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Treatment of Unstable Displaced Distal Radius Fractures Using Kapandji Technique

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ABSTRACT

Background: One of the most frequent injuries seen in orthopedic practice is distal radius fractures. X-ray is the most common test used to determine the presence of a fracture. In some cases, a CT scan is needed to confirm a fracture or exclude intraarticular extension. Intrafocal Kapandji wiring is a safe and effective technique for treating stable fractures of the lower end of the radius.

Objective: The current study aimed to evaluate the results of treatment of unstable displaced distal radius fractures in adults with the kapandji procedure.

Patients and methods: A total of 18 patients were included in this clinical trial, with a mean age of 46.61 years; 61.1% of them were female. The extra articular unstable displaced distal radius fractures they had were treated by the Kapandji procedure at the Orthopedic Department, Zagazig University Hospital (Egypt) and Central Ajdabia Hospital (Libya), during the period from March 2022 to September 2022, with 6 months follow up.

Results: Concerning overall outcome, only 1 (5.6%) patient had fair outcome, 8 (44.4%) patients had good outcome while 9 (50%) patients had excellent outcome. Concerning complications, no patient had tendon injury, no neurovascular injury or sundeck's atrophy. Meanwhile, 7 (38.9%) patients had superficial infection.

Conclusion: An efficient surgical approach for treating distal radius fractures is closed reduction and percutaneous k-wire fixation using kapandji technique.

Keywords: Distal radius, Fracture, Kapandji, Clinical trial, Zagazig University.

INTRODUCTION

One of the most frequent fractures is a fracture of the distal radius injuries encountered in orthopedic practice. They make up 7%−14% of all bony injuries in adults. Risk factors for these fractures include reduced bone mineral density, female sex, early menopause, and family history in the elderly [(1)].

Different kinds of stresses can cause a distal radius fracture depending on position of the wrist joint at time of fall. These are primarily eccentric avulsion, axial compression, and bending moments, followed by different types of fracture [(2)].

During distal radius fracture, the multiple ligamentous attachments to the bone frequently remain intact, enabling reduction through "ligamentotaxis" [(3)].

The first step in diagnosis is a person's own observation of symptoms. A fracture is diagnosed during a physical examination and serial radiography. The most frequent test to identify a bone fracture is an X-ray affected side, Because not all fractures are visible on a single x-ray, a series of X-rays was taken with at least two views of the area to confirm the presence of the fracture [(4)]. It may take numerous examinations from various angles to clearly identify the fracture lines in some fractures, which are frequently difficult to discern. In some circumstances, a CT scan is necessary to show a fracture [(4)].

One of the fixation methods utilized in clinical practice for the treatment of distal radial fractures is the volar locking plate (VLP), while another is external fixation (EF) [(5)].

Due to the extensive dissection of soft tissue around the fracture site and the requirement for removal surgery in cases of intra-articular fractures, internal fixation with VLP is a typical treatment for unstable distal radius fractures [(5)].

External fixation has a multiple disadvantages, some of which include pin track infection, pin loosening neuropathies of the superficial or median radial nerve, radial shortening, and loss of radial tilt [(6)]. The double intrafocal pinning method was initially explained by Aldalbert Kapandji in 1976 [(7)]. Intrafocal Kapandji wiring is a safe and effective technique for treating unstable fractures of the lower end of the radius. It is simple to learn. The used technology is inexpensive [(8)].

The current study aimed to evaluate the results of treatment of unstable displaced distal radius fractures in adults with the kapandji procedure.

PATIENTS AND METHODS

A total of 18 patients (7 males and 11 females) with extra articular unstable displaced distal radius fractures were included in this clinical trial, with a mean age of 46.61 years (range 24 - 77 years) and 61.1% of them were female.

The extra articular unstable displaced distal radius fractures they had were treated by the Kapandji procedure at the Orthopedic Department, Zagazig University

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Hospital (Egypt) and Central Ajdabia Hospital (Libya), during the period from March 2022 to September 2022, with 6 months follow up.

