International Journal of Medical Research Professionals
P-ISSN: 2454-6356; E-ISSN: 2454-6364
DOI: 10.21276/ijmrp

Original Research Article.

Role of Percutaneous Pinning and Cast Application in Extra-Articular And Simple Intra-Articular Management of Distal Radius Fractures: A Clinical Study

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ABSTRACT

Background: Distal end radius fracture is a common fracture seen in the routine orthopedic 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 functional and radiological of extra-articular and simple intra-articular distal radius fractures using closed pinning and cast immobilization.

Materials and Methods: A prospective study of 37 skeletally mature patients with displaced extra- and intra-articular fractures without significant comminution was done. Closed reduction was done under anesthesia and fixation done with 2 or 3 Kirschner-wires followed by cast for 6 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 37 patients. The average preoperative radial height changed from 2.7 to 13.2 mm postoperatively and a final value of 10.9 mm. The average volar tilt changed from −11.25° preoperatively, 12.1° postoperatively, and 9.7° at the final follow-up. Only two patients had a significant loss of reduction. Pin tract infection, joint stiffness, pin migration, and complex regional pain syndrome 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 and simple intra-articular distal radius fractures.

Keywords: Cast Application, Closed Reduction, Distal Radius Fractures, Percutaneous Pinning.

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Article History:

Received: 19-11-2017, **Revised:** 17-12-2017, **Accepted:** 21-01-2018

Access this article online	
Website: www.ijmrp.com	Quick Response code
DOI: 10.21276/ijmrp.2018.4.1.119	

INTRODUCTION

Fracture of the distal radius is one of the most common fractures encountered in the orthopedic practice and accounts for one-sixth of all fractures seen in the emergency department.[1] Although all age groups are affected, the fracture is more common in females and the elderly.[2] 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.[3] 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.[4]

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.[5] Closed reduction and cast immobilization has been the mainstay of treatment of these fractures, but it results in malunion, poor functional, and cosmetic outcome.[6] Loss of reduction and need for re-manipulation has been seen in 46–67% patients.[7] 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.

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

MATERIALS AND METHODS

A prospective study of distal radius fractures managed by closed reduction, percutaneous Kirschner-wire fixation, and cast immobilization was conducted in the Department of Orthopedics, ESIC Model Hospital, Namkum, Ranchi Jharkhand, India. An informed, written consent was taken from all the patients. Thirty seven 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 fracture and intra-articular fracture without significant comminution and having an articular step-off <2 mm. The exclusion criteria were the fractures in skeletally immature patients, significant dorsal comminution involving more than one-third of the anteroposterior (AP) diameters of the radius, oblique volar fractures, die punch fractures, open fractures, multiple injured patients, bilateral fractures, and fractures presenting after 1 week 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. Fractures were classified using the Arbeitsgemeinschaft für Osteosynthesefragen (AO) classification. All the patients were scheduled for surgery within 24 h of the admission. Under branchial 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°. Closed reduction was done manually by applying longitudinal traction and correcting the angulation by manipulating the distal fragment. The goal of the reduction was to regain the radial height and correct the radial and volar tilt of the distal radial epiphysis. The quality of the reduction was then checked with fluoroscopy in AP and lateral projections, by rotating the C-arm around the wrist while the patient's hand was held steady.

Acceptable criteria for fracture reduction were radial inclination of >15°, radial shortening of <5 mm compared to the contra-lateral side, sagittal tilt between 15° dorsal and 20° volar tilt and intra-articular step-off of <2 mm. After proper prepping and draping, fixation was then performed with two or more 1.5 mm Kirschner-wires. The Kirschner-wires were introduced at the styloid process of the radius, holding the drill parallel to the ground, while the Kirschner-wire was held at 45° angle to the longitudinal axis of the radius. When the angle between the Kirschner-wires and the axis of the radius at the styloid process is <45°, piercing the medial cortex of the radius above the fracture often becomes impossible, as the Kirschner-wire slides into the medullary cavity, which will result in decreased stability. Metaphyseal fractures of the radius are more stable when two parallel Kirschner-wires connect four opposite points on the radius cortex. In fractures with a punch fragment, a Kirschner-wire was inserted transversely, after reduction of the fracture. An attempt to reduce it can be made with a percutaneous Kirschner-wire used as a lever, pushing the fragment upwards. Sometimes a Kirschner-wire was also passed through dorsal access between the 4th and 5th extensor compartments. After final confirmation of the reduction, the Kirschner-wires were bent and cut away from the skin, so as to avoid pressure lesions. A well-fitted below elbow plaster of Paris cast was applied for external immobilization with the limb in slight ulnar deviation. However, in all patients above 65 years, younger patients with intra-articular comminution and patients with documented osteoporosis above elbow cast was applied. Finger, elbow, and shoulder physiotherapy was started in the hospital itself, and the patients were discharged after 24 h.

