

Original Research Article

Outcome analysis of extraarticular distal humerus locking plate for fresh fractures of humerus shaft

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ABSTRACT

Background: The complex anatomy of distal humerus with proximity of radial nerve make the exposure and fixation of these fractures difficult. The standard technique of plate osteosynthesis consider at least eight cortices hold in both distal and proximal ends. Obeying these principles becomes difficult in distal humerus fractures. These difficulties have been overcome with the use of anatomical extra-articular distal humerus plate which has more hole density in the distal part with 3.5 mm screws for greater hold in distal part.

Methods: A prospective study was carried out at Institute of Medical Sciences BHU Trauma Centre for 19 cases of distal third fracture excluding open fractures of patients between 18-68 years who attended our OPD or Emergency from June 2017 to July 2019. All patients were operated with the triceps-reflecting modified posterior approach. Regular follow-up was done to evaluate elbow functionality, fracture union, secondary displacement, non-union, implant failure and any complications; Mayo Elbow Performance score (MEPS) was used for the final functional assessment.

Results: Fourteen 73.6% male and 5 (26.3%) female patients with mean age 41 years constituted the study group, who had an average follow-up of 17.1 months. Preoperatively one patient had radial nerve palsy (neuropraxia) who recovered completely 3 months after surgery. Overall, 18 (94.7%) patients were adjudged to have complete radiological union within 14 weeks; Mean flexion achieved was 134 ± 11.5 (range 90–140). Average MEPS at the latest follow-up was 94.7 ± 7.5 .

Conclusions: Extra-articular fractures of distal humerus can be satisfactorily treated with the use of single anatomically pre-contoured locking compression plate with excellent elbow functional range of motion and union rates.

Keywords: Distal humerus fracture, Plate osteosynthesis, Extra-articular

INTRODUCTION

Distal 1/3rd fracture of humerus are difficult to manage owing to their complex regional anatomy. These fractures are often displaced and rotated so proper anatomical reduction is of prime importance to the management. Both non operative and operative methods have been proposed for the management but in recent times surgical

intervention has taken a lead.¹⁻⁴ Pop cast or Sarmiento's functional brace have been used to manage these fractures but the fractures distal third of the humerus are very difficult to treat with brace owing to rotational forces acting on it which leads to mal-alignment.^{2,5,6}

Operative management of these fractures with stable internal fixation is also a tough task owing to proximity

of elbow joint and restoration of functional elbow movement. Plate osteosynthesis with 4.5 mm dynamic compression plate does not provide adequate stability in distal small fragment with chances of plate impingement in olecranon fossa which could block extension. With the aim of engaging at least 8 cortices in distal fragment also, dual plating is an option which provides multiple points of fixation in distal fragment but it involves long operative time and a lot of soft tissue stripping exposing to infection and non-union.^{6,7} Apart from dual plating, Lambda and metaphyseal plate have been proposed but these have not proved to be reliable.⁸⁻¹¹

Extra-articular distal humerus plate is anatomically pre-contoured and has 4.5mm locking holes at proximal end and 3.5 mm locking holes at distal end which provides larger numbers of screws to be placed in short distal fragment. Also, it has a tapered end which fits at lateral condyle thus minimizing soft tissue irritation. This study was conducted to evaluate the outcome of extra-articular distal humerus plate (EADHP) for fractures of distal third humerus.

METHODS

Patients with extra-articular fracture of humerus shaft admitted through Emergency and OPD between June 2017 and July 2019 in Trauma Centre BHU were selected for the study. After taking proper consent and abiding by the inclusion criteria, 20 patients were selected and operated within 7 days of trauma. One patient lost to follow up so, total 19 patients was followed up.

