



Functional Outcome of Bicolumn Locking Plate Osteosynthesis in Intra Articular Fractures in Distal Humerus

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ABSTRACT

Background: Intra-articular fractures of the distal humerus are a complex type of fracture that involves the elbow joint. Such fractures may cause pain, stiffness, and disability if not properly addressed. Fractures of the distal humerus are caused by high-energy trauma in young patients and low-energy trauma in elderly patients. Such fractures require surgical stabilization to permit early joint mobilization. **Objective:** To determine the frequency of functional outcome of bicolumn locking plate osteosynthesis in intra articular fractures in distal humerus. **Study Design:** Descriptive cross-sectional study. **Duration and Place of Study:** This study was conducted from October 2024 to April 2025 in the Department of Orthopedic Surgery Khyber Teaching Hospital Peshawar. **Methodology:** A total of 157 patients aged 18 to 60 years with intra-articular distal humerus fractures were included. Patients underwent open reduction and internal fixation using bicolumn locking plates in 90–90 configuration. Functional outcome was assessed at 12 weeks using Mayo Elbow Performance Score. Data was analyzed using statistical software. Chi square test or Fisher exact test was applied after stratification. **Results:** The mean age was 41.01 ± 11.84 years. Excellent outcome was observed in 49.7% patients, good in 29.9%, fair in 12.7% and poor in 7.6% patients. No significant association was found between functional outcome and age, gender, residential status, socioeconomic status or ASA grade ($p > 0.05$). **Conclusion:** Bicolumn locking plate osteosynthesis provides good functional outcome in intra-articular distal humerus fractures and allows early mobilization with stable fixation.

INTRODUCTION

Intra-articular fractures of the distal humerus are a type of complex fracture involving the elbow articular surface and usually result from high-energy trauma such as road traffic accidents or fall from height in younger patients.¹ However, in elderly patients, these fractures may result from low-energy trauma due to decreased bone quality. Elbow dysfunction may result from disruption in the normal anatomy due to these fractures if not managed well.² Due to the complex anatomy of the distal humerus with two columns and an articular surface, comminuted fractures may result in these patients.³ These types of fractures may result in swelling, pain, stiffness, and potential disability in patients if not promptly attended to due to potential poor functional recovery or a potential restriction in elbow mobility due to arthritis or poor healing.⁴

The main objectives in the management of distal fractures of the humerus are restoration of congruity, stability, and early mobilization of the elbow joint.⁵ The

results in conservatively treated displaced fractures are poor; thus, surgical treatment is currently accepted as the standard treatment.⁶ Open reduction and internal fixation are preferred in surgical procedures to allow direct visualization and proper alignment of fragments in relation to the joint surface.⁷ Early postoperative physiotherapy plays a central role in regaining lost ranges in the elbow joint, but complications may arise in cases with poor internal fixation and delayed rehabilitation in relation to infection, stiffness, nonunion, and implant failure, respectively.⁸

Bicolumn locking plate osteosynthesis has been identified as an accepted method for the fixation of intra-articular fractures of the distal part of the humerus due to the fact that it provides excellent fixation of the medial as well as the lateral column of the humerus.⁹ Locking plates are beneficial, especially in osteoporotic bone, as well as in comminuted fractures, as traditional plating systems would not be able to provide a satisfactory degree of stability.¹⁰ With the immobilization of both columns, there

is an excellent preservation of the anatomical reduction of the articular surface, as well as early mobilization of the elbow, which is imperative for achieving excellent functional results.¹¹ A considerable amount of evidence suggests that bicolumn locking plate osteosynthesis provides superior functional results, as well as a decreased rate of implant failure.¹²

In a study by Jagadish U, et al. has shown that 47% of cases had an Excellent outcome followed by 33% of patients who had a good and 13% had fair. Only 7% of patients had poor functional outcome treated with bicolumn locking plate osteosynthesis in intra articular fractures in distal humerus.¹³

There is a need to conduct this research in Peshawar due to the high number of road accidents and trauma cases in the region which are responsible for the distal humerus fractures. There is a lack of information regarding the functional outcome of bicolumn locking plate osteosynthesis in intra-articular distal humerus fractures in the region and the information that is currently present is mainly generated from abroad. Also the patients, injuries and facilities in Peshawar are different in other regions which may affect the outcome of the surgery.

