

Ligamentotaxis supplemented by K wires fixation versus volar plate and screws fixation for management of unstable fractures of the distal radius

El Sayed Said^a, Hesham H.Refae^b, Abdel Rahman Elmodather Ali^{a*},
Hamdy H. Tammam^a

^aOrthopaedics & Traumatology Department, Faculty of Medicine, South Valley University, Qena, Egypt.

^bOrthopaedics & Traumatology Department, Faculty of Medicine, Aswan University, Aswan, Egypt.

Abstract

Background: Fractures of the distal radius was found to be one of the most common skeletal injuries treated by orthopedic or trauma surgeons

Objectives: To evaluate the outcome after operative treatment of unstable distal radius fractures to obtain good alignment through different methods of treatment as closed reduction and pinning, bridging and open reduction with volar plate-and-screw fixation.

Patients and methods: Our study was a prospective, randomized trial conducted between 2018 and 2019 including 40 patients with displaced, unstable fractures of the distal radius .They were randomized to be managed either by ligamentotaxis supplemented with K-wire fixation or with volar plate fixation with similarity of both groups in the compared variables including age, gender ,mode of trauma , medical co-morbidities and the pattern of fracture.

Results: The study was conducted on 40 patients with the mean age of ligamentotaxis group 38.9 years (Range 22-57), while the plating group was 39.45 years (Range 29-51). More than half of patients underwent ligamentotaxis were males and 60% of patients in the plating group were females .Patients in ligamentotaxis group had either road traffic accident or fell on ground with almost equal proportions, but in the plating group falling on ground was the most common. AO fracture type B was the most common among our sample. No statistically significant difference was found between both groups neither at 3 months nor at 6 months follow up. However, the Mayo score showed statistically significant improvement along the follow up

Conclusions: We concluded that there is no evidence for the superiority of one treatment over the other either using locking plate and screws or ligamentotaxis supplemented by k wires.

Keywords: Ligamentotaxis; K wires; Volar plate; Unstable fractures

***Correspondence:** abd_elrahman_ali@med.svu.edu.eg

DOI: 10.21608/svuijm.2021.49582.1040

Received: 1 November, 2020.

Revised: 11 November, 2020.

Accepted: 2 February, 2021.

Published: 27 January, 2024

Cite this article as: El Sayed Said , Hesham H.Refae, Abdel Rahman Elmodather Ali, Hamdy H. Tammam (2024). Ligamentotaxis supplemented by K wires fixation versus volar plate and screws fixation for management of unstable fractures of the distal radius. *SVU-International Journal of Medical Sciences*. Vol.7, Issue 1, pp: 227-236.

Copyright: © Said et al (2024) Immediate open access to its content on the principle that making research freely available to the public supports a greater global exchange of knowledge. Users have the right to Read, download, copy, distribute, print or share link to the full texts under a [Creative Commons BY-NC-SA 4.0 International License](https://creativecommons.org/licenses/by-nc-sa/4.0/)

Introduction

Fractures of the distal radius was found to be one of the most common skeletal injuries treated by orthopedic or trauma surgeons. In fact, these injuries account for about one-sixth of all fractures seen and treated in emergency department. and those are the most common fractures of the upper limb (Axelrod,et al.,2005).

The most common cause of these pattern of fracture is a fall on outstretched hand. IN young adults this fracture is the result of high energy trauma as a fall from a considerable height or a motor car accident. The risk of these injuries is increased in patients with osteoporosis and other metabolic bone diseases (Golden, 2016)

Anatomical articular alignment augmented with stable fixation improved the functional outcome when union is achieved (Wagner et al.,2008; Trumble et al.,2013). Many options for obtaining stable fixation after achieving reasonable alignment in these injuries have been described including closed reduction and pinning, bridging and open reduction with locked plate fixation through a lot of approaches (Khanduja et al.,2010)

Successful results can also be achieved when using external fixation in such injuries, but also has been associated with general complications of external fixation including stiffness of the fingers, loss of reduction, neurovascular injury and pin-track infection (Ahlborg and Josefsson, 2011; Kitaoka et al., 2015)

