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17(10) 2022
Research Article

Comparative study of functional and radiological outcome of augmented external fixator versus volar locking plate in intraarticular fractures of distal end radius

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Received: 28.09.2022;
Manuscript No. JOTSRR-22-76179;
Editor assigned: 30.09.2022, PreQC No. JOTSRR-22-76179 (PQ);
Reviewed: 14.10.2022, QC No. JOTSRR-22-76179 (Q);
Revised: 17.10.2022, Manuscript No. JOTSRR-22-76179 (R);
Published: 24.10.2022, DOI.10.37532/1897-2276.2022.17(10).76

Abstract

Introduction: Augmented external fixation and Open reduction with volar locking plate are two frequently used modalities in the management of intraarticular fractures of distal end radius. However, there is still controversy regarding the optimal surgical modality. The present study was performed to compare the functional and radiological outcomes of Augmented External Fixation (AEF) versus Volar Plate Fixation (VPF) in the management of patients with intraarticular fractures of the distal end of the radius.

Materials and Methods: This prospective study was done between December 2019 and December 2021. This study included 40 patients with intraarticular fractures of the distal end of the radius. All patients fulfilling inclusion criteria were randomly allocated into two groups. Group A was treated with an AEF and Group B with VPF. Functional assessment was done by measuring the wrist range of motion, hand grip strength, and Mayo Wrist Score. The radiographic parameters included radial height, radial inclination, and volar tilt. Follow-up was done at 6 weeks, 3 months, and 6 months post-operatively.

Results: In our study at all follow-ups, the VPF group had a significantly better Mayo wrist score and wrist flexion, wrist extension, forearm supination, and pronation compared to the AEF group ($p< 0.05$). There were no significant differences in terms of hand grip strength and postoperative radiological parameters ($p> 0.05$).

Conclusion: VPF is a better surgical option as compared to AEF based on our short-term functional outcome in the management of patients with intraarticular fractures of the distal end of radius, on account of better wrist flexion and extension, forearm rotation and Mayo wrist scores, and fewer complication rates.

Keywords: Distal radius fracture, intraarticular, augmented external fixator, volar plate fixation, mayo wrist score

INTRODUCTION

Fractures of the distal end of the radius are the most common fractures that present in the department of orthopaedics or emergency [1]. With increasing life expectancy, it is estimated that the incidence of distal end radius fractures will also rise. In elderly individuals, fractures of the distal end of the radius occur most commonly after minor falls (osteoporotic fractures) while in a younger population they are the result of high-energy trauma [2,3]. The distal end of radius fractures can be broadly classified into extra-articular and intra-articular fractures [4]. A vast majority of these fractures are intraarticular and result in disruption of either or both the radiocarpal and radioulnar joints. Anatomical reduction and initiation of early movement remain the main goals of treatment. However, the best method of achieving this remains a debatable topic. Over the last three decades, modalities of treatment have evolved from plaster immobilization to percutaneous wiring and pinning, bridging external fixation to augmented external fixation and in the modern era, internal fixation with various kinds of plating [5-7]. Even with numerous studies being conducted on distal radius fractures, there is only a limited number assessing the comparison of outcomes between modalities of treatment, especially between augmented external fixation and internal fixation with volar plating. Therefore, the present study was conducted to compare closed reduction and augmented external fixation with open reduction and internal fixation using volar locking plates for the treatment of distal radius fractures, in terms of functional and radiological outcomes, and complications.

MATERIALS AND METHODS

This prospective study was conducted in the Department of Orthopaedics of a tertiary care hospital. Institutional ethical committee clearance was obtained before the conduct of the study. Patients presenting with intraarticular fracture of the distal end of the radius were admitted to this hospital. Upon admission, detailed history of the patient was obtained including the mode of the injury. Relevant investigations were done and the patients received primary care.

The inclusion criteria were: the intraarticular distal end of radius fracture, age over 18 years, unilateral distal radius fracture, and no contraindication to anaesthesia. The exclusion criteria were: open fracture, bilateral distal radius fractures, fractures >2 weeks old, any other associated injury/fracture, and pathological fractures.

