16 Indications for Repair: Who Really Needs Surgery?

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Incidence

The incidence and prevalence of rotator cuff disease is important information for patients and providers when considering treatment options in symptomatic patients. Rotator cuff tears are a common cause of morbidity, resulting in shoulder pain, arm dysfunction, and sleep disturbances; the prevalence of tears increases with age [1–3]. The three most traditional means to assess incidence of rotator cuff tears are (1) cadaveric studies, (2) ultrasound (US), and (3) magnetic resonance imaging (MRI). Overall, the incidence of *any* rotator cuff tear (partial or full thickness) in cadaveric studies approaches 30 % [4]. Cadaveric studies are highly variable. Neer reported 25 full-thickness rotator cuff tears in 500 cadaveric shoulders (5 %) in 1983 [5]. Petersson [6] reported 32 rotator cuff tears in 99 cadaveric shoulders (32.3 %) (14 full thickness, 18 partial thickness). Ozaki et al. [7] reported 96 rotator cuff tears (48 %) (27 full thickness, 69 partial thickness) in 200 cadaveric shoulders. Reilley et al. [4] reviewed and combined nine studies that evaluated tears in 2553 cadaveric shoulders with complete data; it was determined that the overall prevalence of any tear was 30 % (12 % full thickness, 18 % partial thickness) in cadavers with a mean age of 70 years.

The incidence of rotator cuff tear diagnosed by ultrasound is also variable and has been strongly correlated with age [2, 3] and presence of shoulder pain. In a review of 100 clinically symptomatic patients, Teefey et al. [8] reported an incidence of 80 % (65 full thickness, 15 partial thickness). Milgrom et al. [2] evaluated 180 asymptomatic patients by ultrasound and discovered 31 partial-thickness tears (17.2 %) and 32 full-thickness tears (17.7 %, 35 % overall). Reilley et al. [4] reviewed the incidence of rotator cuff tears by ultrasound in 11 papers (1449 subjects) and determined the overall prevalence to be 40.7 %.

MRI is a common modality used to diagnose rotator cuff tears in current practice. The incidence of rotator cuff tears diagnosed by MRI is also variable. Sher et al. [9] reported 14 full-thickness and 22 partial-thickness rotator cuff tears in 96 asymptomatic subjects for a total incidence of 34.3 %. The mean age of patients in Sher's study was 54 years. Torstensen and Hollinshead [10] evaluated 57 symptomatic patients (average age 41) and discovered 40 (70.2 %) full-thickness rotator cuff tears by MRI. Reilley et al. [4] reviewed the incidence of rotator cuff tears diagnosed by MRI in 13 papers (761 subjects) and determined the overall prevalence to be 41.1 %. Rotator cuff tears are likely present in between 30 and 40 % of the population.

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Tears are more common in symptomatic patients [4, 8, 10], and the prevalence of tears increases with age [2, 3].

Natural History

The natural history of rotator cuff pathology also impacts decision making for patients with rotator cuff problems. Neer conceptualized rotator cuff pathology as a spectrum of diseases [5] beginning with edema and hemorrhage of the tendon bursa early and progressing to fibrosis, tendonitis, and, in later stages, partial and complete tendon tearing. Debate regarding the etiology of these changes continues inclusive of intrinsic tendon degeneration and extrinsic mechanical factors. The fate of partial-thickness tears has been described by Yamanaka et al. [11] who performed repeat arthrography on 40 conservatively treated partial-thickness rotator cuff tears at a mean interval of 412 days; during this interval, 10 % of tears healed, 10 % decreased in size, 53 % increased in size, and 28 % progressed to full-thickness tears. Increased incidence of tears has also been associated with increasing age [2, 3]. There is therefore strong evidence that tear size and incidence increase with time.

