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Applications of the Brief ICF Core Set as a Conceptual Model in Distal Radius Fractures

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Abstract

Purpose—In 2009, the World Health Organization (WHO) published a conceptual outcomes framework for evaluating upper extremity injury and disease known as the Brief International Classification of Functioning, Disability, and Health (ICF) Core Set for Hand Conditions. The purpose of this study is to apply the ICF conceptual model to outcomes for distal radius fractures (DRFs) and determine the contribution of each ICF domain to patient satisfaction, as measured by the Michigan Hand Outcomes Questionnaire. We hypothesize that objective outcome measures will contribute most to patient satisfaction, compared to personal and environmental factors.

Methods—Consecutive, eligible patients with unilateral unstable DRFs were recruited as part of a larger study analyzing the volar locking plate system (VLPS) in DRFs. Both patient-rated and objective functional outcomes data were collected at six weeks, three months, and six months after surgery. Patient satisfaction was measured using the Michigan Hand Outcomes Questionnaire (MHQ) satisfaction score, which is a sub-section of the overall MHQ. Study variables (age, race, gender, education, marital status, religious affiliation, Jebsen-Taylor Test, MHQ-ADL, MHQ-Work, grip strength, key pinch strength, flexion, extension, ulnar deviation, radial deviation, pronation, supination, MHQ-Pain, MHQ-Aesthetic, and MHQ-Function) were linked to their corresponding ICF domain (personal factors, environmental factors, activity and participation, and body function). Hierarchical regression was used to assess the contribution of each ICF domain to variation in overall patient satisfaction at each time point.

Results—53 patients with unilateral DRFs treated with the volar locking plating system were enrolled. Regression analysis indicate that measured study variables explain 93% (six weeks),

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98% (three months), and 97% (six months) of variation in patient satisfaction (as evaluated by 5 questions in the Michigan Hand Questionnaire). For all three study assessment dates, activity and participation variables (MHQ-ADL, MHQ-Work, Jebsen-Taylor Score) contributed the most to variation in patient satisfaction. Relative to activity and participation or body function factors, personal and environmental factors played a considerably smaller role in predicting changes in patient satisfaction.

Conclusions—The results demonstrate that it is possible to consistently model the relative contributions of each ICF domain to patient satisfaction over time, and the findings are consistent with previous research (i.e., that the majority of outcomes variation is due to physical/functional factors). These results are strong enough to support continued use and further research using the ICF model for upper extremity outcomes.

Key terms

International Classification of Functioning, Disability, and Health; ICF; Outcomes; Distal Radius Fractures; the MHQ

In 1980, the World Health Organization (WHO) initiated development of a universal framework for classifying the consequences of disease.¹ The goal of this model was to provide a comprehensive, internationally flexible, biopsychosocial representation of overall health that included environmental, sociodemographic, and psychological contributions - factors that were previously understudied.²⁻³ In 2001, this descriptive method of organizing outcomes, known as the International Classification of Functioning, Disability, and Health (ICF), was formally published (<http://www.who.int/classifications/icf/en/>).³ The ICF model is composed of five major domains: 1) body structure, 2) body function, 3) personal factors, 4) environmental factors, and 5) activity/participation (Figure 1).³⁻⁴ These five domains encompass categories that focus on a patient's function and disability relating to his/her health condition (body function, body structure, and activity/participation) and contextual factors that impact his/her overall health state and often vary considerably between different cultures and socioeconomic atmospheres (external environmental factors, internal personal factors).³⁻⁴

To ensure comprehensive coverage of the many different factors that can impact patients' overall health state, the original ICF model included an extensive list of over 1,400 variables grouped into the above five domains.³ Using this model, several researchers have linked variables from pre-existing outcomes tools to the ICF domains to evaluate how well the existing outcome measures assess the overall health state associated with specific conditions, and to validate the utility of the ICF method for these conditions.^{2,5-11} Although the results of these studies successfully validated the use of the comprehensive ICF framework for a variety of conditions, including distal radius fractures⁵, many researchers expressed concerns regarding the feasibility of sorting through such a lengthy list of categories for each disease.¹² Consequently, the WHO developed a smaller ICF Checklist with 125 variables and several targeted Brief ICF

Core Sets for evaluating specific health conditions.¹²⁻¹⁷ The goal of each Brief ICF Core Set is to select critical, disease-specific sets of variables out of the original comprehensive ICF

model that may serve as standards for reporting health status in future clinical studies pertaining to that disease.¹² In 2009, the WHO published a Brief ICF Core Set for Hand Conditions, which now requires worldwide implementation and validation (Appendix A).¹⁸ This Brief ICF Core Set for Hand Conditions was the result of a consensus meeting convened in Switzerland and attended by representatives from over 20 nations, in which the senior author of this paper was the representative from the United States.

