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Distal radius fractures: a prospective study of the clinical and radiological outcomes in surgically managed patients

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ABSTRACT

Background: Objective of the research was to evaluate radiological and functional outcome in fractures of the distal radius treated by various surgical methods.
Methods: 89 patients with distal radius fractures were randomly divided into three groups according to a computer-generated table of randomization. 40 patients were managed by K wire fixation. 22 patients were managed by external fixator. 27 patients were managed by volar plating technique. Anatomical restoration was evaluated by posterior-anterior and lateral radiographs obtained preoperatively and at 09 months of follow up to evaluate radial height (RH), radial inclination (RI) and volar tilt (VT). Functional outcome was evaluated using Mayo scoring system.
Results: According to Mayo score, in K-wire group 72.5% (n=29) patients had excellent to good outcome, 17.5% (n=7) had fair outcome while as 10% (n=4) patients had poor outcome. In external fixator group 72.7% (n=16) patients had excellent to good outcome while as 27.3% (n=6) had fair outcome. In volar plating group 81.5% (n=22) patients had excellent to good outcome while as 18.5% (n=5) had fair outcome.
Conclusions: In our study we found that volar locked plating provides advantage in dorsally or volarly displaced intra-articular fractures with excellent to good radiological outcome. However, in type B (partial intra-articular fractures) fractures, volar locking compression plate (LCP) and external fixator provide almost equivocal results. Percutaneous pinning can be recommended for extra-articular or simple intra-articular fracture patterns, with a loss of volar and/or RI but without significant radial shortening.

Keywords: Distal radius fractures, K-wiring, External fixation, Volar plating

INTRODUCTION

Fractures of lower end radius are most common fractures of the upper extremity encountered in practice and constitute 17% of all fractures and 75% of all forearm fractures. These injuries account for approximately one sixth of all fractures seen and treated.[1]

Restoration of radial length, radial tilt and congruity of articular surfaces is important for good functional results. Failure to achieve and maintain near anatomic restoration can lead to various deformities and disabilities. The treating orthopaedician has an armamentarium of treatment options to select from to accomplish this.[2] Regardless of these fractures being common, there is no clear consensus on their treatment as there is no clear clinical-based evidence in the literature. The high incidence of distal radius fractures and the inconsistencies in treatment practices indicate further investigation is warranted to understand current treatment methods and outcomes.[3] Recognition of fracture patterns, secure fixation of fractures and maintenance of reduction is the

key for successful management of more complex fractures of distal radius.

The aim of the treatment was to restore and maintain anatomy**,** grip strength and motion so that the patient can return to former activities.

METHODS

This was a prospective study of 89 patients with distal radius fractures conducted in Government Medical College and Hospital, Jammu for a period of one year from September 2018 to October 2019. The patients were randomly divided into three groups according to a computer-generated table of randomization. All the patients were surgically treated for their distal end radius fracture. K-wire group consisted of 40 patients who were managed by K-wire fixation. External fixator group had 22 patients managed by external fixator while as volar plating group had 27 patients managed by volar plating technique.

Patients with fractures of distal end radius of either side or both sides, with or without ulnar styloid fracture, of age group 18-85 years, of either sex having closed fractures of up to 3 cm from distal articular surface of radius willing for treatment were enrolled for this prospective open randomized case control comparative study. Patients less than 18 years or more than 85 years, having compound fractures associated with vascular injuries or had associated multiple injuries were excluded from the study.

All fractures were classified according to the Association for Osteosynthesis (AO) classification system by getting anterio-posterior (AP) and lateral (lat) views of radiographs of the wrist at the time of the initial injury.[4] Some patients needed computed tomography (CT) scan of wrist for further evaluation of intra-articular fractures.

The patients were admitted to the hospital and were operated on as soon as possible, depending on the condition of the local tissue, hematoma, tissue oedema and other associated injuries. After obtaining informed written consent, the surgical procedure was carried out. Procedure was performed under brachial plexus block or general anaesthesia under fluoroscopic guidance. All the surgeries were performed by the same surgeon who was well versed with procedure and the implants used.

Procedure for K-wiring

Under axillary block or general anaesthesia, the patient was placed in the supine position with the involved limb in traction with a finger trap through the index finger, and provided counter traction. An accurate reduction in the fracture was the first step in the treatment plan. The K-wires were placed under C-arm guidance. In the post-operative period, the limb was kept strictly elevated for a period of 2 days. Patient was encouraged to begin active finger movements as soon as the effect of anaesthesia wore out. Patient at the end of 2 days was asked to mobilize his elbow. At this time the pin sites were inspected and then dressed. If pin sites and mobilization were satisfactory, the patient was then discharged the next day. The patients underwent follow-up at our outpatient clinic at 2-week intervals following hospital discharge. The healing of the fracture was assessed both clinically and radiographically at each follow-up at the end of four weeks a check X-ray was taken and if satisfactory signs of union were present, the pins were removed as was the slab and patient given a crepe bandage.

