

Radiological Assessment and Functional Outcomes of Hand and Wrist in Patients with Distal End Radius Fractures

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Abstract

Background: Fractures of distal end of radius are the most common fractures among the patients treated at emergency rooms. Despite a considerable progress in medical field over the last several years, distal end of radial fracture outcomes seem to be unsatisfactory in fairly large number of cases. The aim of this study was to determine the functional outcome of hand and wrist after distal end of radius fractures managed by different treatment modalities, to determine the complications of each methods used for treatment of distal end of radius fractures, to compare anatomical outcome with functional outcome after management of fracture distal end of radius.

Methods: A clinical, observational, prospective type of study was carried out on 40 cases with fractures of distal end of radius. The fractures were classified according to AO classification. After initial evaluation patients were taken up for either conservative or operative treatment. All the cases were followed up and assessed for minimum of 6 months. Patients with complications were followed up more frequently.

Results: Anatomical results were evaluated according to Sarmiento's modification of Lindstrom Criteria. Clinical and functional results were evaluated according to demerit point system of Gartland and Werley with Sarmiento modification

Conclusions: There is direct relationship between anatomical result and functional outcome. Therefore, every effort should be made to restore normal length and alignment, as well as articular surface congruency of distal radius.

Keywords: Distal end of radius, Demerit point system of Gartland and Werley with Sarmiento modification, Sarmiento's modification of Lindstrom criteria, Functional evaluation

Introduction

Fractures of distal end of radius are the most common fractures among the patients treated at emergency rooms [14]. Despite a considerable progress in medical field over the last several years, distal end of radial fracture outcomes seem to be unsatisfactory in fairly large number of cases. Injury to upper limb influence the hand functions in many ways. Loss of hand function is extremely handicapping in any profession. Maximum restoration of hand function is the goal of every orthopedic intervention after the distal end of radius fracture. By virtue of multiple functions it performs, hand has acquired the status of an organ. Many treatment methods are available for distal radius fractures including close reduction with cast, functional bracing, external fixation, percutaneous pinning, internal fixation or a combination of these methods [14]. Fracture of the distal end of the radius remains one of the most challenging of the fractures to treat. There is no consensus regarding the description of the condition and the appropriate outcome especially regarding hand functions. Possessing knowledge of outcomes of distal radius fractures allows the physician to better counsel individual patients and determine the best management to optimize treatment. This

study was planned to assess functional outcomes in terms of function of hand in patients with distal radius fracture treated with different modalities of treatment including conservative and surgical methods.

Methods

This prospective type of study included 40 patients with fracture of distal end radius who attended outpatient or emergency service of our institute. Patients who did not give their consent for the study, patients below 18 years of age, patients with associated injury to hand or carpal bones were excluded.

All the patients were subjected to clinical and radiographic examination. Plain radiographs of PA (posteroanterior) and lateral view of wrist with distal forearm were done to know the location, extent and type of fracture. The fractures were classified according to AO classification into type A (extra-articular), type B (partial articular) and type C (complete articular). The radiographs were assessed in terms of loss of palmar tilt or presence of dorsal tilt, radial shortening and radial inclination. After anesthetic evaluation, patients were taken up for either pop cast or surgical treatment. All the cases were followed up and assessed for minimum of 6 months. Clinical, radiological and functional evaluation were performed at 6 week, 3 months and 6 months. Patients with complications were followed up more frequently. Anatomical results were graded according to Sarmiento's modification of Lindstrom Criteria [1]. Clinical and functional results were evaluated according to demerit point system of Gartland and Werley with Sarmiento modification [2] at each follow up.

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Results

Total 40 patients were included in this study. 25 (62.5 %) were male and 15 (37.5 %) were females. The mean age was 45 years. The mode of injury was fall on outstretched hand in 20 cases (50 %) and road traffic accidents in 20 cases (50 %).

According to AO Classification, 20 cases (50%) had TYPE A fracture, 9 cases (22.5%) had TYPE B fracture, and 11 (27.5%) cases had TYPE C fracture. 18 patients were treated with closed reduction with percutaneous K-wire fixation and pop cast, 9 patients were treated with Open Reduction and Internal Fixation with Plating, 13 cases were treated with close reduction and pop cast.

A) Anatomical results were graded according to Sarmiento's modification of Lindstrom Criteria [1].

1. Correction of dorsal tilt: Normally, distal articular surface of radius has palmar inclination of 110 on lateral view of wrist X-ray. Out of 18 patients managed with close reduction (CR) and percutaneous K-wire fixation and pop cast, 2 patients had loss of palmar inclination between 1-100 and 1 patient had loss of 11-140. Out of 13 patients managed with close reduction and pop cast, 2 patients had loss of palmar inclination between 1-100. In this study, none of the patient had loss of reduction following open reduction and internal fixation with plate.

