International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Outcome of External Fixator for Intra-Articular Distal Radius Fracture

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Abstract: ***Background: Among the fractures occurring on upper limb, those of distal radius are the most frequent, estimated as accounting for 16% of all skeletal fractures. It is important to reconstruct the anatomy of the distal radius as good as possible, since anatomical reconstruction is a predictor for good functional outcome, especially in the active patient. Objective: To evaluate the the treatment of intra-articular distal radius fractures by External fixator Ligamentotaxis. Patients and Methods: We conducted this study to evaluate the treatment of 30 patients with intra-articular distal radius submitted to external fixation attending at Soad kafafi Hospital. We used AO classification to classify the distal radial fractures and Mayo score for scoring the postoperative evaluation. Results: Regarding basic demographic data our results showed that the ages of the studied patients' group were ranging between 31 – 67 years old with mean ± SD: 48.9 ± 9.7 years. 17 patients were males (56.7%) with mean age 48.06 ± 9.76 years and 13 patients were females (43.3%) with mean age 50.0 ± 9.9 years. There was no statistically significant difference between males and males regarding their ages. Conclusion: External fixation still has a good share in many studies with good accepted results. External fixation is sometimes the method of choice in cases of poor skin conditions or open fractures or severely comminuted intraarticular fractures. External fixation doesn't permit wrist motion and wrist stiffness has been associated with this mode of treatment.***

Keywords: Distal radius fractures, external fixation**,** volar locking plate

1. Introduction

Distal radius fractures (DRF) are a common type of acute traumatic fracture.

It accounts for approximately 1/6 of all fractures and usually occurs in middle-aged and older adults over 60 years, with a higher prevalence in women due to osteoporosis. In young adults, the fracture often results from severe trauma, with injuries to the radiocarpal and distal radioulnar joints.[1,2]

Because wrist joints, especially radiocarpal joints, are complex and highly involved in daily activities, special expertise is usually required in the management of this condition, as any inappropriate treatment can affect the functional recovery of the wrist, with huge negative impacts on patients' quality of life [3]**.**

The fixation techniques used in the clinical practice for the treatment of distal radial fractures are percutaneous pinning with Kirschner wire (K-wire), volar locking plate (VLP) and external fixation (EF). Although there are various reports claiming the superiority of one method over another, the decision on the treatment modality is multifactorial. The patient's age, occupation, familiarity of the procedure to the surgeon, the comorbidities such as tendon and median nerve injuries should be taken into account, as well as the fracture configuration [4,5]

External fixation is one of the common methods for the clinical treatment of DRF using ligamentotaxis. Due to the development of external fixation, it is now possible for surgeons to achieve an anatomical reduction of the articular surface, stable fixation, and good surgical results in treating fractures. [6]

Ligamentotaxis is the principle of molding fracture fragments into alignment as a result of tension applied across a fracture by the surrounding intact soft tissues. Uniplanar ligamentotaxis obtained by longitudinal traction does not always restore palmar tilt to the distal radius. Multiplanar ligamentotaxis extends the principle of uniplanar ligamentotaxis to include translation of the hand in the dorsal-palmar and the radial-ulnar planes to effect appositional and tilting alignment of the distal fragment(s) of a fractured radius. Use of an external fixator that allows adjustments in multiple planes helps restore anatomic alignment and maintain fracture reduction during healing [7]

Aim of the Work

Our study is aiming to evaluate the the treatment of intra-articular distal radius fractures by External fixator Ligamentotaxis.

Patients and Methods

Type of study: A prospective study

Sample size: 30 patients operated at Soad Kafafi Hospital with fractures of intra-articular distal radius fulfilling all inclusion and exclusion criteria.

Study Period: from June 2022 to January 2023.

Study Population:

Inclusion criteria: Age between 18 and 70 years. Intra-articular fractures. Patient can tolerate external fixator

Exclusion criteria: Age less than 18 and more than 70 years. Uncooperative patient. Old fracture > 2 weeks old. Unhealthy deformed wrist.

Study Tools:

Preoperative Evaluation: The patient should be assessed clinically, laboratory and radiologically. **Clinically:** History taking, examination of wrist, neurovascular examination, soft tissue injury, compartment syndrome, and any other associated deformity. **Radiologically:** X-ray of Wrist AP/Lat and CT scan. **Laboratory:** routine preoperative Investigations.