Procedure for external fixator

Under brachial block or general anaesthesia, the upper extremity was prepared and draped. The fracture was reduced manually. A 2-3 cm incision over dorso-radial aspect of index metacarpal base was made followed by blunt dissection while taking care to preserve the radial sensory nerve. 3 mm half pins were inserted at $30\text{-}45^0$ dorsal to frontal plane of hand and forearm. Pin position and length were confirmed fluroscopically. A 4cm incision 8-10cm proximal to wrist joint was given. 3 mm half pins were inserted between radial wrist extensors at 30^0 dorsal to frontal plane of forearm. Incision was closed and external fixator frame was applied. Postoperatively wrist was immobilized in supination for ten days and the fixator removed at 6 weeks. Active and passive motion was started on the first postoperative day.

Procedure for volar plating

Surgery was performed under appropriate anaesthesia i.e. either general anaesthesia or supra clavicular block under tourniquet control. In this technique, the skin was incised longitudinally along the course of the flexor carpi radialis (FCR) tendon. The FCR sheath was opened and the tendon retracted to the radial side to expose the ulnar corner of the distal radius (this can be extended into a carpal tunnel release). The FCR tendon was also retracted to the ulnar side to expose the radial styloid and scaphoid fossa. Great care was taken to avoid pressure on the median nerve. Underneath the FCR sheath lies the flexor pollicis longus (FPL) tendon. This was retracted ulnarly revealing the pronator quadratus (PQ) muscle. The PQ muscle was elevated from its radial origin and reflected ulnarly to expose the distal radius.

If the fracture is very distal, it is not necessary to completely elevate this muscle. The palmar extrinsic radiocarpal ligaments should not be detached from the radius to expose the joint surface as this may destabilize the wrist. Palmar fragments may often be comminuted and impacted. Each fragment was identified, elevated, and reduced. As the palmar surface of the distal radius is originally flat, the application of a flat implant onto this surface usually corrects any malrotation of the fracture fragments.

The C-arm was used to check for screw placement and reduction. Radiographs of the wrist joint were taken after

surgery. Sutures were removed after 10 days and active wrist motion started. Cast was applied for 6 weeks postoperatively.

Radiological evaluation

Radiological assessment was done in terms of residual radial inclination (RI), radial height (RH) and volar tilt (VT) and the results were graded according to the lid strom criteria. Radiological parameters included measurement of through anterio-posterior and lateral radiographs.

AP view provides information about RI and RH. RI is a measurement of the radial angle. A line is drawn along the articular surface of the radius perpendicular to the long axis of the radius, and a tangent is drawn from the radial styloid. The normal angle is 15-25º. RH is a measurement between 2 parallel lines that are perpendicular to the long axis of the radius. One line is drawn on the articular surface of the radius, and the other is drawn at the tip of the radial styloid. The normal RH is 9.9-17.3 mm.[5]

In the lateral view, the VT of the distal radius articular surface is measured. A line perpendicular to the long axis of the radius is drawn, and a tangent line is drawn along the slope of the dorsal-to-volar surface of the radius. The normal angle is 10-25º.[5]

These measurements were taken pre operatively and at 9 months follow up. At the end of the study all the data was compiled and analyzed statistically by a one-way measure analysis of variance (ANOVA) test. P value less than 0.05 was considered to be statistically significant.

Functional evaluation

Patients were evaluated by using modified mayo wrist score. It is a physician-rating scoring system which gives us a total score of a 100; 25 for the assessment of pain, 25 for the active extension/flexion arc of the wrist, 25 for grip strength, and 25 for the ability to return to regular activities. The pain is rated according to patient's description.

RESULTS

There was no statistical difference among the groups in terms of their age, sex and side involved.

Mode of trauma was fall (54 [61%]) in most of the patients while road traffic accident (29 [32%]) was the second most common mechanism of injury. Assault was the least common mode with a total of 6 (7%) patients. The only exception was in volar plating group in which road traffic accident (59%) was most common mode (Figure 4).

K-wire group mainly involved fracture types A2, A3, B1, B2, C1 and C2. External fixator group involved fracture types A3, B2, B3, C2 and C3. Volar plating group involved fracture types A3, B2, B3, C1, C2 and C3.

In K-wire group we found a mean RI of 21.1±4.56°, RH of 10.67±2.97 mm and VT of 9.42±3.19°. In external fixator group we found a mean RI of 20.31±3.79°, RH of 11.18±3.99 mm and VT of 8.5±2.73°. In volar plating group we found a mean RI of 22.07±4.08°, RH of 12.44±4.08 mm and VT of 10.85±2.74° (Table 1).

