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Evidence-based Management of Rotator Cuff Tears (Acute and Chronic)

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Abstract

Purpose of Review This paper should serve as a guide for nonoperative physicians in the management of rotator cuff tears and provide an algorithm of when to refer patients for potential operative repair.

Recent Findings While physical therapy remains the mainstay of conservative treatment, recent studies have examined various injections to improve pain and function in partial- and/or full-thickness rotator cuff tears, such as suprascapular nerve blocks, subacromial hyaluronic acid, and intratendinous platelet-rich plasma.

Summary Patients who experience an acute, full-thickness rotator cuff tear should be referred as soon as possible for potential surgical repair; however, clinicians should consider the patient's age and activity level. The algorithms for both acute partial-thickness tears and chronic degenerative rotator cuff tears are similar and should initially include a conservative approach of pain control, physical therapy, and potentially various injections before possible referral for surgical evaluation. We anticipate future research examining the role for biologic agents in the conservative treatment of rotator cuff tears.

Keywords Rotator cuff tear · Rotator cuff disease · Nonoperative treatment · Conservative management

Introduction

The rotator cuff (RTC) is a group of four muscles (supraspinatus, infraspinatus, teres minor, and subscapularis) originating from the scapula and inserting on the humerus to provide motion and dynamic stability to the glenohumeral joint. Rotator cuff disease is a wide spectrum that includes acute injury, chronic injury, tendonitis, tendinosis, partial tears, and complete tears. It is a common cause of shoulder pain leading to more than 4.5 million physician visits per year; rotator cuff tears have a prevalence of 13–54% in the general population, with higher rates in patients over 60 years old [1, 2, 3]. The incidence of rotator cuff repair (RCR) has increased over the past two decades to become the most commonly performed shoulder surgery in the USA with an estimated annual cost of $1.2–1.6 billion [4, 5, 6].

Most rotator cuff tears involve the supraspinatus tendon; however, they can extend posteriorly or anteriorly to involve the infraspinatus or the subscapularis and long head of the biceps tendon, respectively. Partial-thickness tears can be interstitial (intrasubstance) or involve either the articular (undersurface) or bursal-sided surface of the tendon, whereas a full-thickness tear extends through both surfaces [7]. Articular-sided partial tears are more common due to the decreased strength and hypovascularity of the undersurface compared to the bursal surface [8]. Partial-thickness tears are graded using the Ellman classification according to depth: grade I (< 3 mm), grade II (3–6 mm), or grade III (> 6 mm) [9]. A full-thickness tear can be further subcategorized into focal versus incomplete for small tears, or complete if it encompasses the full width of a tendon. These can also be graded using the classification described by DeOrio and Cofield as either small (< 1 cm), medium (1–3 cm), large (3–5 cm), or massive (> 5 cm or involving two or more tendons) [10].

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Rotator cuff tears can present acutely related to shoulder trauma or as a chronic finding related to overload, subacromial impingement, and gradual degeneration of the tendons. Practitioners should rely on the patient's history of symptoms, as well information from diagnostic imaging to determine an acute versus chronic tear. MRI findings of a chronic tear include cephalad migration of the humeral head and fatty atrophy of the supraspinatus and infraspinatus, whereas edema of the associated muscle and kinking of the central tendon are associated with traumatic tears [11, 12]. Musculoskeletal ultrasound in the hands of an appropriately experienced practitioner can provide additional detail as to the nature of the rotator cuff tear. Acute tears tend to occur more proximally and are filled with anechoic fluid, while cortical irregularity of the greater tuberosity next to a hypoechoic tendon abnormality suggests a chronic tear [13, 14]. The purpose of this review is to discuss the nonoperative and surgical treatment options that are available for both acute and chronic rotator cuff tears, as well as suggested practice guidelines for how to approach treatment.