Operative

Technique : Under general anesthesia and supine position: External fixator with pinning(by K-wires) or without were used to maintain reduced position of distal radius. Adequate reduction of distal radius fracture using traction to restore radial height, ulnar deviation to reduce radial displacement together with volar tilt to reduce dorsal deviation under image intensifier (volar tilt can be aided by putting a sterile pad under radius proximal to fracture site). Per-cutaneous K-wires were inserted (while an assistant maintaining the reduction). One or two wires inserted from radial styloid directed proximally toward opposite intact cortex (fig. 1), wires can be added from dorsoulnar directed towards the volar aspect to hinge opposite intact cortex.

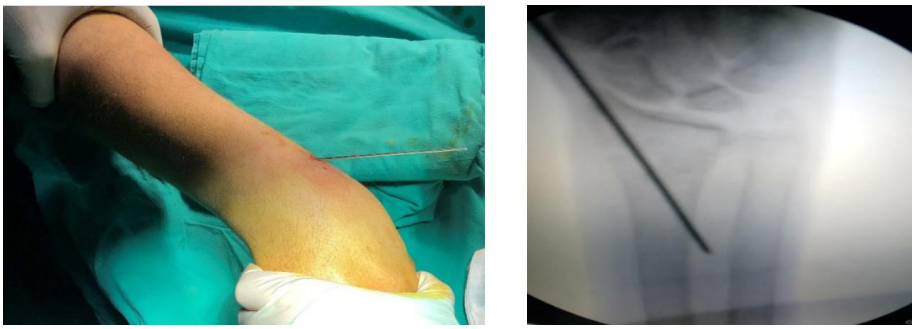

Figure 1: K-wire inserted from radial styloid.

Another wire was added to maintain distal radioulnar joint (DRUJ),wire taken from ulna to reduced radius (avoid injury of superficial radial nerve) or from radius to ulna after proper dissection to avoid of superficial radial nerve injury (reduction of DRUJ was done by supination or pronation of forearm depending on direction of dislocation) in case of associated distal radioulnar joint dislocation

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Figure 2

The proximal fixator pin sites are exposed with a small incision madevia a mini-open technique on the dorsal radial aspect of the radial shaft. It is important to identify the superficial branch of the radial nerve and protect it before pin insertion as it is susceptible to injury during this step. Proximal pins can be placed in the interval between the extensor carpi Radialis brevis and longus, thereby reducing the risk of irritation of the superficial branch of the radial nerve. The pins (size 3.0 mm or 4.0 mm) are placed in the radial shaft after predrilling and using a soft-tissue protector. The spacing of the 2 proximal pins is often determined by the particular fixator being used but should be at least 2-3 cm apart. The pins are hand driven into the far cortex of the radius and their position is confirmed with image. The skin is then closed around the proximal pin sites. (fig. 2)

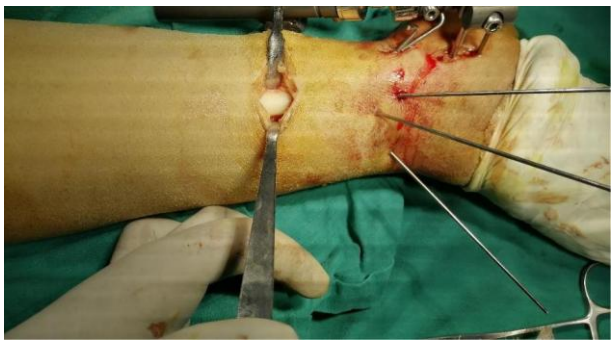

Figure 2: Skin incision to introduce proximal schanz

Insertion of distal schanz: skin incision is made over base of second metacarpal dorsoradially, dissection is carried down

to reach bone, insertion of two 3mm or 2.5 mm schanz dorsoradially near base of metacarpal (guided by image intensifier) 40-60 degrees in reference to horizontal plane. (fig. 3)

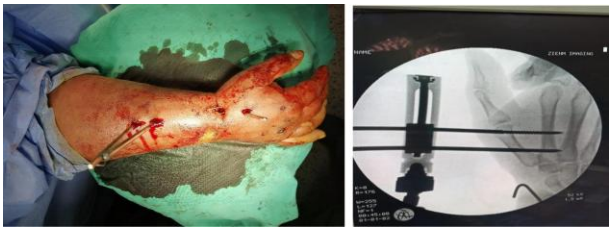

Figure 3: Insertion of distal schanz

Tighten the clamps to the proximal and distal schanz. then start distraction and confirmation of reduction under image

Postoperative protocol:

- **Hospital stay:** Patients are kept for a day observation period then discharged.
- **Follow up:** Patients followed weekly till one month then monthly until a minimum of six months: with clinical and radiological assessment. A daily dose of vitamin C 500 mg for fifty days was given to reduce incidence of complex regional pain syndrome (sudeck's atrophy). Pin tract care using normal saline or chlorhexidine.
- **Mobilization:** encourage elevation of the limb and mobilize the digits, elbow and shoulder on postoperative day. Then begin finger and grip strength exercises.
- **Methods of assessments of results: AO** classification was used in this study.

