



Mini Review

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A Brief Review of Reverse Shoulder Arthroplasty for Rotator Cuff Arthropathy

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Abstract

Reverse total shoulder arthroplasty is an increasingly popular procedure performed by orthopedic surgeons. The indications have expanded over the past two decades with well documented success in the treatment of rotator cuff arthropathy. Patients with loss of rotator cuff function experience altered shoulder biomechanics that lead to superior humeral head migration, acetabulization of the acromion and progressive glenohumeral arthritis. Clinically, patients present with chronic shoulder pain, weakness and loss of range of motion that impacts activities of daily living. To address this, a reverse total shoulder can be performed. The procedure is normally done in the beach chair position utilizing the deltopectoral approach. A humeral stem with liner and glenosphere is implanted into the humerus and scapula, respectively. The procedure has shown consistent improvements in pain, strength, range-of-motion and function. Complications include dislocation, instability, fracture and infection.

Keywords: Rotator cuff arthropathy; Reverse total shoulder arthroplasty; Arthritis, Shoulder; Shoulder replacement; Review

Abbreviations

TSA – Total shoulder arthroplasty

RTSA - Reverse total shoulder arthroplasty

CTA - Cuff tear arthropathy

RCR - Rotator cuff repair

AHI - Acromiohumeral index

MMI - Maximum medical improvement

ER - External rotation

ROM - Range of motion

Introduction

Shoulder arthroplasty is an increasingly popular procedure, with a rise in volume of 103.7% from 2011 to 2017 [1]. This trend is particularly notable when examining the reverse shoulder arthroplasty (rTSA) rates which increased in volume by 191.3% between 2011 and 2017 and increased in incidence by 178.3% within the same time period [2]. Additionally, 42% of all shoulder arthroplasties (anatomic, reverse, or hemiarthroplasty) were

rTSAs in 2011 [3]. Using Poisson regression model, overall volume of rTSA was projected to increase 353% by 2025. The demand for all shoulder arthroplasties is expected to increase over 750% by 2030[4].

The indications for rTSA have steadily grown over recent years and now typically include glenohumeral arthritis due to osteoarthritis or cuff tear arthropathy (CTA), failed

hemiarthroplasty, malunion, nonunion, humeral fracture, or proximal humeral tumor [5-7]. Rotator cuff tear arthropathy is an increasingly recognized cause of glenohumeral arthritis [5-10]. Anatomic shoulder arthroplasty was historically the gold standard for rotator cuff pathology, until Grammont designed the initial reverse total shoulder arthroplasty (rTSA) in 1987 which has been continually improved upon and optimized [5,6,11,12]. Approved in the US in 2004, rTSA bypasses the need for an intact rotator cuff and creates stability by lowering the humeral head and medializing the center of rotation [5-9,11-13].

Anatomy and Biomechanics

The rotator cuff consists of the supraspinatus, infraspinatus, teres minor, and subscapularis muscles [8]. The first three are considered external rotators, while the subscapularis functions mainly in internal rotation [5]. The first group inserts at the greater tuberosity of the humerus and the subscapularis inserts at the lesser tuberosity. The supraspinatus consists of an anterior and posterior portion. Initially thought to solely contribute to external rotation, this muscle also functions in forward flexion and abduction. Bearing more mechanical stress, the anterior portion is more susceptible to tearing.

Also relevant to rotator cuff arthropathy and reverse total shoulder arthroplasty is the deltoid. The deltoid muscle has three components, each with separate functions. The anterior deltoid flexes, the middle deltoid abducts, and the posterior deltoid extends the shoulder. Mainly, the rotator cuff functions to stabilize the humeral head within the glenoid fossa and to allow concentric rotation of the humeral head. Specifically, the supraspinatus and subscapularis are the major stabilizers in mid-range of motion and the subscapularis, infraspinatus and teres minor are the major stabilizers in the end-range of motion [14,15]. Loss of rotator cuff function has been shown to disrupt the glenohumeral stability [16].

