Preoperative Predictors of Postoperative Opioid Usage, Pain Scores, and Referral to a Pain Management Service in Total Knee Arthroplasty

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Abstract *Background:* Little is known about preoperative predictors of postoperative pain and referral to a recuperative pain management service after total knee arthroplasty (TKA). *Questions/Purposes:* We sought to identify the preoperative predictors of postoperative pain scores, referral to a pain management service, and narcotic usage in patients undergoing primary total knee arthroplasty. *Methods:* We performed a prospective cohort study of 97 TKAs from a single surgeon. Pre and 6-week postoperative WOMAC, visual analog pain scale (VAS) scores, narcotic usage, and catastrophizing pain scores were collected. *Results:* After adjusting for all other variables, higher age and catastrophizing pain scores were associated with lower odds of postoperative opioid usage. Increasing age and BMI were associated with lower odds of being referred to pain management. There was no relationship between self-reported preoperative pain tolerance and postoperative change in WOMAC or VAS pain scores. *Conclusions:* This information may help surgeons advise their patients preoperatively and set expectations during the recovery period.

Keywords total knee arthroplasty · outcomes · pain management · opioid usage · preoperative predictors

Introduction

Total knee arthroplasty (TKA) is a common treatment for degenerative joint disease of the knee. Some experts predict the demand for TKAs will exceed 3.4 million procedures by the year 2030 [22]. Overall, total knee replacement (TKR) is a successful procedure in relieving pain and improving function [9, 10, 13, 14, 19]; however, 10–30% of TKA patients complain of persistent pain despite normal radiographs and physical examination [12, 18, 27, 37, 38, 39]. With the expected increase in TKR volume within the USA, the number of patients returning to the surgeon's office with complaints of pain would be expected to increase proportionally.

Psychological distress has been cited as a cause of continued pain after TKA [1, 2, 4, 5, 15, 23, 30]. One study prospectively followed 140 patients to determine if health-related beliefs (self-efficacy, pain catastrophizing, and fear of movement) were associated with poor outcome 6 months following surgery [30]. This study found catastrophizing pain was the only psychological predictor of poor WOMAC pain outcomes.

The pain catastrophizing scale (PCS) has been validated as one of the strongest psychological predictors of pain [7, 28, 33, 34]. Pain catastrophizing is exaggerated negative thoughts during actual or anticipated painful experiences [33]. We hypothesized that the PCS would predict postoperative pain outcomes at 6 weeks, which would correlate with Riddle's 6-month findings [30]. Although, preoperative psychological distress has been documented as a predictor of pain outcome scores, little has been published on it as a predictor of narcotic usage and/or referral to a pain management service.

Level of Evidence: Level I: Prognostic study.

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The aims of this study were to identify whether patient-specific preoperative predictors including preoperative WOMAC pain score and visual analog pain scale (VAS) catastrophizing pain scores were predictive of postoperative pain scores, referral to pain management and predictors of postoperative narcotic usage.

Patients and Methods

We conducted a prospective cohort study of 100 consecutive patients who underwent primary total knee arthroplasty (TKA) for a diagnosis of osteoarthritis or posttraumatic arthritis by the senior author. Patients were enrolled in the study from May 2011 to April 2012. Exclusion criteria included a diagnosis of inflammatory arthritis, a previous ipsilateral knee arthroplasty, and failure to consent to be included in the study. Of the 100 consecutive patients recruited, 97 patients were followed up at 6 weeks for postoperative data collection. This was an institutional review board-approved study.

At preoperative consultation, patient information collected included age, height, weight, and BMI (Table 1). Preoperative narcotic usage, recorded as morphine equivalents, visual analog pain scale (VAS), WOMAC, and pain catastrophizing scale (PCS) were recorded. Patients were also asked to rate their preoperative pain tolerance on a scale from 1 to 5; with 1 signifying a low tolerance to pain and 5 being a high pain tolerance. All questionnaires were administered in person, and data was collected and recorded by research assistants with a minimum of 2 years of experience.

