

Outcome of Management of Intra Articular Distal Radius Fractures

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Received date: December 09, 2020; Accepted date: December 23, 2020; Published date: December 30, 2020

Citation: Musa OAY, Abdelrahim HG, Ali LAM (2020) Outcome of Management of Intra Articular Distal Radius Fractures. Trauma Acute Care Vol. 6 No. 1: 89.

Abstract

Using Spanning External Fixation

Background: Fractures of distal radius are very common injuries, accounting for about 15% workload of an orthopedic trauma unit. While cast treatment is universal for stable fractures, unstable fractures with comminution and intra-articular involvement are a different injury and are treated mainly by ligamentotaxis with proper restoration of anatomy.

Objective: In this study, we evaluated the functional outcome of spanning external fixator with or without augmentation for management of intra-articular distal radius fractures.

Materials and methods: The study was performed on 25 patients with intra-articular distal radius fractures. Patients, who met inclusion criteria, were operated with spanning external fixation with or without augmentation by percutaneous K wires in some patients. Functional evaluation at three months was done using DASH Scoring system, post-operative range of movements, postoperative grip strength and post-operative complications. Results: The study comprised of 25 patients in age group of 20-69 years, including 10 males and 15 females with a mean age of 47 years. The mean admission to surgery interval was 1.2 days, the mean operative time was 35 minutes. The mechanism of injury included road traffic accident (n=7). The post-operative wrist joint range of motions which assessed by goniometer are dorsiflexion (59.91 Mean 14.24 SD), palmar-flexion (62.7 Mean 7.64 SD), radial deviation (17.83 Mean 3.39 SD), ulnar deviation (42.39 Mean 7.19 SD), pronation (85.2 Mean 9.94 SD), supination (84.57 Mean 7.82 SD). The postoperative hand grip strength mean was (82.86%). Functional evaluation done using DASH scoring system, the mean of this score system was (36.54).

Conclusion: For treating unstable, comminuted, intra-articular distal radius fractures the spanning external fixation with or without percutaneous K wires is an excellent option. The technique is simple with acceptable rate of complications and produces satisfactory outcome in majority of fractures.

Keywords: Intra-articular distal radius fractures; Comminuted; Spanning external fixation

Background

Fractures of the DR are common and incidence of complex radius fracture is increasing day by day due to high velocity trauma. The increasing incidence of these injuries may be attributed to an aging population (osteoporotic fractures) and the growing participation in outdoor pursuits (higher energy fractures). Whereas a large number of these fractures are managed non-operatively, the number of patients who undergo surgical management is considerable.

Over the past 30 years, the surgical treatment of DRFs has shifted from cast immobilization to numerous surgical options such as the use of external fixation and volar locking plates. There are distinctive differences in these two surgical techniques and postoperative rehabilitation protocols. Previously some authors have compared volar locked plating with external fixation, but there is still insufficient evidence regarding which gives the best outcome.

Spanning external fixation can be useful as primary or adjunctive treatment in certain DRFs. The external fixator neutralizes the axial load placed on the distal radius by physiological activity of the forearm musculature. It can be placed in a bridging or non-bridging (does not cross the wrist joint) technique, with or without supplemental stabilization.

Volar locking plates are commonly used in the treatment of selected DRF such as low-energy or relatively uncomplicated fractures. They have limitations, however, in the management of highly comminuted fracture patterns and in poly trauma patients. In these patients, other methods such as spanning fixation have emerged as useful alternatives in the surgeon's choice for treatment of these challenging fractures. Upper extremity fractures have been estimated to account for up to 1.5% of all United States emergency room visits, and 44% of these are attributed to fractures of the radius and ulna [1]. Men have a 5-fold higher risk of sustaining a high-energy distal radius fracture than women. Despite this, the overall age-adjusted

incidence of distal radius fractures is 4 to 5 times greater in women than men [2]. In women, the greatest lifetime risk for a distal radius fracture occurs in the postmenopausal years, owing to a reduction in bone mass [3], and the incidence of comminuted intra-articular fractures increases in both sexes with advancing age [4].

External fixation of DRFs traditionally has involved either spanning or simple nonspanning devices. Spanning fixation is particularly useful in open or highly comminuted fractures with an unstable soft-tissue envelope. In the past, non-spanning external fixation typically was reserved for fractures with a noncomminuted extraarticular distal fragment to which several large pins or Kirschner wires (K-wires) could be secured.

