Minimal Invasive Approach to Proximal Humerus Fractures with Diaphysis Extension in Elderly

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Abstract
Surgical treatment of proximal humeral fractures with diaphysis extension continues to be a challenge especially in osteoporotic patients. Anatomic locking plates have been used with satisfactory results. The aim of this study was to
describe the technical tips and to investigate the functional results of minimal invasive percutaneous plate osteosynthesis (MIPPO) in proximal humerus fractures with diaphysis extension in elderly patients.

**Keywords:** Humerus fracture, proximal, minimal invasive

**INTRODUCTION**

Proximal humerus fractures account for 5% of all fractures and 45% of humeral fractures [5]. The injury typically occurs with low energy trauma in elderly patients [21]. Even though good results of conservative treatment have been reported in the literature over the last two decades [23,1], surgical treatment gained great popularity with the advance of new locking plate designs, which may achieve higher stability and allow early functional treatment of patients with osteoporosis [27]. Although open procedures are reliable options, biologic fixation and minimally invasive surgery became a highly accepted alternative. Because of its advantages and good clinical outcomes, use of minimal invasive percutaneous plate osteosynthesis (MIPPO) has been highlighted in the treatment of proximal humerus fractures, which has been described primarily for comminuted fractures of tibia and femur [20,4].

Although there are many studies about proximal humerus fractures, there is still controversy in both classification and treatment of the proximal humerus fractures with diaphysis extension. The aim of this study was to investigate the functional results of MIPPO in proximal humerus fractures with diaphysis extension in elderly patients.

**PATIENTS AND METHOD**

Between January 2010 and June 2011, 5 patients with proximal humerus fractures with an average age of 66.2 years, were treated by MIPPO technique. Bone mineral density of all patients was measured by dual-emission X-ray absorptiometry (DXA) before surgery. A T-score of -2.5 or below was accepted as osteoporosis. There were three female and two male patients who stated normal pre-injury shoulder range of motion. Mechanisms of injury, classification according to AO of the fractures and other preoperative details are given in Table 1.

**Surgical Technique**

All patients underwent the same surgical procedure in beach chair position with chest elevated about 30°. For visualization of the reduction and screw positions, the image intensifier was placed parallel to the longitudinal axis of the arm.
Deltoid split technique was performed for proximal humeral approach. A 5-cm skin incision was made beginning at the anterolateral tip of acromion extending approximately 5 cm distally (Figure 1). Deltoid fascia and fascicles were dissected longitudinally to expose the greater tubercle. Axillary nerve was identified and taped meticulously, then pulled aside (Figure 2). In order to access the lateral aspect of more distal levels of humerus shaft, 3–5 cm longitudinal incisions were performed (Figure 1). The radial nerve was explored and retracted. A subdeltoid extraperiosteal tunnel was created along the humerus with a periosteal elevator inserted from the proximal incision to distally. Before advancing the plate, reduction was checked and confirmed using an image intensifier again.

An anatomic locked proximal humerus plate was then advanced through the created tunnel antegradely, along the lateral surface of the humerus, beneath the axillary nerve and the deltoid muscle maintaining the distal plate tip on the bone. A threaded drill guide was used as a handle to help positioning the plate. Before screw engagement, K-wires were introduced through the holes, which are designed to protect the preliminary reduction (Figure 3). Then a cortical reduction screw was used to conserve the alignment. Locking screws were then inserted using a sleeve protection assembly and a drill guide to protect the neurovascular structures. The intact axillary nerve that was pulled aside was released over the plate (Figure 4).

The final alignment of the fracture and the implant were checked under image intensifier (Figure 5). Patients were discharged with a shoulder immobilizer sling within 48-72 hours after surgery. Passive elbow and shoulder mobilization was permitted as tolerated. The sling and stitches were removed at 10 to 14 days. Functional outcomes were assessed by UCLA scoring system and Constant Shoulder Score (CSS) after complete union was achieved [6].

RESULTS

All patients were followed up for a mean of 11.8 months (range 9-17 months). The average T-score was -2.98. The mean healing time of the fractures was 17.4 months (14-20 months). While the average active forward flexion of the shoulder was 147° (120°-160°), the mean abduction was 81° (75°-90°). Results according to UCLA scoring system averaged as 30.8 (27-34) and the CSS scores’ mean was 75.6 (73-82) (Table 2).

DISCUSSION

Management of proximal humerus fractures is one of the most debated issues in orthopaedic practice. Approximately 20 to 40% of proximal humerus fractures are displaced and require surgical intervention [24]. The heterogeneity of multiple
factors including, patients’ age, activity level, fracture type and osteoporosis, makes it difficult to determine optimal treatment option for the fracture pattern. Diaphysis extension of the fracture line is also another challenge. The aim of the current study was to describe MIPPO technique and investigate the functional results of the proximal humerus fractures with a diaphysis extension treated by MIPPO. With an average age of 66.2, our study showed that minimal invasive technique is a safe and useful alternative for the treatment of proximal humerus fractures with diaphysis extension in osteoporotic bones.

