Massive Rotator Cuff Tears: Trends in Surgical Management

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abstract

Compared with smaller tears, massive rotator cuff tears present significant clinical management dilemmas for the treating surgeon because they are often fraught with structural failure and poor outcomes. To optimize healing, current surgical methods look to optimize footprint coverage and enhance the biological environment for healing. Double-row techniques have demonstrated clear biomechanical advantages in controlled cadaveric studies, but have yet to demonstrate clear clinical efficacy over more simple repair techniques. When repairs for massive rotator cuff tears fail, options include revision repair or superior capsular reconstruction, an option to bridge the tissue gap with human dermal allograft or fascia lata autograft in hopes of containing the humeral head from superior migration and precluding rotator cuff arthropathy. Although latissimus transfers remain a reasonable option for massive, irreparable rotator cuff tears in appropriately indicated patients, clinical results are often unpredictable. Older patients with chronic, massive rotator cuff tears with pseudoparalysis can achieve predictable, often excellent clinical results with a reverse total shoulder arthroplasty. [Orthopedics. 2016; 39(3):145-151.]

Compared with smaller tears, massive rotator cuff tears present significant treatment challenges for the treating surgeon because they are often complicated by structural failure and poor outcomes (Figure 1). Structural failure rates have been reported to range from 20% to 94%, and the failure usually occurs at the tendon-bone interface.1-5 To enhance healing of the tendon, current surgical methods look to maximize footprint coverage and optimize the biological environment for healing. When compared with single-row repairs, double-row techniques have demonstrated clear biomechanical advantages in controlled cadaveric studies, and have demonstrated a significant benefit to retear rates.6-9 However, although several studies have yielded equivocal short-term clinical outcomes when comparing single-row with double-row techniques,9-11 it is unknown whether asymptomatic short-term retears with the single-row technique will progress to larger, more symptomatic tears necessitating revision. To enhance the biologic environment of the repair, several biologic...
agents have been studied but their clinical efficacy has been inconclusive in the setting of large economical costs, precluding widespread use.²,¹²-¹⁵

When repairs of massive rotator cuff tears fail, options include simple debridement with biceps tenotomy or tenodesis, revision repair with or without patch augmentation, or superior capsular reconstruction (SCR), an option to bridge the tissue gap with human dermal allograft or fascia lata autograft in hopes of containing the humeral head from superior migration and precluding rotator cuff arthropathy. Although patch augmentation has demonstrated good early clinical results,¹,¹⁶,¹⁷ SCR using either a tensor fascia lata autograft or a human dermal allograft (ArthroFlex; Arthrex, Naples, Florida) is a new technique with promising preliminary clinical and biomechanical results, but long-term clinical results remain largely unknown due to the novelty of the technique.¹⁸-²¹

Although latissimus transfers remain a reasonable option for massive, irreparable rotator cuff tears in appropriately indicated patients, clinical results are often unpredictable.²²-²⁴ Older patients with chronic, massive rotator cuff tears with pseudoparalysis can achieve predictable, often excellent clinical results with a reverse total shoulder arthroplasty. Both of these surgical management strategies are outside the scope of this review.

This article presents the authors’ preferred management strategies when dealing with massive rotator cuff tears. The authors discuss both nonsurgical and surgical management and their preferred surgical technique for dealing with massive tears: the trans-osseous equivalent double-row technique. For patients with irreparable rotator cuff tears, the authors discuss the indications and surgical technique for SCR using human dermal allograft, which has become their technique of choice.

**Physical Examination**

The examination should begin with a thorough assessment of range of motion and a comprehensive neurovascular examination to assess for the integrity of axillary and suprascapular nerve function. Inspection may reveal deltoid atrophy, or periscapular atrophy of the infraspinatus, which can also be a clue to the chronicity of the tear. The surgeon should also evaluate the presence of scars, particularly from open procedures, which can provide insight into the challenges of a revision procedure. Massive tears involving the infraspinatus will typically present with increases in passive internal rotation as well as an external rotation lag sign. Similarly, massive tears involving the subscapularis will often present with an increase in passive external rotation and an internal rotation lag sign. Further, supraspinatus tears may demonstrate a drop arm sign.

