REVIEW ARTICLE

Reverse shoulder arthroplasty for proximal humeral fractures: update on indications, technique, and results

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The introduction of the reverse shoulder arthroplasty has provided shoulder surgeons with more options for the treatment of complex proximal humeral fractures in the elderly. Early reported results suggest that the average functional outcome may be better than hemiarthroplasty in certain patients and specific clinical scenarios. In addition, these results seem to be reached more quickly with less dependence on rehabilitation. The reverse prosthesis may be particularly useful in patients aged older than 70 years, especially those with severely comminuted fractures in osteopenic bone. These factors likely have a negative impact on the results of hemiarthroplasty and internal fixation. Despite the potential benefits of reverse arthroplasty for fracture, there is a significant learning curve with the use of this prosthesis, and it has its own set of complications. The surgeon must show appropriate judgment when selecting a reverse arthroplasty in the setting of a proximal humeral fracture and, furthermore, be well acquainted with the surgical technique and prosthetic options at the time of surgery. Although the longevity of this prosthesis remains unknown, midterm outcomes are promising.

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Fractures of the proximal humerus are the third most common fracture in persons aged older than 65 years.4 Given the increasing growth rate of this age group, there will be a large projected increase in these types of fractures over the next 20 years.31 The fractures sustained by this population are typically more comminuted, usually complex 3- or 4-part fractures, and have poor bone quality compared with those fractures sustained by younger patients. Surgical options for these fractures include open reduction and internal fixation (ORIF), hemiarthroplasty, and reverse total shoulder arthroplasty. However, the results after ORIF and hemiarthroplasty of 3- and 4-part fractures in the elderly can be disappointing, and a multitude of complications have been reported.2,10,23,39,42 Recently, enthusiasm for closed reduction and percutaneous fixation and open reduction with nail fixation and osteosutures for 3-part fractures has increased, but these techniques are recommended only in certain situations.1,26,32

ORIF of complex proximal humeral fractures in the elderly remains a challenge, mainly because of the osteoporotic bone and degenerated rotator cuff that may be encountered at the time of surgery. To improve fixation in weak bone, locking-plate technology has been frequently used over the past 10 years. These “fixed-angle constructs” were designed to withstand the muscle forces of the rotator cuff and potentially prevent varus collapse of the fracture. Although this technology has improved on previous screw-plate constructs, recent studies have shown a high failure
rate and a mean of 3 complications per patient, with a rate of secondary screw cutout of up to 57%. Although restoring proximal humeral anatomy may offer the patient a chance at a traditional total shoulder arthroplasty in the future, the need for multiple revisions may predispose the patient to an inferior outcome.

Traditionally, when ORIF is not an option, hemiarthroplasty has been the treatment of choice for comminuted fractures in the elderly. This method of treatment was described by Neer as a means to achieve pain relief and improved function. Later studies using hemiarthroplasty for this indication reported inconsistent results with regard to function, power, and range of motion. The functional outcome largely depends on the anatomic healing of the tuberosities to the humeral shaft and prosthetic implant, which ultimately enables good function of the rotator cuff. In a patient with osteopenic bone and/or comminuted tuberosities, anatomic healing is unreliable, with a 50% rate of tuberosity malpositioning. Improper prosthetic version or height and tuberosity malreduction may inappropriately stress the rotator cuff and hinder tuberosity healing. The surgeon must understand these complexities and be vigilant at the time of surgery. Indeed, surgeon experience has been shown to contribute to outcomes. Given these multiple variables, mixed results have been reported with this type of prosthesis.