These fractures have potential to compromise mechanical function of hand in an extreme manner [5]. Closed reduction and plaster application usually leads to early loss of reduction and late collapse. In most instances good functional end result is possible by skillful and intelligent use of different treatment modalities. However in their endeavor to obtain good result, the surgeons in most developing countries face many challenges [6].

Spanning external fixation

External fixation is a technique that uses ligamentotaxis to pull the fracture fragments into better alignment. The surgeon dissects and drills threaded pins into the radius proximal to the fracture and into the index finger metacarpal distal to the fracture and spanning the carpal joint. The surgeon attaches to these pins a mechanical frame with rods, which can be used to apply traction in different directions to pull on the hand to reduce the fracture fragments. This technique has recently begun to fall out of favor among hand surgeons as improved internal fixation technologies have become available. It still has a variety of indications that make it the procedure of choice. For fractures with extensive bone disruption, plate application may not be possible. Also, crush injuries may damage the soft tissue envelope such that the surgeon does not want to dissect extensively to apply a plate and screws to obtain rigid fixation. In this case an external fixator is the ideal choice. Finger motion should be started early because a potential drawback of the technique is stiff fingers as a result of over-distraction with the device. However, wrist motion must wait for removal of the device.

Problem statement

Highly comminuted fracture patterns and in polytrauma patients those fractures are very challenging in management. Comminuted intra-articular fractures about the wrist joint are common. These fractures represent a major burden for both patients and health services as their complications may stay for long period.

Justification

The aim of this study is to provide the national database by preliminary data about the outcome of intra articular distal radius fracture treated by spanning external fixation.

The incidence of fracture of the distal radius contributes up to 8–15% among all fractures of the upper limb. Moreover, External Fixation is an important technique during the treatment of the injuries involving the wrist area. Hence, the knowledge of the outcome values of this technique is imperative for restoring the hand function.

Specific objectives

- To evaluate the post-operative wrist joint range of motion.
- To evaluate the post-operative grip strength.
- To record the complications of Spanning External Fixation if it present (Pin-track infection, Implant failure, Iatrogenic Fractures and Superficial radial nerve injury) by clinical examination and laboratory test.
- To assess the disabilities of the arm, shoulder and hand by the (DASH) Score.

Materials and Methods

Study design

It is a multi-centers hospital- based prospective cross-sectional observational analytic study.

Study area

The study is conducted in Sharg-Alneel, Future and Omdurman hospitals. These centers are located in Khartoum city with large capacity of beds serving patients from the whole state of Khartoum with good facilities and advanced equipment.

Study population

Patients attended Sharg-alneel, Future and Omdurman hospitals that need a definitive management for Intra articular distal radius fracture and operated by spanning external fixation from (2017-2020).

Inclusion criteria

- Skeletally mature patients with intra-articular distal radius fracture
- AO type 23 B1 and 23 C fractures only
- Closed fractures

Exclusion criteria

- Simple extra-articular fractures
- Volar and dorsal shear injuries (Barton fractures)

Sampling

It is total coverage sample non convenient covering all samples underwent fixation by external fixation with distal radius intra-articular fracture during the period of the study. With 25 patients "26 hands.

Study variables

Wrist joint range of movements: Each participant was examining his/her wrist range of motion using a Goniometer and the data was recorded to the data sheet.

The post-operative hand grip strength: Each participant was examined his/her by hand dynamometer that calculates the grip strength.

The complications rate of spanning external fixation by clinical examination and laboratory test: Pin track infection was excluded clinically first and if it suspected laboratory tests were conducted.

