

## ORIGINAL ARTICLE

## A Prospective Study of Percutaneous Pinning and Cast Application in Simple Intra-Articular and Extra-Articular Distal End Radius Fracture

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### Abstract

**Background:** Distal end radius fracture is a common fracture seen in the routine orthopaedic practice. Although most of these fractures are managed by cast application, the loss of reduction and malunion rates are high. Closed reduction, percutaneous pinning, and cast application offers a simple method of managing these fractures. This study was done to evaluate the anatomical and functional outcome of extra-articular and simple intra-articular distal radius fractures using closed pinning and cast immobilization. **Materials and Methods:** A prospective study of 51 skeletally mature patients with displaced extra-articular and simple intra-articular fractures without significant comminution was done. Closed reduction was done under anaesthesia and fixation done with 2 or 3 k-wires followed by cast for 4 weeks. Final follow-up was done after 6 months using Sarmiento's modification of Lindstrom criteria and demerit point system of Gartland and Werley. **Results:** The fracture united in all the 51 patients. The average preoperative radial height changed from 2.5 to 13.5 mm postoperatively and a final value of 10.7 mm. The average volar tilt changed from  $-10.25^\circ$  preoperatively,  $12.1^\circ$  postoperatively, and  $9.5^\circ$  at the final follow-up. Only two patients had a significant loss of reduction. Pin tract infection, joint stiffness were the major complications. **Conclusion:** Closed reduction, percutaneous pinning, and cast immobilization is a technically simple and an effective method for managing displaced extra-articular distal radius fractures.

**Keyword:** Distal radius fracture, Close reduction, Pin in plaster technique, Caste application, Percutaneous pinning,

### INTRODUCTION

Fracture of the distal radius is one of the most common fractures encountered in the orthopaedic practice and accounts for one-sixth of all fractures seen in the emergency department.<sup>1</sup> Although all age groups are affected, the fracture is more common in females and the elderly.<sup>2</sup> With the increase in life expectancy, the incidence of this fracture is expected to rise in the developing world. The most common mechanism of injury is falling over onto the outstretched hand.<sup>3</sup> The characteristics of such fractures are directly related to the force of the trauma, wrist angle at the moment of the trauma, and the bone health.<sup>4</sup>

The management of distal radius fractures has evolved over time with different factors such as fracture type, bone stock, associated lesions, age of the patient, and surgeon's experience all playing a role.<sup>5</sup>

Closed reduction and cast immobilization has been the mainstay of treatment of these fractures, but it results in malunion, poor functional, and cosmetic outcome.<sup>6</sup>

Loss of reduction and need for re-manipulation has been seen in 46–67% patients.<sup>7</sup>

To overcome this loss of reduction, a number of treatment options have been advocated. These include percutaneous pinning and cast application, external fixation and open reduction and internal fixation.

Pin-in-plaster relies on ligamentotaxis to maintain the reduction. Yet, excessive traction across the wrist ligaments, which leads to stiffness, can be avoided. Postoperatively, the pin-in-plaster functioned as a neutralization device, preventing fracture collapse and decreasing the biomechanical demands on the internal fixation hardware. Closed reduction,

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percutaneous pinning, and cast immobilization is a simple procedure for extra-articular distal radius fractures without significant comminution. The present study was done to study the functional and anatomical outcomes of these fractures using percutaneous pins and cast immobilization.

## MATERIAL AND METHODS

A prospective study of distal radius fractures managed by closed reduction, percutaneous Kirschnerwire fixation, and cast immobilization was conducted between December 16 to December 18 in the Department of Orthopaedics, Dr. S.N. Medical College and associated group of hospital, Jodhpur. An informed, written consent was taken from all the patients. 51 patients with distal radius fractures fulfilling the inclusion criterion were included in the study. The inclusion criteria in the study were skeletally mature patients with displaced extra-articular and simple intra-articular fracture without significant comminution. The exclusion criteria were the fractures in skeletally immature patients, significant dorsal comminution involving more than one third of anteroposterior diameter of the radius, oblique volar fractures, die punch fracture, open fractures with Gustillo-Anderson grade 2 & 3, multiple injured patients, bilateral fractures, and fractures presenting after 10 days of trauma.

