

A STUDY OF FUNCTIONAL OUTCOME OF VARIOUS MODALITIES OF TREATMENT FOR DISTAL RADIUS FRACTURES

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ABSTRACT

Background: Heightened awareness of the widening scope of distal radius fractures has led to the emergence of a substantial change in concepts that rational treatment should incorporate. Among these concepts prominent is that functional recovery is directly proportional to accuracy of skeletal restoration. The optimal management aims at accurate skeletal anatomy restoration by closed or open treatment, recognition and repair of associated injuries and supervised rehabilitation by skilled therapists. To achieve this various modalities of treatment are available i.e. closed reduction and POP cast application, closed reduction and percutaneous K-wire fixation under fluoroscopic guidance, ligamentotaxis and stabilization with external fixator, open reduction and internal fixation with plates. Still there is no consensus on which treatment is superior or firm guidelines regarding treatment decisions hence this study was undertaken. **Materials and Methods:** The study was conducted on patients presenting with distal end radius fracture in Department of Orthopaedics, Department of Orthopaedics, Vydehi institute of Medical Sciences & Research Centre, Bangalore. Intervention was contemplated after explaining the details of treatment modality with cast for undisplaced extra-articular fractures, percutaneous fixation with K-wires for minimally displaced extra-articular and undisplaced stable intra-articular fractures, external fixation used for ligamentotaxis for unstable grossly comminuted intra-articular fractures and volar plating for displaced non-comminuted intra-articular fractures. **Result:** The present study comprised of 100 patients of distal radius fractures, the average age of patients was 38.6 years with the range being 20-70 years. Fall on outstretched hand was the commonest cause of the trauma (62%). Male patients (76%) outnumbered female patients (24%). AO A2 type of fracture was the most common type of fracture pattern encountered (46%). Out of 100 patients on whom results were analysed, 34% patients were treated by plating, 42% by cast application, 13% by percutaneous K-wire application, 7% by external fixator and 4% by external fixator with k-wire. Using the demerit point score we had 16 (47.1%) excellent results in volar plating, 12 (28.57%) in cast, 3 (23.1%) in K-wire fixation, 1 (14.3%) in external fixator, Good results were found in 22(52.38%) in cast application, 7 (53.8%) in k-wire, 9 (26.5%) in volar plating, 2 (28.6%) in external fixator, 2 (50%) in ex-fix with k-wire fixation. Complication such as irregular articular surface, wrist pain, finger stiffness, malunion, pin tract infection and K-wire loosening was observed. **Conclusion:** Functional outcomes are related more related to the quality of anatomical reduction than to the method of immobilization. Extraarticular fractures give better results than intra-articular fractures. Locking compression plate is a safe and effective treatment for most complex fractures of distal radius. Due to complexity of AO C2 and C3 fracture types, outcome results were limited irrespective of fixation method used. As anatomical reduction and early mobilization are most effectively achieved by operative interventions, we propose that operative intervention should be recommended in management of distal radius fractures in affordable patients.

INTRODUCTION

Fractures of distal end radius contribute up to 20% of all fractures presented to emergency departments.^[1] Distal radius fractures have an approximate incidence of 1:10,000 and represent 16% of skeletal and 74% of forearm fractures.² Prevalence is more among females and progressive increase in complications with age is seen, as osteopenia and osteoporosis become more prevalent with aging.^[2] The most common mechanism of injury is falling over outstretched hand.² The characteristics of distal radius fractures (location, joint involvement, comminution and degree of soft tissue injury) are directly related to the force of the trauma, wrist angle at the moment of the trauma and bone health.² Heightened awareness of the widening scope of distal radius fractures has led to the emergence of a substantial change in concepts that rational treatment should incorporate. Among these concepts prominent is that functional recovery is directly proportional to accuracy of skeletal restoration. The overly optimistic attitude that a favourable outcome will eventuate despite residual deformity must be tempered by the realization that the common factor predisposing to a suboptimal recovery is mal-union. The distal radial joint anatomical restoration is the rationale for operative treatment. Most studies with associated as little as ^[1] mm of incongruity of the distal radius articular surface with worse outcomes, whereas some studies report have found no association of radiographic arthrosis and outcomes. The degree of articular surface displacement and disruption, the stability and reducibility of each fracture, as well as any concurrent injury to adjacent nerves, tendons or carpal structures must be assessed carefully in logical treatment planning. The optimal management aims at accurate skeletal anatomy restoration by closed or open treatment, recognition and repair of associated injuries and supervised rehabilitation by skilled therapists.^[3] Even though 1000 peer-reviewed published studies on distal radius fractures management, still there is no consensus on which treatment is superior or firm guidelines regarding treatment decisions.^[4,5] Many confounding variables exist, which are somewhat controversial: like level of anatomical restoration, quality of the bone, the advances in techniques and devices, the experience and ability of the surgeon and outcomes in elderly populations. Bimodal age distribution gives different outcomes, multiple reports indicate that older, low demand patients tend to tolerate incongruity, deformity, and malunion well compared to younger age group. Having been recognized nearly for two hundred years, fractures of the distal radius recently have become the focus of an intense resurgence in interest regarding optimal management. In present study, we aimed to compare the functional outcomes of treatment of distal end radius fractures with various modalities

