

# Fixation of Supracondylar Intercondylar Fracture Humerus by Anatomical Distal Humerus Plates

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## Abstract

### Background

Fractures of the distal humerus have traditionally been a significant challenge to be treated for the orthopedic surgeons. The anatomical complexity, limited bone stock of the distal segment, frequent fracture comminution, and the close proximity of neurovascular structures add to the difficulty of fracture treatment. The locking compression plate and distal humerus plate (LCP-DHP) system produces high-quality reconstructions and sufficient stability, thereby enabling early mobilization for distal humerus fractures.

### Objective

The aim of this study is to evaluate fixation of supracondylar intercondylar humeral fractures by anatomical distal humeral plates. Functional results will be assessed with Mayo elbow performance (MEP) scores.

### Materials and Methods

A prospective study of 20 patients with supracondylar intercondylar humeral fractures was treated by anatomical distal humeral plates in the department of Orthopaedics at Al-Azhar university hospitals between the period of October 2016 till September 2017. Variables of each patient were recorded and analyzed with respect to age, sex, fracture type, mode of injury, limb involvement, associated injuries, follow up, complications and final outcomes. These patients were followed up at different intervals i.e. at every week for first 1 months, then interval of 1 month for next 6 months and then at 3-month interval.

### Results

As regard 20 patients in this study, the result of our study showed 8 cases (40%) had excellent result, 8 cases (40%) had good result, and 4 cases (20%) had poor result. The Mean  $\pm$ SD of score was  $83.5 \pm 17.6$ .

### Conclusion

Locked compression plates have been popularized that utilize fixed angle screws that are believed to provide superior fixation. They have an additional advantage of neocortical screw placement that avoids risk of screw tips projecting into the joints. These locked compression plates and distal humerus plates are more useful in patients with osteoporotic bones, metaphyseal comminution and very low type of intra-articular fractures.

### Keywords

Supracondylar Intercondylar Fracture Humerus - Anatomical Distal Humerus Plates.

## Introduction

Fractures of the distal humerus have traditionally been a significant challenge to be treated for the orthopedic surgeons. The anatomical complexity, limited bone stock of the distal segment, frequent fracture comminution, and the close proximity of neurovascular structures add to the difficulty of fracture treatment. [1]

Distal humerus fractures comprise approximately 2% of all fractures. They have a bimodal age distribution, with peak incidences occurring between the ages of 12 and 19 years, usually in males, and those aged 80

years and older, characteristically in females.[2]

Humeral intercondylar fractures are often caused by the impact of the trochlear notch of the ulna, leading to the separation and dislocation of the bilateral condyles. [3]

The locking compression plate and distal humerus plate (LCP-DHP) system produces high-quality reconstructions and sufficient stability, thereby enabling early mobilization for distal humerus fractures. [4] This technique has been shown to achieve satisfactory function of the elbow joint and high rate of union. [5]

While recent advances in implant design, surgical approach, and fixation techniques lead to good functional outcomes, distal humerus fractures are still associated with several complications. These complications include loss of reduction, implant failure, non-union, malunion, ulnar nerve neuropathy, elbow stiffness, and heterotopic ossification. [1]

The majority of distal humerus fractures occur in one of two ways, low energy falls or high energy trauma. [6]

High-energy injuries are the cause of most distal humerus fractures in younger adults. Motor vehicle collisions, sports, falls from height, and industrial accidents predominate. [2]

**Riseborough & Radin** Classify the as four types. The fragments can be in place, displaced, rotated or comminuted. [7] Jupiter Classification of I.C.Humerus Fracture was high-T, low-T, Y, H, medial lambda, lateral lambda and multiplane T. [8] **AO/The Orthopedic Trauma Association's** classification Assigned three main types of distal humerus fracture. **Type A:** extra-articular (supracondylar fracture) 80% extension type. **Type B:** Intraarticular- single column (partial articular). **Type C:** intraarticular- both columns fractured and no portion of the joint contiguous with the shaft (complete articular). [9]

