

## Original Research Article

# Analysis of surgical fixation of displaced proximal humerus fractures using PHILOS plate

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### ABSTRACT

**Background:** The treatment of displaced proximal humeral injuries still throws challenges in identifying variables to prognosticate the outcome and optimizing a good clinical result. This study attempts to analyze the functional outcome of surgery of such fractures with proximal humeral interlocking system (PHILOS) plate and evaluate variables which help in predicting the prognosis.

**Methods:** This is a retrospective and prospective study of 30 patients with displaced proximal humerus fractures - 2 part, 3 part, 4 part and fracture dislocations according to Neer classification, surgically treated using PHILOS plate during 2011 and 2014. Evaluation of patients was done on follow-up by an independent observer for union by radiographs and functional assessment by Constant-Murley score and DASH (disabilities of the arm, shoulder and hand) score.

**Results:** The mean age of the patients was 40.4 years (range 18-65). 83.3% of the patients were male. The mean follow-up was 18.9 months (4-36 months). The mean Constant-Murley score and the DASH score were 76 and 16 respectively at the last follow-up. Our analysis showed that the patient's age, delay in surgery, and Neer's classification influenced the prognosis of the fracture. Medial metaphyseal extension in the fracture or an intact medial neck showed a better outcome. Complications were seen in 5 patients. Avascular necrosis was seen in 3 patients.

**Conclusions:** Osteosynthesis of displaced proximal humeral fractures with PHILOS plate provides a good outcome, with low complication rate. Patient's age and the type of fracture based on Neer's classification prognosticate the outcome.

**Keywords:** Proximal humerus fractures, PHILOS plate

### INTRODUCTION

Proximal humeral injuries account for 5% of all the fractures, and are more common in elderly individuals.<sup>1</sup> Undisplaced fractures are often treated conservatively whereas surgery is indicated in displaced proximal humeral fractures. The incidence of these fractures increase with age especially in women. Elderly people with these fractures pose potential difficulty during surgery, owing to osteoporosis, making it difficult to treat

them with traditional plate and screws.<sup>2</sup> Several techniques have been described for fixation of the fracture - plate and screws, laminar plate, intramedullary nail, percutaneous K wire fixation and hemiarthroplasty. To increase the mechanical stability of these fractures, premoulded plates with locking screws have been used. The AO/ASIF developed the proximal humeral interlocking system or PHILOS (Synthes, Stratec Medical Ltd, Mezzovico, Switzerland). This system aims to preserve fracture biology, minimize soft tissue damage

and provide a stable angular construct. It is particularly useful in osteoporotic elderly patients, for secure fracture fixation, stabilization and quick shoulder mobilization, quick and uneventful healing and good clinical results.<sup>3-5</sup> It is considered appropriate treatment for proximal humeral fractures and gives early range-of-motion with acceptable results.<sup>6,7</sup> It also provides a stable fixation in young patients with good-quality bone for early mobilization and fracture stabilization to bony union.<sup>8,9</sup> Angle-stable plates assure high primary fixation stability. The pitch difference between the wide shaft thread of an angle-stable screw against the fine thread of the screw head has a limited compression effect during final screwing home. Loosening of the screw from the plate is theoretically not possible when correctly anchored.

Clinical and intraoperative variables have been suggested as prognostic criteria including age, sex, fracture classification, plate positioning, initial fracture patterns and adequacy of reduction.<sup>10</sup> The aim of this study was to analyse the incidence, mechanism of injuries, fracture patterns, clinical results, complications, and prognosticate preoperative and intraoperative variables in proximal humeral fracture fixations using PHILOS plate system.

## METHODS

A retrospective and prospective study was conducted after obtaining institutional ethical committee approval from our institute. Between 2001 and 2014, thirty patients of proximal humerus fractures fixed with PHILOS locking plate were included in the study with the following inclusion and exclusion criteria.

### Inclusion criteria

Patients with closed displaced proximal humerus fractures - 2 part, 3 part, 4 part and fracture dislocations according to Neer classification.<sup>11</sup>

### Exclusion criteria

Compound fractures, fractures with distal neurovascular deficits, undisplaced fractures of proximal humerus, skeletally immature patients, patients with pathological fractures, patients with brachial plexus injury, patients with medical contraindications for surgery were excluded from the study.