Population studies suggest rotator cuff tears are prevalent in asymptomatic shoulders. Patients in their 50s have a 13 % rate of asymptomatic tears, compared to 20 % of patients in their 60s, 31 % of patients in their 70s, and between 50 and 80 % of patients greater than 80 [2, 3]. Longitudinal studies suggest subsequent development of pain in previously asymptomatic shoulders over time. Moosmayer et al. evaluated initially asymptomatic rotator cuff tears at 3-year follow-up and determined 18 of 50 (36 %) became symptomatic [12]. Similarly, Yamaguchi et al. [13] observed 23 of 45 (51 %) initially asymptomatic patients go on to become symptomatic over a mean of 2.8 years. Mall et al. [14] observed development of symptoms in 34 of 69 (49 %) previously asymptomatic tears over a 1.9 year period. Patients who are initially identified as "asymptomatic" are at risk for both symptom development and tear progression over time.

Demographic Variables

Patient demographics are usually among the first variables considered when deciding to recommend rotator cuff repair to patients.

Age

Older chronological age should not preclude appropriate and symptomatic patients from operative interventions. Although increased age is classically thought to correlate with poorly repairable tissue and worse outcomes [15, 16], postoperative pain relief and improved function have proven reliable in older patients. Cofield et al. report outcomes 13 years after rotator cuff repair and determined that advanced age was associated with worse results in terms of motion and strength but not satisfaction, pain relief, or reoperation [15]. Rhee et al. [17] evaluated outcomes of rotator cuff tears in patients in their 60s versus their 70s; they determined that there was no difference with respect to age, and outcomes were more closely related to the size of tear. Pai and Lawson [18] report good to excellent results in 78 % of patients undergoing rotator cuff repair over the age of 70. Hattrup reported a comparison of outcomes between patients under and over the age of 65. The under 65-year-old cohort demonstrated excellent results in 88.6 % of cases, compared to 77.2 % of cases over the age of 65 [19]. Good and excellent results are achievable when performing rotator cuff repairs in elderly patients. No strict age cutoff for surgical indication is appropriate as there is significant interpersonal variability in activity level, and good outcomes are achievable.

Younger chronological age and physiologically young patients with full-thickness rotator cuff tears are often indicated for surgical intervention sooner than chronologically or physiologically older patients. Younger patients tend to be more active and are more likely to be working in occupations that require a strong arm. One of the predictors of failure of nonoperative treatment for rotator cuff tears has been shown to be activity level, which tends to be higher in chronologically and physiologically younger patients (MOON data—unpublished—Warren Dunn correspondence). Younger patients also have higher life expectancies and, given that rotator cuff tears rarely heal on their own but rather tend to progress, repair may be more desirable in this population. There is no agreed upon age where early repair should be performed, but younger than 50–55 years of age is a frequently used cutoff by many surgeons.

Gender

While there is some inconsistency in the literature [17, 19], female gender has been correlated with inferior results after rotator cuff surgery [15, 16]. Cofield et al. [15] evaluated 105 patients who underwent repair of chronic rotator cuff tears at a mean follow-up of 13 years. Female gender was associated with worse outcomes in terms of pain relief and active motion at final follow-up, but gender did not predict patient satisfaction or reoperation. Romeo et al. [16] evaluated 72 patients (44 men and 28 women) at an average follow-up of 4.5 years. Worse outcomes were seen in women over the age of 65 with regard to the simple shoulder test and Constant-Murley scores, while no such correlations were present in men [16]. Rhee et al. [17] performed a retrospective review of 238 patients ages 60–79 who underwent rotator cuff repair. They created a sex- and tear size-matched model and determined there was no difference in outcomes with respect to gender. Good outcomes have been demonstrated in males and females and gender should not factor into surgical indications. However, outcomes after surgery may differ based on gender.