Table 1: Radiological outcome.

Parameters	K wiring group	External fixator group	Volar plating group	P value
Radial inclination	21.1±4.56°	20.31±3.79°	22.07±4.08°	0.349
Radial height (mm)	10.67±2.97	11.18±3.99	12.44±4.0	0.144
Volar tilt	9.42±3.19°	8.5±2.73°	10.85±2.74°	0.121

We evaluated our patients on basis of Mayo score categorizing the data on the basis of pain, work status, range of motion and grip strength. In K-wire group 72.5% (n=29) patients had excellent to good outcome, 17.5% (n=7) had fair outcome while as 10% (n=4) patients had poor outcome. In external fixator group 72.7% (n=16) patients had excellent to good outcome while as 27.3% (n=6) had fair outcome. In volar plating group 81.5% (n=22) patients had excellent to good outcome while as 18.5% (n=5) had fair outcome (Figure 5).

Complications

Out of 40 patients in K-wire group, 6 patients had stiffness and 5 patients had superficial infection. In external fixator group 3 patients presented with pin site infection while as 4 had joint stiffness and 3 patients had loosening of the fixator device. 3 patients among volar plating group suffered from tendon injury, 2 had residual stiffness, 2 patients had infection of the implant and 1 patient suffered from malunion.

DISCUSSION

The management of fractures of distal radius has always been a debatable and challenging issue for orthopaedic surgeons. The ultimate goal is to restore grip strength and motion and allow quick return of function and to minimize the risk for future degenerative changes in the wrist joint.

The rise of intra articular distal radius fractures and its various presentations of complexity in even younger individuals are predominantly due to high energy trauma especially road traffic accidents. Different types of fractures may occur due to the anatomy of the distal radius and the effects of forces in different directions. It is often

not possible to have a successful outcome using the same approach and materials for different types of fractures.

Distal radial fractures are being treated by various methods i.e. closed reduction with cast immobilizations, percutaneous pinning, external fixation and ORIF with conventional plating.

In K-wire group we found a mean radial inclination of 21.1±4.56°, RH of 10.67±2.97 mm and VT of 9.42±3.19° (Table 1). We evaluated our results and compared them with those obtained by various other studies following the same modality of treatment.[6-8] In external fixator group we found a mean radial inclination of 20.31±3.79°, RH of 11.18±3.99 mm and VT of 8.5±2.73° (Table 8). Similar results were obtained in studies carried out by Geller and Dwyer.[9,10] In volar plating group we found a mean radial inclination of 22.07±4.08°, RH of 12.44±4.08 mm and VT of 10.85±2.74° (Table 8). Our results are in line with the study carried out by Masood et al, Abulaban and Geller.[6,9,11]

We evaluated our patients on basis of Mayo score categorizing the data on the basis of pain, work status, range of motion and grip strength. In K-wire group 72.5% (n=29) patients had excellent to good outcome, 17.5% (n=7) had fair outcome while as 10% (n=4) patients had poor outcome. In external fixator group 72.7% (n=16) patients had excellent to good outcome while as 27.3% (n=6) had fair outcome. In volar plating group 81.5% (n=22) patients had excellent to good outcome while as 18.5% (n=5) had fair outcome.

Despite the lack of consensus, a change from closed surgical treatment to open reduction and plating has occurred in the past decade.[12-14] A relevant question is whether the advantage of a faster rehabilitation after volar plating rationalizes a change of surgical methods if increased costs and potential unknown complications are taken into account. Because the patient-rated outcomes in the long-term appear similar, the complications of each method are important outcome variables. The cost of each method is not irrelevant. External fixation is less expensive than volar plating and, with the exception of the pins, the fixation device can be reused. In addition, external fixation generally requires less costly time in the operation theatre. On the other hand, if patients regain wrist function sooner after volar plating, the costs in term of sick leave and social services will decrease.

Although distal radius fractures are one of the most common fractures encountered in the emergency department, the optimal treatment remains without consensus opinion. A trend toward increased distal radius fracture open reduction and internal fixation has been identified, with biomechanical and clinical studies suggesting treatment advantages of certain fixation methods over others. Well-controlled patient trials are still missing to lend objective findings to management algorithms.

Case 1

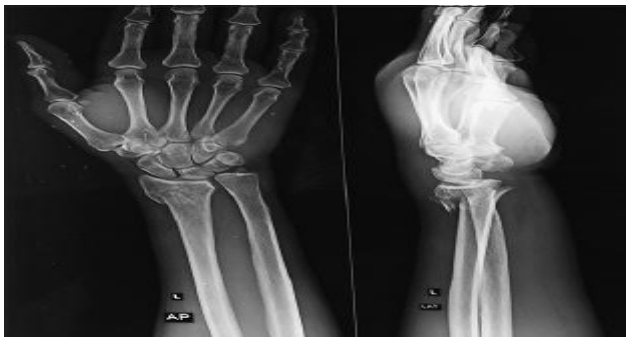

Figure 1: Pre-op AP and lateral X-ray.