### Surgical technique

All the cases were operated by the same team of surgeons under general anesthesia. The delto-pectoral approach was used, but instead of developing delto-pectoral plane, the dissection was done through the substance of deltoid leaving 1 cm of deltoid intact adjacent to the delto-pectoral groove. This modification enabled us proper lateral placement of plate and also reduction of the displaced greater tuberosity fracture. In all the cases we have used PHILOS plate. Proper placement is done by

keeping the plate 8 mm inferior to upper border of greater tuberosity and 5 mm posterior to the bicipital groove. Emphasis was given to restoring the neck shaft angle, reconstruction of the avulsed rotator cuff and minimal handling of the medial soft tissue sleeve. Final dynamic image intensifier check was done to confirm the absence of inadvertent penetration of screws into the joint and to check the proper position of the plate.

Post operatively, the shoulder was immobilized in an arm pouch and gentle pendulum exercises were started. In the very osteoporotic individuals, a J slab was applied till suture removal. Controlled abduction and flexion beyond 90° was encouraged as early as possible within 2-3 weeks based on stability of osteosynthesis and the bone quality.

Patients were followed up regularly and were evaluated by an independent observer, for radiological union by radiographs and functional assessment using Constant-Murley Score and DASH score at each follow-up.<sup>12,13</sup>

## RESULTS

The mean age of the patients was 40.4 years (range 18-65) as shown in Figure 1. The mean follow-up was 18.9 months (4-36 months). The fractures were more common on the right side (78%) compared to the left (22%). 83.3% of the patients were male. Road traffic accident was the commoner (78%) mode of injury and the rest were by trivial trauma like slip and fall. There were 10 cases (33.3%) of Neer's 2 part fracture, 8 cases (27%) of 3 part and 8 cases (26.6%) of fracture dislocation as seen in Figure 2. Most of the cases were operated in the first week (53.3%). Surgeries done in the third week (20%) were due to delayed presentation as in Figure 3.

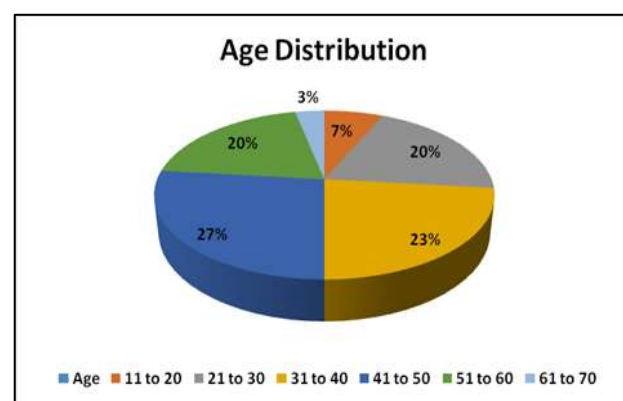


Figure 1: Age distribution.

Bone grafting was not used in any of the cases. The mean neck shaft angle calculated using immediate post-operative radiographs was 136.3° and that after fracture union was 131.6°, with a mean 4.7° collapse. The average time of union was 12.5 weeks. In our study we noted that the range of motion was affected by the severity of the fracture pattern, delay in presentation, age and bone stock

of the individual. Younger individuals with good bone stock showed favourable results with a mean range of flexion of 136°, abduction of 133° and external rotation of 85°. Adequacy of reduction, delayed presentation, fracture pattern and increased age seem to be the variables associated with poor outcomes as shown in Figure 4-6.

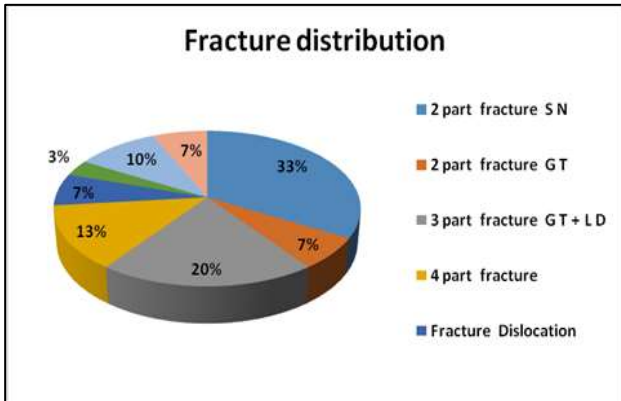


Figure 2: Fracture distribution based on Neer's classification.

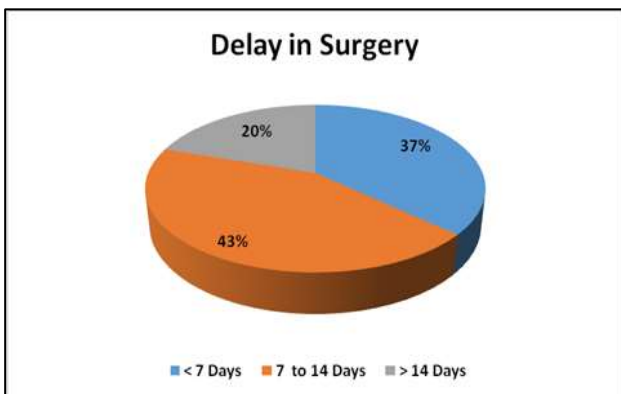


Figure 3: Delay in surgery.