Workers' Compensation

Pending workers' compensation claims are associated with poor satisfaction with nonoperative treatment of rotator cuff tears [20]. In addition, McKee and Yoo [21] determined that patients who had filed a workers' compensation claim and who underwent surgical repair had lower shoulder pain and disability index scores as well as SF-36 scores both preoperatively and postoperatively compared to those who had not filed claims. In a retrospective review, Misamore et al. [22] reported outcomes of rotator cuff repairs in 103 consecutive patients; of these, 54 % of patients with open workers' compensation claims were rated good or excellent at 45 months compared to 92 % good and excellent results in those without claims. Workers' compensation was also associated with lower satisfaction and worse ASES scores in patients with recurrent rotator cuff tears [23]. In conclusion, workers' compensation is associated with poor tolerance for physical therapy, inferior preoperative status, and worse postoperative outcomes.

Patient History and Physical Exam

Duration of Symptoms

Not all patients with rotator cuff tears are symptomatic [2, 9]; however, progression of initially asymptomatic tears often occurs [12–14]. Pain is typically over the lateral shoulder or deltoid, and it often occurs at night and with overhead activities [24]. There remains significant controversy in the literature regarding duration of clinical symptoms as an indication for rotator cuff repair. Prior studies suggest nonoperative treatment initiated early is associated with improved outcomes, while late initiation of nonoperative treatment (>1 year) is associated with less favorable results [25]. Bokor et al. [26] evaluated 53 patients at an average of 7.6 years after arthroscopically diagnosed full-thickness rotator cuff tears treated nonoperatively. They noted 86 % of patients that initiated nonoperative management within 3 months of symptoms had satisfactory results, compared to 56 % of patients who had shoulder pain for >6 months prior to presentation. Bartolozzi et al. [25] reported a series of 136 patients treated nonoperatively for rotator cuff disease. They concluded that a greater than 1-year history of pretreatment clinical symptoms correlated with unfavorable clinical outcomes with nonoperative treatment.

More recent studies suggest the duration of symptoms has no effect on outcomes. The MOON Shoulder group, a multicenter cohort, evaluated 450 patients stratified by the duration of symptoms at the time of presentation [27]. They determined that there was no correlation of prolonged pretreatment symptoms with rotator cuff disease severity or patient outcomes. This study, however, did not exclude patients who had already begun nonoperative treatment modalities.

Increased symptom duration does not necessarily translate to inferior surgical results. Bjorkenheim et al. [28] evaluated 78 rotator cuff repairs at 5–10 year follow-up and concluded preoperative symptom duration did not correlate with outcome of surgery.

Acute versus Chronic Tears: Surgical Timing

Determining chronicity of rotator cuff tears is often difficult. In some circumstances, patients may suffer complete traumatic full-thickness tears after a fall or shoulder dislocation [29]. Acute rotator cuff tears are thought to account for less than 10 % of patients presenting with symptomatic rotator cuff disease [16, 29, 30]. Bassett and Cofield performed a retrospective review of 37 patients who had surgical repair within 3 months of an acute rotator cuff tear. The average follow-up was 7 years, and the authors determined that early surgical repair (defined as <3 weeks) was associated with the better shoulder function at follow-up [29]. Hantes et al. [31] evaluated 35 patients with traumatic rotator cuff tears; 15 patients had early repair (<3 weeks) while 20 patients had delayed repairs (>3 weeks). Average follow-up for the two groups was 34 and 38 months, respectively. Postoperatively, the early repair group demonstrated significantly better UCLA scores, Constant scores, and range of motion. However, there is some evidence that delayed rotator cuff repair for acute tears has no effect on outcome [16, 32, 33]. The matter of surgical timing was summarized in a recent systematic review by Mukovozov et al. [34] who identified 15 studies reporting the interval to surgical management of acute rotator cuff tears. The acute surgery group, defined as <3 months between injury and surgery, was inclusive of 7 studies and 209 patients. Eight studies including 162 patients comprised the surgical delay group of acute rotator cuff tears. This systematic review determined that early repair (<3 months) was associated with significantly improved Constant scores, UCLA shoulder scores, and better abduction and elevation [34].

