Role of Extra-articular distal humerus plate in distal third fractures of humerus

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Abstract

Background: The choice of implant for the fixation of extra articular distal humerus fracture has always been a matter of debate among the treating surgeons. Plates of various shapes and designs have been in use. An anatomically pre-contoured Locking compression plate (LCP)- Extra articular distal humeral plate (EADHP) has been developed for sturdy fixation of distal humeral extra articular fractures and has solved the dilemma of the treating surgeon regarding the choice of implant. This study focuses on the functional outcome of distal third extra articular humeral fractures fixed with the above mentioned plate.

Material and methods: Twenty four patients presenting to our casualty and OPD with extra articular distal humerus fracture were operated between June 2014 and December 2016. All patients were operated by triceps splitting approach. Patients were regularly followed and clinico-radiological outcome was recorded in terms of elbow range of movement, fracture union time, implant failure, secondary displacement, non union, infection and other complications. Mayo elbow Performance score was calculated and used for final functional outcome.

Results: A total of 24 patients were operated (19 male and 5 female). Twenty three patients had radiological union after a mean of 3.5 months. One patient went into non union. The average follow up period was 18 months. Mean flexion of elbow achieved at last follow-up was 125±18.5⁰ (Range 75-135⁰) and the mean loss of extension was 5⁰±5.5⁰ (Range 0-15.5⁰). Average Mayo elbow performance score at the final follow up was 88.6±6.5. There was one case of infection, no neurovascular deficit post operatively or implant failure in any of the cases.

Conclusion: Anatomical precontoured distal humeral locking plates allow for stable fixation and initiating early elbow physiotherapy thereby yielding satisfactory functional and radiological outcome with minimal to no complication.

Keywords: Distal humerus fracture, Locking compression plate, Extraarticular distal humeral plate osteosynthesis.

Introduction

Management of extra articular distal third humeral fracture (EADTHF) is difficult and challenging to the operating surgeon due to its peri articular location, distal fragment size being small, poor bone quality in older patients and associated comminution at fractured bone. There are proponents of both the conservative and operative treatment of these fractures. Operative treatment is preferred as maintaining distal fragment in functional braces is very difficult and that too requires prolonged immobilization leading to stiffness. The main aim of operative treatment is to ensure stable and sturdy fixation [1, 2]. EADTHF accounts for about 3% of all fractures and 16% of humerus fractures in adults[3]. With the use of functional brace Sarmiento et al. treated 85 EADTHF and had 4% non-union and 16% malunion the majority being varus angulation [4]. As per Jawa et al surgical treatment of EADTHF provides quicker and better functional return and good alignment in comparison to functional brace[5].

Managing EADTHF by intramedullary nails is very difficult due to flat cross section of the bone, narrow medullary canal, and small distal fragment leads to small working length hence unstable. Moreover if there is radial nerve palsy separate incision is required to explore the nerve. Therefore achieving osteosynthesis using plates has now become established modality of treatment for EADTHF[6]. To achieve stable fixation it has been recommended to put at least four screws in distal as well as proximal fragment and use of a plate of thickness > 3.5mm[7]. But these principles are very difficult to be taken care of in distal third humeral fracture due to the region being transition zone between the diaphysis and supracondylar region, lack of flat surface for the plate to sit on, and due the small distal fragment putting even three screws is difficult as the distal extent of plate is limited by the olecranon fossa and would lead to impingement if plate violates the fossa.

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Therefore standard 4.5 mm dynamic compression plates or locking compression plate are unable to provide adequate stability.

With the advent of precontoured extra-articular distal humeral locked compression plates (EADHP) fixation became more stable, biological, and required less soft tissue stripping as it utilizes lateral column for screw purchase avoiding and bypassing the olecranon fossa posing as distal limit to conventional plates. So with the aim to analyse the functional as well as radiological outcome of EADTHF and associated complications with the use of EADHP we conducted this study.

Material and Methods
A prospective study of 24 patients was performed who presented to our casualty and OPD with extra articular distal third humerus fracture between June 2014 and December 2016. Prior to the study informed written consent was obtained from all the patients. Those patients with compound fracture, pathological fracture, intra-articular fractures or intercondylar fractures, <15 years of age, floating elbow injury, vascular injury and frank compartment syndrome were excluded from the study. Antero-posterior and lateral X-ray was done for all patients and the fracture was classified as per AO-OTA classification (Table-1).

