

## Novel 5-pin technique for distal radius fractures

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### Abstract

**Background:** Distal radius fractures are one of the most common skeletal injuries encountered in orthopaedic department. The treatment options include POP casting, volar/ dorsal plating, external fixation, and K-wiring. This study was conducted to assess the functional and radiological outcome of a novel percutaneous 5-pin technique in distal radius fractures.

**Materials and methods:** This is a retro-prospective observational study from January 2018 to June 2020. Novel percutaneous 5-pin technique in a sequential configuration following a closed reduction was performed, followed by physiotherapy, and functional outcome was assessed at 3&6 months following K-wire removal using Cooney's modification of Green and Obrien scoring and evaluated for functional status, pin loosening, tendon impalement, and nerve injury. Radiological outcome was assessed at 6 months using Sarmiento scoring system (Modified lidstorm criteria)

**Results:** All 31 patients were assessed. The mean age of patients was 58.45 years, 61.3% was females, with domestic low energy falls being most common mode of injury. All patients were followed up for 6 months post-K-wire removal and 51.6% of patients had excellent outcome, 25.8% had good outcomes and 22.6% of patients had fair outcome with a functional range of supination and pronation movements. All fracture unions were satisfactory and 3 patients (9.7%) developed CRPS, 1 patient developed pin loosening. None of them developed tendon impalement or nerve injuries.

**Conclusion:** The novel percutaneous 5-pin technique includes two additional ulnoradial wires which provide superior rotational stability and avoid the chance of late collapse and maintain radial height, unlike conventional K-wire techniques. Thus, avoiding the need for more invasive techniques and allows early mobilization of wrist and fingers preventing stiffness, resulting in an excellent outcome.

**Keywords:** Distal radius fractures, Green and Obrien scoring, K-wire, Novel 5 pin technique

### Introduction

The distal radius fractures are one of the most common skeletal injuries encountered in orthopaedic departments. The history of fractures of distal radius reflects the evolution of the understanding of many conditions in orthopaedic trauma. Reported lifetime risks of distal radius fractures from the age of 50 onward range from 12% to 52.7% for women and 2.4% to 6.2% for men. Percutaneous pinning of fractures of distal end of Radius was first suggested in early 20th century and many different constructs of pins have been described. This study is intended to assess the results of fracture distal end of radius treated with closed reduction and percutaneous pinning – five pin technique. It is a minimally invasive and economically cheaper technique compared to other methods and available studies shows good outcomes.

### Material and Methods

All patients more than 18 years of age and less than 90 years of age with fracture distal end of radius treated by five pin

technique at Baby memorial hospital - meeting the inclusion and exclusion criteria in the mentioned time frame. The time frame was 2018 -2020. This is a prospective Observational study. Fisher's exact test was used when appropriate for analysing categorical variables. Statistical significance was defined as  $P < 0.05$ .

Calculation:

Single Proportion - Absolute Precision

Expected Proportion 0.96 Precision (%) 7

Desired confidence level (1- alpha) % 95

Required sample size 30

$$n = \frac{Z_{(1-\alpha/2)}^2 * p(1-p)}{d^2}$$

Where, p - Expected proportion; d - Precision;  $Z_{1-\alpha/2}$  - Two-sided Z value for corresponding  $\alpha$  (1.96).

Selection criteria: Inclusion criteria a) Fracture distal end of radius b) Age greater than 18 years to 90 years c) Patients willing for regular follow up at 3 months, 6 months d) Patients fit for surgery e) Patient willing for treatment and given written informed consent Exclusion criteria a) Patients with open physis b) Compound injuries c) Patients with distal ulnar shaft fracture (23 A1) and Volar/Dorsal Barton fractures (23 B3) d) Smokers.

