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*Original Article*

# Modified cerclage wiring in comminuted transolecranon fracture-dislocations of the elbow

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**Abstract:** Transolecranon fracture-dislocations are a result of high-energy trauma, caused due to axial loading of the flexed forearm, with associated anterior dislocation of the ulna with respect to the distal humerus. The usual management of these comminuted and unstable fractures is by using locking compression plates via the dorsal approach. However, plating in cases of poor soft tissue coverage and open wounds can be precarious. In this study, we aimed to evaluate outcomes of cerclage wiring in the management of comminuted trans-olecranon fracture-dislocations in such scenario. A total of seven patients diagnosed with trans-olecranon fracture-dislocation with poor soft tissue coverage who underwent cerclage wiring were included in the study. The aim was to realign the proximal portion of the olecranon to the trochlea and restore the normal ulnohumeral articular relationships accomplished by the anatomical reconstruction of the greater sigmoid notch. Reconstruction of the proximal ulna was started from the distal to the proximal direction so as to convert an unstable fracture into a stable one. After the reduction of the proximal fragment, two long 2 mm K wires were inserted from the tip of the olecranon into the intramedullary canal (with at least 1 wire passed subchondrally), and later cerclage was done. Postoperatively the patient was immobilized for a duration of two weeks and was later started on active assisted mobilization of the elbow. All patients showed fair-to-excellent outcome on the Mayo elbow performance score (MEPS) at the final follow-up (five patients had an excellent score, one had a good score, and one had a fair score). At the final follow-up, the mean extension, flexion, pronation and supination were -20, 117.14, 82.85 and 78.57 degrees respectively. The key components of such management are the restoration of articular congruity, including continuity of the sigmoid cavity, ulnar length, and early initiation of active elbow movements to avoid joint stiffness. Optimal functional results can be achieved with K wire and cerclage when a stable anatomic reconstruction is accomplished, as a feasible alternative to plating.

**Keywords:** Transolecranon, fracture, dislocation, cerclage, wiring, elbow

## Introduction

Trans-olecranon fracture-dislocation is caused due to axial loading of the flexed forearm, with associated anterior dislocation of the ulna with respect to the distal humerus [1]. These injuries are a result of high-energy trauma to the elbow, causing severe soft tissue injury. Such fractures, if inadequately treated, can lead to significant morbidity with compromise in joint function. Few studies have previously published trans-olecranon fracture-dislocations which were managed by plating (**Table 1**). Bailey et al. and Mortazavi et al. have showed adequate results in such cases when managed with open reduction and internal fixation with plating [2, 3]. On the other hand, Mouhsine et al. in their case series have achieved lesser outcome scores and lesser mean range of motion [4]. In cases with poor soft tissue condition, open injuries, and non-affordability to costly anatomically contoured implants, the fracture may not be amenable to the plating. The management of such cases by a modified cerclage wiring technique as a practical method is contemplated. Hence, we aimed to evaluate outcomes of cerclage wiring in the management of comminuted trans-olecranon fracture-dislocations of the elbow with poor soft tissue coverage.

## Materials and methods

This study was a retrospective study carried out in a tertiary care center from January 2017 to

**Table 1.** Previously publshed studies on transolecranon fracture dislocation

| Author | Terms used | Number of cases |
|---|---|---|
| Wilppula et al. [6] | Olecranon fracture complicated by forward dislocation of forearm | 5 |
| Biga and Thomine [5] | Transolecranon fracture-dislocation | 13 |
| Scharplatz and Algower [16] | Atypical Monteggia lesion | 3 |
| Guerra and Innao [17] | Transolecranon fracture-dislocation | 24 |
| Loup [18] | Olecranon fracture associated with anterior dislocation of elbow | 1 |
| Wolfgang et al. [19] | Type D olecranon fracture | 5 |
| Wilkerson [20] | Anterior elbow dislocation with olecranon fracture | 1 |
| Ring et al. [21] | Transolecranon fracture-dislocation | 13 |
| Bailey et al. [2] | Mayo type III fracture | 11 |
| Ikeda et al. [14] | Mayo type III fracture | 4 |
| Moushine et al. [4] | Transolecranon fracture-dislocation | 14 |
| Fahsi [22] | Transolecranon fracture-dislocation | 10 |
| Our study | Transolecranon fracture-dislocation | 7 |

