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External fixation versus plating in intra-articular distal end radius fractures

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ABSTRACT

Background: Distal end radius fractures are one of the most common encountered fractures in Orthopaedics. Prompt intervention in terms of volar locking plate or external fixation can be performed. The purpose of this study was to derive a better outcome as to which type of fixation is a better choice for the treatment of intra-articular distal end radius fracture.
Methods: A prospective randomized controlled study was conducted with 30 patients and comparison was made between the plating and external fixator group using the modified clinical-scoring system of Green and O'Brien and demerit point system at each follow-up.
Results: In the plating group 14 patient's fracture united in 6th week and 1 patient's fracture united at 8th week this result was similar to the external fixator group were 14 patient's fracture united in 6th week and 1 patient's fracture united at 8th week. 1 patient each developed wrist joint stiffness and delayed union in the plating group as compared to the external fixator group were 1 patient each developed wrist joint stiffness, delayed union and broken implant in situ and pin tract infection.
Conclusions: During the initial follow ups the functional outcome of the plating group were better than the external fixator group but as the time passed at the final follow up plating was only marginally better than the external fixator group. It was seen that radiologically plating lead to a better correction of all the parameters as compared to external fixator group.

Keywords: Volar locking plate, External fixation, Distal end radius fracture, Intra-articular

INTRODUCTION

Fractures of the distal end of the radius represent approximately 16% of all fractures treated by orthopaedic surgeons.[1] The percentage of these fractures that are considered unstable and require surgical fixation has been reported to be as high as 40 to 49%.[2] The usual mode of injury of fractures of the distal end of the radius is due to fall on outstretched hand with wrist in hyperextension either involving vehicular accident, blow on a closed fist or fall from height on level ground. Beside the bony cartilaginous anatomy, also the radio-carpal, ulno-carpal and intercarpal ligaments and the triangular fibro cartilaginous complex seem to be of utmost importance. Dysfunction of these structures can lead to bad outcome after a fracture of the distal radius.[3] As for all fractures, the goal of the treatment should be to restore function of the affected wrist at the best, to limit pain as much as

possible and to reach this goal as soon as possible. No single therapy can be offered for all fracture types and patient specific criteria (biological age, degree of osteoporosis, pre-existing limitations, etc.) are often more indicating what therapy should be offered than pure anatomical considerations. In case of intra-articular fractures, the anatomical reduction of both the metaphyseal area and the radio-carpal and distal radio-ulnar joint are essential to obtain good functional results.[4] In the treatment of mostly comminuted distal radial intra articular fractures, surgeons may encounter serious complications such as difficult reduction and stabilization, loss of reduction while immobilization period, limitation of range of movement, post traumatic arthritis of the wrist. Knirk and Jupiter found that radiological arthritis developed in 91% of wrists which had any degree of articular step and in all of those with a step greater than 2 mm.[5] Among various classification systems, the AO classification system is the most suitable one because of reflecting the severity of the fracture and for helping the surgeon and the patient to know the possible outcomes.[6] Anatomic reduction with stable fixation is the treatment of choice for displaced intra-articular fractures of the distal part of the radius. Over the past decade, there has been increasing interest in plate fixation, especially volar plate fixation, of distal radial fractures.[7] Closed reduction and external fixation also presents itself as a good option for the fixation of distal radius intra-articular fracture, with its advantage being a minimal invasive procedure, reduced surgical trauma, improved reduction by ligamentotaxis, protection of fracture until healing occurs and smaller learning curve although it is also not devoid of demerits like collapse of intermediate compartment of the distal radius, more loss of radiological parameters as compared to plating, malunion, pin tract infection and loosening of pins in case of osteoporotic bone. The purpose of this study was to derive a better outlook for resolving the dilemma as to which type of fixation is a better choice for the treatment of intra-articular distal end radius fracture.

METHODS

The prospective randomized controlled study was conducted in the department of orthopaedic surgery of SRMS-IMS, Bareilly from November 2016 to July 2018 on 30 patients with 15 patients in each group having Intra-articular fracture of distal end radius. These patients presented to the emergency and study was done after obtaining approval from hospital ethics committee.

