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What factors are associated with a second opioid prescription after treatment of distal radius fractures with a volar locking plate?

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Abstract
Purpose Knowledge of factors associated with patient's requests for a second opioid prescription after volar plate fixation of a fracture of the distal radius might inform better pain management protocols and encourage decreased and safer use of opioids. This study tested the primary null hypothesis that there is no difference in demographics, prior opioid prescriptions, injury characteristics, and psychological factors between patients that do and do not receive a second opioid prescription following treatment volar locking plate after distal radius fracture.
Patients and Methods We used data on 206 patients enrolled in one of two prospective studies. Their mean age was 53 years±SD 15, and 60 (30 %) were men. Forty-seven (23 %) patients received a second opioid prescription. We recorded additional demographics, AO fracture type, American Society for Anesthesiologists (ASA) classification, radiographic parameters at the time of injury prior to reduction and after surgery, and catastrophic thinking.
Results Male sex (odds ratio [OR] 2.2, 95 % confidence interval [CI] 1.0–4.6, partial pseudo R^2=0.018, P=0.044) and greater dorsal angulation of the articular surface on the lateral post injury radiograph (OR 0.98, 95 % CI 0.96 to 1.0, partial pseudo R^2=0.033, P=0.040) were associated with a second opioid prescription after surgery (pseudo R^2 0.12, P=0.0071).
Conclusions One measure of fracture severity (dorsal displacement) was independently associated with a second opioid prescription, but alone it accounted for 3.3 % of the variation. Other factors such as the patient's expectation prior to surgery, in particular the realization that injury and surgery hurt, might be addressed in future research.
Level of Evidence Prognostic II

Keywords Catastrophic thinking · Fracture · Opioid · Radius

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Introduction

There is substantial variation in the amount of opioids consumed by patients after orthopedic surgery [1, 2]. In 2004, it was estimated that the USA accounted for 85 % of the world's oxycodone consumption and 99 % of its hydrocodone consumption [3]. Most patients have acceptable pain relief with acetaminophen or tramadol after orthopedic surgery in other parts of the world [1, 4, 5].

Patients who take more opioids after fracture treatment report greater pain intensity and less satisfaction with pain relief, both in the immediate postoperative period [4, 6] and 1–2 months after surgery [7]. One might expect patients with injuries to larger bones, certain anatomic areas, more than one fracture, or specific procedures to have greater pain and use more opioids, but that was not the case [4, 6]. Previous research also found an association between greater postoperative opioid use and psychological factors, catastrophic thinking, and health anxiety in particular [7, 8].

Previous research found that most patients prescribed opioids during recovery from operative treatment of a fracture of the distal radius stop taking opioids within a few days [2]. Knowledge of the factors associated with a second opioid prescription might inform better pain management protocols and encourage decreased and safer use of opioids after orthopedic surgery. In particular, we were interested in ineffective coping strategies such as catastrophic thinking, characteristics that may be amenable to coaching [9, 10]. This study tested the primary null hypothesis that there is no difference in demographics, prior opioid prescriptions, injury characteristics, and psychological factors between patients that do and do not receive a second opioid prescription following treatment of their distal radius fracture with a volar locking plate. Additionally, we assessed factors associated with disability and pain measured at suture removal.

Materials and Methods

Study Design

After institutional review board approval for secondary use of the data, we reviewed 220 adult patients treated with a volar locking plate after distal radius fracture who were recruited for two previous prospective studies. One randomized controlled trial ($n=94$) compared formal occupational therapy with instructions for independent exercises [11]; the other observational cohort study ($n=116$) addressed factors associated with finger stiffness [12]. Exclusion criteria for both studies were [1] treatment more than 4 weeks after trauma [2]; inability to complete enrollment forms due to any mental status or language problems (e.g., dementia, head injury, overall illness) [3]; pre-injury lack of near-normal finger motion of the uninjured hand [4]; additional injuries except ulna fractures.

