

Original Research Article

Functional outcome of locking anatomical plate in extra articular fractures of the distal humerus

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ABSTRACT

Background: Extra articular distal humerus fractures are difficult to treat with conventional implants like intra medullary nail, 4.5 DCP and dual plate. The present study aims to study the functional outcome of the extra articular distal humerus plate (EADHP).

Methods: 48 patients with displaced extra articular distal humerus fractures were included in the study. Inclusion criteria were age more than 18 years, closed fractures with or without radial nerve palsy and less than 3 weeks old trauma. Patients aged less than 18 years, those having open fractures, fractures more than 3 weeks old, non – unions and pathological fractures were excluded from the study. All patients were operated with EADHP. Clinically, the outcome was assessed by the disability of arm, shoulder and hand (DASH) score and elbow range of motion radiologically, union was evaluated on anteroposterior and lateral radiographs.

Results: Out of 48 patients, 12 had AO type 12 A1 fracture, 26 patients had type B1 fractures and remaining 10 had type C1 fractures. Mean DASH score at final follow up was 18.1; range being 12.6 to 35.7 points. The mean elbow range of motion was 0 to 130 degrees (range: 120 to 140 degrees). The mean duration for complete radiological fracture union was 14 weeks, range being 12 to 18 weeks.

Conclusions: The extraarticular distal humerus plate is an ideal implant for the fixation of distal humerus fractures since it provides good stability of fracture and enables early return to function.

Keywords: Extra articular, Distal, Humerus, Plate, LCP

INTRODUCTION

Extra articular distal humerus fractures are common injuries which are associated with complex fracture pattern, metaphyseal comminution and radial nerve palsy due to entrapment between the fracture fragments and the lateral inter muscular septum. Due to all these problems and complications, anatomical reduction and adequate stabilization of the fracture is essential to ensure timely union of the fracture without any untoward complications. Traditionally, these fractures have been treated conservatively like use of cast or Sarmiento's functional brace.¹ However, these fractures being in the

distal third of the humerus are very difficult to treat with brace.¹⁻³ The brace also has no control over the rotational malalignment of the fracture and also to restore the axial length of the humerus. Consequently, the risk of non union, shortening and malunion are high with the use of functional brace.

In order to achieve stable, anatomical reduction and restoration of length, operative methods of treatment subsequently replaced conservative management of these fractures.⁴⁻⁷ These operative techniques include intra medullary nail, 4.5 mm DCP and bi-columnar distal humerus plates. The intramedullary nail is difficult to

insert due to the small size of medullary canal and small distal fragment. Similarly, difficulty to achieve 8 cortical purchase in the distal fragment poses restriction on use of the 4.5 mm DCP. Bi columnar plating, despite being a viable option, involves excessive stripping of soft tissues. Hence, to circumvent the disadvantages of these two plates, the extra articular distal humerus plate (EADHP) was devised.⁸ This plate is a locking compression plate specifically pre-contoured to be placed in the centre of the diaphysis of the humerus in the proximal fragment and the distal part of the plate is contoured to be placed on the lateral supracondylar ridge in the distal fragment. Increased options for locking screw insertion in the distal fragment is designed to allow greater stability of the construct and earlier mobilization.¹⁰ The present study aims to evaluate the functional and radiological outcomes of fractures of the distal third of humerus treated with the EADHP.

METHODS

48 consecutive patients with displaced metaphyseal extra articular distal humerus fractures treated with open reduction and internal fixation with the EADHP were included in the present study, conducted at the Department of Orthopaedics, Grant Medical College, Mumbai between September 2016 to December 2018. All patients with history of trauma to the arm were evaluated clinically and radiologically (with antero posterior and Lateral views of the humerus) to diagnose extra articular distal humerus fractures. Neurovascular deficit especially, radial nerve palsy was checked in each patient. All fractures were classified according to the AO /OTA classification (AO type 12-A/B/C). All patients with displaced extra articular fractures of the distal humerus shaft which could not be fixed with conventional 4.5 mm LC- DCP with 4 cortical screws in each fragment was included in the study. Other inclusion criteria were age more than 18 years, closed fractures with or without radial nerve palsy and less than 3 weeks old trauma. Patients aged less than 18 years, those having open fractures, fractures more than 3 weeks old, non – unions and pathological fractures were excluded from the study. Patients satisfying these criteria were selected for the study. A written informed consent of all patients was taken before inclusion into the study.

