Review Article

Degenerative Rotator Cuff Tears: Refining Surgical Indications Based on Natural History Data

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Abstract

Degenerative rotator cuff tears are the most common cause of shoulder pain and have a strong association with advanced aging. Considerable variation exists in surgeons' perceptions on the recommended treatment of patients with painful rotator cuff tears. Natural history studies have better outlined the risks of tear enlargement, progression of muscle degeneration, and decline in the function over time. This information combined with the known factors potentially influencing the rate of successful tendon healing such as age, tear size, and severity of muscle degenerative changes can be used to better refine appropriate surgical indications. Although conservative treatment can be successful in the management of many of these tears, risks to nonsurgical treatment also exist. The application of natural history data can stratify atraumatic degenerative tears according to the risk of nonsurgical treatment and better identify tears where early surgical intervention should be considered.

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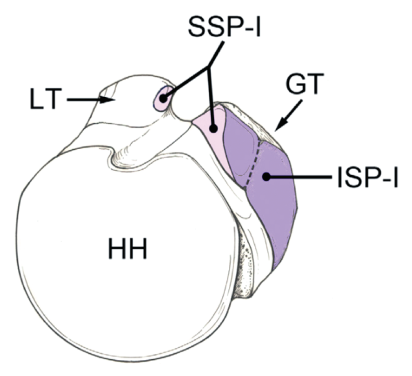
Rotator cuff disease is the most common cause of shoulder disability and is especially prevalent in the aging population.[1] Many authors suggested that rotator cuff disease is a natural aging phenomenon, given the strong association with age and the fact that most tears are asymptomatic.[2,3] Cadaveric and in vivo imaging studies have shown the rates of asymptomatic rotator cuff tears to increase proportionally with age, with 20% of patients in their sixties and up to 80% of patients older than 80 years having tears.[2] Yamaguchi et al[4] found that patients with a painful cuff tear at the age of 66 years or older have a 50% chance of having a contralateral rotator cuff tear that is often unknown to the patient. Asymptomatic tears develop pain in approximately 30% to 40% of patients within 2 to 5 years.[5-8] Additionally, male sex, dominant arm, history of heavy labor, certain acromial characteristics, and genetic factors correlate with rotator cuff tears.[9,10]

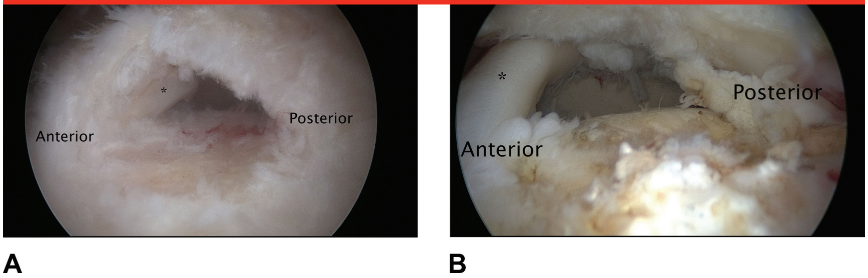
Although the natural history of degenerative rotator cuff tears has recently been better defined, many unanswered questions remain regarding the risk factors for disease progression, in particular pain development. Natural history studies are fundamental for developing appropriate treatment algorithms. Despite the high prevalence of rotator cuff pathology, substantial controversy exists regarding the optimal management of symptomatic rotator cuff disease.[11] Trends in nonsurgical management and rotator cuff repair have varied markedly over time.[12] Further complicating the matters, the symptom duration does not correlate

Figure 1



Insertional rotator cuff anatomy according to Mochizuki in an illustration of the superior right proximal humerus. GT = greater tuberosity, HH = humeral head, ISP-I = infraspinatus insertion, LT = lesser tuberosity, SSP-I = supraspinatus insertion. (Reproduced with permission from Mochizuki, T, Sugaya, H, Uomizu, M, et al: Humeral insertion of the supraspinatus and infraspinatus: New anatomical findings regarding the footprint of the rotator cuff. *J Bone Joint Surg Am* 2008;90: 962-969.)

