

FUNCTIONAL OUTCOME OF PROXIMAL HUMERUS FRACTURES MANAGED BY PROXIMAL HUMERUS INTERLOCKING SYSTEM (PHILOS) PLATE

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ABSTRACT

Background: Proximal humerus fractures are commonly managed with proximal humerus internal locking system (PHILOS) plating to achieve stable fixation and early functional recovery. This study evaluated the functional outcomes of displaced proximal humerus fractures treated with PHILOS plating. **Methods:** This prospective observational study included 20 patients with displaced proximal humerus fractures treated by open reduction and internal fixation using a 3.5-mm PHILOS plate. Fracture healing was assessed clinically and radiologically, while functional outcome was evaluated using the Constant–Murley Shoulder Score at 3, 6, 12, and 24 weeks postoperatively. **Results:** The majority of patients were aged 41–60 years (45%), females (60%), and sustained injuries following road traffic accidents (65%). Closed fractures accounted for 90%, with two-part and three-part fractures each comprising 40% of cases. Mean clinical and radiological union times were 8.2 and 8.4 weeks, respectively. The mean Constant–Murley score improved from 51.10 ± 6.50 at 3 weeks to 84.20 ± 6.99 at 24 weeks. At final follow-up, 85% of patients achieved satisfactory or excellent outcomes. Postoperative complications occurred in 15% of patients, limited to joint stiffness (10%) and superficial infection (5%), with no cases of malunion, non-union, implant failure, or avascular necrosis. **Conclusion:** PHILOS plate fixation provides reliable fracture union, progressive functional improvement, and favourable clinical outcomes with a low complication rate, making it an effective treatment option for displaced proximal humerus fractures.

Keywords: Proximal humerus fracture, PHILOS plate, Constant–Murley score, functional outcome, fracture union

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INTRODUCTION

Proximal humerus fractures are among the most common fractures involving the shoulder girdle and account for approximately 4–6% of all fractures encountered in orthopaedic practice.[1] They represent the third most common osteoporotic fracture, following fractures of the hip and distal radius, and their incidence has increased steadily over recent decades owing to increasing life expectancy, population ageing, and the growing prevalence of osteoporosis. [2,3]

The proximal humerus plays a fundamental role in shoulder biomechanics and upper limb function. Even minor disruption of proximal humeral anatomy may result in pain, restricted range of motion, muscle weakness, and long-term functional disability. Therefore, restoration of anatomical alignment, preservation of vascularity, and early rehabilitation remain the primary objectives in the management of proximal humerus fractures. [3,4] Various surgical techniques have been described for displaced proximal humerus fractures, including percutaneous pinning, intramedullary nailing, locking plate fixation, hemiarthroplasty, and reverse shoulder arthroplasty.[5,6]

The **Proximal Humerus Internal Locking System (PHILOS)** plate represents one of the most important advances in the operative management of proximal humerus fractures. It is a precontoured locking plate specifically designed to match the

anatomy of the proximal humerus while allowing multiple multidirectional locking screws to be inserted into the humeral head.[7] This fixed-angle construct provides superior stability, particularly in osteoporotic bone, preserves periosteal blood supply, maintains fracture reduction, and permits early postoperative mobilization. In addition, dedicated suture holes facilitate fixation of the tuberosities and improve rotator cuff stability. These biomechanical advantages have made PHILOS plating one of the preferred implants for displaced proximal humerus fractures.[8]

Despite these advantages, PHILOS plating is associated with several complications, including screw penetration into the glenohumeral joint, varus collapse, malunion, non-union, avascular necrosis of the humeral head, subacromial impingement, infection, and postoperative shoulder stiffness.[9] The present study was therefore undertaken to evaluate the functional outcome of displaced proximal humerus fractures managed with the Proximal Humerus Internal Locking System (PHILOS) plate at a tertiary care centre. The study aims to assess fracture union, postoperative complications, and functional recovery using standardized clinical and radiological assessment methods, thereby contributing further evidence regarding the effectiveness and safety of PHILOS plating in the management of displaced proximal humerus fractures.

MATERIALS AND METHODS

The clinical, prospective observational study was conducted at the Department of Orthopaedics, Adichunchanagiri Institute of Medical Sciences, B.G. Nagara, Mandya, from August 2024-February 2026. The study was started after receiving ethical clearance from the Institutional Ethics Committee. A total of 20 patients fulfilling the inclusion criteria were selected for the study.

