Glenohumeral Arthritis and Total Shoulder Replacement

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Introduction

Although the shoulder is the second most commonly reported site of chronic joint pain after the knee (30.6 vs 63.4%), clinically significant arthritis of the glenohumeral joint is relatively uncommon.[1] The shoulder is the third most common large joint to require surgical reconstruction, after the knee and hip; shoulder arthroplasty accounting for three percent and hip and knee accounting for 96 percent of all inpatient arthroplasty procedures performed in 2006. From 1998 to 2008 there was a 2.5 times increase (from 19,000 to 47,000) in the number of shoulder arthroplasties performed in the United States with more than two thirds performed on patients older than age 65.[2] Approximately two thirds of shoulder replacements are performed on females.

Primary glenohumeral osteoarthritis is the most common etiology followed by rotator cuff tear arthropathy, post-traumatic arthritis, avascular necrosis and rheumatoid arthritis. There are a variety of non-operative and operative treatment modalities available, ranging from activity modification and nonsteroidal anti-inflammatory medications to surgical reconstruction with shoulder replacement. Contemporary shoulder arthroplasty designs offer options for management of advanced arthritis that have proven to provide predictably successful outcomes with improvement in pain and function.

Anatomy and Pathophysiology

The glenohumeral joint functions as a ball and socket. It normally consists of a congruent humeral head and glenoid that articulate through a smooth and well-lubricated cartilage surface. In contrast to the hip joint, the glenohumeral joint has very little intrinsic skeletal stability and is highly dependent upon the surrounding soft tissues (labrum, capsule, ligaments, and rotator cuff) for stability. Primary glenohumeral osteoarthritis is characterized by gradual articular cartilage loss typically beginning on the posterior glenoid and central aspect of the humeral head with osteophytes forming around the anatomic neck of the humerus. (Figure 1) Limitation of shoulder motion results from articular deformity and capsular contracture. (Figure 2) In some cases there can be dramatic internal rotation contracture, eccentric posterior glenoid erosion and posterior subluxation of the humeral head. While there is usually minimal involvement of the rotator cuff in patients with primary glenohumeral osteoarthritis, rotator cuff tear arthropathy is thought to be the result of chronic massive rotator cuff tearing with altered glenohumeral kinematics and joint nutrition.[3] Rheumatoid arthritis is a systemic inflammatory disease that affects all of the periarticular tissues including the articular cartilage, bone and soft tissues. Rheumatoid involvement of the shoulder results in gradually worsening joint destruction with bony erosion as well as rotator cuff tearing and degeneration. The prevalence of advanced rheumatoid involvement of the shoulder has been substantially reduced by disease modifying pharmaceuticals. Post-traumatic glenohumeral arthritis is a relatively uncommon sequelae of proximal humerus fractures and is the result of articular incongruity, fracture nonunion, or post-traumatic

