International Journal of Research in Orthopaedics
Reddy US et al. Int J Res Orthop. 2019 May;5(3):509-514
http://www.ijoro.org

Original Research Article

DOI: http://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20191793

Functional outcome of elbow joint in AO type 13C fractures treated with open reduction and internal fixation using dual plates

Uyyalawada Sreedhar Reddy[1], Bheemsingh Samorekar[2]*, Vinay J. Mathew[3], Anil Kumar Mettu[4]

Department of Orthopaedics, [1]Viswabharathi Medical College, Penchikalapadu village, Kurnool, Andhra Pradesh, [2]Gadag Institute of Medical Sciences, Gadag, Karnataka, [3]Josco Hospital, Pandalam, Alleppey, Kerala, [4]ESIC Medical College, Hyderabad, Telangana, India

Received: 08 February 2019
Revised: 21 March 2019
Accepted: 23 March 2019

***Correspondence:**
Dr. Bheemsingh Samorekar,
E-mail: bheemsinghvs@gmail.com

ABSTRACT

Background: Distal end of the humerus, with its unique orientation of articular surfaces supported by a meagre amount of cancellous bone, makes its fracture a constant challenge to orthopaedic surgeons. Aim of the study is to evaluate the functional outcome of surgical management of intercondylar AO type C fractures of distal end of humerus using dual plating.
Methods: A prospective study was conducted at our hospital between January 2015 to December 2016. Thirty five consecutive patients with intercondylar (AO Type C) fracture of distal humerus, included in study as per inclusion criteria. All patients were treated surgically using triceps reflecting approach and posterior trans-olecranon approach with ulnar nerve exploration and fixation using dual plating and tension band wiring for olecranon osteotomy wherever done.
Results: In 35 patients, final results using MEPS scoring system excellent outcome is noticed in 15 patients (42.86%), good results is noticed in 13 patients (37.14%), fair result is noticed in 5 patients (14.29%) and poor result is noticed in 2 patients (5.71%). There was statistical significant difference in flexion range of movement arc at 2 and 6 months in our study.
Conclusions: Open reduction and internal fixation of AO type 13C fractures is challenge to surgeon, preoperative planning and mastering the technique over a period of time gives good to excellent functional outcomes.

Keywords: Humerus, Distal, Fracture, Open reduction

INTRODUCTION

Distal humeral fractures account for approximately 2%–6% of all fractures and for approximately 30% of all elbow fractures.[1] The complex anatomy of the distal end of the humerus, with its unique orientation of articular surfaces supported by a meagre amount of cancellous bone, makes its fracture a constant challenge to orthopaedic surgeons.[2] The complex shape of the elbow joint, the adjacent neurovascular architecture, and the sparse soft tissue envelope combine to make these fractures difficult to treat. Acceptable results have been reported in a majority of patients treated by open reduction and internal fixation.[3] Peaks of incidence were described in males aged 12 to 19 years and in females age 80 and older.[4] The most common causes of these fractures are falls in the elderly population and sports injuries or road traffic accidents in the younger patients.[5] Majority of the distal humerus fractures (96%) have a complex pattern involving both the columns and the

articular surface (AO type C injuries).[6] In the early and middle parts of twentieth century, operative treatment was combined with devascularizing exposure, inadequate fixation, and cast immobilization. The result was often elbow stiffness and delayed healing. In this context, non-operative treatments, such as the so-called bag of bones technique (a short duration of immobilization in either a cast or a collar and cuff followed by mobilization as tolerated) were established as treatment alternatives.[7] As with any displaced intraarticular fracture, the principles of anatomic restoration of the articular surface, stable fixation, and early motion are the optimal treatment goals.[8] Restoration of painless and satisfactory elbow function after a fracture of the distal humerus requires anatomic reconstruction of the articular surface, restitution of the overall geometry of the distal humerus and stable fixation of the fractured fragments to allow early and full rehabilitation.[9] Although it is wise to be prepared to perform a total elbow arthroplasty in the event that a complex fracture is not amenable to internal-fixation, one must keep in mind the functional limitations and eventual failure associated with total elbow arthroplasty. A surgeon treating a healthy active patient with a fracture of distal humerus should make every attempt to reconstruct and preserve the native bone.[10]

Aim of the study

- To evaluate the functional outcome of surgical management of intercondylar AO type C fractures of distal end of humerus using dual plating.

