Management of Comminuted Distal Radial Fractures Using Volar Plating versus External Fixation Augmented by K wires

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ABSTRACT

Background: Distal radius fractures are the most common fractures of the upper extremity, representing approximately one-sixth of all fractures treated in the emergency room. Various classification systems are used to classify distal radius fractures. There are different methods for treatment of this type of fractures.

Objective: This study aimed to evaluate the best procedure in management of comminuted distal radial fractures and attainment of better outcomes.

Patient and methods: This study involved 30 patients with distal radial fractures who divided equally into: 15 patients performed volar plate in group (A) and other 15 patients applied external fixation augmented by K-wires group (B). The follow-up in was six months.

Results: The mean operation time was 54.00 ± 12.28 minutes in volar plating group, in comparison with 36.33 ± 5.16 minutes in external fixation group. There was statistically clinical significance between the two groups. Patients treated with volar plating had flexion range of 10-85, radial deviation range of 5-30 and ulnar deviation range of 20-40, while patients treated with external fixation augmented by k-wires had flexion range of 60-85, radial deviation range of 10-28 and ulnar deviation range of 20-35. Patients treated with external fixation augmented by k-wires had extension range of 45-85 better than those treated with volar plating (10-85). Patients treated with external fixation augmented by k-wires had grip strength range of 15-27, while patients treated with volar plating had grip strength range (8-27).

Conclusion: Volar plating had better functional outcomes when compared to external fixation. Whereas grip strength and ROM data were similar between the two groups.

Keywords: Volar plating; External fixation; Radial fractures.

INTRODUCTION

A fracture of the distal radius is considered unstable by definition if it is unable to resist displacement following anatomic reduction [(1)]. Treatment of broken bones follows one basic rule: the broken pieces must be put back into position and prevented from moving out of place until they are healed [(2)]. The treatment of distal radius fractures requires a meticulous reconstruction of the joint surface, as well as stable internal fixation and early functional post-operative treatment. Extra-articular fractures require both the restoration of the volar tilt and radial length to reduce the possibility of displacement [(3)].

Closed reduction and cast immobilization is still the mainstay of treatment for non-displaced and stable fractures [(4)]. There are multiple surgical options of treatment for patients with distal radius fractures, including percutaneous K-wire fixation, use of an external fixator, fixation with volar or dorsal plates (locking or nonlocking), bridge plating, or a combination of these techniques. Although the best choice depends to some extent on the characteristics of the fracture (open/closed, non-displaced/displaced, extra-/intra-articular), there is little high-quality evidence to inform this decision-making [(5)].

External fixation can play a role in fractures of the distal radius with epiphyseal lesions or with associated dislocations, which can be considered composite osteoligamentous lesions rather than fractures. An external fixator is the only tool to do this in high-energy fractures [(6)]. Complications associated with external fixator are pin-track infection, iatrogenic lesion of the superficial radial nerve. Overdistraction of the wrist joint may lead to complex regional pain syndrome (CRPS). Usually the external fixator is applied for 6 weeks especially in osteoporotic bone quality with weak hold of the pins, loosening of the pins occurs quite early so that they have to be removed before definitive bone healing [(7)].

The aim of the present study was to evaluate the best procedure in management of comminuted distal radial fractures and attainment of better outcomes.

PATIENTS AND METHODS

This study included 30 patients with distal radial fractures who enrolled for open reduction and internal fixation by volar plate in group (A), external fixation augmented by K-wires in group (B). Participants were numbered from 1 to 30 and divided equally into: 15 patients performed volar plate in group (A) and other 15 patients applied external fixation augmented by K-wires group (B).

Inclusion criteria: Patient with closed unilateral comminuted distal radius fractures (occurred in less than 14 days). Extra-articular fracture type A3 and intra-articular distal radius fractures type C2, C3 according to AO/OTA Classification in patients who surgically fit.

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Exclusion criteria: Patient with concomitant fracture at the same injured limb, skeletal diseases (e.g., Tumors, Paget disease, or rheumatoid arthritis) and patients who were surgically unfit.

Surgical assessment:

Routine preoperative management including laboratory and radiological examination for all the studied patients. The patient positioned supine and place the forearm on a hand table under general or regional anesthesia.

In Group (A): Volar plating using Modified Henry approach. Longitudinal incision was made over the flexor carpi radialis (FCR) tendon. After exposure and refreshing of the fracture site, the fracture was reduced and provisionally fixed under C-arm using k-wires. The plate should be positioned on the distal radius proximal to the Watershed line. Plate was fixed to bone distally beginning with the most ulnar screw using the funnel-shaped end of the VA-LCP drill sleeve at the desired angle.

