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Research Article

Functional Outcome of Displaced Proximal Humerus Fractures Managed by Proximal Humerus Interlocking System Plate

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Abstract

Background: Proximal humerus fractures are common, especially in the elderly, and often result from low-energy falls or high-energy trauma in younger patients. These fractures pose a management challenge due to varied patterns and complex anatomy. While many are treated conservatively, displaced or comminuted fractures often require surgical fixation. Locking plates, particularly the proximal humeral internal locking system (PHILOS), offer stable fixation and improved outcomes, especially in osteoporotic bone. This study aims to assess the functional outcome of displaced proximal humerus fractures treated with PHILOS plating at a tertiary care teaching hospital in Mumbai, India.

Methods: This prospective observational study involved 30 adults with displaced proximal humerus fractures treated with PHILOS plating. After informed consent, patients underwent surgery and standardized postoperative rehabilitation. Shoulder function was assessed using the Constant-Murley score (CMS) at 6 weeks, 3 months, and 6 months. Data were analyzed using t-tests and chi-square tests. Results were expressed as mean ± standard deviation (SD) and percentages, with significance set at $P < 0.05$.

Results: This study included 30 patients (mean age: 52.5 years); 70% were men. Most injuries were due to road traffic accidents (RTAs) (70%), with two-part fractures being most common (60%). Radiological union occurred at 6-8 weeks in 80%, 9-12 weeks in 16.7%, and after 12 weeks in 3.3% of patients. The CMS improved significantly over 6 months ($P < 0.0001$). Functional outcomes were good to fair in most patients. Postoperative complications occurred in 36.67%, mainly shoulder stiffness (23.33%), followed by impingement (10%) and malreduction (3.33%).

Conclusion: The PHILOS plate offers stable fixation and favorable functional outcomes in proximal humerus fractures, with timely union and improved CMS, making it an effective option despite minor complications.

Keywords: Proximal Humerus; Fractures; Internal Fixation

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Background

Proximal humerus fractures, one of the most frequent fractures in the human body, are on the rise, along with the incidence of trauma-related bone injuries in recent years (1). The incidence of proximal humeral fracture is 26% of humeral fractures and about 4% of total fractures (2). The primary risk factors for proximal humeral fractures are low bone mineral density (BMD) and an increased risk of falls. In older adults with osteoporotic bone, it is the most prevalent kind of fracture (3, 4).

The most common mechanism for these fractures is falls on an outstretched hand in elderly and high-velocity trauma in active age group (5). In patients aged < 50 years, the mechanism is often related to high-energy trauma, such as significant falls from height, motor vehicle accidents, or athletic injuries (6). Nearly three-quarters of proximal humeral fractures occur in the elderly, with women affected approximately three times more often than men (7). Among individuals older than 65 years, these fractures represent the second most common injury of the upper limb, following distal radius fractures. In contrast, complex fracture patterns and fracture-dislocations are more commonly encountered in physically active, middle-aged patients (8).

The management of proximal humerus fractures is a challenging task to any surgeon due to a number of factors and mainly due to complex fracture type. It leads to decreased day to day activity and affects functional outcome (9). Priority one should be on limb function restoration (10). Patient-related factors like age, co-morbidity, fracture pattern, bone quality, arm dominance, activity level, professional demands, ability to comply with post-operative rehabilitation protocol, and more importantly, the expectation of the patients from particular intervention were taken into account before proceeding with any appropriate intervention (11). Reduction of displaced proximal humerus fractures is a challenging task as various fracture patterns can occur owing to the complex anatomy (12). Usually, most proximal humeral fractures are stable and nondisplaced or mildly displaced. These can be treated conservatively with early rehabilitation (13, 14).

Conservative management may result in non-union, malunion, and avascular necrosis (AVN), which may lead to pain and dysfunction (15). However, for optimal shoulder function, surgical intervention is necessary for

significantly displaced and comminuted fractures. As soon as the patient's overall health permits, the procedure should be performed. Even a short delay of a few days can complicate fracture reduction, while prolonged postponement may lead to bone resorption, thereby compromising the ability to achieve stable internal fixation (16). The usage of locking compression plates has been recommended recently. Locking plate systems were developed to address the limitations, high failure rates, and complications associated with traditional fracture fixation methods (17).

