Original Article

Access this article online

Quick Response Code:

Website: www.joas.org.in

DOI: 10.4103/JOASP.JOASP_15_20

Study of functional outcome of surgical management of distal humerus fractures with bicolumnar plating

Neetin P Mahajan, Prasanna Kumar G S, Ved Ashish Ravesh, Nikhil D Palange, Shashibhushan S Varekar

Abstract

INTRODUCTION: Distal humerus fractures in adults comprise 2% of all fractures and 30% of all humeral fractures. Intra-articular distal humerus fractures account for 37% and involve both medial and lateral columns. Most of the distal humeral fractures in adults must be treated surgically to get better functional outcome. The aim of this study was to assess the efficacy, technical requirements, functional outcome, radiological and clinical union, and complications of distal humerus fractures treated with bicolumnar plating.

MATERIALS AND METHODS: This was a prospective study of 35 cases of distal humerus fractures conducted at a tertiary care hospital, who were treated surgically with bicolumnar plating using posterior approach with transolecranon osteotomy between 2016 and 2018. The Mayo Elbow Performance Score was used for the assessment of functional outcome.

RESULTS: Thirteen (37.14%) patients got excellent outcome, 17 (48.58%) got good outcome, 4 (11.42%) got fair outcome, and 1 (2.86%) got poor outcome, and the complications observed were infections, nonunion, implant failure, and elbow stiffness. Distal end radius fracture was the common association with distal humerus fracture in our study.

CONCLUSION: Open reduction and internal fixation with bicolumnar plating is the treatment of choice for distal humerus fracture mainly in type B and C fractures. Fracture types, use of locking plates, stable fixation, and meticulous repair of soft tissues along with early elbow mobilization influence the final functional outcome. Bicolumnar plating provides better stability, allows early elbow range of motion, and prevents stiffness.

Keywords:

Bicolumnar plating, distal humerus fractures, functional outcome, locking plates, olecranon osteotomy

Introduction

Distal humeral fractures have a bimodal age distribution with high incidence between the ages of 12 and 19 years (usually in males) and more than 80 years in females (because of increased elbow carrying angle and osteoporosis).[1] High-energy injuries such as road traffic accidents, fall from height, sports, industrial accidents, and firearms have been the causative factor for distal humeral fractures in adults. Low-energy injuries such as fall from standing height causes fractures of distal humerus in most of the elderly patients. Historically, the treatment outcome of the distal humeral fractures remained problematic because of lack of understanding of bony anatomy, lack of precontoured locking plates, and higher rates of infection. Till today, the treatment of the distal humerus fractures has remained a challenging problem in spite of advanced techniques and implant designs because of complex regional anatomy with limited options for internal fixation, articular comminution, and quality of architecture of inherent bones.[2] Type C intra-articular distal humeral fractures in adults must be treated surgically to get better functional outcome.

Department of Orthopaedics, Grant Government Medical College, Mumbai, Maharashtra, India

Address for correspondence:
Dr. Prasanna Kumar G S, Room No 201, High Rise Building, GT Hospital, Mumbai - 400 001, Maharashtra, India.
E-mail: prasannakumargs5@gmail.com

Received: 16 April 2020
Revised: 26 April 2020
Accepted: 07 July 2020
Published: 23 December 2020

How to cite this article: Mahajan NP, Kumar GSP, Ravesh VA, Palange ND, Varekar SS. Study of functional outcome of surgical management of distal humerus fractures with bicolumnar plating. J Orthop Spine 2020;8:75-9.

