Functional and Radiographic Outcomes of Distal Radius Fractures Managed Non-Operatively at Western Visayas Medical Center during the Covid-19 Pandemic

David John C. Villareal, MD, Lucille P. Detoyato, MD, FPOA

Western Visayas Medical Center

Department of Orthopedics

DOI: 10.29322/IJSRP.14.05.2024.p14934
10.29322/IJSRP.14.05.2023.p14934

Paper Received Date: 21st April 2024
Paper Acceptance Date: 24th May 2024
Paper Publication Date: 31st May 2024

***Abstract*-** In recent years, studies have recognized the need for timely management of distal radius fractures in correlation with functional outcome. The unfortunate occurrence of COVID-19 as a global threat quickly affected health seeking behavior and patients' time to consultation. The aim of this study was to determine the functional and radiographic outcome of non-operatively managed distal radius fractures who were ideal surgical candidates. A total of 15 patients with distal radius fractures were enrolled in this study. Total enumeration of patients was done from March 2020 to December 2021. Using the patient archiving system, their pre-casting radiographic parameters were obtained. Measurement of functional outcome and post-casting radiographic parameters shortly followed. Additional functional assessment was done using the DASH Score and PRWE Score. Grip strength between the injured and uninjured sides revealed a statistically significant difference (p=<0.001) between the two variables. Grip strength was also influenced through a statistically significant relationship with the presence of a distal radius fracture. Among the radiographic parameters, only ulnar variance showed a statistically significant relationship with both DASH and PRWE scores. DASH Scores and PRWE Scores showed acceptable values with 93% and 60% respectively. Two patients had substantial deviations from normal radial height, radial inclination, and ulnar variance yet had the best DASH and PRWE scores. No significant relationship was found between functional and radiographic outcomes with the exception of ulnar variance as a radiographic parameter.

***Index Terms*-** COVID-19 pandemic, Distal radius fractures, Functional outcome, Non-operative, Radiographic outcome

I. INTRODUCTION

The COVID-19 pandemic has undoubtedly affected numerous aspects of orthopedic patient care. Lengthy restrictions to travel and social contact have crippled access to specialist care as well as forcing clinicians to modify their daily clinic routines. Admission protocols have also been altered to suit more emergent cases. However, despite sustaining injuries requiring emergency attention, elderly patients in particular tend to delay initial consult in fear of contracting COVID-19. This poses the problem of patients with distal radius fractures presenting late into the course of disease.

Distal Radius fractures remain the most common fracture seen in the emergency department (McQueen, 2015). They comprise 3% of all upper extremity injuries and have an incidence greater than 640,000 in the United States alone (Wolfe, 2010). As many as 20% to 50% of distal radius fractures were considered inadequately reduced and require surgical fixation (Ranjeet, 2012). Advancements in technology, understanding of biomechanics, and deforming forces have significantly improved the chances of restoring stability particularly for unstable fracture patterns.

One of the numerous studies in support of good functional outcomes with surgical fixation was done by Phadnis, et al. (2012). Their study is a single center large population series which demonstrated good to excellent results in the majority of patients involved after volar locking plate fixation of the distal radius. Complication rates were found to be comparable to other non-operative and operative treatment modalities.

Operative management continues to have a role despite late presentation as shown by Lee, et al. (2020). No significant differences in radiographic outcomes or complication rates between patients were found, with delayed versus early surgical treatment for distal radius fractures. Providers treating patients with late presentation or late displacement still have the option of surgical fixation beyond the first few weeks after injury.

General Objective:

To determine the functional and radiographic outcomes of distal radius fractures managed non-operatively from February 2020 to December 2021.

Specific Objectives:

1. To enumerate the demographic profile of patients as to the following
   a. Sex
   b. Age
   c. Handedness
2. To determine the post-casting functional outcomes of patients with distal radius fractures using the following instruments and motions
   a. DASH questionnaire and PRWE score
   b. Wrist flexion and extension
   c. Wrist pronation and supination
   d. Radial and ulnar deviation
   e. Grip strength
3. To determine radiographic outcomes of distal radius fractures managed non-operatively during the COVID-19 pandemic as to:
   a. Pre-casting measurements
   b. Post-casting measurements
4. To determine acceptability of radiographic outcomes using pre-casting and post-casting radiographic measurements

II. IDENTIFY, RESEARCH AND COLLECT IDEA

Research Design

This study had a cross sectional study design

Study Population

All patients with isolated fractures of the distal radius who fit surgical indications but have been managed non- operatively at Western Visayas Medical Center from February 2020 to December 2021

Inclusion Criteria

All patients who sustained isolated fractures of the distal radius who fit surgical indications but have been managed non-operatively at the Western Visayas Medical Center emergency department, outpatient department, or admitted was included in this study.