Range of Motion

Active and passive ranges of motion are important concerns in the indication for surgical repair of rotator cuff tears. Poor preoperative range of motion has been correlated with inferior results after rotator cuff repair. Patients who are unable to achieve 100° of active abduction preoperatively commonly have compromised postoperative results [35, 36]. Feng et al. [36] followed a cohort of 1067 patients for an average of 7.9 years and determined those who had greater than 90° of active abduction preoperatively had improved postoperative outcomes. Pai and Lawson [18] corroborated these findings when they observed good and excellent results more frequently in patients with preoperative abduction greater than 90°. While improved preoperative active range of motion is associated with superior outcomes, close evaluation of passive ROM is crucial to rule out concomitant adhesive capsulitis or “frozen shoulder.” Rotator cuff tears may be observed concurrently with adhesive capsulitis. In general, adhesive capsulitis should be successfully addressed before rotator cuff pathology is surgically managed [37]. Tauro [38] determined that patients with a total range of motion deficit of 70° or more (a combination of loss of abduction, forward flexion, and internal and external rotation) were more likely to have lasting postoperative adhesive capsulitis and poor results of rotator cuff repairs [38].

It is critically important to evaluate both active and passive range of motion prior to recommending rotator cuff repair to patients. Good preoperative active range of motion clearly correlates with improved outcomes. Furthermore, it is crucial to diagnose and treat adhesive capsulitis prior to addressing rotator cuff pathology. It is much preferable to get passive range of motion restored prior to performing surgery of a rotator cuff tear, given that a period of immobilization typically occurs postoperatively.

Strength

The loss of strength and function in rotator cuff disease is often used as an indication for repair [39, 40]. Patients with objective weakness on physical exam often fail physical therapy or other conservative modalities [25]. In a study performed by Bartolozzi et al. [25], patients without weakness at the time of presentation obtained good and excellent results with physical therapy 74 % of the time. Patients presenting with moderate and severe weakness (grade 3 or less out of 5) experienced good and excellent outcomes only between 13 and 33 % of the time with conservative management. The mean follow-up in their study was 20 months. Furthermore, Bartolozzi found that functional impairment at the time of presentation was associated with poor outcomes with conservative management. This finding has been disputed by recent MOON cohort data as preoperative weakness was not associated with failure of physical therapy programs [41]. Surgery should be considered when weakness is present in young and active patients who wish to regain strength; in elderly patients, a full course of structured physical therapy is prudent as improvements in strength are often observed [40].

Preoperative weakness has been associated with worse outcomes after rotator cuff repair [25, 35, 36]. Ellman et al. [35] evaluated 50 patients at an average of 3.5 years after rotator cuff repair; he determined patients with preoperative external rotation strength grade less than 3 had significantly worse outcomes than those with preoperative strength 4 or 5. In conclusion, indications for rotator cuff repair based on strength should include both those with good strength who fail conservative treatments and young active patients with weakness who need or want return of strength.

Physical Exam

Impingement signs described by Hawkins [42, 43] and Neer [44, 45] are positive in most patients presenting with rotator cuff disease. MacDonald et al. [46] prospectively evaluated the diagnostic accuracy of these impingement signs in 85 consecutive patients undergoing shoulder arthroscopy. The sensitivity of the Neer and Hawkins signs for detecting rotator cuff tears is 85 % and 88 %, respectively [46]. Leroux et al. [47] demonstrated similar sensitivities (89 % and 87 %) of Neer and Hawkins signs. Some propose a further exam with an impingement tests [5] (i.e., subacromial injection with local anesthetic after a positive impingement sign and repeating exam to assess for improvement). While the impingement test has proven reliable in detecting rotator cuff disease, correlations with patient outcomes have proven inconsistent [48, 49].

