The impact of demographic factors and comorbidities on distal radius fracture outcomes

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Abstract

Background Despite the prevalence and consequences of distal radius fracture (DRF), there is limited research that analyzes the effects of demographic factors and comorbidities as they relate to pain, perceived disability, and functional outcomes.

Methods All data for this study were examined retrospectively within an established clinical database. Patients with DRF were evaluated during their first and final visits with a criterion-based numeric pain scale (CR12), the Disability of the Arm, Shoulder, and Hand (DASH) questionnaire, and a global rate of change scale to assess outcomes of pain, perceived disability, and function, respectively.

Results The number of days between injury and initial therapy evaluation were inversely correlated with changes in perceived pain and perceived disability ($r=-0.315$, $p=0.000$; $r=-0.348$, $p=0.000$). In addition, moderate and statistically significant correlations were noted between work status and average CR12 and DASH scores at final re-evaluation ($r=0.392$, $p=0.000$, $r=0.473$, $p=0.000$). No significant relationships were noted between additional demographic factors or comorbidities and pain, perceived disability, or function during statistical analysis.

Conclusions Patients without diabetes, hypertension, or depression and those who were not smokers had better outcomes in terms of pain, perceived disability, and function in this

study. In addition, earlier timing of initial evaluation after injury and full duty work status were significantly related to improvement in pain and perceived disability. Timing of initiation of therapy and return to work are suggested as avenues for future research.

Keywords Distal radius fracture · Outcomes · Comorbidities · Demographic factors

Distal radius fracture (DRF) can have a severe impact on a person's quality of life by limiting range of motion in the wrist and the ability to complete daily tasks such as dressing, toileting, grooming, and feeding. When a person sustains a DRF, the primary symptoms include edema, pain, and deformity, along with poor range of motion, strength, and dexterity [10]. DRF accounts for one sixth of all fractures in patients over the age of 50 and are the most frequent fractures in the upper limb [1]. Furthermore, up to one fifth of all patients with a DRF have been reported to experience residual symptoms such as pain, nerve symptoms, and disability after 1 year [16]. Despite the prevalence and consequences of this diagnosis, there is limited research that analyzes the effects of demographic factors and comorbidities as they relate to pain, perceived disability, and functional outcomes following DRF.

Numerous demographic factors and comorbidities have been previously suggested as intervening variables in the study of fracture outcomes. Gender and age have been identified as variables that may affect the healing process [14, 18], while earlier return to function has been correlated with both injury to the dominant hand [2, 3] and earlier referral to therapy [27]. Comorbidities including depression, smoking, diabetes, and hypertension have been previously associated with negative effects on bone mineral density (BMD) [5–7, 28, 29, 32], an increased risk for falls and fractures [5, 28, 32] and delayed healing time [13, 22].

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Demographic factors and comorbidities have been postulated to impact pain, function, and outcomes following fracture. The role of the hand therapist is to help individuals regain function; however, the effect of demographic factors and comorbidities specific to DRF outcomes is unclear. Therefore, the primary purpose of this research study was to analyze the outcomes of patients with DRF. Secondly, this study assessed the impact of demographic factors and comorbidities on pain, perceived disability, and functional outcomes in patients with DRF.

Materials and Methods

This quantitative study was retrospective in design. All data for this study were examined within an established clinical database at a private outpatient clinic. The Institutional Review Board of the sponsoring institution approved this study with a community partnership agreement from the private outpatient clinic.

Sampling

Participants were identified using a convenience sampling technique at a private outpatient clinic. Patients with a diagnosis of DRF were entered into the clinical database by the therapists providing evaluation and intervention. Patients were excluded from the clinical database if they were less than 18 years old, attended only one therapy session solely for the purpose of orthotic fabrication, were scheduled immediately following a physician's visit without prior notification, were insured by Medicare, and/or were not fluent in English. The final exclusion criteria were determined by the private outpatient clinic prior to initiation of this study.