The aim of the present study was to compare the results of external and internal fixation methods for the treatment of fractures of distal end of radius. The two treatment groups were compared with the radiological, clinical, and functional outcomes of fixation either by ligamentotaxis fixation or volar plating for a displaced moveable fracture of the distal radius

Patients and methods

From 2018 to 2019 over a period of one year, 40 patient with consecutive fractures of the distal radius with the inclusion criteria of the fracture pattern of the distal radius requiring operative treatment that can be

fixed either by ligamentotaxis and Kirschner (K)-wires or open reduction and internal fixation with exclusion criteria including volar and dorsal shear fractures, young skeletal immature patients and those refuse to participate. The study was approved by the Institution Review Board and the patients were consented. Cases were then randomized to undergo either ligamentotaxis and a K-wires fixation or fixation with a locked volar plate-and-screw with no differences between the groups as regard the age, gender, hand dominance, pattern of fracture, socio-economic status or the associated medical co-morbidities as (cardiovascular, endocrine , pulmonary disease, or malignancy)(Table.1). Baseline clinical details, including mode of trauma and the Disabilities of Arm, Shoulder and Hand (MAYO) functional score was obtained. A complete history was taken, and physical examination performed, with attention of neurovascular deficits and open wounds. Standard radiographs were taken at presentation including antero-posterior (AP), lateral, and oblique views. The fractures were classified according to the system of the Orthopedic Trauma Association (AO/OTA) (Hoppenfield and Deboer ,2000) beside, for comparison, radiographs of the normal wrist were obtained to evaluate reduction .The patients were chosen randomly for treatment at presentation using a random-number generator, which assigned either external fixation or volar plating to each patient.

Operative technique

Patients were operated either under general or regional anesthesia.. In the ligamentotaxis group closed reduction was performed with using acouple of pins inserted in the base of the second metacarpal and another two inserted in the distal third of the radius in a mini- open surgical technique. After application of the external fixator and achieving an acceptable alignment, percutaneous K-wires were placed to maintain the reduction as described in (Fig. 1).

These K-wires were left protruding outside the skin to be removed easily with the external fixator as an outpatient. If we could not achieve an acceptable closed reduction, one or more small incisions were made to achieve acceptable reduction and K-wires fixation. At the end, we reduce traction

from the device, and it was left in place to maintain the reduction as a neutralization device

All the cases in the plating group underwent a similar procedure through a standard volar approach to the wrist of Henry (Hoppenfield and Deboer P,2000).

Table 1. Comparison of Radiological Characteristics of the Two Groups

Parameters	Groups*		P value
	Ligamentotaxis (N = 20)	ORIF (N = 20)	
Gender*			0.113 ²
Male	13 (65)	8 (40)	
Female	7 (35)	12 (60)	
Mode of trauma*			0.605 ²
RTA	7 (35)	6 (30)	
Falling on ground	7 (35)	10 (50)	
Falling from height	6 (30)	4 (20)	
Handedness*			0.752 ²
Dominant	10 (50)	9 (45)	
Not dominant	10 (50)	11 (55)	
Fracture type*			0.896 ²
B2	5 (25)	7 (35)	
B3	7 (35)	6 (30)	
C1	2 (10)	3 (15)	
C2	2 (10)	1 (5)	
C3	4 (20)	3 (15)	
Time to fixation, days			
Mean ± SD	2.85 ± 1.53	3.55 ± 1.79	0.192 ¹

Data are presented as No. (%).¹Independent t test; ²Chi-square test.

