THE JOURNAL OF SURGICAL RADIOLOGY

Journal of Surgical Radiology

Site: https://journalsurgrad.com/

ISSN Print 2156-213X| ISSN Online: 2156-4566 Volume: 05 Issue: 02 Open Access

Research Article

Functional outcomes of intercondylar distal humerus fractures treated by open reduction and internal fixation through olecranon osteotomy versus triceps-splitting approaches in adults: A prospective randomized comparative study

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Article History
Received: 10-01-2026
Revised: 25-01-2026
Accepted: 10-02-2026
Published: 16-02-2026

Citations:
Dhore, A. A., Reddy, M. P. L., Kumar, A. K. S., Sreeranga, N., Lakshmeesha, T., Chavan, P. B., & Kalmesh, S. K. Functional outcomes of intercondylar distal humerus fractures treated by open reduction and internal fixation through olecranon osteotomy versus triceps-splitting approaches in adults: A prospective randomized comparative study. J Surg Radiol, V5 (2) 30-39

Abstract: ***Introduction:*** Displaced intercondylar fractures of the distal humerus are difficult to treat because the articular surface must be reconstructed while stable fixation and early elbow movement are preserved. Olecranon osteotomy offers wide exposure, whereas a triceps-splitting approach avoids creation of an additional osteotomy. The relative functional benefit of either approach remains uncertain. **Methods:** This prospective randomized comparative study included 28 adults with AO/OTA type 13-C intercondylar distal humerus fractures treated at Hassan Institute of Medical Sciences. Fourteen patients underwent open reduction and internal fixation through an olecranon osteotomy and 14 through a triceps-splitting approach. The Mayo Elbow Performance Score (MEPS), elbow range of motion, radiographic union, and complications were assessed at 1, 6, 12, and 24 weeks. Between-group comparisons were made using the independent-samples t test, chi-square test, or Fisher exact test, as appropriate. A p value below 0.05 was considered statistically significant. **Results:** Functional recovery improved in both groups during follow-up. At 24 weeks, the mean MEPS was 88.21 ± 8.45 after olecranon osteotomy and 85.36 ± 9.12 after triceps splitting ($p = 0.324$). The mean flexion-extension arc was 116.43 ± 12.34° and 111.42 ± 14.67°, respectively ($p = 0.311$). Complete radiographic union was seen in 13 of 14 patients (92.86%) in the osteotomy group and 12 of 14 patients (85.71%) in the triceps-splitting group ($p = 0.538$). The only significant between-group difference was operative time, which was longer with olecranon osteotomy (142.36 ± 18.45 versus 128.57 ± 15.23 minutes; $p = 0.033$). Overall complication rates were comparable. **Conclusion:** Both approaches produced good short-term functional and radiological outcomes. Olecranon osteotomy required more operative time but did not provide a statistically superior MEPS, range of motion, union rate, or complication profile at 24 weeks. The approach may therefore be selected according to fracture configuration, soft-tissue condition, and the surgeon's experience.

Keywords: distal humerus fracture; intercondylar fracture; olecranon osteotomy; triceps-splitting approach; Mayo Elbow Performance Score

INTRODUCTION

Distal humerus fractures are uncommon, but they remain among the more demanding injuries around the elbow. The difficulty is greatest when the fracture extends between the condyles and disrupts the articular surface. In these cases, treatment must restore joint congruity, rebuild both columns, and protect the nearby ulnar nerve and other soft-tissue structures. [1,2]

The distal end of the humerus is formed by medial and lateral columns that support the trochlea and capitellum. This three-dimensional arrangement is mechanically efficient but leaves little room for error during reduction. Intercondylar fractures may form T- or Y-shaped patterns and are often comminuted. Younger adults commonly sustain these injuries after high-energy trauma, whereas low-energy falls may produce similar fractures in older patients with weaker bone. [1,10]

Historically, displaced intercondylar fractures treated without anatomical reduction were frequently followed by pain, stiffness, instability, and loss of elbow function. Open reduction and internal fixation is now the usual treatment for reconstructible fractures because it permits direct reduction of the joint surface and stable fixation of the columns. [2,8,13]

The operation has four practical goals: accurate articular reduction, restoration of the medial and lateral columns, fixation strong enough to allow early movement, and preservation of the extensor mechanism and neurovascular structures. Plate position and construct stability are important, but adequate exposure is equally necessary when the fracture is complex. [3,15]