Surgical steps

With the patient under general anaesthesia and in lateral position, a midline posterior incision, centered over the fracture site was taken. The long and lateral head of the triceps were separated and the radial nerve with profunda brachii vessels isolated between the long and medial heads of the triceps. The nerve was adequately mobilized to prevent iatrogenic injury. Distally, the triceps was lifted off the bone only on the lateral side to expose the lateral epicondylar ridge. Oblique fractures or wedge comminuted fragments were stabilized with 4.5 mm lag

screws. After ensuring adequate reduction, the fracture was fixed with EADHP while protecting the radial nerve. The plate was applied such that the proximal straight portion of the plate lies on the proximal shaft fragment and the lower curved end over the distal humeral fragment. The plate is then fixed with appropriate sizes of cortical and locking screws combination in the proximal fragment and locking screws in the distal fragment.

Implant

In all cases, we used the stainless steel extra articular distal humerus plate (EADHP). This plate is a 3.5 mm LCP with anatomical contour corresponding to the shaft and lateral surface of the distal end of humerus. The distal part curves towards the lateral supracondylar ridge, i.e. without encroaching upon the olecranon fossa. The plate has provision for 5 locking 3.5 mm screws distally which enables adequate fixation by screws in the smaller distal fragment. The plate is tapered distally which minimizes the soft tissue irritation. The distal 2 screws are angled towards trochlea and capitellum. Proximally, the plate has provision for 3.5 mm locking or cortical screws (i.e. combi- hole) and has a narrow construct. The locking screws enable fixed angle construct, ensuring angular stability whereas the combi hole part enables inter- fragmentary or dynamic compression. The plates are different for left and right side and range from 4 hole to 12 hole in length.

Post-operative protocol

Post operatively, patients were placed in a soft padded dressing and a sling. Check dressing of the wound and drain removal were done on the 3rd postoperative day. Gentle passive shoulder and elbow mobilization were started on 1st or 2nd postoperative day, depending on patient tolerance. Active and assisted mobilization was started after 2 weeks and full mobilization with full weight bearing after radiological assurance of union. Patients were followed at monthly intervals till radiological and clinical union of fracture was seen. Functional outcome at final follow up i.e. after first evidence of radiological union, was assessed and documented for analysis.

Assessment of outcome

Clinically, the outcome was assessed by the disability of arm, shoulder and hand (DASH) score and elbow range of motion. Fracture union was assessed clinically by absence of tenderness on palpation and the absence of pain on performing day to day activities. Radiologically, union was evaluated on anteroposterior and lateral radiographs. Bridging of the fracture site in at least 3 of the 4 cortices on AP and lateral views was considered definitive sign of union. All data was compiled in MS Excel 2013 and analysed by Epi info 7 software.

RESULTS

A prospective study of 48 patients with extra articular distal third shaft of humerus fracture treated with EADHP was carried out in our institution from September 2016 to December 2018. The study group comprised of 30 males and 18 females indicating higher incidence of these injuries in males (Figure 1). Patients ranged from 25 to 57 years with average age being 45 years. Most patients (21) had history of road traffic accident like fall from two- wheeler whereas others had history of fall from height (27 patients). 2 patients had fracture of the ipsilateral distal end radius while 1 patient had associated ankle injury. 3 patients had pre-operative radial nerve palsy which was found to be neurapraxia as intra operatively the nerve was found to be intact without any visible anatomical damage and the nerve function recovered after 4 -6 weeks (mean: 5.8 weeks). 29 patients were operated 3 days after trauma, 17 patients after 1 week and 2 patients after 2 weeks following trauma. These patients were postponed so as to allow the soft tissue and skin condition to heal before posting for surgery. Although these 2 patients had superficial abrasions at incision site, none of the patients had an open fracture. Out of the 48 patients, 12 had AO type 12 A1 fracture (simple), 26 patients had type B1 fractures (Wedge spiral) and remaining 10 had type C1 fractures (comminuted spiral) (Figure 2). Plate was selected such that 8 cortical purchase was possible in the proximal fragment. Hence, the 8 holed plate was used in the majority of cases (38 patients). In the remaining 10 patients, owing to a long spiral oblique fracture or extensive comminution, 10 hole plate was chosen (Figure 3). Inter – fragmentary lag screws were needed to fix wedge fragment (“butterfly” fragment) or long/spiral oblique fractures in 36 cases. 5 to 6 locking screws were used in the distal fragment (Figures 4 and 5).

