



Original Research Article

Functional Outcomes of Dual Plating in AO Type 13C Distal Humerus Fractures: A Prospective Study from a Tertiary Care Center.

Article History:

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Abstract: Background: AO type 13C distal humerus fractures are complex intra-articular injuries requiring stable fixation to restore elbow function. **Objective** To evaluate the functional outcome of the elbow joint in patients with AO type 13C distal humerus fractures treated with open reduction and internal fixation (ORIF) using dual plating. **Methodology** This prospective observational study was conducted at the Department of Orthopedic Surgery, Saidu Group Of Teaching Hospital, Swat, from April 2022 to March 2024. A total of 74 adults with AO type 13C fractures had ORIF surgery with either orthogonal or parallel dual plating. We used the Mayo Elbow Performance Score (MEPS) and the Visual Analog Scale (VAS) to look at functional outcomes at 12 and 18 months. They also wrote down the sort of surgery, the type of plating, any problems that came up, and how well the bones healed on X-rays. We used SPSS version 26.0 to do the statistical analysis, which included chi-square tests with a significance threshold of $p < 0.05$. **Results** Among the 74 patients, 52 (70.27%) were male and 22 (29.73%) were female. The most common cause was road traffic accidents (54.05%), and 62.16% had normal bone quality. Orthogonal plating was used in 52.70% and parallel plating in 47.30%. At 18 months, 51.35% had excellent MEPS outcomes, 32.43% good, 12.16% fair, and 4.05% poor. The mean MEPS improved from 82.3 ± 9.7 at 12 months to 87.1 ± 8.3 at 18 months ($p = 0.046$). Radiological union was achieved in 71 patients (95.95%). Common complications included elbow stiffness (14.86%) and post-traumatic arthritis (9.46%). **Conclusion** Dual plating provides satisfactory functional recovery in AO type 13C distal humerus fractures with high union rates and acceptable complication rates.

Keywords: Distal humerus fracture, AO type 13C, dual plating, MEPS, elbow function, open reduction, internal fixation.

INTRODUCTION

Distal humerus fractures, especially AO type 13C, are a difficult orthopedic problem because they affect the joint, break into several pieces, and may cause stiffness and long-term impairment [1,2]. Younger people frequently get these fractures from high-energy trauma, whereas older people with osteoporotic bones commonly get them from low-

energy falls [3]. AO type 13C fractures completely break the joint and cause different levels of metaphyseal comminution. To get the elbow working again, it is important to do anatomical reduction and solid fixation [4]. The elbow joint is very important for the movement and function of the upper limb. Its distinctive structure, which has little soft tissue covering and

complicated joints, makes it prone to problems including stiffness, heterotopic ossification, infection, and arthritis after an injury [5]. Not only does a complicated intra-articular fracture need to heal on its own, but the joint has to be restored to its original shape and the person needs to start moving again right once to prevent long-term impairment [6]. For AO type 13C fractures, open reduction and internal fixation (ORIF) with dual plating has become the standard surgical method. This method allows for stable fixation and early range-of-motion exercises [7]. The twin plate approach, which usually uses an orthogonal or parallel design, makes managing comminuted distal humerus fractures more biomechanically stable [8]. Different studies have shown different results depending on the kind of surgery, the type of implant, and the rehabilitation that takes place after the surgery. However, there is still no agreement on the best ways to mend things, especially in places where resources are limited [9]. Also, the surgery needed for ORIF may be quite invasive, and it commonly involves olecranon osteotomy or triceps-sparing techniques, each of which has its own set of risks and advantages [10]. To have good functional results, it's important to find the right balance between getting enough visibility for anatomical reduction and limiting soft tissue damage [11].

Because treating these fractures is so complicated and the elbow joint is so important for function, looking at the results of dual plate fixation after surgery gives us a lot of information about how orthopedic doctors work and how patients recover from difficult elbow injuries.

Research Objective

To evaluate the functional outcome of the elbow joint in patients with AO type 13C distal humerus fractures treated with ORIF using dual plating.

Methodology

Study Design and Setting

This prospective observational study was conducted at the Department of Orthopedic Surgery, Saidu Group Of Teaching Hospital, Swat. The study spanned a period of two years, from April 2022 to March 2024.

