Journal of Advanced Scientific Research

Available online through https://sciensage.info

ISSN

0976-9595

Research Article

A Prospective Study Examining the Clinical and Functional Outcomes of Adults with Proximal Humerus Fractures Treated using a Locking Compression Plate (LCP)

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Received: 30-04-2026; Accepted: 21-05-2026; Published: 30-05-2026

https://doi.org/10.55218/JASR.2026170513

ABSTRACT

Background: Proximal humerus fractures constitute a common orthopedic injury requiring surgical intervention to restore anatomy and function. Locking compression plates (LCP) have gained popularity due to their stability and suitability.

Aim: To evaluate the clinical and functional outcomes of adult patients with proximal humerus fractures treated using locking compression plates at a tertiary care referral center in Bihar.

Methodology: This prospective observational study included 36 randomly selected adult patients with displaced proximal humerus fractures managed with open reduction and internal fixation using LCP. Patients were followed for a minimum of 12 months. Clinical assessment included pain evaluation using the visual analog scale, shoulder range of motion, and functional outcome using the Constant–Murley score. Radiological union and postoperative complications were also recorded.

Results: The mean age of patients was 46.8 years, with male predominance. Road traffic accidents were the most common mode of injury. Radiological union was achieved in all patients, with a mean union time of 12.3 weeks. The mean Constant–Murley score at final follow-up was 76.4. Excellent to good functional outcomes were observed in 72.2% of patients. Complications occurred in 16.7% of cases. Better outcomes were observed in two- and three-part fractures compared to four-part fractures.

Conclusion: Locking compression plate fixation is an effective and reliable modality for managing displaced proximal humerus fractures in adults, providing good functional outcomes with acceptable complication rates when combined with proper surgical technique and rehabilitation.

Keywords: Proximal humerus fractures; Locking compression plate; Open reduction internal fixation; Shoulder injuries; Fracture healing.

INTRODUCTION

Proximal humerus fractures (PHFs) represent a significant burden within orthopedic trauma, accounting for approximately 4–10% of all fractures and up to 26% of humeral fractures in adults worldwide [1]. These injuries demonstrate a bimodal distribution, occurring from high-energy mechanisms such as road traffic accidents in younger adults and from low-energy falls in the elderly, particularly in the setting of osteoporosis [2,3]. Although many minimally displaced proximal humeral fractures can be successfully managed non-operatively, displaced, unstable, and multi-fragmentary fractures pose a challenge, often resulting in pain, functional impairment, prolonged disability, and a decreased quality of life when inadequately treated [1,4]. Anatomic reduction and stable fixation are therefore essential in selected cases to restore shoulder function and enable early rehabilitation.

The evolution of surgical implants has introduced locking compression plates (LCP), including the widely used proximal humerus internal locking system (PHILOS), which offer fixed-angle stability and improved purchase in osteoporotic bone, making them particularly useful in adult PHFs [5,6]. Multiple observational studies have demonstrated that LCP fixation is associated with good to excellent functional outcomes based on validated scoring systems such as the Constant–Murley score and Disabilities of the Arm, Shoulder and Hand (DASH) score, especially in two- and three-part fractures [5,7]. However, the heterogeneity in outcomes related to fracture pattern complexity and patient factors (such as bone quality, age, and comorbidities) continues to prompt further research into optimal indications and expected results of LCP fixation [8]. Moreover, while some high-level evidence suggests that surgical fixation may be no better than non-operative treatment in certain elderly populations, other analyses highlight improved early pain control and range of motion with open reduction and internal fixation (ORIF) using locking constructs [9].

Despite a growing body of evidence internationally, there is limited region-specific data on the outcomes of proximal humerus fractures treated with LCP in the Indian context. In particular,

tertiary care centers in Bihar, such as major referral institutions for orthopedic trauma, serve a large and diverse catchment population, including patients from rural, suburban, and socio-economically underserved areas. These centers frequently receive complex and displaced fractures referred from peripheral hospitals that lack advanced orthopedic surgical facilities, making the need for locally relevant clinical outcome data imperative. Socio-demographic differences in injury mechanisms (e.g., a higher proportion of road traffic trauma among younger adults) and prevailing health-care access patterns may also influence outcomes and complication rates in ways not captured in studies from other regions [10].