Table 1: Mean and range of stastical data.

	Mean	Range
Age	45 years	25 to 57 years
Follow up	10.8 weeks	4 to 12 weeks
DASH score	8.1	12.6 to 35.7
Elbow ROM	130 degrees	120 to 140 degrees
Fracture union	14 weeks	12 to 18 weeks
Time for recovery of radial nerve (3 cases)	5.8 weeks	4 to 6 weeks

The mean duration of follow up was 10.8 weeks (range: 4 to 12 weeks). Mean DASH score at final follow up i.e. after radiological union was 18.1; range being 12.6 to 35.7 points (DASH in normal individuals is 10 ± 14.68). The mean elbow range of motion was 0 to 130 degrees (range: 120 to 140 degrees). One patient had 5 degree deformity and another had 10 degree deformity at the elbow. No incidence of iatrogenic radial nerve palsy was encountered in our study. The mean duration for complete radiological fracture union was 14 weeks, range being 12 to 18 weeks. No complications like non union,

superficial or deep infections and plate failure were seen in our study.

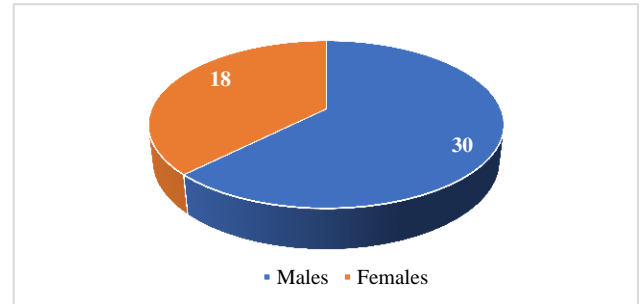


Figure 1: Sex distribution of the patients in the study.

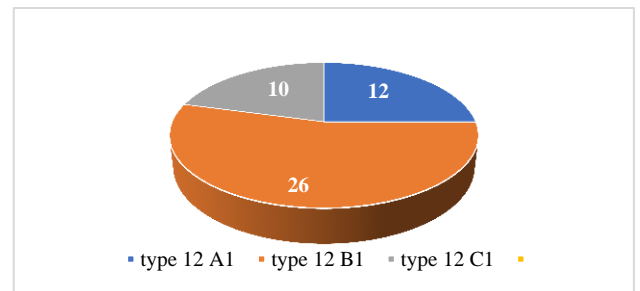


Figure 2: Distribution of fractures as per AO classification system.

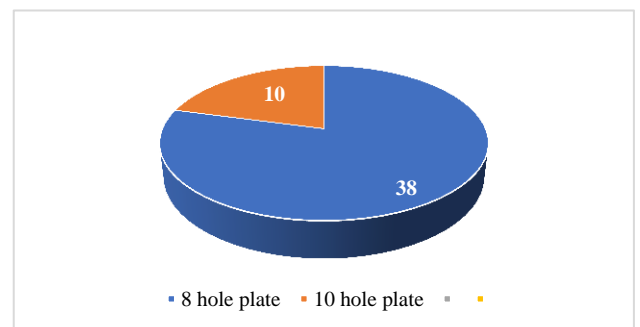


Figure 3: Distribution as per plate size used in fixation.

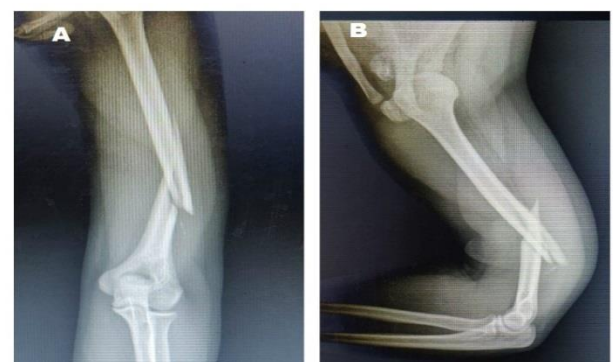


Figure 4: 55 year old patient with distal humerus extra articular fracture in AP (A) and lateral (B) views.