Objectives

- To assess union of distal humerus fractures fixed with dual plating, study the range of movement of elbow following distal humerus fracture fixation with dual plating and to assess the complications associated with dual plating of distal humerus.

METHODS

A prospective study was conducted at our KIMS, Secunderabad (India) a tertiary care hospital between January 2015 to December 2016. Thirty five consecutive patients with intercondylar (AO Type C) fracture of distal humerus, included in study as per inclusion criteria. On admission of the patient, a careful history was elicited from the patient and/or attendants to reveal the mechanism of injury and the severity of trauma. The patients were then assessed clinically to evaluate their general condition and the local injury. Methodical examination was done to rule out fractures at other sites. Local examination of injured elbow is done. Any nerve injury was looked for and noted. Distal vascularity was assessed by radial artery pulsations. Radiographic study was done taking AP and lateral X-ray of the involved elbow. CT scan/ MRI were done in comminuted fractures for preoperative planning of fracture fragment fixation. All patients were informed before they were included in study and written consent for wilful participation was taken. Fractures were classified as per AO classification and only AO type 13C was included in the study. All patients were treated surgically using triceps reflecting approach and posterior trans-olecranon approach with ulnar nerve exploration and fixation using dual plating and tension band wiring for olecranon osteotomy wherever done. Inclusion criteria had all AO type 13C open and closed fractures, age >18 years and <80 years and all patients willing to participate in the study. Exclusion criteria were patients with neuro muscular disorders affecting upper limbs, pathological fractures except osteopenic and osteoporosis, associated neuro vascular injuries, ipsilateral radial head and olecranon fractures and pre-existing upper limb congenital deformity. Antibiotics prophylaxis was with inj. Cefuroxime 1.5 grams IV pre-operatively at the time of induction before tourniquet application and two doses of Cefuroxime 1.5 mg IV post surgery 12 hours apart. Surgical procedure had patients operated under brachial block/general anaesthesia. Patient was placed in lateral position with arm supported and forearms hanging. Operated limb exsanguination was done for 2 minutes and the pneumatic tourniquet was inflated. The limb was painted and draped. The elbow was exposed posteriorly through an incision beginning 5 cm distal to the tip of the olecranon and extending proximally medial to the midline of the arm to 10-12 cm above the olecranon tip. The skin and subcutaneous tissue was reflected to either side carefully to expose the olecranon and triceps tendon. The ulnar nerve was isolated and gently retracted from its bed and secured using two wet umbilical tapes held by mosquito forceps which were stabilized to the drape (not hanging freely). Lateral arthrotomy was done and the level of olecranon osteotomy was decided, which was just proximal to the coronoid process. A chevron olecranon osteotomy was done in all patients. Collateral ligaments especially the lateral collateral ligament was released partially on the posterior aspect in some bulky and obese patients to aid good intercondylar reduction. Soft tissue attachments to the fragments were preserved as much as possible. Unnecessary stripping was prevented as it leaves the bone fragments without a vascular supply and jeopardizes healing. Fragments of the humerus were assembled in 3 steps- reduction and fixation of condyles together forming a single articular unit, if fractured- the medial or lateral epicondylar ridge was fixed to the humeral metaphysis, reassembled condyles were fixed to the humeral metaphysis. Condyles were reduced and held with a bone holding clamp. Reduced condyles were provisionally fixed with Kirschner wires. Later 4 mm cancellous screws were inserted across the reduced condyles. Reduction and fixation of the condyles to metaphysis, Reduction and temporary stabilization of the medial and lateral columns was done by using crossed Kirschner wires. Medial and lateral pillars were reconstructed using pre contoured column specific locking compression plates (Figure 1).

