Indian Journal of Orthopaedics Surgery 2023;9(2):81–88

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Indian Journal of Orthopaedics Surgery

Journal homepage: https://www.ijos.co.in/

Original Research Article

Evaluation of functional results of different treatment modalities in Intra-articular fracture of distal end of radius in adults at a tertiary care hospital in Eastern India

Avinash Naik[1], Snigdha Singh[2,*], Meenakshi Pandey[3], Nishant Panda[4], Shakti Prasad Das[5]

[1]*District Headquarter Hospital, Sundargarh, Odisha, India*
[2]*London School of Hygiene & Tropical Medicine, United Kingdom*
[3]*Government Medical College, Sundargarh, Odisha, India*
[4]*Watford General Hospital, West Hertfordshire Teaching Hospital, Hertfordshire*
[5]*Kalinga Institute of Medical Sciences, KIIT Univer, Kalinga Institute of Medical Sciences, KIIT University,, Bhubaneswar, Odisha, India*

ARTICLE INFO

Article history:
Received 24-04-2023
Accepted 16-05-2023
Available online 30-05-2023

Keywords:
Distal radius fracture
Plating
Ellis approach
Unstable fracture
Pain score
Function score

ABSTRACT

Introduction: Fractures of the distal radius (DRF) are the most common orthopedic injuries: one out of every six fractures presented at emergency department is a distal radius fracture. Almost two-thirds of these fractures are displaced and need to be reduced. Epidemiological studies point out that the age rate curve is bimodal and that the highest incidences are found in children and the elderly. DRF constitute 14% of all extremity injuries. They occur as a result of high or low energy trauma resulting in significant injury and impairment of function of the upper extremity. Randomized controlled trial has been attempted to scrutinize the best method for treating DRF, ranging from methods of conservative treatment to advanced strategies of plate osteo-synthesis.

Materials and Methods: 124 Patients with 126 intra-articular distal radius fractures were studied, who met with predefined inclusion and exclusion criteria at Department of Orthopaedics, Kalinga Institute of Medical Sciences, Bhubaneswar from 1st October 2017 to 30th September 2019. They underwent different treatment interventions. The cases were followed for 12 months at regular intervals for serial clinical & radiological evaluation. Functional grading and pain scoring was done for different treatment modalities. Radiological grading was made based on union/ non-union of fracture.

Results: Majority with wrist fracture were of age 20-40 years followed by the age group 61-80 years. Grip strength was reported better in surgical group(79.2%). Mode of treatment is statistically significant with Palmar flexion ($p = 0.015$), Supination ($p=0.025$) and Pronation ($p<0.001$) of wrist post surgical treatment. Plating group experience significantl less pain ($p=0.012$). Mean function score for surgical group is 19.8.

Conclusion: The impetus for the inclination towards treatment of wrist fracture by surgery, mainly plating method, stands multifactorial and might bring better outcomes in terms of range and degree of movement, expedited recovery, lower chances of malunion and in a way, better prognosis and quality of life in case of DRF.

1. Introduction

Fractures of the distal radius (DRF) are the most common orthopedic injuries: one out of every six fractures presented

* *Corresponding author.*
E-mail address: drsnigdhas92@gmail.com (S. Singh).

https://doi.org/10.18231/j.ijos.2023.019

at emergency department is a distal radius fracture.[1] Distal radius fractures constitute around 20% of all fractures.[2] They occur as a result of high or low energy trauma resulting in significant injury and impairment of function of the upper extremity.[3] The orthopedic literature features several surgical options for this kind of injury, and each option has its own peculiar advantages and complications.[2]

The American Academy of Orthopedic Surgeons is currently unable to recommend any specific treatment—whether conservative or surgical—and, in the latter case, they also do not suggest which surgical procedure is the best one.[2] Choice of treatment depends on many factors, such as the patient's age, life style, associated medical conditions, compliance, functional demands, limb dominance, type of fracture, severity and alignment of the fracture, condition of the soft tissue, and concomitant fractures.[4–7] The treatment goal for fractures of the distal end of the radius is fully functional recovery of the wrist and prerequisite are restoration of the anatomy and early mobilization. Poor fracture reduction might be the cause of secondary arthritis and decline in functional outcome.[8,9] Treatment by closed reduction and cast immobilization can be carried out on a large scale at low expense and without admission; however, this often leads to poor radiological results and re-displacement, which can be as high as 40%, according to Mulders et al.[10]