Inclusion and Exclusion Criteria

Inclusion criteria included patients aged 18 years and above presenting with AO type 13C distal humerus fractures who underwent ORIF using dual plating. Only those who consented to participate and completed a minimum of 12 months of follow-up were included.

Exclusion criteria were patients with pathological fractures, open fractures with Grade III soft tissue injury (Gustilo-Anderson classification), associated

neurovascular injuries, previous elbow surgery, or those lost to follow-up before final functional assessment. To minimize attrition bias, attempts were made to contact and retrieve follow-up data from patients lost to follow-up via phone calls and clinic reminders, and reasons for loss were documented.

Sample Size

A total of 74 patients were enrolled using convenience sampling from the eligible inpatient and outpatient orthopedic population presenting with AO type 13C distal humerus fractures. The rationale for using convenience sampling was the single-center design and the intent to include all consecutive patients meeting the inclusion criteria over the two-year study duration. A formal a priori sample size or power calculation was not conducted, as the study was exploratory in nature and aimed to reflect real-world clinical outcomes in a tertiary care setting. However, the final sample size is comparable to similar observational studies on complex elbow fractures treated with dual plating, such as Reddy et al., [12] and Asfuroglu et al., [13]. This limitation is acknowledged in the discussion section.

Data Collection

We obtained clinical data ahead of time from hospital records, surgery notes, and follow-up visits. All patients had ORIF done by a typical posterior route with two plates (orthogonal or parallel arrangement). All patients followed a conventional postoperative rehabilitation plan, which included passive and active-assisted range-of-motion activities beginning on the second day after surgery to make sure that everyone recovered at the same rate. We used the Mayo Elbow Performance Score (MEPS) to check functional outcomes at 12 and 18 months after surgery to identify late problems such post-traumatic arthritis. We also captured extra data where it was available. We used a Visual Analog Scale (VAS) from 0 to 10 to measure how bad the pain was at the last follow-up. They also kept track of things like radiological healing, range of motion, pain levels, and problems like infection, implant failure, or joint stiffness. An independent orthopedic resident who was not engaged in the patients' surgical care did the outcome evaluations to prevent observer bias.

Statistical Analysis

We used SPSS version 26.0 to look at the data. We employed descriptive statistics to sum up the demographic information, clinical results, and outcome measures. We used mean $\pm$ standard deviation to show continuous variables like age, range of motion, and MEPS. Frequencies and percentages were used to show categorical variables. The chi-square test was used to look at the links between clinical factors and functional outcomes. A p-value of less than 0.05 was regarded as statistically

significant.

Ethical Approval

The study was approved by the **Institutional Review**

Board (IRB). Before enrolling, all participants gave their written permission. The research kept data privacy and confidentiality very carefully.

RESULTS

A total of 81 patients initially met the inclusion criteria and were enrolled in the study (figure 1). During follow-up, 7 patients were lost due to relocation, refusal, or unresponsive contact, and were excluded from the final analysis. Thus, the results are based on 74 patients who completed at least 12 months of follow-up.