i.e. closed reduction and POP cast application, closed reduction and percutaneous K-wire fixation under fluoroscopic guidance with postop cast immobilization, ligamentotaxis and stabilization with external fixator, open reduction and internal fixation with locking compression plates and buttress locking compression plate.

MATERIALS AND METHODS

2.1 SOURCE OF DATA:

The study was conducted in 107 patients presented in Department of Orthopaedics, Vydehi Institute of Medical Sciences & Research Centre, Bangalore.

2.2 INCLUSION CRITERIA:

1. Age: Above 18 years up to 70 years of either sex
2. Undisplaced fracture and displaced unstable comminuted fracture of the distal radius
3. Reported within 7 days of injury (fresh fracture)
4. Gave informed consent for operative care.

2.3 EXCLUSION CRITERIA

1. Pathological fractures
2. Fractures with implant failure
3. Open/severely comminuted fracture with bone loss
4. An ipsilateral upper limb fracture
5. A pre-existing inflammatory or degenerative arthritis of the injured wrist, ipsilateral elbow or shoulder (which would affect the functional outcome)
6. Associated arterial and neural injuries
7. Patients noncompliant for postoperative physiotherapy and follow-up.

2.4 CLINICAL ASSESSMENT:

On admission of the patient, a careful history was elicited from the patient and/or attender to reveal the mechanism of injury and the severity of the trauma. The patients were then assessed clinically to evaluate their general condition and the local injury. Methodical examination was done to rule out fractures at other sites.

2.5 RADIOGRAPHIC ASSESSMENT:

Standard guidelines were utilized to get radiographs – Antero-posterior and lateral radiographs of the affected wrist were taken and the fracture patterns were classified based on the AO classification of fractures of distal radius.

2.6 PRE OPERATIVE EVALUATIONS AND TREATMENT INTERVENTION:

Inpatients meeting the inclusion and exclusion criteria are selected for the study. All the patients were explained about the aims of the study, the methods involved and an informed written consent was obtained before being included in the

study. Intervention was contemplated after explaining the details of treatment modality with cast for undisplaced extra-articular fractures, percutaneous fixation with K-wires for minimally displaced extra-articular and undisplaced stable intra-articular fractures, external fixation used for ligamentotaxis for unstable grossly comminuted intra-articular fractures and volar plating for displaced non-comminuted intra-articular fractures.

2.7 POST OPERATIVE PERIOD AND FOLLOW UP EVALUATION:

Immediate post-operative complications like fat embolism, compartment syndrome, neurological damage and vascular injury is looked for. Patient is started on physiotherapy exercise protocol based on the treatment modality. Intravenous antibiotic regimen was continued for 5-7 days after the surgery. Another 5 days of oral antibiotics were

advised. Suture or staple removal was done at 10-12th post-operative day.

After operative treatment, patients were discharged and followed up in our outpatient department at specific intervals and were subjected to clinical examination and on the last follow-up were assessed according to the demerit point system of Gartland and Werley with Sarmiento et al modification.⁶ On radiological post op evaluation and follow up Restoration of radial length, radial inclination and volar angle were measured. Patient followed clinically and radiologically at 4week, 8 week, 12 week, 24 week and 48 weeks. Out of 107 patients 7 patients were lost to follow up and were excluded from study results analysis.

