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# Chevron olecranon osteotomy and fixation with kirschner wires and tension band in the surgical treatment of distal humeral fractures in adults: clinical evaluation of 32 cases

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## Summary

**Objective**. This study aimed to evaluate long-term outcomes and complications after olecranon osteotomy for complex distal humerus fractures.

**Methods**. We retrospectively reviewed adult patients with AO/OTA 13-C fractures treated by open reduction and internal fixation via olecranon osteotomy from 2005 to 2015. Thirty-two patients were assessed clinically and radiographically, and functional outcomes were measured using the Mayo Elbow Performance Score (MEPS) at a mean follow-up of 10 years.

**Results**. Olecranon osteotomy for complex distal humerus fractures produced mostly positive outcomes: 84% of patients had excellent or good MEPS results. Mean flexion-extension was 100° (range 10°-130°). By fracture type, 100% of C1, 69% of C2, and 90% of C3 had excellent/good results. Complications included nonunion (1), implant prominence (10), heterotopic ossification (2), and ulnar nerve entrapment (2). The purpose of our study is to evaluate the long-term outcomes of patients with type C fractures treated surgically with Chevron olecranon osteotomy.

**Conclusions**. Olecranon osteotomy provides adequate exposure and, with stable fixation and early rehabilitation, yields good long-term results with manageable complications. The retrospective design and small sample size are limitations of the study.

**Key words:** humerus fractures, chevron osteotomy, outcomes, fixation, function

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## Introduction

Distal humerus fractures have an incidence of approximately 5.7 cases per 100,000 individuals annually[1]. These injuries present considerable challenges, especially in elderly patients, due to factors such as osteoporotic bone, metaphyseal comminution, and decreased tolerance for joint immobilization.

In adults, surgical intervention represents the standard of care for displaced distal humerus fractures. Open reduction and internal fixation (ORIF) is the most com-

monly employed technique. Total elbow arthroplasty (TEA) is generally reserved for selected elderly patients or fractures unsuitable for reconstruction.

Closed reduction with external fixation and elbow hemiarthroplasty are used less frequently. Several surgical approaches have been described, most of which use a posterior midline incision and emphasize careful identification and protection of the ulnar nerve[2]. The decision to transpose the ulnar nerve is at the surgeon's discretion. For complex bicondylar intra-articular fractures (AO/OTA type 13-C) (Fig. 1), olecranon osteotomy is often performed to improve visualization and facilitate anatomic reduction, although this method carries specific osteotomy-related complications.

Recent research has provided additional knowledge of the outcomes of olecranon osteotomy and ORIF.

Intra-articular distal humerus fractures managed with ORIF and olecranon osteotomy demonstrate high osteotomy union rates (approximately 98%) and low conversion rates to TEA, even among geriatric patients[3]. Revision rates for nonunion or fixation failure remain relatively low.

Mini-fragment plate fixation for olecranon osteotomy appears promising, with lower rates of hardware removal and consistent union compared with traditional tension band wiring or larger plate constructs. This technique may reduce implant-related irritation[4].

Alternative surgical exposures, including the surgical flip-dislocation approach without olecranon osteotomy, have been investigated for type 13C3 fractures to reduce disruption of the extensor mechanism while continuing sufficient articular exposure[5].

Overall, ORIF with stable dual-column fixation remains the primary treatment for displaced distal humerus fractures. Current research remains focused on comparing plating configurations, such as parallel versus orthogonal, as well as functional outcomes and complication profiles[6]. Non-surgical management is typically reserved for non-displaced fractures or for patients who are not suitable candidates for anesthesia and surgery[17]. This strategy generally involves immobilization followed by controlled mobilization[8]. Our study aims to evaluate the long-term outcomes of patients with type C fractures treated surgically with Chevron olecranon osteotomy fixed with Kirschner wires.

## Materials and methods

This retrospective study was conducted at a single tertiary referral center. We reviewed all adults who underwent surgery for distal humerus fractures from January 2005 to December 2015. Only those with complete clinical and radiographic data were included. A minimum follow-up of 10 years was required for the final analysis.

