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Minimally invasive plate osteosynthesis with PHILOS plate for proximal humerus fractures

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ABSTRACT

Objectives: The aim of the present study was to evaluate results, including clinical and radiological outcomes and number of complications, following minimally invasive plate osteosynthesis (MIPO) of proximal humerus fractures, using the PHILOS® proximal humerus internal locking system (Synthes Holding AG, Solothurn, Switzerland).

Methods: Retrospectively evaluated were 31 patients treated with MIPO (12 male, 19 female; average age: 58.4 years). Four patients had 2-part fractures, 14 patients had 3-part fractures, and 13 patients had 4-part fractures, according to Neer classification. Healing, complications, and head-shaft angle (HSA) were radiographically evaluated. Clinical outcomes were assessed at 1-year follow-up with Constant score.

Results: Average Constant scores for fractured and normal shoulders were 73.2 ± 10.9 and 84.8 ± 5.1, respectively. Varus progression, fracture type, and age had no significant effect on functional outcome. Average postoperative and follow-up HSA's were 130.80 ± 7.70 and 128.80 ± 10.00, respectively. Significant varus progression was observed during follow-up ($p = 0.01$). Varus progression was more prominent in patients with postoperative HSA < 130° ($p < 0.001$). Inferomedial calcar screw usage, fracture type, and age had no significant effect on varus progression. Complications included 2 implant failures, 1 case of avascular necrosis (AVN), 1 primary screw cut-out, 1 axillary nerve injury, and 1 radial nerve injury (22.6% overall).

Conclusion: MIPO is a safe and effective option for the treatment of proximal humerus fractures, with good functional recovery and fewer complications, which are typically technique dependent. Reduction may be difficult, resulting in varus progression. Another disadvantage is risk of axillary nerve injury. Careful surgical technique and correct implant selection is important in the prevention of nerve injury.

Level of evidence: Level IV, Therapeutic study.

Introduction

Proximal humerus fractures are very common injuries, with increasing incidence in elderly patients.[1] Surgical treatment is usually preferred for displaced fractures. Various methods have been introduced, including the use of percutaneous k wires, plates, intramedullary nails, and arthroplasty.[2,3] After the development of angular stable locking plates, surgical fixation of proximal humerus fracture became more popular.[4] Deltopectoral approach had traditionally been used for plate fixation, though the extensile approach causes additional soft tissue damage, deltoid muscle injury, and impairment of the anterior circumflex humeral artery, which may lead to complications including nonunion, avascular necrosis (AVN), and infection.[5]

In 2005, Gardner described the anterolateral deltoid-splitting approach for treatment of proximal humerus,[6] and this approach was also used as a component of minimally invasive plate osteosynthesis (MIPO) in treatment of proximal humerus fractures. The approach has the advantages of less soft tissue stripping, better preservation of blood supply, and direct visualization of greater

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tuberosity. In recent years, MIPO has been extensively used to treat proximal humerus fractures.[7–15]

The aim of the present study was to evaluate results, including clinical and radiological outcomes and number of complications, following MIPO implemented with use of the PHILOS® proximal humerus internal locking system (Synthes Holding AG, Solothurn, Switzerland).

Patients and methods

The present study was approved by committee of Çankaya Hospital. Between December 2006 and August 2014, 44 patients with displaced proximal humerus fractures were treated using the MIPO technique. Four patients treated with conventional plates were excluded. Of the remaining 40 patients treated with the PHILOS® plate, 9 patients were lost during follow-up. Ultimately, medical reports of 31 patients who completed at least 1 year of follow-up were retrospectively evaluated. Twelve male and 19 female patients, with an average age of 58.4 years (range: 18–83), were included. Sixteen patients (51.6%) were younger than 60 years of age; 15 patients (48.4%) were older (Table 1).

All fractures were classified according to Neer classification, using x-ray and computed tomography imaging. Four patients (12.9%) had 2-part, 14 patients (45.2%) had 3-part, and 13 patients (41.9%) had 4-part fractures.

Average delay between injury and surgery was 3 days (range: 1–10). All procedures were performed under general anesthesia with the patient in beach chair position. A lateral longitudinal incision was proximally made, beginning at the anterolateral tip of the acromion, and extending at a maximum of 5 cm distally (Fig. 1a). Deep dissection was performed through avascular deltoid raphe (Fig. 1a). Nonabsorbable sutures were passed through the insertion sites of the subscapularis, supraspinatus, and infraspinatus tendons. These sutures were used for mobilization and reduction of the tuberosities. If necessary, k wires were used for indirect reduction of the humeral head or for temporary fixation of tuberosities. The axillary nerve was palpated blindly by the index finger through the incision (Fig. 1b). Full exploration of the axillary nerve was not performed. Submuscular tunnel was prepared underneath the axillary nerve, using a blunt elevator.