Management of Chronic Rotator Cuff Tears

Physical Therapy

Physical therapy has become the mainstay of conservative treatment for symptomatic chronic rotator cuff tears, including both partial and full-thickness tears; however, the success is variable. Physical therapy for rotator cuff tears focuses on strengthening of the scapular stabilizers and rotator cuff muscles, as well as improving range of motion and stretching of the shoulder capsule [15]. An important consideration when initiating treatment is the natural progression of rotator cuff tears managed nonoperatively. Patients with rotator cuff tears have a risk of developing a larger tear, fatty infiltration, and/or muscle atrophy if treated conservatively; these risks appear to be higher in patients over 60 years old and in those with a full-thickness tear [16, 17]. Patients with a full-thickness tear appear to have approximately 50% chance of progressing the size of their tear; however, Moosmayer and colleagues demonstrated deterioration of functional outcomes at 8.8 years was only associated with an increased tear size of $\geq$ 20 mm in the anterior–posterior plane [16]. The risk of tear progression was similar in other studies with shorter follow-up periods as well [17, 18]. While the risk of tear progression is overall lower in partial rotator cuff tears, high-grade partial-thickness tears involving > 50% of tendon thickness are more likely to progress in size compared to low-grade partial-thickness tears [19].

There are few studies directly comparing physical therapy to other treatment options, including operative management of rotator cuff tears, and there is significant heterogeneity, incomplete outcome reporting, and high risk of bias in the available literature; however, there is evidence to support the use of exercise in treating both partial- and full-thickness rotator cuff tears [20, 21, 22]. In patients with small and medium full-thickness rotator cuff tears (< 3 cm), there was no significant difference in patient-reported outcomes at 5 years in cohorts treated with physical therapy or operative RCR, and both groups demonstrated meaningful improvement in their strength and function compared to baseline [23]. Another study demonstrated similar findings in patients treated with either operative repair or physical therapy, with no significant difference in pain, patient satisfaction, or shoulder function at 2-year follow-up [24]. We recommend that all patients with chronic partial- or full-thickness rotator cuff tears undergo at least 6 weeks of physical therapy either preceding or concomitant to an injection, or prior to consideration of operative intervention.

Extracorporeal Shockwave Therapy

Extracorporeal shockwave therapy (ESWT) is a non-invasive therapy that involves soundwave delivery to a focused area of the body. It was initially developed for the treatment of nephrolithiasis and is now being extensively studied for musculoskeletal conditions [25, 26]. There have been several studies examining ESWT for both calcific and non-calcific rotator cuff tendinopathy, and more recent studies examining its use in rotator cuff tears [27, 28]. One small study examining the effect of ESWT in both athletes and older patients with rotator cuff tendinopathy and partial rotator cuff tears demonstrated high patient satisfaction with significantly improved pain and function at 1-year post-treatment [29]. A recent case series looked at the effect of ESWT in multiple shoulder conditions including partial rotator cuff tears and found significantly improved pain and function in all groups at 3 months post-treatment, as well as improved tendon appearance on MRI 6 months after shockwave treatment [30]. Prior animal studies have shown that ESWT stimulates neovascularization of tendons and is associated with early release of markers related to angiogenesis, which authors hypothesized may play a role in improving the blood supply and regenerating the tendon at the tendon-bone junction [31, 32]. Large, prospective randomized-controlled trials are needed to further examine this modality; however, ESWT may represent a potential treatment option for patients looking to avoid operative intervention.

Injections: Corticosteroid, Suprascapular Nerve Block, Hyaluronic Acid, Platelet-rich Plasma, Mesenchymal Stromal Cells

