

SINGLE INSTITUTE EXPERIENCE OF AO TYPE 'C' DISTAL HUMERUS FRACTURES

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Abstract

Background: Distal humerus fractures in adult accounts for 2% to 6% of all fractures and are bimodal in distribution. Computed tomography(CT) will provide detailing of complexity of the fractures which helps in better pre-operative planning. Open reduction and internal fixation of intra-articular distal humerus fractures is a complicated procedure which requires a thorough understanding of fracture orientation, knowledge of the available fixation techniques and technical expertise with various challenges. In recent past, numerous studies have shown good results concerning range of motion, union rates and functional outcome scores at mid- to long-term follow-up. The aim of this study is to report the outcomes of a 6 year, single-center experience of operatively treated type C distal humerus fractures and to analyze the indicators for reoperation. **Materials and Methods:** Total 121 patients with type C distal humeral fractures treated surgically and met our inclusion and exclusion criteria with minimum follow up of 1year from the year 2017 to 2023 at our institution were enrolled in the study. Patients were assessed for the radiological union, range of movement, possible complications, status of hardware inside and functional outcome assessed with Mayo elbow performance score(MEPS). Statistical analysis is done with SPSS software 26.0. **Results:** Total 129 patients of the distal humerus fracture of AO type-C were treated in our institute. Among them, 121patients were available for follow up, 7 cases were not available for follow up and 2 were deceased. Of the 121 patients, 41 were female and 80 were male. Follow-up time ranged from 12 to 72 months (mean of 22 months). The mean age was 47 years old (range 1–80). The fracture has been healed by mean duration of 2.8months, ranging from two to fourteen months. 93 out of 121patients (77%) suffered no postoperative complication. Reoperation was indicated in 28 (23%) patients. **Conclusion:** The concept of bi-columnar fixation with locking compression plates provides good fixation with satisfactory fracture reduction and ensures healing in almost all cases. Reoperation rates are quite high even with improved internal fixation techniques. There was a higher rate of reoperation where olecranon osteotomy was done. Hence, surgeon should consider methods of fixation that inherently avoid soft-tissue irritation and implant prominence when dealing with olecranon osteotomy approach. Alternatively, bi-lateral-tricipital approach can be used in selected cases.

INTRODUCTION

We are witnessing a turnaround in recent years in the field of orthopaedics surgery with evidence-based approach and technical advancement with dedicated research, that promised a better care for complex intra-articular fractures. Treating elbow joint injury poses more difficulty because of its complex anatomy

and biomechanics involving three joints that move synchronously.^[1]

Distal humerus fractures account for 2% to 6% of all adult fractures and around 30% of humerus fractures and are bimodal in distribution, which occur as a result of either high energy trauma in young adults and low energy trauma in the elderly with osteoporotic bone.^[2]

The diagnosis of these fractures can be made with plain X-rays, but computed tomography (CT) will provide detailing of morphology and complexity of the fractures which helps in better pre-operative planning.^[3] Among the many classifications described, the AO or OTA classification takes into account the location of the fracture and comminution, while the Jupiter and Mehne classification is based on the morphology of the fracture.^[4,5]

Among the distal humerus fractures, AO type C fractures which are usually high velocity injuries which disrupt the distal humeral columns are challenging because of the following reasons.

1. Distal humerus fractures are invariably associated with adjacent soft tissue injuries with compromised skin conditions with or without blebs that delays the surgery.
2. The complexity of joint anatomy makes it difficult to get adequate joint exposure. The maximum is around 60% with olecranon osteotomy.^[6]
3. The unique anatomy of the distal humerus makes it challenging to fix the plates.^[7]

Historically, in 1937, Eastwood proposed the 'treat as a bag of bones' technique for conservative management of distal humerus fractures which required prolonged immobilization thereafter leading to elbow stiffness and heterotopic ossification.^[8]

In treating distal humerus fractures, the main goal is to get a painless, stable and functional elbow. The outcome of surgical treatment depends on many factors. The elbow joint is notoriously known for stiffness and contractures because of the initial injury as well as the subsequent surgical trauma.