Open reduction and fixation by a locked pre-contoured volar plate was used in all cases of this group(**Fig. 2**). A volar plaster splint was applied post-operatively. The patients attended to the outpatient clinic regularly at two and six weeks and at three, six and 12 months for follow up.. After one week the stitches and dressing were removed. Patients treated by ligamentotaxis started finger exercises and were seen every two weeks for radiological evaluation. A dry sterile gauze dressing was placed around the

pins to reduce skin-pin movement. No dedicated regimen for pin-care was used. Those in the plate group were placed in a removable splint for comfort and permitted to early move the wrist and fingers freely. They were seen after six weeks for radiological evaluation. At six weeks the external fixator frame and K-wires were removed in the outpatient clinic without anesthesia. All patients had formal physiotherapy to ensure active and passive finger, wrist movement (if able) and forearm

movement. At every assessment, we recorded the number of physiotherapy sessions and an independent observer assessed the range of movement of the wrist and fingers using a goniometer. MAYO questionnaire was used to measure the

functional outcome; Pain was scaled by using the visual analogue scale (0, no pain; 10, severe pain). Grip strength was evaluated at every visit and on the normal side three months for comparison.



Fig.1. 24 Years old male presented with fracture distal Rt radius motor car accident, Plain AP and Lateral X-ray views (A), postoperative plain X ray views (B) and Closed reduction and ligamentotaxis with supplementary k-wires was done, a clinical photo showing external fixator with k-wires (C), Three month follow up (D), a and six month follow up (E) clinical photo showing functional range of motion six month later (F) .



Fig.2. 28 Years old female presented with fracture distal Lt radius, falling over ground , Plain AP and Lateral X-ray views (A), open reduction and volar plate was done, a clinical photo showing skin incision (B) postoperative plain AP and lateral x-ray (C), three months follow up (D), six months follow up (E) a clinical photo showing skin incision three months later (F)

Radiological evaluation at each post-operative visit was done after taking AP and lateral radiographs and included assessment of union of the fracture, development of wrist arthritis and loss of reduction. Measurements of height, radial inclination,

ulnar variance and tilt were made on each radiograph (**Table.2**). The appearance of arthritic change (**Knirk and Jupiter,2010**) was noted if developed usually at the six- and 12-month radiographs.

Table .2.Comparison of Radiological Characteristics of the Two Groups

Affected side			P value
Radial inclination	12.1± 3.42	12.60± 3.22	0.548 ¹
Radial height	4.65± 1.66	4.10 ± 1.86	0.351 ¹
Ulnar variance	3.35± 1.39	3.70± 1.59	0.438 ¹
Volar tilt	4.50 ± 1.64	2.40± 2.44	0.006 ¹
Normal side			
Radial inclination	21.65 ± 1.42	21.63 ± 1.09	1.000 ¹
Radial height	12.15 ± 1.04	12.00 ± 0.92	0.722 ¹
Unar variance	-0.37 ± 2.28	-0.35 ± 2.23	0.956 ¹
Volar tilt	10.80 ± 6.12	8.85 ± 4.88	0.272 ²

*data are presented as mean ± standard deviation. ¹mann-whitney test; ² independent t test

Statistical analysis

We used the chi-squared test for categorical variables such as gender, hand dominance, fracture pattern, co-morbidities, and Student's *t*-test for continuous variables such as age. Differences in clinical results evaluating

the range of movement and radiological measurements were assessed using *t*-tests while in the follow-up MAYO score by linear regression while controlling for baseline scores

Results

The study was conducted on 40 patients divided into 2 groups. The mean age of ligamentotaxis group was 38.9 years (Range 22-57), while the mean age of plating group was 39.45 years (Range 29-51). More

than half of patients underwent ligamentotaxis were males. On the other hand, 60% of patients in the plating group were females.

Patients in ligamentotaxis group had either road traffic accident, fell on ground, or fell from height with almost equal proportions, but falling on ground was the most common mode of trauma in the plating group. The incidence was Nearly 50% of patients in both groups had their dominant hand affected. In the ligamentotaxis group, there was only one patient with pin tract infection and one case of radial collapse. On the other hand, 2 patients in the plating group had wound infections treated by the appropriate antibiotics, 3 patients had radial shortening and one patient demonstrated delayed union (**Table .3**)

Table 3. Postoperative complications

Variables	Groups	
	Ligamentotaxis (N = 20)	Plating (N = 20)
Infection	1 (5)	2 (10)
Delayed union	0 (0)	1 (5)
Radial collapse	1 (5)	3 (15)

* Data are presented as No. (%).

