Full length article

Outcome after internal fixation of intraarticular distal humerus (AO type B & C) fractures: Preliminary results with anatomical distal humerus LCP system

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ABSTRACT

Purpose: The treatment of intraarticular fractures of the distal humerus is challenging and involves the risk of complications and bad functional results. Anatomical and stable internal fixation with early postoperative mobilization is expected to improve the functional outcomes. The objective of this study was to evaluate the functional and radiological results, along with the complications associated, of open reduction and internal fixation using precontoured anatomical locking LCP plate system for intraarticular distal humerus fractures in adult patients.

Methods: This prospective study consist of 31 patients with a mean age of 41.2 years (range 19–62) were treated with open reduction and angular stable internal fixation. All underwent posterior transolecranon surgical approach. Mean follow-up to the final interview was 10 months (from 6 to 20 months). All operated patients were available at the time of last followup. AO classification showed 26 C-fractures (9*13C1, 12*13C2, 5*13C3) and 5 B-fracture (1*13B1, 1*13B2, 3*13B3). There were 25 closed fractures and 6 open grade 1 fractures. The clinical followup using Mayo elbow performance score (MEPS) and radiographic follow up with elbow anterior–posterior and lateral view X-rays were performed postoperatively.

Results: The mean MEPS was 87.9 points out of 100 (range 55–100) with 61% Excellent, 29% good and 10% fair and poor scores. Mean elbow flexion of 115.8° (range 85°–150°). The mean deficit in extension was 19° (range 5°–35°). All olecranon osteotomy were united. Nonunion of distal humerus fracture occurred in 2 cases. Other complications were hardware prominence in 3 cases, superficial infection in 4 cases and Ulnar nerve neuropraxia in 1 case which was recovered uneventfully. Revision surgery was not required in any complication.

Conclusion: Open reduction and internal fixation with precontoured distal humerus anatomical locking plate system is a good method of treatment for complex Supra- intercondylar fracture of distal humerus with good functional outcome and low rates of complications. Even though early results are promising, longer term investigations and larger patient groups are necessary to confirm the presented data.

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1. Introduction

Majority of the distal humerus fractures (96%) have a complex pattern involving both the columns and the articular surface (AO type B and C injuries).¹

High percentage of unsatisfactory functional results following conservative treatment has been reported in the literature.² On the other hand, open reduction and internal fixation (ORIF) of distal humeral fractures with plates and screws has been associated with complications such as implant loosening associated with secondary loss of reduction, malposition and malunion of the frag-

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ments.^{3,5,10} Comminution of the fragments, osteopenia, delicate articular anatomy of the distal humerus, deficient bone stock available in the olecranon fossa for implant placement, further complicate the situation. The latest generation precontoured anatomical low compression locking distal humerus plate system allows angular stable and rigid fixation of intraarticular distal humerus fractures. These specially designed plating system for distal humerus provide better biomechanical properties and enhanced anchorage in these complex, unstable & more challenging injuries. Due to these advantages, early mobilization and aggressive functional rehabilitation is possible and functional outcome might be improved.

The objective of this study was to analyze the functional and radiological results, along with the complications associated, of open reduction and osteosynthesis with internal plating for intraarticular distal humerus fractures in adult patients.

2. Methodology

This prospective study was based on a series of 31 consecutive patients who were operated on from June 2014 to June 2015 for distal intercondylar humerus fracture using the 3.5 mm precontoured distal humerus medial and lateral anatomical locking plating (90:90 orthogonal) system through a posterior transolecranon approach. The criteria for inclusion were: patients aged more than 18 years, with close and open grade 1 (according to Gustilo-Anderson classification) intraarticular distal humerus fractures and fracture dislocations classified intercondylar type B and C according to the AO classification system. Exclusion criteria were: patient below age of 18 years, open grade 2 & 3 fracture, supracondylar extraarticular fractures (AO type A), previous operative treatment because of the fracture (external fixation excluded), history of primary or metastatic tumors with pathologic fracture and those who were unfit for major surgery. Seven of the patients were women and twenty four were men. The average age of the patients was 41.2 years (range 19–62). Mean follow-up up to the final interview was 10 months (from 6 to 20 months). All operated patients were available at the time of last followup.