Exclusion Criteria

A. Patients with multiple injuries
B. Patients who underwent operative treatment
C. Patients who do not understand the language in which the instruments (DASH, Fil-DASH, and PRWE score) are expressed

Sample Size

Total enumeration was done thus no sample size was calculated

Data Gathering Tools

This study employed validated patient reported instruments such as the Disabilities of the Arm, Shoulder and Hand (DASH) Score, its Filipino translated counterpart, the Fil-DASH score, and the Patient-Rated Wrist Evaluation (PRWE) Score.

Study Procedure

All wrist and hand x-ray images from February 2020 until December 2021 was searched individually using the integrated Picture Archiving and Communications System (PACS) employed by Western Visayas Medical Center. It was used to identify all patients who met the inclusion criteria. The general data and contact details of eligible patients was retrieved from the hospital record section. Patients were then contacted and recalled for follow-up.

On follow-up, information about the study was fully explained. This included the patient's consent to participate, benefits of participation, and freedom of withdrawal anytime from the study.

Eligible patients had their x-rays evaluated for radial height, radial inclination, ulnar variance, intra-articular gap and step-off on a posteroanterior (PA) view, and volar tilt on the lateral view of the radiograph. Injury x-rays were measured using digital tools available through the hospital PACS. Post casting x-rays were taken immediately after reduction or after cast removal.

Functional outcome was measured using the Patient Rated Wrist Evaluation (PRWE) Score, Disabilities of the Arm, Shoulder and Hand (DASH) score, grip strength, range of wrist extension and flexion, wrist pronation and supination, and radial and ulnar deviation.

The DASH questionnaire is a patient-rated tool and is the most validated measure of upper extremity functional status. Questions are based on daily activities, symptoms including pain, and an optional work and sports/performing arts module. A final score is calculated, ranging from 0 (*no disability*) to 100 (*the most severe disability*). Thus, a higher score indicates greater disability. The standard DASH Questionnaire was originally developed in English but its Tagalog translated equivalent, the Fil-DASH Questionnaire, was made available at our patient's request.

The PRWE (Patient Related Wrist Evaluation) Score is a test specifically developed for patients with distal radius fractures. It is a 15-item patient reported questionnaire which examines severity and frequency of pain (5 questions) and ability to perform activities of daily living (10 questions). Comparing the PRWE Score with the DASH and Gartland and Werley Score, it showed fair validity and good responsiveness and reliability.

Administration of functional outcome measures was done provided patients have had complete removal of the cast or splint for a minimum period of 8 weeks. Prior to examination, a Wrist PA and lateral x-ray views were taken to ensure radiographic union in at least three cortices.

Grip strength was measured using a locally available hand grip dynamometer with a maximum capacity of 90kg or 198 lbs. Patients had three attempts with instruction to maximally grip the dynamometer during each attempt. No rest period was provided in between the attempts. The mean of the three attempts was their final grip strength measurement. The exact process was then done with the unaffected extremity as well.

Range of motion functional outcome measurements involve objective measurement of wrist extension and flexion, wrist pronation and supination. Patients were instructed to actively flex and extend their injured wrist. The maximum point of flexion and extension were measured against the static forearm using a goniometer. These measurements were also taken for the contralateral limb.

The wrist pronation and supination were measured with the aid of a marker, pen, or a similar sized cylindrical object. The patient was instructed to grip the object against the palm with the wrist in a neutral starting position. The elbows were flexed to 90 degrees and tucked near the torso. From this position, the patient was instructed to pronate and supinate the forearm. Attention was given to the elbow such that it should not move during pronation and supination. The point of maximum pronation and supination was noted using a goniometer and measured from the neutral starting point. Similar to the other outcome measures, measurements from the contralateral unaffected extremity were also obtained.

Measurement of radial and ulnar deviation was done with the forearm in neutral position. The patient was then instructed to deviate the wrist in a radial and ulnar direction with the digits fully extended. The maximum point of radial and ulnar deviation was measured using a goniometer and the same measurement was done with the unaffected extremity.

Data Analysis Procedure

Data was analyzed using SPSS version 29. 95% confidence interval was used. A Spearman rho correlational test was used. Paired t-test was used for relevant data. Patients had their radiographic parameters obtained from injury and post management radiographs. Digital measurements were obtained using a PACS (picture archiving and communication system) and were noted with pre-adjustment for 10% magnification.