Pathophysiology of Rotator Cuff Arthropathy

As described by Neer et al in 1983, a deficient rotator cuff leads to superior migration of the humerus due to loss of downward compressive force within the glenoid fossa [8,12]. Humeral migration can erode the superior surface of the glenoid and anteroinferior aspect of the acromion, as well as wear out articular cartilage in areas of higher glenohumeral compression due to joint instability [8].

Burkhart also provides a description of the pathogenesis of rotator cuff arthropathy. Normally, inferior portion of the rotator cuff balances out the deltoid moment and the subscapularis is inferiorly balanced against the infraspinatus and posteriorly against the teres minor [6-9]. With a deficient rotator cuff, elevation of the shoulder causes anterosuperior translation of the humeral head [8,12]. Contact of the humeral head articular cartilage with the anteroinferior margin of the acromion fragments cartilage and causes synovial thickening, effusion, and calcium phosphate crystal deposition [6-9].

Other causative factors include dispersion of synovial fluid due to loss of water-tight seal upon rotator cuff damage, cytokine effects

(from increased production of interleukin-1 β , TNF, and MMPs), and fatty infiltration, but mechanical forces have been shown to be the most important factor [5-8, 10, 12].

Clinical Presentation

The patient with cuff tear arthropathy is most commonly a female older than 65 with severe shoulder pain of long duration. The dominant side is most often affected. Pain typically presents in the anterolateral shoulder, interferes with sleep, and worsens with activity. Inspection may reveal shoulder profile deformity due to upward migration of the humeral head as well as atrophy of the infraspinatus and supraspinatus muscles [9]. Physical examination likely reveals marked weakness on external rotation, positive full can test, audible crepitus, and severely limited active and passive range of motion. Most noticeable may be the presence of pseudo-paralysis which presents as an inability to actively elevate the shoulder above 90 degrees [15]. A known risk factor for cuff tear arthropathy is prior rotator cuff repair (RCR) [5,8,10,14]. Rotator cuff pathology is exceedingly common and accounts for 250,000 surgical procedures annually in the United States [8,10]. The mid-term (3-10 year) rate of developing CTA in one study of patients with arthroscopic RCR was 11.5%, with long-term (20+ year) rates ranging from 19-66% in other studies of the same patient populations [10].

Radiographic Findings

Staging of rotator cuff arthropathy is generally a radiographic endeavor. The Hamada classification describes the plain radiograph changes in the shoulder in the setting of rotator cuff deficiency [17]. The classification highlights the superior migration of the humeral head, following by acetabulization of the acromion and finally progression of glenohumeral arthritis. In Grade 1, there is an acromiohumeral interval (AHI) of >6mm with a normal glenohumeral joint. In Grade 2, there is an AHI of <5mm. In Grade 3, there is acetabulization of the acromion. In Grade 4, there is narrowing of the glenohumeral joint and finally in Grade 5 there is humeral head collapse. Reverse total shoulder arthroplasty is typically reserved for Hamada Grades [4-5].

Evolution of Treatment

Various forms of arthroplasty have been utilized in the management of rotator cuff arthropathy. Initially, constrained and non-constrained anatomic total shoulder arthroplasty were thought to be the answer. However, the deficient rotator cuff resulted in high rates of revision due to implant loosening and instability [18,19]. Due to poor outcomes with total shoulder arthroplasty, hemiarthroplasty was then utilized in the treatment for rotator cuff arthropathy. Unfortunately, while this form of arthroplasty provided predictable pain relief, they did not demonstrate sufficient improvements in strength, range of motion or function [20,21].

The Grammont prosthesis introduced in the 1980s was the pre-cursor to the reverse total shoulder. It addressed the altered biomechanics in rotator cuff arthropathy by bringing the center of rotation of the glenohumeral joint medial and distal. This allowed the deltoid to function to offset the diminished rotator

cuff, improved strength, range of motion and decreased risk of component loosening [22,23]. Since the introduction of the Grammont prosthesis, there has been continued improvement in the design and implantation. While the best indication for reverse total shoulder is based on the presence of rotator cuff arthropathy, it is important to recognize that there are contraindications. A deficient deltoid, axillary nerve damage, diminished glenoid bone stock and infection are contraindications to reverse total shoulder arthroplasty [24,25].