Corticosteroid injections (CSI) are used often in treating musculoskeletal complaints; however, there is concern for the use of steroids in or around tendons as they can contribute to collagen collapse, loss of tensile strength, and tendon rupture [33, 34]. Steroids can also predispose patients to infection with future surgical procedures, and there is some evidence that they can increase the risk of rotator cuff failure if performed in the 6 months prior to surgery [35, 36]. A Cochrane review of multiple randomized-controlled trials of varying sample sizes and quality found that while subacromial corticosteroid injections provide short-term pain relief from rotator cuff tears, the effects tend to be temporary [37]. Corticosteroid injections may be useful in symptom relief in patients with significant pain associated with their RTC tear not managed with oral pain medications, but the risks should be carefully reviewed with the patients. Another option for those looking to avoid the potential risks of corticosteroid is a subacromial injection with the non-steroidal anti-inflammatory drug (NSAID) ketorolac, which has been shown to significantly improve pain and function in patients with subacromial impingement syndrome [38]. The basic science literature has demonstrated varying results of NSAIDs on tendon histology; however, they may have positive effects in the maturation and remodeling phases seen in degenerative processes [39, 40]. Although future studies are needed to further explore this, a subacromial ketorolac injection is a potential therapeutic option for patients with pain due to chronic partial- or full-thickness rotator cuff tears.

Another option for potential pain relief is a suprascapular nerve block (SSNB). The suprascapular nerve is a peripheral nerve that originates from the ventral rami of C5 and C6 roots and comes off the upper trunk of the brachial plexus. It contains both motor and sensory nerve fibers. After passing through the suprascapular notch, the sensory fibers depart as the superior articular branch to innervate the coracoclavicular and coracohumeral ligaments, the acromioclavicular and glenohumeral joints, and the subacromial bursa [41]. While the injectate type and volume varies in the literature, 5 cc of bupivacaine 0.25% or 0.5% is commonly used and a steroid can potentially be added for a therapeutic effect [42, 43]. Ultrasound (US) guidance can be used to identify the nerve at the floor of the suprascapular fossa, as well as to identify the nearby suprascapular artery to avoid during the procedure [44]. Several small studies have examined the utility of SSNB in chronic rotator cuff tendinitis/tendinosis and have demonstrated temporary improvement in pain and range of motion after SSNB alone or in addition to physical therapy [45, 46]. A small double-blinded, randomized-controlled trial compared SSNB to subacromial CSI in patients with symptomatic partial- and full-thickness RTC tears and found significantly improved pain and function at 12 weeks in the SSNB compared to the subacromial group [47•]. US-guided suprascapular nerve block is a safe injection that can provide temporary relief in patients with rotator cuff disease, especially in those with concomitant arthritis or potentially awaiting surgical repair. We recommend 2 cc of lidocaine 1% plus 2 cc of ropivicaine 0.2% for a diagnostic injection, with the option to add 0.5 cc of dexamethasone 4 mg/mL for therapeutic effect.

Hyaluronic acid (HA) is a naturally produced polysaccharide with viscoelastic properties that contributes to the lubrication, shock absorption, and nutrition of joint tissues and is a commonly used and well-tolerated treatment for knee osteoarthritis; however, it is also thought to have anti-inflammatory and pain-relieving properties which may lend itself to treatment of soft tissue pathologies [48]. HA injections (weekly × 3–5 weeks) into the subacromial bursa have been shown to improve pain and function associated with partial rotator cuff tears but were not found to improve either outcome in complete tears [49, 50, 51]. The HA injections were well tolerated in all studies and no significant adverse effects were reported. A recent systematic review and meta-analysis found support for the efficacy of HA injections in improving pain and function related to partial rotator cuff tears [52]. Additional prospective randomized-controlled trials are needed to further examine the efficacy of HA in RTC tears, as well as data to determine the most effective molecular weight of HA and the frequency at which it should be injected.

