Massive chronic rotator cuff tear: what could be done?

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Abstract

Massive rotator cuff tears have been variously defined as tears exceeding 5 cm in diameter or involving at least two tendons.

Massive retracted tears of the rotator cuff are difficult to manage. They usually occur in older patients with compromised tissue. Visualization of a massive tear is a challenge even when extensile exposures are utilized. Once exposed, the torn rotator cuff tissue may not have sufficient length to be adequately mobilized and reduced anatomically. Additionally, after repair, the weakened tissue may not withstand rigorous therapy and can tear again.

Nevertheless, the management of massive, retracted rotator cuff tears continues to evolve as techniques for treatment improve.

This article provides an overview of the nature and pathogenesis of massive rotator cuff tears, reviews widely accepted forms of management based on previous studies, and discusses the efficiency of the different surgical modalities for these conditions.

No conflict of interest

Keywords: shoulder, massive cuff tear, reconstruction, arthroscopic repair
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Introduction

While small tears can occur without symptoms, massive tears are always associated with weakness and disability. Massive tears are rarely due to an acute injury; rather, they are usually chronic.\(^1\)

The treatment of large and massive rotator cuff tears has been challenging; significant tendon retraction, muscle atrophy, and scarring prevent easy reduction of the free tendon edge to the rotator cuff footprint.\(^2,\,3\)

Nonetheless, the management of massive retracted rotator cuff tears continues to evolve as techniques for treatment improve.\(^4\) Moreover, it is important to determine the definitive treatment of massive rotator cuff tear at the time of its identification.\(^1\)

They key parameters for the treatment are the patient’s symptoms, reparability of the lesions, and the short and the long term functional demands.\(^1\)

Anatomy and biomechanics

The rotator cuff consists of the supraspinatus, infraspinatus, teres minor, and subscapularis. These play a crucial role in active stabilization of the glenohumeral joint. Additionally, there are other active stabilizers, including the deltoids, pectoralis major, latissimus dorsi, teres major, and biceps brachii. Passive stabilizers include the glenoid and coracoacromial arch, the glenoid labrum, and the joint capsule.\(^5,\,6\)

The anterior and posterior rotator cuff muscles provide concavity compression, which is a balancing force across the glenoid. In other words, the cuff muscles compress the humeral head against the concave surface of the glenoid.\(^5,\,6\) Burkhart\(^7\) studied the force couple concept; he reported that normal shoulder function is possible with a massive unrepaired tear of the rotator cuff. Normal function of an unrepaired cuff tear can occur only if there is a balance of two important force couples, one in the coronal plane and the other in the transverse plane. This balance depends upon the functional integrity of the anterior cuff, the posterior cuff, and the deltoid.\(^7\)

Early rotator cuff disease usually affects the anterior insertion of the supraspinatus tendon.\(^6\) However, recently, Kim et al. reported that degenerative rotator cuff tears start approximately 15 mm posterior to the biceps tendon.\(^8\) The anterior and posterior force couple may be disrupted with the progress of the disease, leading to alteration in the kinematics.\(^7\)

Although it is not well known at which stage cuff tear can alter the kinematics of the glenohumeral joint, a recent biomechanical study demonstrated that involvement of the
infraspinatus tendon is necessary to cause significant changes in the humeral head kinematics.\textsuperscript{9}

**Classification**

Various classifications of rotator cuff tears have been proposed.\textsuperscript{1} Rotator cuff tears are usually classified according to the chronicity and size of the tear. The chronicity of a tear can refer to the duration of either symptoms or pathology.\textsuperscript{10}

There are many approaches to classifying the size of rotator cuff tears. The most common is based on the largest dimension of the tear. Small tears measure less than 1 cm; medium tears, 1 to less than 3 cm; large tears, 3 cm to less than 5 cm.\textsuperscript{10}

**Massive tear**

Massive tear has several definitions. According to Cofield, massive tears measure more than 5 cm.\textsuperscript{11} Moreover, Gerber et al.\textsuperscript{12} used a definition that included disruption of 2 tendons or more to define massive tears.

