

Advanced Arthroscopic Treatment for Massive Rotator Cuff Tears: A Review Article

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Abstract

Rotator cuff tear is a disease with shoulder pain and dysfunction which is caused by repeated upper limb movement and chronic lesions of the shoulder joint. Patients with massive rotator cuff tear have persistent pain and limited upper extremity activity, seriously affecting their life quality. As the massive rotator cuff tear is common and exhibits various limitations in active and passive shoulder motion, the early diagnosis and treatment are very important. With the rapid development of arthroscopic techniques, arthroscopic rotator cuff repair could maximize the retention of the deltoid muscle in the acromion attachment points, with some advantages, contributing to the joint function exercises and rehabilitation after the operation. In recent years, there are many arthroscopic repair clinical studies about massive rotator cuff tears with some encouraging results. Here, in this article we have reviewed the recent approaches, surgical advances and postoperative rehabilitation in relation to massive rotator cuff tear.

Keywords: massive rotator cuff tear, arthroscopic repair, shoulder joint.

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1. Introduction

Rotator cuff tear is a disease with shoulder pain and dysfunction which is caused by repeated upper limb movement and chronic lesions of the shoulder joint, and it is also a common cause of shoulder pain and dysfunction, of which the size of rotator cuff tear is an important prognosis factor [1]. Patients with massive rotator cuff tear will have persistent pain and upper extremity activity limitation, seriously affecting their quality of life. With the rapid development of arthroscopic techniques, the mirror processing technology for massive rotator cuff injury is becoming more and more mature, and arthroscopic rotator cuff repair could maximize the retention of the deltoid muscle in the acromion attachment points, with some advantages, such as less surgical trauma, wide vision, smaller joint interference, contributing to the joint function exercises and rehabilitation after operation [2]. There have been advances in the surgical approach to rotator cuff repair, it has gradually evolved from open to arthroscopic and this transformation has been accompanied by changes in available repair methods. In recent years, there are more and more arthroscopic repair clinical studies with some encouraging results. Healing rates differ for different procedures used for rotator cuff repair. The purpose of this review is to determine whether a specific repair method is associated with significantly higher structural healing rates, and whether the

surgical approach was associated with a difference in healing rates for a given repair method.

2. Definition of a massive shoulder tear

At present, there is no defined definition of massive shoulder tear. In Europe, authors considered that rotator cuff tears involving more than two tendons are divided into a massive tear [3]. However, the North American region defined it as a massive tear of the shoulder tear which is larger than 5 cm in diameter [4]. Burkhart et al. [5, 6] divided the massive tear into three categories: crescent tear, "U" type tear and "L" shaped tear. Crescent tear shows a smaller tearing tension; uniform retraction appeared in "U" type tear, and retract to the apex of the labrum position; "L" type tear related to vertical and horizontal retraction. Massive rotator cuff tears of tendon retraction generally exceed the glenoid rim frequently associated with subacromial impingement syndrome in patients with limb weakness, and biceps long head tendon proximal lesions and other diseases. Massive rotator cuff tear can cause severe pain and dysfunction, so patients suffered great pain.

2.1 Pathologically Biomechanical Mechanism of massive rotator cuff tear

The normal biomechanics of the shoulder joint is closely related to the mechanical stability of the muscles around the joint. In fact, the normal biomechanics is actually the mechanical balance on

each plane. Glenohumeral joint keep the mechanical balance when shoulder moving containing the deltoid and rotator cuff (largely supraspinatus muscle, supraspinatus, teres minor and subscapularis muscle) maintained. As in shoulder abduction, the rotator cuff keeps the deltoideus balance that the humeral head cannot shift up. If a massive rotator cuff tear occurs, the mechanical balance of the shoulder joint is damaged, resulting in the shoulder dysfunction. Burkhart et al. [7,8] summarized three kinds of mechanical balance failure mode that patients with a massive rotator cuff tears appeared: a) Only supraspinatus tear, the shoulder joint retained a certain function; b) massive tear involving subscapularis muscle and infraspinatus muscle or teres minor, in which the mechanical balance of the shoulder joint is damaged, resulting in the limited shoulder function; c) All the rotator cuff tendons involved, the humeral head shifting. The shoulder function is severely impaired, with significantly clinical symptoms. Exploring the pathologically biomechanical mechanism of massive rotator cuff tear could guide clinicians to select the appropriate surgical plan.

