CASE SERIES

Evaluation of functional outcome using dual plating in treatment of intra-articular distal humerus fractures in adults

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Abstract

Of all the humerus fractures in adults, 30% are of the distal end of the bone. The dual plate is strong biomechanically. The current study was conducted at Al-Yarmouk Teaching Hospital, Baghdad, Iraq, between July 1, 2019 to July 1, 2021 to study the role of dual plating in intra-articular distal humerus fractures.

Included were 20 adult patients, all with intra articular fracture of the distal humerus and treated and evaluated by open reduction and internal fixation technique using dual locking plating. Clinically the final results were assessed using the Mayo Elbow Performance Score (MEPS). The final results were observed to be excellent in 12 (60 %), good in 6 (30%), fair in 2 (10 %) patients, with no poor results recorded. One patient had transient ulnar neuropraxia which recovered spontaneously after six weeks and one patient developed superficial skin infection which responded to antibiotic treatment. The mean of MEPS was significantly higher after six months and one year than that after two weeks, two months, and four months of operation.

Keywords: Elbow, Distal, Articular, Fractures, Humeral, Humerusb

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Introduction

Anatomically, the distal humerus has a triangular shape in the coronal plane which consists of medial and lateral columns with a "tie arch". Understanding this simple idea is important when reconstructing complex fractures. The thinnest part is the central region and is composed of olecranon fossa and coronoid fossa.[1,2] The peri-particular region anastomosis consists of many arteries that supply blood to the distal humerus, the elbow joint and its supporting structures.[3] Historically, such fractures have been treated conservatively despite the fact that many studies have recorded it to be associated with significantly impaired functional outcome. Developments in surgical techniques have led to improved functional outcome in the treatment of patients and have resulted in rigid fixation being the current standard of care. Surgical treatment appears to have satisfactory results during follow-up demonstrating excellent or good outcome in 86% cases.[4] There are many classification systems that primarily depend on fracture patterns (sagittal or coronal) and the association of the medial and lateral column of the distal humerus. The AO classification is most commonly used internationally, which divides the distal humerus into: (A) extra-articular, (B) partial articular in which part of the articular segment is still in continuity with the shaft, and (C) bicolumnar "complete" articular fractures.[5] Type C is subdivided into C1: T or Y fractures, C2: simple articular fracture where non-articular supracondylar area is comminuted, and C3: Articular fracture is segmental or comminuted.[5] Mechanism of fractures of the distal humerus are mainly the result of trauma to the elbow joint. The patterns of fracture, mainly bimodal, is distributed between young males due to high velocity trauma and elderly females who usually have osteoporotic fractures.[6] Diagnosis is achieved through history, clinical examination including swelling of the distal arm and elbow joint, obvious deformity, and painful attempted movements. Loss of sensation in case of nerve injury and absence of pulse in vascular injury association,[7] and imaging studies are essential for the diagnosis of the fracture.[8] Standard radiological examination include an AP and lateral X-ray of the elbow joint and humerus. The appearance of the "double-arc sign" is pathognomonic, which means a coronal shear fracture mostly extending into the trochlea.[8] CT scan is essential for pre-operative planning and can be helpful to precisely determine the type of the fracture.[9] Conservative treatment has been highly significantly associated with decreased range of elbow joint movement as compared to surgical treatment particularly in type C fractures.[10] Surgical treatment through Open Reduction and Internal Fixation (ORIF) using various approaches include Olecranon osteotomy, Triceps-reflecting approach, Triceps-reflecting anconeus pedicle approach, and Triceps-splitting approach.[10]

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Olecranon osteotomy with ulnar nerve transposing anteriorly provides adequate exposure of fracture and is useful in intra-articular comminuted fractures. The osteotomy is usually fixed with a plate and screws, tension band wiring, or intramedullary screw fixation following fracture of the distal humerus.[11] With presently available technology, it has been noticed that by using pre-contoured locking plating peri-articularly, most displaced distal humerus fractures can be successfully treated with surgical intervention.[12] Primary total elbow arthroplasty has an option in the management of severe intra-articular distal humerus fractures with comminution and bone loss in the elderly patient.[13] "The Mayo Elbow Performance Score (MEPS) used to evaluate functional outcome consist of four domains: pain (45 points), stability (10 points), range of motion (20 points), and daily functional tasks (25 points). Total score was categorised as 90-100 = excellent, 75-89 = good, 60-74 = fair, and 0-59 = poor."[14] In this case series, the role of dual plating in intra-articular distal humerus fractures has been discussed.