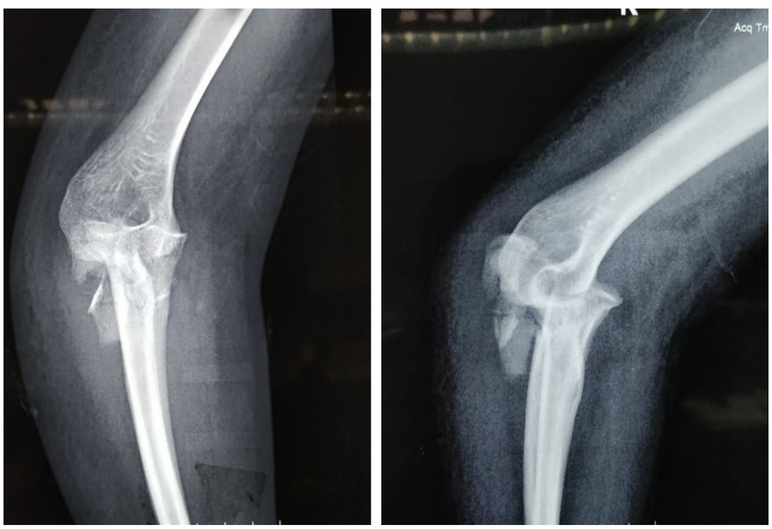

**Figure 1.** Case 6-anteroposterior and lateral radiograph of the elbow showing tansolecranon fracture dislocation.

December 2020. All patients presenting with a transolecranon fracture-dislocation of the elbow, which were managed by Kirschner wires (K-wire) fixation and Cerclage wiring technique, were considered for inclusion. After the local and neurovascular examination, anteroposterior (AP) and lateral radiographs of the elbow were performed and were reviewed. The diagnosis of such fracture was made when an olecranon fracture was associated with the anterior translation of the forearm in relation to the distal humerus on the lateral radiograph and intact proximal radioulnar joint on the anteroposterior and lateral view (**Figure 1**). The details of the patients are summarized in **Table 2**. All the patients were operated on under general anesthesia and by a single surgeon.

*Procedure*

The patient was placed in a lateral position with the arm supported over a padded post. A midline longitudinal posterior approach was used. The skin incision was applied 5-6 cm proximal to the elbow in the midline and curved medially or laterally over the olecranon extending 5 cm distally over the proximal forearm. This was followed by a dissection of superficial fascia and subcutaneous tissues. The aim was to realign the proximal portion of the olecranon to the trochlea and restore the normal ulno-humeral articular relationships accomplished by the anatomical reconstruction of the greater sigmoid notch. After thorough debridement and identification of fracture fragments, the first and foremost step is the reduction of the radiocapitellar joint, which can be done by a posteriorly directed pull to the forearm with the elbow in 90 degrees of flexion. The radial head is reduced easily in the majority of cases but may require relocation of the radial head in an annular ligament in selected cases. Reconstruction of the proximal ulna is started from the distal to the proximal direction so as to convert an unstable fracture into a stable one. It was followed by anatomical reduction of coronoid if involved, and visualization of coronoid was enhanced by reflecting up

**Table 2.** Demographic and fracture characteristics of all patients

| Case | Age/ Sex | Side/ Dominant arm | Mechanism of injury | Open/ Closed | Presence of nerve injury | Associated injury | Classification |
|---|---|---|---|---|---|---|---|
| 1. | 28/M | R/D | RTA | Gd 2 | None | Lateral condyle fracture | Mayo 3B |
| 2. | 52/M | L/ND | RTA | Closed | None | Both bone forearm fracture | Mayo 3B |
| 3. | 30/M | R/D | RTA | Closed | None | None | Mayo 3B |
| 4. | 45/M | R/D | assault | Open 3a | None | Rt coronoid process fracture | Mayo 3B |
| 5. | 26/M | L/ND | RTA | GD 3a | None | Lateral condyle fracture and radial shaft fracture | Mayo 3B |
| 6. | 26/F | R/D | RTA | Closed | None | Humeral shaft fracture | Mayo 3B |
| 7. | 23/M | R/D | RTA | Open Gd 2 | None | Rt proximal humerus fracture | Mayo 3B |

M, Male, F, Female, L, left, R, right, ND, non dominant, D, dominant, Gd, Grade, RTA, road traffic accident.