An olecranon osteotomy provides a broad view of the distal humeral articular surface. After a chevron-shaped osteotomy, the triceps-olecranon unit can be reflected proximally, allowing direct visualization of the trochlea, capitellum, and both columns. This exposure is particularly useful when several small articular fragments must be assembled. The additional osteotomy, however, requires secure repair and may lead to symptomatic hardware, delayed union, or nonunion. [4,5]
Triceps-preserving and triceps-splitting approaches were developed to avoid complications related to an olecranon osteotomy. In the triceps-splitting approach, the tendon and muscle are divided in the midline to reach the posterior distal humerus, then repaired after fixation. The approach maintains the olecranon intact, but visualization of the articular surface may be more limited in markedly comminuted fractures. [5,6,9]

The choice of approach therefore involves a trade-off. Wider exposure may simplify reduction, while preservation of the olecranon may shorten the procedure and remove the need for osteotomy fixation. Regardless of the approach, the functional result depends on the quality of reduction, stable fixation, soft-tissue handling, and timely rehabilitation.

Functional recovery is commonly reported using the Mayo Elbow Performance Score, which combines pain, movement, stability, and performance of daily activities into a 100-point score. An elbow arc of approximately 30° to 130° has traditionally been regarded as sufficient for many daily activities, although modern tasks may require a somewhat wider range. [7,14,16]

Comparative studies have not shown a consistent advantage for one posterior approach in every fracture pattern. Some reports emphasize the exposure obtained through olecranon osteotomy, whereas others describe acceptable results with triceps-preserving techniques. Differences in fracture complexity, surgeon experience, fixation methods, and follow-up make direct comparison difficult. [9,11,12,13]

The present study compared olecranon osteotomy and triceps-splitting approaches in adults with AO/OTA type 13-C fractures. Functional score, range of motion, fracture union, and complications were assessed over 24 weeks. The working hypothesis was that the wider exposure provided by olecranon osteotomy might result in better function, although the approach could also increase operative time and osteotomy-related morbidity.

1) AIMS AND OBJECTIVES

The primary aim was to compare functional outcomes after open reduction and internal fixation of intercondylar distal humerus fractures performed through an olecranon osteotomy or a triceps-splitting approach in adults.
The objectives were to compare MEPS at 1, 6, 12, and 24 weeks; measure flexion, extension, pronation, and supination; assess radiographic union and time to union; record approach-related and general complications; and compare patient satisfaction, return to work, and independence in daily activities at the final follow-up.

MATERIALS AND METHODS

Study design and setting

A prospective randomized comparative study was carried out in the Department of Orthopaedics, Hassan Institute of Medical Sciences, Hassan, Karnataka. Recruitment and follow-up were undertaken from January 2022 to December 2023. Approval was obtained from the Institutional Ethics Committee before enrolment, and written informed consent was taken from every participant. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Sample size

The sample size was estimated for comparison of two independent means using the formula:
$n = 2 \times (Z_{1-\alpha/2} + Z\beta)^2 \times S^2 / d^2$
For a 95% confidence level and 80% power, $Z_{1-\alpha/2} = 1.96$ and $Z\beta = 0.84$. The pooled standard deviation was taken as 12.84, calculated from (16.79 + 8.89)/2, and the anticipated difference was 9.58. Substitution gave $n = 2 \times (2.80)^2 \times (12.84)^2 / (9.58)^2 = 28.17$. The final sample was therefore fixed at 28 patients, with 14 patients in each group.

Participants

Adults aged 18 years or older with an intercondylar distal humerus fracture classified as AO/OTA type 13-C were considered for inclusion. Patients had to be suitable for operative treatment and willing to provide written consent. Exclusion criteria were pathological fractures, open injuries with major soft-tissue damage, an ipsilateral both-bone forearm fracture, pre-existing elbow deformity or dysfunction, active infection around the elbow, previous surgery on the affected elbow, medical unfitness for anaesthesia or prolonged surgery, and refusal to participate.

Randomization and group allocation

Eligible participants were assigned in equal numbers to the two treatment groups by the chit method. Chits marked “olecranon osteotomy” or “triceps splitting” were kept in sealed opaque envelopes. An independent nurse who was not involved in the operation or outcome assessment drew the envelope. Group 1 included 14 patients treated through an olecranon osteotomy, and

Group 2 included 14 patients treated through a triceps-splitting approach.