Several surgical options for distal radius fractures have been described, such as percutaneous pinning and casting and external fixation.[4–6,11] Open Reduction Internal Fixation (ORIF) using the volar locking plate technique represents the most chosen option.[10,12,13] A recent randomized controlled trial showed that ORIF treated patients have faster recovery of function compared with external fixation, however, no functional advantage was demonstrated at 2 years follow up.[14] A number of treatment options exist to counteract the loss of reduction in unstable distal radius fractures in which maintenance of anatomic reduction is a prime requisite.[15] External skeletal fixation, with or without augmentation of K wires, has been long used for the treatment of unstable extra-articular and selected intra-articular distal radius fractures, which uses the principle of 'Ligamentotaxis' for reduction and restoration of articular congruity.[13,15,16]

DRF has an impact over the health care system due to the effect on a young labor force and also in the elderly. Thus, this study was taken up to scrutinize the best method to treat DRF, be it the method of conservative treatment or the advanced strategies of plate osteo-synthesis.

2. Objectives

1. To assess patterns of intra-articular fractures of distal end of radius.
2. To study the functional outcomes of different modalities of treatment for intra-articular fracture of distal end of radius in adults.

3. Materials and Methods

124 Patients with 126 intra-articular distal radius fractures were studied. 48 patients opted for conservative management due to financial constraints, while 76 patients underwent surgical management. In the study area, the intra-articular Distal radius fractures are managed conservatively and surgically after proper counselling of the patient and as per their will. Surgical methods adopted were Pinning, Ligamentotaxis with external fixator & plating. Out of the 76 cases treated surgically, 19 were managed by Pinning, 8 required Ligamentotaxis with External fixator in aided to plating or pinning, of that 1 was managed with ligamentoaxis with external fixator only & 50 with only Plating, of these, 3 required the help of pinning for fixation at Department of Orthopaedics, Kalinga Institute of Medical Sciences, Bhubaneswar from 1^{st} October 2017 to 30th September 2019 after Institutional Ethics approval. The study was self funded.

The study includes the patients who met with predefined inclusion & exclusion criteria of this study. To be a part, the patient had to be $\geq$ 20 years old, presenting with fractures of distal end radius of either side or both side (closed type) within 2 weeks of injury and the fracture should be up to 3 cm from distal articular surface of radius. The ones excluded were either having Compound fractures or Pathological fractures, a fracture beyond 3 cm from distal articular surfaces of radius (diaphyseal extension), history of trauma > 2 weeks, epiphyseal injuries of distal radius, patient associated with carpal injuries/fractures or refracture at the same site.

After initial resuscitation in the emergency, closed fractures were splinted & operated at the earliest. Preference was given for management of life threatening emergencies i.e. head injury, blunt trauma abdomen, blunt trauma chest & patients were taken up for orthopedic surgery once patient was out of danger, till then fractures were managed with slab application & elevation. After the patient with intra-articular distal radius fracture got admitted / planned to treat on outpatient basis, all the necessary clinical details were recorded in proforma prepared for this study along with the routine investigations. Most cases of distal Radial fractures which were minimally displaced & comminuted were sent into conservative group, whereas fractures which were displaced & comminuted, were sent into surgical group by keeping patient preference for conservative and surgical after proper counselling.

Surgical procedure was done under anesthesia, general or supra clavicular block, patient in supine position with affected wrist on side table, the fracture was approached. For Pinning, K wires - 1mm, 1.5mm & 2mm was used, while for external fixation, Schanz pins - 2.5, 3.5mm Clamps, Connecting rods were used. For plating, Ellis Plate /Distal

radial LCP was used.

For Pinning, fracture site was identified under image intensifier. Usually, the radial styloid is pinned to the proximal shaft in a reduced position. Once the lateral cortex is reconstituted, the intermediate column (lunate facet) is pinned from dorsal ulnar to proximal radial. Finally, the central impaction fragments can be supported using subchondral transverse wires. Plaster was applied if fracture fixation was doubtful.

While for External fixation, Schanz pins were fixed to lateral border of radius (minimum 2pins) after stab incision at the planned pin site & drilling it. Similar procedure was done on radial border of 2nd metacarpal. After traction & counter traction the fracture reduction was done under image intensifier & pins fixed to connecting rod with clamp, as needed after reduction, fixation was done with pins or plate.