Case Series

A follow-up study on 20 patients was conducted at the Orthopaedics Department at Al-Yarmouk Teaching Hospital, Baghdad, during a period of two years from July 1, 2019, to July 1, 2021. All the patients had been diagnosed with intraarticular fracture of the distal humerus and were treated operatively via a trans-olecranon posterior approach, and open reduction and internal fixation using the 3.5mm pre-contoured distal humerus medial and lateral anatomical locking plating. All of them included in the study were given detailed information about the study and consent was obtained for publishing their cases. All these operations were done by different well-experienced surgeons in Al-Yarmouk Teaching Hospital. The inclusion criteria were intra articular fracture of distal humerus type C either close or open grade 1, age> 18 years and Body Mass Index ≥ 25 kg/ m^2. The exclusion criteria were open grade 2 and 3 fracture, supracondylar extra-articular fractures type A and B according to AO classification,[5] previous operative treatment because of the fracture, history of pathologic fracture due to primary or metastatic tumours, and BMI< 25 kg/ m^2. For data collection, a full medical and surgical history of the patients was obtained and full clinical systemic physical examination was accomplished. Radiological examination by X-ray and CT-scan (Figure 1 and 2) and laboratory investigations were done. MEPS was used for assessment of final results and elbow joint function. Patients' records were reviewed and then they were followed-up at intervals of two weeks, two, four, and six months, and one year. The data was analysed using Statistical Package for Social Sciences (SPSS) version 26. The data is presented as mean, standard deviation (SD) and ranges. Paired t-test was used to assess and compare the continuous variables of data during different periods of follow-up. A level of P value > 0.05 was considered significant.

Surgical technique

Every patient was given general anaesthesia (GA) or a brachial block (three patients). The patient was placed in lateral decubitus position and the arm was supported in the holder with forearm hanging. Trans-olecranon posterior approach to elbow was used with ulnar nerve identification and transposing anteriorly, Chevron olecranon osteotomy was done, reduction of fracture using K-wires for primarily fixation with distal humerus locking plate and cancellous screws were used as lag screws, internal fixation with bi-column plating was applied for the sustained fractures. Reduction of the olecranon osteotomy was performed under direct vision and fixed by tension band wiring (Figure 3). Post-operatively, the patients were kept in post-operative ward under observation for 24 hours and then shifted to the orthopaedic ward. Antibiotic injection Cephalosporin, single dose pre-operatively and for 72 hours post-operatively was given, while intravenous analgesia were given on the first day only, followed by oral analgesia when needed. On the second day, the drain and backslab was removed and the wound was inspected, and X-ray was taken in both AP and lateral positions (Figure 4). Early mobilisation was started after 48 hours in the form of movement flexion-extension and pronation-supination of the elbow joint. The patients were discharged with advice of active exercise of the elbow and fingers movement. Instructions were given to patients about treatment, appropriate physiotherapy and keeping their operated limb elevated. The sutures were removed on day 11-14. Patients were followed-up after two weeks, two, four, and six months, as well as one year. The cases were assessed clinically using the MEPS, as well as radiologically by X-rays of the elbow joint for assessment of union or any deformity.

Results

A total of 20 patients with intra articular fracture of distal humerus treated by early open reduction and internal fixation were included in this study. The distribution of the study patients is shown in (Table 1). Age of patients ranged from 24 to 63 years with a mean of 41.3±13.3 years. Half of the patients in the study were aged ≥ 40 years and the other half were aged < 40 years). Regarding gender, there were more males than females (80% versus 20%) with a male to female ratio of 4:1. The most common mechanism of injury was RTA (n=7 ;35%) and the right

Table-1: Distribution of study patients by general characteristics.

