Original Article

Comparative Study for Assessment of Functional Outcome of Intraarticular AO Type C Distal Humerus Fractures Treated by Parallel Plating

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Abstract

Background: Complex distal end of humerus fractures are one of the most challenging cases in orthopedics. There is a paucity of literature on outcomes of parallel reconstruction plates using olecranon osteotomy technique along with large sample size. This study focuses primarily on rate of various complications encountered in intraarticular AO Type C distal humerus fractures. **Materials and Methods:** In this prospective study, we included 94 patients with isolated closed intraarticular AO type C distal and humerus injuries. Exclusion criteria were polytrauma, open injuries, and pathological fractures (except osteoporosis). The followup was done immediate postoperatively, 6 weeks, 6 months, 1 year and at 2 years. Range of motion (ROM), Mayo Elbow Performance Score (MEPS), and Disabilities of the Arm, Shoulder, and Hand (DASH) score was recorded at each visit. Assessment of union was done based on X-ray. Patients were classified into two groups; Group 1 – patients without complications (n = 64) and Group 2 – with one or more complications. **Results:** The average duration of surgery was 2 h and 15 min. The complication rate was 31.9% (30/94), however, a total of 45 complications were noted. The difference between ROM in the two groups was statistically significant ($P < 0.05$), however, the difference between MEPS and DASH score was not statistically significant. The most common complication found was ulnar nerve neuropathy. **Conclusion:** Parallel plating using olecranon osteotomy is an acceptable approach for this fracture, but due to inherent nature of this injury, it has its own set of complications which must be counseled before surgery and active participation of patient is required to obtain realistic expectations and goals for the future.

Keywords: *Complications, functional outcomes, intercondylar humerus, parallel plating*

Introduction

The management of complex distal humerus fractures, especially AO Type C fractures is one of the most challenging aspects in the field of orthopedics.[1] Lower end of the humerus is peculiar for its unique orientation of articular surface and limited quantity of cancellous bone.[1] Operative intervention is required in almost every case. With further advancement, different internal fixation methods have developed to improve the outcome. Various modalities for fixation include using only articular screws to plating in different arrangement (parallel/orthogonal) to precontoured anatomical plates.[2-4] Total elbow arthroplasty is preferred in elderly osteoporotic patients with comminuted fractures.[5] There is bimodal age distribution in distal humerus fractures. High-energy injuries are common in younger patients, while low-energy injuries are more prevalent in elderly. Sanchez-Sotelo *et al*.[6] recommended eight objectives for achieving maximum fixation in the distal fragment and to ensure adequate stability at the supracondylar level.

There is a paucity of literature on outcomes and complications of parallel reconstruction plating using olecranon osteotomy technique alone. We present this study which focuses primarily on rate and types of various complications encountered in the treatment of fresh isolated closed intraarticular distal humerus fractures using the above mentioned technique alone. We also aim to study whether there is any difference in functional outcome in patients at final followup (2 years) having complications of the surgery *vis-à-vis* patients without any complications.

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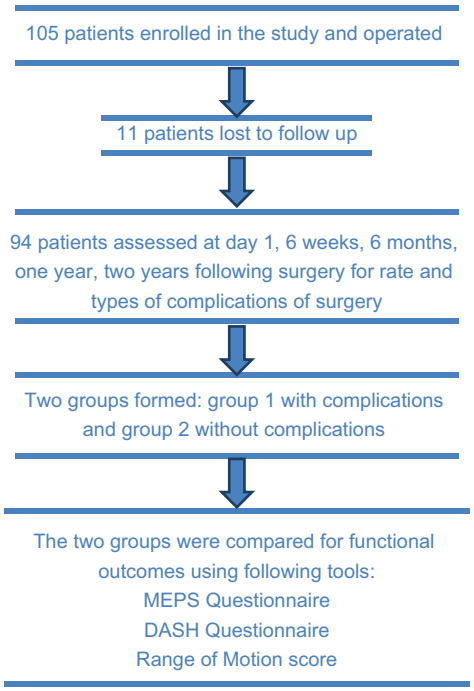
Materials and Methods

This prospective study was conducted in the Department of Orthopedics at our institute. Patients were enrolled for the study from January 2012 to January 2015. One-hundred and five patients were enrolled in the study and due written consent was obtained. The inclusion criteria were fresh AO Type C fractures (<7 days), age between 18 and 60 years, and isolated closed intraarticular distal humerus fractures. Exclusion criteria were polytrauma patients, open injuries, pathological fractures (except osteoporosis), fractures with distal neurovascular injury, fractures with associated compartment syndrome, and parents/guardians/patients not willing to participate in the study. Eleven patients were lost to followup after the surgery and the remaining 94 were analyzed using "as treated" protocol [Flow Chart 1].