Imaging

Plain films are often obtained in the initial workup of patients with shoulder pain. The acromiohumeral distance measured from the superior aspect of the humerus to the inferior boarder of the acromion on anteroposterior or true AP shoulder plain films has been associated with chronicity of rotator cuff tears. Distances 7 mm or less have been shown to correlate with larger tears and decreased strength, motion, and satisfaction after surgical repair [35, 50]. Plain shoulder radiographs are often used to evaluate acromial shape preoperatively. Bigliani characterized acromion morphology as flat, curved, or hooked [51]. Acromion morphology has not been demonstrated to correlate with outcomes following repair [36, 52]. Classically, type 2 or 3 (curved or hooked) acromions were thought to contribute to external subacromial impingement [44]. A prospective, randomized controlled trial has shown no differences in patient outcomes between rotator cuff tears treated with repair and acromioplasty and those treated with repair alone [52]. MacDonald et al. [52], however, did report higher reoperation in patients treated with repair alone at 2-year follow-up. As part of the AAOS clinical practice guidelines for rotator cuff problems, the academy suggests routine acromioplasty is not required at the time of rotator cuff repair [53, 54].

MRI

Advanced imaging allows clinicians to accurately evaluate rotator cuff tear characteristics when deciding to indicate patients for repair. While multiple modalities have proven reliable, MRI and US are the techniques most commonly used [55–57]. It is important to evaluate tear size, tendon retraction, muscle atrophy, and fatty infiltration as these factors are associated with reparability.

Tear Size and Retraction

It should be recognized that tear size is a dynamic variable as small tears have been shown to increase in size over time [13, 58]. Also, in general, the size of tears generally increases with patient age [15]. Surgeons can reliably differentiate partial from full-thickness tears on advanced imaging but cannot reliably measure the size of full-thickness tears in millimeters. A study by Kuhn et al. [59] demonstrated that agreement among surgeons is poor when trying to measure full-thickness rotator cuff tear size on MRI. They suggest cuff tear size is best assessed by the anatomic level of retraction (i.e., adjacent to the footprint, at the level of the humeral head, and at the level of the glenoid) as described by Patte [60].

Maman et al. [58] performed an MRI follow-up study on patients treated conservatively for rotator cuff disease. He noted progression of tears was associated with advanced age, full-thickness tears, and fatty infiltration of rotator cuff musculature. Large tears have classically been demonstrated to be a negative predictor of outcome in patients treated without surgery [61]. This finding was contradicted by data from the MOON cohort [41] who showed increased tear size and retraction were not associated with failure of a physical therapy program.

The size of the rotator cuff tear has been demonstrated to correlate strongly with patient outcome after surgical repair [15, 16, 19, 36, 62]. Cofield et al. [15] evaluated 105 patients at a mean of 13.4 years after rotator cuff repair. They determined increased size of the tear at the time of treatment was associated with worse postoperative motion, strength, and patient satisfaction score. Reoperations were also higher in patients with larger tears during the follow-up period. Massive tears with significant retraction may be more challenging to repair, and some may be deemed irreparable. However, with contemporary arthroscopic techniques, all but the most retracted and atrophic tears can at least be repaired partially.

Muscle Atrophy and Fatty Infiltration

Muscle bodies of the rotator cuff commonly degenerate after their associated tendons tear and detach. This muscle degeneration is characterized by decrease in volume (atrophy) and fatty infiltration [35, 50, 63]. Coleman et al. [64] observed a 12-fold increase in intramuscular fat content after simulated full-thickness rotator cuff injury in a sheep model. Atrophy of the rotator cuff musculature at the time of presentation has been associated with worse pretreatment pain and function measured by the Western Ontario Rotator Cuff (WORC) Index and the American Shoulder and Elbow Surgeons (ASES) scores [65]. These MRI findings, however, do not seem to predict failure of conservative management [41]. The presence of fatty infiltration has been associated with decreased rates of tendon healing after surgery; however, they are not associated with worse postoperative subjective outcomes [66–68].