Inclusion & Exclusion Criteria

Individuals of age between 18-80 yrs with displaced proximal humeral fractures classified as Neer two-part, three-part, or four-part injuries, with proximal humeral fractures associated with shoulder dislocation were included.

Elderly patients of age >80yrs with severely comminuted fractures, patients who were medically unfit to undergo surgical intervention, with Fractures involving splitting of the humeral head.

All patients presenting with proximal humeral fractures underwent a standardized evaluation and treatment protocol. On admission, demographic details, mechanism of injury, time to presentation, occupation, associated injuries, comorbidities, and relevant medical history were recorded using a structured trauma assessment form. A comprehensive systemic and local clinical examination was performed, including assessment of shoulder deformity, swelling, skin condition, distal neurovascular status, and sensory function. Associated injuries involving the head, chest, abdomen, spine, or pelvis were excluded.

The affected limb was initially immobilized using a universal shoulder immobilizer. Radiographic evaluation included Neer's trauma series comprising true anteroposterior (AP), scapular Y, and axillary views, with a Velpeau view obtained when indicated. Computed tomography (CT) was performed in selected cases for detailed fracture assessment. Fractures were classified according to Neer's classification.

All patients underwent routine preoperative investigations, including complete blood count, renal function tests, serum electrolytes, blood grouping and cross-matching, bleeding and clotting profile, random blood glucose, urine examination, chest radiography, and electrocardiography in patients aged >40 years. Additional investigations were performed when clinically indicated. Medical comorbidities were optimally managed before

surgery, and all patients were assessed according to the American Society of Anesthesiologists (ASA) physical status classification. Final fitness for surgery was determined jointly by the treating physician and anaesthesiologist.

Patients with displaced two-, three-, or four-part proximal humeral fractures deemed suitable for fixation based on fracture configuration, bone quality, patient age, functional demand, and associated injuries underwent open reduction and internal fixation (ORIF) using a 3.5-mm proximal humerus internal locking system (PHILOS) plate.

Surgery was performed electively under either interscalene block or general anaesthesia with prophylactic intravenous antibiotics administered before incision. Patients were positioned in either the beach-chair or supine position under fluoroscopic guidance. A standard deltopectoral approach was used with meticulous preservation of the cephalic vein, axillary nerve, long head of the biceps tendon, and surrounding soft tissues to maintain humeral head vascularity. Fracture fragments were anatomically reduced and temporarily stabilized with Kirschner wires under fluoroscopic guidance.

The PHILOS plate was positioned at least 8 mm distal to the greater tuberosity and centred on the lateral aspect of the proximal humerus. Proximal fixation was achieved using appropriately sized 3.5-mm locking screws, while distal fixation was completed using cortical and/or locking screws through the combi-holes based on fracture characteristics. Fracture reduction and implant position were confirmed using intraoperative fluoroscopy. After thorough saline irrigation, the wound was closed in layers using standard techniques. Following surgery, the operated limb was immobilized using an arm pouch or shoulder immobilizer. Sutures were removed approximately 10 days post-operatively.

The collected data were entered in Microsoft Excel and analyzed using the SPSS 24.0. Descriptive statistical analysis was performed for all study variables. For comparison of functional outcome scores across different follow-up periods, repeated measures analysis was used for normally distributed data, while a non-parametric equivalent was considered when data were not normally distributed. A p-value of less than 0.05 was considered statistically significant.

Result

Table 1. Baseline Demographic and Injury Characteristics of the Study Population (N = 20)

Variable	Category	n (%)	P value
Age (years)	18–20	4 (20.0)	0.221
	21–40	4 (20.0)	
	41–60	9 (45.0)	
	>60	3 (15.0)	
Sex	Male	8 (40.0)	0.371
	Female	12 (60.0)	
Side of injury	Left	9 (45.0)	0.655
	Right	11 (55.0)	
Mechanism of injury	Road traffic accident	13 (65.0)	0.0043
	Fall	6 (30.0)	
	Electric shock	1 (5.0)	
Fracture type (Neer's classification)	Two-part	8 (40.0)	0.066
	Three-part	8 (40.0)	
	Four-part	2 (10.0)	
	Fracture-dislocation	2 (10.0)	
Fracture status	Closed	18 (90.0)	0.00034
	Open (Gustilo-Anderson Type I & II)	2 (10.0)	
Time from injury to surgery	<12 hours	1 (5.0)	0.0043
	12–24 hours	6 (30.0)	
	>24 hours	13 (65.0)	

RTA, road traffic accident.