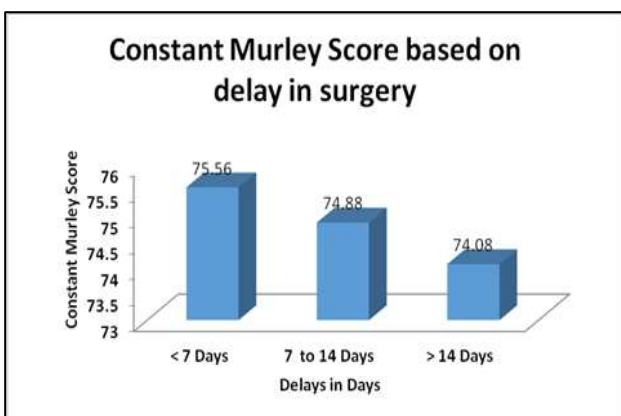


Figure 4: Constant-Murley score based on the delay in surgery.

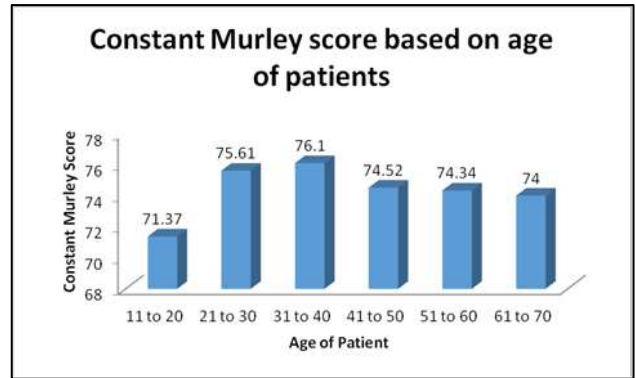


Figure 5: Constant-Murley score based on the age of patients.

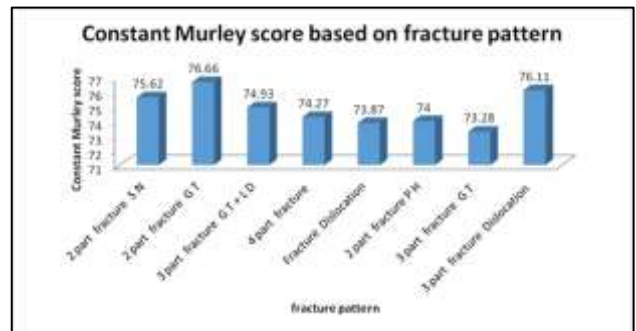


Figure 6: Constant-Murley score based on the fracture pattern.

The mean Constant-Murley score and the DASH score were 76 and 16 respectively at the last follow-up. The younger age group showed better Constant-Murley scores than the elderly. Five patients had complications -2 cases of avascular necrosis with shoulder stiffness, 2 cases of only significant shoulder stiffness and one case of screw perforation. No patient had infection post operatively.

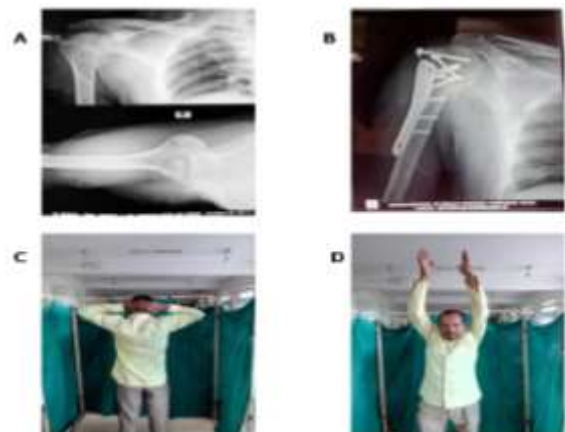


Figure 7: A case of 3 week old posterior fracture dislocation 3 part Neer's, fixed with PHILOS plate.



**Figure 8: A case of Neer's 3 part fracture treated with PHILOS plate.**

## DISCUSSION

Surgical treatment is recommended for most of the displaced proximal humerus fractures. In patients with baseline higher shoulder function and intrinsically higher expectations, surgical management is a good option.<sup>5</sup> Osteosynthesis using locked angle-stable plate shows promising results. Our study of 30 cases was done to analyse outcome of proximal humeral fracture fixation using PHILOS plate. We found in our study that age had an influence on the outcome. Elderly patients demonstrated lower Constant-Murley and DASH scores compared to the younger age groups. Neer's type 3 and type 4 fractures had lesser mean range of motion compared to the Neer's type 1 and 2. Type 3 and 4 fractures had better outcome in younger patients than the older patients. Fracture dislocations had better prognosis in type 2 than types 3 and 4.

