

Reverse Total Shoulder Arthroplasty in the Massive Rotator Cuff Tear

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In the patients of retracted massive rotator cuff tears, there are much of difficulty to functional recovery and pain relief. Nevertheless the development of treatment, there are still debates of the best treatments in the massive rotator cuff tears. Recently various of treatments are introduced; these are acromioplasty with debridement, biceps tenotomy, great tuberosity with biceps tenotomy, partial repair, mini-open rotator cuff repair, arthroscopic rotator cuff repair, soft tissue augmentation, tendon transfer, flap, hemiarthroplasty, and reverse total shoulder arthroplasty. That there is no difference of result for reverse total shoulder arthroplasty between patients who have massive rotator cuff tear without arthritis and patients who have cuff tear arthropathy. Reverse total shoulder arthroplasty is one of reliable and successful treatment options for massive rotator cuff tear. Especially it is more effective for patients who have a pseudoparalysis. (*Clin Shoulder Elb* 2014;17(3):145-150)

Key Words: Reverse total shoulder arthroplasty; Massive rotator cuff tear; Pseudoparalysis; Deltoid dysfunction

Introduction

Patients with retracted massive rotator cuff tears have much difficulty in functional recovery and pain relief. Despite of the development of treatment, there are still debates about the best treatments in the massive rotator cuff tears. Recently, various of treatments are introduced; these are acromioplasty with debridement,^{1,2)} biceps tenotomy,³⁾ tuberosity with biceps tenotomy,⁴⁾ partial repair,^{5,6)} mini-open rotator cuff repair,^{7,8)} complete arthroscopic rotator cuff repair,^{9,10)} soft tissue augmentation,^{11,12)} tendon transfer,^{13,14)} deltoid flap,^{15,16)} hemiarthroplasty,¹⁷⁾ and reverse total shoulder arthroplasty.¹⁸⁾

Generally, 'massive rotator cuff tear' means that more than 5 cm sized tear or more than 2 of 4 rotators' complete tear lesions, or both of them.¹⁾ But there is a tendency to use the name of 'massive rotator cuff tear' extensively for various different symptoms. Potential healing capacity of rotator cuff and technically satisfied repair are considered more important than size of rotator cuff tear.¹⁹⁾ In many cases of acute rotator cuff tear, it is possible to repair it if there is some degree of mobility even though more than 2 cuff lesions are involved.

Reverse total shoulder arthroplasty is one of effective and

proven treatments in the cuff tear arthropathy.^{20,21)} But if there are not much injuries in articular cartilage of humeral head, arthroplasty is not an easy treatment to choose for both doctors and patients. Therefore, to apply reverse total shoulder arthroplasty to who have massive rotator cuff tears without cuff tear arthropathy, first of all we should understand the mechanism of massive rotator cuff tear and shoulder instabilities.

Physiology and Mechanism

Stability of gleno-humeral joint is formed by bony structures and soft tissue structures and the rotator cuff tendons provide dynamic stability for the shoulder by creating compressive force through centering the humeral head within the glenoid fossa,^{22,23)} and are critical for glenohumeral stability throughout its range of motion.²⁴⁾ Normal state of rotator cuff tendons play a role as fulcrum to change the shear force by deltoid muscle to rotation force, enabling a shoulder elevation.^{25,26)} But if there is absent of rotator cuff, this mechanism is lost. Therefore the shear force by deltoid muscle elevates humeral head and precludes the shoulder elevation.

A stable lever arm is formed by 'force couple' of rotator

Received July 6, 2014. **Revised** August 14, 2014. **Accepted** August 18, 2014.

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Financial support: None. **Conflict of interests:** None.

cuff.²⁷⁾ While the rotator cuff creates a net inferior and compressive vector, the strong deltoid muscle provides a superiorly directed force, resulting in a balanced 'force coupling' of glenohumeral joint. In addition, anterior and posterior force vectors are balanced by the subscapularis, teres minor, and infraspinatus.²⁸⁾ If there is rotator cuff tear, compensation mechanism for loss of abduction force by rotator cuff increases the deltoid force.^{29,30)} If an isolated supraspinatus tear is relatively small, glenohumeral stability is preserved with contraction of the large adductors (latissimus dorsi and pectoralis major muscles).^{30,31)} However, if cuff tear lesion is extended to posterior area, it disturbs 'force couple' mechanism, so it induces loss of compensation.³¹⁾ As a result, joint reaction force vector migrates outside the glenoid rim, and it causes instability of shoulder joint.^{30,31)} The loss of a stable fulcrum induces pseudoparalysis or intermittent anterosuperior escape of upper arm (Fig. 1). But if partial or full repair of rotator cuff is possible, a recovery of 'force couple' could happen.^{8,12)}

