

## Original Research Article

# Proximal humerus fractures operated with PHILOS plate: 4 year prospective study

Shreepad Kulkarni, Avinash Kulkarni, Amit Patel\*, Tapan Gupta

Department of Orthopaedics, BLDE University, Bijapur, Karnataka, India

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**\*Correspondence:**

Dr. Amit Patel,

E-mail: amitpatel3219@gmail.com

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### ABSTRACT

**Background:** Fractures of proximal humerus are still an unsolved problem in many ways. Locked plating is becoming more common; precise knowledge of and experience with the surgical technique is required to maximize clinical outcomes. However the goal of proximal humerus fracture fixation should be stable reduction allowing early mobilization. This study is conducted to study the results and complications of proximal humeral fractures treated by anatomic locking compression plate (PHILOS- proximal humerus interlocking system) and PHLP- Pro.

**Methods:** This is a 4 year prospective study, conducted in the department of Orthopaedics in Shri B M Patil Medical College & Hospital, Vijaypur. Displaced two part, three part and four part fractures of proximal humerus with or without shoulder dislocation including fractures involving osteopenic bone were included. The functional assessment was done according to constant Murley score and DASH score at the end of 6 months.

**Results:** Out of 60 patients, 56 were available for follow-up: 24 patients having excellent results (4 are 2 part, 20 are 3 part fractures), 32 patients having good results (22 are 3 part, 10 are 4 part fractures). None of the patients had fair or poor results.

**Conclusions:** In conclusion, the internal fixation of proximal humeral fractures with the use of anatomic locking compression plates yields reliable results when utilized correctly. We believe that, provided the correct surgical technique is used by competent surgeon, the anatomic locking compression plate is suitable for the stabilization of proximal humeral fractures and can lead to a good functional outcome.

**Keywords:** Proximal humerus fracture, PHILOS, PHLP, Constant Murley score

### INTRODUCTION

Cofield's summary of treatment of proximal humeral fractures is an indication of the difficulty of treating these injuries, from first evaluation to final outcome much controversy and confusion still exist, and no single treatment protocol or algorithm has been proved to be universally effective.<sup>1</sup> As indicated by Cofield areas still in question include radiographic diagnosis, operative, non-operative treatment, consideration of patient age in treatment decision making, surgical approach, fracture fixation or hemiarthroplasty, type of internal fixation, and rehabilitation protocol.

Fractures of proximal humerus are still an unsolved problem in many ways. Disagreement exists regarding reliability of classification system. The indication for surgical management continues to be modified. Fixation techniques are myriad and none is ideal for all cases.<sup>2</sup>

Fractures of proximal humerus are not uncommon especially in older age group. They represent no more than 3% of all upper extremity fractures.<sup>3</sup> Their overall incidence has been reported to be 73 cases per 100,000 individuals per year.<sup>4</sup> About 85% fractures are minimally displaced and are effectively treated symptomatically with immobilization followed by early motion. The remaining 15% of fractures are displaced, unstable and

may have disruption of blood supply. Treatment of these fractures is a therapeutic challenge. Displaced and unstable fractures are commonly treated by open reduction and internal fixation.

Various therapeutic options for displaced proximal humeral fractures are k wires, tension band wiring, humeral nails, anatomic plate osteosynthesis like PHILOS (proximal humerus interlocking system) and PHLP (proximal humerus locking plate) and hemiarthroplasty.<sup>4,5</sup> The choice of technique and device depends on type of fracture, quality of bone, age and reliability of patients. Recently, open reduction and internal fixation (ORIF) with locked plating has demonstrated promise in the treatment of displaced, comminuted proximal humerus fractures. This approach offers several potential advantages compared with more traditional open techniques.<sup>6</sup> These benefits include improved fracture stability because of the fixed-angle construct, particularly in more comminuted fracture patterns and in osteoporotic bone; a short period of immobilization with the opportunity for earlier rehabilitation, lower risk of damage to the rotator cuff or need for implant removal, reduced hardware complications and in patients with more complex fractures, the potential to avoid the use of hemiarthroplasty.<sup>7</sup>

Locked plating is becoming more common; precise knowledge of and experience with the surgical technique is required to maximize clinical outcomes. However the goal of proximal humerus fracture fixation should be stable reduction allowing early mobilization.

This study is conducted to study the results and complications of proximal humeral fractures treated by anatomic locking compression plate (PHILOS- proximal humerus interlocking system).

