Rotator Cuff Tears in the Throwing Athlete

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Abstract: Tears of the rotator cuff, both partial, and less commonly, full thickness, are relatively common in the throwing athlete. The rotator cuff is subjected to enormous stresses during repetitive overhead activity. The supraphysiological strains, especially when combined with pathology elsewhere in the kinetic chain, can lead to compromise of the cuff fabric, most commonly on the undersurface where tensile overload occurs. Exacerbation by a tight posterior capsular, anterior instability, and internal impingement render the cuff progressively compromised, with intrinsic shear stresses and undersurface fiber failure. Advances in imaging technology, including contrast magnetic resonance imaging, dynamic ultrasound, and arthroscopic visualization have enhanced our understanding of cuff pathology in this athletic population. Unfortunately, this has not yet translated into how to best approach these athletes to return them to their previous level of activity. Nonoperative management remains the mainstay for most throwers, with arthroscopic debridement an effective surgical option for those with refractory symptoms. Despite technological advances in cuff repair in the general population, comparable outcomes have not been achieved in high-level throwers. Widespread appreciation that securing the cuff operatively will likely end an athletes' throwing career has led to adopting a surgical approach that emphasizes debridement over repair for nearly all partial and full-thickness tears. Whether advances in surgical technique will ultimately permit definitive and lasting repairs that allow overhead throwers to return to their previous level of sports remains unknown at this time.

Key Words: rotator cuff tear, partial thickness, overhead athlete, shoulder, PASTA lesion, PAINT lesion

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Rotator cuff tears have become an increasingly recognized source of pain and impairment in the overhead athlete.[1,2] Advances in radiographic and diagnostic techniques have improved our ability to detect and quantify tear extent, and advances in arthroscopic surgical techniques have led to new operative treatment strategies. However, despite improved recognition and surgical treatment, successful management of the thrower with a torn cuff remains elusive. Although debridement has proven effective in managing some overhead athletes with cuff pathology, surgical repair of significant partial and full-thickness tears has not led to predictable recovery and return to previous levels of throwing. Complicating management is the fact that partial cuff pathology is frequently accompanied by concomitant pathology, including internal impingement, SLAP lesions, and subacromial pathology. The purpose of this manuscript is to address where we are with respect to understanding the natural history, presentation, evaluation, treatment strategies, and their outcomes in overhead throwers with partial and full-thickness rotator cuff tears.

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PREVALENCE OF ROTATOR CUFF TEARS IN THROWERS

Despite a number of cadaveric, imaging, and arthroscopic studies, the true incidence of rotator cuff tears in the overhead athlete remains unclear. In a study of 20 throwers, Connor et al[1] reported partial or full-thickness cuff tears in 8 of 20 (40%) dominant shoulders, compared with none in the nondominant shoulder. Payne et al[3] reported that articular-sided tears comprised 91% of all partial-thickness tears in a cohort of young athletes. The actual prevalence of cuff tears in throwers is likely underappreciated, as many, including those with full-thickness tears, are asymptomatic.[1,4–6]

PATHOPHYSIOLOGY OF PARTIAL CUFF TEARS

Historically, rotator cuff tears were attributed to outlet impingement as initially described by Neer.[7] Today, basic science and advanced imaging technology have revealed that cuff pathology in throwing athletes is in fact multifactorial.[8–10] The repetitive nature of throwing in overhead athletes places supraphysiological loads of up to 108% of body weight[11] and humeral angular velocities upwards of 7000 degrees/s.[12] Because of the relatively avascular tendon insertion site, these loads and torques, which are accentuated during the acceleration and deceleration phases of the throwing cycle, can lead to repetitive microtrauma to the tendon insertions.[13] These forces and consequent cuff strain have been demonstrated to lead to articular surface partial-thickness cuff tears, either due to compression from internal impingement (Fig. 1)[14,15] or tensile failure from overload of the capsular articular attachment of the rotator cuff.[16,17] Several potential factors may contribute to the development of pathologic internal impingement, including repetitive microtrauma and intratendinous strain during eccentric contraction of the rotator cuff in the deceleration phase of throwing. Additional contributory factors may include subtle anterior instability with attenuation of the anterior band of the inferior glenohumeral ligament, contracture of the posterior capsular, decreased humeral retroversion, tension overload, poor throwing mechanics, and scapular muscle imbalance.[18–20] Kibler and McMullen[21] has also postulated that scapular dyskinesis and protraction of the scapula can position the posterior glenoid against the cuff and provide a mechanism for rotator cuff injury.