Pseudoparalysis is defined as a condition to elevate the arm passively but not actively, and can be caused in the absence of neurologic lesion.³²⁾ Surgeons must identify conditions that may clinically mimic pseudoparalysis caused by a rotator cuff tear, such as axillary nerve injury, deltoid dehiscence, or cervical radiculopathy.³³⁾ Also, it is important to distinguish between true pseudoparalysis and limitation of motion induced by pain. Careful inspection is needed to find out the possibility of anterosuperior escape of humeral head during forward flexion or abduction of arm. And examiners should check whether the angle of arm is maintained during passive forward flexion (90–120 degree) to confirm the symptoms by massive rotator cuff tear. In massive rotator cuff tear, reverse articular surface prevents the upper migration, recovers deltoid tension and attributes the stability of



Fig. 1. Antero-posterior radiograph of the right shoulder showing superior migration of the humeral head, which is indicative of a massive rotator cuff tear.

shoulder joint. Also, superiorly directed force of deltoid is converted to rotation force, enabling elevation of arm.³⁴⁾

Indications and Contraindications

In the preoperative macro resonance imaging (MRI), it is unlikely to benefit from repair in case of more than 40 mm length and width of tear lesion, fatty degeneration at the infraspinatus, and thinning of supraspinatus at the superior glenoid area.³⁵⁾ Also, large (>5 cm) tears that involve two or more rotator cuff tendons with atrophy and a high degree of fatty infiltration (Goutallier stage 3 or 4) are unlikely to benefit from attempts of surgical repair.^{27,36,37)} Like this, patients who have irreparable massive rotator cuff tear lesions are to take reverse total shoulder arthroplasty into consideration. Eligible candidates for reverse total shoulder arthroplasty should demonstrate forward elevation of less than 90 degree, and have weakness of the rotator cuff musculature on physical examination.¹⁸⁾ Often these patients would have no problem in full passive shoulder motion.³³⁾

Indications for reverse total shoulder arthroplasty are; First, who have old age, multiple underlying diseases such as diabetes mellitus, smokes or chronic rotator cuff tear lesion that is less capable to be healed, painful symptoms under the physical examinations, less than 90 degree of forward flexion and retracted rotator cuff without upper migration of humeral head under the MRI.³⁷⁻⁴⁴⁾ Second, patients who have massive rotator cuff tear with pseudoparalysis, pain and apparent anterosuperior escape of humeral head are also indicated.^{19,45-47)}

But patients who have massive rotator cuff tear with abnormal function of deltoid are contraindicated for reverse total shoulder arthroplasty.³³⁾ That is, in cases of cervical myelopathy, previous open rotator cuff repair history, or axillary nerve palsy, good results are not expected. Cervical myelopathy and deltoid disfunction are not guaranteed for successful results of reverse total shoulder arthroplasty. We should consider the cervical myelopathy when patients have pain along the peripheral nerve dermatome, radiating pain from elbow to fingers, and pain with neck extension or flexion. Preoperative evaluation of the deltoid function is necessary, especially for those who underwent previous open rotator cuff repair. Above mentioned, there is no satisfactory result for patients who have deltoid disfunction.^{33,36)} Besides, isolated supraspinatus tear and possibility of full range forward flexion are also contraindicated for reverse total shoulder arthroplasty.³⁶⁾

Results

Werner et al.⁴⁸⁾ reported that the reoperation rate was lower and the final Constant score was higher in patients who were initially treated with a primary reverse shoulder arthroplasty than in patients who were treated with a reverse shoulder arthro-

plasty after a prior failed rotator cuff repair or failed arthroplasty. Cuff et al.⁴⁹⁾ reported similar improved outcomes in primary use of reverse shoulder arthroplasty, compared with use in revision settings. Whereas primary and revision arthroplasties resulted in similar improvements in the range of motion, the pain and relative Constant scores were significantly higher following the primary procedures.⁴⁸⁾ Wall et al.⁵⁰⁾ described that there is no difference in the result from reverse total shoulder arthroplasty between patients who have massive rotator cuff tear without arthritis and patients who have cuff tear arthropathy. But Boileau et al.¹⁸⁾ described that patients who have preoperative limitation of motions are expected better results than patients who have preoperative full range of motions. Patients who have preoperative full range of motions are reported decrease of 24 degree forward flexion, less increase of Constant score, and more increase of dissatisfaction index after reverse total shoulder arthroplasty. Mulieri et al.⁵¹⁾ described that results of 60 patients without arthritis who underwent reverse total shoulder arthroplasty show the increase of American Shoulder and Elbow Surgeons score from 33.3 to 75.4, which is similar results of patients with arthropathy. Besides, visual analog pain score is improved from 6.3 to 1.9, simple shoulder test score is from 1.6 to 6.5, and visual analog score for function is from 3.2 to 7.1. And also in the range of motions, there are increase of forward flexion from 53 to 134 degree, increase of external rotation from 27 to 51 degree, and increase of internal rotation from S1 to L2. That is, there are relatively good results in patients who have massive rotator cuff tear regardless of having arthritis.³³⁾ Generally, there is better result in the primary reverse total shoulder arthroplasty groups compared to secondary reverse total shoulder arthroplasty groups with previous rotator cuff repair.⁴⁸⁾ However, patients who have preoperative pseudoparalysis are expected better results and satisfactions than patients who have spared range of motions (>90 forward flexion).³³⁾