Conservative treatment is accepted in the elderly before arthrolysis and arthroplasty. [10] and in cases of hemiplegia sequelae involving the ipsilateral upper limb advanced osteoporosis and Fractures with extensive bone loss, but the functional result will always be unsatisfactory.[11] Patients with nondisplaced fractures may also be managed with a trial of nonoperative management. [2]

Surgical fixation of these fractures enhances stability, allows immediate motion and obviously decreases the risk of delayed fracture displacement. Common method of fixation is perpendicular and parallel plates. [2]

Arthroplasty is the most reasonable option for elderly patients with unrepairable distal humerus fractures. [2] There are common approaches for surgical exposure of I.C. fracture humerus include Classic olecranon osteotomy (At bare area of sigmoid notch), Triceps anconeus sparing approach (TRAP), Bryan & Morrey approach, Triceps splitting approach and Triceps tongue reflecting approach. Complications of I.C. Fracture Humerus include Ulnar nerve injury, Elbow stiffness and Contracture, Delayed union and Nonunion, Heterotopic Ossification (HO), Malunion, Infection (superficial or deep) and Myositis ossificans.

Anatomical DHP have several advantages. Posterolateral and medial plates allow implant placement to address the individual fracture pattern. Plates are precontoured for anatomical fit. Posterolateral plate with lateral support offers the option for two additional screws placed lateral to medial. Monocortical fixation is sufficient since the diverging nature of the screws in the locked holes ensures good construct stability. Posterolateral plates offer fixation of the capitulum with three distal screws. Five options for screwing into the distal block permit the fixation of extremely distal fractures, especially in osteoporotic bone as the screws are also locked into the plate. The two-plate construct creates a girder-like structure which strengthens the fixation. The posterolateral plate functions as a tension band during elbow flexion, and the medial plate supports the medial side of the distal humerus. Orthogonal plates have high stiffness and strength relative to other constructs for the various movements (flexion, extension, rotation). LCPs can also be used as a neutralization plate, resorting to shorter plate and one less screw per fragment. [12, 13]

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## Patients and Methods

From October 2016 to October 2017 a prospective study was undergone at Alazhar university hospitals (Al-Hussein and Sayed Galal hospitals), Cairo, Egypt on patients with supracondylar intercondylar fracture humerus treated by ORIF with anatomical distal humeral plates.

The inclusion criteria included mature skeleton, recent supracondylar intercondylar fracture humerus and 4 months post-operative follow up.

The exclusion criteria include skeletally immature patients, neglected fracture humerus, concomitant neurovascular injury, previous elbow surgery, loss of follow-up, pre-existing deformity, disability, infection and Unfit patient for surgery.

According to age of patients, 70% of patients were adults of  $73.3 \pm 5.1$  years while 30% were old age of  $35 \pm 10.3$  years.

According to sex distribution in all studied cases, there were 30% males and 70% females.

According to the affected side in all studied cases, there were 50 % Rt. sided affected and 50 % Lt. sided affected.

According to mode of fracture, fall on elbow accounts for about 40% while road traffic accident accounts for 60% of studied cases (Table- 1).

Classification of fracture in studied patients was C1:40%, C2: 20% and C3: 40% (Table- 2). 80% of cases showed isolated fracture while 20% of cases showed associated other fractures.

**Table (1):** Showing Cause of Injury

Cause of Injury	No. of Patient (N=30)	Percentage
Fall	8	40
RTA	12	60

**Table (2):** Showing Types of Fracture (AO Classification)

Type of fracture	No. of cases (N = 30)	Percentage
C1	8	40
C2	4	20
C3	8	40

### Operative and Surgical Technique

All cases were operated in the lateral decubitus position with the elbow 90° flexion and forearm hanging on the side over an arm support. Tourniquet was used routinely in all patients. Skin was disinfected, and the operating field from mid arm to mid forearm was draped. We used a posterior midline longitudinal incision. Triceps sparing was performed in all cases (Figur-1B). The ulnar nerve was isolated, protected (Figur-1A). Medial and lateral condyles were fixed together with K-wire or screw. After reconstruction of the articular surface, the medial and lateral columns were reduced and provisionally fixed to the metaphysis with crossed 2 mm K-wires. Then both the columns were reconstructed using anatomical distal humeral plates (Fig-1C). Plates were applied at 90° to each other (Orthogonal plating). In some cases, the plate needed to be bent slightly to fit the individual anatomy of the distal humerus. At the end of the procedure, reconstruction of the soft tissues was performed. Wound was closed in layers over a negative suction drain, antiseptic dressing done and