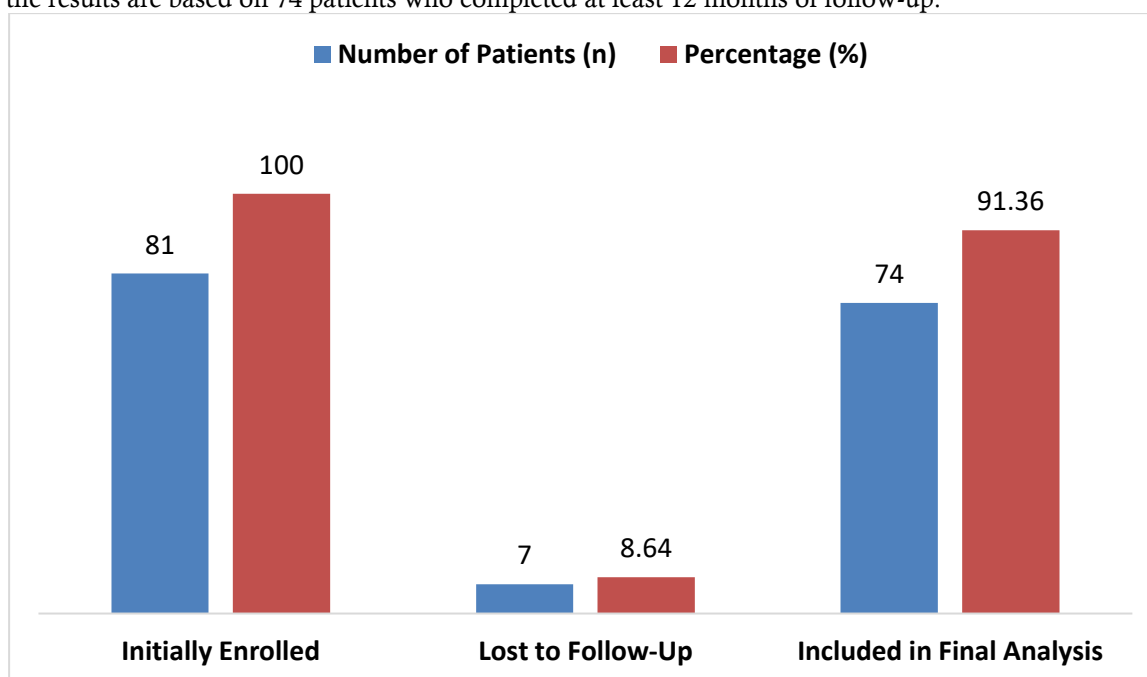


Figure 1: Follow-Up Compliance and Attrition Summary

Among the 74 patients analyzed, 52 (70.27%) were male and 22 (29.73%) were female (table 1). The most affected age group was 31–45 years (28.38%), followed by 18–30 years (25.68%). Road traffic accidents were the leading cause of injury (54.05%), and the right elbow was involved in 41 cases (55.41%). Normal bone quality was present in 46 patients (62.16%), while 28 (37.84%) had osteoporotic bones.

Table 1: Demographic and Clinical Profile of Patients (n = 74)

Variable	Category	n (%)
Age Group (years)	18–30	19 (25.68%)
	31–45	21 (28.38%)
	46–60	17 (22.97%)
	>60	17 (22.97%)
Gender	Male	52 (70.27%)
	Female	22 (29.73%)
Mode of Injury	Road Traffic Accident	40 (54.05%)
	Fall	28 (37.84%)
	Other (assault, industrial)	6 (8.11%)
Side Involved	Right	41 (55.41%)
	Left	33 (44.59%)
Bone Quality	Normal	46 (62.16%)
	Osteoporotic	28 (37.84%)

A majority of patients (44; 59.46%) underwent surgery using the olecranon osteotomy approach, while 30 (40.54%) had a triceps-sparing approach (table 2). Orthogonal plating was used in 39 patients (52.70%), and parallel plating in 35 (47.30%). Mean operative time was 142.6 ± 18.5 minutes, and all patients (100%) initiated postoperative rehabilitation within two days. No statistically significant association was found between plating type or surgical approach and MEPS scores at 18 months ($p > 0.05$).

Table 2: Surgical Details and Fixation Configuration (with Chi-Square p-values)

Parameter	Category	n (%)	Association with MEPS at 18 months (p-value)
Surgical Approach	Olecranon Osteotomy	44 (59.46%)	0.814
	Triceps-Sparing	30 (40.54%)	
Plating Configuration	Orthogonal Dual Plates	39 (52.70%)	0.128
	Parallel Dual Plates	35 (47.30%)	
Mean Operative Time (min)	Mean $\pm$ SD	142.6 $\pm$ 18.5	—
Postoperative Rehab	Within 2 days	74 (100.00%)	—

At 12 months, 29 patients (39.19%) had excellent outcomes, which improved to 38 patients (51.35%) by 18 months (table 3). Good results were seen in 27 (36.49%) and 24 (32.43%) patients at 12 and 18 months, respectively. Fair outcomes decreased from 13 (17.57%) to 9 (12.16%), and poor outcomes from 5 (6.76%) to 3 (4.05%) over the same period. The mean MEPS improved from 82.3 $\pm$ 9.7 at 12 months to 87.1 $\pm$ 8.3 at 18 months ($p = 0.046$).