In Group (B): External fixation with pinning to maintain reduced position of distal radius. Per-cutaneous K-wires were inserted and other wire was added to maintain distal radioulnar joint (DRUJ) and reduction of DRUJ was done. The pins are placed in the radial shaft after predrilling and using a soft-tissue protector. The skin is then closed around the proximal pin sites.

The patient hands were photographed after surgical intervention (after obtaining informed consent) for follow up.

Follow up evaluation:

The average results hand Grip Strength measured in kilograms. Range of motion (ROM) is a measurement of the distance and direction a joint can move to its full potential. Radiological parameters of distal radius for the operated side of both groups.

Ethical approval:

The study was approved by the Ethical Committee of Zagazig, Faculty of Medicine. An informed consent was obtained from every patient in this research. Every patient received an explanation for the purpose of the study. All given data were used for the current medical research only. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

Data were analyzed using the Statistical Package for Social Science (IBM SPSS) version 23. The comparison between groups was done by using Chi-square test, Fisher exact test and independent t-test, while with non-parametric distribution comparison was done using Mann-Whitney test. One Way ANOVA test, Kruskall-Wallis test and Spearman correlation coefficients were used to assess the correlation between two quantitative parameters. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following: P-value > 0.05: Non significant (NS), P-value ≤ 0.05: Significant (S), P-value < 0.01: Highly significant (HS).

RESULTS

The present study included 30 patients with a mean age of 40 years **(Figure 1)**. Twelve males and 3 females for group (A) and ten males and five females for group (B) **(Figure 2)**. The two groups showed occupational difference and variability **(Figure 3)**. Fall on out stretched hand (FOOSH) is found to be the commonest trauma to produce fracture as in 20 patients (66.7%), 3 patients presented post falling from height (FFH) (10%), 4 patients presented post RTA (13.3%), 2 patients presented motorcycle accident (6.7%), 1 patients presented post direct trauma (3.3%) **(Figure 4)**.

The mean operation time was 54.00 ±12.28 minutes in volar plating group, in comparison with 36.33 ± 5.16 minutes in external fixation group. There was statistically clinical significance between two groups (p=0.00) **(Table 1)**. Regarding clinical results between the two groups were summarized in **Table (2)**. Patients treated with volar plating had flexion range of 10-85, radial deviation range of 5-30 and ulnar deviation range of 20-40. While Patients treated with external fixation augmented by k-wires had flexion range of 60-85, radial deviation range of 10-28 and ulnar deviation range of 20-35. There was no statistically clinical significance between the 2 groups (p = 0.086, 0.656 and 0.195 respectively). Despite of that, there was significant statistical correlation between the 2 groups regarding extension (p = 0.046) **(Table 2)**. Patients treated with external fixation augmented by k-wires had extension range of 45-85 better than those treated with volar plating (10-85) **(Figure 5)**.

Patients treated with external fixation augmented by k-wires had grip strength range of 15-27. Patients treated with volar plating had grip strength range of 8-27. There was no significant statistical difference between the 2 groups regarding extension (p = 0.209) **(Figure 6)**.

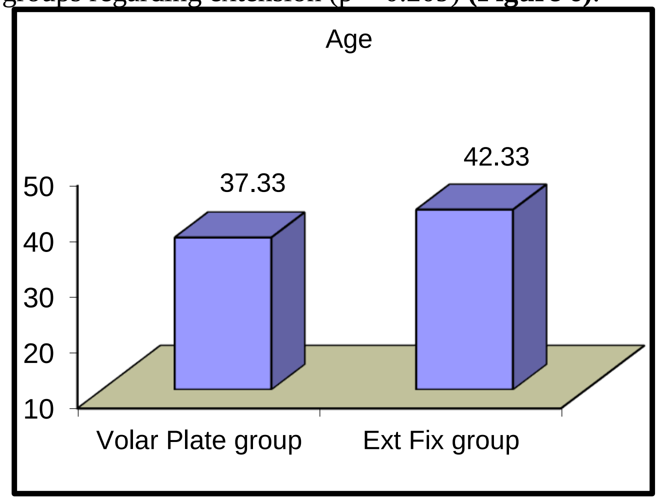

Figure (1): Distribution of patients regarding age.