All the patients were treated with open reduction and internal fixation with the EADHP after proper pre-operative work up including clinical and radiological evaluations. X-ray of elbow with arm in antero-posterior and lateral view to diagnose extra articular distal humerus fractures, also to exclude any intra-articular element. Often the distal fragment is rotated and displaced, so proper assumption of size of distal fragment is important to consider proper implant. Neurovascular deficit especially, radial nerve palsy was checked in each patient. All fractures were classified according to the AO/OTA classification.¹² Inclusion criteria were age more than 18 years, closed fractures with or without radial nerve palsy and less than 2 weeks old trauma. Patients aged less than 18 years, those having open fractures, fractures more than 2 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. Regular follow-up was done to evaluate elbow functionality, fracture union, secondary displacement, non-union, implant failure and any complications; mayo elbow performance score (MEPS) was used for the final functional assessment.¹³ All data were analysed by SPSS® software.

Surgical steps

After proper pre-operative and pre-anaesthetic work up, patients were operated in lateral decubitus position with arm hanging over a side support under general anaesthesia or regional blocks. All patients were given second generation cephalosporin 1 g injection after sensitivity test just before skin incision was made. With proper sterile painting and draping fracture was approached through the midline posterior incision and triceps-reflecting approach. Radial nerve was identified and protected both at lateral inter-muscular septum and at spiral groove; status of radial nerve was documented in every case. Triceps was lifted from lateral inter-muscular septum and fracture site was exposed. Fracture was reduced under vision and provisionally held with Kirschner's wire or bone holding clamps; depending upon the fracture configuration, fragments were lagged, whenever appropriate. Appropriate length of plate was chosen with aim of engaging at least 4-5 locking screws distally and proximally and slid under the radial nerve, its proximal end was centred on diaphysis of humerus, and the distal end of the plate was placed over postero-lateral aspect of distal humerus just lateral to olecranon fossa and inferior to it up to the capitellum. Final position was checked under C-arm and fixation done accordingly. Closure was done in layer over Romovac drain.

Post-operative protocol

An arm pouch was given to all the patients post-operatively for 2 weeks. Mobility in the form of passive elbow and shoulder exercises was started from post-operative day 1. Check dressing of the wound and drain removal were done on the 2nd post-operative day.

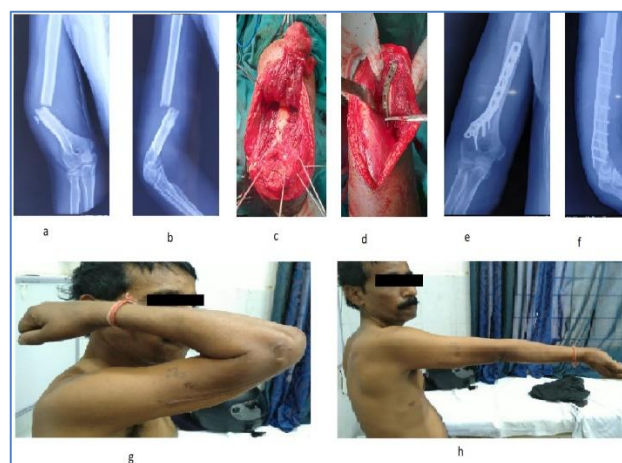


Figure 1: 30 years old male sustained road traffic accident presented with distal humerus fracture (OTA/AO type 12-A2) with (a and b) AP and lateral radiographs, (c) provisional fixation with k-wires with plate applied posteriorly, (d) post-operative AP, (e and f) lateral radiograph showing excellent alignment, and (g and h) full elbow function 1 year after surgery.

Gentle passive shoulder and elbow mobilization were started on first or second post-operative day, depending on patient tolerance. Active and assisted mobilization was started after 3 weeks and full mobilization with full weight bearing after radiological assurance of union.

Clinically, the outcome was assessed by elbow range of motion and activity. Final functional evaluation was done using mayo elbow performance score (MEPS). Range of motion of elbow was measured using a goniometer. Radiological, union was declared on anteroposterior and lateral radiographs with bridging of the fracture site in at least 3 cortices. Follow up x ray was evaluated every 4 weeks for assessment of union.