Inclusion criteria: Patients was older than 18 years. Extra-articular unstable displaced distal radius fractures. Both genders were included.

Excluded criteria: Patients aged below 18 years. Patients can't stand to anesthesia pathological fractures or comminuted distal radius fractures. Intra-articular extension to wrist joint and open fractures.

Pre-operative:

Based on the patient's name, age, and other information gathered during the clinical assessment sex, occupation and dominant side. A total of 16 (88.9%) patients reported that they had fracture after falls, remaining 11.1% had RTA. A total of 12 (66.67%) cases had right distal radius fracture, while 6 (33.33%) cases had left radius fracture (33.33%).

All patients included in this study were closed fracture. All patients were classified according to the Frykman classification 13 (72.2%) cases were type I and 5 (27.8%) were type II. All patients were assessed radiological via plain radiographs taken of the wrist joint from the PA and lateral sides, with measurements of the radial length, radial inclination, and volar tilt. Laboratory tests, such as CBCs (complete blood counts). Testing for kidney and liver function. Under image-intensified fluoroscopy supervision, two to three K-wires were used to treat each patient.

Surgical technique:

The procedure was carried out under general anesthesia. The fracture was first reduced under C ARM; Restoring radial height while replicating anatomic radial inclination and volar tilt were the objectives of the reduction.

To protect the sensory branches of the radial nerve and the extensor tendons, a tiny cutaneous incision was made prior to insertion and dissected bluntly down to bone. Put a dorsal to volar wire into the fracture gap with the beginning point over Lister's tubercle, centered on the third metacarpal axis, and levered distally buttressing the proximal fragment to restore palmar tilt. The fixation is then secured by passing the wire through the cortex close to the fracture. The wire is subsequently placed at the fracture gap's center on the radial aspect.

Once the wire supports the proximal fragment, restoring radial inclination, the drill was elevated. The fixation is then secured by passing the wire through the cortex close to the fracture (**Figure 1**).

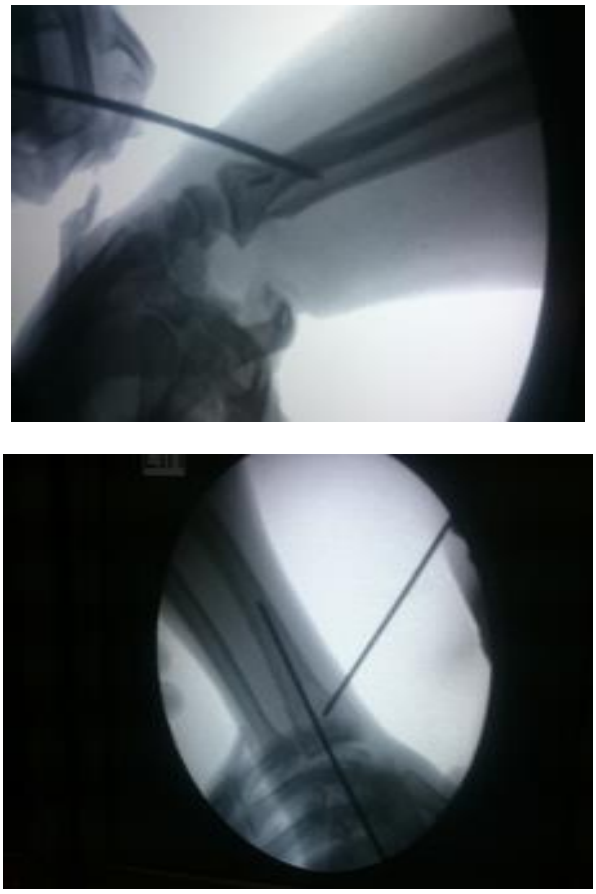

Figure (1): Intraoperative correction of radial deviation and dorsal angulation with k-wires.

