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Prospective study on outcome of distal radial fractures treated with closed reduction and percutaneous pinning

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Abstract: Background: Vast majority of fractures of distal radius are articular injuries that result in disruption of both radiocarpal and radioulnar joints. Therefore, this study evaluates the functional and radiological outcomes of distal radius fractures treated by percutaneous pinning in ulno-carpal joint and distal radius.
Material and Methods: A Prospective Interventional Study conducted at Department of Orthopaedics, N.S.C.B. Medical College and Hospital, Jabalpur (M.P.) with the study population of patients attending OPD and casualty diagnosed with distal Radius fracture from the duration of 1st March 2021 to 31st June2022. Total of 50 Sample size was taken estimated through the formula $n = \frac{z^2 \times p \times q}{d^2}$. Data analysis was done through the IBM software SPSS and the statistical association was fund with the Confidence Interval of 95% and p-value> 0.5.
Results: Total of 50 patients, 30 were male, and 20 were females, who were assessed through follow-up.According to Sarmiento score of range of motion, 21 Patients have excellent score (0-2),12 patients have good score (3-8), 12 patients have fair (9-20), and 5 patients have poor (above 21).
Conclusion: Closed reduction and percutaneous K-wire fixation is a less intrusive, safer, and successful approach to preserve the reduction, avoid radial collapse during healing, and maintain DRUJ stability even when the fracture is extensively comminuted, intra-articular, or unstable.

Keywords: Prospective Interventional Study; Percutaneous Pinning technique; Distal Radius fracture; Sarmiento score.

1. Introduction

The development of knowledge about a variety of orthopaedic trauma diseases can be seen in the history of distal radius fractures. Prior to Petit, Pouteau, and Colles, it was thought that a dislocation of the distal radio-ulnar joint (DRUJ) or a carpal injury was the underlying nature of distal radial injury. After writing his thoughts in "On the Fractures of the Carpal Extremity of the Radius" in 1814, Abraham Colles became the first author to describe distal radius fractures in English literature [1].

Although 20% of all fractures treated in emergency rooms are distal radial fractures, many are not "totally exempt from discomfort" following treatment. More than 1000 peer-reviewed papers have been published on the topic over the previous few decades, yet there is no agreement on the best treatment. The extent to which the anatomy is restored, the quality of the bone, the development of new techniques and devices, the experience and skill of the surgeon, and the results in older populations are just a few of the many confounding factors that exist [2].

The early technique of cast immobilisation and closed reduction has led to malunion, rigid joints, and deformity. By interfering with the extrinsic hand musculature's mechanical advantage, it has a negative impact on how the wrist and hand work [3–5]. Radius collapse and DRUJ subluxation are frequently caused by closed reduction and POP immobility [6].

One of the first methods of fixation, percutaneous pinning adds more stability. Depalma described a 45° angle in ulno-radial pinning [7]. Stein recommends adding a second, 2-mm dorsal K-wire with radio-ulnar

pinning [8]. Raycheck advised ulno-radial pinning in addition to the fixation of the DRUJ, while Kapandji described double intrafocal pinning into the fracture surface using 2-mm K-wires [9,10].

Ligamentotaxis and joint-spanning external fixation immediately neutralise the axial load over the radius and minimise the impacted articular fragments indirectly [11]. For unstable intra-articular fractures, Ruch and Ginn, Schumr, and numerous others described open reduction and internal fixation of the distal radius [12]. Doiatal provided an explanation of arthroscopically guided fracture reduction [13]. Therefore, this study evaluates the functional and radiological outcomes of distal radius fractures treated by percutaneous pinning in ulno-carpal joint and distal radius.

2. Material and methods

The present study was conducted at the Department of Orthopaedics, N.S.C.B. Medical College and hospital, Jabalpur(M.P.) India after obtaining informed and written consent from the study subjects.

2.1. Study Design

Prospective interventional.

2.2. Study Period

1st March 2021 to 31st June2022.

2.3. Study Population

All the patient attending OPD and casualty of Orthopaedic department with diagnosed distal Radius fracture.

2.4. Study Site

Department of Orthopaedics, N.S.C.B. Medical College and Hospital,Jabalpur (M.P.).

2.5. Sampling Method

Convenient sampling method was used.

2.6. Sample size estimation

50.

$$n = \frac{z^2 \cdot p \cdot q}{d^2},$$

where, n = sample size; z = 1.96 (for a 95% confidence level and 0.05 alpha); p = assumed probability of occurrence or concordance of results; q = 1 - p; d = marginal error (precision).

2.7. Inclusion Criteria

- Sustained a fracture of the distal radius (comminuted extra-articular and intra-articular).
- Patients age is of over 55 years.
- Fractures should be operated within 14 days of trauma.