RESULTS

Table 1: Age distribution of patients studied

Age in years	Patients	
	No	%
20-30	16	16
31-40	29	29
41-50	33	33
51-60	12	12
61-70	10	10
Total	100	100
Mean±SD	38.6± 9.3 years	

Table 2: Gender distribution of patients studied

Gender	Patients	
	No	%
Female	24	24
Male	76	76
Total	100	100

Table 3: Occupation distribution of patients studied

Occupation	Patients	
	No	%
Farmer	14	14
Homemakers	18	18
Businessman	31	31
Government officer	04	04
Labourer	16	16
Lawyer	02	02
Student	04	04
Teacher	08	08
Truckdriver	03	03
Total	100	100

Table 4: Mode of Injury distribution of patients studied

Mode of Injury	Patients	
	No	%
Road-traffic accident	28	28
Fall on outstretched hand	62	62
Fall from height	6	6
Contact sport	4	4
Total	100	100

Table 5: Fracture type distribution of patients studied

AO type of fracture	TREATMENT MODALITY					Total
	POP CAST	K-WIRE	PLATING	EX FIX	EX-FIX with K wire	
A2	28	7	11	0	0	46
A3	0	2	4	2	0	7

B1	8	1	4	0	0	13
B2	0	0	4	0	0	4
B3	0	0	6	0	0	6
C1	6	2	2	0	1	12
C2	0	1	2	4	2	8
C3	0	0	1	1	1	4
TOTAL	42	13	34	7	4	100

Table 6: Functional Outcome of patients studied

Demerit Score	TREATMENT MODALITY				
	POP CAST	K-WIRE	PLATING	EX FIX	EX-FIX with K Wire
Excellent	12 (28.57%)	3 (23.1%)	16 (47.1%)	1 (14.3%)	0
Good	22 (52.38%)	7 (53.8%)	9 (26.5%)	2 (28.6%)	1 (25%)
Fair	6 (14.28%)	3 (23.1%)	9 (26.5%)	2 (28.6%)	2 (50%)
Poor	2 (4.76%)	0	0	2 (28.6%)	1 (25%)
total in No.(%)	34 (100%)	13 (100%)	34 (100%)	7 (100%)	4 (100%)

Table 7: Complication in patients studied

Demerit Score	Treatment Modality				
	POP CAST	K-WIRE	Plating	EX FIX	EX-FIX with K Wire
Malunion	1	0	0	2	1
Pin tract infection/ infection	0	2	0	1	0
K-wire loosening	0	2	0	0	1
Wrist and finger stiffness	4	0	1	2	1
Reflex Sympathetic osteodystrophy	4	0	0	0	0
Radiocarpal arthritis	2	0	0	2	1

DISCUSSION

The fracture of the distal radius is the most common fracture encountered in daily practice.

Since Colles Abraham (1814),^[7] publication on “the fracture of the carpal extremity of the radius” in Edinburgh Medical Journal, no other fracture has been discussed about as much. Even after 200 years the best treatment for this fracture remains enigmatic and a topic of perennial debate, which speaks of the complexities involved in this injury. If these fractures are not assessed properly and not treated on time, angulation, shortening and articular incongruity may lead to permanent deformity and loss of function. The objective of fracture distal end of radius treatment is restoration of normal function. Important concept is that functional recovery is directly proportional to the accuracy of skeletal restoration. Fundamental application of fracture treatment is to achieve accurate fracture reduction and after that to use immobilization method which will help in maintaining and holding reduction. Using Traditional conservative method for treatment of Intra-articular fractures of distal end of the radius sometimes can be difficult. Several treatment options are available for preventing loss of reduction in an unstable fracture of the distal end of the radius. There is no consensus with regards to the optimal management of these fractures and lack of scientific evidence to allow definitive conclusions concerning the main aspects of managing distal radius fractures. In this context of the research gap, the present study was undertaken to compare the functional outcome of treatment fracture distal end radius with various treatment modalities.

For closed reduction and cast immobilization, all fractures can be considered which are characterized by minor comminution, with or without partial

displacement. To check for any re-displacement, the fracture should be maintained under closed observation. Extra-articular fractures with severe comminution of the distal end of the radius or fractures having no more than two articular fragments, in which anatomical reduction is obtainable, are susceptible to percutaneous fracture fragment pinning and plaster cast application. This is not effective for fractures with high energy complexes or fractures associated with issues with soft tissue that prohibit the use of plaster casting. External fixation is universally acknowledged in young patients with intra-articular comminuted distal radius fracture as superior to plaster immobilization. Some unstable extra-articular fractures with substantial comminution and inability to sustain reduction after an initial attempt at closed treatment in a cast, certain multiple trauma conditions, and involvement of dysfunctional contra lateral limb, extreme open fractures with significant soft tissue damage and neurovascular compromise and bilateral injury are other indications for external fixation. To apply traction and recover displacements, external fixation depends on the ligament taxis theory. One of the recent advances in the treatment of distal radius fractures is open reduction and internal fixation with locking plates. Major indication for ORIF is complex intra-articular fractures in which articular fragments are displaced, rotated or impaired. While there is increasing enthusiasm for the operative approach for fractures of the distal end of the radius, even when the surgeon is experienced, serious complications such as loss of fixation, median nerve neuritis, reflex sympathetic dystrophy, wound infection and late post-traumatic arthritis can occur.