The study was approved by the local ethical committee. Baseline hematological investigations and ELISA for hepatitis B, hepatitis C, and HIV were done. Comorbidities such as hypertension and diabetic status were assessed preoperatively. X-rays (anteroposterior and lateral views) and noncontrast computed tomography scans of the distal humerus and elbow of the involved side were obtained in all the patients for preoperative planning.

Operative procedure

All the patients were operated using standard technique along with tourniquet, using posterior approach to the elbow with olecranon osteotomy. Patients were placed in the lateral decubitus position after induction under general anesthesia or supraclavicular block. About 10 cm long incision was made starting 5 cm above the elbow joint, curving on lateral side at olecranon tip, and continuing on the shaft of the ulna. Skin and soft tissue were dissected, and ulnar nerve was identified, isolated, and protected with the use of infant feeding tube. Meticulous mobilization of the ulnar nerve and release of medial intermuscular septum was performed to prevent ulnar nerve injury. Then, V-shaped chevron osteotomy of the ulna was done 2 cm from the tip of olecranon. Intraarticular portion of the distal humerus was visualized, provisional reduction with K wires was achieved, and then parallel reconstruction 3.5 mm plates were applied [Figure 1]. After reconstruction of the distal humerus, olecranon osteotomy site was reduced and fixed with tension band wiring. Closure was done in layers. The principle of surgery complied with the principles of fixation as given by Sanchez-Sotelo *et al.*[6] Single dose of preoperative and three doses of postoperative antibiotics in the form of ceftriaxone (1 g) and amikacin (500 mg) were given. Patients were mobilized gradually from the 1st postoperative day with both active and passive exercises. Continuous passive motion under the supervision of experienced physiotherapists was started from the next day.



Flow Chart 1: Summarizing methodology of the study

Patients were followed subsequently immediate postoperatively, 6 weeks, 6 months, 1 year, and 2 years. Clinical assessment was done by goniometric assessment of range of motion (ROM) by one of the authors (R. P.). Mayo Elbow Performance Score (MEPS) and Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire forms were filled by patients on each followup visit. Assessment of union was done based on serial X-ray imaging by a single senior author (I.K.D.).

Several complications which were noticed in our study were implant impingement, nonunion, ulnar nerve neuropraxia, wound dehiscence, elbow stiffness, heterotopic ossifications, and degenerative joint disease. Patients were categorized into Group 1 if they did not have any of these complications and were classified

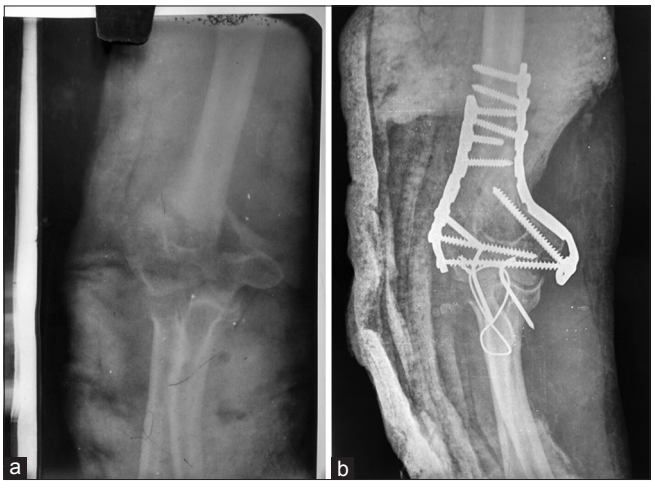


Figure 1: Photographs showing preoperative X-ray (3a) and postoperative (3b) X-ray of a patient

into Group 2 if they had one or more than one above mentioned complications. The two groups were compared on the basis of MEPS, DASH, and ROM to see for any statistical difference.

Results

One-hundred and five patients fulfilled inclusion criteria of the study, of which 11 were lost to followup after surgery (attrition rate: 10.4%). The remaining 94 patients were analyzed using "As Treated" protocol. Of the 94 cases included in our study, 67 were male and 27 were female (M:F = 2.48:1). Dominant extremity was involved in 62 cases, while in 32 cases, nondominant extremity was involved. The mean age group was 46.4 years (range 18–58 years). Twelve cases were diabetic and 6 patients were hypertensive at the time of admission and all of these patients were adequately optimized before surgery.

The average duration of surgery was 2 h and 15 min (range 1 h 24 min to 4 h 32 min). Average blood loss was 156 ml (range 110–320 ml) with an average tourniquet time of 2 h and 8 min (range 1:30–3:30 h). Patients were followed up after 6 weeks, 6 months, 1 year, and 2 years. The mean followup was 31 months (range 24–38 months). The complication rate in our study was found to be 31.9% (30/94); however, a total of 45 complications were noted in our study group as 18 patients had one complication, 9 patients had two complications while 3 patients had three complications [Table 1].