Palpation of the long head biceps tendon (LHBT) within the bicipital groove is essential during the examination, as lesions to the LHBT are strongly associated with rotator cuff tears. The surgeon must also assess for concomitant symptomatic acromioclavicular joint arthritis through palpation as well as by assessing for pain with cross-body adduction.

Strength testing of all rotator cuff muscles is imperative. The authors prefer to assess the supraspinatus in the forward flexed position in the scapular plane, and the infraspinatus and subscapularis with the arm in abduction. The authors routinely perform a homoblower’s test in abduction and external rotation to assess the integrity of the teres minor. Special attention should be paid to the subscapularis, of which lesions to the upper part of the tendon are often correlated with biceps tendon lesions and LHBT instability. Tests for the subscapularis include the belly press test, the lift-off test, and the bear hug test.

The surgeon must assess the function of each tendon and for the presence of pseudoparalysis, which indicates a lack of compensation for the detached rotator cuff tendons. Compensation is typically seen in the setting of a strong deltoid and an intact, functional subscapularis.²⁵ A pseudoparalytic shoulder without a functional subscapularis is a contraindication to a latissimus transfer, and the presence of symptomatic arthrosis would necessitate an arthroplasty.

**Imaging**

For all patients with suspected rotator cuff pathology, the authors routinely obtain 3 radiographic views of the shoulder: true anteroposterior (Grashey), axillary lateral, and outlet (scapular Y). Although plain radiographs will not clearly identify soft tissue, they are highly valuable in elucidating the chronicity of massive tears as well as identifying the presence of glenohumeral arthritis or rotator cuff arthropathy. When evaluating the radiographs, the authors look for narrowing of the acromiohumeral interval and superior migration of the humeral head, which are keys to diagnosing underlying rotator cuff disease. Glenohumeral arthritis is often more clearly identified on the axillary lateral radiograph. The outlet view is used to assess the acromial morphology.

Although ultrasonography can be successfully used to diagnose rotator cuff disease, it is highly user-dependent. The authors prefer magnetic resonance imaging to evaluate the structural integrity of the rotator cuff. Magnetic resonance imaging can be used to assess the size and location of the tear, the quality of the tendon, and the chronicity of the tear. The sagittal T1 image may show atrophy or fatty infiltration of the involved musculature, which can highlight the chronicity of the tear and also provide prognostic information. Axial views can evaluate the integrity of the subscapularis as well as associated LHBT tendinosis, tears, or static instability.

**Nonsurgical Treatment**

The authors reserve nonsurgical treatment for patients with massive tears and associated activity-related pain without evidence of pseudoparalysis, indicating a well-compensated force couple. Nonsurgical management typically begins with...
guided physical therapy to strengthen the intact portion of the rotator cuff and deltoid as well as the periscapular musculature. Strengthening the intact rotator cuff and scapular stabilizers, in theory, should offload the tear edges and provide a strong foundation for maintenance of a strong force couple to prevent progressive rotator cuff arthropathy. For these patients, the authors often provide a subacromial corticosteroid injection to decrease the inflammation during the rehabilitation process. In elderly, low-demand patients who do not wish to undergo a surgical procedure or who are medically unfit for surgery, the authors also choose nonoperative treatment.

When treating these patients nonsurgically, clinical expectations must be managed because the goal is to provide pain relief and improved function. Although some studies have shown promising early clinical results in these patients, there appears to be a strong predilection for tear progression with development of symptoms, as well as the development of cuff tear arthropathy. Further, several studies have reported poor results of nonoperative management of massive tears. 

Zingg et al. retrospectively evaluated 19 consecutive patients with massive rotator cuff tears involving 2 or 3 tendons who were treated nonoperatively. At a mean 4-year follow-up, despite maintenance of shoulder function and mild pain symptoms, there was a significant progression of glenohumeral arthritis and narrowing of the acromiohumeral interval. Moreover, significant progression in tear size and fatty infiltration occurred, and 50% of the seemingly reparable tears were deemed irreparable at final follow-up.

