The association of education level on outcome after distal radius fracture

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Abstract

Background Socioeconomic factors have been found to be predictors of outcome for other ailments. The purpose of this study was to evaluate the association of patient education level on pain and disability after distal radius fracture.

Methods A series of patients with distal radius fractures ($n = 335$) were enrolled into a prospective research registry. Standard demographic information was obtained from patients, including a five-value categorical education variable. After treatment with closed reduction, external fixation, or internal fixation patients were evaluated for pain, function (Disability of the Arm, Shoulder, and Hand score [DASH]), range of motion (ROM), and grip strength at standard intervals until 12 months post-injury. A series of linear mixed effects models were developed to evaluate the relationship between time from injury and education level with each of the outcomes measured.

Results Complete demographic and 12-month follow-up data were available on 227 patients (75 %). There were neither group differences in mode of injury, severity, nor treatment modality after stratification by education level. Mixed effects model analyses revealed a significant linear association

between level of education and measured outcomes at each follow-up point. Overall, each increase in education level demonstrated a doubling of improvement in pain, ROM, grip strength, and DASH score.

Conclusions Outcome of distal radius fracture depends on acute care and follow-up rehabilitation; however, patient-related factors indicative of socioeconomic status are becoming increasingly relevant as predictors of outcome and should be considered by the orthopaedist.

Keywords Education · Socio-economic status · Distal radius fracture · Function · Outcome · Pain · Symptom score

Introduction

Theoretically, restoration of distal radius anatomy is the primary consideration for preventing long-term pain and disability. However, patient-related factors may also contribute to the result. Recently, socioeconomic factors have been found to be predictors of outcome after treatment of a variety of medical conditions including asthma, cardiac problems, and distal radius fracture surgery [6, 7, 18, 20, 22, 25, 26].

The purpose of this study was to evaluate the relationship between patient education level on pain and disability following distal radius fracture. We hypothesize that patients with less formal education will have poorer outcomes associated with greater pain and functional impairment.

Materials and Methods

Between February 2004 and January 2007, 335 patients presented to our institution with a distal radius fracture and were enrolled in a prospective research registry. Research protocol and all procedures followed were in accordance with the ethical standards of the responsible committee on human

Investigation performed at: Hospital for Joint Diseases at NYU Langone Medical Center, New York, NY, USA and Jamaica Hospital Medical Center, Jamaica, NY, USA

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experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008(5). Written informed consent was obtained from all patients included in the study. All patients were initially treated with closed reduction, placed in a sugar tong splint, and instructed to return for definitive management of their fracture. Upon return, patients were either treated non-operatively or with operative intervention (external fixation or volar locking plate).

Registry data were collected by trained research personnel from the private offices of three fellowship trained orthopaedic surgeons. The demographic information collected included age, gender, race, medical comorbidities, mechanism of injury, fracture severity, marital status, employment status, and level of education. Patients' highest level of education was determined to be in one of five categories: did not graduate high school, high school or GED equivalent, some college, college degree, or at least some postgraduate education. Primary outcome measures were pain and function. Pain was determined using the standardized 10-point Visual Analog Scale (VAS). Function was assessed using the 'Disability of the Arm, Shoulder, and Hand' (DASH) symptom score, range of motion, and grip strength. Demographic information and pre-injury DASH responses were obtained by interviewing

the patient and questioning them on their pre-injury status, and the outcome measures described were obtained at standard follow-up intervals (3, 6, and 12 months). Range of motion was recorded after measurement with a goniometer. Grip strength was tested using a calibrated dynamometer.

For analyses, poly-trauma registry patients or those with concomitant injuries to an upper extremity were excluded. Patients who did not provide complete socio-demographic data, including and in particular highest level of education, were also excluded. Patient cohorts were then stratified by five-group education level. A series of linear mixed effects models with random coefficients were developed to allow for time varying outcomes (at 3, 6, and 12 months) within subjects. These models were used to determine the relationship between education and each of the outcome measures.

Results

Three hundred and four research registry patients satisfied study inclusion criteria. Of the 304 included, 202 (66 %) were female and 144 (47 %) were Caucasian (Table 1). The average age at the time of injury was 55 (range, 18–90). When cohorts

Table 1 Patient variables: demographic, injury, treatment, and baseline dash symptom score