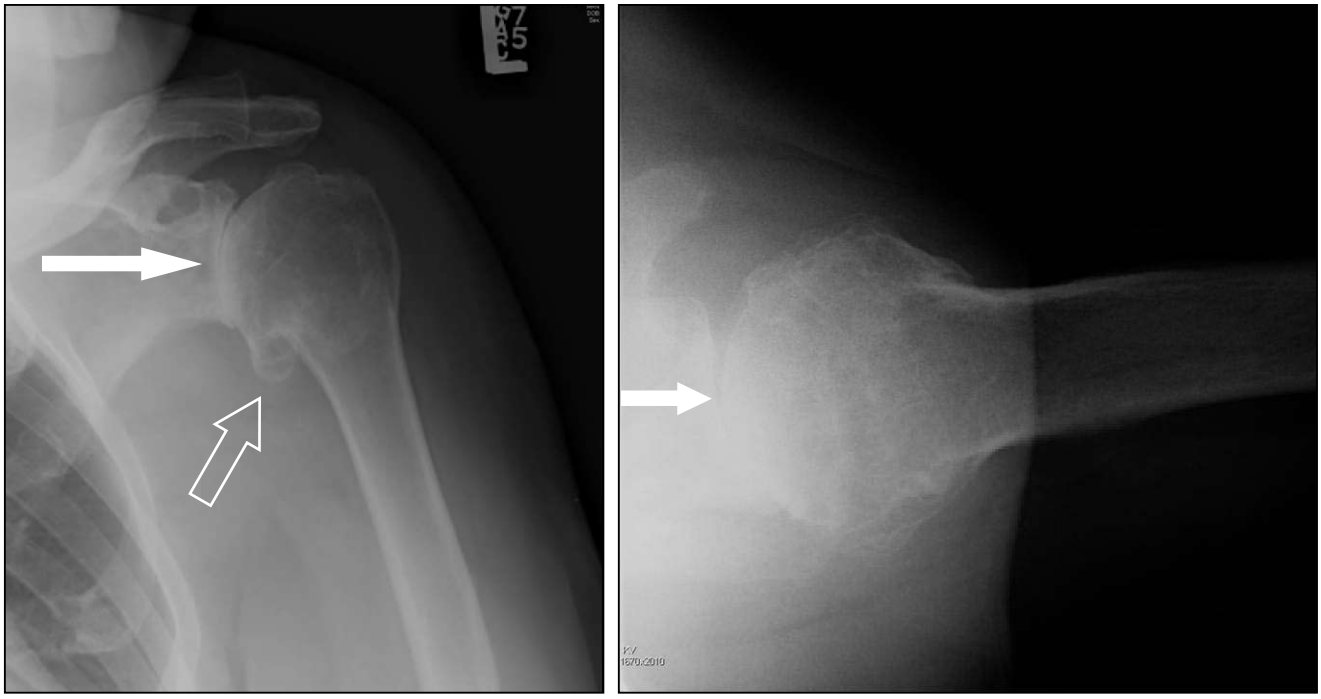

Figure 1a (left) and b (right). (a) True anterior posterior view of a left shoulder with advanced glenohumeral osteoarthritis. Note the joint space narrowing (solid arrow) and inferior humeral neck osteophytes that are characteristic of this condition. (b) Axillary lateral view of the same left shoulder demonstrating joint space narrowing (solid arrow).

Figure 2. This is a 66 year old patient with glenohumeral osteoarthritis of the right shoulder. Note the limitation of shoulder elevation typical of osteoarthritis.

avascular necrosis, and is more commonly associated with open reduction and internal fixation of severe displaced fractures.

Patient Evaluation

Patients with shoulder pain are evaluated with a thorough history and physical examination. Standard radiographic views used to assess glenohumeral arthritis include a true anteroposterior view, and axillary lateral view. (Figure 1) Both of these projections clearly demonstrate the joint space compared to typical routine shoulder radiographs. The key features include decreased glenohumeral joint space, osteophytes, subluxation, and bony deformity. In most cases, advanced imaging is not required to determine the diagnosis of glenohumeral arthritis. However, ultrasound, MRI or CT arthrogram should be obtained if there is a question about the integrity of the rotator cuff and surgery is being considered. In addition to the presence of a tendon tear, the quality of the rotator cuff musculature can be assessed for atrophy and fatty degeneration which are indicators of the chronicity of the pathology as well as function. A diagnosis of chronic large and massive rotator cuff tear can usually be established based upon the findings of a physical examination with spinati atrophy and rotator cuff weakness, and plain radiographs. (Figure 3) **Computed tomographic (CT)** scans are obtained to evaluate the anatomy of the glenoid, bony erosion and wear, in preparation for shoulder replacement surgery.[4]

Treatment

Treatment for glenohumeral arthritis begins with non-operative management including oral non-steroidal anti-inflammatory and analgesic medications, range of motion and strengthening exercises, corticosteroid injections, and activity modifications. The use of viscosupplementation is controversial and currently not FDA approved for use in the shoulder. Recent reports suggest that there might be some beneficial effect and further study is required to definitively establish efficacy.[5] When non-operative treatment fails to provide adequate symptomatic relief various surgical options including arthroscopy, hemi-arthroplasty (humeral head replacement), and total shoulder arthroplasty can be considered. Options of historical interest include shoulder arthrodesis and resection arthroplasty which reserved for salvage of severe post-arthroplasty infections or shoulder paralysis.

Arthroscopic debridement may be considered in some patients who are not candidates for shoulder replacement.[6] These include younger patients and patients with less severe disease. Arthroscopic procedures allow for removal of loose bodies, capsular release, synovectomy, and debridement of loose flaps of cartilage. Some patients will have improvement of symptoms; however these results deteriorate with time. Patients with advanced glenohumeral arthritis are not good candidates for arthroscopy which can exacerbate their symptoms.

