

ORIGINAL RESEARCH

Distal humerus fractures treated with anatomically pre contoured locking compressive plates: Study of 25 cases

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Received: 16 December, 2023

Accepted: 18 January, 2024

ABSTRACT

Introduction: Distal humerus fractures, accounting for about 2% of all fractures, predominantly affect elderly women due to osteoporosis and present a bimodal distribution, with young individuals typically injured through high-energy events. These fractures often result in significant morbidity. The introduction of LCPs has notably advanced the treatment of these fractures. These plates, tailored to the distal humerus anatomy, offer stable fixation even in osteoporotic bones, reducing the risk of postoperative complications and aiding in the management of complex fracture patterns. **Materials and Methods:** This was a prospective cohort study conducted in the department of orthopaedics in which 25 patients with distal humerus fractures were included on the basis of a predefined inclusion and exclusion criteria. All patients were treated by open reduction and internal fixation using anatomically pre contoured locking compressive plates. The patients were followed up till 20 weeks post operatively. The functional assessment was done using Mayo elbow performance score (MEPS). P value less than 0.05 was taken as statistically significant. **Results:** There was a slight female predominance (52%) with a mean age of 43.46 +/- 12.34 years. The most common injury mechanism was a fall from a bike (64%). Left-sided fractures were more prevalent (64%). Fractures were predominantly classified as C1 (44%) in the AO/OTA classification. All patients underwent open reduction and internal fixation using anatomically pre-contoured locking compressive plates. Functional outcomes assessed by the Mayo Elbow Performance Score showed significant improvement post-operatively, with 82% of patients achieving an excellent or good outcome. Complications were minimal, with only one case of superficial skin infection and another of arthrofibrosis in an elderly patient. **Conclusion:** Distal humerus fractures treated by Open reduction and internal fixation with anatomically pre-contoured locking compression plates give excellent functional outcomes across different age groups with minimal complications.

Keywords: Distal Humerus Fractures, MEPS, anatomically pre contoured Plates, Outcome.

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INTRODUCTION

Distal humerus fractures constitute about 2% of all fractures. These fractures can lead to substantial morbidity particularly in the adult population. Distal humerus fractures are also more common in the elderly women due to osteoporosis.¹ The epidemiological data suggest a bimodal distribution with peaks in the young where high-energy and fall from significant height is the common cause. Whereas in elderly the trivial injuries such as a fall on the floor can also result in intra-articular fractures. This dichotomy in the patient population presents unique challenges in management.²

Clinically, patients with distal humerus fractures present with classical signs and symptoms such as pain, swelling, and decreased range of motion in the elbow. In more severe cases, neurovascular compromise may be evident that needs an urgent intervention. The physical examination should be thorough and include assessment for associated injuries and skin integrity particularly if surgical intervention is considered.³

Imaging plays an important role in the diagnosis and management of distal humerus fractures. Standard anteroposterior and lateral radiographs are the initial imaging modality. In complex cases computed

tomography (CT) with 3D reconstruction can be invaluable in understanding the fracture geometry which is crucial for preoperative planning. On the basis of imaging the fractures can be classified using AO/OTA (Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association) classification, which categorizes these fractures based on their anatomic location and the complexity of the fracture pattern.⁴

Treatment of distal humerus fractures has evolved significantly over the years. Non-operative management, consisting of splinting or casting, is typically reserved for non-displaced or minimally displaced fractures.⁵ However, the majority of these fractures require surgical intervention due to the intra-articular nature and the tendency for displacement. Traditional fixation methods include Kirschner wires, screws, and conventional plates. However, these techniques often fall short in providing stable fixation, especially in osteoporotic bone.⁶