The PCS is a 13-item scale where scores range from 0 to 52 [33]. A score of zero indicates no catastrophizing and 52 indicate severe catastrophizing. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) is a validated instrument to follow disability and pain in TKA patients [24].

All 97 patients who were included in data analysis underwent primary TKA with Exactech Logic posterior stabilized cemented components including patellae resurfacing under spinal epidural anesthesia combined with an immediate postoperative single-injection femoral nerve block.

Postoperative physical therapy was standardized within the institution where continuous passive motion machines were utilized on the first postoperative day and the patients began ambulating on the same day with a walker and progressed as indicated. Pain was controlled for the first 24 h with the epidural and then managed with oral analgesics by an in-hospital pain management service. Coumadin was used as postoperative anticoagulation for a total of 6 weeks.

All 97 patients were seen in the clinic at 6 weeks postoperatively. During this visit, the same research assistant that recorded the preoperative data also collected VAS, WOMAC, and postoperative narcotic usage, recorded as morphine equivalents. Referral to a recuperative pain management was determined by the combination of three objective criteria: (1) lack of pain relief with oxycodone 5/325 mg (standard dose 1 to 2 tablets every 4 h), (2) failure to adequately flex the knee greater than 90°, and (3) pain-related inability to comply with the routine physical therapy protocol. Recuperative pain management is a separate service from the inpatient anesthesia pain management service which controlled all patient immediate postoperative pain during the hospital admission after the epidural was discontinued.

Patient characteristics at baseline were summarized by mean and standard deviation (SD) for continuous variables and frequency and percentage for categorical variables. Multiple logistic regressions were used to explore the relationship between preoperative PCS score and postoperative referral to pain management and narcotic usage while adjusting for age, sex, and BMI. Logistic regression results are reported as odds ratios (OR) with 95% confidence intervals (95% CI). Multiple linear regressions were employed to assess the association between preoperative PCS and change in WOMAC pain, stiffness, and function subscale scores and VAS pain score while controlling for demographic variables and corresponding preoperative score. Linear regression results are reported as β coefficients with 95% CI. The relationship between self-reported preoperative pain tolerance and postoperative referral to a pain management service and narcotic usage were assessed with Cochran-Armitage trend tests. Spearman's rank correlation coefficients (ρ) with 95% CI were calculated to examine the association between preoperative pain tolerance and improvement in WOMAC pain, stiffness, and function and VAS pain scores. All hypothesis tests were two sided with a p value <0.05 considered statistically significant. All statistical analyses were performed using SAS version 9.3 (SAS Institute, Cary, NC).

Results

Eleven of the 97 patients included in the study used preoperative narcotic analgesia. The morphine equivalent range was 3.75–15.

There was no evidence of a relationship between PCS score and odds of postoperative referral to pain management (OR 1.03, 95% CI 0.98–1.08), but a higher PCS was associated with a slight decrease in odds of postoperative opioid

Table 1 Patient demographics

	Mean	Range
Age	68	44–87
BMI	34.7	19.8–53.3
	Number	Percent
Gender		
Male	36	37.1
Female	61	68.9
Side		
Right	48	49.5
Left	33	34
Bilateral	16	16.5
Diagnosis		
OA	95	97.9
Traumatic	2	0.021

Table 2 Logistic regression models for relationship between preoperative PCS score and postoperative referral to pain management and opioid use

Outcome	Odds ratio (95% confidence interval)	<i>p</i> value
Referral to pain management		
Preop PCS	1.03 (0.98–1.08)	0.227
Age	0.93 (0.87–1.00)	0.048
Sex (male vs. female)	1.28 (0.41–3.97)	0.675
BMI	0.85 (0.74–0.97)	0.015
Opioid use		
Preop PCS	0.96 (0.93–1.00)	0.041
Age	0.95 (0.90–1.00)	0.041
Sex (male vs. female)	0.58 (0.24–1.41)	0.230
BMI	1.01 (0.94–1.08)	0.844

usage (OR 0.96, 95% CI 0.93–1.00) (Table 2). After adjusting for demographic variables and the corresponding preoperative WOMAC or VAS pain score, there was no evidence of an association between a higher preoperative PCS score and change in WOMAC pain (β -0.06, 95% CI -0.35–0.24), stiffness (β -0.24, 95% CI -0.53–0.05), function (β -0.10, 95% CI -0.38–0.18), or VAS pain (β 0.03, 95% CI -0.01–0.07) (Table 3).