2. Correction of radial shortening: Two patients each managed using CR with percutaneous K-wire (2/18), and CR with POP cast (2/13) had radial shortening (3-6 mm).

In the present study all the patients managed with open reduction and internal fixation with plate had radial shortening < 3 mm.

3. Correction of radial inclination: Normally, distal articular surface of radius has inclination of 230 toward ulna on PA (Posteroanterior) view of wrist X-ray. In the present study none of the patients managed with different treatment modality had loss of radial inclination.

B) Clinical and functional results were evaluated according to demerit point system of Gartland and Werley with Sarmiento modification [2] at each follow up. It is based on (a) assessment of residual deformity, (b) subjective evaluation, (c) objective evaluation, (d) evaluation of complications

1. Assessment Of Residual Deformity - Treatment Modality (Table 1):

In the present study, Out of 18 patients managed with close

	Prominent Ulnar Styloid (No. Of Patients)	Residual Dorsal Dorsal Tilt (No. Of Patients)	Radial Deviation Of hand (No. of Patients)
CRIF With K Wire	33.33%(6/18)	16.67%(3/18)	11.11%(2/18)
ORIF With Plate	22.22%(2/9)	0%	0%
CR And Pop Cast	15.38%(2/13)	7.69%(1/13)	7.69%(1/13)

	Excellent (No Pain, Disability, or Limitation of Motion)	Good (Occasional Pain, Slight Limitation of Motion)	Fair (Occasional Pain, Some Limitation Of Motion, Weakness In Wrist, Activities Slightly Restricted)	Poor (Pain Limitation Of Motion, Disability, Activities More Or Less Markedly Restricted)
CRIF With K-Wire and Pop Cast	11.11%(2/18)	72.22%(13/18)	11.11%(2/18)	5.56%(1/18)
ORIF With Plate	11.11%(1/9)	88.89%(8/9)	0%	0%
CR and Pop Cast	7.69%(1/13)	76.92%(10/13)	7.69%(1/13)	7.69%(1/13)

Movement	Closed Reduction With K-Wire & Casting (Mean ± SD In Degrees) (A)	Open Reduction And Internal Fixation With Plate (Mean ± SD In Degrees)(B)	Close Reduction With Pop Casting (Mean ± SD In Degrees)(C)
Palmar Flexion	51.11 ± 8.50	56.11 ± 3.33	45.38 ± 10.30
Dorsiflexion	48.89 ± 9.48	55.56 ± 5.27	43.85 ± 7.40
Radial Deviation	14.44 ± 1.62	15.56 ± 2.24	13.85 ± 2.99
Ulnar Deviation	23.89 ± 5.30	24.11 ± 4.96	18.38 ± 4.81
Supination	64.17 ± 6.70	67.22 ± 3.63	62.31 ± 9.04
Pronation	62.22 ± 7.12	67.22 ± 3.63	62.31 ± 6.33

Complications	Closed Reduction With K-Wire & Casting % (No. Of Cases)	Open Reduction and Internal Fixation With Plate % (No. Of Cases)	Close Reduction with Pop Casting % (No. Of Cases)
Infection	5.56%(1/18)	0%	0%
Stiffness Of Fingers	11.11%(2/18)	11.11%(1/9)	15.38%(2/13)
Residual Pain	38.89%(7/18)	22.22%(2/9)	30.77%(4/13)
Hand Shoulder Syndrome	5.56%(1/18)	0%	0%
Numbness/Tingling In Hand Or Finger	5.56%(1/18)	0%	0%

reduction with percutaneous K-wire fixation and pop cast, 6 patients had prominent ulnar styloid, 3 had residual dorsal tilt and 2 had radial deviation of hand.

Out of 9 patients managed with open reduction and internal fixation with plate, 2 patients had prominent ulnar styloid.

Out of 13 patients managed with close reduction and pop cast, 2 had prominent ulnar styloid, 1 had residual dorsal tilt and 1 had radial deviation of hand.

2. Subjective Evaluation-Treatment Modality (Table 2):

Out of 18 patients managed with close reduction with percutaneous K-wire fixation and pop cast, 2 patients had fair and 1 patient had poor subjective outcome. Out of 13 patients managed with close reduction and pop cast, 1 patient had fair and 1 had poor subjective outcome.

All the patients managed with open reduction and internal fixation with plate had excellent or good subjective outcome

3. Objective Evaluation(Range of Movement)- Treatment Modality (Table 3):

In present study, mean range of palmar flexion, dorsiflexion and ulnar deviation at 6 month follow up were significantly reduced in close reduction and pop cast group as compared to open reduction and internal fixation with plate.