The indications for shoulder arthroplasty include severe proximal humerus fractures, glenohumeral osteoarthritis, post-traumatic arthritis, rotator cuff tear arthropathy, avascular necrosis, capsulorrhaphy arthropathy, inflammatory arthritis, and failed previous shoulder arthroplasty. The first modern shoulder replacement design was developed by Dr Neer in the 1950s to treat severe displaced proximal humerus fractures.[7] The initial design was a metallic humeral head replacement. An all polyethylene glenoid component was subsequently introduced because arthritic patients treated with humeral head replacement tended to have inadequate

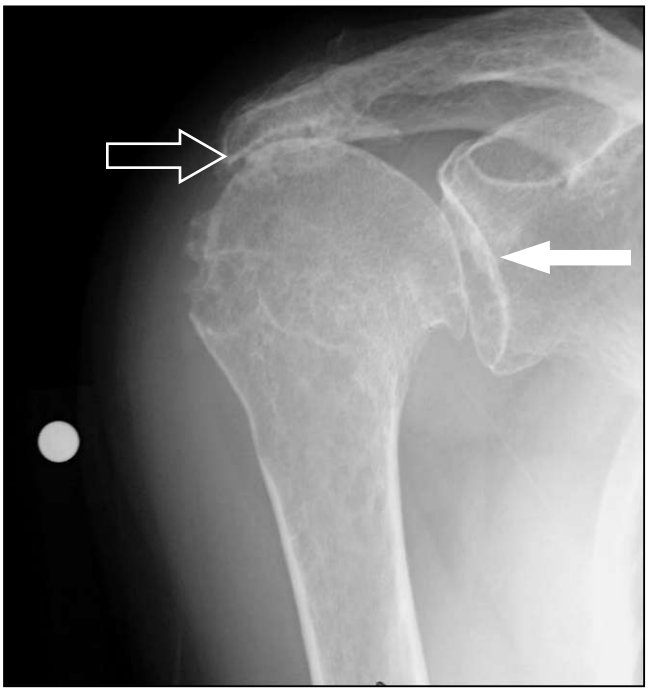

Figure 3. This is a true anterior posterior plain radiograph of a right shoulder with rotator cuff tear arthopathy. Note the elevation of the humeral head relative to the glenoid (solid arrow) as well as the narrowing of the acromiohumeral space (open arrow). These findings are characteristic of a chronic massive rotator cuff tear.

Figure 4a (left) and b (right). Pre (a) and postoperative (b) anterior posterior plain radiographs of a patient with avascular necrosis and humeral head collapse without glenoid involvement treated with humeral head replacement (hemiarthroplasty).

pain relief. Further advances led to implant systems that emphasize anatomic reconstruction of the glenohumeral joint. More recently, reverse total shoulder replacement designs were developed to treat patients with rotator cuff deficiency.

Hemiarthroplasty (Humeral Head Resurfacing and Replacement)

Humeral head replacement is primarily used to treat patients who have isolated articular involvement of the humerus. Patients with early stage avascular necrosis and post-traumatic arthritis may have relatively normal glenoid articular surface and can be treated with a humeral head replacement or humeral resurfacing implant.[8,9] (Figure 4) There are occasional patients with primary glenohumeral osteoarthritis who have either minimal involvement of the glenoid or who desire a vigorous lifestyle for whom a hemiarthroplasty is appropriate.[10] This can be combined with biologic tissue resurfacing of the glenoid or concentric glenoid reaming. However, several studies have demonstrated that total shoulder replacement yields more reliable pain relief compared to humeral head replacement (ball replacement) for osteoarthritis.[11-13] Although there is a definite tendency to consider humeral head replacement in younger patients with glenohumeral arthritis and convert to a total shoulder in the future if needed, the revision surgery is more difficult and complicated than primary total shoulder replacement.[14]

Rotator cuff tear arthropathy was traditionally treated with humeral hemiarthroplasty. However, the outcomes were very variable and the recent advent of reverse total shoulder replacement has provided more predictable and durable results.[15] Humeral head replacement is also preferred over anatomic total shoulder replacement for rheumatoid patients when there is rotator cuff disease or glenoid erosion.[16]