2.2 Surgical indications of arthroscopic treatment for massive rotator cuff tear

Surgical decision making for full-thickness rotator cuff repair is complex. Clinical presentation and patient preferences can be quite variable. Although many series of rotator cuff repair exist in the literature, relatively there is a few definite indications surgery.

Most of the patients with rotator cuff tear have a positive impingement signs on physical evaluation. The Hawkins and Neer impingement sign are most commonly used during the examinations [9,10]. These physical examination procedures have been reported to be very sensitive to rotator cuff tears [11]. However, Kirkley et al [12] called into question the usefulness of the impingement test because it did not reliably predict outcome after subacromial decompression in patients with tendinosis or partial thickness tears.

Some studies found a high probability of predicting the combination of full-thickness rotator cuff tear. A 98% chance of a full-thickness tear was found by Murrell and Walton [13] in patients with weakness in abduction, positive impingement signs, and age greater than 60 years. Park et al [14] found that a combination of a positive painful arc sign [15], a drop arm sign [16], and weakness in external rotation produced a 91% probability that a rotator cuff tear

was present. In addition, Hertel et al [17] described lag signs, which are helpful in diagnosing full-thickness tears. These include the external rotation lag sign and the drop sign.

The prevalence of rotator cuff disease has been shown to be quite high and appears to be associated with aging. MRI of asymptomatic volunteers demonstrated partial or complete tears of the rotator cuff in 4% of patients <40 years of age and 54% in those >60 years of age[18]. Multiple advanced imaging methods are available including MRI, MRI arthrogram, double-contrast arthrography, CT arthrogram, and ultrasound. Each has allowed clinicians to directly and accurately assess for the presence of a full-thickness rotator cuff tear [19-22]. MRI and ultrasound are the most common methods of rotator cuff assessment and have been proven accurate in assessing full-thickness rotator cuff tear size [20,22].

Most of the guidelines used for decision making in treating rotator cuff tear are based on limited evidence and minimal science. Factors that seem to be important include the duration of symptoms, acuity of tear, weakness, size of the tear, muscle atrophy, and fatty infiltration are most important indications.

Deciding the operative treatment needs to evaluate the risks and benefit associated with it. Studies shows that the overall long-term clinical results of both arthroscopic and open rotator cuff repairs are durable, with over 90% good or excellent results at 10 years [23,24]. Similarly, results of treatment of partial-and full-thickness rotator cuff tears without repair have shown moderate success with 45% to 82% satisfactory results [25-28]. Nevertheless, most People consider both reparability and healing of the tear to be important for the best outcome. It is mostly performed in middle-aged patients with a painful massive tear, trauma-precipitating symptoms, radiographs with the humeral head centered in the glenoid, and an MRI showing less than 50% fat changes within the muscles. Attention should be paid to avoid the injury of nerve in the operation and to reduce intraoperative blood pressure by controlling hypotension and skilled techniques to maintain a clear visual field of vision.