Mean range of ulnar deviation was also significantly reduced in close reduction and pop cast group (18.38) as compared to close reduction with percutaneous k wire fixation (23.89).

Mean range of radial deviation, supination and pronation at 6 month follow up was not significantly different after different treatment modalities.

4. Complications-Treatment Modality (Table 4):

In the present study, Out of 18 patients managed with close reduction with percutaneous k wire fixation and pop cast, 1 patient had pin tract infection, 2 patients had stiffness of fingers, 7 patients had occasional residual wrist pain while work, 1 patient had hand shoulder syndrome, and 1 patient had symptoms of median nerve involvement.

Out of 9 patients managed with open reduction and internal fixation with plate, only 1 patient had stiffness of fingers and 2 patients had residual wrist pain.

Out of 13 patients managed with close reduction and pop cast, 2 patients had stiffness of fingers and 4 patients had residual pain.

5. Finger Function- Treatment Modality (Table 5):

Total of 5 patients had limitations of hand functions at first follow up with restrictions of movements of fingers and thumb. Different thumb movements at carpometacarpal and interphalangeal joints and finger movements as shown in the table were assessed. All 5 patients had limitations in performing simple activities like ability to grasp an object, to turn a key, to prepare bed, to use knife in kitchen work, to fasten shirt buttons, to write, to open jar, tying or lacing shoes. Various hand functions requiring power grip, precision grip, hook grip, lateral pinch grip (key grip) and many activities involving combination of grips were markedly restricted.

In all these patients extensive rehabilitation was performed under the care of physiotherapist which turn out to be extremely helpful and 3 out of 5 patients were satisfied with final outcome. One patient developed hand shoulder syndrome and her final outcome was poor as per Demerit point system of Gartland and Werley's with Sarmiento et al. modification. One another case also had poor outcome and both of these cases were non-compliant despite proper counselling and they didn't follow home exercise program and other instructions.

6. Grip Strength Evaluation-Treatment Modality (Table 6):

In the present study, Out of 18 patients managed with close reduction with percutaneous k wire fixation, 7 patients had grip strength 60% or less of opposite side at 6 month follow up.

Out of 9 patients managed with open reduction and internal fixation with plate, only 1 patient had grip strength 60% or less of opposite side at 6 month follow up.

Out of 13 patients managed with close reduction and pop cast, 7 patients had grip strength 60% or less of opposite side at 6 month follow up.

Grip strength achieved at 6 month follow up was not significantly different after different treatment modalities.

Final functional evaluation in different fracture type

In the present study none of the patients with AO Type B Fracture (9 patients) had fair or poor outcome.

Out of 20 patients with AO Type A Fracture, 4 patients had fair outcome.

Out of 11 patients with AO Type C Fracture, 1 patient had fair and 2 had poor outcome.

Comparision of anatomical (radiological) outcome with functional outcome

In the present study, 1 patient had 110 or > loss of palmar inclination whose functional outcome was poor as per Demerit point system of Gartland and Werley's with Sarmiento et al. modification. The correlation of loss of palmar inclination 110 or more and poor functional outcome was found to be highly significant (p<0.001)

4 patients had radial shortening 3mm or more, of these 2 patients had good and 2 had poor outcome as per Demerit point system of Gartland and Werley's with Sarmiento et al. modification. The correlation of radial shortening 3mm or more and poor functional outcome was found to be highly significant (p<0.001)

Discussion

Distal end radius fractures are one of the commonest fracture seen orthopaedic trauma setting. Meticulous, and comprehensive approach is required to achieve fully functional hand and wrist as poorly functional and stiff hand and wrist create a big challenge in day to day life of a common man. Lets first talk about some basic parameters observed in our study.

Distal radial fracture was more common in the 3rd to 6th decade with an average of 45 years. The average age in our study is comparable to the studies of AyhanKilic et al (2009) [11], Kevin C. Chung et al. (2006) [12] and R.E. An akwe et al (2010) [13] who had an average age of 45 years, 48.9 years and 48 years respectively. Road traffic accidents and simple fall on outstretched hand were the most common mode of injury. 20 cases (50%) accounted for road traffic accidents and 20 (50%) accounted for simple fall on outstretched hand. This is comparable to the studies of AyhanKilic et al (2009) [11] and Kevin C. Chung et al. (2006) [12].

In the present study(avoid using this sentence again and again), statistically significant correlation was found between anatomical results with that of functional results. This is consistent with studies of Jupiter [2], Ericson [3], Porter [4], Cooney [5]. They also suggested that there is a direct relationship between anatomical result and functional outcome. Therefore every effort should be made to restore normal length and alignment, as well as articular surface congruency of distal radius.