The combination of conventional plate technology along with the newly designed locking screw is the basis for new locking plate osteosynthesis. The basic idea of this technology is a fixed angular relationship between the screws and the plate, which offers both axial and angular stability, sufficient buttressing, and load-sharing support, all of which work together to prevent fracture fragment collapse and loss of reduction (18, 19). To lessen difficulties, particularly in elderly osteoporotic individuals, the proximal humeral internal locking system (PHILOS) plate was introduced (20). PHILOS plates can be used to treat even mildly displaced fractures in order to mobilize them early and prevent shoulder tightness. Highly comminuted 3- and 4-part fractures can be reconstructed with rotator cuff sutural ties with plate, thereby enhancing the functional outcome (21).

The objective of this study is to evaluate the functional outcome of displaced proximal humerus fractures managed by PHILOS plate at a tertiary care teaching hospital in Mumbai, India. This is a descriptive outcome study, not a comparative or definitive effectiveness trial.

Methods

This was a single-center, prospective observational study carried out on 30 patients over two years in a tertiary care center. The study protocol was reviewed and approved by the Institutional Review Board (IRB). Written informed consent was obtained from the patients. All the data collected were kept strictly confidential and used for this study as described below.

This study included patients over 18 years of age, of either gender, who were willing to participate. Eligible participants were skeletally mature and presented with displaced proximal humeral fractures as per Neer's classification (two-, three-, or four-part fractures) and associated shoulder dislocation. Exclusion criteria were patients under 18 years of age, unwilling to participate, those with pathological fractures due to primary, secondary, or metastatic tumors, open fractures, distal neurovascular deficits, polytrauma, ipsilateral distal humerus fractures, or those unfit for surgery due to pre-existing comorbidities.

Data Collection: On admission, a careful history was elicited from the patients regarding the injury and the severity of the trauma. The patients were then subjected to thorough systemic and local examination. The local examination of the injured shoulder was conducted to check for swelling, deformity, loss of function, and altered attitude. Distal neurovascular examination was carried out. An X-ray in anteroposterior (AP) and axillary views was taken, and computed tomography (CT)-scan was performed to better delineate the fracture anatomy. Once the patients with confirmed proximal humerus fracture were counselled regarding the nature of injury and treatment options and were informed about the study, written informed consent was obtained in order to participate in the study. The patients were then subjected to routine investigation and pre-anesthetic evaluation, and after physical fitness, they were posted for surgery. Patients were treated by open reduction and internal fixation (ORIF) using a 3.5 mm PHILOS plate under general/regional anesthesia.

Technique: Following induction of anesthesia, the patient was positioned in the beach-chair position. Surgical landmarks included the coracoid process and the humeral shaft. A straight skin incision was made extending from the coracoid process to the deltoid insertion. The deltopectoral interval was developed using the cephalic vein as a landmark, and the clavipectoral fascia was incised to expose the fracture site. Fracture fragments were anatomically reduced and provisionally stabilized with Kirschner wires (K-wires), with reduction confirmed under fluoroscopic guidance. Nonabsorbable 2-0 Ethibond sutures were used to control and secure the tuberosities. A locking plate was positioned on the anterolateral aspect of the proximal humerus and fixed with appropriate screws. The tuberosity sutures were then passed through the plate for additional stability. Layered wound closure was performed. Postoperatively, all patients were immobilized in an arm pouch with a cuff and collar sling. Active assisted and passive exercises of the shoulder were initiated during the first three weeks, after which active range of motion (ROM) exercises for the shoulder were started, along with muscle strengthening exercises. All postoperative rehabilitation was carried out under the guidance of an experienced physiotherapist. This included passive forward flexion and external rotation and then active movements under the guidance.

Outcome Measures: Primarily, the shoulder functions were assessed using the standard Constant-Murley score (CMS) proforma at six weeks, three months, and six months postoperatively. The protocol mentioned in the Danish version of the modified CMS was followed to measure individual parameters. The duration of fracture union was used as a secondary outcome.

Statistical Analysis: All the data collected from patients were compiled in a Microsoft Excel sheet and were analyzed. Continuous measurement data were displayed as mean ± standard deviation (SD) (minimum-maximum), while categorical measurement results were displayed as numbers (%). Significance was evaluated at the 5% threshold of significance. Student's t-test was used to find the significance of study parameters on continuous scale between two groups on metric parameters and to find the significance of study parameters on continuous scale with each group. Associations between categorical variables across two or more groups were evaluated using the chi-square test or Fisher's exact test, as appropriate.