	Less than H.S.		H.S. or equivalent		Some college		College Degree		Postgraduate		Overall	<i>p</i> value
	<i>N</i>	(%)	<i>n</i>	(%)	<i>n</i>	(%)	<i>n</i>	(%)	<i>n</i>	(%)		
Sex												
Female	38	(19)	59	(29)	36	(23)	46	(23)	23	(11)	202	0.5
Male	23	(23)	30	(29)	23	(15)	15	(15)	11	(11)	102	
Age (mean, range)	56	(17–87)	57	(18–90)	51	(19–82)	53	(22–83)	53	(25–75)	55	0.16
Race												
White	9	(6)	44	(31)	30	(26)	38	(26)	23	(16)	144	<0.001
Black	4	(11)	13	(37)	11	(11)	4	(11)	3	(9)	35	
Hispanic	34	(48)	21	(30)	8	(7)	5	(7)	3	(4)	71	
Asian	10	(23)	10	(23)	7	(30)	13	(30)	3	(7)	43	
Other	4	(36)	1	(9)	3	(9)	1	(9)	2	(18)	11	
AO classification												
Type A	28	(19)	41	(28)	24	(24)	34	(24)	17	(12)	144	0.5
Type B	11	(21)	15	(28)	16	(13)	7	(13)	4	(8)	53	
Type C	22	(21)	33	(31)	19	(19)	20	(19)	13	(12)	107	
Mechanism												
High energy	10	(19)	18	(33)	13	(17)	9	(17)	4	(7)	54	0.7
Low energy	51	(20)	71	(28)	46	(21)	52	(21)	30	(12)	250	
Treatment												
Non-operative	29	(20)	50	(34)	27	(18)	26	(18)	14	(10)	146	0.4
Operative	32	(20)	39	(25)	32	(22)	35	(22)	20	(13)	158	
Work related	7	(11)	12	(13)	5	(8)	7	(11)	5	(15)	36	0.8
Compensation	6	(10)	7	(8)	4	(7)	7	(11)	3	(9)	36	0.9
Pre-injury DASH												
Mean (range)	8.6	(0–77)	6.5	(0–86)	4.2	(0–54)	4	(0–50)	3.3	(0–64)	5.6	0.9

were stratified by patients' highest level of education, 61 patients (20 %) had not graduated high school, 89 (29 %) had a high school degree, 59 (19 %) completed some college, 61 (20 %) had a college degree, and 34 (11 %) had received at least some postgraduate education. Pre-injury DASH scores on average were 5.6 (Fig. 1). The difference in baseline DASH scores amongst cohorts was not statistically significant ($p=0.9$). The cohorts were similar with respect to the distribution of age, gender, fracture severity, worker's compensation status, mechanism of injury, and treatment modality.

Among the 304 included patients, 3, 6, and 12 months follow-up data were available on 227 (75 %). The 25 % with missing data points were excluded from the analysis. Overall, 76 cohorts improved significantly on measures of pain and function during the 12-month course of follow-up ($p<0.001$). At 1-year follow-up, the mean DASH symptom score was 16.2 (range, 0–80) with 86 % of wrists experiencing “excellent” (<20 points) or “good” (20–39 points) results. Twelve patients (5 %) reported a “poor” (>60 points) DASH symptom score. Mean 1-year VAS pain score was 1.7 (range, 0–10) while wrist extension was 58° and wrist flexion was 53° . Eighty-two percent of patients regained full digital motion.

The mixed effects models analyses demonstrated significant differences in all outcomes with linear improvement as a function of follow-up time and education (Table 2). Overall, wrist extension improved by 1° ($b=1.0$; $p<0.001$), per follow-up period of 3, 6, and 12 months. This change trajectory was doubled ($b=2.01$; $p<0.001$) for each increase in education level; wrist extension improved 2° per follow-up period, per increase in education level (Fig. 2). This pattern held true for wrist flexion ($b=2.26$; $p<0.001$), supination ($b=1.20$; $p=0.011$), pronation ($b=0.83$; $p=0.002$), ulnar deviation ($b=0.76$; $p=0.015$), radial deviation ($b=0.79$; $p=0.007$), VAS pain ($b=-0.22$, $p<0.001$), grip strength ($b=2.10$; $p=0.026$), and DASH symptom score ($b=-2.16$; $p=0.001$).

Fig. 1 Pre-injury DASH scores, on average, were 5.6. The apparent difference in baseline DASH scores amongst cohorts was not statistically significant. However, the 12-month follow-up course revealed greater rates of improvement in the patients with greater education

Discussion

As surgeons, we primarily focus on restoration of anatomy as the important factor in improving patients' lives after distal radius fracture. Restoration of anatomy has been shown to be particularly important in the young and active patient with intra-articular displacement [5, 12, 14]. We have also seen that near anatomic radiographic results do not necessarily predict excellent clinical outcomes [4, 8, 11, 24, 28]. Recently, we have come to recognize that the patients' assessment of function and outcomes may not match the criteria that we use to define a good or excellent outcome [6, 15, 16, 23]. Patient focused instruments such as the SF-36 and DASH [1, 2] try to assess patient function after an injury and to estimate the social and psychological impact of the injury and recovery. The patients' pre-injury mental health status and degree of depression has been shown to be a predictor of outcomes for some upper extremity ailments [15, 16, 23].

Socioeconomic status has also been shown to affect health-related outcomes for various medical conditions including heart disease, stroke, and cancer [3, 7, 13, 17–19, 21]. Using income as an indicator of socioeconomic status, Chung et al. [6] showed that household income significantly affects 3 month as well as 1-year outcome in a study of 66 distal radius fractures treated with volar locking plates [6]. Similarly, MacDermid [17] found patient education level to have a positive effect on 6-month pain and function and Grewal [10] showed that education is an important variable for modeling outcomes [10, 17]. The phenomenon of education-dependent outcomes is not limited to upper extremity injuries. Outcomes following general orthopaedic injury is affected by education as well [27].