Data obtained from objective measurement of functional outcomes was averaged, tabulated and a similar paired chi-square test was applied.

III. RESULTS AND FINDINGS

From the total number of 24 patients eligible, only 15 were included in this study. Table 1 shows the clinico-demographic profile of each patient as to sex, age, and hand dominance. Table 2 shows the number of patients with functionally acceptable and not acceptable results. Table 3A and 3B shows the pre-casting and post-casting values of all patients respectively. Table 4 shows the number of acceptable post-casting radiographic outcomes while Table 5 shows the number of acceptable post-casting functional outcomes.

Table 1
Clinico-demographic Profile of Patients

	Sex	
	Number of Patients (N=__)	% from total number of patients
Male	8	53.33%
Female	7	46.66%
	Age (years)	
	Number of Patients (N=__)	% from total number of patients

20 and below	2	13.33%
21-30	0	0
31-40	3	20%
41-50	1	6.66%
51-60	2	13.33%
61-70	6	40%
70 and above	1	6.66%

Handedness

	Number of Patients (N=__)	% from total number of patients
Right Hand Dominant	14	93.33%
Left Hand Dominant	1	6.66%

Of the 15 patients included in this study, 53% were male and 40% belong to the 61-70 year old age group. This indicates male and "young" elderly predominance of these fractures. Despite being only 47%, the seven female patients comprise nearly half of all patients in this study. As to handedness, a great majority of patients were right hand dominant.

Table 2
Post-Casting Functional Outcomes of Patients with Distal Radius Fractures

	Functional Outcomes			
	Number of Patients (N=__) (Acceptable)	**% from total number of patients**	**Number of Patients (N=__) (Not Acceptable)**	**% from total number of patients**
DASH Score	14	93.33%	1	6.66%
PRWE Score	9	60%	6	40%
Wrist Flexion	6	40%	9	60%
Wrist Extension	8	53.33%	7	46.66%
Wrist Supination	11	73.33%	4	26.66%
Wrist Pronation	11	73.33%	4	26.66%
Radial Deviation	11	73.33%	4	26.66%
Ulnar Deviation	2	13.33%	13	86.67%
Grip Strength	1	6.66%	14	93.33%

Table 2 shows that 14 (93%) of the 15 patients had acceptable DASH Scores. Majority of PRWE scores were also acceptable at 60%. Notable also is that only 1 patient exhibited acceptable grip strength measurement and 93% had fairly weak grip strength.

Table 3A
Radiographic Outcome of Distal Radius Fractures (Pre-Casting)

		Pre-Casting					
Case no.	**Age/Sex**	**Radial Height (mm)**	**Radial Inclination (degrees)**	**Volar Tilt (degrees)**	**Articular Gap (mm)**	**Articular Step-off (mm)**	**Ulnar Variance (mm)**
1	83/F	1.45	6.63	-22.45	0	0	10.38
2	59/F	7.58	15.40	-16.66	0	0	5.32

3	31/M	4.82	7.57	-24.18	1.91	1.91	6.99
4	63/F	5.51	11.68	8.81	0	0	5.62
5	19/M	9.66	21.25	32.37	0	0	3.70
6	64/F	6.07	15.47	-20.98	0	0	5.44
7	18/M	4.84	8.56	6	0	0	0
8	33/M	5.64	9.37	9.57	0	0	3.24
9	32/M	14.45	24.96	-20.09	4.13	6.83	6.31
10	67/M	8.32	16.93	13.69	2.25	2.15	2.71
11	67/F	2.39	6.60	11.06	0	0	7.29
12	65/M	7.72	13.24	0	0	0	7.17
13	57/F	1.36	2.25	23.6	0	0	9.55
14	66/F	5.96	11.83	12.30	0	0	2.84
15	46/M	2.95	21.20	3.75	0	0	5.41

Table 3A shows the pre-casting radiographic measurements of every patient. As expected of patients in this age group, the patient with the most advanced age presented with the worst radiographic measurement. This patient had the most angular tilt at 22.45 degrees and the most flat radial height and inclination (1.45mm, 6.63 degrees respectively).