Variable	No (n= 20)	Percentage%
Age (Years)		
< 40	10	50.0
≥ 40	10	50.0
Gender		
Male	16	80.0
Female	4	20.0
Mechanism of injury		
RTA	7	35.0
FOOSH	6	30.0
MVA	6	30.0
Twisted injury	1	5.0
Affected side		
Right	15	75.0
Left	5	25.0
Types of fractures		
C1	2	10
C2	15	75
C1	3	15

RTA= Road Traffic Accident
FOOSH=Fall On Outstretched Hand
MVA=Motor Vehicle Accident

Table-2: Comparison in means of MEPS during one year after operation.

	Follow-up period					
	2 Weeks Mean ± SD	2 Months Mean ± SD	2 Months Mean ± SD	6 Months Mean ± SD	1 Year Mean ± SD	*P – Value* *
Mean of MEPS	45.25 ± 10.6	77.25 ± 12.8	-	-	-	0.001
	45.25 ± 10.6	-	90.75 ± 10.5	-	-	0.001
	45.25 ± 10.6	-	-	96.5 ± 6.9	-	0.001
	45.25 ± 10.6	-	-	-	97.5 ± 7.0	0.001
	-	77.25 ± 12.8	90.75 ± 10.5	-	--	0.001
	-	77.25 ± 12.8	-	96.5 ± 6.9	-	0.001
	-	77.25 ± 12.8	-	-	97.5 ± 7.0	0.001
	-	-	90.75 ± 10.5	96.5 ± 6.9	-	0.001
	-	-	90.75 ± 10.5	-	97.5 ± 7.0	0.001
	-	-	-	96.5 ± 6.9	97.5 ± 7.0	0.05

* Paired t-test used MEPS= Mayo Elbow Performance Score.

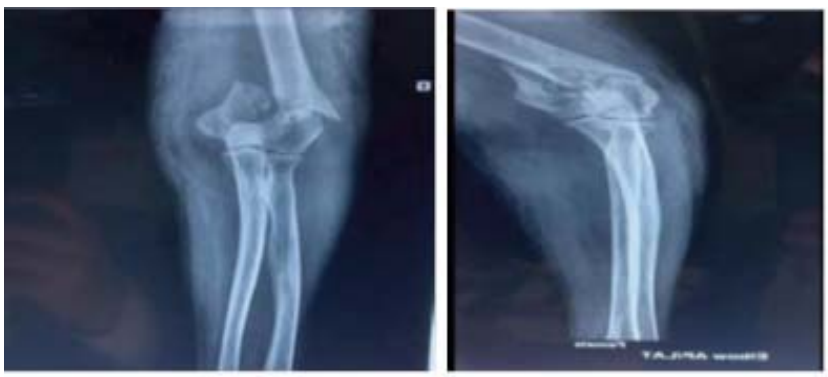

Figure-1: Preoperative X-ray (AP and lateral views) of intra articular fracture of distal humerus.

side was affected in (n=15 ;75%) cases. Regarding the types of fractures, 2(10%) were type C1, 15(75%) type C2, and 3 (15%) type C3. The average time of union radiologically was 12±4 weeks and it was united in all the patients. Comparison in mean of MEPS during one year after operation is shown in Table 2. It was obvious that the mean of MEPS was significantly higher after one year than that after two weeks, and two and four months of operation. It was significantly higher after six months as compared to after two weeks, and two and four months of operation, significantly higher after four months than after two weeks and two months, and significantly higher after two months than that after two weeks of operation (P >0.05). No statistically significant change was noted in the mean of MEPS (P ≥ 0.05) after one year compared to that after six months of operation. Established on all of the criteria mentioned above, the functional outcome according to MEPS appeared to be excellent in 12(60 %) patients, good in 6 (30%), and fair in 2(10 %) patients, while no poor result was noted in the current study. Regarding complications, one patient had transient ulnar neuropraxia record in early postoperative period and recovered spontaneously, while one patient developed superficial skin infection after two weeks of receiving antibiotic treatment. The comparison in mean of pain score during the period of one year post-operatively is shown in Table 2. In this study, the mean pain score after six and twelve months was 44.25 ±3.4 and 44.25±3.4 respectively which was significantly increased compared to that after two weeks (18.75 ±6.7), two months (36.0 ±7.5), and four months (42.75 ±5.5) of operation, increased significantly after four months compared to that after two weeks and two months of operation, and significantly increased after two months compared to that after two weeks. There was no statistically significant change in the mean of pain score (P ≥ 0.05) after one year compared to that after four and six months of surgery.

