

Original Research Article

Functional outcome of proximal humerus fractures treated with open reduction and internal fixation using proximal humerus locking plate: a prospective hospital-based study

Rudra Sardar*, Rajiv Roy, Arshad Ahmed, Rajkumar Poria, Dibakar Mallick

Department of Orthopaedics, Calcutta National Medical College and Hospital, Kolkata, West Bengal, India

Received: 27 December 2025

Revised: 07 February 2026

Accepted: 02 March 2026

***Correspondence:**

Dr. Rudra Sardar,

E-mail: rudra3.rs@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Proximal humerus fractures account for 4-6% of all fractures and may result in significant functional impairment when displaced and inadequately treated.¹ Locking plate fixation offers angular stability and improved fixation, particularly in osteoporotic bone.^{2,3}

Methods: This prospective hospital-based study was conducted from June 2023 to July 2024. Thirty patients aged 18–65 years with acute displaced Neer two-part and three-part proximal humerus fractures were treated with open reduction and internal fixation using proximal humerus locking plates through a deltopectoral approach. Functional outcome was assessed using the Constant-Murley score and DASH score. Radiological union and complications were documented. Statistical analysis was performed using chi-square tests.

Results: The mean age was 44 years, with female predominance (60%). Two-part fractures constituted 60% and three-part fractures 40%. Radiological union was achieved in all cases. Functional outcomes were excellent in 20%, good in 50%, moderate in 20%, and poor in 10% of patients. Early surgery (≤ 5 days) and two-part fractures were significantly associated with better outcomes ($p < 0.05$). Late complications such as stiffness and malunion negatively influenced outcomes ($p = 0.002$).

Conclusions: Open reduction and internal fixation using proximal humerus locking plates provides reliable union and satisfactory functional outcomes in displaced proximal humerus fractures when performed early and with appropriate patient selection.

Keywords: Proximal humerus fracture, PHILOS plate, Constant-Murley score

INTRODUCTION

Proximal humerus fractures account for the approximately 4-6% of all the fractures and are commonly encountered in the elderly individuals following low-energy falls and in the younger patients due to the high-energy trauma.¹⁻⁶ While minimally displaced fractures are treated conservatively, displaced fractures may result in the malunion, stiffness, and compromised the shoulder function if inadequately managed.²⁻⁷ Disruption of the humeral head blood supply, following displaced fractures

may compromise the fracture healing and functional recovery.⁸ Several studies have reported inferior outcomes with conservative treatment for displaced fracture patterns.^{9,10} Open reduction and internal fixation (ORIF) using locking plates has gained popularity due to improved biomechanical stability, angular fixation, and suitability in osteoporotic bone.^{11,12} The PHILOS plate has demonstrated encouraging functional and radiological outcomes in multiple clinical studies.^{13,14} Despite advances in implant design, complications such as shoulder stiffness, screw cut-out, malunion, and fixation failure

continue to be reported.¹⁵⁻¹⁷ This study evaluates the functional and radiological outcomes of proximal humerus fractures treated with ORIF using proximal humerus locking plates.

METHODS

Study design

A prospective descriptive study was conducted at the Department of Orthopaedics, Calcutta National Medical College and Hospital, Kolkata. Ethical approval was obtained from Institutional Ethics Committee prior to commencement of the study and written informed consent was obtained from all participants.

Study period

The duration of the study was June 2023 to July 2024.

Sample size

Sample size was 30 patients.

Inclusion criteria

The study included patients aged 18 to 65 years who presented with acute displaced proximal humerus fractures within three weeks of injury. Only Neer two-part and three-part fractures were considered eligible for inclusion.

Exclusion criteria

Patients with open fractures, pathological fractures, or four-part proximal humerus fractures were excluded from the study. Additionally, individuals with associated neurovascular injuries or head injuries were not considered eligible for inclusion.

