Section: Orthopaedics

Original Research Article

OUTCOME ANALYSIS OF PROXIMAL HUMERUS FRACTURES TREATED WITH PHILOS PLATING AND STRAIGHT NAILING – A COMPARATIVE STUDY

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Received : 05/11/2025
Received in revised form : 24/12/2025
Accepted : 13/01/2026

Keywords:
Fracture Fixation; Internal; Humeral Fractures; Intramedullary Nailing; Bone Plates; Shoulder Joint.

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DOI: 10.47009/jamp.2026.8.1.85

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2026; 8 (1); 450-454

ABSTRACT

Background: Proximal humerus fractures are common injuries, particularly in older adults, and their optimal surgical management remains debated. Locking plates and intramedullary nails are widely used for displaced Neer type 2–4-part fractures, but differences in outcomes and complications continue to be reported. This study aimed to evaluate displaced Neer type 2–4-part proximal humerus fractures by comparing PHILOS plate fixation with straight intramedullary nailing. **Materials and Methods:** This prospective analytic study was conducted at Mahatma Gandhi Memorial Government Hospital, Trichy, over two years. Thirty patients with Neer type 2–4-part proximal humerus fractures were treated with either PHILOS plating or straight intramedullary nailing and followed for a minimum of six months. Functional outcome was assessed using the Neer Shoulder Score, along with radiological union and complications. **Result:** Baseline demographic and fracture characteristics were comparable between groups. The mean operative time was longer with PHILOS plating (134.33 ± 19.35 minutes) compared with intramedullary nailing (100.00 ± 15.47 minutes). Intraoperative blood loss was higher in the PHILOS plating (260.00 ± 49.43 ml vs 78.67 ± 32.92 ml). Hospital stay was similar in both groups. Postoperative complications occurred in 26.7% of the nailing and 13.3% of the PHILOS group, with infections observed in the PHILOS plating and mechanical complications observed in the nailing group. Radiological union was achieved in 93.3% of the nailing group and 80% of the PHILOS group, without statistical significance. Functional outcomes assessed by the Neer score were comparable between groups (85.73 vs 84.27). **Conclusion:** Both PHILOS plating and straight intramedullary nailing provide satisfactory and comparable functional and radiological outcomes. Intramedullary nailing was associated with shorter operative time and reduced blood loss, supporting individualised implant selection.

INTRODUCTION

Proximal humerus fractures are common injuries in adults, accounting for nearly 5.7% of all fractures. Among individuals >64 years, these fractures are the third most frequent non-vertebral injury, occurring after fractures of the femoral neck and the distal radius.[1] Proximal humerus fractures follow a bimodal age pattern. Younger patients usually bear these injuries after high-energy trauma, such as road traffic accidents, while in older individuals, they most often result from low-energy falls associated with osteoporosis and age-related loss of bone strength.[2] With increasing life expectancy and an ageing population, the incidence of proximal humerus fractures is expected to increase significantly, with projections suggesting an almost increase by 2030.[2] Management of proximal humerus fractures is challenging due to the complex anatomy and the crucial functional role of the shoulder. In elderly patients, poor bone quality further complicates fixation and leads to prolonged rehabilitation with residual functional limitation.[3] A range of methods, including conservative treatment, percutaneous pinning, fixation with plates or intramedullary nails, and arthroplasty procedures such as hemiarthroplasty or reverse shoulder arthroplasty in selected cases, can manage proximal humerus fractures.[4] Treatment decisions for proximal humerus fractures are guided

ISSN (O): 2687-5365; ISSN (P): 2753-6556

by the fracture pattern, bone quality, patient age, functional needs, and surgeon experience. Arthroplasty is preferred in elderly patients with poor bone quality, whereas fixation is appropriate in younger, active individuals.[5]

Advances in implant plan have introduced locking plates such as PHILOS to improve fixation in osteoporotic proximal humerus fractures. Despite improved angular stability and screw anchorage, clinical outcomes with locking plates remain unpredictable, with complications still being reported.[6] Modern fixation methods, especially locking plates, were introduced to improve stability and fixation in osteoporotic bone. However, clinical results have been varying, with complications such as screw cut-out and avascular necrosis, and no clear advantage in functional outcomes over other treatment methods.[7]

Surgical and non-surgical treatments of displaced proximal humerus fractures result in similar functional outcomes. However, surgery is associated with higher complication rates, which has led to continued debate and uncertainty over the most appropriate treatment strategy.[8,9] There is no clear agreement on the best fixation method for displaced Neer type 2–4 proximal humerus fractures. Outcomes are assessed by functional recovery, radiological union, and complication rates, which can differ with both the fixation method and patient factors. This study aimed to evaluate displaced Neer type 2–4-part proximal humerus fractures by comparing PHILOS plate fixation with straight intramedullary nailing.

