Fibromyalgia Survey Criteria Are Associated with Increased Postoperative Opioid Consumption in Women Undergoing Hysterectomy

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ABSTRACT

Background: The current study was designed to test the hypothesis that the fibromyalgia survey criteria would be directly associated with increased opioid consumption after hysterectomy even when accounting for other factors previously described as being predictive for acute postoperative pain.

Methods: Two hundred eight adult patients undergoing hysterectomy between October 2011 and December 2013 were phenotyped preoperatively with the use of validated self-reported questionnaires including the 2011 fibromyalgia survey criteria, measures of pain severity and descriptors, psychological measures, preoperative opioid use, and health information. The primary outcome was the total postoperative opioid consumption converted to oral morphine equivalents.

Results: Higher fibromyalgia survey scores were significantly associated with worse preoperative pain characteristics, including higher pain severity, more neuropathic pain, greater psychological distress, and more preoperative opioid use. In a multivariate linear regression model, the fibromyalgia survey score was independently associated with increased postoperative opioid consumption, with an increase of 7-mg oral morphine equivalents for every 1-point increase on the 31-point measure (Estimate, 7.0; Standard Error, 1.7; P < 0.0001). In addition to the fibromyalgia survey score, multivariate analysis showed that more severe medical comorbidity, catastrophizing, laparotomy surgical approach, and preoperative opioid use were also predictive of increased postoperative opioid consumption.

Conclusions: As was previously demonstrated in a total knee and hip arthroplasty cohort, this study demonstrated that increased fibromyalgia survey scores were predictive of postoperative opioid consumption in the posthysterectomy surgical population during their hospital stay. By demonstrating the generalizability in a second surgical cohort, these data suggest that patients with fibromyalgia-like characteristics may require a tailored perioperative analgesic regimen.

What We Already Know about This Topic
- Higher scores on the survey criteria for fibromyalgia questionnaire have been shown to predict increased opioid consumption after arthroplasty although the generalizability of this has not been tested.

What This Article Tells Us That Is New
- In 208 women undergoing hysterectomy, higher scores on a fibromyalgia survey were independently associated with increased opioid consumption after accounting for known risk factors.
- This fibromyalgia survey may be useful in identifying individuals at high risk for increased opioid consumption after surgery.

Pain after hysterectomy is a major issue contributing to patient discomfort, decreased patient satisfaction, risk for postoperative morbidity and mortality, and increasing medical costs due to extended hospital stays. It has been estimated that there are 433,621 hysterectomies performed each year in the United States, of which 12 to 17% are done for chronic pelvic pain. With a large number of cases performed annually and the possibility of same-day discharge for some patients undergoing hysterectomy, there are economic and patient-safety implications in determining ways to avoid postoperative pain and any factors that lengthen hospital stays. It has been shown in a multicentered, retrospective study that factors predictive of severe acute postoperative pain include younger age, female sex, increased body mass index, preoperative surgical site pain severity, preoperative use of opioids, and general anesthesia. Cognitive factors and pain coping strategies, such as pain catastrophizing, and mood disorders such as depression and anxiety have also been shown to influence acute pain in patients undergoing hysterectomy.
Fibromyalgia is a commonly studied pain disorder, which is associated with aberrant central pain processing. Fibromyalgia is associated with higher levels of central nervous system neurotransmitters that facilitate pain and lower levels of those that down-regulate pain. In addition, fibromyalgia patients have higher endogenous opioids levels with lower opioid receptor availability, which could hypothetically make them less responsive to opioids. In 2011, the fibromyalgia survey criteria were described for use in lieu of the 1990 criteria, which included a tender point examination. Although not intended to be used for diagnosing fibromyalgia without a clinical evaluation, it has been suggested that these criteria can be used in an epidemiological manner. Our group previously demonstrated that the survey criteria for fibromyalgia independently predicted increased opioid consumption after total hip and knee arthroplasty, even when controlling for other predictors such as demographics, preoperative pain intensity, mood, anxiety, catastrophizing, anesthesia type, and surgery. Whereas higher fibromyalgia survey scores were predictive of increased opioid consumption in arthroplasty, it is not known whether a fibromyalgia-like phenotype would also predict increased opioid consumption in other surgical cohorts, such as patients undergoing hysterectomy. It is important to demonstrate the generalizability of this finding among a separate surgical cohort to increase acceptance of the preoperative fibromyalgia score in clinical decision making. The objective of this prospective, observational cohort study was to assess the impact of the fibromyalgia score on acute pain outcomes in subjects undergoing hysterectomy. We hypothesized that higher fibromyalgia survey scores would predict higher postoperative opioid consumption after hysterectomy. Length of stay was studied as a secondary outcome. These data could help to establish preoperative algorithms that personalize pain medicine to the individual patient phenotype rather than using the current care patterns that are dictated primarily by the surgical condition and not tailored based on patient characteristics.