TYPES OF CUFF TEARS

Cuff pathology in throwers runs the spectrum from tendinosis to partial articular, bursal, and intratendinous tears, to complete detachment (Fig. 2). Partial-thickness tears of the rotator cuff have been long recognized, first

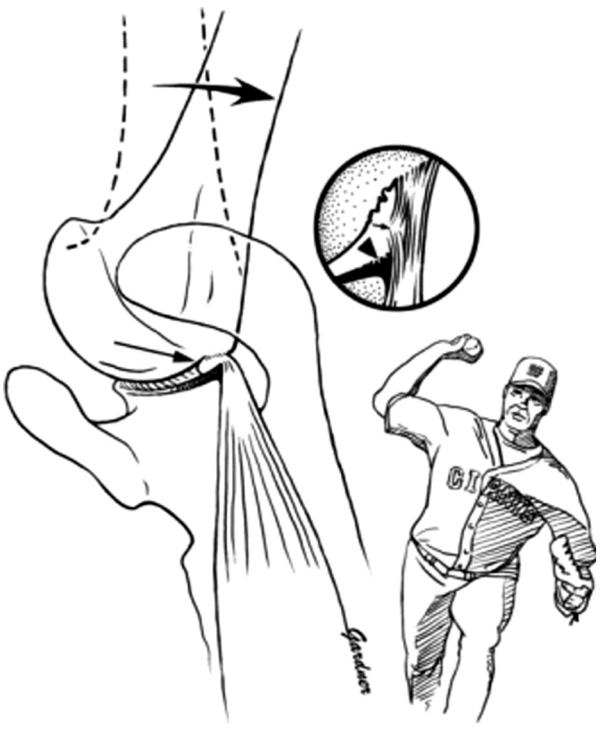

FIGURE 1. Posterosuperior impingement: diagram demonstrates impingement of the undersurface of the rotator cuff (arrow) between the labrum and adjacent humeral head that occurs during abduction and external rotation (curved arrow) as in throwing. Labral fraying (arrowhead-insert) and an undersurface rotator cuff tear (arrow-insert) may occur as a result.

described in 1934 by Codman,[22] who estimated an incidence twice that of full-thickness tears.

Articular-sided Tears

Articular-sided tears are far more common than bursal-sided tears in the overhead athlete population.[16,23–25] Tears typically occur at the posterior supraspinatus and anterior infraspinatus.[1,2,26] Articular-sided tears are probably multifactorial, due to a lower stress to failure ratio on the articular side, as well as differential anatomy, with less distinct and randomly oriented collagen bundles and strength compared with the bursal side.[7,27–30] Another possible explanation is the relative hypovascularity of the articular cuff.[27] Snyder[31] has defined partial articular supraspinatus tendon avulsions as "PASTA" lesions identifying this as a separate clinical entity.

Intratendinous Tears

Yamanaka and Fukuda[32] and Conway[2] expanded on Snyder's PASTA description by drawing attention to the commonly occurring intratendinous extension of these lesions, particularly in overhead-throwing athletes. Conway coined the term "PAINT" lesion to describe partial-thickness articular-surface tears with intratendinous extension. The rotator cuff's 5-layer histologic structure predisposes it to the development of internal shear forces.[28] Recent literature has emphasized a growing interest in the role of intratendinous strain in the pathogenesis of rotator cuff pathology.[8,10,30,33]

Bursal-sided Tears

Bursal-sided tears are more common in the middle-aged and older-aged athlete, and have long been associated with the phenomenon of subacromial impingement. These tears can occur primarily, or secondary in association with intra-articular and/or intratendinous cuff pathology.

CLASSIFICATION OF ROTATOR CUFF TEARS

Tear pattern classification is an important preoperative and intraoperative consideration. Determination of cuff tear location and extent influence treatment decision-making, and permit comparison when evaluating treatment outcomes. In the first such classification of partial cuff tears, Ellman's classification[23] includes descriptions based on tear depth: grade 1: < 3 mm deep or 25%; grade 2: 3 to 6 mm deep or 50%; grade 3: > 6 mm deep or $> 50\%$ and tear area (in mm^2). Snyder revised this classification system to include location (articular, bursal, or complete) and tear severity (0 to 4 scale, ranging from normal to > 3 cm severe cuff injury).[31]

CLINICAL PRESENTATION

Partial and even full-thickness cuff tears in athletes can be surprisingly variable in their presentation, ranging from mild discomfort and decreased throwing velocity to chronic aching pain and inability to throw. Sometimes the thrower will note the rather abrupt onset of pain, occasionally accompanied by a "pop" (suggesting possible tearing of the cuff and/or labrum), either in the absence of prior symptoms, or more commonly, as an exacerbation of previous symptoms. Other common complaints include early fatigue, decreased strength or pitch velocity, loss of pitch location, mechanical symptoms, and instability.[34]