The advent of anatomically pre-contoured locking compressive plates has transformed the management of these fractures. These plates conform to the anatomy of the distal humerus and provide stable fixation even in cases where bone quality is poor.⁷ The locking mechanism allows for angular stability which is helpful in comminuted fractures and osteoporotic bone.⁷ These plates provide secure fixation with minimal risk of screw loosening or pull-out. The design of these plates often allows for a more minimally invasive approach which can reduce soft tissue disruption. Use of these plates is reported to be associated with decreased risk of postoperative complications such as infection and non-union. This is particularly beneficial in the elderly population where soft tissue healing may be compromised.⁸

Despite these advantages, there are limitations to the use of anatomically pre-contoured locking plates. One of the primary concerns is the need for precise surgical technique; incorrect placement of these plates can lead to suboptimal outcomes and complications such as joint stiffness or heterotopic ossification. Additionally, in extremely comminuted fractures, even these advanced plates may not provide sufficient stability, necessitating adjunctive fixation methods or alternative surgical strategies.⁹

With this background we conducted this study of patients with distal humerus fractures treated by anatomically contoured locking compressive plates.

MATERIALS AND METHODS

This was a prospective multicentric study of patients admitted with distal humerus fractures conducted in KIMS hospital and General hospital at Amalapuram, Andhra Pradesh. Duration of study was 2 years (From January 2022 to December 2023). Ethical committee permission and consent of patient regarding treatment plan, safety and utilizing the data for academic purpose was taken. The sample size was calculated by formula $N = (Z \alpha/2)^2 \times \sigma^2 / d^2$ on the basis of pilot

studies done on the topic of distal humerus fractures assuming 90% power and 95% confidence interval, the sample size required was 25 patients so we included 25 patients. Demographic details such as age and gender of all the patients was noted. Mode of injury and comorbidities associated with patients was also recorded.

Skin condition at the fracture side noticed and above elbow slab with limb elevation and analgesics given at the time of admission. All patients evaluated were for anesthesia fitness for surgery and taken for ORIF surgery without any delay. Lateral decubitus position with elbow support was used in all the fracture fixation and tourniquet applied in few cases. All extra articular metaphyseal fractures were treated with posterior approach tongue type triceps cutting without olecranon osteotomy and AO type long anatomically pre contoured LCP osteosynthesis performed. Patient with bicolumnar fractures with intra articular fractures treated with posterior approach, ulnar nerve identification and separation was done without anterior transfer. Olecranon chevron osteotomy performed as per need of fracture fixation and orthogonal type anatomically precontoured LCP osteosynthesis was performed. Olecranon osteotomy was fixed with modified TBW technique in 14 patients and olecranon plating was done in 2 patients and 3 patients were treated with TBW and 6.5 cc screw fixation. Intra operative reduction of fractures was confirmed by high quality C-arm Images. Wound closure was done in standard manner and post op above elbow slab was given with limb elevation. Wound check was done on 2nd day and suture removal was done on 10th day.

Gentle physiotherapy with active assisted flexion extension range of movement exercises along with finger strengthening exercises were started on day 3 as per patient's comfort. All patients followed in OPD at 2,4,6,8,12 and 20 weeks. For radiological confirmation of fracture union x rays were taken at interval of 6 weeks and 12 weeks and 20 weeks. Functional outcome was assessed by Mayo Elbow Performance Score (MEPS)¹⁰ tasks carried out on OPD basis at every follow up visit till 20 weeks post operatively.

The statistical analysis was done using SPSS version 21.0, presenting quantitative data as mean and standard deviation, while qualitative data was analysed using frequency and percentage tables. Unpaired t-tests were employed for quantitative data, and Chi-square tests were used for qualitative data. P value less than 0.05 was taken as statistically significant.

INCLUSION CRITERIA

1. Adult Patients presenting with distal metaphyseal extra articular closed fractures, closed columnar intra articular fractures and intra articular surface fractures (capitellum, trochlear).
2. Those who gave consent to be part of study.

3. Age Above 18 years.

EXCLUSION CRITERIA

1. Those Who refused consent.
2. Age below 18 years.
3. Compound fractures, fractures with vascular injuries and fractures with dislocation.
4. Surgically unfit patient and very elderly patient above 80 years.
5. Patients with polyarthritis, rheumatoid arthritis or psoriatic arthritis likely to affect the assessment of functional outcome.