To evaluate the effectiveness, the functional outcome and complication associated with various

treatment modalities for fracture of distal radius various research studies have been done. Diaz Garcia et al,^[8] (2012) systematically reviewed with^[5] common techniques: the volar locking plate system, non-bridging external fixation, bridging external fixation, percutaneous K- wire fixation, and cast immobilization for the management of Distal radial fractures in patients aged 60 and over. They concluded that the functional outcomes were no different from those of surgically treated groups for patients age 60 and over, despite worse radiographic outcomes associated with cast immobilization. Saraogi A. A. et al,^[9] (2014) investigated to find out conceptual and practical guidance for precision treatment of distal radius fracture. 120 patients of distal radius fractures were treated with Cast immobilization, Augmented External fixation, Volarlocking plate fixation, Percutaneous Pinning and plaster immobilization. Standard A.O. classification was used. "Demerit point rating system" of Gartland & Werley (modified) was used to assess the functional outcomes. A2 was the most common type of fracture. 63.3% results was obtained in the plating group as compared to 46.7% in the cast group and the k-wiring group. Excellent result outcome found in 63 patients, 31 patients had good, 23 patients had fair and 3 patients had poor result outcome. Study concluded that various factors like, patient's age, fracture anatomy, displacement, reducibility, stability and articular incongruity of fractures affects functional outcome. These factors are more related to the quality of anatomical reduction than to the method of immobilization. For unstable fractures, volar locking plating has proved to be safe and effective treatment. Isapure W et al (2014)¹⁰ did a study to compare the different methods for the treatment of distal radial fractures based on the outcome at the end of treatment. Among the 301 patients who were included in the study. Of the total number of cases admitted for distal radius fracture, nearly 75% cases were operated using percutaneous fixation with K-wires (n=80), locking compression plate (n=75), and external fixation (n=77). It was observed that patients who were treated with locking compression plate (93.3%) had remarkably better clinical appearance of wrist joint than percutaneous fixation with K-wires and external fixation. 96% had better treatment outcome with regard to the restoration of movements of the wrist joint and resumption of normal activities for patients treated with locking compression plate than percutaneous fixation with K-wires and external fixation. The study concluded that better treatment option for fracture of distal end radius was locking compression plating, than the percutaneous fixation, and external fixation methods. Tripathi S. K. et al,^[11] (2015) conducted a study on 204 patients to compare different modes of treatment such as cast/slab; percutaneous fixation with k-wire, external fixation & plate osteosynthesis. Out of 204 cases with distal end radius fracture, nearly 10% (n=21) cases were

managed with cast, 22% (n=45) with percutaneous fixation with K-wire, 23.5% (n=48) with external fixator, 19% (n=38) with both external fixator and K-wire and 25% (n=52) with plate osteosynthesis. The authors concluded that when compared to cast, percutaneous K-wire fixation and external fixator, usage of plating for distal end radius fracture has increased considerably over a period of time. A total of 412 patients were examined in 2016 by Lakshminarayana S et al,^[12] and the type of treatment was compared between the different treatment modalities available, such as cast/slab; k-wire percutaneous fixation, external fixation & osteosynthesis of the plate. Nearly 12 percent of cases were treated with cast, 22 percent with percutaneous fixation with k-wire, 24 percent with external fixator, 19 percent with both external fixator and k-wire, and 23 percent with plate osteosynthesis out of the total number of cases (n=412) for fracture distal end radius. This study concludes that the frequency of distal end radius fracture plating increased over a period of time and, compared to cast, percutaneous k-wire fixation and external fixator, plating increased over a period of time. Sakhuja R et al,^[13] (2019) sought to find both conceptual and realistic guidelines with a predicted favourable outcome for precision treatment. Cast immobilisation, percutaneous pinning, external fixation, and volar locking plate fixation were studied in total of 50 patients with distal end-radius fractures. Classification by Fernandez was used. The functional outcome were analysed using Gartland and Werley's Demerit Point Method (modified). Lindstrom criteria were used for the anatomical evaluation (modified). Study concluded that volar locking compression plate fixation gives excellent functional and anatomical results than other modalities of treatment. In a retrospective cohort study on "Remote Injuries and Outcomes after Distal radius Fracture Management" in 2019, Ogunleye A et al,^[14] treated 181 Distal Radius Fractures in 176 patients over the 5-year duration of the study in a retrospective cohort study. Forty-eight (26.5 percent) of the fractures were managed with casting non-operatively, 12 (6.6 percent) with closed reduction and pinning, and 119 (65.7 percent) with open reduction and plating. The mean follow-up amounted to 5.2 months. The incidence of complications was 18.2 percent. Persistent pain, accompanied by median neuropathy, loss of reduction, arthritis, and distal radio-ulnar joint dysfunction, was the most common complication in 5 cases. After controlling for age, body mass index, surgeon and other confounders, a significantly increased risk of complications was associated with remote injury. In a meta-analysis of a randomised controlled trial in China of the comparison of conservative and surgical treatment for distal radius fracture, Song J et al,^[15] (2015) concluded that "Operative treatment tends to be more successful for distal radius fracture compared to conservative treatment when the radiographic findings have been