The purpose of the present investigation is to apply measurable outcomes (MHQ and objective functional outcomes) of surgically treated DRFs to a comprehensive conceptual model based on the Brief ICF Core Set for Hand Conditions. Using the Brief ICF Core Set for Hand Conditions as a guide, we aim to evaluate the relative contribution of each ICF domain (personal factors, environmental factors, activity and participation, and body function) to variation in overall patient satisfaction (as measured by the MHQ-satisfaction score) at six weeks, three months, and six months after surgery for DRFs. We hypothesize that objective outcome measures will contribute most to patient satisfaction, compared to personal and environmental factors.

Methods

Consecutive, eligible patients with unilateral unstable DRFs were recruited as part of a larger study analyzing the VLPS in DRFs.¹⁹ To control for the effect of different treatment methods on overall patient outcome, we chose to limit our analysis to surgical patients treated with the volar locking plating system (VLPS).²¹⁻²² Patients with concomitant upper extremity injuries, bilateral fractures, or other systemic injuries were excluded from our study. After surgery, all patients received a removable splint to protect their injured wrists for a total of six weeks. Within one week of surgery, all patients began a six week structured hand therapy program focused on passive finger range of motion, hand and wrist edema control, and active wrist motion. Patients were encouraged to use their surgical hand and return to their usual activities of daily living with the splints as tolerated.

Outcomes Evaluation

Previous research has shown that patients with surgically treated DRFs are able to achieve a substantial portion of their total recovery by the six month follow-up visit.^{5,19-20,23} Based on these findings, we anticipated that there would be enough outcome variation (change in MHQ-satisfaction score) between zero and six months to demonstrate the relative contributions of each ICF domain to changes in patient satisfaction. At each scheduled post-operative visit, both patient-rated and objective functional outcome measures were assessed. Patient-rated hand outcomes were measured using the Michigan Hand Outcomes Questionnaire (MHQ), which was self-administered by the patient at each visit. The MHQ is a validated comprehensive and sensitive instrument capable of measuring various health-status domains proven to be important to patients with hand disorders, including: 1) overall hand function, 2) activities of daily living, 3) pain, 4) work performance, 5) aesthetics, and 6) patient satisfaction.²⁴⁻²⁷ In addition to the MHQ, we also collected data regarding objective functional outcomes (Jebesen-Taylor Test, grip strength, key pinch strength) and

wrist/forearm range of motion (flexion, extension, pronation, supination, radial deviation, ulnar deviation).

In an effort to increase compliance, patients who were unable to attend clinic visits were given the option to mail in their MHQ questionnaire, and local therapists were contacted and asked to obtain grip strength and range of motion values for their patients. Given its complexity, the Jebsen-Taylor test was only administered in our clinic. Because we only included patients with unilateral fractures in our study, and thus the impact of hand dominance was variable, we chose to exclude the writing portion of the Jebsen-Taylor test. Previous studies have shown that writing ability strongly correlates with hand dominance, and an evaluation of the Jebsen-Taylor test in patients with rheumatoid arthritis demonstrated that the writing portion of the test did not strongly correlate with patient abilities to perform activities of daily living.²⁸⁻²⁹