## METHODS

This is a prospective study, conducted in the department of Orthopaedics in Shri B M Patil Medical College & Hospital, Vijaypur. All patients with displaced proximal humerus fractures admitted in this hospital from February 2012 to January 2016 were considered for the study if they fulfilled following criteria

### *Inclusion criteria*

Displaced two part, three part and four part fractures of proximal humerus with or without shoulder dislocation including fractures involving osteopenic bone and two part fractures involving only greater or lesser tuberosity were included in this study.

### *Exclusion criteria*

Acute infections, fractures in children during growth phase and compound fractures.

The study was approved by local ethics committee. There were 60 patients, 38 males and 22 females. The mean age of patients was 52.5 years (range 21-76). The right shoulder was involved in 38 patients and left in 22 patients. 38 patients sustained fracture following RTA whereas 22 patients sustained fracture following a fall. The diagnosis was established by clinical evaluation and radiological examination in standard anteroposterior and lateral views and CT scan (occasionally). The fractures were classified based on Neer's classification system. 4 patients had two part fracture, 44 patients had three part fractures and 12 patients had four part fractures.

### *Anaesthesia and patient positioning*

The operation is performed under general anaesthesia. Patient is placed in supine position. Folded sheet is placed in interscapular region. The fluoroscopic imaging equipment is positioned at the head end of the bed and rotated over shoulder to allow optimal imaging intraoperatively.



**Figure 1: Patient positioning.**



**Figure 2: Patient drapping.**

### *Surgical approach*

A deltopectoral approach was preferred. Once through the interval, an extensive hematoma is usually encountered and is evacuated by aspiration or digitally to expose the fracture. Slight abduction of the arm relaxes the deltoid muscle and enables better access to the humeral head. The long head of the biceps tendon is identified at the upper border of the pectoralis major

muscle, and its course is followed proximally. This tendon is important in orienting the anatomy of the proximal humerus because it runs in the intertubercular groove between the greater and lesser tuberosities. The biceps tendon is particularly useful for orientation in the presence of four part fractures, when anatomy can be significantly distorted.

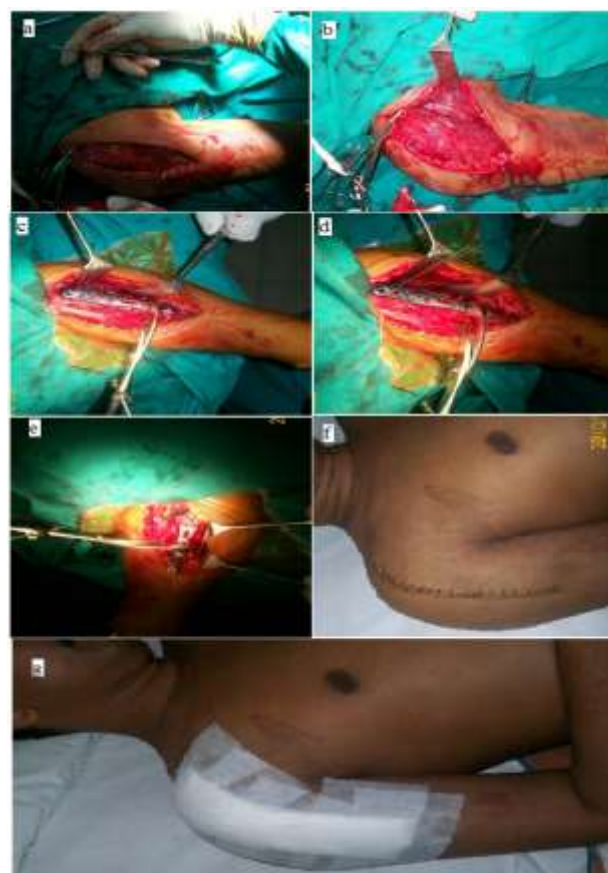
Prior to attempted fracture reduction, the rotator cuff is generously tagged with nonabsorbable sutures anteriorly, posteriorly, and superiorly to assist with reduction of the fracture fragments and ultimately, to reinforce fixation of the fracture to the plate. Now the head fragment can be gently manipulated under direct visualization with a periosteal elevator introduced into the fracture gaps. In the presence of varus tilt of the head fragment, the position can be corrected by pulling on the superior suture loop through the supraspinatus tendon while maintaining longitudinal traction on the arm. Tagged tuberosity fragments can be reduced to the humeral shaft and may also indirectly reduce a head fragment. Once the head fragment has been reduced, the tuberosities are pulled together with the sutures and fitted via digital manipulation. Poor results have been shown with improper reduction of the tuberosities. In comminuted fractures, temporary fixation with K-wires is recommended to hold the fracture reduction. Care must be taken so that the wires do not interfere with subsequent plate positioning

After temporary fracture reduction is achieved, the precontoured anatomic locking compression plate is positioned approximately 8 mm distal to the upper edge of the greater tuberosity. Care should be taken to avoid placing the plate too high because this could increase the risk of subacromial impingement. However, care should also be taken to avoid placing the plate too low which could prevent optimal screw placement in the humeral head.