We used mid-line triceps splitting approach in all patients (Fig.1). Patients were operated in lateral decubitus position with their elbow flexed over a padded support under general or brachial anaesthesia. Midline skin incision was given extending from the tip of olecranon distally to as required proximally depending on the site of fracture. Triceps muscle was split in the midline and elevated off the lateral supracondylar ridge. We explored the radial nerve in the spiral groove in all cases. Once the radial nerve crossed from medial to lateral it remained protected by the lateral half of the split triceps muscle. Fracture fragments were stabilized provisionally with K wires and lag screw were used wherever needed. An EADHP of appropriate length was taken and passed under the radial nerve with the proximal end of the plate centred over the humeral shaft and the distal end lying over the posterior aspect of lateral supracondylar ridge just lateral to the olecranon fossa reaching up to the capitellum. Reduction as well as the position of plate and screw sizes was confirmed in image intensifier before the closure was done in layers (Fig. 2 and 3 ).

Active assisted and passive elbow physiotherapy was started in all patients from the next post operative day. Patients were discharged after wound inspection after 72 hours from surgery and were regularly called for follow up in our OPD. Functional outcome was evaluated by using Mayo Elbow Performance score (MEPS). Range of movement, activity level, radiological assessment in form of union, secondary displacement, implant failure, loosening of screws was evaluated at the final follow up. Fracture was said to have united if the three cortices were seen to have united on two orthogonal views of X-ray radiographs.
Results
Twenty four patients were included in this study and were followed for an average of 21 months (range 16 - 36 months). Of the 24 patients 19 were male and 5 were female. Mean injury to surgery time was 60 hours (12 – 96 hours). The mean age of the patients was 28.5 years (18- 45 years) with 80% patients being in the age range of 20- 30. In eighteen (75%) patients the mode of injury was road traffic accident, in 4 (16.6%) due to assault and in 2 (8.3%) patients due to fall from height. Fifteen (62.5%) patients had involvement of left humerus and 9 (37.5%) had right sided injury. Of the 24 patients 23 patients had achieved union at mean time of 3.5 (range 3 - 4.5) months. No patient developed radial nerve palsy. Mean flexion achieved at final follow up was 125°±18.5° (Range 75-135°). Mean extension loss that is residual flexion deformity at the final follow up was 5°±5.5° (Range 0-15.5°). One patient went into non union because in this the fracture was just above the olecranon fossa and only three screws were applied in the distal fragment that too over the thin lateral supracondylar ridge of the distal humerus. He had to be operated again 1 year after the index surgery whereby implant removal was done and the fracture ends were freshened and fixed with two recon plates on posterolateral and medial aspect of the distal humerus along with iliac crest bone graft. One patient developed superficial infection with wound gaping after suture removal but it healed with daily cleaning and dressing and appropriate antibiotics. There was no deep infection. There was no case of implant failure or secondary displacement of fracture. Three patients complained of implant prominence over the distal humerus posterolateral aspect and had undergone implant removal after a mean of 12 months (range 9 – 16 months). The average MEPS at the final follow up of all the patients was 88.6±6.5.

Discussion
The choice of implant used for fixation of distal thirdextraarticular humeral fracture is a matter of debate and varied opinions prevail among the operating surgeons regarding the same. The distal fragment being small and various torsional forces acting at the fracture site prevent stable fixation with the conventional plates. Due to the above reasons the purpose of achieving stable fixation and proper alignment of the fracture fragments is defeated. Therefore various authors have come up with different designs and constructs of plate to accomplish this purpose.

An inverted ‘Y’ plate or lambda plate was developed by Saragaglia et al[8] which contained two arms and a stem that can be remodelled to fit the contour of distal humerus. But these had only simple holes and plate can only be applied in compression mode thereby posing threat of inadequate fixation in comminuted fractures and osteoporotic bones. Dual plating has been utilized by Prasaran et al[9] al. to fix distal third humeral fracture where they have used 3.5 mm as well as 2.7 mm reconstruction plates mainly used for pelvic fractures. They used single posterior midline incision, average union time being 11.5 weeks and range of motion arc achieved post operatively was 4°- 131°. The main disadvantages were excessive triceps reflection to secure plate on both column, and the plates being weaker as compared to 4.5 mm plates. An ipsilateral lateral tibial head buttress plate was used by Levy et al.[10] after modifying it to fit over the distal humerus contour. The posterior hole of the expanded portion of the tibial plate was cut using a high speed rotary diamond- cutting tool. The sharp edges were rounded off and the plate was bent in opposite direction to reverse the original bent in the plate. This gave them a 4.5 mm limited contact dynamic compression plate which can anatomically be seated on lateral column. They reported good results but the problem was cumbersome modification process and necessity of bulk production. Custom made ‘hybrid’ locking plates was used by Spitzer et al. [11] for distal third humeral fractures which had 4.5 mm locking holes at one end and the other end consisted of a cluster of 3.5 mm locking holes. They showed an excellent outcome however this involved modification over existing design and their bulk production all over the world.