Plating was done by the Ellis approach where sub periosteally the Pronator Quadratus was detached from lateral border of the radius. This was followed by lateral bending of the distal part of the incision for a finer access to the articular surface. Anatomic reduction of both the radial & the intermediate columns was done by either using the manual ligamentotaxis or dismentalling the fractured bone fragments with help of an osteotome. A volar locking plate (Ellis plate) was used, the reduction and screw placement were verified under an image intensifier. If found necessary, additional stabilization was carried out either with k-wires or cancellous screws. At the end of the procedure, the detached end of the pronator quadratus was reattached to the edge of brachioradialis. Distal Radio-Ulnar Joint instability was checked in every case during the operation post fixation of distal radius by the ballotment test, keeping forearm in neutral position.[15]

Post operatively, analgesics and antibiotics were prescribed. Records available in the form of admission notes, operative notes, progress notes & follow up OPD records were analyzed. After the completion of the hospital treatment patients were discharged & called for follow up for 12 months at out patient level, at regular intervals for serial clinical & radiological evaluation. We considered a fracture united if there were no pain on palpation or attempted motion, no increase in warmth at the fracture site, no discomfort on carrying weights & serial roentgenograms demonstrated bone trabaculae crossing the fracture site or union of 3 cortices. The functional, radiographic & overall results were recorded. A 10 point Likert scale for 5 items was used to assess the pain (1= no pain to 10 = the worst pain) where index score ranged from 5-50 where a lower score indicates less/ absence of pain. While, for the function score (10 items), Likert scale was used (1= no difficulty to 10= difficult to function). The index is constructed by summing the item scores. The score ranges from 10-100 where a higher score indicates difficulty in functioning.

Radiological grading was made based on union/ non-union of fracture and presence of any residual deformity. The final outcome is compared with the results available from the latest literature. Data analysis was done using STATA-17 where Chi square test and ANOVA was applied. Cross tabulation of two variables to get crude association.

Was carried out and Chi square test was performed to examine the association between exposure and outcome.

4. Results

This study reports that majority of the patients with wrist fracture were of age 20-40 years followed by the age group 61-80 years. 34.7% patients were from lower socio-economic class (Table 1) who were mainly daily laborers by occupation. It was interesting to see that majority were workers at various construction sites. It was noted that 56.25% of the patients opting for conservative treatment were of age 20-40 years.

Table 1: Baseline characteristics of the study patients, N=124

Variables	Frequency (%)
Age (Years)	
20-40	68 (54.8%)
41-60	12 (9.7%)
61-80	40 (32.3%)
81-100	4 (3.2%)
Gender	
Male	91 (73.4%)
Female	33 (26.6%)
Socio economic status	
Upper middle class	26 (21%)
Upper lower class	19 (15.2%)
Middle class	36 (29%)
Lower class	43 (34.7%)
Medical history (at least for more than 5 years)	
Diabetes	48 (38.7%)
Hypertension	61 (49.2%)
Sickle cell anaemia	2 (1.6%)
Respiratory Tuberculosis	1 (0.8%)

On further detailed investigation, the present study reports that fracture wrist was more common on the non dominant hand (54%) which was due to fall on outstretched hand while working (Table 2). Of the 124 patients in study, 2 had bilateral wrist fractures. Road traffic accidents were reported to be the second most common cause (25.8%) of wrist fracture among the study participants. Moreover, this study found a statistical significance between the mode of injury and fracture laterality (p =0.041).

49 wrists underwent the conservative procedure while 19 wrists had k- wire fixation, where 16 had been fixed with percutaneous pinning after closed reduction and 3 required open reduction and fixed with k-wire.

Table 2: Description of the injury succumbed by the patient, N=124

Variables	Frequency (%)
Presence of fracture on dominant hand	57 (46%)
Fracture involving bilateral hand	2 (1.6%)
Time since fracture	
≤ 2 weeks	69 (55.6%)
≤ 1 weeks	55 (44.4%)
Mode of injury	
Domestic fall	85 (68.5%)
Fall from height	7 (5.6%)
RTA	32 (25.8%)
Fracture laterality	
Right	59 (47.6%)
Left	65 (52.4%)