This study was done by combination of clinical assessment(**Table.5**), simple plain radiographic assessment(**Table.4**) (AP and lateral plain x ray view) with AO fracture

type B was the most common among our sample representing 60% and 65% in ligamentotaxis group and plating group respectively.

Table 4. Comparison of Radiological Characteristics of the Two Groups

Parameters	Groups ^a		Pvalue [‡]
	Ligamentotaxis (N = 20)	Plating (N = 20)	
Radial Inclination			
Postoperative	21.63 ± 1.44	21.62 ± 1.09	* 0.980 ³
3 months	21.60 ± 1.43	21.61 ± 1.09	* 0.980 ³
6 months	21.54 ± 1.42	21.61 ± 1.08	* 0.871 ³
P value [†]	* 0.250 ¹	* 0.095 ¹	
Radial Height			
Postoperative	12.14 ± 1.02	11.94 ± 0.923	* 0.587 ⁴
3 months	12.05 ± 1.06	11.93 ± 0.91	* 0.956 ⁴
6 months	12.04 ± 1.06	11.91 ± 0.90	* 0.989 ⁴
P value [†]	* 0.082 ¹	** 0.002 ¹	
Ulnar Variance			
Postoperative	-0.14 ± 2.22	-0.38 ± 2.20	* 0.774 ⁴
3 months	-0.12 ± 2.22	-0.38 ± 2.20	* 0.711 ⁴
6 months	0.17 ± 2.04	-0.35 ± 2.11	* 0.461 ⁴
P value [†]	* 0.168 ²	* 0.459 ²	
Volar Tilt			
Postoperative	12.30 ± 5.14	11.60 ± 5.77	* 0.688 ³
3 months	12.25 ± 5.15	11.62 ± 5.78	* 0.718 ³
6 months	12.20 ± 5.21	11.57 ± 5.77	* 0.721 ³
P value [†]	* 0.259 ¹	* 0.218 ¹	

^a Data are presented as mean ± standard deviation. [†] Denotes statistical difference between preoperative and postoperative results of each group. [‡] Denotes statistical difference between both groups. ¹ Repeated measure ANOVA; ² Friedman test; ³ Independent t test; ⁴ Mann-Whitney U test. * P value > 0.05; ** P value < 0.05.

Table 5. Correlation between fracture type and Mayo Wrist Score

Groups				
Variables	Ligamentotaxis (N = 20)		Plating (N = 20)	
3 months follow up				
Correlation coefficient	-0.810		-0.647	
P value*	0.000		0.002	
6 months follow up				
Correlation coefficient	-0.497		-0.726	
P value*	0.026		0.000	
* Spearman correlation				
Satisfactory	5 (25)		6 (30)	
Good	6 (30)		6 (30)	
Poor	2 (10)		3 (15)	
Mayo Wrist Score at 6 months				
Excellent	12 (60)		11 (55)	
Satisfactory	4 (20)		5 (25)	
Good	2 (10)		1 (5)	
Poor	2 (10)		3 (15)	
P value ‡	0.043 ²		0.029 ²	

* Data are presented as No. (%). † Denotes statistical difference between both groups. ‡ Denotes statistical difference within each group. ¹Chi-square test; ²McNemar-Bowker test.

Discussion

Distal radius fractures are the commonest bone fractures all over the world. They are the most popular fractures of the upper extremity forming about one-sixth of all fractures managed in the emergency departments. With falling over an outstretched hand is the commonest injury.

Intra-articular fractures of the distal radius are commonly encountered injuries. They are often unstable fractures and usually occur because of high-energy trauma. The goals of current treatment are centered on restoration of bony anatomy of the distal radius (radial angle, radial length and volar tilt) with specific attention to the anatomical reduction of articular surfaces of radio-carpal and radio ulnar joints. (Lakshmanan et al.,2010)

These injuries can be treated in a less invasive method by closed reduction and fixation by percutaneous pinning compared with other open surgeries. Our study aims at assessing the functional outcome of this treatment in distal radius fractures. 40

patients with distal radius fractures included in this study divided into 2 groups: The first group included 20 cases treated by closed reduction and Ligamentotaxis supplemented with percutaneous K wires fixation. and the other 20 cases treated by Volar plate at Qena University Hospital.