The majority of patients were aged 41–60 years (45.0%), followed by 18–20 years and 21–40 years (20.0% each), while patients aged >60 years accounted for 15.0%. Females constituted a slightly higher proportion of the cohort than males (60.0% vs. 40.0%). Right-sided injuries were marginally more common than left-sided injuries (55.0% vs. 45.0%). Road traffic accidents were the predominant mechanism of injury (65.0%), followed by falls (30.0%) and electric shock (5.0%). Most fractures were closed injuries (90.0%), with only 10.0% being Gustilo-Anderson type I or II open fractures. According to Neer's

classification, two-part and three-part fractures were equally the most frequent fracture patterns (40.0% each), whereas four-part fractures and fracture-dislocations each accounted for 10.0% of cases. The majority of patients (65.0%) underwent surgery more than 24 hours after injury. A statistically significant predominance was observed for closed fractures, road traffic accidents as the mechanism of injury, and surgery performed after 24 hours ($p < 0.05$), whereas the distributions of age, sex, side of injury, and Neer's fracture type were not statistically significant ($p > 0.05$).

Table 2. Fracture Characteristics of the Study Population (N = 20)

Variable	Category	n (%)
Neer's fracture type	Two-part	8 (40.0)
	Three-part	8 (40.0)
	Four-part	2 (10.0)
	Fracture-dislocation	2 (10.0)
Fracture status	Closed	18 (90.0)
	Open (Gustilo-Anderson Type I & II)	2 (10.0)
Time from injury to surgery	<12 hours	1 (5.0)
	12–24 hours	6 (30.0)
	>24 hours	13 (65.0)
	Mean $\pm$ SD (hours)	27.30 $\pm$ 16.40

Table 2 summarizes the fracture characteristics of the study population. Two-part and three-part fractures were the predominant injury patterns, each accounting for 40.0% of cases, while four-part fractures and fracture-dislocations each constituted 10.0%. Closed fractures were observed in the

majority of patients (90.0%), with only two patients (10.0%) presenting with Gustilo-Anderson type I or II open fractures. The mean interval from injury to surgery was **27.30 $\pm$ 16.40 hours**, and most patients (65.0%) underwent operative fixation more than 24 hours after injury.

