Pre-contoured locking plates vs conventional reconstruction plates in AO type C Distal humerus fractures: A prospective randomised study

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Abstract

Background: Reconstruction plates have been used from a long time for fixation of distal humerus fractures. Locking plates are increasingly used now-a-days. The aim of this study is to compare the radiological and functional outcome of AO type C distal humerus fracture treated with pre-contoured locking plates with conventional reconstruction plates.

Material and Methods: A total of 25 patients of AO type C distal humerus fracture were treated using locking plates (n=14) or reconstruction plates (n=11) and compared for radiological union and for functional outcome by Mayo Elbow Performance Score (MEPS).

Results: The mean duration of surgery and hospital stay was similar in both the groups. The mean Range of motion and MEPS score was significantly higher in locking plate group as compared to conventional reconstruction plates at 3 months post operatively. However both of them were similar at 6 months and 12 months post operatively. 93% union rate in locking plate group and 91 % union rate in reconstruction plate group were seen at the end of 12 months follow-up. Excellent and/or good results were obtained in 93% in locking plate group which is significantly higher than reconstruction plate group in which only 82% patients had excellent and/ or good results.

Conclusion: Locking plates has advantage over reconstruction plates in early mobility and greater functional outcome.

Keywords: Distal Humerus fracture, AO Type C, Locking Plate, Reconstruction plates, MEPS Score.

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Introduction

Fractures of distal humerus are relatively uncommon injuries in adults and are very challenging to manage. Approximately 7% of the adult fractures involves the elbow, of which about one-third involve the distal humerus [1,2]. The proximity of neurovascular structures, the frequent occurrence of metaphyseal bone loss and significant articular comminution, and the unforgiving tendency of the elbow toward capsular stiffness and heterotopic ossification make these fractures often difficult to treat [3,4].

Overall incidence of distal humerus fracture is increasing, mimicking the increasing incidence of hip, proximal humerus and wrist fractures [5]. Historically, these injuries were treated by means of closed reduction and slinging (the so called "bag of bones" technique) because the results of open reduction and internal fixation were poor [6]. Advances in the techniques of open reduction and internal fixation and newer implants along with the goal of anatomic

restoration and early mobilization, the standard of care has now shifted to surgical treatment of these injuries by open reduction and internal fixation. The ultimate surgical goals are stable facture fixation and early mobilization of elbow [7]. Depending upon the severity of communition and displacement, open reduction and internal fixation can be done with locking plates, reconstruction plates, cannulated cancellous screws (C.C. screws), kirschner wire or tension band wiring. The introduction of anatomical pre-contoured locking plate technology approximately a decade ago, ushered in the latest advances for the management of distal humerus fractures, offered enhanced biomechanical properties and more robust fixation, thus allowing early rehabilitation. Controversy persists, whether standard non-locking plate screws construct well-placed to maximize subchondral buttressing performs better than locking screws placed through the factory preset trajectories which are often distant from and not parallel to the articulation of the distal humerus. Further long term, clinical benefits of locking plate fixation for distal humerus fractures are not known [8]. The aim of this study was to compare and evaluate the results of pre-contoured locking plates and conventional reconstruction plates in management of AO type C distal humerus fractures in adults with regard to functional outcome using Mayo Elbow Performance Score (MEPS) and radiological outcome in terms of rate of union.

Materials and Methods

This randomized prospective study was done comparing patients with intra-articular distal humerus fractures AO type C treated either by pre-contoured locking plates or conventional reconstruction plates after getting approval from institutional ethical committee and written consent from all patients. Fractures were classified using the AO/OTA classification system on the basis of preoperative X-rays and CT scans. All AO type C distal humerus fractures, with age more than 18 years were included in the study. Open fractures, pathological fractures, fractures with neuro-vascular injury and associated fracture of ipsilateral upper limb were excluded from the study.

All the fractures were treated with definitive open reduction and internal fixation (ORIF) within 3 days. For the surgical procedure, the patients were placed in the lateral position with the involved arm supported and forearm hanging allowing at least 90° flexion. In all patients, posterior approach along with Chevron osteotomy of the olecranon was done. The ulnar nerve was explored routinely; however, transposition was only performed in those patients where mechanical irritation seen by medial plate, was a concern. After temporary reduction and fixation with K-wires, osteosynthesis using either the anatomically pre-contoured locking compression plates or 3.5mm reconstruction plates were used for both the columns. The patients were randomly randomized into these groups. Olecranon osteotomy was fixed with cannulated cancellous screws or tension band wiring (fig 1).