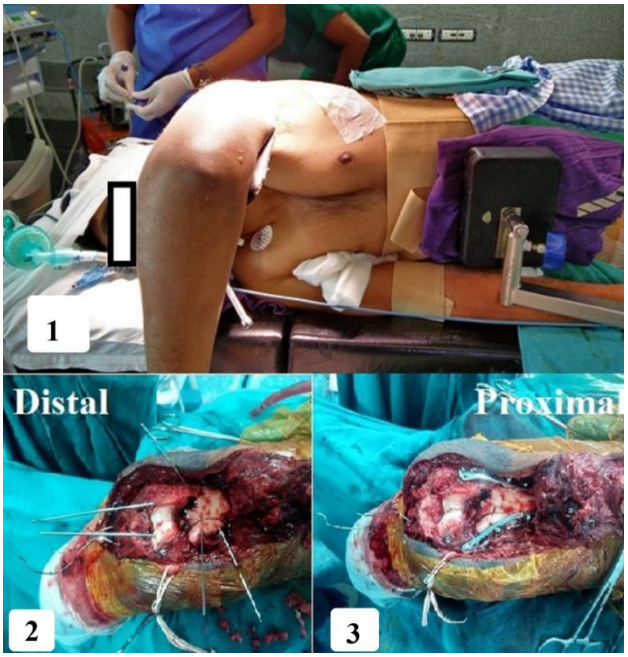

Figure 1: Lateral position of patient with arm support in 1, open reduction and fragment fixation with multiple K-wires in 2, pre-contoured dual column locking plates fixed in 3.

Both orthogonal and isoplanar plating techniques were used depending on the surgeon's preference with respect to exposure in our study. But isoplanar plating was done in majority of patients. Putting the elbow through a range of motion tested the stability of the internal fixation. At the end tension band wiring was done for olecranon osteotomy using 2 mm K-wires and SS wires. The tourniquet was deflated and haemostasis was achieved. Incision was closed in layers. Pressure bandage was applied and limb was immobilized using arm sling. Post-operatively Patients were instructed to keep the limb elevated and move fingers actively. Suction drain if used was removed after 24-48 hours. A total of 3 doses of IV Antibiotics were given to the patient. Wound inspection was done on 2nd post operative day and gentle elbow ROM exercises (passive and active assisted) were started under the direct supervision of the operating surgeon and then physiotherapy was started, on POD 3 patient is discharged after teaching physiotherapy exercises. Patient was reviewed on 14th post-operative day for suture removal. Arm pouch sling was used from day of surgery to until 3weeks and gentle ROM exercises of upper limb were done 4 times daily removing arm pouch at home. Serial radiographs were taken at 2 months, 3 months and 6 months post-op. The post- operative follow up period ranged from 6 months to 12 months (Mean follow up - 9.4 months) and the minimum follow up period was 6 months. The functional assessment of patient was done according to Mayo Elbow performance Score (MEPS) at 2 months and 6 months post-op. The data collected was entered in Microsoft Excel and Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) 20.0 software. The methods used were student paired t test, student unpaired t test and ANOVA test.

RESULTS

The available data was analysed and results were drawn at 2 months, and 6 months follow up. The distribution of age was between 18- 68 years; the average age was 42.66 years with peak incidence of between 30-45 years (Figure 2).

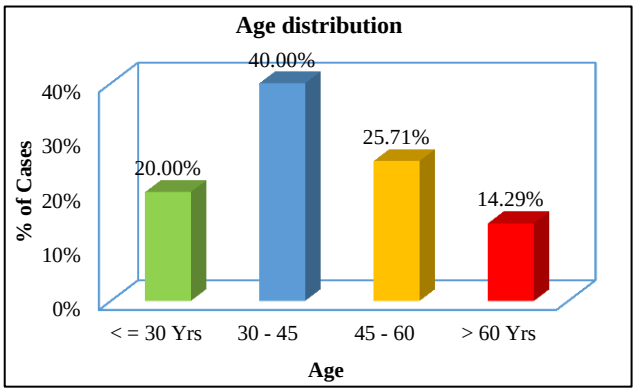

Figure 2: Age distribution of study participants.

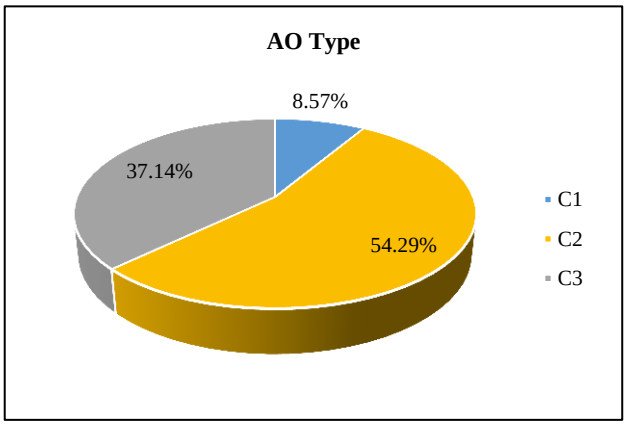

Figure 3: Fractures according to AO types.