Table 3B
Radiographic Outcomes of Distal Radius Fractures (Post-Casting)

Post-Casting							
Case no.	**Age/Sex**	**Radial Height (mm)**	**Radial Inclination (degrees)**	**Volar Tilt (degrees)**	**Articular Gap (mm)**	**Articular Step-off (mm)**	**Ulnar Variance (mm)**
1	83/F	3.14	4.46	-23.01	0	0	13.64
2	59/F	6.07	10.52	-15.34	0	0	6.97
3	31/M	2.56	3.89	-20.4	1.51	1.83	6.50
4	63/F	6.10	13.43	6.33	0	0	6.40
5	19/M	10.69	24.16	32.55	0	0	6.01
6	64/F	5.32	11.36	12.12	0	0	3.11
7	18/M	6.49	12.50	-21.58	0	0	2.25
8	33/M	5.88	9.14	14.7	0	0	3.42
9	32/M	12.47	23.55	-23.97	3.32	3.74	6.65
10	67/M	8.65	17.92	15.98	1.55	1.58	6.09
11	67/F	1.84	7.43	16.42	0	0	6.36
12	65/M	8.52	16.05	25.81	0	0	9.93
13	57/F	1.36	2.25	23.6	0	0	9.55
14	66/F	5	11.06	-22.17	0	0	5.43

15	46/M	2.95	21.20	3.75	0	0	5.41
Mean		5.80 (SD=3.24)	12.59 (SD=6.89)	-3.62 (SD=20.25)	6.51 (SD=2.85)	0.43 (SD= 0.96)	0.47 (SD=1.08)

Table 3B shows that patient 13 had the worst values among the post casting radiographic measurements despite having improved parameters pre-casting. This suggests inherent instability of this patient's fracture pattern.

Table 4
Acceptability of Post-casting Radiographic Parameters

Acceptability (Radiographic)		
	Number of Patients (N=__)	**% from total number of patients**
Acceptable	0	0%
Not Acceptable	15	100%

Table 5
Acceptability of Post-casting Functional Outcomes

Acceptability (Functional)		
	Number of Patients (N=__)	**% from total number of patients**
Acceptable	2	13.33%
Not Acceptable	13	86.67%

As to acceptability, Tables 4 and 5 show that among the 15 patients, only two had acceptable post casting values comprising only 13% of the population and all patients presented with unacceptable radiographic outcomes. While majority of patients had more than one acceptable parameter, it did not translate to a general acceptable outcome.

Table 6
Correlation of DASH Score and Radiographic Outcomes

Correlations

			DASH Score	Radial Height	Radial Inclination	Volar Tilt	Articular Step off	Articular Gap	Ulnar Variance
Spearman's rho	DASH Score	Correlation Coefficient	1.000	-.127	-.190	.281	-.256	-.236	.573*
		Sig. (2-tailed)	.	.651	.498	.310	.357	.398	.025
		N	15	15	15	15	15	15	15
	Radial Height	Correlation Coefficient	-.127	1.000	.789**	.161	.278	.329	-.089
		Sig. (2-tailed)	.651	.	<.001	.567	.315	.231	.752
		N	15	15	15	15	15	15	15
	Radial Inclination	Correlation Coefficient	-.190	.789**	1.000	.279	.163	.214	-.282
		Sig. (2-tailed)	.498	<.001	.	.315	.561	.443	.308
		N	15	15	15	15	15	15	15
	Volar Tilt	Correlation Coefficient	.281	.161	.279	1.000	-.414	-.408	-.264

		Sig. (2-tailed)	.310	.567	.315	.	.125	.131	.341
		N	15	15	15	15	15	15	15
	Articular Step off	Correlation Coefficient	-.256	.278	.163	-.414	1.000	.993**	.174
		Sig. (2-tailed)	.357	.315	.561	.125	.	<.001	.536
		N	15	15	15	15	15	15	15
	Articular Gap	Correlation Coefficient	-.236	.329	.214	-.408	.993**	1.000	.158
		Sig. (2-tailed)	.398	.231	.443	.131	<.001	.	.573
		N	15	15	15	15	15	15	15
	Ulnar_Variance	Correlation Coefficient	.573*	-.089	-.282	-.264	.174	.158	1.000
		Sig. (2-tailed)	.025	.752	.308	.341	.536	.573	.
		N	15	15	15	15	15	15	15

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 7
Correlation of PRWE Score and Radiographic Outcomes