2.8. Exclusion Criteria

- Fractures which require open reduction.
- Pathological fractures should be ruled out.
- There is evidence that the patient will be unable to adhere to trial procedures or complete questionnaires, such as in cognitive impairment.

2.9. Methods

Baseline data collection was done using radiological, biochemical, and pathological investigations, including:

1. X-ray of the forearm with wrist joint true anteroposterior view and lateral view.
2. Complete blood counts.
3. Random blood sugar.
4. Serum uric acid.
5. Serum creatinine.
6. Liver function tests: SGOT, SGPT.
7. Erythrocyte sedimentation rate (ESR).
8. C-reactive protein (CRP).
9. Chest X-ray and ECG.
10. HIV/HBsAg/HCV testing.

2.10. Procedure

The patient was positioned supine on the operating table, with the limb on a side table. Under regional anesthesia (if unsuccessful, general anesthesia was used at the discretion of the anesthetist), the surgical site was painted and draped. Fracture alignment was achieved by traction-counter traction, and the reduction was confirmed by an image intensifier. 1.5- or 2-mm K-wires were passed from the radius styloid, crossing the fracture site obliquely to exit the dorso-ulnar cortex of the radius shaft. Another K-wire was passed from the dorso-ulnar aspect of the distal radius between the 4th and 5th extensor compartments and directed to engage the volar radius cortex of the proximal fragment. The exposed ends of the K-wires were then either bent or inserted into metal balls. The pin sites were dressed, and then a below-elbow slab was applied on the volar surface with the wrist in a neutral position.

2.11. Post-Operative Protocol

After the surgery, the patient's limb was raised for three days. Once the anesthesia wore off, the patient was encouraged to move their fingers. If three days later the patient expressed a desire to move their elbow, pin locations were inspected and dressed. If pin sites and mobilization were good, the patient was discharged and scheduled for weekly pin site inspections and follow-up. At four weeks, if there were sufficient symptoms of union, the pins and slab were withdrawn, and the patient was given a crepe bandage. The patient was instructed to gently move their wrist at home. If union was inadequate after four weeks, the patient was observed at five and six weeks. After removing the K-wires, the patient was instructed to move their wrist. No cases showed insufficient union at six weeks. After a month, the patient's wrist range of motion was evaluated. If the patient's range of motion was not adequate, a physiotherapist was consulted.

2.12. Ethical Approval

The study was conducted after obtaining ethical approval from the IEC committee of the medical college. The committee reviewed the study protocol and ensured that it met ethical standards for conducting research involving human subjects. Written informed consent was obtained from all patients prior to their enrollment in the study. This ensured that the patients were fully informed about the study and its potential risks and benefits, and that they voluntarily agreed to participate. The study was conducted in accordance with ethical guidelines and principles for research involving human subjects.

3. Results

Table 1 depicts the Socio-demographic characteristics and clinical presentation of participants the mean age of participant was 59±4.5 years, where there is predominance of male gender (60%), and 40% were female. Most of the fracture i.e., 56% were in right side while 44% in left side. According to AO classification, 56% were extra articular, 32% were partially articular and only 12% were completely articular.

Table 1. Demographic characteristic and clinical presentation of study participants

Particulars	**Sub particulars**	**N**
Mean Age (in years)	Mean ± Std Deviation	59±4.5
Sex	Female	20
	Male	30
Affected Side	Left	22
	Right	28
Fracture type	Extra Articular A	28
	Partially Articular B	16
(AO classification)	Completely Articular C	6

In Table 2 presents the distribution of Sarmiento score with Mean±SD of various groups, where Group A:1.68±1.156, Group B: 10.94±4.864 and Group C: 23.5±1.049. While comparing among three Groups, however, there was Statistically significant difference between three groups (p>0.5).

Table 2. Distribution of mean sarmiento score

Variable	**Group**	**N**	**Mean**	**SD**	**p-value**
Sarmiento score	A	28	1.68	1.156	0.001
	B	16	10.94	4.864	
	C	6	23.5	1.049	
	Total	**50**	**7.26**	**7.912**	

Table 3 presents the distribution of excellent, fair, good, and poor percentages of Sarmiento's Modification of Lindstrom Criteria. In Group A, the excellent percentage was 89.3%, fair percentage was 75%, good percentage was 10.7%, and poor percentage was 0%. In Group B, the excellent percentage was 12.5%, fair percentage was 0%, good percentage was 12.5%, and poor percentage was 0%. In Group C, the excellent percentage was 0%, fair percentage was 24%, good percentage was 0%, and poor percentage was 100%. There was a statistically significant difference between all groups ($p < 0.001$).