The mean range of motion score after two months was 19.25±1.8, four months was

Figure-2: Preoperative CT-scan of intra articular fracture of distal humerus

months (18.25 ±5.2) and six months (22.5 ±4.1) of operation. It was significantly higher after six months than that after two weeks, two and four months of operation, significantly higher after four months than that after two weeks and two months of operation, and significantly higher after two months than after two weeks of operation (P value>0.05). Figure 5 shows the range of motion at four months post-operatively in a 21-year-old male patient.

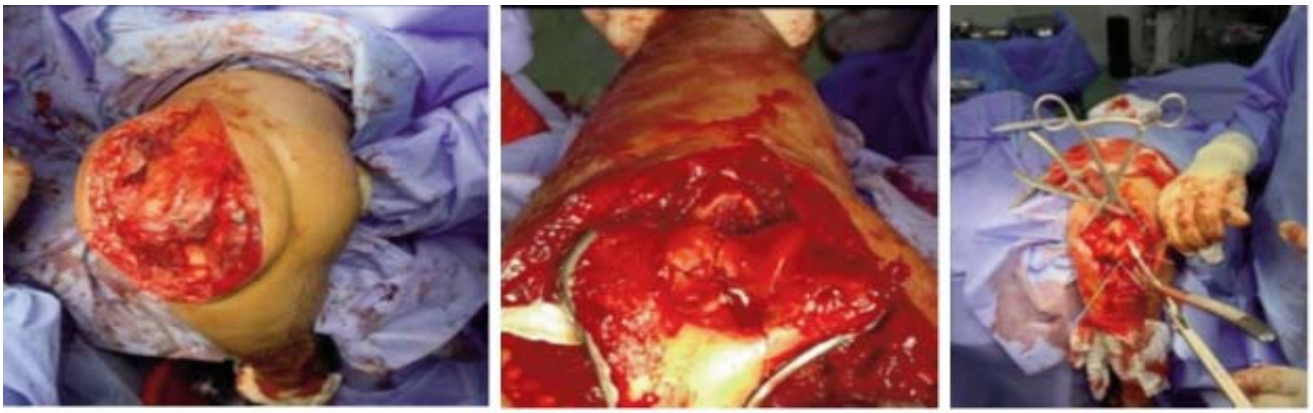

Figure-3: Intraoperative posterior trans-olecranon approach.

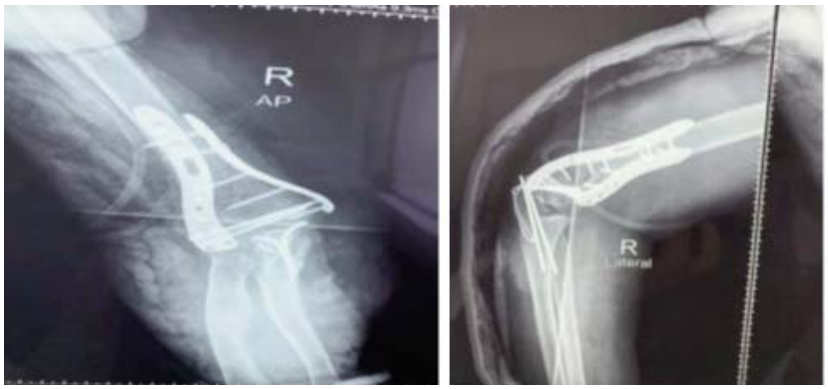

Figure-4: Postoperative x-ray (AP and lateral views)