The introduction of the reverse shoulder prosthesis in 2004 to the United States has offered shoulder surgeons a new and promising alternative for the treatment of shoulder pathologies. The reverse shoulder prosthesis is made up of a baseplate and glenosphere construct on the glenoid side with a humeral cup and stem on the humerus. This is a semiconstrained device that relies on the tension of the deltoid for stability. There are 2 current design methodologies. One is based on the original Grammont-style prosthesis, with a medialized center of rotation at the baseplate-glenoid interface. The second design places the center of rotation more laterally within the glenosphere. Despite the differing biomechanics, both prostheses allow for a greater deltoid lever arm, which enables arm elevation in the absence of a functioning rotator cuff. Early European experience with reverse arthroplasty for proximal humeral fracture has been encouraging. This implant has recently been used in the United States for the treatment of complex proximal humeral fractures, on the premise that a reverse shoulder arthroplasty (RSA) may offer a more reliable return of function given its lesser dependence on tuberosity healing. The purpose of this article is to review the indications of RSA for fracture, the outcomes of operatively treated proximal humeral fractures, and the surgical and technical aspects regarding the use of the RSA for fractures.

Evolving indications for RSA

Traditional indications for RSA have been rotator cuff arthropathy, fracture sequelae with arthritis, and failure of a prior arthroplasty. Boileau et al reported their initial results using this technology for the aforementioned indications and showed improved function and elevation. These early results have prompted the expanding use of the RSA to treat other complex shoulder problems.

Given the versatility afforded by the RSA, this prosthesis has become a salvage option for a failed hemiarthroplasty. In patients with rotator cuff deficiency in the face of glenohumeral arthritis, a standard total shoulder arthroplasty is contraindicated because of the risk of eccentric loading and early loosening of the glenoid component. Hemiarthroplasty for the cuff-deficient arthritic shoulder has resulted in variable gains in function and unreliable improvement in pain. RSA can provide pain relief and restoration of elevation for a failed hemiarthroplasty. A recent study by Levy et al used RSA for failed hemiarthroplasties and attained improvements in pain and function when using an RSA with a lateralized center of rotation.

RSA has also recently been used for the treatment of rotator cuff deficiency without arthritis. Repair of massive rotator cuff tears in the elderly with pseudoparalytic shoulders has been associated with high failure rates. This has prompted the use of the RSA as a means to improve pain and restore active elevation to the shoulder. Cuff et al used an RSA to treat patients with rotator cuff deficiency without arthritis and achieved good short-term outcomes with improved American Shoulder and Elbow Surgeons and Simple Shoulder Test scores, as well as improved motion. The long-term results for this indication are still lacking, but the RSA has allowed treatment of these patients who previously had no good surgical option.

RSA has recently been applied to the treatment of acute 4-part proximal humeral fractures. This implant can provide reliable forward elevation, improved functional scores, and pain relief in the carefully selected patient. Shoulder surgeons currently restrict its use to complex 3- or 4-part fractures in elderly patients because the longevity of this type of implant has yet to be determined. RSA has been used more frequently for these fractures because it is less reliant on a functioning rotator cuff and healing of the tuberosities. Recently, many studies have been published on the outcomes of this implant for proximal humeral fractures, and the indications, technique, and outcomes will be further discussed in this review.

Problems in treatment of proximal humeral fractures

Nonoperative management

Nonoperative management is best reserved for non-displaced fractures of the proximal humerus or those patients who are medically unfit for surgery. Three- and 4-part fractures have been treated nonoperatively but with poor results. Predicting which 3- or 4-part fracture will do well
with nonoperative management is difficult, and a patient’s decision not to undergo surgery may have its own untoward consequences. Complications with this method of treatment have been nonunion and malunion, as well as osteonecrosis of the humeral head. Malunions of the proximal humerus can cause significant restriction in external rotation and abduction from a malunited greater tuberosity fragment. This can be significantly debilitating for a more active elderly patient. Osteonecrosis can also cause significant collapse of the humeral head, leading to global degeneration of the glenohumeral joint, although some patients in whom osteonecrosis develops may still have a satisfactory outcome.