Open reduction and internal fixation of intra-articular distal humerus fractures is a complicated procedure which requires a thorough understanding of fracture orientation, knowledge of the available fixation techniques and technical expertise with various challenges like difficulty in getting sufficient exposure of the injured joint and reconstruction of articular surfaces, inter - condylar involvement, presence of comminuted fragments, limited bone stock for stable fixation especially in osteoporotic elderly patients and associated morbidity, if not constructed anatomically.^[9]

Few different surgical approaches that have been used to fix type C distal humerus fractures include posterior approach using a triceps flap, triceps lateral, triceps splitting approach, combined lateral and medial, and with olecranon osteotomy.^[6]

Even with the complexity involved in treating these fractures, in recent past, good number of studies have shown good results in relation to range of motion, fracture union rates and functional outcome scores at mid- to long-term follow-up. However, many studies have mentioned about reoperation particularly related to infection, stiffness of the joint and implant removal.^[7,9-11]

The aim of this study is to report the outcomes of a 6 year, single-center experience of operatively treated type C distal humerus fractures and to assess the

radiological union, functional outcome and analyze the indications for reoperation rate and to quantify the relative contribution of the patient (age, gender), type of injury (fracture sub-classification, open fracture), and the treatment (delay in surgery, type of approach and duration of postoperative immobilization) factors to the prognosis for reoperation.

MATERIALS AND METHODS

In the years 2017-2023, all patients with type C distal humeral fractures treated at our institution were recorded. One-hundred and twenty-one patients who satisfied the inclusion and exclusion criteria were enrolled in the study.

Inclusion Criteria

- Age of more than or equal to 18 years from both the sexes with distal humerus fractures [AO type 13C]
- Closed and Early Gustilo-Anderson type 1 and 2 open fractures,
- Subjects with bilateral distal humerus fractures were also included.

Exclusion Criteria

- Age – less than 18 years
- Gustilo-Anderson type 3 fractures
- Closed fractures with neuro-vascular injuries
- Co-existing ipsilateral upper limb fractures
- Pathological fractures
- Revision surgeries or operated elsewhere
- Upper limb congenital deformity
- Existing degenerative or inflammatory arthritis of the elbow and
- Patients who refused to give informed written consent

Surgical Technique

- Senior trauma surgery team operated all the cases electively with prior consent.
- Pre-operative planning was made with Radiographs and CT images.
- Standard surgical procedure was followed with universal precautions.
- General anesthesia or regional Brachial plexus block were used.
- Lateral position was used with arm on a side bar and a high pneumatic tourniquet.
- The incision was posterior, midline longitudinal curved over the olecranon.
- Ulnar nerve was identified, retracted and secured in all cases,
- Articular exposure approach has been decided by operating surgeon as demanded by the fracture pattern and method of fixation.
- Fixed angle locking compression plates were used for fixation.
- Inter - condyles were fixed with cannulated cancellous screws and Osteotomy repaired by tension band wiring in necessary patients.

Post-Operative Management

- Parenteral Third generation cephalosporin was given for 48 hours post-operatively till the drain tubes were removed. Then oral antibiotic was administered till the suture removal.
- Oral indomethacin (75mg/day) was started on post-operative day one and given for three weeks.
- Active mobilization was started after first dressing under the supervision of a physiotherapist.
- Patients were evaluated at 6 weeks, 12 weeks , 6months, 1 year and then annually.
- In the follow up wound related complications, range of movements at elbow joint and distal radio ulnar joint, return to routine /professional activities, fracture union, ulnar neuropathy, implant failure and heterotopic ossification were assessed.
- Radiological bone union was assessed with radiographs with 2 views.
- Functional outcome was assessed by Mayo elbow performance score

Fracture healing was assessed by the following:

- Absence of local tenderness or pain to vertical percussion,
- Absence of abnormal movement,
- X-ray revealing continuous callus at the fracture site and no distinct fracture line, and
- The Ability to lift and hold a 1 kg object for 60 seconds without pain or deformation at the fracture site.^[7]

In the subsequent follow up, patients were assessed for range of motion, radiological union, possible complications like stiffness, heterotopic ossification, superficial or deep infection, implant irritation and functional outcome assessed with Mayo elbow performance score(MEPS).

Statistical Analysis: Data from all three series has been compiled in Excel sheet and analysis was done with SPSS 26 software.



Range of movement – Pronation, Supination, Extension and Flexion.