Figure 2



A, Anterior cable intact tear. Typical appearance of degenerative rotator cuff tear. Tear involves the supraspinatus and anterior infraspinatus within the rotator crescent. The anterior attachment of the supraspinatus is intact, preventing severe retraction of the supraspinatus tendon. * = biceps tendon. **B**, Anterior cable disrupted tear. This degenerative cuff tear involves the anterior supraspinatus tendon uncovering the biceps tendon. More severe retraction of the supraspinatus muscle is seen. * = biceps tendon.

with the rotator cuff tear severity or other patient factors.[13] Clinical guidelines provided by the American Academy of Orthopaedic Surgeons on the management of rotator cuff disease are largely weak or inconclusive because of lack of high-quality evidence. Their recommendations highlight the need for further research to better define the natural history of rotator cuff disease and the results of both surgical and nonsurgical intervention to further refine treatment recommendations.[14]

Tear Characteristics—Degenerative Cuff Disease

The insertional anatomy of the rotator cuff must be considered when discussing degenerative rotator cuff tears. Mochizuki et al[15] showed that the supraspinatus footprint on the greater tuberosity was much smaller than previously thought. The insertion extends a mean of 12.6 mm in the anterior to posterior direction into a tapered insertion that is much smaller laterally than medially. The infraspinatus tendon curves anteriorly covering a mean of 32.7 mm of the superior and posterior greater tuberosity in the sagittal plan (Figure 1). Previous studies of the infraspinatus tendon footprint cited a range of 16 to 29 mm in the anterior to posterior dimension. Mochizuki et al highlighted the morphology of infraspinatus tendon as curving superiorly onto the greater tuberosity sweeping lateral the supraspinatus insertion. These findings are clinically relevant in that many tears classified as isolated to the supraspinatus tendon based on previous anatomic definitions actually also involve the infraspinatus tendon.

Degenerative rotator cuff tears develop from age-related changes that may be directly related to the poor vascularity of the rotator crescent. Along a continuum, tears likely progress from tendinopathy to partial to full-thickness tears over time. Previous theories suggesting that degenerative tears begin at the anterior supraspinatus tendon insertion adjacent to the biceps tendon have been challenged by prospective research. Kim et al[16] mapped the common locations of asymptomatic and symptomatic full-thickness degenerative cuff tears in 272 patients using ultrasonography, measuring the distance from the anterior tear margin to the biceps tendon. Only 33% of tears involved the most anterior aspect of the supraspinatus tendon (Figure 2). The most common location of tears involved an area 13 to 17 mm posterior to the biceps tendon. Small full-thickness tears most commonly involved an area 15 mm posterior to the biceps tendon, suggesting that degenerative tears most commonly originate here. This region correlates with the infraspinatus and supraspinatus junction commonly described as the rotator crescent that is bordered by the rotator cable.[15] Isolated small- and medium-sized tears with or without disruption of the anterior supraspinatus tendon were compared by Namdari et al.[17] They found that anterior supraspinatus disrupted tears had a larger tear size and possessed greater supraspinatus muscle degeneration. However, no differences in baseline or postsurgical functional outcomes (ASES; 92 versus 93) or healing rates (93% versus 86%) for anterior supraspinatus intact versus disrupted tears were seen.[17]

Disruption of the rotator cuff tendon is felt to lead to muscular fatty infiltration (FI) and atrophy, secondary to tendon retraction and impaired force transmission. Rotator cuff tear size and location are directly related to the patterns of fatty muscle degeneration. Kim et al[18] demonstrated that fatty degeneration was nearly exclusive to full-thickness tears. Thirty-five percent of the shoulders had evidence of fatty degeneration on ultrasonography, and tears with fatty degeneration had a greater width and length than those without. In this cohort, disruption of the anterior supraspinatus insertion (anterior cable) was the most important predictor of supraspinatus muscle degeneration, whereas larger tear size was the best predictor of infraspinatus muscle degeneration.