METHODOLOGY

This descriptive cross sectional study was carried out in the Department of Orthopedic Surgery Khyber Teaching Hospital Peshawar from 1 October 2024 to 10 April 2025. Approval for the study was taken from the hospital ethical review committee before initiation of data collection and the study was conducted according to institutional ethical standards. The sample size was 157 patients which was calculated using WHO sample size calculator by keeping confidence level at 95% margin of error at 4% and expected frequency of poor functional outcome as 7% in patients treated with bicolumn locking plate osteosynthesis for intra articular distal humerus fractures.¹³ Patients were recruited through non probability consecutive sampling technique. Patients aged from 18 to 60 years of both genders having distal humerus fracture involving AO classification 13C1, 13C2 or 13C3 on plain radiograph and belonging to ASA grade I or II were included. Patients having history of radial nerve palsy, pathological fracture due to bone disease or malignancy, polytrauma involving same side limb, periprosthetic fracture, hypersensitivity to implant material or active infection at fracture site were excluded. Distal humerus fracture was considered when fracture line involved the distal end of humerus with intra articular extension classified as AO 13C1, 13C2 or 13C3 on X-ray. Before starting data collection written informed consent was taken from each patient after explaining the nature, purpose, possible risks and benefits of the study.

Demographic variables including age, gender, body mass index, residential status, socioeconomic status, ASA grade, duration of fracture in days were recorded on a predesigned proforma. All patients were assessed clinically with detailed history and physical examination. Plain radiographs of elbow joint including anteroposterior and lateral views were obtained for all cases. A 3 dimensional CT scan was advised to evaluate fracture configuration in detail. After completion of baseline

laboratory investigations and anesthesia assessment, surgical procedure was performed. Patients were positioned laterally and posterior surgical approach with olecranon osteotomy was used. The ulnar nerve was identified and carefully mobilized. Intercondylar fragments were converted into a single articular block using 4.5 mm partially threaded cancellous screws. After restoration of articular surface, metaphyseal reduction was achieved by aligning shaft with condyles while preserving medial and lateral columns. Distal humerus locking plates were employed in a 90-90 configuration on both sides, while olecranon osteotomy was stabilized by tension band wiring. Post-operative management involved a posterior splint for 14 days. Active ROM exercises commenced on removing the splint. Patients were reviewed every six weeks for a period of six months. Clinical assessment was carried out during each review, advice on physio was reinforced, and any complication noted was recorded. Evaluation of the outcome was done by assessing the Mayo Elbow Performance Score at 12 weeks post-surgery. In the Mayo Elbow Performance Score, a score above 90 was regarded as an excellent outcome, 75 to 89 good, 60 to 74 fair, while a score below 60 was poor.

Data was entered and analyzed using SPSS version 26. Categorical variables including gender, residential status, socioeconomic status, ASA grade and functional outcome were expressed as frequencies and percentages. Quantitative variables such as age, body mass index and duration of fracture were presented as mean \pm standard deviation or median with interquartile range for non normal data after checking normality using Shapiro Wilk test. Functional outcome was stratified with respect to age, gender, residential status, socioeconomic status, ASA grade. Post stratification chi square test or Fisher exact test was applied where appropriate and p value ≤ 0.05 was considered statistically significant.

RESULTS

The study included 157 patients which their mean age were 41.01 ± 11.84 years and mean BMI was 29.73 ± 3.72 Kg/m². The mean duration of fracture was found to be 7.39 ± 4.15 days. Out of total patients, 85 (54.1%) was males and 72 (45.9%) was females. Majority of patients was from rural areas 96 (61.1%) while 61 (38.9%) was from urban areas. Regarding socioeconomic status, 64 (40.8%) patients was poor, 63 (40.1%) was middle class and 30 (19.1%) was rich. According to ASA grade, 97 (61.8%) patients was classified as ASA Grade I and 60 (38.2%) was ASA Grade II (as shown in Table-I).