RESULTS

Total 129 patients of distal humerus fracture of AO type C were treated in our institute. Among them, 121 patients were available for follow up, 7 cases were not available for follow up and 2 were deceased. Of the 121 patients, 80 were male and 41 were female. Follow-up time ranged from 12 to 72 months (mean of 22 months). The mean age was 47 years old (range 18–80). Fourteen patients presented with open fractures, of which three were type II, and eleven were type I based on the classification of Gustilo and Anderson. The mean duration between injury and surgery was three days, ranging from 0 to 15 days. Among the 14 patients with open fractures, only one underwent emergency surgery. In that patient, emergency debridement and fracture fixation was performed.

According to the AO classification system, 10(8%) fractures were type C1 (simple articular), 24(20%) were type C2 (metaphyseal comminution), and 87(72%) were type C3 (multifragmentary). Determination of the classification was made by the consultant surgeon at the time of surgery.

The fracture had healed in a mean duration of 2.8 months, time duration ranging from two to fourteen months. 93 out of 121 patients (77%) suffered no postoperative complication. The demographic and injury characteristics of these patients along with postoperative complications were summarized in [Table 1].

Total 28 patients encountered one of following complications and almost all patient got good to excellent functional range of motion which was summarized in [Table 2].

Reoperation rate: Reoperation was indicated in 28 (23%) of 121 patients because of both acute and chronic complications like wound dehiscence or superficial infection in 9 cases, symptomatic hardware in 19, deep infection in 1, re-fracture of humerus at different level, contracture in 1, and ulnar neuropathy due implant irritation in 1 case. Among these 4 patients had both superficial infection as well as hardware irritation. There was no case of non-union of either distal humerus or olecranon osteotomy

Patient and injury factors associated with reoperation:

Lower rate of reoperation has been noted with increasing patients age ($P < 0.029$) [Figure 1]. The type of the fracture, that is AO type C3 comminuted fracture was not correlated with a higher rate of reoperation ($P < 0.146$). In addition, gender ($P < 0.772$), and the presence of any open fracture ($P < 0.111$) did not show any association with reoperation rate.

Approach type and reoperation rate

27 out of 28 patients who underwent a reoperation were operated with olecranon osteotomy approach with either hardware irritation or superficial infection as an indication in majority of the cases.

Other treatment factors and reoperation rate:

Ulnar nerve transposition and bone graft usage did not show correlation with reoperation rate. There was no association proven with time to surgery less than 3days and post-operative immobilization of seven days or more.

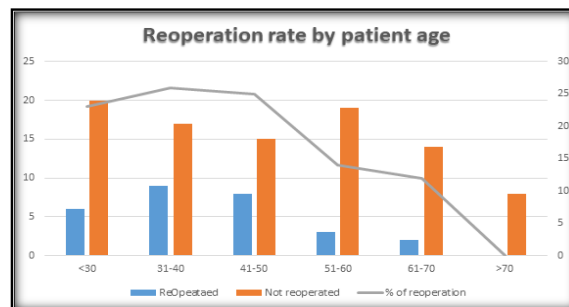


Figure 1 Re-operation rate by patient age

Table 1: Demographic data of the patients

Characteristics Patients	Total
Gender, n (%)	
Male	80(66%)
Female	41(34%)
Age(years) Mean	45.45years
Range	(21-80years)
Cause of injury, n (%)	
Simple fall	35(30%)
Fall from height	17(14%)
Traffic accident	67(55%)
Assault	02(1%)
Fracture type (AO/OTA),n (%)	
C1	10(8%)
C2	24(20%)
C3	87(72%)
Open fracture, n (%)	14

AO/OTA Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association

Table 2: Findings of the patients at the postoperative and follow-up periods

Characteristics Patients	Total
Postoperative complications,	
Superficial wound site infection	09
Ulnar neuropathy	01
Deep infection	01
symptomatic hardware	19
re-fracture of humerus	01
contracture	01
According to the MEPI score, n (%)	
Excellent	92(76%)
Good	17(14%)
Fair	11(9%)
Poor	1(1%)
Functionality at the last follow-up	
Median (Minimum-Maximum)	
Elbow joint flexion, degree	118.36 (77-130)
Loss of extension, degree	07.64(0-13)

MEPI: Mayo Elbow Performance Index

DISCUSSION

In distal humerus fractures, high comminution and intra articular extension are common. The complex

anatomy with less bone stock with insufficient subchondral bone complicates the surgical management.^[14] To get the successful end results anatomical reduction with column specific fixation is

the cornerstone. Pre-contoured anatomical LCP plates have become 'gold standard' among the available plates. Dual plating will provide stable and accurate reduction and allows early mobilization of joint.^[15] Orthogonal and parallel orientations are the two popular methods of dual plating. Proper pre-operative planning is crucial for satisfactory outcome.