Statistical Analysis

Using the categories outlined in the Brief ICF Core Set for Hand Conditions as a guide, we grouped study variables (age, race, gender, education, marital status, religious affiliation, Jebsen-Taylor Test, MHQ-ADL, MHQ-Work, grip strength, key pinch strength, flexion, extension, ulnar deviation, radial deviation, pronation, supination, MHQ-Pain, MHQ-Aesthetic, and MHQ-Function) into the appropriate corresponding ICF-domain (personal factors, environmental factors, activity and participation, body structure, and body function, Table 1).¹⁸ None of the collected study variables in our dataset corresponded to the body structure group (anatomical body structures affected by the health condition), and therefore this group was eliminated from our analysis. Demographic variables of age, gender, race, and level of education were included in the personal domain. Although the “personal factors” domain is not explicitly documented in the brief core set for hand conditions, we included this domain in our analysis, given that it is a contextual component of the ICF model (Figure 1) and has been documented in previous studies to impact treatment received and overall outcome.^{23,30} Marital status and religious affiliation were categorized into the environmental domain because they were felt to represent patient “support and relationships” (Table 1, Appendix A). According to the ICF model, “activity” and “participation” are defined as the execution of a task/action and involvement in life situations, respectively.³ Thus, we grouped the Jebsen-Taylor test, the MHQ-activities of daily living score, and the MHQ-work score into the activities and participation domain. Similarly, “body functions” are described by the ICF model as physiological functions of the body systems, including psychological functions and sensation.³ The majority of our study variables corresponded to this group, which included grip strength, pinch strength, flexion/extension, radial/ulnar deviation, pronation/supination, MHQ-pain, MHQ-aesthetic, and MHQ-function.

Objective functional outcomes (wrist range of motion, grip strength, key pinch strength, pronation, supination, and Jebsen-Taylor test) were normalized as a percentage of the value for the contralateral (uninjured) wrist. Because a lower score for the Jebsen-Taylor test represents a better functional outcome, we subtracted the original percentage score from 100% to obtain a value consistent with other reported parameters for which a higher score

represents a better outcome. Based on prior published findings, we adjusted grip strength for a 10% strength increase in the dominant hand if the right hand was dominant but did not adjust grip strength calculations if the left hand was dominant.³¹

We then used a series of multiple regression models to predict variation in patient satisfaction at six weeks, three months, and six months. Previous literature has demonstrated that patient satisfaction regarding surgery is affected by both objective functional outcomes as well as personal and environmental factors.³²⁻³³ Therefore, we considered patient satisfaction, as measured by the MHQ, to be the best comprehensive indicator of overall health.³²⁻³³ MHQ satisfaction is a sub-section of the MHQ and composed 12 questions (6 for each limb) that assess how content or fulfilled each patient feels regarding the current health status of their upper extremities – 1) satisfaction with overall function, 2) satisfaction with finger motion, 3) satisfaction with wrist motion, 4) satisfaction with strength, 5) satisfaction with pain, and 6) satisfaction with sensation. Due to the unilateral nature of the DRF patients enrolled in our study, it was critical for us to be able to distinguish satisfaction regarding only the affected limb. Using hierarchical regression methods we were able to evaluate the relative contribution of each individual study variable and each ICF domain to measured variation in patient satisfaction.³⁴ Hierarchical regression requires that variables and/or groups of variables be entered in a specific sequence, because the model will automatically adjust for any observed variation in satisfaction associated with earlier variables or groups of variables.³⁴ The order of variable entry into our model is shown in Table 1. Potentially confounding contextual variables for which the participant has little or no control over, such as personal and environmental factors, were entered first into our model in order to control for their effects.

Logistic regression models were used to determine whether missing data at the six month follow-up date was related to the subjects' satisfaction scores at six weeks and three months. All analyses were conducted using SPSS version 16 and SAS version 9.1, and significance was set at $p < 0.05$.

Results

A total of 53 eligible patients (mean age 54 years) with unilateral DRFs were entered into our study. The demographic characteristics of all enrolled patients are given in Table 2. Most patients included in our study were female, right-handed, of Caucasian descent, and had completed at least some college or vocational training. Patient compliance with follow-up visits decreased over time. All 53 patients were available for outcome assessment at six weeks and three months, however only 40 (75%) patients presented for outcome assessment at six months. Complete outcomes data sufficient for regression analysis were available for 33 out of 53 patients (62.3%) at six weeks, 38 out of 53 patients (71.7%) at three months, and 27 out of 40 patients (67.5%) at six months. Mean patient satisfaction scores (MHQ satisfaction scores) were 60.4 ± 28.9 at six weeks, 72.1 ± 25.9 at three months, and 78.2 ± 24.4 at six months. We did not find any association between missing six month outcomes and MHQ-satisfaction scores at six weeks ($p = 0.76$) and three months ($p = 0.59$). This suggests that missing outcomes at 6 months are likely random and provides some assurance

that our missing data were not influenced by previously observed outcome measurements, such as poor function or decreased satisfaction.

