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Treatment of Distal Ulnar Fractures by Distal Ulnar Hook Plate

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Abstract

Background: Distal ulna fractures are relatively uncommon in isolation, but they are frequently associated with distal radius fractures in the form of ulnar styloid fractures. Locked distal ulna fixation is an attractive method to provide low profile, stable fixation that allows early range of motion [ROM] and rehabilitation of the hand, wrist, and forearm. The aim of this work was to evaluate the clinical and radiological outcomes of distal ulna hook locking plate for fixation of distal ulna fractures associated with or without distal radius fractures. Methods: A prospective study included 20 participants underwent open reduction and internal fixation by distal ulnar hook locking plate at Benha university Hospital, Mansheit El-Bakry general hospital, Cairo, Egypt. Results: Mayo score was estimated during this study which revealed that mean Mayo score was 87.5, ranged from 60 to 100; 70% of cases had excellent, 20% had good and 10%had satisfactory Mayo score. Overall grip strength proportion was evaluated during this study which revealed that mean proportion of overall grip strength was 87.6%. Dominant grip strength proportion was evaluated during this study which revealed that mean proportion of overall grip strength was 86.4%. Non-dominant grip strength proportion was evaluated during this study which revealed that mean proportion of overall grip strength was 92.5%. Among all studied cases, 80% had no complications, 5% had infection, 5% had non-union revision and Delayed union in our study occurred in 2 patients [10 %]. Conclusion: The distal ulna hook plate is an anatomic plate contoured to fit to the distal ulna. The good outcomes achieved in this study suggest that usage of the distal ulna hook plate could be an alternative treatment method for fixation of distal ulnar fractures. All distal ulna fractures achieved good results, functional outcomes were promising, including wide wrist ROM and no DRUJ instability.

Key words: distal ulna, distal ulnar fractures, distal ulnar hook plate.

1. Introduction

Distal ulnar fractures, especially styloid injuries, classically have not been repaired, recently have these injuries been considered important. Certain fracture patterns of the distal ulna contribute to distal radioulnarr joint [DRUJ] incongruity and potential instability. Several reasons make fixation of distal ulna fractures difficult, which includes, high incidence of osteoporosis in the affected patient population, proximity of the injury to the articular surfaces, and lack of a proper implant to treat these injuries [1].

The locking compression distal ulna plate [LC-DUP] is an anatomically contoured implant with a low profile and fixed angle that provides proper stability to treat injuries of the distal ulna. The plate was designed for the treatment of distal ulna fractures, but its success has led to an extension of its indications to be used in treating symptomatic Basi styloid ulnar nonunion, ulnar shortening osteotomy for ulnocarpal abutment syndrome [1].

Some studies have reported poor outcomes in unstable distal ulna fractures treated non-operatively [2]. Several studies reported that unstable or malaligned fractures of the ulnar head or neck can affect DRUJ function and diminish distal forearm stability, which can contribute to the risk of distal radius nonunion and callus encroachment of the DRUJ, leading to chronic pain and instability [3].

Furthermore, intra- articular distal ulna head or neck fractures have been associated with disruption of the distal radio-ulnar ligament, resulting in a loss of structural support for the triangular fibrocartilage complex [4]. For these reasons, several studies have recommended operative treatment when displaced or unstable intra-articular distal ulna fractures remain after reduction and firm fixation of the concomitant distal radius fracture [5].

Open reduction with internal fixation of the distal ulna fracture can allow secure fixation and early motion. However, small, and often osteoporotic fracture fragments typically exist, and the short non-articular arc of the ulnar head limits hardware placement, which can interfere with the distal radioulnar joint or the articular surface of the ulnar head [6].

Locked distal ulna fixation is an attractive method to provide low profile, stable fixation that allows early range of motion [ROM] and rehabilitation of the hand, wrist, and forearm [7].

Thus, Dennison and Ring et al introduced the locked plate fixation technique for the treatment of distal ulna fractures and achieved relatively good outcomes. However, this technique has some limitations, if the fracture extends to the intra- articular neck or head portion, fixation and restoration of these plates can be difficult because the articular surface of the fixation area is not large enough [8].

