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Proximal periarticular locking plates in proximal humeral fractures: functional outcomes

Leah M. Schulte, MD*, Lauren E. Matteini, MD, Robert J. Neviaser, MD

Department of Orthopaedic Surgery, George Washington University, Washington, DC, USA

Background: Some recent studies have asserted that locking plates do not provide adequate fixation of proximal humeral fractures. The purpose of this study is to review our experience with proximal humeral locking plates, including complications, functional outcomes, and predictors of successful treatment.

Materials and methods: At our institution, 45 patients (46 shoulders) with displaced proximal humeral fractures were treated with a proximal humeral locking plate over a 6-year period. Patients underwent standard surgical and rehabilitation protocols and were evaluated clinically with Disabilities of the Arm, Shoulder and Hand and American Shoulder and Elbow Surgeons standardized outcome measurements and range of motion at last follow-up. Radiographs obtained preoperatively, immediately postoperatively, and at final follow-up were evaluated for fracture type, union, and change in alignment.

Results: There were 43 patients (44 shoulders) available for range-of-motion and functional outcome measures with an average follow-up of 34 months. Fracture types included 19 two-part, 21 three-part, 3 four-part, and 1 head-splitting fracture. The mean Disabilities of the Arm, Shoulder and Hand score was 11. The average American Shoulder and Elbow Surgeons score was 85. The average visual analog pain score was 0.8. The average range of motion was as follows: elevation, 140°; external rotation at side, 49°; external rotation in abduction, 77°; and internal rotation, T11. No patient had evidence of screw cutout, varus collapse, or avascular necrosis. One patient required hardware removal.

Conclusions: Displaced proximal humeral fractures can be successfully fixed with locking plates when attention is paid to anatomic reduction, proper plate placement below to the greater tuberosity to allow abduction, screws in the head with subchondral bone purchase, calcar screws from inferior-lateral to superior-medial and delaying shoulder motion until at least 2 weeks.

Level of evidence: Level IV, Case Series, Treatment Study.

Keywords: Proximal humeral fracture; locking plates; ASES; DASH

Proximal humeral fractures are a common problem in orthopaedics, accounting for 5% of all fractures.[1] These fractures occur with an incidence of 6.6 per 1,000 person-years,[23] and greater than 70% of patients are over the age of 60 years.[38] Osteoporosis is thought to be a key factor in fractures in this age group,[35] because proximal humeral fractures rank third in fragility fractures, after the hip and distal radius.[23] Approximately 80% of these fractures are nondisplaced or minimally displaced and are therefore stable and amenable to nonoperative treatment;[9] however, displaced, unstable fractures frequently require open reduction and internal fixation (ORIF) for early mobilization.[12] There are many options for stabilizing these fractures, including percutaneous pinning, screw osteosynthesis, plating, intramedullary nailing, and

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*Reprint requests: Leah M. Schulte, MD, 500 Tripoli St. Suite 413, Pittsburgh, PA 15212, USA.

E-mail address: leahmschulte@gmail.com (L.M. Schulte).

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hemiarthroplasty.[8,23,35,38] All of these methods have reported complications such as pain, stiffness, implant failure, loss of reduction, nonunion, malunion, impingement, and osteonecrosis of the humeral head.[1,9,23,37,38] As a result, there is no consensus on optimal treatment of these fractures.[9]

Periarticular locking plates with fixed-angle stability have been shown to be effective in osteoporotic bone.[1] Previous outcome studies of periarticular locking plates report complication rates as high as 36% and include impingement, screw penetration, screw cutout, and loss of fixation (Fig. 1).[28] Many authors attribute the high complication rates to surgical technique, malreduction, or too many or too few screws in the humeral head.[1,6,18,28] These complications have led to questioning the efficacy of proximal humeral locking plates.[14]

The purpose of this study is to review our experience with proximal humeral locking plates, including complications, functional outcomes, and predictors of successful treatment.