Nonoperative Treatment

The primary indication for operative management of rotator cuff tears is failure of nonoperative management. Physical therapy has been demonstrated to be effective in 67–83 % of patients with atraumatic symptomatic rotator cuff pathology [40, 69, 70]. Data from the MOON cohort [40] suggests physical therapy is effective in managing up to 75 % of full-thickness atraumatic rotator cuff tears. They also demonstrated patients who failed nonoperative management tended to do so in the first 12 weeks of their physical therapy program. In a retrospective review of 616 patients, Morrison et al. [69] found that 67 % of partial-thickness tears were treated successfully with physical therapy.

In contrast, Moosmayer et al. [70] performed a controlled trial of 103 patients randomized to either physical therapy (PT) of rotator cuff repair. They determined that operative repair resulted in superior constant scores, ASES scores, improved pain-free abduction, and overall reduction in pain as compared to treatment with PT. Interestingly, only 9 of the 51 (17 %) patients randomized to physical therapy in their study failed nonoperative treatment and elected to undergo surgical repair [70] (Figs. 16.1 and 16.2).

Data from the MOON cohort [41] suggests patient expectations regarding physical therapy are the strongest predictor of nonoperative management failure. In other words if the patient believes therapy will work for them, then it probably will. If the patient does not think therapy will help them then it likely will not. Furthermore, they identified younger age, higher activity level, and abstinence from smoking as independent factors that predict failure of physical therapy programs for treatment of symptomatic full-thickness rotator cuff tears. Nonetheless, 6–12 weeks of a structured physical therapy program should be generally prescribed prior to offering surgery for patients with atraumatic, symptomatic, full-thickness rotator cuff tears.

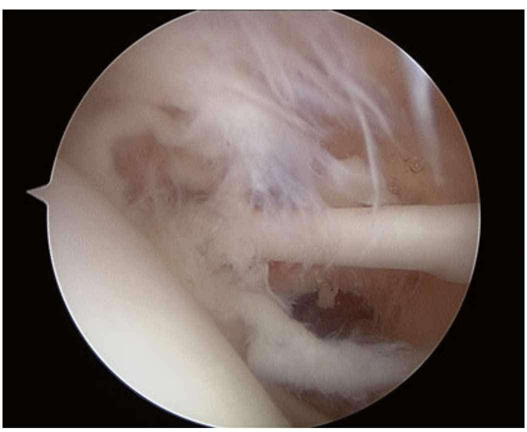

Fig. 16.1 Intra-articular view of a partial-thickness rotator cuff tear with significant intra-articular fraying

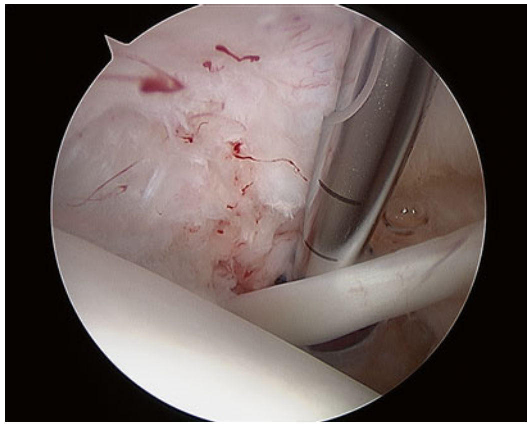

Fig. 16.2 Intra-articular view of a partial-thickness rotator cuff tear after debridement

It should be recognized that the MOON cohort [40, 41] excluded acute and traumatic rotator cuff tears. Conservative management likely has a limited role in these patients. As mentioned, there is evidence that patients surgically treated within 3 months of an acute injury [34] have improved outcomes; some even advocate repair within 3 weeks of injury [29, 31]. Physical therapy, therefore, should have a limited role in the preoperative treatment of acute rotator cuff tears from traumatic events. A proposed treatment algorithm for management is displayed in Fig. 16.3.