Natural History

Tear Enlargement and Pain Progression

Defining the risks of tear progression and symptom development is critical in developing treatment algorithms and can be best understood by looking at natural history studies. The natural history of degenerative rotator cuff tears has been recently defined in asymptomatic patients followed prospectively. Given that rotator cuff disease is often bilateral, screening the contralateral shoulder in patients with a painful rotator cuff tear provides a valuable study group where no treatment intervention is needed.[4,19] Keener et al[5] examined the risks of cuff tear enlargement and pain development in 224 asymptomatic shoulders with known full-thickness tears (118), partial-thickness tears (56), and intact rotator cuffs (50) followed annually with ultrasonography and clinical examination (Table 1). At 5 years of follow-up, the risk of tear enlargement of 5 mm or greater was 49%. Tear severity (full thickness versus partial thickness) and hand dominance were associated with a greater enlargement risks; however, subject age, sex, and baseline tear size were not. The risks of tear enlargement at 2 and 5 years were 22% and 50%, respectively, for full-thickness tears and 11% and 35%, respectively, for partial-thickness tears. This data suggest that although tear progression is common, the timeline is relatively slow. Keener et al[20] investigated tear progression in anterior supraspinatus intact compared with that in disrupted tears in 139 patients with minimum 2-year follow-up. They found no statistical difference in the risk of enlargement, time to enlargement, or magnitude of enlargement between groups. However, a trend exists towards greater enlargement risks in the cable-disrupted tears (67% vs. 52%, $P = 0.09$) versus intact tears.

The factors important for pain development in shoulders with asymptomatic tears are not clearly defined.[21] Interestingly, in patients presenting with a painful rotator cuff tear, disease severity does not correlate well with VAS pain scores. Both Mall et al[19] and Keener et al[20] have prospectively demonstrated that tear enlargement is a risk factor for pain development; however, absolute correlations do not exist. In the study by Keener et al,[20] 46% of asymptomatic shoulders developed pain over a 5-year period. Although the risk of pain development was approximately 70% more likely if enlargement occurred, 37% of the newly painful shoulders did not enlarge and 38% of enlarged tears remained asymptomatic. Pain development was associated with clinically notable decline in shoulder function. There are clearly factors other than tear enlargement that play a role in pain development in shoulders with degenerative tears, and it is important to remember that other potential pain generators may play a role in symptom onset.

Multiple other studies with variable methodologies have attempted to define the tear enlargement risks in both asymptomatic and painful shoulders. Moosmayer et al[6] prospectively followed 50 full-thickness degenerative rotator cuff tears for 3 years and showed that symptoms developed in 36% of patients. The symptomatic group had a larger increase in tear size, a greater progression of muscle degeneration, and more frequent biceps pathology on follow-up imaging compared with the asymptomatic group. In patients with symptomatic full-thickness tears managed nonsurgically, using ultrasonography, Safran et al[7] demonstrated that 49% of tears increased in size within 2 years. The only variable associated with increased pain was tear enlargement at the time of follow-up. Using MRI, Maman et al[8] retrospectively reviewed 59 patients with rotator cuff tears, with imaging a different time points. They found that age greater than 60 years, full-thickness tears, and FI were all associated with tear progression. Tear enlargement occurred in 19% at 18 months and at 48% with follow-up beyond 18 months. Moosmayer et al[22] reported the findings of a selected subgroup of 49 subjects with small- and medium-sized full-thickness tears, who were followed for a mean of 8.8 years and managed nonsurgically. The authors excluded 23 shoulders requiring surgery during the study period. This study demonstrated great variability in the magnitude of tear enlargement (mean tear width increase was 8.3 mm). One-third of the tears increased greater than 10 mm (half of these were greater than 20 mm). Progression of degenerative muscle changes was noted in half the subjects. Shoulder function remained stable if the tear size increase was less than 10 mm. Declining ASES and Constant scores were noted with tear enlargement greater than

