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Functional and Radiological Outcomes After Locking Compression Plate Fixation of Proximal Humerus Fractures

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ABSTRACT

Background: The proximal humerus fractures are becoming quite frequent, especially among the aging population, and are linked with considerable functional disability. Locking compression plate (LCP) fixation has been popular because it provides angular stability, particularly in osteoporotic bone. Nonetheless, the inconsistency of the functional results and the occurrence of complications make it necessary to further assess them in clinical practice.

Objective: To compare the functional and radiological results of locking compression plate fixation in adult patients with proximal humerus fractures.

Methods: It was a prospective observational study that was carried out at General Hospital, Lahore, Pakistan, between March 2023 and February 2025. Ninety-two patients (80 adults) were involved in the study with a displaced proximal humerus fracture (Neer 2-, 3-, and 4-part). Open reduction and internal fixation surgery was performed in the case of fractures using a locking compression plate. Constant-Murley Score (CMS) and DASH score were used to determine functional outcomes, whereas fracture union and time to healing were used as radiological outcomes. The data were measured with SPSS 26, and the p-value was taken to be 0.05.

Results: The average age of patients was 56.3 ± 11.8 years, and there was an overrepresentation of males (58.8%). The rate of radiological union was 93.8% with an average healing time of 15.2 ± 2.9. There was a great improvement in functional outcome, where CMS rose by 31.8 ± 5.9 at 6 weeks to 76.4 ± 8.6 at 6 months ($p < 0.001$). The complications were reported in 18.7% of patients, as usual, shoulder stiffness.

Conclusion: The fixation of proximal humerus fractures with locking compression plates is a good method that ensures an effective fracture union and a considerable functional restoration of the situation in simpler fractures.

Keywords: Proximal humerus fracture, Locking compression plate, PHILOS, Functional outcome, Radiological union, Constant-Murley score

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INTRODUCTION

Proximal humerus fractures constitute a major and notably growing group of injuries to the upper extremity, comprising about 4-6% of all adult fractures, and are one of the most prevalent fractures in elderly patients [1]. Their prevalence has steadily increased over the past few decades, and to a large degree, the aging of the population, the rise in life expectancy, and the rise in the prevalence of osteoporosis are all causes [2]. These fractures are usually related to high-energy trauma in the younger population, but low-energy falls on osteoporotic bone in older adults [3].

The anatomy of the proximal humerus is complicated, and its reliance on an intact vascular supply and soft tissue envelope makes the treatment of those fractures especially

difficult. Neer's classification system is a popular method to classify these injuries according to displacement and fragment involvement as a basis of treatment choice. Although minimally displaced fractures may commonly be managed using conservative methods and achieve good results, displaced 2-part, 3-part, and more so 4-part fractures may necessitate surgical intervention to maintain anatomy, retain shoulder function, and avoid long-term disability [4,5].

Locking compression plate (LCP) fixation, especially that using the proximal humerus internal locking systems (PHILOS), has become a popular method of fixing plates over the last few years. These implants have a purpose of achieving angular stability with fixed-angle screw constructs, which are particularly beneficial in osteoporotic bone, where traditional fixation techniques might be ineffective. LCP fixation to maximize functional recovery and fracture healing is achieved by preserving a reduction and enabling early mobilization [6,7].

Clinical outcomes after LCP fixation are not consistent in spite of these theoretical benefits. Despite the constant reports of high rates of radiological union, functional outcomes vary according to various factors, such as the age of the patient, bone quality, fracture pattern, surgical procedure, and postoperative rehabilitation [8]. Moreover, some of the other problems, which include screw penetration, varus collapse, implant failure, and avascular necrosis of the humeral head, remain clinical issues of concern. Taking this into consideration, there is still a necessity for a wholesome comparison of functional and radiological outcomes after locking compression plate fixation in actual clinical experiences, especially in resource-strapped health facilities [9,10].

This research was thus aimed at evaluating the clinical outcomes of LCP fixation in proximal humerus fractures by examining functional, radiological, and related adverse outcomes and complications in patients experienced at a tertiary care unit [11].

MATERIALS AND METHODS

This prospective observational study was carried out within the Department of Orthopaedic Surgery in General Hospital, Lahore, Pakistan, over a duration of 2 years, beginning March 2023 to February 2025. The study was ethically approved by the Institutional Review Board (IRB Ref No: LGH/2023/021) before the operation of the study decision, and all the procedures followed the principles of the Declaration of Helsinki. All participants were enrolled with informed consent, which was written.

The sample of the study comprised 80 adult patients who presented with proximal humerus fractures, with the use of a consecutive sample. The eligible patients include patients aged 18-75 years of age with displaced proximal humerus fractures that were categorized as Neer 2-part, 3-part, or 4-part fractures. Only patients who agreed to receive operative management were included. Patients who had pathological fractures or open fractures, neurovascular injury, polytrauma, previous shoulder pathology, and were medically unfit to undergo surgery were also excluded to reduce confounding factors.