Materials and Methods

Institutional review board (University of Michigan, Ann Arbor, Michigan) approval was obtained. Adult patients (218 yr old) scheduled for hysterectomy for a benign indication between October 2011 and December 2013 were prospectively recruited on the day of surgery in the preoperative waiting area. No power analysis was performed when the study was planned. All patients recruited during the period of the study were considered for inclusion subject to the exclusion criteria and availability of the measurements required for the analysis. Exclusion criteria included inability to provide written informed consent, non-English speakers, and prisoners. Written informed consent was obtained from all participants. Study reporting conforms to the STReNGTHening the Reporting of Observational studies in Epidemiology Statement.

Phenotyping Battery

Patients completed preoperative phenotyping using validated self-report measures. The primary measure of interest was the 2011 fibromyalgia survey criteria. The fibromyalgia survey is composed of the number of painful body areas assessed by using the Michigan Body Map (0 to 19) and comorbid symptoms such as fatigue, trouble thinking, and headaches assessed by using the Symptom Severity Index (0 to 12). Hence, the total fibromyalgia score ranges from 0 to 31. The measure has demonstrated good reliability, convergent validity, and discriminant validity. Previous cut points have been described to categorize a person as “fibromyalgia positive”; however, the continuous score was used for the analyses in the current study. Additional phenotyping included pain severity (Brief Pain Inventory; 0 to 10 composite score using the mean of the average, least, worst, and pain right now; overall body pain and surgical site pain assessed separately); neuropathic pain descriptors (Pain DETECT), anxiety and depression (Hospital Anxiety and Depression Scale), and catastrophizing (Coping Strategies Questionnaire). The medication list from the preoperative records was printed and reviewed with the patient by a research assistant. All medications administered as needed were reviewed in detail to ensure the ability to differentiate the varied patterns of opioid use (e.g., differentiating patient who uses one hydrocodone per week from the person who takes three daily). The average daily opioid consumption was converted to a 24-h oral morphine equivalent (OME) total. Opioids administered by the anesthesiology team before and during surgery were also converted to OMEs as a covariate. Demographics, body mass index, and American Society of Anesthesiologists (ASA) physical status score were collected from the electronic medical record (Centricity; General Electric Healthcare, USA). Because all patients received general anesthesia, the anesthetic technique was not assessed. The surgical approach was recorded as vaginal, laparoscopic, robotic, or open.

Acute Pain Outcomes Assessment

The total postoperative opioid consumption (primary outcome) was obtained from the institutional electronic order entry system (Carelink*) and nursing records throughout in the postanesthesia care unit and the inpatient course, as previously described by Brummett et al. Opioid use in the postanesthesia care unit was assessed separately and included in the total postoperative opioid consumption (combined with opioids administered after the postanesthesia care unit). All opioid data (preoperative, intraoperative, and postoperative) were converted to morphine equivalents (OME) for analyses. The length of stay was included as a covariate for postoperative opioid consumption to account for differences in opioids that were merely due to longer inpatient stays.