Table 1

Natural History Studies of Untreated Rotator Cuff Tears

Study	Study Group	Duration of F/U	Imaging Modality	Results
Moosmayer et al[6]	50 asymptomatic full-thickness tears	3 yr	Ultrasonography and MRI	36% of shoulders developed pain. Painful shoulders had greater enlargement (10.6 mm versus 3.3 mm). Increased rate of progression of advanced atrophy in the symptomatic group (35% versus 12%). Increased rate of fatty muscle degeneration in the symptomatic group (35% versus 4%).
Maman et al[8]	49 nonsurgically managed symptomatic rotator cuff tears	Minimum 6 mo, with range of 7–58 mo	MRI	F/U longer than 18 mo associated with greater tear progression (48% versus 19%). Age >60 years associated with tear progression (54% versus 17%). 24% of full-thickness tears and zero partial-thickness tears developed muscle atrophy. Risk of tear enlargement associated with the presence of fatty muscle infiltration.
Keener et al[5]	Asymptomatic patients with 118 full-thickness tears, 56 partial-thickness tears, and 50 controls	Mean 5.1 yr	Ultrasonography	46% developed pain (50% full-thickness tears, 46% partial-thickness tears, and 28% controls). Tear enlargement occurred in 61% of full-thickness tears, 44% of partial-thickness tears, and 14% of controls. Tear enlargement associated with hand dominance. Tear enlargement associated with pain development. Tear enlargement associated with cuff muscle degeneration. Tear size, age, and sex not correlated with enlargement.
Safran et al[7]	61 symptomatic full-thickness rotator cuff tears in 51 patients aged <60 yr	2-3 yr	Ultrasonography	49% of tears enlarged, 43% of tears were stable, 8% of tears decreased in size. Correlation of tear enlargement and pain development. Age, prior trauma, initial tear size. and bilateral tears were not associated with tear enlargement.
Fucentese et al[24]	24 symptomatic full-thickness rotator cuff tears in patients aged <65 yr who declined surgery	Mean 42 mo	Initial MR arthrogram, F/U MRI	Mean Constant score was 75 at F/U. 11 patients had no tear or smaller tear at F/U. 9 patients had no change in tear size. 6 patients (25%) had increased tear size. Progression of FI from zero to 14% of cohort, but none were advanced.

FI = fatty infiltration, F/U = follow-up

20 mm and progression of muscle degeneration.

Progression of Muscle Degeneration

It has been well recognized that larger and more chronic rotator tears are associated with a greater likelihood of advanced fatty muscle degeneration compared with smaller tears. However, the timeline for the progression of muscle degeneration and the risk factors for these changes have not been well-defined. Muscle degenerative changes are thought to be clinically relevant because they have been linked to poorer clinical outcomes and lower tendon healing rates following surgery (Figure 3). A recent report prospectively examined the risks of fatty muscle degeneration progression using ultrasonography.[23] In a cohort of 156 full-thickness tears (the majority being small or medium sized), 55% of tears had some degree of fatty muscle degeneration

Figure 3

A **B** **C**

T1-weighted parasagittal MRI images demonstrating rotator cuff muscle health. **A**, Right shoulder. All cuff muscles healthy. **B**, Right shoulder. Supraspinatus (thin arrow) with Goutallier grade II changes (fatty change noted but more muscle than fat). Infraspinatus (thick arrow) with grade III changes (equal muscle and fat). Teres minor (*) with advanced fatty infiltration. **C**, Left shoulder. Supraspinatus (thin arrow) and infraspinatus (thick arrow) with grade IV changes (more fat than muscle).

during a follow-up period of 6.0 years. The presence of muscle degeneration was linked to older age and larger tear size at baseline. Progression of muscle degeneration was more common in tears that enlarged (43% versus 20%). Progression of fatty muscle changes in enlarged tears was more common in tears that were larger at enrollment (13.0 versus 10.0 mm) and in tears with a greater magnitude of enlargement (9.0 versus 5.0 mm), and when the anterior supraspinatus was torn (53% versus 17%). Although considerable variability exists in temporal progression of muscle changes compared with enlargement events, the median time from an enlargement event to the progression of muscle degeneration was 1.0 and 1.1 years for the supraspinatus and infraspinatus, respectively.