Adequacy of reduction is essential for a good clinical result in fixation of these fractures.<sup>14</sup> Several reduction parameters have been described and observing them is important to get optimal results. Mean neck shaft angle in the immediate postoperative period in the study was 136.3°. After a mean follow up of 18.9 months (4-36 months), we found a mean decrease in neck shaft angle by 4.7°. We attribute the loss to initial varus collapse in cases with medial metaphyseal comminution. Solberg et al noted similar findings in his series of seventy patients older than 55 years where initial fracture angulation had a bearing on the outcome.<sup>16</sup> Fractures with medial metaphyseal extension or intact medial neck do not have significant decrease in the neck shaft angle, at union, when reduced adequately. We have always used an inferior locking screw through the neck into the head to prevent such collapse.

It is important to retain the medial soft tissue sleeve around the neck to prevent avascular necrosis of the

humeral head. The combination of a metaphyseal fragment smaller than 8 mm or a periosteal lesion and involvement of the anatomical neck is related to a 97% risk of ischemia of the humeral head.<sup>17</sup> Preoperative assessment of the local bone density, patient's age, intraoperative anatomic reduction and restoration of the medial cortical support leads to successful surgical fixation of proximal humerus fractures.<sup>14</sup> Fixed angle locking plates are advised commonly in the treatment of these complex fractures and are particularly useful in the elderly with poor bone quality.<sup>15</sup>

Loss of vascularity is neither related to age nor the type of Neer's fracture but more to the available medial soft tissue sleeve and its integrity. We had 3 cases of avascular necrosis in our series of which two were elderly patients and one was a 45 year old man. Two cases had dislocations and one was a Neer's two part fracture. In all our cases we took care to minimize soft tissue dissection at the medial neck. Among various factors, the most relevant predictors of ischemia were the length of the dorsomedial metaphyseal extension and the integrity of the medial hinge.<sup>17</sup>

All the elderly patients in our group had a mean range lesser than the younger population. The range of motion also reduces with the severity of fracture particularly those with a varus collapse. Sproul et al in a meta-analysis reported a complication rate of 49%.<sup>3</sup> In our study we had a much lesser complication rate of 16.6% which was possibly due to a small sample size and lesser number of complex fractures.

The PHILOS plate design provides stable fixation with a good functional outcome and eliminates failure and impingement syndrome.<sup>18</sup> Even though it showed excellent long-term results after the first postoperative year it is always important to follow patients for more than one year after surgery as some complications may arise in the future.<sup>19,20</sup>

It was reported that PHILOS shows good applicability and respects bone biological properties without interfering with the blood supply to the humerus head, thereby avoiding complications like avascular necrosis. There was no requirement to shape the plate, enabling stabilization at constant angles leading to early mobilization, and no implant insufficiency resulting in high Constant-Murley shoulder scores.<sup>21,22</sup>

The PHILOS system allows an angular locking construct, especially helpful in 3 part and 4 part fractures. Correct placement of the plate minimizes impingement and improves the purchase of the screws in the neck while preventing collapse of the head. The mean Constant-Murley score of 76% was comparable to other studies as given in Table 1.<sup>18,23-27</sup> The limitations of our study were a smaller sample size and a short term follow-up mean 18.9 months. These made it difficult to assess many variables and make comparative analysis.

**Table 1: Comparison of Constant–Murley score of locking plates of our study with other studies.**

Investigator	Method of treatment	Constant-Murley score
<b>Robinson and Page<sup>23</sup></b>	Minimally invasive screw fixation	68
<b>Wijgman et al<sup>24</sup></b>	Cerclage wires or T-plate	67
<b>Hessmann et al<sup>25</sup></b>	T-plate ± bone cement or bone graft	69
<b>Wanner et al<sup>26</sup></b>	Double one-third tubular plate	61
<b>Koukakis et al<sup>18</sup></b>	Angle-stable locking humerus plate	73.6
<b>Fankhauser et al<sup>27</sup></b>	Angle-stable humerus	74.6
<b>Our study</b>	PHILOS	76

Our study had homogeneous sample; the patients were operated with a standard technique and reduction maneuvers. The PHILOS system allows good fracture stability, and early mobilization. This study draws attention to the need to assess more elaborately the prognostic factors in surgeries of proximal humerus fractures.

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