Inclusion criteria were:

- AO/OTA type 13-C distal humerus fracture[9];
- age ≥ 18 years at the time of surgery;
- surgical treatment performed through a posterior olecranon osteotomy approach;

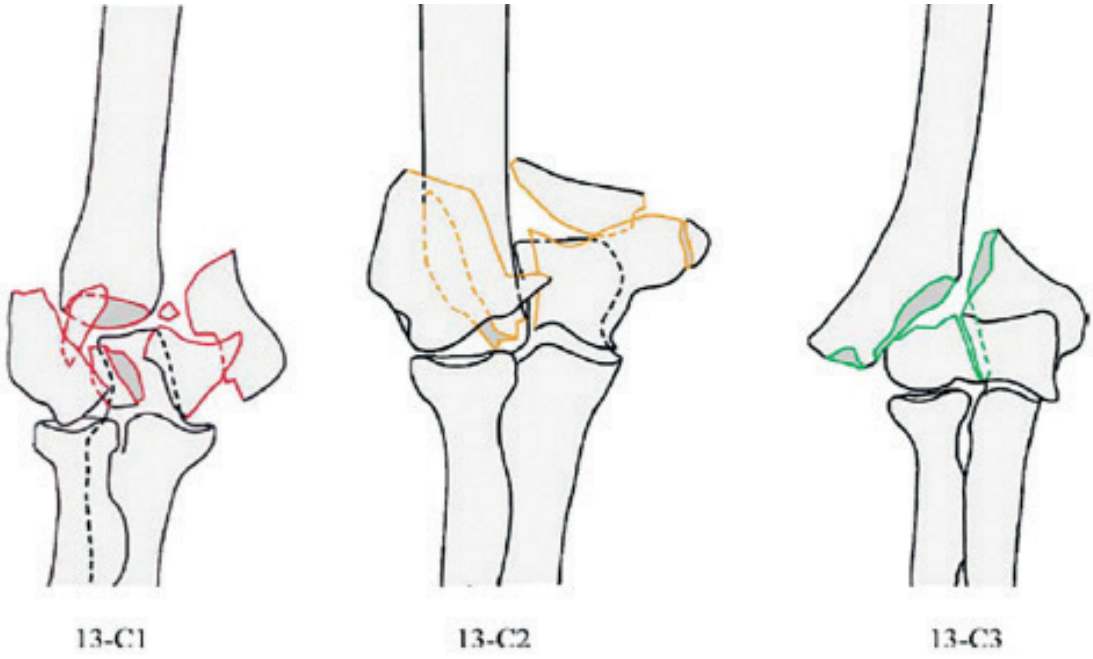



**Figure 1. AO classification: distal humerus fractures 13-C.**

**Table I. Demographic and fracture characteristics of the study cohort (n = 32).**

| Variable | Value |
|---|---|
| Number of patients | 32 |
| Male | 15 (46.9%) |
| Female | 17 (53.1%) |
| Mean age (years) | 53 |
| Age range (years) | 27-80 |
| AO/OTA Type C1 | 9 (28.1%) |
| AO/OTA Type C2 | 13 (40.6%) |
| AO/OTA Type C3 | 10 (31.3%) |

- fixation of the distal humerus with plate-and-screw constructs;
- the olecranon osteotomy required stabilization with Kirschner wires and tension-band wiring;
- adoption of a standardized postoperative rehabilitation protocol;
- availability of complete postoperative clinical and radiographic follow-up.

Exclusion criteria were:

- open elbow fractures;
- multiple injuries involving the ipsilateral upper limb.

During the study period, 113 distal humerus fractures were treated at our institution. Among these, 60 fractures were managed with ORIF using plates and screws, and 39 fractures were classified as bicondylar intra-articular fractures (AO/OTA type C).

A total of 32 patients met all inclusion criteria and were included in the study (Tab. I). The cohort consisted of 15 men and 17 women. The mean age was 53 years (range: 27-80 years). According to the AO/OTA classification, fracture patterns were distributed as follows: 9 type C1 fractures (Fig. 2), 13 type C2 fractures, and 10 type C3 fractures.

All surgeries were performed under general anesthesia, with patients prone and the affected arm on an armrest. A tourniquet was always used.

A posterior midline skin incision was used in all cases, allowing the creation of full-thickness medial and lateral flaps. The ulnar nerve was systematically identified, released, and protected throughout the procedure. Exposure of the distal humerus was achieved through a standard extra-articular V-shaped (chevron) olecranon osteotomy, performed proximal to the tip of the olecranon.