The definition of an irreparable rotator cuff tear is less clear. Irreparable rotator cuff tears are typically large and retracted, with degeneration and multifunctional muscle bellies.\textsuperscript{6}

**Aetiology**

Massive rotator cuff tears can present in three clinical settings

- **Acute traumatic massive tears**

This usually occurs in younger individuals. Patients do not have the typical signs of chronicity, such as substantial supraspinatus or infraspinatus.\textsuperscript{10}

- **Acute on chronic massive tears**

Patients usually have pre-existing chronic symptomatic rotator cuff tearing and then sustain an injury that causes an acute extension of the tear.\textsuperscript{10} After an acute traumatic injury, patients are often unable to actively elevate the injured arm. Some patients present with arm ecchymosis.\textsuperscript{10}

- **Chronic massive tears**

Patients are often older, less active, and present with shoulder pain with an insidious onset. Patients usually have infraspinatus muscle atrophy and may have a chronic biceps tendon rupture. Surprisingly, some of these patients have good elevation strength because of compensatory deltoid muscle strength.\textsuperscript{10}
Physical examination

A detailed physical examination is necessary to accurately determine the status of the rotator cuff. Physical examination begins with inspection of the shoulder. Atrophy of the supraspinatus and infraspinatus fossae can signify chronic involvement.6

A massive cuff tear can occasionally be detected as a palpable defect in the supraspinatus tendon at the anterolateral aspect of the shoulder.13 Loss of passive shoulder motion is uncommon in the presence of a large or massive rotator cuff tear.10

External rotation weakness and external rotation lag are signs of massive rotator cuff tearing involving the infraspinatus tendon. An external rotation lag is determined by passively positioning the arm in maximum external rotation. In marked weakness, the patient is unable to hold the arm in this position and the hand falls towards the abdomen.10

The infraspinatus is assessed by measuring the external rotation strength with the arm in abduction. The teres minor is assessed by evaluating external rotation with the arm at 90 degrees of abduction.6 Patients with subscapularis disruption have internal rotation weakness, excessive passive external rotation, and a positive lift off test or belly press test. A subscapularis tear could be overlooked by an inexperienced surgeon.14

Radiographic evaluation

Plain radiographs

Imaging should always begin with five plain radiographic views: a true anteroposterior (AP) view, an anteroposterior view in internal and external rotation, an axillary lateral view, and an outlet view.10, 15

Elevation of the humeral head relative to the glenoid and narrowing of the acromiohumeral space indicate longstanding rotator cuff pathology. Acromiohumeral space less than 7 mm is consistent with a rotator cuff tear, and a space of less than 5 mm indicates a massive tear.10

The radiographic findings of rotator cuff tear arthropathy include loss of joint space, elevation of the humeral head, erosion of the greater tuberosity, and articulation of the humeral head with the acromion.10, 15

Arthrography

Arthrography was previously considered the best diagnostic modality for these cases. Nevertheless, it is invasive and does not provide information in comparison to magnetic resonance imaging (MRI).
**Ultrasongraphy**

Teefey et al.\(^\text{16}\) have demonstrated high rates of sensitivity and specificity using ultrasonography in diagnosing rotator cuff tears. Likewise, Mall et al.\(^\text{17}\) reported that ultrasonography has had a moderate (72%) to excellent (100%) accuracy in detecting fatty degeneration. Nonetheless, acceptance of ultrasonographic imaging of the rotator cuff has been variable. The variability is related mainly to inexperience, as ultrasonography is considered a very operator-dependent modality; and to differing diagnostic criteria.\(^\text{6, 10}\)

**Magnetic resonance imaging**

Magnetic resonance imaging is a highly accurate modality and provides detailed anatomic information about the rotator cuff. Additionally, MRI can determine the size of rotator cuff tears and the status of the rotator cuff muscles.\(^\text{17}\) This information could help in confirming the chronicity of the tearing and in guiding the surgeon for proper decision making for treatment.\(^\text{10}\) The muscle bellies are assessed with a T1-weighted sagittal oblique MRI, and cuts must be sufficiently medial to allow proper assessment of the bellies.\(^\text{6}\) The degree of fatty degeneration should be noted to determine the reparability and functioning of the tissue.\(^\text{6}\)

Although many studies have confirmed the accuracy of MRI for assessing the rotator cuff, specific indications for MRI have rarely been addressed.\(^\text{18}\)

**Management**

There are different approaches to treating patients with chronic massive rotator cuff tears.