Resurfacing (stemless) humeral head replacement may be considered in some patients where the bone of the humeral head will support a stemless prosthesis. (Figure 5) One potential advantage of this prosthesis design is that it preserves the humeral bone in the event that a revision replacement is required in the future. In general, these designs are indicated for younger patients who wish to continue an active lifestyle and some older patients where possible conversion to an alternate prosthesis (e.g., reverse shoulder replacement) may be required.[22]

Anatomic Total Shoulder Replacement

The goal of anatomic total shoulder replacement is to restore normal bony anatomy and shoulder kinematics while replacing both the humeral and glenoid articular surfaces and is indicated when there is both humeral and glenoid arthritis with an intact and functioning rotator cuff. (Figure 6) This is the preferred treatment for advanced glenohumeral os-

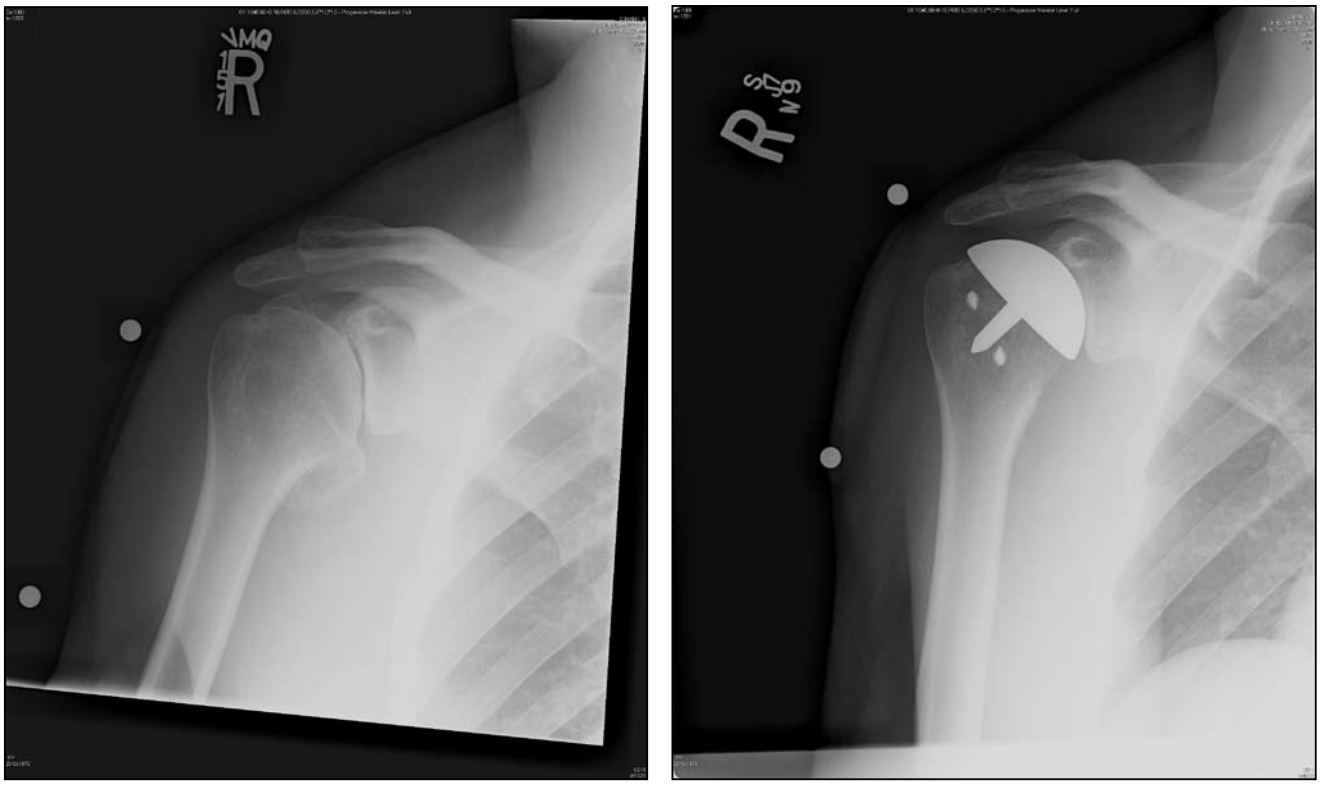

Figure 5a (left) and b (right). (a) True anterior posterior plain radiograph of a 43 year active male with pain who failed previous arthroscopic surgery. (b) Post-operative radiograph after humeral resurfacing.