Although patients may benefit from nonoperative treatment in the setting of massive rotator cuff tears, the likelihood of tear progression and cuff tear arthropathy often limits the use of this modality to the most low-demand patients, those medically unfit for surgery, or those wishing to avoid surgery. Thus, for most patients, the authors elect surgical management with a goal of decreasing pain, improving function, and containing the humeral head to prevent progression of rotator cuff arthropathy.

**Surgical Treatment**

Although a multitude of surgical options exist for management of massive rotator cuff tears, the authors have found rotator cuff repair for reparable tears and SCR for irreparable tears the most consistent regarding clinical outcomes. Debridement and biceps tenotomy or tenodesis may be a viable option in the most elderly, low-demand patients with limited functional goals. 

Latissimus transfers for irreparable posterosuperior rotator cuff tears have demonstrated some promising results in the literature regarding improvements in range of motion and clinical outcomes. Unfortunately, results are often unpredictable and are associated with progression of glenohumeral arthritis and superior migration of the humeral head. 

Worse outcomes after latissimus transfer are typically seen in patients with an incompetent subscapularis, in patients with teres minor atrophy, or in the setting of revision surgery. The current authors have found the results of latissimus transfer to be unpredictable, and have moved toward SCR for management of irreparable posterosuperior rotator cuff tears. For elderly patients and those with signs of rotator cuff arthropathy and pseudoparesis, the authors elect reverse total shoulder arthroplasty, given the predictable outcomes and often excellent results.

Below, the authors discuss the surgical techniques for their most robust treatment options when dealing with massive rotator cuff tears. They elect repair in patients with reparable rotator cuff tears and SCR for irreparable tears.

**Massive Rotator Cuff Repair**

Where possible, the authors elect arthroscopic repair of massive rotator cuff tears. Despite high structural failure rates of the tendon in massive rotator cuff repair, clinical outcome scores remain consistently good when compared with preoperative values. However, if the tendon does not heal, the patient is at increased risk of progressive superior humeral head migration and rotator cuff arthropathy. Further, improved clinical outcome scores have been correlated with the integrity of the repair. Thus, when indicating patients with massive rotator cuff tears for surgery, the current authors choose the most robust construct possible in the form of a transosseous equivalent double-row technique to optimize the biomechanical properties for healing. The transosseous equivalent double-row technique has demonstrated greater tendon-bone contact area and pressure as well as a higher load to failure compared with other double-row techniques.

The authors use a regional interscalene nerve block and general anesthesia. The patient is first placed in the beach chair position and prepped and draped in standard fashion. An articulating arm holder is used (Trimano; Arthrex) for control of the limb during surgery. A posterior portal is first established 2 cm distal and 1 cm medial to the posterolateral corner of the acromion. The arthroscope is inserted posteriorly and under direct vision a standard anterior working portal is established through the rotator interval using an outside-in technique. A diagnostic arthroscopy is then performed, evaluating the integrity of the articular cartilage of the humeral head and glenoid, the labrum and biceps-labral complex, and the rotator cuff. Particular attention is paid to the biceps tendon, which is mobilized into the joint from the bicipital groove using a probe to evaluate for the presence of tearing, synovitis, or instability. If it is deemed pathologic, the biceps tendon is released from the superior labrum using an arthroscopic biter, later to be retrieved for open subpectoral biceps tenodesis.

Attention is then turned to the subacromial space using the same posterior portal. A standard lateral portal is established ap-
proximately 2 cm distal to the acromion in its midline. A 5.0-mm arthroscopic shaver is introduced and used to perform a thorough subacromial bursectomy, with careful attention paid to removing tissue from the anterior, lateral, and posterior subdeltoid spaces to improve visualization. An acromioplasty is routinely performed in this setting. Should it be indicated, a distal clavicle excision can also be performed prior to rotator cuff repair.

