

Does Radiological outcome influence Functional outcome in Intra-articular Distal Radius Fracture? A Prospective study

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Abstract

Purpose: The objective of this study was to evaluate the functional and radiographic outcome in distal end radius intra articular fracture treated with volar locking plating at 1yr follow up. To check for association between radiographic parameters and objective and subjective functional outcome.

Materials and methods: In a prospective study, 37 patients were evaluated who had undergone volar locking plating for intra articular distal radius fractures in our institute during a 2 year period from April 2014 to May 2016. Clinical and radiographic analysis were performed on follow up at six and twelve months. Stewart scoring method was used for radiographic evaluation. For Subjective assessment PRWE score was used. ROM and Grip strength were measured for objective evaluation.

Result: The correlation between the radiographic score and the subjective assessment for patients more than 60 years of age, was not statistically significant. However, in younger age group there was positive correlation between radiographic score and subjective PRWE score. There was a positive correlation between radiographic outcome and functional objective outcome in younger age group. However, the correlation between the radiographic score and the objective functional assessment in age group more than 60 years was not statistically significant. ROM functional score and Grip strength were significant predictors of disability (subjective PRWE score).

Conclusion: The majority of the patients had a good to excellent radiographic score which correlated positively with both the objective and subjective functional score, especially in the younger patients; among older patients, functional outcomes were largely independent of radiographic outcomes. The positive correlation between radiological and functional outcome in younger patients suggests that proper articular reconstruction is essential and regular follow-up radiographs are required to assess that reduction of the fragments is maintained till fracture union is achieved. The patient's age is an important factor in the overall patient satisfaction regardless of the radiographic and the objective functional scores. Hence age and functional demand of patient should be considered during planning of treatment options.

Keywords: Wrist; Trauma; Fracture; Distal radius; Volar Locking Plating; Radiographic Outcome; Functional Outcome; Fracture fixation.

Introduction

Although distal radial fractures account for up to 20% of all fractures treated in emergency departments, many are not “completely exempt from pain” after treatment. Still there is no consensus on which treatment is superior or firm guidelines for treatment decisions. Complicating matters further is the fact of a bimodal distribution of patients(1). Bone quality also is a confounding variable in trying to determine the best treatment for a particular patient. Bone quality is directly related to the ability to obtain and maintain reduction. In patients with poor bone quality, low-energy trauma may produce significant displacement and comminution. Both clinical outcome and biomechanical studies demonstrate that maintenance

of palmar tilt (normally 11 degrees), of ulnar variance (normally -2 mm), and of radial height (normally 12 mm) is the most important factor in obtaining good results. There is a growing understanding that many techniques may result in satisfactory long term clinical outcomes but have real short term advantages for patients. The significance of these short term advantages for the patient must now be weighed against the financial impact of routine operative intervention has cost. In addition, with an aging society with greater longevity, previously held dictums of cast treatment for geriatric patients are being challenged both by surgeons and society. An increasing preponderance of published studies supports the need for operative intervention in this aging population(2). There is both general consensus and scientific evidence that restoration of the anatomy of the distal radius is closely linked to restoration of function(3). An improved understanding of kinematics, bone quality, and muscle forces acting across the fracture has led to increased awareness of a fracture's relative stability, as well as the development of innovative devices to counteract these forces and restore stability. Treatment aims should be to reconstruct the anatomy as good as possible, to guarantee

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that there is no loss of reduction & to allow for a functional after treatment as soon as possible(4). Biomechanical studies have shown that fractures fixed using locked plates have greater stability than either dorsal or volar non-locked plates. Volar plates have the advantage of causing lower incidence of complications relating to the extensor tendons, compared with dorsal plates. The radiological results of fracture treatment have no meaning unless they are considered in light of functional outcome. Review of literature reveals inconsistency in correlation between radiological and functional outcome and the disability of the patients. This study had been taken up to assess the correlation between anatomical and functional outcome in these patients with distal radius fracture.

Material and methods

In a prospective study, 37 skeletally mature patients were evaluated who had undergone volar locking plating for intra articular distal radius fractures in our institute during a 2 year period from April 2014 to May 2016. Ethical approval for the study was gained from our institutional ethical committee.

Inclusion Criteria:

(1) Age more than 18 years. (2) Patients with closed intra articular distal end radius fracture. (3) Patients with such fracture with history of trauma < 2 weeks.

Exclusion criteria:

(1) Patients lost in follow-up. (2) Patients with additional wrist injury (Carpal Fracture). (3) Patients with pathological or tumor-related fracture. (4) Patients presenting with distal neurovascular deficit. (5) Patients having severe systemic disease (Class V-VI of the ASA Physical Status Classification). (6) Patients having history of substance abuse that would preclude reliable assessment.