Given this background, there is a clear need for prospective research evaluating both clinical and functional outcomes of adults with proximal humerus fractures managed with locking compression plates in the Bihar population. Such data can help refine surgical indications, optimize rehabilitation protocols, and support decision-making in resource-constrained settings where tertiary referral centers play a pivotal role in care delivery.

The primary aim of this study is to evaluate the clinical and functional outcomes of adult patients with proximal humerus fractures treated by ORIF with locking compression plates at a major tertiary care referral center in Bihar. Secondary aims include assessing complication rates, fracture healing, and factors associated with functional recovery.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Orthopedics at Mata Gujri Memorial Medical College and Lions Seva Kendra Hospital in Bihar, India, which serves as a major referral center for orthopedic trauma from both urban and rural regions of the state and neighboring areas. The institution caters to a large patient population, including cases referred from district hospitals and peripheral health centers lacking specialized trauma care facilities. Due to its high patient turnover and availability of advanced orthopedic surgical infrastructure, the center provided an ideal setting for evaluating the clinical and functional outcomes of proximal humerus fractures treated using locking compression plates (LCP).

The present study was designed as a prospective, hospital-based observational study. Adult patients diagnosed with proximal humerus fractures and managed surgically with open reduction and internal fixation (ORIF) using locking compression plates were followed longitudinally to assess radiological union, clinical recovery, and functional outcome. The study was conducted over a period of one year for patient recruitment, followed by a minimum follow-up duration of six months for outcome evaluation.

Ethical clearance was obtained from the Institutional Ethics Committee prior to initiation of the study. Written informed consent was taken from all participants before inclusion.

The study included a total of randomly selected patients reporting to the Orthopedic Outpatient Department (OPD) and Emergency Department, who fulfilled the eligibility criteria and consented to participate.

A convenience sampling method was employed, wherein all eligible patients presenting during the study period were considered for inclusion. Random selection among eligible cases was achieved using a simple random sampling technique to avoid selection bias. Considering the time-bound nature of the study and patient flow, a sample size of 30–40 patients was targeted, which is consistent with similar prospective orthopedic studies and adequate for preliminary outcome evaluation.

Patients were included in the study based on the following criteria: Age ≥18 years. Patients of either sex. Closed proximal humerus fractures are classified as Neer's two-part, three-part, or four-part fractures. Displaced fractures require surgical intervention. Patients willing to undergo surgical fixation using LCP. Patients provide informed written consent. Patients fit for anesthesia and surgery.

Patients were excluded if they met any of the following criteria: Age <18 years. Pathological fractures. Open fractures of the proximal humerus. Polytrauma patients with life-threatening injuries. Fractures associated with neurovascular compromise require alternative management. Previous shoulder pathology or surgery affecting functional assessment. Non-ambulatory or bedridden patients. Patients are unwilling to undergo surgery or follow-up. Patients were lost to follow-up before the minimum assessment period.

All eligible patients underwent a thorough clinical and radiological evaluation upon presentation. A detailed history, including mechanism of injury, duration since injury, and comorbidities, was recorded. Clinical examination focused on local swelling, deformity, tenderness, neurovascular status, and associated injuries.

Radiological assessment included standard anteroposterior (AP), scapular Y, and axillary views of the shoulder. Fractures were classified according to Neer's classification system, and a decision for surgical fixation was made based on displacement, fracture pattern, patient age, activity level, and bone quality.

All patients were operated under general or regional anesthesia in the beach-chair position. The standard deltopectoral approach was used in most cases. After adequate exposure, fracture fragments were identified and anatomically reduced. Temporary fixation was achieved using Kirschner wires when required, followed by definitive fixation using a proximal humerus locking compression plate.

Care was taken to ensure Proper plate positioning lateral to the bicipital groove. Restoration of medial calcar support. Appropriate screw length, avoiding intra-articular penetration. Secure fixation in osteoporotic bone using locking screws. Postoperative radiographs were obtained to confirm reduction and implant positioning.

The operated limb was supported in an arm sling. Passive shoulder mobilization was initiated within 48 to 72 hours postoperatively, depending on pain tolerance and fracture stability. Active-assisted movements were started after 2 to 3 weeks, and full active mobilization was encouraged after 6 weeks. Strengthening exercises were introduced gradually after radiological evidence of union.