The cohort was also prospectively followed longitudinally for 6 months for chronic pain outcomes, which are
not included in the current article. The opioid consumption data represent the primary outcome analysis for the acute pain portion of this prospective, observational cohort study.

**Statistical Analysis**

Data were entered into the Assessment of Pain Outcomes Longitudinal Electronic Data Capture system. Missing data for the validated instruments were handled as recommended by instrument authors and further described in a previous publication. Other missing data were handled as described by the authors of each individual instrument. For the Brief Pain Inventory and PainDETECT tools, if patients were missing more than one item, the subject was excluded. For the Hospital Anxiety and Depression Scale, anxiety and depressive symptom scores, a single value for the missing item was inferred by imputation of the mean if six of the seven values were present. For all other tools, one missing question was allowed. Patients were not excluded for having one incomplete questionnaire.

Data were analyzed by using R 3.1.1 and SPSS (version 19; SPSS Inc., USA).

The cohort was divided into tertiles based on the estimates of 1/3 and 2/3 percentiles of the distribution of the fibromyalgia survey score for descriptive data and univariate outcomes analyses. Mean and SDs are presented for preoperative covariates. Between-groups comparisons were based on univariate models specific to the scale of the variable being considered (linear regression with continuous data, logistic with binary data). Histograms and Q–Q plots were examined to assess normality. Nonparametric analysis of the overall differences by group was performed by using the Kruskal–Wallis test. Bonferroni adjustment for multicomparisons was used in reporting the statistical significance of test results.

Total postoperative opioid consumption throughout the entire postoperative course was converted into OMEs for outcomes analyses. Multivariate linear regression models were used to analyze postoperative opioid consumption. All preoperative covariates, as well as intraoperative opioid administration and length of stay, were included as covariates in the multivariate modeling. Model-based hypotheses testing and a search for the best parsimonious model (variable selection) were performed using likelihood ratio tests and the Bayesian Information Criterion (BIC). BIC is preferred in the theory-based approach as it provides consistent estimates of the true model. Furthermore, a 10-fold cross-validation procedure was conducted to provide an assessment of model’s performance in future observations and predict shrinkage effects when the model is applied out-of-sample. The variable selection procedure was included in the cross-validation loop and was done anew for each training subset of the data. Models were conducted with missing data on relevant data excluded. Backward search for the best model was conducted starting from all variables included in the initial full model and supervised by medical experts within the limits of uncertainty allowed by the technical procedure. Interactions were tested by the likelihood ratio tests. Two-sided tests and 0.05 significance levels were used throughout.

**Results**

**Subject Participation and Demographics**

A total of 208 patients of the 307 patients approached agreed to participate (68% participation rate). In analysis of participants versus nonparticipants, there were significant differences for age (participants 47.6 yr vs. nonparticipants 50.4 yr; \( P = 0.033 \)) and race (84.6% Caucasian; \( P < 0.0001 \)). One patient withdrew on the day of surgery, one patient was excluded from analysis due to additional surgeries during the same admission, and three patients were excluded because they did not undergo the planned hysterectomy and instead underwent a different procedure as outlined in the flowchart (fig. 1). Regarding missing data, eight patients of the 203 analyzed were missing data for the fibromyalgia survey score and were not included in the analysis. Data from 195 patients were analyzed.

**Preoperative Phenotype and Outcomes by Tertile of Fibromyalgia Survey Score**

A histogram of fibromyalgia scores is shown in figure 2. The mean fibromyalgia score for the entire cohort was 6.5 (±4.4) with a range of 0 to 24. A total of 17 patients (8.2%) met the previously described cut points of being termed “fibromyalgia positive.” The subjects were divided into tertiles based on fibromyalgia survey score (low, 0 to 4, \( n = 68 \); moderate, 5 to 7, \( n = 59 \); and high, 8 to 24, \( n = 68 \)). As shown in table 1, there were no significant differences in age, race, body mass index, surgical approach, or ASA physical status score between fibromyalgia score tertiles. In addition, there were differences in surgical site body pain, overall body pain, depressive symptoms, anxiety, and catastrophizing between all groups (\( P < 0.0001 \) for all listed). Patients in the high fibromyalgia group were taking more daily opioids preoperatively and were on a higher average opioid dose (OME) when compared with the low and moderate groups (\( P < 0.01 \) for each comparison).