Scoring systems used were for functional status - Cooney modification of Green and O'Brien's score at 3 and 6 months & Radiological scoring - Sarmiento scoring system (Modified

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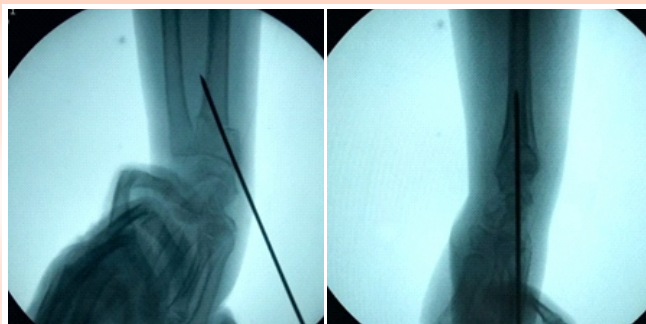


Figure 1: C-Arm images showing first k-wire from radial styloid in AP and lateral views

Lidstorm Criteria) at 6 months.

### Surgical method

Under general/ regional anaesthesia, Closed manipulation of the fracture is done under traction and under C arm guidance, reduction of fracture is confirmed. The traction is maintained from start to end of the procedure thus preventing any telescoping of fracture fragments. All rotations during the procedure are ensured to be done at the shoulder joint thus eliminating the risk of supination and pronation at the fracture site.

2mm K-wire used for fixation

First k-wire – (Radial styloid wire): It stabilises the radial column. Adequate care must be taken while inserting the radial styloid wire to avoid injury to the superficial radial nerve.

Second k-wire – (Ulnar corner wire): It goes from the dorso-ulnar corner of distal radius to the lateral-volar cortex of proximal radius. It stabilises the intermediate column.

Third k-wire – (Lister's tubercle wire): Adequate care must be taken not to injure the tendon of extensor pollicis longus (EPL) by staying radial to the tubercle to engage the volar cortex of the proximal radius. This wire prevents dorsal tilt of the distal fragment.

<sup>1</sup>Glanvill et al., "Superficial Radial Nerve Injury during Standard K-Wire Fixation of Uncomplicated Distal Radial Fractures."

<sup>2</sup>Yammine, Rafi, and Furhad, "Tendon and Neurovascular Injuries of the Distal Radius after Pinning with Kirschner Wires."

<sup>3</sup>"Management of Distal Radius Fractures – A New Concept of



Figure 3: C-Arm images showing third k-wire from lister's tubercle in AP view

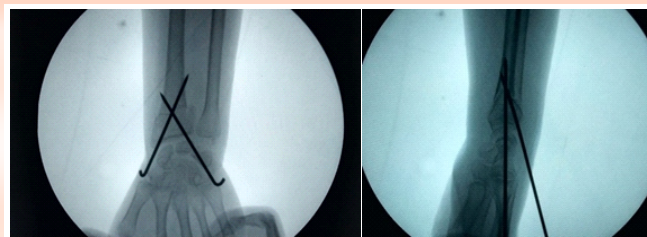


Figure 2: C-Arm images showing second k-wire from ulnar corner in AP and lateral views

Closed Reduction and Standardised Percutaneous 5-Pin Fixation - PN Vasudevan, BM Lohith, 2018."

Fourth k-wire – (Distal radio-ulnar wire): k-wire inserted from distal fragment of the radius to the ulna (through DRUJ) parallel to the wrist joint line at subchondral level in fully supinated position of forearm, all the while maintaining the reduction with traction. This k-wires maintains radial length. In unfractured forearms, the radiographically measured tilt was significantly affected by rotation. Palmar tilt increased with supination and decreased with pronation. Sarmiento et al. advocated immobilization in a position of supination to decrease the deforming force of the brachioradialis, which may cause loss of reduction.

Fifth k-wire – (Proximal radio-ulnar wire): It is the most important of all, passing from the radial shaft to ulna in full supinated position. It controls the proximal radius and along with the distal radio-ulnar wire and intact ulna works like an external fixator sparing the wrist.

All puckering of skin caused by the k wire entry were relieved with small stab incisions to prevent any chance of skin necrosis/infection at the pin site.

