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Functional Outcome of treatment of distal humerus fractures using distal humeral locking plates

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Abstract

Objective: *The treatment of multifragmentary, intraarticular fractures of the distal humerus is difficult, even in young patients with bone of good quality. Small distal fragment, diminished bone mineral quality and increased trauma-associated joint destruction make stable*
joint reconstruction more problematic. The anatomically preshaped locking plates allow angular stable fixation for these complex fractures. We evaluated functional results of patients treated with open reduction and internal fixation with distal humerus locking plates for complex distal humerus fractures.

Methods: *Thirty consecutive patients with articular fractures of the distal humerus were treated by open reduction and internal fixation with AO distal humerus plate system and locking reconstruction plates. According to AO/ASIF classification, there were 2 cases of type A2, 4 cases of type A3, 1 case of type B1, 1 case of type B2, 11 cases of type C1, 4 cases of type C2 and 7 cases of type C3. Open reduction with triceps splitting technique was used in all patients. The clinical and radiographic follow-up was performed and outcome measures included pain assessment, range of motion, and Mayo elbow performance score.*

Results: *Thirty patients were available for the final outcome analysis. There were 19 males and 11 females with an average age of 38.4 years (18-73 years). Clinical and radiological consolidation of the fracture was observed in all cases at an average of 11.6 weeks (9-14 weeks). The average follow-up was 12 months (10-18 months). Using the Mayo elbow performance score the results obtained were graded as excellent or good results in 23 patients (76.6%). One patient had superficial infection.. There were no cases of primary malposition or secondary displacement, implant failure. There were two cases of ulnar neuropathy which recovered conservatively.*

Conclusion: *Anatomically preshaped distal humerus locking plate system is useful in providing stable fixation for complex distal articular fracture and facilitating early postoperative rehabilitation. The low rate of implant failure in the present study indicates that the technique is promising and warrants further investigation.*

Keywords: *Humerus; Fractures, bone; Bone plates; Fracture fixation, internal.*

Introduction

Injuries involving distal end of the humerus represent a constellation of complex articular fractures. Distal humeral fractures account for 2%-6% of all fractures and about 30% of all elbow fractures[1].They are often multi-fragmented and have complex anatomy with limited options for internal fixation. Historically, distal humeral

fractures have a propensity for poor clinical outcome after treatment. Prolonged immobilisation of the elbow predisposes to joint stiffness, muscle atrophy, and permanent functional impairment[3,4,5] Therefore the consensus has shifted towards treating these fractures with open reduction and stable internal fixation so as to restore painless and satisfactory elbow function by early mobilization[6,7]. Conventional implants and techniques have not been able to completely address the problem of implant failure and substantial stability in small distal osteoporotic fragments[8,9,10]. The high failure rate is due to insufficient area for insertion of ample number of screws in a small sized distal fragment, resulting in poor stability at bone-plate interface.[11,12] Distal humerus locking plates (DHP) provide higher stability by permitting multiple screws in small distal fragment, thereby, addressing some of the limitations of conventional implants. The present prospective study was planned to evaluate the results of DHP in operative management of distal humeral fractures.

Methods

This prospective study comprised 30 consecutive patients with articular fractures of the distal humerus. Patients of all ages and of either sex after fusion of epiphysis were included in this study. Exclusion criteria included pathological fracture, previously operated or non-functional elbow and Grade IIIB and IIIC open fractures (Gustilo and Anderson classification).All fractures were classified on the basis of AO Muller classification. After detailed clinical-radiological examination and informed consent, all patients were subjected to surgery under pneumatic tourniquet. In lateral position through a modified Campbell's posterior approach, the ulnar nerve was identified and mobilized to prevent iatrogenic damage. Triceps was dissected into two planes. The superficial aponeurotic portion reflected as an inverted V-shaped flap along the coronal plane and the deeper muscle was incised in the sagittal plane. The fracture was reduced to correct anatomic position, including articular surface with special attention to trochlear reconstruction. Reduction was temporarily held by K-wires and reduction bone clamps. The fracture was stabilized using pre-contoured DHP and/or locking reconstruction plates as per preoperative planning. The more comminuted column with small distal fragment was fixed using radial or ulnar DHP. The other column was fixed with another DHP or locking reconstruction plates depending upon the size of distal fragment, fracture pattern and the stability of fixation (Figure 1).

After the fracture fixation, the stability of fixation was checked by moving the elbow joint through the complete range of motion. The incision was closed by layers over a negative suction drain. Postoperatively Plaster of Paris (POP) back slab was given to give rest to the operated part and mediolateral stability. Supervised physiotherapy in the form of active flexion and extension at elbow was permitted by breaking the POP back slab at elbow as soon as patient was reasonably pain free, usually by the 2nd or 3rd postoperative day. Patients were reviewed at 2 and 4 weeks and followed by monthly interval for clinical-radiological evaluation and complications if any (nonunion, malunion, screw cutout, myositis ossificans and implant breakage). Final outcome measures included pain assessment, range of motion and Mayo elbow performance score (MEPS)[12] Results were considered excellent if the MEPS was 90

or above, good if it was between 75 and 89, fair between 60 and 74 and poor less than 60.