PHYSICAL EXAMINATION

Examination of the injured shoulder in an overhead athlete can be somewhat confusing because of the frequency with which they have concomitant pathology, including posterior capsular tightness, labral fraying or tearing, and/or instability of the biceps anchor (SLAP tears). Physical examination of the rotator cuff relies on the traditional Neer and Hawkins impingement signs, though they are nonspecific.[35,36] Palpation may reveal tenderness over the supraspinatus insertion, the posterior glenohumeral joint capsule, biceps tendon, or the AC joint. All components of the cuff should be tested for pain and strength, including the supraspinatus, the infraspinatus, and the subscapularis. Kibler et al[37] has emphasized that supraspinatus strength testing requires scapula stabilization for true assessment. Examination for glenohumeral internal rotation deficit is performed in the supine position. With the scapula stabilized by one hand of the examiner (or an assistant), the shoulder is gently rotated first externally until the scapula begins to move, noting the degree of rotation. Similarly, internal rotation is measured, and the amount of rotation compared with the opposite shoulder. Typically, throwers demonstrate increased external rotation (and concomitant decreased internal rotation) in their throwing shoulder. The side-to-side total range of motion however, should be comparable. Loss of net shoulder rotation (due to decreased internal rotation) of 25 degrees or more reflects glenohumeral internal rotation deficit.[38] Finally, inspect for any asymmetry in scapular rhythm. Core

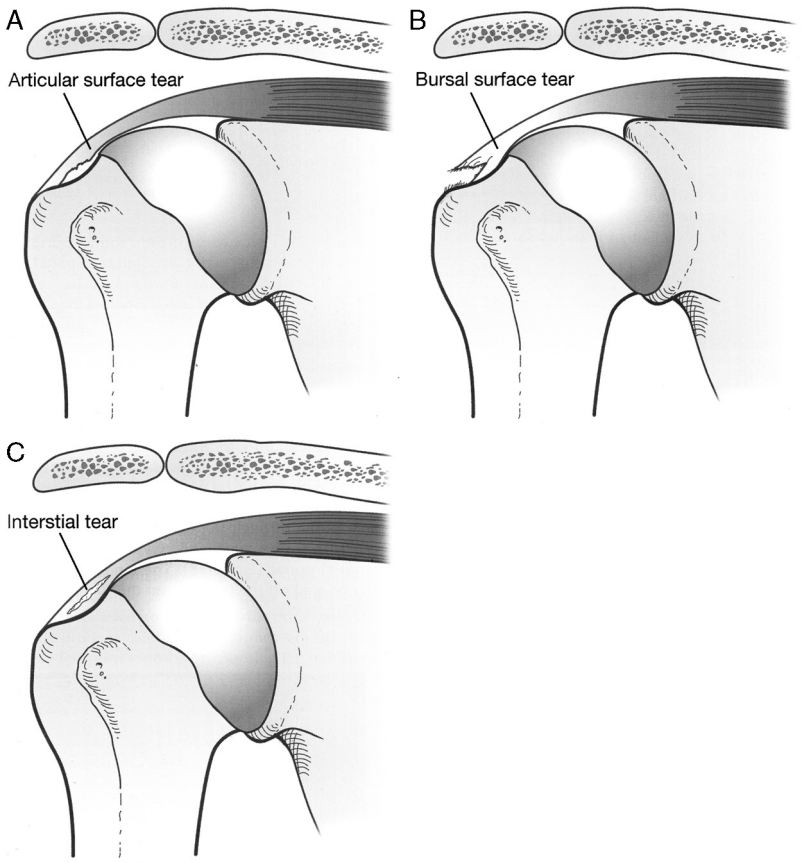

FIGURE 2. In throwers, partial tears of the rotator cuff are most commonly seen on the undersurface of the supraspinatus (A), but can also occur less commonly on the bursal surface (B), and/or within the tendon itself (C). From Burkhart et al.[76] Adaptations are themselves works protected by copyright. So in order to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.

strength and control can be assessed using the single leg squat described by Kibler.[39]

Recently, emphasis on detection of internal impingement led to the description of multiple physical examination tests, including the internal impingement sign,[40] modified relocation sign,[41] and the Internal Rotation Resistance Test.[42] However, few of these tests have been independently evaluated, and their true sensitivity and accuracy is unknown. In addition, the reliability of these maneuvers may differ among examiners.[43,44]

Finally, because concomitant pathology in throwers is common, attention must also be given to examination of the AC joint, biceps tendon long head, biceps/labral complex (for SLAP lesions), and glenohumeral joint for instability. Evaluation of the cervical spine and a thorough neurovascular examination of the upper extremity completes the examination.

