Indications, Technique, and Pitfalls of Reverse Total Shoulder Arthroplasty for Proximal Humerus Fractures

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Abstract

Management of proximal humerus fractures with hemiarthroplasty has been shown to yield unpredictable and inconsistent outcomes. Risk factors for clinical failure following hemiarthroplasty include postoperative tuberosity failure, advanced age, female sex, osteoporosis, and inability or unwillingness to participate in the extensive rehabilitation required. In this difficult-to-manage injury, reverse total shoulder arthroplasty (rTSA) for fracture has been shown to reliably restore elevation, even in cases of tuberosity failure, and to restore rotational movements if the tuberosity heals. In addition, a fracture-specific implant design has been suggested to improve the likelihood of tuberosity healing. Early results indicate that fractures of the proximal humerus that are indicated for arthroplasty should be considered for rTSA. Tuberosity integrity appears to impact rotational movement but not restoration of elevation.

Hemiarthroplasty has been considered the treatment of choice for proximal humerus fractures in the elderly in which open reduction and internal fixation is not considered possible or desirable. However, the success rates for this procedure have been highly variable. Increased age, alcohol consumption, tobacco use, female sex, osteoporosis, noncompliance with postoperative immobilization, and inability to participate in a postoperative rehabilitation program have been identified as risk factors for failure. Postoperatively, failure of the reconstructed tuberosities to heal anatomicly after hemiarthroplasty for fracture has consistently been associated with poor functional outcomes. For these displaced proximal humerus fractures in elderly patients, reverse total shoulder arthroplasty (rTSA) has been used with success. This paper will address the indications, technique, and potential pitfalls of rTSA for fracture.

Gallinet and associates compared humeral head replacement (HHR) and rTSA for fractures of the proximal humerus and concluded that the rTSA group demonstrated a more reliable restoration of function above shoulder level than the HHR group. Although tuberosity healing is critical to restoring forward elevation in HHR, the status of the greater tuberosity is not as important for the restoration of elevation following rTSA for fracture. In early reports all investigators used “first-generation” devices that were not specifically designed for fracture. Tuberosity healing rates were understandably lower in part because the Grammont-style design has a large, bulky metaphyseal component, similar to the different designs of non-fracture specific hemiarthroplasty stems. This makes anatomic reconstruction of the tuberosities difficult. More recent designs have incorporated lower-profile metaphyseal bodies, and healing rates of the tuberosities are anticipated to improve, as Kralinger and colleagues demonstrated using a fracture-specific hemiarthroplasty. The presence of a fixed fulcrum prosthesis may partially neutralize the pull of the deltoid and the effect it may have on the tuberosities. Thus, with fracture-specific implants, we may see tuberosity healing rates that exceed those reported following hemiarthroplasty. Whereas tuberosity healing is not critical for the restoration of elevation, it is important for the restoration of external rotation and should be considered one of the goals of proper surgical technique for rTSA for fracture.

Cazeneuve and Cristofari and Cazeneuve and coworkers reported progressive loss of function in patients followed for up to 17 years after rTSA for fracture. However, their technique included complete excision of the tuberosi-
ties and insertion of the round Grammont-style glenoid baseplate in the center of the glenoid—a position that has since been recognized as suboptimal due to the likely formation of higher-grade scapular notching. The deterioration of functional results in their series correlated with high-grade scapular notching and secondary humeral-sided lucency associated with polyethylene debris. As the surgical technique for rTSA has been refined and the incidence of scapular notching has significantly decreased, this mode of failure is far less likely to be a factor.

Indications for rTSA for fracture are constantly evolving because of the reliability of the procedure with or without tuberosity union. Older, lower-demand individuals who are incapable of performing or cooperating with an intensive rehabilitation program with displaced comminuted fracture patterns are the ideal candidates for the procedure. This group has a lower likelihood of success with hemiarthroplasty and may benefit the most from rTSA. More expanded indications, such as bipolar injuries to the glenohumeral joint, are being explored but do not have supportive data at this time.

