Psychosocial Factors affecting variation in Patient Reported Outcomes after Elbow Fractures

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Abstract

Background

The purpose of this study was to identify factors associated with limitations in function [measured by patient-reported outcome measures (PROMs)] 6 to 9 months after elbow fractures in adults, from a range of demographic, injury, psychological, and social variables measured within a week and 2 to 4 weeks after injury.

Methods

We enrolled 191 adult patients sustaining an isolated elbow fracture and invited them to complete PROMs at their initial visit to the orthopaedic outpatient clinic (within a maximum of 1 week after fracture), between 2 to 4 weeks, and between 6 and 9 months following injury. 183 patients completed the final assessment. Bivariate analysis was performed followed by multivariable regression analysis accounting for multicollinearity. This was evaluated using partial R^2, correlation matrices, and variable inflation factor assessment.

Results

There was a correlation between multiple variables within a week of injury and 2 to 4 weeks after injury with PROMs 6 to 9 months after injury in bivariate analysis. Kinesiophobia measured within a week of injury and self-efficacy measured at 2 to 4 weeks were the strongest predictors of limitations 6 to 9 months after injury in multivariable regression. Regression models accounted for substantial variance in all PROMs at both time points.

Conclusions

Developing effective coping strategies to overcome fears related to movement and re-injury, and finding ways of persevering with activity despite pain within a month of injury, may enhance recovery after elbow fractures. Heightened fears around movement and sub-optimal coping ability are modifiable using evidence-based behavioural treatments.

Level of Evidence: Level II –Prospective Cohort Study

Keywords: Patient outcomes; Elbow fractures; Psychosocial determinants; Resilience

Introduction

Although adult fractures of the elbow are relatively uncommon (i.e. around 5% of all fractures), some of these injuries and their sequelae substantially impact quality of life[19,24,27,31,38]. The World Health Organization (WHO) International Classification of Disability, Functioning and Health (ICF) provides a framework to assess this impact from the patient's perspective[6,7] (Figure 1).

The WHO framework includes domains representing psychological factors [e.g. depression, anxiety, pain interference, and kinesiophobia (the fear of movement or re-injury), and catastrophization (the exacerbation of fearful aspects of pain)] that are predictive of limitations [quantified by patient-reported outcome measures (PROMs)] in studies involving elbow conditions[8,9, 10, 11]. Most of these are cross-sectional investigations involving cohorts that combine traumatic and non-traumatic conditions throughout the upper limb[8, 9,10,11].

This work represents a prospective, longitudinal study of a focused cohort of isolated elbow fractures assessed from first orthopaedic review after the emergency department to several months after injury[44,33]. We aimed to identify the demographic, injury, psychological, and social factors associated with limitations 6 to 9 months after elbow fractures using the WHO ICF as a framework for organising these variables (Figure 2).

The primary null hypothesis was that the magnitude of limitations (measured by the Patient Reported Outcome Measurement Information System Upper Extremity Physical Function Computer Adaptive Test, PROMIS UE PF CAT) 6 to 9 months after an elbow fracture was not associated with psychological and social factors assessed within a week of injury, accounting for demographic and injury-related factors. Secondarily, we assessed the influence of psychological and social variables measured 2 to 4 weeks after injury on 6-9 month PROMIS UE PF CAT. Finally, we repeated these evaluations for other PROMs

(Quick Disabilities of the Arm, Shoulder and Hand [QuickDASH], European Quality of Life Index-3L [EQ-5D-3L], and Oxford Elbow Score) measured 6-9 months after injury.

Materials & Methods

A consecutive series of 191 adult patients sustaining isolated elbow fractures attending new patient fracture clinics between 1st January 2016 and 31st August 2016 at a level I trauma center were enrolled in a research and ethics committee-approved study (IRAS No. 16/YH/0017).

Inclusion criteria included fluency in English, being eighteen years of age or older, and the ability to provide informed consent. Patients with other injuries were excluded, as were those with re-fracture of the elbow during recovery from a prior injury, fracture in a mal-united elbow after a previous fracture, and peri-prosthetic fracture surrounding a prior elbow fixation or joint replacement.

Of the 191 patients invited to participate, eight patients (4.2%) declined due to time constraints leaving a total of 183 in the study, including 91 women and 92 men with a mean age of 48.2 years ± 20.2 (range, 18-93) (Table I).