MATERIALS AND METHODS

This prospective analytic study included 30 patients with Neer type 2–4-part proximal humerus fractures and was conducted over two years in the Department of Orthopaedics at Mahatma Gandhi Memorial Government Hospital, Trichy, collaborated to K.A.P. Viswanatham Government Medical College, Trichy. Ethical committee approval was obtained, and informed written consent was taken from all participants.

Sample size calculation: The sample size was calculated based on an expected mean difference of 5 points in the Neer Shoulder Score between groups, with a standard deviation of 6.5, a 95% confidence level, and 80% power. This yielded a required sample size of 26.5, which was rounded to 30 patients. The sample size was calculated using the formula: $n = [(Z\alpha/2 + Z\beta) / (\Delta / \sigma)]^2 \times 2$.

Inclusion Criteria

Patients >18 years with closed proximal humerus fractures of Neer type 2, 3, 4 without neurological or vascular injury, and who consented to participate were included.

Exclusion Criteria

Patients who were immunocompromised, pregnant or breastfeeding, had cognitive impairment affecting assessment or rehabilitation, or had pathological fractures were excluded.

Methods: Eligible patients were enrolled and assigned to two treatment groups through an allocation method. Patients in Group A underwent fixation with a PHILOS plate, while those in Group B were treated with straight intramedullary nailing. Demographic details and fracture characteristics were documented at admission. Clinical and radiological data were collected prospectively. All procedures were performed under general or regional anaesthesia using traditional surgical techniques. Functional outcome was evaluated using the Neer Shoulder Performance Score, which assesses pain, range of shoulder motion, muscle strength, and ability to perform activities of daily living. This score was recorded during follow-up visits.

Radiological assessment was focused to fracture union. Union was defined by visible callus formation and cortical bridging on plain radiographs. Standard anteroposterior and axillary views were obtained preoperatively and repeated at 3, 7, 10, and 13 weeks postoperatively to monitor the progression of healing. Alignment and angulation were not analysed separately. A uniform postoperative rehabilitation protocol was followed in both groups to minimise bias in functional assessment. Each patient was followed for a minimum duration of six months. Intraoperative and postoperative complications, including rotator cuff injury, nerve injury, infection, implant failure, malunion, and non-union, were recorded systematically and included in the final analysis.

Statistical analysis: Data were entered and analysed using SPSS v29. Categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate. Continuous variables, including Neer's score, were analysed using the Student's t-test or Mann–Whitney U test, depending on data distribution. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 30 patients meeting the inclusion criteria were enrolled. All patients completed the minimum 6-month follow-up and were included in the final analysis. The mean age was (PHILOS: 50.47 ± 13.62 years; nailing: 45.40 ± 9.24 years). Females were the majority in the PHILOS plating (PHILOS: 60%), while males were more common in the intramedullary nailing group (nailing: 53.3%) ($p = 0.714$). Road traffic accidents were the leading cause of injury in both groups (PHILOS: 53.3%; nailing: 60%) ($p = 1.01$). Right-sided fractures were more common than left-sided fractures in both groups (PHILOS: 60%; nailing: 53.3%) ($p = 0.713$) [Table 1].

Three-part fractures were most frequent in the PHILOS plating group (PHILOS: 60%; nailing: 53.3%; $p = 0.164$). Associated injuries were observed

ISSN (O): 2687-5365; ISSN (P): 2753-6556

in both groups (PHILOS: 33.3%; nailing: 40%; p = 0.701) [Table 2].

Table 1: Baseline demographic and injury characteristics

Variable	Category	Group A (n = 15)	Group B (n = 15)	p value
Age (years)		50.47 ± 13.62	45.40 ± 9.24	-
Gender	Male	6 (40%)	8 (53.3%)	0.714
	Female	9 (60%)	7 (46.7%)	
Mode of Injury	Accidental fall	7 (46.7%)	6 (40%)	1.01
	Road traffic accident	8 (53.3%)	9 (60%)	
Side of Injury	Right	9 (60%)	8 (53.3%)	0.713
	Left	6 (40%)	7 (46.7%)	

Table 2: Fracture pattern (Neer classification) and associated injuries

Variable	Category	Group A (n = 15)	Group B (n = 15)	p value
Fracture type (Neer classification)	2-part	3 (20%)	8 (53.3%)	0.164
	3-part	9 (60%)	5 (33.3%)	
	4-part	3 (20%)	2 (13.3%)	
Associated injuries	Present	5 (33.3%)	6 (40%)	0.701
	Absent	10 (66.7%)	9 (60%)	

All patients in the intramedullary nailing group were operated through the deltoid-splitting approach (PHILOS: 20%; nailing: 100%), while most patients treated with PHILOS plating underwent the deltopectoral approach (PHILOS: 80%; nailing: 0%) [Table 3].