Results

The study included 30 patients aged between 20 and 60 years, with an average age of 52.5 years. Of these, 21 (70%) were men and 9 (30%) were women. The right side was affected in 20 patients (66.67%), while the left side was involved in 10 patients (33.33%). The most common mechanism of injury was road traffic accidents (RTAs) (70%), followed by falls (26.67%) and electric shock (3.33%). According to Neer's classification, 21 patients (70%) had two-part fractures, 6 patients (20%) had three-part fractures, and 3 patients (10%) had four-part fractures (Table 1).

Table 1. Demography

Variable	Value
Mean age (year) (range: 20-60)	52.5
Gender [n (%)]	
Men	21 (70.00)
Women	9 (30.00)
Side [n (%)]	
Right	20 (66.67)
Left	10 (33.33)
Mechanism of injury [n (%)]	
Fall	8 (26.67)
Road traffic accident	21 (70.00)
Electric shock	1 (3.33)
Neer's type [n (%)]	
2-part	21 (70.00)
3-part	6 (20.00)
4-part	3 (10.00)
Total	30 (100)

In this study, 28 patients (80%) showed radiological union at 6-8 weeks. Five patients (16.67%) showed union between 9-12 weeks, while only one patient (3.33%) demonstrated union after more than 12 weeks (Table 2).

Table 2. Duration of radiological union

Radiological union in weeks	n (%)
6-8	24 (80.00)
9-12	5 (16.67)
> 12	1 (3.33)
Total	30 (100)

The mean CMS at 6 weeks was 31.75 ± 7.14, which improved to 54.68 ± 8.46 at 3 months and further increased to 69.71 ± 10.52 at 6 months. The improvement in scores over time was statistically significant, with all P-values being < 0.0001 (Table 3). This clearly indicates that the functional outcome improved over the period of time using locking plates.

Table 3. Average Constant-Murley score (CMS)

CMS	6 weeks	3 months	6 months
Mean ± SD	31.75 ± 7.14	54.68 ± 8.46	69.71 ± 10.52
P-value		< 0.0001	
			< 0.0001
		< 0.0001	

CMS: Constant-Murley score; SD: Standard deviation

Based on the CMS, 2 patients (6.67%) had excellent outcomes, 14 patients (46.67%) had good outcomes, and 12 patients (40%) showed fair outcomes. Only 2 patients (6.67%) had poor outcomes. Overall, the majority of patients achieved good to fair functional results (Table 4).

Table 4. Functional results according to Constant-Murley score (CMS)

CMS	n (%)
Excellent	2 (6.67)
Good	14 (46.67)
Fair	12 (40.00)
Poor	2 (6.67)
Total	30 (100)

CMS: Constant-Murley score

In our study, 11 out of 30 patients (36.67%) experienced postoperative complications. The most common complication was shoulder stiffness, observed in 7 patients (23.33%) which was managed by physiotherapy, followed by impingement in 3 patients (10%) and malreduction in 1 patient (3.33%) (Table 5).

Table 5. Complications

Complications	n (%)
Impingement	3 (10.00)
Malreduction	1 (3.33)
Stiffness	7 (23.33)
Total	11 (36.67)

Discussion

Proximal humeral fractures are managed conservatively or operatively based on fracture displacement and angulation. This study followed Neer's classification. Surgical challenges include osteoporotic bone, angular instability, implant impingement, bone loss, and screw back-out. Based on the fracture pattern, bone quality, and patient age and activity, ORIF was planned. The primary goal was near-anatomical reduction and stable fixation to enable early mobilization.

PHILOS plating is associated with complications such as varus collapse, screw cut-out, and AVN, particularly in osteoporotic bone. Careful patient selection is essential, and arthroplasty may be preferable for elderly patients with complex fracture patterns.

This single-center prospective observational study aimed to evaluate the functional outcomes of PHILOS plating in displaced proximal humeral fractures. This is a descriptive outcome study, not a comparative or definitive effectiveness trial. Management was based on Neer's classification, considering fracture displacement and angulation. Thirty patients meeting inclusion criteria were assessed. The study focused on achieving near-anatomical reduction and stable fixation for early mobilization. Results were compared with findings from previous studies to evaluate the effectiveness and complications associated with PHILOS plating.

In our study, participants ranged from 19 to 62 years, with a mean age of 52.5 years; most (53.33%) were aged 41-60. Several studies support our age and gender findings. Deepak et al. reported most proximal humerus fractures in the age group of 41-60 years (22). Similarly, Vijayvargiya et al. found half of their patients in the range of 40-60, highlighting the common occurrence in middle-aged adults due to declining bone strength (23). In terms of gender, 70% were men and 30% were women, consistent with Sagar et al. (24). However, Deepak et al. reported a higher female prevalence, suggesting some population-based variation.