Platelet-rich plasma (PRP) is an autologous concentration of platelets with at least 1,000,000 platelets/μL in 5 mL of plasma isolated from the patient's whole blood using centrifugation. PRP is thought to accelerate the healing process through modulating the inflammatory response and pain-relieving pathways via the release or attraction of growth factors, cytokines, and mesenchymal stromal cells [53, 54]. The literature related to PRP as a potential treatment for rotator cuff pathology is growing; however, studies are mixed in relation to its efficacy. One open study examined the safety and efficacy of a dual PRP injection into the supraspinatus insertion and glenohumeral joint space and found significantly improved pain and functional scores that persisted at 2 years. There were no adverse effects and no patient with a partial tear progressed to a full-thickness tear [55•]. A recent randomized-controlled trial compared a subacromial injection of either leukocyte-poor PRP or corticosteroid and found significantly improved pain and function in the PRP cohort at 3 months, but no significant change between the two groups at 12 months with similar failure rates [56]. There have been several recent systematic reviews with meta-analyses examining the use of PRP for rotator cuff disease in a nonoperative setting (inclusive of both partial tears and tendinopathy) also reporting conflicting results [57, 58, 59, 60, 61]. The PLRA classification system described by Mautner and colleagues discusses the important characteristics to report when conducting research using PRP; however, the authors of these recent review articles note the wide heterogeneity in the methodology as well as the reporting of how the PRP was prepared, including the total administered platelet count, leukocyte content (leukocyte-rich versus leukocyte-poor), and type of leukocytes present, and the use of an activating agent [62].

While we acknowledge the mixed evidence, it appears that PRP can provide relief to patients with partial RTC tears. Giovannetti and colleagues conducted a systematic review examining the effect of various subacromial injections in partial rotator cuff tears (corticosteroids, PRP, prolotherapy) and found that while corticosteroid injections significantly reduced pain in the short and medium term (< 12 weeks) compared to other injections, PRP provided significant pain reduction and better functional outcomes at all points, including long term (> 24 weeks) [63]. A combined injection of hyaluronic acid and PRP (weekly × 4 weeks) into the subacromial space was found to significantly improve pain and function of partial small to medium bursal-sided tears compared to either PRP, hyaluronic acid, or normal saline alone, with associated significant reduction of anterior to posterior tear size as measured by MRI at 12 months in both the PRP and PRP + HA groups [64]. We recognize the need for standardization of PRP preparation methods as well as the consistent reporting of cellular content. Once this is homogenized, then the optimal PRP injection and possible combination with current therapies can be better determined. However, it is our opinion that intratendinous PRP is a safe treatment option for patients who wish to pursue additional nonoperative treatments for rotator cuff tendinopathy and tears.

Mesenchymal stromal cells (MSCs) are multipotent cells that can be isolated from different tissues, including adipose, bone marrow, synovium, and umbilical cord blood. They can affect the healing response via activation of cell proliferation and differentiation, as well as decreased inflammation and cell apoptosis [65, 66]. There are few case reports and low-level clinical studies in the literature examining the effects of stromal cell injections on rotator cuff tears. Recent case studies and small pilot studies have examined microfragmented adipose tissue (MFAT) injections ± additional PRP injections as a possible treatment option for chronic partial supraspinatus tears with resulting improvements in pain and function [67, 68, 69]. A small open study found that an intratendinous injection of adipose tissue–derived mesenchymal stromal cells (AD-MSCs) significantly reduced shoulder pain and increased RTC strength at 1 and 2 years post-injection with associated decreased size of the tear seen on corresponding MRI [70]. In a small case-controlled study, Kim and colleagues compared a combination of bone marrow–derived mesenchymal stem cells (BM-MSCs) + PRP injected into the rotator cuff tear to a control group who received daily physical therapy and demonstrated significantly decreased pain and significantly improved shoulder function at 3 months in the injection group [71]. In a similar small case-controlled study, Centeno and colleagues compared a BM-MSCs + PRP + platelet lysate intratendinous injection to home exercise program in patients with partial to full-thickness RTC tears and found significantly improved pain and function in the biologics cohort at 3 and 6 months [72]. Larger, prospective randomized-controlled studies are needed to examine the value of mesenchymal stromal cells in the treatment of rotator cuff tears.

Additional Nonoperative Treatments

There are other modalities that are used by practitioners in the treatment of rotator cuff tears (therapeutic ultrasound, acupuncture, transcutaneous electromagnetic stimulation, low-level laser therapy); however, there is insufficient evidence as to their benefits in this specific injury population. We recognize these are low-risk procedures and may be considered as adjunctive treatment with experienced practitioners.