19.75±1.1, six months was 19.75 ±1.1 and after one year it was significantly increased 19.75 ±1.1, when it was compared to that after two weeks of surgery, (16.0 ±3.5). There was no statistically significant change in the mean range of motion score, p≥ 0.05 after one year compared to that after two, four, and six months of operation. Comparison in mean function score during one year after operation is shown in Table 2. Mean function score was significantly higher after one year (23.5 ±4.0) than that after two weeks (0.5 ±2.2), two months (12.0 ±5.2), four

Patients provided their consent about publishing their data and permission was sought to use their photographs.

Discussion

Intraarticular distal humeral fractures represent about 30% of all fractures around the elbow joint in the adult population. The mechanism of injury of these fractures was mainly high velocity trauma and required a perfect reduction to restore the articular surface of the elbow joint and more rigid internal fixation in order to prevent stiffness as well as for early mobilisation of the joint and to give better functional outcomes.[15]

Despite great evolution in the methods of treatment of distal humerus fractures, there exist different controversial rules, involving the surgical approach preferred, fixation method, and type of implants used for fixation. ORIF with plates and screws has been the best operative treatment used for distal humerus fractures.

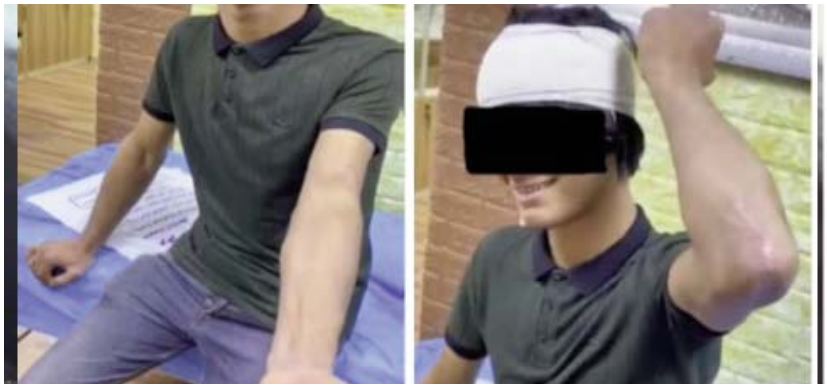

Figure-5: Range of motion four months postoperatively in a 21-year-old male patient

However, because distal humerus has a limited bone stock ORIF can be very challenging, especially in the presence of osteoporotic bone and severe comminution.[16] In the current study, the mean of MEPS was significantly higher (P value>0.05) after six months and one year than that after two weeks, and two and four months of operation, while no significant difference was noted in the mean after one year compared to that after six months of operation MEPS (P= 0.05). It is in agreement with a study by Kumar et al (2015), in which during the first week after the procedure the MEP score was 5.0±01.26 which significantly and gradually increased during six weeks, three months, and six months to reach the best score at one year of follow up (P<0.05).[17] The mean of pain scores in this study after six months and one year were significantly higher than two weeks and two months, increased significantly after four months compared to that after two weeks and two months of operation, and increased significantly after two months compared to that after two weeks (P >0.05), while there was no significant change in the mean of pain score (P ≥ 0.05) after one year compared to that after four and six months of operation. The satisfactory restoration of painless elbow joint movement after intra-articular fracture of distal humerus needs perfect articular surface reconstruction, restoration of the geometrical shape of the distal humerus, and stable rigid fixation of the fracture fragments to help early and proper rehabilitation of the elbow joint. Although these aims are now greatly accepted by the orthopaedic society, they may be technically difficult to apply.[18] Regarding the range of motion score in this study, the mean after two, four and six months and one year were significantly increased than after two weeks (P >0.05), while there was no significant change after one year as compared to that after two, four, and six months of operation (P ≥ 0.05). This is in agreement with the results reported by Virani et al in 2017, as mentioned that mean ranges of motion within functional range improved after surgery with significant association among the study patients (P <0.001).[19] However, it is different from that reported in a study by Kumar et al in 2015, in which during the first week after the procedure the range of motion score was 21.38±05.70 which significantly and gradually increased during three weeks, six weeks, three months (P<0.05), while during the time of follow-up from three months to six months and from six months to one year, the functional and clinical results showed improvement but the changes were slow and insignificant (P>0.05).[17]

