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Original Research Paper

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EXTRA-ARTICULAR DISTAL HUMERUS FRACTURES: SINGLE PLATE AND SINGLE APPROACH

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ABSTRACT **Purpose** Extra articular distal humerus fractures are notorious for periarticular smaller distal fragment and associated radial nerve palsy. Conservative treatment though achieves union but with propensity to angulation deformity. Operative means with the dual plate leads to severe periosteal stripping. The purpose of the study was to prospectively analyse the clinical and radiological outcomes of the single postero-lateral extra-articular distal humerus plate in such fractures. **Materials and methods** Our cohort included 27 patients (20 males and 7 females) with the distal humerus fractures with the mean age of 29.8 +/- 7.4 years with 12 A,B,C and 13 A fractures. All patient were operated by a single group of surgeons by modified posterior triceps reflecting approach. **Results** Evaluation was done by time to union, range of elbow movement and Quick DASH scores. Average follow up was for 77.92 +/- 10.34 weeks. All fractures achieved union at a mean period of 10.61 +/- 1.61 weeks. The mean active flexion was 120.37 +/- 6.03 degrees. The mean Quick DASH score at the end of one year was 13.30 +/- 5.70. **CONCLUSION** The extra-articular distal humerus plate gives excellent results when applied through the modified posterior triceps reflecting approach and followed up with sincere rehabilitation programme.

KEYWORDS : extra-articular humerus fracture, modified triceps reflecting approach, posterolateral plate, Quick DASH score

INTRODUCTION

The distal humerus marks a watershed region from the cylindrical shaped diaphysis to the flattened triangular shaped metaphysis.1 Fractures in this region vary from simple spiral pattern to the more complex form with comminution. Smaller distal fragment, a peri-articular location, higher incidence of associated radial nerve injury makes the management of distal extra articular humerus fractures more challenging.2 The aim of the treatment is to enable early elbow movement along with proper anatomical alignment.

Traditionally humerus shaft fractures have been best treated conservatively with functional brace as reported by Sarmiento et al in their study group of 85 patients. However 84% of their patients had malunion, varus (81%) being the most common. O'Driscoll et al 4 showed varus deformity secondary to supracondylar malunion of the distal part of the humerus may have important long-term clinical implications including tardy postero-lateral instability. In recent times operative intervention has been favoured in the view of radial nerve injury during closed manipulation, difficulty in controlling angulation and elbow stiffness by conservative means.5 Open reduction and internal fixation with plates has been evolving. A 4.5mm low contoured dynamic compression plate is an ideal choice with 6-8 cortices purchase on both sides of the fracture.6 However, the distal fragment is too small and the olecranon fossa makes it more difficult to get adequate purchase in the distal fragment. To overcome these difficulties surgeons have tried various implants and their modifications e.g. metaphyseal LCP7, 8, modified lateral tibial head buttress plate9 , double plates in parallel or orthogonal orientation10 , medial distal tibial locked titanium cobra head plate11, 4.5 mm DCP in an oblique posterior orientation with 5-8 angle off centre from one axis of the humerus9 etc.

The advantages of a single plate would include decreased surgical exposure, decreased surgical time and potentially faster rehabilitation due to minimal iatrogenic soft tissue injury as compared to dual plating. The locking compression extra-articular distal humerus plate (EADHP), also known as the "J-plate", is an anatomically shaped, angular stable fixation system designed for extra-articular fractures of the distal humerus. The aim of this retrospective study was to evaluate the clinical and radiographic results after open reduction and single-column fixation of fractures of the distal humerus with the EADHP system and compare these results with data from the literatures to confirm the reproducibility. We hypothesised that the EADHP would enable adequate fracture fixation and satisfactory elbow function and early return to work.

Materials and methods

The retrospective study was conducted in a tertiary care centre after permission from the ethical committee. We studied 27 patients (20 males and 7 females) of mean age of 29.8 +/- 7.4 years (19 to 48 years) with extra articular distal humerus fractures (EADHF) between Sep 2014 to Feb 2017 who were treated with extra articular distal humerus locking plate (EADHP). We included skeletally mature patients with open or closed distal third humerus fractures with OTA types 12 A, 12 B, 12 C, 13 A(13A2 and 13A3) who approved of the written informed consent and followed up for atleast one year post operatively. Pathological fractures, open fractures of Gustillo and Anderson12 grade II and III and polytrauma patients were excluded from the study. Two patients were lost to follow up and hence were excluded from the final analysis.

On presentation, the patients were resuscitated and splintage was given in the emergency department. Antero-posterior and lateral radiographs of the arm including the shoulder and elbow were done (Figure 1), the neurological status and other associated injuries were documented.