The locking compression distal ulna hook plate was introduced for the treatment of distal ulna fractures. This plate is precontoured anatomically and has a slim design, rounded edges, and a polished surface, which limits the irritation of overlying soft tissues. In addition, it can be used to achieve angular stable fixation of the fragments regardless of the bone quality, and a lower risk of primary and secondary loss of reduction exists [9].

The aim of this work was to evaluate the clinical and radiological outcomes of distal ulna hook locking plate for fixation of distal ulna fractures associated with or without distal radius fractures.

2. Patients and Methods

This prospective study includes 20 patients with distal ulnar fracture treated by distal ulnar hook locking plate at Benha university Hospital and Mansheit El-Bakry general hospital, Cairo, Egypt.

2.1Inclusion criteria:

- Age group: adult older than 18 years old
- Sex: both sex
- Recent distal ulnar fracture [extra or intra articular], not more than three weeks.
- Displaced distal ulna fracture within the distal 5 cm
- Unstable fracture of neck and head ulna with more than 10-degree angulation
- With or without distal radius fracture
- Displaced [more than 2mm] styloid ulna

2.2Exclusion criteria:

Any cases with the following criteria were excluded

- Skeletally Immature
- Stable distal ulna fracture
- Pathological fracture
- Open fractures
- Severely comminuted head ulna fracture

2.3Patient evaluation:

Preoperative workup:

All patients were admitted in the ordinary ward and history was taken to assure functional activity. Full workup including clinical examination, radiological evaluation as well as laboratory investigations was performed for every patient.

Methods of clinical assessment:

1. Personal data:
   - Name, age, gender, occupation, special habits, address, date of admission, side affection and dominant hand.
2. Mechanism of injury and type of the fracture.
3. History taking:
   - Medical illness, drug history and history of previous surgery.
4. Pre-injury functional ability of the patient, assessment of previous wrist pain and any wrist deformity.
5. Examination:
   - Skin condition, discoloration, localized tenderness and deformity of the upper limb.
   - Examination for any associated injuries, vascular or neurological.
6. Laboratory study**:**
   - Complete blood picture.
   - Fasting blood sugar.
   - Bleeding time, prothrombin time.
   - Blood urea and creatinine.
   - Liver enzymes.

Demographic features:

Gender incidence:

There were 14 males and 6 females.

Age incidence:

The age of the patients ranged from 20 to 50 years.

Mechanism of Injury:

Out of 20 cases: 9 patients were due to direct trauma, 8 were due to fall from height, and 3 were due to RTA.

Side of injury:

Out of the 20 patients, there were 9 right sided and 11 left sided.

Dominance:

Out of the 20 patients, there were 17 patients with right dominant hand and 3 left dominant hand.

Bilaterally:

All patients have unilateral affection pattern.

Radiological evaluation:

PA and lateral views of the fractured wrist joint and distal ulna were taken for each patient to allow for preoperative assessment and classification of fractures. CT [sagittal, coronal and axial] ulna were taken for assessment of intraarticular fracture if needed.

Surgical Technique:

Twenty patients with distal ulnar fracture were managed with open reduction and internal fixation using the distal ulnar locking compression hook plate [Titanium].

Fitness to surgery:

The patients were assessed for fitness for surgery by clinical history, examination, and routine pre-operative laboratory investigations.

Consent:

Standard consent was taken from the patients

Surgical procedure:

Anesthesia:

Patients were anaesthetized by general anesthesia, all patients received 3rd generation cephalosporins [cefotaxime] preinduction to anesthesia.

Position:

Patients were operated on a standard orthopedic table, in supine position, the pneumatic tourniquet was applied to the affected limb for all patients then preparation and draping the affected side.

