

A Comparative Study to Analyze the Functional Outcome of Intra - Articular Fractures of Distal Radius Treated with Plating and Percutaneous Pinning

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Abstract: *Introduction:* Fractures of distal radius are the most common fractures of upper limb constituting around 17% of all fractures and 75% of all forearm fractures. Among the causes of distal radius fractures, Colles fracture is the most common cause. These fractures are treated by variety of techniques like manipulation and pop casing, percutaneous pinning, external fixation and plating. Present study compares functional outcome of intra articular distal radius fractures treated with percutaneous pinning and plating. *Materials and Methods:* The present study was carried out in department of orthopaedics, Narayana medical college, Nellore, for a period of 1 year from July 2022 to June 2023. 40 patients participated in this study. 26 patients underwent plating and 14 patients underwent k wiring. Follow up was done at 3,6,12 weeks following surgery. Functional outcome was evaluated using modified Mayo wrist score and DASH evaluation questionnaire. *Results:* In the present study patients treated with plating have better functional outcomes than those treated with percutaneous pinning. Functional outcomes were assessed using MAYO and DASH score.

Keywords: Colles fracture, plating, k-wiring, Mayo score, DASH questionnaire

1. Introduction

Fractures of Distal Radius are the most common fractures of the upper limb constituting 17% of all fractures and 75% of all forearm fractures (1). Due to population explosion, an aging society & an increase of high-speed motor vehicle accidents, the number of distal radial fractures can be expected to increase in the coming decades. So, the distal radius fracture requires a new re-assessment and a newer concept for correct and adequate management. Rise in life expectancy and osteoporotic changes in the skeleton cause an increase in late complications. There is increased risk with a family history of osteoporosis or fractures. Smoking leads to an increased risk of lower Bone Mineral Density (BMD). The Distal radius fractures occur most often in older postmenopausal women, as it has four folds increased risk in women than in men, mostly aged 60-70 years.

Among the causes of distal radius fractures, the Colles' fracture is the most common cause, in which the broken fragment of Radius tilts upward, it was first described in 1814 by an Irish surgeon and anatomist, Abraham Colles – hence the name “Colles” fracture. (5) Treatment of fractures dates back to, an ancient Indian Surgeon Susrutha, who is credited for treatment of bone fractures, some of which are still in practice. The distal radius fractures damage mechanical foundation of man's most elegant tool, hand. No other fracture had a greater potential to reduce hand function.

Despite being a very common fracture in terms of incidence, distal radius fracture is often neglected. Especially among the poor and backward class people who often take

Treatment in native bandages. The complications include stiffness, malunion, nerve injury, tendon injury, non union and complex regional pain syndrome.

Distal radial fractures are treated by wide variety of techniques such as closed manipulation, POP cast reduction and percutaneous pins, pin and plaster, ligamentotaxis, external fixation & internal fixation.

Open reduction and internal fixation have been indicated to address the unstable distal radius fractures and for those with articular incongruity that cannot be reduced and maintained through closed manipulation and ligamentotaxis and percutaneous pinning. Ellis plating is preferred, as screws directly reinforce against collapse and loss of palmar tilt. Volar buttress is used in younger individuals and locking compression plate in old and osteoporotic individuals (6). With smaller and more distal fragments, dorsal plate has to be positioned distally on the dorsum of the radius making extensor tendon injury likely (2). Ellis volar fixed angle plates are an effective treatment for unstable extraarticular distal radius fractures allowing an early post operative rehabilitation (3). In Ellis plate if the screws are not fixed to distal fragment it seeks some function. Under 100N axial load, the palmar compression Ellis plate restores stability comparable to that of an intact radius, and is superior to the conventional palmar or dorsal T-plates (4).

