

## Original Research Article

# Double column fixation for type C fractures of the distal humerus by precontoured bi-condylar plating in a 90-90 pattern

Mohammad Rafiqul Islam Khan<sup>1\*</sup>, Alif Laila<sup>2</sup>, Md. Harun Are Rashid<sup>3</sup>,  
Muhammad Sayeed Mahmud<sup>4</sup>, Mohammad Shamsul Alam<sup>5</sup>

<sup>1</sup>Department of Arthroplasty, Dhaka Medical College Hospital, Dhaka, Bangladesh

<sup>2</sup>Department of Obstetrics and Gynecology, Dhaka Medical College Hospital, Dhaka, Bangladesh

<sup>3</sup>Department of Arthroscopy and Sports Medicine, Dhaka Medical College Hospital, Dhaka, Bangladesh

<sup>4</sup>Department of Orthopaedic Oncology and Musculoskeletal Tumor, National Institute of Traumatology and Orthopaedic Rehabilitation, Dhaka, Bangladesh

<sup>5</sup>Department of Orthopaedic Surgery, Dhaka Medical College Hospital, Dhaka, Bangladesh

**Received:** 15 March 2025

**Revised:** 14 April 2025

**Accepted:** 19 April 2025

### \*Correspondence:

Dr. Mohammad Rafiqul Islam Khan,  
E-mail: [shimulk55@gmail.com](mailto:shimulk55@gmail.com)

**Copyright:** © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

## ABSTRACT

**Introduction:** Distal humerus fractures, particularly Type C fractures, present significant challenges in orthopaedic trauma management due to their complexity and the intricacies involved in surgical repair. This study aimed to assess double-column fixation for type C fractures of the distal humerus by pre-contoured bi-condylar plating in a 90-90 pattern.

**Methods:** This retrospective study was conducted in the Department of Orthopedics, Upazilla Health Complex, Munshigonj, Bangladesh, from January 2014 to January 2018. A total of 38 patients were evaluated based on set criteria. Functional outcomes were assessed using the Mayo Elbow Performance Score (MEPS) at six months. Data were analyzed using SPSS version 20.0, with descriptive statistics applied to demographics, surgical methods, and outcomes.

**Result:** This study of 38 patients with Type C distal humerus fractures found most were aged  $\leq 47$  (71.1%) and male (55.7%). C2 fractures were most common (65.8%). Time to surgery and hospital stay increased with fracture complexity. MEPS results showed 26.7% had excellent and 57.8% good outcomes. Complications included elbow stiffness (21.1%), arthritis (13.2%), heterotopic bone (10.5%), fixation failure (7.9%), and infection (5.3%).

**Conclusion:** Most patients had good to excellent outcomes based on MEPS. Though some experienced complications like stiffness and heterotopic ossification, overall results support the technique's effectiveness in restoring elbow function.

**Keywords:** Distal humerus, Type C fracture, Double column fixation, Bi-condylar plating

## INTRODUCTION

Distal humerus fractures, particularly type C fractures, present significant challenges in orthopaedic trauma due to the complex anatomy and the essential function of the elbow joint. These fractures are most commonly seen in adults, often resulting from high-energy trauma such as

motor vehicle accidents or falls from height, which frequently leads to comminution and intra-articular involvement. Type C fractures, classified by the AO/OTA system, are characterized by their intra-articular extension and severe comminution, necessitating precise anatomical reduction and stable fixation to restore joint function and prevent complications like stiffness, non-union, and post-traumatic arthritis.<sup>1,2</sup> The primary goal in managing these

fractures is to achieve stable internal fixation, allowing early mobilization, which is essential for functional recovery. Traditionally, treatment methods have varied, including non-surgical approaches, Kirschner wire (K-wire) fixation, external fixation, and various plating techniques.

However, non-operative management is often associated with poor outcomes, including significant joint stiffness, especially in complex intra-articular fractures. This has led to a shift towards surgical techniques with a focus on achieving rigid fixation to support early motion, critical to maintaining elbow function.<sup>3</sup> Among surgical methods, pre-contoured bi-condylar plating in a 90-90 configuration—commonly referred to as orthogonal plating—has gained acceptance as a preferred technique for type C distal humerus fractures. In this technique, one plate is placed medially and the other laterally in orthogonal planes, creating a configuration that offers significant biomechanical advantages.