Surgical Technique for rTSA

The patient is placed in beach chair positioning under general anesthesia, with or without interscalene block [11,26]. In the United States, a deltopectoral approach is most commonly used [1,7,11,12,26,27,28,29]. The cephalic vein is visualized and lateralized [7]. The subscapularis is tenotomies or peeled from the lesser tuberosity and ~1-2 cm of the pectoralis major tendon may be released for better exposure [1,7, 8,11,28,29]. Release of the subacromial, subdeltoid, and sub conjoint spaces is achieved with blunt dissection and occasional electrocautery [7,28]. The musculocutaneous and axillary nerves should be identified and protected [7,11,28]. A Kolbel retractor is placed under the deltoid and conjoint tendon [31]. The humeral capsule is released with progressive external rotation, and complete osteophyte resection is performed to increase glenoid exposure [7,28]. The humerus is then dislocated and the head cut generously, given that supraspinatus preservation is unnecessary in this reverse procedure [7,28,29]. Glenoid retractors are placed followed by labrum resection and release of the anterior capsule, subscapularis, posterior and inferior capsule, and some of the triceps origin to allow low positioning of glenoid baseplate and reduce notching [7,8,28]. The baseplate and glenosphere are placed and optimal tension set with added polyethylene thickness [5-8,11,28]. Typically, the glenoid baseplate is uncemented and fixed, as inferior as possible, with locking screws while the humeral stem is cemented or press fit [1,5,6,8,11,13,26,28].

Rehabilitation Protocol

Post-op protocols vary but typically involve sling immobilization for 4 weeks with elbow, wrist, and finger AROM encouraged from day [11,12,26,27,30]. At 0-2 weeks post-op, pendulum exercises and passive forward flexion and abduction typically begin and active ROM usually begins around week [4-6,11,12,26,30]. Patients are advised to avoid internal rotation and “push-off” activities for the first 6 weeks due to the risk of instability [30].

Outcomes

Maximum medical improvement (MMI) is achieved at 1-year post-op in patients undergoing rTSA for CTA, with rapid improvement in the first 3 months that tapers throughout the 1st year [4]. A systematic review by Cabarcas et al. found that clinically significant improvements occur in patient-reported outcome measurements, forward flexion, and abduction by 3 months with improvements in external rotation between 3 to 6 months and 6 months to 1 year [4]. The lag in ER gain was attributed to relative

internal rotation while in post-op sling [4]. Statistically significant improvements in pain and function remained present at 10-year follow up in a large cohort study by Sheth et al. from 2021 [13]. Jobin et al demonstrated that the benefits of the reverse total shoulder were significantly correlated to the deltoid lengthening provided by the prosthesis [32]. Favard et al demonstrated an implant survivorship of 89% at ten years in a retrospective review [33]. The complication rate for rTSA varies between 4.8% to 68%, though most studies examining outcomes are not recent [4]. Given the highly technical nature of rTSA, complications typically occur at a higher rate than anatomic TSA [4]. Possible complications include dislocation (most common; rate: 1.5-31%), heterotopic ossification, limited external rotation, instability, infection, fracture, or peripheral nerve injury [5,11,12,26,31]. The best outcomes are typically found in patients over 70 years old and those with less pre-op ROM, which reinforces the importance of proper patient selection and counseling [6,9]. Worse outcomes are found in males, workers compensation cases, patients with multiple medical comorbidities including depression [34].

Conclusion

The reverse total shoulder has proven to be a reliable operation for the treatment of rotator cuff arthropathy over the past few decades. It addresses the arthritic component to provide pain relief and restores shoulder biomechanics to a degree that allows increased strength and range of motion. Overall, patients experience a greater quality of life due to this procedure. The reverse total shoulder is not without its complications, which include dislocation, instability, fracture and infection. However, throughout the years, research has led to the characterization of more appropriate indications for surgery, surgical techniques, implant designs and post-operative rehabilitation protocols. Ultimately, reverse total shoulder arthroplasty is a well-supported treatment for rotator cuff arthropathy.

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Conflict of Interest

No conflict of interest to report.