ORIF of the distal humerus fracture was performed with two anatomical 3.5-mm plates in a dual-column configuration, fixed with 3.5-mm screws to restore articular congruity and achieve stable fixation.

The olecranon osteotomy was reduced using a temporary reduction clamp and definitively fixed in all patients with two Kirschner wires and a tension band construct (Fig. 3). The tension band was knotted at the level of the anterior cortex distal to the osteotomy. No subcutaneous drains were used.

All patients followed a standardized postoperative rehabilitation protocol. Supervised physiotherapy started on the second postoperative day. Passive range-of-motion (ROM) exercises



**Figure 2. Preoperative image of a C1 fracture according to the AO/OTA classification.**

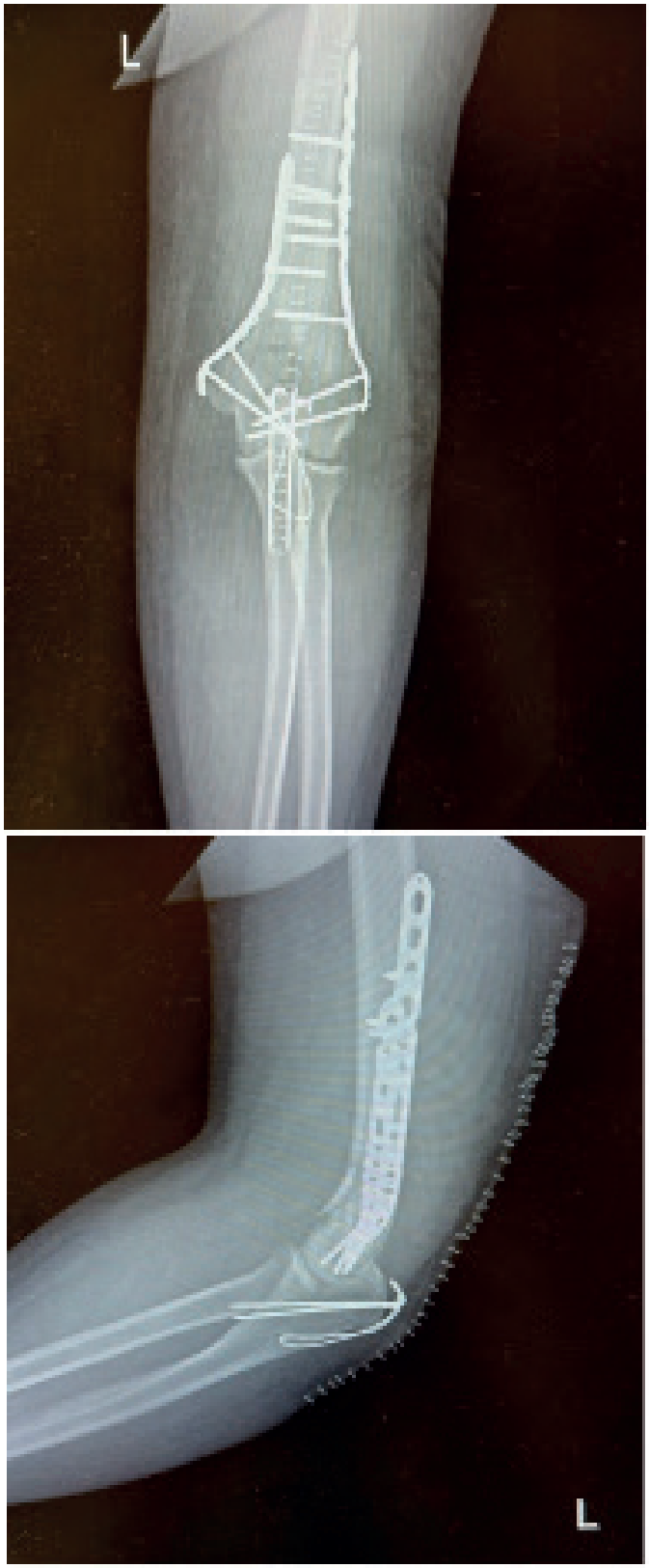


**Figure 3. Post-operative X-ray showing definitive fixation of the olecranon osteotomy with two Kirschner wires and a tension band structure.**

started as early as possible, usually on the first day after surgery, and increased as tolerated.

Active elbow mobilization was also initiated on the first postoperative day. Patients were allowed to use the affected limb for normal daily activities, except for lifting heavy loads. A continuous passive motion (CPM) device (Kinetec) was used to facilitate early elbow motion and gradual ROM recovery.