Participants provided demographic details including level of education, marital, social and work status, and arm dominance. Clinical variables included prior arm injury, neurovascular compromise, open or closed fracture, having a surgical procedure, and adverse events gathered from electronic health records. Chart-derived complications include stiffness treated with manipulation under anesthesia and disproportionate pain after injury despite corticosteroid injection and physical therapy. Age-adjusted Charlson Comorbidity Index (CACI)[7] and Index of Multiple Deprivation 2015 (IMD)[57], were generated using comorbidity data and postal codes respectively. CACI is a validated scoring tool predictive of one-year mortality accounting for a range of comorbidities[7]. IMD combines information from national administrative data to form a relative rank of social deprivation based on geographical location defined by the UK Office for National Statistics[57]. The rank was converted to a percentage (IMD factor) with lower percentage signifying greater deprivation.

PROMs were completed on a secure, web-based data collection platform (Assessment Center[SM], Northwestern University, Chicago USA)[13]. Data was captured at baseline (initial orthopaedic consultation, within a week of attendance in the emergency department), early follow-up (2 to 4 weeks) and final assessment (6 to 9 months). Patients completed assessments in person (58%), by telephone (34%), or via an electronic online link (8%). None were lost to follow-up.

Complications included those related to operative treatment e.g. wound infection, as well as those with a strong subjective component e.g. elbow stiffness treated with manipulation under anaesthetic, or prolonged pain leading to a pain specialist referral.

Injuries were independently classified by two authors [PJ; SG] by energy [e.g. high speed road traffic accident (high); fall from standing height (low)], and by the AO/OTA Fracture and Dislocation Classification[53] and modified Mason[28,20,5] systems to enable a comprehensive characterization of injuries. These were further categorized into radial head/neck, intra-articular, or extra-articular fractures to simplify analysis. The majority were isolated fractures of the radial head and neck, followed by intra-articular fractures e.g. distal humerus and olecranon fractures, and extra-articular fractures of the distal humerus, proximal radius and /or ulna.

Regarding medications, anti-depressant use was recorded and defined as any earlier use i.e. for pre-existing depression or a new diagnosis of depression in the acute recovery phase (the first month following injury). Use of opioid analgesia was defined as continued use of any opioids more than 2 weeks after injury. Patients using opioids prior to injury were only included in this opioid use group if there was an increase in their intake after fracture.

Outcome Measures

PROMs were administered in the following order i) PROMIS UE[18], ii) PROMIS Pain Interference (PROMIS PI) [1], iii) PROMIS Depression[14,36], iv) PROMIS Anxiety[36], v) PROMIS Emotional Support (PROMIS ES) [39], vi) PROMIS Instrumental Support (PROMIS IS)[39], vii) QuickDASH[3,29,47], viii) Oxford Elbow Score (OES)[54]), ix) EQ-5D-3L[46,58], x) Pain Catastrophizing Scale (PCS)[45], xi) Pain Self-Efficacy Questionnaire-2 (PSEQ-2)[4,32], xii) Tampa Scale for Kinesiophobia-11 (TSK-11)[52]. Descriptions of these measures are detailed in Appendix I and scores are provided in Appendix II.

Statistical analysis

Descriptive statistics included frequencies and percentages for discrete variables, and mean, standard deviation and range for normally distributed continuous variables. Bivariate analysis involved unpaired Student's t-test or analysis of variance for comparing continuous and discrete variables and Pearson correlation for continuous variables. Strength of correlations were classified as high (>0.70), high-moderate (0.61-0.69), moderate (0.40-0.60), moderate-weak (0.31-0.39) and weak (<0.30)[43].

Data was checked for multicollinearity, where two or more predictor variables in a multiple regression model are highly correlated, meaning that one can be linearly predicted from the other with a substantial degree of accuracy. This may be indicated by high beta, high standard error and wide 95% confidence intervals, and assessed with partial R^2, correlation matrices at less than 1 week and 2-4 weeks, and variable inflation factor (VIF). VIF measures the extent to which the variance of estimated regression coefficients and independent variable increase due to collinearity. A correlation greater than 0.80 was considered an indication of multicollinearity and led to omission of one of the two variables with this high correlation (Appendix III).

After adjusting for multicollinearity, the remaining psychosocial measures and each independent variable correlating with limitations at less than a week, and 2-4 weeks, with $p<0.10$ in bivariate analysis, were entered into multivariable regression. Eight multivariable models were created in total i.e. one for each PROM with independent variables at less than a week and at 2-4 weeks. $p<0.05$ was considered statistically significant in multivariable analysis.

An a-priori power analysis indicated that a minimum sample size of 160 would provide 80% statistical power with alpha set at 0.05. This was based on a regression with ten predictors and an assumption that an independent variable would account for 3.5% or more of the variability in limitations and the complete model would account for at least 30% variability. All statistical analysis was performed using STATA 14.0 (StataCorp LP, College Station, TX, USA). No sources of funding were related to this work.

