



## RESEARCH ARTICLE

### FIXATION OF PROXIMAL HUMERUS FRACTURES USING PHILOS PLATE

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#### ABSTRACT

**Objective:** The purpose of this study is to evaluate functional outcome of open reduction and internal fixation with proximal humeral internal locking system (PHILOS) for proximal humerus fractures.

**Method:** Functional outcomes of 11 men and 17 women aged 27 to 76 (mean, 53.21) years who underwent Philos plate fixation for proximal humeral fractures by deltopectoral approach were reviewed retro prospectively. 18 patients were in the age group of <60 years and 10 patients in the age group of >60 years. According to Neer classification system, 5, 9 and 14 patients had 2-part, 3-part, and 4-part fractures, respectively. Functional evaluation of the shoulder was done using Constant-Murley score.

**Results:** Patients were followed up for 12 to 18 (mean 15) months. All fractures united clinically and radiologically. The mean time for radiological union was 13 weeks (range 10-18 weeks). At the final follow-up the mean Constant-Murley score was 72 (range 35-90). The results were excellent in 8 patients, good in 15 patients, fair in 3 patients and poor in 2 patients. During the follow-up, 2 cases of malreduction, two cases of subacromial impingement and one case of infection were noted. No cases of AVN, hardware failure, locking screw loosening or nonunion were noted.

**Conclusion:** Philos plate fixation provided stable fixation and allowed early range-of-motion exercises.

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## INTRODUCTION

The main aim of treatment in proximal humerus fracture is to achieve a painless shoulder with full function. Proximal humeral fractures constitute about 4 to 5% of all fractures (Habermeyer and Schweiberer, 1989). Most of the fractures are stable and minimally displaced so they can be treated conservatively with good functional outcome (Young and Wallace, 1985). Displaced and unstable fractures are difficult to manage and they require surgical intervention. Different modalities of treatment used for proximal humerus fractures include- percutaneous Kirschner wire fixation, suture fixation, external fixation, tension band, intramedullary nailing, plating and prosthetic replacement (Kristiansen *et al.*, 1987; Park *et al.*, 2003; Rajasekhar *et al.*, 2001; Robinson *et al.*, 2003; Sadowski *et al.*, 2003; Sehr *et al.*, 1988; Wanner *et al.*, 2003). In younger patients fracture occurs because of high velocity trauma whereas low velocity trauma can be the cause in older

individuals because of osteoporosis. Several complications associated with these fractures include- cut-out or back-out of the screws and plates, nonunion, avascular necrosis (AVN), nail migration, and rotator cuff impingement syndrome (Sadowski *et al.*, 2003; Bjorkenheim *et al.*, 2004). Proximal humeral internal locking system (PHILOS) has been developed to solve these complications, it provides angular and axial stability and minimises the risks of screw toggle and pull out as well as reduction loss. Divergent or convergent locked screws improve the pull out resistance of the whole construct (Wagner 2003). Locking plates fail at a greater load than non-locking plates (Walsh *et al.*, 2006).

## MATERIALS AND METHODS

28 patients, 11 men and 17 women aged 27 to 76 (mean, 53.21) years who underwent Philos plate fixation for proximal humeral fractures by deltopectoral approach were reviewed retro prospectively between 2012 to 2015. 18 patients were in the age group of <60 years and 10 patients in the age group of >60 years. The surgical indication were 2 part, 3-part or 4-part

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closed proximal humeral fractures with angulation of  $>45^\circ$  or displacement of  $>1$  cm. Patients with fractures that were open or older than 3 weeks, or with a history of primary or metastatic tumours were excluded. The fractures were classified according to the Neer classification system. 5, 9 and 14 patients had 2-part, 3-part, and 4-part fractures, respectively. Surgery was performed in supine position on a radiolucent table under general anaesthesia using the anterior deltopectoral approach. The cephalic vein was retracted laterally or ligated to prevent inadvertent injury. The greater and lesser tuberosity fragments were tagged with non-absorbable sutures. The tuberosity fragments were reduced to the lateral cortex of the shaft. K-wires were used in humeral head as joysticks and fixed temporarily with the humeral shaft. The PHILOS plate was ideally placed 8-10 mm distal to the superior tip of the greater tuberosity just lateral to bicipital groove from the lateral view, the plate was centred against the lateral aspect of the greater tuberosity. An adequate gap was left between the plate and the biceps tendon to prevent disruption of the anterior humeral circumflex artery or entrapment of the tendon. First screw was placed in oval hole and tightened lightly so that the height of the plate could be adjusted. Fracture reduction and plate position were reconfirmed under image before placing other screws. Locking screws were placed in humeral head using drill guide. Subchondral screw position was confirmed under two image views. Minimum of five head screws were used. Finally screws were placed in humeral shaft. Minimum of three bicortical screws were used in all patients. Rotator cuff, capsule and subscapularis muscle tears/avulsions were repaired meticulously.

