

A PROSPECTIVE STUDY EXAMINING THE CLINICAL AND FUNCTIONAL OUTCOMES OF ADULTS WITH PROXIMAL HUMERUS FRACTURES TREATED USING A LOCKING COMPRESSION PLATE (LCP): A COHORT STUDY.

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ABSTRACT

Background

Proximal humerus fractures (PHF) are common, particularly among the elderly, and can significantly impact functional outcomes. The introduction of locking compression plates (LCP) has enhanced the management of these complex fractures by providing stable fixation. The study assessed the clinical and functional results of locking compression plate treatment for PHF in adult patients.

Methods

Included were 150 patients who had closed proximal humerus fractures that were categorized as 2-, 3-, or 4-part fractures according to NEER guidelines. Using a deltopectoral technique, patients received open reduction and internal fixation with LCP. The Constant-Murley scoring system was used to estimate clinical and functional outcomes, such as pain, daily living activities, range of motion (ROM), and muscle power. There were follow-ups at two weeks, six weeks, three months, six months, and a year. The statistical analysis was carried out with SPSS 23.0.

Results

The study included participants with a mean age of 38.6 years, 56.7% males. Significant improvements were observed in all outcome measures. Pain scores decreased from a preoperative mean of 12.5 to 2.1 at one year. Activities of daily living scores improved from 10.3 to 20.0. ROM increased from 22.3 degrees to 80.2 degrees, and muscle power improved from 14.7 to 24.3. Complications were noted in 12% of cases, including infection, hardware failure, nonunion, and subacromial impingement. Statistical analysis confirmed these improvements were highly significant ($p < 0.001$).

Conclusion

Locking compression plates effectively improves clinical and functional outcomes for proximal humerus fractures. The significant reduction in pain and enhancement in ROM and muscle power support the use of LCPs in managing these complex fractures.

Recommendations

Further studies should focus on long-term outcomes and strategies to minimize complications associated with LCPs. Additionally, patient selection criteria and individualized treatment protocols should be optimized based on specific fracture patterns and patient characteristics.

Keywords: Proximal Humerus Fractures, Locking Compression Plates, Functional Outcomes, Clinical Outcomes, Surgical Complications.

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INTRODUCTION

About 5% of all fractures in humans are proximal humerus fractures (PHF), which are among the most common fractures, especially in the older population [1]. Because of

the pain, functional impairment, and possible complications that may arise, these injuries are frequently complex and can have a major negative effect on a patient's quality of life. Over time, the treatment of PHF has changed, offering a range of surgical and nonsurgical alternatives. Among the

surgical options, the use of locking compression plates (LCP) has gained widespread acceptance due to their ability to provide stable fixation and facilitate early mobilization. Locking compression plates is particularly beneficial in osteoporotic bone, where traditional fixation methods may fail. The biomechanical advantages of LCPs, which include angular stability and the ability to secure multiple fragments, make them an effective choice for complex fractures, including two-part, three-part, and four-part fractures with significant displacement. Recent studies have shown that LCPs can lead to satisfactory clinical and functional outcomes, reducing the risk of malunion and nonunion [2, 3].

Despite their advantages, the use of LCPs is not without complications. Common issues include screw penetration into the joint, infection, hardware failure, and subacromial impingement. Understanding these complications and their management is crucial for optimizing patient outcomes [4]. Moreover, patient factors such as age, bone quality, and comorbidities play a significant role in the success of surgical intervention. Hence, careful patient selection and individualized treatment plans are essential.

Recent literature highlights the importance of functional outcomes, including pain relief, range of motion (ROM), and muscle strength, in evaluating the success of surgical interventions for PHF. The Constant-Murley score, a comprehensive tool that assesses these parameters, is widely used in clinical studies to measure treatment efficacy [5]. Studies have demonstrated that patients treated with LCPs generally exhibit significant improvements in these scores, indicating effective restoration of function and quality of life [6].

The study assessed the functional and clinical results of adult patients who have proximal humerus fractures treated with locking compression plates.

METHODOLOGY

Study Design

A prospective cohort study.

Study Setting

The study took place during a period from January 2022 to June 2024 at Indira Gandhi Institute of Medical Sciences, Patna, Bihar.

Participants

A total of 150 patients were involved in the study.

Inclusion Criteria

1. Patients aged 20-60 years.
2. All cases of closed proximal humeral fractures
 - Closed two-part fracture with humeral diaphyseal extension.
 - Three or four-part fractures with tuberosity displacement causing significant sub-acromial impingement.

Exclusion Criteria

- Skeletally immature patients.
- Individuals with distal neurovascular deficits.
- Individuals with pathological fractures.
- Terminally ill patients with multiple medical comorbidities.