Preoperative data collection was done by detailed history taking and systematic clinical examination of injured elbow. Preoperative radiographs in two planes (antero-posterior (AP), and lateral views) were obtained to analyze the fracture. Fractures were classified according to the preoperative X-rays and the intraoperative findings. AO classification showed 26 C-fractures (9*13C1, 12*13C2, 5*13C3) and 5 B-fracture (1*13B1, 1*13B2, 3*13B3).

There were 25 closed fractures and 6 open grade 1 fractures. 5 patients had tense soft tissue swelling and ecchymosis and they were treated after resolution of soft tissue swelling usually within 7–9 days. Detailed Informed consent of the patient or relatives was taken prior to the surgery.

All underwent posterior transolecranon surgical approach. 3.5 mm precontoured distal humerus anatomical LCP system belongs to the latest generation of locking compression plates. The screws in the distal humerus are locked into the plate and cannot back out or totter, which is a particular advantage in the distal region close to the joint with low amount of cancellous bone. The plates are preshaped in different sizes to fit on the ulnar and dorso-radial column.

2.1. Postoperative period

Patients were instructed to keep the limb elevated and move their fingers and elbow joint. Early controlled passive mobilization of the elbow was started 48 h postoperatively after removal of the

drainage. After discharge, patients completed a physical therapy program with passive and active mobilization of the joint in full range of motion. Suture/staples were removed within the 9th to 16th postoperative day and check X-ray in anteroposterior and lateral views were obtained.

2.2. Follow-up

After suture removal, patients were advised to report for follow up after 4 weeks and 8 weeks, 12 weeks, 16 and 24 weeks thereafter every 3 months. At each follow up a detailed clinical and radiological examination was done and patients were assessed subjectively for the symptoms like pain, swelling and restriction of joint motion, ability to perform daily routine activities. Using 2 elbow projections (anteroposterior and lateral), we assessed radiographic consolidation and state of the osteosynthesis material (migration, breakage). Functional assessment was effected by measuring the range of mobility with a manual goniometer, evaluating elbow stability, and using the scales of the Mayo Elbow Performance Score (MEPS) which include an assessment of the arc of joint mobility, stability and functionality of the elbow and the presence or absence of pain). Patients were instructed to carry out physiotherapy in the form of active flexion-extension and pronation-supination without loading at 3–4 weeks postoperatively.

BICOLUMN FIXATION WITH DISTAL HUMERUS LCP SYSTEM.

3. Results

3.1. Functional evaluation

At final follow up, the mean MEPS was 87.9 points out of 100 (range 55–100) with a mean elbow flexion of 115.8° (range 85°–150°). The mean deficit in extension was 19° (range 5°–35°). There were no final limitations in pronation and supination in any cases. All elbows were stable at followup with no difference in radial or ulnar stress opening in comparison to the contralateral side, a negative pivot shift test and a negative moving valgus stress test.

The mean functional result of the MEPS was 22.74 points of 25. Majority of patient (22 out of 31) were able to do all 5 functions included in mayo elbow performance score (daily hygiene work by themselves, comb their hair by themselves, feed by their own, put on their shirts by their own and put on their shoes by their own). The majority of patients (20/31) reported no pain at all, eleven patients reported mild pain over 24 h and usual activities of daily living and working. Based upon Mayo Elbow Performance Score, there were 19 patients (61%) with a mean excellent result (90–100), 9 patients (29%) with good (75–89), 1 patient with a fair result (60–74) and 2 patients with poor result. (below 60).

3.2. Radiographic assessment

Union was achieved completely in 29 patients (93.5%) at final follow up. Average time required for union was 16 weeks (range 12–24). 2 fracture remained as painless nonunion. The patients did not require reoperation in either of these cases. There were no cases of primary malposition or secondary dislocation. All osteotomy of the olecranon underwent consolidation as well.