There were 20 males and 15 females. Male patients constituted 57.14% and female were 42.86%. Male to female ratio is 1.3:1. In the mechanism of injury, 25 (71.43%) patients sustained fractures following road traffic accidents and 10 (28.57%) sustained fracture due to simple fall. Right upper limb was involved in 13(37.14%) and left upper limb in 22 (62.86%) cases. For all patients dominant limb was right upper limb. The study had 3 patients (8.57%) of type C1, 19 patients (54.29%) of C2 and 13 patients (37.14%) of C3 according to AO classification (Figure 3).

Among them 26 patients (74.29%) had closed fractures, 9 patients had open fractures and as per Gustilo Anderson fracture classification- 3 patients (8.57%) had type I injury, 5 patients (14.29) type II injury and 1 patient (2.86%) had type IIIA injury. Depending on duration

since trauma, 6 patients (17.14%) were operated within 10 hours, 18 patients (51.43%) were operated between 11-24 hours and 11 patients (31.43%) were operated after 25 hours of trauma (Figure 4).

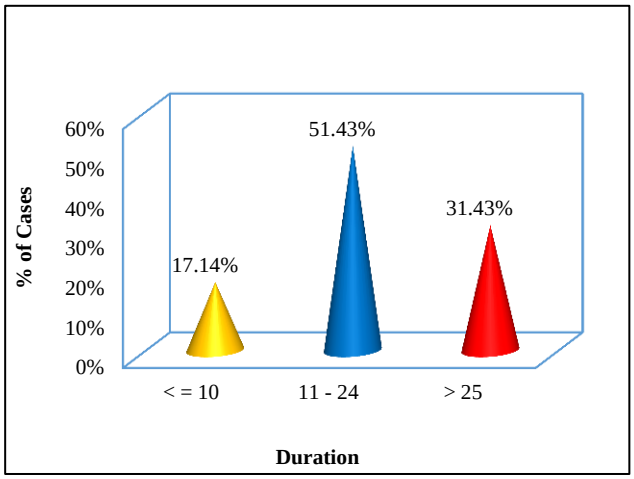

Figure 4: Time duration between trauma and surgery.

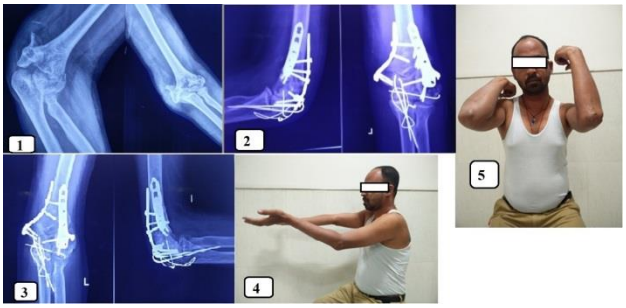

Figure 5: Pre-op radiographs showing distal humerus type 3C fracture in 1, immediate post-op radiograph in 2, six months follow-up radiograph showing uniting fracture in 3, six months follow-up showing elbow range of motion in 4 and 5.

The choice of implants was based on surgeons' preference and financial constraints. No decision on type of implant with respect to fracture pattern was made. Pre-contoured anatomical column specific locking compression plate (LCP) from two manufactures- PDL LCP in 19 patients (54.29%) and Synthes LCP in 16 patients (45.17%) were used in this study. Both the implants have similar design except for the material of make with synthes implants being titanium made and PDL implants of 316L stainless steel. In this study isoplanar plating was done for 20 patients (57.14%) and orthogonal plating for 15 patients (42.86%) based on fracture patterns and exposure. Only 2 patients (5.71%) were operated with triceps reflecting approach. and were type C1 AO fractures. All the patients with C2 and C3 injuries were operated by posterior approach with olecranon osteotomy and the choice of approach was based on fracture pattern and surgeon preference. There was no statistical significance between approach used and functional outcome in the study group probably because of small sample size in triceps reflecting approach. In the 35 patients, 19 patients (54.29%) received brachial block and 16 patients (45.71%) received general anaesthesia. There were no intra operative anaesthesia related complications with respect to type of anaesthesia given. There was variation in fracture union time duration with 28 patients (80%) having union between 9-12 weeks, 6 patients (17.14%) taking more than 12 weeks and 1 patient (2.86%) having union in less than 8 weeks. Range of motion at 2 months post-op was measured. For 3 patients in AO type C1 mean ROM was 81.67, for 19 patients in type C2 was 65.26 and for 13 patients in type C3 mean ROM was 66.15 (Figure 5 and 6).