At the end of 2 years followup, out of 94, 64 patients were categorized into Group 1 (without complications) while 30 patients were categorized into Group 2 (with complications).

Implant impingement was observed in five cases (5.3%). In four out of five cases, the impingement was due to the K wires and the fifth case had impingement due to stainless steel wire used for tension band wiring. All five patients became asymptomatic following implant removal.

The most common complication in our study was ulnar nerve neuropathy [Figure 2]. A total of 14 cases (14.8%) had sensory and 3 cases (3.1%) had motor deficit in the ulnar nerve which recovered in 3 months on its own. Wound dehiscence was observed in 12 cases (12.7%) [Figure 3]. Eight of these 12 cases were diabetic. The problem of wound dehiscence was tackled by negative suction wound therapy.

Nonunion was observed in 6 cases (6.38%), it was at supracondylar level in all these patients. However, in one of these patients, union was achieved following varus collapse leading to implant impingement [Figure 4]. Implant removal was done to relieve the impingement.

Heterotrophic ossification was observed in three cases (3.1%). Four cases (4.2%) had degenerative joint disease. According to the Broberg and Morrey scale[3] for

Table 1: Complications observed after operation

Name of complication	*n*
Implant impingement	5
Ulnar neuropathy	14 (sensory in 14 and motor in 3)
Wound dehiscence	4
Elbow stiffness	11
Nonunion	6
Heterotrophic ossification	3
Degenerative joint disease	1
Implant failure	1
Total	45

Figure 2: Clinical photograph showing postoperative ulnar neuropathy

posttraumatic arthritis, 1 patient had Grade 1, 2 patients had Grade 2, and 1 patient had Grade 3 degenerative arthritis.

Functional ROM was classified according to Cassebaum classification.[7] Twelve cases (12.7%) had very good, 53 (56.4%) had good, 18 (19.1%) had fair, and 11 (11.7%) had poor outcomes in terms of ROM as assessed by goniometer readings [Figure 5].

The average time to union in our study was 11.8 weeks (range 9–26 weeks) which is consistent with other studies.[8-11]

The average ROM for Group 1 and 2 at 2-year followup was 123.45^0 and 113.87^0, respectively. The average MEPS score was 88.28 and 88.67 for Group 1 and 2. The average DASH score was 39.63 and 39.61 for Group 1 and Group 2, respectively.

The independent sample *t*-test was used to compare between MEPS, DASH, and ROM between the two groups [Table 2]. ROM between the two groups was found to be statistically significant ($P < 0.05$), but there was no statistical difference between the two groups in terms of MEPS and DASH score.

Discussion

Intraarticular distal end humerus fractures have always been a challenge to orthopedic surgeons due to inherent

Table 2: Comparison of functional outcome between patients with and without complication

Functional score	With complication (*n*=30), mean (SD)	Without complication (*n*=64), mean (SD)	*P*	Combined (*n*=94)
Disabilities of the Arm, Shoulder, and Hand score at 2 years	39.61 (3.29)	39.63 (2.74)	0.972	39.62 (2.91)
MEPS	88.67 (9.28)	88.28 (8.13)	0.838	88.40 (8.47)
Mayo Elbow Performance Score at 2 years				
ROM at 2 years	113.87 (16.79)	123.45 (8.99)	0.006	120.39 (12.76)

SD=Standard deviation, ROM=Range of motion

Figure 3: Clinical photograph showing wound dehiscence in postoperative period

Figure 4: Photograph showing X-ray of the patient following varus collapse

complications of these injuries which require proper intraarticular reduction and metaphyseal compression. O'Driscoll in his famous article described two limiting factors which cause poor outcome. The first limiting factor was decreased ROM of the elbow due to immobilization and the second was nonunion at the supracondylar level.[6] We have given special emphasis on early mobilization of patients and active assisted exercises are started from the 1st postoperative day. Continuous passive motion exercises were started on the CPM machine from the 2nd postoperative day. The ROM exercises and CPM were under the supervision of experienced physiotherapists.

Our study comprises of 94 cases treated by olecranon osteotomy approach with parallel plating, and only closed fractures were considered for the study, in comparison to other studies which either has more than one approach or configuration of plating. The surgery was performed by one of the three authors of the study (H. B., R. P., and I. K. D.).

The scoring of the patients was done by a single orthopedic surgeon (R. P.). Average ROM in our study was found to be 120.39^0 at 2-year followup in comparison to only 27.86 at immediate postoperative period. This can be explained by pain in early postoperative period which restricts the ROM. As the pain settles down, the ROM increases. The optimum ROM is achieved over the next 6 months. The ROM did not change much after 6 months of followup.