References

- Mizuno N, Denard PJ, Raiss P, Walch G (2013) Reverse Total Shoulder Arthroplasty for Primary Glenohumeral Osteoarthritis in Patients with a Biconcave Glenoid. *The Journal of Bone and Joint Surgery-American* 95(14): 1297-1304.
- Wagner ER, Farley KX, Higgins I, Wilson JM, Daly CA, et al. (2020) The incidence of shoulder arthroplasty: rise and future projections compared with hip and knee arthroplasty. *Journal of Shoulder and Elbow Surgery* 29(12): 2601-2609.
- Jain NB, Yamaguchi K (2014) The contribution of reverse shoulder arthroplasty to utilization of primary shoulder arthroplasty. *Journal of Shoulder and Elbow Surgery* 23(12): 1905-1912.
- Cabarcas BC, Gowd AK, Liu JN, Cvetanovich GL, Erickson BJ, et al. (2018) Establishing maximum medical improvement following reverse total shoulder arthroplasty for rotator cuff deficiency. *Journal of Shoulder and Elbow Surgery* 27(9): 1721-1731.

5. Chae J, Siljander M, Wiater JM (2018) Instability in Reverse Total Shoulder Arthroplasty: Journal of the American Academy of Orthopaedic Surgeons 26(17): 587-596.
6. Smithers CJ, Young AA, Walch G (2013) Reverse shoulder arthroplasty. *Curr Rev Musculoskelet Med* 4(3): 389-408.
7. Gumina S, Grassi FA, Paladini P (2019) Reverse Shoulder Arthroplasty: Current Techniques and Complications eBook: 978-3-319-97743-0.
8. Gumina S (2017) Rotator cuff tear: pathogenesis, evaluation and treatment 1st ed. Italy: Springer Pg No: 438.
9. Khan WS, Longo UG, Ahrens PM, Denaro V, Maffulli N (2011) A Systematic Review of the Reverse Shoulder Replacement in Rotator Cuff Arthropathy, Rotator Cuff Tears, and Rheumatoid Arthritis. *Sports Medicine and Arthroscopy Review* 19(4): 366-379.
10. Misir A, Uzun E, Kizkapan TB, Ozcamdalli M, Sekban H, et al. (2021) Factors associated with the development of early- to mid-term cuff-tear arthropathy following arthroscopic rotator cuff repair. *Journal of Shoulder and Elbow Surgery* 30(7): 1572-1580.
11. Boutsidiadis A, Lenoir H, Denard PJ, Panisset JC, Brossard P, et al. (2018) The lateralization and distalization shoulder angles are important determinants of clinical outcomes in reverse shoulder arthroplasty. *Journal of Shoulder and Elbow Surgery* 27(7): 1226-1234.
12. Petrillo S, Longo UG, Papalia R, Denaro V (2017) Reverse shoulder arthroplasty for massive irreparable rotator cuff tears and cuff tear arthropathy: a systematic review 101(2): 105-112.
13. Sheth MM, Heldt BL, Spell JH, Vidal EA, Laughlin MS, et al. (2021) Patient satisfaction and clinical outcomes of reverse shoulder arthroplasty: a minimum of 10 years' follow-up. *Journal of Shoulder and Elbow Surgery* S1058-2746(21)00728-X.
14. Labriola JE, Lee TQ, Debski RE, McMahon PJ (2005) Stability and instability of the glenohumeral joint: the role of shoulder muscles. *J Shoulder Elbow Surg* (1 Suppl S): 32S-38S.
15. Lee SB, Kim KJ, O'Driscoll SW, Morrey BF, An KN (2000) Dynamic glenohumeral stability provided by the rotator cuff muscles in the mid-range and end-range of motion. A study in cadavera. *J Bone Joint Surg Am* 82(6): 849-857.
16. Hsu HC, Luo ZP, Cofield RH, An KN (1997) Influence of rotator cuff tearing on glenohumeral stability. *J Shoulder Elbow Surg* 6(5): 413-422.
17. Hamada K, Fukuda H, Mikasa M, Kobayashi Y (1990) Roentgenographic findings in massive rotator cuff tears. A long-term observation. *Clin Orthop Relat Res* (254)92-96.