Table 1: Demography of our study

Parameters	Number
No of patients operated	27
No of patients included	25

Age (mean) in years	29.77+/-7.44
Sex	
Male	20 (74.07%)
Female	7(25.93%)
Side	
Right	8(29.63%)
Left	19(70.37%)
Mode of injury	
Road traffic accident	20 (74.07%)
Fall from height	4 (14.81%)
Slip and fall	3 (11.11%)
Associated injury	
Fracture both bone forearm (contralateral side)	1
Fracture clavicle (contralateral side)	1
Fracture inferior pubic rami (ipsilateral side)	1
Radial nerve palsy	1

Of the 27 patients with distal humerus fractures, 20 were due to motor vehicle accidents (74.07%), 4 were due to fall from height (14.81 %) and 3 were due to slip and fall (11.11 %). 8 were right sided injuries (29.63%) and 19 were left sided injuries (70.37%). 4 patients had grade I open fractures. 2 patients had an associated orthopaedic injury in the contralateral upper extremity (fracture clavicle and fracture both bone forearm respectively), and one patient had ipsilateral inferior pubic rami fracture. (Table 1)

Implant

The extra articular distal humerus plate is a peri-articular side specific anatomically contoured 3.5 LCP with a distal angular offset meant for the postero-lateral surface, sparing the olecranon fossa. The distal part of the plate has a relatively low profile with higher locking screw hole density to allow more screws. The two distal most screws are directed towards the capitellum and the trochlea allowing larger screws to get strong purchase. The proximal part has combi-holes allowing either locking or non-locking screws (inter-fragmentary or dynamic axial compression). This implant can be used either as a fixed-angle bridge plate or a neutralisation plate with inter-fragmentary compression.

Operative technique

The surgery was performed without the use of tourniquet with the patient in lateral decubitus position, shoulder in 90 degrees of flexion, full internal rotation, and neutral abduction. The elbow was flexed. All surgeries were performed by the same consultant. We used the modified posterior triceps reflecting approach to the humerus as described by Gerwin, Hotchkiss and Weiland.13 Manipulative reduction was performed under direct vision. Reduction clamps, K wires and lag screws were used for provisional reduction and stabilisation of the fracture. Finally the EADHP was applied on the posterior aspect of humeral shaft and fixed with locking screws distally and a combination of cortical and locking screws proximally giving compression wherever necessary.

Postoperatively, the patients were given a well padded dressing and a sling. Early passive mobilisation of shoulder, elbow and wrist was started on the 2nd postoperative day as tolerated. Active and assisted movements of the arm in the sling were encouraged within the 1st week. Patients were followed clinically and radiologically at monthly intervals till fracture union and gain of fully functional status. Union was defined as the absence of pain at fracture site on clinical examination and bridging callus on three cortices on two radiographic orthogonal views. At the end of one year of follow up the Quick DASH score was evaluated based upon the questionnaire filled up by the patient.

Results

The most common fracture pattern encountered was spiral fracture (12A1) followed by the simple transverse type (12A3). Comminution was present in 8 fractures. (Table 2). The mean interval between the injury to the internal fixation was 2.13 days. Open fractures (18.51 %) were debrided and operated on the same day as of the injury. Average blood loss was 185 ± 15.5 ml (150–250 ml), measured using the surgical swab weighing technique. Average duration of follow up was 77.92 +/- 10.34 weeks.

All patients achieved union of the fracture site (figure 2). The mean time for radiological union was 10.69 +/- 1.61 weeks (8 to 13 weeks). The mean active flexion of the elbow was 120.37 +/- 6.033 degrees, with extension loss of 5 degrees and 20 degrees in two patient respectively. The mean Quick DASH score of the study group at the end of one year was 13.30 +/- 5.703 (range 11-36). One patient had radial nerve palsy preoperatively. He underwent radial nerve exploration during the definitive fixation, and it was found to be intact but contused. Another patient had post operative radial nerve palsy. However, both recovered within 3 months of post operative period. One patient had superficial suture line infection which subsided following intra-venous antibiotics and regular dressings. There was no failure of internal fixation and no deep infection reported. No patient complained of painful hardware in our series or required hardware removal. No patient required any secondary procedure.

Table 2: Fracture Patterns in our study

Type of Fracture (AO)	Number (%)
12 A	
12A1	7(25.92)
12A2	1(3.70)
12A3	6(22.22)
12 B	
12B1	1(3.70)
12B2	4(14.81)
12B3	1(3.70)
12 C	
12C1	1(3.70)
13 A	
13A2	5(18.52)
13A3	1(3.70)
Total	27(100)

DISCUSSION

The metaphyseal-diaphyseal portion of the distal humerus is not only relatively thin and weak in comparison to other areas of the humerus but also its an area where deformative rotational forces are extensive leading to delayed or non-union. Functional bracing has been recommended as an effective modality for the management of these injuries; however with limitations such as skin problems, malalignment, loss of external rotation at shoulder, and lack of predictability of the final outcome.3 Hence in order to prevent delayed union or non-union a stable fixation is necessary with minimal soft tissue stripping.