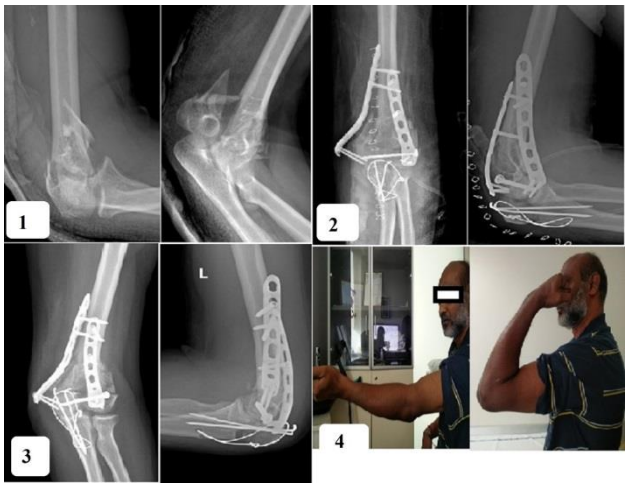

Figure 6: Pre-op radiographs showing distal humerus type 3C fracture in 1, immediate post-op radiograph in 2, six months follow-up radiograph showing uniting fracture in 3, six months follow-up showing elbow range of motion in 4.

There was no significance with respect to ROM at 2 months and fracture type in this study group (p=0.15). Range of motion at 6 months was also measured and for 3 patients in AO type C1 mean ROM was 113.33, for 19 patients in C2 was 92.11 and for 13 patients in C3 was 94.62. There was no statistical significance in functional outcome among the 3 different groups (p=0.215). There was statistical significance in flexion range of movement arc at 2 and 6 months with flexion ROM better at 6 months than at 2 months.

There was statistical significance in MEPS score at 2 and 6 months with MEPS better at 6 months than at 2 months. Final results using MEPS scoring system showed excellent outcome in 15 patients(42.86%), good results in 13 patients(37.14%), fair result in 5 patients(14.29%) and poor result in 2 patients (5.71%). 1 patient (2.86%) had olecranon TBW non-union, 1 patient (2.86%) had superficial infection and 1 patient (2.86%) had both lateral condyle non-union and ulnar nerve neuritis. This study had olecranon TBW non-union in 1 patient (2.86%), superficial infection and 1 patient (2.86%) and

both lateral condyle non-union and ulnar neuritis complication in 1 patient (2.86%).