18. Post M, Jablon M (1983) Constrained total shoulder arthroplasty: Long-term follow-up observations. *Clin Orthop Relat Res* 173: 109-116.
19. Franklin JL, Barrett WP, Jackins SE, Matsen FA III (1988) Glenoid loosening in total shoulder arthroplasty: Association with rotator cuff deficiency. *J Arthroplasty* 3: 39-46.
20. Arntz CT, Matsen FA, Jackins S (1991) Surgical management of complex irreparable rotator cuff deficiency. *J Arthroplasty* 6(4): 363-370.
21. Arntz CT, Jackins S, Matsen FA 3rd (1993) Prosthetic replacement of the shoulder for the treatment of defects in the rotator cuff and the surface of the glenohumeral joint. *J Bone Joint Surg Am* 75(4): 485-491.
22. Flatow EL, Harrison AK (2011) A history of reverse total shoulder arthroplasty. *Clin Orthop Relat Res* 469(9): 2432-2439.
23. Palsis JA, Simpson KN, Matthews JH, Traven S, Eichinger JK, et al. (2018) Current Trends in the Use of Shoulder Arthroplasty in the United States. *Orthopedics* 41(3): e416-e423.
24. Feeley BT, Gallo RA, Craig EV (2009) Cuff tear arthropathy: current trends in diagnosis and surgical management. *J Shoulder Elbow Surg* 18: 484-494.
25. Drake GN, O'Connor DP, Edwards TB (2010) Indications for reverse total shoulder arthroplasty in rotator cuff disease. *Clin Orthop Relat Res* 468(6): 1526-1533.
26. Lopiz Y, Rodriguez-González A, Martín-Albarrán S, Marcelo H, García-Fernández C, et al. (2018) Injury to the axillary and suprascapular nerves in rotator cuff arthropathy and after reverse shoulder arthroplasty: a prospective electromyographic analysis. *Journal of Shoulder and Elbow Surgery* 27(7): 1275-1282.
27. Sershon RA, Van Thiel GS, Lin EC, McGill KC, Cole BJ, et al. (2014) Clinical outcomes of reverse total shoulder arthroplasty in patients aged younger than 60 years. *Journal of Shoulder and Elbow Surgery* 23(3): 395-400.
28. Chawla H, Gamradt S (2020) Reverse Total Shoulder Arthroplasty: Technique, Decision-Making and Exposure Tips. *Curr Rev Musculoskelet Med* 13(2): 180-185.
29. Mesiha M, Boileau P, Walch G (2013) Technique for Reverse Total Shoulder Arthroplasty for Primary Glenohumeral Osteoarthritis with a Biconcave Glenoid. *JBJS Essential Surgical Techniques* 95(14): 1297-1304. 30. Dillon MT, Chan PH, Inacio MCS, Singh A, Yian EH, et al. (2017) Yearly Trends in Elective Shoulder Arthroplasty, 2005-2013: Trends in Shoulder Arthroplasty. *Arthritis Care & Research* 69(10): 1574-1581.
31. Morris BJ, Haigler RE, O'Connor DP, Elkousy HA, Gartsman GM, et al. (2015) Outcomes of staged bilateral reverse shoulder arthroplasties for rotator cuff tear arthropathy. *Journal of Shoulder and Elbow Surgery* 24(3): 474-481.
32. Jobin CM, Brown GD, Bahu MJ, Gardner TR, Bigliani LU, et al. (2012) Reverse total shoulder arthroplasty for cuff tear arthropathy: the clinical effect of deltoid lengthening and center of rotation medialization. *J Shoulder Elbow Surg* 21(10):1269-1277.
33. Favard L, Levigne C, Nerot C, Christian Gerber, Lieven De Wilde, et al. (2011) Reverse prostheses in arthropathies with cuff tear: Are survivorship and function maintained over time?. *Clin Orthop Relat Res* 469(9): 2469-2475.
34. Brian C Werner, Alexandra C Wong, Gregory T Mahony, Edward V Craig, David M Dines, et al. (2016) Causes of poor postoperative improvement after reverse total shoulder arthroplasty. *J Shoulder Elbow Surg* 25: e217-222.