Operative Repair

Surgical intervention for chronic rotator cuff tears should be considered only after the patient has failed a trial of conservative management, as rotator cuff repair has not consistently been shown to result in superior pain control or functional outcomes compared to nonoperative management [73]. Surgical approaches include rotator cuff debridement or rotator cuff repair (arthroscopic or open). For patients with massive rotator cuff tears, concomitant glenohumeral arthritis, or significantly limited function, surgeons may consider an alternate procedure such as a tendon transfer or reverse total shoulder arthroplasty [74, 75]. Surgical outcomes depend on several variables. There is strong evidence that older age is associated with increased re-tear rates and worse patient-reported outcomes [76, 77, 78]. Increased tear size is a risk factor for poor healing after rotator cuff repair, as well as baseline fatty degeneration and muscle atrophy, which do not improve after rotator cuff repair [76, 78]. While the number of comorbidities does not necessarily predict worse outcomes after rotator cuff repair, patients with diabetes and current smokers were found to have worse patient-reported outcomes and higher re-tear rates after rotator cuff repair [79, 80, 81]. As discussed previously, physical therapy was shown to be non-inferior to rotator cuff repair at 5 years for small- to medium-sized full-thickness tears; however, a follow-up study was published showing that the operative group had significantly improved pain and function compared to the PT group at 10 years [82•]. We recommend a surgical consult for patients with symptomatic small- to medium-sized full-thickness tears who have failed a course of physical therapy and conservative management.

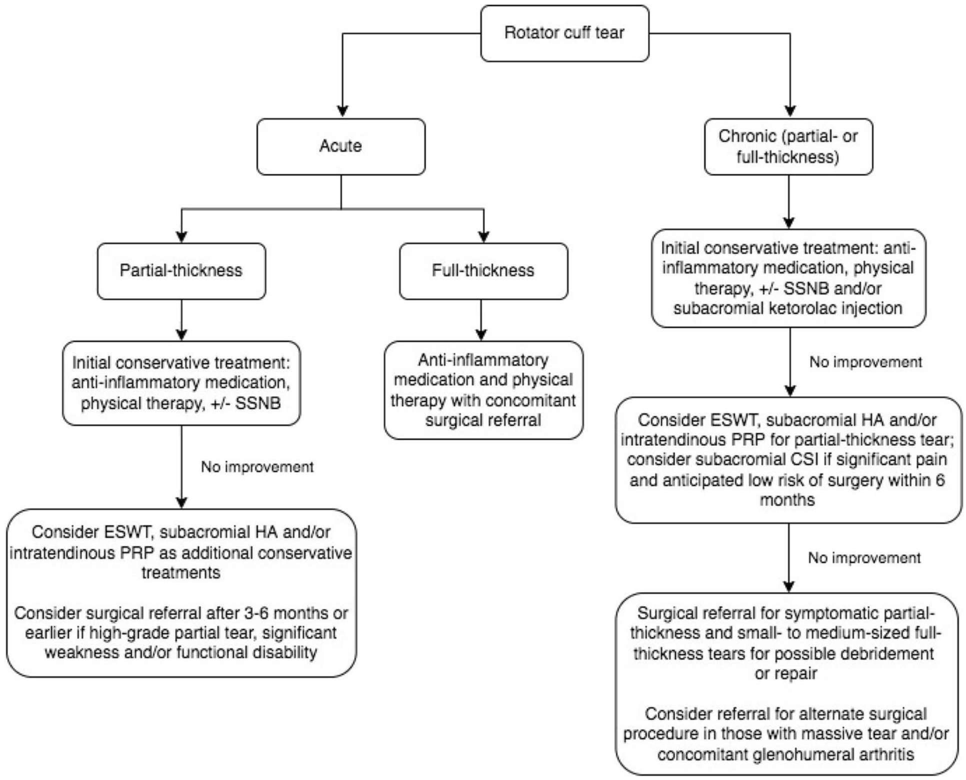

Fig. 1 Recommendations for the nonoperative physician's approach to the management of rotator cuff tears