Studies suggest that the 90-90 configuration improves torsional stability and minimizes the risk of fixation failure when compared with parallel plating techniques.<sup>4</sup> This setup not only provides robust fixation but also aligns with the complex anatomy of the distal humerus, enabling more effective load distribution and reducing stress concentrations that could lead to implant failure.<sup>5</sup> In comparison, other configurations such as parallel plating have been widely studied and employed; however, some literature suggests potential limitations, especially regarding torsional stability in comminuted type C fractures. Several biomechanical studies have demonstrated that orthogonal plating, with its unique alignment, offers superior stability, particularly in resisting rotational forces that are prominent in the distal humerus during functional activities.<sup>6</sup>

Additionally, clinical studies report that patients with orthogonal plating experience fewer complications related to implant loosening and non-union, facilitating better long-term outcomes.<sup>7</sup> Evidence suggests that patients treated with precontoured, anatomically fitted plates have higher rates of union and functional scores compared to traditional, non-precontoured plates.<sup>8</sup> In addition to biomechanical and clinical advantages, the 90-90 orthogonal plating technique is reported to facilitate more straightforward and effective rehabilitation. Because of the stable fixation provided by the dual-column setup, patients can often begin early range of motion exercises within weeks of surgery, minimizing the risk of elbow stiffness, which is a common and debilitating complication.

Early mobilization is critical for maintaining joint mobility and muscle function, especially in the elbow, where prolonged immobilization often leads to stiffness that can compromise long-term functional outcomes.<sup>9,10</sup> This study aimed to assess double-column fixation for type C fractures of the distal humerus by pre-contoured bi-condylar plating in a 90-90 pattern.

## METHODS

This study utilized a retrospective design to evaluate the outcomes of surgical intervention for Type C distal humerus fractures through various posterior approaches.

### *Study place*

The study took place in the Department of Orthopedics, Upazilla Health Complex, Munshigonj, Bangladesh.

### *Study duration*

The study duration was from January 2014 to January 2018.

A total of 38 patients were included, each undergoing surgery using one of the four main types of posterior approaches: olecranon osteotomy, triceps-sparing approach, triceps-splitting approach, and triceps-reflecting approach.

For the olecranon osteotomy, the olecranon was removed to provide direct access to the posterior aspect of the distal humerus. In the triceps-sparing approach, the triceps muscle was preserved, allowing for a less invasive exposure while still enabling adequate visualization of the surgical site. The triceps-splitting approach involved splitting the triceps muscle along its midline, while the triceps-reflecting approach required reflecting the triceps muscle to expose the distal humerus.

Once access was achieved, the triceps muscle was elevated from the posterior aspect of the humerus and separated from the medial intermuscular septum. The lateral side of the triceps was further elevated, and the anconeus muscle was either divided or dissected on the lateral side to improve surgical exposure. After completing the necessary surgical repairs and stabilization of the fracture, a splint was applied to the elbow joint, maintaining it in a position of 90 degrees of flexion to promote optimal healing.

Postoperatively, patients began a structured range of motion program starting at 10-15 days after surgery, aimed at regaining elbow flexibility and function. Follow-up assessments were scheduled every four weeks for a total duration of six months. The functional outcomes were evaluated using the Mayo Elbow Performance Score (MEPS) at the six-month follow-up. The MEPS assesses various factors including pain, range of motion, stability, and functional activities, providing a comprehensive overview of elbow performance post-surgery.

### *Inclusion criteria*

Inclusion criteria include adults aged 18 years and older. Diagnosis of type C distal humerus fractures based on radiographic findings. Patients undergoing surgical intervention using one of the four posterior approaches: olecranon osteotomy, triceps-sparing, triceps-splitting, or

triceps-reflecting. Patients who provided informed consent to participate in the study.

### Exclusion criteria

The exclusion criteria include patients with open fractures or associated vascular or nerve injuries. Individuals with a history of prior elbow surgery on the affected arm. Patients with pathological fractures due to malignancy or osteoporosis. Individuals with significant comorbidities that would affect postoperative rehabilitation (e.g., severe cardiovascular disease, uncontrolled diabetes). Patients who declined to participate or were unable to provide informed consent. Individuals with follow-up less than six months post-surgery.