The patients were reviewed after 1 week to look for any loosening of the cast or radiological displacement of the fracture. If found loose the cast was replaced by another well-fitting cast. Further, follow-up was done at 4 and 6 weeks, and clinical and radiological healing was assessed. Usually, by 6 weeks, clinical and radiographic examination showed sufficient progression of fracture healing. The Kirschner-wires were usually removed after 6 weeks of immobilization on an outpatient basis without local anesthesia. The cast was also removed at the same time, and active-assisted wrist motion, pronation-supination, and hand-grip exercises were started. A protective wrist splint was applied for 2–4 weeks after removal of the cast. The splint was removed at the time of exercises and washing. The final evaluation was done after 6 months. The results were evaluated clinically and radiologically using Sarmiento's modification of Lindstrom criteria[8] and by the Sarmiento *et al*.'s modification of the demerit point system of Gartland and Werley.[9]

RESULTS

The study involved 37 patients, comprising 15 males (40.5%) and 22 females (59.45%). The age of patients ranged from 19 to 78 years, the average age being 61.3 years. The most common mechanism of injury was fall on an outstretched hand in 27 patients (73%), followed by road traffic accident in 6 patients (16%), fall from height in 3 patients (8.1%), and direct blow in 1 patient (2.7%). The left side was involved in 21 of our patients (56.5%) and 16 patients (43.5%) had right-side involvement. The radiological assessment using the AO classification was done by the senior author. According to the AO classification, A2 fracture was the most common type accounting for 17 patients (45.9%), A3 in 4 patients (11%), B1 in two (5.4%), C1 in 10 (28.8%), and C2 in 3 patients (9.6%).

All the fractures united in our study group. Restoration of anatomy was excellent in 25 patients (68.67%), 10 patients (28.25%) had a good anatomical outcome while 2 (3.08%) had fair results. Preoperative radiographic assessment showed that the average radial height was 2.7 mm (range 1–6 mm), and volar tilt was −11.25° (range 3–−17°). Assessment of postoperative radiographs revealed that the average radial height was 13.2 mm (range 7–16 mm), and volar tilt was 12.1° (range 7–14°) on the immediate postoperative X-rays. At the time of pin removal at 6 weeks, radial height was 11.8 mm (range 4–16 mm) and volar tilt 10.6° (range 3–14°). At the final follow-up at 6 months, the average radial height was 10.9 mm (range 1–16 mm) and the average volar tilt was 9.7° (range 1–14°). The Kirschner-wires remained well fixed till radiological union in 27 patients with <5° changes in the volar tilt between the immediate postoperative radiographs and the radiographs at union. Four patients had more than 5° loss of reduction despite a satisfactory clinical result. One patient had significant loss of reduction which necessitated reoperation, but the patients refused surgery.

Two patients had pain at the pin tract site which necessitated examination of the pin sites. Using the modified Oppenheim classification, two were graded as Grade 1 and two as Grade 2. All of these responded to dressings and antibiotics. At the time of removal of cast, 7 other patients had redness and discharge at the pin tract site (Grade 1 infection) which responded in all cases to dressings only. Two patients (5.4%) had joint stiffness which improved with supervised physiotherapy. Four patients (10.9%) had reduced grip strength by <60% of normal, one patient (2.7%) developed malunion. Three patients had moderate pain with severe restriction of activities. No patient had iatrogenic nerve, tendon injury, wrist arthritis, or subluxation of distal radio-ulnar joint.