Hierarchical Regression Analysis

Regression results for six weeks, three months, and six months are presented in Tables 3, 4, and 5, respectively. The total R^2 value next to each group of variables (ICF domain) represents the cumulative percent of variation in patient satisfaction that can be explained by the corresponding sequence of variable groups entered into the model, whereas the change in R^2 (ΔR^2) indicates the relative contribution of that specific group (beyond the contribution from previous groups) to variation in patient satisfaction. Overall, our results indicate that the measured outcome variables included in our study explain 93% (Table 3), 98% (Table 4), and 97% (Table 5) of variation in patient satisfaction at six weeks, three months, and six months, respectively. Figure 2 represents the relative contribution of each ICF domain (variable group) to variation in patient satisfaction at each follow-up date. The contribution of each ICF domain to variation in patient satisfaction for a specific follow-up date is determined by the R^2 change listed for each domain in Tables 3, 4, and 5. For all three outcome assessment times, the activity and participation domain contributed the most to variation in patient satisfaction (65% at six weeks, $p < 0.01$; 80% at three months, $p < 0.01$; 51% at six months, $p = 0.01$). Although not statistically significant, our results demonstrate that relative to objective outcome measures (body function and activity and participation variables), personal and environmental factors made considerably smaller contributions to patient satisfaction at all three follow-up times (22% at six weeks, $p = 0.34$; 11% at three months, $p = 0.72$; 20% at six months, $p = 0.56$). This finding may be explained by the acute nature of DRFs.

The impact of independent variables on patient satisfaction varied over the study period. At six weeks, we found that both gender ($p = 0.03$) and MHQ-ADL score ($p = 0.01$) were significantly associated with patient satisfaction results (Table 3). However, three months after surgery, as patients began to regain function and range of motion, we found that MHQ-Work score ($p = 0.01$), ulnar deviation ($p = 0.02$), pronation ($p = 0.01$), MHQ-Pain score ($p = 0.03$), and MHQ-Function score ($p < 0.01$) were all significantly associated with patient satisfaction (Table 4). Finally, at six months, our results did not reveal any variables to be significantly associated with patient reported satisfaction (Table 5). This may be explained by the small sample size and the fact that by six months after surgery, most patients have already achieved substantial portion of their recovery and are able to return to their pre-injury functional status. Taken together, these results illustrate the variation in individual-level factors associated with patient satisfaction over time, and thus support the need for a comprehensive, flexible method of evaluating grouped post-operative outcomes over time.

Power Analysis

Because our findings indicated no statistically significant difference among the changes in R^2 corresponding to the personal and environmental factors domain, we conducted a post hoc power analysis to determine the change in R^2 for each ICF domain that could be detected with 80% power using the sample size available in our study. At the six week follow-up period, our study had 80% power to detect a change in R^2 of 0.30 for the personal

factor domain, 0.20 for the environmental factor domain, 0.07 for the activity and participation domain, and 0.07 for the body function domain. At the three month follow-up period, our study had 80% power to detect a change in R^2 of 0.27 for the personal factor domain, 0.20 for the environmental factor domain, 0.03 for the activity and participation domain, and 0.01 for the body function domain. At the six month follow-up period, our study had 80% power to detect a change in R^2 of 0.36 for the personal factor domain, 0.27 for the environmental factor domain, 0.15 for the activity and participation domain, and 0.06 for the body function domain. All power calculations were based on hierarchical regression assuming the observed percent of variation explained by the earlier domains.