Outcome Measures

At suture removal, after informed consent, a researcher not involved in patient care recorded the patient's age, sex, body mass index, tobacco use, carpal tunnel release at the time of surgery, days between injury and surgery, and if the injury involved the dominant hand. AO fracture type was recorded at the time of surgery (extra-, partial-, or complete articular). We extracted patients' American Society for Anesthesiologists (ASA) classification from the anesthesiology reports and recorded the treating surgeon. We also measured the following radiographic parameters at the time of injury prior to reduction and after surgery [1]: ulnarward inclination [2], ulnar variance [3], volar tilt [4], and ulna intact [13]. Patients completed the Pain Catastrophizing Scale, a measure of misinterpretation or overinterpretation of nociception (catastrophic thinking). This questionnaire comprises 13 items, scored on a 4-point Likert scale, ranging from 1 (*not at all*) to 4 (*all the time*). The total score ranges from 13 to 52 points with a higher score indicating greater catastrophic thinking [14]. Arm specific disability was evaluated by the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire. It consists of 30 questions scored on 5-point Likert scales, ranging from 1 (*no problems/pain*) to 5 (*impossible*). Scores range between 0 and 100 points, a higher score indicating worse upper extremity specific disability and pain [15]. Patients rated their pain intensity on an 11-point ordinal scale, ranging from 0 to 10, where 0 was *no pain* and 10 *the worst pain ever* [16].

From the pharmacy records and the patient charts, we extracted the type of opioid prescribed, the dosage, and the number of pills. We also had records of a second opioid prescription within 30 days after surgery and all opioids prescribed 90 days prior to surgery. We divided this period in four time frames: (1) opioids prescribed up to 90 days before fracture; (2) opioids prescribed between fracture and 4 days before surgery; (3) opioids prescribed up to 3 days before surgery (perioperative opioids); (4) any opioid prescription in addition to the first opioid prescription given postoperatively up to 30 days after surgery. Medication with additional acetaminophen or nonsteroid anti-inflammatory drugs was grouped with its type of opioid (e.g., vicodin and norco with hydrocodone). Extended release compositions were sorted with the main opioid group (e.g., oxcontin grouped with oxycodone). Using equianalgesia conversion factors [17–19], we changed all opioids to oral morphine equivalent dosages (Table 4). Subsequently, we calculated the prescribed morphine dosage during the four time periods.

Study Population

We excluded 14 patients because they were initially treated at another hospital, and we could not track their prescribed opioid medication. Our final cohort included 206 patients, of whom 60 (30 %) were men. The mean age was 53 years (±SD [standard deviation] 15, range 19–89) (Table 1). A second opioid prescription was provided to 47 (23 %) patients; mean oral morphine equianalgesia dosage prescribed was 244 mg (±SD 77, range 100–450) (Table 2). The majority of patients were treated by one of three surgeons, surgeon A operated 155 (75 %) patients, surgeon B 19 (9 %) patients, and surgeon C 14 (7 %) patients; 8 other surgeons together operated the remaining 18 patients (9 %) (Table 1).

Statistical Analysis

To identify independent factors associated with (1) additional opioid prescription, (2) disability, and (3) pain, we

Table 1 Baseline characteristics of patients with a distal radius fracture treated with a volar locking plate

Demographics	Value
Patients	206
Age, years (range)	53±15 (19–89)
Male	30 % (62)
Body mass index	26±6.0
Smoking	8.9 % (17)
ASA classification	
1	36 % (73)
2	58 % (117)
3	5.9 % (12)
Treating surgeon	
A	75 % (155)
B	9.2 % (19)
C	6.8 % (14)
Other	8.7 % (18)
Trauma-related factors	
Injury to dominant side	43 % (88)
Carpal tunnel release during ORIF	18 % (38)
AO classification	
A	41 % (84)
B	13 % (26)
C	47 % (96)
Ulna fracture	58 % (119)
Days between injury and surgery	8.8±5.8
Radiographic parameters after injury	
Ulnarward inclination	12±8.5°
Ulnar variance	1.4±4.7 mm
Volar tilt	−13±21°
Radiographic parameters after surgery	
Ulnarward inclination	20±4.6°
Ulnar variance	−0.21±3.0 mm
Volar tilt	5.9±8.2°
Questionnaires	
Pain catastrophizing scale	18±6.9
DASH score	48±19
Numerical rating of pain intensity	3.6±2.6