Table 3. Distribution of sarmiento's modification of lindstrom criteria among subjects

Variable	**Group**			**Total**
	A	B	C	
Excellent	25	2	0	27
	89.3%	12.5%	0%	54%
Fair	0	12	0	12
	0%	75%	0%	24%
Good	3	2	0	5
	10.7%	12.5%	0%	10%
Poor	0	0	6	6
	0%	0%	100%	12%
Total	**28**	**16**	**6**	**50**
	100%	**100%**	**100%**	**100%**

Table 4 depicts the demerit point system of Gartland and Werley with Sarmiento et al.'s modification in which 42%(21) participant were having excellent score, 24%(12) cases were having good score and 24%(12) were having fair score and only 8% (05) were having poor score.

Table 4. Distribution based on demerit point system of Gartland and Werley with Sarmiento modification.

Particulars	**Score**	**No. of cases**
Excellent	0-2	21
Good	3-8	12
Fair	9-20	12
Poor	>21	05

4. Discussion

All the fifty cases of distal radius fractures united in an average period of 6.8 weeks. Excellent anatomicalresults were observed in 21 patients (42%), good results in 12 cases (24%), while 12 cases (24%) had fair results and 5 cases (10%) were having poor results. The duration from the date of injury to the date of operation ranged from 1 to 14 days (average 5.50 days).

Our study's consequences included wrist posttraumatic arthritis (n = 2), inferior radio-ulnar joint subluxation (n = 2), Sudeck's osteodystrophy (n = 1), and malunion (n = 2). Due to a lack of infrastructure, closed reduction and POP immobilisation are still used in many areas. However, because it cannot stop early radial collapse and its associated consequences of malunion, wrist discomfort, and stiffness, this treatment has a high failure probability in unstable distal radius fractures [15]. According to Sarmiento, it is appropriate for stable extra-articular distal radius fractures.

An intra-articular incongruity greater than 2 mm is primarily associated with misalignment and unsatisfactory results. Loss of wrist flexibility and function is linked to dorsal angulation more than 20 degrees. Loss of forearm rotation is linked to radial shortening of >4 mm, while ulnar wrist pain is linked to radial shortening of >5 mm. [16] Therefore, a sustained decrease with 1-2 mm of articular displacement, 10o of dorsal angulation, and 2-3 mm of radial shortening are appropriate treatment objectives for an active person [16]. By using ligamentotaxis, external fixation can maintain the radial length and inclination but not the palmar tilt. According to Sanders et al. (1991) and Chang (1999), complications like infection and tendon injury are directly attributable to the pin placement in as many as 55% of cases.

The well-known procedure of closed reduction and percutaneous pinning was first described by Kapandji in 1976 [9]. He has backed traditional double intrafocal pinning for distal radius fractures that are unstable. The identical fracture was pinched by Nonnenmaclor and Kempfe in 1988 and then Green in 1992, both of whom reported successful outcomes [17]. In 1997, Naidu et al. discovered that the cross pinning of a distal radius fracture is a biomechanically robust construct in both torsion and cantilever bending stresses [18]. Depalma described ulno-radial pinning drilled at a 45° angle, 4 cm proximal to the ulnar styloid, in cases of distal radius fracture with unstable DRUJ [7].

Ulno-radial pinning with DRUJ fixation was described by Rayhack [10]. While Py and Desmanet have recommended elastic pinning for comminuted unstable distal radius fractures to successfully stop the secondary displacement of shattered pieces. In the previous decade, orthopaedic surgeons worldwide advocated open reduction and internal fixation for comminuted, intra-articular distal radius fractures. Volar and dorsal plating with newer implants and procedures gives secure fixation and early functional improvement. Tamara D. Rozental's investigations reveal that percutaneous pinning and plating are both effective in long-term functional outcome. Alexia Karantana, FRCS(Orth), 2013 JBJS [19].

5. Conclusion

Closed reduction and percutaneous K-wire fixation is a less intrusive, safer, and successful approach to preserve the reduction, avoid radial collapse during healing, and maintain DRUJ stability even when the fracture is extensively comminuted, intra-articular, or unstable. Patients treated with closed reduction and percutaneous pinning for distal radius fractures had excellent range of motion, normal Disabilities of the Arm,Shoulder, and Hand scores, and no significant differences in the radio graphic parameters between fracture fixation and fracture healing. Complications werefew. Furthermore, Pinning is an efficacious, low-cost treatment option for 2- and 3-part distal radius fractures with excellent long-term results.

6. Limitation

As the study was done in public sector hospital setting, all the strata of community not available in equal size, most of participants were either from lower or lower middle class. There was a smaller number of follow-up patients as some of them were went-through the loss to follow-up, and also minimal sample size could not make the results to get generalized on the larger scale.

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Conflicts of Interest: Write conflict of interests or write "The authors declare that they do not have any conflict of interests."

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