Postoperatively, the elbow was splinted in 90° flexion and the limb was kept elevated to decrease swelling and patient was encouraged to move their fingers. Intravenous antibiotics were continued till post-operative day 2. Suction drain was removed after 48 hours and wound inspection was done at 2nd and 5th post-operative day. Oral antibiotics and analgesics were given to the patient till the time of suture removal. Sutures/staples were removed on the 12th postoperative day. At 2 weeks POP slab was removed and patient was given arm pouch and active elbow and shoulder range of motion exercises were started as per patients pain tolerance. Patients were instructed to carry out physiotherapy in the form of active elbow flexion-extension and pronation-supination. Patients were advised not to lift heavy weight or exert the affected upper limb.

Patients were followed up regularly at 6 weeks, 3 months, 6 months and 12 months post-operatively. At each follow up, patients were assessed subjectively for pain, swelling and restriction of joint motion. The functional assessment of the patient was done according

to Mayo elbow performance score and radiological assessment done for union. The results were statistically analyzed using Mann Whitney U test and a level of $p < 0.05$ was considered significant.

Results

A total of 25 patients (18 men and 7 women) were included in this study. The baseline characteristics of the patients in both groups are given in Table 1. The mean age of patients was 35 years (range 18 to 75 years). The dominant arm was involved in 16 fractures (16/25). AO type C1 (simple intra-articular) fracture was found in 9 patients (9/25), AO type C2 (simple articular fractures with metaphyseal comminution) were seen in 12 cases (12/25) and 4 fractures (4/25) were classified as AO type C3 (multi-fragmentary intra-articular) fractures. Locking plates were used in 14 patients and reconstruction plates were used 11 patients. Mean duration of surgery and mean duration of hospital stay were comparable in both the groups (p value= 0.661 and 0.622 respectively).

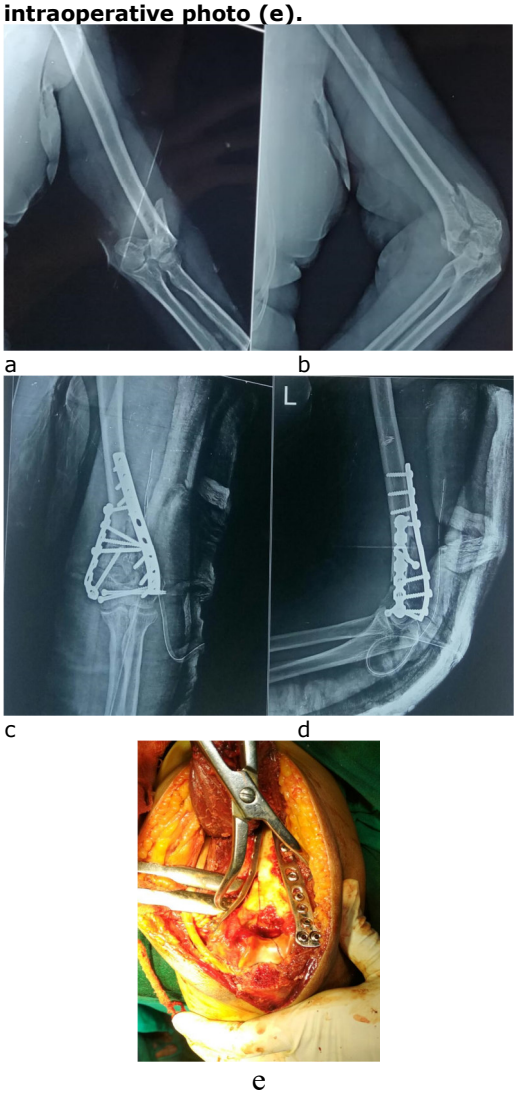
Range of motion was statistically higher in locking plate group as compared to reconstruction plates groups at 3 months ($p<0.0001$) while the difference was statistically insignificant at 6 ($p =0.085$) and 12 ($p=0.166$) months follow-up. Similarly, on comparing the mean MEPS score, the difference was found to be statistically higher in locking plate group at 3 months ($p=0.029$) but at 6 ($p=0.066$) and 12 ($p=0.107$) months the difference was statistically insignificant. About 93% patients in locking plate group and 82% patients in reconstruction plate group achieved excellent and/or good results as per MEPS score. Union rate was 93% in locking plate and 91% in reconstruction plate group at the end of 12 months follow-up, with no significant difference between the two groups (table 1).

2 cases had superficial infection, one each in locking and reconstruction plate group which were healed with antibiotics. 3 case of post-operative stiffness were reported, one in locking plate group and two in reconstruction plate group which were managed with physiotherapy and manipulation under anaesthesia. After which, all 3 patients achieved reasonably good to fair range of motion. One case of postoperative ulnar nerve neuropathy was reported in locking plate group which required anterior transposition of ulnar nerve at 4 months post-operatively and subsequently complete recovery occurred at final follow-up. One case of non-union was observed each in locking plate group and reconstruction plate group which further required revision surgery with bone grafting. Interestingly, no case of failure of osteosynthesis of olecranon osteotomy was observed in our series.