Preoperative radiographic assessment of fracture pattern and comminution was done using AP and lateral views of the wrist. Radiographs of the opposite side were also taken.

Under axillary block or general anesthesia, the patient was positioned supine on the operating table with the affected forearm maintained parallel to the floor with flexion of the elbow at 90°. The fracture alignment was achieved by traction – counter traction and the reduction confirmed by the image intensifier. 1.5 or 2 mm K-wire was passed from the radial styloid crossing the fracture site obliquely to exit the dorsoulnar cortex of the radial shaft. Another K-wire was passed either parallel to the first wire or from the dorsoulnar aspect of the distal radius between the 4th and 5th extensor compartments and directed to engage the volar radial cortex of the proximal fragment. The exposed ends of the K-wires were then bent and cut. The pin sites were then dressed.

Then a below elbow slab was applied on the volar surface with the wrist in neutral position.

In the post-operative period, the limb was kept strictly elevated for a period of 2 days, encouraged to begin active finger movements. 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.

Patient was asked to review weekly for pin site inspection and 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. He was then asked to mobilize the wrist gently at home. If at four weeks union was not satisfactory then, patient was followed up at five and then six weeks. At the end of which, the K-wires were removed and patient was asked to mobilize the wrist. We did not encounter any case not showing satisfactory union at 6 weeks. The patient was reviewed at the end of a month after removal of pins as regard to range of motion of the wrist. If there was no satisfactory range of movements, patient was advised to visit the physiotherapist.

The patients were final followed up for an average period of 6 months. During the follow up, X-rays were taken and the patients were assessed. Anatomical analysis was done using 'Sarmiento's Modification of Lindstorm Criteria'<sup>8</sup> and functional analysis was done using 'Sarmiento et al Modification of Demerit Point System of Gartland & Werley'.<sup>9</sup>

## RESULTS

The study involve 51 patients, comprising 21 males (41.1%) and 30 females (58.9%). The age of patients ranged from 20 to 78 years, the average age being 52.8 years. The most common mechanism of injury was fall on outstretched hand in 32 patients (62.7%) followed by road traffic patients in 11 patients (21.6%), fall from height 8 patients (15.7%). The right side involved in 28 patients (54.1%) and 23 patients (45.1%) had left side involvement.

**Table 1: Demographic and others characteristics of the patients**

Sex distribution	No. of cases (%)
Male	21 (41.1%)
Female	30 (58.9%)
Mode of Injury	No. of Cases (%)
Fall	40 (78.4%)
RTA	11 (21.6%)
Side Involvement	No. of Cases (%)
Right	28 (54.9%)
Left	23 (45.1%)

Preoperative radiographic assessment showed that the average radial height was 2.5 mm (range 1–6 mm), and volar tilt was  $-10.55^\circ$  (range  $3^\circ$ – $-17^\circ$ ). Assessment of postoperative radiographs revealed that the average radial height was 13.5 mm (range 7–16 mm), and volar tilt was  $12.1^\circ$  (range  $7^\circ$ – $14^\circ$ ) on the immediate postoperative X-rays. At the time of pin removal at 6 weeks, radial height was 11.5 mm (range 4–16 mm) and volar tilt  $10.6^\circ$  (range  $3^\circ$ – $14^\circ$ ). At the final follow-up at 6 months, the average radial height was 10.7 mm (range 1–16 mm) and the average volar tilt was  $9.5^\circ$  (range  $1^\circ$ – $14^\circ$ ). The Kirschner-wires remained well fixed till radiological union in 47 patients with  $<5^\circ$  changes in the volar tilt between the immediate postoperative radiographs and the radiographs at union. four patients had more than  $5^\circ$  loss of reduction despite a satisfactory clinical result.

Four patients had pin site infection which responded to dressing and antibiotics. Four patients had joint stiffness which improved with supervised physiotherapy. Five patients had reduced grip strength by  $<60\%$  of normal, two patients developed malunion and one patient developed complex regional pain syndrome Type 1 that later improved within 2 months by physical therapy and pain management. No patient had iatrogenic nerve, tendon injury, wrist arthritis, or subluxation of distal radio-ulnar joint.