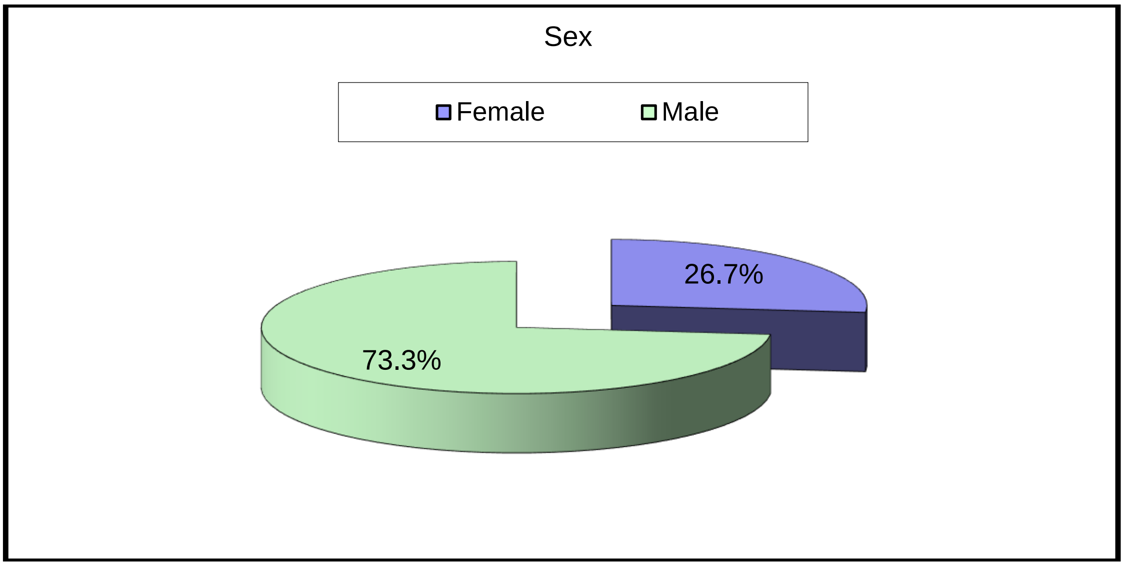

Figure (2): Distribution of the patients regarding sex

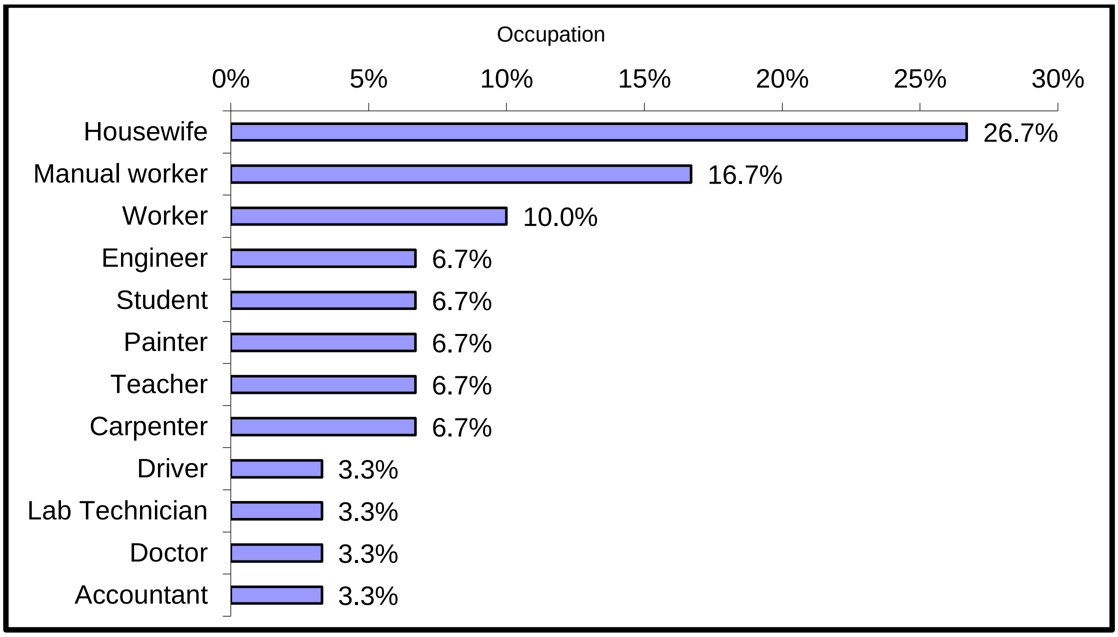

Figure (3): Distribution of the patients regarding to the occupation

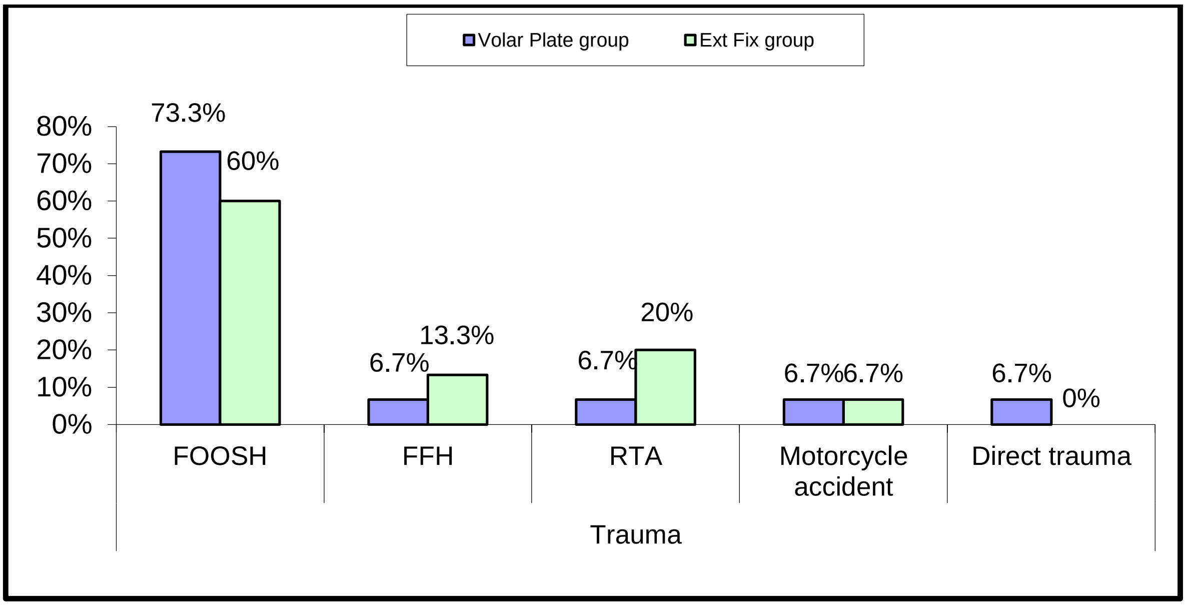

Figure (4): Distribution of the patients regarding to mode of trauma

Table (1): Comparison of mean Operative time between two groups

		Volar Plate group	Ext Fix group	Test value	P-value
		No. = 15	No. = 15		
Operative Time (min.)	Mean ± SD	54.00 ± 12.28	36.33 ± 5.16	5.137•	0.000
	Range	40 – 90	30 – 45		

P-value > 0.05: Non-significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant, Independent t-test; ≠: Mann-Whitney test.

Table (2): Relation output of clinical results between two groups

		Volar Plate group	Ext Fix group	Test value	P-value
		No. = 15	No. = 15		
Flexion	Mean ± SD	62.00 ± 22.58	73.00 ± 7.97	-1.779•	0.086
	Range	10 – 85	60 – 85		
Extension	Mean ± SD	60.00 ± 22.83	74.00 ± 12.28	-2.091•	0.046
	Range	10 – 85	45 – 85		
Pronation	Mean ± SD	75.33 ± 6.67	74.67 ± 5.81	0.292•	0.773
	Range	65 – 85	65 – 85		