Continuous variables as mean±standard deviation; discrete data as percentage (number)

ASA American Society for Anesthesiologists, *DASH* Disabilities of the Arm, Shoulder, and Hand

Table 2 Opioid-related factors of patients with a distal radius fracture treated with a volar locking plate

Opioid-related factors	Value
Opioids within 90 days prior to injury	5 % (10)
Oral morphine equianalgesia	2725±5106 mg
Opioids between injury and surgery	44 % (91)
Oral morphine equianalgesia	309±233 mg
Opioids perioperative	81 % (167)
Oral morphine equianalgesia	470±215 mg
Second opioid prescription	23 % (47)
Oral morphine equianalgesia	244±77 mg
Types of opioid prescribed up to surgery	
Oxycodone	84 % (174)
Hydrocodone	28 % (58)
Hydromorphone	3.9 % (8)
Codeine	3.9 % (8)
Tramadol	2.4 % (5)
Propoxyphene	1.9 % (4)
Second opioid prescriptions (n=47)	
Oxycodone 5 mg	13 % (6)
Hydrocodone 5 mg	68 % (32)
Hydrocodone 7.5 mg	4.3 % (2)
Hydromorphone 2 mg	2.1 % (1)
Codeine 30 mg	8.5 % (4)
Propoxyphene 100 mg	4.3 % (2)

Continuous variables as mean±standard deviation; discrete data as percentage (number)

created three multivariable models. The potential explanatory variables associated with our outcome measurements were selected based on the feasibility of measurement in the clinical setting and their possible influence on a second opioid prescription. Multiple logistic and linear regression models were created by entering catastrophic thinking (our primary explanatory variable) in addition to all other variables associated with each of the three response variables on exploratory bivariate analysis with $P<0.10$ (see bivariate analysis in Tables 5 and 6). In case of significant association with both morphine equianalgesia dosage and opioid prescription, we only included equianalgesia dosage in our model due to covariance of both factors. Pseudo and adjusted R^2 indicate how much variability in the outcome variable the model accounts for. The partial R^2 indicates for how much variability each variable accounts for by itself.

We used multiple linear imputation for missing values (number of imputations set to 40): 15 tobacco use (7.3 %), 4 ASA classification (1.9 %), 56 volar tilt after injury (27 %), 3 ulnar variance after surgery (1.5 %), 2 volar tilt after surgery (0.97 %), 6 pain scores (2.9 %), and 20 DASH scores (9.7 %). All R^2 are the average of the 40 imputed sets.

Continuous variables are described as mean (±SD), discrete variables as percentage and number. Data histograms were visually inspected to assess data distribution. Accordingly, we compared continuous and discrete variables by unpaired Student's *t* test or analysis of variance, continuous variables by Pearson correlation, and discrete variables by Fisher's exact test. Bivariate analysis was performed only on complete data.

We considered a two-sided P value of less than 0.05 significant; all statistical analyses were performed using Stata 13.0 (StataCorp LP, Texas, USA).

A priori power analysis for a multiple logistic regression analysis, including catastrophic thinking as our key predictor of additional opioid prescription, was based on a pilot dataset of 108 patients. The probability of additional opioid prescription was 0.33 (2 of 6) at the mean catastrophic thinking of 17. Probability increased to 0.50 (2 of 4) at an increase of 1 standard deviation in catastrophic thinking (standard deviation 5.9). Assuming a moderate squared multiple correlation of 0.40 between catastrophic thinking and other predictors in the model, power analysis for a multiple logistic regression with multiple predictors indicated 181 patients would provide 0.90 power with alpha set at 0.05 (powerlog command, Stata 13.0, StataCorp LP, Texas, USA).