Partial-Thickness Tears

Operative management of partial-thickness rotator cuff tears is controversial. Management options for partial-thickness tears that fail physical

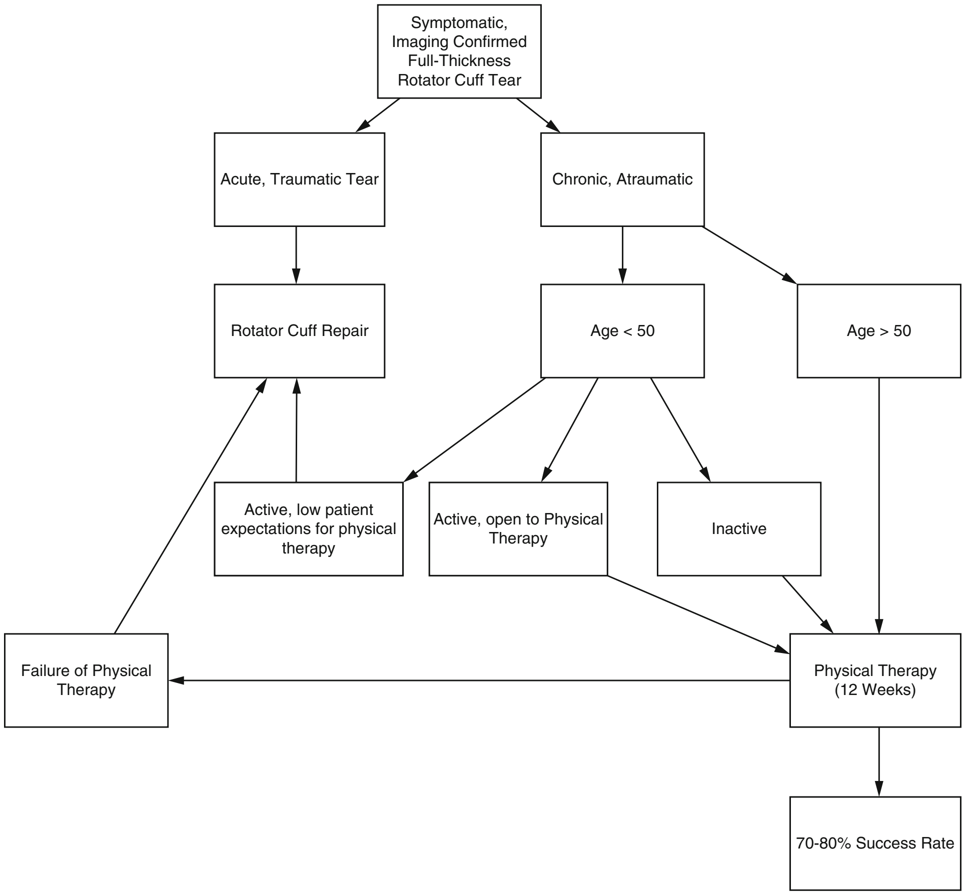

Fig. 16.3 A proposed treatment algorithm for patients with imaging-confirmed, full-thickness rotator cuff tears

therapy include tendon debridement, acromioplasty, and excision with repair. In general, symptomatic partial-thickness tears in patients that fail conservative management may be offered surgical intervention which can include debridement or repair depending on tear depth.

Partial-thickness rotator cuff tears involving more than 50 % of the affected tendon are often offered tear completion and subsequent repair. Dugas et al. [71] studied the insertional anatomy of the rotator cuff in 20 cadaveric shoulders. They determined that the mean medial-lateral diameter of the supraspinatus insertion is 14.7 mm. Symptomatic high-grade partial-thickness rotator cuff tears (defects >5–7 mm) who fail conservative treatment may be offered tear completion and repair with good expected results. There is evidence that symptomatic partial-thickness tears involving >50 % of the tendons are best treated with conversion to a full-thickness tear and repair [72, 73]. Webber et al. [72] compared 32 patients with partial-thickness RTC tears treated with debridement compared to 33 patients treated with conversion to full-thickness tears followed by repair. All tears in their series involved >50 % of the affected tendon defined by a >6 mm RTC defect; they found reoperation to be significantly higher in patients who underwent debridement alone. They also reported higher UCLA scores in patients treated with repair of partial rotator cuff tears compared to those treated with debridement. Bursal-sided tears may be resistant to nonoperative care and subacromial decompression alone [74]. Kim et al. [75] reported similar outcomes in patients undergoing repair of bursal- and articular-sided