3. Shoulder arthroscopy for the treatment of massive rotator cuff tears

3.1 Simple arthroscopic debridement and shoulder arthroplasty

With the development of arthroscopic techniques, some scholars hope to take a simple rotator cuff debridement and acromion plasty that does not repair rotator cuff by use of the minimally invasive arthroscopic. By these methods, it will relieve pain and improve function as possible. The technology was originally applied to elderly patients suffering from huge rotator cuff tears with severe pain and relatively low activity requirements. Even though these patients don't improve the shoulder strength a lot, the pain caused by shoulder impingement syndrome was eliminated and the function improved. Burkhart et al [29,30] reported that arthroscopic treatment can significantly ease the pain of patients and improve shoulder function. Ellman et al. [31,32] reported that the pain of patients with massive rotator cuff tear after arthroscopic debridement were significantly reduced, but the power or function not significantly improved. However, Zvijac et al [33] reported that for the next application of arthroscopic debridement and subacromial decompression for Massive damage, symptoms may be aggravated over time. Kempf et al [34] reported that the overall Constant score was not significantly increased in patients after arthroscopic debridement and long-term rehabilitation exercises. Our team found that simple debridement and shoulder forming may well relieve the patient's pain, though a limited functional improvement, but for those elderly patients with the less functional requirement and more severe pain, it is more suitable.

4. Repair of massive rotator cuff tear under arthroscopy

The following table shows the comparison of different arthroscopic surgical techniques and their outcomes.

Table 1: Comparison of different techniques for repairing massive rotator cuff tears under arthroscopy

Study	Technique	Cases	Preoperative Score	Postoperative Score
Burkhart et al[35]	Edge convergence principle	59	14	29.9
Lo IK et al[38]	Interval Slide Technique	94	10	28.3
Rousseau et al[42]	Side-to-side technique	50	14	32.1
Ivan Wong et al[43]	Tissue engineering	45	18.4	27.5

4.1.1 Partial repair using the edge convergence principle

Along with the rapid development of technology and a variety of arthroscopic instruments and endoscopic operations suture anchors appeared, single row, double row, fixed bridge technology have been widely used in small and medium rotator cuff tear

repair. Many reports have indicated that rotator cuff tear repair can be easily carried out via arthroscopic technique. Since the present study on the mechanism of shoulder and rotator cuff biomechanics is more and clearer, many scholars have summarized a lot of suture techniques in the treatment of huge shoulder repair. In a study partial repair was performed in 59 patients by using edge convergence principle under arthroscopy and the average follow-up of 3. 5 years, found significant remission in pain, function, strength and motion of the joint [35]. Duralde et al performed a partial repair on 24 patients with massive rotator cuff tear, after operation, 67% of patients got excellent or good, 83% of patients with pain relief, 92% of patients felt that the results were satisfactory, further proving that the mechanical balance of the partial repair and reconstruction of the rotator cuff is feasible [36]. Bennett performed the partial repair in 37 patients with massive repair torn shoulder, the postoperative Constant score and ASES scores were significantly improved and the pain significantly reduced, the patients' satisfaction rate was 95%. The suture method of edge convergence is applied to some massive "U" shaped and V-shaped tear [37].

4.1.2 Repair of massive interval slide retract rotator cuff tear by Arthroscopic repair technique

In general, massive rotator cuff tear will adhere to the surrounding tissue seriously. It cannot be repaired due to too much tension. Burkhart [38] reported the application of Interval Slide Technique. He firstly completed release of the front side of the rotator cuff gap, then release the supraspinatus, infraspinatus tendon gap between the completions of the rear shoulder rotator cuff gap along the bottom. After the completion of the supraspinatus, infraspinatus tendon activity improved significantly; supraspinatus tendon can be no tension on the outside of the fixed bone bed, infraspinatus muscle tendon can be fixed to the outside of the bone bed to move forward as far as possible the final suture residual defects established couple balance. Rotator cuff interval slide technology needs skilled arthroscopic operation skills and mastery of strict surgical indications, the biomechanical requirements of the shoulder joint can be accord with the reconstruction of the shoulder. Burkhart et al applied this method to complete the 94 patients with massive rotator cuff tear, including nine cases of massive, retraction, adhesions and fixation. No tear of the rotator cuff did not occur in the patients after operation, and the UCLA score increased to 28.3 points from 10 points. A loose solution of rotator cuff gap for massive rotator cuff

tear with adhesive is helpful for increasing the activity degree of the tendon. It provides a good technical proposal for the repair of massive rotator cuff tear. I believe that this technique is applicable to any of the great rotator cuff tear repair.