Preoperative assessment

The preoperative evaluation documented the mechanism of injury, associated injuries, comorbidities, and pre-injury function. Examination included the condition of the skin and soft tissues, deformity, swelling, and distal neurovascular status. Standard anteroposterior and lateral radiographs were obtained in all patients. Computed tomography with three-dimensional reconstruction was used selectively when comminution made the fracture pattern difficult to define. Routine laboratory investigations and anaesthetic assessment were completed before surgery, and patients were counselled about the procedure, rehabilitation, and possible complications.

Olecranon osteotomy approach

Patients in Group 1 were operated under general anaesthesia in the lateral decubitus position. A pneumatic tourniquet was placed on the proximal arm and inflated to 250 mmHg after exsanguination. Through a posterior midline incision, the ulnar nerve was identified, mobilized, and protected. Anterior transposition was performed only when considered necessary. A chevron osteotomy was made through the bare area of the olecranon and the triceps-olecranon unit was reflected proximally. The articular fragments were reduced first, followed by restoration of the medial and lateral columns. Temporary Kirschner-wire fixation was replaced by definitive fixation with precontoured plates in an orthogonal or parallel configuration according to the fracture pattern. The olecranon osteotomy was repaired with two parallel Kirschner wires and figure-of-eight tension-band wiring. After haemostasis and layered closure, the elbow was supported in a posterior splint at 90° of flexion.

Triceps-splitting approach

Group 2 underwent the same anaesthetic, positioning, tourniquet, and posterior skin-incision protocol. The triceps tendon and muscle were divided longitudinally in the midline, from the musculotendinous region towards the olecranon insertion, while retaining the medial and lateral attachments. The ulnar nerve was identified and protected. Articular reconstruction and bicolumnar plating were then performed using the same fixation principles as in Group 1. At the end of fixation, the triceps split was repaired anatomically with interrupted absorbable figure-of-eight sutures, followed by layered wound closure and posterior splinting.

Postoperative care and rehabilitation

Both groups followed the same postoperative protocol. Intravenous antibiotics were administered for 48 hours and were followed by oral antibiotics to complete five days. Analgesia was provided using a multimodal regimen. The posterior splint was removed on the first postoperative day, and supervised active-assisted flexion, extension, pronation, and supination were started within pain tolerance. Lifting and weight-bearing through the operated limb were avoided for six weeks. Strengthening was introduced thereafter. Clinical and radiographic reviews were scheduled at 1, 6, 12, and 24 weeks.

Outcome assessment

The primary outcome was the MEPS. Pain contributed 45 points, range of motion 20 points, stability 10 points, and performance of daily activities 25 points, for a maximum score of 100. Scores of 90-100 were classified as excellent, 75-89 as good, 60-74 as fair, and below 60 as poor. Elbow and forearm movement was measured with a goniometer. Stability was assessed clinically, and daily function was evaluated from activities such as feeding, personal care, and hygiene. Secondary outcomes were radiographic union, time to union, infection, hardware prominence, nerve symptoms, heterotopic ossification, triceps weakness, revision surgery, patient satisfaction, and return to work. Union was defined as bridging callus across at least three cortices on orthogonal radiographs with loss of the visible fracture line. Outcome assessment was performed by an independent observer who was not involved in the surgery.

Statistical analysis

Data were entered in Microsoft Excel and analysed using Statistical Package for the Social Sciences, version 12.0. Continuous variables are presented as mean ± standard deviation and categorical variables as number and percentage. Normality was assessed with the Kolmogorov-Smirnov test. The independent-samples t test was used for continuous between-group comparisons. Categorical variables were analysed with the chi-square test or Fisher exact test when expected cell counts were small. All tests were two-sided, 95% confidence intervals were used, and $p < 0.05$ was considered statistically significant. The planned analysis followed intention-to-treat principles; when a follow-up value was unavailable, the last recorded observation was carried forward.

RESULTS

Baseline characteristics

All 28 enrolled patients were included in the analysis, with 14 patients in each group. Mean age was 42.36 ± 13.21 years in the olecranon osteotomy group and 44.71 ± 14.85 years in the triceps-splitting group ($p = 0.652$). Men accounted for 8 of 14 patients in Group 1 and 9 of 14 in Group 2 (p = 0.705). Road traffic injury was the most frequent mechanism, occurring in 18 patients overall. AO/OTA subtype distribution was similar: 11 fractures were type C1, 12 were type C2, and 5 were type C3. The interval from injury to surgery was also comparable between groups (4.21 ± 1.87 versus 4.64 ± 2.15 days; p = 0.563) (Table 1).