Materials and methods

After obtaining institutional review board approval, we reviewed all proximal humeral fractures from 2003 to 2009 at our institution. This showed 45 patients (46 shoulders) who had undergone ORIF with a proximal humeral locking plate. Inclusion criteria for the study were a proximal humeral fracture treated with a locking plate and at least 1 year of follow-up. The patients were contacted and scheduled for a follow-up office visit with an independent surgeon not involved in the surgery or care of the patients. At this visit, range of motion of both shoulders was measured with a goniometer for elevation, external rotation at the side and in abduction, and internal rotation. Final radiographs were evaluated for union, hardware status, avascular necrosis, and fracture anatomy. Review of all subjects' medical records was performed to obtain data including age, arm dominance, worker's compensation status, mechanism of injury, concomitant injuries, type of fracture, previous radiographs and reports, and complications or further procedures.

Patients also completed the American Shoulder and Elbow Surgeons (ASES) scoring survey, as well as the Disabilities of the Arm, Shoulder and Hand (DASH) scoring survey.[20,32] The DASH patient assessment has been validated for injuries to both the distal and proximal portions of the upper extremity.[5] The ASES survey has been validated for shoulder evaluation.[30]

Surgical technique

Surgery was performed with the patient under general anesthesia. Appropriate prophylactic antibiotics were given before surgery and for 24 hours postoperatively. All fractures were approached through a standard deltopectoral interval in the captain's chair position.[19] The fracture was exposed and fragments mobilized without excessive periosteal stripping to preserve soft tissues and blood supply. By use of C-arm fluoroscopy, the fracture fragments were

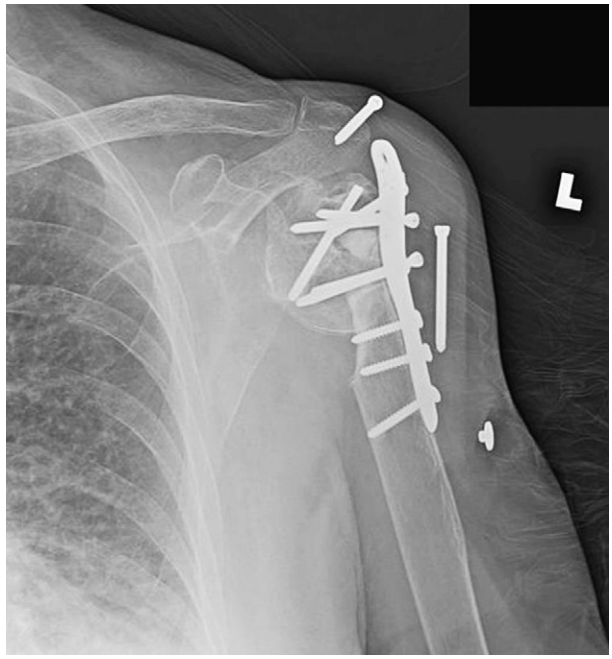

Figure 1 Radiograph of a failed proximal humeral ORIF.

reduced. These difficult fractures required different reduction techniques for different fracture patterns. Elevators were used to raise the articular surface gently when it was impacted into valgus. Traction sutures were placed at the tendon-bone junction of both the subscapularis and supraspinatus muscles, if the tuberosities were fractured, to control the involved tuberosity. The head and tuberosity fragments were reduced with confirmation by fluoroscopy, and an anatomically precontoured 3.5-mm LCP Proximal Humerus plate (Synthes, Oberdorf, Switzerland) was placed 8 to 10 mm distal to the tip of the greater tuberosity and temporarily fixed with a stabilizing wire. The shaft was reduced to the head and clamped to the plate using a Lowman clamp. If a large amount of metaphyseal extension was present, that fragment was incorporated into the shaft reduction and held by the reduction clamp. Occasionally, circlage wires were used to hold this fragment reduced. Plate placement and reduction was confirmed with fluoroscopy with the arm in neutral and varying degrees of external rotation. Anatomic reduction and avoidance of a varus position was achieved in all cases. If fluoroscopy indicated that the plate required repositioning or the reduction was not acceptable, the clamp was loosened enough to make the necessary changed and retightened. Screw holes were drilled into the head, and the depth and location of the drill bit were confirmed by fluoroscopy (Fig. 2). The desired depth was into subchondral bone of the central, posterior, and inferior regions of the humeral head between 5 and 8 mm from the articular margin, without penetration into the joint. After the first screw was placed in the head, the plate fixed to the shaft with a screw. Similar steps were used for the placement of the remaining