Figure 6a (left) and b (right). Pre (a) and post-operative (b) plain radiographs of a 78 year old female with advanced glenohumeral osteoarthritis who was treated with an anatomic total shoulder replacement.

Figure 7a (left) and b (right). (a) True anterior posterior plain radiograph of a patient with rotator cuff tear arthopathy. (b) Post-operative radiograph after reverse total shoulder replacement.

teoarthritis.[17] Total shoulder replacement in the presence of rotator cuff tearing is associated with early glenoid implant loosening and failure. Total shoulder replacement is also indicated in cases of rheumatoid arthritis with a good rotator cuff, avascular necrosis and post-traumatic arthritis with glenoid involvement. Patients with rheumatoid arthritis and an intact rotator cuff have better outcomes and lower revision rate after total shoulder replacement compared to humeral head replacement.[16] Over 95% of patients will achieve satisfactory results, with improvements in pain relief, range of motion,and function. The survival of total shoulder replacement is comparable to the hip, with 85% of prosthesis remaining intact at 20 years.[18] Surgeon experience is important; recent studies have shown that the complication rate after total shoulder replacement is reduced when preformed by surgeons and at centers with greater volume of shoulder replacements.[19-21]

Reverse Shoulder Replacement

Reverse total shoulder replacement was designed for use in patients with rotator cuff insufficiency. This includes patients with chronic massive unrepairable rotator cuffs with or without glenohumeral arthritis, rheumatoid arthritis and rotator cuff tearing, some patients with severe proximal humerus fractures, and cases requiring revision of a failed previous anatomic shoulder replacement.[22-26] In patients with rotator cuff deficiency, total shoulder replacement is prone to early failure of the glenoid prosthesis. In these patients, hemiarthroplasty or reverse shoulder arthroplasty are a more appropriate surgical procedures. This revolutionary shoulder arthroplasty was first approved for use in the United States by the FDA in 2004. It was reported that approximately 2000 reverse total shoulder arthroplasties were performed in the U.S. in 2004 and that market analysis predicts that this number will increase to 30,000 in 2012.

Reverse total shoulder replacement "reverses" the normal relationships in the shoulder, replacing the native glenoid socket with a ball (glenosphere) and converting the native humeral head (ball) to a humeral socket. (Figure 4) The increased constraint of this construct allows for the intact deltoid muscle to raise the arm even in the absence of a rotator cuff. This increased constraint however, also limits the amount of stress which this prosthesis will endure, and therefore reverse total shoulder arthroplasty is typically reserved for older patients with lower functional demands.[30] Reverse shoulder provides dramatic improvements in pain and function in patients with the combination of glenohumeral arthritis and rotator cuff disease.

Post-operative Course and Rehabilitation

Patients having shoulder replacement surgery will typically require one to two days in the hospital. Many patients have almost immediate improvements in pain. Physical therapy is begins immediately and the program is tailored to the type of prosthesis used. In cases of anatomic shoulder replacement, passive range of motion exercises begin immediately after surgery. Active use and range of motion begins after six weeks. Strengthening is avoided for the first six weeks to prevent injury to the healing subscapularis tendon. Patients wear a sling to protect this repair for four to six weeks. Patients are able to resume their usual daily activities after three months. For reverse total shoulder replacement is associated with an increased risk of post-operative dislocation is increased. Therefore physical therapy is often more limited during the first six weeks post-operatively. Rehabilitation exercises are continued for at least six months to achieve an optimal outcome.

Summary

Shoulder replacement surgery is a reliable procedure that provides predictable results in patients with all types of glenohumeral arthritis. When performed by an experienced surgeon for the right indications, and with appropriate physical therapy, dramatic improvements in pain and function are seen in the majority of patients. With the recent availability of the reverse prosthesis, even patients with rotator cuff deficiency may have pain relief and restoration of shoulder function after reverse shoulder arthroplasty.

Discussion of off-label usage

Viscosupplementation, hyaluronans are mentioned. Product not listed.

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