IMAGING STUDIES

Plain radiographs are usually normal in the overhead athlete with shoulder pain, but several changes have been documented in those with rotator cuff tears. These include greater tuberosity sclerosis, cystic changes in the tuberosity and type II or III acromial morphology.[45] Enthesopathic findings at the greater tuberosity, including notching and cystic changes, have been associated with partial-thickness articular surface tears in throwing athletes.[46] An outlet view is important to assess acromial morphology, obligatory in those who are potential surgical candidates. Currently, the most common radiographic study of choice for evaluating the rotator cuff is magnetic resonance imaging (MRI). However, distinguishing partial cuff tears from tendinosis, and assessing the extent of cuff involvement has been traditionally difficult using conventional MRI technology[47] (Fig. 3). With the advent of MR arthrography (MRA), recognition and assessment of partial undersurface and insubstance cuff tears has been considerably enhanced.[48–51] MRA followed by obtaining sequences with the arm in an abducted/externally rotated position, is the current test of choice in the overhead athlete with shoulder pain with a suspected partial-thickness tear or labral pathology (Fig. 4).[51]

One must use caution when interpreting the significance of radiographic findings. Because despite improvements in MRI, overhead athletes often have abnormal signal abnormalities in the rotator cuff, even in the absence of symptoms. In one such study of minor league baseball players, 40% were found to have abnormalities of the rotator cuff.[1] Furthermore, recent evidence has demonstrated MRI abnormalities in pitchers after throwing, requiring up to 5 to 6 days before they "normalize" to baseline.[6,52]

FIGURE 3. In this para-coronal T2-weighted MRI of the left shoulder, signal abnormality can be appreciated within the rotator cuff supraspinatus' terminal insertion interstitially. On this image, the articular and bursal-sided cuff appear intact. From Burkhart et al.[77] Adaptations are themselves works protected by copyright. So in order to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.

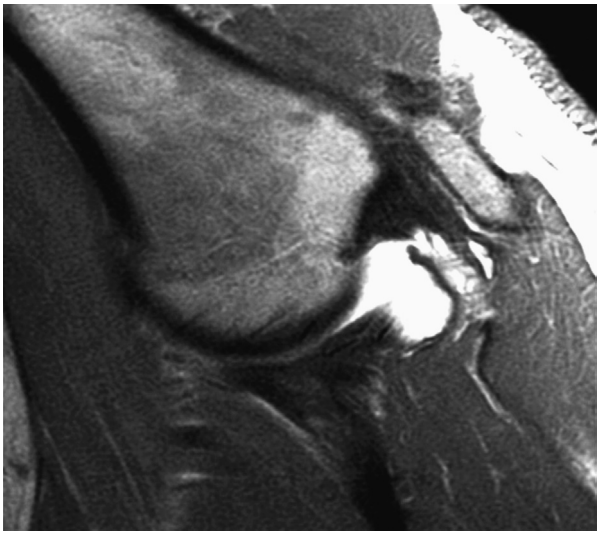

FIGURE 4. Undersurface cuff pathology in a thrower can be detected with greater sensitivity and specificity through use of intra-articular contrast and positioning the arm in abduction and external rotation (ABER sequence). Note the undersurface articular-sided tear and intratendinous extension in this partial-thickness cuff tear. From Brockmeir et al.[74] Adaptations are themselves works protected by copyright. So in order to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.

Ultrasonography, historically shown to be very sensitive and accurate in assessing the cuff, has been limited due to dependence upon operator skill and experience. Recently, availability of portable units and ability to examine both shoulders in a dynamic manner, has led to growing interest in this modality as the imaging technique of choice in rotator cuff assessment.[4,53] Ultrasound has been shown to be similar to MRI in accurately diagnosing full-thickness tears and determining the degree of retraction and dimensions of the tear.[4,53,54] Although current literature suggests that ultrasonography and MRI provide relatively similar sensitivity and specificity for the diagnosis of partial-thickness tears,[4] one significant advantage of MRI that may deserve consideration is its ability to diagnose other pathology, such as labral tears.