Procedures

As part of standard procedure at the private outpatient clinic, all patients with DRF were evaluated during their first visit. Scores from the criterion-based numeric pain scale (CR12), the Disability of the Arm, Shoulder, and Hand (DASH) questionnaire, and a global rate of change scale (GROC) scale were used to assess outcomes of pain, perceived disability, and function, respectively. Patients were also asked to complete a medical screening form that included questions pertaining to the comorbidities of interest in this study (Appendix 1).

The DASH questionnaire is a subjective outcome measure that has a disability/symptom scale representing a continuum from no disability, quantified at zero, to complete disability, quantified at 100, with lower scores indicating lower perceived disability [20]. Many studies have indicated that the

DASH questionnaire is both valid and reliable for diagnoses of the upper limb [12, 31]. A CR12 pain scale (Appendix 2) was adapted by the private outpatient clinic from the Borg CR12 scale for the purposes of this study. The Borg CR12 scale is a ratio scale that uses verbal anchors to describe both pain and/or exertion on a numerical scale from zero to 10+, quantifying the numerical values into a function [4]. Using the CR12, pain levels were reported in this study for present pain, best pain, and worst pain, ranging from 0 to 10+.

After the initial evaluation, it was determined whether the patient met the inclusion criteria for the database. If the inclusion criteria were met, patient data from every evaluation and re-evaluation were included in the clinical database throughout the course of treatment. In addition to the medical screening form, the CR12 pain scale, and the DASH questionnaire, final re-evaluation data also included data from a GROC scale, which was used to measure a change in injury status. The GROC scale (Appendix 3) used in this study was an 11-point scale that ranged from −5 to +5 with 0 being in the middle. Zero represented no change, and ± 5 represented the greatest amount of change possible, with the positive numbers indicating improvement and the negative numbers indicating deterioration.

Demographic factors, comorbidities, pain, and functional outcomes were extracted from the clinical database by the research team. In order to ensure the accurateness of these scores, the outcome measures were re-scored and verified by research members. Research team members also confirmed the correctness of the demographic factors and comorbidities that were listed within the database. Once all information was verified, the database, minus identifying information, was transferred to a spreadsheet for data analysis. Relationships between demographic factors/comorbidities as compared to pain, perceived disability, and functional outcomes were analyzed.

Results

Demographic Factors

The sample in this study included 182 subjects ranging in age from 18 to 76 years with a mean age of 50 years. Demographic data as organized by subjects, injured extremity, timing, and comorbidities are presented in Table 1, and averages and ranges of all outcome measures are presented in Table 2.

The mean number of days between initial evaluation and final re-evaluation was 44.03 with a mean number of 13.54 therapy visits during this timeframe. The number of days between injury and initial therapy evaluation were inversely correlated with changes in perceived pain and disability in this study. A moderate and statistically significant inverse correlation was noted between the number of days between DOI and

Table 1 Demographic data

Subjects	63 males (34.6 %) and 119 females (65.4 %) 122 surgical interventions (67 %) 60 nonsurgical interventions (33 %)
Injured extremity	80 injured dominant hands 95 injured non-dominant hands 7 injured both hands
Timing	Date of injury to date of surgery: 11 (range 0–321)days Date of surgery to initial evaluation: 26 (range 6–117)days Date of injury to initial evaluation: 54 (range 11–375)days
Smoking	Non-smoker: 97 Prior smokers: 49 Current smokers: 36
Other Comorbidities	Diabetes: 15 (8 %) Hypertension: 42 (23 %) Current depressive symptoms: 40 (22 %)

initial evaluation and change in CR12 scores ($r=-0.315$, $p=0.000$). A moderate and statistically significant inverse correlation was also noted between the number of days between DOI and initial evaluation and change in DASH scores ($r=-0.348$, $p=0.000$). These results indicate a potential relationship between an increased number of days that elapsed between injury and initial evaluation and less change in perceived pain and disability over time. No additional significant correlations were noted between demographic factors and pain, perceived disability, or function during statistical analysis ($r<0.30$).