Surgical technique

All patients underwent ORIF using proximal humerus locking plates through the deltopectoral approach under general or regional anaesthesia. Provisional reduction was achieved using Kirschner wires, followed by definitive plate fixation under fluoroscopic guidance.

Postoperative protocol

Passive mobilization was initiated early, followed by gradual active range-of-motion exercises. Follow-up visits were scheduled at 2 weeks, 4 weeks, 3 months, and 6 months.

Outcome measures

The functional and clinical outcomes were evaluated using the Constant-Murley score and the Disabilities of the Arm, Shoulder, and Hand (DASH) score.

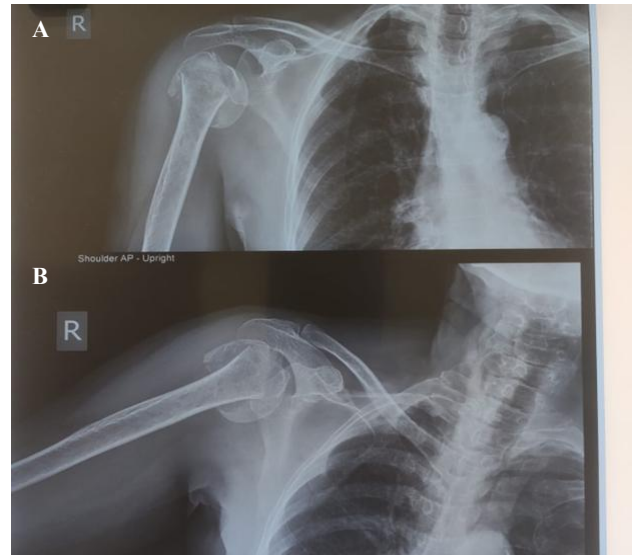


Figure 1 (A and B): Pre-operative radiograph.

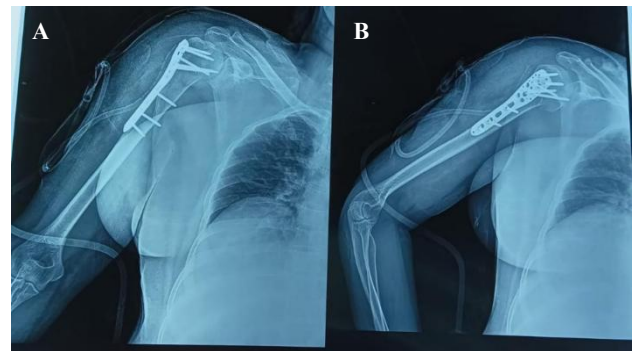


Figure 2 (A and B): Post-operative radiograph.

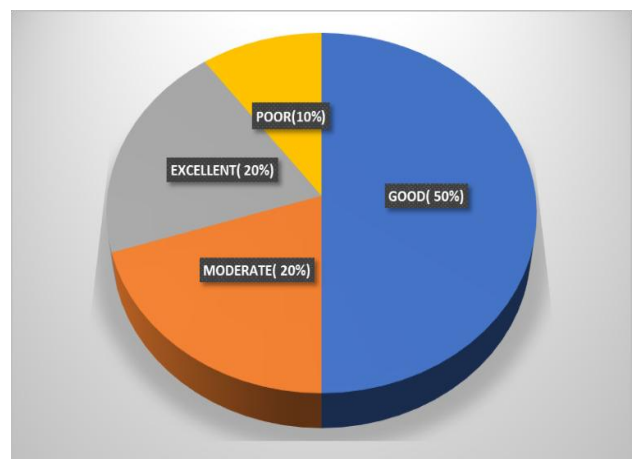


Figure 3: Functional outcome (6 months) based on constant-Murley score.

Radiological assessment was performed to determine fracture union and confirm proper bone healing. Any complications arising during the treatment or follow-up period, such as infection, non-union, malunion, implant failure, or neurovascular injury, were carefully documented and analysed.

Statistical analysis

Data were analysed using Jamovi software (version 2.5.1). The Chi-square test was applied. A p value <0.05 was considered statistically significant.