Every patient also underwent open reduction and internal fixation with a proximal humerus locking compression plate (PHILOS system). The standard deltopectoral approach was used to perform the surgical procedures under general anesthesia. The pieces of the fractures were put back by careful reduction under direct visualization with special care in restoring the humeral hinge position and the neck-shaft angle. Kirschner wires were used temporarily to fix the areas as necessary, and then permanent fixation was done by placing locking screws into the humoral head to maintain angular stability. All cases were done by intraoperative fluoroscopy to ensure appropriate reduction and implant positioning.

The affected limb was placed in a shoulder immobilizer for a period of two weeks postoperatively. Subsequently, passive type range-of-motion exercises were introduced, then gradually advancing to active and resistive exercises under the supervision of a physiotherapist. Follow-up of all the patients was done regularly at 6 weeks, 12 weeks, and 6 months.

At the follow-up visit, the Constant-Murley Score (CMS) and the Disabilities of the Arm, Shoulder and Hand (DASH) score were used to assess the functional outcomes. Standard radiographs of anteroposterior and axillary views were used to detect the union of the fracture, the position of the implants, and alignment. Radiology union was determined by the existence of bridging callus at fracture sites and the absence of pain during movement of the shoulders.

Spreadsheets were keyed in and studied through the Statistical Package of Social Sciences (SPSS) version 26. Continuous variables were reported in the form of mean and standard deviation, whereas categorical variables were reported in terms of frequencies and percentages. The paired t-tests were used to analyze the changes in the functional scores as time progressed. The association between the type of fracture and outcomes was assessed using chi-square and one-way ANOVA, where it was applicable. The p-value of less than 0.05 was taken as statistically significant.

RESULTS

The analysis involved 80 proximal humerus fracture patients who underwent locking compression plate fixation. The average age of the participants was 56.3, and the standard deviation amounted to 11.8 years, which means that most respondents were middle-aged and older. Male patients were more frequently hit with 47 (58.8%) cases, whereas females were 33 (41.2%) cases. This age trend indicates the rising rate of such fractures among the aged populations because of the decline in bone mineral density and the mechanisms associated with falls that have been recorded in past clinical research.

Neer's classification of fracture revealed that 2-part fractures were frequent, with 34 (42.5%) patients having such fractures, 3-part fractures were next with 28 (35.0%) patients, and 4-part fractures were last with 18 (22.5%) patients. The given tendency aligns with the available literature that indicates that the less complex types of fractures are more likely to be met in the tertiary care facility.

Radiology assessment showed that the rate of fracture healing after fixation was high. During the follow-up period, union was attained in 75 (93.8%) patients, and the mean of the union time was 15.2 ± 2.9 weeks. In 3 (3.7%) cases, a delayed union was observed, and in 2 (2.5%) cases, a non-union. In most cases, restoration of the neck-shaft angle was satisfactory, and no major implant failure had been observed after the procedure. The results align with the past reports that indicate that there is a high degree of reliability in fracture stability and healing when locking plates are used.

There was improved functioning in the long run. The average Constant-Murley Score (CMS) continued to grow at 6 weeks to 55.7 ± 7.1 at 12 weeks, up to 76.4 ± 8.6 at 6 months ($p < 0.001$). Equally, the DASH score was significantly decreased between 62.4 ± 7.8 at week 6 and 21.3 ± 5.2 at week 6 months; this showed that there was significant improvement in the upper limb functioning. The cases of 2-part fractures showed quite good functional recovery than those with more complicated fracture types, i.e., 3-part and 4-part fractures, which indicated the importance of the severity of the fracture on the clinical outcome.

The incidence of postoperative complications was noted in 15 (18.7%) patients throughout the follow-up period. Shoulder stiffness was the most prevalent complication, occurring in 7 (8.7%) patients, and was treated using physiotherapy. Screw penetration was observed in 3 (3.8%) cases, and close observation was done. The superficial infection was seen in 3 (3.8%) patients and treated successfully with antibiotics. Avascular head necrosis was detected in 2 (2.5%) patients, mostly in 4-part fractures. The total level of complication is similar to those reported in the literature in the past, with the complication rates at 15% to 30% after locking plate fixation.

In general, the results indicate that locking compression plate fixation has high radiological union and functional improvement over time. The results of these, however, depend on the complexity of the fracture, and complication rates are not high but still clinically significant and demand both close surgical practice and aftercare.