**Nonoperative treatment**

Patients can be treated through activity modifications, oral nonsteroidal anti-inflammatory medications, and subacromial corticosteroid injections. Generally, the value of conservative treatment is not well established, and there is no proof that conservative treatment could alter the course of the natural progression of massive tears.\(^\text{1, 19}\)

However, Zingg et al.\(^\text{20}\) have documented a good clinical outcome using nonoperative treatment despite significant progression of degenerative structural joint changes. Similarly, Bokor et al.\(^\text{21}\) reported improvement in 50% to 85% of patients. In this study, patients with symptoms lasting longer than 6 months had poorer outcomes.

In general, conservative treatment may lead to a satisfactory clinical outcome in selected low-demand patients. Therefore, conservative treatment is often appropriate in patients with irreparable tears. However, it is not suitable in patients with reparable tears and in patients with high mid to long term functional demands.\(^\text{1}\)
Surgical management

Biceps tenotomy and tenodesis

Tendinopathy of the long head of the biceps (LHB) has been identified as a common source of pain in patients with rotator cuff tears. Walch et al. introduced arthroscopic biceps tenotomy as a routine pain treatment in rotator cuff disease.

Subsequently, Kempf et al. conducted a multicenter study and concluded that the benefits of LHB tenotomy were evident and could be isolated in case of massive rotator tears. It seems that LHB tenotomy was particularly effective for massive tears of two or more tendons.

Walch et al. followed 307 patients who underwent biceps tenotomy solely for the treatment of rotator cuff pain. The satisfactory rate was 87% after a mean of 57 months. However, patients with fatty infiltration of the subscapularis showed less satisfactory results.

Isolated tenotomy of the biceps, however, has not been proven to prevent further degeneration of the joint. Therefore, it may not be the ideal long term option for patients with reparable tears and high functional demands.

Subacromial debridement and decompression

The arthroscopic approach for subacromial debridement is easier and has a more rapid rehabilitation than an open approach because the deltoid origin is preserved.

In Rockwood et al.’s study, acromioplasty, subacromial decompression, and debridement of massive, irreparable lesions of the supraspinatus and infraspinatus tendons were performed in 50 patients. At final follow up, there were satisfactory clinical results in 83% of patients.

Kilniger et al. compared the results of arthroscopic debridement in massive, irreparable rotator cuff tears with and without tenotomy of the LHB. They reported that arthroscopic debridement provides reliable expectation for improvement in function, decrease in pain, and improvement in shoulder scores for most patients. Additional LHB tenotomy did not significantly influence the postoperative results.

Although this approach appears to decrease pain and increase range of motion, it decreased the strength of elevation in another series of patients.

The coracoacromial arch should be maintained by avoiding excessive acromioplasty and by preserving the coracoacromial ligament, which is considered a major restraint against superior migration of the humeral head.
Tuberoplasty has been suggested as an additional option to achieve a higher degree of sphericity of the acromiohumeral articulation during elevation. The tuberoplasty procedure involves removal of exostoses on the humerus, followed by reshaping of the greater tuberosity to create a smooth, congruent acromiohumeral articulation.\textsuperscript{30}

Fenlin et al.\textsuperscript{30} reported on 20 patients who underwent tuberoplasty with a minimum 27-month follow up. On the basis of the modified UCLA rating scale, the overall score increased from 9.3 to 27.7, with 12 excellent results, 6 good results, and 1 fair result (95\% satisfactory). Pain relief was most dramatic, with 13 patients (68\%) completely pain-free. All patients were able to perform activities of daily living, and 9 of 11 who were employed preoperatively returned to work.

The ideal patient for debridement is a relatively inactive individual with massive irreparable rotator cuff tear who failed on nonoperative treatment.\textsuperscript{1}

Rotator cuff repair

The goal in repair surgery is to reattach the rotator cuff tendons to the humerus and to decompress the subacromial space without disrupting the coracoacromial arch. Several techniques have been used to mobilize the rotator cuff tendons and facilitate repair.