**Figure 2.** Case 6-anteroposterior and lateral radiograph of the elbow at the final followup showing reduced elbow with united olecranon fracture.

the proximal fragment with its triceps attachment. All the fragments were held by multiple threaded or smooth K wires. After the reduction of the proximal fragment, two long 2 mm K wires were inserted from the tip of the olecranon into the intramedullary canal, and preferably one K wire should be passed subchondrally as much as possible. A 2 mm drill was used to drill a tunnel through the ulna about 4 cm distal to the fracture site and 5 mm anterior to the posterior cortex. An 18 gauge stainless steel wire was prepared and passed through this tunnel from medial to lateral side in a figure of 8 configuration over the K-wires beneath the triceps. The wire was then tensioned by rotation of both the ends of the wire. Another Cerclage wire looped around the K wires, medial and lateral fragments (Lateral Ulnar Collateral ligament attachment) of greater sigmoid notch was tightened enough to provide adequate stability. It is important to keep the elbow in 90-degree flexion while tightening cerclage wires to avoid shortening of the sigmoid notch or disruption of the olecranon coronoid angle. The K wire tips were then cut and bent. Antero-Posterior and lateral view radiographs were taken using a C-arm image intensifier, and the articular congruity was checked. Elbow range of motion (ROM) was then carried out to check the stability of fixation. The wound was then washed with normal saline and closed in layers.

*Postoperative period:* In the postoperative period, the elbow was immobilized at 90 degrees of flexion in an above elbow plaster slab for a period of 2 weeks to allow for soft tissue healing. Wound inspection followed by antiseptic dressing was done on the second Postoperative day. Active assisted elbow range of motion was started after 15 days of surgery post slab removal. The outcome of the patients was assessed both radiologically and functionally. Radiographic evaluation included anteroposterior and lateral radiographs of the elbow for the union, including the assessment of proximal ulna dorsal angulation (PUDA), olecranon diaphyseal angle (ODA), and articular angle (AA). Clinical evaluation was done using Mayo Elbow Performance Score (MEPS) and Broberg-Morrey score.

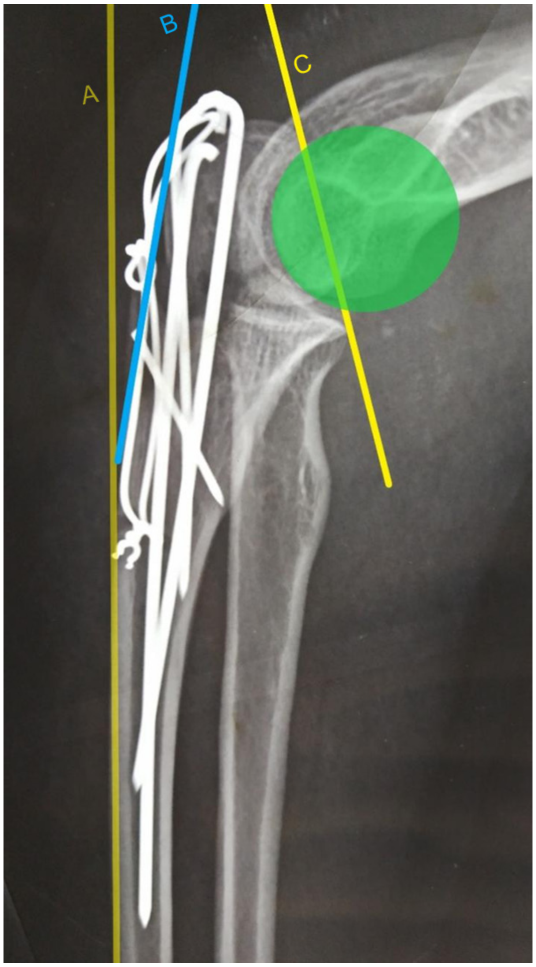


**Figure 3.** Case 6-lateral radiograph of the elbow showing anatomic reduction and restoration of the proximal ulna angle. (A) the axis of mediolateral diaphysis (ulna midshaft axis), (B) the axis of the posterior cortex of olecranon, (C) line passing between superior and inferior tips of trochlear notch. Angle between line (A) and (C) is olecranon diaphyseal angle (ODA), angle between (B) and (C) lines is articular angle (AA).