RESULTS

A total of 20 patients were included in the study, of which 1 patient lost to follow up; hence, the final results were calculated for 19 patients (14 male and 5 female) with mean age of 41 years (range 19-65) years. AO/OTA classification of fractures of the study patients was done with majority having 12-A2 (10 patients) average duration of follow-up was 17.1 months (range 12-20 months). 2 patients had associated injuries, and one patient had grade 1 open fracture. Surgical fixation was performed within a mean delay of 3.7 days from the date of injury utilizing the triceps reflecting modified posterior approach. Mean operative time and blood loss was (109±14.1) minutes and (232.8±40.8) ml respectively. No intra-operative complications were noted in relation to implant application. One patient had pre-operative radial nerves palsy (neuropraxia) and recovered completely within 3 months. Intra-operatively, continuity of radial nerve was found in all patients. Of the 19 patients, 18 patients 94.7% showed radiological union within 3and half months (14 weeks). Mean flexion achieved was 134±11.5 (range 90-140) (Figure 1).

Table1: Patient’s characteristics with follow up results.

Patient’s characteristics	Mean	Range	
		From	To
Age	41.05	19	65
Follow up duration (months)	17.11	12	20
MEPS score	94.74	70	100
Time of union (weeks)	12.21	10	18
Active flexion	134.00	90	140
Delay in surgery (days)	3.79	1	7
Operative time (min)	109.58	92	140
Blood loss (ml)	232.89	200	325
Outcome after surgery	10.61	8	14

One patient, who developed elbow stiffness and flexion deformity, had associated unla shaft fracture for which plate osteosynthesis was done. One of them showed superficial wound at suture site for which appropriate

antibiotics were prescribed. Implant prominence over posterolateral aspect of distal humerus was noted in majority of the patients, especially in thin built individuals, but none of the patients had undergone implant removal. Average MEPS at the latest follow-up was 94.7±7.5. There were no cases of re-displacement of fracture, implant failure or any other implant-related complication in follow-up.

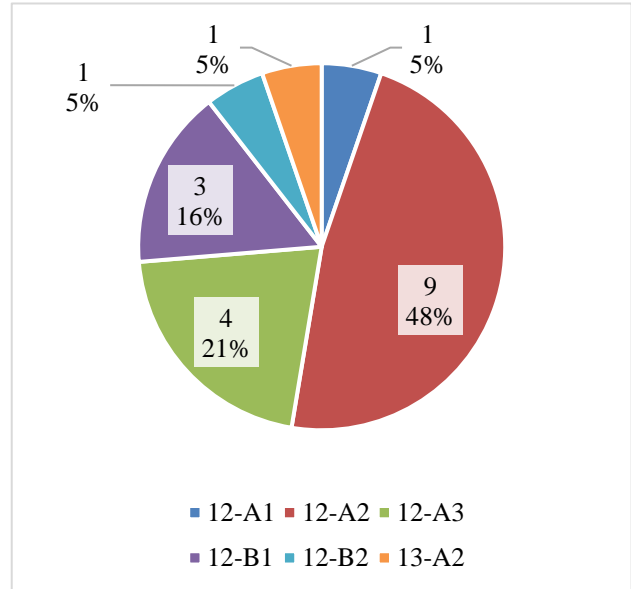


Table 2: OTA/AO classification of patients.

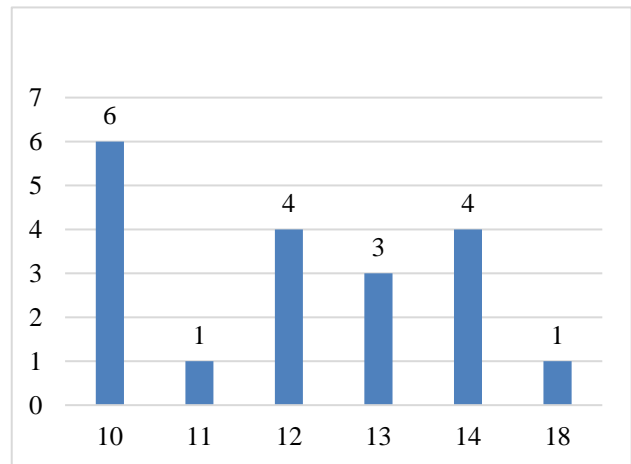


Table 3: Fracture union time (in weeks).