While all patients' results improved over time, we found that each increase in the level of education (as in from high school to college) corresponded to 2 to 1 rate of improvement over time. Using wrist extension as a model, the data in Table 2 can be interpreted as follows: A “Time” coefficient of 1.02 given in the analysis shows that, overall, wrist extension improves by 1° per follow-up period.

Table 2 Mixed models analysis of time-varying outcomes and education level

Outcome	Time coefficient ^a	<i>p</i> value	Education coefficient ^b	<i>p</i> value
Pain	−0.09	<0.001	−0.22	<0.001
Range of motion (degrees)				
Wrist extension				
Wrist flexion	1.07	<0.002	2.26	<0.002
Forearm supination	1.14	<0.003	1.20	0.011
Forearm pronation	0.56	<0.004	0.83	0.002
Ulnar deviation	0.58	<0.005	0.76	0.015
Radial deviation	0.46	<0.006	0.79	0.007
DASH symptom score	−1.21	<0.007	−2.16	0.001
Grip strength (lbs.)	2.72	<0.008	2.10	0.026

^a Time coefficient represents the overall degree of change in the outcome per follow-up point over 12 months

^b Education coefficient represents the degree of change in the outcome, per follow-up, per increase in level of education

The “education” coefficient of 2.01 shows that wrist extension improves an additional 2° per follow-up period, per level of education. This would mean that in the time between the 3- and 12-month follow-up, wrist extension of those lacking high school diplomas improved by 6° overall (10×2 follow-up intervals + 20×1 education level). This can be contrasted to patients with postgraduate education who improved wrist extension by 12° in the same time period (10×2 follow-up intervals + 20×5 education levels). This pattern held true for all measured ranges of motion, VAS pain level, and DASH symptom scores. These findings demonstrate an important association of education on clinical orthopaedic outcomes.

The majority of the patients in our study were women, which is reflective of the population that sustains distal radius fractures [9]. The baseline DASH data (pre-injury) was obtained at the initial visit by asking the patients to state how they were functioning the week before the injury. Although patients with higher education levels generally reported better baseline DASH scores, there was no statistical difference between groups. The patients in this study were all treated by the same surgeons, within the same clinical setting, by the same resident group. They also had similar access to post-

operative care, rehabilitation, and occupational therapy. The groups had a similar distribution of age, gender, fracture severity, compensation status, mechanism of injury, and treatment modality. Yet, we still see a greater rate of improvement in the patients with greater education. This finding highlights the importance of education level as a strong predictor of both objective measures of outcome (ROM and grip strength) as well as subjective outcomes (VAS pain and DASH symptom scores).

In planning this study, we prospectively collected information about the patients' income levels as well. The goal was to use income levels as another predictor of socioeconomic status. We encountered some difficulty with the use of income as a marker for socioeconomic status. For example, we had many retired patients who reported little active income, but who were highly educated with very sound financial foundation. We also had college students who had no active income but were privy to or endowed with a strong financial basis. We attempted to construct a matrix that would take into account both income and education; however, we did not have adequate data variable detail to complete such a task. Several examples of informative data that should be part of such a matrix, yet we encountered

Wrist Extension After Distal Radius Fracture, by Education

Fig. 2 A “time coefficient” of 1.02 given in the analysis shows that, overall, wrist extension improved by 1° per follow-up period. The “Education Coefficient” was 2.01. Between the 3- and 12-month follow-up, wrist extension for those lacking high school diplomas improved by 6°

overall (10×2 follow-up intervals + 20×1 education level). This is in contrast to patients with postgraduate education who improved their wrist extension by 12° during the same time period (10×2 follow-up intervals + 20×5 education levels)

as missing, are home/property ownership, liquid and non-liquid assets, number of dependents, and bank accounts (national, foreign).

The simplistic beauty of education level is both a curse and blessing. While it may not be as strong a predictor of outcome as said financial matrix, it was still a robust predictor of general socioeconomic status and is easily assessed during any patient's visit to the office or hospital. Ultimately, while we strive to control the quality of the reduction and the rates of complications, patient socioeconomic status is simply not within the surgeon's control. Recognition of the role of socioeconomic status is important in order to educate patients and to develop and drive-home management strategies focused, in particular, on those at risk for poorer outcomes. The outcomes after distal radius fractures depend on acute care and follow-up rehabilitation; however, patient-related factors indicative of socioeconomic status are becoming increasingly relevant as predictors of outcome and should be considered by the physician.

Conflict of Interest NP is a consultant for IMDS and Stryker, and holds stock in Small Bone Innovations. BP declares that he has no conflict of interest. SR declares that he has no conflict of interest. KE is a consultant for and receives royalties from Exactech, receives institutional grants from Omega, OREF, and Synthes, and holds stock in Johnson & Johnson.

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