

A Retrospective Analysis of Functional and Radiological Outcome of Different Modalities of Treatment of Fracture of Distal Radius

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Abstract

Background: Fractures of the distal radius remain the most common fractures approximately one-sixth of all fractures treated in emergency departments. There are three main peaks of fracture distribution: the first peak is in children ages 5 to 14, the second is in males under age 50 and the third peak is in females over the age of 40 years. Risk factors are - decreased bone mineral density, female gender, ethnicity, heredity & early menopause have all been shown to be risk factors for this injury. The outcome of these fractures is not uniformly good regardless the treatment instituted. A thorough understanding of the anatomy & biomechanics of the wrist is a prerequisite when treating these lesions. There is a strict relationship between the quality of anatomical reconstruction and the long-term functional outcome. No single treatment is the solution for every type of fracture in every kind of patient. Based on the functional anatomy, we analyze the actual treatment possibilities & try to develop strategies in the choice of treatment for different fracture types in different patient groups.

Materials and Methods: 92 Patients with extra-articular distal radius fractures were studied retrospectively. 30 were treated with conservative management and 62 with surgical management. Out of 62 cases treated surgically, 11 were managed by Plate osteosynthesis, 27 with Ligamentotaxis with External fixator & 24 with K wire fixation using Kapandji method at Department of Orthopaedics, Sri Rama Chandra Bhanja Medical College and Hospital, Cuttack, Odisha, since July 2018 to November 2020.

Results: The association of individuals anatomical parameters with the functional results was measured by Chi-square test of association and Odds ratio with the criteria of Stewart et al. taken as base line for comparison. This study showed a significant association of dorsal angulation < 10° and loss of radial inclination of < 9° with functional results, P < 0.001 also with loss of radial height < 6 mm, P < 0.001 (0.005). On reviewing literature only few articles were found determining values of individual radiological parameters for better functional outcome specially Smilovic et al. (2003) and few of them noted which parameters affect the function most but not determining the values for them.

Conclusion: There was no significant difference in the functional outcome of conservative treatment in comparison to various surgical modalities namely plate osteosynthesis, ligamentotaxis and k wire reduction with Kapandji method in case of extra articular and partial articular fractures of distal radius. Therefore, we cannot generalize one treatment method for all fracture patterns and treatment should be individualized to a particular fracture.

Keywords: Distal radius fracture, Radiological outcome, Functional outcome

Introduction

Fractures of the distal radius remain the most common fractures approximately one-sixth of all fractures treated in emergency departments [1]. There are three main peaks of fracture distribution: the first peak is in children ages 5 to 14, the second is in males under age 50 and the third peak is in females over the age of 40 years. Risk factors are- decreased bone mineral density, female gender, ethnicity, heredity and early menopause have all been shown to be risk factors for this injury [2].

Majority are being treated with plaster of paris cast following closed reduction with local anaesthesia. However, other distal radial fractures require surgical management and many treatment methods are available [3].

The outcome of these fractures is not uniformly good regardless the treatment instituted. A thorough understanding of the anatomy & biomechanics of the wrist is a prerequisite when treating these lesions [4]. There is a strict relationship between the quality of anatomical reconstruction and the long-term functional outcome. No single treatment is the solution for every type of fracture in every kind of patient. Based on the functional anatomy, we analyze the actual treatment possibilities & try to develop strategies in the choice of treatment for different fracture types in different patient groups. Treatment aims should be to reconstruct the anatomy as good as possible, to guarantee that there is no loss of reduction and to allow for a functional after treatment as soon as possible.



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Materials & Methods

92 Patients with extra-articular distal radius fractures were studied retrospectively. 30 were treated with conservative management and 62 with surgical management. Out of 62 cases treated surgically, 11 were managed by Plate osteosynthesis, 27 with Ligamentotaxis with External fixator and 24 with K wire fixation using Kapandji method at Department of Orthopaedics, Sri Rama Chandra Bhanja Medical College and Hospital, Cuttack, Odisha since July 2018 to November 2020.

Method of collection of data

Inclusion criteria

1. Patients with history of previous intervention for distal radius fracture.
2. Male and female of age >18 yrs.
3. Unilateral isolated distal radius fracture.
4. AO Classification 23A1, 23A2, 23A3, 23B1.

Exclusion criteria

1. Bilateral or segmental fracture of radius.
2. Previous neurovascular deficit.

Scoring system

1. Patient Rated Wrist Evaluation [5].

Radiological assessment

All the radiological parameters viz Dorsal Tilt, radial inclination and radial length were measured using micro Dicom software.