Correlations

			PRWE Score	Radial Height	Radial Inclination	Volar Tilt	Articular Step off	Articular Gap	Ulnar Variance
Spearman's rho	PRWE Score	Correlation Coefficient	1.000	-.131	-.254	.242	-.272	-.254	.574*
		Sig. (2-tailed)	.	.643	.361	.386	.326	.360	.025
		N	15	15	15	15	15	15	15
	Radial Height	Correlation Coefficient	-.131	1.000	.789**	.161	.278	.329	-.089
		Sig. (2-tailed)	.643	.	<.001	.567	.315	.231	.752
		N	15	15	15	15	15	15	15
	Radial Inclination	Correlation Coefficient	-.254	.789**	1.000	.279	.163	.214	-.282
		Sig. (2-tailed)	.361	<.001	.	.315	.561	.443	.308
		N	15	15	15	15	15	15	15
	Volar Tilt	Correlation Coefficient	.242	.161	.279	1.000	-.414	-.408	-.264
		Sig. (2-tailed)	.386	.567	.315	.	.125	.131	.341
		N	15	15	15	15	15	15	15

	Articular Step off	Correlation Coefficient	-.272	.278	.163	-.414	1.000	.993**	.174
		Sig. (2-tailed)	.326	.315	.561	.125	.	<.001	.536
		N	15	15	15	15	15	15	15
	Articular Gap	Correlation Coefficient	-.254	.329	.214	-.408	.993**	1.000	.158
		Sig. (2-tailed)	.360	.231	.443	.131	<.001	.	.573
		N	15	15	15	15	15	15	15
	Ulnar Variance	Correlation Coefficient	.574*	-.089	-.282	-.264	.174	.158	1.000
		Sig. (2-tailed)	.025	.752	.308	.341	.536	.573	.
		N	15	15	15	15	15	15	15

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 8
Grip Strength of the Injured and Uninjured Side

Paired Samples Effect Sizes

					95% Confidence Interval	
			Standardizer[a]	Point Estimate	Lower	Upper
Pair 1	Grip Strength of Injured Side - Grip Strength of Uninjured Side	Cohen's d	4.93131	-1.458	-2.181	-.709
		Hedges' correction	5.21673	-1.378	-2.062	-.671

Comparison of the grip strength between the injured and uninjured sides using a paired t-test revealed a statistically significant difference (p=<001) between the two variables.

Due to the presence of data outliers in the extremes of two patients, Spearman correlation was used. Overall, only ulnar variance shows a statistically significant relationship with both DASH and PRWE scores. Other radiographic parameters did not show a significant relationship.

Despite ulnar variance being the only statistically significant relationship between functional and radiographic parameters, DASH Scores and PRWE Scores show a majority of acceptable values with 93% and 60% respectively. No difference in results were influenced by sex, age, and hand dominance. Two of these patients have substantial deviations from normal radial height, radial inclination, and ulnar variance yet have the best DASH and PRWE scores. No statistically different outcomes were established between DASH and PRWE with range of motion, however, these were clinically significant as reflected by the best scores of these two patients.

Discussion

The unique challenges presented by the COVID-19 situation in our locality certainly altered our approach in dealing with distal radius fractures. Fractures that meet surgical indications were managed conservatively and its associated complications became quickly evident. Approximately 20% to 50% of distal radius fractures were considered inadequately reduced and require surgical fixation (Ranjeet, 2012).

While surgical fixation was not impossible during the height of the COVID-19 pandemic, it posed additional cost and risk to both healthcare workers and patients. Surgical indications for managing distal radius fractures remain fixed and conservative management may not be enough to produce satisfactory results as in the study by Baawa-Ameyaw, et al. (2020).

In this study, we determined the functional and radiographic outcomes of conservatively managed fractures that initially fit surgical indications on presentation. All of these patients were managed with casting or splinting and followed up at regular intervals. Once radiographic union was established the cast or splint was then removed.

Correlational analysis failed to establish a significant relationship with functional outcomes and most radiographic parameters. The only radiographic parameter that was significantly related to functional outcome was ulnar variance. Another notable result of this study was that despite severe discrepancies in radiographic measurements, patients continue to present with good DASH and PRWE scores. A similar absence of relationship is observed with functional range of motion values and instrument scores. Comparison of grip strength in the injured and uninjured sides also revealed a statistically significant relationship between these two variables.

Similar findings were reported by Ludvigsen, et al. (2021). They compared functional and radiographic outcomes of AO Type A3 distal radius fractures treated with a volar locking plate vs external fixation. Patient follow-up was done at a minimum of one year post surgery. Their results revealed that neither fixation method established a correlation between functional and radiographic outcomes. Their study also shows that despite operative management and the opportunity to correct radiographic parameters within acceptable limits, it still does not equate to a better functional result.