Each participant was fulfilled DASH score to assess his/her joint stiffness

Surgical technique

Under regional block or general anesthesia, patients put on supine position. After standard draping and painting, closed reduction was done by manual traction under image intensifier (appropriate traction used without disrupting the intercarpal ligaments). Then external fixator with four schanz pins (2.5-3.5 mm), sometimes augmented by Kirschner wire and a rod were used for stabilizing the fracture. The proximal pins in radius were placed first at about the junction of upper and lower half of radius at dorsolateral plane of forearm. Another pin was placed in the second metacarpal base in line with the proximal pins in the radius. Damage to the SRN (superficial radial nerve) was avoided by mini incision down to the bone. The pins were joined by a rod and the upper pin was tightened to the rod using a clamp. Traction was manually applied in the longitudinal direction with counter traction applied at the level of elbow. Then the metacarpal pin was tightened keeping hand in functional position. The whole procedure was performed under fluoroscopic control. The fixation was augmented with the percutaneous K wires in cases that need more stability. Pin site sterile dressings were done and limb was elevated to reduce swelling. Early hand grip and movements are encouraged. Active and passive finger motion, elbow motion was started from the first postoperative day. The external fixator and pins were usually removed at 6 weeks to avoid the displacement risk.

Methods of data collection

Each participant was interviewed by the researcher and filled the data collection sheets which contain information about the personal data "Age, Gender, Occupation and the dominant hand" time and mechanism of trauma and the date of operation. Then each patient was examined at three months from the fixation time. Measurements which are include history of past hand trauma and the wrist range of movements recorded by goniometer. Dynamometer also used to obtain the hand grip strength compared with contralateral hand for each hand, 3 grip strength values were obtained. These values were averaged, and the injury of contralateral sides was compared. DASH "Arabic translated" score also obtained and filled by the patient. The Disabilities of the Arm, Shoulder, and Hand (DASH)

score was used to assess activities of daily living, pain, and quality of life after surgery.

Plan for data analysis and interpretation

Data were analyzed using SPSS Program Ver. 21"IBM" that calculates the range, mean, standard deviation and range of the parameters. ANOVA and one-sample T-test were used.

Results

The period from February 2017 to January 2020, 25 patients (26 hands) with unstable intra-articular distal radius fractures were treated by external fixation at Sharg-alneel, Future and Omdurman hospitals and all patients were available till final follow-up at three months post-operatively as minimum period to assess the functional outcome. There were 10 males (40%) and 15 females (60%). In the age group of 20 to 69 years with mean age of 47 years, with 13 patients less than 50 years and 12 patients more than 50 years.

All the patients were right hand dominant. Right side was involved in 9 patients (34.6%) and left side in 16 patients (65.4%) (Figure 1).

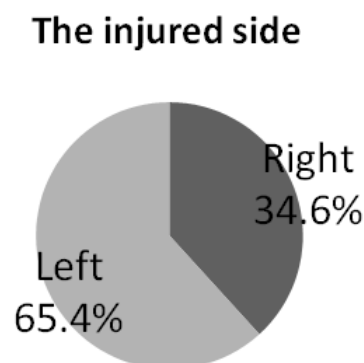


Figure 1: The right and left distribution regarding the injured side.

Regarding the study variables compared with the gender distribution the only statistically significant result was in the DASH score which represent a satisfied ability of using the upper limb among males rather than females (P 0.04) (Table 1).

	Male		Female		p
	Mean	SD	Mean	SD	
DASH Score	28.52	5.38	40	9.92	>0.05 (0.04)

Table 1: The result of DASH score among Gender groups.

In comparison of the age groups, statistically significant results in Dorsiflexion and DASH Score were recorded which shows that the age can affect the regain of normal hand functions (Table 1).

	Mean	SD	Mean	SD	p
	Dorsiflexion	66.18	13.20	54.17	9.16

DASH Score	30.74	6.44	41.85	10.72	<0.05 (0.007)
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Table 2 : The result of Dorsiflexion and DASH score among age groups.

The mechanism of injury included road traffic accident (n=7, 28%), and trivial fall (n=18, 72%). As per AO classification, all of fractures were 23 B1 and 23 C

The mean interval from date of trauma to time of surgery was 2 days with a range of zero to four days. Majority of patients were discharged on the first postoperative day. The mean duration of the operative procedure was 35 minutes. All the patients started finger mobilization exercises on the first postoperative day. All patients have no previous hand trauma to the injured site or the contralateral site. Except for one patient who had bilateral wrist injuries.

The evaluation of the post-operative wrist joint range of motions which assessed by goniometer is illustrated in (Table 3).

