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Humeral shaft fractures following TSA

*Karimdad Otarodifard, MD, R. Bruce Canham, MD, and Leesa M. Galatz, MD**

Shoulder and Elbow Service, Washington University Orthopedics, Barnes-Jewish Hospital, 660 South Euclid Ave, Campus Box 8233, St. Louis, MO 63110

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ABSTRACT

Periprosthetic fractures are difficult postoperative complications after arthroplasty. Fractures that occur intraoperatively should be stabilized at the time of surgery. Revision stems can bypass the fracture. Plates and cerclage wires are another option. Fractures that occur in the postoperative setting may be treated non operatively if the fracture involves the shaft distal to the stem and the stem is stable.

Greater tuberosity fractures can also be treated non operatively if the stem is stable. Fractures that result in instability or occur in the setting on an unstable prosthesis require operative revision. Radial nerve palsy is a common complication of operative treatment, and the nerve should be carefully protected.

1. Background

Periprosthetic humerus fractures are rare occurring in only 0.6–3% of all shoulder arthroplasties. They most often occur intraoperatively, and risk is increased by several technical errors. Intraoperative fractures tend to occur secondary to poor surgical exposure with increased leverage, improper positioning, poor reaming technique, cortical notching, and oversized implants among others [1]. Patient-associated risk factors for periprosthetic fractures include osteopenia, age, sex, and rheumatoid arthritis (RA).

In general, there is a higher rate of nonunion in periprosthetic fractures compared to other humerus fractures. Distraction caused by the stem as well as increased force transmission through the implant is thought to play a role [2]. Risk factors for delayed healing also include RA, female sex, and osteopenia. Krakauer et al. [3] reported that 85% of fractures occurred in women with an average age of 71 years. Others also found that RA was present in 55–100% of patients with postoperative humerus fractures [2,4].

2. Classification

Fractures about a humeral implant are classified according to location. Wright and Cofield [4] described 3 different types; type A is centered near the tip of the stem and extends proximally; type B is centered around the tip; and type C is located distal to the stem. Campbell and Iannotti described a similar classification system based on location. Type 1 fracture involved the tuberosities; type II was in the metaphyseal region; type III were located around the tip of the stem; and type IV were distal to the tip in the diaphysis [5].

Osteopenia is an important risk factor for periprosthetic fractures. It is classified according to ratio of the cortical thickness compared to the width of the humeral diaphysis. A ratio >50% indicated normal bone, 25–50% indicated mild osteopenia, and <25% indicated severe osteopenia. Based on this definition, osteopenia was present in 75% of the periprosthetic humeral shaft fractures [5,6].

*Corresponding author.
E-mail address: galatzl@wudosis.wustl.edu (L.M. Galatz).

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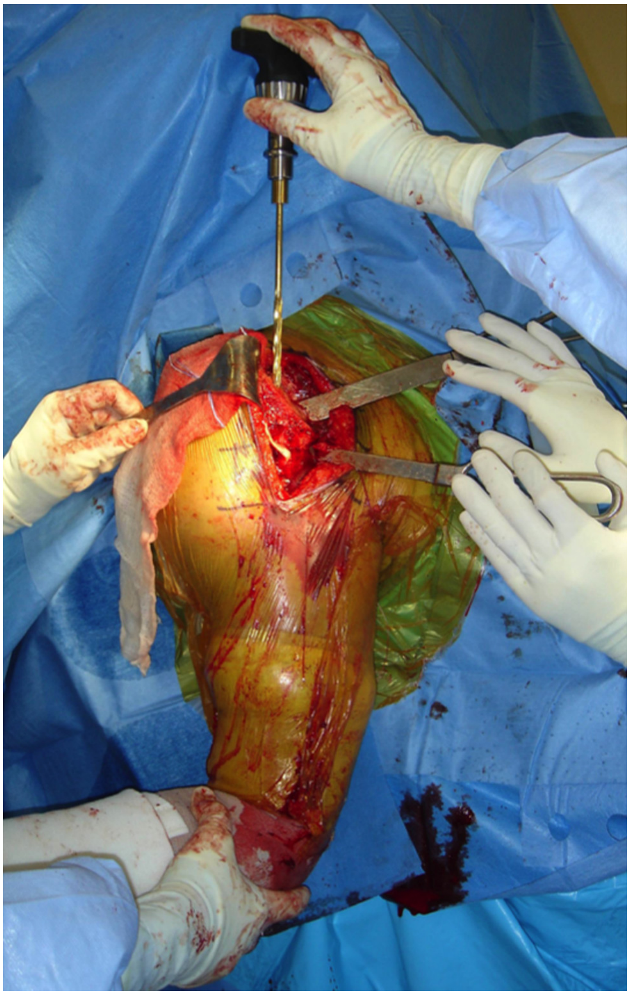

