scale from 0 to 10, with 0 representing no pain and 10 unbearable pain. The average preoperative pain rating was 6.8 (Table II). Function is rated from 0 to 3, with 0 representing inability to perform the activity and 3 no shoulder pain when the activity is performed. Findings regarding activities of daily living are summarized in Table I. Of those who responded, 61 described their work as physical and 16 as sedentary.

Because significant trauma may vary from one patient to the next, we used the patient's assessment on a questionnaire as to whether the patient thought that an isolated, significant traumatic event was related to the onset of his or her shoulder problem.

The patients were divided into three groups on the basis of physical examination, history, examination under anesthesia, and findings at arthroscopy. Group 1 consisted of 85 patients (75 men and 10 women) with an average age of 52.3 years (range, 45 to 67 years). Their average preoperative pain rating was 6.7. This group had a history and physical examination results consistent with the impingement syndrome. They demonstrated no evidence of increased translation on physical examination or examination under anesthesia and had no arthroscopic findings consistent with glenohumeral instability (abnormal translation, Bankart lesion, Hill-Sachs lesion, ligamentous laxity, or tearing). No isolated instances of significant trauma were recorded in this group, but fourteen of these patients noted some minor traumatic event that they associated with the onset of their shoulder pain. Imaging studies had accurately predicted the partial cuff tear in nine patients (seven arthrograms and two magnetic resonance imaging scans); an additional two patients had arthrograms interpreted as complete cuff tears and were classified as false-positive. Forty-seven imaging studies (10 magnetic resonance imaging scans and 37 arthrograms) were falsely negative.

Patients in group 2 had a history, findings on examination under anesthesia, and findings on arthroscopic visualization that were consistent with instability. This group included 14 patients (nine men and five women) with an average age of 33.1 years (range, 16 to 42 years). Their preoperative pain rating was 7.2. Ten patients (71%) related the onset of the shoulder pain to a significant traumatic event.

Table II Pain (averages)

Group	Preoperative	Postoperative
1	6.7	1.2
2	7.2	2
3	4.5	1

Pain was rated by patients on an analog scale from 0 to 10, with 0 representing no pain and 10 unbearable pain.

Group 3 included 12 patients (11 men and one woman) with an average age of 44.4 years (range, 22 to 51 years). All of the patients noted significant shoulder trauma before the onset of their shoulder problem. The injuries were a direct blow to the shoulder in five patients, a fall on the outstretched hand or elbow in five, and a twisting injury to the arm in two. No findings of shoulder instability were present on preoperative physical examination, and no arthroscopic evidence of shoulder instability was identified.

The physical examination findings are summarized in Table III. The majority of the loss in movement was in internal rotation, averaging three vertebral levels. The primary impingement sign was positive if subacromial pain was produced with maximum passive elevation of the involved arm. The secondary sign[14] was positive if similar pain was produced when the arm was elevated 80° and maximally internally rotated, and the tertiary sign was positive if pain was produced with the arm abducted 90° (painful arc).

A standard series of radiographs was obtained. These radiographs included an anteroposterior view on a 14 inch by 17 inch film to visualize the lung fields, an axillary lateral view, and a supraspinatus outlet view.[20] Anterior acromial spurs were noted in 14 patients, anterior acromial sclerosis in 18, and greater tuberosity changes in 22. Acromioclavicular (AC) joint arthritis was noted in 15, and inferior AC spurs were found in 10. Acromial shape was classified in 96 patients: type I, 2; type II, 65; and type III, 29.[4]

Surgery was performed for persistent pain that interfered with activities of daily living, work, or sports and was unresponsive to a minimum of 12 months of appropriate, nonoperative care, or for increasing pain after a period of 6 months (range, 6 to 48 months; average, 13.1 months). This nonoperative treatment consisted of activity modification, non-steroidal antiinflammatory medications, and a home rehabilitation program with range-of-motion, isometric, and isokinetic exercises.[12]

Table III Findings of physical examination

Range of motion (averages, ranges in parentheses)	
Preoperative	
Elevation	145° (125 to 150)
External rotation	80° (60 to 95)
Internal rotation	T10 (T5 to T12)
Postoperative	
Elevation	147° (130 to 150)
External rotation	71° (65 to 95)
Internal rotation	T10 (T5 to L2)
Impingement sign positive*	
Primary	55 shoulders
Secondary	27 shoulders
Primary + secondary	39 shoulders

*See text for definitions.