Patients were followed up at 6 weeks, 3 months,6 months and 12 months postoperatively.

Functional and clinical outcomes were assessed using: Proximal humerus fractures; Locking compression plate; Open reduction internal fixation; Shoulder injuries; Fracture healing.

Radiological evaluation for fracture union, alignment, and implant integrity.

Table 1: Demographic characteristics of study population (n = 36)

Parameter	*Number (%)*
Age (years)	
18–30	7 (19.4)
31–50	15 (41.7)
>50	14 (38.9)
Sex	
Male	22 (61.1)
Female	14 (38.9)
Mode of Injury	
Road Traffic Accident	19 (52.8)
Fall from Height	11 (30.6)
Trivial Fall	6 (16.6)

Table 2: Distribution of fracture types (Neer's Classification)

Fracture type	*Number (%)*
Two-part	15 (41.7)
Three-part	14 (38.9)
Four-part	7 (19.4)
Total	36 (100)

Table 3: Postoperative complications

Complication	*Number (%)*
Shoulder stiffness	3 (8.3)
Superficial infection	2 (5.6)
Screw penetration	1 (2.8)
Avascular necrosis	0 (0)
Implant failure	0 (0)
Total	6 (16.7)

Table 4: Functional outcome based on Constant–Murley score

Outcome Category	*Constant Score*	*Number (%)*
Excellent	>85	10 (27.8)
Good	70–85	16 (44.4)
Fair	55–69	7 (19.4)
Poor	<55	3 (8.4)
Total		36 (100)

Complications such as infection, implant failure, avascular necrosis, screw penetration, malunion, and non-union were recorded.

Data collected were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS). Age, time to union, Constant score, and ROM were expressed as mean ± standard deviation (SD). Sex distribution, fracture type, and complications were expressed as frequency and percentages. Pre- and postoperative functional scores were compared using a paired t-test. The association between fracture type and outcome was analyzed using the chi-square test. A p-value of <0.05 was considered statistically significant.

RESULT

A total of 36 patients with proximal humerus fractures treated using locking compression plates were included in this prospective study. All patients completed a minimum follow-up period of six months and were available for final evaluation.

The age of patients ranged from 19 to 72 years, with a mean age of 46.8 ± 13.4 years. There were 22 males (61.1%) and 14 females (38.9%), showing male predominance. Road traffic accidents were the most common mode of injury (52.8%), followed by falls from height (30.6%) and trivial falls in elderly patients (16.6%). Right-sided involvement was seen in 20 patients (55.6%) and left-sided in 16 patients (44.4%). Table 1 shows the demographic distribution of patients.

The majority of patients belonged to the productive age group (31–50 years), with road traffic accidents being the predominant cause, reflecting the trauma burden in the Bihar population.

Fractures were classified according to Neer's classification. Two-part fractures were the most common, followed by three-part and four-part fractures.

Two-part and three-part fractures constituted nearly 80% of cases, making them the most frequent indications for surgical fixation using LCP.

Radiological union was observed in most patients between 10 and 14 weeks, with a mean union time of 12.3 ± 2.1 weeks. Delayed union was observed in two cases. There were no cases of non-union.

Complications were recorded in 6 patients (16.7%). The most common complication was shoulder stiffness, followed by superficial infection and screw penetration.

The overall complication rate was low. Most complications were minor and manageable with conservative treatment and physiotherapy, indicating the safety and reliability of LCP fixation.

Functional outcome was assessed using the Constant–Murley Score at final follow-up (6 months). The mean Constant score was 76.4 ± 9.2. Outcomes were categorized as excellent, good, fair, and poor.

A total of 72.2% of patients achieved excellent to good functional outcomes, demonstrating that LCP fixation provides satisfactory shoulder function in most cases. Poor outcomes were mainly associated with four-part fractures and delayed physiotherapy.

Two-part fractures showed the best outcomes, with 86.6% achieving excellent or good results. Three-part fractures had 71.4% excellent to good outcomes, while only 42.8% of four-part fractures achieved similar results. This difference was statistically significant ($p < 0.05$), indicating that fracture complexity adversely affects functional recovery.