Factors Affecting Rotator Cuff Healing

When considering surgical treatment, it is paramount to understand factors that influence rotator cuff healing. Although the correlation between successful tendon healing and clinical outcomes is debated, it is generally felt that better and more consistent clinical results are obtained following a successful tendon healing. Therefore, identification of factors that better predict and surgical strategies that improve tendon healing is important in identifying the optimal surgical candidates. Park et al[25] reported on 339 patients undergoing arthroscopic rotator cuff repair for small- and medium-sized tears. They found patient age, tear size, and FI of the cuff muscles to be important risk factors in the development of recurrent rotator cuff tears. Multiple other studies have consistently shown that patient age, tear size, and fatty muscle infiltration are key factors in predicting tendon healing following rotator cuff repair.

Patient age plays an important role in cuff tendon healing following surgery. Early literature from Harryman et al[26] revealed a strong correlation with rotator cuff healing and patient age, with older patients more likely demonstrating recurrent defects. Boileau et al[27] reviewed the healing rates and functional outcome of 65 consecutive patients with full-thickness tears treated with arthroscopic cuff repair. They reported complete healing in 71% of patients, noting age to be strongly correlated with tendon healing. Patients with a healed repair were on average 10 years younger (57.8 ± 9.4 years) than those with a failed repair (68 ± 7.6 years). Furthermore, for patients younger than 55 years, the healing rate was 95%, and for patients older than 65 years the healing rate dropped to 43%.[27] Oh et al[28] reported on 187 patients undergoing arthroscopic or mini-open rotator cuff repair with a minimum follow-up of 1 year. The average age of patients with an intact repair CT arthrogram was 58 years compared with 63 years for patients with a retear. They also found that tendon retraction and FI of the infraspinatus were risk factors for poor healing. This finding highlights the influence of age and other intrinsic tear characteristics on rotator cuff healing.

In multiple studies, tear size has been shown to influence healing rates after repair. Galatz et al[29] reported on the structural integrity of large and massive rotator cuff tears after arthroscopic cuff repair. Recurrent tendon defects were identified in

94% of shoulders. Although advances in surgical techniques have improved the healing rates of arthroscopic cuff repair, tear size continues to be one of the primary determinants of successful tendon healing. Park et al[25] studied a large cohort of patients with small- to medium-sized rotator cuff tears and found that patients with tears >2 cm had a healing rate of 65% compared with a healing rate of 89% in patients with tears ≤2 cm. More recent literature from Tashjian et al[30] has shown that tear retraction plays an important role in tendon healing following repair of degenerative cuff tears. They investigated 42 patients undergoing arthroscopic rotator cuff repair and reported an overall healing rate of 86%. Tendon healing was seen in 92% of tears when the musculotendinous junction was lateral to the glenoid compared with a healing of 56% in tears with retraction of the musculotendinous junction medial to the glenoid.

Both FI and muscular atrophy are well-established risk factors influencing tendon healing following rotator cuff repair. Park et al[25] found grade 2 and higher fatty degeneration of the infraspinatus to be an independent risk factor for recurrent tears. Chung et al[31] reviewed the results of 272 patients undergoing arthroscopic cuff repair. Increased FI of the supraspinatus, infraspinatus, and subscapularis was associated with decreased tendon healing. Furthermore, with multivariate analysis, increased FI of the infraspinatus was an independent risk factor for recurrent tendon defects following repair. Kim et al[32] also found FI of the infraspinatus to be an independent risk factor for a recurrent cuff tear with multivariate analysis of 132 patients following repair of full-thickness cuff tears.

Rotator cuff tears resulting from acute injuries are thought to be more likely to heal than degenerative rotator cuff tears after surgical repair. Similar to tendon injuries elsewhere, it makes biologic sense that the healing environment is optimal in the acute setting before chronic degenerative changes have occurred. While this concept is common dogma, research supporting this notion is limited. Tan et al[33] studied the effects of recent trauma and tendon healing in 1,300 patients undergoing arthroscopic cuff repair. No notable difference was observed in the healing rates between patients who reported shoulder pain secondary to a specific event compared with tears with a more insidious pain onset. In patients reporting traumatic event, delaying surgery by more than 24 months correlated with decreased tendon healing. Other studies have demonstrated a benefit of earlier surgical management of traumatic rotator cuff tears. Petersen and Murphy[34] investigated 36 shoulders with acute rotator cuff tears and found improved functional outcomes for patients who underwent surgery in less than 4 months after injury compared with those who underwent surgery after 4 months.