Results

Accounting for potential interaction of variables using multivariable analysis, male sex (odds ratio [OR] 2.2, 95 % confidence interval [CI] 1.0–4.6, partial pseudo R^2=0.018, P=0.044), and greater dorsal angulation of the articular surface on the lateral post injury radiograph (OR 0.98, 95 % CI 0.96 to 1.0, partial pseudo R^2=0.033, P=0.040) were associated with a second opioid prescription after surgery (pseudo R^2 0.12, P=0.0071), but not with catastrophic thinking. The odds of a second opioid prescription were 2.2 times higher in male patients. The odds of a second prescription increased with 2 % with every degree of less volar angulation of the articular surface after injury (Table 3).

Higher DASH scores were independently associated with ASA class 2 (β regression coefficient [β] 5.6, 95 % CI 0.57 to 11, SE 2.6, partial R^2=0.014, P=0.029), injury to the dominant side (β 8.8, 95 % CI 4.1 to 13, SE 2.4, partial R^2=0.048, P<0.001), and greater catastrophic thinking (β 1.1, 95 % CI 0.78 to 1.5, SE 0.18, partial R^2=0.14, P<0.001) (adjusted R^2 0.33, P<0.001). The β regression coefficient indicates that patients with ASA class 2 on average have 5.4 points higher DASH scores compared to patients with ASA class 1. Patients with an injury to the dominant hand have 9.9 points higher DASH scores. Also, every point increase in catastrophic thinking on average results in a 1.1 point higher DASH score (Table 3).

More pain was independently associated with ASA class 2 (β 0.78, 95 % CI 0.068 to 1.5, SE 0.36, partial R^2=0.014, P=0.032), carpal tunnel release at the time of plate fixation (β 0.91, 95 % CI 0.046 to 1.8, SE 0.44, partial R^2=0.015, P=0.039), greater dorsal angulation of the articular surface on the lateral post surgery radiograph (β −0.042, 95 % CI −0.084 to 0.0011, SE 0.021, partial R^2=0.014, P=0.044), and greater catastrophic thinking (β 0.12, 95 % CI 0.060 to 0.17, SE 0.028, partial R^2=0.073, P<0.001) (adjusted R^2 0.17, P<0.001). The β regression coefficient indicates that patients with ASA class 2 on average have 0.78 points higher pain scores compared to ASA class 1 patients. Patients undergoing additional carpal tunnel release have 0.91 point higher pain scores. Pain score increases 0.042 points with every degree of less volar angulation of the articular surface after surgery. Every point increase in catastrophic thinking on average results in 0.12 higher pain scores (Table 3).

Discussion

Patients who take more opioids after fracture treatment report greater pain intensity and less satisfaction with pain relief [4, 6, 7]. Knowledge of the factors associated with greater opioid use might inform better pain management protocols and encourage decreased and safer use of opioids after orthopedic surgery. We aimed to identify factors associated with a second opioid prescription after distal radius fracture surgery.

This study has some limitations. First, we were only able to track opioid prescriptions 90 days prior to injury prescribed by physicians at our hospital. Our study cannot account for opioids prescribed by outside providers. Secondly, we did not measure the number of pills actually taken; instead, we used a second opioid prescription as a surrogate measure. Thirdly, we only had complete data on 149 patients, mainly because volar tilt after injury could not be determined in 56 (27 %) patients. Deleting missing cases would result in a large loss of data. Instead, we addressed this by multiple linear imputation, which maintains the overall variability in the data while preserving relationships with other variables. Nonetheless, this decreases reliability of volar tilt after injury as a factor in our multivariable models. Fourthly, our secondary outcome measures (disability and pain) were assessed at 2 weeks after surgery and only apply to short follow-up times. Results cannot be extrapolated to long-term outcomes. Finally, most of the patients come from a single practice with a strict opioid policy (20 5 mg oxycodone with acetaminophen pills after surgery, a second script for hydrocodone 5 mg with acetaminophen after office evaluation, then no more opioids). Therefore, the findings of the study may not apply to the average surgeon and average patient in other setting, particularly in the USA where opioids are often prescribed for pain.