In our study, right-sided proximal humerus fractures were more common, seen in 66.67% of participants. This finding aligns with Sagar et al., who reported 65% of fractures on the right side (24), and Deepak et al., who found right-sided involvement in 55% of cases (22). The higher incidence of right-sided fractures may be due to hand dominance and the instinctive use of the dominant limb during a fall or trauma.

The most frequent mechanism of injury was RTA, accounting for 70% of cases. The similar findings were shown by Rao, where they reported that about 72% of patients had RTAs as mechanism of injury (25), and Deepak et al., who found a similar incidence at 65% (22). These results underline the significant role of high-energy trauma in such fractures, especially in urban populations.

According to Neer's classification, our study showed that 70% of cases were 2-part fractures, followed by 3-part fractures in 20%, and 4-part in 10% of patients. Similar trends were reported by Rao, with a predominance of 2-part (52%) and 3-part (32%) fractures (25). In addition to this, Deepak et al. in their study found that 2- and 3-part fractures were the most common type (22). These findings suggest that simpler fracture patterns are more prevalent, possibly due to the nature of the trauma and patient age.

In our study, 80% of patients showed radiological union between 6 and 8 weeks, with an average healing time of 8.6 weeks. Similarly, Deepak et al. reported an average union time of 8.4 weeks (22), and Shahid et al. observed union at around 8 weeks (26). However, Leonard et al. documented a comparatively longer average union

period of 12 weeks in their study (27).

The mean CMS in our study demonstrated significant functional improvement over time, starting at 31.75 ± 7.14 at 6 weeks, progressing to 54.68 ± 8.46 at 3 months, and reaching 69.71 ± 10.52 at 6 months. The differences between these intervals were statistically significant ($P < 0.0001$), indicating consistent postoperative recovery. These results align closely with those of other studies. Siddalingamurthy et al. reported mean scores of 28.12 at 6 weeks, 50.15 at 12 weeks, and 63.76 at 6 months (28). Rao observed improvements from 36.24 to 55.44 and then to 69.84 across the same time frames (25), while Patted and Sadiq recorded scores of 32.12, 52.25, and 68.81, respectively (29).

In terms of functional outcome classification of our study, two people (6.67%) had excellent results, fourteen (46.67%) had good results, twelve (40%) had acceptable results, and two (6.67%) had bad results. Similar distributions were found by Rao, who reported 4% excellent, 44% good, 44% fair, and 8% poor results (25), Patted and Sadiq, with 30% excellent, 40% good, 20% fair, and 10% poor outcomes (29), and Sagar et al. who reported 20% excellent, 45% satisfactory, 25% unsatisfactory, and 10% poor results (24). In Sathavu et al. study, the functional outcome was assessed using the CMS. Results showed that 7 patients had excellent outcomes, 10 had good, 2 had moderate, and 1 had a poor outcome (30). The average CMS at the final follow-up was 81.26. These findings support the effectiveness of PHILOS plating in delivering reliable and progressive improvement in shoulder function.

Among 30 participants, complications included impingement in 3 (10%), malreduction in 1 (3.33%), and stiffness in 7 (23.33%). Siddalingamurthy et al. also reported stiffness in 15.4%, impingement in 11.5%, and malreduction in 3.8% of cases. Combined complications were noted in some patients (28). In Deepak et al. study, stiffness was most common (20%), followed by postoperative infection and implant loosening, each in 5% of participants (22).

This study is limited by its small sample size, single-center design, and urban tertiary care setting, which restrict generalizability, particularly to rural populations with different healthcare access. Larger, multicenter studies with broader geographic representation are needed to validate and extend these findings.

Conclusion

This observational study concludes that PHILOS plate fixation may provide acceptable fracture stability, radiological union, and functional improvement in adult proximal humerus fractures. However, given the small sample size, lack of a control group, and notable complication rate, conclusions should be interpreted cautiously and are applicable primarily to similar clinical settings. Further comparative studies with larger cohorts are warranted.

- Ethics approval and consent to participate: Ethics committee approval was taken from IRB.
- Consent for publication: Consent was taken from all the participants.
- Availability of data and materials: The datasets used and/or analyzed in the current study are available from the corresponding author upon reasonable request.

Conflict of Interest

The authors declare no conflict of interest in this study.

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