A higher BMI was associated with lower odds of postoperative referral to pain management (OR 0.85, 95% CI 0.74–0.97), and higher age was also associated with lower odds of postoperative referral to pain management (OR 0.93, 95% CI 0.87–1.00) and opioid use (OR 0.95, 95% CI 0.90–1.00) (Table 2). There was also evidence of an association between male sex and a greater improvement in WOMAC

pain (β 7.78, 95% CI 1.37–14.19), stiffness (β 10.30, 95% CI 3.23–17.37), and function (β 6.60, 95% CI 0.51–12.69) (Table 3).

There was no evidence of a correlation between preoperative pain tolerance and change in WOMAC pain (ρ 0.11, 95% CI -0.09–0.31), stiffness (ρ 0.05, 95% CI -0.15–0.25), function (ρ 0.06, 95% CI -0.14–0.26), or VAS pain (ρ -0.04, 95% CI -0.24–0.16). There was no observed association between pain tolerance and the probability of being referred to pain management (p =0.636) or postoperative opioid usage (p =0.438).

Discussion

Persistent pain after total knee arthroplasty is a common problem reducing patient satisfaction [12, 18, 27, 37–39]. During the preoperative period, identifying predictors of persistent pain could lead to interventions to improve postoperative patient satisfaction. We hypothesized that an increase in preoperative VAS and PCS and a decrease in self-reported pain tolerance would predict postoperative narcotic usage, referral to recuperative pain management, and pain outcomes.

Our study has several limitations. First, our patients were followed for 6 weeks. There is substantial literature to support that patients continue to improve far past 6 weeks postoperatively [8, 17, 40]. Six weeks, however, was an ideal follow-up point in this study because we were investigating early postoperative outcomes of being referred to a recuperative pain management service, as well as postoperative narcotic usage. All patients in our practice are referred to the Recuperative Pain Management Service in the early postoperative period, and the 6-week follow-up captured these patients. Additionally, patients taper their use of narcotic pain medication in the early postoperative period, the majority being free of narcotics by the first follow-up appointment. Our goal was to identify any predictors of continuing narcotic analgesia beyond this time point. Second, we included simultaneous bilateral procedures in the analysis. This could confound our results, as some bilateral TKA patients have more pain and increased risk of complications [25, 26, 32, 36]. Third, we have a relatively small sample size compared to other similar studies [23, 30]. Despite our relatively small sample size, we were able to demonstrate lower odds of being referred to a recuperative pain management service for those with higher BMI and age as well as all categories of the PCS predicting postoperative narcotic usage. Fourth, the pain tolerance scores from 1 to 5 were self-reported. We did not use a studied and validated instrument; however, there is not one available within the literature. Our goal was to determine if a patient's self-reported baseline pain tolerance had an implication on postoperative outcomes, much like preoperative discomfort and functional status have been shown to affect outcome [35]. Fifth, each surgeon has their own threshold to refer a patient to a Recuperative Pain Management Service. If a surgeon's criteria is not similar to ours, outlined in the material and methods section, the reported findings of reduced odds of

Table 3 Linear regression models for relationship between preoperative PCS score and change in WOMAC pain, stiffness, function, and VAS pain scores