Thirty-six patients received subacromial cortisone injections; the average number of injections was 1.7; range, 1 to 5.

Surgical Technique

Arthroscopic subacromial decompression and acromioclavicular joint resection were performed according to previously described techniques.[12, 13] Open repair of a significant partial-thickness tear was performed by first marking the area of tear with a Prolene suture (Ethicon, Inc., Somerville, NJ) passed through the lesion during the arthroscopic examination. An arthroscopic decompression was performed. A surgical incision was then made, and the suture was identified exiting from the bursal surface of the rotator cuff. The area of damaged tendon was excised, and repair of the tendon to adjacent tendon or bone was performed as determined by the tear location and geometry. Neviaser and Neviaser,[21] Post and Cohen,[25] and Sahlstrand[28] have reported similar treatments. Our indication for open repair was a partial-thickness tear involving greater than 50% of the thickness of the cuff in a physically active patient.

Instability was corrected by use of open surgical techniques. A standard deltopectoral incision was used, and the subscapularis tendon was detached laterally and separated from the capsule. The capsule was divided laterally. A Bankart lesion, if present, was repaired with suture anchors. In the absence of a Bankart lesion, anteroinferior instability was corrected by first placing the arm in 30° of abduction and 30° of external rotation and then shifting the shoulder capsule superiorly and laterally. If the instability was multidirectional in nature, a Neer capsule shift was performed.[19]

Surgical Findings

Surgical findings were confined to the rotator cuff, the biceps tendon, and the glenoid labrum. The average rotator cuff tear size was 1.9 cm by 1.1 cm. The majority of tears were in the supraspinatus (n = 76), with 26 in the infraspinatus and 9 in the teres minor. Fifty-one tears were classified as grade 1, 39 as grade 2, and 21 as grade 3. Minimal arthroscopic rotator cuff debridement of displaced flaps and frayed edges was performed in all cases. The biceps tendon was inflamed in 10 shoulders, frayed in 7, and partially torn in 5. Fourteen superior labral separations were seen, but only 7 extended from anterior to posterior and could, therefore, be classified as superior labral anterior and posterior (SLAP) lesions. The remainder of the labral findings are listed in Table IV.

Group 1. Subacromial findings consistent with impingement but not required for diagnosis were erosion or fraying of the rotator cuff bursal surface, the acromion, or the coracoacromial ligament. Patients underwent arthroscopic subacromial decompression because it was believed that there was a significant structural abnormality (type 3 acromion, inferior AC osteophyte), confirmatory subacromial space findings, or both, such that expansion of the subacromial space would allow the tendon abnormality to heal. These procedures were performed according to previously described techniques.[12] Forty-four tendon lesions were grade 1, 29 were grade 2, and 12 were grade 3. These lesions were located in the supraspinatus in 67 shoulders, in the infraspinatus in 16, and in the teres minor in 2. Three patients underwent an open repair of a partial-thickness tear at the time of the index arthroscopic examination.

Group 2. Thirteen patients had anterior or anterior-inferior instability, and 1 patient had posterior instability. At surgery, 12 glenoid lesions were noted: 4 central chondral defects, 5 anterior rim fractures (all in patients with anterior instability), and 3 anterior-inferior ligament-labrum separations (Bankart lesions) in patients with anterior-inferior instability. Three patients were noted to have chondral defects in the superior aspect of the humeral head and corresponding lesions in the posterior portion of the rotator cuff consistent with the lesion described by Walch[31] and Jobe.[16] Four cartilaginous and 2 bony Hill-Sachs lesions were also identified. None of the Hill-Sachs lesions were apparent on preoperative radiographs. The depth of tendon tear in 6 shoulders was grade 1, 6 others were grade 2, and 2 were classified as grade 3. The locations of tearing in this group were more diverse, with 6 in the supraspinatus and 4 each in the infraspinatus and teres minor. One patient from this group had a planned, open Neer capsular shift immediately after the arthroscopic examination. Open stabilization was performed because we believed that the patient's symptoms were caused by instability. We believed that the partial tear was a result of the instability and not the primary cause of the patient's symptoms.