A total of 40 patients were included in the study. The patients were then randomly divided into two groups of 20 patients each using random number tables generated online. Group A was treated with an augmented external fixator (AEF) and Group B with volar plate fixation (VPF). Patients as well as the next-of-kin were explained about the surgery and written informed consent for the surgery was obtained from all patients.

SURGICAL TECHNIQUE

Augmented external fixation: For AEF, two 3.5 mm Schanz pins in the radius proximal to the fracture and two 2.5 mm pins in the second metacarpal were inserted. The Schanz pins were interconnected with connecting rods and universal clamps. After frame application, the reduction was achieved via manual traction (ligamentotaxis) in all cases. Distal fragments were reduced and fixed with the help of two K-wires. Interconnecting rods and clamps were tightened. The final reduction was confirmed under fluoroscopic guidance in anteroposterior and lateral views (Figure 1).

Volar Plate Fixation: Modified Henry's approach was used to make a longitudinal skin incision. All fracture fragments were reduced and held provisionally with K-wires. Variable angle volar locking plate and screws were placed and position confirmed under fluoroscopic guidance in anteroposterior and lateral views (Figure 2). Postoperatively, a below elbow splint was applied for 4 weeks.

FOLLOW-UP AND POSTOPERATIVE EVALUATION

For both groups, in the early postoperative period, range of motion exercises for shoulder, elbow, and finger joints were started to prevent joint stiffness. In Group A external fixator and K-wires were removed at 6 weeks-8 weeks post-surgery and in Group B below elbow splint was removed at 4 weeks post-surgery and wrist range of motion exercises and grip strength exercises were started. All the patients were followed up at 6 weeks, 3 months, and 6 months postoperatively. Functional assessment was done by measuring the wrist range of motion and hand grip strength. A goniometer was used to measure wrist flexion, extension, supination, and pronation, and hand grip strength was measured using a Jamar dynamometer. All the patients were scored according to the Mayo-Wrist scoring system. Standard anteroposterior and lateral radiographs of the wrist were taken at the final follow-up. Radiological assessment was done by measuring radial height, radial inclination, and volar tilt.

Fig. 1. **a.** Preoperative radiograph showing intraarticular fracture of the distal end of radius; **b.** Postoperative radiograph with the augmented external fixator *in situ.*

Fig. 2. **a**. Preoperative radiograph showing intraarticular fracture of the distal end of radius; **b.** Postoperative radiograph with Volar locking plate *in situ*.

STATISTICAL ANALYSIS

The data were presented in terms of mean ± standard deviation, frequencies, and percentages. To compare categorical variables between the groups, the Chi-square test was used. To compare continuous variables between the groups, the Unpaired t-test was used. To compare the mean change in scores, Paired t-test was used. A p-value of less than 0.05 was considered statistically significant.

RESULTS

There were 40 patients in our study, out of which 20 patients underwent AEF and the remaining 20 patients underwent VPF. The demographic attributes of all the patients are present in Table 1.

In our study, most of the patients in both groups were in the age group between 40-60 years. The mean age of patients in the AEF group was 51.73 years, and in the VPF group, it was 47.70 years. In our study, female patients (60%) were more than male patients (40%). The AEF group included 7 males and 13 females and the VPF group included 9 males and 11 females. In our study, the dominant/right wrist (twenty-six, 65%) was involved more commonly than the non-dominant/left wrist (fourteen, 35%). In our study, most of the patients had a C2 type fracture (thirteen; 32.5%) followed by C3 (nine; 22.5%), B2 and C1 (six; 15%), and B1 and B3 (three; 7.5%).

The detailed surgery data of the patients are given in Table 2. The mean duration of surgery was 34.33 minutes in AEF group and 75.60 minutes in VPF group. The mean blood loss was 10.20 ml in AEF group and 44.17 ml in VPF group. The differences between the two groups in terms of duration of surgery and blood loss were statistically significant ($p<0.05$).