Percutaneous K-wire fixation provides additional stability and is one of the earliest forms of internal fixation. The technique that has been reported and discussed most frequently is the intrafocal (Kapandji) technique. The initial technique was described by using two pins for unstable extra-

articular fractures in younger adults. Indications have been expanded to include fractures with minimally displaced intra-articular fragments and elderly patients, and a third pin was used dorso-ulnarly. The present study compares functional outcome of intra-articular distal radius fractures treated with percutaneous pinning (K-wiring) and Plate fixation.

Aims and Objectives

- To Study Intra articular fractures of distal Radius treated by percutaneous K wiring and plating. To Compare the functional results of Treatment of these fractures with K-wires and Plating.
- To Study the outcome and Post-operative complications of these fractures treated by K wires and plating.

2. Materials and Methods

The present study was carried out in department of orthopaedics, Narayana medical college, Nellore, for a period of 1 year from July 2022 to June 2023. Informed consent was taken from all the patients and ethics committee approval was taken as per the institutional protocols. Inclusion criteria are age between 20 to 65, intra articular, unilateral distal radius fractures.

Preoperative assessment was done as per the institutional protocol and preop radiographs were obtained and relevant radiological parameters were measured and documented before surgery.

Operative Technique:

Patients were given regional anesthesia involving brachial plexus block and interscalene block and general anesthesia was given for patients with failed regional anesthesia.

Prophylactic Intravenous antibiotic injection ceftriaxone 1 gram was administered intravenously before surgery during the induction of anaesthesia. After Anaesthesia was given, patient was placed in a supine position with arm placed on an sidearm table. The affected limb was elevated for 2-3 minutes for examination and exsanguinated. Then a mid-arm esmarch rubber bandage tourniquet was applied and the limb was placed on a sidearm table. Forearm and hand were thoroughly scrubbed, painted with betadine and spirit and draped.

Surgical Procedure

All cases are treated with a volar locking compression plate using a volar Henry's approach and Percutaneous K-wiring.

Surgical Procedure for Plating

Volar Henry's approach was used in all patients treated with Plating. An incision is made between the flexor carpi radialis (FCR) tendon and the radial artery. This interval is developed, revealing the flexor pollicis longus (FPL) muscle at the proximal extent of the wound and the pronator quadratus muscle more distally. The radial artery is carefully retracted radially, while the tendons of the flexor carpi radialis (FCR) radially and flexor pollicis longus (FPL) ulnar side. The pronator quadratus is divided at its most radial aspect, leaving a small cuff of muscle for later reattachment. Any elevation of the muscle of the FPL should be performed

at its most radial aspect, as it receives its innervation from the anterior interosseous nerve on its ulnar side. After the pronator quadratus has been divided and elevated distal radius was exposed. After verifying under fluoroscopy, distal radius locking compression plate (LCP) or dynamic compression plate (DCP) was applied after reducing the fracture fragments. First, a standard cortical screw was applied to the most distal oval hole of the vertical limb of the plate in order to temporarily secure the plate to the proximal fragment. This allowed concomitant proximal and distal plate adjustment. After fixing the distal fragment with subchondral screws, radial length was gained, when necessary, by pushing the plate distally. The first standard screw can be either left in situ or exchanged with another locking screw. The oval hole is a combination hole designed for locking head screw placement at the distal end and standard screw placement at the proximal end of the same hole.

The optimal placement of the distal screws is important. They must be inserted at the radial styloid, beneath the lunate facet, and near the sigmoid notch. The distal screws can be of either monocortical or bicortical engagement. More volar tilt can be achieved during distal screw placement when the wrist is volarly flexed as much as possible by an assistant. Moreover, radial length can be further improved by pushing the whole plating system distally while using the oval plate hole and screw as a glide. The final position of the plate was confirmed using fluoroscopy. Pronator quadratus muscle was used at the time of closure, to cover, in part, the implants that were applied to the anterior surface of the radius. Once stable fixation was achieved and haemostasis secured, the wound was closed in layers and sterile compression dressing was applied. The tourniquet was removed and capillary refilling was checked in the fingers. The operated limb was supported with an anterior below elbow POP slab with the wrist in neutral position. The average surgical time was around 70 minutes (50 to 90 minutes).