<sup>4</sup>Jensen et al., "The Effect of Forearm Rotation on Radiographic Measurements of the Wrist."

<sup>5</sup>Sarmiento et al., "Colles' Fractures. Functional Bracing in Supination."

<sup>6</sup>Vasudevan and Lohith, "Management of Distal Radius Fractures – A New Concept of Closed Reduction and Standardised Percutaneous 5-Pin Fixation."

### Postoperative care

Postoperative splinting is performed with a removable wrist brace in functional position of the wrist. The limb is kept elevated. Patient is encouraged to move his fingers from first post-operative day. Antibiotics and analgesics continued as per protocol. On postoperative day 2 check dressing done and condition of wound noted. Check X-ray is taken in both anteroposterior and lateral views. Patients are encouraged to remove the splint themselves for 15 minutes each at least six

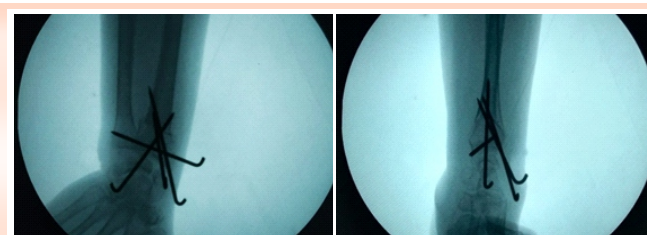
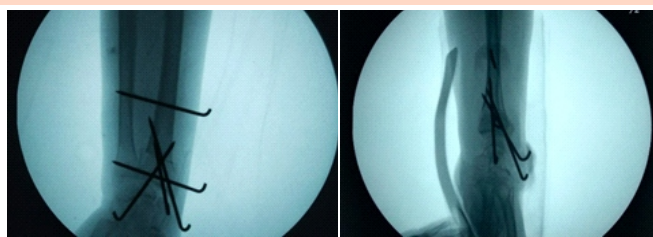


Figure 4: C-Arm images showing distal radioulnar k-wire (4th wire) in supination AP and lateral views





**Figure 5:** C-Arm images showing proximal radioulnar k-wire (5th wire) in supination AP and lateral views



**Figure 5:** clinical image showing final position of all k-wires

times a day and to mobilise the wrist, fingers, elbow and shoulder within their tolerable limits. The patient is discharged on post-operative day 2 with Oral analgesics.

The wrist brace is to be continued for a period of six weeks.

### Follow up

All patients had post op follow up visits on, follow-up at 2 weeks for Wound inspection and dressing, follow up at 4 weeks for radio-ulnar k-wires removal (4th and 5th) after check x-ray, follow-up at 6 weeks for removal of remaining 3 K-wires following check x-ray and assessing fracture union. Patient data collected at 3 months, 6 months.

Patient is asked to start supination and pronation exercises after the removal of radioulnar k wires by the end of 4 weeks. After removal of K wires at 6 weeks, wrist ROM exercises and physiotherapy are started.

### Discussion

Our study comprised thirty-one patients with distal radius fracture who were treated with closed reduction and k-wire fixation by Five pin technique. Overall final outcome was assessed in terms of regaining the lost wrist function using Cooney modification of Green and Obrien's score and Sarmiento score for radiological outcomes.

This study consists of patients from 18 years of age to 88 years of age. Mean age of the patient was  $58.45 \pm 15.03$ . This reflects that fracture distal end of radius is a fragility fracture occurs frequently in osteoporosis bone. Fracture was more common in female gender (61.3%). In a study conducted by Kate W et al says, the women in this study were approximately 4.88 times more likely than men to obtain a distal forearm fracture. 61.3% patients had domestic falls, 29% patients were injured in road traffic accidents and 9.7% patients were injured in fall from height. This concludes most common cause of the fracture is slip and fall or low energy falls. there is a significant association

between age of the patient and mode of injury. In younger age group is mainly resulted from high energy falls or road traffic accidents. P value is significant. (P value -  $<0.001$ )