Complications

Various complications of reverse total shoulder arthroplasty are reported. However, the summary of reported complications represents the series of common aspects. Most common complication is scapular notching.^{20,48)} In case of lateralized rotation axis of glenosphere, decrease complication of scapular notching is reported.^{30,49)} In the biomechanical studies, medialized rotation of glenosphere induces relatively frequent increase of scapular notching.^{52,53)} Some studies reported that postoperative dislocation is most common complications.^{48,49)} Although it is not reported in all of studies, postoperative infection rates (16%) are relatively increased after the revisional arthroplasty.²⁰⁾ History of previous operations increased the frequency of potential complications and reoperations.⁴⁸⁾ And also history of previous operations decreased the survival rate of implants.⁵¹⁾ Postoperative acromion fractures are also one of common complications.^{21,54)} The reason of this complications is still unclear, but it frequently occurs at the base of acromion and also occurs at the shaft of clavicle (Fig. 2). A common presentation of acromion fracture appears after direct trauma, intense exercise or excessive manipulation.³³⁾ But trauma is not necessary condition for acromion fracture, and insufficient fracture by intense tension of deltoid is also one of reasons.⁵⁵⁾

Though according to recent reports, there is no much relationship between humeral lengthening by intense tension of deltoid and acromion fracture.⁵⁶⁾ And preoperative acromion fracture and Os acromiale do not have an adverse effect on postoperative prognosis.⁵⁴⁾ Boileau et al.¹⁸⁾ reported a 8.7% complication ratio; these were dissociation of implants, axillary mass, periprosthetic fracture and aseptic loosening.

Mulieri et al.⁵¹⁾ described a 20% complication ratio in the patients without arthritis. In his study, there was 4 metallic baseplate failures caused by design of prosthesis. After modified design of prosthesis, there was no metallic baseplate failure. Except the case of metallic baseplate failure, complication ratio

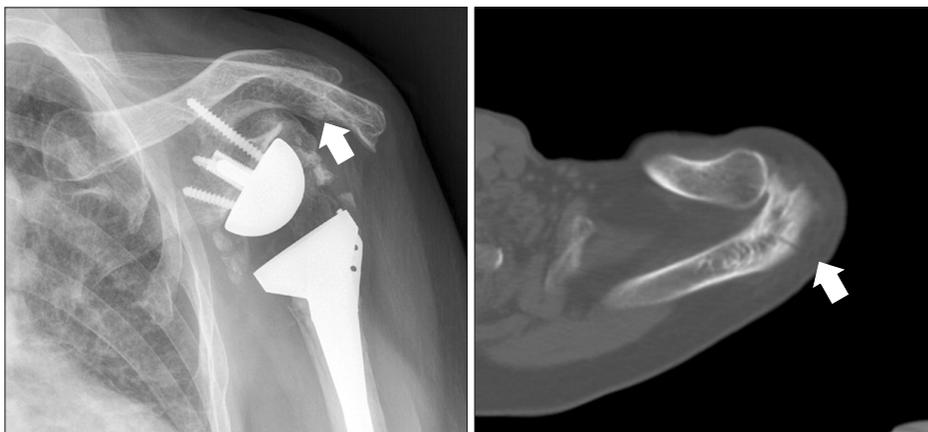


Fig. 2. Acromial fracture (arrows) following reverse shoulder arthroplasty.

Table 1. Causes of perioperative complications in the reverse total shoulder arthroplasty

Causes of postoperative complication	
Heterotopic ossification	
Periprosthetic fracture	
Acromion fracture	
Dislocation	
Causes of intraoperative complication	
Poor screw fixation	
Center hole drille	
Calcar fracture	
Humeral shaft fracture	
No anterior screw	
Glenoid cavity fracture	

was about 13%; these were 3 acromion fracture, 1 periprosthetic fracture, 1 dislocation, 1 screw breakage, 1 hematoma and 1 deep infection. There are another complications such as heterotopic ossification (10%). Shoulder dislocation (2.5%), and periprosthetic fracture with stem loosening were reported (Table 1). Frequency of complications between arthritis group and non-arthritic group made no significant difference.⁴⁸⁾

Conclusion

Reverse total shoulder arthroplasty is one of reliable and successful treatment options for massive irreparable rotator cuff tear without arthritis especially for those who are experiencing shoulder instability and pseudoparalysis, but non arthroplasty options either have failed or had a low likelihood of success. RTSA has been shown to increase patient function and decrease pain. Although RTSA is revolutionized treatment of rotator cuff deficient shoulder, its use must be tempered toward the appropriate patients. In case of appropriately selected patients, comparable functional improvement, pain relief, and patient satisfaction can be expected. There are still many complications related to this procedure. However, with stringent patient selection and proper surgical technique, high patient satisfaction scores are typically achieved at the time of short to intermediate-term follow-up. Further studies are required to evaluate the efficacy these devices bring in the long term.

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