Another study by Mishra (2020) determined the functional outcome of surgically treated distal radius fractures in elderly patients. Their study presented an even longer time of follow-up at a mean of 5.4 years post surgery. Their findings revealed generally good functional outcomes but found multiple confounding factors that contributed to unpredictable results despite a good surgical reduction and fixation. They also had patients who presented with good PRWE scores while having a poorly reduced fracture.

In support of these multiple studies, Ochen, et al. (2020) goes on to say that the capacity of both operative and non-operative methods to achieve good results contributes to the absence of a consensus on the definitive management of distal radius fractures. While operative management may be more suited for a younger, working population, the low demand elderly patient can still benefit greatly from conservative treatment.

Budget constraints, health risks, logistic problems, and fluctuating local COVID alert levels enable non-operative management as a viable alternative for our local patients. Despite the established benefits of surgical treatment, multiple studies still support good functional outcomes with non-operative management even in younger patients.

IV. CONCLUSION

Results of this study reveal no significant relationship between functional and radiographic outcomes with the exception of ulnar variance as a radiographic parameter. Based on the analysis conducted, findings show that grip strength is influenced through a statistically significant relationship with the presence of a distal radius fracture. This suggests that despite unacceptable radiographic parameters, patients continue to have an acceptable functional outcome of their injured limb.

Recommendations

To future researchers, a greater sample size in a multi-center study is recommended. Longer time to follow-up and additional functional outcome parameters is suggested as well. Involvement of patients who have opted for conservative management under private consultants may also be considered to broaden the scope of the study. Additional resources such as time and budget are also strongly advised to further successful patient follow-ups.

To individuals in top management, patient follow-up long after a healed injury is streamlined by provision of correct contact details such as phone numbers and addresses. Updating these details should be performed during each clinic visit. This is to avoid exclusion of patients secondary to them being entirely lost to follow-up.

Strict and consistent adherence to radiographic positioning of extremities is also advised. This avoids marginal errors in measurement during x-ray positioning. Future researchers may also opt to supervise radiographic positioning to ensure correct placement.

To physicians, the researcher recommends inclusion of conservative management as a definite treatment option especially for poor surgical candidates and elderly patients. This withholds excessive cost to time and money for the patient and avoids surgical complications altogether.

To patients, the researcher advises strict adherence to follow-up schedule. Every patient responds differently to any treatment and post-operative success is largely gauged on each clinic visit. While resources may be understandably limited, there are ways to circumvent such. The treatment does not end with application of treatment but concludes when there is satisfactory return to pre-injury outcome.

APPENDIX

Radiographic Parameters

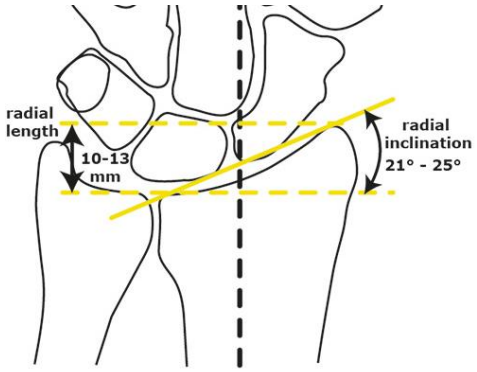

Figure 3. Radial length and radial inclination measurement

Radial height or length is measured on the PA radiograph as the distance between one line perpendicular to the long axis of the radius passing through the distal tip of the radial styloid.

A second line intersects distal articular surface of ulnar head. This measurement averages 10-13 mm.

Radial inclination is measured by the angle formed by a line drawn tangential to the distal radial articular surface on a posteroanterior (PA) radiograph and one perpendicular to the shaft of the radius. This parameter averages 21-25 degrees.

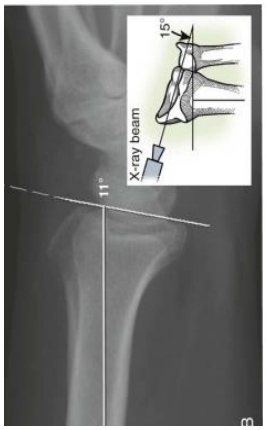

Figure 4. Volar tilt measurement

Palmar tilt is measured by the angle created by a line drawn between the dorsal and palmar lips of the lunate facet and the longitudinal axis of the radius. Palmar tilt averages 11 degrees.

