Original Article

Prospective relation between catastrophizing and residual pain following knee arthroplasty: Two-year follow-up

Michael E Forsythe MD1, Michael J Dunbar MD FRCS PhD2, Allan W Hennigar BSc2, Michael JL Sullivan PhD3, Michael Gross MD FRCS2

BACKGROUND: Pain is the primary indication for both primary and revision total knee arthroplasty (TKA); however, most arthroplasty outcome measures do not take pain into account.

OBJECTIVE: To document the prospective pain experience following TKA, with subjective pain-specific questionnaires to determine if comorbidities, preoperative pain or preoperative pain catastrophizing scores are predictive of long-term pain outcomes.

METHODS: Fifty-five patients with a primary diagnosis of osteoarthritis of the knee, who were scheduled to undergo TKA, were asked to fill out the McGill Pain Questionnaire (MPQ) and the Pain Catastrophizing Scale (PCS) preoperatively and at three, 12 and 24 months follow-up. Comorbidities were extracted from the Queen Elizabeth II Health Sciences Centre health information system.

RESULTS: The overall response rate (return of completed questionnaires) was 84%. There was a significant decrease in the MPQ scores (P<0.05) postoperatively. PCS scores did not change over time. Receiver operating characteristic curves revealed the number of comorbidities per patient predicted the presence of pain postoperatively (P<0.05). Preoperative PCS scores and comorbidities were significantly higher in the persistent pain group (P<0.05).

CONCLUSIONS: The number of comorbidities predicted the presence of pain at 24 months follow-up and, for the first time, preoperative PCS scores were shown to predict chronic postoperative pain. This may enable the identification of knee arthroplasty patients at risk for persistent postoperative pain, thus allowing for efficient administration of preoperative interventions to improve arthroplasty outcomes.

Key Words: Catastrophizing, Comorbidity, Helplessness, Knee, Osteoarthritis, Outcomes, Pain, Ruminations, Surgery, Total knee arthroplasty

Arthritis is the leading cause of disability in North America (1). Osteoarthritis (OA) is the most common form of arthritis, affecting approximately 21 million people in the United States and three million people in Canada (1,2). In advanced stages of the disease, joint deterioration can lead to significant pain and limitations of function. Patients with severe symptomatic OA of the knee may be considered candidates for knee replacement surgery (total knee arthroplasty...
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Research over the past three decades has highlighted the importance of psychological factors as contributors to pain experience (16-18). Research attention turned to psychological variables associated with pain when it became evident that physical variables accounted only for modest variance in pain outcomes (19,20). The term ‘pain catastrophizing’ has been used to describe a response style to painful experiences that is likely to be associated with negative pain outcomes (21). Pain catastrophizing is characterized by a tendency to focus excessively on pain sensations (ie, rumination), to exaggerate the threat value of pain sensations (ie, magnification) and to perceive oneself as being unable to control pain symptoms (ie, helplessness) (22). Recent reviews of the literature have identified pain catastrophizing as one of the most robust psychological predictors of pain experience (22,23). A relation between catastrophizing and pain intensity was demonstrated in more than 600 studies across a wide range of clinical and experimental conditions (22,24).

Although the relation between catastrophizing and pain experience has been shown to be robust, the prognostic value of measures of catastrophizing for the development of chronic pain following TKA has not been systematically investigated. The majority of studies conducted to date have been cross-sectional in design (19). As such, whether catastrophizing is an ‘antecedent’ or ‘consequence’ of heightened pain experience following TKA cannot be determined with any certainty.

Roth et al (25) recently reported on the prognostic value of a measure of catastrophizing for perioperative pain following TKA. In the latter study, catastrophizing was assessed the day before surgery and was used to predict pain severity during the first three days following surgery. Although significant relations between catastrophizing and pain emerged ‘within’ each test point, preoperative pain catastrophizing did not predict postsurgical pain (25). It is possible that the effects of pain medication, which are likely to be administered to a significant degree in the period immediately following surgery, may have obscured the relation between presurgical catastrophizing and postsurgical pain.

There is a basis nevertheless for considering that catastrophizing may predict long-term or chronic pain. Research on health outcomes associated with musculoskeletal conditions supported the prognostic role of catastrophizing for the development of chronic pain (23,26-28). There is also a growing amount of literature reporting that the determinants of acute postsurgical pain may differ in important ways from the determinants of chronic pain (29-31). It is possible that the adverse effects of catastrophizing on pain experience following TKA may only emerge over an extended period of time.