Correct plate position checked and the adequacy of fracture reduction confirmed on fluoroscopic imaging. K-wires are temporarily inserted into the screw holes to hold the plate in place. With the plate appropriately positioned and the fracture reduced, proximal and distal screws are placed in the plate.

We prefer to insert the tip of each locking screw to a distance at least 5 mm short of the subchondral bone. When all screws have been placed, the rotator cuff sutures are threaded through the small holes in the proximal end of the plate and tied down for additional fixation.

During wound closure, we placed a drain deep to the deltopectoral interval to close down any dead space. All patients received perioperative antibiotics. Adjuvant bone grafting was not used.



**Figure 3: Surgical approach. (a) Surgical incision; (b) Deltopectoral groove exposed; (c, d) Temporary plate fixation with k wires; (e) Fixation of drill sleeves; (f) Skin closure; (g) Dressing applied.**

#### *Postoperative care*

Postoperatively, the arm is immobilized in a shoulder immobilizer. The drain is removed 48 hours after surgery. The patient progresses through a three-phase rehabilitation program consisting of I) Passive or assisted exercises. II) Active exercises starting at approximately 4-6 weeks postoperatively. III) Strengthening or resisted exercises beginning 10 to 12 weeks after surgery.

#### *Follow up*

All the patients were followed up by clinical and radiographic assessment immediately after treatment and at 1, 3, and 6 month. Radiographic assessment was made by anteroposterior and axillary views taken immediately after surgery. Union was defined with presence of bridge callus in two views and AVN was defined with loss of bony substance and presence of diffuse sclerotic area in the humeral head. Malunion was defined if there was displacement of more than 5mm or an angulation of more than 40 degree of any fragment. The functional assessment was done according to Constant Murley score and DASH score at the end of 6 months.



## RESULTS

Total 60 patients were included in the study. Out of 60 patients 44 patients were operated with PHILOS (proximal humerus interlocking system) and 16 patients were operated with PHLP (proximal humeral locking plate). Patients were ranged from 21 to 76 years (mean age 52.5 years) with 38 males and 22 females.

Mode of injury was high energy trauma (road traffic accidents) in 38 cases and low energy trauma (fall at home) in 22 cases. According to Neer's classification, out of 60, 4 (6.67%) were two part fractures, 44 (73.33%) were three part fractures, 12 (20.00%) were four part fractures.

**Table 1: Sex ratio.**

Type of fracture	Male	Female
<b>4 part</b>	8	4
<b>3 Part</b>	26	18
<b>2 Part</b>	4	0

Out of 60 patients, 56 were available for follow-up: 24 patients having Excellent results (4 are 2 part, 20 are 3 part fractures). 32 patients having Good results (22 are 3 part, 10 are 4 part fractures). None of the patients had fair or poor results.

**Table 2: Results according to CMS scoring.**

Type of fracture	Excellent (86-100)	Good (71-85)	Fair (56-70)	Poor (0-55)	Mean
<b>Two part fracture</b>	4 (Mean 91)	0	0	0	91
<b>Three part fracture</b>	20 (Mean 88)	22 (Mean 81)	0	0	84.5
<b>Four part fracture</b>	0	10 (Mean 76)	0	0	76

The mean Constant Murely score was 83.83. For two part fractures the mean constant Murely score was 91.0. For three part fractures the mean Constant Murely score was 84.5. For four part fractures the mean Constant Murely score was 76.0. The mean DASH score was 17.95.

## DISCUSSION

Proximal humeral fractures represent an increasing challenge for health-care system because of the increasing proportion of elderly individuals in the population. The majority of patients with these fractures are more than 60 years old, and most these fractures are related to osteoporosis. Nevertheless, stable reduction is essential for healing of these fractures and for achieving early functional recovery of the shoulder. In patients with osteoporotic bones and/or comminuted fractures, operative stabilization is challenging and remains controversial.

Successful outcome after plate osteosynthesis of proximal humerus fractures have been reported.<sup>8-10</sup> Open reduction and internal fixation of proximal humerus fractures with non-locking plates and screws has been shown to provide strongest fixation in non-osteoporotic bone.<sup>10</sup> As the stability of osteosynthesis with non-locking plates and screws, relies on the friction between the plate and the bone, the effectiveness of traditional plate and screw fixation decreases with bone quality.