Functional outcome: Mean functional score mean at 3 months was  $73.55 \pm 10.26$  and 6 months it was  $87.42 \pm 9.12$ . In this study, 51.6% patients had excellent functional status, 25.8% had good functional status and 22.6% patients had fair functional status at the end of 6 months. This correlates with Adawy El et al study showing, total of 36 (51.4%) cases got excellent score, 18 (25.7%) cases were good, 12 (17.1%) cases were fair, and four (5.7%) cases were poor at 18 months follow up. Bhasme et al study says in patients treated by Five pin technique, the scores were found to be excellent or good in most cases (lower scores) and comparable to volar plate fixation as found in other studies. In our study Functional outcomes did not depend on Patient's age, sex, mode of injury. P value of above-stated parameters were not significant. In our study, outcome depended only on fracture types. Comminuted intra articular fractures results in poorer outcomes compared to extra articular fractures. P-Value of this association was significant. (P- value = 0.014). It's evident that type of the fracture is a determinant of functional outcome.

Radiological outcomes at 6 months: In this study, 13 (41.9%) patients had excellent radiological outcome, 11 (35.5%) had good and 7 (22.6%) had fair radiological outcome at 6 months. Radiological outcomes did not depend on Patient's age, sex or mode of injury. P value of above-stated associations were not significant. It depended only on Fracture types. Comminuted intra articular fractures results in poorer outcomes compared to extra articular fractures. P Value of this association was significant. (P-value 0.016). It's evident that type of the fracture is a single most important determinant of radiological outcome. Type C fractures treated by percutaneous pinning with 5-pin technique gives good to fair radiological outcomes compared to more excellent results given in Type A and B fracture types.

Complications: In this study, 87.1% patients had no complications, 9.7% patients had CRPS and 3.2% patient had Pin loosening. A systematic review study by Franceschi et al<sup>7</sup> Nordvall, Glanberg-Persson, and Lysholm, "Are Distal Radius Fractures Due to Fragility or to Falls?"

<sup>8</sup>Nellans, Kowalski, and Chung, "The Epidemiology of Distal Radius Fractures."

<sup>9</sup>Meena et al., "Fractures of Distal Radius."

<sup>10</sup>Cowie, Anakwe, and McQueen, "Factors Associated with One-Year Outcome after Distal Radial Fracture Treatment."

<sup>11</sup>Chavhan et al., "Functional and Radiological Outcome in Distal Radius Fractures Treated with Locking Compression Plate."

says, complication rate is higher in K-wire group. CRPS in 1.7% of the patients. In our study 9.7% patients developed CRPS. Pawan Kumar et al study shows Reflex sympathetic dystrophy (CRPS) developed in 3 (10%) patients which correlates with this study and pin-tract infection was observed in 4 (15%) cases which was controlled with short-term antibiotics. We had

3.2% pin tract infection. 5 pin technique Study by Vasudevan et al shows, six patients (1.2%) experienced numbness and mild neuralgia along the sensory branch of the radial nerve which resolved completely after removal of the wires and local massage. In our study, none of the patients experienced numbness or neuralgia along superficial radial nerve.

### Conclusion

5-pin technique is a minimally invasive and effective technique in treating extra articular and displaced partial intra articular fractures of distal radius. It gives functional outcomes better than conventional k-wire constructs (2 pins or 3 pins), as regular k-wire constructs are always supported by plaster. It

allows early mobilization as we use removable wrist splint postoperatively. Wrist range of motion exercises started on first postoperative day, this prevents stiffness of fingers, wrist and CRPS. It has shorter operating time compared to open reduction and Plating. Minimal scarring compared to open reduction and plating and no scar related complications. Cheaper means of fixation compared to volar locking plates. Re-operation rate is zero compared to plating where implants need to be removed after union in young patients. Fracture biology (periosteal blood supply and fracture hematoma) is undisturbed in closed reduction where it is violated in open reduction.

**Declaration of patient consent :** The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

**Conflict of interest:** Nil **Source of support:** None

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