Statistical analysis

Data collected were entered in Microsoft excel 2019. Data analysis was performed using Statistical Packages for Social Sciences (SPSS) Version 20. Categorical data were presented as proportions.

Results

Analysis of results in case of distal radius fracture

The overall mean age of people who suffered with distal radius fracture was found to be 46.88 ± 10.44 years. While the people under age group of 51-60 years consists of 33.6% of the total group out of which 35% underwent conservative treatment. Males (69.2%) were found to be more effected than females (31.1%).

Out of 92 people right hand (91.2%) was more involved as compared to the Left hand (8.8%). AO type 23A1 fractures (34.7%) were most common in occurrence followed by 23A2 (32.4%) and 23AB1 (30.2%). Overall mean pain score according to PRWE system was found to be 19.25 ± 8.55 out of which conservative group, ligamentotaxis, K-wire (Kapandji method) and plate osteosynthesis group has a mean score of 21.20 ± 8.16 , 15.67 ± 9.54 , 19.83 ± 7.11 and 21.45 ± 8.17 respectively.

Overall mean functional score according to PRWE system was found to be 19.20 ± 8.22 out of which conservative group, ligamentotaxis, K-wire (Kapandji method) and plate osteosynthesis group has a mean score of 21.47 ± 7.77 , 19.19 ± 9.25 , 18.93 ± 6.77 and 21.00 ± 8.25 respectively.

Dorsal angle: On comparing individual radiological parameters among study groups there was no significant association, but on

comparison with functional parameters there was found to be an association with $p < 0.001$ with dorsal angle group of 1° - 10° and 11° - 14° . Loss of Radial Length significant association $p > 0.001$ was found between loss of radial length and overall functional assessment.

Loss of radial inclination: on comparison with functional parameters there was found to be an association with $p < 0.001$ with dorsal angle group of $< 9^\circ$ and $> 9^\circ$

Discussion

We studied retrospectively 92 Patients, with extra-articular distal radius fracture. 30 were treated with conservative management, 62 with surgical management. Out of 62 surgical 24 were managed by Pinning, 27 by Ligamentotaxis with External fixator and 11 with plate osteosynthesis.

Age distribution

Most common age group as 51-60 years (31.0%) with mean age being 48.50 ± 10.26 years in conservative group. Where as in surgical group the mean age was 47.04 ± 9.33 years for ligamentotaxis with external fixation, 43.17 ± 10.83 for K wire fixation with Kapandji technique [6] and 50.45 ± 11.7 for plate osteo synthesis.

Sex distribution

In our series of 92 patients, there were 64 male (69.5%) and 28 female (31.5%) similar to Harish Kapoor et al [7] study.

Classification

AO type 23A1, 23A2 and 23B1 were more common among among surgical group.

The excellent and good outcome in conservative group was seen only in stable, minimally comminuted & minimally displaced fracture pattern. Excellent and good outcome were seen in many of such fracture pattern among surgical group.

Laterality

Overall Right side was more commonly injured (84%). Right side was more affected among surgical group (67%) and left in conservative group (37%).

Functional assessment

On PRWE functional assessment for pain, out of a total score of 50 the conservative group had a mean pain score of 21.20 ± 8.16 while surgical modalities like Ligamentotaxis with external fixation the mean score was 15.67 ± 9.54 , K wire fixation with Kapandji method and Plate osteosynthesis has a mean pain scoring of 19.83 ± 7.11 and 19.25 ± 8.55 respectively. The mean overall PRWE functional score of 19.20 ± 8.22 .

The incidence of the Colles' fracture was highest among 51-60 years age group. It was more common in men 64 (69.5%) than men 28 (31.5%). It is in contrast to Chung K C et al 2020 [6] where 86.7% were women with a mean age of 70.9 ± 8.9 years.

The normal anatomical variation of the distal radius measured from the normal control wrist were, radial inclination mean of $23.6 \pm 1.74^\circ$ (20 - 30°), palmar tilt mean of $8.6 \pm 0.97^\circ$ (0 - 15°) and radial bone length mean of 12.02 ± 1.06 mm (8 - 18 mm). This data are comparable with the data given below (Table 1).