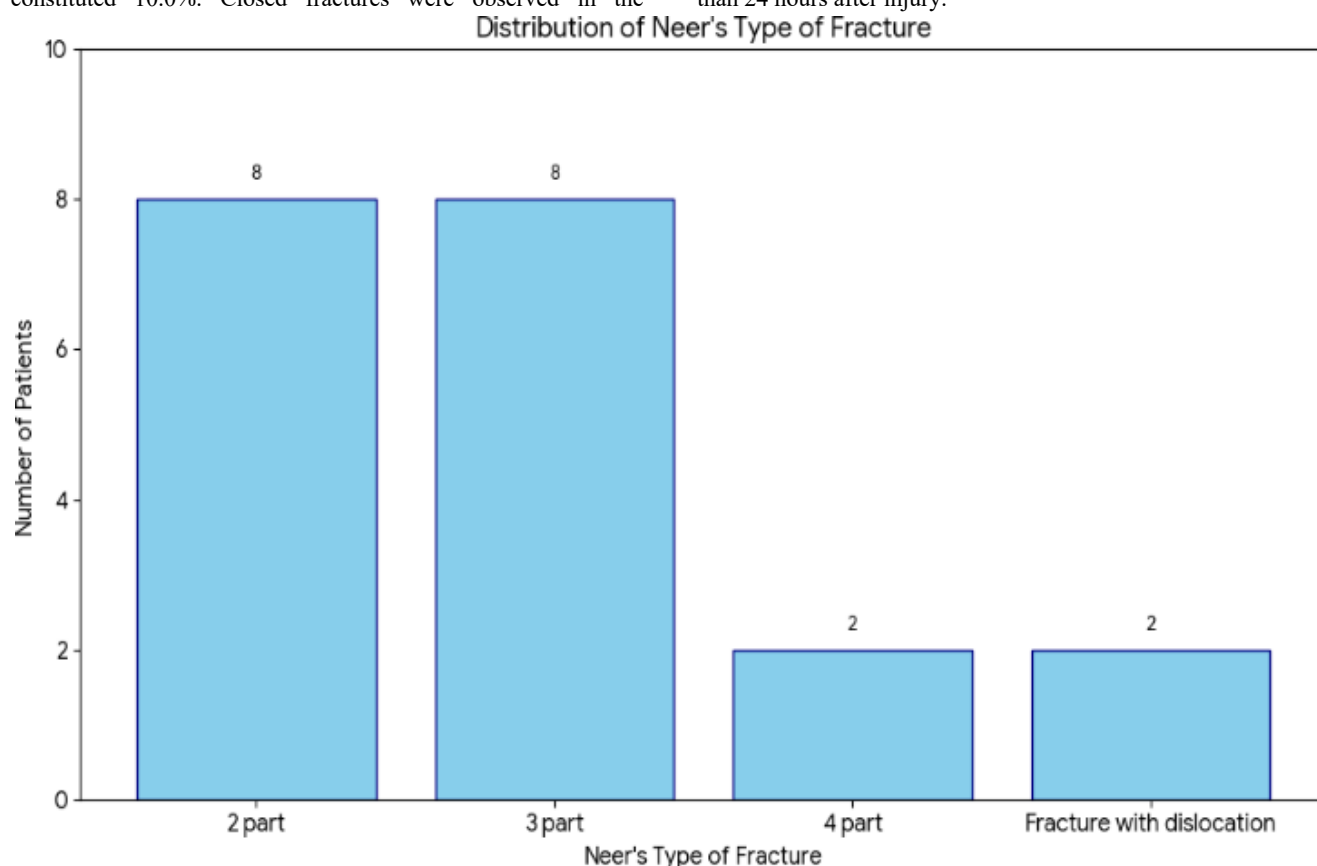


Figure 1. Distribution of Neer's type of Fracture

Table 3. Functional Recovery According to Constant–Murley Score During Follow-up

Constant–Murley Score	3 weeks	6 weeks	12 weeks	24 weeks
<70	20 (100.0)	17 (85.0)	5 (25.0)	1 (5.0)
70–79	0	3 (15.0)	12 (60.0)	2 (10.0)
80–89	0	0	3 (15.0)	13 (65.0)
≥90	0	0	0	4 (20.0)
Mean ± SD	51.10 ± 6.50	62.00 ± 7.23	71.95 ± 7.82	84.20 ± 6.99

Table 3. demonstrates progressive functional recovery following PHILOS plate fixation as assessed by the Constant–Murley score over the 24-week follow-up period. At 3 weeks, all patients (100%) had scores below 70, indicating poor early postoperative shoulder function. By 6 weeks, 15.0% of patients had improved to scores of 70–79, while the remaining 85.0% continued to have scores below 70. At 12 weeks, functional improvement became more evident, with 60.0% of patients achieving scores of 70–79 and 15.0% attaining scores of 80–89, whereas only 25.0% remained below 70. At the final 24-week assessment, the majority of patients (65.0%) achieved scores

between 80 and 89, and 20.0% attained excellent scores of ≥90. Only one patient (5.0%) had a score below 70, while two patients (10.0%) had scores between 70 and 79.

The mean Constant–Murley score increased steadily from 51.10 ± 6.50 at 3 weeks to 62.00 ± 7.23 at 6 weeks, 71.95 ± 7.82 at 12 weeks, and 84.20 ± 6.99 at 24 weeks, reflecting continuous improvement in pain relief, shoulder mobility, strength, and overall function. These findings indicate that PHILOS plate fixation provided favourable functional recovery, with most patients achieving satisfactory to excellent shoulder function by six months postoperatively.