The main goal of operative management of distal humerus fractures is to restore the anatomy of the joint surface with stable internal fixation with restoration of limb alignment, rotation, and pillar reconstruction, which allows early mobilization of joint which leads to better functional outcome. With the advent of computed tomography (CT) with three-dimensional (3D) reconstruction improves the identification and visualization of fracture pattern which helps in decision-making and identifying the location of fracture fragments intraoperatively which in turn helps in decreasing the operative time and better functional outcome.[3]

Complex fractures of the distal humerus are not amenable to single-column plating because of thin cortices for holding screws, wide medullary canal, relative osteopenia, and fracture comminution, which are proven to be less stable to loads as compared to bicolumnar plating. Based on the clinical and biomechanical studies,[4-7] fixation with double plating is currently recommended for the management of distal humerus fractures. The precontoured bicolumnar anatomical locking plates are nowadays proven to be gold standard in treating the distal humerus fractures because the locking compression plate can be used both as a conventional plate using only dynamic compression and as a pure internal fixator using locking head screws. The purpose of this study was to assess the efficacy, technical requirements, functional outcome, radiological and clinical union, and complications of distal humerus fracture treated with bicolumnar plating.

Materials and Methods

This prospective study was conducted at a tertiary care hospital from March 2016 to April 2018 over a period of 2 years. Forty-two patients having displaced distal humerus fractures were admitted and included in the study after obtaining valid consent and ethical committee approval. Fractures were classified according to the AO classification, all the patients were treated primarily with bicolumnar plating, and the functional outcome was assessed using Mayo Elbow Performance Score (MEPS). Seven operated patients did not come for follow-up, so 35 patients were taken for the final functional assessment.

The collected data were entered into MS Excel and then were analyzed, statistically evaluated in Statistical Package for the Social Sciences-17; Chi-square/Fisher's test was performed for qualitative data and Student's *t*-test was performed for quantitative data. $P < 0.05$ was considered statistically significant.

Inclusion criteria were (a) the patients with closed distal humerus fractures, (b) age limit: mature skeleton, and (c) patients who were medically fit for surgery. Exclusion criteria were (a) medically unfit patients for surgery, (b) compound fractures, (c) patients not willing for surgery, (d) pathological fractures, and (e) infections.

On admission, detailed examination of the patients was done after hemodynamic stabilization, which includes screening for head, abdominal, and pelvic injury, and patients were subjected to routine preoperative investigations. All our patients received primary immobilization with an above-elbow slab. X-rays of the elbow with humerus, both anteroposterior and lateral views were taken. Patients with severe comminution required CT scan/3D CT scan for better understanding of fracture anatomy.

Patients were operated in lateral decubitus position with upper arm supported by a padded post/bolster with the application of the tourniquet in the upper arm. Posterior approach with Chevron osteotomy was used, and fixation was done using 4 mm CC screws and bicolumnar plating [Figure 1]. Osteotomy was fixed with k wire and tension band wiring, and the wound was closed in layers.

Postoperatively, strict limb elevation was given to reduce swelling and active finger movements was started. Above-elbow slab was given for 1 week, for soft tissue to heal. Suction drain removal and first wound check dress were done on day 3. Intravenous antibiotics were continued for 3–5 days. Postoperative physiotherapy was started depending on the stability of the fixation, and in most of the cases, range of motion (ROM) of the elbow was initiated by 7–10 days, to give time for soft tissues to heal and to prevent wound gaping. Suture removal was done on 10–14 days.

The first follow-up was at 6 weeks and subsequent follow-ups were done at 3 months, 6 months, and at 1 year and 2 years. In each follow-up, the functional MEPS (excellent >90, good 75–89, fair 60–74, and poor <60) was recorded to compare the improvement or deterioration in the outcome. At every follow-up,

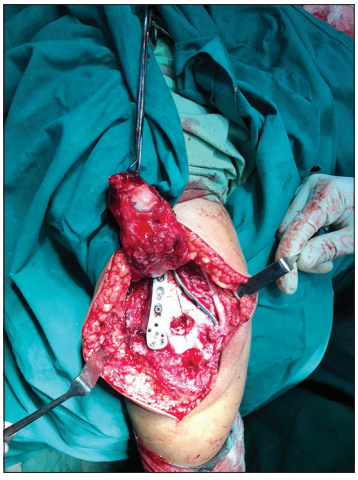

Figure 1: Final fixation with bicolumnar plating

X-rays were taken to check for union, delayed union, nonunion, and implant failure. We also assessed elbow range of movements, explained the role of physiotherapy in getting full range of elbow movements.