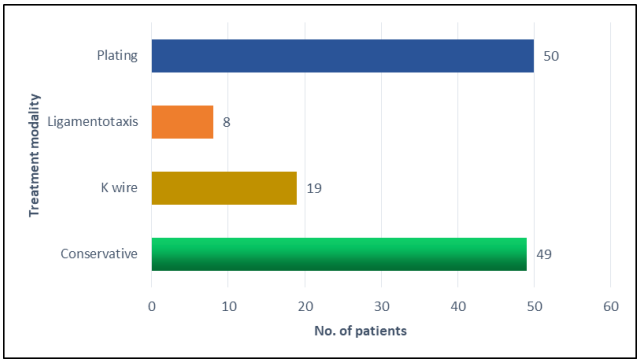

Fig. 1: Distribution of patients on basis of type of management provided, N=124

8 wrists had ligamentotaxis with 1 wrist having fixed with ligamentotaxis only, 2 wrists needed fixation with percutaneous pinning with k-wire with ligamentotaxis and 4 wrists were fixed with plating where reduction was achieved with the help of ligamentotaxis. 1 wrist was fixed with plating, k-wires with help of ligamentotaxis.

Majority (50 wrist) did undergo open reduction with internal fixation with plate, out of which, 3 required k-wire fixation for better fixation post reduction.

The radiological variables - radial height, radial inclination, palmar tilt and ulnar variance of the fractured as well as normal wrist were recorded, preoperatively and post-operatively. Table III depicts the range of movement of the wrist post various treatment modalities. In the study it was found that the best range of movement was obtained with open reduction and internal fixation with plate and screw.

Further, on assessment of the grip strength, it was >50% compared to the normal wrist in 67.3% (33) in the conservative group & 79.2% (61) in the surgical group. Whereas, it was < 50% compared to the normal wrist in 32.7% in the conservative group & 20.8% in the surgical group.

V depicts the information regarding the degree of wrist movement reported post various treatment modalities. The mean Palmar-flexion of wrist for conservative group was 61.2° and 70° for surgical group while, mean Pronation for conservative group was 73.3° and 70.8° for surgical group. Among the surgeries, post plating was found to facilitate better range of wrist movement. Moreover, it was found that the mode of treatment is statistically significant with Palmar flexion (p value = 0.015), Supination (p value=0.025) and Pronation (p value<0.001) of wrist post surgical treatment.

On analyzing the loss of wrist movement post fracture treatment, it was found that patients who have undergone conservative treatment were unable to have a total functioning wrist. More than 30% patients who underwent conservative treatment had loss of movement of greater than 50% of total functionality while treatment with surgery using plating, showed better result in terms of regaining the lost movement (Table 5).

Figure 2 depicts the pain score assessed in the study participants. The mean pain score for conservative group was 21.3 and 15.4 for patients in the surgical group. Patients with a pain score below 20 in the conservative group, K Wire group, Ligamentotaxis group and Plating group were 61.2%, 57.9%, 75% and 96%, respectively. We can conclude that patients in the plating group experience significantly less pain (p value=0.012).

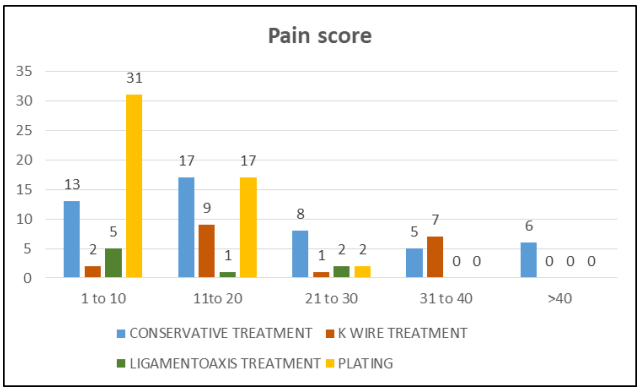

Fig. 2: Pain score assessment of patients, N=124

The mean function score for conservative and surgical group was found to be 30.5 and 19.8, respectively. A function score of more than 50 was reported by 69.4% of patients in conservative group, 57.9% in K Wire group (Figure 3). The functionality was not statistically significant with the plating group of patients which could be explored with a larger sample in future studies.