A recent systematic review on the nonoperative treatment of proximal humeral fractures noted good functional results with nonoperative management. This study included all proximal humeral fractures, with the minority being 3- and 4-part fractures, and noted that 3- and 4-part fractures treated nonoperatively had the highest complication rate of 48%, with varus malunion occurring at a rate of 23%. If the humerus heals in a severely malunited position, the shoulder may not be amenable to future reconstruction with a standard total shoulder arthroplasty. A later study showed that malunions often inhibit shoulder function, and the resultant deformity and rotator cuff dysfunction may necessitate treatment with RSA in the future. Surgery should at least be considered in active and healthy patients with 3- and 4-part fractures because it can potentially restore anatomy and consequently improve function.

**Closed reduction and internal fixation**

Closed reduction and percutaneous pinning (CRPP) has gained popularity among some surgeons in the treatment of proximal humeral fractures. This method of fixation offers the advantage of less periosteal stripping and disruption of the blood supply to the fracture fragments. Improved American Shoulder and Elbow Surgeons, Constant, and pain scores were seen after CRPP of displaced proximal humeral fractures. Using this technique may be technically demanding, and conversion to an open procedure is sometimes needed. Although some 3- and 4-part proximal humeral fractures have been successfully treated with CRPP, this procedure may be better suited for 2-part fractures.

In addition to CRPP, closed reduction and intramedullary nailing are preferred by some surgeons. The current evidence is limited with regard to the use of intramedullary nailing for 3- and 4-part fractures. With this technique, there continues to be concern with regard to damaging the rotator cuff footprint during nail insertion. A detailed discussion of this technique is beyond the scope of this report.

**Open reduction and internal fixation**

ORIF of 3- or 4-part fractures is often a good surgical option to restore anatomy. However, difficulty maintaining fracture reduction postoperatively and hardware-related complications have caused some surgeons to have reservations about this type of operative intervention. Obtaining an anatomic reduction and maintaining it in the face of osteoporotic bone are difficult. A study evaluating the outcomes of 3- and 4-part proximal humeral fractures in the elderly resulted in a 51% early complication rate and a 26% reoperation rate in the treatment of 82 shoulders with osteosynthesis. This particular study concluded that fractures treated with fixed-angle plates had a lower malunion rate and a lower rate of malpositioning of the fracture fragments. However, the rate of malunion, screw cutout, and hardware impingement is significant. This can have major negative consequences for the patient, including severe glenoid erosion leading to secondary arthroplasties in over 50% of patients. There is recent evidence supporting ORIF over nonoperative management.

**Hemiarthroplasty**

Hemiarthroplasty for the treatment of proximal humeral fractures is one of the most complex and technically difficult procedures to perform in shoulder surgery. Multiple variables including proper prosthetic height, retroversion, and tuberosity reduction and fixation come into play to achieve a satisfactory result. Initial reports by Neer and Tanner and Cofield showed that this procedure can offer good pain relief but variable functional return. Obtaining an anatomic reconstruction can be difficult with comminuted tuberosities. This is an important consideration because tuberosity nonunion will inhibit function and lead to clinical failure. Recent studies have compared nonoperative management with hemiarthroplasty for the treatment of 4-part fractures in the elderly and failed to show a functional benefit with hemiarthroplasty, although there was a trend toward improved pain relief with hemiarthroplasty. Long-term follow-up of hemiarthroplasties for fracture have shown sustained pain relief but variable gains in functional return. It appears that a better result can be attained in younger patients and patients with less comminuted tuberosities. Improper retroversion, poor tuberosity positioning, and excessive prosthetic height have been implicated as factors associated with a poor functional result. Although a good result is possible, longer-term follow-up studies have shown failures due to improperly functioning rotator cuffs often requiring additional surgery. Therefore, hemiarthroplasty yields predictable pain relief but variable range of motion that is often due to tuberosity malposition and nonunion. When hemiarthroplasty is used, proper implant position and tuberosity reduction and fixation are critical.

