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Glenohumeral osteoarthritis and reverse shoulder replacement

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The reverse total shoulder arthroplasty (rTSA) was initially introduced as a solution to deficiencies of the rotator cuff with subsequent degenerative joint disease, called rotator cuff tear arthropathy. The rTSA has since then seen a significant increase in utilization, particularly in patients with glenohumeral osteoarthritis. This article aims to provide a comprehensive review of the role of rTSA in the treatment of glenohumeral osteoarthritis, highlighting a series of reported clinical outcomes, survivorship analyses, and common complications found within the literature.

Glenohumeral osteoarthritis (GHOA) is a degenerative joint disease of the shoulder that has been estimated to occur in roughly 17% of middle-aged and elderly adults.[4] Although the etiology of and biochemical pathways that exacerbate GHOA are not fully understood, it has been generally accepted that focal or global cartilage loss secondary to progressive wear, joint trauma, or incompletely understood biochemical pathways increases humeral head-glenoid friction during glenohumeral articulation, causing osteophyte formation, periarticular cysts, and subchondral sclerosis.[1,10] These features are responsible for inducing joint inflammation, pain, and stiffness, symptoms commonly reported by patients with GHOA.

The shoulder replacement was first introduced as a viable surgical treatment for GHOA, specifically the anatomic total shoulder arthroplasty (aTSA). The aTSA functions by reconstructing the anatomy of the shoulder using humeral- and glenoid-sided implants, which provide reapproximated premorbid glenohumeral joint positioning and smooth articulating surfaces to promote pain-free, impingement-free, and stable range of motion.[7] Patients receiving aTSA, especially those with severe arthritic changes, report significant improvements across all clinical metrics,[11,25] awarding aTSA as the gold standard for GHOA surgical interventions in many cases.

Variations of the shoulder replacement were soon thereafter invented to combat other pathologies of the shoulder. The reverse total shoulder arthroplasty (rTSA) was introduced to the orthopedic scene in the 1980s by Paul Grammont initially as a solution to deficiencies of the rotator cuff with subsequent degenerative joint disease, called rotator cuff tear arthropathy.[3] The medialized center of rotation, improved leveraging of the deltoid, and semiconstrained humeral cup, among other design superlatives, restored glenohumeral range of motion and stability.[6,7] Since its inception, the rTSA has seen a significant uptick in utilization as its indication profile has widened to include other shoulder pathologies, a growth in volume that can be attributed most aptly to its use in GHOA cases.[8,14] As seen by current trends and projections of future case volume, rTSA seems to be replacing aTSA as the preferred prosthesis for many surgeons when treating primary GHOA, especially in the elderly population.[16,26] However, rTSA implantation in the younger patient diagnosed with GHOA with an intact rotator cuff continues to be debated among leading surgeons, largely for 2 main reasons: rTSA implant longevity has not yet been fully studied in the younger, more active patient population, and the aTSA continues to provide comparable-if-not-superior functional outcomes, especially in the younger, active patient through maintaining native shoulder anatomy and biomechanics.

This article aims to summarize the role of rTSA in the treatment of GHOA and covers a series of reported clinical outcomes, survivorship analyses, and common complications found within the literature.

The evolving role of rTSA in glenohumeral osteoarthritis

RTSA has revolutionized the landscape of shoulder arthroplasty since its inception. Originally, rTSA was designed to manage rotator

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cuff tear arthropathy and massive irreparable rotator cuff tears. With an evolving understanding of biomechanics coupled with advancements in surgical techniques and implant design, rTSA indications have expanded to include a wide range of pathologies including failed arthroplasty, instability arthropathy, proximal humerus fractures, and, most notably, GHOA with intact rotator cuff. Currently, the rate of shoulder arthroplasty has witnessed a dramatic increase in the United States with most of the growth attributed to a 191% increase in rTSA implantation from 2011 to 2017 secondary to the expanding indications.[2] Wagner et al have demonstrated in a Poisson model that rTSA will increase by 235.2% by 2025 which would surpass the growth rate of total knee and hip arthroplasty.[26]

ATSA has historically been considered the gold standard for the management of primary GHOA. In patients with advanced glenoid deformities such as the Walch B2 and B3 types, an augmented or non-augmented glenoid polyethylene component can be implanted to correct the deformity, although each includes their own unique inherent risks. Implanting a non-augmented polyethylene often mandates accepting a more retroverted and medialized glenoid which increases the risk of glenoid component loosening and rotator cuff detensioning.[9,27] In a retrospective study on 92 aTSAs with non-augmented glenoid components for biconcave glenoid deformities, Walch et al reported a cumulative incidence of glenoid component loosening and revision rate at an average of 6.5 years to be 20% and 16%, respectively. Unfortunately, augmented glenoid polyethylene components are relatively new, with the current literature lacking long-term results.[27] In a recent systematic review of aTSAs with augmented glenoid components, radiolucencies were found in 35% of cases at a mean follow-up of 37 months. In addition, surgeons anecdotally report higher clinical and radiological failures after aTSA to be associated with large glenoid deformities, which require the use of these unsubstantially studied large wedge and stepped augmented glenoid components.[22] As such, there has been a paradigm shift toward performing rTSA for primary GHOA to mitigate the risks of late rotator cuff failure and advanced glenoid deformity in older and younger patients, respectively.