Full activity generally resumed between weeks five and six, based on clinical and radiographic findings. NSAIDs were prescribed only after fracture healing to manage pain and encourage early active exercises.

Clinical and functional outcomes were assessed using anatomical evaluation and the Mayo Elbow Performance Score (MEPS). Radiographic assessments were done at 3, 6, and 12 months postoperatively to evaluate fracture healing and osteotomy union (Fig. 2). The mean duration of follow-up was 10 ± 2 years.

## Results

According to the Mayo Elbow Performance Score (MEPS), functional outcomes were excellent in 12 patients (12/32, 38%), good in 15 patients (15/32, 47%), and poor in 5 patients (5/32, 16%). Overall, 27 of 32 patients (27/32, 84%) achieved excellent or good results (Tab. II). At the final follow-up, the mean elbow flexion-extension range of motion was 100° (range 10-130°).

According to the AO/OTA classification, fracture patterns were distributed as follows: 9 type C1 fractures, 13 type C2 fractures, and 10 type C3 fractures.

Functional outcomes differed according to fracture type (Tab. III). All patients with type C1 fractures achieved excellent or good results (9/9, 100%). Among type C2 fractures, 9 of 13 patients (69%) achieved excellent or good outcomes, while 4 (31%) had poor results. In the type C3 group, 9 of 10 patients (90%) achieved excellent or good outcomes, and 1 (10%) had poor results. Patients who underwent olecranon osteotomy for well-defined fracture patterns and limited soft-tissue edema had superior functional outcomes, as indicated by a higher proportion of excellent and good MEPS scores.

Complications included heterotopic ossification in two patients and ulnar nerve entrapment in two cases, both of which re-

**Table II. Functional outcomes according to MEPS (n = 32).**

| MEPS Outcome | n | % |
|---|---|---|
| Excellent | 12 | 38% |
| Good | 15 | 47% |
| Poor | 5 | 16% |
| Excellent + Good | 27 | 84% |

**Table III. Functional outcomes according to AO/OTA fracture type**

| Fracture Type (AO/OTA) | Total (n) | Excellent/Good n (%) | Poor n (%) |
|---|---|---|---|
| C1 | 9 | 9 (100%) | 0 (0%) |
| C2 | 13 | 9 (69%) | 4 (31%) |
| C3 | 10 | 9 (90%) | 1 (10%) |

quired surgical release of fibrotic adhesions.

Olecranon osteotomy-related complications occurred in 11 patients (34%), including one case of olecranon nonunion and 10 cases of symptomatic implant prominence. Ten patients underwent a second surgery for hardware removal, after which all resumed normal daily activities without further limitations.

## Discussion

Management of distal humerus fractures is challenging due to the elbow's complex anatomy and the need for both anatomic articular reduction and stable fixation to enable early mobilization. Sufficient visualization of the distal humeral articular surface is critical for anatomical reconstruction and optimal outcomes, especially in intra-articular (AO/OTA type C) fractures. Historically, the olecranon osteotomy approach has been widely used to improve articular exposure, facilitating direct visualization and reduction of complex fracture patterns. This exposure is a main advantage of the osteotomy technique, allowing precise restoration of articular congruity and alignment[11].

Despite its advantages, olecranon osteotomy is associated with several complications, as consistently reported in the literature. Large-scale studies indicate that osteotomy-related complications, including hardware irritation, delayed union, nonunion, wound complications, ulnar neuropathy, and heterotopic ossification, are relatively common and must be carefully considered. A systematic review of over 1,700 osteotomies reported wound infections in approximately 4.2% of cases, delayed union in up to 1.7%, and nonunion in 2%, with additional complications such as neuropathy and hardware failure[11].

In contrast to early concerns that olecranon osteotomy inherently increases morbidity, several recent clinical series suggest that with modern fixation techniques and careful soft-tissue handling, nonunion rates may be low and overall complication profiles acceptable. In a multicenter cohort of nearly 150 patients undergoing ORIF with olecranon osteotomy, osteotomy union was achieved in 98% of cases, with a relatively low rate of revision surgery for nonunion or fixation failure. Importantly, conversion to TEA after primary ORIF was uncommon (approximately 2%)[2].