Supination	Mean ± SD	76.33 ± 7.90	74.33 ± 7.29	0.721•	0.477
	Range	60 – 85	60 – 85		
Radial deviation	Mean ± SD	16.00 ± 6.87	17.07 ± 6.09	-0.450•	0.656
	Range	5 – 30	10 – 28		
Ulnar deviation	Mean ± SD	32.00 ± 8.41	28.53 ± 5.60	1.329•	0.195
	Range	20 – 40	20 – 35		
Grip strength	Mean ± SD	19.20 ± 6.77	21.73 ± 3.54	-1.285•	0.209
	Range	8 – 27	15 – 27		
Volar tilt	Median (IQR)	9 (3 – 10)	2.8 (-0.5 – 8)	-1.624≠	0.104
	Range	-7 – 12	-12.3 – 15		
Radial inclination	Mean ± SD	21.19 ± 3.16	21.94 ± 2.78	-0.687•	0.498
	Range	13.5 – 24.4	18 – 28.2		
Radial height	Mean ± SD	9.17 ± 3.08	10.87 ± 2.59	-1.637•	0.113
	Range	2 – 14	7 – 15		
Articular stepoff (mm)	Median (IQR)	0.5 (0 – 0.7)	0 (0 – 1)	-0.428≠	0.669
	Range	0 – 1.5	0 – 2		
QDASH	Median (IQR)	6.8 (4.5 – 11.5)	9.1 (5 – 15)	-1.409≠	0.159
	Range	2.5 – 27.3	2.5 – 25		
Gartland-werley	Median (IQR)	2 (2 – 5)	4 (2 – 5)	-1.339≠	0.180
	Range	0 – 9	2 – 9		
Gartland-werley	Excellent	8 (53.3%)	5 (33.3%)	1.292*	0.524
	Good	6 (40.0%)	9 (60.0%)		
	Fair	1 (6.7%)	1 (6.7%)		
Union (weeks)	Mean ± SD	6.73 ± 1.03	7.20 ± 1.47	-1.004•	0.324
	Range	5 – 8	5 – 10		