Discussion

Historically, surgical outcomes have primarily concentrated on using objective functional measures to evaluate the residual impairment and complications associated with a given procedure. However, over the past several decades, physicians, payers, and policy makers have recognized the importance of using patient reported outcomes to assess functional status and health-related quality of life.^{32-33,35} Increased patient expectations of being involved in their own medical decision-making have driven recent research to pay closer attention to an individual patient's preferences and wishes regarding his/her own health care.³⁵ As a result, there is a current rising demand for studies that provide evidence regarding how treatments and interventions for various conditions are likely to affect outcomes from the patient's perspective.

Due to the acute nature of DRFs and their generally favorable recovery pattern, previous research has focused on the predominant impact of physical/functional factors on patient reported outcomes.³⁷ However, other studies have strongly defended the influence of psychosocial factors on patient rated outcome scores.³⁸ In 2005 Harris et al. applied the *comprehensive* ICF framework to distal radius fracture outcomes collected from three previously validated outcome tools (PRWE, WOM, and SF-36).⁵ They included data from 790 distal radius fracture patients (not controlling for treatment type) and evaluated outcomes at one week, three months, and one year. Their objective was to determine the amount of variation in SF-36 score (dependent variable = physical and mental health score) that could be explained using the other outcome measures, which were organized according to the ICF model. The authors found that the PRWE only explained 13% (one week) and 33% (three months) of SF-36 physical health score variation and 10% (three months) and 8% (one year) of SF-36 mental health score variation. Furthermore, they found that wrist impairment scores were even less powerful predictors of health status (as measured by the SF-36) than PRWE.

In this study we have applied a similar methodology to assess patient satisfaction among surgically treated DRFs using the International Classification of Functioning and Disability (ICF) Brief Core Set for Hand Conditions. Patient satisfaction has become increasingly regarded as a valid metric for evaluating overall health outcomes.^{33,36,39} Patient satisfaction is an entirely subjective concept that relates many factors including lifestyle, past experience, and future expectations, as well as individual values and those of society.³² In terms of health care, patient satisfaction may be thought of as the degree to which a patient

feels he/she has received high-quality health care.³² In this study, we measured patient satisfaction using the MHQ-satisfaction score, which is a sub-section of the overall MHQ score geared toward measuring satisfaction. Given the low predictive value of the PRWE and WOM to explain variation in SF-36 scores, we chose to analyze different DRF outcome measures (MHQ, Jebsen Taylor Test, range of motion measurements, and patient demographic factors) and also controlled for DRF treatment type by only including surgical patients treated with volar plate fixation. By linking these previously validated DRF outcome variables to the ICF domains, we were able to examine the relative contributions of each domain to patient satisfaction over time.

We found that our measured study variables, organized according to the Brief ICF Core Set for Hand Conditions, explain 93%, 98%, and 97% of variation in satisfaction at six weeks, three months, and six months, respectively. Furthermore, we found that objective outcome measures (body function; activity and participation) accounted for the majority of observed variation in patient satisfaction compared to contextual outcome measures (personal and environmental factors). These findings are consistent with previous work suggesting that DRFs mainly affect the physical domains of health.^{5,37} However, our results do not necessarily negate the contributions of psychosocial, personal, and environmental factors on patient-reported satisfaction, because these factors did contribute to a lesser extent to the overall observed satisfaction.

The results of our study are limited by several factors. As with all clinical studies involving outpatient subjects, we were unable to maintain 100% recruitment throughout the 6-month follow-up period. However, further analysis demonstrated that missing data at the 6-month follow-up time was not associated with outcomes from the previous period ($p = 0.59$). This suggests that there is no difference in outcomes between the missing data group and the observed data group, and it provides some assurance that missing data were not dependent on unobserved measurements such as poor outcome.

Due to the small sample size of our study, our results lacked 80% power to detect the small observed change in R^2 associated with personal and environmental factors. Based on these findings, we recommend that future studies utilizing the ICF model for DRFs include a larger sample size. In addition, although we attempted to measure a broad range of demographic, environmental, objective, and functional variables to correlate with satisfaction, it is certainly possible that we omitted other factors that may have increased our observed overall R^2 or changes in R^2 for each group of variables.

