

## Research Article

# Outcome of locking plate fixation for proximal humerus fractures

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**Received:** 04 February 2016

**Accepted:** 27 February 2016

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## ABSTRACT

**Background:** The objective of the study was to evaluate functional outcome of open reduction and internal fixation with proximal humeral internal locking system (PHILOS) plate for proximal humerus fractures.

**Methods:** We reviewed 30 patients who underwent open reduction and internal fixation with PHILOS plate between the years 2010 to 2015. There were 23 men and 7 women with a mean age of 36 years (range 20-64). There were 22 patients in the age group of <60 years and 8 patients in the age group of >60 years. According to Neer classification system, 12, 11 and 4 patients had 2-part, 3-part, and 4-part fractures, respectively and 2 patients had 4-part fracture dislocation. All surgeries were carried out at our tertiary care trauma center. Functional evaluation of the shoulder at final follow-up was done using Neer's Evaluation Criteria.

**Results:** The mean follow-up period was 20 months (range 14-40 months). All fractures united clinically and radiologically. The mean time for radiological union was 13.2 weeks (range 9-26 weeks). At the final follow-up the mean Neer's Evaluation Criteria was 90 (range 76-100). The results were excellent in 17 patients, Satisfactory in 8 patients, Unsatisfactory in 4 patients and Failure in 1 patient. During the follow-up, 3 cases of varus malunion, 1 case of failure of fixation were noted. No cases of AVN, hardware failure, locking screw loosening, infection or nonunion were noted.

**Conclusions:** PHILOS provides stable fixation in proximal humerus fractures. In order to prevent the complications like avascular necrosis, knowledge of anatomy and vascular supply of head of humerus and good surgical dissection to preserve vascularity of humeral head is important.

**Keywords:** Proximal humerus, PHILOS

## INTRODUCTION

Proximal humerus fractures have an incidence of 5% among all the fractures.<sup>1</sup> It is second most common upper extremity fracture, 2<sup>nd</sup> only to distal radius fracture in patients more than 65 years. They are the third most common fracture overall following hip and distal radius fracture.<sup>2-6</sup> High energy trauma is the cause in young adults, resulting in fracture dislocations, whereas low energy injury like simple fall while walking can be the reason in older individuals, basic reason being osteoporosis due old age; such low energy fractures can be treated conservatively.

Many different techniques have been described like closed reduction and percutaneous K-wire fixation, open reduction followed by fixation with tension band, intramedullary nails, or locking plates and prosthetic replacement.<sup>7-10</sup> Various complications like nonunion at fracture site, avascular necrosis of head of humerus, nail migration, rotator cuff impingement syndrome, cut out of implants can occur.<sup>11,12</sup> PHILOS have been designed to improve internal fixation in elderly patients where bones in whom bones are severely osteoporotic and help prevent complications. There is minimal soft tissue dissection and the plates provide adequate axial and angular stability.

This study is done in order to determine the outcome of proximal humerus fracture with PHILOS plating.

## METHODS

The study includes 30 patients with proximal humerus fractures treated with PHILOS plate during the period of 2010 to 2015. Written informed consent was taken from all these patients.

### Inclusion criteria

1. Closed proximal humerus fractures (2-,3-, 4-part according to Neer classification system).
2. Patients older than 18 years of age.

### Exclusion criteria

1. Open fractures.
2. Pathological fractures.
3. Patients with failed conservative treatment.

There were 23 male and 7 female patients with a mean age of 36 years (range 20-64). There were 22 patients with age <60 years and 8 patients were in the age >60 years. Fracture was caused by trivial fall in 8 patients and caused by road traffic accidents and fall from height in the rest of the 22 patients. Fractures were classified based on preoperative plain radiographs. According to Neer classification system, 12, 11 and 4 patients had 2-part, 3-part, and 4-part fractures, respectively and 2 patients suffered 4-part fracture dislocation. Head splitting was noted in 1 patient.

Patients were operated at our hospital under proper aseptic conditions. Patient was placed supine with a sandbag under scapula to elevate the shoulder. Proper draping was done in order to make the shoulder an upper limb properly exposed. A deltopectoral incision described by Crensham in 1987 is made on the anterior aspect of the shoulder with exposure of the deltoid muscle. Then, the deltoid and pectoralis major muscles along with the overlying cephalic vein are identified.

With the shoulder in abducted ( $70^{\circ}$  to  $90^{\circ}$ ) position, a few fibres of deltoid along with cephalic vein are retracted medially, while the rest of the deltoid is retracted laterally. This is done throughout the length of the incision.

Bone spikes are placed, one posteriorly and one superiorly to the head of the humerus. Two more spikes are placed to distal shaft anteriorly and posteriorly. This will expose the proximal humerus and the shaft of the humerus, along with the fractured site. With strict traumatic technique, very little of the periosteum is lifted to expose the underlying cortical bone so as to protect the blood supply & to be able to anatomically reduce the fractured fragments at the surgical neck.

Proximal holes of the PHILOS plate & the holes are drilled into the proximal humerus (head) up to the subchondral bone and are fixed with appropriate length locking screws. The other remaining holes are drilled into the shaft & fixed with appropriate length screws (3.5mm).

The shoulder movements are confirmed clinically & fracture reduction is confirmed on image intensifier. Wound is closed in layers with vicryl and ethilon over a drain. Wound dressing is done and then, a chest-arm strapping to provide compression and immobilization is given.