The patients were taken up for surgery after obtaining written and informed risk consent of the nature and complications of the surgery. The fractures were classified according to AO Classification. All patients were operated under brachial plexus block. Fractures was exposed through the distal part of the Henry approach between the FCR and radial artery via an 8 to 9cm longitudinal incision directly over the distal course

of the FCR tendon. Then reduced with an initial hyperextension maneuver, followed by flexion of the wrist while the apex of the deformity is stabilized with a thumb. The fracture was then temporarily fixed with an oblique Kirschner wire inserted percutaneously through the radial styloid. A volar locking plate (2.7mm, for a few patients 3.5mm was used) applied and fixed with screw after positioning to fit the volar metaphyseal flare of the radius. Using a predesigned data sheet, relevant information was recorded. Each patients in this study was assessed according to a battery of functional and radiographic outcomes. All the patients were called for follow up visits at 6 months and 1 year. At each follow up patients were assessed for-

Radiographic Evaluation:

Standard wrist radiographs (AP and lateral) of injured and uninjured wrist obtained immediately following injury, after immediate post-op, at 6 months and 1 year after injury. Radial length, Radial tilt and Dorsal tilt (or Volar tilt) were measured at each visit compared with radiographs of the uninjured contralateral wrist and the differences were measured. The results were graded according to Stewarts Scoring System(5)(Table 1).

Disability Evaluation:

Subjective assessment: Subjective assessment of pain and disability was done using patient rated wrist evaluation (PRWE) score. Total score were graded into Excellent (0-25), Good (26-50), Fair (51-75), or Poor (76-100). Objective physical characteristics: The objective clinical parameters evaluated were grip strength and range of movements. Grip strength was measured using a hand dynamometer. The uninjured hand grip strength was measured as a reference. Score was recorded in form of Percentage of grip strength of uninjured side and graded as Excellent (76-100), Good (51-75), Fair (26-50), or Poor (0-25). Measurement of involved wrist range of motion (ROM) was done using a plastic goniometer. The values of ROM were measured in degrees and then scored on a 26 point ROM Scale (Table 2) into Excellent (≥ 20), Good (13-19), Fair (7-12) or Poor (≤ 6).

Statistical analysis

Statistical analysis was done according to descriptive

Table 1: Radiographic Score: Anatomical scoring method

Final dorsal angle (degrees)	*Loss of radial length (mm)	*Loss of radial angle (degrees)	Score for each measurement
Neutral	Under 3	0-4	0
1-10	3-6	5-9	1
11-14	7-11	10-14	2
≥ 15	≥ 12	≥ 15	4

Anatomical grade obtained by addition of the three scores for each result: excellent 0; good 1-3; fair 4-6; and poor 7-12

*Difference between control and final radiographs; if the control side had suffered previous fracture, an average value was used

Table 2: Active range of movements in wrist scoring

Max. Score	SCORING OF THE ACTIVE RANGE OF MOVEMENTS IN THE WRIST					
	Extension	Flexion	Ulnar deviation	Radial deviation	Pronation	Supination
0	<10°	<10°	<5°	<5°	<10°	<10°
1	$\geq 10^\circ$	$\geq 10^\circ$	$\geq 5^\circ$	$\geq 5^\circ$	$\geq 10^\circ$	$\geq 10^\circ$
2	$\geq 20^\circ$	$\geq 20^\circ$	$\geq 15^\circ$	$\geq 15^\circ$	$\geq 20^\circ$	$\geq 20^\circ$
3	$\geq 30^\circ$	$\geq 30^\circ$	$\geq 25^\circ$		$\geq 40^\circ$	$\geq 40^\circ$
4	$\geq 40^\circ$	$\geq 40^\circ$			$\geq 60^\circ$	$\geq 60^\circ$
5	$\geq 50^\circ$	$\geq 60^\circ$			$\geq 70^\circ$	$\geq 70^\circ$
6	$\geq 70^\circ$					

and inferential statistics. Descriptive statistics- Mean, Standard Deviation were performed on the variables obtained. Inferential statistics- Tests used were Chi-square test, Wilcoxon Signed Rank Test and Kruskal Wallis Test. Statistical correlation for description of the association between parameters was done with the Spearman correlation.

