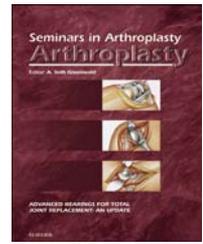


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The continuing role of hemiarthroplasty in the treatment of proximal humerus fractures

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ABSTRACT

Three- and four-part proximal humerus fractures may be successfully managed with non-operative or operative treatment. When surgery is indicated, younger patients with proximal humerus fractures commonly undergo open reduction and internal fixation, while older patients are often treated with reverse shoulder arthroplasty. However, for the active, older patient with a fracture that cannot be reliably reconstructed, hemiarthroplasty remains a viable treatment option. The orthopedic surgeon must carefully review each patient's overall clinical picture and select the treatment technique with the most advantageous risk/benefit profile for that individual.

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Proximal humerus fractures are common. Epidemiologic studies suggest that they account for approximately 4% of all fractures and increase in incidence with age [1–3]. In young patients, these injuries tend to occur less frequently, and they are often associated with higher-energy trauma. However, in older patients, especially those with osteoporotic or osteopenic bone, proximal humerus fractures may result from lower-energy injury mechanisms, such as a fall from standing. Historically, most proximal humerus fractures in older patients have been treated nonoperatively. Nonoperative treatment results in predictable improvements in pain and function for a majority of patients [4].

At least since Neer described his classification system and treatment algorithm for proximal humerus fractures, there has been an increasing effort by surgeons to predict which, if any, of these injuries should be treated surgically [5,6]. Using Dr. Neer's criteria, displaced two-, three- and four-part proximal humerus fractures have been recognized as potentially benefitting from surgical treatment [6]. In a systematic

review, Misra and colleagues demonstrated that nonoperatively managed patients with three- and four-part proximal humerus fractures had more pain and a decreased range of motion compared with those treated operatively with fixation or arthroplasty [7]. This determination, along with increasing surgical treatment options and improving technology, has likely contributed to the increase in operatively treated proximal humerus fractures in recent years.

Surgical treatment of proximal humerus fractures can be divided into those options designed to reconstruct the patient's existing anatomy with fracture fixation and those which replace the displaced or damaged articular surface with a prosthesis. Fixation options include percutaneous pins or screws, intramedullary nailing, and open reduction and internal fixation using non-locked or locked plating. Replacement options consist of hemiarthroplasty and reverse shoulder arthroplasty. Each technique has a unique risk/benefit profile, and the indications for each surgical tactic continue to evolve as implant technology advances and more

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functional outcome data becomes available. Open reduction and internal fixation and reverse shoulder arthroplasty, in particular, have seen a significant increase in use compared with other modalities. Registry data from the National Inpatient Sample analyzed by Sabesan revealed a significant increase over time in open reduction and internal fixation and reverse shoulder arthroplasty but no significant change in hemiarthroplasty for the treatment of proximal humerus fractures [8].

Patients with three- and four-part proximal humeral fractures who are physiologically young, active, have good bone stock, and a fracture pattern amenable to reconstruction will likely benefit from open reduction and internal fixation. Patients with a healed fracture following open reduction and internal fixation typically have few surgeon-imposed activity limitations, and the implant has an indefinite lifespan. Excellent postoperative outcomes can be achieved [9]. However, open reduction and internal fixation has been associated with high rates of complications, including screw cutout, varus collapse, and avascular necrosis [10]. Older patients may be especially at risk, with Owsley reporting a 43% rate of screw cutout in a subset of patients over the age of 60 undergoing internal fixation with a locked plate [11]. Fracture characteristics, such as metaphyseal head extension <8 mm, a disrupted medial hinge, and fracture of the anatomic neck have been shown to correlate well with humeral head ischemia at time of injury and may predispose patients to a poor outcome [12].

Originally designed to treat cuff tear arthropathy, reverse shoulder arthroplasty has become an increasingly popular option for the treatment of three- and four-part proximal humerus fractures in the elderly [8]. Multiple authors have evaluated the results of reverse shoulder arthroplasty compared with hemiarthroplasty for the treatment of proximal humerus fractures. For patients over the age of 70, Sebastián-Forcada and colleagues demonstrated superior pain relief and functional outcomes, and Cuff and Pupello reported improved American Shoulder and Elbow Surgeons and Simple Shoulder Test scores for reverse shoulder arthroplasty versus hemiarthroplasty [13,14]. Boyle also demonstrated better 6-month and 5-year Oxford Shoulder Scores for reverse shoulder arthroplasty when compared with hemiarthroplasty in patients with an average age over 70 [15]. For the older, lower-demand patient, reverse shoulder arthroplasty may be preferable to hemiarthroplasty [16,17].