There was an increase in postoperative opioid consumption between low versus high fibromyalgia score groups (\( P = 0.013 \)) as seen in table 2. Figure 3 demonstrates the scatterplot of total postoperative opioid consumption and the fibromyalgia survey score. Length of stay was not significantly different between groups (table 2).

**Fibromyalgia Survey Score Independently Associated with Postoperative Opioid Consumption**

The primary outcome, postoperative opioid consumption, was positively associated with the continuous fibromyalgia survey score in the multivariate linear regression model (\( P < 0.0001 \)). Multivariate analysis also showed that higher ASA physical status score, catastrophizing, laparotomy surgical approach, and preoperative opioid consumption were
all predictive of increased postoperative opioid consumption (table 3). Backward variable selection using likelihood ratio tests and the BIC-based model selection procedure resulted in one and the same best model with $\text{BIC} = 2,231$ presented in table 3. Over the set of cross-validation runs, the best variables presented in table 3 were selected 80 to 100% of the time, whereas selection frequency of other variables did not exceed 10%. Shrinkage from the raw $R^2$ of 0.53 based on the best model to the cross-validated $R^2$ of 0.35 was observed. The linear regressions with the log-transformed response were also considered. However, there was no improvement in fit as judged by the plots of residuals. The results of modeling without the transformation were confirmed, and the fibromyalgia survey score still was statistically significantly correlated with postoperative opioid use (data not shown).

**Discussion**

**The Fibromyalgia Survey Score Predicts Increased Postoperative Opioid Use**

This study demonstrated that increased fibromyalgia survey scores are predictive of increased postoperative opioid use after hysterectomy. These data support the findings by Brummett et al., which showed this survey score as independently associated with increased postoperative opioid consumption in total hip and knee arthroplasty cohorts, and support the fact that the fibromyalgia survey score is more broadly useful in predicting opioid consumption after surgery. Each 1-point increase on the 31-point fibromyalgia survey score was associated with an adjusted increase of almost 7-mg oral morphine in the postoperative inpatient period (table 3), which is close to the estimated 9 mg OME increase in the total knee and hip arthroplasty cohort.

The use of the fibromyalgia survey criteria in a surgical cohort represents a relatively novel approach to predicting postoperative pain and opioid consumption. It is important to stress that this is not a cohort of fibromyalgia patients. Instead, the current study assessed the spectrum of signs and symptoms associated with fibromyalgia as a means to place patients on a continuum of sensitivity. Based on that which is known about fibromyalgia, our group believes that patients higher on this measure represent a population with pain that is more “centralized” in nature (e.g., altered central nervous system pain processing). Not surprisingly, the fibromyalgia survey scores in this cohort are much lower than a pure fibromyalgia cohort. In the 2011 survey criteria for fibromyalgia, patients were classified as “fibromyalgia positive” if their scores were widespread body pain 7 or greater (score ranges 0 to 19, body map assessment) and symptom severity index 5 or greater (score range 0 to 12) or widespread pain index of 3 to 6 and symptom severity index 9 or greater. More simply, a total score of 13 or greater has also been termed positive for fibromyalgia. The validity of the survey criteria in a fibromyalgia cohort when compared with the 1990 American College of Rheumatology criteria (which included the tender point examination) has been established. Preoperative diagnoses of fibromyalgia were not assessed, as the diagnosis can be influenced by patients’ access to health care and the treating physician. Whether the strength of these relations would be stronger in a “pure” fibromyalgia cohort is challenging to estimate.
Table 1. Preoperative Pain Phenotype Based on Fibromyalgia Survey Score Divided into Low, Medium, and High Scores