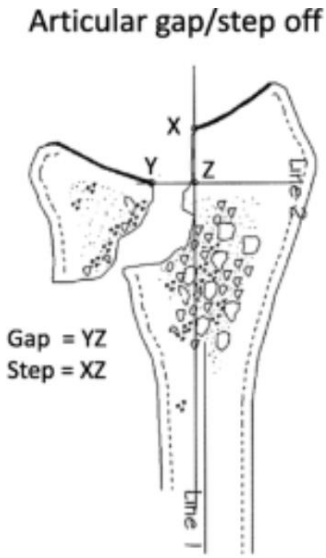

Figure 5. Articular gap and step-off measurement

Articular step-off is the vertical height between the two fracture fragments and articular gap is the horizontal distance between the two fracture fragments. Less than 2mm of articular gap and step-off is preferred.

Figure 6. Ulnar variance measurement

Ulnar variance was measured as the distance between a line perpendicular to the longitudinal axis through the distal ulnar aspect of the radius and the distal cortical rim of the ulna. It is measured within an average range of +2 to -2mm. +1 and +2 is positive ulnar variance, 0 is neutral, and -1 and -2 is negative ulnar variance.

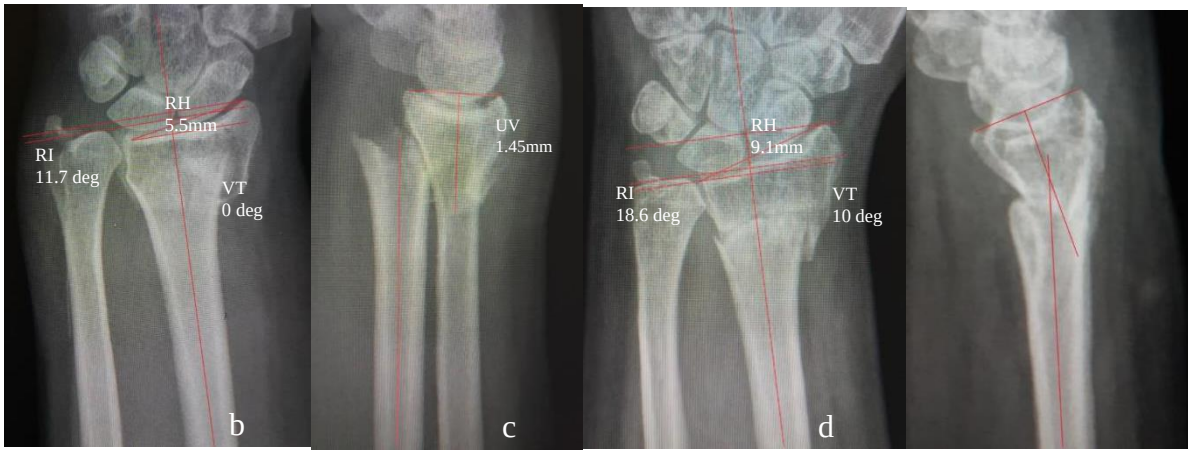

Figure 7. Pre-casting (a,b) and post-casting (c,d) radiographs of one of the patients enrolled in this study with the correct measurements of Radial Height (RH), Radial Inclination (RI), ulnar variance (UV),and Volar Tilt (VT)