PRP has also been examined as an adjunct to the operative management of RTC tears; however, the outcomes are mixed. The American Academy of Orthopaedic Surgeons does not recommend the use of PRP with rotator cuff repair in their clinical practice guidelines as it has not been shown to improve postoperative patient-reported outcomes [75]. There have been studies that suggest biologic augmentation with PRP could decrease re-tear rates after surgery; however, as we have noted above, there is a lack of standardization of PRP formulation [83, 84]. While there are fewer studies examining MSCs as an adjuvant to rotator cuff repair, a case-controlled study comparing intra-operative BM-MSCs during arthroscopic rotator cuff repair to a control group found significantly increased intact single-row repairs at 6 months and 10 years in the stem BM-MSC group [85]. We anticipate future studies examining biologic augmentation of rotator cuff repair with PRP and MSCs for various sized tears.

Management of Acute Rotator Cuff Tears

Acute rotator cuff tears typically occur in younger patients (under 60 years old), more commonly in males, who experience a traumatic event (i.e., falling on an outstretched arm or a trauma involving an abducted arm in external rotation) [86]. Patients with acute, partial-thickness tears have been shown to have significant functional improvement with conservative treatment [87]. While the literature suggests that high-grade partial-thickness tears involving > 50% of the tendon are more likely to progress in tear size following nonoperative treatment, there is evidence that patients who perform at least 6 months of conservative treatment prior to surgical repair of a partial-thickness tear have improved postoperative outcomes compared to patients who undergo immediate surgical repair following their injury [88]. We recommend patients with a partial-thickness rotator cuff tear follow a similar algorithm as described above beginning with pain control and physical therapy with consideration of adjunct modalities and injections if warranted [89]. We recommend a trial of conservative treatment for 3–6 months before initiating surgical referral for a partial-thickness tear, but of course, this may occur sooner based on the shared decision making between the patient and physician, especially in the setting of high-grade tears, significant weakness, and/or functional disability [1]. Initial nonoperative treatment is typically recommended for athletes as well, including overhead and master athletes, with operative management reserved for those who fail to improve with consistent conservative treatment [15, 90]. We do not recommend the use of subacromial corticosteroid injections in the setting of an acute partial- or full-thickness tear due to the risk of further tendon degeneration. A suprascapular nerve block may provide further pain relief in addition to or instead of oral anti-inflammatory medications. Shockwave treatment and intratendinous PRP may be considered as well for partial-thickness tears that do not improve with anti-inflammatory medications and physical therapy in patients who are interested in deferring surgical referral.

In otherwise healthy patients who have sustained an acute, full-thickness rotator cuff tear, there is strong evidence that surgical repair should be performed to improve function and prevent tear enlargement and significant muscle atrophy [91, 92]. While the timing is debated in the literature, there is evidence that repair should be performed within 4 months of injury, but ideally within several weeks [93, 94, 95]. We recommend that all patients with acute full-thickness tears be evaluated by a surgeon for potential repair, even though they may ultimately defer operative repair after considering the size of the tear, the patient's age, and their activity level.

We have summarized our recommendations and general approach for the treatment acute and chronic partial-thickness and full-thickness rotator cuff tears in Fig. 1.

Conclusion

Rotator cuff tears are one of the most common presenting etiologies of shoulder pain; however, treatment can be challenging, especially the decision for when nonoperative physicians should refer patients to an orthopedic surgeon to discuss operative repair. Patients who experience an acute, partial-thickness rotator cuff tear should be managed conservatively with pain control, physical therapy, and potential injections. Patients who experience an acute, full-thickness rotator cuff tear should be referred as soon as possible for potential surgical repair; however, clinicians should consider the patient's age and activity level. Patients with chronic degenerative rotator cuff tears (both partial- and full-thickness) should be managed initially with a conservative approach that includes pain control, physical therapy, and potentially injections, and can potentially be referred for a surgical evaluation after treatment failure. We anticipate future research examining the role for biologic agents in conservative treatment of rotator cuff tears.

Declarations

Conflicts of Interest The authors declare no competing interests.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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