Surgical Technique for Distal Ulna Fracture Fixation:

- The subcutaneous border of the distal ulna was palpated by moving the fingers distally and proximally to identify the tip of styloid ulna. A direct approach to the subcutaneous distal ulnar shaft is made using a 6– 8- cm long longitudinal medial incision that starts at the tip of the ulnar styloid and continues proximally [fig, 1]. [10]

Fig. (1) Approach of distal ulna. [10]

The internervous plane lies between the extensor carpi ulnaris muscle, which is supplied by the posterior interosseous nerve, and the flexor carpi ulnaris muscle, which is supplied by the ulnar nerve. Incised the deep fascia along the same line as the skin incision, the dorsal sensory branch of the ulnar nerve is identified and carefully protected (fig2,3). [10]

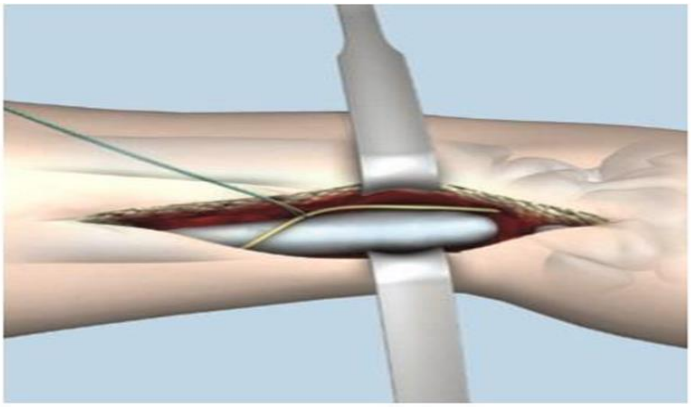

Fig. (2) Gently retract dorsal cutaneous branch of the ulnar nerve. [10]

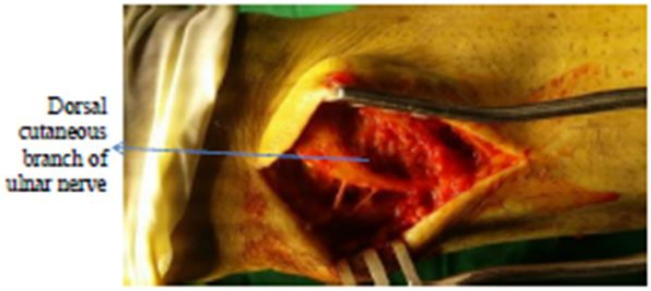

Fig. (3) The dorsal cutaneous branch of the ulnar nerve. [10]

Great attention is required at this stage to avoid injury to this nerve, which crosses the bone at this level to supply the dorsal skin of the hand. Neuromas in this area tend to be troublesome and are often the source of significant symptoms.

2.4. Statistical analysis

The collected data was revised, coded, tabulated and introduced to a PC using Statistical package for Social Science (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). Data were presented and suitable analysis was done according to the type of data obtained for each parameter. Mean, Standard deviation (± SD), minimum and maximum for parametric numerical data. Frequency and percentage of non-numerical data. P value is considered significant if <0.05 at confidence interval 95%.

3. Results

Union outcome was evaluated clinically by range of motion, no click at fracture site, radiologically by serial Xray. Union outcome was evaluated within this study in relation to total percentage of each time interval was recorded within this study, which revealed that 8 weeks, was (5%), 10 weeks was (5%), 12 weeks was related to (80%) and 24 weeks was (10%), with mean (±SD) time of union was 12.9 (±3.9) weeks. Pearson`s correlation test was performed between both parameters which revealed that there was insignificant weak positive correlation as P-value > 0.05 and r < 1 table (1).

Table (1) Duration of union among all studied cases.

			Cases n=20		p	r
	mean±SD	**Duration of union**	**N**	**%**		
Union Outcome	12.9±3.9	8 Weeks	1	5 %	0.146*	0.331**
		10 Weeks	1	5 %		
		12 Week	16	80 %		
		24 Week	2	10%		
		Total	20	100%		

N; Number, %; Percentage, SD, standard deviation, P; Probability Level, r; Pearson`s Correlation Coefficient *Insignificant Difference **Weak Positive Correlation

Moderate pain was found in 10%, mild pain was found in 10% and no pain was found in 80%. Restricted functional status was found in 40% while regular activity was achieved in 60% [table 2].

Table (2) Pain intensity and functional status among all studied cases.