Using the Sarmiento’s modification of Lindstrom criteria, 33 patients (64.7%) had excellent results, 13 (25.5%) had good results, 5 (9.8%) patients had fair results. Based on the functional evaluation, using the demerit point system of Gartland and Werley, 31 patients (60.8%) had excellent results, 14 (27.4%) had good results, 4 (7.8%) had fair results, and two patients had poor results.

**Table 2 : Sarmiento’s modification of Lindstrom criteria**

	Residual deformity	Loss of radial tilt ( $^\circ$ )	Radial Shortening (ml)	Loss of radial deviation ( $^\circ$ )
Excellent	No deformity/insignificant	0	3	5
Good	Slight	1-10	3-6	5-9
Fair	Moderate	11-14	7-11	10-14
Poor	severe	At least 15	$\geq 12$	$>14$

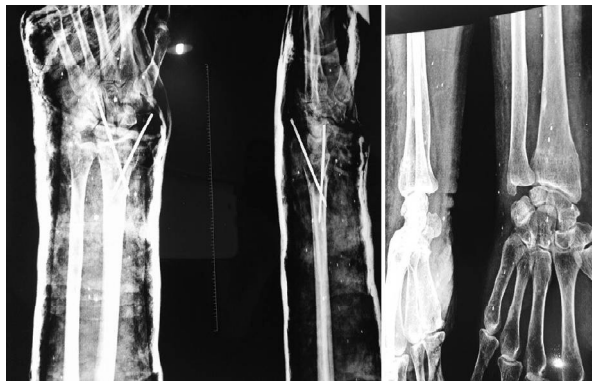
**Table 3:- comparison of results between the functional and anatomical outcome in the present study**

Results	Gartland & Werley (Functional Outcome)	Sarmiento’s (Anatomical Outcome)
Excellent	60.8%	64.7%
Good	27.4%	25.5%
Fair	7.8%	9.8%
Poor	3.9%	0

**Fig 1:- Pre-operative AP & lat view**



**Fig 2:-intra-operative C-arm image**



**Fig 3:- Immediate post-operative radiographs and X-ray of same patients at 6 months showing fracture union with good radiological outcome**

## DISCUSSION

Distal radius fracture is a common injury. The importance of anatomic reduction has been demonstrated by clinical studies as well as by laboratory assessment of force and stress loading across the radiocarpal joint.<sup>10,11</sup>

An accurate reduction in the fracture is the first step in the treatment of the distal radius fracture. After anatomic reduction in the fracture is achieved, many methods are available to maintain alignment and prevent repeat displacement. The methods of immobilization include casting, percutaneous pinning, external fixation, internal fixation with plate, or internal fixation combined with external fixation depending on the different types of fractures. Every method has its advantages and some limitations.

The most commonly used and widely accepted treatment method is cast immobilization. Although cast immobilization alone avoids surgery and related complications, cast cannot maintain distraction to correct length or control the rotation of the distal fragment when comminution is present.<sup>12</sup> Loss of reduction usually happens after 2 weeks of casting despite a perfect initial anatomic reduction.<sup>13</sup>

Closed reduction and percutaneous pinning has been advocated as early as 1952 by De Palma.<sup>14</sup> Recent reports with good results by different authors have renewed interest in this method. Clancey reported a 96.4% satisfactory result in 30 patients treated with percutaneous pinning and casting of the fractures of radius.<sup>15</sup> The basic prerequisite of this method is to achieve a good reduction. Since most of our patients presented early, manipulative reduction was sufficient to restore the radial length and volar tilt. Fracture fixation was stable in the majority of our cases, and significant secondary displacement was seen in only two patients. Good bone stability was achieved with two 1.5 or 2 mm Kirschner-wires, as also noted by other authors.<sup>16</sup> However, the elbow can be left free only if the bone is strong enough as the wires cannot resist the pull of brachioradialis in osteoporotic bones. Due to this fact we immobilized the elbow in comminuted fractures, all fractures in patients above 60 years of age and patients with documented osteoporosis. The immobilization of elbow did not have any effect on the final elbow function as none of our patients developed elbow stiffness. Rosati *et al.* have shown that 0° volar tilt does not impair the range of motion of the wrist and hand because it is compensated for by the midcarpal joint.<sup>5</sup>