Group 3. The remaining 12 patients had a partial-thickness cuff tear with no evidence of impingement or instability. This group had the highest percentage of significant partial tears. Seven patients had type 3 tears, four had type 2, and one had a type 1. The tear location was in the supraspinatus in nine shoulders and in the infraspinatus in three. Two patients from this group had an open repair of the partial-thickness tear done during the same sitting as the arthroscopic procedure.

RESULTS

Patient satisfaction was determined by a self-assessment questionnaire in which the patients rated the amount of pain they had with various activities of daily living. Patients rated themselves as satisfied with their outcome in 98 of the 111 shoulders. Activities of daily living ratings are summarized in Table I.

Range of motion is noted in Table II. Those patients who had abnormal results could be divided into two groups. The first is a group of four patients who required open release after failing to respond to an intensive period of physical therapy. This group is discussed in the complications section below. The second group, 28 patients, exhibited minor losses of external and internal rotation. Neither of these losses caused any functional deficit. Furthermore, no differences could be found among the three patient subgroups.

Further Surgical Procedures

Eight patients later had open instability repair: three Bankart repairs and five anterior capsular reconstructions.[19] Five patients in group 2 desired no further treatment. The average interval between arthroscopy and open stabilization was 7.5 months.

Table IV Labral tears

	Anterior	Posterior	Superior	Inferior
Torn	14	8	14	1
Separated	15	9	14	4
Shredded	42.5	24	38	8

Four patients from the impingement group later underwent open rotator cuff repair, two partial and two complete tears were found at the time of open repair. Open repair was performed because of continued pain in three patients and increasing pain in one patient. The average interval between the arthroscopic and open procedures was 8 months. All four tears were classified as grade 2 at the time of the index arthroscopic examination.

One patient in the traumatic tear group also underwent open tendon repair. At the time of arthroscopy the tear was noted to be 80% of the tendon thickness (grade 3).

Late open AC joint resection was performed in two patients from the impingement group. Both patients had improvement with their initial arthroscopic subacromial decompression but had persistent pain localized to the AC joint.

Complications

No intraoperative complications were noted in the study group. Seven postoperative complications occurred: meralgia paresthetica in one patient, urinary retention in two patients, and significant postoperative stiffness in four shoulders. No vascular or infectious complications were found.

Four patients required open anterior release for postoperative stiffness. They had the primary diagnosis of impingement (group 1) and were initially treated with arthroscopic subacromial decompression. All cases involved the dominant extremity: three right and one left. This group included two men and two women. The average age of these patients was 38.8 years, compared with the 42.5 year average for the entire study group. No statistical differences in the preoperative ranges of motion, tear sizes, or treatment regimens were noted in these four patients. No arthroscopic findings consistent with adhesive capsulitis (synovitis or fibrosis in the axillary pouch, synovitis or contracture in the area of the rotator interval) were noted at the time of the index arthroscopic surgery. Before the open release the average elevation and external rotation were 108° and 30°, respectively. Open release was performed at a mean of 5.5 months after the initial surgery. At an average follow-up of 19 months from the time of open release, the average ranges of motion had improved to 132° and 57°.

Failures

Seven patients stated that their shoulders were the same after surgery; one patient believed that his shoulder was worse. Of the three patients from group 1 who did not improve, one had significant degenerative changes of both the glenoid and humeral head noted at surgery. The second had significant stiffness and required an open release. One patient continued to complain of pain, although no objective source for the shoulder problem could be identified.