Table I

Patient Demographics

| Demographics | Mean \pm SD |
|-----------------------------|-------------------|
| Age (years) | 41.01 \pm 11.84 |
| BMI (Kg/m ²) | 29.73 \pm 3.72 |
| Duration of Fracture (days) | 7.39 \pm 4.15 |
| Gender | |
| Male n (%) | 85 (54.1%) |
| Female n (%) | 72 (45.9%) |
| Residential Status | |
| Rural n (%) | 96 (61.1%) |
| Urban n (%) | 61 (38.9%) |
| Socioeconomic Status | |

| | |
|------------------|------------|
| Poor n (%) | 64 (40.8%) |
| Middle n (%) | 63 (40.1%) |
| Rich n (%) | 30 (19.1%) |
| ASA Grade | |
| I n (%) | 97 (61.8%) |
| II n (%) | 60 (38.2%) |

The functional outcome of bicolumn locking plate osteosynthesis in intra-articular fractures in distal humerus showed that 78 (49.70%) patients achieved excellent outcome, 47 (29.90%) patients had good outcome, 20 (12.70%) patients showed fair outcome and 12 (7.60%) patients had poor outcome (as shown in Table-II).

Table II

Functional Outcome of Bicolumn Locking Plate Osteosynthesis in Intra-articular Fractures in Distal Humerus

| Functional Outcome | Frequency | %age |
|--------------------|-----------|--------|
| Excellent | 78 | 49.70% |
| Good | 47 | 29.90% |
| Fair | 20 | 12.70% |
| Poor | 12 | 7.60% |
| Total | 157 | 100% |

When association of functional outcome with demographic factors was analyzed, it was observed that in patients aged ≤ 40 years, 42 (53.8%) had excellent outcome, 20 (25.6%) had good outcome, 10 (12.8%) had fair outcome and 6 (7.7%) had poor outcome. In patients aged >40 years, 36 (45.6%) achieved excellent outcome, 27 (34.2%) had good outcome, 10 (12.7%) had fair outcome and 6 (7.6%) had poor outcome, with p-value of 0.683 which shows no significant association. Among

Table III

Association of Functional Outcome with Demographic Factors

| Demographic Factors | | Functional Outcome | | | | p-value |
|----------------------|-----------|--------------------|------------|------------|-----------|---------|
| | | Excellent n(%) | Good n(%) | Fair n(%) | Poor n(%) | |
| Age (Years) | ≤ 40 | 42 (53.8%) | 20 (25.6%) | 10 (12.8%) | 6 (7.7%) | 0.683 |
| | >40 | 36 (45.6%) | 27 (34.2%) | 10 (12.7%) | 6 (7.6%) | |
| Gender | Male | 42 (49.4%) | 24 (28.2%) | 10 (11.8%) | 9 (10.6%) | 0.505* |
| | Female | 36 (50.0%) | 23 (31.9%) | 10 (13.9%) | 3 (4.2%) | |
| Residential Status | Rural | 49 (51.0%) | 32 (33.3%) | 8 (8.3%) | 7 (7.3%) | 0.191* |
| | Urban | 29 (47.5%) | 15 (24.6%) | 12 (19.7%) | 5 (8.2%) | |
| Socioeconomic Status | Poor | 32 (50.0%) | 21 (32.8%) | 7 (10.9%) | 4 (6.3%) | 0.442* |
| | Middle | 33 (52.4%) | 17 (27.0%) | 6 (9.5%) | 7 (11.1%) | |
| | Rich | 13 (43.3%) | 9 (30.0%) | 7 (23.3%) | 1 (3.3%) | |
| ASA Grade | I | 47 (48.5%) | 33 (34.0%) | 11 (11.3%) | 6 (6.2%) | 0.460 |
| | II | 31 (51.7%) | 14 (23.3%) | 9 (15.0%) | 6 (10.0%) | |