The wound was closed over a suction drain, which was removed after 24 to 48 hours postoperatively. Arm was supported with a sling. Pendulum along with passive forward flexion and external rotation was started from the first postoperative day followed by active assisted exercises after 3 weeks and active exercises after 6 weeks. Strengthening exercises were started 10 to 12 weeks after surgery. Patients were followed up fortnightly for 2 months, then after every month till 6 months then every 3 monthly till 1.5 years. At every follow up, patients were assessed clinically for shoulder stability and range of motion and bridging trabecular bone for verification of radiological union. Functional evaluation of shoulder at final follow up was done using Constant-Murley score. (Table 1)

## RESULTS

Patients were followed up for 12 to 18 (mean 15) months. The mean age of our twenty-eight patients (male 11 and female 17) was 53.21 (27-76). 18 patients were in the age group of  $<60$  years and 10 patients in the age group of  $>60$  years. According to Neer classification system, 5, 9 and 14 patients had 2-part, 3-part, and 4-part fractures, respectively. The commonest cause of injury was automobile accident in 17(60%) patients, followed by fall on out stretched hand in 5 (18%) patients, sports injuries in 4 (14%) patients, and other causes in 2 (8%) patients (Table 2). According to the Constant score, functional outcomes were excellent in 8 (29%) patients, good in 15 (53%), fair in 3 (11%), and poor in 2 (7%).