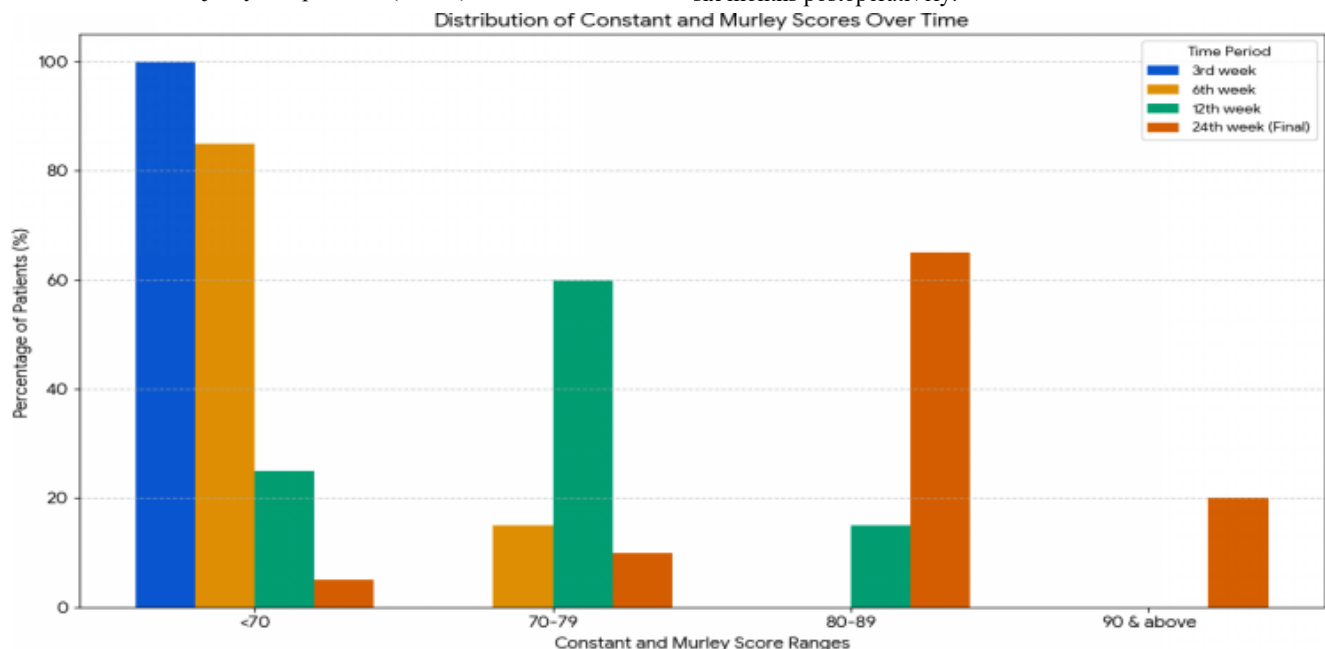


Figure 2. Distribution of Constant and Murley Scores Over Time

Table 4. Final Functional Outcome and Postoperative Complications (N = 20)

Variable	Category	n (%)
Final functional outcome (Constant–Murley grade)	Excellent	4 (20.0)
	Satisfactory	13 (65.0)
	Unsatisfactory	2 (10.0)
	Failure	1 (5.0)
Postoperative complications	None	17 (85.0)
	Joint stiffness	2 (10.0)
	Surgical site infection	1 (5.0)
	Hardware loosening	0 (0.0)
	Malunion	0 (0.0)
	Non-union	0 (0.0)
	Avascular necrosis (osteonecrosis)	0 (0.0)

Table 4. summarizes the final functional outcomes and postoperative complications following PHILOS plate fixation. At the final 24-week follow-up, 17 patients (85.0%) achieved satisfactory or excellent functional outcomes, including 13 patients (65.0%) with satisfactory results and 4 patients (20.0%) with excellent results according to the Constant–Murley grading

system. Unsatisfactory outcomes were observed in 2 patients (10.0%), while 1 patient (5.0%) was classified as a failure.

Postoperative complications were infrequent, with 17 patients (85.0%) experiencing an uncomplicated recovery. The most common complication was joint stiffness, affecting 2 patients (10.0%), followed by one case (5.0%) of postoperative surgical

site infection. Importantly, no cases of hardware loosening, malunion, non-union, or avascular necrosis of the humeral head were observed during the follow-up period. These findings suggest that PHILOS plate fixation provided favourable functional outcomes with a

low complication rate in the management of proximal humeral fractures.