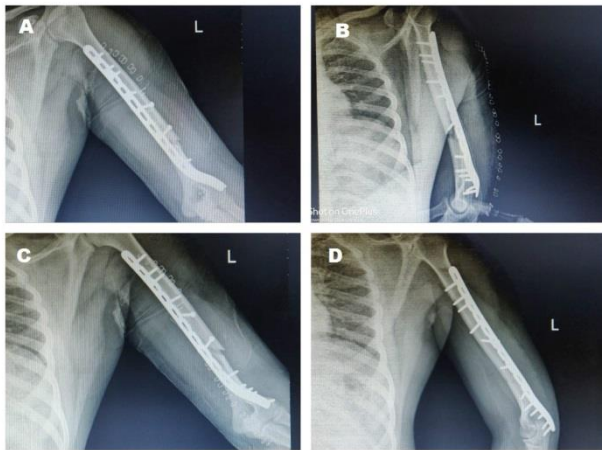


Figure 5: (A and B) Immediate postoperative AP and lateral images of the above patient after open reduction and fixation with 3 lag screws and EADHP; (C and D): AP and lateral views at union.

DISCUSSION

Extra-articular distal humerus fractures have been traditionally difficult to treat owing to complex fracture pattern, large deforming forces and inability to control alignment of the small distal fragment. Initially, conservative management in the form of cast was advocated. Sarmiento et al described use of functional brace to treat these fractures.¹ In his study of 85 patients, he advised initial splinting of the fracture with either hanging cast, u-slab or sling and swathe which was later replaced by plastic brace once the swelling and pain subsided. Sarmiento preferred this method of treatment since it is easy to apply, well tolerated by patients who refused surgery and enhances union by physiologically controlled movements. However, problems like skin irritation, difficulty in maintaining fracture alignment, non union, elbow stiffness and radial nerve injury have made this technique less popular in the recent times where most surgeons prefer operative treatment for these fractures as it allows adequate anatomical reduction, stable fixation and earlier mobilisation with minimal risk of complications.¹¹ Jawa et al, in their retrospective study of 40 patients concluded that 21 patients treated with functional bracing had 100 percent union rate but with greater degree of angular and rotational malalignment and elbow stiffness than those treated with plate and screw fixation (19 patients). They stated that operative treatment allows more predictable alignment and greater stability than functional bracing. However, in their study, the rate of radial nerve palsy was greater in patients who were operated with plate and screws.³

Operative methods for fixation of distal third extra articular humeral fractures have evolved considerably over the years.¹² It is difficult to fix these fractures with an intramedullary nail owing to the limited medullary canal, small size of the distal fragment and difficulty to control reduction of the small distal fragment especially if

it is comminuted. Also, there is risk of iatrogenic fracture during distal locking. Hence, fixation of these fractures is ideal with use of plate and screws. Although humeral shaft fractures are fixed with conventional 4.5 mm DCP with 8 cortical purchases in each fragment, this plate cannot be used in distal third humerus fractures due to small size of the distal fragment which does not allow the minimal 8 cortical purchase. Also, the plate may occupy the olecranon fossa distally and cause mechanical block to extension. To circumvent these problems with the conventional DCP, numerous modifications to this plate were devised. Schatzker and Tile advised placement of plate posteriorly as the surface is flat, avoids the ante cubital fossa, allows distal extension of the plate and offers the option of dual plating in case of inadequate fixation by a single plate.¹³ Moran described the use of conventional straight 4.5 mm DCP posteriorly in an oblique plane orientation which was 5-8 degree of- center from the long axis of the humerus and angled the most distal screw proximally. Such alignment of the DCP improves the fixation of the distal fragment. However, it posed difficulty in extending proximal fixation owing to the obliquity of the plate. This was problematic in long oblique or highly comminuted fractures which require long plates. Also, patients had complaints of implant prominence with this fixation method.¹⁴ Levy, in 2005 described plating with a modified lateral tibial buttress plate (Synthes) which had an angular offset of 22 degrees thus allowing the plate to match the contour of the lateral column, while at the same time allowing to extend proximally at the shaft.¹⁵ Dual locking plates (orthogonal and parallel) have also been described, but require extensive periosteal stripping for exposure and hence not recommended routinely as this increases chances of non union and infection.^{16,17} Other plate designs like the Lambda plate and metaphyseal locking plate have also been described, but none of them are as efficient as the EADHP in terms of biomechanical stability and lesser complications.¹⁸⁻²⁰