**RSA for acute proximal humeral fractures**

The complexity of treating proximal humeral fractures combined with the variable results obtained through nonoperative
management, ORIF, and hemiarthroplasty has led to a shift toward the use of RSA for complex proximal humeral fractures, especially in patients aged older than 70 years (Fig. 1). RSA is attractive for the treatment of proximal humeral fractures because it is less reliant on a functioning rotator cuff for proper function and pain relief. However, results with reverse arthroplasty are also somewhat dependent on tuberosity position and healing, just not as critically as hemiarthroplasty. Altering the mechanics of the shoulder to use the deltoid as a primary rotatory force can offer improved forward elevation of the extremity. Tuberosity healing can be achieved with an RSA and, if achieved, may improve the function of the RSA.²²

Initial reports using RSA for fracture have been promising. A prospective cohort study of 20 patients with proximal humeral fractures showed improved Constant scores and Short Form 36 scores close to age-related norms when the Delta III RSA (Depuy Orthopaedics, Warsaw, IN) was used for acute fractures in the elderly.³⁴ This study showed that patients attained a mean of 112.5° ± 38.1° of abduction and 122.6° ± 32.8° of anterior elevation with a mean Constant score of 67.8. This small group of patients incurred 2 dislocations and 2 infections. Bufquin et al¹⁹ prospectively evaluated the use of RSA for the treatment of 3- and 4-part fractures in patients with a mean age of 78 years. They followed up patients for a mean of 22 months, and the patients achieved mean active anterior elevation of 97° and mean external rotation of 30°. Interestingly, in this study, tuberosity nonunion only slightly affected external rotation but did not affect any other motion parameter at final follow-up. This study shows that tuberosity nonunion may not significantly affect the final outcome after RSA and that RSA may be the best option for patients with comminuted tuberosities and osteoporosis. Although these initial reports have shown good results, further studies have disclosed the high incidence of scapular notching, neurologic complications, and component loosening seen at midterm follow-up using the RSA for the treatment of fractures.¹¹,¹²

These initial results of RSA for fracture were promising, and studies comparing RSA with a hemiarthroplasty have since been published. Gallinet et al²³ retrospectively reviewed 21 patients who had a hemiarthroplasty and 19 patients who had an RSA for the treatment of 3- or 4-part fractures in a population with a mean age of 74 years. All RSAs were implanted through a superolateral approach with deltoid detachment. Patients treated with an RSA showed superior abduction (mean, 91° vs 60°), forward elevation (mean, 97.5° vs 53.5°), and Constant scores (mean, 53 vs 39). The hemiarthroplasty group had better external and internal rotation. Although 15 cases of scapular notching were noted, no patient needed a revision of an RSA at a mean follow-up of 12.4 months. Garrigues et al²⁴ echoed these results and showed that RSA for treatment of

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**Figure 1**  
(A) Anteroposterior radiograph of a 4-part proximal humeral fracture in an elderly 76-year-old woman.  
(B) Scapular-Y radiographic view.  
(C) Postoperative anteroposterior view after treatment with RSA.  
(D) Postoperative axillary view.
acute fractures in the elderly did outperform hemiarthroplasty. However, they concluded that this must be balanced with an increased cost in a population that has a limited life expectancy.

Another study compared the use of hemiarthroplasty with RSA for the treatment of acute proximal humeral fractures in the elderly. The patients with RSA had significantly better Oxford Shoulder Scores (41.5 vs 32.3, \( P = .022 \)) at 5 years. There was no difference in revision rate or 1-year mortality rate. RSA was deemed superior to hemiarthroplasty, and the results seem to be sustained for the midterm. Lenarz et al. retrospectively reviewed 30 patients with a mean age of 77 years (range, 65-94 years) who had undergone a primary RSA for the treatment of a 3- or 4-part proximal humeral fracture. The patients had improved postoperative outcome scores and good pain relief at a minimum follow-up of 12 months. This series had a 10% complication rate; however, no complication required another operation.