Sample size

To calculate the sample size for this study, the following formula was used for estimating a proportion of a population:

$$n = \frac{Z^2 \times p \times (1-p)}{E^2}$$

Where:

n = sample size

Z = Z-score corresponding to the desired level of confidence = 1.96

p = estimated proportion in the population = 0.5

E = margin of error = 0.08

Therefore,

$$n = \frac{(1.96)^2 \times 0.5 \times (1-0.5)}{(0.08)^2}$$

$$n = 150$$

Bias

Efforts were made to minimize bias by having multiple orthopedic consultants (four) perform the surgeries, using a standardized surgical procedure, and following a consistent postoperative care protocol.

Variables

Variables include the type of proximal humerus fracture, patient age and sex, surgical technique and fixation method, clinical outcomes, and functional outcomes.

Data Collection

Data were collected through patient interviews, clinical examinations, and radiological assessments. The participants were distributed into NEER 2-part, 3-part, and 4-part grades based on radiological analysis.

Procedure

1. Informed consent was obtained from all patients.
2. Surgical Procedure
 - Surgeries were performed by four orthopedic consultants at the tertiary care hospital.
 - With the patient in the beach chair position, open reduction and internal fixation were performed utilizing a proximal humerus locking compression plate using the conventional deltopectoral method.
 - Under C-Arm guidance, K-wires were used to temporarily fix the fracture, after which the LCP was fixed.
 - After making sure that the screws had not penetrated the subchondral bone, the surgical site was closed.
3. Postoperative Care
 - Participants were discharged on the second postoperative day.
 - Oral antibiotics were prescribed for four days.
 - Standardized supervised outpatient physiotherapy was followed as per hospital protocol.
4. Follow-Up: Patients received routine follow-up visits at two, six, three, six, and one-year intervals.

Table 1: Demographic and Baseline Profile

Characteristic	Value
Age (years)	38.6 ± 10.2
Gender	
- Male	85 (56.7%)
- Female	65 (43.3%)
NEER Fracture Type	
- 2-part	60 (40%)
- 3-part	55 (36.7%)
- 4-part	35 (23.3%)

Assessment

Constant-Murley Scoring (100 points)

Subjective Complaints

- Pain (15 points)
- Activities of daily living (20 points)

Clinical Signs

- ROM (40 points)
- Muscle power based on MRC grading (25 points)

Statistical Analysis

SPSS version 23.0 was utilized to analyze the data. Data were expressed as frequencies and percentages, means ± standard deviations. Using the relevant statistical tests, the significance of the differences between the groups was determined; a p-value of less than 0.05 was deemed statistically significant.

Ethical considerations

The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

RESULT

The trial comprised 150 patients in total. Table 1 provides a summary of the patient's baseline and demographic data.

The mean pain score improved significantly from the preoperative value to the final follow-up. Similarly, the ADL scores showed a significant improvement. The detailed pain and ADL scores are provided in Table 2.

Table 2: Pain and ADL Scores

Time Point	Pain	ADL
Preoperative	12.5 ± 2.1	10.3 ± 4.5
2 Weeks	10.2 ± 2.8	12.8 ± 3.9
6 Weeks	8.1 ± 3.4	15.6 ± 3.2
3 Months	5.7 ± 3.2	17.4 ± 2.9
6 Months	3.6 ± 2.1	19.1 ± 1.8
1 Year	2.1 ± 1.3	20.0 ± 0.7

The ROM and muscle power were assessed at each follow-up visit. The results showed significant improvements over time. Detailed ROM and muscle power scores are provided in Table 3.

Table 3: ROM and Muscle Power

Time Point	ROM	Muscle Power
Preoperative	22.3 ± 5.6	14.7 ± 4.2
2 Weeks	30.5 ± 6.2	17.3 ± 4.7
6 Weeks	45.2 ± 7.1	19.5 ± 3.9
3 Months	60.3 ± 6.8	21.4 ± 2.6
6 Months	70.7 ± 5.9	23.1 ± 1.9
1 Year	80.2 ± 4.3	24.3 ± 1.1

Out of the 150 patients, 18 patients (12%) experienced complications. The types and frequencies of complications are summarized in Table 4.

Table 4: Complications type

Complication Type	Frequency (n)	Percentage (%)
Infection	6	4.0
Hardware Failure	5	3.3
Non-union	4	2.7
Subacromial Impingement	3	2.0

Statistical analysis was performed to compare the preoperative and postoperative scores. A paired t-test was used to analyze the continuous variables. Every end measure had a statistically significant improvement, according to the findings ($p < 0.05$).