Table 3: Functional Outcome Based on Mayo Elbow Performance Score (MEPS)

MEPS Category	Score Range	12 Months (n, %)	18 Months (n, %)	p-values
Excellent	90–100	29 (39.19%)	38 (51.35%)	0.046
Good	75–89	27 (36.49%)	24 (32.43%)	
Fair	60–74	13 (17.57%)	9 (12.16%)	
Poor	<60	5 (6.76%)	3 (4.05%)	
MEPS	Mean $\pm$ SD	82.3 $\pm$ 9.7	87.1 $\pm$ 8.3	—

At final follow-up, the average flexion–extension arc was 106.8 $\pm$ 15.2 degrees, and the average pronation–supination arc was 144.3 $\pm$ 11.7 degrees (table 4). Pain assessment revealed that 35 patients (47.30%) were pain-free (VAS 0), 30 (40.54%) had mild pain (VAS 1–3), and 9 (12.16%) had moderate pain (VAS 4–6). No patients reported severe pain (VAS $\geq$ 7).

Table 4: Range of Motion (ROM) and Pain Scores at Final Follow-Up

Parameter	Mean $\pm$ SD / Category	n (%)
Flexion–Extension Arc (degrees)	106.8 $\pm$ 15.2	—
Pronation–Supination Arc	144.3 $\pm$ 11.7	—
Pain (Visual Analog Scale)	None (VAS 0)	35 (47.30%)
	Mild (VAS 1–3)	30 (40.54%)
	Moderate (VAS 4–6)	9 (12.16%)
	Severe (VAS $\geq$ 7)	0 (0.00%)

The most frequent complication was elbow stiffness, observed in 11 patients (14.86%), followed by post-traumatic arthritis in 7 patients (9.46%) and heterotopic ossification in 6 (8.11%), shown in figure 2. Superficial and deep infections occurred in 4 (5.41%) and 2 (2.70%) patients, respectively. Implant failure occurred in 3 (4.05%), while nonunion was reported in 2 patients (2.70%). Three patients (4.05%) required revision surgery.

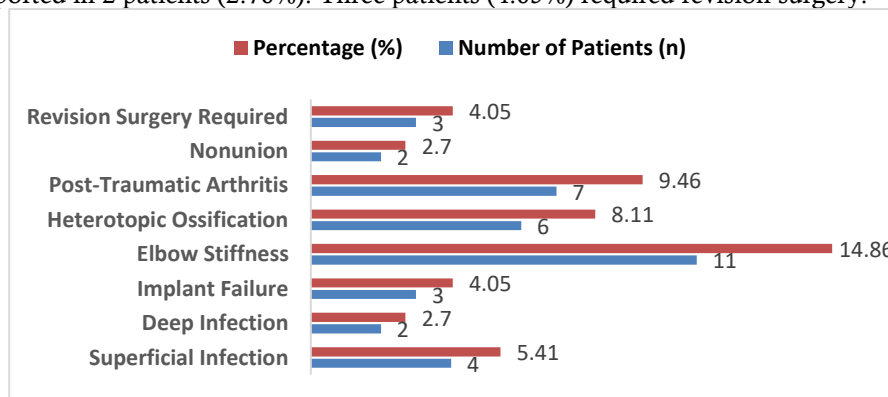


Figure 2: Frequency and Types of Postoperative Complications Observed During Follow-Up (Up to 18 Months) Among the 39 patients treated with orthogonal plating, 21 (53.85%) achieved excellent outcomes, 12 (30.77%) had good results, and 6 (15.38%) had fair or poor outcomes (table 5). In the 35 patients with parallel plating, 17 (48.57%) had excellent outcomes, 12 (34.29%) had good results, and 6 (17.14%) had fair or poor outcomes. No statistically significant association was found between plating type and MEPS at 18 months ($p = 0.128$).

Table 5: Association Between Plating Configuration and MEPS at 18 Months

Plating Type	Excellent (n, %)	Good (n, %)	Fair/Poor (n, %)	p-value
Orthogonal (n=39)	21 (53.85%)	12 (30.77%)	6 (15.38%)	0.128
Parallel (n=35)	17 (48.57%)	12 (34.29%)	6 (17.14%)	

Radiological union was achieved in 71 patients (95.95%) with a mean time to union of 14.3 ± 2.7 weeks. One patient (1.35%) had delayed union (≥ 20 weeks), and 2 patients (2.70%) developed nonunion, aligning with the clinical complication data (table 6).