Clinical Outcomes—Higher Level Evidence

Multiple prospective studies have documented excellent outcomes following surgical repair of degenerative rotator cuff tears.[35,36] More recently, several prospective randomized trials have compared surgical versus nonsurgical management of rotator cuff tears. Moosmayer et al[37] performed a randomized trial comparing physical therapy with surgical management of traumatic and degenerative rotator cuff tears. The authors originally reported the outcomes of 103 patients with a minimum follow-up of 1 year. In patients with small- to medium-sized rotator cuff tears, they found markedly greater improvements in ASES and Constant scores for the patients undergoing surgical treatment. Long-term follow-up continued to demonstrate statistically significant improvements in ASES and Constant scores for patients undergoing surgery; however, these improvements were not considered clinically relevant at 5-year follow-up because the differences failed to reach the minimal clinically important difference threshold.[38] The crossover rate increased to 24% by 2 years, with 12 of 51 patients initially randomized to physical therapy undergoing surgical repair. The authors found that 37% of the patients treated with physical therapy had greater than 5 mm increase in tear size on 5-year follow-up ultrasonography. The authors supported an initial trial of physical therapy for small- to medium-sized rotator cuff tears; however, they cautioned that without surgery, many tears have an increased risk of enlargement and decreased function.

Kukkonen et al[39] performed a randomized controlled trial comparing the outcomes of physical therapy, acromioplasty and physical therapy, or rotator cuff repair for 160 patients with full-thickness, degenerative rotator cuff tears. They found no notable difference in the functional scores or patient satisfaction between groups at 2 years. The authors recommend physical therapy as the preferred initial treatment for isolated supraspinatus tears, with a caveat that many tears treated without repair increase in size at short-term follow-up. Lambers Heerspink et al[40] conducted a prospective randomized trial investigating surgical versus nonsurgical treatment in 56 patients with degenerative rotator cuff tears. At 1-year follow-up, a notable improvement was observed in VAS pain scores for patients treated with cuff repair; however, no notable difference was seen in Constant scores between groups. A subgroup analysis of healing data within revealed that patients with intact repairs demonstrated notable

Table 2

Treatment Recommendations Based on Patient and Tear Characteristics

Risks of Tear Enlargement/ Muscle Degeneration Progression	Patient and Tear Characteristics	Treatment Recommendation
Low risk	Partial-thickness tears Large tears with advanced muscle changes Degenerative tears in patients aged >65–70 yr Atraumatic full-thickness tears less than 15 mm in size with an intact anterior cable	Maximize conservative treatment, surgery if persistently asymptomatic.
Medium risk	Age under 62-65 years Atraumatic full-thickness tears >15 mm Anterior cable disruption Acute on chronic tears–preserved function	Informed discussion of surgical and nonsurgical options warranted. Consider surveillance exams with successful conservative treatment.
High risk	Acute traumatic full-thickness tears Acute on chronic tears with new pseudoparalysis or profound external rotation weakness Minimal muscle degenerative changes Age compatible with healing	Strong consideration for early surgical repair.

improvements in pain and functional outcome compared with patients treated nonsurgically.

Although these studies suggest an advantage of surgery over conservative management of rotator cuff tears at short-term follow-up when patients are randomized at baseline presentation, the magnitude of the clinical relevance of these findings is challenged by defined minimal clinically important difference thresholds. Importantly, these studies do not make a distinction between tears with varying risk factors for progression and do not adequately address the potential downsides of nonsurgical treatment over time. These include the tear enlargement risks, degenerative muscle change progression, and the subsequent deleterious effects of cuff repair healing seen with advancing age.