Results

Multiple variables within a week of injury correlated with PROMIS UE 6-9 months after elbow fractures in bivariate analysis (Appendix IV). Of these variables, kinesiophobia was the strongest psychological predictor in multi-variable regression, after adjusting for multi-collinearity. This accounted for 14% of the variance (TSK-11: Partial R^2 = 0.14, p=0.005) (Table II). Other factors related to work status i.e. not being retired (Partial R^2 = 0.21, p=0.000) and not being unemployed (Partial R^2 = 0.18, p=0.000) also explained a significant proportion of the variability.

Multiple variables at 2-4 weeks after injury also correlated with PROMIS UE 6-9 months after elbow fractures in bivariate analysis (Appendix V). Of these variables, coping strategy (measured by PSEQ-2) was the strongest psychological predictor in multivariable regression, after adjusting for multi-collinearity. This accounted for 12% of the variance (PSEQ-2: Partial R^2 = 0.123, p=0.003) (Table III). Other dominant factors included being male (Partial R^2 = 0.115, p=0.000), and not being retired (Partial R^2 = 0.126, p=0.000).

Kinesiophobia within a week of injury also consistently explained a substantial proportion of the magnitude of limitations at 6-9 months measured by QuickDASH (Partial R^2 = 0.08, p=0.005), OES (Partial R^2 = 0.122, p=0.000) and EQ-5D-3L (Partial R^2 = 0.069, p=0.001) (Table II). Other factors that explained a substantial proportion of the variance included older age, the use of opioids, the use of antidepressants, and being retired but these were not consistent across PROMs.

Pain self-efficacy and instrumental support consistently accounted for a substantial proportion of the variability in QuickDASH, OES and EQ-5D-3L in multivariable analysis (PSEQ-2; [QuickDASH (Partial R^2=0.136; p=0.004); OES (Partial R^2=0.195, p=0.002); EQ-5D-3L (Partial R^2=0.125, $p<0.001$); PROMIS Instrumental support; [QuickDASH (Partial R^2=0.273; $p<0.001$); OES (Partial R^2=0.256, $p<0.002$); EQ-5D-3L (Partial R^2=0.166,

$p<0.001$)]. Other factors that explained a substantial proportion of the variance in greater limitations included being male, antidepressant use, not being retired and being unemployed, but these were not consistent across PROMs. No injury-related correlates of limitations at either stage of recovery were selected in multivariable analysis.

Discussion

The combination of psychosocial variables in this study explained a high proportion of the variability in measures of limitations. In particular, kinesiophobia, the fear of movement or further injury within a week of elbow fracture appears to be a dominant predictor of limitations at 6-9 months. At two to four weeks, self-efficacy, the resilience and ability to cope with injury, and instrumental support, were the strongest determinants. These findings held true for region-specific and general health PROMs.

The concept of kinesiophobia encompasses a fear that activities and movements may risk further injury, pain and disruption of the underlying fracture. One could consider such fears as a normal part of the post-traumatic experience. However, such fears may also evoke maladaptive responses such as a heightened desire to protect their arm and become over-cautious about movement, which may slow recovery. This psychological barrier to movement could compound the biological processes involved in the development of post-traumatic stiffness, a common complication of elbow trauma [26]. Despite the lack of evidence supporting the timing of mobilization following elbow fractures, most surgeons agree on the principle of stretching the elbow and using it for light daily tasks as soon as it's safe. For most fractures this is after a few days of immobilization for comfort [26,17,35]. Based on these findings, recovery from a fracture of the elbow may be delayed by unhelpful thoughts, perceptions, and behaviours related to pain with movement within a week of injury. Interactions that instil confidence, increase engagement, and grant license to ideas that may be unfamiliar or counterintuitive during recovery, could provide the best response in this instance and limit adverse sequel such as elbow stiffness.

A few weeks to a month after elbow fracture, there appears to be a transition toward self-efficacy being the dominant factor in influencing limitations. One explanation could be that as symptoms diminish following the acute event and patient's begin to experience life with their injury, the focus shifts from fear-based thoughts around painful movement toward learning to cope and adapt. Those with less adaptive mindsets may have greater limitations than expected for their condition [25].