Source	Radial inclination	Palmar inclination	Radial bone length	Ulnar variance
Mishra et al (2016)	23.27±7.42° (11.3-42.1°)	10.7±5.28° (1-16.9°)	11.31±4.9mm (7.1-30.4mm)	0.66±2.46mm (-2.4+4.1 mm)
Dario P et al (2014)	21-25°	7-15°	10-13mm	0.7- 4.1mm
Campbell 13 th ed 2017(p.2993)	20°	11°	12mm	±2mm
Green operative hand surgery 7 th ed 2017	23°	11°		-1mm
This study	23.6± 1.74° (20 -30°)	8.6±0.97° (0-15°)	12.02±1.06mm (8-18 mm)	

Table 1: Normal anatomical variation in Radiological parameters

Now coming to the comparison of overall functional (PRWE score) and anatomical out come (as per Stewart et al. criteria) [8] of this study.

On PRWE functional assessment for pain, out of a total score of 50 the conservative group had a mean pain score of 21.20 ± 8.16 while surgical modalities like Ligamentotaxis with external fixation the mean score was 15.67 ± 9.54, K wire fixation with Kapandji method and Plate osteosynthesis has a mean pain scoring of 19.83 ± 7.11 and 19.25 ± 8.55 respectively. The mean overall PRWE functional score of 19.20 ± 8.22.

Radiological assessment

The association of individuals anatomical parameters with the functional results was measured by Chi-square test of association and Odds ratio with the criteria of Stewart et al. [9] taken as base line for comparison. This study showed a significant association of dorsal angulation < 10° and loss of radial inclination of < 9° with functional results, P < 0.001 also with loss of radial height < 6 mm, P < 0.001 (0.005). On reviewing literature only few articles were found determining values of individual radiological parameters for better functional outcome specially Smilovic et al. (2003) [9] and few of them noted which parameters affect the function most but not determining the values for them [10, 11, 12]. Few selected studies were discussed below (Table 2).

Limitation of this study is a small sample size (n 92). This study followed a multivariate analysis using ANOVA for analysis's of the data, as distal radius fracture is associated with multiple factors apart from anatomical parameters hence a larger sample size may have been better for correlation. Again from the literature anatomic reduction always may not be only parameter for better function as indicated by most of the studies and also by Cooney [13], Dobyn [14] and Lindscib [15], who pointed out that soft tissue injury was also equally responsible for the resulting stiffness which is not taken into account in this study may be the drawback (Table 3).

Strength of the study is only few studies have actually conducted for

Author	Study	Results	Conclusion
Young and Rayan et al 2000	Outcome following nonoperative treatment of displaced distal radius fractures in low-demand patients older than 60 years	Got 88% excellent or good functional results and 68% excellent or good anatomical results	Radiographic outcome did not correlate with the functional outcome.
Garland and Wery 1951	Evaluation of healed Colles' fractures	Good functional results (68.3%) achieved despite of poor radiological appearances.	The residual dorsal tilt more strongly associated with poor outcome than the loss of radial inclination or radial height or ulnar variance. However Cases showing more accurate reduction have best outcome.
Slogaard et al 1988	Function after distal radius fracture	Functional results were excellent or good with dorsal angulation below 10° and loss of radial height < 7mm.	Function was influenced by radiographic results. It is rational to improve the function results by better reduction technique of the fracture and prevention of secondary displacements.
Finsen V et al (2013)	The relationship between displacement and clinical outcome after distal radius (Colles') fracture	Reviewed 260 patients. Though there exist a statistically significant association between functional and anatomical results by Bivariate analysis however multiple regression showed dorsal angulation, ulnar variance and radial inclination accounts only 11% of variability.	They concluded that final radiological alignment of distal radius fracture has minor influence on clinical outcome of Colles' fracture.
Anzarut A et al 2004	Radiologic and patient-reported functional outcomes in an elderly cohort with conservatively treated distal radius fractures	Out of 74 patients 47(69%) had acceptable radiographic outcome and 44 (59%) had satisfied functional result at 6 month.	Concluded that acceptable radiographic reduction was not associated with better functional outcome.
Jenkins NH et al. 1988	Mal-union and disfunction-in Colles' fracture.	Results of 61patients. Anatomical parameters at union were dorsal angulation was mean of 9°(sd 12.1) , mean loss of radial inclination 7.8°(sd 7.2°) and mean radial shortening of 4 mm (sd3.9mm). Loss of grip strength and loss of flexion were taken as the functional parameter. A multilinear regression analysis showed statistically significant correlation between grip strength and loss of radial inclination and dorsal angulation and same with loss of flexion but did not reach level of significance.	Final recovery of the grip strength was related to the inclination of the articulate surface of healed radius both coronal and sagittal plane. Loss of radial length appears to become important determinant of longterm pain.
Arrora R et al. 2011	A prospective randomized trial comparing nonoperative treatment with volar locking plate fixation for displaced and unstable distal radial fractures in patients sixty-five years of age and older.	Prospectively analysed 73 patients the range of motion,the level of pain,and the PRWE and DASH scores were not different between the operative and nonoperative treatment groups	Thus achieving anatomic reconstruction did not convey any improvement in range of motion or better ability of daily leaving activities in elderly.
Lingde Kong et al.2019	The Necessity of Restoration of Radiologic Parameters by Closed Reduction in Elderly Patients with Distal Radius Fractures.	Out of 96 patients 75(78.1%) got acceptable reduction and 21(21.9%) got poor reduction.a significant correlation was found between ulnar positive variance with grip strength (r=-0.35,p=0.03) and dorsal angulation with wrist flexion.(r=0.31, p=0.02)	They concluded that satisfactory reduction is the first choice as mallignment leads to decreased grip strengths, unsatisfactory appearance and certain limitation of wrist movements.
Chung K C et al 2020	Assessment of Anatomic Restoration of Distal Radius Fractures Among Older Adults: A Secondary Analysis of a Randomized Clinical Trial.	Data of 166 patients analysed with 2-phase multivariable regression models only 2 of the 84 correlation coefficients calculated were statistically significant rip strength with radial inclination and MHQ ADL score with ulnar variance.	They conclude that precise restoration of the wrist anatomy is not associated with better functional outcome.
This study	a retrospective analysis of functional and radiological outcome of different modalities of treatment of extraarticular or partial articular fracture of distal radius	Of 92 patients correlation of functional results with various surgical modalities showed no significant difference, while assessment of radiological parameters with the functional outcome showed a significant correlation between them P < 0.001(0.0005)	Concludes anatomical reduction and maintenance of the reduction of the fracture is priority for better functional outcome.