It is not long time back when the open fixation of distal third humerus fractures used to be a challenge with the decision making with respect to implant. A 4.5 LCP was sometimes used with compromised distal fixation, or used in an off-centre pattern to prevent impingement on the olecranon fossa.8 Many surgeons thus preferred a double plate fixation in either parallel or orthogonal fixation, at the cost of more soft tissue stripping, increased and exhaustive surgical time.10,14 A cadaveric study of the mechanical properties of these plates 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 whereas dual plating was biomechanically superior for distal osteotomies.15 Various surgeons have reported excellent results with EADHP. 16, 17, 18, 19 Our study evaluated clinical and radiographic outcomes after ORIF of extra-articular distal humerus fractures with a single lateral column plate.The encouraging results confirm our hypothesis that adequate fracture fixation and satisfactory functional outcome may be achieved with this device.

Now a days with increasing high velocity road traffic trauma fracture patterns are more complex and difficult to classify. In our study group 70.04 % fractures were due to road traffic accident. The mean age of the study group is 29.8 +/- 7.4 years, denoting relatively young group of patients who are bread earners of the family and the necessity of their early return to work. In our study group we have included both type 12 (A,B and C) and type 13 A (A2 and A3) fractures. John T. Capo et al16 included only type A fractures, Kharbanda et al 17 and Jain et al 20 included only type 12 fractures. However Fawi et al 18 and J. A. Scolaro et al19 included both type 12(A,B and C) fractures and 13 A fractures. We encountered the most common fracture pattern to be spiral type, which is in consensus with previous literature.[21]

We used the modified posterior approach by subperiosteal reflection of the medial and lateral heads of the triceps medially as described by Gerwin et al. This approach has been reported to give maximum exposure of the humerus (the distal 94 per cent of the humerus) as compared to the other two approaches described in his study. We experienced no difficulty in proximal extension of the approach even to put 8 or 10 hole plate. In this approach iatrogenic radial nerve injury is minimised since the radial nerve is released from the lateral inter-muscular septum making it less amenable to iatrogenic stretch injury.Though we don't have a comparative control, the blood loss with the above approach is definitely lesser than the triceps splitting approach. Sparing the triceps muscle limits the formation of intramuscular adhesions and scar formation and theoretically reduces the chances of elbow contracture and improves post-operative triceps function. The same approach has been used with success by various surgeons 16, 18, 19 However, inspite of utmost care in dissection of nerve, still we encountered an iatrogenic radial nerve palsy. The patient was one of the six patients in whom the nerve was being compressed by the distal bone spike laterally. The patient with preoperative palsy was found to have interposition of the nerve between the bone fragments intra-operatively.

The mean time for radiological union in our study group was 10.69 +/- 1.61 weeks. It has been reported to be 12 weeks in the study by Kharbanda et al 17, 22.4 weeks by Jain et al 20, 15.7 weeks by Fawi et al 18 and 7.3 months Capo et al respectively. Jain et al attribute their delay in radiological union due to more complex fracture patterns. Capo et al16 and Fawi et al18 included non-unions (24%) along with fresh fractures in their study. Various surgeons have reported non-unions with this device.20 However in our study all fractures united in a shorter time in comparison to other studies. This could be attributed to our minimal soft tissue stripping, biological but stable fixation. The mean active flexion of the elbow was 120.37 +/- 6.033 degrees, with extension loss of 5 degrees and 20 degrees in two patient respectively. All but one patient in our study group had a satisfactory return to elbow function with 76 % cases (n = 21) having an excellent and 16 % having a good Quick DASH score. These results are comparable to the results obtained by Scolaro et al 19, Kharbanda et al 17. (Table 3)

Table 3: Comparison of our study with other studies

Studies	Mea	Percentage of union	Mean time to union (In Weeks)	Duration Of Follow Up (months)	Range Of Movement Arc (Degree)	Clinical Outcome Scores
J Capo et al*	39	100	29.2	10.4	120	25.8 (DASH)
Kharbanda et al*	44	100	12	25.6	125	17.6 (DASH)
Jain et al	37.3	88.46	22.4	11.6	>100(flexion 141.2)	96.15 (MEPS)
Fawi et al*	47.5	100	15.7	20	Full	36.5 (oxford elbow score)
Scolaro et al	36	95	-	22	-	17.5 (Quick DASH)
Our study	29.77	100	10.69	18.68	118.80	13.3(Quick DASH)

*the study included fresh fractures along with fracture non-union patients.

Limitations of the study included small cohort of patients and lack of comparative groups. It was difficult to obtain a

sufficient number of patients because this fracture is not a common injury. Future studies are warranted for detailed comparisons with groups that use other treatment methods.

CONCLUSION

The extra articular distal humerus anatomically contoured plate applied through a modified posterior approach combined with early rehabilitation programme in the treatment extra articular distal humerus fracture yields excellent clinical and radiological results and allows early return to work.

Conflict of interest

The authors declare that there are no conflicts of interests.

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