Table 3: Operative and perioperative parameters of PHILOS plating and intramedullary nailing

Variable	Parameter	Group A (n = 15)	Group B (n = 15)
Surgical approach	Deltopectoral (DP)	12	0
	Deltoid-splitting (DS)	3	15

The mean duration of surgery was longer with PHILOS plating (PHILOS: 134.33 ± 19.35 minutes; nailing: 100.00 ± 15.47 minutes). Intraoperative blood loss was higher in the PHILOS plating (PHILOS: 260.00 ± 49.43 ml; nailing: 78.67 ± 32.92 ml). The duration of hospital stay was comparable between the two groups (PHILOS: 5.67 ± 2.58 days; nailing: 5.93 ± 3.73 days) [Table 4].

Table 4: Operative parameters of PHILOS plating and intramedullary nailing

Parameter	Group A (n = 15)	Group B (n = 15)
Duration of surgery (min)	134.33 ± 19.35	100.00 ± 15.47
Intraoperative blood loss (ml)	260.00 ± 49.43	78.67 ± 32.92
Hospital stays (days)	5.67 ± 2.58	5.93 ± 3.73

Complications were more frequent in the intramedullary nailing, occurring in 4 patients (26.7%), compared with 2 patients (13.3%) in the PHILOS plating. Most patients in both groups had no complications, accounting for 86.7% in the PHILOS plating and 73.3% in the nailing group. Infection complication observed 2 vs 1 in the PHILOS plating with nailing, while rotator cuff injury and varus malunion occurred exclusively in the intramedullary nailing [Table 4].

Table 4: Postoperative complications in PHILOS plating and intramedullary nailing

Complication	Category	Group A (n = 15)	Group B (n = 15)
Any complication	Yes	2 (13.3%)	4 (26.7%)
	No	13 (86.7%)	11 (73.3%)
Type of complication	Infection	2	1
	Rotator cuff injury	0	2
	Varus malunion	0	1

Radiological union was achieved in a higher percentage of patients treated with intramedullary nailing (PHILOS: 80%; nailing: 93.3%; p = 0.283). Functional outcomes were comparable between the two groups, with mean NEER scores (PHILOS: 85.73; nailing: 84.27; p = 0.555) [Table 5].

Table 5: Radiological and functional outcomes of PHILOS plating and intramedullary nailing

Outcome	Category	Group A (n = 15)	Group B (n = 15)	p value
Radiological outcome	United	12 (80)	14 (93.3)	0.283
	Delayed union	3 (20)	1 (6.7)	
NEER score (mean)		85.73	84.27	0.555

ISSN (O): 2687-5365; ISSN (P): 2753-6556

DISCUSSION

The intramedullary nailing and PHILOS plating provided comparable functional outcomes and radiological union in proximal humerus fractures. Intramedullary nailing demonstrated shorter operative time and reduced intraoperative blood loss, while radiological union and functional outcomes were comparable between groups. Complications differed by fixation method, but most patients had uneventful recovery, supporting both techniques as effective when appropriately selected.

In our study, the two groups were demographically comparable, with similar gender distribution, injury mechanism, and fracture laterality, ensuring baseline homogeneity for outcome comparison. Similarly, Guo et al. in a comparative study reported similar baseline characteristics between locking plate and intramedullary nail groups, with mean ages of 61.3 ± 13.9 and 65.6 ± 11.2 years, respectively. Gender, side of injury, and mechanism, including road traffic accidents, showed no significant intergroup differences ($p > 0.05$). In this study, the overall mean age was 53.24 years, with comparable baseline characteristics between groups, with males predominating (60%).10 Pradeep et al. Road traffic accidents were the commonest injury mechanism (47.5%). Right-sided fractures were more frequent than left (62.5% vs 37.5%), showing a demographic pattern comparable to surgically treated proximal humerus fracture series.[11] These findings support baseline demographic comparability across studies, with consistent injury patterns and representative patient profiles, supporting valid intergroup comparisons and strengthening the external validity of our study.