	Xiaofei Yu, (no=31)	This Study(no=26)	p
	Mean (SD)	Mean (SD)	
Dorsiflexion	62.3 (7.7)	59.91 (14.24)	>0.05(0.49)
Palmarflexion	60.2 (11.8)	62.7 (7.64)	>0.05(0.12)
Radial deviation	19.4 (7.7)	17.83 (3.39)	>0.05(0.06)
Ulnar deviation	29.5 (4.6)	42.39 (7.19)	<0.05(0.02)
Pronation	66.8 (9.6)	85.2 (9.94)	<0.05(0.01)
Supination	63.6 (8.9)	84.57 (7.82)	<0.05(0.01)

Table 3: Wrist ROM parameters in the whole study in compare with Xiaofei Yu values.

Regarding the hand grip strength, 3 grip strength values were obtained in each hand using lb unit. These values were averaged, and the injury and contralateral sides were compared. A 10% adjustment for dominant handgrip strength in right-handed patients was used for this comparison. The mean of hand grip was (82.86%).

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 with good results of hand motions and DASH system score. Fracture at pin site, late collapse and re-displacement were also not seen.

Discussion

This study is a multi-center, hospital-based analytic study. The evaluation of the post-operative wrist joint range of motion was done using Goniometer. The evaluation of the post-operative grip strength was done by the Hand Dynamometer. DASH score also included in this study. All the statistical analysis was done by SPSS Ver21. Paired T-test and One-sample T-test were used for comparing the means of the parameters. Twenty three (n=26) hands were included in the study.

Patients in this study aged between 20 to 69 years and most of them above 40 years and the majority are females with closed unstable distal intra- articular radius fractures (Figure 2) . This result reflects the effect of osteoporosis resulting in such fractures. This fact is proved by Larsen et al when they stated that fractures of distal radius are very common especially in osteoporotic post-menopausal women and contribute significantly to the work in orthopedic emergency. They usually result due to fall on outstretched hand and subsequent fracture because of osteoporosis. In young people they are usually a result of high energy trauma such as motor vehicle accidents and fall from height with marked displacement and comminution of distal radius [7].

For distal radial fractures, the functional result is the most important factor in assessing the outcomes and this was proved by Older M et al. [8], this justifies the needs to assess the functional outcome in patients with distal radius intra articular fracture treated by spanning external fixation Regarding this study the assessment of functional outcome was the most important objective.

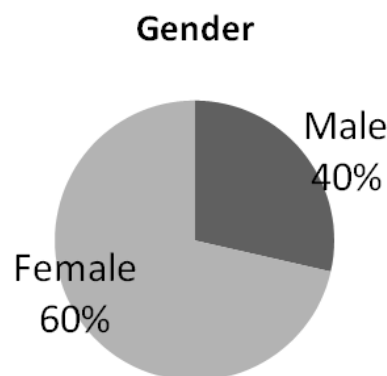


Figure 2: Distribution of the population of the study By Gender.

For stable distal radius fractures cast method provides the best functional result. However for unstable comminuted intrarticular fractures, external fixation with or without augmentation has become the treatment of choice [9]. Especially with the factors such as osteoporosis, lack of surgeon experience and availability of the instruments. Comminuted intrarticular fractures deserve special attention because neither casting method nor ORIF is suitable for these fractures. With casting method and percutaneous K wires, most of these fractures redisplace leading to a poor result. ORIF with a volar plate is also not suitable because the fragments are too small to hold screws, soft tissue stripping and osteoporosis is common in elderly [10].

The present day external fixators are lighter and comfortable allowing cleaning of pin sites, re-manipulation and any necessary adjustments. The duration of external fixation is also debatable with some authors advocating early removal at 3 weeks while others advocating routine removal at 6 weeks. The concerns with early removal are re-displacement, however Haddad M in a study of 36 patients using external fixator for 3 weeks and 5 weeks, found no significant difference in the two

groups [11]. On the other hand in this study, removal of the external fixation done after six weeks to avoid the displacement risk.

In this study, and during the clinical follow-up, a standard goniometer was used to evaluate active ROM (wrist flexion and extension and wrist radial and ulnar deviation, measured down the long axis of the forearm and the index ray), and forearm pronation and supination were measured from the 90 elbow flexion position using the humerus as the reference point with the shoulders in 0 of flexion, abduction, and external rotation. I found all measurements of wrist ROM are close to normal range parameters (Table 4).