CASE SERIES- 01

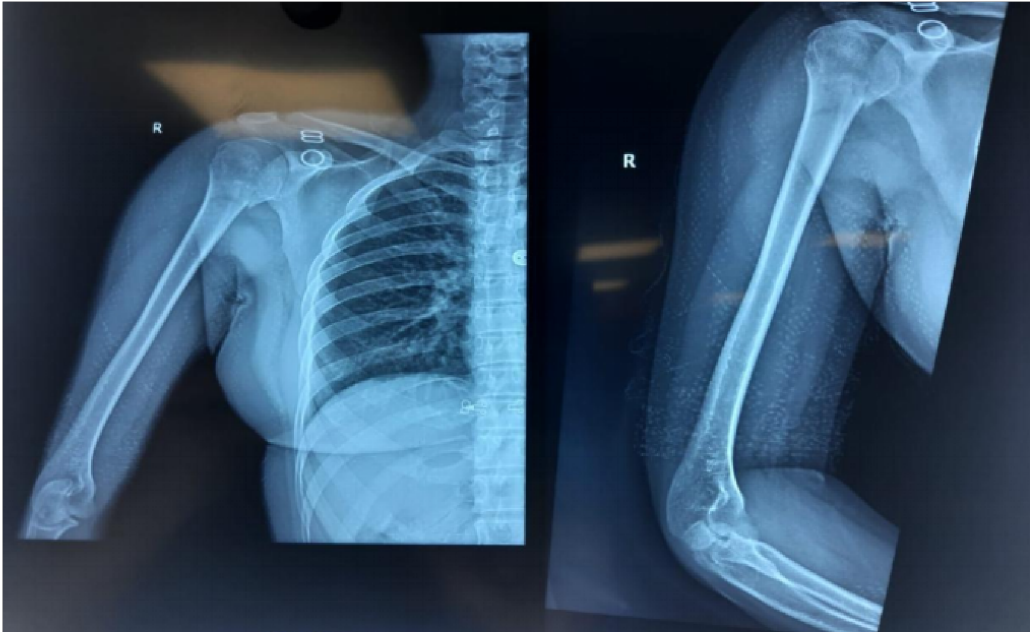


Figure 3. Pre Op X-Ray: Ap and Lateral View

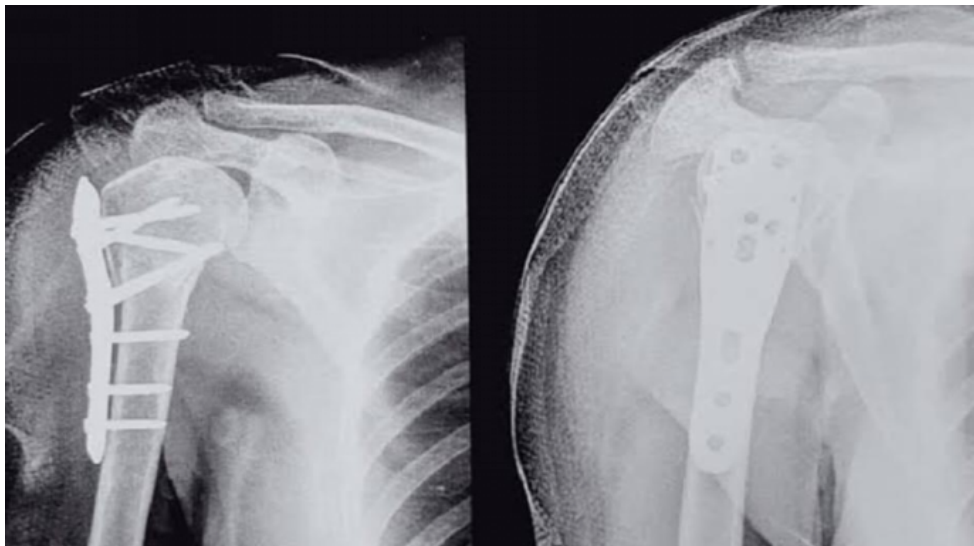


Figure 4. Post Op X-Ray: Ap and Lateral View



Figure 5. Forward Flexion and Abduction At 6 Months



Figure 5. Internal Rotation and External Rotation At 6 Months

CASE SERIES- 02

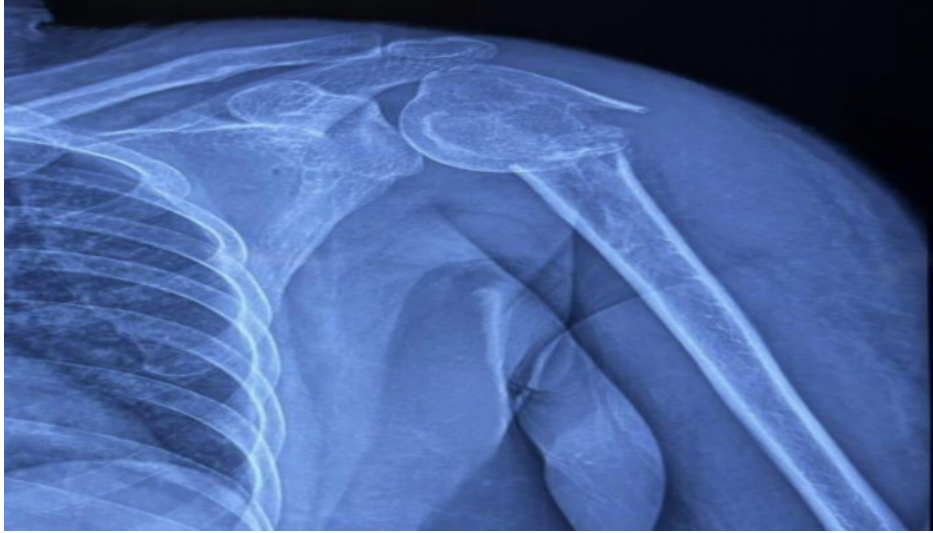


Figure 6. Pre Op X-Ray: Ap View

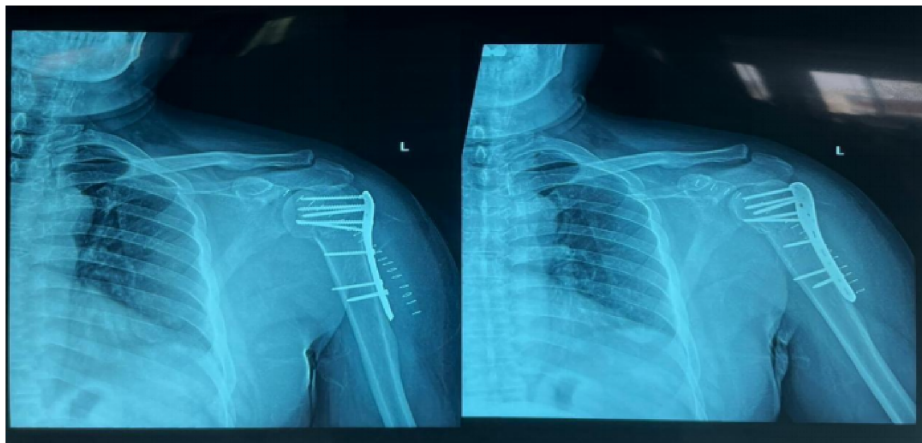


Figure 7. Post Op X-Ray: Ap View and Lateral View



Figure 8. Forward Flexion and Abduction At 6 Months



Figure 9. Internal Rotation and External Rotation At 6 Months

DISCUSSION

Fractures of the proximal humerus continue to represent a significant clinical challenge in orthopaedic practice. Although many of these fractures can be managed conservatively, displaced injuries frequently require operative intervention to restore anatomy and function. The increasing life expectancy of the population and rising prevalence of osteoporosis have contributed to a steady growth in the incidence of such fractures, particularly among elderly individuals. The present study was undertaken to evaluate the functional outcome of displaced proximal humerus fractures treated with PHILOS plating.

The present study demonstrated a predominance of patients in the 41–60-year age group, with a mean age of 42.9 years, which is lower than that reported by Neer [10], Dolfi Herscovici [11], and

Court-Brown et al. [2]. The relatively younger age profile is likely attributable to the predominance of high-energy trauma in the study population. Females constituted 60% of the cohort, which is consistent with the increased susceptibility of postmenopausal women to proximal humeral fractures secondary to osteoporosis, as described by Court-Brown et al. [2]. Right-sided injuries were slightly more frequent than left-sided injuries, similar to observations in previous series. Road traffic accidents were the leading mechanism of injury (65%), followed by falls (30%), reflecting findings reported by Dolfi Herscovici [11] and Aaron [12], where high-energy trauma constituted a major cause of displaced proximal humeral fractures.