Statistical analysis

Data were analyzed with the Chi-square test and Student's *t* test. For all tests, probability less than 0.05 was considered significant

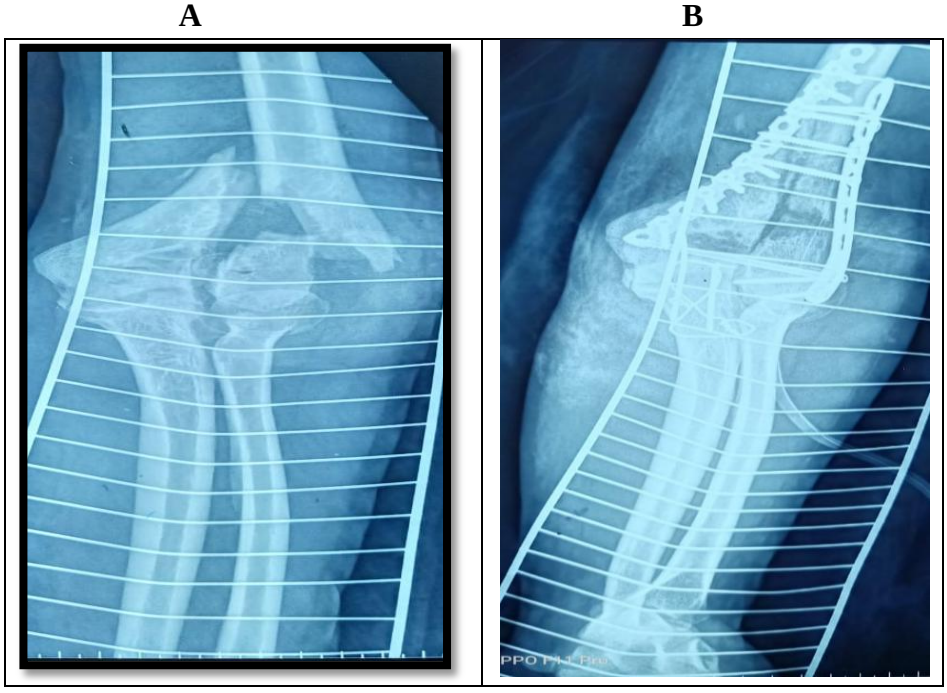
Results

A total of 30 patients were included. There were 19 males and 11 females with an average age of 38.4 years (18-73 years). Majority of cases were

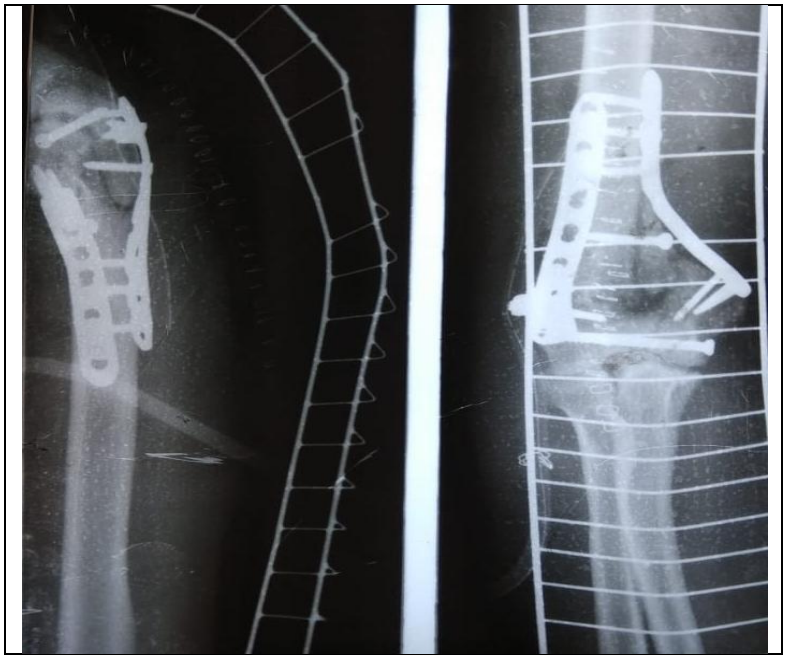
due to road traffic accident in younger age group and direct fall onto elbow was a common mode of injury in the older age group. Average delay to operation from the time of injury was three days (range 2-10 days), which was mostly due to delay in reporting to the hospital. According to AO/ASIF classification, there were 2 cases of type A2, 4 cases of type A3, 1 case of type B1, 1 case of type B2, 11 cases of type C1, 4 cases of type C2 and 7 cases of type C3. The average follow-up period was 12 months (10-18 months). Clinical-radiological consolidation of the fracture was observed in all cases at an average of 11.6 weeks (9-14 weeks. There were 3 incidences of ulnar nerve distress in the postoperative period and on subsequent follow-up whch recovered after 3 months. The superficial infection observed in one case was managed by antibiotics. No significant varus or valgus deformity was seen in any of the patients. By 6-8 weeks postoperatively, all the patients had triceps power at least grade 4 or more.18 patients (70%) had no pain, while eight patients (20%) had slight pain with continuous activity requiring no analgesics and remaining four patients (10%) reported having moderate pain with occasional activity and needed some form of medication. With respect to motion, average arc of flexion-extension was 102° (range 70°-130°), with all patients exhibiting full supination and pronation. 19 patients had motion arc greater than 100°. The results obtained in terms of MEPS calculated for each of the 30 patients monitored showed excellent and good results in 23 patients (76.6%), fair in 5 (16.6%) and poor in 2 (6.6%). Mean MEPS scores of types A, B and C fracture groups were 94, 83, and 84 respectively with overall average of 85. Postoperative performance of type A fracture was significantly better than those of type B and type C ($P<0.05$). The recovery of activities of daily life (combing one's hair, getting dressed, performing personal hygiene tasks, putting on shoes and feeding oneself) had a mean MEPS score of 4.2 out of 5 activities.