4.1.3 Arthroscopic side-to-side technique to repair the massive shrinkage of shoulder tear

The ultimate goal of rotator cuff repair is to achieve tendon-bone healing. The tension of the rotator cuff should not be too large for the surgical repair, so it must be developed a variety of arthroscopic techniques for the treatment of massive rotator cuff tears [39, 40]. "side-to-side" technology is mainly used to deal with the massive longitudinal tear. Through the mirror under a line from the torn vertex suturing rotator cuff tears at both ends of the closed rotator cuff, tear notch with single or double row anchor screw rotator cuff is fixed on the bone bed. St Pierre [41] has confirmed that the application of this technology can increase the probability of suturing the tendon healing. Rousseau et al. [42] reported the use of the application in the treatment of 50 cases of patients with massive rotator tear, with the Constant score improved from 40% to 91.7% at an average follow-up of 24 months and 88% of surgery patients were either satisfied or very satisfied.

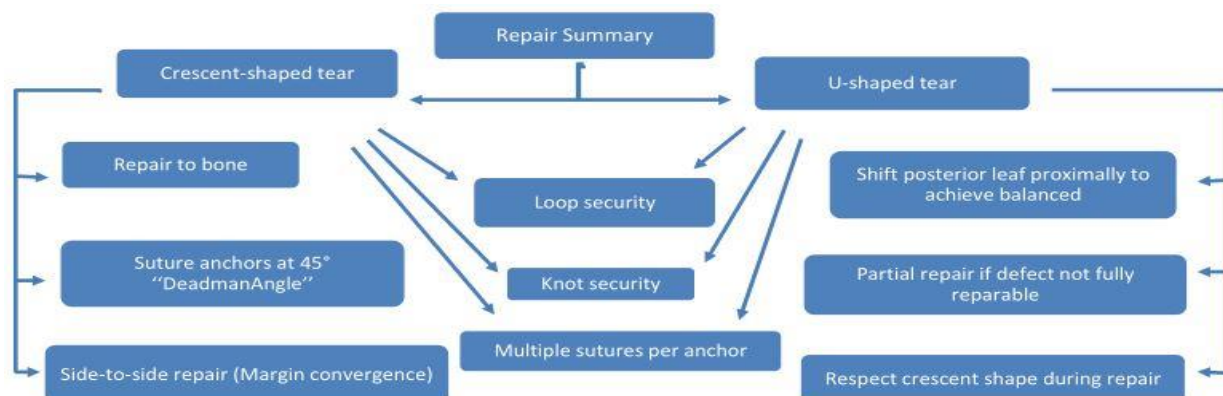
4.1.4 Arthroscopic repair of tissue engineering to repair massive retract rotator cuff tear

Many patients with massive rotator cuff tear severe fat infiltration, poor quality tendon belong irreparable damage, so direct repair is very difficult. With the promotion of the development of tissue engineering and arthroscopic operating technology. Some scholars have applied Graftjacket (acellular dermal matrix) under arthroscopy to repair the Graftjacket repair to the defect of the tendon by using various thread technique and suture anchors. This technique was applied in 45 patients who were not directly repaired by a rotator cuff tear, the UCLA score was

increased from 18.4 to 27.5 after an average follow-up of 2 years and the WORC average score was 75. 2 points, ASES average score was 84. 1 points [43]. No rejection reaction occurred. Some scholars have reported that 16 cases of massive irreparable rotator cuff tear repaired using allograft material [44]. Patients who were satisfied the results. Snyder et al. [45] also reported Arthroscopic acellular human dermal repair 18 cases of massive rotator cuff tear were repaired by acellular human dermis under the arthroscopy, it also has received satisfactory results. However, I believe that the further study is needed to explore the efficacy of the application materials, including biocompatibility, mechanical characteristics.