P-value > 0.05: Non significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant•: Independent t-test;
≠: Mann-Whitney test

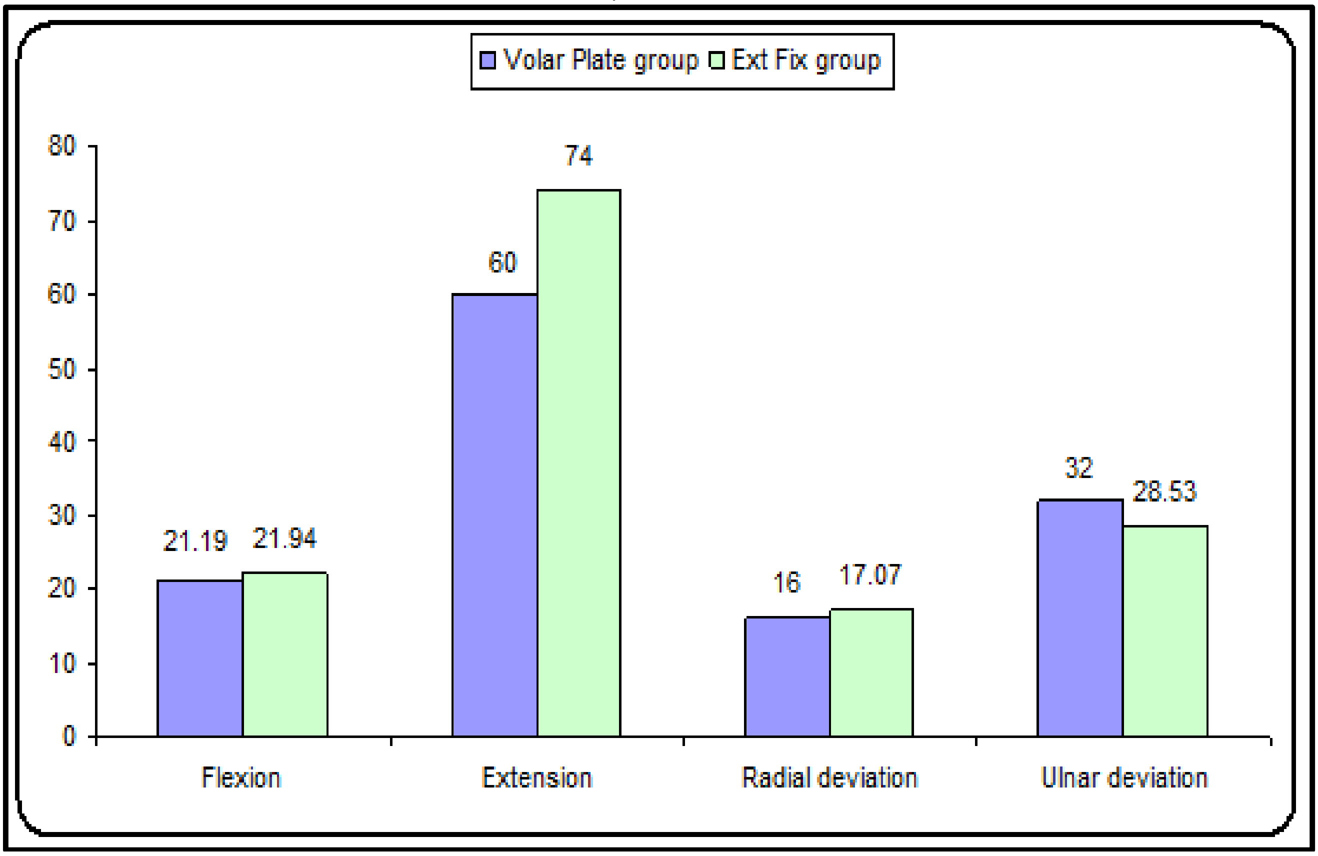

Figure (5): Bar chart illustrating comparison of range of motion between the two groups

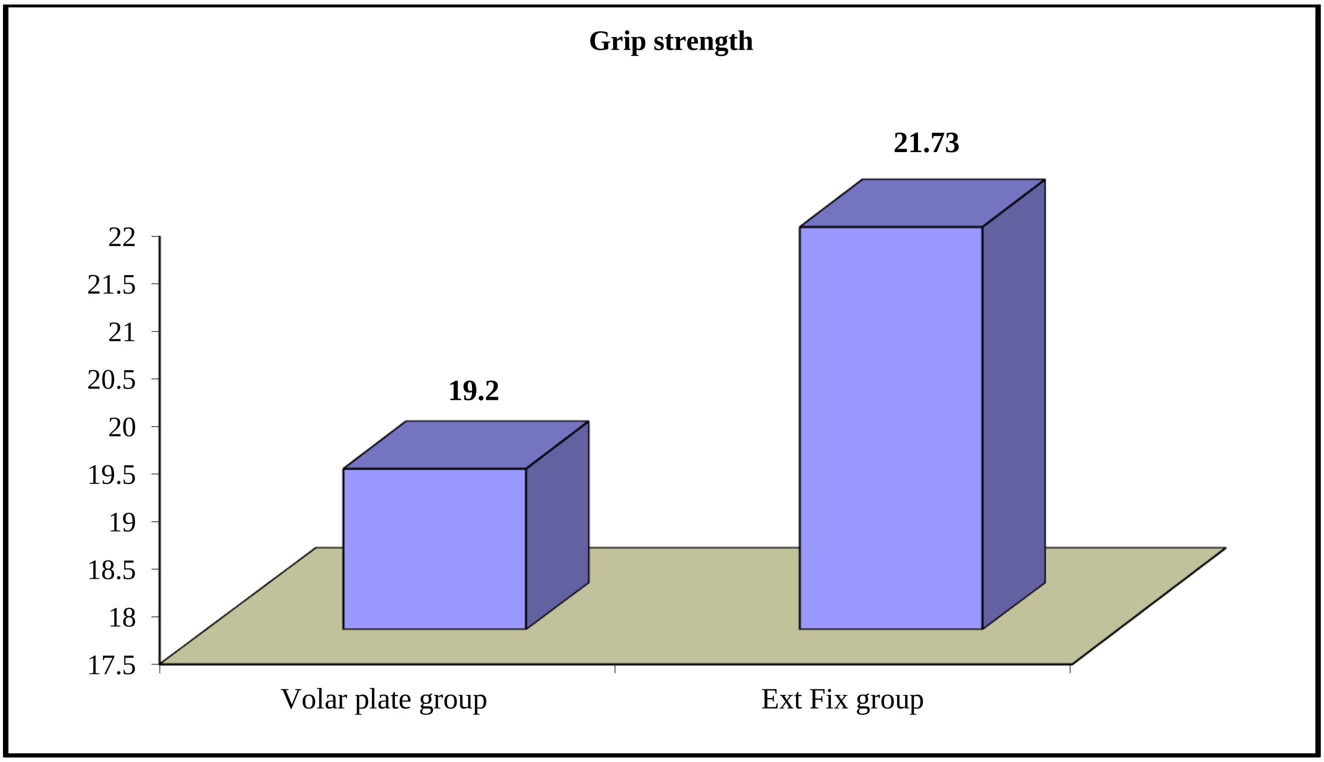

Figure (6): Bar chart illustrating comparison of grip strength between the two groups

DISCUSSION

Fractures of the distal radius are commonly encountered injuries. They usually occur because of high-energy trauma in young individuals and low-energy trauma in elderly. Current treatment goals are centered on restoration of bony anatomy of the distal radius (radial inclination, radial length and volar tilt) with specific attention to the restoration of articular surfaces of radiocarpal and radioulnar joints [(8)].