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Low FM FM Score 0–4</th>
<th>Moderate FM FM Score 5–7</th>
<th>High FM FM Score 8–24</th>
<th>P Value (Regression for Overall Group)</th>
<th>P Value (Low FM vs. Moderate FM)</th>
<th>P Value (Low FM vs. High FM)</th>
<th>P Value (Moderate FM vs. High FM)</th>
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</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>49.6 (10.71)</td>
<td>46.27 (8.12)</td>
<td>45.76 (10.15)</td>
<td>0.050</td>
<td>0.057</td>
<td>0.023</td>
<td>0.772</td>
</tr>
<tr>
<td>Race (% Caucasian)</td>
<td>83.8</td>
<td>89.8</td>
<td>85.3</td>
<td>0.600</td>
<td>0.321</td>
<td>0.812</td>
<td>0.442</td>
</tr>
<tr>
<td>Preoperative pain, affect, function</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical site body pain†</td>
<td>0.51 (1.48)</td>
<td>1.60 (2.10)</td>
<td>2.47 (2.75)</td>
<td>&lt;0.0001</td>
<td>0.005*</td>
<td>&lt;0.0001*</td>
<td>0.025</td>
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<tr>
<td>Overall body pain</td>
<td>1.19 (1.71)</td>
<td>2.06 (1.77)</td>
<td>3.84 (2.24)</td>
<td>&lt;0.0001</td>
<td>0.012*</td>
<td>&lt;0.0001*</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>Depressive symptoms†</td>
<td>2.12 (2.58)</td>
<td>3.21 (3.11)</td>
<td>6.09 (3.63)</td>
<td>&lt;0.0001</td>
<td>0.058</td>
<td>&lt;0.0001*</td>
<td>&lt;0.0001*</td>
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<tr>
<td>Anxiety</td>
<td>5.2 (4.13)</td>
<td>6.75 (3.73)</td>
<td>8.43 (4.16)</td>
<td>&lt;0.0001</td>
<td>0.036</td>
<td>&lt;0.0001*</td>
<td>0.022</td>
</tr>
<tr>
<td>Catastrophizing†</td>
<td>2.52 (4.01)</td>
<td>3.91 (4.89)</td>
<td>7.20 (6.19)</td>
<td>&lt;0.0001</td>
<td>0.144</td>
<td>&lt;0.0001*</td>
<td>0.001*</td>
</tr>
<tr>
<td>Preoperative opioids (% taking opioids)</td>
<td>8.82</td>
<td>8.47</td>
<td>23.53</td>
<td>0.016</td>
<td>0.944</td>
<td>0.020</td>
<td>0.203</td>
</tr>
<tr>
<td>Preoperative opioid average daily dose (OME, mg)†</td>
<td>0.628 (2.66)</td>
<td>0.838 (3.72)</td>
<td>5.67 (17.15)</td>
<td>0.008</td>
<td>0.910</td>
<td>0.005*</td>
<td>0.010*</td>
</tr>
<tr>
<td>Medical, anesthetic, and surgical variables</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>28.52 (6.41)</td>
<td>30.22 (6.33)</td>
<td>29.98 (7.19)</td>
<td>0.288</td>
<td>0.153</td>
<td>0.203</td>
<td>0.840</td>
</tr>
<tr>
<td>ASA status (% per group)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASA score 1 and 2</td>
<td>95.6</td>
<td>89.8</td>
<td>83.8</td>
<td>0.143</td>
<td>0.30</td>
<td>0.050</td>
<td>0.321</td>
</tr>
<tr>
<td>ASA score 3 and 4</td>
<td>4.4</td>
<td>10.2</td>
<td>16.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Surgical approach (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional laparoscopy</td>
<td>25.0</td>
<td>35.6</td>
<td>41.2</td>
<td>0.249</td>
<td>0.592</td>
<td>0.087</td>
<td>0.237</td>
</tr>
<tr>
<td>Robotic (Davinci)</td>
<td>26.5</td>
<td>20.3</td>
<td>27.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laparotomy</td>
<td>13.2</td>
<td>13.6</td>
<td>4.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaginal and LAVH</td>
<td>35.3</td>
<td>30.5</td>
<td>26.5</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

