Hemiarthroplasty for Proximal Humeral Fractures
Indications, Pitfalls, and Technique

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Abstract

Complex displaced proximal humerus fractures are frequently treated with a fracture prosthesis. This paper outlines the indications, introduces various fracture protheses, describes the surgical technique, and rehabilitation for treatment of proximal humerus fractures with a fracture prosthesis hemiarthroplasty. Outcomes are noted to be improved when near anatomic humeral head height, and retroversion is obtained using a small body proximal humeral replacing implant designed for fracture treatment. The use of a common platform stem allows for relatively easy conversion to a reverse shoulder arthroplasty if tuberosity nonunion should occur.

Proximal humeral fractures are common representing the third most frequent fracture in patients over 65. Hemiarthroplasty for the treatment of complex proximal humerus fractures is a common surgical option. Neer reported promising results with this technique in the 1970s. However, further reports have not reproduced such promising results with overall good pain relief but limited functional outcome. Changes in implant designs and a trend toward reverse total shoulder arthroplasty (rTSA) in elderly patients may improve functional outcomes.

Indications

Indications for hemiarthroplasty are based on the possibility of loss of vascularization of the humeral head with resulting avascular necrosis and humeral head collapse. Poor bone quality and complex fractures making osteosynthesis very difficult are other indications for arthroplasty. Patient considerations are important as well, such as overall health status, social situation, and rehabilitation ability. Olsson and coworkers showed a 40% one year mortality rate after proximal humeral fractures in fragile elderly patients. The most common indications for hemiarthroplasty include 4-part fractures, most 3-part fractures, displaced anatomic neck fractures, fracture dislocations, head splitting fractures, and impacted humeral head fractures involving greater than 40% of the articular surface.

The Neer system is the most widely used classification system for proximal humeral fractures. The greater tuberosity, lesser tuberosity, articular portion of the humeral head, and the shaft are all considered a “part.” These structures must be displaced greater than 1 cm or angulated greater than 45° to be considered a “part” in describing the fracture type. Valgus impacted 4-part fractures often require special consideration. These fractures usually have an intact medial hinge possibly preserving blood supply. The AVN rate has been reported to be between 26% and 75%. Iannotti and Aschauer recommend open reduction and internal fixation of these fractures if there is an intact medial hinge.

Preoperative Planning

Proximal humeral fractures are challenging and require careful preoperative planning. Several reports have shown that results are dependent on the experience of the surgeon. Orthogonal x-rays should be obtained to check the head and tuberosity position. The patient may not tolerate an axillary view. Non-contrast CT scans are invaluable in these cases. Dines recommends CT for a more exact analysis of fragment size and position. Hernigou even recommends a preoperative CT of the uninjured shoulder to assess anatomic version. Boileau recommends a preoperative x-ray of the entire humerus bilaterally to determine proper length.
Technique

Patients are placed in the beach chair position. A deltopectoral approach is most commonly utilized. The tuberosity and head fragments are first identified. The head should be carefully removed and kept for later bone graft beneath the tuberosities. The biceps tendon and bicipital groove are identified. Some recommend keeping the biceps tendon intact; however, it frequently interferes with later tuberosity reduction, and I routinely release it and perform a tenodesis at the end of the case. The pectoralis major tendon should be conserved to assist in height determination of the head. A large #5 suture is placed at the musculotendinous junction of the lesser and greater tuberosities for mobilization, and the rotator interval is opened. Frequently, the fracture line between the tuberosities is just posterior to the bicepital groove. Occasionally, the tuberosities remain connected. It is possible to leave them connected, but this may interfere with later reduction if the stem has a lateral fin designed to sit in the bicepital groove. The shaft is then sequentially reamed for the stem allowing for a small cement mantle. Two drill holes are made in the shaft, and two #2 nonabsorbable sutures are passed for later vertical stabilization of the tuberosities. After reaming the shaft, a trial stem is selected allowing for a 1 to 2 mm cement mantle. A larger trial stem may be chosen to assist with stability of the stem during trial reduction.