DISCUSSION

Regardless of the method of treatment, substantial damage to the distal humerus usually results in some limitation of motion, pain, weakness, and possibly instability. In cases of open reduction and internal fixation several factors influence the stability of fixation like: quality of bone, type of fixation device, number and size of fracture fragments, condition of soft tissues after injury.[11] In our study, these fractures were common in the 30-45 years age group, with average age being 42.66 yrs. There was bimodal distribution of patients with 14 patients between 30-45 years and the most common mode of injury in these was road traffic accident. Our findings are comparable to the study made by Tyllianakis et al and Chen et al.[12,13] Wang et al, in his study noted 60% male and 40% female incidence.[14] Tyllianakis et al noted 54% female incidence and 46% male incidence. Our series had a male predominance with 57.14% and 42.86% female patient, which is comparable to Wang et al study.[14] Male predominance is probably due to their increased involvement in outdoor activities. Jupiter JB et al reported about 38% incidence of fractures in right distal end of humerus.[7] Henley et al reported about 45% incidence of fractures in right side distal end of humerus.[15] Wang et al, series reported about 70% incidence in right side and 30% in left side.[14] Right-sided predominance is probably due to direct fall injury on to the predominant side that is right in our series. This was comparable with other studies. The bone undergoes anteroposterior and posteroanterior cyclic force during elbow flexion and extension.[16] Dual-plate fixation has been described by several authors and seems to provide the most secure fixation. Helfet and Hotchkiss studied the rigidity and fatigue performance of several methods including the dual-plate fixation.[17] Although there are many fixation construct, the biomechanical behavior of the osteosynthesis depends more on plate configuration than plate type. Surgeon experience and orientation of approach may dictate the choice of a plate construct for the fracture configuration. In our study group, 15 patients were operated by orthogonal plating and 20 were operated by isoplanar plating. Non-union was observed in only one case of orthogonal plate fixation. There was no case of implant failure in both the groups. With respect to union, complications, functional outcome there was no difference among both the positioning types. In a study by Lee at al similar results were observed in 67 pateints.[18] We prefer orthogonal plating method in cases of coronal shear fractures, where posterior to anterior fixation may provide additional stability to the intra articular fractures. Isoplanar plating method may be the preferred technique used for fractures that occur at the most distal end of the humerus. Olecranon osteotomy for exposure and fixation of the distal humeral fracture was initially popularised by Cassebaum.[19] Henley et al reported a 57% incidence of complications with the transverse osteotomy, including symptomatic prominence of the K-wire, broken tension band wire, delayed union and non-union.[7] In 1990 Helfet et al studied biomechanical advantages of the chevron osteotomy with the point of the "V" turned distally. In addition to providing mechanical stability to rotational stresses the larger area of contact between the ends of the osteotomy enhances bony union.[6] We used this technique of chevron osteotomy in our study; we had one case of metalwork prominence and one case of non-union. We used triceps reflecting approach in two of the three type C1 fractures. Theoretically triceps reflecting approach would avoid the complications associated with olecranon osteotomy: metal work prominence, delayed or non union, broken tension wire. The choice of approach was based on operating surgeons preference and orientation. We did not find any significance with the type of approach and functional outcome in our study. A large comparative study comparing both the approaches would better delineate the effectiveness of tricpes reflecting approach. Fernandez- Valencia et al in their study had 8.3% superficial infection, 8.3% implant failure, 3% ulnar neuropathy, 8,3% myositis ossificans whereas Krishnamurthy et al, had 2% superficial infection, 1% non-union, 2% implant failure, 2% ulnar neuropathy.[20,21] Our results for mean AOM (arc of motion), MEPS and functional outcome results were comparable with Sanchez-Sotelo et al, Reising et al, Athwal et al and Tian et al.[22-25] Sanchez-Sotelo et al had 34 patients study with mean AOM of 99 and mean MEPS 85. Tian et al had 13 patients study with AOM of 106.2±22.0, mean MEPS of 89.6±11.8, good to excellent results of 84.6%. Our study had significant improvement in outcome and arc of motion of elbow in each fracture type from 2 months to 6 months which may be attributed to the physiotherapy.

Limitations

Sample size of 35 patients is small to conclude the benefits of any surgical intervention. Follow-up duration of 6 months is also too short for any study. Radiological evaluation was decided by the respective surgeon himself hence may be biased. As various surgeons had operated with different experience and the results may vary which was not taken into consideration in this study.

CONCLUSION

Fractures of the distal humerus often produce extensive soft tissue injury in addition to the bony injury. Preoperative roentgenograms should be carefully evaluated with CT scan and 3D reconstruction especially in comminuted fractures to know the fracture pattern and for pre-operative planning of fracture specific fragment fixation. Open reduction and internal fixation of AO type 13C fractures is challenge to surgeon, preoperative planning and mastering the technique over a period of time gives good to excellent functional outcomes. Internal fixation of intra-articular distal humerus (AO type C) fractures using double column plating is an effective procedure ensuring stability of fixation and