Patients in the high fibromyalgia survey score group had significantly worse preoperative pain characteristics, including higher pain severity, more neuropathic pain, greater psychological distress, and more preoperative opioid use compared with the low fibromyalgia score group. Data presented as mean (SD) if continuous, or proportions (%) if categorical. Statistics and P values are regression model based with fibromyalgia tertile group as a categorical covariate. Model is linear for continuous response and logistic for binary. First P value represents the overall regression result, and the individual between group comparisons are noted in the P values to follow. Unadjusted P values are presented. Statistical significance for overall regression results set at the level of P < 0.05.

* Significant comparisons for post hoc analyses using Bonferroni-corrected α of 0.016. † Variable is not normally distributed. Nonparametric analyses conducted for nonnormally distributed data using the Kruskal-Wallis test. Results relatively unchanged in nonparametric approaches (nonparametric data not shown).

ASA score = American Society of Anesthesiologists physical status score; FM = fibromyalgia survey score; LAVH = Laparoscopic-assisted vaginal hysterectomy; OME = oral morphine equivalents measured in milligram.
Fibromyalgia Score Predicts Acute Opioid Use

Whereas only 8.2% of this cohort met these criteria of being termed “fibromyalgia positive,” the associations between the increased fibromyalgia score and opioid consumption were demonstrated across the continuum of scores in the multivariate modeling (table 3). These data further underscore the importance of assessing patients who are sometimes termed “subclinical” or “subthreshold,” as the defined cut points fail to account for the middle of the distribution. Our group is interested in larger studies of a broader group of surgical cohorts to try to consider thresholds above which patients tend to require more opioids or have differential perioperative outcomes. In clinical care, it is more likely that higher scores on the measure would trigger deeper phenotyping and assessment to consider appropriateness of alternative acute pain treatments, whereas patients lower on the measure could get a more typical perioperative algorithm.34

Fibromyalgia from a Physiologic Perspective

It has been shown that patients with fibromyalgia have lower μ-receptor availability,14 and higher endogenous opioid levels (cerebrospinal fluid levels),13 compared with those without fibromyalgia. A study by Bruehl et al.35 found that individuals with preexisting high endogenous opioid function had a smaller benefit from morphine administration than those with lower opioid function, with individual differences in endogenous opioids accounting for 29% of the variance in responsiveness to opioids in the acute setting. The degree of endogenous opioid function was determined by finding the difference between pain values after administration of placebo and administration of naloxone, an opioid receptor antagonist.36 This same group investigated chronic pain as well and found that those with lower natural opioid levels had better acute relief from morphine in the treatment of chronic back pain than those patients found to have higher endogenous opioid levels.35

These physiologic findings may have great clinical significance in guiding how clinicians treat pain in this population of patients. It has long been believed that opioids are less effective in fibromyalgia patients due to these known central nervous system physiologic abnormalities.9 In this study, we attempted to capture these biological differences at a phenotypic level through the fibromyalgia survey score. The identification of this patient population exhibiting fibromyalgia-like symptoms, paired with data showing that this group of patients has a decreased response to opioid medications, may allow clinicians to use a simple phenotypic battery to practice personalized pain medicine. The fibromyalgia survey score may serve as a biomarker for an individual’s endogenous opioid tone and may therefore predict their response to exogenous opioids. Future studies including imaging and prospective follow-up are needed to better elucidate the clinical applicability of the findings.