Percutaneous pinning and cast immobilization is a technically simple procedure as compared to open reduction and volar plating. This method does not require prolonged hospital stay and the patients can be discharged on the first postoperative day. This is an advantage in the developing countries where the orthopedic wards are overburdened. In addition, the removal of pins is an outdoor procedure and does not require admission or re-surgery. The main problem in this method remains the pin tract infection, which is compounded by the fact that the pin tract care is impossible because of the plaster. The frequent follow-up to assess any sign of pin tract infection is mandatory. Pin tract infection rate after this procedure varies from 7% to 35%.<sup>17,18</sup>

In our study, the functional outcome was evaluated using Gartland & Werley system 60.8% of the cases showed excellent, 27.4% of the cases showed good, 7.8% cases showed fair and only 3.9% cases showed poor results. The anatomical outcome was evaluated using Sarmiento's modification of Lindstrom's criteria. The results of this study were comparable to the other studies that had been done previously.

Study by Uzzaman et al showed anatomical results (acc. To Sarmiento and Latta's score) was satisfactory in 80% cases of percutaneous K-wire fixation group whereas in conventional group it was 35%.<sup>19</sup> Functional results (Sarmiento and Latta) in above study was satisfactory in 70% of percutaneous fixation group and 30% in conventional group. All these anatomical and functional results correlate with the study of Max Scheck – where satisfactory results were in 75% cases and Gartland and Werley's series – where the satisfactory result was 70%.

Loss of reduction usually happens after 2 weeks of casting despite a perfect initial anatomic reduction.<sup>11</sup> Gartland and Werley obtained a 68.3% satisfactory result, and Sarmiento et al reported an 82% satisfactory result treated with the casting technique.<sup>20</sup> Spira and Weigl reported a 51.4% unsatisfactory result with reduction and use of cast in the treatment of comminuted fracture of distal radius with articular involvement.<sup>21</sup> Closed reduction and percutaneous pinning

relies on intrafocal manipulation and pinning or manual traction, reduction, and pinning, to hold the fracture in an appropriate anatomic alignment. Clancey reported a 96.4% satisfactory result in 30 patients treated with percutaneous pinning if the articular surface of the radius was not comminuted into more than two fragments.<sup>22</sup>

There is a definite risk of injury while passing the pins but we did not report any such case in our study.<sup>23,24</sup> Introducing the wires through the radial styloid process, thereby avoiding the neurovascular structures, coupled with limited skin incision, when needed, could be reasons for this result.<sup>25</sup> Rehabilitation was usually necessary since wrist stiffness was common immediately following cast and pin removal. However, almost all of the patients could achieve a good range of motion of the wrist after a period of physical therapy. There was no incidence of posttraumatic arthritis reported in our patient population because of the short-term follow-up.

## CONCLUSION

During the period between Dec 2016 and Dec 2018, 51 patients with distal radius fracture were treated with closed reduction and percutaneous pinning and followed up for an average period of 6 months at the Dr. S.N. Medical College and associated group of hospital, Jodhpur. The age group of the patients was from 20 to 78 years with the average age being 52.8 years. The anatomical evaluation by Sarmiento's Criteria showed 33 patients with excellent result, 14 patients with good result and 4 with a fair result. At final follow-up by 'The Gartland and Werley criteria' for functional outcome 31 patients had excellent result, 14 had good result, 4 had fair result and 2 had a poor result. There were no major complication noted except for pin site infection in 4 cases. The results of our study were in accordance with standard studies of distal radius fractures treated with closed reduction and percutaneous pinning. Kirschner wire fixation is cheaper and quicker to perform.