Our study shows that fracture pattern and associated injuries were comparable between groups. Likewise, Guo et al. show that three-part fractures were most common in the locking plate group (47.2%), while two-part fractures predominated in the intramedullary nail group (39.3%). Four-part fractures were infrequent, and the fracture pattern was comparable between groups ($p = 0.519$).10 Wang et al. show that fracture configuration was comparable between groups, with OTA/AO 11C1.1 and 11C3.1 fractures were similar between locking plate and intramedullary nail fixation ($p = 0.209$). Baseline characteristics and complication rates showed no significant intergroup differences ($p > 0.05$).[12] These studies show similar fracture patterns and baseline profiles across treatment groups, supporting comparisons and strengthening the credibility of our fracture pattern findings.

In this study, intramedullary nailing used a deltoid-splitting approach with shorter surgery and less blood loss, while hospital stay was comparable between groups. Similarly, Bu et al. found that the intramedullary nail group had a shorter operative duration (87.31 ± 23.32 min) than the plate group (101.52 ± 24.62 min, $p = 0.01$) and lower intraoperative blood loss (189.34 ± 62.03 mL vs. 222.87 ± 76.42 mL, $p = 0.03$), while hospital-related parameters were comparable between groups.[13] Song et al. patients treated with locking plates had a longer operative time (120 ± 20.6 min vs 80 ± 10.5 min, $p < 0.001$) and higher intraoperative blood loss (350 ± 57.2 ml vs 100 ± 29.3 ml, $p < 0.001$) than those treated with intramedullary nails, while hospital stay was comparable between groups ($p = 0.118$).[14] These studies demonstrate shorter operative time and reduced blood loss with intramedullary nailing, supporting our findings of reduced operative burden with comparable hospital stay.

In this study, infections were observed in the plating group, while mechanical complications were observed in the nailing group. Similarly, Bu et al. found that postoperative complications were reported in 26.47% of patients in the intramedullary nail group and 54.17% in the plate group ($p = 0.01$). Plate-related complications included screw cut-out (4.17%) and humeral head necrosis (2.08%), while no articular penetration was observed in the nail group. Most patients in both groups had an uncomplicated postoperative course.[13] These findings show complication profiles vary by fixation method while overall recovery remains favourable, supporting our observation of method-specific complications with largely uncomplicated postoperative outcomes.

In our study, radiological union and functional outcomes were comparable between intramedullary nailing and PHILOS plating, with no significant intergroup differences. Similarly, Gracitelli et al. in a randomised trial of 72 patients, Constant-Murley scores at 12 months were comparable between intramedullary nailing and plating (70.3 vs 71.5; $p = 0.750$), with similar radiological alignment. However, overall complication ($p = 0.002$) and reoperation rates ($p = 0.041$) were higher in the nailing group.[15] Liu et al. show that radiographic union at 3 months was higher with intramedullary nailing (92.5%) than PHILOS plating (84.0%), with complete union in both groups by 6 months. Functional outcomes improved in both groups, with higher 12-month Constant-Murley scores in the nailing group (80.62 ± 9.73 vs 72.83 ± 8.87; $p = 0.037$).[16] These studies confirm comparable union and functional outcomes between fixation methods, supporting our results while highlighting expected variation in complication and recovery patterns across different cohorts.

Strengths of this study include its prospective design, use of a validated functional outcome measure, uniform rehabilitation protocol, and direct intergroup comparison within a single institutional setting.

Limitations:

The small sample size and short follow-up limit generalizability and long-term assessment. Single-centre design and surgeon-dependent techniques may present bias, while the lack of blinding could affect functional outcome evaluation.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Clinical implications

Both PHILOS plating and intramedullary nailing are effective for proximal humerus fractures, based on fracture pattern, bone quality, patient functional demands, and surgeon expertise. Future studies with larger sample sizes, longer follow-up, and multicentre designs are required to define complication profiles and long-term functional outcomes between fixation methods.

CONCLUSION

Both PHILOS plating and straight intramedullary nailing obtained comparable functional recovery and radiological union in Neer type 2-, 3- and 4-part proximal humerus fractures. Intramedullary nailing showed advantages of shorter operative time and reduced intraoperative blood loss, while complication patterns differed between techniques. Implant choice should be individualised based on fracture morphology, bone quality, and patient functional demands.

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ISSN (O): 2687-5365; ISSN (P): 2753-6556