Clinical Applicability of the Fibromyalgia Survey Score

Validation of the fibromyalgia survey score in a second surgical cohort increases the clinical applicability of this scoring system in practice. The importance of demonstrating generalizability of predictive modeling was described in a recent editorial by Drs. Eisenach and Houle.37 This survey is an easily

Table 2. Postoperative Opioid Consumption and Length of Stay Outcomes by Tertile of Fibromyalgia Survey Scores

| Tertile | Low FM | Moderate FM | High FM | P Value
| FM Score 0–4 | FM Score 5–7 | FM Score 8–24 | (Regression for Overall Group) | (Low FM vs. Moderate FM) | (Low FM vs. High FM) | (Moderate FM vs. High FM) |
|----------|---------|-------------|---------|------------------|
| FM Score 0–4 | n = 68 | 72.3 (80.3) | 79 (76.0) | 93 (79.7) | 0.019 | 1.000 | 0.013* | 0.018 |
| FM Score 5–7 | n = 59 | | | | | | |
| FM Score 8–24 | n = 68 | | | | | | |

Univariate analyses demonstrated higher total postoperative opioid consumption in the high vs. the low groups. Patients in the high fibromyalgia score group did not have a significantly longer inpatient course compared with patients in the low group. Data presented as median (IQR) for total postoperative OME (mg) and mean (SD) for length of stay. Statistics and P values are regression model based with fibromyalgia tertile group as a categorical covariate for length of stay. Nonparametric Kruskal–Wallis test P values are presented for total postoperative OME (mg). The first P value represents the overall regression result, and the individual between-group comparisons are noted in the P values to follow. Unadjusted P values are presented.

* Statistically significant result. For post hoc between-group analyses, a Bonferroni correction was applied (α of 0.016).

FM = fibromyalgia survey score; OME = oral morphine equivalents measured in milligram.

Fig. 3. Scatterplot of opioid consumption and the fibromyalgia survey score. The figure shows the scatterplot of the preoperative fibromyalgia survey score (measure ranges from 0 to 31) and total inpatient postoperative opioid consumption in oral morphine equivalents (OME).
administered tool that can better prepare providers for the postoperative course of a patient at the individual level allowing for a personalized care plan. It is possible that patients with higher fibromyalgia survey scores would receive substantial benefit from regional analgesia and/or adjunct pharmacological therapies (e.g., serotonin–norepinephrine reuptake inhibitors, gabapentinoids). This one-page survey would be a simple and clinically relevant tool to administer before surgery to aid in development of the anesthetic and pain management plan. Although the measure does a good job of distinguishing patients with worse preoperative phenotypes and independently predicts increased opioid consumption, there are patients higher on the measure that do well (fig. 3). It is possible that additional domains of pain and affect need to be included to increase the predictive value of the measure. Our group is currently exploring these concepts.

It is also possible that patients who are more fibromyalgia-like would benefit from adjunctive medications that go beyond the acute, inpatient period to further address subacute pain after hospital discharge. Aiding surgeons in the identification of patients prone to more severe acute pain and creating individualized care plans is an opportunity for anesthesiologists to add value in the Perioperative Surgical Home model.†

**Additional Predictors of Postoperative Opioid Use**

Additional predictors of increased postoperative opioid consumption include higher ASA class, catastrophizing, laparotomy surgical approach, and preoperative opioid use. The laparotomy surgical approach being a predictor of increased opioid consumption is clinically relevant to obstetricians and gynecologists in their surgical decision making for each patient. Because this surgical approach is predictive of increased opioid use, providers should attempt to use alternative surgical approaches unless otherwise contraindicated.

**Limitations**

This study is limited in that it is a single-center study and therefore is limited by our institutional guidelines, patient population, and surgeon preferences and techniques. Further studies with multiple centers would add generalizability of the fibromyalgia survey criteria and its clinical application. In this study, we used postoperative OME consumption as a proxy variable for postoperative pain, and we were unable to collect individual pain scores for each patient due to inconsistent recording in the patient record. Opioid consumption is not likely a perfect proxy for the severity of pain. In the future, we plan to prospectively collect pain score data.