## Results

A total of seven patients with transolecranon fracture-dislocation were identified and included in this study. The mechanism of injury in most of the patients was a road traffic accident, except in one patient who suffered the injury due to an assault. All the patients were type 3B as per Mayo classification. 4 of the patients suffered from open fractures, which required additional debridement prior to fixation. All the patients were operated on within one week of the injury. Except for one patient, the remaining six patients suffered associated injuries in the same limb, which required additional definitive fixation in the same sitting. Anatomic reduction of the fracture was assessed postoperatively by proximal ulna dorsal angulation (PUDA), a mean value of 6.3 ± 2.4, olecranon diaphyseal angle (ODA), a mean value of 23.4 ± 6.1, and articular angle (AA), with a mean of 29.7 ± 4.5 (**Figure 3**; **Table 3**). The radiological evaluation at final follow-up showed a united fracture in all patients without any complications (**Figure 2**). Two patients developed hardware related problems. As per the clinical evaluation, the mean extension was -20 degrees, and the mean flexion was 117.14 (**Figure 4**), the mean forearm pronation and supination were 82.85 degrees and 78.57 respectively, and mean MEPS and Broberg-Morrey scores were 90.71 and 87.42, respectively. The results of the patients are enumerated in **Table 4**.

## Discussion

In 1974, Biga and Thomine described a form of injury in which there was a fracture of the proximal ulna with anterior dislocation of the elbow joint and was named transolecranon fracture-dislocation [5]. The transolecranon fracture-dislocation occurs due to direct trauma to the elbow in mid flexion, resulting in the instability of the elbow joint. The ulno-humeral joint becomes unstable, but the stability of the radio-ulnar joint is not compromised [4]. Various terms have been used in the past to describe this term [4]. These include atypical Monteggia fracture-dislocation, Mayo type 3 elbow injury. It is differentiated from Monteggia fracture by the presence of an intact annular ligament, and hence the radio-ulnar relationship is preserved [2, 4, 6].

The main aim of fixation is the restoration of articular congruity, ulnar length, and early initiation of painless elbow movements [7]. So, one must look for displacement and the presence of comminution as guiding factors for the management of these fractures [8]. Proper analysis of radiographs of the elbow, as well as Computed Tomography (CT) scans, aid in the diagnosis of such injuries. The presence of comminution distal to the semilunar notch renders the fracture unstable [8]. The vascularity of the fragments and the fracture gap also affect the union process [9]. The critical seg-

**Table 3.** Postoperative radiological measurements

| Case | ODA (Olecranon-diaphysis angle) | PUDA (Proximal ulna dorsal angulation) | AA (Articular angle) |
|---|---|---|---|
| 1. | 30 | 3 | 33 |
| 2. | 30 | 7 | 37 |
| 3. | 21 | 8 | 29 |
| 4. | 29 | 3 | 32 |
| 5. | 18 | 7 | 25 |
| 6. | 16 | 9 | 25 |
| 7. | 20 | 7 | 27 |
| Mean value | 23.4 ± 6.1 | 6.3 ± 2.4 | 29.7 ± 4.5 |

**Figure 4.** Case 6-clinical photo at the final follow-up showing terminal loss of flexion and extension of the elbow.

ment in such fractures is the bony fragment between the proximal part of the olecranon and the tip of the coronoid, which must be meticulously reduced in order to restore the appropriate length. Normally proximal ulna has a physiologic apex dorsal bow that has been named "proximal ulna dorsal angulation" (PUDA). Restoration of this angle is very important during the fixation of proximal ulna fractures. In the literature, the mean PUDA was found to be 5.7°, 6.2° ± 2.7° (range 1° + 11.2°) and 8.49° ± 2.69° (range 1.70° + 14.1°) in different studies [10-13]. In our study, PUDA was 6.3° ± 2.4° which was similar to the previous studies.