Inclusion criteria being skeletally mature patient (more than 20 years), all displaced intra articular fractures of distal end of radius, injury less than 2 weeks old and compound grade 1 fracture. Patients who didn't meet inclusion criteria were excluded. Written informed consent for participation was taken from all the patients. Complete history was taken and physical examination was done. They were assessed for vascular and neurological status. Antero-posterior and lateral radiographs were done of injured as well as uninjured wrist. All the intra-articular fracture of distal end radius cases were admitted and immobilized with Plaster of Paris slab. Limb was kept elevated. The OTA/AO **(**Orthopaedic Trauma Association / Arbeitsgemeinschaft für Osteosynthesefragen (Association of Orthopaedics)) classification was used to classify distal end radius fractures. All unacceptably reduced fractures were selected for surgical fixation. These patients were randomized by random number generator, which assigned external fixator or volar locked plating to each operative patient. Regional or general anaesthesia was given. No tourniquet was applied for external fixator application and for volar plating tourniquet was used. Affected hand and forearm was scrubbed, painted and draped as standard method. Intravenous(IV) antibiotics were administered 30 minutes before the start of the procedure.

Figure 1: Application of Schnaz pin for external fixation of Distal end radius fracture.

Figure 2: Postoperative photograph of external fixator for distal end radius fracture.

In case of external fixator application, closed reduction of the fracture was done under C-arm guidance. If there were unstable fracture fragments, they were percutaneously fixed with multiple Kirschner wire. Two stab incisions, one at the lateral aspect of the shaft of the 2nd metacarpal and another, one centimetre distal to the

former was given. Through each incision, drilling was done with 1.8 mm drill bit, and then 2 mm schanz pins were inserted (i.e. 2nd Metacarpal). Another two stab incisions were made, the first approximately 8 cm proximal to fracture site and another, one inch proximal to the first incision. Taking care not to injure the tendons, nerves and vessels (bare area), drilling was done with 2.5mm drill bit and with T-handle 3.5 mm schanz pins was inserted (Figure 1). The distractor / connecting rod was then connected to all the 4 schanz pins by means of clamps (Figure 2). Under C-arm guidance, further distraction if necessary was carried out by the fixator. At the end of the procedure sterile dressing was applied over the pins. IV Antibiotics were continued over the next post-operative day and then were switched over to oral antibiotics (cefuroxime 500 mg BD) for the next 5 days. Immediate post-operative check X-rays was taken in both AP and lateral views. Active exercises of all the fingers, elbow and shoulder joints was carried out. The patient was discharged on the 5th post-operative day after the first dressing change. The patient was called for inspection and dressing change at the interval of one week for the next 4 weeks. The patients were assessed subjectively for pain at the fracture site: clinically for tenderness and loosening of the pins. The external fixator was removed after 6 to 8 weeks under local anaesthesia depending upon the union of the fracture. Check X-ray was taken in both AP and lateral view.

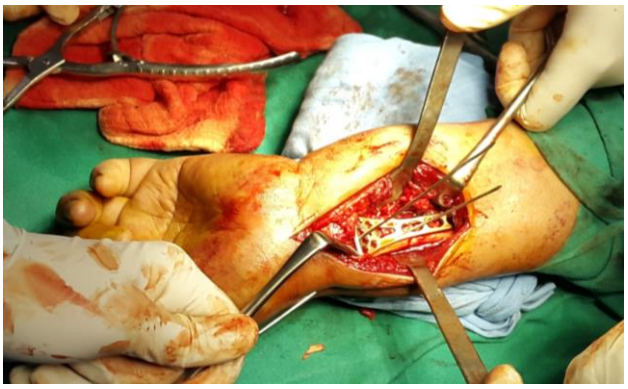

Figure 3: Intraoperative photograph showing volar angle plate temporary fixed with K-wire in situ.

Figure 4: Photograph showing distal radius plate after final screw placement.