No of Patients	**30**
Male/Female	**19/11**
Classification (AO)	**A2(2) A3(4) B1(1) B2 (1) C1(11) C2(4) C3(7)**
Complications	**Ulnar Neuropathy (3) Superficial infection (1)**
MEPS	**Good(23) Fair (5) Poor(2)**

Figure 1



Preoperative (A) and Postoperative Xray (B)



Postoperative Xray

Discussion

Distal humeral fractures are difficult management problems on account of the complex anatomy of the elbow, small sized fracture fragments and the limited amount of subchondral bone.[13,14] It is now generally accepted that the most favorable outcome of displaced intraarticular fractures is provided by surgical reconstructive procedure. One of the frequent clinically reported complication of open reduction is implant failure that occurs by loosening of the bone-implant anchorage at distal fragment.[4,15,16] To prevent such failure two principles must be satisfied:

Fixation in the distal fragment must be maximized and all fixations in distal fragments should contribute to stability between the distal fragments and the shaft. This is possible only if as many screws as possible are placed in the distal fragments; the screws in the distal fragments lock together by interdigitation creating a fixed-angle structure and the plates must be strong and stiff enough to resist breaking or bending before union occurs.[16] We preferred anatomically pre-contoured DHP for the above cited reasons. Locking reconstruction plate was used to reconstruct the other column wherever distal fragment was sufficiently large. The locking plates provide a fixed plate screw construct with multiple screw options for easy application in distal complex fractures thereby providing angular stability. In our series there was no case of nonunion or implant failure whereas markedly high failure rate has been reported in the literature for conventional plates especially loosening of distal screws[4,17,18] Locking plates allow greater perioperative stability and early rehabilitation. This does indicate that these locking plates provide better fixation than conventional plates and permit early mobilization with better rehabilitation. *In vitro* biomechanical assessment has also shown that these plates provide better stiffness in bending and torsion than conventional reconstruction plates as borne out by the absence of implant loosening in the present study.[19] Adequate exposure is a prerequisite for treatment of distal humeral fractures. These fractures can be made more or less difficult to treat based on exposure. Transolecranon (olecranon osteotomy), triceps-splitting, and triceps-reflecting are the most common posterior surgical approaches to the adult elbow. The transolecranon approach, which provides complete posterior visualization, requires olecranon osteotomy and is associated with possible complications such as prominence/ migration of hardware and possible displacement/

nonunion of osteotomy.[6,17] In our series all patients were operated on through posterior Campbell's approach in lateral position.

The mean MEPS in this series was 85 with most patients (76.6%) reaching either excellent or good results. Best treatment outcome was achieved with type A fractures. Taking the fracture type into consideration, functional results deteriorated with degree of joint involvement, which is coherent with findings of Korner et al[4] that outcomes from type C fractures are less promising than type A. Mean range of motion is 102° in the present study which is comparable to earlier studies using same implant. Analogous functional results have been attained with use of conventional implants in types A and B fractures. But in type C fractures with small distal fragment, the results have not been so encouraging[20,21]. The rate of implant failure is remarkably low despite the high proportion of type C fractures included in our study. The final outcome is slightly better in younger patients.

Conclusion

In conclusion, locking plate is a versatile implant providing stable-enough fixation and helping restoration of normal anatomy for good result and early rehabilitation. The results of our study do indicate that DHP system is a useful option in distal humerus fractures even type C injuries with comminuted small distal fragments, although larger control studies with long term follow-up may be required before advocating it for wider application.

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