Plating has been used in comminuted fractures for a long time now. However, the elbow lacks the luxury of good soft tissue coverage, and this can contribute to wound dehiscence and exposure of implant, especially in cases with poor soft tissue and open injuries [8]. Baecher et al. also suggested that due to lack of soft tissues, there is irritation of soft tissues prompting the implant removal [8]. Niglis et al. reported high rates of posterior impingement with locking plates in olecranon [14]. Another issue that can be encountered is, in cases of comminuted fractures, the proximal bone fragment may be small and thin, making the plate fixation difficult [15]. Moreover, there is a variation in ulnar morphology, with the proximal ulna angulated dorsally to about 5 degrees. Very few plates accommodate this angulation in their design. The use of un-contoured plates may lead to malunion. However, these shortcomings of plates can be overcome by the use of tension band wiring and can be a plausible alternative to plate fixation.

Tension band wiring in such comminuted fracture-dislocations incorporates the use of long intramedullary K wires since the anterior cortex may not be intact in the majority of cases. Such a technique allows us to perform tension band wiring while mitigating the chance of wire migration. Also, the presence of intact radial head or fixed fracture of radial head retaining the lateral column support and maintain the secondary constraint of elbow stability helps to support an optimal fixation by tension band wiring without any collapse. Such a technique is useful in

**Table 4.** Postoperative clinical assessment of all patients

| Case | Time from injury to surgery | Final follow up in month | Postop. Flexion/ extension | Postop. Supination/ pronation | MEPS | Result | Complications | Broberg-Morrey |
|---|---|---|---|---|---|---|---|---|
| 1. | 1 day | 12 | 10°-120° | 90°/80° | 100 | Excellent | None | 88 |
| 2. | 7 days | 14 | 20°-120° | 70°/70° | 95 | Excellent | None | 93 |
| 3. | 3 days | 48 | 10-120 | 90/90 | 100 | Excellent | None | 95 |
| 4. | 1 day | 12 | 40-110 | 80/80 | 90 | Excellent | None | 80 |
| 5. | 3 days | 24 | 20-110 | 70°/60° | 80 | Good | None | 91 |
| 6. | 5 days | 16 | 20°-120° | 90°/80° | 95 | Excellent | None | 86 |
| 7. | 1 day | 4 | 20-120 | 90/90 | 75 | Good | None | 79 |

MEPS, Mayo elbow performance score; Postop, postoperative.

cases with compromised soft tissue and open wounds also since it involves the use of minimal hardware.

In our study, all the patients had Mayo-3b type of olecranon fracture, and were associated with either poor soft tissue condition or open injuries. The results were fair to good, and were comparable with the results of plate fixation in transolecranon fracture-dislocation in the literature [2, 3]. One patient had a fair MEPS score and another patient had good score, and the rest all had an excellent score of MEPS. There were no cases of wound infection or heterotrophic ossification in our study, and no problem of K wire migration was encountered. Bailey et al., in their study of 25 patients over 5 years, operated 11 cases of transolecranon fracture dislocation with plating. The mean MEPS score achieved in these patients was 90, similar to the mean score in our study [2]. Mortazavi et al. have operated 7 cases of transolecranon fracture dislocation with plating, The mean flexion, extension loss, pronation and supination measured were 115, 22, 75 and 83 degress respectively. In addition, the mean Broberg score in these patients was 88 [3]. These results are comparable to the outcome parameters in our study. Overall, the results of our patients validate the fact that stable anatomic fixation when obtained, regardless of the implant used, can provide optimal results and advocates the use of tension band wiring, whenever appropriate, as a feasible alternative to the plating, especially in cases of open injuries and poor soft tissue coverage.

The limitations of our study were retrospective cohort, small sample size and lack of any comparative group. However, since the criteria of patients included in our study is limited to transolecranon fracture dislocation in poor soft tissue conditions and as such the fracture itself is a rare entity, a comparative study may not be feasible to perform and appropriate comparsions were made with similar studies in literature.

## Conclusion

Comminuted Transolecranon fracture dislocations of the elbow require precise surgical management due to their complexity. The key components of such management are the restoration of articular congruity including continuity of the sigmoid cavity, ulnar length, and early initiation of active elbow movements to avoid joint stiffness. Optimal functional results can be achieved with K wire and Cerclage when a stable anatomic reconstruction can be achieved. The idea of the mean values of the angulations of the proximal ulna is a useful guide for anatomical Reduction of the fracture and restoration of bony anatomy during the surgery. However, a long term study with larger patients can provide further strong evidence.

## Disclosure of conflict of interest

None.

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