Comorbidities

The mean scores for outcome measures specific to those subjects with comorbidities of smoking, diabetes, hypertension, and depression are reported in Table 3. Current smokers reported a higher incidence of pain as measured by the CR12 at initial evaluation than previous smokers and non-smokers. At final re-evaluation, current smokers again reported higher pain than previous smokers and non-smokers,

although subjects reported a lower score on the CR12 at final re-evaluation when compared to initial evaluation regardless of smoking status. Similarly, the average DASH score reported by current smokers was higher at both the time of initial evaluation and final re-evaluation than previous and non-smokers. However, non-smokers scored lower on the DASH at initial evaluation while previous smokers scored slightly lower on the DASH than their counterparts at the time of final re-evaluation (Table 3).

Subjects who reported having diabetes, hypertension, or depression were observed to have a higher CR12 and DASH score at both initial evaluation and final re-evaluation as compared to those who did not report having these comorbidities. However, as with smoking status, subjects scored lower on both the CR12 and the DASH at final re-evaluation compared to initial evaluation regardless of the presence of diabetes, hypertension, or depression. As illustrated in Table 3, all subjects indicated an improvement in function as the mean scores for the GROC were in the positive range. Previous smokers reported a greater rate of change than their current smoker and non-smoker counterparts. In addition, a greater rate of change was reported for participants who did not have a diagnosis of diabetes, hypertension, or depression. No significant relationships were noted between these comorbidities and pain, perceived disability, or function during statistical analysis.

Work Status

The results of this study suggested relationships between work status and self-reported pain and disability. At the initial evaluation, subjects in this study reported work status as follows: 59 full duty, 39 modified duty, and 84 not working. At final re-evaluation, 83 subjects reported working full duty, 48 reported modified duty, and 48 had not returned to work. Three subjects did not report their work status upon final re-evaluation.

As shown in Table 4, subjects reporting full duty work status averaged a score of 3.48 on the CR12 pain scale at initial evaluation compared to 1.58 at final re-evaluation. Subjects on modified duty averaged 3.68 at initial evaluation compared to 2.46 at final re-evaluation, while those off duty averaged 4.45 at initial evaluation compared to 2.94 at final re-evaluation. A moderate and statistically significant correlation

Table 2 Outcome measures

Outcome measure	Initial evaluation	Final re-evaluation
Criterion-rated pain scale (CR12)	Present pain: 2.73 (range 0–9) Best pain: 2.20 (range 0–9) Worst pain: 6.99 (range 1–11) Average: 3.97 (range 0.33–9.33)	Present pain: 1.40 (range 0–6) Best pain: 1.20 (range 0–6) Worst pain: 4.04 (range 0–10) Average: 2.18 (range 0–6)
Disabilities of the Arm, Shoulder, and Hand (DASH)	46.29 (range 7–92.5)	21.76 (range 0–73)
Global rate of change (GROC)	N/A	3.03 (range –4 to 5).

Table 3 Mean outcome measure score of participants with comorbidities

Comorbidity	Criterion-based pain scale (CR12)				Disabilities of the Arm, Shoulder, and Hand (DASH)				Global rate of change (GROC)	
	Evaluation	SD	Re-evaluation	SD	Evaluation	SD	Re-evaluation	SD	Mean	SD
Smoker										
Current	4.78	1.69	2.75	1.54	50.99	18.49	27.37	20.16	2.72	1.45
Previous	3.71	1.73	2.17	1.17	46.96	20.28	19.68	12.63	3.14	0.76
Never	3.80	1.78	1.97	1.29	45.28	21.67	20.74	16.37	3.09	1.26
Diabetes										
Yes	4.64	1.79	2.73	1.32	53.93	17.60	26.02	18.75	2.33	2.27
No	3.91	1.78	2.13	1.34	46.22	21.00	21.38	16.29	3.10	1.03
Hypertension										
Yes	4.59	1.84	2.61	1.51	52.32	17.67	23.75	18.93	2.90	1.48
No	3.79	1.74	2.05	1.26	45.22	21.40	21.17	15.73	3.07	1.10
Depression										
Yes	4.60	1.91	2.51	1.39	50.31	20.25	24.26	16.89	2.83	1.38
No	3.80	1.72	2.08	1.31	45.89	20.90	21.06	16.40	3.09	1.14

was noted between work status and average CR12 scores at final re-evaluation ($r=0.392$, $p=0.000$), indicating a relationship between return to work and decreased pain.