In our study, 30 patients were males indicating the higher incidence of distal humerus fractures in males than in females. Most of the fractures occurred due to high energy trauma i.e. road traffic accidents. Also, the association of these fractures with other injuries and the complex fracture patterns (AO type 12 B1 and C1) in majority patients point out the high energy mode of trauma that predispose to these fractures. The mean age of the patients was 45 years. All these correlate with other similar studies conducted earlier.^{6,21}

In all our patients, the EADHP was used to fix the fracture. The plate length was selected so as to ensure 4 cortical screws in the proximal fragment. Thus 8 hole plate was used in 38 patients and 10 hole in 10 patients. Biomechanical and cadaveric studies have proved the efficiency and stability of this plate when used to fix extra articular distal humerus fractures. In some cases with transverse simple or short oblique fractures, the plate was used in dynamic compression mode by use of

an eccentric cortical screw to achieve axial compression across the fracture site. In other cases with long oblique and spiral oblique fractures or fractures with comminution, one or more lag screws were used to achieve interfragmentary compression and anatomical reduction of the fragments. In such cases, the plate was used in neutralization mode and fixed with centric screws. In some cases, it was necessary to pre-bend the proximal part of the plate before placing over the shaft of humerus so as to match with the contour of the shaft and to achieve compression at fracture site. However, excessive bending may lead to change in direction of the locking screws and also damage the screw holes making the use of locking sleeves difficult. These problems are prevented by bending the plate while the sleeve has been fixed in the hole and restricting the bending only in between the holes.²² The use of EADHP is very simple and affords many advantages like ability to compress fracture site, ability to be used as a neutralization plate, good purchase of screws in distal fragment by use of 5 locking screws and low profile design (3.5 mm as compared to DCP which is 4.5 mm) which leads to less chances of implant prominence and soft tissue irritation.

We used the triceps splitting approach in our cases in which only the lateral part of distal humerus was exposed thus avoiding complete devascularization of the distal fragment and excessive soft tissue stripping. In all cases, the radial nerve was identified, mobilized, isolated by feeding tube and protected throughout the surgery. We had no case of post operative radial nerve palsy with this strict protocol. The safety of radial nerve with the use of EADHP has been documented by many other studies. Gerwin et al proposed a triceps reflecting approach in which instead of splitting the triceps, its lateral border is elevated from the distal humerus and lateral aspect of shaft. The radial nerve is identified and isolated. The advantages of this approach is limited stripping of soft tissue, avoidance of splitting triceps, relatively bloodless field and extensibility. Other approaches like TRAP (triceps reflecting anconeus pedicle) and combined olecranon osteotomy, lateral paratricipital sparing and deltoid insertion splitting (COLD) approach have also been described by other authors but these are not as frequently used. They are most useful in cases of intraarticular extension of the fracture line to view the articular surface.

The mean DASH score of our case group was 18.1 (range being 12.6 to 35.7 points) The DASH score of the normal population is 10 points (with S.D. of 14.68) The mean elbow range of motion at final follow up was upto 130 degrees. In a retrospective study of 20 patients with extraarticular distal humerus fracture, Kharbanda et al used Gerwin's approach for fixation with EADHP. They reported mean DASH score of 17.6 (range 13.3 to 38.3 points) and mean elbow range of motion of 125 degrees at final follow up with one patient having elbow flexion deformity of 5 degrees.²¹ Similar study of 26 patients by Jain et al reported good/excellent UCLA shoulder score

in 23 patients and fair in 3 patients. The Mayo Elbow performance Score was excellent in 21 cases and good in 5 cases. The authors concluded that EADHP is a reliable option for treatment of these fractures with stable fixation which gives early return to function.²⁰ There are numerous other studies which document the efficiency of this plate in treatment of distal humerus fractures.^{17,22}

The limitations of our study are small sample size and lack of a control group to compare the results. Large randomized controlled trials may be more effective to shed more light on the subject. A comparison between EADHP and other modes of fixation will be ideal.

CONCLUSION

The extraarticular distal humerus plate is an ideal implant for the fixation of distal humerus fractures as it matches the contour of the distal humerus and gives rigid stability by means of its locking screws distally which enhances fixation and thus ensures timely union of the fracture and early return of elbow function. The plate can be used in compression as well as neutralization mode. It is an effective and safe means of treating extraarticular distal humerus fractures and is the implant of choice for these fractures at present in our institution.

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Ethical approval: The study was approved by the institutional ethics committee

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