Attention is next turned to the rotator cuff tissue. The arthroscope is inserted into the lateral portal for an enface view of the tear, and an accessory anterolateral portal is established off the anterolateral border of the acromion; a cannula is inserted through this portal. An arthroscopic grasper is introduced to assess the pattern of the tear and the tendon mobility (Figure 2). A reparable tendon tear can typically be pulled laterally to the footprint with the arm in neutral abduction and rotation. If the tendon is significantly retracted, the authors routinely release the rotator interval tissue, including the coracohumeral ligament, which often will tether the supraspinatus medially (Video 1). A thorough release should mobilize a reparable tear to the footprint without significant tension. However, if tension still exists, the footprint may be medialized up to 5 mm by removing 5 mm of the lateral humeral head cartilage with a burr. The greater tuberosity footprint is then prepared to a bleeding base using a burr to optimize the biological environment for healing.

The trans-osseous equivalent double-row repair begins by inserting a 4.5-mm SwiveLock (Arthrex) anchor preloaded with FiberTape (Arthrex) suture at the posteromedial articular margin. A suture shuttling device is used to pass a PDS (Ethicon, Somerville, New Jersey) suture through the medial tendon and to then shuttle the FiberTape through the medial tendon. The authors use a #2 FiberWire (Arthrex) cinch suture at the likely sites of “dog ears” to keep these sites reduced. A second 4.5-mm SwiveLock anchor preloaded with FiberTape suture is then placed into the anteromedial articular margin to complete the medial row, and the steps above are repeated to shuttle the FiberTape through the medial tendon anteriorly.

Attention is now turned to the lateral row. Using a free 4.5-mm SwiveLock, one limb of each FiberTape suture anteriorly and posteriorly is loaded along with a single cinch stitch if needed. The posterior anchor is then inserted at the greater tuberosity margin laterally; however, prior to impaction, each limb of suture is tensioned to reduce the tendon to the greater tuberosity footprint. The process is repeated for the anterolateral anchor (Figure 3).

Postoperatively, patients with massive rotator cuff repairs are managed differently from those with standard rotator cuff repairs. Patients who undergo massive repair are immobilized in an abduction sling for 6 weeks without motion to optimize the chances for healing. At week 6, the authors allow true passive range of motion only, with goals of 140° of forward flexion, 40° of external rotation, and 80° of abduction by week 12. At week 12, the authors advance patients to phase II, which includes active range of motion as tolerated with light passive stretching at the end ranges of motion. At this time, patients begin scapular stabilization exercises. At week 18, strengthening is advanced to include bands and weights to strengthen the deltoid, rotator cuff, and scapular stabilizers. Full recovery after massive rotator cuff repair is expected at a minimum of 6 months postoperatively.

Superior Capsular Reconstruction

Irreparable rotator cuff tears are a difficult clinical problem, and treatments have evolved over time. Xenograft and synthetic patch augmentation have been used with some success for reparable rotator cuff tears, enhancing the biologic healing by acting as a collagen scaffold. However, with xenografts, concern exists regarding the potential for an inflammatory response and subsequent failure to heal. The SCR using a human dermal allograft or autograft fascia lata has been suggested as a viable alternative for managing irreparable rotator cuff tears by reconstructing the superior capsule to restrain superior migration of the humeral head in the cuff-deficient shoulder. Early biomechanical and clinical results have demonstrated the ability to contain the humeral head from superior migration, and in several cases, SCR was able to reverse a pseudoparalytic shoulder. The current authors choose SCR in patients younger than 65 years with massive irreparable rotator cuff tears without evidence of glenohumeral arthritis.