In the present study, improvement in range of movement (palmar flexion, dorsiflexion, ulnar deviation) was statistically significant after open reduction and internal fixation than in close reduction and pop cast group. However, Arora r et al [10] concluded that minor limitations in the range of wrist motion and diminished grip strength, as seen with nonoperative treatment, did not limited

Table 5: Finger Function- Treatment Modality

Joint	Range of Motion	Close Reduction and K-Wire Fixation (No. of Patients)	Open Reduction and Plate Fixation (No. of Patients)	Close Reduction and POP Cast (No. of Patients)
MCP (0-90°)	0-90°	16	8	11
	0-60°	1	1	0
	0-30°	0	0	1
	<30°	1	0	1
PIP PIP (0-110°)	0-110°	16	8	11
	0-60°	1	1	0
	0-30°	0	0	1
	<30°	1	0	1
DIP 0-60°)	0-60°	16	8	11
	0-30°	2	1	0
	<30°	0	0	2

Table 6: Grip Strength Evaluation-Treatment Modality

Evaluation of Grip Strength	Grip Strength < 60% Or Less Of Opposite Side (Using Dynamometer)		
	At 7 Weeks (No. of Patients)	At 3 Months (No. of Patients)	At 6 Months (No. of Patients)
Close Reduction with Percutaneous K-Wire and Cast	100%(18/18)	94.44%(17/18)	38.89%(7/18)
Open Reduction and Internal Fixation with Plate	100%(9/9)	66.67%(6/9)	11.11%(1/9)
Close Reduction and POP Cast	100%(13/13)	92.31%(12/13)	53.85%(7/13)

functional recovery at 1 year.

Range of movements achieved was also compared with different fracture types. Mean range of dorsiflexion, radial deviation, ulnar deviation, supination, pronation at 6 month follow up was not significantly different after different fracture types. Mean range of palmar flexion at 6 month follow up was significantly reduced in AO Type C Fracture (45.910) as compared to AO Type B Fracture (56.110).

In the present study no statistical significant difference was found between functional outcome (by Gartland & Werley De-merit scoring system [2] and type of fracture. This is comparable to study by Altissimim et al [8].

Residual pain in distal radioulnar joint was the most common complication which is comparable to studies of Solgaard et al [7] and Baruah et al [9]. Complication rate after different treatment modality did not show any statistical difference. One patient developed hand shoulder syndrome with major complaints of pain and tenderness, impairment of joint mobility (shoulder, elbow, wrist, fingers) and swelling. Patient was advised regular physiotherapy sessions but she refused because of severe pain and was noncompliant despite proper counseling. This resulted in poor functional outcome. Patient had limited hand performance which negatively affected the quality of life and patient's independence in performing everyday activities. One case managed with close reduction and percutaneous K-wire fixation had complaint of tingling and numbness in thumb and radial two digits. Symptoms were probably due to initial fracture displacements and subsided after 2 months.

Although there was no statistically significant difference in grip strength between various methods of treatment, around 37.5% of patients had diminished grip strength as compared to normal unoperated wrist (normal) at 6 month follow up. This is comparable to study by Baruah et al [9].

The power grip is the result of forceful flexion of all finger joints with the maximum voluntary force that the subject is able to exert under normal biokinetic conditions. The grip strength is affected by many conditions and muscle strength is one of these factors. The

synergistic action of flexor and extensor muscles, the interplay of muscle groups, fatigue, hand dominance, age, state of nutrition, pain, cooperation of the patient, restricted motion, pain and sensory loss can influence the strength of the grip. Various hand functions requiring power grip, precision grip, hook grip, lateral pinch grip (key grip) and many activities involving combination of grips were also assessed and was found to be disturbed in cases who had finger stiffness and restrictions of thumb movements in different directions. These skillful activities were regained after subsidence of edema of hand.

Detailed evaluation of hand function in this study revealed that, 5 patients developed finger stiffness following different treatment modalities. There was no significant correlation between various treatment modalities and poor finger function. Poor finger function might have been due to edema subsequent to soft tissue trauma. This signifies benefit of treating the distal radius fracture early to minimize development of edema and pain, so that full range of movements of fingers and proximal joints can be restored. At the same time, it also allows for some function in light daily living activities early after fracture reduction.

Conclusion

From the present study it is concluded that anatomical reduction after distal end radius fracture results in better hand and wrist functional outcome.

Close reduction with pop cast and closed reduction with percutaneous k-wire fixation are simple, minimally invasive techniques which provides fairly good functional outcome. So, invasive open reduction and internal fixation technique should be reserved for complex intra-articular (AO Type C) distal radius fractures in high functional demanding patients.

Effective measures to reduce soft tissue swelling specially in hand should be started as early as possible after distal end radius fracture. Optimal recovery will occur when patients successfully accept full responsibility for their rehabilitation as well as continue with their home exercise program.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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