The clinical results of proximal humerus fractures in elderly treated by different methods including conservative measures, open reduction and plate fixation, closed reduction and internal fixation (percutaneous pin fixation, intramedullary fixation, MIPPO) and prosthetic replacement have been reported in the literature [22,15,31]. There is little evidence and poor consensus regarding the optimal treatment modality in this population [14]. Nonoperative methods are the treatment of choice in proximal humeral fractures which are often nondisplaced [7]. Lill et al. reported good results in patients with displaced two to three-part fractures with conservative treatment [12]. Although conservative treatment is highlighted with its lower complication rates and cost also in three-part displaced fractures, there are advocates of internal fixation with locking plates because of a relatively better function after fracture healing [25].

Percutaneous pinning is one of the popular methods with proven benefits in treatment of proximal humerus fractures. A recent study emphasized that K-wire fixation provides better results in two-part rather than three-part proximal humerus fractures [16]. However, poor stability is criticized compared with intramedullary devices and conventional plating, improved cosmesis and lower rates of avascular necrosis in closed reduction and pin fixation have been reported [30]. It has also been suggested that the use of unthreaded pins appear to be more prone to failure in case of significant osteoporosis [16]. Pin migration, infection, neurovascular injury, and malunion are further complications of this technique [18].

Intramedullary nailing has been traditionally indicated in diaphysis fracture of humerus with an approved primary stability and superior biomechanical behaviors [28,2]. Moreover it appears to be an excellent solution in complex cases of proximal humerus fractures with concomitant shaft involvement [11,8]. On the other hand interfragmentary motion, which is prevented successfully by locking plates that provide an early pain free rehabilitation remains as an unsolved problem in intramedullary humeral nails [3]. Inadvertent fractures through the entry point, injuries to axillary nerve or the ascending branch of the anterior circumflex artery are potential risks during nailing [17,26].

Although satisfactory results can be achieved with both locking plates and
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Intramedullary nails, locking plates provide greater angular stability, leading to lower rates of implant failure or loss of fixation, thus allowing earlier mobilization in osteoporotic bone [13, 29]. Minimally invasive techniques with better preservation of soft-tissues are advocated in both proximal and diaphysis humerus fractures independently [9, 19]. However to our knowledge, minimal invasive lateral approach in proximal humerus fractures with diaphysis extension has not been discussed in the previous studies. Ji et al. described a safe lateral minimal invasive approach in distal humerus shaft fractures [10].

In our series these complex fractures were treated safely by minimal invasive lateral approach. Long locking plates were preferred to obtain the optimal working length. Although preservation of the axillary nerve and radial nerve appears to be the biggest challenge, knowledge of the topographic anatomy of the nerves provides a safe and feasible procedure. However, prolonged fluoroscopy time, poor neurovascular monitorization, inadvertent muscle detachment during tunnel preparation and long learning curve are the main restrictions of this technique.

The surgical treatment of complex humerus fractures that involve metaphysis and diaphysis is still a topic of controversy. Osteoporosis also complicates these fractures by increasing the failure rate. MIPPO appears to offer an effective option in the solution of this problem providing greater angular stability, and allowing early rehabilitation of the patient.

CONCLUSION

Treatment of proximal humerus fractures with diaphysis extension in osteoporotic elderly patients can be successfully treated by MIPPO. Restrictions of the technique may be overcome by improving both the technique and the implants.
Table 1. Preoperative details of the patients. (LET: low energy trauma, HET: high energy trauma)

<table>
<thead>
<tr>
<th>Patient No</th>
<th>Sex</th>
<th>Age (Years)</th>
<th>Side</th>
<th>Cause</th>
<th>Tuberosity / Neck Involved</th>
<th>AO Classification</th>
<th>Associated Injury</th>
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<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>64</td>
<td>R</td>
<td>LET</td>
<td>-/+</td>
<td>12 A1.1</td>
<td>None</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>71</td>
<td>R</td>
<td>LET</td>
<td>+/-</td>
<td>11 A1.1</td>
<td>Distal radius fracture (L)</td>
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<tr>
<td>3</td>
<td>F</td>
<td>66</td>
<td>L</td>
<td>LET</td>
<td>+/+</td>
<td>12 B1.1</td>
<td>None</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>61</td>
<td>R</td>
<td>LET</td>
<td>-/+</td>
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<td>None</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>69</td>
<td>R</td>
<td>HET</td>
<td>+/-</td>
<td>12A1.1</td>
<td>Non displaced pubic ramii fx (R)</td>
</tr>
</tbody>
</table>

Table 2. Results of the patients (abd: abduction, flex: flexion, CSS: Constant Shoulder Score, UCLA: University of California, Los Angeles)

<table>
<thead>
<tr>
<th>Patient</th>
<th>Time of injury to surgery (days)</th>
<th>Follow-up (month)</th>
<th>Union time (weeks)</th>
<th>Shoulder abd./Forward flex.</th>
<th>CS S</th>
<th>UCL A</th>
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<tbody>
<tr>
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<td>11</td>
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<td>75/120</td>
<td>68</td>
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REFERENCES


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