Table 1. Results comparing locking plate and reconstruction plate

Parameters	Locking plate group (n=14)	Reconstruction plate group (n=11)	p-value
Age	38.07±18.73	31.81±10.65	0.3337
Gender (M:F)	8:6	10: 1	0.090
Laterality (R:L)	8:6	8:3	0.6766
AO type (C1:C2:C3)	5:7:2	4:5:2	0.9581
Mean surgical duration (min)	139.64± 12.16	137.27 ± 14.55	0.661
Mean hospital stay (days)	8.50 ± 2.74	9.09±3.18	0.622
Range of Motion			
3 months	43.2l±8.22	33.18±6.80	<.0001
6 months	76.42±14.06	71.36±15.98	0.085
12 months	1 11.35± 17.7	102.72±20.90	0.166
Mayo Elbow performance Score			
3 months	53.92±11.l2	42.27±13.84	0.029
6 months	66.42±10.45	59.69±14.96	0.095
12 months	82.85±9.94	76.36±13.24	0.107
Union			
Union rate	93%	91%	0.089
Complications			
Superficial infection	01	01	
Post-operative stiffness	01	02	
Ulnar nerve neuropathy	01	00	
Non-union	01	01	

Fig 1. Pre-operative & post-operative AP (a & c) and lateral (b & d) X rays of a type C1 distal humerus fracture treated with pre-contoured locking plate with intraoperative photo (e).



Discussion

In recent years, the techniques used to treat distal humerus fractures have evolved significantly, from conservative treatment to open reduction using different fixation methods and systems. Inspite of advances, treatment of distal humerus fracture still remains one of the most demanding challenges in elbow surgery. Further type C fractures of distal humerus are most difficult to manage in spite of the advancement in fixation technique [1-3].

The locking plate technology in the management of distal humerus fractures has various biomechanical and theoretical advantages. Despite of these stated advantages, there are scanty clinical data directly comparing its efficacy to non-locking plate fixation for the management of intra-articular distal humerus fractures. Hence we performed this study to determine whether locking plates offered any advantages over non-locking plates in term of functional and radiological outcomes. Our results showed that though at initial 3 months follow-up, the results were statistically higher in locking plate group with regard to mean range of motion and mean MEPS score, there exist's no statistically significant difference between the two groups in term of functional and radiological outcome at final follow-up of one year. The data demonstrate that while non-locking constructs allowed for more ideal screw positioning, the rate of union was equivalent between both groups. The difference between the two groups at initial 3 months follow-up might be due to less rigid fixation provided by reconstruction plates in comparison to locking plates leading to delay in range of motion exercises.

Very few studies have directly compared the functional and radiological outcome between locking and non-locking construct. Berkes et al, retrospectively analyzed 96 patients with intra-articular distal humerus fractures and compared the locking and non-locking construct on the basis of clinical and radiological outcome, fixation failure, complications and cost-effectiveness. They found that though locking construct costs on an average 348% more than the non-locking construct, there exists no statistically significant advantage that locking plates provide with regard to adequacy of fixation, clinical and radiographic outcomes and complications [8].

Komer et al biomechanically compared non-locking and locking plate and found that the stiffness of the construct was not different if arranged in the same configuration [9]. Another study by the same group compared orthogonal constructs using conventional reconstruction plates, locking compression plates, and precontoured distal humerus locking plates in cadaveric specimens of varying bone mineral densities and concluded that fixation with either locking or non-locking plates is acceptable in patients with good bone

mineral density, but locking plates could prove to be more effective in patients with lower bone mineral density [10]. Since there were no large data available comparing the locking and non-locking constructs for AO type C distal humerus fractures, we therefore did this study and compared our results with previous studies and found equivocal rates of non-union, functional outcome, and complication rates [11-13].

The results of this study verify that there has been no statistically significant advantage that locking plates provide with regard to adequacy of fixation, clinical outcomes and complications. Though non-locking plates allow for ideal screw placement but, the impact of this is unknown. The results of this study does not provide enough data to make any recommendations at present but it definitely serves as a critical analysis of locking and non-locking plates fixation that might stimulate future research on this topic.

Conclusion

Locking plates has advantage over reconstruction plates in treatment of distal humerus AO type C fractures in early mobility and greater functional outcome, but long term functional and radiological outcome of both locking plates and reconstruction plates are comparable.

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