For internal fixation with plating the standard modified Henry approach was taken to expose the fracture fragments. An 8 cm incision over the forearm between the radial artery and the flexor carpi radialis was taken. The incision was carried to the sheath of the flexor carpi radialis and the tendon was released from its sheath, the tendon was then retracted ulnarly and an incision was made in the floor of the tendon sheath. This exposed the flexor pollicis longus (FPL) muscle belly, which was then swept to the ulnar side by blunt dissection. The transverse muscle fibers of pronator quadratus was then evident and was released from the radial side of the radius and elevated subperiosteally from the radius in a volar direction, a cuff of pronator quadratus was left attached to the radius for later repair. Open reduction was performed with the aid of intra-focal leverage, traction by an assistant, and provisional fixation by temporary Kirschner wires (Figure 3) then the volar plate was positioned under fluoroscopic guidance and first a screw was inserted into the centre of the oblong hole, of size 3.5 mm to allow proximal-distal adjustment. The proper placement of the volar plate was confirmed with fluoroscopy, and when necessary, the plate was shifted proximally or distally to provide the best placement for the distal screws. 2.0 mm drill bit was used to drill the distal holes, a screw of 2 mm shorter than the measured length was used to avoid having a prominent distal screw. After placement of the distal screws, the remaining proximal screws were inserted (Figure 4). C arm was used to assist the evaluation of fracture reduction and fixation. After repositioning the pronator quadratus on its radial attachment with the help of 2-0 vicryl, the wound was closed in layers and aseptic dressing was done. Postoperatively radiographs will be taken, the limb will be kept elevated with the help of arm sling, active finger, wrist, elbow and shoulder exercises will be started at the earliest possible. Aseptic dressing was done on the 5th post-operative day and after inspecting the condition of the wound the patient was discharged. The patients were called after every 5th day for dressing and on the 14th day after inspecting for any wound gaping or discharge, the sutures were removed. Active finger movement was started immediately after the surgery and limb elevation was done for 1 week in both the cases. Wrist physiotherapy was started immediately after surgery in case of plating and after 6 weeks in case of external fixation. Shoulder and elbow mobilization were done regularly.

Follow-up was done at 2 weeks, 6 weeks, 3 months and 6 months and thereafter. At each follow up patients were assessed clinically, radiologically and the complications were noted. The results were graded as excellent, good, fair and poor according to the parameters present in the modified clinical-scoring system of Green and O'Brien and Demerit point system at each follow-up. X-Ray of wrist joint- AP and Lateral views were taken at each follow up and were compared from the normal side for palmar tilt, radial inclination, radial length, radial shift, ulnar variance and articular incongruity.

Statistical analysis

Interpretation and analysis of obtained data was done using appropriate statistics. Data was entered and analyzed on Microsoft Excel and SPSS version 19.

RESULTS

In the present study a total of 30 patients with fracture of the distal end radius with intra-articular extension were included, out of which 15 patients were included in external fixator group and 15 patients in volar plating group and the following observations were made.

The age ranged from 19 to 64 years. Maximum patients were between 20-30 years (43.33%) and the average age of the patient was 36.1 years. There was male predominance with male to female ratio being 23:7. Twenty-four patients had road traffic accident, four had fall on the floor and one each had fall of heavy object and assault. Right hand of 16 patients was injured and 14 patients had injured their left hand. According to AO classification 13 (43.3%) patients had 32-B2, 8 (26.8%) patients had 23-C1, 4 (13.3%) patients had 23-C2 type fracture, 3 (10.0%) patients had 23-B3 type fracture and 1 (3.3%) patient each had 23-C3 and 23-B1 type fracture. 6 patients came with associated injuries which included fracture shaft tibia of left side, bimalleolar fracture of right side, head injury, fracture patella of left side and 4th, 5th, 6th right rib fracture respectively.

In the plating group 14 patient's fracture united in 6th week and 1 patient's fracture united at 8th week this result was similar to the external fixator group were 14 patient's fracture united in 6th week and 1 patient's fracture united at 8th week. 1 patient each developed wrist joint stiffness and delayed union in the plating group as compared to the external fixator group were 1 patient each developed wrist joint stiffness, delayed union and broken implant in situ and pin tract infection. Final result at 3rd month and 6th month using Green O'Brien scoring system (Table 1). End result point range at 3rd month and 6th month using demerit point system (Table 2). Radiological assessment: pre-operative, immediate post-operative and at 6th month (mean±SD) (Table 3).