The most important factors in performing a hemiarthroplasty with a fracture prosthesis are 1. obtaining proper humeral head height, 2. getting version correct, and 3. secure fixation of the tuberosities. Tuberosity fixation and union may be difficult if the stem is not put at the correct height and version. Boileau and colleagues showed that humeral lengthening greater than 10 mm, shortening greater than 15 mm, or 40° or more of retroversion adversely impact the Constant score. Overall, the top of the humeral head should be approximately 10 mm above the top of the greater tuberosity. Restoring this relationship has been shown to be associated with good outcomes. Numerous techniques are available to determine the proper height of the stem. Reports have shown that the summit of the humeral head is on average 5.6 cm above the superior border of the pectoralis major tendon (Fig. 1). Krishnan and coworkers recommend using fluoroscopy to restore the “gothic arch” between the medial edge of the humerus and the lateral border of the scapula (Fig. 2). This is effective especially if the medial calcar is intact. Frequently, the lateral cortex of the greater tuberosity can be pieced back to the shaft fragment allowing proper height determination as well. If preoperative x-rays of the normal humerus were obtained, the length should be restored to within 10 mm of the normal side. Finally, laxity of the shoulder can be assessed during trial reduction. Anteroposterior translation should be 50% of the width of the glenoid, and inferior translation should be 50% of the height of the glenoid, allowing a finger to be easily placed in the subacromial space. Humeral retroversion on average is 20° to 30°. Most fracture systems have an alignment rod that when placed in line with the forearm will approximate average retroversion. The humeral head should be facing the glenoid when the arm is in neutral rotation. The use of the bicepital groove to set version has been controversial. Some investigators recommend aligning the lateral fin of the implant with the bicepital groove, while Baig and associates showed variability in its position according to the height being considered. Whatever technique is employed, this is a crucial step. Boileau showed that excess of 40° of retroversion caused increased stress on the greater tuberosity possibly leading to separation and nonunion of the fragment.

Once the proper height and version have been determined...
the shaft is prepared for cement. I typically place a portion of the head distally in the canal to act as a cement restrictor. When the cement is ready, the fracture stem is placed at the appropriate height and version and allowed to harden. If the implant has suture holes or fins, care should be taken to keep them free of cement. The choice of fracture stem has been controversial. Implant design has been shown to impact on tuberosity healing.11 There are two basic types of humeral fracture prosthesis: those implants having a narrow proximal body with fins for bone ingrowth between the tuberosities (Fig. 3) or implants with a thicker proximal body similar to a primary stem. Most have some type of porous or hydroxyapatite proximal coating. Narrow proximal implants conserve tuberosity bone and require a bone graft to restore the lateralization of the tuberosities. Thicker proximal body implants lateralize the tuberosities without bone graft, but may require removing bone from the tuberosities for proper reduction to the stem. With the recent popularity of reverse TSA for these fractures, modularity of the stem is a must to allow easy conversion to a reverse prosthesis if tuberosity healing is incomplete and function is poor. Lower profile stems have been shown to allow less tuberosity migration than higher profile stems,16,24 resulting in a high rate of tuberosity healing.21

With the stem now in proper position, a trial head is placed and the shoulder reduced. The previously mentioned parameters of laxity should be reassessed, and the fit of the tuberosities to the stem confirmed. Care should be taken not to place too large a head to avoid overstuffing the joint and compromising tuberosity fixation. The shoulder is then dislocated, and the head removed. It is much easier to pass sutures with no head on the stem. Suture fixation techniques are somewhat specific to the stem type, but several principals should be followed. Usually a #5 nonabsorbable suture is used (I use two in each tuberosity). Each tuberosity should be secured to the stem as well as each other with a final circlage suture. I repair the greater tuberosity first with the arm in neutral rotation, followed by the lesser tuberosity. Bone graft from the humeral head is placed under each tuberosity prior to reduction. Next, the rotator interval should be closed. Vertical fixation to the shaft should be obtained with the previously placed sutures in the shaft. These are

Figure 3 Equinoxe proximal humeral platform fracture stem (Exactech, Inc., Gainesville, FL).

Figure 4 Diagram of tuberosity suture technique.
passed through the musculotendinous junction of each tuberosity. The vertical sutures are not tied until this point for if performed earlier they tend to displace the tuberosities in a distal direction. Finally, the circlage suture which goes around both tuberosities and through the hole on the medial body of the stem or below the humeral head is tied (Fig. 4).

**Postoperative Rehabilitation**

Postoperative rehabilitation consists of sling wear for 6 weeks. I use an external rotation sling, which has been recommended. Early passive range of motion is initiated. Active motion of the elbow, wrist, and hand are allowed as tolerated. Compliance can be difficult in elderly patients, and a rehabilitation facility may be necessary. At 6 weeks active assisted range of motion is started. Strengthening may begin at 12 weeks. Patients should be informed that maximum recovery can take 6 to 12 months.

**Disclosure Statement**

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**References**