*Fischer Exact Test

DISCUSSION

The results demonstrated that majority of patients 78 (49.70%) achieved excellent functional outcome and 47 (29.90%) had good outcome, which indicates that this surgical technique is highly effective for managing complex distal humerus fractures. The high success rate can be attributed to the fact that bicolumn locking plate provide stable fixation through dual plating configuration which allows early mobilization and prevents joint stiffness. The anatomical reduction and rigid fixation achieved through this method promotes better bone healing and restoration of articular congruity which are essential for optimal elbow function. The mean age of patients was 41.01 ± 11.84 years which suggests that intra-articular distal humerus fractures commonly occurs

in middle-aged population who are more physically active and prone to high-energy trauma. When functional outcome was stratified by age groups, no significant difference was found ($p=0.683$), suggesting that bicolumn locking plate osteosynthesis provides consistent results regardless of patient age. The observed outcomes can be explained in relation to the stabilizing fixation provided by the locking plates, which helps in overcoming the effects of age-related issues, resulting in favorable outcomes in young as well as old patients. The gender distribution in the patients comprised 85 males (54.1%) and 72 females (45.9%), indicating a minor predominance in the patient population due to the common occurrence of traumatic injury in the male population. However, the outcomes in the patients did not demonstrate a statistically significant

association with gender ($p = 0.505$), indicating the equal effectiveness of the technique in the male as well as the female population, which can be explained in relation to the biological healing process not differing in the two genders in this age group.

The present study showed excellent functional outcome in 78 (49.70%) patients and good outcome in 47 (29.90%) patients, which is comparable with findings of Miah MI *et al.*,¹⁴ who reported 84% excellent or good results using 90/90 distal humerus locking plate system. Similarly, Sharma P *et al.*,¹⁵ achieved 85.3% excellent to good results with orthogonal plating, and Sunil B *et al.*,¹⁶ reported excellent results in 17 patients (56.67%) and good in 8 (26.67%). These similarities can be explained by the fact that all studies utilized dual plating techniques which provides stable fixation and allows early mobilization, leading to better functional recovery. The mean age in current study was 41.01 ± 11.84 years which is consistent with Sharma P *et al.*,¹⁵ who reported mean age of 42.2 years and Dr. Lionel John *et al.*,¹⁷ with mean age of 40 years, suggesting that distal humerus fractures predominantly affects middle-aged active population. However, Qaisar Azim *et al.*,¹⁸ reported lower success rates with excellent outcome in only 3 patients (6.98%) and good in 9 (20.93%), which is considerably lower than present study findings. This difference might be due to variations in surgical expertise, fracture complexity, or different rehabilitation protocols. Jung SW *et al.*,¹⁹ studied older patients with mean age of 59.07 years using triangular fixation technique and achieved mean MEPS of 88.68, demonstrating that good outcomes can be achieved even in elderly population with appropriate surgical technique.

The gender distribution in present study showed 85 (54.1%) males and 72 (45.9%) females, which shows male predominance similar to Miah MI *et al.*,¹⁴ who reported 28 males and 22 females, and Sharma P *et al.*,¹⁵ with 22 males and 12 females. This pattern reflects higher incidence of

traumatic injuries in males due to occupational hazards and outdoor activities. However, Kumar J *et al.*,²⁰ reported female predominance with 13 females and 8 males, which might be due to smaller sample size or regional demographic variations. The present study found no significant association between functional outcome and age ($p=0.683$), which is supported by Dr. Lionel John *et al.*,¹⁷ who reported success rate of 88.9% in patients younger than 40 years and 93.3% in those older than 40 years, showing minimal age-related difference. This suggests that bicolumn locking plate osteosynthesis is effective across all age groups when proper surgical technique is employed. Ali *et al.*,²¹ also demonstrated good to excellent functional outcomes with mean MEPS score of 83.3, further supporting the effectiveness of bicolumnar locking plating technique regardless of patient demographics.

The limitations of the present study are discussed as follows. First, the present study is conducted in a specific setting, which may limit the application of the data to a specific demographic setting. Second, the duration of follow-up may be short to assess the late complications that may appear during a longer period of time. Finally, the lack of a control group that is subjected to other surgical techniques may limit the definitive assessment of the superiority of bicolumn locking plate osteosynthesis. Finally, the experience of the surgeon may vary in the patients included in the present study.

CONCLUSION

The present study concludes that bicolumn locking plate osteosynthesis is a very effective technique in the treatment of intra-articular distal humeral fractures, as most patients showed excellent to good outcomes in terms of functionality. It is a technique that provides stability to the fracture site, thus allowing early mobilization of patients, which in turn enhances the functioning of the elbow joint.

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