As with massive rotator cuff repair, the patient is placed in a beach chair posi-
tion. The same portals and technique are used for SCR, including the diagnostic glenohumeral arthroscopy, subacromial bursectomy, and acromioplasty. If an associated subscapularis tear is identified, it is repaired to the lesser tuberosity using a trans-osseous equivalent double-row technique using four 4.5-mm SwiveLock anchors. Once the posterosuperior rotator cuff has been deemed irreparable, the decision is made to perform the SCR and the graft is obtained. The authors choose human dermal allograft over autograft fascia lata because of the robust integrity of the human dermal allograft tissue and the avoidance of donor-site morbidity.

First, the superior glenoid and greater tuberosity need to be prepared to bleeding bone using a burr to optimize biologic healing of the graft. The superior labrum is left intact to optimize superior stability of the humeral head. The authors then use a 10-mm PassPort (Arthrex) cannula through the lateral portal to facilitate passage of the graft. Accessory anterolateral and posterolateral portals are established through stab incisions to enable placement of two 3.0-mm biocomposite SutureTaks (Arthrex) each double-loaded with #2 FiberWire suture. The SutureTaks are then inserted into the superior glenoid behind the superior labrum, one anterior and the other posterior (Figure 4).

Through the anterolateral portal cannula, two 4.5-mm SwiveLock anchors pre-loaded with FiberTape suture are placed into the posterosomedical and anteromedial greater tuberosity footprint. The distance between each of the 4 anchors is then measured (anterior-posterior, and medial-lateral) to obtain a precise measurement for the space needed to be spanned by the allograft. Suture limbs from each of the 4 anchors are then sequentially pulled out of the lateral PassPort cannula (Figure 5), being careful to keep them separated into 4 quadrants for suture management and to prevent suture tangling. The allograft is then prepared and cut: the authors typically add 5 mm to each side of the graft from medial-lateral and anterior-posterior based on the intra-articular measurements. Using a Scorpion (Arthrex) suture passing device, the limbs from the SutureTaks and SwiveLocks are then passed into the marked points on the allograft, which has been cut to size.

Medially on the graft, one limb from each FiberWire suture is tied together centrally to create a medial pulley for shuttling the graft. The two remaining medial limbs are then used to shuttle the graft through the PassPort and then down onto the glenoid neck. In this step, using a KingFisher Grasper (Arthrex) on the graft is helpful for facilitating graft shuttling. Once the graft is adjacent to the glenoid neck, the medial suture limbs are then tied (or, alternatively, passed into a labral SwiveLock more medially on the glenoid neck) to secure the graft to the glenoid.

With the graft positioned over the defect and secured medially, one limb from each lateral SwiveLock anchor is retrieved and passed into a 4.5-mm SwiveLock anchor. The limbs are then tensioned, and the anchor is passed into the posterolateral greater tuberosity. The steps are repeated for another anterolateral SwiveLock, to create a suture bridge construct laterally to compress the graft to the greater tuberosity footprint (Figure 6). Using #2 FiberWire, margin convergence sutures are then passed through the graft and into the remnant of posterior rotator cuff using a Scorpion or suture shuttling device and are then tied (Figure 7). To avoid over-constraining the shoulder, the authors do not suture the graft anteriorly to the subscapularis (Video 2). The postoperative rehabilitation is the same as that for massive rotator cuff repair discussed above.

**Conclusion**

Massive rotator cuff tears are a difficult clinical problem. They are often complicated by structural failure and poor outcomes when compared with smaller tears. When dealing with a massive rotator cuff tear, the authors elect repair in the setting of reparable tissue and SCR when the tear...
is irreparable in a young, motivated patient without significant glenohumeral arthritis. For older, lower-demand patients, the authors elect reverse total shoulder arthroplasty when pseudoparalysis is present, or in the presence of rotator cuff arthropathy. Although latissimus transfers remain a reasonable option for massive, irreparable rotator cuff tears in appropriately indicated patients, clinical results are often unpredictable, and the authors have largely abandoned this procedure in favor of SCR. Although early clinical and biomechanical results of SCR are promising, studies are needed evaluating the medium- and long-term clinical outcomes of this procedure and its ability to restrict superior migration, contain the humeral head, and possibly prevent the progression to rotator cuff arthropathy.

REFERENCES