Results

Out of 35 patients, 15 were male and 20 were female. The most common age group was >60 years (37.14%) followed by 31–45 years (34.29%); left-sided fractures were seen in 57.14% of cases; and a history of fall and road traffic accidents (RTA) was seen in 60% and 40% of cases, respectively. In the present study, 45.71% of patients had C1, 45.71% had C2, and 5.72% had C3 type fractures and the remaining 2.86% had B2 fracture [Table 1]. Associated fractures were seen in 20% of patients, in that 14% were distal end radius (DER) fractures, and Monteggia and proximal humerus fractures were 3% each. Duration of trauma was <10 days in 80% and >10 days in 20% of the cases, with an average of 8.68 days and the range from 2 to 17 days. We got 48.85% excellent, 57.15% good outcome in patients treated within 10 days of trauma 10 days and 14.28% excellent and 14.28% good outcome in patients treated after 10 days.

We used conventional plates in 40% and locking plates in 60% of the patients. 60% of the patients required >120 min for surgery and 40% required <120 min; ulnar nerve transposition was done in 28.57% of the patients mainly in C2 and C3 fractures. Intraoperative complications noted were difficulty in reduction (8.57%) and unstable fixation (8.57%). The average blood loss was 157 ml with a range of 100–220 ml.

Early postoperative complications were superficial skin infection (5.53%), deep infection (2.86%), and neuropraxia (2.86%); the late postoperative complications were screw back-out (5.71%), implant failure (5.71%), stiffness (2.86%), nonunion (2.86%), and implant prominence (2.86%). In the present study, 40% of the patients showed clinical union at 1–3 months and 60% in 3–6 months with an average of 13.94 weeks with a range of 10–24 weeks. 28.57% of patients showed radiological union at 1–3 months and 71.43% showed at 3–6 months with an average of 14.91 weeks with a range from 10 to 26 weeks and the average ROM observed was 106.51°.

We observed 8.57% unstable fixation, 2.86% difficult reduction with conventional plating, and 5.71% difficult reduction with locking plate intraoperatively. Complications observed in early post operative period were superficial skin infections (2.86%), ulnar nerve neuropraxia (2.86%) with conventional plating and deep infection (2.86%), superficial skin infection (2.86%) with locking plating. Late post operative complications observed were 2.86% implant failure, 2.86% non union,5.71% screw back out and 2.86% implant failure, 2.86% implant prominence,2.86% stiffness with conventional and locking plates respectively. 42.85% of patients with C1 fractures and 37.14% of patients with C2 fractures showed excellent-to-good functional outcome [Table 2]; 34.28% of patients with conventional bicolumnar plate and 51.42% of patients with locking bicolumnar plate showed excellent-to-good functional outcome [Table 3]; and the difference was not statistically significant (P = 0.836). The mean MEPS was 76.85 at 3 months, 81.85 at 6 months, and 84.42 at 1 year, and we observed 37.14% excellent outcome, 48.58% good outcome, 11.42% fair outcome, and 2.86% poor outcome [Table 4] [Figure 2 and 3].

Discussion

The peak incidence of fracture was found to be in the age group of > 60 years (37.14%), because of osteoporotic falls, which is comparable to the study by Ditsios *et al*.;[8] majority of the patients were female comprising 57.14%, which is similar to study by Pantalone *et al*.[9] and Biz *et al*.[10] Increased number of female sex distribution may be due to increased carrying angle of elbow in females, bimodal age distribution, osteoporotic falls, and fall of old age females in villages walking on the uneven roads, as most of the patients were referred from villages as this is the tertiary care hospital. Left-sided fractures were more, which is similar to Kumar *et al*.[11] The mechanism of injury was found to be fall in 60% of patients, whereas the rest 40% reported road traffic accidents, which is comparable to the study by Biz *et al*.[10] Out of 35 cases, 1 was B2 subtype, whereas 16 had C1, 16 had C2, and 2 cases had C3 subtype; this is similar to the study by Kural *et al*.[12] 20% of the patients had associated fractures in which DER fracture was seen in 14%, and Monteggia and proximal humerus fractures was 3% each. Hence, detailed clinical examination of other joints such as