RESULTS

Out of 25 patients with distal humerus fractures there were 12 (48.00%) males and 13 (52.00%) females. There was a slight female preponderance with a M:F ratio of 1:0.83. In this study comprising 25 cases of distal humerus fractures, the majority (52%) of patients were aged between 41-60 years. The age group 21-40 years accounted for 28% of cases, while those over 60 years represented 20%. The least affected age group was individuals under 20 years, constituting only 4% of cases. The mean age of the patients was 43.46 +/- 12.34 years. (Table 1)

Table 1: Age Distribution of Studied cases.

Age	No of cases	Percentage
Less than 20 years	1	4.00%
21-40 years	7	28.00%
41-60 years	13	52.00%
More than 60 years	5	20.00%
Total	25	100.00%
Mean Age : 43.46 +/- 12.34 years.		

Amongst 25 cases 16 (64.00%) patients had fracture of left whereas 9 (36.00%) patients had right distal humerus fractures. The most common mechanism of injury was fall from bike (64.00%) followed by fall in washroom (8.00%). The other causes included "Assault", "Fall from tree", and "Sports injury", each accounting for 1 (4%) patient.

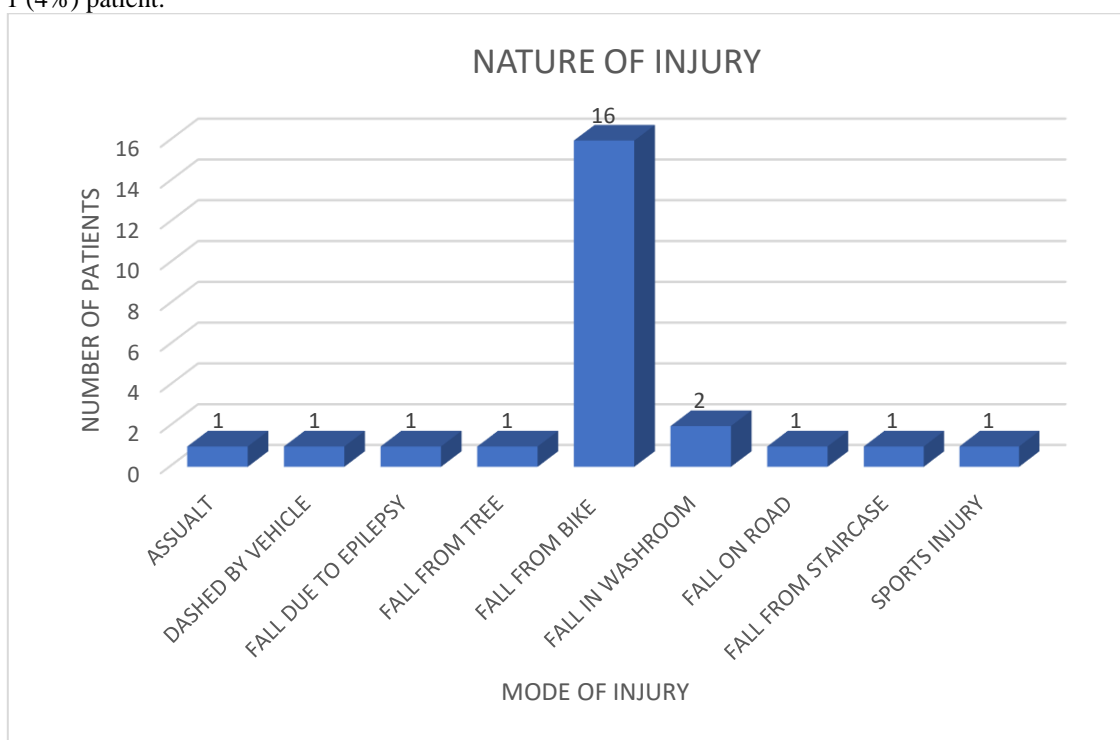


Figure 1: Nature of injury seen in cases with distal humerus fractures.