Although there are a fair number of articles showing the superiority of RSA over hemiarthroplasty, we believe that these results need to be interpreted with caution. There is a clear indication for an RSA in an elderly patient with a comminuted proximal humeral fracture with osteoporotic bone. There is recent evidence supporting the use of an RSA for massive rotator cuff tears in patients aged younger than 65 years or even as young as 46 years. However, it cannot be overstated that using an RSA for fracture should be reserved for an elderly patient or in cases in which no other option will attain a satisfactory result. In summary, RSA appears to have good outcomes and has some advantages over hemiarthroplasty for the treatment of acute fractures in the elderly, although long-term follow-up studies are still lacking.

**Surgical approach**

The surgical approach for an RSA has been either the standard deltopectoral approach or the anterosuperior approach. Each approach has its advantages and disadvantages. The deltopectoral approach is the universal and familiar approach to the shoulder. It allows adequate access to the fracture fragments for suture fixation and provides excellent glenoid exposure after fracture fragment mobilization. However, exposure and reduction of the greater tuberosity can be challenging through the deltopectoral approach. The anterosuperior approach uses a more limited superiorly based incision and a deltoïd split. One potential advantage of this approach is greater tuberosity access. Disadvantages include the requirement for deltoid detachment and potential dehiscence, as well as limited extensibility. The latter issue is especially relevant during humeral shaft exposure, particularly if there is shaft comminution.

Our preferred surgical technique uses a deltopectoral approach. The patient is placed in the beach-chair position with the arm draped free. A mechanical arm holder (McConnell Orthopaedics, Greenville, TX, USA) assists with positioning of the extremity throughout the entire case. We ensure that the patient’s arm can be adducted and extended during the case for proper humeral preparation. A skin incision is made from the coracoid process distally (approximately 10 cm). We prefer to retract the cephalic vein laterally. The axillary nerve is identified medially underneath the conjoined tendon. The musculocutaneous nerve is identified posterior to the conjoined tendon before placement of a self-retaining retractor between the conjoined tendon and the deltoid. A soft tissue biceps tenodesis is performed in all cases. The proximal humeral fracture fragments are then mobilized with a Cobb elevator. The humeral head is removed between the fractured greater and lesser tuberosities. If any of the articular surface remains with either tuberosity, it is removed. We place heavy nonabsorbable sutures around the lesser and greater tuberosities at the tendon-bone junction to obtain control of the fragments and for final tuberosity reconstruction (Fig. 2). The tuberosities are often comminuted and osteoporotic, and identifying the subscapularis anteriorly and the infraspinatus and teres minor posteriorly will allow suture placement. The supraspinatus is routinely resected. It is important to place all of the greater tuberosity sutures at this point because it is difficult to do so after the glensphere is implanted.

We then direct our attention to the preparation of the glenoid. Retractors are placed to protect the axillary nerve anteriorly. A curved retractor may be placed posteriorly on the glenoid to retract the humeral shaft and tuberosity posteriorinferiorly (Fig. 3). We remove the labrum and biceps anchor sharply from the glenoid. An inferior capsular release is performed along the glenoid with a knife or electrocautery until we are able to visualize and palpate the lateral pillar of the scapula. A centering pin is then placed in the glenoid so that the baseplate will be positioned at the inferior-most aspect of the glenoid (Fig. 4). The glenoid is reamed, and the baseplate is impacted and screwed into position. The glensphere is then impacted onto the baseplate securely. The glensphere size is determined by the size of the patient; for most patients, we use a 36-mm articulation.