Table 1: Fracture type (according to AO classification)

Type of fracture	Distribution (*n*=35), *n* (%)
B2	1 (2.86)
C1	16 (45.71)
C2	16 (45.71)
C3	2 (5.72)
Total	35 (100)

Table 2: Association between type of fracture and functional outcome

Fracture type	Excellent	Good	Fair	Poor	Total
B2	1	0	0	0	1
C1	8	7	0	1	16
C2	4	9	3	0	16
C3	0	1	1	0	2
Total, *n* (%)	13 (37.14)	17 (48.58)	4 (11.42)	1 (2.86)	35

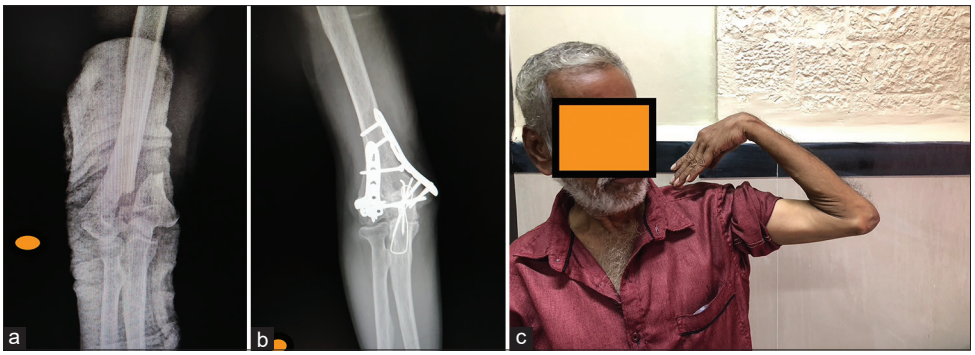

Figure 2: (a) Case 1 preoperative X-ray. (b) Case 1 postoperative X-ray (after fracture healing). (c) Case 1 functional outcome

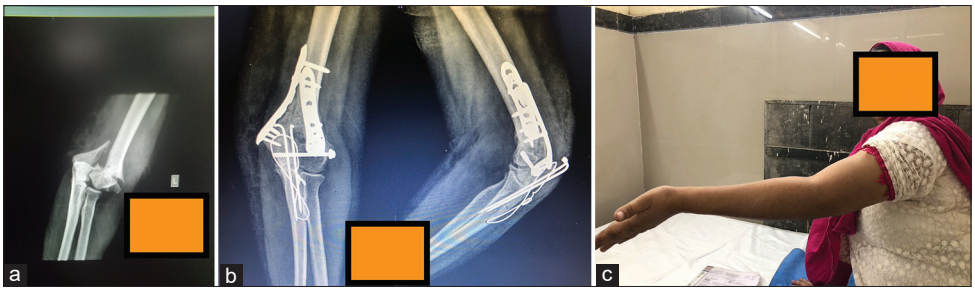

Figure 3: (a) Case 2 preoperative X-ray. (b) Case 2 postoperative X-ray (after fracture healing). (c) Case 2 functional outcome

Table 3: Association between type of plate and functional outcome

Type of plate	Excellent	Good	Fair	Poor	Total	*P*
CP	5	7	2	0	14	0.836
LCP	8	10	2	1	21	
Total	13	17	4	1	35	

CP: Conventional plate, LCP: Locking compression plate

Table 4: Functional outcome (Mayo Elbow Performance Score)

Outcome	*n* (%)
Excellent	13 (37.14)
Good	17 (48.58)
Fair	4 (11.42)
Poor	1 (2.86)
Total	35 (100)

ipsilateral wrist and shoulder is essential to diagnose other associated injuries as advised by Gradl and Jupiter.[13] We did CT scan in 17.14% of patients and 3D CT scan in 51.42% to know the fracture anatomy better preoperatively to prevent time consumption during surgery and to achieve accurate reduction. Gradl and Jupiter[13] suggested the use of CT scan for classification and preoperative planning of articular comminution.