Fluoroscopy was utilized to assess alignment and stability following pin insertion. In order to make sure that no tendons have been tied, passive finger and wrist flexion is evaluated. With a blade, any skin tethering is cut loose. Pins were curved and separated from the skin by about one centimeter. An above elbow slab is placed postoperatively.

Post-operative and Follow-up: Postoperative pain and inflammation were managed with analgesics, anti-edema medications and limb elevation. Postoperative To check for reduction and wire length, radiographs were taken. After 10 days, the stitches were removed. An above elbow slab was applied in the first week then transferred to a short arm cast. A 6 weeks after surgery, the wires are removed.

Ethics Approval

This study was ethically approved by the Institutional Review Board [IRB] of the Faculty of Medicine, Zagazig University. Written informed consent was obtained from all participants. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

Statistical Analysis

IBM SPSS Statistics for Windows was used to gather, tabulate, and statistically analyze all data (Version 23.0. Armonk, NY: IBM Corp. 2015). Qualitative data were defined as numbers and percentages. Chi-Square test and Fisher's exact test were used for comparison between categorical variables as appropriate. Quantitative data were tested for normality by Kolmogorov-Smirnov test. Normal distribution of variables was described as mean and standard deviation (SD). Independent sample t-test/ Mann-Whitney U test was used for comparison between groups. Wilcoxon signed rank test was used for comparison for paired quantitative data. P value ≤0.05 was considered to be statistically significant.

RESULTS

Subjective domain ranged from 0 to 4 with median 2, objective domain score ranged from 0 to 1 with median 0, deformity domain score ranged 0, while complications domain score ranged from 0 to 6 with median 0.5 (**Table 1**).

Table (1): Distribution of patients according to Gartland and Werley scoring system.

Variable	Median (IQR)	Range
Subjective domain	2 (1.5 – 2)	0 – 4
Objective domain	0 (0 – 0)	0 – 2
Deformity	0 (0 – 0)	0 – 0
Complications	0.5 (0 – 3)	0 – 6

IQR interquartile range.

Union time of patients was 4 weeks in 5 (27.8%) patients, 5 weeks in 5 (27.8%) patients, and 8 (44.4%) patients within 6 weeks (**Table 2**).

Table (2): Distribution of patients according to union time.

Variable	N= 18	%
Union time:		
4 weeks	5	27.8%
5 weeks	5	27.8%
6 weeks	8	44.4%

Concerning overall outcome, only 1 (5.6%) patient had fair outcome, 8 (44.4%) patients had good outcome while 9 (50%) patients had excellent outcome (**Table 3**).

Table (3): Distribution of patients according to outcome.

Variable	N= 18	%
Total		
Fair	1	5.6%
Good	8	44.4%
Excellent	9	50%

Table 4 showed that there was statistically significant relation between outcome and age (lower age significantly associated with excellent outcome). There was statistically non-significant relation between outcome and either gender, mode of trauma, time till operation, operation time, cast time, time till union, and incidence of superficial infection.

Table (4): Relation between outcome and studied parameters.

Variable	Fair/good	Excellent	U	P value
	Median(IQR)	Median(IQR)		
Age (year)	60(48.5 – 63.5)	37(30 – 44)	-2.74	0.006*
Time since fracture	2(1 – 4.5)	3(1 – 7)	-0.871	0.384
Variable	**N=9 (%)**	**N=9 (%)**	χ^2	**P value**
Sex:				
Female	7 (77.8%)	4 (44.4%)	Fisher	0.335
Male	2 (22.2%)	5 (55.6%)		
Mechanism of injury:				
Fall	8 (88.9%)	8 (88.9%)	0	>0.999
RTA	1 (11.1%)	1 (11.1%)		
Operative duration:				
20 minutes	6 (66.7%)	5 (55.6%)	Fisher	>0.999
25 minutes	3 (33.3%)	4 (44.4%)		
Union time:				
4 weeks	2 (22.2%)	3 (33.3%)	0.68	0.41
5 weeks	2 (22.2%)	3 (33.3%)		
6 weeks	5 (55.6%)	3 (33.3%)		
Superficial infection				
No	4 (44.4%)	7 (77.8%)	Fisher	0.335
Yes	5 (55.6%)	2 (22.2%)		

U: Mann Whitney test. χ^2: Chi square test. IQR: Interquartile range. *P<0.05 is statistically significant.