RESULTS

The mean age of patients was 44 years. Females constituted 60% of cases. The most common mode of injury was falling at ground level (50%).

Table 1: Base line demographic and fracture characteristics of study participants.

Parameter	Category	N (%)
Age (years)	18-30	6 (20)
	31-50	12 (40)
	>51	12 (40)
Sex	Male	12 (40)
	Female	18 (60)
Mode of injury	Fall at ground level	15 (50)
	Fall from height	9 (30)
	RTA	6 (20)
Neer's fracture type	Two-part	18 (60)
	Three-part	12 (40)
Duration before surgery	<6	21 (70)
	>6	9 (30)

Table 2: Functional outcome at 6 months.

Outcome category	Number (%)
Excellent	6 (20)
Good	15 (50)
Moderate	6 (20)
Poor	3 (10)

Table 3: Association of clinical variables with functional outcome.

Variable	Better outcome	P value
Early surgery (<6 days)	Yes	<0.05
Neer's type (two-part)	Yes	<0.05
Late complications	No	0.002

Two-part fractures were seen in 60% and three-part fractures in 40%. Radiological union was achieved in all patients. Functional outcomes were excellent in 20%, good in 50%, moderate in 20%, and poor in 10%.

Early surgical intervention and simpler fracture patterns were significantly associated with better outcomes ($p < 0.05$). Late complications such as stiffness, malunion, and heterotopic ossification adversely affected functional results.

DISCUSSION

This study demonstrates that ORIF with proximal humerus locking plates yields favourable functional outcomes in displaced proximal humerus fractures consistent with earlier studies by Fazal et al and locking plate fixation has shown biomechanical advantages in osteoporotic bone.^{18,19} The observed female predominance and low-energy mechanism of injury are consistent with epidemiological studies reported by Robinson et al and Court-Brown et al.^{5,6} Two-part fractures yielded better results compared to three-part fractures due to reduced complexity and easier anatomical restoration similar to findings reported by Sudkamp et al and Gupta et al Hawkins et al also reported inferior outcomes in three part fractures compared to two part fractures.¹⁴⁻²¹ Similar observations were noted by Robinson et al who demonstrated better functional recovery in simpler fracture configurations.²²

Early surgical fixation was associated with improved outcomes, corroborating reports by Spross et al, Kaminski et al and Lapner et al emphasized that early surgical intervention facilitates anatomical reduction, improves post operative shoulder function.²³⁻²⁵ Shoulder stiffness remained the most common late complication, emphasizing the importance of postoperative rehabilitation and consisting with previous reports by Egol et al, Brorson et al and Rechsteiner et al.^{7,17,26} While some systemic reviews have questioned the superiority of surgical treatment over conservative management, selected displaced fractures continue to benefit from operative fixation.²⁷ Recent studies comparing ORIF with arthroplasty suggest that internal fixation remains a viable option in younger patients with reconstructible fractures.²⁸

CONCLUSION

ORIF using proximal humerus locking plates is a reliable method for treating displaced two-part and three-part proximal humerus fractures, offering good functional outcomes and high union rates when performed early and with appropriate patient selection.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Neer CS. Displaced proximal humeral fractures. J Bone Joint Surg Am. 1970;52:1077-89.
2. Bjorkenheim JM, Pajarinen J, Savolainen V. Locking plate fixation of proximal humeral fractures. Acta Orthop Scand. 2004;75(6):741-5.
3. Charalambous CP, Siddique I, Valluripalli K, Kovacevic M, Panose P, Srinivasan M, et al. PHILOS plate for proximal humerus fractures. Arch Orthop Trauma Surg. 2007;127(3):205-10.