Outcome	$\hat{a}$ (95% confidence interval)	<i>p</i> value
Change in WOMAC pain		
Preop PCS	-0.06 (-0.35–0.24)	0.710
Preop WOMAC pain	-0.74 (-0.93 to -0.54)	<0.001
Age	0.24 (-0.12–0.60)	0.189
Sex (male vs. female)	7.78 (1.37–14.19)	0.018
BMI	0.01 (-0.50–0.51)	0.981
Change in WOMAC stiffness		
Preop PCS	-0.24 (-0.53–0.05)	0.103
Preop WOMAC stiffness	-0.92 (-1.09 to -0.76)	<0.001
Age	0.06 (-0.33–0.45)	0.761
Sex (male vs. female)	10.30 (3.23–17.37)	0.005
BMI	0.34 (-0.21–0.89)	0.226
Change in WOMAC function		
Preop PCS	-0.10 (-0.38–0.18)	0.497
Preop WOMAC function	-0.61 (-0.79 to -0.42)	<0.001
Age	0.20 (-0.13–0.53)	0.239
Sex (male vs. female)	6.60 (0.51–12.69)	0.034
BMI	0.34 (-0.14–0.81)	0.160
Change in VAS pain		
Preop PCS	0.03 (-0.01–0.07)	0.092
Preop VAS pain	-0.81 (-1.02 to -0.60)	<0.001
Age	-0.01 (-0.06–0.04)	0.749
Sex (male vs. female)	-0.87 (-1.78–0.04)	0.061
BMI	-0.01 (-0.08–0.07)	0.874

pain management referral for older patients and heavier patients may not have external validity.

Psychological distress had been associated with increased pain after total knee arthroplasty [1, 2, 4, 5, 15, 23, 30]. Riddle found in a similar study of 140 patients that pain catastrophizing was the only consistent psychological predictor of poor WOMAC pain outcome at 6 months [30]. Multiple other studies outside of orthopedic surgery have supported Riddle's finding that patients with a higher PCS have a worse outcomes [11, 15, 20, 21]. This is contrary to our 6-week findings that a higher catastrophizing score was associated with decreased odds of postoperative opioid usage. However, outcome measures were different between our study and others, where a higher catastrophizing score seemed to have an inverse effect on opioid usage. A higher PCS was associated with a slight decrease in odds of postoperative opioid usage (OR 0.96, 95% CI 0.93–1.00). A higher-powered study is necessary to further delineate this clinical association versus a statistical difference without clinical consequence.

Our finding of increasing age and BMI being associated with lower odds of being referred to a recuperative pain management service complements published studies [3, 6, 16, 29, 31]. These studies found increasing age to be associated with decreased postoperative pain scores as well as reduced use of postoperative opioids. Our findings complement these studies in that patients with reduced pain scores are less likely to need a referral to a recuperative pain management service. Our finding of lower odds of postoperative referral to pain management and opioid usage with increasing age must be further evaluated with a higher-powered study to determine the clinical impact on this statistical difference.

We hypothesized preoperative self-reported pain tolerance would predict postoperative pain, evaluated by a change in WOMAC and VAS pain scores. This is the first report of data of this kind within the literature. We found that self-reported pain tolerance failed to correlate with reduced pain. This non-association would need replication in a larger study, but may indicate that many patients cannot accurately predict the relative extent of their postoperative pain.

Our findings suggest that older and heavier patients are less likely to be referred to a pain management service after total knee arthroplasty. Elderly patients as well as patients with high PCS are less likely to use opiates in the immediate postoperative period. Preoperative self-reported pain tolerance is not predictive of change in pain outcomes 6 weeks after total knee arthroplasty as hypothesized. Preoperative screening with the pain catastrophizing score may facilitate postoperative pain and assist the surgeon in counseling their patients as to postoperative expectations after total knee arthroplasty.

Disclosures

Conflict of Interest: Trevor R. Banka, MD, Allison Ruel, BA, Kara Fields, MS and Jacques YaDeau, MD, PhD have declared that they have no conflict of interest. Geoffrey Westrich, MD is a board member of Eastern Orthopaedic Association and Knee Society and employee at

Exactech, Stryker, and DJO and receives payments for development of educational presentations from Exactech, Stryker, and DJ and research support from Exactech and Stryker, outside the work.

Human/Animal Rights: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Informed Consent: Informed consent was obtained from all patients for being included in the study.

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

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