Further, in the study, union of the fractured bone was assessed using X-Ray at various intervals, over a period of 12 months. 51.9% and 87% of wrists showed union by 6 weeks and 3 months respectively in surgical group whereas, it was 34.6% and 67.3% in the conservative group during 6 weeks and 3 months respectively. Hence, it is evident

Table 3: Range of wrist movements experienced post application treatment modality, N=124

Movement	Treatment Modality			
	Conservative (%)	K- Wire (%)	Ligamentoaxis (%)	Plating (%)
Dorsi-flexion	57.4	63.7	68.2	72.4
PalmarFlexion	61.4	67.4	75.6	70.6
ADP	121.8	131.6	142.5	143
Radial Deviation	9.1	6.1	7.5	10.8
Ulnar Deviation	15.7	16.6	16.9	19.7
ARU	24.5	22.6	24.4	27.6
SUP	75.7	77.6	81.3	81
APS	149	145	158.8	152.9
PRO	73.3	66.8	77.5	71.3
		p value = 0.001		

Table 4: Degree of wrist movement reported post application treatment modality, N=126

Degree of movement	Conservative	K-wire	Ligamentoaxis	Plating	p-value
Dorsi- Flexion					
0-10	3 (6.1%)	0 (0%)	0 (0%)	0 (%)	
11-20	2 (4.1%)	1 (5.3%)	0 (0%)	0 (%)	
21-30	2 (4.1%)	1 (5.3%)	1 (12.5%)	0 (%)	0.32
31-40	0 (0%)	0 (0%)	1 (%)	0 (%)	
41-50	7 (14.3%)	0 (0%)	0 (%)	1 (%)	
>50	35 (71.4%)	17(89.4%)	6 (%)	49 (%)	
Palmar-Flexion					
<50	16 (%)	2 (%)	1 (%)	6 (%)	
51-75	16 (%)	11 (%)	1 (%)	29 (%)	0.01
>75	17 (%)	6 (%)	6 (%)	15 (%)	
ARC of Dorsi-Palmar Flexion					
<100	7 (%)	2 (10.5%)	1 (12.5%)	1 (2%)	
101-150	27 (%)	12 (63.2%)	4 (50%)	33 (66%)	0.488
>150	15 (%)	5 (26.3%)	3 (37.5%)	16 (32%)	
Radial Deviation					
0-10	38 (77.5%)	17 (89.5%)	8 (100%)	35 (70%)	0.313
11-20	16 (32.65%)	11 (57.9%)	1 (12.5%)	29 (58%)	
Ulnar Deviation					
0-10	7 (14.3%)	1 (5.3%)	1 (12.5%)	5 (10%)	
11-20	32 (65.3%)	16 (84.2%)	7 (87.5%)	33 (66%)	0.527
21-30	10 (20.4%)	2 (10.5%)	0 (0%)	8 (16%)	
31-40	0 (0%)	0 (0%)	0 (0%)	4 (8%)	
ARC of Radio Ulnar Deviation					
<10	6 (12.2%)	1 (5.3%)	1 (12.5%)	0 (0%)	
11-50	43 (87.8%)	8 (42.1%)	7 (87.5%)	50 (100%)	0.521
>50	0 (0%)	10 (52.6%)	0 (0%)	0 (0%)	
Pronation					
<50	5 (10.2%)	3 (15.8%)	2 (25%)	9 (18%)	
50-75	15 (30.6%)	7 (36.9%)	0 (0%)	15 (30%)	0.05
>75	29 (59.2%)	9 (47.3%)	6 (75%)	26 (52%)	
Supination					
<50	3 (6.1%)	1 (5.3%)	1 (12.5%)	0 (0%)	
50-75	14 (28.6%)	9 (47.35%)	1 (12.5%)	17 (34%)	0.025
>75	32 (65.3%)	9 (47.35%)	6 (75%)	33 (66%)	
ARC of pronation- supination					
<100	3 (6.1%)	3 (15.8%)	1 (12.5%)	0 (0%)	
101-150	20 (40.8%)	7 (36.8%)	1 (12.5%)	17 (34%)	0.13
>150	26 (53.1%)	9 (47.35%)	6 (75%)	33 (66%)	

Table 5: Description of loss of wrist movement with respect to various treatment modalitie

Loss of Movements (%)	Conservative	K wire	Ligamentotaxis	Plating
1-10	3 (6.1%)	2 (10.5%)	0 (0%)	5(10%)
11-20	5 (10.2%)	2 (10.5%)	6 (75%)	6 (12%)
21-30	0 (0%)	6 (31.6%)	0 (0%)	19 (38%)
31-40	17 (34.7%)	2 (10.5%)	0 (0%)	10 (20%)
41-50	9 (18.4%)	5 (26.3%)	0 (0%)	10 (20%)
>50	15 (30.6%)	2 (10.5%)	2 (25%)	0 (0%)
Mean ± SD	26.5±6.17	26.8±1.6	32.6±2.2	26.5±5.85