Table 1: Baseline Characteristics and Fracture Distribution (n=80)

Variable	Value
Age (years), Mean ± SD	56.3 ± 11.8
Gender	
Male	47 (58.8%)
Female	33 (41.2%)
Fracture Type (Neer Classification)	
2-part	34 (42.5%)
3-part	28 (35.0%)
4-part	18 (22.5%)

Table 2: Radiological and Functional Outcomes

Outcome	Value
Radiological Outcomes	
Union achieved	75 (93.8%)
Delayed union	3 (3.7%)
Non-union	2 (2.5%)
Mean time to union (weeks)	15.2 ± 2.9
Functional Outcomes (CMS)	
6 weeks	31.8 ± 5.9
12 weeks	55.7 ± 7.1
6 months	76.4 ± 8.6
Functional Outcomes (DASH)	
6 weeks	62.4 ± 7.8
12 weeks	38.6 ± 6.5
6 months	21.3 ± 5.2

Table 3: Postoperative Complications

Complication	Frequency (%)
Shoulder stiffness	7 (8.7%)
Screw penetration	3 (3.8%)
Superficial infection	3 (3.8%)
Avascular necrosis	2 (2.5%)
Total complications	**15 (18.7%)**

DISCUSSION

The current study compared functional and radiological outcomes of locking compression plate fixation of proximal humerus fractures in a tertiary care environment. The results indicate that this surgery mode has a high fracture union rate and a high functional outcome in the long term. These findings support the emerging evidence on locking plate fixation as a sound form of treatment in the case of displaced proximal humerus fractures [10,11].

The rate of radiological union in this study (93.8) is comparable to the results of other research studies, where the union rates of more than 90 percent have been reported in the case of locking compression plate systems [12]. Angular stability provided by locking screws enables it to be effectively fixed even on osteoporotic bone, thus eliminating the possibility of secondary displacement. The average time of union (around 15 weeks) also validates the usefulness of this method in enhancing a timely recovery of the fracture [13-15].

There was a statistically significant functional recovery as measured by the Constant-Murley Score and DASH score at every follow-up interval. The gradual improvement of CMS and the following reduction of DASH scores indicate recovery of shoulder mobility, strength, and general functional ability. These results can be compared to previous clinical research, which has already shown significant functional improvements after PHILOS plating. These positive results are likely to be attained by early mobilization, which is achievable through stable fixation [16,17].

In this study, the complexity of fractures was established as a significant outcome determinant. The functional recovery of patients with Neer 2-part fractures was better than the functional recovery of patients who had 3-part and 4-part fractures [18]. The given observation is consistent with the current literature, which indicates that as fracture comminution increases, the vascularity of the humeral head is compromised, and it becomes more challenging to achieve anatomical reduction. Therefore, more complicated fractures tend to be linked with worse functional results and increased complications [19,20].

Although the total results were favourable, a significant percentage of patients (18.7) had complications. The most frequent complication was shoulder stiffness, which can be explained by the fact that it was immobilized over a long period or did not follow the rehabilitation protocols appropriately [21]. Although with a lower incidence, screw penetration is a known complication of locking plate fixation, especially in situations where bone quality is poor or screw placement is not optimal. Avascular necrosis is not a prevalent condition, but its onset in a few patients demonstrates the necessity to maintain soft tissue attachments and blood flow during surgery [22].

Surgical fixation with locking plates has the benefit of anatomical restoration and early mobilization over conservative treatment; it, however, has not been without risks. Other studies have proposed that non-operative management can provide similar results when the functional demands of the patient are low, and he or she is of old age. Thus, the selection of patients is always essential, considering the age, bone density, fracture pattern, and expectations of functional performance [23,24].

The advantages of the research are that it is a prospective study and assesses both functional and radiological outcomes. Nevertheless, some limitations are to be admitted. The sample size is relatively small, and the study is designed as a single-center study, which could undermine the extrapolation of the data. Also, the six-month follow-up time that is sufficient to evaluate initial results could not be able to detect long-term complications like late avascular necrosis or implant-associated problems [25].

CONCLUSION

Fixation in compression plates is a viable and secure medical procedure that can be used to treat displaced proximal humerus fractures to achieve high percentages of fracture healing and a high level of functional recovery. The most successful results are obtained with less complicated models of fracture, and more severe fractures are related to relatively inadequate recovery and increased complication risks. A thorough surgical practice, proper patient selection, and systematic postoperative rehabilitation are the key to optimum functional effects and reduced problems.

Conflict of Interest: The authors declare no conflicts of interest.

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Authors' Contributions: J.S. conceived and designed the study. M.A. and F.H. were responsible for data collection and clinical management. A.J.M. performed data analysis and interpretation. All authors contributed to manuscript writing, critical revision, and approved the final version.

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Data Availability: The datasets generated and analyzed during this study are available from the corresponding author upon reasonable request.

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