The duration between trauma and surgery is essential to get better functional outcome; we got 48.85% excellent and 57.15% good outcome in patients treated before 10 days and it is comparable to Sailesh *et al*.[14] 60% of the patients required more than 120 min for surgery and 40% required <120 min. Most of the C2, C3 fractures and use of conventional plate required more time because of difficulty in reduction, maintaining reduction in osteoporotic bones and time consumption in bending, contouring of conventional plates, which is similar to the study by Kelkar and Rajput[15] with the mean operating time of 120.33 min.

Anterior transposition of ulnar nerve was done in 29% of patients, mainly in types C2 and C3, because more fracture comminution can lead to excessive callus formation, which may compress the ulnar nerve. We did not find any ulnar nerve palsy after the anterior transposition. In the nonulnar nerve transposition group, one patient had ulnar nerve neuropraxia, which was recovered fully in 6 weeks and Patel *et al*.[16] also observed one case of neuropraxia. Meticulous dissection and handling of ulnar nerve during surgery is important to prevent postoperative ulnar nerve injury. The intraoperative, early postoperative, and the late postoperative complications are similar to Patel *et al*.[16] We observed more complications (unstable fixation, nonunion, and screw back-out) with the conventional plating. Nonunion was managed with bone grafting, stiffness was managed with continuous passive motion (CPM) exercises, superficial skin infection was managed with appropriate antibiotics and dressing, deep infections were managed with debridement and wound wash, and implant prominence was managed with implant removal after the fracture union. We observed less complications with locking bicolumnar plates, as it provides more stable fixation and hold the fracture fragments better till union occurs as it is a fixed angle implant.

We observed the clinical union at 3–6 months in 60% and at 1–3 months in 40% of patients with an average of 13.94 weeks with a range of 10–24 weeks. Clinical union was assessed by absence of pain, tenderness, no motion at fracture site on examination, full range of movements at the nearby joints, and ability to perform daily routine activities without pain.[15] Radiological union was assessed by observing the callus formation on three cortices in two views;[15] this is similar to the study by Kumar *et al*.[11] with an average union time of 14.6 weeks.

Thirteen (37.14%) patients had MEPS >90, 17 (48.58%) had score 75–89, 4 (11.42%) had score 60–74, and 1 (2.86%) had score <60. In the present study, 85.72% of patients got the excellent-to-good results, which is similar to the study by Ditsios *et al*.,[8] and the mean MEPS in the present study is 84.42, which is similar to Kural *et al*.[12] Four patients got the ROM more than 120°, 23 got 100°–120°, and 08 patients got <100°. The mean ROM achieved was 106.51° with a range from 80° to 128°, which is similar to Daniel *et al*.[17] It is important to start the elbow mobilization early to get better ROM and better functional outcome.

Conclusion

Open reduction and internal fixation is the treatment of choice for distal humerus fracture mainly in the type B and type C fractures. Careful examination of ipsilateral shoulder and wrist is essential to rule out other associated fractures. Fracture types influence the final functional outcome along with stable internal fixation that is C1 fractures have better functional outcome than C3 fractures. Preoperative CT scan is very essential for planning of surgery, and early surgery is recommended to get better elbow ROM and good functional outcome. Locking compression plate is the better option to treat distal humerus fractures with good functional outcome and less complications as compared to conventional plates. Anatomical reduction, stable fixation, and early elbow mobilization are the prerequisite for the better functional outcome.