The patient whose condition worsened with treatment was from group 2 and had an open stabilization 6 weeks after the diagnostic arthroscopy. No acromioplasty was performed. Four patients from group 2 remained the same after surgery (diagnostic arthroscopy); three declined stabilization procedures, and one patient underwent a Bankart repair. This patient continues to complain of moderate pain and is unable to return to work.

DISCUSSION

The purpose of this article is to present our experience with a single anatomic lesion that seems to represent a common meeting ground of several different pathologic conditions, each of which presents various treatment options.

The early arthroscopic literature contains varied results for the treatment of partial-thickness rotator cuff tears. Andrews et al.[2] presented follow-up on 34 of 36 patients with ASPRCT and achieved 85% success with debridement of the tear without acromioplasty. In contrast, Ogilvie-Harris and Wiley[23] found only 50% success with debridement of partial tears without acromioplasty. Recently, several studies have documented the results of arthroscopic subacromial decompression in the treatment of partial tears.[1, 5, 7, 27, 29] All the authors reported inferior results when compared with subacromial decompression for impingement without a partial tear.

The concept of "pseudoimpingement" on the basis of instability was popularized by Jobe, Tibone, Glousman, and others.[11-13, 17, 22, 30] With the increasing use of shoulder arthroscopy, it is becoming evident that instability can be associated not only with rotator cuff tendinitis but with ASPRCTs as well. It is presumed that the increased humeral head translation causes elongation of the tendon beyond its physiologic limits and produces tearing. It is also possible, however, that the rotator cuff tear is the primary lesion.

Our work postulates that several factors may be responsible for the partial-thickness rotator cuff tear, but it is not meant to be an in-depth study of all mechanisms of tendon failure and does not exclude other possible mechanisms for tendon damage. Walch et al.[31] and Jobe[16] have reported on abutment of the posterior superior glenoid rim against the articular surface of the rotator cuff when the arm is positioned in abduction and external rotation. In addition, other mechanisms for tendon failure are likely to exist.

In our series, we believed that several factors caused the articular surface tears. Certainly impingement plays a significant role in the pathogenesis of this lesion. Our data suggest that 85 of 111 cases (76%) were attributable to impingement. This leaves, however, a substantial number of patients, 24%, with other causes for this anatomic lesion. We think that the lesions in these patients could be caused by instability or trauma.

We believe that those patients in group 3 sustained their partial tear on the basis of a single traumatic event. This group, theoretically, may not benefit from either decompression or stabilization. No evidence exists that debridement alone stimulates tendon healing. The lesion may be treated with minimal debridement of the tear and appropriate rehabilitation if the partial tear is grade 1, or is grade 2 or 3 in a physically inactive patient. A grade 2 or 3 lesion in a physically active patient may require open repair to achieve a successful outcome.

An area of uncertainty is the significant postoperative stiffness that developed in four patients. We were unable to find any factors to differentiate these patients from the others. We cannot determine whether the stiffness would have occurred in the absence of surgical intervention, whether surgery caused or accelerated this process, or whether the partial tear and stiffness are two separate, unrelated findings. It is also possible that adhesive capsulitis or posttraumatic stiffness was misdiagnosed in these patients.

CONCLUSION

Partial-thickness rotator cuff tears have been considered as part of a rotator cuff disease continuum that includes overuse of an essentially normal tendon, tendinitis, tendon fibrosis, partial-thickness tendon tear, and complete tendon tear. These lesions were thought to occur solely on the basis of subacromial impingement. This article suggests that the cause of one of these lesions (ASPRCT) is multifactorial and includes impingement but also includes tendon overload caused by glenohumeral instability and significant trauma. Intrinsic tendon failure as part of the natural aging process or as a separate entity must also be considered. We believe that the ASPRCT should not be considered a discrete entity but rather a common meeting point of several pathologic conditions. It is incumbent on the treating physician to understand the underlying disorder and devise a treatment plan based on that pathologic condition.

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