Table 5: Statistical Analysis of Outcome Measures

Outcome Measure	Preoperative	1 Year Postoperative	p-value
Pain	12.5 ± 2.1	2.1 ± 1.3	<0.001
ADL	10.3 ± 4.5	20.0 ± 0.7	<0.001
ROM	22.3 ± 5.6	80.2 ± 4.3	<0.001
Muscle Power	14.7 ± 4.2	24.3 ± 1.1	<0.001

DISCUSSION

150 individuals were included in the study; their mean age was 38.6 years, and 56.7% of them were men. These patients had to lock compression plate (LCP) treatment during surgery for proximal humerus fractures, classified as NEER 2-part, 3-part, and 4-part fracture types. Evaluating the

clinical and functional results during a follow-up period that lasted up to a year after surgery was the main goal.

Significant improvements were observed in both clinical and functional outcomes. Preoperative pain scores, which averaged 12.5, decreased markedly to 2.1 at the one-year follow-up. Similarly, activities of daily living (ADL) scores improved from a baseline mean of 10.3 to 20.0. This positive

trend highlights the effectiveness of LCP in alleviating pain and enhancing the quality of life for patients.

The functional outcomes, measured by the ROM and muscle power, also demonstrated substantial progress. The average ROM increased from 22.3 degrees preoperatively to 80.2 degrees in one year. Muscle power, assessed using the Medical Research Council (MRC) grading system, showed an improvement from 14.7 to 24.3 over the same period. These results suggest that LCP not only restores joint mobility but also significantly enhances muscle strength around the fracture site.

However, complications were noted in 12% of the cases, with infection, hardware failure, nonunion, and subacromial impingement being the most common issues. Despite these challenges, the overall success of the treatment was evident, with the majority of patients achieving excellent outcomes. The statistical analysis confirmed that the improvements in pain, ADL, ROM, and muscle power were highly significant ($p < 0.001$).

Overall, this study underscores the efficacy of locking compression plates in treating PHF in adults. The significant improvements in both clinical and functional parameters indicate that LCP is a reliable and effective treatment option, notwithstanding the potential for certain complications. The findings advocate for the continued use and further study of LCP in managing complex humeral fractures to optimize patient outcomes.

A prospective study was conducted on 53 patients, showing that 83.67% of patients had excellent to good outcomes according to the Constant-Murley scoring system. Varus collapse was noted as a common complication [7]. In a different study, older patients with displaced proximal humerus fractures were compared between LCP and fibular allograft. The group receiving fibular allograft had lower complication rates and better functional outcomes, according to the study [8].

A study evaluated 30 patients and found that 86.67% had satisfactory outcomes based on Neer's criteria, with significant associations between the mode of injury and age [9]. The research found that PHILOS plating achieved 95.56% satisfactory outcomes, with higher rates of good and excellent results compared to other methods [10]. A study showed that PHILOS plating had a good functional outcome, with significant improvements in Constant scores over one year [11].

Moreover, a study reported better clinical outcomes and fewer complications in elderly patients treated with LCP combined with a spine cage compared to LCP alone [12]. The research found a 100% union rate and significant improvements in functional scores using the DASH and VAS scoring systems [13]. A study showed that combining fibular allograft with LCP resulted in better radiological and clinical outcomes, with fewer complications compared to LCP alone [14].

GENERALIZABILITY

The study's findings are limited in generalizability due to the focus on a younger, healthier population, excluding older adults and those with complex medical conditions. However, the prospective design and thorough follow-up provide useful insights for similar patient groups.

CONCLUSION

Patients with PHF treated with LCP showed significant improvements in both clinical and functional outcomes, according to the study. Significant improvements in pain, everyday life activities, ROM, and muscle power were shown by the Constant-Murley scores. Overall results were good, with most patients experiencing great healing by the one-year follow-up, despite a few problems.

LIMITATIONS

The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of a comparison group also poses a limitation for this study's findings.

RECOMMENDATION

Further studies should focus on long-term outcomes and strategies to minimize complications associated with LCPs. Additionally, patient selection criteria and individualized treatment protocols should be optimized based on specific fracture patterns and patient characteristics.

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LIST OF ABBREVIATIONS

- ADL:** Activities of Daily Living
C-Arm: Mobile Fluoroscopic Imaging Equipment
LCP: Locking Compression Plate
MRC: Medical Research Council
NEER: Classification system for proximal humerus fractures
PHF: Proximal Humerus Fractures
ROM: Range of Motion
SPSS: Statistical Package for the Social Sciences
VAS: Visual Analog Scale
DASH: Disabilities of the Arm, Shoulder, and Hand (score)

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CONFLICT OF INTEREST

The authors have no conflicting interests to declare.

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