During the past 10 years, volar locking plate (VLP) has gained the most popularity in the treatment of distal radius fractures, due to its superior biomechanical property [(9)]. By contrast, external fixation (EF) is not so extensively used, but was preferred by a fair number of surgeons due to its easy application, improved reduction by ligamentotaxis, no need of secondary procedure, and the acceptable results. However, the higher complication rate should be a concern, including pintract infection, loss of reduction, radial sensory nerve injury, and complex regional pain syndrome [(10, 11)].

In the present study, most of patients were males. In a study of **Jeudy *et al.*** [(12)] revealed the ratios of females to males were 26/10 for the external fixator group and 31/8 for the volar plate group.

In our study, the mean age of the external fixator (EF) group was 42.33 years, while of the volar plate (VP) group was 37.33 years. **Rizzo *et al.*** [(13)] reported that the mean age in EF was 48 years and for VP was 45 years. Besides, **Rozental *et al.*** [(14)] reported that the mean age in EF was 51 years and in VP was 52 years. **Wilcke *et al.*** [(15)] reported that the mean age in EF was 55 years and in VP was 56 years. Also, **Grewal *et al.*** [(16)] reported that the mean age in EF was 58 years and in VP was 53.8 years. In addition, **Safdari *et al.*** [(17)] reported that the mean age in EF was 48.3 years and in VP was 46.3 years.

In this study, the mean operative time was statistically significantly less with external fixation group (Range: 30-45 min) than in volar plate group (Range: 40-90 min). There are many studies that support our results as in **Yu *et al.*** [(18)].

In this study, objective range of movement in each direction was recorded. This demonstrated that there was no big difference between the two procedures but external fixation showed a significantly better performance in wrist extension (P value=0.046) but statistically insignificant in flexion and radial deviation. A possible explanation for this might be that we allowed early exercises by stress ball and some special exercises at home on the second week postoperatively in patients managed by external fixation. And also the type of our study (Prospective comparative study) made us evaluate the ROM at the end of the minimum follow up period (6 months) therefore no differences in wrist motion were found at any follow-up period as mentioned by **Wei *et al.*** [(19)]**.** There are many studies that support our results as in **Shukla *et al.*** [(20)] who reported that external fixation was superior to volar plating starting from 6 months follow up and increasing at the end of the 1st year, and also the results were better in patients aged < 50 years if treated with EF. **Egol *et al.*** [(21)] compared between volar plating (39 patients) and external fixation (38 patients) and reported that the patients treated by volar plating had a statistically significant early improvement in the range of movement of the wrist, this advantage diminished with time and in absolute terms the difference in range of movement was clinically unimportant. Also, **Rozental *et al.*** [(14)] in their study between ORIF (23 patients) and external fixation (22 patients) in treatment of distal radius fractures, reported improved results in wrist motion and grip strength initially in the volar plating group, which diminished over time with both procedures providing good restoration of wrist function at 1 year postoperatively.

In this study, the average grip strength was insignificantly high in external fixation patients (21.73) compared to volar plating patients (19.20). Our result is in agreement with **Grewal *et al.*** [(16)] study, in which 53 patients were randomized to be treated with ORIF (27 patients) and augmented external fixation (26 patients). The ORIF group had higher levels of pain at 1 year when compared to the external fixator group. However, this was equalized after hardware removal. The external fixation group showed an average grip strength of 97% compared to the normal side and 86% in the dorsal plate group. Also, **Rizzo *et al.*** [(13)] who retrospectively compared between 41 patients treated with volar plating and 14 patients treated with external fixation augmented by k wires. The average grip strength was 29 kg (90% of the healthy hand) in EF and 26 kg (88%) in ORIF. The external fixation group had improved grip strength, which was ascribed to the fact that they had longer-term follow-up.

CONCLUSION

Volar plating had better functional outcomes when compared to external fixation. Whereas grip strength and ROM data were similar between two groups.