Fractures were classified on the basis of AO/OTA classification. The most common fracture was found to be C1 (complete articular fracture with the articular surface fragmented and displaced) with 11 (44.00%) patients, followed by C2 (partial articular fractures where the articular surface is split and part of it remains attached to the intact shaft) with 7 (28.00%) patients, and A2 (extra-articular fractures with a simple pattern) with 5 (20.00%) patients. C2 (partial articular fractures with the articular surface split) type of fractures were seen in 2 (5%) patients (Figure 2).

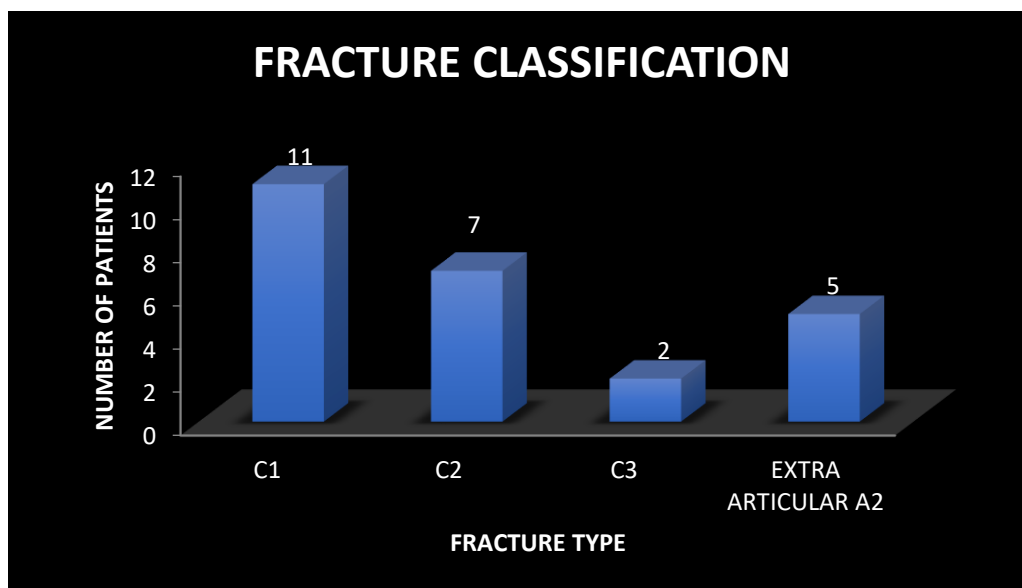


Figure 2: AO/OTA classification of fractures in studied cases.

All patients were treated by open reduction and interna fixation by anatomically pre contoured locking compressive plates. Intra operative reduction of fracture was confirmed by high quality C-arm Images Wound closure done in standard manner and post op above elbow slab was given with limb elevation. Wound check was done on 2nd day and suture removal done on 10th day. (Figure 3).