Table 1: Final result at 3rd month and 6th month (Green O'Brien scoring system).

Result	Plate		External fixation	
	3rd month	6th month	3rd month	6th month
Poor	2	0	5	0
Fair	9	2	10	4
Good	4	1	0	2
Excellent	0	12	0	9
Total	15	15	15	15

Table 2: End result point range at 3rd month and 6th month (Demerit point system).

Result	Plate		External fixation	
	3rd month	6th month	3rd month	6th month
Poor	0	0	4	0
Fair	2	2	6	4
Good	8	5	4	6
Excellent	5	8	1	5
Total	15	15	15	15

Table 3: Radiological assessment: pre-operative, immediate post-operative and at 6th month (mean±SD)

Assessment time	Treatment modality	Palmar tilt (degree)	Radial inclination (degree)	Radial length (mm)	Radial shift(mm)	Ulnar variance (mm)	Articular incongruity (mm)
Pre-operative	Plate	6.53±6.22	18.13±5.19	7.87±2.33	16.33±1.88	0.60±1.88	2.80±1.01
	External fix	2.60±6.20	16.13±4.60	6.73±2.89	19.13±2.42	0.87±2.10	2.73±1.28
Post-operative (immediate)	Plate	10.20±4.77	23.00±4.19	11.07±2.31	13.73±1.03	-2.13±1.81	0.87±0.74
	External fix	7.07±4.37	23.60±3.56	10.93±3.26	15.33±2.23	-0.87±1.77	0.87±0.74
	P value	0.047	0.629	0.892	0.021	0.115	1.00
Post-operative (6 months)	Plate	10.20±4.77	23.00±4.19	11.07±2.31	13.73±1.03	-2.13±1.81	0.07±0.26
	External fix	7.07±4. 37	23.60±3.56	10.93±3.26	14.67±2.53	-0.87±1.77	0.00±0.00
	P value	0.047	0.629	0.892	0.211	0.115	0.334

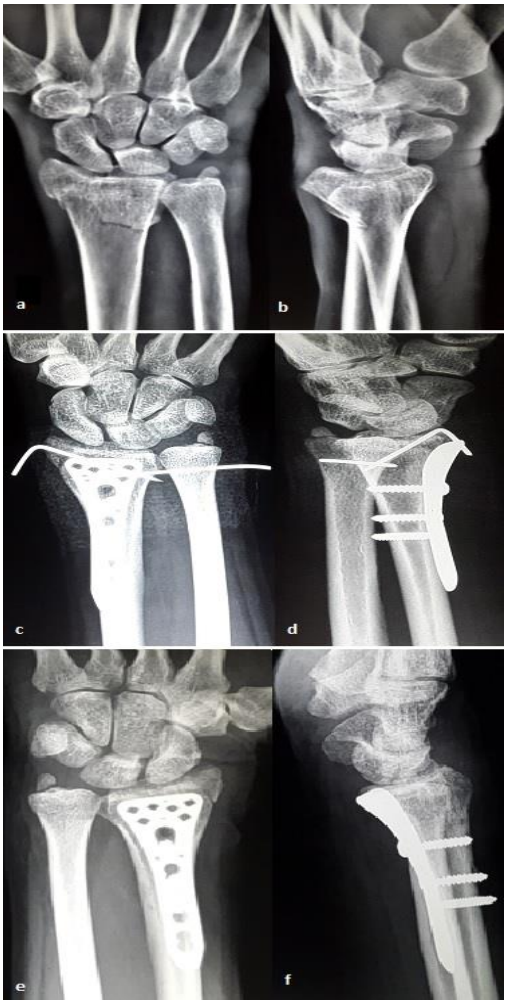

Figure 5: (a) Preoperative X-ray AP and (b) lateral view showing distal end radius fracture. Immediate postoperative X-ray (c) AP and (d) lateral view showing distal end radius fracture fixed with volar locking plate. Postoperative 6 month follow-up X-ray (e) AP and (f) lateral view.