Humeral preparation is then performed with the arm adducted and extended. The humeral shaft is reamed to provide a 1-mm cement mantle around the humerus. The trial implant is then placed in 20° of retroversion. Humeral version is judged by using the patient’s forearm in relation to the alignment rods on a humeral stem jig. The humeral stem and liners are then trialed with attention to range of motion, soft tissue tension, and implant impingement. The height of the implant in relation to the humeral calcar is noted for final implantation. Some systems provide a height.
and alignment jig to assist in trial reduction and re-creation of the trial position with the final implant. Restoration of humeral length is the most important factor in minimizing postoperative dislocation.35 This can be extremely challenging in cases of severe shaft comminution. Comparison radiographs of the normal side with radiographic markers can assist the surgeon in determining height.35 In addition, the distance of the top of the pectoralis major to the top of the humeral head is known. This can be extrapolated to the top of the reverse humeral component.41 Before final implantation, 2 drill holes are placed anteriorly and posteriorly to the bicipital groove. Two double-loaded nonabsorbable sutures are placed in these holes and are used for vertical fixation of the tuberosities to the humeral shaft. The final humeral implant is cemented into place (Fig. 5). Attention is then directed to secure tuberosity fixation around the humeral implant. Autologous graft from the humeral head is placed beneath the tuberosities and, if the system permits, within a window in the implant. The previously placed transverse tuberosity sutures are then tied around the implant and to each other for horizontal fixation (Figs. 6 and 7). The previously placed sutures in the humeral shaft are placed around the respective tuberosities for vertical fixation to the shaft (Figs. 8 and 9).6 Thus, the construct has vertical and horizontal fixation. The wound is closed in a standard fashion over a drain to prevent hematoma formation. We remove our drains on postoperative day 2 (Fig. 10).
Technical points

Tuberosity fixation

Tuberosity fixation to the implant and to the shaft remains important for the RSA when used for fracture. Recent evidence has shown that improved rotation may be obtained if the tuberosities are repaired anatomically to the RSA implant. Gallinet et al. treated elderly patients with proximal humeral fractures with an RSA and found that patients with anatomic healing of the tuberosities had improved forward elevation (127.2° vs 96.5°), external rotation at the side (19.7° vs 1.6°), and external rotation at 90° of abduction (49.4° vs 10.3°) when compared with patients who had nonunion or malunion. The patients with healed tuberosities also attained better Constant and Disabilities of the Arm, Shoulder and Hand scores. It is important to note that although the patients with healed tuberosities fared better, the other patients still reported good results with acceptable function.

When one is repairing the tuberosities during this procedure, meticulous handling of the tuberosities is necessary. Nonabsorbable sutures are placed through the bone-tendon junction of each fragment as described by Boileau et al. The sutures can be placed before glenosphere placement because the implant may limit one’s ability to suture the greater tuberosity. Vertical sutures are also placed to secure the shaft to the tuberosities. Failure to perform this step will cause the tuberosities to ride high on the implant because the proximal humerus is now more distal and medial than before. Prior teaching for a traditional hemiarthroplasty for a proximal humeral fracture included the addition of a medial cerclage suture to limit interfragmentary motion.

Implant positioning

Positioning of the baseplate and glenosphere on the glenoid is crucial to the success and longevity of the RSA. These concepts hold true regardless of the indication for the RSA. The baseplate should be positioned inferiorly on the glenoid to limit scapular notching. Although inferior tilting of the glenosphere has been suggested by some authors, there is little evidence to show that this improves function or limits notching. In fact, there is basic science evidence to suggest that inferior tilting leads to earlier contact of the humerus with the lateral scapula, and inferior tilting in a series of RSAs performed for rotator cuff tear arthropathy showed no advantage over neutral tilt. In addition, one study that used an RSA with a more lateralized center of rotation in the treatment of fractures showed no glenoid notching. To achieve inferior positioning of the glenosphere, inferior capsular release is essential for glenoid exposure for proper baseplate positioning. The inferior-most portion of the glenoid must be adequately visualized to properly position the glenoid baseplate. A knife or electrocautery can be used to free up the capsule and inferior glenohumeral ligaments from the inferior glenoid. Triceps muscle release on the inferior portion of the glenoid may be needed.