			Cases n=20	
Pain intensity	**No pain**	**N (%)**	**16**	**80%**
	mild	**N (%)**	2	10%
	moderate	**N (%)**	2	10%
Functional status	**regular activity**	**N (%)**	12	60%
	restricted	**N (%)**	8	40%

Pain may be due to hardware prominence, neuropraxia of dorsal sensory branch of the ulnar nerve and DRUJ arthrosis.

Total percentage of each extension value was recorded which revealed that, (65°) was (10 %), (70°) was (40 %), (75°) was (50%). Mean and range of extension was 71.5° (60°-75°).

In addition, total percentage of each flexion value was recorded within this study which revealed that, (60°) was (5%), (65°) was (5%), (70°) was (60%), (75°) was (30%). Mean flexion was 70.75° and ranged from 60° to75° table (3).

Table (3) Range of movement [extension and flexion] among all studied cases.

			Cases n=20	
Extension	**60°**	**N (%)**	1	5%
	65°	**N (%)**	1	5%
	70°	**N (%)**	8	40%
	75°	**N (%)**	10	50%
		mean±SD	71.5 ±4.6	
		Range	60-75	
Flexion	**60°**	**N (%)**	1	5%
	65°	**N (%)**	1	5%
	70°	**N (%)**	12	60%
	75°	**N (%)**	6	30%
		mean±SD	73±2.5	
		Range	70-75	

Range of movement [pronation and supination]:

Total percentage of each supination value was recorded within this study which revealed that (60°) was (15%), (65°) was (20%], (70°] was (25%), (75°) was (40%). Mean supination was 69.5° and ranged from 60° to 75°.

In addition, total percentage of each pronation value was recorded within this study which revealed that, (60°) was (5%), (65°) was (15%), (70°) was (30%) and (75°) was (10%). Mean pronation was 71.25° and ranged from 60° to 75° table (4).

Table (4) Range of movement [pronation and supination] among all studied cases.

			Cases n=20	
Supination	**60°**	**N (%)**	3	15%
	65°	**N (%)**	4	20%
	70°	**N (%)**	5	25%
	75°	**N (%)**	8	40%
		mean±SD	69.5±5.6	
		Range	60-75	
Pronation	**60°**	**N (%)**	1	5%
	65°	**N (%)**	3	15%
	70°	**N (%)**	6	30%
	75°	**N (%)**	10	50%
		mean±SD	71.25±4.6	
		Range	60-75	

Range of movement [ulnar and radial deviation]:

Total percentage of each ulnar deviation value was recorded within this study which revealed that, (25°) was (10%), (30°) was (5%), (35°) was (85%). Mean ulnar deviation was 33.75° and ranged from 25° to 35°.

In addition, total percentage of each radial deviation value was recorded within this study which revealed that, (15°) was (10%), (20°) was (15%) and (25°) was (15%). Mean radial deviation was 20.25° and ranged from 15° to 25° table (5).

Table (5) Range of movement (ulnar and radial deviation) among all studied cases.

			Cases n=20	
Ulnar deviation	**25°**	**N (%)**	2	10%
	30°	**N (%)**	1	5%
	35°	**N (%)**	17	85%
		mean±SD	33.75±3.2	
		Range	25-35	
Radial deviation	**15°**	**N (%)**	2	10%
	20°	**N (%)**	15	75%
	25°	**N (%)**	3	15%
		mean±SD	20.25±2.6	
		Range	15-25	

Grip strength:

Overall grip strength proportion was evaluated during this study which revealed that mean proportion of overall grip strength was 87.6%.

Using paired t test, it was revealed that there were non-significant differences between both hands as p value >0.05 table (6).

Table (6) Descriptive and correlative study of overall (Dominant+non-dominant) Grip strength.

	Operated side	**Normal Grip strength**	**p**
mean	31.1	35.5	0.191*
range	13-50	18-55	
		87.6%	

P, probability *Non-significant difference

Dominant grip strength:

Dominant grip strength proportion was evaluated during this study which revealed that mean proportion of overall grip strength was 86.4%.

Using paired t test, it was revealed that there were non-significant differences between both hands as p value >0.05 table (7).

Table (7) Descriptive and correlative study of Dominant Grip strength.