Comparison of our results in this present series with other similar studies is shown below:

Wakefield and McQueen (Wakefield and McQueen,2000) proceeded a randomized, prospective study, matching a classic physiotherapy protocol with none after conservative management of a distal radial fracture in patients with age older than 55 years. They concluded that good results were achieved without a formal rehabilitation and some factors correlated with poorer results as malunion and the pre-injury level of function. However, they found that an improved range of palmar and dorsiflexion of the wrist at six months can be achieved by physiotherapy.

The evaluation of clinical and radiological results was good to excellent after operative

treatment of distal radial fractures. In one meta-analysis which included 46 papers, with 916 patients treated by external skeletal fixation and 603 by open reduction and internal fixation, the authors found that there was no evidence to support that one treatment method was superior over the other. In another systematic review of the literature performed by Paksima et al, of 31 articles there were only two randomized clinical trials and two non-randomized comparisons. They found that for unstable fracture patterns the operative treatment was favored and external fixation was superior to internal fixation. (Paksima et al., 2004) Eventually, in a Cochrane database review of 48 randomized trials, including more than 4300 patients, it found that the studies lacked to support evidence for the success of one method of treatment to be superior to other methods (Margaliot, 2013) In one randomized trial comparing the outcome of using mini-open reduction and fixation by dorsal plating external fixation, it concluded that there was no difference in outcome while using the DASH scores, but found a higher rate of complications in the dorsal plating group. In another randomized study performed on 90 patients with displaced distal radial fractures with intra-articular extension, treated with closed reduction and plaster, external fixation, or non-locking plating and screws, external fixation alone was found to be superior to other methods and achieved the best outcome. (Margaliot et al., 2013)

We found that the problem in trying to compare the results of previously conducted studies with our result lies in that most of the earlier studies used fixation by plates and screws applied dorsally that is found to lead to irritation of the extensor tendon and lead to its rupture. (Khanduja et al., 2005; Hahnloser et al., 2006; Keller and Steiger, 2006).

This led to the recent change to the use of volar locked plates for the treatment of these kind of fractures. The use of volar locking plates is found to be clinically and biomechanically associated with achieving better outcome over dorsal, non-locked

plating for management unstable fractures due to lower rate of complications and more stiffer construct (Orbay, 2004). As regard to the external fixator which we used, we chose a joint-spanning construct because it can be used in most distal radial fractures as many studies have compared bridging with non-bridging external fixation. In one study, McQueen randomized 60 patients with lost acceptable reduction to treatment by either non-bridging external fixation or bridging external fixation, without supplementary K-wire fixation. The functional results as regard movement of the wrist and hand grip strength were better in the plate group so we can approve that some types of fixation must be provided for the distal fragments in such fractures. (McQueen, 2002) However, we had little experience of using the non-bridging method. So we chose to use the bridging technique of ligamentotaxis supplemented with K-wire fixation of fractured fragments.

And currently, a little information was available comparing the use of external fixation versus volar locked plating.

Wright, Horodyski and Smith retrospectively compared 21 patients who had been managed by a volar plate with 11 patients treated by ligamentotaxis. Although they reported no functional difference between the two groups, the final radiological outcome was better in the plating group. However, the limitations of this study lies in the small numbers and retrospective nature and this made it difficult to support one treatment method over the other (Wright et al., 2007)

Conclusion

We compared the outcome of fixation of distal radius fractures using locked plates and screws through classic volar approach vs external fixation supplemented by k wires fixation in a prospective randomized manner with improvement of both clinical and radiological result at three and six months after volar locked plating, but although the improved early ranges of movement of the wrist were statistically considerable, the true difference was of small clinical importance. None of the improvements was

related to a better result. As regard complications, there was a greater happening for re-operation in the plating group although the similarity between the number of complications between the two methods. However, our study displayed no proof for the excellence of one treatment over the other. The obstacle of this study included a short follow-up period and a small study group; however, we expect to report our long-term results in the near future.