Operative findings

Olecranon osteotomy took longer than triceps splitting. Mean operative time was 142.36 ± 18.45 minutes in Group 1 and 128.57 ± 15.23 minutes in Group 2 (p = 0.033). Blood loss, fluoroscopy time, plate configuration, and hospital stay did not differ significantly. Anatomical articular reduction was recorded in 12 patients in the osteotomy group and 11 in the triceps-splitting group. One osteotomy extended beyond the intended line and was managed by modifying the fixation; no intraoperative neurovascular injury occurred (Table 2).

Mayo Elbow Performance Score

MEPS increased steadily in both groups. At 1 week, mean scores were 42.14 ± 8.76 and 41.43 ± 9.12 in the osteotomy and triceps-splitting groups, respectively. At 6 weeks, the corresponding scores were 64.29 ± 10.45 and 62.14 ± 11.23; at 12 weeks, they were 79.64 ± 9.87 and 76.43 ± 10.56. By 24 weeks, mean MEPS had reached 88.21 ± 8.45 in Group 1 and 85.36 ± 9.12 in Group 2 (p = 0.324). Ten patients in Group 1 and eight in Group 2 had an excellent final score. No patient had a poor result, and the distribution of outcome categories did not differ significantly (p = 0.542) (Table 3).

Range of motion

At 24 weeks, mean flexion was 128.57 ± 11.34° after olecranon osteotomy and 125.71 ± 13.45° after triceps splitting (p = 0.527). Mean extension lag was 12.14 ± 5.67° and 14.29 ± 6.78°, respectively (p = 0.347). The resulting flexion-extension arc was 116.43 ± 12.34° in Group 1 and 111.42 ± 14.67° in Group 2 (p = 0.311). Pronation, supination, and total forearm rotation were also similar. A functional flexion-extension arc of at least 100° was achieved by 12 patients in Group 1 and 11 in Group 2 (Table 4).

Radiographic healing

Early callus was visible in nine patients in the osteotomy group and eight in the triceps-splitting group at 6 weeks. By 12 weeks, bridging callus across at least three cortices was present in 11 and 10 patients, respectively. At 24 weeks, 13 patients in Group 1 and 12 in Group 2 had complete union (p = 0.538). Mean time to union was 14.71 ± 2.34 weeks after olecranon osteotomy and 15.43 ± 2.67 weeks after triceps splitting (p = 0.439). Thirteen of the 14 olecranon osteotomies united solidly; one had an asymptomatic fibrous union. No loss of reduction was identified in either group (Table 5).

Complications

Most adverse events were minor. Superficial infection occurred in two patients in Group 1 and one in Group 2; all resolved with antibiotics and wound care. Transient ulnar-distribution paraesthesia was reported by two and three patients, respectively, and resolved within three months. Hardware prominence was more frequent after osteotomy (three versus one patient), and two patients in that group later underwent elective implant removal. Heterotopic ossification was seen in two patients in each group, although it caused clinically important restriction in only one patient in Group 2. Subjective triceps weakness was reported by one patient after osteotomy and two after triceps splitting. There were no deep infections, permanent nerve injuries, distal humerus nonunions, malunions, fixation failures, or revision procedures. Overall complication rates were 35.71% and 42.86% (p = 0.683) (Table 6).

Patient-reported recovery

At 24 weeks, mean satisfaction scores were 8.21 ± 1.45 in the osteotomy group and 7.86 ± 1.67 in the triceps-splitting group (p = 0.541). Twelve patients in Group 1 and 11 in Group 2 stated that they would choose the same procedure again. Eleven and 10 patients, respectively, had returned to their previous occupation. Mean time to return to work was 16.43 ± 3.21 weeks after osteotomy and 17.14 ± 3.67 weeks after triceps splitting (p = 0.583). All patients had regained independence in basic daily activities by the final visit.