thereby permitting early range of motion resulting in good to excellent functional outcomes in most patient age groups.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. Korner J, Lill H, Müller LP, Rommens PM, Schneider E, Linke B. The LCP concept in the operative treatment of distal humerus fractures-biological, biomechanical and surgical aspects. Injury. 2003;34(2):20-30.
2. Jupiter JB, Morrey BF. Fractures of the distal humerus in adults. In: Lampert R. The elbow and its disorder. 3rd ed. Philadelphia, London, New York, St. Louis, Sydney, Toronto: WB Saunders company; 2000: 293-329.
3. Kuntz JR, David G, Baratz ME. Fractures of the elbow. Orthop Clin North Am Jun. 1999;30(1):37-61.
4. 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.
5. Lill H, Korner J, Josten C. Fractures of the distal humerus. In: Josten C, Lill H, eds. Elbow Injuries, Biomechanics, Diagnostics, Therapy. Darmstatt: Steinkopff; 2001: 163-182.
6. McCarty LP, Ring D, Jupiter JB. Management of distal humerus fractures. Am J Orthop. 2005;34:430–8.
7. Jupiter JB, Neff U, Holzach P. Intercondylar fractures of the humerus: An operative approach. J Bone Joint Surg Am. 1985;67(2):226-38.
8. Helfet DL, Schmeling GJ. Bicondylar intraarticular fractures of the distal humerus. Clin Orthop Relat Res.1993;292:26-36.
9. O'Driscoll SW, Sanchez-Sotelo J, Torchia ME. Management of the smashed distal humerus. Orthop Clin North Am. 2002;33(1):19-33.
10. Holdsworth BJ, Mossad MM. Fractures of the adult distal humerus: Elbow function after internal fixation. J Bone Joint Surg Br 1990;72(3):362-5.
11. Schmidt-Horlohe K, Bonk A, Wilde P, Becker L, Hoffmann R. Functional results after osteosynthesis of the distal humerus fracture with an anatomically precontoured, angular-stable double plate system. Z Orthop Unfall. 2010;148:300-8.
12. Tyllianakis M, Panagopoulos A, Papadopoulos AX, Kaisidis A, Zouboulis P. Functional evaluation of comminuted intra-articular fractures of the distal humerus (AO type C). Long term results in twenty-six patients. Acta Orthop Belg. 2004;70(2):123-30.
13. Chen G, Liao Q, Luo W, Li K, Zhao Y, Zhong D. Triceps sparing versus olecranon osteotomy for ORIF analysis of 67 cases of intercondylar fractures of the distal humerus. Injury. 2011;42(4):366-70.
14. Wang KC, Shih HN, Hsu KY, Shih CH. Intercondylar fractures of the distal humerus: routine anterior subcutaneous transposition of the ulnar nerve in a posterior operative approach. J Trauma. 1994;36(6):770-3.
15. Henley MB. Intra-articular distal humeral fractures in adults. Orthop Clin North Am. 1987;18(1):11-23.
16. Morrey BF, An KN. Functional evaluation of the elbow. In: Morrey BF, editor. The Elbow and its Disorders. 3rd ed. Philadelphia: WB Saunders; 2000: 74-83.
17. Helfet DL, Hotchkiss RN. Internal fixation of the distal humerus: a biomechanical comparison of methods. J Orthop Trauma. 1990;4:260-4.
18. Lee SK, Kim KJ, Park KH, Choy WS. A comparison between orthogonal and parallel plating methods for distal humerus fractures: a prospective randomized trial. Eur J Orthop Surg Traumatol. 2014;24(7):1123-31.
19. Cassebaum WH. Open reduction of T- and Y-fractures of the lower end of the humerus. J Trauma. 1969;9:915-25.
20. Fernandez-Valencia JA, Munaz-Mahamud E, Ballesteros JR, Prat S. Treatment of AO Type C Fractures of the Distal Part of the Humerus through the Bryan-Morrey Triceps-Sparing Approach. ISRN Orthop. 2013: 525326.
21. Krishnamurthy MO, Sreenivasulu PSB, Rajkumar K, Mahaboob VS. Evaluation and Outcome of Surgical Management of Supracondylar Fracture Humerus with Intercondylar Extension in Adults. Sch J App Med Sci. 2014;2(6):3274-80.
22. Sanchez-Sotelo J, Torchia ME, O'Driscoll SW. Complex distal humeral fractures: internal fixation with a principle-based parallel-plate technique. J Bone Joint Surg Am. 2007;89:961-9.
23. Reising K, Hauschild O, Strohm PC, Sudkamp NP. Stabilisation of articular fractures of the distal humerus: Early experience with a novel perpendicular plate system. Int J Care Injured. 2009;40:611–7.
24. Athwal GS, Hoxie SC, Rispoli DM, Steinmann SP. Precontoured parallel plate fixation of AO/OTA type C distal humerus fractures. J Orthop Trauma. 2009;23:575-80.
25. Dasheng T, Juehua J, Jun Q, Jianming L. Comparison of two different double-plate fixation methods with olecranon osteotomy for intercondylar fractures of the distal humeri of young adults. Exp Ther Med. 2013;6:147-51.

Cite this article as: Reddy US, Samorekar B, Mathew VJ, Mettu AK. Functional outcome of elbow joint in AO type 13C fractures treated with open reduction and internal fixation using dual plates. Int J Res Orthop 2019;5:509-14.