Table 6: Radiological Healing Status at Final Follow-Up (n = 74)

Radiological Outcome	n (%)	Mean Time to Union (weeks)
Complete Union	71 (95.95%)	14.3 ± 2.7
Delayed Union (≥ 20 weeks)	1 (1.35%)	—
Nonunion	2 (2.70%)	—

DISCUSSION

The research looked at how well AO type 13C distal humerus fractures healed after being treated with ORIF and two plates. Our results were good, with the average MEPS going from 82.3 ± 9.7 at 12 months to 87.1 ± 8.3 at 18 months. At the last follow-up, most patients had excellent (51.35%) or good (32.43%) results. The results are in line with what was seen before, when a comparable group of patients with AO/OTA type 13-C2 and C3 distal humerus fractures treated with dual plating had a median MEPS of 85 and 78% had good to outstanding outcomes at least two years later [14].

There was no significant difference in functional results depending on the kind of plating used. 53.85% of patients treated with orthogonal plating had great MEPS outcomes, whereas 48.57% of patients treated with parallel plating had excellent MEPS outcomes ($p = 0.128$). This is in line with what was found before, which also said that there was no statistically significant difference in MEPS between orthogonal and parallel plating in AO type C fractures [15]. In the same way, our comparison of surgical methods showed that the results for patients who had an olecranon osteotomy (59.46%) were similar to those for patients who had a triceps-sparing approach (40.54%) ($p = 0.814$). This is similar to what previous research found, which found no significant functional differences between the two methods when standardized rehabilitation was followed [16].

After surgery, there were some problems, but they were not too bad. The most prevalent kind of pain was elbow stiffness (14.86%), followed by post-traumatic arthritis (9.46%) and heterotopic ossification (8.11%). These rates are lower than those seen in a previous research, which found that stiffness led to reoperation in a large number of patients (part of the 32% reoperation rate), and heterotopic ossification was seen in 8% of cases [1]. The pain results in our trial were good. 47.30% of patients said they had no pain, and 40.54% said they only had minor discomfort (VAS 1–3). These findings show how important it is to start therapy right once. In our research group, it started on the

second day after surgery.

Radiological union happened in 95.95% of patients, and the average time it took was 14.3 ± 2.7 weeks. This is in line with what a prior research found: 90.6% of patients with fractures healed after 8 weeks of treatment with dual plating utilizing the posterior approach and olecranon osteotomy [17].

This research shows that dual plating works well for AO type 13C distal humerus fractures in terms of both function and X-ray results. It shows that both types of plating and surgical procedures work well. The results promote early rehabilitation and help doctors make decisions.

Study Strengths and Limitations

One of the best things about this research is that it was planned ahead of time and used a standard surgical procedure, rehabilitation regimen, and independent outcome evaluation. This makes the findings more reliable and valid. With a sample size of 74 and a minimum follow-up of 12 months, it was possible to use proven scoring systems like MEPS and VAS to get relevant results for both short- and mid-term functional outcomes. Also, comparing orthogonal and parallel plating and olecranon osteotomy and triceps-sparing methods gives surgeons more information to help them make decisions. However, the study's shortcomings include the fact that it was done at just one site and that convenience sampling was used, which may make the results less applicable to other situations. Not randomizing the groups might lead to selection bias, and no power calculation was done to find differences between the subgroups. Lastly, the radiological examination just looked at union rates and didn't use sophisticated imaging to look at joint congruity or degenerative changes in detail.

Conclusion

This research shows that dual plating with ORIF leads to good functional results in AO type 13C distal humerus fractures. Over 18 months, MEPS scores went from 82.3 to 87.1 and the union rate was high (95.95%). The orthogonal and parallel layouts

worked about the same, and starting rehab early led to less discomfort and fewer problems, such elbow stiffness (14.86%) and post-traumatic arthritis (9.46%). These results show that dual plating is a good and repeatable way to treat difficult intra-articular distal humerus fractures in adults.

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