**Conclusions**

As was previously demonstrated in a total knee and hip arthroplasty cohort, this study demonstrated that increased fibromyalgia survey scores were predictive of postoperative opioid consumption in the posthysterectomy surgical population during their hospital stay. This finding reiterates that the fibromyalgia survey score is an important clinical tool that can be used to detect phenotypic differences in patients with centralized pain syndromes, such as fibromyalgia, and better treat pain in the postoperative period.

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Table 3. Best-fit Linear Regression of the Multivariate Analysis of Postoperative Opioid Consumption

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>65.063</td>
<td>13.017</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Fibromyalgia survey score</td>
<td>6.952</td>
<td>1.662</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>ASA class 3 or 4</td>
<td>−48.489</td>
<td>21.397</td>
<td>0.02</td>
</tr>
<tr>
<td>Brief Pain Inventory severity</td>
<td>−10.063</td>
<td>3.261</td>
<td>0.002</td>
</tr>
<tr>
<td>Anxiety (HADS)</td>
<td>−5.427</td>
<td>1.726</td>
<td>0.002</td>
</tr>
<tr>
<td>Catastrophizing</td>
<td>4.464</td>
<td>1.460</td>
<td>0.003</td>
</tr>
<tr>
<td>Surgical approach of laparotomy</td>
<td>197.949</td>
<td>20.385</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Preoperative opioids (OME, mg)</td>
<td>5.491</td>
<td>0.627</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

The fibromyalgia survey score was independently associated with an increased postoperative opioid consumption, with an increase of 7-mg oral morphine equivalents for every 1-point increase on the 31-point measure. In addition to the fibromyalgia survey score, multivariate analysis showed that higher ASA class, catastrophizing, laparotomy surgical approach, and preoperative opioid use were also predictive of increased postoperative opioid consumption ($R^2 = 0.534$). Multivariate analysis was performed with total inpatient postoperative opioid consumption (converted to OME) as the dependent measure and the best linear regression model is shown above. Estimates and standard error are listed. ASA class = American Society of Anesthesiologists physical status classification system; HADS = Hospital Anxiety and Depression Scale; OME = oral morphine equivalents measured in milligram.
Competing Interests
Dr. Clauw is a consultant for Pfizer, Inc. (New York, New York), Johnson and Johnson (New Brunswick, New Jersey), Forest Pharmaceuticals (New York, New York), Merck (Whitehouse Station, New Jersey), Nuvo Research, Inc. (Mississauga, Ontario, Canada), Eli Lilly, Inc. (Indianapolis, Indiana), Grunenthal Pharma Ltd. (Dublin, Ireland), Jazz Pharmaceuticals, Inc. (Palo Alto, California), and Purdue Pharma (Stanford, Connecticut). The other authors declare no competing interests.

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John Bonica’s Presentation Copy to Capt. Thomas Robbins

Before chairing the Department of Anesthesiology in 1960 at the University of Washington, Dr. John J. Bonica directed “Departments of Anesthesia” at Tacoma General Hospital and Pierce County Hospital. For trainees at those facilities, Dr. Bonica bound (left and middle) typewritten pages into a red volume titled Manual of Anesthesiology for Medical Students, Interns, and Residents. Anesthesia mentor Bonica presented this manual “with very best wishes” (right) to a Captain Thomas Robbins. After I won this presentation volume on an internet auction, I decided to donate this “manual” to the Wood Library-Museum in memory of another Bonica disciple, Richard G. Black, M.D., who mentored me patiently for 6 months on pain management and regional anesthesia for the elderly, during my Hopkins–National Institutes of Health fellowship in geriatric anesthesiology. (Copyright © the American Society of Anesthesiologists, Inc.)

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