Two-part and three-part fractures were the predominant fracture patterns, each accounting for 40% of cases, while four-part

fractures and fracture-dislocations constituted 10% each. This distribution is comparable with the series reported by Neer [10] and Dolfi Herscovici [11]. Most fractures were closed injuries (90%), and the majority of patients underwent surgery more than 24 hours after injury. Despite this interval, satisfactory fracture healing and functional outcomes were achieved, suggesting that delayed fixation beyond 24 hours did not adversely influence the overall results when meticulous reduction and stable fixation were achieved.

Clinical union was achieved at a mean of 8.2 weeks, while the mean radiological union time was 8.4 weeks, comparable to the findings of Shahid R et al. [13] and earlier than those reported by Leonard M et al. [14]. Functional recovery showed progressive improvement throughout follow-up, with the mean Constant–Murley score increasing from 51.10 ± 6.50 at 3 weeks to 84.20 ± 6.99 at 24 weeks. The final mean score compares favourably with those reported by Gaheer RS et al. [15], Martinez AA et al. [16], Kumar GN et al. [17], Venkateswarlu CH et al. [18], and Iacobellis C et al. [19], indicating that PHILOS plating provides stable fixation permitting early rehabilitation and satisfactory restoration of shoulder function.

At the final follow-up, 85% of patients achieved satisfactory or excellent functional outcomes, while only one patient (5%) had a poor outcome. The overall complication rate was low, with postoperative stiffness occurring in two patients and superficial infection in one patient. Importantly, no cases of implant loosening, malunion, non-union, or avascular necrosis were observed. Similar favourable outcomes have been reported by Shahid R et al. [13] and Kumar GN et al. [17], whereas Geiger EV et al. [20] and Neer [10,21] documented comparatively higher complication rates, particularly in complex fractures. The low complication rate observed in the present study may be attributed to meticulous surgical technique, stable fixation using the PHILOS plate, preservation of soft tissues, and adherence to structured postoperative rehabilitation protocols.

The present study has several strengths that enhance the reliability of its findings. A standardized treatment protocol was followed, with all patients undergoing open reduction and internal fixation using a 3.5-mm PHILOS plate through the deltopectoral approach, thereby minimizing treatment-related variability. Baseline demographic and fracture characteristics were systematically recorded, and fracture healing was assessed using both clinical and radiological union. Functional recovery was prospectively evaluated at predefined postoperative intervals using the validated Constant–Murley Shoulder Score, enabling comprehensive assessment of shoulder function over time. Furthermore, postoperative complications and final functional outcomes were systematically documented, providing a comprehensive evaluation of the safety and effectiveness of PHILOS plate fixation. However, the study has certain limitations. It was conducted at a single tertiary care centre with a relatively small sample size, which may limit the generalizability of the findings and preclude meaningful subgroup analyses. The six-month follow-up period was sufficient to assess fracture union and early functional recovery but may not have captured late complications such as avascular necrosis, post-traumatic arthritis, or implant failure. In addition, the absence of a comparison group treated with alternative fixation methods or conservative management limits direct assessment of the relative efficacy of PHILOS plating. Finally, patient-reported outcome measures, bone mineral density, rehabilitation compliance, and surgeon-related factors, which may influence functional outcomes, were not evaluated separately.

CONCLUSION

Overall, the findings suggest that PHILOS plating is a dependable method for managing displaced proximal humerus fractures and can provide good functional outcome with acceptable morbidity. However, successful results depend not only on the implant but also on patient selection, fracture pattern, bone quality, timing of surgery, surgical expertise, and

compliance with physiotherapy. Therefore, treatment should be individualized, and patients should be counselled regarding the need for regular follow-up and rehabilitation. Although the present study supports the effectiveness of PHILOS plating, further studies with larger sample size, longer follow-up, and comparison with other treatment modalities are recommended to assess long-term functional outcome, late complications, and overall treatment superiority. Thus, PHILOS plate fixation remains a useful and reliable surgical option for displaced proximal humerus fractures in routine orthopaedic practice.

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