DISCUSSION

Traditionally shaft humerus fractures are treated satisfactorily with functional braces. The problems associated are predictability of outcome, technicality, loss of functional movement of shoulder and elbow and long waiting time.^{6,14}

Now with rise of road traffic accidents; more of complex fractures, nerve injuries and multiple trauma there has

been shift towards operative management of fractures of shaft humerus.¹⁵ Surgical management of extra-articular distal humerus fractures is challenging with its complex anatomy, vicinity to neurovascular structures, short distal fragment with relatively flat metaphyseal part.⁶ Intramedullary nailing is good option for diaphyseal fractures but distal third fractures owing to its short and flat shape and small medullary cavity, nailing leads to mal-union and non-union more often.¹⁶

Plate osteosynthesis with 4.5 mm dynamic compression plate offers excellent results for diaphyseal fractures but in distal third fractures usual principle of engaging 8 cortices are not fulfilled. Many modifications of plates have been tried to overcome this difficulty.

Moran MC described modified lateral approach with use of conventional straight 4.5 mm DCP in an oblique plane orientation which was 5-8 degree off centre from the long axis of the humerus and angled the most distal screw proximally with aim of improving the fixation of the distal fragment.¹⁷ Owing to oblique plate, fractures requiring long plate length were difficult to manage. Also, patients had complaints of implant prominence with this fixation method.

Levy had used the lateral proximal tibial head buttress locking plate of same side with aim of matching the lateral column with the offset of plate.¹¹ No implant failure occurred in the series of cases but they felt the need of designer improvement to counter the need.

Dual plating provides stable construct and facilitates early range of motion but the risk of infection and non-union are associated with it owing to soft tissue stripping and long operative time.^{18,19}

Scolaro JA conducted a biomechanical study which found that EADHP provided significantly greater bending stiffness, torsional stiffness, and yield strength than a single 3.5 mm LCP plate for osteotomies created 80 mm from the trochlea.²⁰ After this many studies showed excellent results with the use of extra-articular distal humerus plate.

In all our patients, we used EADHP to fix the fracture. Adequate plate length was chosen as to ensure at least 4 cortical screws in the proximal fragment. We have used triceps sparing a modified posterior approach proposed by Gerwin et al. This allows excellent visualization but causes minimum de-vascularization of bone, spares extensor mechanism to allow early movements, with added advantage of exploration of radial nerve both at lateral inter-muscular septum and spiral groove thus the chances of radial nerve injury are minimized to a greater extent.²¹ This approach also hastens the healing potential as the triceps muscle is not split or incised and thus there is hardly any adhesion formation or elbow contracture associated with another approach. In our study we found excellent union rate with 94.7% showed radiological

union within 3 and half months 14 weeks. Mean flexion achieved was 134±11.5 (range 90-140) with average MEPS at the latest follow-up was 94.7±7.5. There were no cases of re-displacement of fracture, implant failure or any other implant-related complication in follow-up. Recently, Trikha et al in a retrospective study analysed functional results following use of EADHP in distal humerus extra-articular fractures 34 patients 94.44% had complete union within 3 months; 2 patients developed non-union.²²

Mean flexion achieved was 122.92±23. Our study found implant prominence especially in thin built patients which was similar to findings of Trikha et al study.

Deepak Jain et al in their study, out of the 26 patients, 23 fractures united with a mean time to fracture union of 22.4 weeks (range 16-28 weeks).²³ Four patients 15.4% had a failure of cortical screws in the proximal fracture fragment at follow up. The longer average union time compared to our study might be attributed to complex fracture pattern and open fractures.

One problem noted during application of plate on posterior aspect was offset of plate away from bone in proximal aspect which demanded pre-bending of plate so anterior opening of fracture site on application of cortical screws be avoided specially in transverse fracture patterns.

The limitations of our study are relatively 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.

CONCLUSION

Use of EADHP is an effective modality in treating extraarticular distal humeral fractures. It gives rigid stability by means of its 3.5mm locking screws distally which enhances fixation and thus ensures timely union of the fracture and early return of elbow function. In small series of our cases, we found excellent outcome of extraarticular distal humerus plate both in terms of union rates and functional scores.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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