Subjects who reported full duty work status averaged a DASH score of 40.21 at initial evaluation compared with 14.25 at final re-evaluation. Subjects on modified duty averaged 48.95 at initial evaluation compared to 25.71 at final re-evaluation, while those off duty work averaged 50.55 at initial evaluation compared to 31.71 at final re-evaluation. A moderately strong and statistically significant correlation was noted between work status and average DASH scores at final re-evaluation ($r=0.473$, $p=0.000$), indicating a relationship between return to work and lower perceived disability after DRF.

Discussion

The primary purpose of this research study was to analyze the outcomes of patients with DRF, with a secondary purpose of assessing the impact of demographic factors and comorbidities on patient outcomes. Patients without comorbidities and non-smokers had better outcomes, and earlier timing of initial

evaluation after injury and full duty work status were significantly related to improvement in pain and perceived disability.

The literature indicates numerous factors that may contribute to pain, perceived disability, and function in patients following DRF, including both demographic factors and the multiple effects of comorbidities. Previous literature has suggested that patients between the ages 45–54 and 75 years or older are suggested as having less satisfactory results following DRF [14]. Female gender and hand dominance have also been identified as variables that negatively impact outcomes [2, 14, 26]. No significant differences based upon age, gender, or hand dominance were found in the current study despite a predominantly female sample with a mean age of 50. Percentages of patients with comorbidities in this study were commensurate with national reporting and previous studies. In this study, 21.9 % of subjects experienced depressive symptoms comparable to 20 % of the sample studied by Walsh and Abbott [30] and a national average of 20 % as suggested by the Center for Disease Control and Prevention [8]. According to the American Heart Association, 33 % of adults aged 20 and older have hypertension [21] and this diagnosis is estimated to affect 26.4 % of the global adult population [19].

Table 4 Mean outcome measure score of work status and mean outcomes

	Criterion-based pain scale (CR12)				Disabilities of the Arm, Shoulder, and Hand (DASH)			
	Evaluation	SD	Re-evaluation	SD	Evaluation	SD	Re-evaluation	SD
Full duty	3.48	1.72	1.58*	1.09	40.21	19.58	14.25**	13.50
Modified duty	3.68	1.61	2.24	1.29	48.95	22.31	21.82	14.46
Off duty	4.45	1.81	2.52	1.41	49.31	20.12	25.33	18.38

* $p=0.000$ ($r=0.392$); ** $p=0.000$ ($r=0.473$)

Twenty-three percent of subjects as researched here reported a history of hypertension.

While there was no statistical significance found with respect to the presence of any of the investigated comorbidities and DRF outcomes, the data were observed to contain the following trends. When assessing the DRF outcomes as a whole, it became evident that regardless of the presence of any comorbidities all individuals reported improved function with a decrease in perceived level of disability, lower pain, and a positively perceived rate of change. While all individuals were observed to have made progress by final re-evaluation, those who did not report having one of the comorbidities investigated in this study scored lower overall during both initial evaluation and final re-evaluation. This indicates a higher level of function for individuals without a reported comorbidity when compared to their counterparts. The exception to this trend was with regard to smoking status and DASH scores. Non-smokers were observed to have a lower score on the DASH at initial evaluation than current and previous smokers; however, previous smokers were observed to have a slightly lower score on the DASH than their counterparts at the time of final re-evaluation. Subjects reporting diabetes also perceived the lowest rate of change on the GROG (2.33). This finding is in agreement with several studies that reported that diabetes reduces BMD, which puts individuals with diabetes at a higher risk for a slower recovery rate [5, 7, 29].

Subjects who reported full duty work status in this study were noted to have lower CR12 and DASH scores as compared to those with modified and off duty work status. A moderate and statistically significant correlation was noted between these variables at final re-evaluation, indicating a relationship between return to work and lower perceived disability and pain after DRF. These results are aligned with a study by Switzer-McIntyre [25] in which subjects with higher perceived function and lower perceived disability were more likely have full duty work status. It is interesting to consider the relationship between work status and decreased pain and perceived disability, and this is suggested as an area for continued research.