TREATMENT

Treatment depends upon a number of disparate factors, including the athletes' symptoms, onset, degree of impairment, response to treatment, timing with respect to season, extent of cuff pathology, and concomitant diagnoses. Treatment also depends upon understanding the natural history and classification of partial rotator cuff tears. Results of prior studies, treatments, and response to previous treatment must be incorporated into any management strategy.

Nonoperative management is the mainstay of treatment for overhead athletes with cuff pathology. This is due to the relatively high asymptomatic prevalence of cuff disease in this population, the frequent response to conservative management among those who are symptomatic, and the unfortunate current reality that surgical intervention does not assure successful resolution and return to activity.

Initial treatment of cuff pathology in an overhead athlete includes cessation from throwing ("relative" rest), a trial of nonsteroidal anti-inflammatory drugs, and a physical therapy program. Posterior capsular contractures are addressed by stretching with the arm adducted and internally rotated (sleeper stretches).[55] When pain decreases and rotator cuff strength and function improve, strengthening of the shoulder girdle and core abdominal and thoracic muscles are strengthened to restore normal scapulothoracic and trunk rotation mechanics. Restoration of proper mechanics is facilitated by a progressive interval throwing or activity program with a sport-specific and position-specific focus. On occasion we will consider subacromial corticosteroid injection.

The duration of nonoperative management varies depending upon the severity of symptoms, extent of cuff pathology, and individual player factors. Although 3 months is a reasonable period for a comprehensive program, some rehabilitation programs can take considerably longer, especially in those athletes with a full-thickness tear. Nonoperative management of partial-thickness cuff tears (and even some full-thickness tears) is thought to be fairly effective for most throwers, despite a paucity of outcome data in the literature.

OPERATIVE MANAGEMENT

Overhead athletes with partial or full-thickness cuff tears that have failed nonoperative management may be

candidates for surgical intervention. However, operative treatment is pursued only with the candid and sobering realization that surgery, especially cuff repair, does not often afford a return to the same level of activity.[3,34,56,57] This has been reinforced in a recent study in which only 57% of high-level throwing athletes undergoing arthroscopic SLAP repairs were able to return to their previous level activity. In this study of 23 elite overhead athletes, Neri et al[68] found a direct correlation between failure to return and the presence of partial cuff tears. For these reasons, nonoperative treatment should be exhausted before undertaking surgical management. The threshold for repairing partial-thickness cuff tears is higher for throwers compared with the nonthrowing population.

Surgical alternatives for treating partial cuff tears include arthroscopic cuff debridement and/or repair. In addition, we will perform a subacromial decompression and/or labral debridement or repair, as necessary. Such decisions may be anticipated before surgery, but are usually determined at the time of arthroscopy, and are influenced by factors such as the patient age, tissue quality, estimated tear depth, presence of additional pathology, and surgeon experience. We generally consider repairing partial tears that exceed 75% of the tendons' thickness in overhead athletes.

ARTHROSCOPIC DEBRIDEMENT

Arthroscopic debridement is important to remove unstable flaps, smooth irregular edges, and permit assessment of the tear depth and extent. Articular-sided cuff tears are addressed using a motorized shaver to remove pathologic tissue back to a healthy stable margin. When present, intratendinous pathology (ie, PAINT lesion) is debrided to remove unhealthy tissue and to enhance a healing response in the delaminated layers. After articular-sided tear debridement, a spinal needle is used to percutaneously pass a monofilament marking suture into the cuff defect before withdrawing the scope from the glenohumeral joint. This suture will facilitate assessment of the cuff on the corresponding bursal side. The subacromial space is examined to assess integrity of the bursal side of the cuff and for subacromial impingement.

Outcome following arthroscopic debridement of partial cuff tears up to 50% thickness in nonthrowers has been well documented, and is generally favorable.[31,58–61] Few series, however, have examined the outcomes after debridement in throwers. Payne et al[3] reported on 40 athletes (75% overhead), with partial tears who underwent arthroscopic debridement and subacromial decompression. They reported an 86% satisfactory outcome with acute, traumatic injuries and a 64% rate of return to preinjury athletic activity. Those with insidious onset of pain from a partial-thickness tear were less successful, with only a 66% satisfactory outcome and a 45% rate of return to preinjury athletic activity. Andrews et al[61] reported 85% good-to-excellent with debridement of partial-thickness tears in 34 overhead athletes at an average of 13 months follow-up. However, all patients in this study had labral pathology as well, and 25% had biceps pathology. Reynolds et al[62] reported positive outcomes on the debridement of small partial-thickness rotator cuff tears in overhead athletes. In their study of 67 pitchers, 76% were able to return to pitching at a professional level and 55% returned to at least the same level of competition.