Other psychological factors had variable interactions with limitations during the recovery process. Depression and anxiety at less than one week were predictive of disability measured by OES and EQ-5D-3L. Due to multi-collinearity, particularly at two to four weeks, multiple psychological variables including depression, anxiety and pain catastrophizing were omitted from regression analysis. Studies involving non-traumatic upper extremity conditions demonstrate a strong correlation between depression, anxiety and the magnitude of limitations [40,49,30,34,51,22]. Notably, in this study, the use of anti-depressants explained a substantial proportion of the variation in limitations represented by QuickDASH, OES and EQ-5D-3L at less than one week and QuickDASH and OES at two to four weeks.

Social factors, such as marital status (i.e. being married or having a partner, being separated, widowed or divorced) and work status (i.e. being retired or unemployed) also explained a proportion of the variation in limitations, although somewhat inconsistently, both at less than a week and at two to four weeks after injury. Instrumental support, the perceived availability of support from others in fulfilling specific functions, in particular accounted for a significant proportion of the variation in limitations two to four weeks after injury. The provision of tangible support from family, friends and partners to fulfil daily functions appeared to have a stronger impact on future health-related outcomes than emotional support which is the perceived feeling of being cared for and valued when faced with the stresses and strains of a painful elbow fracture. This may reflect the needs of relatively younger, more active demographic who may be faced with greater practical commitments related to their activities of daily life and work.

Surprisingly no clinical or injury-related factors, except complications, explained significant amounts of the variability in disability across measures at less than a week and at two to four weeks after injury.

As additional findings, this study also demonstrated (i) the feasibility of delivering multiple PRO measures during recovery from elbow trauma, as early as day 0 post-injury, (ii) the ability to efficiently administer PRO measures, including CATs, via a web-based electronic portal, and (iii) the possibility of achieving a robust set of patient outcomes with low levels of missing data and participant attrition using a full-time investigator [6,12,11,48].

These findings must be considered in light of some limitations. Firstly, it is recognized that a single-center study may not be representative of the wider population despite a wide range in demographic profile and indices of deprivation. Second, the best multivariable models in this study demonstrated a large proportion of the variance in limitations, however other unaccounted factors could also have had a substantial influence on PROMs e.g. fracture displacement during recovery, re-injury, uncontrolled pain and the development of stiffness in injured and adjacent joints. Third, injury type may have been too variable and classified too broadly with each category containing a heterogenous range of injuries of varying levels of severity. For instance, the management of a comminuted intra-articular fracture of the distal humerus is often more complex than an isolated simple intra-articular fracture of the olecranon. Despite this, the majority were isolated fractures of the radial head and neck. Future studies should assess more homogenous diagnoses and treatments e.g. isolated, non-operatively managed radial / neck fractures, and perform similar assessments to see if the findings are replicated. Fourth, PROMIS ES and IS were not assessed at less than 1 week due to a programming error. Although this may have influenced the analysis, it is unlikely to have substantially affected the overall interpretation of results.

Finally, a more detailed approach could also have been taken to define complications with future studies delineating operative adverse events e.g. infection, from "subjective" issues such as disproportionate pain and pain requiring a cortisone injection.

Conclusion

Identifying factors, such as kinesiophobia, self-efficacy and instrumental support, that are modifiable and predictive of limitations early in the recovery process supports greater attention on the mental health and social wellbeing of elbow fracture patients alongside their physical needs and clinical management during the healing process. The use of enhanced communication with enabling and empowering language should be applied by health care professionals while some patients may require more intensive coaching, cognitive therapies and social support. These strategies may be the most effective way of further improving patient outcomes following elbow injuries[16,44,41].

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Table Legend

Table I: Patient Demographics

Table II: Multivariable analysis of influential factors at less than a week for limitations (measured using PROMIS UE PF, QuickDASH, OES, EQ-5D-3L) at 6-9 months

Table III: Multivariable analysis of influential factors at 2-4 weeks for limitations (measured using PROMIS UE PF, QuickDASH, OES, EQ-5D-3L) at 6-9 months

Appendix I: Patient Reported Outcome Measurements (PROMs) and Descriptions

Appendix II: Health-Related Outcomes and Performance-Based Measures During Recovery Following Elbow Fracture

Appendix III: Correlation Matrices for psychological variables and age versus CACI

Appendix IV: Bivariate analysis of explanatory variables at less than a week with PROMs at 6 – 9 months

Appendix V: Bivariate analysis of explanatory variables at 2-4 week PROMs at 6-9 months

Figure legends

Figure 1. The World Health Organisation International Classification of Disability, Functioning and Health (WHO ICF) Framework applied to two examples of patients with Elbow Fractures

Figure 2. Components of the WHO ICF Framework represented by PROMs and other variables used to assess limitations after Elbow Fractures