Results

The mean age of our study population ($n = 37$) was 46 years (range, 19 – 70 years), and 2 patients (5.4%) were female. Nineteen fractures (51.3%) were of the dominant hand. The commonest injury mechanism was a Road Traffic Accident, with majority of fractures being AO type C regardless of age and gender. On radiographic assessment, 18 patients (48.6%) had fair radiographic score, 11 patients (29.7%) had good score, while 3 patients (8.1%) had an excellent radiographic score and 5 patients (13.5%) had a poor score. On objective assessment of the wrist function with respect to ROM, 18 patients (48.6%) had a good objective functional score, 7 patients (18.9%) had fair, while 12 (32.4%) had excellent functional objective score and none of the patients had a poor score. On objective assessment of the wrist function with respect to grip strength, 14 patients (37.8%) had a good objective functional score, 15 patients (40.5%) had fair, 8 (21.6%) had excellent, while none of the patients had poor score. Subjective assessment of the wrist function showed that 24 patients (64.8%) had a good PRWE score, 2 patients (5.4%) had fair, while 11 (29.7%) had excellent PRWE score and none of the patients had a poor score. Grip strength at 1 year follow up was found to have a negative correlation with age of patient (Spearman's Correlation Coefficient (ρ) = -0.559, $P < 0.001$). Meaning younger the patient better the recovery of grip strength. The radial tilt was more closely related to grip strength and all of the movements except radial deviation. Dorsal tilt was also found to be correlated to ROM score (Table 3). There was a negative correlation between radiographic score and functional objective outcome in younger age group (ROM-Spearman's Correlation Coefficient (ρ) = -0.765, $P < 0.001$; Grip strength-Spearman's Correlation Coefficient (ρ) = -0.632, $P < 0.001$). This shows that, the better the radiographic outcome the better the

functional objective outcome in patients under 60 years of age. However, the correlation between the radiographic score and the objective functional assessment in age group more than 60 years was not statistically significant (ROM $p = 0.062$, Grip strength $p = 0.237$). The correlation between the radiographic score and the subjective assessment for patients more than 60 years of age, was not statistically significant ($p = 0.872$). However, in younger age group there was positive correlation between radiographic score and subjective PRWE score (Spearman's Correlation Coefficient (ρ) = 0.834, $P < 0.001$). Which indicates that age was an important factor particularly on subjective assessment of the outcome and overall patient satisfaction. This implies that older patients tend to have lower (PRWE) score i.e. better subjective score despite lower radiographic scores, probably, due to lower functional demands. There was negative correlation between the mean subjective PRWE score and the objective ROM functional score (Spearman's Correlation Coefficient (ρ) = -0.706, $P < 0.001$). This indicates that, better objective functional assessment is associated with higher patient satisfaction. Grip strength also was a significant predictor (Spearman's Correlation Coefficient (ρ) = -0.451, $P = 0.005$) of disability (PRWE score).

Discussion

Because of the high incidence and an increasing elderly population, fractures of the distal end radius are an important public health issue. Despite numerous techniques used to restore anatomic congruity after distal radius fractures, it is unclear if such restoration translates to improved functionality. The primary purpose of this study was to evaluate the correlation between radiographic parameters and functional outcome assessments. In recent years, wrist injuries evaluation is focused on assessment of disability from the patient's perspective (PRWE). That is why it is important to examine how the objective characteristics' impairment contributes to the overall disability. Smail stressed the importance of patient's satisfaction in the assessment of end results (6). As compared with 6 month follow up, assessment at 1 year follow up had worse radiographic scores, but much better objective and subjective functional scores (Wilcoxon Signed Rank Test, P value < 0.001). This shows that physiotherapy and close monitoring of recovery in follow up visits will improve patient function regardless of radiological outcome. Stuby et al (7) also found that early functional postoperative therapy resulted in better ROM outcome. There was a loss in mean radial length (9.5 mm to 7.3 mm) and mean radial tilt (22° to 18°) from immediate post-operative assessment to 1 year

Table 3: Radiographic parameters Vs Objective parameters

	Radial length		Radial tilt		Dorsal tilt		Radiographic score	
	Correlation Coefficient	P-value						
Flexion	0.166	0.327	0.374	0.023	-0.106	0.532	-0.424	0.009
Extension	0.367	0.026	0.413	0.011	-0.316	0.057	-0.612	<0.001
Ulnar deviation	0.44	0.006	0.551	<0.001	-0.367	0.026	-0.704	<0.001
Radial Deviation	0.115	0.497	0.14	0.41	0.03	0.859	-0.282	0.091
Pronation	0.276	0.099	0.338	0.041	-0.433	0.007	-0.646	<0.001
Supination	0.265	0.113	0.292	0.08	-0.388	0.018	-0.62	<0.001
ROM	0.31	0.062	0.45	0.005	-0.4	0.014	-0.742	<0.001
Grip strength	0.213	0.205	0.442	0.006	-0.251	0.134	-0.562	<0.001

follow up. This indicates there is some collapse of radial articular surface during follow up. These findings are in keeping with the findings of some other studies(8, 9).