Surgical Repair

Suboptimal outcomes after debridement, concern about tear progression, and advances in arthroscopic repair techniques have led to the growing perception that partial cuff tears ought to be repaired more frequently. Current recommendations in the general population are to debride tears $< 50\%$ of the cuff's thickness, and repair those exceeding 50%. Although this approach is largely empiric, some biomechanical rationale has been established by Mazzocca et al,[10] in which cuff tissue in proximity to partial tears demonstrated increased pathologic loading when the tear exceeded 50% thickness. Recommendations to debride or repair based on the extent of partial tearing depends upon accurate estimate of tear depth. Yet, currently there is no direct technique by which such determination can be reproducibly made. Spencer and colleagues have shown that when estimating depth of partial-thickness cuff tears, interobserver agreement was poor, at only 0.44.[63]

Clinical results have varied depending upon the repair technique and the cohort on whom it has been applied. Overhead athletes in particular have not shown uniformly good results after repair.[64–66] Other coexistent pathology may also influence the decision to do a repair. The decision may also be influenced by the athlete's age and position. For example, an older pitcher (over age 30) with a significant partial-thickness cuff tear is better served by debridement alone, when compared with a younger pitcher or position player, in whom repair may be a more important consideration given his career horizon. The older player has already proven he is a "survivor."

Partial-thickness cuff tears exceeding 75% of their thickness, and full-thickness cuff tears, may be considered for repair when they have failed nonoperative treatment or arthroscopic debridement. Recommendations for arthroscopic (rather than open) rotator cuff repair are based on the perception that arthroscopic repair has a lower risk of stiffness, and perhaps an ability to more anatomically recreate the cuff footprint, both advantages in the overhead athlete. Transosseous equivalent double row repairs have been shown to have increased strength, resistance to cyclic and rotational loading, and improved footprint coverage compared with single-row techniques.[51,69] However, data with respect to return to throwing activity is sparse in the literature, with the most recent study of pitchers undergoing miniopen cuff repair using a transosseous technique having only a 12% chance of return to baseball.[34] Advances in arthroscopic repair technology have probably lowered our threshold for repairing cuffs in nonthrowers, but the clinical outcomes and return to activity results have raised our threshold for repair in the throwing population.

Repair Techniques

Full-thickness cuff tears can be repaired using either single or dual row techniques, either arthroscopically or by a miniopen approach. When treating partial tears however, repairs can be performed by either a transtendinous approach (Fig. 5)[69] or by completing the partial to a full-thickness tear and repairing it accordingly.

A number of surgical techniques have been described for repairing partial tears. The technique chosen is influenced by tear location and/or surgeon preference. Several recent articles have described techniques by which partial-thickness bursal tears can be repaired arthroscopically.[69,70] Bursal-sided partial-thickness tears are usually completed to full-thickness tears, and repaired using suture anchors

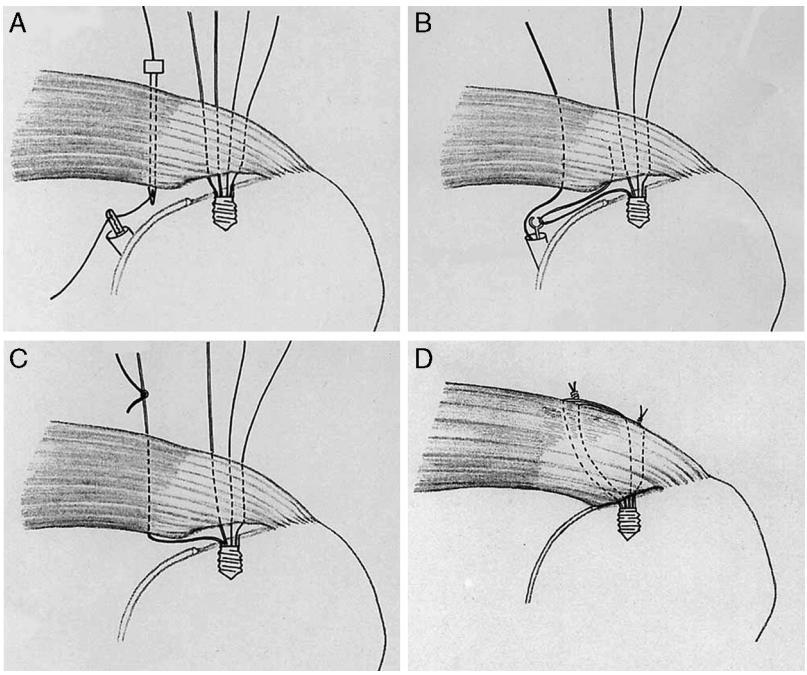

FIGURE 5. Significant partial-thickness undersurface cuff tears may be fixed using a "transtendinous" approach, in which suture anchors are used to reapproximate the articular tear, while preserving the bursal-sided cuff integrity. In (A), a suture anchor has been placed percutaneously into the cuff footprint. In (B and C) a spinal needle is used to shuttle through monofilament suture and retrograde shuttle out the anchor's permanent sutures. In (D) the sutures are tied in the subacromial space on the bursal side of the cuff, reapproximating the tendon to its' footprint. From Ide et al.[75] Adaptations are themselves works protected by copyright. So in order to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.