Finally, given that this is the first study to utilize the brief ICF core set for hand conditions, it is also necessary to present a balanced discussion regarding the limitations of the ICF model and our analytic approach. It is important to note that although the ICF model represents a comprehensive way of viewing impairment, it only provides a framework for categorizing data collected from previously validated outcomes tools and does not, in and of itself, constitute a validated outcomes tool. As such, the findings and implications of any study utilizing the ICF model are highly contingent on the validity of the outcomes data collected and the subjective categorization of various outcomes into the ICF domains. Based on the above limitations, it is certainly possible for different studies utilizing the ICF method

with different outcomes tools to obtain varying results – an example can be seen in comparing our study findings with the results of Harris, MacDermid and Roth.⁵ Moreover, our methods of categorizing pre-existing outcome measures into the ICF domains did not specifically test for interaction between variables in different domains or recognize the potential contribution of certain variables to more than one domain.

We believe that obtaining the maximum benefit from the comprehensive structure of the ICF requires selection of an all-encompassing outcome of interest (i.e., dependent variable) that is impacted by all aspects of the ICF model, such as patient satisfaction. In the above study, we calculated patient satisfaction using the 6 question sub-section of the MHQ that is dedicated to determining patient satisfaction regarding the affected unilateral hand/wrist. The satisfaction domain contains questions that encompass patients' perception of the overall hand outcome, which makes the satisfaction domain a natural dependent variable in this analysis. We acknowledge that the MHQ satisfaction domain has not been used in this fashion, and this study may encourage future studies to continue to validate various domains in the MHQ.

Despite the above limitations, we believe the results presented in the current study support further application of the Brief ICF Core Set for Hand Conditions to model upper extremity outcomes as measured by the MHQ. Currently, there is a need for a comprehensive yet flexible method for evaluating the role of pre-existing upper-extremity outcome tools. The structure of the ICF model is a method of organizing and evaluating pre-existing outcomes for a variety of hand conditions. By applying hierarchical regression methods to the ICF conceptual model, we are able to understand the relative contribution of both individual variables and groups of variables (measured by pre-existing outcome tools) to changes in a particular outcome of interest (in this case, satisfaction) at different time points. By evaluating outcome in this manner, researchers can better understand the distribution of outcome predictors and how to improve upon pre-existing outcomes tools. Furthermore, the organization of the ICF domains ensure comprehensive inclusion of easily adaptable personal and environmental factors in outcome assessment and also allows for determination of the relative contribution of these factors on overall satisfaction compared to objective measures. However, validation of the Brief ICF Core Set for Hand Conditions requires further examination with a variety of patient samples, treatment algorithms, and variables from other pre-existing outcomes tools. We believe that the results of this early effort of applying the Brief ICF Core Set for Hand Conditions to distal radius fractures warrant further investigation of this potentially promising conceptual model in the field of hand surgery.

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Appendix A. Brief ICF Core Set for Hand Conditions[‡]

ICF Domain	ICF Category
Body Functions	Emotional Functions Touch Function Sensory Functions Related to Temperature and Other Stimuli Sensation of Pain Mobility of Joint Functions Stability of Joint Functions Muscle Power Functions Control of Voluntary Movement Functions Protective Functions of the Skin
Body Structures	Spinal Cord and Related Structures Structure of Shoulder Region Structure of Upper Extremity
Activities and Participation	Carrying Out Daily Routine Lifting and Carrying Objects Fine Hand Use Hand and Arm Use Self-Care Domestic Life Interpersonal Interactions and Relationships Work and Employment
Environmental Factors	Products and Technology Support and Relationships Services, Systems, and Policies

[‡] Adapted from the 2009 World Health Organization Conference Proceedings¹⁸

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Figure 1. Current Framework of the International Classification of Functioning, Disability and Health (ICF)[‡]

[‡] Composed of categories that focus on a patient's function and disability relating to his/her health condition (body function and structure, activity, participation) and the contextual factors that impact the overall health state, which often vary considerably between different cultures and social atmospheres (external environmental factors, internal personal factors)

Figure 2. Relative Contribution of Each ICF Domain to Variation in Patient Satisfaction

† Each column in the above bar graph is organized according to the order of variable group entry into the regression analysis, with group 1 on the bottom of each bar and group 4 at the top of each bar. The contribution of each ICF domain to variation in patient satisfaction for a specific follow-up date is determined by the R^2 change listed for each domain in Tables 3, 4, and 5.