limb immobilized in above elbow slab with elbow in 90 degree flexion and mid-prone position. Operated limb was elevated and patient was advised to keep moving the fingers and shoulder joint. Hand grip strength exercises were also begun. The arms were assessed clinically with respect to pain relief, instability, range of motion and functional improvement. Radiological assessment was done by antero-posterior and lateral views. Drain was removed after 48 hrs. And skin sutures were removed after 2 weeks post-operative. After one week, controlled assisted active mobilization of elbow was started and, after 2 weeks, active mobilization was performed.

Post-operatively, patients were evaluated both clinically as well as radiologically at different intervals which were started from 1st week for a period of one month. Follow up of another next three months at interval of 4 weeks up to six months.

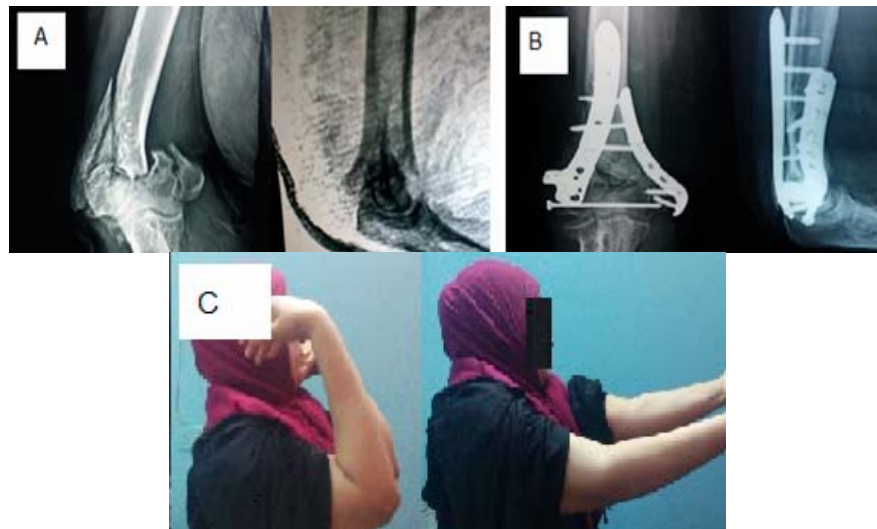
In each visit, radiological assessment of union and fracture callus quality was done in addition to functional limb assessment by Mayo Elbow Performance Scoring (MEPS).



**Figure (1):** A: posterior midline longitudinal incision. B: Ulnar nerve exploration. C: Fracture reduction & fixation with anatomical DHP.



**Figure (2):** case 1, a: preoperative x ray. B: postoperative x ray after 4 month. C: clinical photo after 6 month.



**Figure (3):** Case 2, a: preoperative x ray. B: postoperative x ray after 4 month. C: clinical photo after 6 month.



**Figure (4):** case 1, a: preoperative x ray. B: postoperative x ray after 4 month. C: clinical photo after 6 month.

## Results

We studied 20 patients with 14 adult age of a Mean  $\pm$  SD  $35 \pm 10.3$  years and 6 old age of Mean  $\pm$  SD  $73.3 \pm 5.1$  years. These 20 patients prospectively followed up for an average of duration was 4-9 months. All fractures were opening reduced and internal fixed by anatomical distal humeral plates. The average time interval between admission and surgery was 4.6 days (ranged 2-7 days). The average operative time was 80 minutes (70-100 min). All the fractures were united by 12-18 weeks (Average 13.80 weeks). 10 patients (50.0%) relieved without post-operative complications. 10 (50.0%) patients achieved post-operative complications. 2 cases (10%) suffered from superficial infection managed by daily dressing with intravenous antibiotics. It was also observed that 2 patients (10%) were developed transient ulnar nerve palsy, which recovered with conservative treatment. Loosening of the intercondylar screw was noticed in 2 (10%) patient; however, the fracture in this patient united well. 2 (10%) patients had metal prominence. 2 cases (10%) suffered from heterotrophic ossification. It was observed that no any patient had reported about deep infection, myositis ossificans, screw in olecranon fossa, implant failure, non-union (Table- 3). According to arc of motion, there were 14 cases (70%) with arch of motion more than 100 degree of flexion arch took 20 points from the score. The other 6 cases