arthroscopically or by miniopen repair technique. Articular-sided defects can also be completed and repaired as a full-thickness tear, or repaired by a "transtendon" technique in which the articular-side fibers are advanced and repaired toward their anatomic footprint. Intratendinous tears may be reapproximated by suture plication of the delaminated layers, and may also be advanced to the footprint using suture anchors. However, unlike their nonathletic counterparts, recreating an attachment at the anatomic footprint may constrain the shoulder and prevent the thrower from getting into the hyperabducted and externally rotated position, effectively compromising their ability to effectively throw.

Preliminary results of arthroscopic repair for partial-thickness tears in the general population are promising.[31,69,71,72] Although encouraging, it is worth pointing out that these studies have not assessed outcome in high-level overhead athletes, and one must exercise caution in extrapolating results to this population. The few studies in which partial-thickness cuff tears have been repaired in throwers reinforce this message. In one such study comparing debridement to arthroscopic repair of high-grade partial tears, Kim[65] found that overhead athletes with higher grade partial tears actually had better outcomes if repaired compared with debridement. Yet they found that even in the 10 patients undergoing repair for full-thickness tears, 7 had a satisfactory ASES score, but return to activity was only 73%. In another study, Van Kleunen and colleagues found that only 35% of a group of 17 high-level baseball players undergoing repair for partial-thickness tears exceeding 50% were able to return to their previous level. However, this was a level IV study in which the cohort also underwent SLAP repair and posterior capsular release.[66] Brockmeier et al[73] presented their technique of arthroscopic intratendinous repair for delaminated partial-thickness tears in high-level overhead athletes (Fig. 6). At early follow-up of 5 months, the authors noted encouraging early results but reported that longer term follow-up was necessary.

Repairs of Full-thickness Tears

Few studies exist on the treatment of full-thickness tears in overhead athletes. Tibone et al[56] in 1986 reported on 45 patients with rotator cuff tears in which 15 were full thickness. All patients underwent an acromioplasty and cuff repair. Overall, 56% of the patients were rated as having a good result permitting them to return to their previous competitive level. Only 41% of pitchers and throwers returned to their previous status, and only 32% of those who competed at a professional or collegiate level returned to play at the same level. Seventy-seven percent of their patients noted difficulty with overhead activities, including a loss of velocity and endurance. Of the 5 professional pitchers in this study, only 2 returned to the professional level. And in the most recent sobering outcome study, Mazoué and Andrews[34] evaluated the results of miniopen rotator cuff repair for full-thickness tears in 16 professional baseball players (12 pitchers) at an average of 67-month follow-up. They found that only 2 players (1 pitcher and 1 position player) with repairs of their dominant shoulder were able to return to a high competitive level of baseball. They concluded that it is very difficult to return a pitcher to