3.3. Complications

There have been no complications with respect to the fixation of the implants and the retention of the fragments in anatomical position. Apart from 2 fractures nonunion, other complication was 1 ulnar neuroapraxias with altered sensation in fourth & fifth finger. These recovered fully during followup without any associated sequelae. Four patients had superficial infection over surgical wound, all were treated successfully by oral antibiotics & local dressing wound care. In 3 patients, implants were clinically prominent without causing any discomfort.

RESULTS OF THE MAYO ELBOW PERFORMANCE SCORE:
CLASSIFICATION TOTAL SCORE: EXCELLENT (90–100); GOOD (75–89); FAIR (60–74); POOR < 60

Function	Points	Definition (Points)	No of elbows	Mean score
Pain	45	None(4.5)	20	39.67
		Mild(30)	11	
		Moderate(15)	0	
		Severe(0)	0	
Motion	20	Arc>100°(20)	9	15.48
		Arc 50–100 degrees(15)	19	
		Arc <50°(5)	3	
Stability	10	Stable(10)	31	10
		Moderate Instability(5)	0	
		Gross Instability(0)	0	
Functions	25	25 points	22	22.74
		20 points	6	
		15 points	1	
		10 points	2	
		5 points	0	
TOTAL	100		31 ELBOWS	87.9

4. Discussion

Restoration of painless and satisfactory elbow function after a fracture of the distal humerus, particularly intraarticular fracture requires anatomic reconstruction of the articular surface, restitution of the overall geometry of the distal humerus, and stable fixation of the fracture fragments to allow early and proper rehabilitation. Although these goals are now widely accepted by the orthopaedic community, they may be technically difficult to achieve.²¹

High percentage of unsatisfactory functional results following conservative treatment has been reported in the literature.² On the other hand, open reduction and internal fixation (ORIF) of distal humeral fractures with plates and screws has been associated with complications such as ulnar neuropraxia,⁶ implant loosening associated with secondary loss of reduction, malposition and malunion of the fragments.^{3,5,10} Several factors are responsible for high complication rates and limited functional results. The distal fragments are usually small and have less amount of subchondral bone reserve which represents significant problems. This may lead to a decreased screw-holding strength in the distal fragments. The complex anatomy of the distal humerus requires challenging three-dimensional plate modeling in order to provide an optimal biomechanical outcome. Finally, the elbow joint has a tendency to

react with contracture and loss of active range of motion to every trauma, surgery or immobilization and, therefore, requires stable internal fixation to allow for early rehabilitation.⁶

Open reduction and internal fixation of both medial and lateral column with the anatomical and reconstruction distal humerus Plating system provides reliable, stable fixation allowing early functional mobilisation of the elbow joint, even in complex fractures and impaired bone quality, resulting in good outcomes for the majority of patients. Recently locked compression plates have been popularized that utilize fixed angle screws that are believed to provide superior fixation.⁷ They have an additional advantage of unicortical screw placement that avoids risk of screw tips projecting into the joints. Pre-contoured plates have also been made available for the medial and lateral columns. These locked compression plates and distal humerus plates are more useful in patients with osteoporotic bones, metaphyseal comminution, or very low type of intra-articular fractures.^{4,8,9}

Olecranon osteotomy has been considered the gold standard, providing excellent exposure and avoiding problems associated with triceps-splitting techniques, including disruption of the extensor mechanism, fibrosis, and intramuscular nerve injuries.^{11,12,13} On the other hand, osteotomies can be complicated with delayed union, nonunion, and prominent hardware, thereby necessitating further surgery.^{2,12} In our study, we found 3 patients having clinically prominent & palpable implant without causing any discomfort. However in our series, all olecranon osteotomies were consolidated at the time of last followup.