Table 2: Association of radiological parameters with functional outcome

Author	Study	Dorsal angulation	Loss of Radial inclination	Loss of Radial height	Ulnar variance	Remarks
Stewart HD et al.(1984)[6]	Functional cast-bracing for Colles' fractures: a comparison between cast-bracing and conventional plaster casts.	<10°	<9°	<6 mm		The anatomic results was not influenced by methods of immobilisation but was related to efficacy of reduction.
Altimissi et al	Long term results of conservative treatment of fractures of the distal radius.	>15°	<5°		>5 mm (radio ulnar index)	No statistically significant relation between the final results and type of fracture.however unsatisfactory results reported with extreme values three radiographic parameters as mentioned.
Slogaraad et al 1988	Function after distal radius fracture	<10°		<7mm		Functional results were excellent or good with dorsal angulation below 10° and loss of radial height < 7mm.
Salmon & Patrick et al 1999.	Prevention of malunion of distal radius fracture	>10°	< or = 17°	>3mm	>1mm	They have taken these radiographic measurements to define malunion in distal radius fracture
Fuji k et al. 2002	Fractures of the distal end of radius in elderly patients: a comparative study of anatomical and functional results.	3°		4mm		Minor deformities as mentioned did not affect functional outcome. However radial shortening of more than 6 mm may result in poor functional outcome.
Smilovic et al. 2003	Conservative treatment of extra-articular Colles' type fractures of the distal radius: prospective study	< or = 9°	< or = 3°	< or = 2 mm		There was significant association between anatomical and functional results. And borderline values for better functions were as mentioned.
Campbell 13 th ed 2017(p.2993)	Acceptable reduction of distal radius fracture.	Neutral (0°)	No less than 10°		No more than 2mm of shortening relative to ulnar head	
This study	a retrospective analysis of functional and radiological outcome of different modalities of treatment of extraarticular or partial articular fracture of distal radius.	< 10°	<9°	< 6 mm		Recommends anatomic reduction of the fracture with in the borderline limits of the individual parameters as mentioned for achieving excellent to good functional results.

Table 3: Radiological and functional outcome

measuring the acceptable borderline anatomical parameters correlated with functional outcome. Therefore we believe that further research with larger sample size and higher statistical analysis models would confirm the values found in this study.

Conclusion

Better the anatomical reduction so do the functional outcome as there is a statistical significant association ($P = 0.005$) between them. This study recommends acceptable borderline values of anatomical

parameters as, dorsal angulation < 10°, radial inclination < 9° and loss of radial height < 6 mm to achieve excellent or good functional results. There was no significant difference in the functional outcome of conservative treatment in comparison to various surgical modalities namely plate osteosynthesis, ligamentotaxis and K wire reduction with Kapandji method in case of extra articular and partial articular fractures of distal radius. Therefore, we cannot generalize one treatment method for all fracture patterns and treatment should be individualized to a particular fracture.

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

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