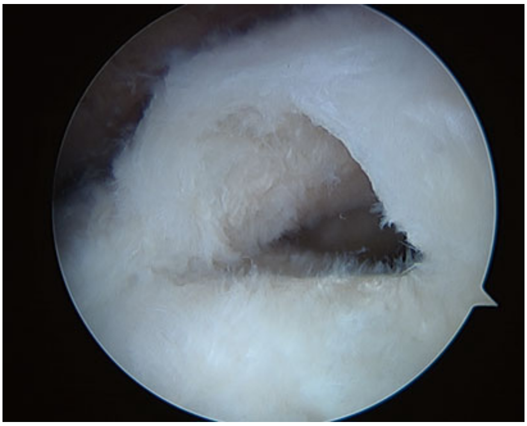

Fig. 16.4 Full-thickness rotator cuff tear

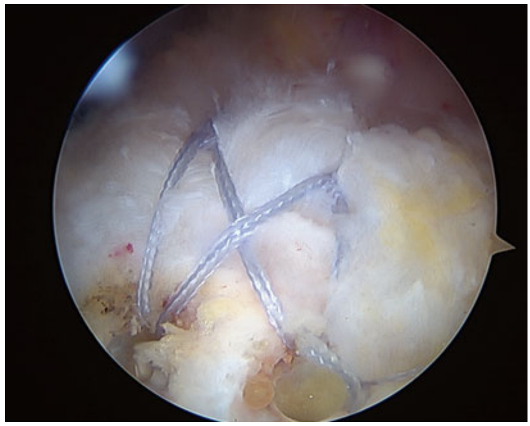

Fig. 16.5 Full-thickness rotator cuff tear status postrepair

partial-thickness tears at a mean follow-up of 36 months. Other techniques have also been described for repair of partial-thickness tears. These include transtendinous PASTA (partial articular-sided tendon avulsion) repair [76] and the all-inside articular-sided rotator cuff repair as described by Spencer [77]. The indications for repair using these other techniques are the same as described above for completion and repair of the tear, and no real data exists demonstrating superiority of one technique over another.

Partial rotator cuff tears that effect <50 % of the tendon may be offered debridement if conservative management fails [78, 79]. Partial-thickness tears result in significant intra-articular fraying that can irritate the glenoid labrum or the long head of biceps tendon with shoulder motion. This is not an uncommon scenario in young active/athletic patients with partial rotator cuff injuries (Figs. 16.4 and 16.5). Debridement of partial-thickness rotator cuff tears in elite throwers has been demonstrated to have good results in 75 % of patients including returning to competitive pitching [80]. Repair of partial-thickness rotator cuff tears in the throwing athlete is rarely indicated as shoulder stiffness may ensue [79]. Patients with partial-thickness rotator cuff tears involving <5–7 mm of the tendon footprint who fail physical therapy may be offered debridement; careful inspection and possible repair of other intra-articular structures in the throwing athlete may also be indicated.

Summary

The indications for rotator cuff repair are still evolving. The prevalence of cuff pathology in asymptomatic patients suggests that many patients can do well without surgery. In addition, the body of evidence is improving regarding indications for surgery. Factors such as patient activity level and patient expectations have been proven to be important considerations for recommending treatment. The rimportance of structural factors such as size of tear and characteristics on MRI remains controversial and requires more investigation.

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