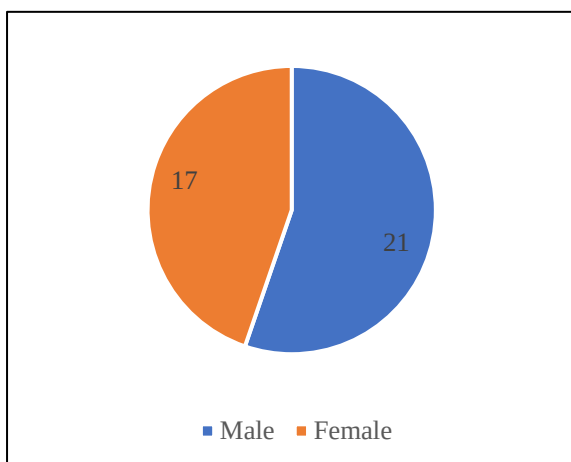
### Statistical analysis

Statistical analysis was performed using statistical package for social sciences (SPSS) version 20.0 to analyze the collected data. Descriptive statistics were calculated for demographic variables, surgical approaches, and postoperative outcomes. Continuous variables were expressed as means and standard deviations, while categorical variables were reported as frequencies and percentages. Ethical approval for this study was obtained from the institutional review board, and all patient data were handled following ethical standards to ensure confidentiality and protect patient privacy. Informed consent was acquired from all participants.

## RESULTS

The data shows that the majority of patients (71.1%) are aged 47 or younger, indicating a prevalence of younger individuals in the study population. The largest single group is the 28-37 age range, accounting for 26.3% of the total (Table 1).

In this study majority of the patients were male (21, 55.7%), followed by females (17, 44.73).



**Figure 1: Distribution of study subjects according to gender (N=38).**

Among the cases, C1 fractures accounted for 5 cases (13.2%), indicating simpler injuries, while C2 fractures were the most common, comprising 25 cases (65.8%) and suggesting a prevalence of more complex injuries. C3 fractures represented 8 cases (21.1%), highlighting significant complexity (Table 2). C1 fractures had a mean duration of 6 days ( $\pm 2$  days), indicating a shorter interval for simpler injuries. In contrast, C2 fractures averaged 8 days ( $\pm 4$  days), aligning with the overall mean duration. C3 fractures showed a longer mean duration of 10 days ( $\pm 3$  days) (Table 3). Patients with C1 fractures had an average stay of 4 days ( $\pm 1$  day), reflecting a shorter recovery period for simpler injuries. Those with C2 fractures had a mean stay of 5 days ( $\pm 2$  days), aligning with the overall average. In contrast, patients with C3 fractures experienced a longer hospital stay of 7 days ( $\pm 3$  days) (Table 4).

Table 5 presents the distribution of patients based on their outcomes, assessed using the Mayo Elbow Performance Score (MEPS) among 38 subjects. The results indicate that 10 patients (26.7%) achieved an excellent outcome, scoring above 90. The majority, 22 patients (57.8%), had a good outcome with scores between 75 and 89. A smaller group of 6 patients (15.5%) fell into the poor outcome category, with scores ranging from 60 to 74. Notably, no patients scored below 60, resulting in a 0% fair outcome.

Elbow stiffness was observed in 8 patients (21.1%), highlighting a significant concern for functional recovery post-surgery. Failure of fixation occurred in 3 patients (7.9%), indicating challenges in maintaining stability after surgical intervention. Post-traumatic arthritis affected 5 patients (13.2%). Heterotopic bone formation was noted in 4 patients (10.5%), which can complicate recovery and restrict range of motion. Additionally, infection was recorded in 2 patients (5.3%) (Table 6).

**Table 1: Distribution of study subjects according to age (n=38).**

| Age range (in years) | N           | %    |
|----------------------|-------------|------|
| 18-27                | 8           | 21.1 |
| 28-37                | 10          | 26.3 |
| 38-47                | 9           | 23.7 |
| 48-57                | 6           | 15.8 |
| 58-67                | 4           | 10.5 |
| 68-77                | 1           | 2.6  |
| Mean                 | 38 $\pm$ 17 |      |

**Table 2: Distribution of study subjects according to fracture type (n=38).**

| Fracture type | N  | %    |
|---------------|----|------|
| C1            | 5  | 13.2 |
| C2            | 25 | 65.8 |
| C3            | 8  | 21.1 |
| Total         | 38 | 100  |

**Table 3: Distribution of patients according to the duration of the interval between injury and surgery (n=38).**

| Fracture type | Mean duration (days) | Standard deviation (days) |
|---------------|----------------------|---------------------------|
| C1            | 6                    | ±2                        |
| C2            | 8                    | ±4                        |
| C3            | 10                   | ±3                        |
| <b>Total</b>  | 8                    | ±4                        |