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.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Palvanen M, Kannus P, Parkkari J, Pitkäjärvi T, Pasanen M, Vuori I, *et al*. The injury mechanisms of osteoporotic upper extremity fractures among older adults: A controlled study of 287 consecutive patients and their 108 controls. Osteoporos Int 2000;11:822-31.
2. Robinson CM, Hill RM, Jacobs N, Dall G, Court-Brown CM. Adult distal humeral metaphyseal fractures: Epidemiology and results of treatment. J Orthop Trauma 2003;17:38-47.
3. Brouwer KM, Lindenhovius AL, Dyer GS, Zurakowski D, Mudgal CS, Ring D. Diagnostic accuracy of 2-and 3-dimensional imaging and modeling of distal humerus fractures. J Shoulder Elbow Surg 2012;21:772-6.
4. Watson JD, Kim H, Becker EH, Shorofsky M, Lerman D, O'toole RV, *et al*. Are two plates necessary for extraarticular fractures of the distal humerus?. Current Orthopaed Pract 2014;25:462-6.
5. Corradi A, Talamonti T, Cabitza P, Bottiglieri G, Secondi F. Innovative techniques for the osteosynthesis of distal humeral fractures. Injury 2010;41:1117-9.
6. Caravaggi P, Laratta JL, Yoon RS, De Biasio J, Ingargiola M, Frank MA, *et al*. Internal fixation of the distal humerus: A comprehensive biomechanical study evaluating current fixation techniques. J Orthop Trauma 2014;28:222-6.
7. Taylor PA, Owen JR, Benfield CP, Wayne JS, Boardman ND 3rd. Parallel plating of simulated distal humerus fractures demonstrates increased stiffness relative to orthogonal plating with a distal humerus locking plate system. J Orthop Trauma 2016;30:e118-22.
8. Ditsios K, Stavridis SI, Savvidis P, Dinopoulos H, Petsatodis G. Midterm clinical and radiological outcomes of the surgical treatment of complex AO type C distal humeral fractures with two different double plate fixation techniques. Hippokratia 2017;21:38-42.
9. Pantalone A, Vanni D, Guelfi M, Belluati A, Salini V. Double plating for bicolumnar distal humerus fractures in the elderly. Injury 2017;48 Suppl 3:S20-3.
10. Biz C, Sperotto SP, Maschio N, Borella M, Iacobellis C, Ruggieri P. The challenging surgical treatment of closed distal humerus fractures in elderly and octogenarian patients: radiographic and functional outcomes with a minimum follow-up of 24 months. Archives of Orthopaedic and Trauma Surgery 2017;137:1371-83.
11. Kumar J, Katto MS, Ahmed MW, Jamil M, Rajput IM, Siddiqui AA, *et al*. Dual plating osteosynthesis technique used for fixation of inter-condylar distal humerus fractures via transolecranon approach. J Liaquat Univer Med Health Sci 2017;16:139-44.
12. Kural C, Ercin E, Erkilinc M, Karaali E, Bilgili MG, Altun S. Bicolumnar 90-90 plating of AO 13C type fractures. Acta Orthop Traumatol Turc 2017;51:128-32.
13. Gradl G, Jupiter JB. Current concepts review-fractures in the region of the elbow. Acta Chir Orthop Traumatol Cech 2012;79:203-12.
14. Senthil Sailesh S, Kannan P, Vignesh P S. Clinical Outcome Analysis of Parallel Plate Technique in Distal Humerus Fractures, International Journal Of Scientific Research 2017;6.
15. Kelkar R, Rajput DS. Functional outcome of orthogonal plating in treatment of distal humerus fracture. Int J Orthopaed 2018;4:78-83.
16. Patel J, Motwani G, Shah H, Daveshwar R. Outcome after internal fixation of intraarticular distal humerus (AO type B & C) fractures: Preliminary results with anatomical distal humerus LCP system. J Clin Orthop Trauma 2017;8:63-7.
17. Leigey DF, Farrell DJ, Siska PA, Tarkin IS. Bicolumnar 90-90 plating of low-energy distal humeral fractures in the elderly patient. Geriatr Orthop Surg Rehabil 2014;5:122-6.