4. Codman EA. *The Shoulder*. Boston: Thomas Todd. 1934.
5. Robinson CM, Wilson A, Dalziel R, Stone M, Wright A, Beverland D. Epidemiology of proximal humeral fractures. *J Bone Joint Surg Br.* 2001;83(3):249-54.
6. Court-Brown CM, Caesar B. Epidemiology of adult fractures. *Injury.* 2006;37(8):691-7.
7. Egol KA, Ong CC, Walsh M, Jazrawi LM, Tejwani NC, Zuckerman JD. Complications of locking plate fixation. *J Orthop Trauma.* 2008;22(3):159-64.
8. Laing PG. Blood supply of the humeral head. *J Bone Joint Surg Br.* 1956;38(1):1100-6.
9. Rangan A, Handoll H, Brealey S, Jefferson L, Keding A, Corbacho Martin B, et al. PROFHER trial. *Lancet.* 2015;385:884-94.
10. Zyto K, Ahrengart L, Sperber A, Törnkvist H. Conservative vs operative treatment. *J Bone Joint Surg Br.* 1997;79(3):412-7.
11. Martinez AA, Cuenca J, Herrera A. Locking plates in proximal humerus fractures. *J Orthop Surg.* 2009;17(1):10-4.
12. Aggarwal S, Bali K, Dhillon MS, Kumar V, Mootha AK. Locking plate fixation in proximal humerus fractures. *Indian J Orthop.* 2010;5:60.
13. Rose PS, Melton LJ III, Morrey BF, Ilstrup DM, Riggs BL. Functional outcome of locking plates. *J Shoulder Elbow Surg.* 2007;16(1):7-12.
14. Gupta AK, et al. Functional outcomes of PHILOS plating. *Int Orthop.* 2012;36:191-8.
15. Hertel R, Hempfing A, Stiehler M, Leunig M. Predictors of humeral head ischemia after intracapsular fracture of the proximal humerus. *J Shoulder Elbow Surg.* 2004;13(4):427-33.
16. Gardner MJ, Weil Y, Barker JU, Kelly BT, Helfet DL, Lorich DG. The importance of medial support in locked plating of proximal humerus fractures. *J Orthop Trauma.* 2007;21(3):185-91.
17. Brorson S, Rasmussen JV, Frich LH, Olsen BS, Hróbjartsson A. Benefits and harms of locking plate osteosynthesis in intra-articular (OTA Type C) fractures of the proximal humerus: a systematic review. *Injury.* 2012;43(7):999-1005.
18. Fazal MA, Haddad FS. PHILOS plate fixation. *J Orthop Surg.* 2009;17(1):15-8.
19. Konrad G. Locking plates in osteoporotic fractures. *J Trauma.* 2010;68:122-8.
20. Südkamp N, Bayer J, Hepp P, Voigt C, Oestern H, Kääb M, et al. Locking plate fixation results. *J Bone Joint Surg Am.* 2009;91(6):1320-8.
21. Hawkins RJ, Bell RH, Gurr K. Three-part fractures of the proximal humerus. *J Bone Joint Surg Am.* 1986;68(9):1410-4.
22. Robinson CM. Surgical neck fractures. *J Bone Joint Surg Am.* 2004;86:135-46.
23. Spross C. Locking plate fixation outcomes. *Injury.* 2020;51:213-20.
24. Kaminski A. ORIF outcomes in proximal humerus fractures. *Injury.* 2022;53:456-62.
25. Lapner P. Proximal humerus fracture management. *J Shoulder Elbow Surg.* 2021;30:123-30.
26. Rechsteiner J. Complications after locking plate fixation. *Injury.* 2020;51:239-45.
27. Handoll HHG, Brorson S, Elliott J, Thillemann TM, Aluko P. Interventions for treating proximal humeral fractures in adults. *Cochrane Database Syst Rev.* 2015;11:CD000434.
28. Jaekel J. Comparison of ORIF and arthroplasty. *Injury.* 2023;54:102-8.

Cite this article as: Sardar R, Roy R, Ahmed A, Poria R, Mallick D. Functional outcome of proximal humerus fractures treated with open reduction and internal fixation using proximal humerus locking plate: a prospective hospital-based study. *Int J Res Orthop* 2026;12:658-61.