Male sex, opioid prescription within 90 days prior to injury, and greater dorsal angulation of the articular surface on the lateral post injury radiograph were associated with a second opioid prescription after surgery but together only accounted for 12 % of the variation in second opioid prescriptions. One measure of fracture severity (dorsal displacement) was independently associated with a second opioid prescription, but alone it accounted for 3.3 % of the variation. We may be able to limit opioid use in recent, frequent, or ongoing opioid users

Table 3 Multivariable analyses of factors associated with an additional opioid prescription, disability, and pain after distal radius fracture surgery

Second opioid prescription	Odds ratio (95 % confidence interval)	Standard error	*P* value	Partial pseudo R^2	Pseudo R^2
Male sex	2.2 (1.0–4.6)	0.83	*0.044*	0.018	0.12
ASA classification[a]					
1	Reference value				
2	1.1 (0.50–2.4)	0.43	0.83		
3	3.0 (0.72–12)	2.1	0.13		
Oral morphine equianalgesia within 90 days prior to injury	1.0004 (0.9995–1.001)	0.00048	0.35		
Oral morphine equianalgesia between injury and surgery	1.0008 (0.9992–1.002)	0.00077	0.33		
Ulna fracture	2.1 (0.94–4.5)	0.82	0.072		
Volar tilt after injury[a]	0.98 (0.96–1.0)	0.010	*0.040*	0.033	
Pain Catastrophizing Scale	1.02 (0.97–1.1)	0.027	0.47		
DASH score	β regression coefficient (95 % confidence interval)	Standard error	*P* value	Partial R^2	Adjusted R^2
Smoking[a]	2.4 (−6.2–11)	4.4	0.58		0.33
ASA classification[a]					
1	Reference value				
2	5.6 (0.57–11)	2.6	*0.029*	0.014	
3	2.0 (−9.6–14)	5.9	0.74		
Surgeon					
A	Reference value				
B	−4.9 (−13–2.8)	3.9	0.21		
C	−5.8 (−15–3.1)	4.5	0.20		
Other	5.7 (−2.3–14)	4.1	0.16		
Oxycodone	−5.4 (−12–1.6)	3.6	0.13		
Propoxyphene	9.2 (−7.4–26)	8.4	0.28		
Injury to dominant side	8.8 (4.1–13)	2.4	*<0.001*	0.048	
Ulnar variance after surgery[a]	−0.73 (−1.5–0.065)	0.40	0.072		
Pain catastrophizing scale	1.1 (0.78–1.5)	0.18	*<0.001*	0.14	
Pain intensity					
Smoking[a]	0.26 (−1.0–1.5)	0.64	0.68		0.17
ASA classification[a]					
1	Reference value				
2	0.78 (0.068–1.5)	0.36	*0.032*	0.014	
3	0.47 (−1.1–2.1)	0.80	0.56		
Oral morphine equianalgesia (mg)					
Prior to injury	0.00026 ($-6.88*10^{-6}$–0.00053)	0.00014	0.056		
Between injury and surgery	0.00067 (−0.00089–0.0022)	0.00079	0.40		
Propoxyphene	2.2 (−0.20–4.7)	1.2	0.071		
Carpal tunnel release during ORIF	0.91 (0.046–1.8)	0.44	*0.039*	0.015	
Volar tilt after surgery[a]	−0.042 (−0.084–−0.0011)	0.021	*0.044*	0.014	
Pain catastrophizing scale	0.12 (0.060–0.17)	0.028	*<0.001*	0.073	

Values set in italics indicate statistically significant difference

ASA American Society for Anesthesiologists, *DASH* Disabilities of the Arm, Shoulder, and Hand, *ORIF* Open Reduction and Internal Fixation

[a] Missing values are imputed using multiple linear imputation (number of imputations set to 40): 15 smoking status, 4 ASA classification, 56 volar tilt after injury, 3 ulnar variance after surgery, 2 volar tilt after surgery, 6 pain scores, and 20 DASH scores. Pseudo and adjusted R^2 are the average of the 40 imputed sets