Figure 2: Post-op AP and lateral X-ray.

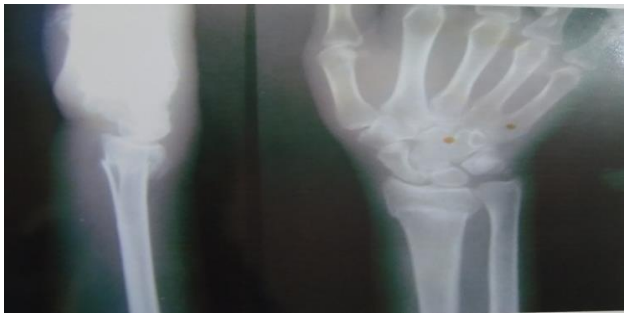

Figure 3: AP and lateral X-ray after K-wire removal.

Case 2

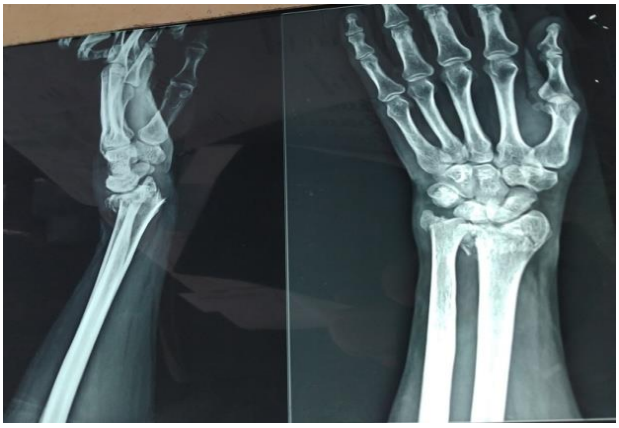

Figure 4: Pre-op lateral and AP X-ray.

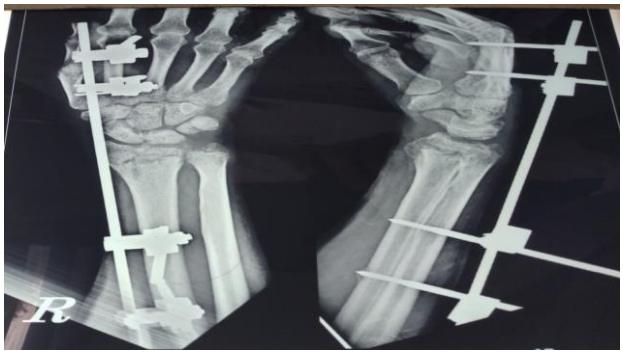

Figure 5: Post-op AP and lateral X-ray.

Figure 6: AP and lateral X-ray after removal of fixator at 12 weeks follow-up.

Case 3

Figure 7: Pre-op AP and lateral X-ray.

Figure 8: Post-op X-ray.

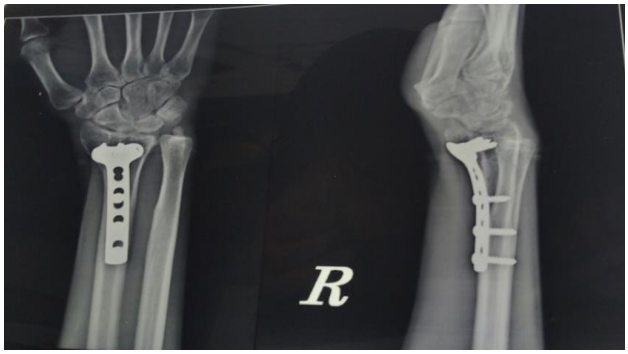

Figure 9: Healed fracture site.

Limitations

The limitation of our study was that the follow up period of our patients was only one year.

So, we could not evaluate the patients on long term functional and radiological outcome.

CONCLUSION

We conclude that functional outcome depends upon patient's age, fracture anatomy, displacement, reducibility, stability and articular incongruity of fractures. They are related more to the quality of anatomical reduction than to the method of immobilization. In our study we found that plating provides advantage in displaced intra articular fractures with excellent to good radiological outcome. However, in type B (partial intraarticular fractures) fractures, volar LCP and external fixator provide almost equivocal results. Percutaneous pinning can be recommended for extra-articular or simple intra-articular fracture patterns, with a loss of volar and/or radial inclination but without significant radial shortening.

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Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

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