Screw fixation and positioning of the glenoid baseplate have been the subject of recent studies. The “3-column concept” of scapula fixation was introduced in 2008. Shoulder surgeons have been placing 3 to 4 screws in the glenoid baseplate to obtain good cortical fixation. Typically, one screw is aimed at the coracoid, one toward the scapular spine, and one down the lateral pillar. Recent studies have shown that the glenoid baseplate may only need 2 screws for adequate fixation. Another study showed that longer screw fixation is obtained by aiming the inferior screw more parallel to the baseplate as opposed to aiming anteroinferiorly down the lateral pillar. There are a variety of RSA implants available today that limit the surgeon to 2 or 4 screws. Given this recent evidence, it is advisable to fix the baseplate with at least 2 locking screws and to aim the screws in such a manner as to obtain the largest amount of bone purchase.

Proper tensioning of the RSA should be addressed to prevent postoperative instability. Shoulder surgeons often rely on the tension of the conjoined tendon and deltoid muscle to assist in the determination of the height of the implant. The implant should be stable before fixation of the tuberosities. Recently, Walch and colleagues proposed that lengthening the humerus with the RSA was associated with improved active anterior elevation. They determined that when the humerus was shortened, all of the patients had poorer functional results. Although the optimum lengthening of the arm was not determined in this study, they advised that the humerus should not be lengthened more than 2.5 cm compared with the opposite side. Over-lengthening theoretically may be associated with a higher incidence of neurologic complications.
Lastly, rotation of the humeral component for the RSA deserves mention. We position the implant in 20° of retroversion with regard to the forearm. Most RSA implants have a jig that is able to hold alignment rods that reference the forearm, which is our preferred method. Prior studies evaluating humeral component positioning in relation to the bicipital groove have shown that this is an unreliable landmark. This also holds true for an RSA given the osteoporotic bone and comminution encountered in proximal humeral fractures in the elderly. Proper rotation is important for tuberosity healing as well as tensioning the remaining rotator cuff to gain improved rotation.

### Complications

Various complications have been reported since the introduction of the RSA, including hematomas, infections, acromial stress fractures, early implant failures/loosening,
and scapula fractures, as well as neurologic injuries. No specific complications with regard to using an RSA for a proximal humeral fracture can be mentioned. The most common postoperative complication is instability, with an incidence of 4.7%. Scapular notching is a frequently discussed complication, although the long-term consequences of this finding have yet to be elucidated. Complication rates in the literature have ranged from 0% to 68%. This procedure has a steep learning curve; however, the complication rate has been shown to decrease after 40 cases. Increasing familiarity with this procedure, improved implant designs, and further research will likely lead to a decrease in complications.

Rehabilitation

Currently, there is no evidence in the literature validating the optimal postoperative program after an RSA. Zumstein et al found in a recent systematic review that most patients were placed in a sling or brace for 3 to 6 weeks. Active shoulder motion was allowed as early as 2 weeks and as late as 6 weeks. Our current protocol after an RSA for a proximal humeral fracture is to place the patient in a sling with an abduction pillow in neutral rotation for 6 weeks. Neutral rotation or an abduction pillow may decrease the risk of tuberosity displacement. Because we routinely remove the supraspinatus during surgery, the stress on the greater tuberosity with the arm hanging in internal rotation is minimized. After 2 weeks, the patient is allowed to remove the sling while at home to perform simple household activities below shoulder level. At 6 weeks, the sling is removed and a home-based pulley program is used to regain motion. At this point, the patient is allowed to use the shoulder as tolerated. We do not routinely use strengthening exercises after an RSA and have not realized any benefit to altering our reverse arthroplasty rehabilitation program in the setting of a fracture. However, we do immobilize the patient for a longer duration initially to allow for tuberosity healing.

Conclusion

RSA for certain proximal humeral fractures in the elderly can show improved outcomes and may have more predictable functional results than hemiarthroplasty based on the current evidence. The longevity and cost-effectiveness of this relatively expensive implant are currently unknown. The use of this new technology should be limited to surgeons with appropriate experience, and indications must be tailored to the patient’s needs and functional goals.

Disclaimer

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