At final follow-up, mean shoulder abduction was 132°, forward flexion was 138°, and external rotation was 42°. The mean VAS pain score improved significantly from 7.2 preoperatively to 1.8 at final follow-up ($p < 0.001$), reflecting effective pain relief and functional restoration following surgical fixation.

DISCUSSION

The present prospective study evaluated the clinical and functional outcomes of adults with displaced proximal humerus fractures treated with locking compression plate (LCP) fixation at a major tertiary care referral center in Bihar. Overall, ORIF with LCP demonstrated largely satisfactory clinical and functional recovery at six months, with a mean Constant–Murley score reflecting predominantly good outcomes and a relatively low rate of major complications. These findings align with broader evidence suggesting that locking plates offer stable fixation, allowing early mobilization and functional restoration in selected displaced proximal humeral fractures [1-3].

In our cohort, a majority of patients achieved excellent or good functional outcomes, particularly those with less complex (two- and three-part) fractures, while four-part fractures were associated with poorer function and higher complication rates. This pattern mirrors observations from other studies reporting that fracture complexity is a significant predictor of outcome following LCP fixation, with three- and four-part fractures showing greater difficulty in achieving anatomical reduction and stable fixation [4,5]. Akash *et al*. found similarly that locking plate fixation results in improved clinical and functional scores overall, although complexity correlated with outcome measures [6]. Additionally, other prospective observational data indicate that two-part fractures generally fare better in terms of Constant score improvement compared with more comminuted patterns [5].

The overall complication rate in this study was acceptable and consistent with recent reports. Shoulder stiffness, superficial infection, and hardware-related issues such as screw penetration were observed, but no cases of avascular necrosis or implant failure were recorded. Published literature continues to emphasize that although LCP fixation is generally effective, clinicians must remain vigilant for specific complications. In a large retrospective evaluation of three- and four-part fractures treated with locking plates, postoperative stiffness and fixation failures were among the most common adverse events, with associations to fracture pattern and bone quality [7]. Moreover, recent work has identified additional predictors of adverse outcomes, such as low cortical thickness, head-splitting fractures, and poor initial reduction, which can increase the risk of loss of reduction and consequent functional impairment [8].

While the complication profile observed was comparable with previous meta-analyses and systematic reviews, some variations exist, likely due to study design differences, rehabilitation protocols, and patient demographics. Systematic review evidence suggests that overall complication rates with locking plates can be as high as 45 to 49%, with varus malunion, screw perforation, and avascular necrosis among notable concerns [2]. The relatively lower complication incidence in our series might reflect rigorous surgical technique, early postoperative physiotherapy, and strict selection criteria.

Radiological union in this study was reliably achieved within 10–14 weeks in most patients, supporting the mechanical stability afforded by the LCP construct. Early mobilization protocols facilitated the return of shoulder range of motion, consistent with the consensus that maintaining soft-tissue integrity and early physiotherapy are pivotal to functional recovery [1]. Rehabilitation has repeatedly been shown to influence outcomes after proximal humerus fracture fixation, with optimized physical therapy contributing significantly to improved range of motion and pain relief. Function scores improve in parallel with radiological consolidation, underscoring the interdependence of biomechanical stability and biological healing.

Although locking plate fixation has become widely adopted for displaced proximal humeral fractures, alternative options like intramedullary nailing or arthroplasty may be considered in specific scenarios, especially in the elderly with poor bone quality or severely comminuted fractures [9]. Evidence comparing intramedullary vs. plate fixation suggests similar functional outcomes between methods, but clear superiority of one technique is not established, emphasizing individualized treatment planning [10].

CONCLUSION

LCP fixation for displaced proximal humerus fractures in adults demonstrates predictable functional improvement and acceptable complication rates, particularly in less complex fracture types. Anatomical reduction, early mobilization, and patient-specific care are key to optimizing outcomes. Future studies with larger samples and long-term follow-up are recommended to further refine surgical indications and rehabilitation pathways for various fracture patterns.

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HOW TO CITE THIS ARTICLE: Maji A, Kumar M, Saw MK, Singh YR, Das BG. A Prospective Study Examining the Clinical and Functional Outcomes of Adults with Proximal Humerus Fractures Treated using a Locking Compression Plate (LCP). *J Adv Sci Res*. 2026;17(5): 61-65
DOI: 10.55218/JASR.2026170513