Functional assessment using:

Mayo wrist score: Mayo Wrist Score requires both patient and physician participation in order to assess pain, the active motion arc (in comparison with the contralateral side), grip strength (in comparison with the contralateral side), and the ability to return to regular employment or activities. Scores range from 0 to 100 with a score of 0 indicating a worse wrist condition and 100 indicating a better wrist condition. (49)

2. Results

Table 1: Basic demographic characteristics of the studied group:

Variable	
Age (Years):	
• Mean ± SD	48.9 ± 9.7
• Range	31- 67
Gender:	
• Female	13 (43.3%)
• Male	17 (56.7%)

Table 2: Age distribution according to gender:

Variable	Males	Females	t-test	p-value
Age (Years):				
Mean ± SD	48.06 ± 9.76	50.0 ± 9.9	-0.536	0.298

Table 3: Trauma and fracture characteristics of studied patients' group:

Variable	
Mode of trauma:	
• Fall on outstretched hand	22 (73.3%)
• Fall from Hight	6 (20.0%)
• RTA	2(6.7%)
Affect Side:	
• Right	19 (63.3%)
• Left	11 36.7%)
AO Classification:	
• C1 simple articular + metaphyseal	14 (46.7%)
• C2 multifrgmentary metaphyseal	12 (40.0%)
• C3 multifragmentary articular or multifragmentary metaphyseal	4 (13.3%)
Soft Tissue injury:	
• No	28 (93.3%)
• Yes	2(6.7%)
Associated Fractures:	
• No	19 (63.3%)
• Distal Radial Ulnar Joint	8 (26.7%)
• Ulnar styloid or distal ulna	3 (10.0%)

Table 3: Surgical data of studied patients' group:

Variable	
Time interval to operation (days):	
• Mean ± SD	5.1 ± 1.8
• Range	1.0 – 7.0
Operative time (minutes):	
• Mean ± SD	33.7 ± 7.0
• Range	23.0 – 45.0
Mean time of external fixator removal (days):	
• Mean ± SD	45.3 ± 4.5
• Range	40 – 55
Clinical Union (weeks):	
• Mean ± SD	5.2 ± 1.0
• Range	4.0 – 7.0
Radiological Union (weeks):	
• Mean ± SD	6.3 ± 1.2
• Range	5.0 – 9.0

Table 4: Post-operative Mayo wrist score in the studied patients' group:

Variable	No (%)
• Excellent	8 (26.7%)
• Good	15 (50.0%)
• Satisfactory	5 (16.6%)
• Poor	2 (6.7%)

Table 5: Complications in the studied patients' group:

Variable	No (%)
No complications:	
• No	13 (43.3%)
• Yes	17 (56.7%)
Pin tract Infections:	
• No	14 (46.7%)
• Yes	16 53.3%)
Sudeck's atrophy:	
• No	26 (86.7%)
• Yes	4 (13.3%)
Mal-union:	
• No	28 (93.9%)
• Yes	2 (6.7%)

Nerve injury:	
• No	28 (93.9%)
• Yes	2 (6.7%)
Tendon injury:	
• No	29 (96.7%)
• Yes	1 (3.3%)
Osteo-arthritis:	
• No	30 (100.0%)
• Yes	0 (0.0%)

Table 6: Outcomes in the studied patients' group:

Variable	No (%)
Satisfaction:	
- Satisfied	26 (86.7%)
- Not satisfied	4 (13.3%)

Table 7: Association between outcome and different variables

Variable	Excellent/ Good N = 23	Fair/Poor N = 7	t-value	p-value
Age (Years):				
Mean ± SD	44.8 ± 6.7	49.6 ± 8.5	1.561	0.129
Gender:				
• Male	13	4	0.0008	0.977
• Female	10	3		
AO Classification:				
• C1	13	1	8.197	0.016*
• C2	10	3		
• C3	1	3		

Case

47 years old female not diabetic and nonsmoker presented to us by closed Rt intra-articular distal radius fracture (23C1) according to AO classification after fall from height. On admission clinical examination, plain x-rays, closed reduction and below elbow cast were done then CT scan. The patient was prepared to surgery which was done at Soad Kafafi hospital.