We have used LCP- Extra articular distal humeral plate which has a thickness of 4.5 mm, precontoured lateral curvature which gives at least 5 screws to be applied over the lateral column ensuring a rigid, stable and strong fixation. Dual plating has been postulated to provide a more stable fixation[12] in distal third humerus fractures but the paradigm is shifting towards the single column fixation with the advent of EADHP. In a comparative study by Meloy et al [13]where results of single column plating by precontoured posterolateral plate was compared with dual column plating for EADTHF. The single column plating group had comparable results in terms of union and alignment but better range of movement and significantly lower complication rates. Dual plating also requires exposure of both the columns of the distal humerus by extensive soft tissue stripping, which seems to be unjustifiable for an extra reticular fracture of distal humerus. Since biological fixation by preservation of soft tissue envelop is a necessity for fracture to heal and has almost replaced the earlier concept of anatomic and rigid fixation[14]

| AO-OTA classification | Number of patients | Percentage of patients |
|-----------------------|--------------------|------------------------|
| 12A1                  | 7                  | 29.10%                 |
| 12A2                  | 5                  | 20.80%                 |
| 12A3                  | 2                  | 8.30%                  |
| 12B1                  | 4                  | 16.60%                 |
| 12C1                  | 4                  | 16.60%                 |
| 13A1                  | 2                  | 8.30%                  |
the concept of dual plating is fading for EADTHF. Although there is no direct study comparing the dual plating and single column fixation but studies have shown higher infection as well as non union rates with dual plating which may be attributed to greater soft tissue stripping and longer operative time required in this method [15,16].

We used triceps splitting approach in all our patients where we approached posterior approach only by splitting the medial head of triceps going proximally where radial nerve was encountered crossing the posterior shaft of humerus in radial groove. This saved us from elevating the whole of the triceps and exploring the radial nerve right from the point where nerve pierced the lateral intermuscular septum till the nerve entering the radial groove. Many studies have utilized the latter that is triceps elevating approach or the modified posterolateral approach by Gerwin et al.[17] and criticized[18] that going by the split medial head can cause intramuscular adhesions and compromise functional outcome but we had comparable results and functional outcome with those studies. Also the radial nerve remains protected by the lateral half of the split medial head along its course on the lateral aspect of humeral shaft before piercing the lateral intermuscular septum and need not be dissected. The added advantage with triceps splitting approach is that when attempted and exposure is inadequate it can be abandoned and converted to triceps elevating approach by retracting the whole triceps medially [17]. We did not need to convert our approach in any patient and also no iatrogenic radial nerve injury was seen in any of the cases which probably can be attributed to the lateral half of the split triceps providing cushioning effect to the radial nerve from being compressed or stretched by the bone levers. Also we avoided excessive retraction on the lateral side by the bone levers.

An average Mayo elbow performance score at the final follow up was 88.6±6.5 and mean flexion of elbow achieved at last follow-up was 125±18.5⁰ (range 90-135⁰) and the mean loss of extension was 5°±5.5° (range 0-15.5°). Mean time to union was 3.5 months. Kharbanda et al. [18] in their study using EADHP achieved union in 12 weeks (range 10–18 weeks), and at final follow-up, the mean flexion was 125⁰ and only one patient had a flexion deformity of 8°. At 1 year follow up the mean DASH score was 17.6 ranging from 13.3 to 38.3 points. Trikha et al. performed study on 34 patients where 94% patients achieved union within 3 months with a mean flexion of 122.92⁰±23⁰ and mean extension was -4.03⁰±6.53⁰, average MEPS at final follow-up was 90.8 + 9.9 and one patient developed radial nerve palsy[19].

Our study had few limitations like small sample size, single centre study, lack of comparison with dual column plating and also comparison with a triceps elevating approach patient group would have strengthened the study. We had one case of infection that was superficial and healed with daily cleaning and dressing. One patient went into non union as the fracture was just above the olecranon fossa due to which only three screws were applied in distal fragment and there was seating difficulty of the plate on the posterior humerus. This is one problem we faced because the plate was precontoured irrespective of patients size therefore seating of the plate in all patients anatomically is not possible and bending the plate afterwards may damage the threads of the locking hole and also change the direction of locking screws. This can lead to improperly directed and loose locking screws thereby leading to loss of reduction. To prevent this, the plate should be bent in between the screw holes with the holes pre-engaged by locking sleeve. Also in case of comminuted fractures varus collapse can occur with only plating of lateral column in absence of union and this can be prevented by using longer plates and wide spaced screws configuration in order to gain the working length. Three patients also had undue hardware prominence over the lateral column due to thin soft tissue envelop, hence must be counselled regarding the same preoperatively and the need for implant removal after union.

In conclusion we feel that EADHP has really turned out to be a panacea for all problems a surgeon is faced with the treatment of EADTHF. However surgeon should be ready with proper preoperative planning and well versed with all approaches to expose humerus from posterior aspect. Reconstruction plates should be kept in reserve in cases of comminuted fracture just above the olecranon fossa so that additional buttress can be provide from the medial aspect.

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