Figure 1

3. Prevention

Proper intra-operative patient positioning is a key factor to avoiding fractures. Ensuring adequate clearance of the humerus allows for easier canal reaming (Fig. 1). Proper soft tissue releases help to avoid overzealous manipulation. It is essential to fully release both the subacromial and subdeltoid spaces. Finally, sufficient release of the inferior capsule is the key to excellent glenoid exposure and helps protect the humerus from forceful retraction and/or torsion.

Reaming errors can also lead to complications. Starting reamers should be inserted 9 mm lateral to the center of rotation and inline with the canal. Staying lateral in the humerus and posterior to the biceps will help to avoid varus placement of the reamer. Collinear reaming will minimize cortical notching and penetration. Sequential reaming using hand controlled reamers helps to give the surgeon a better tactile response to avoid over-reaming. Limiting reaming to the earliest cortical chatter also help reduce the stress placed on cortical bone. Using slightly undersized trials and implants is preferable to forceful impaction of larger stems. Care should be taken when impacting reverse prostheses with a proximal flare because this can cause a stress riser and subsequent fracture in the metaphysis. Athwal et al. [7] found that using a press-fit humeral component had a 2.9 relative risk of intra-operative fracture compared to a cemented component.

Postoperatively, patients who have had notching or canal transgression, a varus positioned stem, an ipsilateral total elbow arthroplasty or a loose stem are all at an increased risk for future fracture.

4. Treatment

Fracture treatment is tailored according to fracture type and characteristics. Important factors to consider include location of the fracture, stability of the fragments, stability of the prosthesis, and bone quality. Non-surgical treatment is feasible in minimally displaced, stable fractures in patients with body habitus amenable to bracing. It may also be necessary in patients with multiple comorbidities where surgical risk may outweigh potential benefits. Surgical treatment is recommended for patients with grossly unstable fractures, loose stems, or with displaced fractures that have not healed after 3 months of nonsurgical treatment [6].

Fractures that occur intraoperatively should always be stabilized at the time of surgery. If discovered intra-operatively, the tuberosity fractures should be repaired with heavy non-absorbable suture or wire. Fractures involving the humeral shaft should be bypassed with a long stem, and stability can be augmented with cerclage wires and possibly allograft bone struts. Plate fixation is also an option. Regardless, as a rule, fractures created at the time of surgery, must be stabilized at the time of surgery.

In evaluating fractures that occur in the postoperative setting, prosthesis stability is an important factor. Loose prostheses generally need to be revised. Type I fractures involving the tuberosities can be treated conservatively when they are non-displaced or minimally displaced. Fractures occurring postoperatively can be treated in a similar fashion. Type II fractures are treated surgically with a long stemmed prosthesis that extends 2 or 3 [1,5] cortical widths past the fracture site. Stems may be cemented or press fitted without significant impact of healing rates [2]. Fixation can be supplemented with cerclage wires or strut allografts. Type III fractures can be treated with stem revision, open reduction internal fixation (ORIF), or a combination of both (Fig. 2). Loose stems are revised to longer implants that bypass the fracture. A well-fixed stem can be retained and the fracture addressed using a hybrid plate with locking screws and cerclage wires. Bone loss is managed with cortical strut grafts and hybrid fixation. Type IV fractures are located below the stem and can be treated similarly to humeral diaphyseal fractures. In the absence of bone loss and stem loosening, fixation using standard plates and screws is used (Fig. 3). Locking or hybrid plates can also be used with or without cerclage wiring.

5. Results

The low incidence of periprosthetic humeral fractures is matched by the relatively small amount of published literature, with most reports being case series and level IV