Regarding function score in the current study, the mean was significantly higher after six months and one year than after two weeks, and two and four months of operation, respectively (P >0.05). It was different in a study done by Tian and his colleagues who reported that no significant differences were noticed in the functional and clinical outcomes of the types of surgical methods among studied patients (P>0.05).[20] Moreover, as compared to the study by Riesing et al, "the results were also different, despite no significant differences in functional outcome when compared with types of fracture or age; it was noted that there was a consistency in better functional results in younger patients and patients with fractures C1 and C2 than C3 type."[21] A study by Papaioannou et al recorded essentials of stable rigid fixation and early rehabilitation, and "observed that functional outcome results were significant when stable fixation was achieved with early physiotherapy."[22]

The differences recorded among the above studies were attributed to several factors, including statistical size of the sample, study design, or related to age, gender and ethnicity, obesity (BMI <25kg/m^2), or factors related to the fractures themselves, i.e., the types of fracture (complexity, open or closed), mechanism of injury, types of olecranon osteotomy, wound complications, and delayed time from injury to surgery.

In the current study, the mean age of the patients was 41.3±13.3 years, with half of them aged more than 40 years and the other half less than 40 years. Regarding gender, there were more males than females (80% versus 20%) with a male to female ratio of 4:1. The most common mechanism of injury in the current study was RTA (35%); the right side was affected in 75%, while the left sided was affected in 25% cases. The results were different as compared to the study by Govindasamy et al done in 2017 which included 38 patients. Of these 20 (14 males

and 6 females) were in the perpendicular plating group (group A) with a mean age of 44.80±12.84 years (range 22 to 65 years) and 18 (13 males and 5 females) in parallel plating group (group B) mean age 40.17±16.42 years (range 18 to 65 years).[23] In a study by Mahapatra et al, conducted in 2017, included 60 patients, 50 (83.33%) males and 10 (16.6%) females, (male to female ratio of 1.5:1),with 18 (30%) between 21 to 30 years, 12 (20%) between 31 to 40 years, 22 (36.67%) between 41 to 50 years, and 8 (13.33%) between 51 to 60 years. The mean age was 34.9±12.63 years. The mechanism of injury was RTA in 38(63.33%) cases and fall from height in 22 (36.67%) cases.[24] In a study on 23 patients by Kumar et al.[17] in 2015, the age of the patients was between 18 – 60 years, (mean age:39.1±11.5 years), found that majority of the patients (n=15 ;65.2%) were older than 35 years. There was a noticeable predominance of males (n=16; 69.6%), with male to female ratio of 2.3:1. The major cause of injury was RTA in 7(69.6%) cases, fall from height in 5(21.7%), and right side was involved in 16 (69.6%) patients.[17] The difference in gender may be due to injuries among male workers. The variability recorded in the above studies is related to different bones being involved in calculating the sample size in each study, socioeconomic status that increase the work by population and make them vulnerable to injuries. In addition, types of road traffic accidents were different in each study, while the injuries among the elderly were due to osteoporosis.[17, 23, 24]

Conclusion

To achieve good functional outcome of elbow joint fractures, accurate preoperative planning, operative treatment with adequate surgical exposure, anatomical perfect stabilisation, and stable rigid anatomical internal fixation are required.

Recommendation

This study recommended the use of olecranon osteotomy with a wide exposure of the field and dual plating for management of intra-articular fractures of distal humerus in adults as it is a valuable and effective procedure with good functional outcome.

Ethical Approval: This research has been approved by Human Research Ethics Committee, Mustansiriyah University, College of Medicine (No: 0061; date: 1 /05/2019).

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Conflict of Interest: None.

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