Movements	Range	Mean	SD	Normal Range	p
Dorsiflexion	(30-75)	59.91	14.24	(0-75)	>0.05 (0.97)
Palmarflexion	(45-75)	62.7	7.64	(0-75)	>0.05 (0.09)
Radial deviation	(10-25)	17.83	3.39	(0-20)	>0.05 (0.32)
Ulnar deviation	(25-50)	42.39	7.19	(0-45)	>0.05 (0.36)
Pronation	(50-90)	85.2	9.94	(0-90)	>0.05 (0.91)
Supination	(60-90)	84.57	7.82	(0-90)	>0.05 (0.79)

Table 4: The post-operative wrist range of movements results.

This means that the effectiveness of spanning external fixation is high.

The results of wrist ROM showed better outcomes and statistically significant in contrast to the study done by Mehmet Talmac et al. who concluded that the spanning EF seems to be the least effective treatment option among the other surgical methods. Among our study population this method reflects the high efficacy of spanning external fixator in treating intra-articular distal radius fractures [12] (Table 5).

	Talmac(no=31)	This Study(no=26)	p
	Mean	Mean	
Dorsiflexion	45	59.91	<0.05(0.01)
Palmarflexion	65	62.7	>0.05(0.153)
Radial deviation	10	17.83	<0.05(0.00)
Ulnar deviation	25	42.39	<0.05(0.02)
Pronation	75	85.2	<0.05(0.02)
Supination	75	84.57	<0.05(0.01)

Table 5: Wrist ROM parameters in the whole study in compare with Talmac values.

Other study done by Xiaofei Yu et al. which stated that wrist ROM did not improve by spanning external fixation but when

comparing with the result of this study there were statistically significance improvement of wrist ROM in ulnar deviation, pronation and supination [13] (Table 3).

These studies reflected the arguments against the use of spanning external fixator as a method for the treatment of intra articular distal radius fracture. However, recently a prospective randomized trial study done by Kapoor et al. found out that the external fixation and percutaneous pinning is the most efficacious for treating unstable distal radius fractures [9].

In addition, Chuang Ma et al. notice that external fixation is more suitable for intra-articular distal radius fracture especially in elderly patients and when comparing his result with ours we found out the result of this study better than Chuang Ma ones [14] (Table 6).

	Chuang Ma	This Study	p
	Mean (SD)	Mean (SD)	
Dorsiflexion	62.87 (4.32)	59.91 (14.24)	>0.05(0.49)
Palmarflexion	61.28 (6.43)	62.7 (7.64)	>0.05(0.57)
Radial deviation	65.67 (4.98)	17.83 (3.39)	<0.05(0.01)
Ulnar deviation	65.57 (3.76)	42.39 (7.19)	<0.05(0.02)
Pronation	81.76 (5.87)	85.2 (9.94)	>0.05(0.054)
Supination	70.12 (6.53)	84.57 (7.82)	<0.05(0.01)

Table 6: Wrist ROM parameters in the whole study in compare with Chuang Ma values.

Regarding the Hand Grip Strength, a calibrated dynamometer was used to measure grip strength and the average of 3 trials of each strength test was calculated. The strength values were calculated as percentages of the contralateral (uninjured) side, as these ratios are more sensitive in detecting clinical changes. A 10% adjustment for dominant hand grip strength in right-handed patients was used for this comparison [15]. In comparison of our result to [13], no statistically significance mentioned (Table 7).

	Xiaofei Yu, (no=31)	This Study(no=24) Corrected Grip	p
	Mean Ib (%)	Mean Ib (%)	
Hand Grip Strength	94	82.2	>0.05(0.12)

Table 7: Wrist Corrected Grip in the whole study in compare with Xiaofei Yu values.

The Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire was used to assess activities of daily living, pain, and quality of life after surgery. The mean of the DASH score was 36.54 among the patients which represent a good regain of hand functions.

In this study no complications were observed unlike study done by Tabish Tahir et al. who mentioned pin tract infection, superficial radial nerve injury and malunion in their study [16],

with different percentage. We regard this result as a good outcome also in comparison to other studies.

Conclusion

Spanning External fixation with or without percutaneous K wires is an excellent option for treating unstable, comminuted, intra-articular distal radius fractures. The technique is fairly simple with low learning curve, has low reoperation rate, acceptable rate of complications and produces satisfactory outcome in majority of fractures. The external fixator is cost effective, takes less surgery time, with less post-operative complications and good functional outcome.

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