Table 1. Demographic and baseline characteristics of the study population

Characteristic	Olecranon osteotomy group (n = 14)	Triceps-splitting group (n = 14)	p value
Age (years), mean ± SD	42.36 ± 13.21	44.71 ± 14.85	0.652
Gender			
Male, n (%)	8 (57.14)	9 (64.29)	0.705

Characteristic	Olecranon osteotomy group (n = 14)	Triceps-splitting group (n = 14)	p value
Female, n (%)	6 (42.86)	5 (35.71)	
Mechanism of injury			
Road traffic accident, n (%)	9 (64.29)	9 (64.29)	0.924
Fall from height, n (%)	3 (21.43)	4 (28.57)	
Fall on outstretched hand, n (%)	2 (14.28)	1 (7.14)	
AO/OTA classification			
Type 13-C1, n (%)	6 (42.86)	5 (35.71)	0.821
Type 13-C2, n (%)	6 (42.86)	6 (42.86)	
Type 13-C3, n (%)	2 (14.28)	3 (21.43)	
Side affected			
Right, n (%)	8 (57.14)	9 (64.29)	0.705
Left, n (%)	6 (42.86)	5 (35.71)	
Time from injury to surgery (days)	4.21 ± 1.87	4.64 ± 2.15	0.563

Table 2. Operative parameters and intraoperative findings

Parameter	Olecranon osteotomy group (n = 14)	Triceps-splitting group (n = 14)	p value
Operative time (minutes), mean ± SD	142.36 ± 18.45	128.57 ± 15.23	0.033*
Intraoperative blood loss (mL)	245.71 ± 52.34	228.21 ± 48.67	0.351
Fluoroscopy time (minutes)	3.42 ± 0.87	3.78 ± 0.94	0.291
Quality of articular reduction			
Anatomical, n (%)	12 (85.71)	11 (78.57)	0.608
<2 mm step-off, n (%)	2 (14.29)	3 (21.43)	
Plate configuration			
Orthogonal, n (%)	8 (57.14)	7 (50.00)	0.705
Parallel, n (%)	6 (42.86)	7 (50.00)	
Intraoperative complications			
None, n (%)	13 (92.86)	14 (100.00)	0.309
Osteotomy extension, n (%)	1 (7.14)	0 (0.00)	
Length of hospital stay (days)	4.71 ± 1.23	4.43 ± 1.15	0.533

**Statistically significant at $p < 0.05$.*

Table 3. Mayo Elbow Performance Score during follow-up and final outcome categories

Outcome	Olecranon osteotomy group (n = 14)	Triceps-splitting group (n = 14)	p value
MEPS at 1 week, mean ± SD	42.14 ± 8.76	41.43 ± 9.12	0.832
MEPS at 6 weeks, mean ± SD	64.29 ± 10.45	62.14 ± 11.23	0.593
MEPS at 12 weeks, mean ± SD	79.64 ± 9.87	76.43 ± 10.56	0.397

Outcome	Olecranon osteotomy group (n = 14)	Triceps-splitting group (n = 14)	p value
MEPS at 24 weeks, mean ± SD	88.21 ± 8.45	85.36 ± 9.12	0.324
Final outcome category			
Excellent (90-100), n (%)	10 (71.43)	8 (57.14)	0.542
Good (75-89), n (%)	3 (21.43)	4 (28.57)	
Fair (60-74), n (%)	1 (7.14)	2 (14.29)	
Poor (<60), n (%)	0 (0.00)	0 (0.00)	

5. **Table 4. Range of motion at 24 weeks**

Range-of-motion parameter	Olecranon osteotomy group (n = 14), mean ± SD	Triceps-splitting group (n = 14), mean ± SD	p value
Flexion (degrees)	128.57 ± 11.34	125.71 ± 13.45	0.527
Extension lag (degrees)	12.14 ± 5.67	14.29 ± 6.78	0.347
Flexion-extension arc (degrees)	116.43 ± 12.34	111.42 ± 14.67	0.311
Pronation (degrees)	74.29 ± 8.45	71.43 ± 9.23	0.384
Supination (degrees)	76.43 ± 7.89	73.57 ± 8.67	0.356
Total forearm rotation (degrees)	150.72 ± 14.23	145.00 ± 16.45	0.313
Functional arc ≥100°, n (%)	12 (85.71)	11 (78.57)	0.625

Table 5. Radiographic union and healing

Parameter	Olecranon osteotomy group (n = 14)	Triceps-splitting group (n = 14)	p value
Radiographic status at 24 weeks			
Complete union, n (%)	13 (92.86)	12 (85.71)	0.538
Delayed union, n (%)	1 (7.14)	2 (14.29)	
Time to union (weeks), mean ± SD	14.71 ± 2.34	15.43 ± 2.67	0.439
Olecranon osteotomy union			
Solid union, n (%)	13 (92.86)	Not applicable	Not applicable
Fibrous union, n (%)	1 (7.14)	Not applicable	
Maintenance of reduction			
No loss of reduction, n (%)	14 (100.00)	14 (100.00)	1.000
Minimal loss (<2 mm), n (%)	0 (0.00)	0 (0.00)	
Radiographic signs of arthritis at 24 weeks, n (%)	1 (7.14)	2 (14.29)	0.543