Table 5 showed that there was statistically non-significant relation between outcome and radial inclination, volar tilt or radial height pre or postoperatively. There was significant change in and radial inclination, volar tilt or radial height postoperatively as compared to preoperative level.

Table (5): Relation between outcome and all of radial inclination, height and volar tilt.

Variable	Fair/good	Excellent	U	P value
	Median (IQR)	Median (IQR)		
Radial inclination **Preoperative** **Postoperative**	 11 (6.5 – 16) 20 (20 – 22)	 16 (9.5 – 18.5) 21 (21 – 22)	 -1.241 -1.122	 0.215 0.262
P (Wx)	0.008*	0.008*		
Volar tilt **Preoperative** **Postoperative**	 -10 (-23.5, -2) 9 (5.5 – 10)	 -9 (-22, -6.5) 7 (5.5 – 10)	 -0.133 -0.316	 0.894 0.752
P (Wx)	0.008*	0.008*		
Radial height **Preoperative** **Postoperative**	 0 (0 – 3.5) 9 (8.5 – 11)	 2 (0.5 – 4.5) 9 (8 – 10.5)	 -0.948 -0.317	 0.343 0.751
P (Wx)	0.008*	0.008*		

U: Mann Whitney test. Wx: Wilcoxon signed rank test. IQR: Interquartile range. *P<0.05 is statistically significant.

Table 6 showed that there was statistically non-significant relation between complications and either age, gender, mode of trauma, time till operation, operation time, cast time, and time till union.

Table (6): Relation between complications and baseline parameters.

Variable	Not complicated	Complicated	U	P value
	Median (IQR)	Median (IQR)		
Age (year)	40 (32 – 50)	60 (39 – 66)	-1.677	0.104
Time since fracture	3 (1 – 7)	2 (1 – 5)	-0.141	0.93
Variable	**N=9 (%)**	**N=9 (%)**	**χ^2**	**P value**
Sex: **Female** **Male**	 7 (63.6%) 4 (36.4%)	 4 (57.1%) 3 (42.9%)	Fisher	>0.999
Mechanism of injury: **Fall** **RTA**	 9 (81.8%) 2 (18.2%)	 7 (100%) 0 (0%)	Fisher	0.497
Operative duration: **20 minutes** **25 minutes**	 8 (72.7%) 3 (27.3%)	 3 (42.9%) 4 (57.1%)	Fisher	0.332
Union time: **4 weeks** **5 weeks** **6 weeks**	 3 (27.3%) 4 (36.4%) 4 (36.4%)	 2 (28.6%) 1 (14.3%) 4 (57.1%)	0.221	0.638

U: Mann Whitney test. χ^2: Chi square test. IQR: Interquartile range.

DISCUSSION

The present study regarding mechanism of injury showed that 16 (88.9%) patients reported that they had fracture after falls; remaining 11.1% had RTA. time passed since fracture until operation ranged from 1 to 7 days with median 2 days.

Refai *et al.* [9] reported that the majority of patients (76.6%) had an injury as a result of a fall, RTA with 16.7%, and other with 6.7%.

Our findings concerning duration of operation, 61.1% had operation for 20 minutes while 38.9% had operation lasted for 25 minutes. All patients had cast time for 6 weeks.