Using the Sarmiento's modification of Lindstrom criteria, 22 patients (59%) had excellent results, 10 (27%) had good results, 4 (10%) patients had fair results, and one patient had poor result. Based on the functional evaluation, using the demerit point system of Gartland and Werley, 21 patients (56.75%) had excellent results, 11 (29.7%) had good results, 4 (10.81%) had fair results, and one patient had poor result.

DISCUSSION

Fractures of the distal end of the radius are quite common, accounting for one-sixth of all fractures seen in the emergency room. The fractures are seen more often in the elderly females after a low-energy trauma. Although Colles stated that the wrist would eventually gain "perfect freedom in all of its motions and be completely exempt from pain" after this fracture, long-term studies have failed to prove so.[10,11] Many clinical and laboratory-based studies have emphasized the importance of accurate anatomical reduction. [12] Every effort should be made to restore normal length, alignment, and articular surface congruency of the distal radius. After achieving accurate reduction, the maintenance of the reduction and prevention of secondary displacement remains of paramount importance. This can be tried by both operative and nonoperative methods, each method having its advantages and limitations. The methods of immobilization include casting, percutaneous pinning, external fixation, internal fixation with a plate, or internal fixation combined with external fixation depending on the different types of fractures. 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.[13] Loss of reduction usually happens after 2 weeks of casting despite a perfect initial anatomic reduction.[14] Although good results have been seen in stable fractures, 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.[15] External fixator has been popular for the treatment of displaced fractures of distal radius. This method maintains radial length and radial inclination by ligamentotaxis, but cannot effectively maintain palmar tilt.[16] Furthermore, complication rates as high as 60% have been reported with the use of external fixator.[17] These mainly include pin loosening, pin tract infection, reflex sympathetic dystrophy, radial sensory neuritis, and delayed union. Open reduction and internal fixation, especially with volar locked plates, is thought to allow faster rehabilitation and better results than other methods. However, a number of randomized controlled trials have demonstrated that wrist function and disabilities of the arm, shoulder, and hand scores after 1 year in volar plating groups are comparable to other modalities such as external fixation and percutaneous pinning.[18,19]

Closed reduction and percutaneous pinning has been advocated as early as 1952 by De Palma.[20] 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.[21] 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 one patient. Good bone stability was achieved with two 1.5 mm Kirschner-wires, as also noted by other authors.[22] 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. Four of our patients had a 5–10° loss of volar tilt when comparing the immediate postoperative radiographs with the final radiographs but the clinical results were satisfactory. 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.[5]

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%.[23,24] Our rate of 24% is comparable to most of the studies. Although some authors have suggested burying the Kirschner-wires to decrease the infection rate, we believe that most of these are mild and can be controlled successfully by taking proper care during insertion and when required dressing and occasional antibiotic use.[25] Besides, the removal of buried wires will involve an additional procedure without any significant improvement in the final outcome.

There is a definite risk of injury while passing the pins but we did not report any such case in our study.[26,27] 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.[28] Problems in peripheral circulation might occur if the cast is too tight. A short-arm splint was necessary if the pin-in-plaster was removed in an earlier stage for any reason. 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

The technique of percutaneous pinning and cast seems capable of restoring reasonable joint function for extra- and simple intra-articular fracture of the distal radius. We consider pinning and casting technique as an efficient method to stop radial shortening and dorsal tilting during the time of bone healing. Most of our study patients achieved excellent to good functional results 6 months after removal of the pins. The technique involves a minimal procedure that provides anatomic reduction, fracture

fixation, and maintenance of reduction with an adequate method of immobilization. Besides, the removal of Kirschner-wires is an outpatient department procedure and is done without the need for any additional anesthesia.

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Source of Support: Nil.

Conflict of Interest: None Declared.

Cite this article as: Shankar Niwas. Role of Percutaneous Pinning and Cast Application in Extra-Articular And Simple Intra-Articular Management of Distal Radius Fractures: A Clinical Study. Int J Med Res Prof. 2018 Jan; 4(1):555-58.
DOI:10.21276/ijmrp.2018.4.1.119