	Operated side	**Normal Grip strength**	**p**
mean	30.6	35.4	0.255*
range	13-50	18-55	
		86.4%	

P, probability *non-significant difference

Non-dominant grip strength:

Non-dominant grip strength proportion was evaluated during this study which revealed that mean proportion of overall grip strength was 92.5%.

Using paired t test, it was revealed that there were non-significant differences between both hands as p value >0.05 table (8).

Table (8) Descriptive and correlative study of overall non-dominant Grip strength.

	Operated side	Normal Grip strength	p
Mean	33.3	36	0.863*
Range	20-50	18-50	
	92.5%		

P, probability

***Non-significant difference**

Mayo score was estimated during this study which revealed that mean Mayo score was 87.5, ranged from 60 to 100; 70% of cases had excellent, 20% had good and 10%had satisfactory Mayo score table (9).

Table (9) Modified Mayo wrist score among all studied cases.

		Cases n=20	
		N	%
MAYO score	**Excellent**	14	70%
	Good	4	20%
	Satisfactory	2	10%
Mean		87.5	
Range		60-100	

Among all studied cases, 80% had no complications.

Two patients, (10%) had delayed union after 4-6 months of serial evaluation clinically and radiologically by Xray, one patient because of smoking, so patient was instructed, as preoperative, to stop smoking and enhance union by intake of calcium and vitamin D, 2nd patient due to early lifting heavy objects by his dominant affected hand and he did not care about the good follow up.

One patient, (5%) had superficial skin infection due to uncontrolled diabetic condition, this infection eradicated with serial dressing, antibiotics, and good regimen for controlling diabetic condition involving food, medications. No debridement was needed.

One patient, (5%) had non-union, after exclusion of infection clinically, laboratory and radiologically, revision fixation occurred with corticocancellous bone graft from the iliac crest. union occurs after 2 months of revision table (10).

Table (10) Complications among all studied cases**.**

	Cases n=20	
No complications	16	80%
Delayed union	2	10%
Superficial infection of skin	1	5%
Non-union	1	5%

4. Discussion

Mayo score was estimated during this study which revealed that mean Mayo score was 87.5, ranged from 60 to 100; 70% of cases had excellent, 20% had good and 10%had satisfactory Mayo score. Quick Dash Score was estimated during this study which revealed that mean Dash score was 6.5, ranged from 2.3 to 11.4; 80% of cases had excellent, 20% had good functional outcome.

Half of the group (50.0%) had age ranged from 30 to 40 years. This agrees with **Lee et al**. [11] in their retrospective analysis of 25 patients with DRF associated with ulnar styloid fracture where the mean age was 49.1 ± 11.6 years. **Meluzinova et al**, [12] in their study of 18 patients with distal ulna fractures associated with distal radius fractures, where the mean age was 58 years with mean follow up for 9 months.

Functional outcome of Lee et al. [11] had mean 90.0 ± 12.2 for MAYO wrist score and 9.2 ± 12.7 for DASH score, which was close to the functional outcome of our study. A positive correlation was found between functional outcome and complication rate regarding the age variability, the more the age the worst the outcome and the higher the complication rate. This might be due to decrease bone quality, union rate and wrist functions

with increased the age, and vice versa. Our results meet with **Tabl et al**. [13] Results who had age close to our study (34 ± 6.2). He reported a mean mayo score of 83.5. The excellent group was 15 patients (75%), good was three patients (15%), satisfactory was two patients (10%), while complications occurred only in two patients (10%).

Cha et al. [14] compared between open reduction internal fixation (ORIF) and conservative treatments of distal ulnar fractures (DUF) associated with distal radius fracture (DRF). The total mean of age in his study was 67.5 years, which was older age group of patients. He reported a DASH score of 13 ± 4 for the patients treated operatively and 14 ± 3 for conservative treatment group. This is high DASH score comparing with the Quick DASH score of current study (6.5) and may be due to the older age of his patients.

Union outcome was evaluated within this study in relation to total percentage of each time interval was recorded within this study, which revealed that 8 weeks, was (5%), 10 weeks was (5%), 12 weeks was related to [80%] and 24 weeks was [10%], with mean [±SD] time of union was 12.9 (±3.9) weeks. Pearson`s correlation test was performed between both parameters which revealed that there was insignificant weak positive correlation as P-value > 0.05 and r < 1.