Assessment of tear reparability

Rationally, the tear is irreparable if the defect cannot be closed intraoperatively or if it is predicted that a successful closure during surgery will almost certainly be associated with structural failure of the repair.\textsuperscript{1}

Irreparable tears based on clinical findings

- Anterosuperior tears with obvious static anterosuperior subluxation with the head under the skin and associated with pseudoparalysis of anterior elevation\textsuperscript{1}
- Anterosuperior tears associated with dynamic anterosuperior subluxation of the humerus upon resisted abduction\textsuperscript{1}
- Posterosuperior and global tears associated with chronic pseudoparalysis of the anterior elevation\textsuperscript{1}
- A true dropping sign indicating that the infraspinatus muscle has Goutallier stage 2 or higher fatty infiltration\textsuperscript{31}

Irreparable tears based on radiographic findings

- Static superior subluxation of the glenohumeral joint with an acromiohumeral interval of 7 mm or less on AP view with the arm in neutral position\textsuperscript{18}
- Static anterior subluxation detected on computed tomography (CT) or MRI\textsuperscript{1}
• Stage 3 or 4 fatty infiltration of the rotator cuff muscles determined by CT or MRI

Open surgical approaches often require multiple incisions or extensive deltoid detachment to visualize the tear margins. Potential complications, such as deltoid dehiscence, scarring, and infection have been reported and are difficult to manage.

The arthroscopic approach has the advantages of visualizing cuff margins, determining reparability, and identifying coexisting problems without disturbing the deltoid attachments.

In the surgical procedure, it is crucial to do adequate tendon mobilization to reduce tension at the repair site. Adequate mobilization is done by releasing all the adhesions between the tendon and the capsule, in addition to the bursal adhesions between the rotator cuff, acromion, and deltoid. Additional releases, such as anterior and posterior interval slides could be performed to increase medial to lateral mobility and achieve repair under minimal tension.

If such repair is not possible, a partial repair is performed or rotator cuff reconstruction is considered. Burkhart et al advocated partial repair. This technique involves repair of the margins of the tear to restore the force couples and "suspension bridge" system of force transmission in the shoulder. Complete coverage of the defect is not considered essential as long as the normal mechanics of the shoulder are restored and the rotator cuff tear is converted to a functional cuff tear.

**Tendon transfers**

Although various tendon transfers have been proposed, the most commonly used have been latissimus dorsi transfer for posterosuperior lesions, and pectoralis major transfer for subscapularis tear.

**Latissimus dorsi transfer**

A healthy strong latissimus dorsi muscle is used to restore the external rotation and head depression forces that are lost in chronic massive rotator cuff tear. Results are better with an intact subscapularis tendon.

Gerber followed sixteen irreparable, massive rotator cuff tears that were treated with latissimus dorsi transfer and reviewed after an average of 33 months. Restoration of approximately 80% of normal shoulder function was obtained, indicating that latissimus dorsi transfer is a safe and valuable alternative for the treatment of this specific type of irreparable rotator cuff tear.
Pectoralis major transfer

Pectoralis major transfer is a valuable salvage procedure for isolated irreparable subscapularis lesions.\textsuperscript{1} In massive anterosuperior tears, pain can be reduced, but results for functional restoration are rather disappointing.\textsuperscript{35}

Shoulder arthroplasty

Humeral head replacement

Humeral head replacement is indicated when nonsurgical modalities fail to provide pain relief in cases with massive rotator cuff tears associated with glenohumeral osteoarthritis. However, the results are discouraging in cases associated with pseudoparalysis.\textsuperscript{1,10}

Reverse total shoulder arthroplasty (RTSA)

Reverse total shoulder arthroplasty was first developed for the management of complex shoulder disorders; nevertheless, the indications have been extended to include irreparable rotator cuff tears. Reverse total shoulder arthroplasty has been proven to be a reliable good short term solution for treatment of disabilities caused by irreparable rotator cuff tearing and rotator cuff arthropathy. It can be done in cases associated with pseudoparalysis of the anterior elevation.\textsuperscript{36} Furthermore, satisfactory results can even be obtained in patients with a past history of failed rotator cuff repair.\textsuperscript{36}

Nonetheless, RTSA solely is biomechanically unable to correct the pseudoparalysis of external rotation. Additionally, familiarity with the complications related to the procedure is essential to achieve better outcomes. Complications include neurologic injury, dislocation, periprosthetic fractures, and hematoma.\textsuperscript{1,37}

Conclusion

Chronic massive rotator cuff tears can cause substantial shoulder pain and dysfunction. As there are currently multiple treatment options for different clinical presentations, careful patient evaluation and treatment selection are critically important.
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