Sling & Bandage chest-arm strapping is continued for 2 weeks. Sutures removed at the end of 2 weeks, then gentle pendulum exercises are started at the end of 2 weeks. Gentle passive flexion, abduction & rotation exercises - after 4 weeks, check X-rays taken at 4 weeks. Active exercises after 8-10 weeks.

Post-operative evaluation was done using Neer's evaluation criteria. In a 100-point system, 35 points are for pain, 25 points for range of motion (flexion, extension, abduction, internal rotation and external rotation), 30 points for function (10 activities including strength, reaching and stability) and 10 points for reconstruction of anatomy based on radiographic appearance. Mean duration of follow up was 20 months (range 14-40 months).

## RESULTS

All the patients had clinical and radiological union. The mean time for radiological union was 13.2 weeks (9-26 weeks). At the final follow-up, the mean Neer's Evaluation score was 90 (76-100). The results were excellent in 17 patients, Satisfactory in 8 patients, Unsatisfactory in 4 patients and Failure in 1 patient. During the follow-up, 3 cases of varus malunion, 1 case of failure of fixation were noted. Patient with implant failure was operated with Bone grafting and replating and is healed well consequently. Remaining patients were not symptomatic enough to undergo repeat surgery. None of the patients had complications like screw loosening, implant breakage or infection.

## DISCUSSION

Different techniques for the fixation of proximal humerus fractures have been described by authors.<sup>7-10</sup> All techniques have varying rate of complications like cut-out or back-out of the screws and plates, loss of fixation, fracture distal to the plate.<sup>13-15</sup>

Locking anatomical plate fixation offers many advantages compared to non-locking plates.<sup>15,16</sup> Care must be taken to preserve the soft tissue attachment during open reduction and internal fixation since damage

to soft tissues may decrease the vascularity of fracture fragments.<sup>17-19</sup>

In our study, we used the standard deltopectoral approach in all the patients. It is important to place the plate according to anatomy of proximal humerus, determination of Screw length with fluoroscopy, insertion of screws to the head in adequate number and position and providing medial cortical continuity prevention of varus.<sup>20</sup> And also to fix tubercle fragments by passing sutures through the plate and rotator cuff bone junction.<sup>21,22</sup>

In our study, overall complication rate was 20%. The main complications were varus malunion in 3 patients, and fixation failure in 1 patient. Fixation failure required reoperation with bone grafting and plating.

Egol et al observed only one case of acute infection in their series of 51 patients who mainly had 3- and 4-part fractures.<sup>23</sup> Gardner et al reported superficial wound dehiscence in one patient and Moonot et al reported one superficial infection that healed with oral antibiotic treatment.<sup>18,22</sup> Low incidence of infection in our study was attributed to meticulous surgical techniques and the special attention paid to soft tissue preservation.

Humeral head screw penetration (0-23%) is noted in various studies.<sup>24-27</sup> In our study, there is one such case. We used intraoperative fluoroscopic monitoring of the drill bit while drilling and also monitored the screw position in two views to avoid articular penetration.

In the past, incidences of AVN have been reported in a wide range, 4%-75% of cases.<sup>19,23,28-31</sup> In our study we did not have a single case of AVN. However follow-up was short term. More cases of AVN could potentially arise with longer observation.<sup>32-34</sup> Hertel and his colleagues evaluated risk factors for humeral head avascular necrosis following intracapsular proximal humerus fracture.<sup>35</sup> They noted that most important predictor was the length of the dorsomedial metaphyseal extension (<8 mm), the integrity of the medial hinge (defined by greater than 2-mm shaft displacement in any direction), and fracture with an anatomic neck component (types 2, 9, 10, 11 and 12 in their binary description system). When three of these criteria were present, the positive predictive value for ischemia was 97%.

Varus malunion is one of the potential complications following fixation of proximal humeral fractures. It is defined as a head shaft angle of less than 120 degrees. Moonot et al reported the incidence of malunion in 3- and 4-part proximal humeral fractures.<sup>22</sup> Björkenheim et al reported 26.3% of the fractures having 2-, 3- and 4-part united in slightly varus position after open reduction and internal fixation with locking plate.<sup>22</sup> Agudelo et al considered primary varus reduction to be an important risk factor which may cause poor results.<sup>25</sup> In our study we observed 3 (10%) cases of varus malunion. We did

not notice nonunion and heterotopic ossification in our series.

According to Neer's evaluation criteria, excellent/good results accounted for 80.33% and only 19.67% had fair/poor results. A relatively small sample size was the main limitation of this study. In conclusion, PHILOS provides stable fixation in proximal humerus fractures. Moreover, good knowledge of anatomy and blood supply of head of humerus and appropriate dissection around shoulder joint is necessary to prevent complications like Avascular necrosis of head of humerus.

## CONCLUSION

The present study of 40 patients was operated for total hip arthroplasty (THA). All the patients were operated by posterolateral approach. The combined anteversion was calculated as the sum of acetabular and femoral anteversion using a CT scan. The patients were followed up for a period of 3 months after the surgery.

From this study, the functional outcome of the patients was better when the combined anteversion was between 4-7ff as compared to the functional outcome when the combined anteversion was either less than 40 " or more than 70'. However, we required larger group of study to validate the findings.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

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**Cite this article as:** Rohra N, Chokshi J, Sanghavi R. Outcome of locking plate fixation for proximal humerus fractures. *Int J Res Orthop* 2016;2:25-8.