Analysis of Radiographic assessment versus Objective outcome:

It is widely believed that accurate reduction and superior radiological results produce good functional results. Trumble et al(10) also attempted to determine this correlation in a series of 52 displaced, intraarticular fractures. These fractures were treated either nonoperatively (cast immobilization) or surgically (external fixation, open reduction and internal fixation, open reduction and internal/external fixation). Functional outcomes measured included ROM, grip strength, and pain evaluation. They reported postoperative gap, step-off, and radial shortening were all "closely correlated" with the final functional outcomes. A study by McQueen and Caspers(11) evaluated the relationship between functional outcome and radiographic displacement in a series of 30 nonoperatively treated patients with distal radius fractures. The average age of the study cohort was 69 years, and 97% were female. Radiographs were analyzed with respect to dorsal angulation and radial shift, and patients were categorized as having good position or malunion based on these radiographs. The malunited group included all patients with a dorsal angulation greater than 100 or radial shift 2 mm or greater. This study assessed functional outcome using grip strength, ROM measurements, the Jebsen-Taylor test, and subjective surveys. In this study population, the patients with good reduction had improved subjective and objective outcomes compared with their counterparts with malunions. However the mean age of the cohort in these studies were relatively low ranging from 40-50 years. However, Young and Rayan(12) did not find a correlation between radiological and clinical results in a study of 25 low-demand patients older than 60 years of age. Roumen et al(13) studied patients above the age of 55 and did not find a correlation between radiological and clinical outcome, but radiological parameters were not separately evaluated. Kojii Fujii et al(14) in his study with elderly population did not find significant correlation between radiological results and functional outcome. These studies cohort comprised of mainly elderly population. In this study while correlating radiological results with objective functional outcome in patients more than 60 years of age, also shows no significant statistical correlation. However, in younger age group, there was significant statistical correlation. In other words, in younger age groups better radiographic outcome is associated with better functionality, unlike in elderly patients where this association is absent. We conclude that the anatomical restoration results in better functional outcome in young groups, but not in older age

group patients. Also we found dorsal tilt and radial tilt have great impact on functional objective outcome and should be restored, the similar results were shown by Forward et al(15) and Jenkins and Mintowt-Czyz(16). However contradictory to it many previous authors(17-20), did not find a significant correlation between loss of radial inclination and clinical outcome.

Analysis of Radiographic results versus Subjective assessment:

One study by Jaremko et al(21) assessed 74 conservatively managed fractures in patients aged 50 or older and reported no statistical correlation between radiographic outcome and patient satisfaction (using DASH and SF-12 surveys). Another study by Ring and Jupiter(22) assessed radiographic and functional outcomes in 20 patients aged 60 or older who had undergone operative fixation following unsuccessful closed reduction. Similarly, PRWE scores were not found to correlate with the radiographic outcomes of these fractures. On assessing disability using PRWE score, for patients more than 60 years of age the findings in the current study were similar to these studies where there was no correlation between the radiographic assessment and the patient reported satisfaction. Meaning, for elderly patients, satisfaction was not necessarily related to good radiographs after treatment. However, in younger age group, there was statistical significant correlation. In other words, in younger age groups better radiographic outcome is associated with patient satisfaction, which is similar to Gilatis(20) findings assessing the outcome of distal radial fractures in young adults. This leads to the conclusion that while elderly patients with low functional demands are more tolerant of poor radiographic result, younger patients with high functional requirement need better articular reduction and alignment. These findings are in keeping with the findings of some other studies(12, 21, 23-26).

Analysis of Objective outcome versus Subjective assessment:

The present study demonstrated that grip strength and ROM were significant predictor of disability (PRWE score). This observation is supported by other studies(27, 28).

Limitations:-Small sample size and shorter follow up duration. Other important radiological parameters like articular step off, comminution, ulnar variance, ulnar styloid fracture and subjective factors not related to injury, such as education level, injury compensation status were not considered in this study. Bone mineral density would have been useful, but was not included in this study.

Conclusion

The majority of the patients had a good to excellent radiographic score which correlated positively with both the objective and subjective functional score, especially in the younger patients; among older patients, functional outcomes were largely independent of radiographic outcomes. The positive correlation between radiological and functional outcome in younger patients suggests that proper articular reconstruction is essential and

regular follow-up radiographs are required to assess that reduction of the fragments is maintained till fracture union is achieved. The patient's age is an important factor in the overall patient satisfaction regardless of the radiographic and the objective functional scores. Hence age and functional demand of patient should be considered during planning of treatment options.

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