Surgical Procedure for K wiring:

The patient was positioned supine on the OT table, with the limb on a side table. Under Regional Anaesthesia or hematoma block (If unsuccessful, then it was converted to General Anaesthesia at the discretion of the anesthetist), the parts were painted and draped. The fracture alignment was achieved by traction – counter traction, and the reduction confirmed by the image intensifier. 1.5 Or 2mm K-wires were passed from the radial styloid crossing the fracture site obliquely to exit the dorsoulnar cortex of the radial shaft. Another K-wire was passed 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. In the case of 60 severely displaced fractures, we use more than two pins for stability. The exposed ends of the K-wires were then either bent, or the ends were inserted into metal balls. The pin sites were then dressed. Then a below elbow slab was applied with the wrist in the neutral position. The average surgical time was around 30 minutes (20 to 50 minutes).

Post OP Care:

Patient were kept nil orally 4 to 6 hours postoperatively. IV

fluids/ Blood transfusions were given as needed. Analgesics were given according to the needs of the patient IV antibiotics were continued for 3 days and switched over to oral antibiotics up to 8th post-op day. The limb was protected in a plaster slab and was elevated over a pillow. Regular dressings were done on 2nd,5th and 7th post-op day. Sutures were removed on 10th post op day. Patient was discharged with slab. Post-operatively, patients were immobilized with a below elbow plaster for another 3 weeks especially if the caging K wire is left in situ, for which patient is advised to attend OPD for dressings. The Plaster slab along with the K-wire is removed during the 3rd week. Gradual mobilization and physiotherapy was started at 3 weeks.

Follow-Up:

Assessment at 1 week: Clinical assessment of pain
 Assessment at 6 weeks: Clinical assessment of pain, Range of motion.
 Assessment at 3 months: Clinical assessment of pain, Range of motion, Clinical & radiological assessment of union.
 Assessment at 6 months: Clinical assessment of pain, Range of motion, Clinical & radiological assessment of union.
 Clinical & functional capabilities with regard to activities of

daily living. Assessment of any complications.

Final Outcome:

Final outcome was evaluated by Modified Mayo wrist score and DASH evaluation questionnaire

DASH evaluation questionnaire

The DASH is a self-administered questionnaire that consists of 30 core questions with an optional 8 further questions, which assess specific work and sport activities. Each item is scored on a 5-point Likert scale with lower scores indicating with minimal impairment. From the item scores, a summative score is calculated. The final score ranges between 0 (no disability) and 100 (the greatest possible disability). Only one missing item can be tolerated and if two or more items are missing, the score cannot be calculated. Based on the DASH score the functional outcome among patients was graded as below.

Excellent outcome– Score between 0 to 25
 Good outcome– Score between 25.1 to 50.0
 Fair outcome– Score between 50.1 to 75.0
 Poor outcome– Score >75.