Our results were comparable to many studies. Ozer *et al*.[12] calculated ROM in Type C1 and C2 with average of 116° and Type C3 fractures having 85°, but this study used triceps-reflecting anconeus pedicle approach and only 11 cases were studied. Other reported studies report total ROM after dual plating irrespective of plate position in other studies range 103–112° for type C distal humerus fractures.[13-15]

The mean MEPS score in our study was found to be 88.4; this result was superior to several studies.[6,16,17] A study by Rebuzzi *et al*.[18] showed an average score of 94.17 which was higher as compared to our study, but this study had less number of cases (*n* = 13). It was a retrospective study in comparison to our study which is a prospective study of 94 cases. Athwal *et al*. reported mean MEPS score of 82 in 37 patients with type C distal humerus fractures fixed with bicolumnar parallel plating.[16]

Average mean DASH score in our study was 39.62, this was better than study by Theivendran *et al*.[17] which has an score of 46.1. This is one of the few studies which compared both MEPS and DASH score in their outcome.

The difference in ROM between the two groups was found to be statistically significant (113.87 and 123.45); however, this can be explained on the basis of change in effect size. There was no statistically significant difference between DASH and MEPS scores in the two groups, as these two scores assesses the functional capacity of upper limb as whole and not solely focuses on the elbow movement. Loss of elbow function can be compensated by combined movement of shoulder abduction, flexion, and humeral internal rotation.

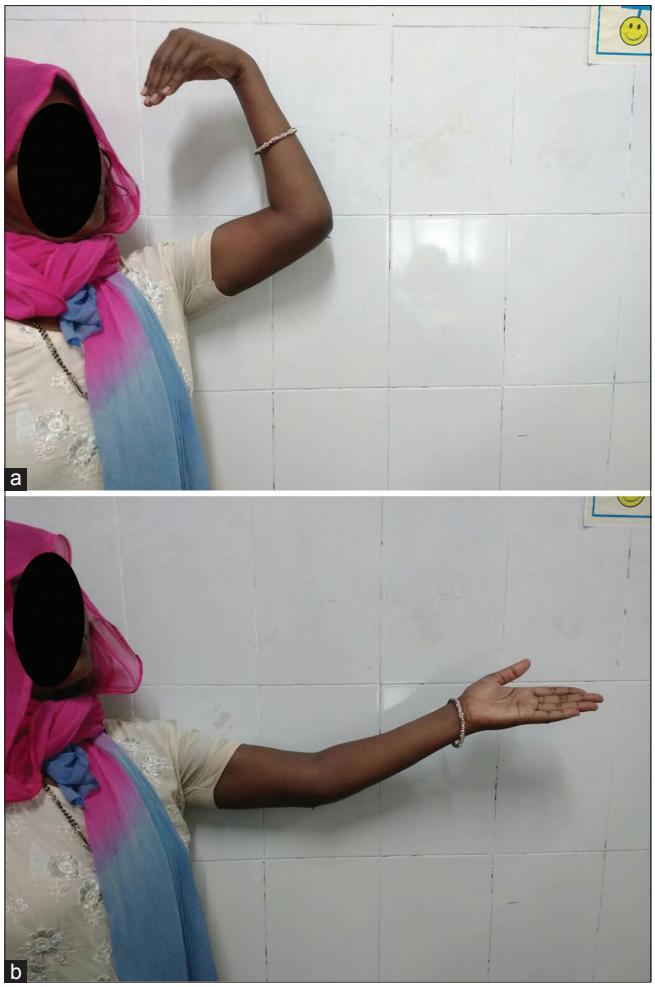


Figure 5: Clinical photographs showing elbow stiffness. (a) Extension. (b) Flexion

Complication rate of up to 48% has been reported in literature.[15,19,20] The complication rate in our study was consistent with the existing literature.

This prospective study reports a single institution study, where all the cases were operated by experienced surgeons, using the same implant, same operative approach and uniform postoperative rehabilitation protocol. Objective outcome measures were involved for comparisons at sequential visits. A limitation of the study was that 11 patients were lost to followup which could have led to a bias owing to the complication of the surgery. No correction for this attrition (10.4%) has been made in this study and the study participants have been analyzed "As treated." Another limitation is that there is no comparative group in this study as we have documented the rate and types of complications encountered using a single technique (parallel plating using olecranon osteotomy).

Conclusion

Parallel plating using olecranon osteotomy is an acceptable approach for AO type C distal humerus fracture patterns despite the inherent complications of this injury. In the current study, around one-third of the patients developed at least one complication after the surgery. The most common complication was found to be ulnar nerve neuropathy. No significant difference was found in functional outcomes in terms of DASH and MEPS score in patients with or without complications. Although the ROM did show a statistically significant difference in patients with complications, the difference itself was quite small ("small effect size"). Yet, it is indeed imperative to counsel the patients about the rate and kind of complications before surgery. This shall improve the active participation of patients and will help the patients to obtain realistic expectations and goals for the future.

Research involving human participants

All procedures were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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