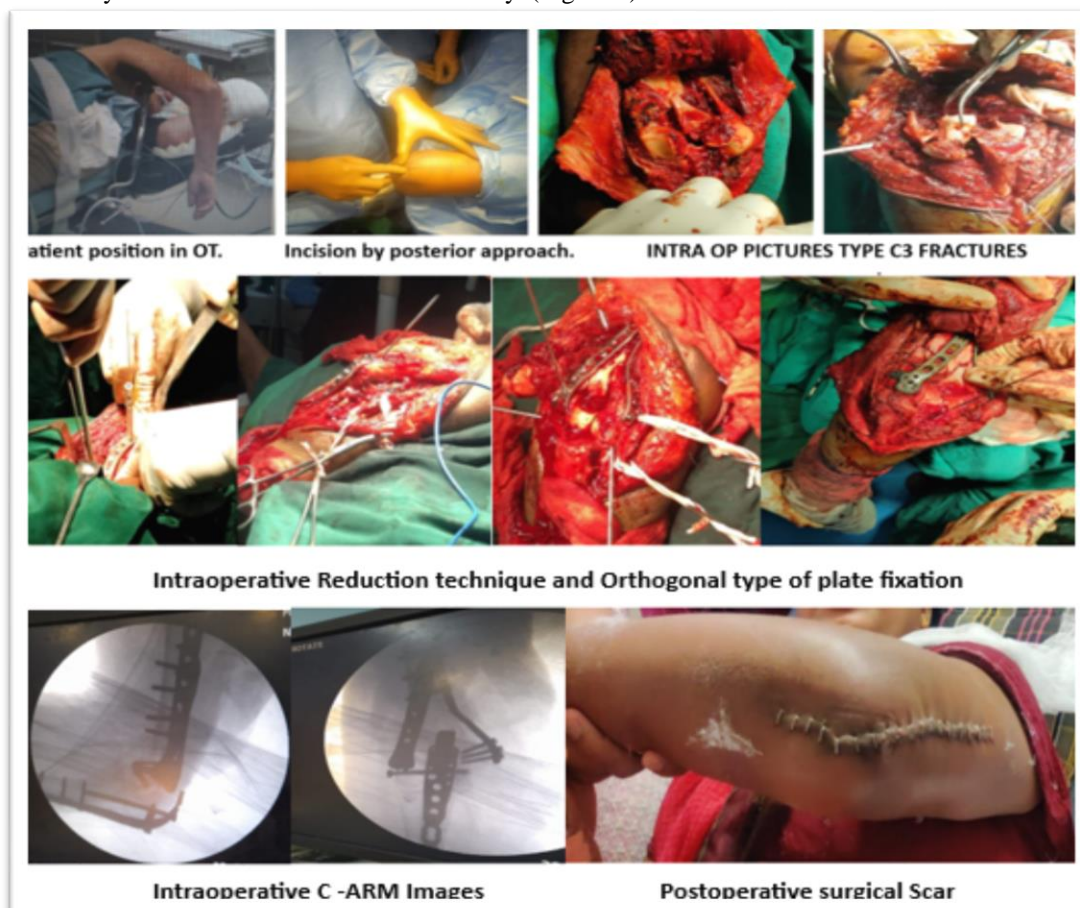


Figure 3: Steps in open reduction and internal fixation in studied cases.

Patients were followed upin OPD at 2,4,6,8,12 and 20 weeks. For radiological confirmation of fracture union x rays were taken at interval of 6 weeks and 12 weeks and 20 weeks (Figure 4)



Figure 4: Immediate postoperative and last follow up X-Rays .

Functional assessment was done by analysis of Mayo Elbow performance score. At the time of presentation, the mean MEPS (Meyo Elbow Performance score) was 38.82. There was a gradual improvement in MEPS score and it was found to be 64.24, 82.98 and 92.76 at 4 weeks, 12 weeks and 20 weeks post operatively (Graph). MEPS score at 20 weeks was found to be more as compared to MEPS at the time of presentation and the difference was found to be statistically significant ($P < 0.005$) (Figure 5).