The use of reverse shoulder arthroplasty in the treatment of proximal humerus fractures is not without its drawbacks. In the United States, reverse shoulder arthroplasty has been shown to be significantly more expensive than hemiarthroplasty. Solomon reported an average cost to the patient of \$57,000 for reverse shoulder arthroplasty and \$33,580 for hemiarthroplasty [18]. Reverse shoulder arthroplasty patients are commonly given significant activity restrictions postoperatively to protect the prosthesis and avoid complications such as dislocation, loosening, and excessive wear. Magnusson conducted a survey of North American and European shoulder surgeons and found that most surgeons place more limitations on patients undergoing reverse shoulder arthroplasty than those undergoing hemiarthroplasty [19]. Interestingly, a recent report by Roberson found no difference in

range of motion or on any of several patient-reported outcome measures for patients with an average age of 71 treated nonoperatively compared to those treated with reverse shoulder arthroplasty [20]. Further investigation is needed, but it seems possible that proximal humeral fractures in the elderly and low-demand patients could be over-treated and incur unnecessary risk and expense with reverse shoulder arthroplasty. These patients may not demand enough of their shoulders to benefit from the decreased activity restrictions associated with hemiarthroplasty and be best managed with nonoperative treatment.

While short term outcome measures may favor the use of reverse shoulder arthroplasty over hemiarthroplasty, long-term radiographic and functional outcomes demonstrate concerning changes and diminishing results. Scapular notching results from contact between the humeral liner of the reverse shoulder arthroplasty prosthesis and the inferior neck of the scapula and is a common finding on postoperative follow-up radiographs. Bonneville documented a 20% incidence of scapular notching at 2-year follow-up of patients undergoing reverse shoulder arthroplasty for fracture, while Namdari found an incidence of 33.5% [21,22]. Work by Mollon et al. [23] suggest that scapular notching is associated with poor outcomes, decreased strength, decreased motion, and higher complication rates at two-year follow-up [23]. Ten-year follow-up data on patients undergoing reverse shoulder arthroplasty, although not for fracture, revealed a 73% incidence of scapular notching and a significant decrease in mean and relative Constant scores from previous medium-term follow-up [24]. For active, healthy patients with a longer life expectancy, reverse shoulder arthroplasty may offer an uncertain long-term outcome.

The use of hemiarthroplasty in the treatment of proximal humeral fractures appears to be waning, but it remains an important part of the orthopedist's armamentarium. As Nevaizer states, "the use of hemiarthroplasty is...limited to middle-aged patients with fractures such as a head-splitting fracture with more than two pieces or four-part fracture dislocations" [9]. Hemiarthroplasty may also be used to treat large humeral head defects in the setting of chronic glenohumeral joint dislocation. While these injuries and other three- and four-part fractures may represent only a small subset of all patients presenting with a proximal humerus fracture, in the properly selected patient, hemiarthroplasty may offer distinct advantages over open reduction and internal fixation or reverse shoulder arthroplasty.

Hemiarthroplasty represents a viable alternative to open reduction and internal fixation for the older, yet active patient with a proximal humerus fracture. Patients in this demographic range who are at risk for avascular necrosis or humeral head collapse, or have, in the opinion of the surgeon, fractures that are unable to be reconstructed, can be treated with hemiarthroplasty. After successful hemiarthroplasty, just as with open reduction and internal fixation, patients are generally allowed to return to activities as tolerated with very few restrictions. As in open reduction and internal fixation, implant-on-implant wear is not an issue as there is no glenoid component. Glenoid articular surface erosion and humeral stem loosening following hemiarthroplasty can occur, but revision-free survival rates are

generally high, with some authors reporting rates near 95% at a mean 10.3-year follow-up [25].

Excellent results following proximal humerus fracture can be achieved with hemiarthroplasty. However, outcomes have been shown to be highly dependent upon anatomic tuberosity reduction and subsequent healing; tuberosity malposition has been documented in as many as 50% of cases [26]. Motion, and especially external rotation, can be restored with proper tuberosity positioning and successful healing. Gallinet et al. [27] reported improved rotation and equivalent outcome scores in a comparison of hemiarthroplasty to reverse shoulder arthroplasty in 2009. Older hemiarthroplasty stem designs and tuberosity repair techniques may have contributed to the variable outcomes seen in early studies. Using more modern fracture-specific stems with design characteristics optimized to encourage tuberosity reduction and healing, several authors have reported increased rates of anatomic tuberosity healing and improved outcomes [28–30].

In conclusion, most fractures of the proximal humerus can be managed nonoperatively. For young, active patients with good bone stock and a three- or four-part proximal humerus fracture, reduction and fixation, most commonly with a locked plate, will be the procedure of choice. For older, lower-demand patients, reverse shoulder arthroplasty can provide reliable short- to mid-term results. For the select few healthy, active, older patients with fractures not amenable to nonoperative management or reduction and fixation, hemiarthroplasty remains a cost-effective, durable treatment option that can return patients to an active lifestyle.

Disclosure

Dr. Grogan reports no proprietary or commercial interest in any product mentioned or concept discussed in this article.

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