analysed and no major differences have been reported from functional outcomes and complication rate.

The present study comprised of 100 patients of distal radius fractures, the average age of patients was 38.6 years with the range being 20-70 years. Fall on outstretched hand was the commonest cause of the trauma (62%) followed by RTA (28%). The minimum follow up was for 24 weeks and the maximum was 48 weeks. Male patients (76%) outnumbered female patients (24%). Businessmen (31%) are most common profession of the study population followed by homemakers (18%). 46% of our cases were AO A2 type of fracture and was the most common type of fracture pattern encountered. Out of 100 patients on whom results were analysed 34% patients were treated by plating, 42% by cast application, 13% by percutaneous K-wire application, 7% by external fixator and 4% by external fixator with k-wire. Using the demerit point score we had 16 (47.1%) excellent results in volar plating, 12 (28.57%) in cast, 3 (23.1%) in K-wire fixation, 1 (14.3%) in external fixator, Good results were found in 22 (52.38%) in cast application, 7 (53.8%) in k-wire, 9 (26.5%) in volar plating, 2 (28.6%) in external fixator, 2 (50%) in ex-fix with k-wire fixation. Fair results were found in 2 (50%) by ex-fix with k-wire fixation, 2 (28.6%) in external fixator, 9 (26.5%) in volar plating, 3 (23.1%) in k-wire fixation and 6 (14.28%) in cast application. There were 2 (28.6%) patients with poor result treated by external fixator application, 2 (25%) in ex-fix with k-wire application and 2 (4.76%) by cast application. Complication such as irregular articular surface, wrist pain, finger stiffness, malunion, pin tract infection and K-wire loosening was observed. Overall results with plating were better as compared to other groups followed by K-wire fixation and cast application. On radiological post op evaluation and follow up Restoration of radial length, radial inclination and volar angle was best achieved in volar plating group.

Our study has a few limitations, the sample was not homogenous regarding the stages of classification system for comparison by different method of treatment, and therefore, the findings are inconclusive. The sample size of our study is limited to one centre and is very small to conclude very effectively. Further prospective randomized controlled studies with larger numbers will be required to evaluate the potential long-term benefits of surgical treatment along with economic evaluation determining the cost-effectiveness of each treatment option.

CONCLUSION

The treatment goal for fractures of the distal end of the radius is fully functional recovery of the wrist and functional results depend on the age of the patient, the anatomy of the fracture, displacement,

reducibility, stability, and fracture articular incongruity. Therefore fractures of the distal radius should be treated by the principles usually applied to other articular fractures. Present study demonstrated that good results can be obtained with closed reduction & plaster cast immobilization in low demand elderly patients, extra articular and stable fractures with high level of patient satisfaction & low complication rate. Volar plating has a relatively better functional outcome for fractures of the distal end of radius as compared to percutaneous k-wire fixation and closed reduction with cast application, particularly in cases of intra-articular fractures. Unstable distal radius fractures and fractures with metaphyseal comminuted zones (A3 and C2 fractures) often require surgical intervention. In these patients volar locking compression plating is a safe and effective treatment with least complications. Similarly, external fixator application proved to be an easy, cost-effective and reliable treatment modality in treating unstable comminuted intra-articular distal end of radius fractures, especially cases having osteoporosis. Hence we conclude that Functional outcomes are related more related to the quality of anatomical reduction than to the method of immobilization. Extraarticular fractures give better results than intra-articular fractures. Locking compression plate is a safe and effective treatment for most complex fractures of distal radius. Due to complexity of AO C2 and C3 fracture types, outcome results were limited irrespective of fixation method used. As anatomical reduction and early mobilization are most effectively achieved by operative interventions, we propose that operative intervention should be recommended in management of distal radius fractures in affordable patients.

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