Figure 1: Pre-reduction -rays AP and lateral wrist views

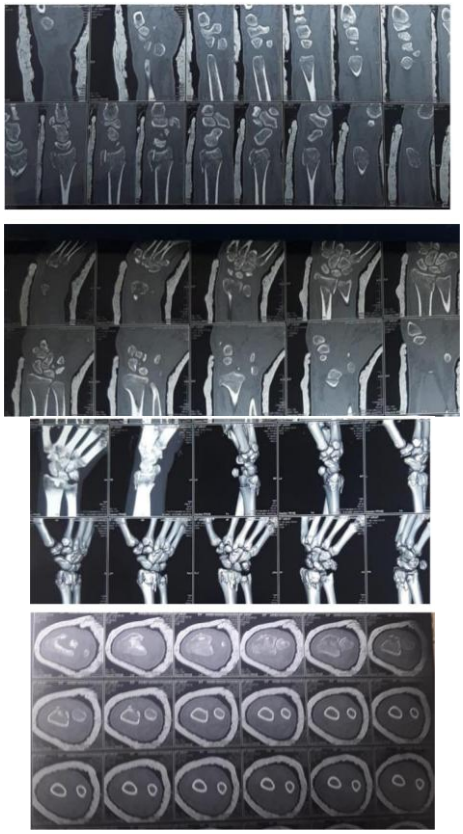

Figure 2: Post-reduction CT scan cuts.

Figure 3: Post-operative X-rays AP and lateral wrist views

Figure 4: Three months follow up X-rays AP and lateral wrist views

Figure 5: ROM after 6 months

3. Discussion

Distal radius fractures are one of the most common injuries encountered in orthopedic practice. They account for one in five bony injuries in both primary and secondary care**.** [8]

Distal radial fractures can result from any trauma to the forearm. They most frequently occur as a result of fall on the outstretched hand (FOOSH) injuries.[9]

The management of distal radius fractures has evolved considerably in the last two decades. Techniques and hardware have improved so much that the surgeon can usually assure good results in these debilitating fractures. [10]

Many fractures of the distal radius are uncomplicated and are effectively treated by closed reduction and immobilization in plaster of Paris (cast). Unstable/intra articular fractures can affect the integrity of the articular congruence and/or kinematics of these articulations. Intra-articular fractures are unstable, difficult to reduce anatomically and to immobilize in closed cast support and are associated with high rate of complications. Distal radius fractures disturb the mechanical foundation of the human's most elegant tool, the hand. The same ligaments, retinacula, tendons, and periosteum that envelop the fracture which are the surgical barriers for open reduction of the fracture fragments, help achieve reduction of the fracture by Ligamentotaxis. [11]

The aim of this study was to evaluate the treatment of intra-articular distal radius fractures by external fixator ligamentotaxis.
In order to achieve this aim this, this study was carried out on thirty patients with comminuted distal radial fracture treated with bridging ex. Fix. From June 2022 to January 2023 from Souad Kafafi university hospital and followed up for 6 months.

Regarding basic demographic data our results showed that the ages of the studied patients' group were ranging between 31 – 67 years old with mean ± SD: 48.9 ± 9.7 years. 17 patients were males (56.7%) with mean age 48.06 ± 9.76 years and 13 patients were females (43.3%) with mean age 50.0 ± 9.9 years. There was no statistically significant difference between males and males regarding their ages.

Similar to our findings was ***Salama et al.,*** [11], who reported in their study on 12 patients with Intra-articular distal radius fracture in order to evaluate the radiological and functional outcome of intra-articular distal radius fractures treated by external fixator using ligamentotaxis, that 8 patients were males 66.7% while 4 were female 33.3% and their ages ranged from 29 to 60 years old with mean age 41.83 years old.

Also, in consistency with our findings was ***Kara et al.,*** [12] who reported in their study on twenty-five patients diagnosed with distal radius fracture, that the median age of the patients was 47.32 (20–76) years. The median ages of the female (n=10, 40%) and male (n=15, 60%) patients were 41.26 (20–75) and 56.4 (44–76) years, respectively.

Baron et al. [13] found that one of the largest gender discrepancies occurred in the distal forearm, when looking at fracture rates in the over 65 age group. According to the data, the women in this study were approximately 4.88 times more likely than men to obtain a distal forearm fracture. ***Brogren et al.,*** [14] also documented comparable differences between elderly men and women, finding women had a higher overall incidence, with almost 5 times more fractures in women than in men.