Figure 1. Pre-operative x-ray of proximal Humerus fracture



Figure 2. Post-operative x-ray of proximal Humerus fracture

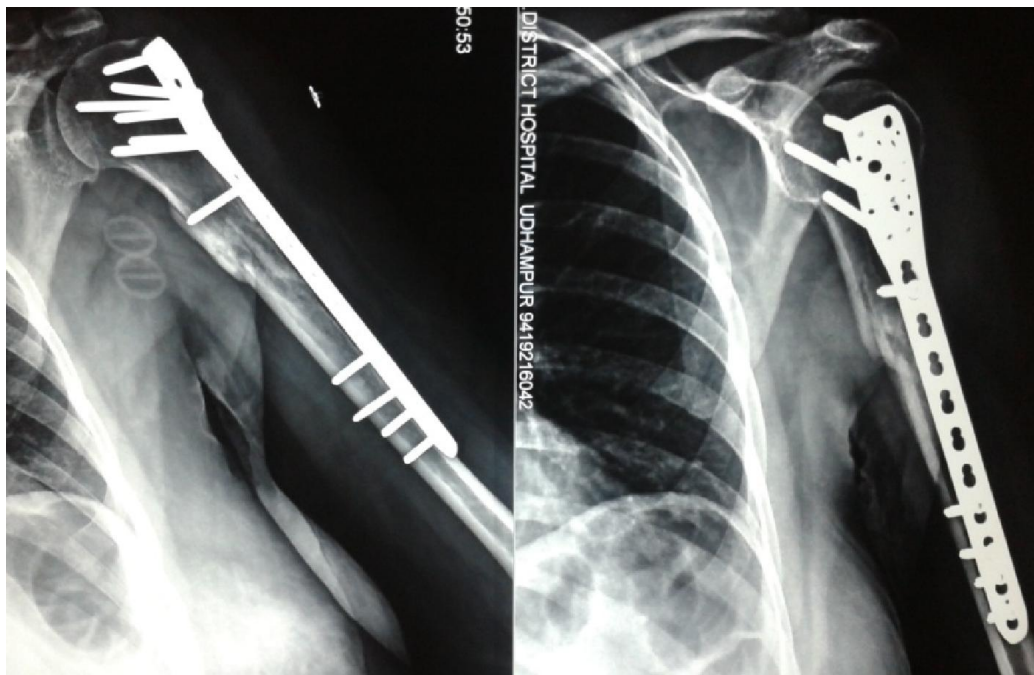


Figure 3. X-ray (AP & Lateral view) showing union of proximal Humerus fracture

Table 1. The Constant scoring system

Category	Score
<b>Pain (15 points)</b>	
None	15
Mild	10
Moderate	5
Severe	0
<b>Activities of daily living (20 points)</b>	
Activity level (10 points)	
Full work	4
Full recreation/sport	4
Unaffected sleep	2
Positioning (10 points)	
Up to waist	2
Up to xiphoid	4
Up to neck	6
Up to top of head	8
Above head	10
<b>Range of motion (40 points)</b>	
Forward elevation (10 points)	
0°-30°	0
31°-60°	2
61°-90°	4
91°-120°	6
121°-150°	8
151°-180°	10
Lateral elevation (10 points)	
0°-30°	0
31°-60°	2
61°-90°	4
91°-120°	6
121°-150°	8
151°-180°	10
External rotation (10 points)	
Hand behind head with elbow held forward	2
Hand behind head with elbow held back	2
Hand on top of head with elbow held forward	2
Hand on top of head with elbow held back	2
Full elevation from on top of head	2
Internal rotation (10 points)	
Dorsum of hand to lateral thigh area	0
Dorsum of hand to buttock	2
Dorsum of hand to lumbosacral junction	4
Dorsum of hand to waist (3rd lumbar vertebra)	6
Dorsum of hand to 12th dorsal vertebra	8
Dorsum of hand to interscapular region (DV 7)	10
<b>Strength (25 points)</b>	25

Table 2. Characteristics of proximal Humerus fractures fixed with PHILOS plate

S.No	Characteristics	No.
1.	Age (yrs) Range (27-76)	Mean age 53.21
2.	Sex Male/Female	11/7
3.	Mode of trauma Automobile accidents/Fall on outstretched hand/Sports/Others	17/5/4/2
4.	Neer classification 2part/3part/4part	5/9/14
5.	Shoulder range of movement Excellent/Moderate/Poor	8/18/2
6.	Constant Score Range (35-90)	Mean 72.25
7.	Time for radiological union (wks) Range (10-18)	Mean 13
8.	Complications Malreduction/Subacromial impingement/Infection	2/2/1
9.	Result Excellent/good/fair/poor	8/15/3/2

Table 3. Comparison of results between 3-part and 4-part fractures

Results	No. of patients 3- part (9)	No. of patients 4- part(14)
<b>Constant score</b>		
Excellent	3	0
Good	6	9
Moderate	0	3
Poor	0	2
<b>Shoulder range of movement</b>		
Excellent	3	0
Moderate	6	12
Poor	0	2

The mean Constant score was 72.25(range, 35–90). Constant scores in 3 and 4-part fractures were compared (Table 3). The shoulder range of movement was excellent in 8 (29%), moderate in 18 (64%), and poor in 2 (7%). The mean time for radiological union was 13 weeks (range 10-18 weeks). There was no significant difference in outcomes between patients with 3-part and 4-part fractures. During the follow-up, two cases of malreduction, two cases of subacromial impingement and one case of infection were noted (Table 2). No cases of AVN, hardware failure, locking screw loosening or nonunion were noted.

## DISCUSSION

There are different modalities of treatment for fractures of proximal humerus varying from conservative management to surgical intervention. Conservative treatment is advised in patients with undisplaced 2 part fractures, patients who are unfit for surgery and low demanding elderly patients. Surgery is indicated in displaced 2 part, 3part and 4 part fractures. 3 part and 4 part fractures are especially difficult to treat because of comminution and there is a possibility of implant failure, loosening of screw, cut out of screw, AVN, impingement syndromes. Different techniques have been described for the fixation of comminuted and displaced proximal humerus

fractures (Ogiwara *et al.*, 1996; Resch *et al.*, 1997; Park *et al.*, 2003; Robinson *et al.*, 2003). The treatment of choice depends on patient age, functional requirements, quality of bone, fracture classification. The PHILOS plate was designed to improve screw fixation and minimize soft tissue dissection. It attempts to achieve these aims through a combination of multidirectional locking screws for the head, precontouring of the plate, and locking screws in the shaft (Moonot *et al.*, 2007). There are many clinical studies which indicate that proximal humerus locking plates have good result in proximal humerus fractures (Fankhauser *et al.*, 2005; Koukakis *et al.*, 2006; Moonot *et al.*, 2007). In our study, treatment of proximal humerus fractures with PHILOS plate provided stable fixation and allowed early range-of-motion to achieve satisfactory functional results.