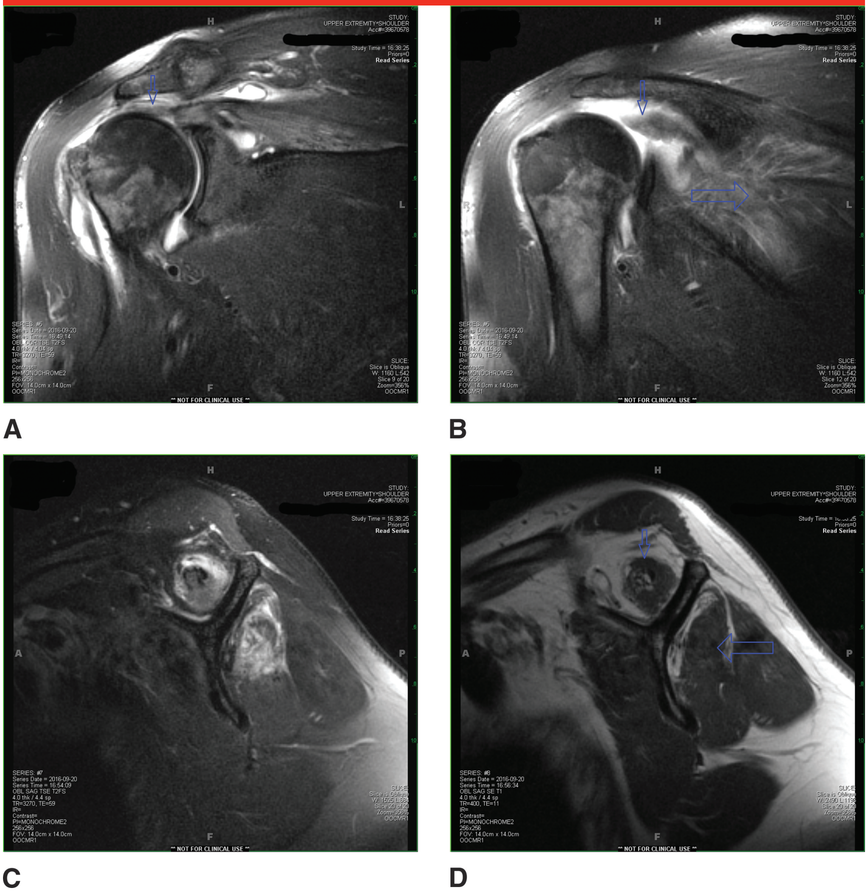
Redefining Surgical Indications Based on Natural History Data

Informed decision making for the management of degenerative rotator cuff tears should entail a complete discussion of the risks and benefits of both surgical and nonsurgical treatment. Conservative treatment is a well-accepted treatment method for atraumatic full-thickness rotator cuff tears in the short term.[41] In many patients with notable medical comorbidities or advanced age, this may well be the preferred treatment. However, we are faced with a challenge when deciding the best treatment for younger patients with full-thickness tears that possess a high likelihood of disease progression. Natural history studies have better clarified tears with a higher risk of progression, highlighting an opportunity to refine surgical indications. Delayed surgical intervention in higher risk tears may allow tear enlargement and/or the development of irreversible muscle changes, which, when combined with the deleterious effects of aging, will decrease the rate of successful tendon healing.[42] Many studies have demonstrated both increased tear size and progression of muscle degeneration within 2 years. Additionally, Chalmers et al[43] have documented increased radiographic progression of arthritic changes in patients with degenerative rotator cuff tears followed prospectively.

Certain tear characteristics warrant consideration for either close surveillance or recommendation for early surgical intervention. Based on the natural history data, tears can be stratified according to the short-term risks of developing features previously shown to adversely affect the healing rates and clinical outcomes of surgery (Table 2). These risks must be taken in the context of specific patient (age) and tear-related factors (size, cable integrity, and fatty muscle degeneration) already present at the time of clinical presentation. Shoulder pain severity is highly variable across tear sizes, and pain can often be managed, at least short term, conservatively. We suggest that anatomic and patient-related features that affect surgical results are better objective criteria than pain severity for consideration for early surgical intervention.