The most common mode of trauma in our study was fall on outstretched hand that was presented in 73.3% of cases followed by fall from height presented in 20.0% of cases and Road traffic accident was the mode of trauma in 6.7% of cases.

In agreement with our findings was ***Salama et al.,*** [11] as they reported that the most common mode of trauma in their studies was the most common mode of trauma in this study was falling on out-stretched hand (41.7%) and falling from height (33.3%) and road traffic accident (25%). Also, was ***Kara et al.,*** [12]**,** who reported that fractures occurred in their study due to falling on the floor at home (n=5, 20%), on flat ground outside the home (n=9, 36%), and from height (n=6, 24%); traffic accidents (n=4, 16%); and direct trauma (n=1, 4%).

In disagreement with our findings was ***Abdel-Ghany et al.,*** [15], who reported in their study on Forty-six patients with distal radius intra- articular fractures were divided into two groups, that the reasons for fracture in group (I) were motor vehicle accident in 19 patients (79.2%), and fall from height in five patients (20.8%) and in group (II) Reasons for injury were fall from height in three patients (13.6%) and motor vehicle accident in 19 patients (86.4%).

The most affected side in our study was the right side presented in 63.3% and the left side was presented in 36.7%.

Against our findings ***Salama et al.,*** [11] who reported that left side fractures were the most common fractures presented in 58.3% of cases while the right-side fractures were presented in 41.7%. Also, was ***Musa et al.,*** [16] who reported in their study on 25 patients with intra-articular distal radius fractures, that all the patients were right hand dominant. Right side was involved in 9 patients (34.6%) and left side in 16 patients (65.4%)

AO classification were used to classify the distal radial fracture pattern and according to this classification, 46.7% of patients were of category C1 (simple articular + metaphyseal), 40.0% of patients were of category C2 (multifrgmentary metaphyseal) and 13.3% of them were of category C3 (multifragmentary articular or multifragmentary metaphyseal).

In the study done by ***Kara et al.,*** [12] they found that according to the AO/ASIF classification, type C (n=15, 57.69%), A2–3 (n=9, 34.61%), B1 (n=1, 3.84%), and B3 (n=1, 3.84) displaced fractures were detected. Nine (34.61%) patients had A2–3, 1 (3.84%) patient had type B1, and 1 (3.84%) patient had type B3 displaced fractures.

While, in the study done by ***Musa et al.,*** [16] they reported as per AO classification, all of fractures were 23 B1 and 23 C

Regarding complication, our results showed that no complications were detected in 17 (56.7%) of cases. Pin tract infection was the most common complication, it was recorded in 53.3% of cases, followed by sudeck's atrophy recorded in 13.3% of cases. Only 2 (6.7%) cases were suffering from mal-union. Nerve injury "superficial radial nerve injury" and tendon injury were recorded in 2 (6.7%) and 1 (3.3%) cases respectively.

In the study done by ***Kara et al.,*** [12] reported that during the early postoperative period, 3 (11.53%) patients developed superficial pin root infection responding to dressings and antibiotics. Reflex sympathetic dystrophy was seen in 2 (7.69%) patients. One (3.84%) patient had hypoesthesia on the area innervated by the sensory branch of the radial nerve. Two (7.69%) patients developed finger stiffness. K-wires applied with a fixator after dynamization were seen to be loosened that required their removal in 2 (7.69%) patients with advanced osteoporosis. The fixator joint completely loosened, and distraction disappeared in week 3 of the control visit in 1 (3.84%) patient with poor cooperation.

In the study done by ***Salama et al.,*** [11] they reported that there were 8% Sudeck's atrophy and 25% had superficial infection, 8% had sensory nerve affection.

While in the study done by ***Musa et al.,*** [16] they reported that no patients developed superficial radial nerve injury or pin site tract infection. Late complications like, tendon ruptures or implant loosening was not reported. There was no incidence of post-operatively hand stiffness

Mayo wrist score was used to evaluate the post-operative pain intensity, Range of Motion, grip strength and Functional Status. And our results showed that excellent outcome was reported in 8 (26.7%) of cases, good outcomes were reported in 15 (50.0%) of cases, outcomes were satisfactory in 5 (16.6%) of cases while poor outcomes were reported in only (6.7%) of cases.

Final outcomes, 26 (86.7%) of patients were satisfied by final results while only 4 (13.3%) were not.

4. Conclusion

External fixation still has a good share in many studies with good accepted results. External fixation is sometimes the method of choice in cases of poor skin conditions or open fractures or severely comminuted intraarticular fractures. External fixation doesn't permit wrist motion and wrist stiffness has been associated with this mode of treatment.

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