(30%) were with arch of motion less than 100 degree of flexion but more than 50 degree arch took 15 points from the score. No recorded cases with arc less than 50 degree of flexion. According to arc of motion, there were 14 cases (70%) with arch of motion more than 100 degree of flexion arch took 20 points from the score. The other 6 cases (30%) were with arch of motion less than 100 degree of flexion but more than 50 degree arch took 15 points from the score. No recorded cases with arc less than 50 degree of flexion. According to pain, there were 8 cases (40%) with no pain took 45 points from the score. 8 cases (40%) were with mild pain took 45 points from the score. 4 cases (20%) were with moderate pain took 15 points from the score. No recorded cases with severe pain. According to function, there were 12 cases (60%) took 25 points from the score, 4 cases (20%) took 20 points from the score, 4 cases (20%) took 15 points from the score and no cases took less than 15 points from function. The description of scores of MEPS in studied patients showed 8 cases (40%) scored 100 points, 4 cases (20%) scored 85 points, 2 cases (10%) scored 80 points, 2 cases (10%) scored 75 points and 4 cases (20%) scored 55 points. The Mean  $\pm$ SD of score was  $83.5 \pm 17.6$ . The description of result of MEPS in studied patients showed 8 cases (40%) had excellent result, 8 cases (40%) had good result, and 4 cases (20%) had poor result. No cases recorded fair result (Table- 4).

**Table (3):** Showing Post-operative complication

Post-operative complication	No. of cases (N = 30)	Percentage
Heterotrophic ossification	2	10%
Superficial infection	2	10%
prominent implant	2	10%
Transient ulnar nerve injury	2	10%
Transcondylar screw loosening	2	10%

**Table (4):** Showing Final Outcome (Mayo Elbow Performance Score)

Outcome	No. of Patient (N= 30)	Percentage
Excellent	8	40
Good	8	40
Fair	-	-
Poor	4	20

## 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 reha-

bilitation. Although these goals are now widely accepted by the orthopaedic community, they may be technically difficult to be achieved. (14) **Zhang, L., et al. (2010)** studied 13 cases of type C distal humeral fracture treated with the AO anatomical locking compression plates. There were 5 males and 8 females with an average age of 52.1 years (range, 24-80 years). Fractures were caused by tumbling in 7 cases,