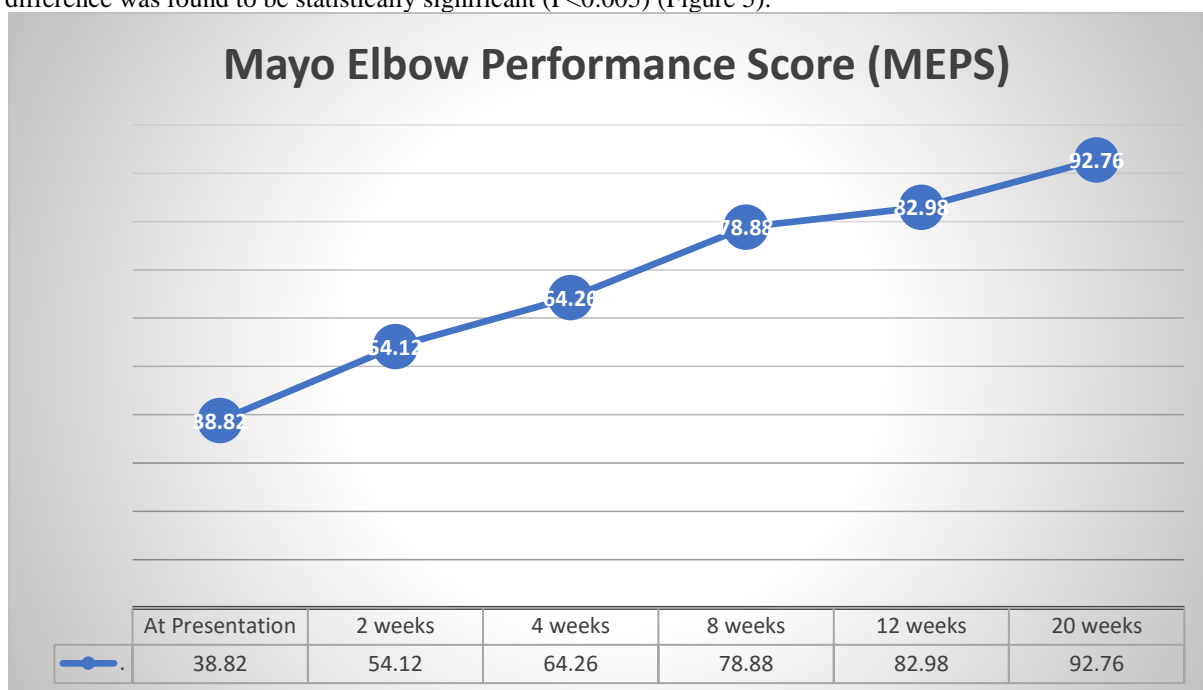


Figure 5: Improvement in Mean MEPS scores over a period of 20 weeks.

The analysis of final function outcome in studied cases showed that out of 25 cases 13 (52%) patients had an excellent outcome. Whereas good and fair outcome was seen in 7 (28%) and 4 (16%) patients had good and fair outcome. Only 1 (4%) patient had poor outcome (Table 2).

Table 2: Final Functional Outcome of studied cases.

Score Range	Interpretation	No of patients	Percentage
90-100	Excellent	13	52.00%
75-89	Good	7	28.00%
60-74	Fair	4	16.00%
0-59	Poor	1	4.00%
Total		25	100.00%



Figure 6: Assessment of functional outcome by MEPS Score excellent (Upper four images) and good results (Lower 2 images).

The analysis of complications showed that there was no significant side effect in any of the studied cases. One patient developed superficial skin infection which was managed by IV antibiotics with no further complication. One elderly lady developed arthrofibrosis and had decreased range of movement due to more complex C3 type of fracture and lack of physiotherapy due to pain

DISCUSSION

The distal humerus possesses a complex 3-dimensional geometry, characterized by medial and lateral supracondylar ridges forming an arc, areas of bone deficiency due to the olecranon and coronoid fossae, a pulley-shaped trochlea, and a round-shaped capitellum. The sigmoid notch of the ulna articulates with the trochlea, forming a hinge pivot-type elbow joint.¹¹

In our study, the most common cause of distal end humerus fractures was self-fall from a bike, a finding consistent with other studies. This prevalence is likely due to our hospital's proximity to a highway and the high incidence of bike riding among the young in rural areas. For elderly patients, self-fall from standing was another common cause.¹² The young age group typically suffered high-energy fractures, while the elderly experienced low-energy fractures. Notably, there was no significant difference in the incidence of fractures between genders or between the right and left sides. The most prevalent fracture type was the bicolunar intra-articular fracture (C1 type), with metaphyseal extra-articular fractures being less common. Nerve injuries accompanying the fractures were infrequent with only three cases of radial nerve injury reported in our study.¹³