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## REFERENCES

1. Buchholz RW, Heckman JD, Brown CM. Rockwood and Green's Fractures in Adults. Vol. 1.

- Philadelphia: Lippincott Williams and Wilkins; 2006. p. 910.
2. Alffram PA, Bauer GC. Epidemiology of fractures of the forearm. A biomechanical investigation of bone strength. *J Bone Joint Surg Am* 1962;44-A: 105-14.
  3. Falch JA. Epidemiology of fractures of the distal forearm in Oslo, Norway. *Acta Orthop Scand* 1983;54:291-5.
  4. Chen NC, Jupiter JB. Management of distal radial fractures. *J Bone Joint Surg Am* 2007;89:2051-62.
  5. Rosati M, Bertagnini S, Digrandi G, Sala C. Percutaneous pinning for fractures of the distal radius. *Acta Orthop Belg* 2006;72:138-46.
  6. Goffton W, Liew A. Distal radius fractures: Nonoperative and percutaneous pinning treatment options. *Orthop Clin North Am* 2007;38:175-85, v-vi.
  7. McQueen MM, MacLaren A, Chalmers J. The value of remanipulating Colles' fractures. *J Bone Joint Surg Br* 1986;68:232-3.
  8. Sarmiento A, Pratt GW, Berry NC, Sinclair WF. Colles' fractures. Functional bracing in supination. *J Bone Joint Surg Am* 1975;57:311-7.
  9. Gartland JJ Jr., Werley CW. Evaluation of healed Colles' fractures. *J Bone Joint Surg Am* 1951;33-A: 895-907.
  10. Knirk JL, Jupiter JB. Intra-articular fractures of the distal end of the radius in young adults. *J Bone Jt Surg Am*. 1986;68:647-59.
  11. Trumble TE, Schmitt SR, Vedder NB. Factors affecting functional outcome of displaced intra-articular distal radius fractures. *J Hand Surg Am*. 1994;19:325-40.
  12. Weil WM, Trumble TE. Treatment of distal radius fractures with intrafocal (kapandji) pinning and supplemental skeletal stabilization. *Hand Clin* 2005;21:317-28.
  13. Fu YC, Chien SH, Huang PJ, Chen SK, Tien YC, Lin GT, et al. Use of an external fixation combined with the buttress-maintain pinning method in treating comminuted distal radius fractures in osteoporotic patients. *J Trauma* 2006;60:330-3.
  14. De Palma AF. Comminuted fractures of the distal end of the radius treated by ulnar pinning. *J Bone Joint Surg Am* 1952;24 A: 651-62.
  15. Clancey GJ. Percutaneous Kirschner-wire fixation of Colles fractures. A prospective study of thirty cases. *J Bone Joint Surg Am* 1984;66:1008-14.
  16. Naidu SH, Capo JT, Moulton M, Ciccone W 2nd, Radin A. Percutaneous pinning of distal radius fractures: A biomechanical study. *J Hand Surg Am* 1997;22:252-7.
  17. Botte MJ, Davis JL, Rose BA, von Schroeder HP, Gellman H, Zinberg EM, et al. Complications of smooth pin fixation of fractures and dislocations in the hand and wrist. *Clin Orthop Relat Res* 1992;276:194- 201.
  18. Hargreaves DG, Drew SJ, Eckersley R. Kirschner wire pin tract infection rates: A randomized controlled trial between percutaneous and buried wires. *J Hand Surg Br* 2004;29:374-6.
  19. Uzzaman KS, Awal KA, Alam MK. Closed reduction and percutaneous kirschner wire fixation combined with plaster cast versus conventional plaster cast immobilization in the treatment of colles' fracture – a prospective randomized comparative study. *J Dhaka Med Coll.* 2008;17(2):98-105.
  20. Sarmiento A, Pratt GW, Berry NC, Sinclair WF. Colles' fractures—functional bracing in supination. *J Bone Jt Surg Am*. 1975;57:311-7.
  21. Spira E, Weigl K. The comminuted fracture of the distal end of the radius. *Reconstr Surg Traumatol*. 1968;11:128-38.
  22. Clancey GJ. Percutaneous Kirschner-wire fixation of Colles fractures—a prospective study of thirty cases. *J Bone Jt Surg Am*. 1984;66:1008-14.
  23. Hochwald NL, Levine R, Tornetta P 3rd. The risks of Kirschner wire placement in the distal radius: A comparison of techniques. *J Hand Surg Am* 1997;22:580-4.
  24. Weber SC, Szabo RM. Severely comminuted distal radial fracture as an unsolved problem: Complications associated with external fixation and pins and plaster techniques. *J Hand Surg Am* 1986;11:157-65.
  25. Steinberg BD, Plancher KD, Idler RS. Percutaneous Kirschner wire fixation through the snuff box: An anatomic study. *J Hand Surg Am* 1995;20:57-6