Table 1
Variable Groups and Order of Entry Into the Hierarchical Regression Model*

ICF Domain	Study Variables
1: Personal	Race, Education, Gender, Age
2: Environmental	Marital Status [‡] , Religious Affiliation [‡]
3: Activity and Participation	Jebsen-Taylor Test, MHQ-ADL, MHQ-Work
4: Body Function	Grip Strength, Key Pinch Strength, Flexion [‡] , Extension [‡] , Ulnar Deviation [‡] , Radial Deviation [‡] , Pronation [‡] , Supination [‡] , MHQ-Pain, MHQ-Aesthetic, MHQ-Function

* We grouped measured independent variables into their corresponding ICF domain and evaluated the relative contribution of each ICF domain and each independent variable to variation in patient satisfaction using hierarchical regression.³⁴ Hierarchical regression requires that variables and groups of variables be entered in a specific sequence, because the model will automatically adjust for differences in the response variable associated with variables in earlier groups.³⁴ Potentially confounding contextual variables which the participant has little or no control over, such as personal and environmental factors, were entered first into our model in order to control for their effects.

[‡] Variables were classified as yes or no; variables were placed into environmental category as an indicator of “support and relationships”

[‡] Variables correspond to wrist and forearm range of motion

Table 2
Patient Demographic Data

Parameter	Number of Patients (%)	P-Value [*]
Gender		
Male	12 (23%)	<0.0001
Female	41 (77%)	
Dominant Hand		
Right	49 (92%)	<0.0001
Left	4 (8%)	
Injured Hand		
Dominant	24 (45%)	0.4922
Non-Dominant	29 (55%)	
Race [‡]		
White	42 (88%)	<0.0001
Black	1 (2%)	
Hispanic	0 (0%)	
Asian or Pacific Islander	0 (0%)	
American Indian or Alaskan Native	3 (6%)	
Other	2 (4%)	
Level of Education [‡]		
High school graduate or GED	7 (15%)	0.0159
Vocational/technical school	2 (4%)	
Some college or associate degree	13 (27%)	
College graduate	10 (21%)	
Professional or graduate school	16 (33%)	
Marital Status		
Married	25 (47%)	0.6803
Not Married (single, divorced/separated, not listed)	28 (53%)	

[‡]Data available for 48 out of 53 patients (91%)

^{*} P-values were calculated using chi-square analysis and evaluate for significant differences in the proportion of patients within each demographic category

Table 3
Hierarchical Regression Analysis for Outcomes Data at Six Weeks*

ICF Domain	R ² (R ² ; p-value [‡])	Variable	Coefficient	Std. Error	P value
		Constant	3.1	36.3	0.93
1 (Personal Factors)	0.19 (0.19; 0.19)	Age	-0.1	0.3	0.68
		Race	-14.5	12.8	0.28
		Gender	21.1	8.3	0.03
		Education	-12.5	10.6	0.26
2 (Environmental Factors)	0.22 (0.03; 0.66)	Marital Status	-0.5	7.3	0.95
		Religious Affiliation	0.2	6.8	0.98
3 (Activity and Participation)	0.87 (0.65; <0.01)	Jebsen Taylor Score	-0.3	0.2	0.09
		MHQ-ADL	1.0	0.3	0.01
		MHQ-Work	0.2	0.2	0.32
4 (Body Function)	0.93 (0.06; 0.58)	Grip Strength	-0.0	0.0	0.88
		Key Pinch Strength	-0.3	0.2	0.19
		Flexion [‡]	0.0	0.3	0.96
		Extension [‡]	0.1	0.4	0.77
		Ulnar Deviation [‡]	-0.3	0.5	0.52
		Radial Deviation [‡]	1.6	0.9	0.11
		Pronation [‡]	-0.2	0.3	0.51
		Supination [‡]	-0.3	0.4	0.47
		MHQ – Pain	-0.3	0.3	0.44
		MHQ – Aesthetic	0.2	0.2	0.48
		MHQ – Function	0.0	0.5	0.96

* The total R² value next to each group of variables (ICF domain) represents the cumulative percent of variation in patient satisfaction that can be explained by the corresponding sequence of variable groups entered into the model, whereas the change in R² (R²) indicates the relative contribution of that specific group (beyond the contribution from previous groups) to variation in patient satisfaction.