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REFERNCES

1. **Porrino J, Maloney E, Scherer K (2014):** Fracture of the Distal Radius: Epidemiology and Pre management Radiographic Characterization. AJR., 203: 551–559.
2. **Tahririan M, Javdan M, Nouraei M *et al.* (2013):** Evaluation of instability factors in distal radius Fractures. J Res Med Sci., 18: 892-6.
3. **Shin E, Jupiter J (2007):** Shin E.K and Jupiter.J.B. Current Concepts in the Management of Distal Radius Fractures. Acta Chirurgiae Orthopaedicae Et Traumatologiae Čechosl., 74: 233-246.
4. **Jose A, Suranigi S, Deniese P *et al.* (2017):** Unstable Distal Radius Fractures Treated by Volar Locking Anatomical Plates. J Clin Diagn Res., 11 (1): 4-8.

5. **Chaudhry H, Kleinlugtenbelt Y, Mundi R *et al.* (2015):** Are Volar Locking Plates Superior to Percutaneous K-wires for Distal Radius Fractures? A Meta-analysis. Clin Orthop Relat Res., 473 (9): 3017-3027.
6. **Obert L, Rey P, Uhring J *et al.* (2013):** Fixation of distal radius fractures in adults: A review. OrthopTraumatolSurg Res., 99: 216-234.
7. **Tsang K, Choi K, Chan Y *et al.* (2014):** Locking Plate for AO Type C Intra-articular Distal Radius Fracture: Volar or Dorsal Approach? Journal of Orthopaedics, Trauma and Rehabilitation, 18 (2): 83-88.
8. **Gliatis J, Plessas S, Davis T (2000):** Outcome of distal radial fractures in young adults. J Hand Surg Br., 25 (6): 535-543.
9. **Bentohami A, De Burlet K, De Korte N *et al.* (2014):** Complications following volar locking plate fixation for distal radial fractures: a systematic review. J Hand Surg Eur., 39 (7): 745–54.
10. **Disseldorp D, Hannemann P, Poeze M *et al.* (2016):** Dorsal or volar plate fixation of the distal radius: does the complication rate help us to choose? J Wrist Surg., 5 (3): 202–10.
11. **Kreder H, Hanel D, Agel J *et al.* (2005):** Indirect reduction and percutaneous fixation versus open reduction and internal fixation for displaced intra-articular fractures of the distal radius: a randomised, controlled trial. J Bone Joint Surg Br., 87 (6): 829–36.
12. **Jeudy J, Steiger V, Boyer P *et al.* (2012):** Treatment of complex fractures of the distal radius: a prospective randomized comparison of external fixation 'versus' locked volar plating. Injury, 43: 174-179.
13. **Rizzo M, Katt B, Carothers J (2008):** Comparison of locked volar plating versus pinning and external fixation in the treatment of unstable intraarticular distal radius fractures. Hand (N Y), 3 (2): 111-117.
14. **Rozental T, Blazar P (2006):** Functional outcome and complications after volar plating for dorsally displaced unstable fractures of the distal radius. J Hand Surg., 31: 359–365.
15. **Wilcke M, Abbaszadegan H, Adolphson P (2011):** Wrist function recovers more rapidly after volar locked plating than after external fixation but the outcomes are similar after 1 year. Acta Orthop., 82: 76-81.
16. **Grewal R, MacDermid J, King G *et al.* (2011):** Open reduction internal fixation versus percutaneous pinning with external fixation of distal radius fractures: a prospective, randomized clinical trial. J Hand Surg Am., 36: 1899-1906.
17. **Safdari M, Koohestani M (2015):** Comparing the effect of volar plate fixators and external fixators on outcome of patients with intra-articular distal radius fractures: A clinical trial. Electron Physician, 7 (2): 1085-1091.
18. **Yu X, Yu Y, Shao X *et al.* (2019):** Volar locking plate versus external fixation with optional additional K-wire for treatment of AO type C2/C3 fractures: a retrospective comparative study. J Orthop Surg Res., 14 (1): 271-75.
19. **Wei D, Raizman N, Bottino C *et al.* (2009):** Unstable distal radial fractures treated with external fixation, a radial column plate, or a volar plate. A prospective randomized trial. J Bone Joint Surg Am., 91: 1568-1577.
20. **Shukla R, Jain R, Sharma N *et al.* (2014):** External fixation versus volar locking plate for displaced intra-articular distal radius fractures: a prospective randomized comparative study of the functional outcomes. J Orthop Traumatol., 15: 265–70.
21. **Egol M, Walsh N, Tejwani T *et al.* (2008):** PaksimaBr idging external fixation and supplementary Kirschner-wire fixation versus volar locked plating for unstable fractures of the distal radius: a randomised, prospective trial. J Bone Joint Surg Br., 90: 1214- 1221.