All studied fractures achieved union and good radiological results. Functional outcomes were promising, including wide wrist ROM and no DRUJ instability. In the study conducted by Lee et al. [11], the mean time of union for distal ulnar fracture fixed with distal ulna lock plate was 12.5 weeks [range, 9-18 weeks]. **Meluzinova et al**, [12] reported that mean time of union for distal ulnar fractures fixed with distal ulna hook plate was 12.4 weeks (range,12-16 weeks).

Manjappa et al. [15] reported in the study of surgical management of forearm bone fractures in adults using limited contact dynamic compression plate that the average time for union was 17 weeks. **Tabl** [13] achieved radiographic union at an average of 8.6 ± 0.73 weeks ranged from 6 to15 weeks post-operative.

Moderate pain was found in 10%, mild pain was found in 10% and no pain was found in 80%. Restricted functional status was found in 40% while regular activity was achieved in 60%.

Total percentage of each extension value was recorded which revealed that, (65°) was (10 %), (70°) was (40 %), (75°) was (50%). Mean and range of extension was 71.5° (60°-75°). In addition, total percentage of each flexion value was recorded within this study which revealed that, (60°) was (5%), (65°) was (5%), (70°) was (60%), (75°) was (30%). Mean flexion was 70.75° and ranged from 60° to75°.

Total percentage of each supination value was recorded within this study which revealed that (60°) was (15%), (65°) was (20%), (70°) was (25%), (75°) was (40%). Mean supination was 69.5° and ranged from 60° to 75°.In addition, total percentage of each pronation value was recorded within this study which revealed that, (60°) was (5%), (65°) was (15%), (70°) was (30%) and (75°) was (10%). Mean pronation was 71.25° and ranged from 60° to 75°.

Total percentage of each ulnar deviation value was recorded within this study which revealed that, (25°) was (10%), (30°) was (5%), (35°) was (85%). Mean ulnar deviation was 33.75° and ranged from 25° to 35°. In addition, total percentage of each radial deviation value was recorded within this study which revealed that, (15°) was (10%), (20°) was (15%) and (25°) was (15%). Mean radial deviation was 20.25° and ranged from 15° to 25°.

Overall grip strength proportion was evaluated during this study which revealed that mean proportion of overall grip strength was 87.6%. Using paired t test, it was revealed that there were non-significant differences between both hands as p value >0.05. Dominant grip strength proportion was evaluated during this study which revealed that mean proportion of overall grip strength was 86.4%. Non-dominant grip strength proportion was evaluated during this study which revealed that mean proportion of overall grip strength was 92.5%.

Among all studied cases, 80% had no complications,5% (one patient) had superficial skin infection, 5% (one patient) had non-union and Delayed union in our study occurred in 2 patients (10 %), **Lee et al** [11] the reported rate of delayed union was one case (4%) and **Meluzinova et al** [12] reported 2 cases (11%). The cases of delayed union in our study ,one due to early lifting heavy object by his dominant affected hand and he did not care about the good follow up and the other was heavy smoker ,this explained the quite delayed union in our study.

Cha et al. [14] divided his study group into two groups, first group treated surgically and showed one patient (3.4%) with delayed union while the second group, which was treated conservatively showed two (6.25%) delayed union patients.

No implant problems occurred in our study, **Meluzinova et al** [12] reported rate of nerve irritation in 5 cases (28%) which forced the extraction of plate in 3 patients. our recommendations to reduce rate of mechanical failure are perfect fit of the implant to the distal part of the ulna with its hooks fitted the styloid ulna. The resistive activity should be delayed until signs of union and callus formation appear.

5. Conclusion

The distal ulna hook plate is an anatomic plate contoured to fit to the distal ulna. The good outcomes achieved in this study suggest that usage of the distal ulna hook plate could be an alternative treatment method for fixation of distal ulnar fractures. All distal ulna fractures achieved good results; functional outcomes were promising, including wide wrist ROM and no DRUJ instability.

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