via a combination of preoperative preparation, close coordination with the patient's other caregivers (a patient should receive opioids from only one caregiver at a time), and strict policies regarding the number, type, and timing of opioid prescription. These ideas merit additional study. Our findings are in line with previous published studies that note a higher postoperative opioid consumption in men [20, 21] and patients who used opioids preoperatively [21]. The reason for a higher opioid consumption in men is unclear and might be related to a difference in effectiveness [22] but is also ascribed to sex differences in fear of addiction, previous pain experience, and tolerance to postoperative pain and opioid side effects [20]. A previous study found that the main factor associated with opioid use 1 to 2 months after musculoskeletal trauma was greater catastrophic thinking [7]. We did not find an effect of catastrophic thinking on second opioid prescriptions after distal radius fracture surgery, perhaps because the surgeons involved are quite strict with opioids and tend to identify and coach catastrophic thinking. Catastrophic thinking can manifest verbally (e.g., “unbearable,” “excruciating,” “it just will not go,” etc.) or nonverbally (e.g., carrying the hand as if it was detached, flinching or retracting, bending rather than extending the wrist when trying to make a fist, etc.) [23]. It is coached primarily by acknowledging it as a normal, “programmed” human response to pain (protect, prepare for the worst), empathizing how difficult and counterintuitive the stretching exercises can be, being patient with the process, and encouraging patients to do things that are meaningful and important to them (e.g., a golfer should putt, a swimmer should swim, a knitter should knit). Another factor that might relate to a second opioid prescription is the patient’s expectation prior to surgery, in particular the realization that injury and surgery hurt. Previous study also showed that greater opioid intake is culturally mediated [4, 5]. These factors might be addressed in future research.

Greater symptoms and disability (higher DASH scores) were most strongly associated with catastrophic thinking. A previous study, assessing 84 patients after distal radius fracture at least 6 months after surgery, found no association of DASH scores with radiographic parameters after surgery (ulnar variance, ulnarward inclination, palmar tilt, articular surface incongruity, osteoarthritis). Conversely, we did find an association of DASH scores with injury to the dominant side, which might be due to our early assessment at suture removal and subsequent patient adaptation. Two other studies also found an association between greater catastrophic thinking and more disability after musculoskeletal trauma in general [24] and after distal radius fracture surgery in particular [25]. Other non-injury-related factors previously associated with greater disability are injury compensation and lower level of education [26]; two factors our study did not measure (very few of our patients were injured at work). The lack of correlation between radiographic measures and disability may reflect the fact that all fractures were treated operatively, with the result that substantial residual malalignment was unusual. Nevertheless, the collective data to date emphasize the influence of other factors in addition to greater pathophysiology (e.g., displacement, fracture type) on disability at suture removal after distal radius fracture.

While factors indicating a more severe injury (carpal tunnel release at the time of plate fixation and greater dorsal angulation of the articular surface on the lateral radiograph) were independently associated with greater pain intensity, the strongest determinant of pain intensity was greater catastrophic thinking. The evidence that psychological factors (depression, pain anxiety, and greater catastrophic thinking) are strongly associated with pain intensity after musculoskeletal trauma is compelling [6, 24, 27]. These aspects of the human illness experience are amendable to cognitive behavioral therapy. Additional study of the use of cognitive behavioral therapy to aid recovery from fracture of the distal radius is warranted. ASA classification measures the severity of preoperative comorbidities and was associated with greater pain intensity after surgery. Greater pain intensity may be due to the preexisting comorbidities, rather than the surgery itself. Future study should also measure preoperative comorbidities. Until then, the relevance of this finding is unclear.

In a setting where the surgeons are cautious and strict with opioid medication (only 23 % of patients received a second opioid prescription), a second opioid prescription after distal radius fracture surgery was not associated with greater catastrophic thinking even though catastrophic thinking was the factor most strongly associated with greater pain intensity. Considered along with the studies’ finding that opioid use is not associated with less pain or greater satisfaction with pain relief, it may be that preoperative and postoperative teaching, coaching, and reassurance along with limited use of opioid medication are a successful pain management strategy.

Statement of Human Rights and Informed Consent This study is approved by our institutional review board and is conducted in accordance with the Helsinki Declaration of 1975, as revised in 2000.

Our institutional review board approved this study. Informed consent is not applicable to this study design as participants of the SOVG signed up for such projects.