The ideal timing of surgery for type C distal humerus fractures remains controversial with some surgeons recommending emergency surgery within 24 hours of injury.^[16,17] In our experience, surgical repair of the fracture should be delayed in patients who have severe local swellings with or without blister and emergency surgery should be considered in case of open fractures with thorough debridement. This improves soft tissue healing and aids in early post-operative functional exercise.^[7]

Many approaches have been described for distal humerus fracture repair, each having its own merits and demerits.^[7] In our institute, most of the cases were done with trans-olecranon approach which gives the maximum visibility of the articular surface and allows accurate articular reduction.^[6]

The triangle shape of the distal humerus in the coronal plane forms two strong columns by proximal extension.^[18] Understanding of this leads to two-column fixation concept with recreating the integrity of the medial and lateral columns.^[6,7]

Many complications including infection, joint stiffness, nerve injury, delayed union, heterotopic ossification, and nonunion of the ulnar olecranon have been reported following the fixation of distal humerus fractures. In our study, total 28 patients reported various complications like wound dehiscence or superficial infection in 9 cases, symptomatic hardware in 19, deep infection in 1 case, re-fracture of humerus at different level, contracture in 1, and ulnar neuropathy due to implant irritation in 1 case and underwent revision surgery. Among these one with deep infection underwent hardware removal and external fixator application till the infection subsided and got poor results. This is similar to the study done by Somerson et al.^[9]

Gofton et al,^[19] reported postoperative heterotopic ossification in 13% of patients with type C distal humerus fractures treated operatively. But we have not encountered any such cases. It may be because of routine prophylactic Indomethacin oral prescription and early exercises.

With strong bi columnar fixation with dual locking plates gives satisfactory fracture reduction and healing ensured in all the patients and there was no case of non-union or delayed union encountered in our study in contrast to findings from several previous reports.^[16,17,19,20]

A good range of factors were reviewed including patient factors (age, gender), type of injury (fracture sub-classification, existence of open fracture), treatment factors (duration of postoperative immobilization, and type of approach) associated

with reoperation because of early, mid or late complications.

Sanchez-Sotelo et al,^[21] reported higher risk of reoperation in the presence of open fractures in which 6 out of 14 patients with an open C3 distal humerus fracture underwent reoperation. But in our study the association between the open fracture and reoperation was not significant. This may be because of not including the type 3 open fractures in our study.

Many studies have reported higher rate of reoperation and symptomatic implants with olecranon osteotomy to other approaches. In our study also we got a positive association between the reoperation rate and olecranon osteotomy approach similar to Somerson et al.^[9] Other than surgical approach no other treatment factors demonstrated an association with reoperation.

The study has been conducted in a single institute, operated by a single trauma surgery team with better rate of patient follow up which can be stated as strength of this study. However, the study also has few limitations.

1. This study is a retrospective review of prospectively gathered data which adds the risk of confounding and bias.
2. Identification of AO type C fractures was done by the consultant surgeon and no separate assessment of radiographs were done.

CONCLUSION

The concept of bi-columnar fixation with locking compression plates provides good fixation with satisfactory fracture reduction and ensures healing in almost all cases. Re-operation rates are quite high even with improved internal fixation techniques. Olecranon osteotomy approach was associated with a higher rate of reoperation. Superficial or deep infection, wound complications and symptomatic implants were the most common indications for reoperation. The additional hardware used on ulna in case of olecranon osteotomy and need for removal of this because of superficial placement and skin irritation justifies the high reoperation rates in olecranon osteotomy cases. Hence, surgeon should consider fixation methods that avoid implant prominence and soft-tissue irritation when dealing with olecranon osteotomy approach. Alternatively, bilatero-tricipital approach can be used in selected cases.

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