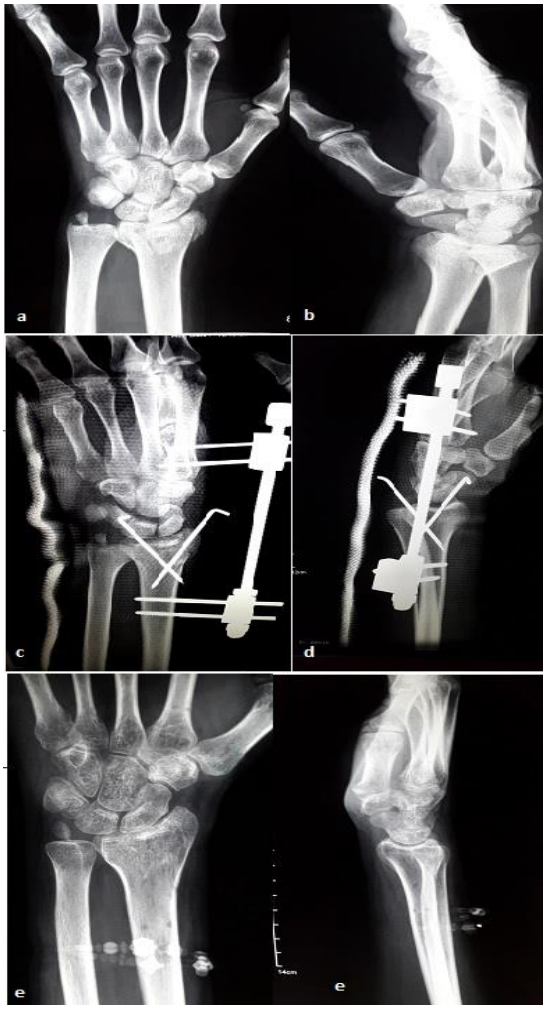

Figure 7: (a) Preoperative X-ray AP and (b) lateral view showing distal end radius fracture. Immediate postoperative X-ray (c) AP and (d) lateral view showing distal end radius fracture fixed with external fixator. Postoperative 6 month follow-up X-ray (e) AP and (f) lateral view.

Figure 6: Clinical picture of range of motion of wrist joint at 6 month follow-up in (a) dorsiflexion and (b) palmarflexion and proximal & distal radio-ulnar joint in (c) pronation and (d) supination.

Figure 8: Clinical picture of range of motion of wrist joint at 6 month follow-up in (a) dorsiflexion and (b) palmarflexion and proximal & distal radio-ulnar joint in (c) pronation and (d) supination

DISCUSSION

Intra-articular fractures of the distal radius represent high energy, complex, unstable injuries and the optimal treatment remains controversial. With the aim of articular restoration and early finger and wrist mobilization, the present study was conducted to compare volar locking plating system and external fixator application and evaluate the clinic-radiological and functional outcomes of the two procedures.

In our study, the average age of the patients was 36.1 years as compared to the study done by Leung et al where the average age of patient was 42 years.[8] There was male predominance seen in our study which was also seen in the findings of Rogachefsky et al in which male:female ratio was 14:3.[9] The most common mode of injury in the present study was road traffic accident (80%) which was also observed in the study by Arora et al (89.09%).[10] In our study it was found that the injury sustained to both the sides were almost equal where right side was slightly higher (53.3%) than the left hand (46.7%). The same findings were also observed in a study done by Wei et al in which there were 12 right and 10 left wrist injury were noted.[11]

According to the Green O'Brien scoring system findings are suggestive that in the initial follow ups (2 weeks and 3 months) the functional outcome of the plating group were better than the external fixator group but as the time passed at the last follow up there was not much significant difference between the results of plating and external fixator.