Functional assessment of all the patients in both groups was done by measuring the wrist range of motion, grip strength, and Mayo wrist scores. The functional outcomes at the final follow-up of 6 months are summarized in Table 3. In our study, wrist range of motion at final follow-up was better in the VPF group when compared to the AEF group and the result was statistically significant. In the VPF group, mean wrist flexion and extension measured 76.33° and 70.13° when compared to 64.22° and 61.37° in the AEF group. Mean supination and pronation in the VPF group measured 75.50° and 74.15° when compared to 64.22° and 61.37° in the AEF group. In our study, grip strength at final follow-up was better in the VPF group when compared to the AEF group; however, the result was not statistically significant. The grip strength was measured 29.77 kg (92% of contralateral) in the VPF group when compared to 26.7 kg (89% of contralateral) in the AEF group. In our study, the Mayo wrist score at the final follow-up was better in the VPF group when compared to the AEF group and the result was statistically significant. In the VPF group, the mean Mayo wrist score was 84.30 when compared to 77.10 in the AEF group.

Radiological assessment was done by measuring radial height, radial inclination, and volar tilt. The radiological parameters at the final follow-up of 6 months are summarized in Table 4. In our study, radiological parameters were restored in both groups. The parameters were better in the VPF group when compared to the AEF group, however, the result was not statistically significant ($p>0.05$).

In our study, any immediate or late postoperative complications were noted. In the AEF group, 6 cases (30%) of complications occurred. Pin tract infection (3,15%) was the most common complication followed by wrist stiffness (2,10%) and loss of reduction requiring re-adjustment (1,5%). In the VPF group, there were 4 cases (20 %) of complications, the most common being scar hypertrophy (2,10%), followed by wrist stiffness (1,5%) and superficial wound infection managed by appropriate antibiotics (1,5%). There was no significant difference in the overall rate of complications between the two groups ($p>0.05$).

Table. 1. Patient demographics.

DEMOGRAPHIC VARIABLES	AEF	VPF
Age(years)	51.73 ± 11.09	47.70 ± 11.43
Sex(male/female)	7/13	09/11
Handedness(dominant/non-dominant)	12/8	14/6

Table. 2. Operative record of patients.

SURGICAL DATA	AEF	VPF	P value
Duration of Surgery (minutes)	34.33 ± 4.03	75.60 ± 5.24	<0.0001
Blood Loss (ml)	10.20 ± 3.03	44.17 ± 8.95	<0.001

Table. 3. Functional outcome at six-month follow-up.

FUNCTIONAL PARAMETERS	AEF	VPF	P value
Wrist Flexion(degree)	64.22 ± 3.71	76.33 ± 6.39	<0.0001
Wrist Extension(degree)	61.37 ± 2.18	70.13 ± 4.33	<0.0001
Supination(degree)	69.12 ± 3.46	75.50 ± 4.17	<0.0001
Pronation(degree)	67.77 ± 3.64	74.15 ± 3.73	<0.0001
Grip Strength(kg)	26.70 ± 5.3	29.77 ± 6.64	0.891
Mayo Wrist Score	77.10 ± 9.7	84.30 ± 10.5	<0.05

Table. 4. Radiological parameters at final follow-up.

RADIOLOGICAL PARAMETERS	AEF	VPF	P value
Radial height(mm)	10.5 ± 1.5	10.9 ± 1.6	0.697
Radial inclination(degree)	19.7 ± 3.3	20.8 ± 4.1	0.543
Volar tilt(degree)	7.5 ± 3.3	8.3 ± 3.5	0.414

DISCUSSION

Augmented external fixation and Open reduction with volar plating are two frequently used modalities in the management of intraarticular fractures of the distal end of the radius with acceptable functional and radiological results. However, there is still controversy regarding the superior surgical modality. The advantages of augmented external fixation are easy surgical technique, improved reduction by ligamentotaxis, minimal surgical exposure, and less operative time [8]. The advantages of open reduction and volar plate fixation are direct visualization and manipulation of the fracture fragments, stable rigid fixation, and initiation of early wrist motion exercises [9].

In this study, we found that most of the patients in both groups were in the age group of 40 years-60 years. The prevalence in this age group can be attributed to the onset of osteoporosis at this age [10]. There was no significant difference in the gender between the groups showing comparability of the groups in terms of gender, however, a female predominance was seen in both AEF (65%) and VPF groups (55%). The higher incidence among females could be attributed to post-menopausal osteoporosis. In this study, the dominant side was involved in 26 out of the 40 cases. This could be attributed to a defence mechanism when falling on the dominant side. In this study, we found that the duration of surgery and amount of blood loss was considerably less in the AEF group. These findings were in agreement with observations made by Chaudhary *et al*. [11].