4.2 Arthroscopic treatment with humeral tendon lesion in the treatment of massive rotator cuff tear

Massive rotator cuff tears usually with biceps tendon lesions and the long head of biceps brachii muscle lesion will increase the occurrence of patients with rotator cuff tear even pain is the main cause of pain. Therefore, some scholars considered that the simple treatment of the long head of biceps tendon to treat massive irreparable rotator tear or reluctant to carry out rehabilitation exercise in elderly patients. In Walch et al. study, 291 patients underwent arthroscopic biceps tenotomy, some patients simultaneously acromioplasty, the average score improved from 48. 4 points to 67. 6 points after an average follow-up 57 months [46]. 87. 0% of patients were satisfied with the surgical results, but 24. 8% of patients experienced increased pain. I think that the biceps tendon may play a role in the inhibition of the humeral head shift, maintaining shoulder stability. Simply cut or fixing may cause shoulder instability and may speed up the process of arthritis, but it can be used as palliative surgery alleviate the suffering of patients with minimally invasive surgery.



The above chart summarizes the different approaches to different types of tears in the surgical treatment of rotator cuff injury.

5. Postoperative rehabilitation

Rehabilitation exercise for patients after shoulder arthroscopy is very important for the rehabilitation of patients. The goal of postoperative rehabilitation is to control pain, protect the healing repaired tissue, restore function to the norm and avoid recurrence. After post-operative restrictions have been established, either a conservative or moderate rehabilitation protocol is selected and customized based on surgical findings. The conservative protocol is characterized by either a delay in the initiation of and/or restriction of passive range of motion. It is common for restrictions to last for 2–4 weeks. The aim is to minimize stress placed on the repaired tissues to facilitate early tissue healing. The moderate protocol is characterized by initiating a passive range of motion on postoperative day 1 while maintaining tolerable pain levels [47]. Gerber et al [48] reported that the early stage of the passive motion repaired interface collagen whose arrangement was disordered after the shoulder joint operation. But after a few weeks of joint bracing, the collagen arrangement tended to be ordered in order to be able to withstand greater tension, showing that early bracing helps tendon-to-bone healing. Arthroscopic surgery on the deltoid muscle with less damage, six weeks early bracing does not produce very serious adhesion.

The general guidelines for rehabilitation following repair of massive rotator cuff tears include the same steps as the protocol following repair of small and medium rotator cuff tears. Although, after massive rotator cuff tears repair, the rehabilitation is delayed by few weeks. The passive range of motion exercises is introduced 7-9 weeks postoperatively within determined limits (such as 120° of elevation and 30° of external rotation). The physiotherapist can begin Scapula controlled exercises as well as submaximal isometrics of uninvolved tendons. Restrictions often continue until 10-11 weeks postoperatively then follows Glenohumeral and rhythmic stabilization exercises. A full recovery from rotator cuff surgery can take up to one year. During this period Clear instructions about restrictions include avoiding any lifting, pushing, pulling, carrying, or any active range of motion is given to the patients. To prevent extension of the arm, particularly in the supine position, a pillow is placed behind the elbow to keep the arm more level with the abdomen. Internal

rotation beyond the stomach and sleeping on the operated shoulder are also avoided.

6. Conclusion

As the massive rotator cuff tear repair is difficult to treat in late stage, the early diagnosis and treatment are very important. Previous studies showed that open repair of massive rotator cuff tear repair can improve clinical outcomes. With the development of arthroscopic techniques, arthroscopic repair of massive rotator tear has achieved encouraging results. As compared to the traditional incisional surgery, arthroscopic repair has many advantages. The advantages of arthroscopic repair are to make more comprehensive and objective assessment of the etiology and pathology of the tear, conduct a comprehensive inspection of the glenohumeral joint cavity and less injury to the soft tissue. Therefore, the shoulder arthroscopic repair will gradually replace the traditional incisional surgery. Meanwhile, with the development of arthroscopic techniques and instruments, endoscopic suture repair technology has been improved by a simple endoscopic synovial debridement to completely endoscopic repair and fixing it in a variety of ways. The studies at present are limited to the surgeon's self-experience and case based. Further researches are to be carried out for better repairing techniques for early healing and better results.

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