The end result in the Demerit point system was found to be similar to the study done by Pradhan et al where they concluded that, at 3 month follow up the plating group showed better functional outcome but as the time passed at the 6 month follow up the results of plating was only marginally better than the external fixator group.[12]

In the study done by Gereli et al radiographically it was seen that palmar plating was associated with better correction of palmar tilt.[13] This may be explained by the fact that distraction primarily occurs via palmar structures and that palmar locking plate provides a better support to the fracture. Traction alone in external fixation cannot correct palmar angulations due to the fact that ligamentotaxis primarily functions through strong palmar links. Aro et al and Fernandez et al in their study showed that restoration of the radial length is the most important factor in achieving a good end result.[14,15] Kapoor et al reported that open reduction and internal fixation provides the best anatomical restoration with patients less likely to develop arthritis in future.[16] The study done by Richard et al found that the external fixation group demonstrated radial shortening of 0.72 mm in the interval between the first postoperative and final follow up radiograph and the volar plate fixation group demonstrated only 0.27 mm of radial shortening during the postoperative period.[17] He concluded that volar plate fixation provides an overall decrease incidence of radial shortening.

Physiotherapy of wrist was stopped for the patients in the plating group and the patient was then followed up after 2 weeks, when an antero-posterior and lateral view X-ray of the wrist was done, signs of union were present thus the slab was removed and physiotherapy was again started. In case of the patient with delayed union in the external fixator group, the fixator was not removed at the second follow up and the patient was followed up at the 8th week, when an antero-posterior and lateral view X-ray of the wrist was done, signs of union were present and then the fixator was removed after which the physiotherapy was started. This coincided with the study done by Pradhan et al where the average union time seen was 6 to 8 weeks.[12]

In our study out of total 15 patients in open reduction and internal fixation with plating group 1 patient each developed wrist joint stiffness and delayed union as compared to the closed reduction and external fixation group were 1 patient each developed wrist joint stiffness, delayed union and broken implant in situ and pin tract infection. Wrist joint stiffness was assessed at the final follow up (6th month), delayed union was assessed at the second follow up (6th week) where 2 patients developed delayed union 1 in each group. There was an incidence of intra-operative brakeage of Shanz pin in one of the patient of the external fixator group, the pin was left in situ.

Kaempffe et al in their study found that Pin tract infections, joint stiffness in the wrist, delayed union and broken implant are among known complications of external fixation.[18] Excessive distraction of the external fixator and prolonged fixation has adverse effects on the surgical treatment of distal radius fractures and can lead to many complications. In a study done by Rozental et al the complication rate was 8.7% in the open reduction and internal fixation group as compared with 27% in the closed reduction and percutaneous pin fixation group.[19]

Richard et al in their study concluded that there was an overall decreased incidence of complications in the volar plate group as compared to the external fixator group.[17]

CONCLUSION

The goal of this study was to assess the functional and radiological outcome of closed reduction and external fixation vs. open reduction and plating of intra-articular fracture of distal end radius.

The contemporary approach to intra-articular and comminuted distal radius fractures is to determine the best fracture-specific treatment method, with consideration of the main goals. It was thus necessary to detail the fracture by imaging methods (oblique

radiographs, computed tomography and, where possible, three-dimensional reconstruction). This enabled a more strategic placement of the material, contributing to a stronger fixation.

After the analysis of the data collected from thirty patients with fractures in the distal end of radius, it was concluded that during the initial follow ups the functional outcome of the plating group were better than the external fixator group but as the time passed at the final follow up plating was only marginally better than the external fixator group. It was seen that radiologically plating lead to a better correction of all the parameters as compared to external fixator group. More number of patients in the external fixator group presented with complications as compared to plating group. Wrist joint stiffness, delayed union, broken implant and pin tract infection were among the known complications found during the study. We found that palmar locking plate fixation was both reliable and was associated with better radiological outcome. Objective and subjective functional assessments, on the other hand, showed no significant superiority between external fixation and palmar locking plate fixation at 6 months follow-up. However, the long term follow up results and the risk of arthritis could not be assessed due the short duration of follow up.

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Ethical approval: The study was approved by the institutional ethics committee

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