**Surgical Technique**

With the patient in a beach-chair position, a deltopectoral incision is used to provide an internervous plane into the glenohumeral joint. With the deltoid and the cephalic vein retracted laterally, the smaller branches of the cephalic vein are coagulated or tied. The upper one-third of the pectoralis tendon can be tenotomized for exposure without substantial functional consequence. The biceps tendon can be tenodesed to the upper pectoralis insertion. After deep retractor placement under the conjoined tendon, the tuberosities can be tagged at the respective myotendinous junction, and any residual supraspinatus is resected to the spine of the scapula and off of the greater tuberosity (Fig. 1). The greater tuberosity will be bare superiorly but with posterior rotator cuff tendons intact. Management of the subscapularis is generally based upon surgeon preference. The lesser tuberosity and the subscapularis tendon can be excised if a lateralized reverse design device is being utilized. More medialized designs may require reattachment of the lesser tuberosity for stability.

Glenoid exposure is more easily achieved than with a standard rTSA because of the soft tissue and capsular injury from the recent trauma. Excision of the labrum and identification of the true bony edges of the glenoid, particularly the inferior glenoid, are critical components of the exposure. The baseplate should be inserted based upon the technique recommended for the selected device followed by glenosphere insertion.

Humeral preparation with reamers and broaches should follow glenoid preparation followed by a trial reduction of the rTSA. Using a smaller stem than determined based upon the reaming or broaching will assist the surgeon in determining proper tension of the construct (Fig. 2). A smaller humeral stem will typically sink farther into the humerus and with gentle traction after reduction can be lifted out of the humeral canal to determine proper height and tension. However, caution is necessary because the shoulder will usually become tighter with tuberosity reattachment.

After the appropriate size and height of the humeral stem are determined with the trial reduction, the final stem can be cemented in approximately 20° of retroversion. After a decision is made about the final components, the final implants are assembled in situ. Tuberosity repair combined with humeral head autograft placed between the tuberosities and the implant is performed after the final implants have been inserted. Horizontal, vertical, and cerclage fixation should be employed to stabilize the tuberosities (Fig. 3).

Closure over a suction drain and sling immobilization for 4 to 6 weeks are recommended. However, the patient should begin a rehabilitation program that includes pendulum exercises on postoperative day 1.

**Pitfalls**

There is a high likelihood of positive findings with electromyography in displaced proximal humerus fractures, which has been reported to exceed 80%. Therefore, patients undergoing this procedure are at risk for plexus stretch, which can compound any trauma-related plexus injury. Over tensioning the rTSA is a problem, particularly early in the surgeon’s learning curve, because instability is a concern. Although there is no objective method to guide proper tensioning other than experience, the more experienced rTSA surgeons tend to insert the fracture implants somewhat looser than primary rTSA implants to avoid the possibility of over tensioning.
Postoperative Care

Patients are immobilized in a sling and swathe or neutral rotation pillow for the first 3 to 4 weeks after surgery followed by progressive mobilization. Given that overhead function can generally be restored with or without tuberosity healing, earlier mobilization can be performed as long as a secure tuberosity repair has been achieved at the time of surgery. Gentle passive stretching for forward elevation should not exceed 150°, and passive external rotation should not exceed 30° to 40°. Depending on pain level and the radiographic appearance of the tuberosities, patients can begin active range of motion 4 to 6 weeks after surgery.

Conclusion

Reverse total shoulder arthroplasty for fracture is an effective solution for patients in whom HHR is likely to be unsuccessful. Whereas technically easier to execute than a standard rTSA or a revision rTSA, over tensioning can lead to postoperative problems including reflex sympathetic dystrophy and brachial plexopathy and should be avoided. Reliable restoration of elevation can be expected, and if tuberosity healing occurs, rotational movement can also be restored.

Disclosure Statement

Howard D. Routman, D.O., F.A.O.A.O., is a consultant for Exactech, Inc., Gainesville, Florida, and receives royalties on products related to this article.

References

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