Plate was inserted percutaneously from proximal to distal (Fig. 1c). Location of the distal incision was determined according to the length of the plate, under fluoroscopic control (Fig. 1d). The distal plate was palpated on the midshaft of the distal humerus. Position of the proximal plate was checked under fluoroscopy. Two k wires were inserted through the first row on the plate, using locking drill sleeves to fix the plate to the humeral head. These k wires also provided information about the position of the most proximal screws. Fixation was started distally with a 3.5-mm cortical screw as a positional screw to indirectly reduce the shaft (Fig. 2a). Proximal fixation was performed, using at least 4 3.5-mm locking screws. If metaphyseal communition was present, a long inferomedial calcar screw (IMCS) was inserted through the fourth row in the plate[16] (Fig. 2a). Additional 2 or 3 3.5-mm locking screws were inserted distally to complete fixation (Fig. 1e). Nonabsorbable sutures were tied to anchor holes to fix the tuberosity fragments and to counterbalance the deforming forces on the fracture. No additional fixation was performed for the tuberosities.

Sling immobilization was postoperatively used for 1 week, and passive- and active-assisted range of motion exercises were immediately begun. Active exercises were begun after 4 weeks. Radiographic evaluations were routinely performed at 6 weeks, 3 months, 6 months and 1 year, by using 20° external rotation projection for anteroposterior view and full internal rotation projection for lateral view (Fig. 2). If suspicion of fracture healing was present at 3 months, radiographic controls were performed more closely. Fracture healing, complications, and head-shaft angle (HSA) were evaluated radiographically. HSA was calculated by the same surgeon (U.G.), according to the method of Hertel et al.[17] (Fig. 3). An angle above 130° was considered the goal of treatment. Clinical outcomes were assessed at 1 year of follow-up with Constant score. Nerve lesions were assessed clinically.

Outcomes of the present study were evaluated with SPSS statistical software (version 23.0; SPSS Inc., Chicago, IL, USA). Comparison of postoperative and follow-up HSA measurements, comparison of varus progression between patients with primary reduction less and more than 130°, and between patients with or without IMCS and varus progression, in terms of fracture type and age, were analyzed with analysis of variance for repeated measures. Comparison of functional outcomes of patients with or without varus progression, in terms of fracture type and age, were analyzed with Student's t-test; p values less than 0.05 were considered statistically significant.

Table 1
Patient demorgaphic data.

Variable	Value
Number of patients	31
Age	
Average	58.4 (range: 18–83)
<60 years	16 (51.6%)
≥60 years	15 (48.4%)
Gender	
Male	12 (38.7%)
Female	19 (61.3%)
Neer fracture type	
2-part	4 (12.9%)
3-part	14 (45.2%)
4-part	13 (41.9%)

Results

No nonunions were observed at follow-up. Complete implant failure (cut-out of all proximal screws) after varus collapse was seen in 2 patients (6.5%) 3 and 4 months after surgery. They had 4-part fractures which were treated without IMCS. Postoperative HSA of these patients were 117° and 122°, with 22° and 5° of varus progression, respectively, at follow-up. Shoulder arthroplasty was performed for these patients. All other patients had radiographic union at 3-month follow-up. One patient (3.2%) developed AVN 6 months after surgery. He had 4-part fracture with poor greater tuberosity reduction. Short proximal screws had been used in the first surgery. Shoulder arthroplasty was performed. Other complications were primary screw perforation in 1 patient (3.2%), who was treated by changing the long screw at 1 month, deep infection in 1 patient (3.2%), who recovered completely after debridement at 3 weeks, axillary nerve injury in 1 patient (3.2%), and radial nerve injury in 1 patient (3.2%) who had relatively short arm length and was treated with a 5-hole plate. Both nerve injuries healed without clinical consequence. No subacromial impingement or secondary loss of greater tuberosity reduction were observed. Hardware removal was not performed. Overall complication rate was 22.6% (7 patients), and overall secondary operation rate was 16.1% (5 patients) (Table 2).

Upon postoperative radiographic examination, HSA measurement less than 130° was observed in 12 patients (38.7%). IMCS was used in 11 patients (35.5%), who had metaphyseal communition. Three-hole PHILOS® plate was used in 6 patients (19.4%), and 5-hole PHILOS® plate was used in 25 patients (80.6%). Average postoperative HSA measurement was 130.8°±7.7° (range:

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