[‡]Testing for significant change in R²

*Variables correspond to wrist and forearm range of motion

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Table 4
Hierarchical Regression Analysis for Outcomes Data at Three Months

ICF Domain	R ² (R ² ; p-value [‡])	Variable	Coefficient	Std. Error	P value
		Constant	43.6	23.3	0.08
1 (Personal Factors)	0.09 (0.09; 0.50)	Age	-0.1	0.1	0.05
		Race	4.3	3.0	0.17
		Gender	-1.8	2.4	0.47
		Education	-5.0	2.5	0.06
2 (Environmental Factors)	0.11 (0.01; 0.82)	Marital Status	-2.0	2.2	0.38
		Religious Affiliation	0.7	2.2	0.74
3 (Activity and Participation)	0.90 (0.80; <0.01)	Jebsen Taylor Score	-0.0	0.1	0.69
		MHQ-ADL	0.2	0.1	0.11
		MHQ-Work	0.2	0.1	0.01
4 (Body Function)	0.98 (0.08; <0.01)	Grip Strength	0.1	0.1	0.05
		Key Pinch Strength	-0.1	0.1	0.65
		Flexion [‡]	-0.2	0.2	0.33
		Extension [‡]	-0.1	0.1	0.56
		Ulnar Deviation [‡]	0.5	0.2	0.02
		Radial Deviation [‡]	-0.4	0.2	0.05
		Pronation [‡]	-0.6	0.2	0.01
		Supination [‡]	0.2	0.1	0.09
		MHQ – Pain	-0.3	0.1	0.03
		MHQ – Aesthetic	0.1	0.1	0.05
		MHQ – Function	0.5	0.1	<0.01

* The total R² value next to each group of variables (ICF domain) represents the cumulative percent of variation in patient satisfaction that can be explained by the corresponding sequence of variable groups entered into the model, whereas the change in R² (R²) indicates the relative contribution of that specific group (beyond the contribution from previous groups) to variation in patient satisfaction.

[‡]Testing for significant change in R²

[‡]Variables correspond to wrist and forearm range of motion

Table 5
Hierarchical Regression Analysis for Outcomes Data at Six Months*

ICF Domain	R ² (R ² ; p-value [‡])	Variable	Coefficient	Std. Error	P value
		Constant	-53.2	81.5	0.54
1 (Personal Factors)	0.13 (0.13; 0.51)	Age	0.3	0.2	0.26
		Race	-9.6	10.3	0.39
		Gender	-7.2	9.5	0.48
		Education	-21.0	12.7	0.15
2 (Environmental Factors)	0.20 (0.07; 0.46)	Marital Status	14.4	6.5	0.07
		Religious Affiliation	-3.5	6.4	0.61
3 (Activity and Participation)	0.71 (0.51; 0.01)	Jebsen Taylor Score	-0.1	0.3	0.73
		MHQ-ADL	-0.3	0.5	0.60
		MHQ-Work	0.2	0.4	0.60
4 (Body Function)	0.97 (0.26; 0.03)	Grip Strength	-0.1	0.2	0.57
		Key Pinch Strength	0.7	0.3	0.09
		Flexion [‡]	-0.0	0.4	0.95
		Extension [‡]	-0.2	0.5	0.64
		Ulnar Deviation [‡]	0.1	0.4	0.89
		Radial Deviation [‡]	1.4	0.8	0.13
		Pronation [‡]	-0.5	0.7	0.53
		Supination [‡]	0.5	0.5	0.35
		MHQ – Pain	-0.5	0.3	0.23
		MHQ – Aesthetic	0.3	0.2	0.18
		MHQ – Function	0.8	0.4	0.10

* The total R² value next to each group of variables (ICF domain) represents the cumulative percent of variation in patient satisfaction that can be explained by the corresponding sequence of variable groups entered into the model, whereas the change in R² (R²) indicates the relative contribution of that specific group (beyond the contribution from previous groups) to variation in patient satisfaction.

[‡] Testing for significant change in R²

*Variables correspond to wrist and forearm range of motion

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