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Conflict of Interest One of the authors (David Ring) certifies that he, or a member of his immediate family, has or may receive payments or benefits during the study period from Wright Medical (USD less than 10,000) (Memphis, TN, USA); Skeletal Dynamics (USD less than 10,000) (Miami, FL, USA); Biomet (USD less than 10,000) (Warsaw, IN, USA); AO North America (USD less than 10,000) (Paoli, PA, USA); and AO International (USD less than 10,000) (Dubendorf, Switzerland).

No other authors have anything to disclose.

Appendix 1

Table 4 Equianalgesia conversion factor

Opioid	Equianalgesia dosage of 10 mg oral morphine (mg)
Hydromorphone [18]	2.5
Oxycodone [18]	6.7
Propoxyphene [17]	0.74
Hydrocodone [18]	10
Tramadol [19]	100
Codeine [18]	67

Appendix 2

Table 5 Bivariate analysis of factors associated with an additional opioid prescription after distal radius fracture surgery

Demographics	Second opioid prescription	No additional opioids	*P* value
Patients	23 % (47)	77 % (159)	
Age	51±16	53±15	0.26
Male	43 % (20)	27 % (42)	*0.046*
Body mass index	27±5.1	26±6.2	0.43
Smoking	9.8 % (4)	8.7 % (13)	0.76
ASA classification			
1	32 % (15)	37 % (58)	0.090
2	55 % (26)	59 % (91)	
3	13 % (6)	3.9 % (6)	
Treating surgeon			
A	81 % (38)	74 % (117)	0.52
B	6.4 % (3)	10 % (16)	
C	8.5 % (4)	6.3 % (10)	
Other	4.3 % (2)	10 % (16)	
Opioid-related factors			
Opioids within 90 days prior to injury	13 % (6)	2.5 % (4)	*0.011*
Oral morphine equianalgesia (mg)	465±2501	34±261	*0.033*
Opioids between injury and surgery	47 % (22)	43 % (69)	0.74
Oral morphine equianalgesia (mg)	184±276	123±196	0.089
Opioids perioperative	77 % (36)	82 % (131)	0.40
Oral morphine equianalgesia (mg)	393±304	377±256	0.73
Types of opioid previously prescribed			
Oxycodone	78 % (37)	86 % (137)	0.25
Hydrocodone	36 % (17)	26 % (41)	0.20
Hydromorphone	4.3 % (2)	3.8 % (6)	1.0
Codeine	4.3 % (2)	3.8 % (6)	1.0
Tramadol	4.3 % (2)	1.9 % (3)	0.32
Propoxyphene	2.1 % (1)	1.9 % (3)	1.0
Trauma-related factors			
Injury to dominant side	44 % (19)	43 % (69)	0.74
Carpal tunnel release during ORIF	19 % (9)	18 % (29)	1.0
AO classification			
A	43 % (20)	40 % (65)	0.21
B	19 % (9)	11 % (17)	
C	38 % (18)	49 % (78)	
Ulna fracture	70 % (33)	54 % (86)	0.064

Table 5 (continued)

Demographics	Second opioid prescription	No additional opioids	*P* value
Days between injury and surgery	8.5±5.7	9.0±5.9	0.61
Radiographic parameters after injury			
Ulnarward inclination	14±7.2	11±8.7	0.18
Ulnar variance	1.9±5.1	1.3±4.6	0.52
Volar tilt	−22±19	−11±21	*0.0078*
Radiographic parameters after surgery			
Ulnarward inclination	20±4.2	20±4.7	0.36
Ulnar variance	0.17±3.2	−0.32±2.9	0.33
Volar tilt	4.4±8.8	6.3±8.0	0.16
Questionnaires			
Pain catastrophizing scale	19±6.0	18±7.1	0.19
Numerical rating of pain intensity	4.8±2.8	3.3±2.4	*<0.001*
DASH score	50±20	47±18	0..34

Continuous variables as mean±standard deviation; discrete data as percentage (number). Values set in italics indicate statistically significant difference
ASA American Society for Anesthesiologists, *ORIF* Open Reduction and Internal Fixation, *DASH* Disabilities of the Arm, Shoulder, and Hand