Disabilities of the Arm, Shoulder, and Hand

Please Rate your Ability to do the Following Activities in the Last week		No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
1	Open a tight or new jar	1	2	3	4	5
2	Write	1	2	3	4	5
3	Turn a key	1	2	3	4	5
4	prepare a meal	1	2	3	4	5
5	Push open a heavy door	1	2	3	4	5
6	Place an object on a shelf above your head	1	2	3	4	5
7	Do heavy household chores (e.g., wash walls, wash floors)	1	2	3	4	5
8	Garden or do yard work	1	2	3	4	5
9	Make a bed	1	2	3	4	5
10	Carry a shopping bag or briefcase	1	2	3	4	5
11	Carry a heavy object (over 10 lbs.)	1	2	3	4	5
12	Change a light bulb overhead	1	2	3	4	5
13	Wash or blow dry your hair	1	2	3	4	5
14	Wash your back	1	2	3	4	5
15	put on a pullover sweater	1	2	3	4	5
16	Use a knife to cut food	1	2	3	4	5
17	Recreational activities which require little effort (e.g., card playing, knitting, etc.)	1	2	3	4	5
18	Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.)	1	2	3	4	5
19	Recreational activities in which you move your arm freely (e.g., playing Frisbee, badminton, etc.)	1	2	3	4	5
20	Manage transportation needs (getting from one place to another)	1	2	3	4	5
21	Sexual activities	1	2	3	4	5
22	During the past week, to what extent has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbors or groups?	1	2	3	4	5
23	During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?	1	2	3	4	5
24	Arm, shoulder or hand pain	1	2	3	4	5
25	Arm, shoulder or hand pain when you performed any specific activity	1	2	3	4	5
26	Tingling (pins and needles) in your arm, shoulder or hand	1	2	3	4	5
27	Weakness in your arm, shoulder or hand	1	2	3	4	5
28	Stiffness in your arm, shoulder or hand.	1	2	3	4	5
29	During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand?	1	2	3	4	5
30	I feel less capable, less confident or less useful because of my arm, shoulder or hand problem.	1	2	3	4	5

Modified Mayo Wrist Score

Cooney et al modified the Green and O’Brien score in 1987 by changing the demerit items and removing radiographic indices. The resulting outcome measure was referred to as the Mayo Wrist Score. This assesses 4 domains: pain, grip strength, range of motion, and return to employment. Each domain is scored out of 25 points to produce a total score out of 100 points. High scores correlate with good function with scores of 90 to 100 points -“Excellent” function ,80-90-“Good function”&,60-80-“Satisfactory”&,Below 60-“Poor”.

Pain	Points		
	25	No pain	0
	20	Mild, Occasional	0-4
	15	Moderate. Tolerable	5-7
	0	Severe to intolerable	8- 10
Functional Status	Points		
	25	Return to regular employment	
	20	Restricted employment	
	15	Able to work, unemployment	
	0	Unable to work, pain	
Range of Motion	Total Motion	Percentage of Normal (%)	
25	≥ 20°	90- 100	
20	100°- 119°	80- 89	
15	90°- 99°	70- 79	
10	60°- 89°	50- 69	
5	30°- 59°	25- 49	
0	0°- 29°	0- 24	
		Percentage of Normal (%)	
25		90- 100	
15		79- 89	
10		50- 74	
5		25- 49	
0		0- 24	

Age Incidence:

Age	No. of cases in Plating Group	No. of cases in K wiring Group
20- 30	6	2
30- 40	5	2
40- 50	7	3
50- 60	8	5
Total	26	14

Gender Incidence:

Sex	Distribution (N= 40)	
	Number	Percentage
Male	24	60%
Female	16	40%
Total	40	100%

Side Involvement

Side Involved	Plating	K wiring	Total
Right	18	10	28
Left	8	4	12
Total	26	14	40

Mode of Initial Injury

Injury	Plate	K Wire
FOOSH	15	08
RTA	09	06
DIRECT BLOW	02	00
TOTAL	26	14

Duration of Surgery

Type of Procedure	Duration of Surgery (min) range	Duration of Surgery (min) Mean
Plating	50- 68	57.76
K wiring	35- 43	37.92

3. Observation and Results

The data was analysed and observations are tabulated as follow.