**Table 4: Distribution of patients according to duration of hospital stay (n=38).**

| Fracture type | Mean duration of hospital stay (days) | Standard deviation (days) |
|---------------|---------------------------------------|---------------------------|
| C1            | 4                                     | ±1                        |
| C2            | 5                                     | ±2                        |
| C3            | 7                                     | ±3                        |
| <b>Total</b>  | 5                                     | ±2                        |

**Table 5: Distribution of patients according to outcome (n=38).**

| MEPS* grading             | N  | %    |
|---------------------------|----|------|
| <b>Excellent (&gt;90)</b> | 10 | 26.7 |
| <b>Good (75-89)</b>       | 22 | 57.8 |
| <b>Poor (60-74)</b>       | 06 | 15.5 |
| <b>Fair (&lt;60)</b>      | 0  | 0.0  |

\*Mayo Elbow Performance Score

**Table 6: Distribution of patients according to complication (n=38).**

| Complication                      | N | %    |
|-----------------------------------|---|------|
| <b>Elbow stiffness</b>            | 8 | 21.1 |
| <b>Failure of fixation</b>        | 3 | 7.9  |
| <b>Post-traumatic arthritis</b>   | 5 | 13.2 |
| <b>Heterotopic bone formation</b> | 4 | 10.5 |
| <b>Infection</b>                  | 2 | 5.3  |

## DISCUSSION

Our study revealed that most patients (71.1%) were aged 47 or younger, with a mean age of 38 years. This age distribution aligns with prior studies indicating that distal humerus fractures often affect younger, active adults due to high-energy trauma mechanisms such as falls, sports, and road traffic accidents. An author highlighted that this age group prioritizes recovery and is more likely to seek prompt surgical treatment for a return to normal activities, which may partially explain the high representation of younger adults in our study.<sup>11</sup>

In our cohort, 55.7% of patients were male, consistent with other studies that indicate a higher incidence of distal humerus fractures in men. This trend may be attributed to greater exposure to high-risk activities, occupational

hazards, and sports among males.<sup>12</sup> In terms of fracture complexity, type C2 fractures were the most common, accounting for 65.8% of cases. This finding is clinically significant, as type C2 fractures typically involve complex articular surface disruption and require meticulous surgical techniques for adequate reduction and fixation. Our results align with the work of O'Driscoll et al, who recommended double-column fixation strategies like the 90-90 configuration for complex fractures to ensure stability and allow early mobilization.<sup>1</sup>

Type C1 fractures, representing 13.2% of cases, generally involve lesser complex patterns with fewer articular fragments, enabling simpler fixation techniques. Consistent with this, Sanchez-Sotelo et al, found that C1 fractures often achieve satisfactory outcomes with single or less complex fixation approaches due to the reduced complexity.<sup>10</sup> C3 fractures, present in 21.1% of patients, pose the greatest challenge due to significant fragmentation and articular involvement. The mean duration between injury and surgery was shortest for C1 fractures (6 days ±2), compared to C2 (8 days ±4) and C3 (10 days ±3) fractures, reflecting an expected trend where simpler fractures often allow for quicker operative intervention. These findings align with those of Rüedi et al and Murphy et al, who emphasized that delays in surgical intervention for complex fractures may arise due to preoperative stabilization needs and planning.<sup>13</sup>

Our results suggest that surgical timing correlates with fracture complexity, with longer intervals for more complex fractures like C3. Similarly, hospital stay duration correlated with fracture complexity, where patients with C3 fractures had a longer mean stay (7 days ±3), likely due to the need for prolonged recovery and postoperative management. Outcomes were assessed using the Mayo elbow performance score (MEPS). A majority of patients achieved good to excellent outcomes, with 26.7% scoring excellent and 57.8% scoring good.

These results reflect positive functional recovery, particularly among patients with adequate fixation stability. Sotelo et al, observed that double-column fixation approaches often yield favorable outcomes in type C fractures due to increased stability and early mobilization benefits.<sup>10</sup> Our results are consistent with these findings, underscoring the benefits of robust fixation for functional recovery. Complications were observed in 47.4% of patients, with elbow stiffness being the most common (21.1%), followed by post-traumatic arthritis (13.2%). Previous studies, such as those by Huang et al, have identified elbow stiffness as a frequent postoperative complication, often resulting from soft tissue contractures and scar formation.<sup>14</sup>

This highlights the importance of early postoperative rehabilitation to reduce stiffness and enhance recovery. Additionally, heterotopic ossification was observed in 10.5% of cases. This finding is consistent with the work of Foruria et al, who noted a similar incidence of heterotopic ossification following distal humerus fracture surgeries

and recommended preventive strategies, such as NSAIDs and, in some cases, prophylactic radiotherapy to reduce its impact on joint mobility.<sup>15</sup>

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

## CONCLUSION

This study concludes that the majority of patients achieved favorable outcomes, with a significant proportion showing good to excellent results based on the mayo elbow performance score. While complications, including elbow stiffness and heterotopic ossification, were observed in a subset of patients, the overall results support the technique's utility in restoring elbow function.