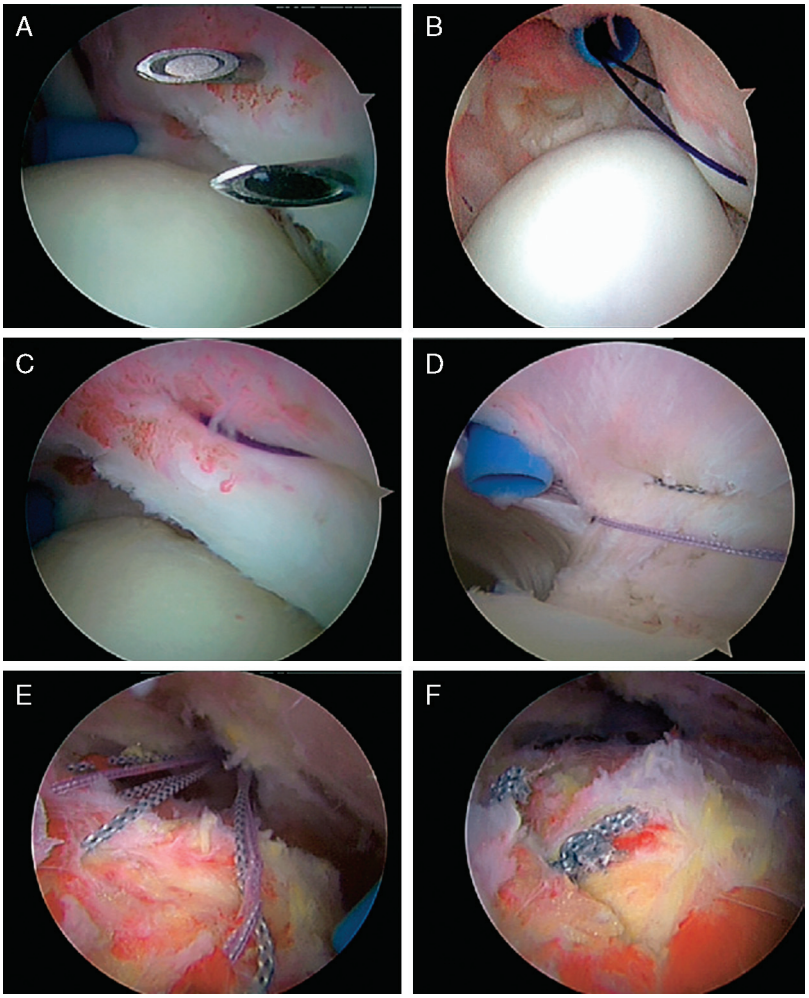

FIGURE 6. Intratendinous extension tears can be approximated by debriding the delaminated section and performing an arthroscopic repair. Viewing a right shoulder from a posterior arthroscopic portal (A), percutaneous spinal needles are initially placed to reduce the articular flap tear (B). PDS suture is then shuttled across the delaminated segment (C), closing down the tear defect (D). A, permanent suture is then shuttled through in place of the PDS monofilament suture. Note a second parallel suture has been placed as well. Repositioning the arthroscope in the subacromial space, the paired sutures are identified, retrieved (E), and tied securely (F). From Brockmeir et al.[74] Adaptations are themselves works protected by copyright. So in order to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.

a high level of competition after repair of a full-thickness rotator cuff tear.

Treatment Algorithm

Despite enthusiasm for repairing partial-thickness defects, the benefit to high-level throwers remains unclear. The problem in this group of high-demand athletes lies in knowing the degree to which anatomy ought to be restored to "normal." Although repair of the intratendinous portion of the cuff may have merit, advancement of the articular defect to the tuberosity risks overconstraining the joint and decreasing the muscle-tendon length of the cuff. Conversely, nonanatomic repair using suture anchors carries with it a significant risk of medializing the cuff insertion, and may alter shoulder anatomy and mechanics.

In throwers, our threshold for repair is considerably higher than that in the general population. We will take into account both the depth of the tear, and the depth and quality of the intratendinous segment. If the depth of the articular-sided tear is $<75\%$, we will perform a debridement only. When the tear is $>75\%$, we will consider transtendon repair, and consider addressing supraspinatus tears earlier than infraspinatus tears. If the intratendinous segment is thin or <1 cm, we will consider debridement of the articular segment only. If it is thick or exceeds 1 cm, we will consider a mattress intratendinous repair with or without an anchor. Finally if the depth of the intratendinous segment is 1 to 2 cm, then we will consider an arthroscopic repair. If it exceeds 2 cm, we will consider a miniopen repair using suture anchors.

SUMMARY

The demands of throwing results in enormous stresses to the rotator cuff. Over time, and occasionally due to injury, cuff failure leads to considerable impairment and

inability to throw effectively. Partial-thickness cuff tears seem to be fairly prevalent in the throwing population, though many are asymptomatic. And fortunately, full-thickness tears are relatively uncommon in baseball players. When $<75\%$ thickness and unresponsive to nonoperative management, consideration can be given to debridement and rehabilitation, which has been effective in some throwers. However, when partial tears are significant (approaching or exceeding 75% thickness), they pose a considerable therapeutic challenge. Nonoperative management may be ineffective at returning them to their previous level of activity, leaving them to the prospect of operative intervention. Surgical intervention has not demonstrated an ability to predictably return this high-demand cohort of patients to competitive play. When operative repair is indicated, great care must be taken to avoid over-constraint of the repair. Despite the allure of advances in our surgical technique, our ability to improve on the current dismal results of cuff repair in throwers remains unproven. We therefore must exercise restraint in advocating surgical intervention except in those players who have failed conservative treatment.

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