References

- **Ahlborg HG, Josefsson PO. (2011)** Pin-tract complications in external fixation of fractures of the distal radius. *Acta Orthop Scand*;70:116-18.
- **Axelrod, Paley, Green.(2005)** Limited open reduction of the lunate facet in comminuted intraarticular fractures of the distal radius. *J Hand Surg.*;13:384-9.
- **Golden GN. (2016)** Treatment and programs of Colles' fracture. *Lancet.* 1:511-4.
- **Hahnloser D, Platz A, Amgwerd M, Trentz O. (2006)** Internal fixation of distal radius fractures with dorsal dislocation: pi-plate or two 1/4 tube plates?: a prospective randomized study. *J Trauma*;47:760-5.
- **Hoppenfield S, Deboer P. (2000)** Surgical exposures in orthopaedics
- **Keller M, Steiger R. (2006)** Open reduction and internal fixation of distal radius extension fractures in women over 60 years of age with the dorsal radius plate(piplate). *Handchir Mikrochir Plast Chir*;38:82-9.
- **Khanduja V, Ng L, Dannawi Z, Heras L(2005).** Complications and functional outcome following fixation of complex, intra-articular fractures of the distal radius with the AO Pi-Plate.
- **Kitaoka HB, Alexander IJ, Adelaar RS, et al (2015).** Clinical rating systems for the ankle hind foot, Mid foot, hallux, and lesser toes. *Foot Ankle In*15:
- **Knirk JL, Jupiter JB.(2010)** Intra-articular fractures of the distal end of the radius in young
- **Lakshmanan P, Dixit V, Reed Mr, Sher JI. (2010)** Infection rate of percutaneous Kirschner wire fixation for distal radius fractures. *J Orthop Surg (Hong Kong)*. Ap
- **Margaliot Z, Haase SC, Kotsis SV, Kim HM, Chung KC.(2013)** A meta-analysis of outcomes of external fixation versus plate osteosynthesis for unstable distal radius fractures..
- **McQueen MM. (2002)** Redisplayed unstable fractures of the distal radius: a randomized, prospective study of bridging versus non-bridging external fixation. *J Bone Joint Surg [Br]* 80-B:665-9.
- **Nader Paksima, Anand Panchal, Martin A Posner, Steven M Green, Charles T Mehiman, Rudi Hiebert . (2004)** A meta-analysis of the literature on distal radius fractures: review of 615 articles. *National Library of medicine Bull Hosp Jt Dis .*;62(1-2):40-6.
No authors listed. Fracture and dislocation compendium: Orthopaedic Trauma Association Committee for coding and classification. *Orthopaedic Trauma*;10
- **Orbay J, Badia A, Khoury RK, Gonzalez E, Indriago I.(2004)** Volar fixed-angle fixation of distal radius fractures: the DVR plate. *Tech Hand Up Extrem Surg*;8:142-8.
- **Trumble TE, Schmitt SR, Vedder NB(2013).** Factors affecting functional outcome of displaced intra-articular distal radius fractures. *J Hand Surg [Am]*;19:325-40.
- **Wright TW, Horodyski M, Smith DW(2007).** Valverde JA, Alonso MG, Porro JG. Use of the Gamma nail in the treatment of fractures of the proximal femur. *Clin Orthop*;350:56–61.
- **Wagner WF Jr, Tencer AF, Kiser P, Trumble TE.(2008)** Effects on intra-articular distal radius depression on wrist joint contact characteristics. *J Hand Surg [Am]*;21:554-60

- **Wakefield AE, McQueen MM. (2000)**
The role of physiotherapy and clinical predictors of outcome after fracture of

the distal radius. J Bone Joint Surg [Br];82-B:972-6