Valisena *et al.* [10] reported that the operation took an average of 26 minutes (with a 10-55 minutes range). After using an above-elbow cast for the first 4 weeks, a below-elbow cast for the next 2 to 4 weeks, and then a short-arm brace until the full recovery of range of motion.

The arm is immobilized in a below elbow cast during the first 4-6 weeks of all studies on the Kapandji procedure, and K-wires are removed by the eighth post-operative week. In some cases, a short-arm brace is then used [11,12,13].

This study showed that union time of patients was 4 weeks in 5 (27.8%) patients, 5 weeks in 5 (27.8%) patients, and 8 (44.4%) patients had union within 6 weeks.

Valisena *et al.* [10] reported that In accordance with the formation of a callus, the K-wires were taken out at a mean post-operative time of 6.4 weeks. While buried K-wires were typically removed under general anesthesia at the ninth postoperative week, unburied K-wires were removed in the office.

Concerning complications in our results, no patient had tendon injury while 7 (38.9%) patients had superficial infection.

Some authors noted a 1.4% rate of neuroapraxia, a superficial pin track infection rate that ranged from very few cases to 5.7%, and a loss of reduction that ranged from 6-8% [14,15].

Pin migration, re-fracture, and wound over-granulation were problems with a reduced incidence [16,17].

Dowdy *et al.* [18] presented an extensor tendon rupture as a complication, with no case of RSD.

Some of them are connected to the injury itself. Fracture displacement can also threaten blood vessels, tendons, or nerves in addition to concurrent soft tissue injuries, with median nerve dysfunction being the most frequent early consequence [19].

Salem *et al.* [20] reported that Only 40% of the group under study experienced a superficial infection, and there were no incidences of tendon injury, NV damage, or Sudek's atrophy.

Ruschel *et al.* [21] reported There was a reflex sympathetic dystrophy (RSD) in 4 (13.8%) cases, with a severe form in 1 case only. Ulnar styloid process pseudoarthrosis occurred in 3 (10.35%) cases. Postoperative low-grade pain at the distal radioulnar joint occurred in 4 (13.8%) cases, and in only 1 (3.4%) case at the radiocarpal joint. One case had a diffuse-type pain. A mild ulnar residual deformity was observed in 44.8% of the cases.

The present study showed that postoperatively, there was a statistically significant increase in radial inclination compared to preoperative level.

Al Mabrouk *et al.* [22] reported that compared to before surgery, there was a statistically significant increase in radial inclination preoperative level.

Salem *et al.* [20] reported that the postoperative increase in radial inclination was statistically significant as compared to preoperative level [20].

Ruschel *et al.* [21] reported that there was a statistically significant reduction of operated wrist motion on goniometric assessment, when comparing to the opposite side, at the end of 12 months ($P<0.01$), with the exception of radial tilt, which was not jeopardized.

Refai *et al.* [9] reported that after surgery, the mean radial inclination was 18 (SD 3.8).

Respecting change in volar tilt the results of the current study revealed statistically significant change in volar tilt postoperatively as compared to preoperative level.

Ruschel *et al.* [21] reported that statistically significant difference was observed between radius volar tilt post-reduction and at wire removal, markedly occurring from the third month ($P<0.01$) and progressively evolving to a mean loss of 4.3º (SD 3.66) at the end of 12 months.

Salem *et al.* [20] reported a statistically significant difference in volar tilt postoperatively as compared to preoperative level.

Al Mabrouk *et al.* [22] reported decrease in volar tilt postoperatively as compared to preoperative level ($P<0.05$). Regarding change radial height there was a statistically significant rise in radial height postoperatively as compared to preoperative level.

Salem *et al.* [20] reported increased radial height postoperatively as compared to preoperative level ($P<0.05$).

Ruschel *et al.* [21] reported that considering radial length, it was noted a significant difference ($P<0.01$) upon wire removal, with progressive reduction and mean shortening of 3.17 mm (SD 1.91) at the end of 12 months.