Table 6. Complications and adverse events

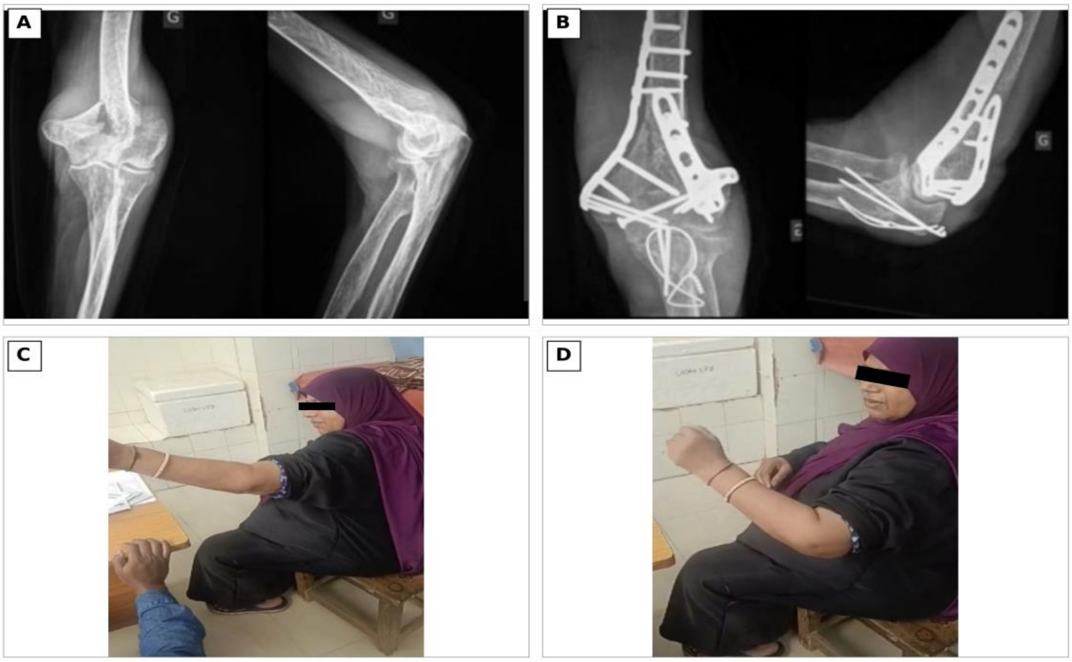
Complication	Olecranon osteotomy group (n = 14)	Triceps-splitting group (n = 14)	p value
Superficial wound infection, n (%)	2 (14.29)	1 (7.14)	0.543

Complication	Olecranon osteotomy group (n = 14)	Triceps-splitting group (n = 14)	p value
Deep infection, n (%)	0 (0.00)	0 (0.00)	1.000
Transient ulnar nerve symptoms, n (%)	2 (14.29)	3 (21.43)	0.619
Permanent nerve injury, n (%)	0 (0.00)	0 (0.00)	1.000
Hardware prominence, n (%)	3 (21.43)	1 (7.14)	0.282
Hardware removal required, n (%)	2 (14.29)	0 (0.00)	0.139
Heterotopic ossification, n (%)	2 (14.29)	2 (14.29)	1.000
Clinically significant HO, n (%)	0 (0.00)	1 (7.14)	0.309
Subjective triceps weakness, n (%)	1 (7.14)	2 (14.29)	0.543
Elbow stiffness requiring MUA, n (%)	0 (0.00)	0 (0.00)	1.000
Distal humerus nonunion, n (%)	0 (0.00)	0 (0.00)	1.000
Olecranon osteotomy nonunion, n (%)	0 (0.00)	Not applicable	Not applicable
Malunion, n (%)	0 (0.00)	0 (0.00)	1.000
Revision surgery, n (%)	0 (0.00)	0 (0.00)	1.000
Overall complication rate, n (%)	5 (35.71)	6 (42.86)	0.683