## Recommendations

Based on the findings of this study, it is recommended that surgical protocols for Type C distal humerus fractures incorporate double-column fixation using pre-contoured bi-condylar plating in a 90-90 pattern, as it has shown promising outcomes. Emphasis should be placed on early postoperative rehabilitation to minimize complications such as elbow stiffness and heterotopic ossification. Additionally, further research with larger sample sizes and extended follow-up is encouraged to assess the long-term functional outcomes and refine management strategies for these complex injuries.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

## REFERENCES

1. O'Driscoll SW, Jupiter JB, Cohen MS, Ring D, McKee MD. Difficult elbow fractures: pearls and pitfalls. Instructional Course Lect. 2003;52:113-34.
2. Robinson CM, Hill RM, Jacobs N, Dall G. Adult distal humeral metaphyseal fractures: epidemiology and results of treatment. Journal of Orthopedic Trauma. 2003;17(1):38-47.
3. Korner J, Lill H, Müller LP, Rommens PM, Schneider E, Linke B. The LCP concept in the operative treatment of distal humerus fractures--biological, biomechanical, and surgical aspects. Injury. 2003;34:20-30.
4. Doornberg JN, Van Duijn PJ, Linzel D, Ring DC, Zurakowski D, Marti RK, Kloen P. Surgical treatment of intra-articular fractures of the distal part of the humerus: functional outcome after twelve to thirty years. JBJS. 2007;89(7):1524-32.
5. Bartolotta RJ, Daniels SP, Verret CI, Fufa DT. Current fixation options for elbow, forearm, wrist, and hand fractures. In: Seminars in Musculoskeletal Radiology 2019;23(2):109-25.
6. Schildhauer TA, Nork SE, Mills WJ, Henley MB. Extensor mechanism-sparing participial posterior approach to the distal humerus. J Orthop Trauma. 2003;17(5):374-8.
7. Athwal GS, Hupel TM, Harmer L, Johnstone C, Hall JA, King GJ. Precontoured parallel plate fixation of AO type C distal humerus fractures. J Orthop Trauma. 2009;6:89-91.
8. Zlotolow DA, Catalano III LW, Barron AO, Glickel SZ. Surgical exposures of the humerus. J American Acad Orthop Surg. 2006;14(13):754-65.
9. McKee MD, Veillette CJ, Hall JA, Schemitsch EH, Wild LM, McCormack R, et al. A multicentre, prospective, randomized, controlled trial of open reduction-internal fixation versus total elbow arthroplasty for displaced intra-articular distal humeral fractures in elderly patients. J Shoulder and Elbow Surg. 2009;18(1):3-12.
10. Sanchez-Sotelo J. Distal humeral fractures: role of internal fixation and elbow arthroplasty. JBJS. 2012;94(6):555-68.
11. Lauder A, Richard MJ. Management of distal humerus fractures. European J Orthop Surg Traumatol. 2020;30(5):745-62.
12. Wardell W, Auerbach B, Woo MJ, Phykitt D. Common orthopaedic shoulder diagnoses encountered in the primary care setting. Osteopathic Fam Phys. 2023;15(2):24-30.
13. Ruedi TP, Murphy WM. AO principles of fracture management. In: AO principles of fracture management 2000: 868.
14. Huang JJ, Paczas M, Hoyer HA, Vallier HA. Functional outcome after open reduction internal fixation of intra-articular fractures of the distal humerus in the elderly. J Orthop T. 2011;25(5):259-65.
15. Foruria AM, Lawrence TM, Augustin S, Morrey BF, Sanchez-Sotelo J. Heterotopic ossification after surgery for distal humeral fractures. Bone & Joint J. 2014;96(12):1681-7.

**Cite this article as:** Khan MRI, Laila A, Rashid MHA, Mahmud MS, Alam MS. Double column fixation for type C fractures of the distal humerus by precontoured bi-condylar plating in a 90-90 pattern. Int J Res Med Sci 2025;13:1877-81.