Concerning Gartland and Werley's scoring system in our study, Subjective domain ranged from 0 to 4 with median 2, all patients had objective domain score 0, The median score for the deformity domain was 0, and the range for the complications domain was 0 to 6 with median 0.5.

Ruschel *et al.* [21] according to Gartland and Werley, functional assessment found 72.1% outstanding and good

performance at 3 months, 89.7% at 6 months, and 96.6% at 12 months.

Concerning overall outcome, only 1 (5.6%) patient had fair outcome, 8 (44.4%) patients had good outcome while 9 (50%) patients had excellent outcome.

Ruschel *et al.* [21] reported that anatomic assessment after 3 months postoperatively with Scheck's method of strength assessment revealed 96.6% good and excellent outcomes, with only 1 case with a bad result.

Al Mabrouk *et al.* [22] reported that regarding Mayo outcome score, 54.2% were excellent, 25% were good, and 20.8% were fair.

In agreement with our findings, the study of **El-Adawy *et al.*** [23] revealed that 4 (5.7%) patients were poor, 12 (17.1%) patients were fair, 18 (25.7%) patients obtained excellent scores, and 36 (51.4%) patients received good scores.

In **Jirangkul *et al.*** [24] study about 74% of the Kapandji group had excellent or good Herzberg ratings at 2 months in the trial.

Dowdy *et al.* [18] employed intrafocal wires in 17 patients, most with extra-articular fractures. They had inserted laterally the first wire, using 1, 2, or even 3 dorsal wires, which were cut below the skin. Radiologic and clinical outcomes were excellent in 100% and 76%, respectively.

Refai *et al.* [9] reported that the mean of the score for cases treated by K-wires and cast was 12.23 (SD 6.354). According to scoring system cases Good cases was 36.67%, Fair cases was 50% and Poor cases was13.3%. Five occurrences of follow-up problems were observed; usually arthritis.

Young and Rayan reported that result following non-operative therapy for low-demand patients older than 60 years with displaced distal radius fractures. About 12% had average to bad performance. An individual patient experienced complicated regional pain syndrome [25].

A total of 95 patients with comminuted distal radius fractures were treated by closed reduction and cast in other trials; their average age was 69 years. Four individuals had complex regional pain syndrome, whereas two instances had pin-track infections. With the exception of one patient who had persistent regional pain syndrome, 87% of patients had good or very good Gartland ratings. Three of them had issues with their hands' ability to grip. After 28 months, 85% showed less than 10° dorsal tilt and less than 6 mm of radial shortening [26].

In another study with 100 patients with a mean age of 65, the Kapandji K-wire approach and oblique radioulnar pinning were contrasted. According to the Martin score, results for patients treated using the Kapandji K-wire method were good to very good, and for patients treated using the oblique radioulnar K-wire method, the results ranged from satisfactory to good. After 10 months of follow-up, Kapandji K-wires groups showed better results. Both approaches have a 30% complication rate. which primarily involve wire migration and nerve discomfort [27].

The results of the current investigation revealed a statistically significant relationship between the outcome and age (lower age significantly associated with excellent outcome). Results and either had a statistically insignificant relationship gender, mode of trauma, time till operation, operation time, cast time, time till union, and incidence of superficial infection.

Ruschel *et al.* [21] reported that age more than 50 years correlates significantly with reduction of wrist flexion, extension, pronation, and supination at 12 months postoperatively. They also found that those patients presented with a lower initial strength on the opposite wrist in comparison to patients less than 50 years of age, but completely recovered in 12 months, in contrast to those who remain with a 4.69 Kgf deficit in relation to the opposite side.

CONCLUSION

Using the Kapandji approach, closed reduction and percutaneous k-wire fixation is a successful surgical option for treating distal radius fractures. This technique has low morbidity and good outcome, easy to learn, and minimally invasive procedure with few complications which can be avoided by strictly adhering to the basic principles of the technique.

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