by traffic accident in 4 cases, and by falling from height in 2 cases. According to AO classification, there were 3 cases of type C1, 6 cases of type C2, and 4 cases of type C3. Two cases complicated by ulnar nerve injuries, 1 by radial nerve injury, 2 by fractures of ulnar olecranon, 3 by fractures of other parts of extremities, and 6 by osteoporosis. The function of elbows recovered from 3 to 32 weeks (10 weeks on average). No fixation failure, myositis ossificans, delayed union, or malunion occurred during the follow-up. The Mayo Elbow Performance score ranged from 75 to 100 with an average score of 95.8; the results were excellent in 9 cases, good in 3 cases, and fair in 1 case with an excellent and good rate of 92.3%. (15) **Govind et al. (2017)** evaluated 30 cases of closed distal end of humerus fractures type C, out of which 10 (33.33%) were high T- type, 4 (13.33%) low T- type, 12 (40.0%) Y- Type, 2 (6.66%) H- Type, 1 (3.33%) medial lamda type and 1 (3.33%) was lateral lamda type fracture. Y- Type fracture was most common followed by high T- type. Out of 30 patients, 18 (60%) were men and 12 (40%) were women. The maximum age of the patient in this study was 66 years and minimum being 23 years, with mean age of 38.50 years. The majority cases were from age group of 20 years to 40 years (50%) followed by above 60 years (20%) (Table-2). The majority of patients were due to fall (53.33%) followed by RTA (43.33%) and only one was sports injury (3.33%). Right humerus was involved in 21 (70%) cases and left humerus in 9 (30%). Whereas six patients had other associated fractures. There were no cases of primary malposition or secondary dislocation. 18 (60%) patients had  $>100^\circ$  while 12 (40%) patients had 60-100° range of motion at elbow. No any patient had reported about deep infection, implant failure. Only three patients were reported for a superficial wound infection, which was treated with antiseptic dressing and antibiotics. It was also observed that two patients were developed transient ulnar nerve palsy, which recovered with conservative treatment. Loosening of the cancellous intercondylar screw was noticed in 1 (3.33%) patient; however, the fracture in this patient united uneventfully and 2 (6.66%) patients had metal prominence (olecranon K-wire and lateral column plate). According to Mayo elbow performance score, the majority patients had achieved excellent outcome (53.33%), followed by good (36.33%), fair (6.6%) and only one poor (3.33%). [16] **Reising, K., et al. (2009)** followed up 40 consecutive patients underwent open reduction and internal fixation with DHP system. There were 19 males and 21 females included in the study with a mean age of 60.5 years (range 14–84). Traffic and skiing accidents were the most common cause of injury in patients 60 years of age and younger [15], whereas falls were observed to be the most common etiology in patients over 60 years of age. Three pa-

tients were polytraumatized. The mean age of these three patients was 43 years (range 25–57). Associated injuries were present in 10 cases. The mean time from the date of injury to internal fixation was 7 days. 'Good' or 'excellent' results were observed in 29/40 patients. Median MEPS was 84 points. There was a tendency towards better functional results in younger patients and injuries without comminution of the articular surface. 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. [17] **S. Greiner et al. (2007)** 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) with mean age of 55.2 years. Clinical MEPS results were good to excellent with a mean of 91+/-11.7 points. There were no cases of primary malposition or secondary dislocation. Complications were 1 delayed union after olecranon osteotomy and 2 transient ulnar nerve irritations. [18]

In present study, our patients were 20 patients with 70% adult age and 30% old age. These 20 patients followed up for an average of duration was 4-9 months. All fractures were opening reduced and internal fixed by anatomical distal humeral plates. 70% of them were female and 30% were males. The left side was affected on 10 cases (50%) and the right side was affected also the same. 60% of the injuries were caused by road traffic accident (12 cases) and 8 cases falling on the elbow (60%). The injuries were classified by AO classification, there were 8 cases of type C1 fracture (40%), 8 type C3 fracture (40%) and 4 cases of type C2 fracture (20%). 16 cases were isolated fracture (80%) and 4 cases were associated with other fracture (20%). 10 patients (50.0%) relieved without post-operative complications. 10 (50.0%) patients achieved post-operative complications. 2 cases (10%) suffered from superficial infection. 2 cases (10%) suffered from transient ulnar nerve palsy, which recovered with conservative treatment. 2 cases (10%) suffered from heterotrophic ossification. 2 cases (10%) had metal prominence. 2 cases (10%) had loosening of the intercondylar screw. No any patient had reported about deep infection, myositis ossificans, and screw in olecranon fossa. implant failure, non-union. The result of our study showed 8 cases (40%) had excellent result, 8 cases (40%) had good result, and 4 cases (20%) had poor result. The Mean  $\pm$ SD of score was  $83.5 \pm 17.6$ .

As we know the major limitations of our study which include the small sample size and relatively short duration of follow-up. This follow-up is too short to address long term development of osteoarthritis.

Furthermore, since we had used only one type of plating and technique, therefore, we cannot make a direct comparison with other plating systems or techniques.

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## Conclusion

The anatomical distal humeral plates were useful in providing stable fixation of supracondylar intercondylar humerus fractures, thereby facilitating early postoperative rehabilitation. We did not observe any case of secondary fracture displacement, non-union or implant failure even in elderly patients with potentially reduced bone mass. Although larger control studies with long term follow-up will be required before advocating it for wider application.

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