Clinical outcomes of rTSA in glenohumeral osteoarthritis

Initially, rTSA was strictly implemented in rotator cuff tear arthropathy; however, this notion has changed to encompass a multitude of indications including primary GHOA. This trend of utilizing rTSA for primary GHOA was first introduced by Mizuno et al who reported excellent outcomes in 27 patients who underwent rTSA for primary GHOA with biconcave glenoids at a mean follow-up of 4.5 years.[18] Several comparative studies have demonstrated equivalent outcomes for aTSA and rTSA for primary GHOA. In a retrospective matched cohort by Steen et al, no differences in patient-reported outcomes or postoperative range of motion were reported when comparing primary aTSA and rTSA for GHOA with intact rotator cuff at an average follow-up ranging from 3.5 to 4 months.[24] In another comparative study by Wright et al, rTSA demonstrated equivalent outcomes to aTSA at a mean follow-up of 7 years regarding patient-reported outcomes, satisfaction, forward elevation, and external rotation.[28] Likewise, a propensity score-matched study by Kirsch et al demonstrated no significant differences between aTSA and rTSA in postoperative pain scores and patient-reported outcome measures. However, aTSA demonstrated significantly better postoperative active forward elevation ($+7°$; $P = .003$), external rotation ($+6°$; $P = .020$), and internal rotation (68.7% vs. 37.3% with behind-the-back reach $\geq$ L3; $P < .001$).[12] In a matched cohort analysis comparing rTSA to aTSA for GHOA with intact rotator cuff, Polisetty et al demonstrated no difference in patient satisfaction, forward elevation, or patient-reported outcome measures, although aTSA patients did have significantly better external rotation ($+7°$; $P = .0008$) and internal rotation ($P = .0005$).[20] Given the results from studies reported above, rTSA appears to have similar success in terms of patient-reported outcomes and satisfaction compared to TSA. However, there is evidence suggestive of better range of motion in patients who receive aTSA compared to rTSA.

Survivorship of rTSA for glenohumeral osteoarthritis

Failure of aTSA is typically due to either rotator cuff failure or loosening of the polyethylene component. In a study of 330 aTSAs who had cemented polyethylene components, the radiographic failure was high with a rate of 57% at 10 years. Additionally, the authors reported the advanced glenoid deformity significantly correlated with increased glenoid component failure.[17] In a 20-year follow-up study by Evans et al on patients who underwent aTSA with all-polyethylene glenoid components, glenoid component and rotator cuff failures were reported at a rate of 80% and 83%, respectively. The advantage of rTSA is that it addresses the common causes of failure associated with aTSA. The semi-constrained design of rTSA obviates the need for a functional rotator cuff, thus avoiding failure due to rotator cuff tears in the long term. Moreover, the glenoid component design offers robust baseplate fixation to the glenoid and the variety of glenosphere sizing and positioning allows for users to adapt to excessive medial glenoid wear or high retroversion correction. For instance, in a prospective multicenter study on rTSA for primary GHOA with intact cuff, the survivorship was 94% at 10 years, regardless of the severity of the glenoid deformity.[5] Furthermore, the improved survivorship in patients who undergo rTSA for primary GHOA has been reported by the 2023 Australian Joint Registry with a survivorship of 92.7% at 14 years, whereas the survivorship of aTSA at 14 years ranges between 73.3% and 90.5% depending on the type of glenoid component.[23]

Complications of rTSA in glenohumeral osteoarthritis

Historically, rTSA has been associated with high rates of complication; however, current reports estimate the overall complication rates for aTSA and rTSA to be generally comparable due to advancements in rTSA designs and evolving techniques. In addition, it is imperative to note that indications impact the complication profile of rTSA as it is currently performed for various diagnoses as opposed to aTSA which is only performed for GHOA with intact rotator cuff. Several studies reported that rTSA for primary GHOA had fewer complications when compared to rotator cuff tear arthropathy including a significantly decreased risk of periprosthetic dislocations and acromial stress fractures, the two most common complications following rTSA.[13,15,21]

In a large comparative international database study of 2224 primary aTSAs and 4158 rTSAs, Parada et al found that the total complication rate for aTSA was 10.7% compared to 8.9% in rTSA at an average 26-month follow-up. The most common complications for aTSA were failure due to rotator cuff tears and glenoid loosening, whereas, rTSA had a higher rate of acromial fractures and instability. In terms of total revisions, aTSA had a revision rate of 5.6% vs. 2.5% for rTSA.[19] Wright et al demonstrated in a retrospective study similar complication and revision rates for rTSA and TSA from primary GHOA in patients; at an average follow-up of 85 months, the complication rates were 12.1% and 13.7%, and the revision rates were 3.0% and 6.9% for rTSA and aTSA, respectively.[28] The complications in rTSA were infection, fractures, and nerve palsy, whereas the most common complication in TSA was rotator cuff failure. In a matched cohort study of aTSA and rTSA for primary GHOA with intact rotator cuff, Polisetty et al reported glenoid

loosening and revision rates of 3.2% and 2.4% in aTSAs, respectively. However, there were no loosening events or revisions in the rTSA group at a minimum follow-up of 2 years.[20] Given the evidence available in the current literature, complication rates of rTSA performed for primary GHOA with an intact rotator cuff are extremely low and comparable to that of aTSA, although the complication profile of each procedure continues to be unique.

Conclusion

RTSA is an effective treatment for GHOA with an intact rotator cuff resulting in highly favorable patient-reported outcomes that are comparable to those of aTSA. The complication profile of rTSA for GHOA with an intact rotator cuff is lower and different compared to the complication profiles of rTSA for other indications such as rotator cuff tear arthropathy. In terms of survivorship, rTSA for primary GHOA may offer significantly lower long-term rates of revision when compared to aTSA. The current evidence supports rTSA as an alternative treatment to aTSA for primary GHOA with an intact rotator cuff due to its design features specifically intended to overcome common causes of long-term failure in aTSA such as glenoid component loosening and rotator cuff failure.

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