Low-risk tears include those with low risk of tear enlargement and progression of muscle degeneration or tears with poor healing capacity.

Figure 4



Acute on chronic rotator cuff tear, right shoulder. **A**, Coronal T2-weighted MRI image. Large retracted tear of the supraspinatus tendon (thin arrow). **B**, Coronal T2-weighted MRI image. Retracted and kinked infraspinatus tendon (thin arrow). Intramuscular edema noted within the infraspinatus (thick arrow). **C**, Parasagittal T2-weighted MRI image. Perimuscular edema noted within the supraspinatus and infraspinatus muscles. **D**, Parasagittal T1-weighted MRI image. Grade III Goutallier fatty changes within the supraspinatus (thin arrow). Grade I/II Goutallier fatty changes within the infraspinatus (thick arrow).

In these tears, there are lower risks of short-term tear progression or the optimal window for surgery has been missed. These include tears at both ends of the disease spectrum: partial-thickness rotator cuff tears and larger tears with advanced fatty muscle degeneration (grade III/IV Goutallier changes) and/or proximal humeral migration. Atraumatic tears in patients older than 65 to 70 years, although still reasonable surgical candidates, have a lower healing rate and consideration for initial conservative treatment is warranted. Included in this group are atraumatic full-thickness tears up to 15 mm in size with an intact anterior supraspinatus tendon and healthy muscles because the short-term risks of tear progression are relatively low. There is time to maximize conservative treatment without affecting the results of later surgery if conservative treatment fails.

Medium-risk tears include those with moderate risk of short-term tear progression in individuals with good healing capacity (age under 62-65 years). These include atraumatic full-thickness tears 15 mm or larger and tears with disruption of the anterior supraspinatus tendon, as well as previously painful shoulders with recent trauma (acute on chronic tears). These risks are amplified if there is already early fatty muscle degeneration because these tears possess a greater risk of progression of muscle degeneration over time. Acute on chronic rotator cuff tears represent a unique challenge in distinguishing whether a preexisting tear was present, and if so, how much of the tear represents acute enlargement (Figure 4). One study suggested MRI features that may distinguish acute from chronic tears.[44] Acute tears have less muscle fatty degeneration, often possessed a wavy or kinked appearing central tendon, and are often associated with perimuscular edema. The amount of tendon retraction was not reliable in distinguishing between acute and chronic tears. For medium-risk tears, an informed discussion of treatment options with the patient is warranted. Surveillance physical or imaging examinations, such as ultrasonography, should be considered to assess potential tear progression with successful conservative treatment. Patients should be counseled not to ignore an increase in shoulder weakness because this may herald tear enlargement.

High-risk tears represent those with the greatest risk of disease progression or tears that possess a high rate of tendon healing because of their acuity. In these shoulders, surgical intervention has the greatest potential to interrupt the natural history of an untreated cuff tear. Included are acute traumatic full-thickness tears, especially those 15 mm or larger, in a previously healthy shoulder. Also included are acute on chronic tears with a dramatic loss of function such as pseudoparalysis and/or profound external rotation weakness. An important consideration for these tears is the quality of the involved muscles, which should possess minimal fatty degenerative changes. Strong consideration for surgical repair is warranted for tears such as these in patients aged 65 years or younger.

Summary

In recent years, an improved knowledge of the natural history of degenerative rotator cuff tears has strengthened our understanding of this disease process. When the risks of disease progression are coupled with the known factors that influence tendon healing following rotator cuff repair, we can better refine surgical indications. The optimal management of tears must be individualized based on the clinical presentation and various patient- and tear-related factors.

References

Evidence-based Medicine: Levels of evidence are described in the table of contents. In this article, references 39 and 40 are level I studies. References 5, 6, 15, 19, 20, 23, 32, 37, 41, 43, and 44 are level II studies. References 4, 7, 8, 13, 16–18, 21, 22, 33, 34, 38, and 42 are level III studies. References 1-3, 9, 11, 12, 25–31, 35, and 36 are level IV studies.

References printed in **bold type** are those published within the past 5 years.

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