Functional Outcome Evaluation

Modified Mayo wrist Score (post op)	Plating	K wiring	Total
Excellent	6	2	8
Good	12	6	18
Satisfactory	7	7	14
Poor	0	0	0

Complications

Complication	No. of cases in Plating Group	No. of cases in K wiring Group
Post op residual pain at 6 weeks	5 (19%)	1 (7%)
Infection	1 (3.8%)	2 (14.2%)
Implant Failure (Prominent Plate/ Pin loosening)	0	3 (21.4)
Finger Stiffness	3 (11.3)	3 (21.4)
Post op Neuropraxia/ Nerve injury	2 (7.6)	0



PRE-OPERATIVE

POST-OPERATIVE



3 MONTHS FOLLOWUP



DORSIFLEXION



PALMAR FLEXION

Case 1: Treated with K Wiring



PREOPERATIVE



POST-OPERATIVE



3MONTHS FOLLOWUP



DORSIFLEXION



PALMARFLEXION

Case 2: Treated With K Wiring



Pre-reduction - AP

Pre-reduction - Lat

Post-reduction - AP



Post-reduction - Lat

6m F.U - AP view

6m F.U - Lat view



6m F.U - Dorsiflexion

6m F.U - Palmar flexion

6m F.U - Pronation



6m F.U - Supination

6m F.U - Radial deviation

6m F.U - Ulnar deviation

Case 1: Treated with Plating



PRE-OPERATIVE

POST-OPERATIVE



Case 2: Treated With Plating & Rom at 6 Months

4. Discussion

In the present study 8 patients were in 20-30 years, 7 patients were in 30-40 years, 10 patients were in between 40-50 years, and 13 patients were in 50 -60 years age group. The patients' age was ranging from 21 to 60 years. The average incidence of age in our study was 40.5 years.

There were 24 men (60 %) and 16(40%) women in the present study. Out of 40 patients, 28 patients (70%) were right handed and 12 patients (30%) were left handed. All the patients in our study population were right hand dominant people. Hence we operated on 28 patients on their dominant side. Fall on outstretched hand was the most common mode of injury accounting for 23(57.5%) cases due to self sustained fall. Other modes of injury were road traffic accidents accounting for 15(37.5%) of cases while direct blow was seen in 2(5%) patients. In the present study the post-operative follow up ranged from 3 months to 12 months

with average being 6.7 months. The average pre-operative grip strength was measured using a dynamometer was 7.8 kg while the average post operative grip strength was 30.3 kg. All the patients in our study treated with plating were operated either by volar Henry's approach or Percutaneous K wiring using Kapandji technique.

The average preoperative range of mobility around the wrist are palmar-flexion of 40.2 degrees, dorsi- flexion of 49.4 degrees, supination of 43 degrees and pronation of 39 degrees. The average post operative range of mobility around the wrist at the final follow up are palmar-flexion of 69 degrees, dorsi-flexion of 70.3 degrees, supination of 70.2 degrees and pronation of 69.1 degrees.

Based on modified mayo wrist score we had 8 excellent, 19 good and 13 satisfactory results. The mean pre op modified mayo wrist score was 28.6 in our study. The mean post op modified mayo wrist score was 80.6 in our study. Based on DASH score we they had mean pre operative score of 59.6 which improved to post op score of 19.6. Post-op residual pain was present in 5 patients at 6 weeks follow-up.

1 case of superficial infection was reported which was treated with dressings antibiotics based on culture report and strict limb elevation. Post-op range of movements were significantly improved. No cases of tendon injuries were reported. 2 cases of median nerve neuropraxia were reported and they had complete recovery at 6 weeks follow-up.

5. Conclusion

Based on our experience and results, we conclude that percutaneous pinning and plate osteosynthesis are reliable methods for the treatment of intra-articular distal radius fractures.

There is a marked improvement of functional outcome by increase of grip strength, range of movements and relief from pain treated with plating as patients treated with plating were mobilized early, subsequently reducing post-operative stiffness.

Volar Henry approach gives good visualization of fracture site in distal radius fractures and has a lower complication rate. The procedure of Percutaneous pinning has less operative time, but there were cases reported with loss of radial length post-operatively. Pin tract Infection was also a complication.

Cases treated with percutaneous pinning also required prolonged immobilization up to 6 weeks which resulted in post-operative stiffness of wrist and fingers.

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