In our study, 84% (n = 23) of the patients had excellent to good outcome. The mean Constant score was 72.25 (range, 35–90) . The mean age of our twenty-eight patients was 53.21 (27-76). Fazal and Haddad (2009) conducted study on 6 men and 21 women aged 22 to 85 (mean, 56) years who underwent Philos plate fixation for displaced proximal humeral fractures. Functional outcome was excellent in 13 patients, good in 36, moderate in 8, and poor in 1. The mean Constant score was 80 (range, 40-100). Bjorkenheim *et al.* (2004) described a study of

72 patients in whom this plate was used, there was a mean Constant score of 72 at follow-up after six months. Koukakis A *et al* (2006) published a series of 20 patients with two-, three- and four-part fractures treated with this plate. The mean Constant score was 76 after six months. Aggarwal *et al.* (2010) in their study found moderate to excellent outcome in 90% of patients. The mean age of the patients in this series was 58.51 years (range 23-81 years) and fracture types were Neer's 2-part, 3-part, and 4-part fractures and fracture dislocations. Thyagarajan *et al.* (2009) in their study on 30 patients showed an overall average Constant score of 57.5. The mean age in this series was 58 years (range 19-92 years) and fractures were Neer's 2-part, 3-part, and 4-part fractures. In Chandan Kumar *et al.* (2013) study, 66% (n = 27) of the patients had excellent to good outcome. The overall mean Constant score was 72.34. Parmaksizoglu *et al.* (2010) in their study showed 68.7% excellent to good results. Mean age was 63 years (range 29-82 years) and fractures were Neer's, 3-part, and 4-part. Solberg *et al.* (2009) in their retrospective study of Neer's, 3 and 4-part fractures showed mean Constant score of 64.7 in 4-part fractures. The mean age of the patients was  $66.5 \pm 8.6$  years. In the study of Aggarwal *et al.* (2010) the mean Constant score for 4-part fractures was  $66 \pm 12.61$  and was significantly inferior to other types. In the study of Chandan Kumar *et al.* (2013) the mean Constant score for 4-part fractures was  $61.09 \pm 14.29$  which was significantly inferior compared to 2-part and 3-part fractures. In our study the mean Constant score in 4-part fracture was 62.64. This result is comparable to the above mentioned studies.

In our study, there were 2 cases of malreduction, two cases of subacromial impingement and one case of infection. No cases of AVN, hardware failure, locking screw loosening or nonunion were noted. In Kiran Kumar GN *et al.* (2014), study the main complications were varus malunion in four patients, deep infection in one patient, subacromial impingement in one patient, fixation failure in one patient and intraarticular screw penetration in one patient. Deep infection and fixation failure required reoperation. Koukakis *et al.* (2006) described two complications; one elderly patient in whom the plate had separated from the humeral diaphysis and another patient with symptoms from prominent metal work. Egol *et al.* (2008) observed only one case of acute infection in their series of 51 patients who mainly had 3- and 4-part fractures. Gardner *et al.* (2007) reported superficial wound dehiscence in one patient and Moonot *et al.* (2007) reported one superficial infection that healed with oral antibiotic treatment. Bjorkenheim *et al.* (2004) reported two cases (3%) of nonunion, three cases (4%) of avascular necrosis, and two implant failures (3%) with loss of fixation. Low incidence of infection in our study was attributed to meticulous surgical techniques and the special attention paid to soft tissue preservation. PHILOS provides stable fixation in proximal humerus fractures. Additionally, meticulous surgical dissection to preserve vascularity of humeral head is necessary to prevent potential complications such as AVN.

## Conclusion

The Philos plate is effective in maintaining fracture reduction in proximal humerus fractures. Due to stable restoration, early

functional aftercare is possible and allows the patient to regain good shoulder function and return to work earlier. Loss of reduction was rarely seen compared with other implants. Fixation with the PHILOS plate is a near ideal technique with a high union rate in the treatment of proximal humeral fractures.

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