REFERENCES

1. Baawa-Ameyaw et al., The Theoretical Impact on Corrective Upper Limb Elective Services following Analysis of Distal Radius Fractures managed non-operatively during COVID-19 pandemic. 2020. https://dx.doi.org/10.1302%2F2633-1462.110.BJO-2020-0126.R1
2. Beaton, D., Guillemin, F., Bombardier, C., & Ferraz, M. B. (2007). Recommendations for the cross-cultural adaptation of the dash ... ResearchGate. Retrieved May 26, 2022, from https://www.researchgate.net/publication/265000941_Recommendations_for_the_Cross-Cultural_Adaptation_of_the_DASH_QuickDASH_Outcome_Measures_Contributors_to_this_Document Coronavirus disease (COVID-19). (2022). World Health Organization. Retrieved February 28, 2022, from https://www.who.int/health-topics/coronavirus#tab=tab_1.
3. Dowrick AS, Gabbe BJ, Williamson OD, Cameron PA. Outcome instruments for the assessment of the upper extremity following trauma: a review. Injury. 2005 Apr;36(4):468-76. doi: 10.1016/j.injury.2004.06.014. PMID: 15755426.
4. Estrella, E., MD, & Orillaza, N., MD. (2019). Fil-DASH. https://Dash.Iwh.on.ca/Available-Translations?fbclid=IwAR0OR4P0kyxh9GWVw6-q4QXJ uRkvFkDXcQl6q2Bhurx-_SHGqIRfqJr4G84. Retrieved February 28, 2022, from https://dash.iwh.on.ca/available-translations?fbclid=IwAR0OR4P0kyxh9GWVw6-q4QXJuRkvFkDXcQl6q2Bhurx-_SHGqIRfqJr4G84
5. Hudak P, Amadio PC, Bombardier C, and the Upper Extremity Collaborative Group. Development of an Upper Extremity Outcome Measure: The DASH (Disabilities of the Arm, Shoulder, and Hand). American Journal of Industrial Medicine 1996; 29:602-608.
6. Knell, G., Robertson, M. C., Dooley, E. E., Burford, K., & Mendez, K. S. (2020). Health Behavior Changes During COVID-19 Pandemic and Subsequent "Stay-at-Home" Orders. *International journal of environmental research and public health*, *17*(17), 6268. https://doi.org/10.3390/ijerph17176268
7. MacDermid JC, Turgeon T, Richards RS, Beadle M, Roth JH. Patient rating of wrist pain and disability: a reliable and valid measurement tool. J Orthop Trauma. 1998 Nov-Dec;12(8):577-86. doi: 10.1097/00005131-199811000-00009. PMID: 9840793.
8. McQueen, M. (2015). Rockwood and Greens Fractures in Adults; Fractures of the Distal Radius and Ulna. (8th ed.). p.1057. Wolters Kluwer
9. Meena, S., Sharma, P., Sambharia, A. K., & Dawar, A. (2014). Fractures of distal radius: an overview. Journal of family medicine and primary care, 3(4), 325–332. https://doi.org/10.4103/2249-4863.148101
10. Ochen Y, Peek J, van der Velde D, et al. Operative vs Nonoperative Treatment of Distal Radius Fractures in Adults: A Systematic Review and Meta-analysis. JAMA Netw Open. 2020;3(4):e203497. doi:10.1001/jamanetworkopen.2020.3497
11. Olech et al., Epidemiology of Distal Radius Fractures in Children and Adults During the COVID-19 Pandemic- A Two Center Study. 2020. https://doi.org/10.21203/rs.3.rs-132986/v1
12. Phadnis, J., Trompeter, A., Gallagher, K. et al. Mid-term functional outcome after the internal fixation of distal radius fractures. J Orthop Surg Res **7,** 4 (2012). https://doi.org/10.1186/1749-799X-7-4
13. Ranjeet N., Estrella E., Distal Radius Fractures: Relationship between Radiologic Parameters and Functional Outcome, 2012, Vol. 46(2), Acta Medica Philippina, p. 55.

14. Singh, R., Goyal, R., Functional and radiological outcome of unstable distal radius fracture treated by conservative or volar buttress plate. 2018. International Journal of Orthopaedics Sciences 2018; 4(2): 80-83
15. Standring, S. (2008). Gray's Anatomy: The Anatomical Basis of Clinical Practice. (40th ed.). Elsevier.
16. Subash et al., An analysis of functional outcome following conservative versus surgical management in fractures of the distal radius. 2018. https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20175067
17. Testa et al., Comparison between Surgical and Conservative Treatment for Distal Radius Fractures in Patients over 65 Years. 2019. https://www.mdpi.com/2411-5142/4/2/26/pdf
18. Wolfe S., Green's Operative Hand Surgery; Distal Radius Fractures, 6th ed., 2010. Elsevier
19. World Health Organization. (n.d.). *Coronavirus disease (covid-19)*. World Health Organization. Retrieved May 24, 2022, from https://www.who.int/emergencies/diseases/novel-coronavirus-2019/question-and-answers-hub/q-a-detail/coronavirus-disease-covid-19
20. Ludvigsen et al., Is there a correlation between functional results and radiographic findings in patients with distal radius fracture A0 type A3 treated with volar locking plate or external fixator?. OTA International: September 2021 - Volume 4 - Issue 3 - p e142 doi: 10.1097/OI9.0000000000000142
21. Mishra P, Iqbal M, Faraj A (2020). Functional Outcome of Distal Radial Fractures in Patients With a Mean Age of 75 Years at a Mean Follow-Up of 5.4 Years. Cureus 12(12): e11959. doi:10.7759/cureus.11959

AUTHORS

First Author – David John C. Villareal, MD, Western Visayas Medical Center, Department of Orthopedics, djvillareal42@gmail.com
Second Author – Lucille P. Detoyato, MD, FPOA, Western Visayas Medical Center, Department of Orthopedics, lucilmd@gmail.com