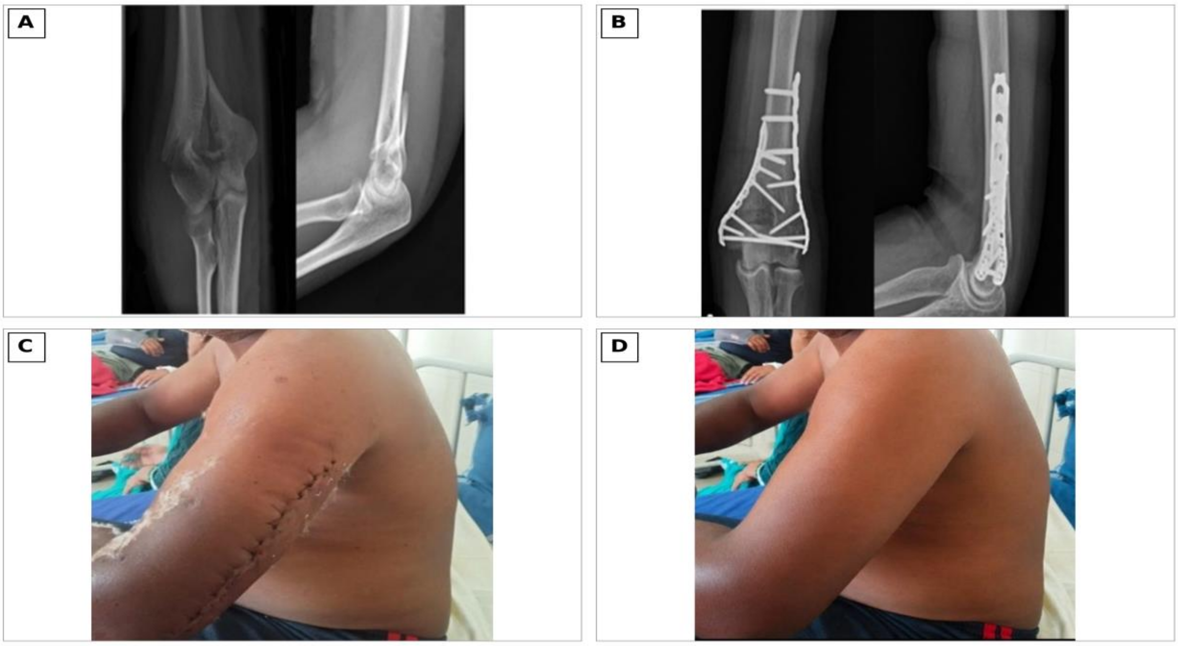
HO, heterotopic ossification; MUA, manipulation under anaesthesia.

2) REPRESENTATIVE CLINICAL AND RADIOLOGICAL OUTCOMES

Figures 1 and 2 show representative radiological and clinical findings from the two treatment groups. The group assignment was identified from the operative records and the presence or absence of olecranon osteotomy fixation on the postoperative radiographs.



6. *Figure 1. Representative olecranon osteotomy case. (A) Preoperative anteroposterior and lateral radiographs showing an intercondylar distal humerus fracture. (B) Follow-up radiographs showing bicolumnar plate fixation and olecranon osteotomy repair with tension-band wiring. (C) Active elbow extension and (D) active elbow flexion during follow-up.*



7. *Figure 2. Representative triceps-splitting case. (A) Preoperative anteroposterior and lateral radiographs showing an intercondylar distal humerus fracture. (B) Follow-up radiographs showing bicolumnar plate fixation without olecranon osteotomy hardware. (C) Early postoperative wound with skin staples and (D) healed posterior surgical scar at follow-up.*

DISCUSSION

The main finding was that both posterior approaches gave similar functional results at 24 weeks. MEPS, range of motion, radiographic union, and the overall frequency of complications did not differ significantly. Olecranon osteotomy did, however, add approximately 14 minutes to the mean operating time.

The two groups were comparable at baseline with respect to age, sex, mechanism of injury, fracture subtype, side, and time to surgery. This balance is important in a small trial because age, bone quality, and the degree of articular comminution can influence recovery after distal humerus fixation. The observed age range and male predominance are in keeping with reports that include both high-energy injuries in younger adults and fragility-related fractures in older patients. [1,10]

Longer operating time with olecranon osteotomy was expected because the surgeon must create and later repair the osteotomy. Zhang and colleagues also described practical differences between triceps-sparing exposure and olecranon osteotomy in type C fractures. [11] In the present series, the additional time did not lead to more blood loss, a longer hospital stay, or a higher infection rate.