Newer techniques involving the use of locking compression plates and screws with angular stability have been introduced in order to avoid complications associated with traditional plates. The anatomic locking compression plates (PHILOS: proximal humerus interlocking system) are designed to maintain a stable

fracture reduction even in osteoporotic bone. Advantages of these plates include gentle fracture reduction with the use of indirect reduction manoeuvres, resistance to screw pull out even in patients with poor bone stock because of the combination of fixed-angle screw-plate locking and three-dimensional placement of screws in humeral head, and possibility of early exercise and a short period of immobilization because of high initial stability achieved.<sup>11</sup>

Moda et al in 1990 treated proximal humeral fractures with plate and screws with AOT plate in 15 patients and blade plate in 10 patients. Excellent or satisfactory results achieved in 21 of 25 (84%). There were 4 (11.4%) unsatisfactory results which were associated with rotator cuff damage. There were 2 patients who had severe stiffness and 1 patient had bicipital tendinitis. They concluded that AO T plate fixation is stable enough to mobilize immediately.<sup>12</sup>

In 1999 Hessman et al concluded that functional results of plate osteosynthesis of unstable and displaced fractures in elderly are good to excellent in 70% of patients when treated with open reduction and internal fixation with plate. Their study included 99 patients with two, three and four part fractures for which open reduction and internal fixation was done with Buttress plate using deltopectoral approach and they found that the incidence of osteonecrosis of humeral head and non-union are rare with this technique.<sup>8</sup>

In 2008 Shahid et al proposed their prospective review of 50 patients treated for proximal humeral fractures with PHILOS plate. 11 patients had 2 part fractures 11 patients had 3 part and 18 had four part fractures. Radiological union was achieved in 40 out of 41 (5 patients died and 4

lost the follow up), complications noted in 4 patients. Their study has shown that PHILOS is the reliable implant for proximal humerus.<sup>13</sup>

In 2009 Brunner et al. evaluated the incidence of complications and functional outcome after open reduction and internal fixation with PHILOS. Study was prospective, multicenter study between September 2002 to September 2005, with 158 fractures in 157 patients. They had primary screw perforation of 14% and secondary screw perforation of 8% and avascular necrosis of 8%. They concluded that fixation with PHILOS plate preserves achieved reduction and a good functional outcome can be expected. More accurate screw length measurement and shorter screw selection should prevent primary screw perforation.<sup>14</sup>

Liu et al in 2010 concluded that treatment of proximal humeral fractures in elderly patients with application of PHILOS plate combined with injectable artificial bone as satisfactory, especially suitable for osteoporotic and comminuted proximal humeral fractures. They studied 17 patients from March 2007 to March 2009 with an average age 71 years (66 to 81). The clinical outcome was excellent in 9 patients, good in 6, moderate in 2 cases.<sup>15</sup>

In 2005 Agudelo et al published the study to determine the efficacy of proximal humeral locking plates (PHLP) and to clarify predictors of loss of fixation. They retrospectively evaluated 153 patients (111 females, 42 males) with mean age 62.3±15.4 years (22-92) with displaced fracture or fracture dislocation of proximal humerus treated with PHLP. The overall incidence of loss of fixation was 13.7%. There was statistically significant association between varus reduction (120 degrees) and loss of fixation. They concluded that there were no intraoperative complications related to locking plate system. Despite the use of fixed angle plate, loss of reduction occurred, primarily in presence of varus malreduction. They suggested that avoiding varus malreduction should substantially reduce postoperative failures.<sup>16</sup>

In 2009 Julie et al. published their prospective, multicenter, observational study. They evaluated the functional outcome and complication rates after open reduction internal fixation of proximal humeral fractures treated with PHLP plates.<sup>17</sup>

They studied 187 patients with average age 62.9±15.7 years. They included displaced three part, four part fractures. At 1 year follow up the mean Constant score was 70.6 and the mean DASH score was 15.2. The reported complication rates were high, 62 complications encountered in 52 patients. 34 of 62 complications are directly related to initial surgical procedure. They concluded that the treatment of displaced proximal humeral fractures with the use of PHLP can lead to good functional outcome provided that the correct surgical

technique is used. We found the results of our study comparable with the above studies.

## CONCLUSION

In conclusion, the internal fixation of proximal humeral fractures with the use of anatomic locking compression plates yields reliable results when utilized correctly. We believe that, provided the correct surgical technique is used by competent surgeon, the anatomic locking compression plate is suitable for the stabilization of proximal humeral fractures and can lead to a good functional outcome.

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