Conservative management of displaced distal humerus intra-articular bicolunar fractures or extra-articular metaphyseal fractures has been reported to be suboptimal, leading to a higher rate of non-union, malunion, elbow stiffness, and lower functional ability, along with chronic pain, Sudeck's atrophy, and

instability.¹⁵ Limited internal fixation using K-wires, cancellous screws, or Herbert screws also yields suboptimal results. Conventional reconstruction plates, 1/3 tubular plates, or dynamic compression plates used in surgical interventions have a higher incidence of non-union and implant failure, as documented in many studies.¹³

Thus, our study focused on the outcomes of open reduction and internal fixation using anatomically precontoured locking compression plates (LCPs). The complex anatomy and limited space of the elbow make internal fixation challenging with ordinary reconstruction plates or non-contoured plates. However, the optimum use of anatomically precontoured LCPs, utilizing the bone stock provided by the two columns, the trochlea, and the capitellum, can achieve mechanically stable and rigid fixation.¹⁴

In our study, the posterior approach was the most common, with olecranon osteotomy performed in all displaced intra-articular bicolunar fractures for better visualization, aiding in the perfect anatomical reduction of intraarticular fragments. Anterior transposition of the ulnar nerve was not performed in all cases. The bicolunar orthogonal fixation with anatomically precontoured LCP fixation was chosen and implemented. According to some studies, there is no functional or mechanical difference (in terms of stiffness, axial loading, and plastic deformation) between parallel or orthogonal types of LCP plate fixation. The average time for fracture union was 12-16 weeks. All patients operated with LCP healed in an anatomical position, and bone grafting was not

necessary as an addition. Postoperative ulnar nerve palsy was not observed in our study. One patient developed superficial skin infection, managed with intravenous antibiotics without further complications. An elderly lady developed arthrofibrosis with a decreased range of movement due to a more complex C3 type of fracture and lack of physiotherapy due to pain. This was also attributed to loss of articular cartilage and comminution, making the fracture more challenging to fix.¹⁵

There was a significant improvement in the range of movement observed from the first week to 12 weeks, with no notable improvement thereafter, a finding consistent with previous studies. Pain gradually decreased, and most patients were able to perform daily activities in an excellent to good range by the end of 20 weeks. According to the Mayo Elbow Performance Score (MEPS), 76% of patients achieved an excellent result, 16% a good result, 4% a satisfactory result, and 4% a poor result. This outcome is comparable to earlier published series such as Jupiter JB et al¹⁶ and Aslam N et al.¹⁷

Bicolumnar fixation with anatomically precontoured LCP is a key factor in the success of our study, compared to results obtained using conventional plates. Postoperative wound healing was good in all patients, with no cases of deep infection, heterotrophic ossification, DVT, malunion, implant failure, instability, or nonunion.¹⁸ This success is attributed to careful handling of soft tissues and the use of optimal implants like anatomically precontoured LCPs. Complications documented in other studies, such as deep infection, implant failure, and olecranon osteotomy non-union, were not observed in our study. Additionally, our study of a small scale suggests that all patients with distal end humerus fractures achieve excellent to good results with open reduction and internal fixation (ORIF) using anatomically precontoured LCP fixation, with very minimal postoperative complications. This success is due to the anatomical shape and quality of purchase provided. Similar results of precontoured LCP were also reported by the authors such as Jayakumar Pet al¹⁹ and Lim JR et al.²⁰

LIMITATION OF THE STUDY

Absence of a comparison group and relatively small number of cases were the important limitation of this study. A comparative study comparing various other management options and larger studies would be required to further substantiate the results of our study. Another limitation of our study was the relatively short follow up period of 20 weeks. Longer follow up period is required for analysis of long-term complications.

CONCLUSION

The study revealed that distal humerus fractures treated with anatomically pre-contoured locking compression plates (LCPs) yield excellent to good

results. This outcome was consistent across both young and elderly patient groups. The use of these plates facilitated optimal fracture union times, provided exceptional stability, and resulted in minimal pain.

Conflict of Interest: None

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