Both groups moved from poor early scores to good mean MEPS values by 24 weeks. The final difference of 2.85 points favoured osteotomy numerically but was neither statistically significant nor large enough to establish clinical superiority. Earlier reports of surgically treated type C fractures have also shown that acceptable function can be obtained through more than one posterior approach when reduction and fixation are sound. [8,9,12,13] The average flexion-extension arc exceeded 110° in both groups, and more than three-quarters of patients achieved at least 100°. This is relevant because the traditional functional arc for many activities is about 30° to 130°, although contemporary tasks may demand additional movement. [14,16] The findings suggest that early rehabilitation and stable fixation were more influential than the approach alone during the first six months.

Fracture union was satisfactory in both groups. The numerical difference in complete union, 92.86% versus 85.71%, was not significant. Thirteen of 14 olecranon osteotomies united solidly, and the single fibrous union was asymptomatic. Coles and colleagues have shown that olecranon osteotomy can provide dependable exposure and healing when the osteotomy and its fixation are carefully performed. [4]

Hardware prominence was the most evident approach-specific problem. Three patients in the osteotomy group reported prominence, and two later underwent implant removal. This is a recognised disadvantage of tension-band constructs around the olecranon. By contrast, the triceps-splitting group avoided osteotomy hardware but still had one case of plate prominence. [4,11]

Transient ulnar nerve symptoms occurred in both groups and resolved without further surgery. The similar frequency suggests that the risk was related more to fracture exposure and nerve handling than to the selected approach. Whether routine anterior transposition is beneficial remains debated, and published studies have not established a uniform policy. [17,18]

Heterotopic ossification was visible in two patients in each group, but only one patient had a clinically important loss of motion. Radiographic heterotopic bone therefore did not necessarily correspond to functional disability in this small cohort. No patient required manipulation under anaesthesia.

Objective elbow extension strength was not significantly different between groups despite occasional subjective weakness. Careful repair of the triceps split and secure restoration of the olecranon mechanism appear to have preserved useful extension in both groups. Anatomical studies of posterior elbow approaches also show that exposure and soft-tissue disruption vary with the chosen technique. [5,6]

Patient satisfaction and return-to-work times supported the clinical findings. Most participants in both groups were satisfied, would choose the same procedure again, and had resumed their previous occupation by the final visit. Manual workers generally required more time than those with sedentary employment, which is expected after a complex intra-articular elbow injury.

The literature does not support a single approach for every type C fracture. An osteotomy may be helpful when direct inspection of a markedly comminuted joint surface is needed, whereas a triceps-splitting or triceps-preserving route may be adequate in fractures that can be reduced through a narrower window. Comparative reports vary because the fracture patterns, fixation systems, and rehabilitation protocols are not uniform. [9,11,12,13]

This study has several strengths. Treatment allocation was prospective, both groups received the same fixation principles and rehabilitation schedule, and the outcome measures were collected at fixed intervals. The study also reported radiological healing, complications, and patient-centred outcomes rather than relying on a single functional score.

The limitations are equally important. Only 28 patients were studied, so small differences and subgroup effects could have been missed. Follow-up ended at 24 weeks and could not assess late post-traumatic arthritis, delayed implant-related symptoms, or long-term deterioration. The work was performed at one institution, and the findings may not apply to surgeons with different experience. Blinding of an examiner is difficult when scars and radiographs reveal the approach. Satisfaction and return to work are also influenced by occupation, expectations, and social circumstances. Finally, no economic comparison was undertaken.

In practice, the results support an individualized choice. Olecranon osteotomy remains useful when exposure is the main priority, particularly in complex articular comminution. Triceps splitting is a reasonable alternative when adequate reduction can be achieved without an osteotomy and when avoiding olecranon hardware is desirable. In either case, stable reconstruction, protection of the ulnar nerve, and early supervised movement remain central to recovery.

Conclusion

At 24 weeks, olecranon osteotomy and triceps-splitting approaches produced comparable MEPS, elbow movement, radiographic union, and complication rates after fixation of AO/OTA type 13-C distal humerus fractures. The osteotomy group required a longer operation, but no functional advantage was demonstrated during the study period.

Both approaches are therefore acceptable when used for an appropriate fracture pattern. Olecranon osteotomy may be selected when broad articular exposure is needed, whereas triceps splitting can avoid osteotomy-related hardware and shorten operative time. The quality of reduction and fixation, careful soft-tissue handling, and early rehabilitation are likely to be more important than the approach alone.

Larger multicentre studies with longer follow-up are needed to clarify whether fracture subtype, bone quality, or long-term post-traumatic changes modify the relative benefits of these techniques.

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