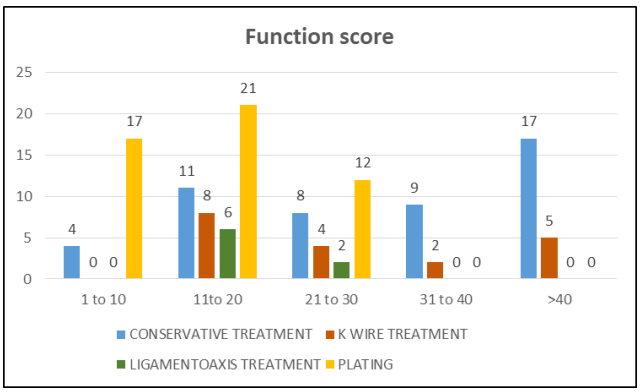

Fig. 3: Function score assessment of patients, N=124

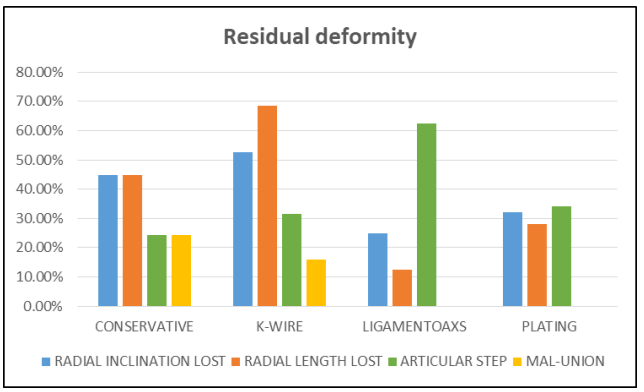

Fig. 4: Residual deformity assessment on radilogical examination, N=124

that surgical intervention had faster rate of union (p value= 0.031).

During the follow up visits in OPD over a period of 12 months i e. on 6^{th} week, 3^{rd} month, 6^{th} month and 12^{th} month, radiological examination was conducted to assess the occurrence of fracture union. It was interesting to note that most of the patients who underwent Ligamentoaxis procedure (62.5%), had union of fracture wrist at the 6^{th} week post surgery, followed by 87.5% fractures showing union by end of 3 months and, all patients showed union by 6 months (Table 6).

The treatment procedure using Plating that proved to be useful in gaining total functionality of wrist is time taking with respect to the time taken for union of fracture.

On radiological assessment of the patients who underwent various treatment modalities, for residual deformities, if any, radial inclination loss was noted in 39.7% of total affected wrists with highest in K-Wire fixation group. Radial length loss was noted in 39.7% of total wrists with majority in the conservative group (Figure 4).

5. Discussion

Fracture of the Distal End Radius is the commonest bony injury around the wrist.[17] Management of these fracture has remained controversial as far as modality of treatment is concerned.[2] From casting to arthroscopic assisted reduction,all treatment modalities have been tried,[2–4,10] Sir Abhram Colle's first described the deformities of Distal end Radius fractures many years before the advent of X Rays.[18] Since then, a lot of modifications in the management of Distal end radius have taken places, which include Closed Reduction with casting, K-Wire fixation, External fixation with Ligamentoaxis, open reduction and fixation with various design plates.[2,13–15]

Incidence of intra articular fracture 1/3rd radius is significantly on rise due to high velocity accidents in young and adults.[19] Painless wrist function is of vital importance for functioning of upper extremity in almost all activities of daily living and precise function of hand. Intra-articular fracture of 1/3rd radius has generally gross comminution and so also small articular fragments.[20] Orthopaedic community differ about specific implants to fix this complex injury.