The majority of previous research has suggested that early intervention facilitates positive outcomes in hand therapy practice [9, 11, 15, 17, 23, 27]. However, arguments against the need for formal occupational therapy have also been made [24]. The results of this study mirrored the majority of previous research as patients who were seen for an initial therapy evaluation sooner had significantly greater changes in pain and disability over time. Reasons for delayed initiation of therapy can range from surgeon preference to therapist availability and depend on patient adherence to organizing and attending their first therapy visit. As evidence continues to support the practice of early intervention, an emphasis on increased communication between all parties to facilitate optimal outcomes is suggested.

Limitations

The primary limitation of this study is that it is retrospective in design using an established clinical database with previously determined inclusion and exclusion criteria. A secondary limitation is the use of an adapted tool for data collection, as the psychometric properties of this tool have not been established. Finally, as the medical screening form was a self-report questionnaire, this research was reliant on the honesty and integrity of the patient. Despite these limitations, this study provides further analysis of DRF outcomes to the current literature.

Conclusion

An increased understanding of the demographic factors and comorbidities as studied here facilitates clinical decision-making and contributes towards client-centered care in the rehabilitation of patients with upper extremity injuries. The results of this study suggest that patients without diabetes, hypertension, or depression and those who were not current or previous smokers had better outcomes in terms of pain, perceived disability, and function. In addition, earlier timing of initial evaluation after injury and work status were significantly related to improvement in pain and perceived disability. The timing of initiation of therapy and return to work are suggested as avenues for future research.

Conflict of Interests None.

Statement of Informed Consent As this study was retrospective and non-experimental in design, informed consent was not obtained. No identifying information is included in this manuscript.

Appendix 1

Medical Screening Form

For Each Question, Circle YES or NO

Have you smoked at least 100 cigarettes in your lifetime?

YES NO

If you answered Yes, do you now average at least 1 cigarette per day?

YES NO

Have you EVER been told by a doctor or health professional that you have diabetes or sugar diabetes?

YES NO

Have you EVER been told by a doctor or health professional that you have hypertension or high blood pressure?

YES NO

Have you EVER been told by a doctor or health professional that you have depression, or anxiety?

YES NO

Appendix 2

Criterion-Based Numeric Pain Scale

Instructions: Rate your major area of pain on 0 to 10+ Pain Rating Scale. Write the number of your pain in the spaces provided; pain now, lowest pain over the last month, and highest pain over the last month.

Listed by the numbers or number ranges are examples of how health care workers will expect someone to look, act, and function. During the evaluation, your pain ratings will be measured against these criteria to see how consistent your complaints are with your behaviors.

- 10+ = **The Worst Pain That Anyone Can Possibly Feel**
You should be in the hospital and are totally dependent on someone for your care
- 10 = **Pain Requiring Emergency Medical Care**
The pain is so bad; you would seek immediate medical attention
- 9 } = **Pain Causing You to Stay in Bed**
8 } You would be able to feed yourself, go to the bathroom and bathe. But for anything else
7 } you would need help.
- 6 = **Pain Causing You to Stay Home**
You would be able to perform all of your own self-care, but your pain would not allow you to travel beyond very short trips to the store or the doctor.
- 5 } = **Pain Causing You to Alter Your Daily Routine**
4 } You would need to change the way you do your normal tasks or to eliminate the hardest
3 } things you do.
- 2 } = **Mild Discomfort**
1 } You can complete all of your normal duties and chores, but with mild discomfort.
- 0 = **No Pain or Discomfort**

Your Pain Ratings (Please choose only 1 number per line):

Your pain level *at this very second*: _____

Your *worst* pain in the last month: _____

Your *least* pain in the last month: _____

Appendix 3

Global Rate of Change Scale

With respect to your upper extremity injury, how would you describe yourself now as compared to immediately after the start of symptoms?

Circle the number that best applies.

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Statement of Human and Animal Rights

As this study was retrospective and non-experimental in design, it is not considered to contain any studies with animal or human subjects.