Appendix 3

Table 6 Bivariate analysis of factors associated with disability and pain at suture removal after distal radius fracture surgery

Demographics	DASH score	*P* value	Pain intensity	*P* value
Age (*r*)	0.061	0.41	−0.036	0.61
Sex				
Men	45±18	0.21	3.4±2.5	0.43
Women	49±19		3.7±2.6	
Body mass index (*r*)	0.12	0.12	0.031	0.67
Smoking				
Yes	57±18	*0.039*	4.6±2.7	0.097
No	47±18		3.5±2.6	
ASA classification				
1	44±18	0.058	3.0±2.2	*0.047*
2	49±19		3.8±2.7	
3	56±17		4.6±2.7	
Treating surgeon				
A	49±18	*0.014*	3.5±2.4	0.69
B	44±20		3.9±3.4	
C	35±12		3.8±3.0	
Other	55±23		4.2±3.0	
Opioid-related factors				
Opioids within 90 days prior to injury				
Yes	51±25	0.60	4.4±3.1	0.32
No	48±18		3.6±2.5	
Oral morphine equianalgesia (mg) (*r*)	0.011	0.88	0.13	0.061
Opioids between injury and surgery				
Yes	49±19	0.33	3.7±2.6	0.72
No	47±18		3.5±2.6	
Oral morphine equianalgesia (mg) (*r*)	0.12	0.11	0.14	0.054
Opioids perioperative				
Yes	47±19	0.33	3.6±2.6	0.88

Table 6 (continued)

Demographics	DASH score	*P* value	Pain intensity	*P* value
No	51±15		3.7±2.4	
Oral morphine equianalgesia (mg) (*r*)	−0.098	0.18	0.069	0.34
Types of opioid previously prescribed				
Oxycodone				
Yes	47±18	*0.023*	3.6±2.6	0.52
No	56±19		3.9±2.7	
Hydrocodone				
Yes	45±19	0.14	3.9±2.8	0.35
No	49±18		3.5±2.5	
Hydromorphone				
Yes	56±14	0.19	3.6±1.8	0.97
No	48±19		3.6±2.6	
Codeine				
Yes	45±22	0.70	2.8±1.2	0.34
No	48±19		3.6±2.6	
Tramadol				
Yes	52±26	0.60	5.0±2.6	0.22
No	48±18		3.6±2.6	
Propoxyphene				
Yes	68±7.1	*0.027*	6.5±2.6	*0.023*
No	48±19		3.5±2.5	
Trauma-related factors				
Injury to dominant side				
Yes	55±19	*<0.001*	3.7±2.3	0.72
No	43±17		3.6±2.7	
Carpal tunnel release during ORIF				
Yes	52±19	0.13	4.3±2.9	0.050
No	47±18		3.4±2.5	
AO classification				
A	48±20	0.80	3.6±2.7	0.67
B	50±17		3.2±2.6	
C	47±18		3.7±2.5	
Ulna fracture				
Yes	48±18	0.84	3.6±2.7	0.98
No	48±20		3.6±2.5	
Days between injury and surgery (*r*)	−0.0097	0.90	0.058	0.42
Radiographic parameters after injury (*r*)				
Ulnarward inclination	−0.084	0.34	−0.031	0.71
Ulnar variance	0.082	0.35	−0.12	0.16
Volar tilt	−0.077	0.37	−0.12	0.15
Radiographic parameters after surgery (*r*)				
Ulnarward inclination	−0.11	0.15	0.019	0.79
Ulnar variance	−0.15	*0.048*	0.013	0.86
Volar tilt	−0.044	0.55	−0.13	0.059
Psychological factor (*r*)				
Pain catastrophizing scale	0.44	*<0.001*	0.31	*<0.001*

Continuous variables as mean±standard deviation; continuous data as Pearson correlation, indicated by *r*; Values set in italics indicate statistically significant difference

DASH Disabilities of the Arm, Shoulder, and Hand, *ASA* American Society for Anesthesiologists, *ORIF* Open Reduction and Internal Fixation

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