A study found bimodal distribution in which there was a peak at age 10 to 14, followed by a peak in the late 70s of life.[21] The present study reports wrist fracture to be more common among the age group of 20-40 years and 61-80 years, which is in accordance to previous studies.[21–23] This can be attributed to the fact that pediatric age group have highly fragile bones whereas the elderly population have reduced bone density or osteoporosis. It was interesting to note that more male were affected in comparison to females which stands similar to findings of studies by MS Khan et al.,[24] Gawali SR et al.[25] and few others[22,23] but in

Table 6: Comparison of time of union with respect to various treatment modalities, N=126

Duration	Treatment modality			
	Conservative	K wire	Ligamentoaxis	Plating
6 weeks	16 (32.6%)	10 (52.6%)	5 (62.5%)	25 (50%)
3 months	17 (34.7%)	7 (36.8%)	2 (25%)	18(36%)
6 months	9 (18.4%)	2 (10.6%)	1 (12.5%)	4 (8%)
12 months	7 (14.3%)	0 (0%)	0 (0%)	3 (6%)

contrary to study done by Ali Azad et al. where adult female population were more affected.[21] Current study finding hints towards young male being more commonly employed in the construction labor jobs and being prone to falls on outstretched hand, leading to wrist fracture. Wrist fractures are 3^{rd} most popular fracture among the men.[26] Moreover, the wrist of the non dominant hand was seen to be more commonly affected (54%) than dominant side(46%) which is in agreement with study done by Ashok et al.[23]

The most commonly used treatment modality was surgery (77 cases). Out of 77 surgical cases, 19 were managed by Pinning, 8 by Ligamentotaxis with External fixator & 50 with plating, as reported in our study. However, in a study done by Ali Azad et al, they found a significant increase in the use of internal fixation (from 8.75 to 20.02%), in addition to a simultaneous decline in percutaneous fixation.[21] The rate of internal fixation was maximum for age group 19-40 years.[21] Moreover, there is evidence that there was better functional score reported with plate fixation in comparison to percutaneous and external fixation.[27]

On assessing the range of movement post various treatment modalities, in present study we found a loss of >50% Grip strength in 67.3% cases who had conservative treatment. This was in line with finding of another study which concluded surgery to be the treatment of choice in wrist fracture.[22] Prashanth G et al.[22] in their study reported mean range of motion to be 43.7 degree for palmar flexion, 54.1 degree for dorsiflexion, 21.1 degree for ulnar deviation, 13.1 for radial deviation, 72.6 degree for supination, 71.6 degree for pronation which is similar to our study and another study conducted by Gawali SR et al.[25] Minimal functional range of movement reported by Prashanth G et al.[22] is in line with the findings of present study. Hence, it may be quoted that the conservative treatment lags in complete or better reversion of damage occurred.

In previous study, 98% cases of wrist fracture united within 3 months post surgery, 2% united within 3-4 months after conservative treatment[22] whereas 87% of wrist showed union by 3 months in surgical group compared to 67.3% in conservative group. Interestingly, the change towards more fracture fixation by Ellis plate accounted in the elderly population could be a reason of surge in risk of malunion due to associated osteopenia/ osteoporosis and need for better quality of life which is in accordance to similar study.[12,13,15,21]

Similar to our findings on the residual deformities, Gawali SR et al. in their study also reported volar angle V, the radial angle and length to be better maintained with surgical modalities than conventional plaster cast method of treatment.[25] This is also in line with many previous studies.[22–24]

6. Conclusion

Conservative management is better in managing un-displaced, minimally comminuted fractures & fractures with minimal initial displacement, for fractures with minimal comminution, the K-wires appear to be giving better results if used with plaster and for the highly comminuted fractures, external fixator was found to be a better option.

The impetus for the inclination towards treatment of wrist fracture by surgery, mainly plating method, stands multifactorial and the probable factors might be better outcomes in terms of range and degree of movement, expedited recovery, lower chances of malunion and in a way, better prognosis.

Thus, plating of wrist fracture is a safe and effective modality of treatment providing a quality of life to the patient post surgery.

7. Source of Funding

None.

8. Conflict of Interest

None.

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Author biography

Avinash Naik, Consultant

Snigdha Singh, Epidemiologist https://orcid.org/0000-0002-7432-4302

Meenakshi Pandey, Assistant Professor

Nishant Panda, SHO https://orcid.org/0000-0002-0941-1119

Shakti Prasad Das, Assistant Professor

Cite this article: Naik A, Singh S, Pandey M, Panda N, Das SP. Evaluation of functional results of different treatment modalities in Intra- articular fracture of distal end of radius in adults at a tertiary care hospital in Eastern India. *Indian J Orthop Surg* 2023;9(2):81-88.