Comparative analyses between olecranon osteotomy and triceps-sparing or paratricipital approaches have not consistently shown significant differences in long-term functional outcomes as measured by MEPS or similar scores[12]. However, some studies indicate that osteotomy may be associated with longer operative times, greater blood loss, and a trend toward higher overall complication rates, particularly for soft-tissue irritation and fixation-related issues.

Technical refinements in the fixation of the osteotomy site have also been investigated. Recent evidence supports the use of mini-fragment plates for osteotomy repair, which appear to be associated with lower rates of hardware removal and reliable union compared with traditional tension-band constructs, without increasing the risk of nonunion[4]. Moreover, emerging institutional data suggest that olecranon plating may yield lower reoperation and nonunion rates than tension-band wiring and other older fixation methods, underscoring the importance of implant selection in optimizing outcomes[13].

While olecranon osteotomy undoubtedly provides excellent visualization, it is important to recognize that less invasive exposure techniques—such as the flip-dislocation bicolumnar approach or triceps-reflecting approaches—can achieve comparable functional results in selected patients and may reduce the incidence of osteotomy-specific complications[5]. These alternative approaches may be particularly advantageous in less comminuted fractures where adequate exposure can be achieved without disrupting the extensor mechanism.

According to Praysonet et al., based on an experimental study, anterior ulnar cortical fixation under the coronoid process, using monofilament or braided steel wire, increases the stability of the cerclage-tie assembly and reduces pin lift, a source of conflict with the soft tissues of the elbow[14]. According to Coles et al., olecranon osteotomy allows exposure of a large joint surface, promoting anatomical reduction[15]. Gainor et al. state that the non-union rate is around 30%, whereas this study found a 7% rate, occurring in only one patient[16].

The literature reports good results for the chevron osteotomy approach to the olecranon, but it can be difficult to perform the osteosynthesis if the olecranon fragment is very small. Inadequate reduction of the olecranon is common, and improper pin trajectory often makes early engagement of the cortical bone difficult[17].

The quality of the osteotomy is sometimes defective (osteo-thick, olecranon too small). The disproportion between the steel wire and the pins used to make the cover is sometimes the cause of an interfragmentary compression defect. The anatomy of the proximal ulna is also a source of false paths. In fact, the olecranon is not located along the axis of the ulna, which has an S-shape[18]. This characteristic explains the difficulties and makes osteosynthesis risky for the positioning of the pins during fixation.

Complications, including heterotopic ossification and post-traumatic osteoarthritis, have been reported in association with complex distal humerus fractures. While these outcomes are not exclusively linked to the osteotomy, they reflect the

severity of the underlying injury and joint trauma. Heterotopic ossification occurs in a minority of patients but can impair motion and functional recovery, and osteoarthritis remains a frequent long-term consequence of intra-articular elbow fractures[11].

Holdsworth and Mossad and Jupiter et al. reported cases of modest periarticular ossification, whereas Kundel et al. reported a higher percentage (49%)[19,20,21]. In our study, only two patients presented with periarticular ossification, but this complication does not appear to be specific to olecranon osteotomy.

Osteoarthritis was found in 68% of cases in a study by McKee et al.[22]. This complication is not a direct consequence of olecranon osteotomy, but rather of complex elbow fractures.

Overall, the decision to perform an olecranon osteotomy should be individualized, considering fracture complexity, surgeon expertise, and available fixation options. While olecranon osteotomy remains a valuable technique for ensuring optimal joint exposure, surgeons must balance its benefits against the risk of osteotomy-related complications and consider alternative approaches when appropriate.

## Conclusions

This study shows that, with careful surgical technique, precise anatomical reduction, stable internal fixation, and early controlled rehabilitation, olecranon osteotomy results in an acceptable complication rate, even for complex intra-articular distal humerus fractures.

Although osteotomy-related complications were observed, they were generally limited in scope and manageable within this series. Olecranon osteotomy remains a valuable approach for achieving adequate articular exposure and facilitating fracture reconstruction. The decision to use this technique should be guided by fracture complexity, patient-specific factors, and the surgeon's expertise. Additional prospective and comparative studies are warranted further to clarify its role relative to alternative surgical approaches.

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### *Authors' contributions*

The individual contributions of authors to the manuscript should be specified in this section.

### *Ethical consideration*

The study was approved by the Ethics Committee (Comitato Etico Territoriale Lazio Area 1, protocol number 0598/2024).

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