Reising K et al.¹⁴ carried out a study of 40 patients with mean age of 60.5 years with distal humerus intraarticular fractures treated by open reduction & internal fixation using a novel, perpendicular, fixed-angle distal Humerus Plate (DHP, Synthes) system with a mean follow-up of 11 months. 'Good' or 'excellent' results were observed in 29/40 patients. Mean MEPS was 84 and Mean ROM was 100°. Complications comprised two superficial wound infections, two cases of heterotopic ossification, one case of delayed union and five cases of transient ulnar neuropathy. Implant failure was observed twice in one patient.

S. Greiner et al.¹⁵ published the results of open reduction and internal fixation of 14 distal humerus intraarticular fracture using anatomically preshaped angular distal humerus plate(12C types and 2B type according to AO CLASSIFICATION SYSTEM) with mean age of 55.2 years. Clinical MEPS results were good to excellent with a mean of 91+/-11.7 points. Mean flexion was 121+/-20.9, mean extension deficit was 17.9° +/- 10.3. Radiographically, complete union was achieved in all patients. There were no cases of primary malposition or secondary dislocation. Complications were 1 delayed union after olecranon osteotomy and 2 transient ulnar nerve irritation.

In present study, we prospectively evaluated a series of 31 consecutive patients with the mean age of 41.2 years who were operated for distal intercondylar humerus fracture including (26C and 5B types according to AO CLASSIFICATION) using the 3.5 mm precontoured distal humerus medial and lateral anatomical locking plate (90:90 orthogonal) system through a posterior trans-olecranon approach. At mean followup of 10 months (range 6–20 months), the mean MEPS was 87.9 points out of 100 (range 55–100) with a mean elbow flexion of 115.8° (range 85°–150°). The mean deficit in extension was 19° (range 5°–35°). Based upon Mayo Elbow Performance Score, there were 19 patients(61%) with a mean excellent result (90–100), 9 patients(29%) with good (75–89), 1 patient with a fair result (60–74) and 2 patients with poor result(below 60). Union was achieved completely in 29 patients (93.5%) at investigation 3 months postoperatively. Average time required for union was 16 weeks (range 12–24).² fractures remained as painless nonunion. There have been no complications with respect to the fixation of the implants and the retention of the fragments in anatomical position. Apart from 2 fractures nonunion, other complications were one ulnar

neuroapraxia, four superficial infections and three clinically prominent hardware without causing any discomfort. Revision surgery was not required in any of above complications.

The average rate of non-union following bicolumnar fractures is rated at 6%.^{16–19} It is more common in low fracture configurations, unstable internal fixation or failure of internal fixation. It generally requires revision surgery with repeat internal fixation and elbow release procedures to improve range of motion.^{16,20} Non-union in most cases involves the supracondylar part of the fracture whereas the intercondylar part usually unites well.¹

In our study, 2 fracture were not united and remained painless at the time of last followup.

The limitations of this present study are related to the inherent weaknesses of relatively less number of patients (n = 31) and short period of follow up (mean = 10 months).

From this study, we can conclude that open reduction and internal fixation with precontoured distal humerus anatomical locking plate system is a good method of treatment for complex supra-intercondylar fracture of distal humerus to get restoration of the articular surface anatomy, stable fixation and early mobilization with good functional outcome and low rates of complications. Even though early results are promising, longer term investigations and larger patient groups are necessary to confirm the presented data.

Preoperative radiograph of Comminuted distal humerus Fracture

Post operative Anteroposterior (AP) and Lateral radiograph showing osteosynthesis using Distal humerus LCP.

6 months followup radiograph at union.

A

B

(Range of movements- extension(A) & flexion(B) at 6 months follow up showing good functional outcome)

Conflict of interest

The authors have no conflicts of interest to declare.

Ethical responsibilities

Protection of persons and animals: The authors declare that no experiments on human beings or animals were performed for this research.

Data confidentiality: The authors declare that no patient data appear in this article.

Right to privacy and informed consent: The authors declare that no patient data appear in this article.

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