In this study, we found that wrist range of motion in terms of wrist flexion and extension and forearm supination and pronation were significantly better in the VPF group when compared to the AEF group. This might be attributed to the fact that volar plate fixation allowed an earlier wrist mobilization. These findings corroborate with the results of multiple studies and reviews on the topic done in the past both in the western and Indian populations. A meta-analysis conducted by Cui Z *et al.* consisted of 738 patients and compared the outcome of external versus internal fixation in intraarticular fracture of the distal radius. The study concluded that the clinical outcome was better in the internal fixation group at a follow-up of six weeks, with similar results at 3 months and 12 months postoperatively, and supported internal fixation over external fixation [12]. Similar results were seen in a meta-analysis conducted by Fu Q *et al*. that consisted of 776 patients with distal end radius fractures treated with either external fixation or a volar locking plate and concluded that volar plating gives better clinical outcomes even at 12 months of follow-up and hence supported the use of volar plating for the management of distal radius fractures [13]. In this study, there was no significant difference in terms of grip strength between the two groups. However, at all follow-ups, the grip strength was found to be better in patients who underwent volar plate fixation. This can be attributed to the early initiation of movement in the VPF group, which was delayed in the AEF group due to immobilization of the wrist joint with an external fixator. This was comparable to observations made by Abramo *et al.* and Rozental *et al*. [14,15].

The Mayo-Wrist Score is a modification of the Geen and O'Brien score [16]. There is a total of 100 points and include four subdomains with 25 points each. The subdomains are pain, wrist dorsiflexion/palmar flexion arc, grip strength, and functional/work status of patients. In this study, we found that the mayo wrist score was significantly higher in the VPF group as compared to the AEF group at all follow-ups of 6 weeks, 3 months, and 6 months. A randomized control trial conducted by Leung F *et al*. consisted of 137 patients and compared augmented external fixation with volar plate fixation for intraarticular fractures of distal end radius and concluded that at the time of final follow-up, the functional outcome based on mayo wrist scorers was significantly better for the volar plate fixation group than those for the augmented external fixation group [17]. Dwivedi *et al*. in a similar study found that at the final follow-up, the mayo wrist score of the volar plating group was 85 compared to 78 for the external fixation group, thus concluding that volar plating is a superior surgical modality in terms of functional outcome [18].

In this study, the radiological assessment was done at the final follow-up by measuring radial height, radial inclination, and volar tilt. Acceptable reduction parameters were obtained and maintained at each follow-up in both groups. The parameters were better in the VPF group when compared to the AEF group, however, the result was not statistically significant. Gereli *et al.*, in their study, concluded that, radiographically, the volar plating was associated with better correction of volar angulation [19]. This may be explained by the fact that the subchondral distal screws of the volar locking plate provide support against palmar angulation losses. Wright *et al.*, concluded in their study that radial shortening was prevented in the volar plating group whereas it occurred more in the external fixator group because of relatively poor correction of the articular surface [20].

LIMITATIONS

The main limitations of the study include a small sample size, short period of follow-up of six months, and the use of a physician-based scoring system.

CONCLUSION

Both surgical techniques have efficacy in the management of intraarticular fractures of the distal end of radius but volar locking plate fixation has more advantages over augmented external fixation as shown by early improvement in wrist range of motion, better grip strength and faster return to activities of daily living. Based on our short-term functional outcome, it can be concluded that volar plate fixation is a better surgical option as compared to augmented external fixation in the management of patients with intraarticular fractures of the distal end of radius, on account of better wrist flexion and extension, forearmrotation and Mayo wrist scores, and fewer complication rates.

ACKNOWLEDGEMENTS

FUNDING

No funding was received for conducting this study.

COMPETING INTERESTS

The authors have no competing interests to declare that are relevant to the content of this article.

ETHICS APPROVAL

Approval was obtained from the ethics committee of Bhabha Atomic Research Centre and Hospital, Mumbai, India.

CONSENT TO PARTICIPATE

Informed consent was obtained from all individual participants included in the study.

CONSENT FOR PUBLICATION

Patients signed informed consent regarding publishing their data.

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