In the present study, patients scheduled for TKA with a primary diagnosis of OA were asked to complete a measure of catastrophizing and pain before surgery, and again at three, 12 and 24 months postoperatively. The primary questions addressed by the present research were whether preoperative pain, preoperative catastrophizing scores and comorbidities predicted the persistence of long-term pain symptoms following surgery.

METHODS
Participants
After appropriate ethics board approval, 55 consecutive patients booked for elective TKA agreed to participate in the present study between January 1999 and January 2000, at the Queen Elizabeth II Health Sciences Centre in Halifax, Nova Scotia. Seventy patients were approached for the study, yielding an approximate enrollment rate of 79%. The mean age of the patient sample was 69.0 years, with a range of 49 to
85 years; there were 35 women (64%) and 20 men (36%). Male and female age distributions were similar.

Measures
Catastrophizing: The Pain Catastrophizing Scale (PCS [21]) was used to assess catastrophic thinking associated with pain. On the PCS, participants rate how frequently they experience each of 13 thoughts or feelings while they are in pain. Ratings are made on five-point scales, with the end points being 0 (not at all) and 4 (all the time). The PCS yields a total score (PCS-T) and three subscale scores assessing ruminating (PCS-R), magnification (PCS-M) and helplessness (PCS-H). The PCS subscales were shown to have adequate to high internal consistency (Cronbach's alphas: PCS-T, 0.87; PCS-R, 0.87; PCS-M, 0.66; and PCS-H, 0.78) (21).

Pain: The McGill Pain Questionnaire (MPQ) consists of 15 adjectives describing sensory, affective and evaluative aspects of pain experience. Patients rate the adjectives (Pain Rating Index [PRI]) that best describe their current pain with a four-point scale, with end points of 0 (none) and 3 (severe) (32). Patients also rate their present pain intensity on a visual analogue scale (VAS) and the overall intensity of their total pain experience on a numerical rating scale, with the end points 0 (no pain) and 10 (excruciating pain).

Comorbidities: Comorbidities for each patient were extracted from the charts and coded using the International Classification of Diseases, 9th revision, Clinical Modification (ICD-9) system. Data were then obtained from the Queen Elizabeth II Health Sciences Centre database. The most common comorbidities included OA of the lower limbs, hypertension, history of tobacco use and diabetes mellitus. Examples of other conditions less frequently reported were obesity, hyperthyroidism, ischemic heart disease, depression and cardiovascular disease. Only the absolute number of comorbidities was used as a variable, and there was no attempt to quantify the actual contribution to pain from each comorbidity for each patient.

Procedure
After appropriate consent, participants were asked to complete the PCS and the MPQ, along with a standard medical history and physical examination, in the same-day surgery clinic approximately one week before surgery. Postoperatively, patients were mailed a copy of each questionnaire at three, 12 and 24 months, along with a self-addressed stamped envelope. A reminder letter with repeat questionnaires was sent out after two weeks if the questionnaires were not returned. Patients were asked to fill out the questionnaires in relation to the operative knee only, because many patients had multiple previously treated joints.

### TABLE 1
Patient demographic variables

<table>
<thead>
<tr>
<th></th>
<th>Men (n=20)</th>
<th>Women (n=35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>70.0±7.2</td>
<td>68.5±8.9</td>
</tr>
<tr>
<td>Length of stay, days</td>
<td>5.9±1.4</td>
<td>5.5±1.6</td>
</tr>
<tr>
<td>Comorbidities*, n</td>
<td>2.6±1.4</td>
<td>1.6±1.3</td>
</tr>
<tr>
<td>Spinal anesthesia, n (%)</td>
<td>10 (50)</td>
<td>17 (49)</td>
</tr>
<tr>
<td>General anesthesia, n (%)</td>
<td>10 (50)</td>
<td>18 (51)</td>
</tr>
</tbody>
</table>

Results presented as mean ± SD unless otherwise stated. *Denotes significant difference (P<0.05) between sexes.

### TABLE 2
Preoperative and postoperative McGill Pain Questionnaire scores

<table>
<thead>
<tr>
<th></th>
<th>Preoperative (n=55)</th>
<th>Follow-up 3 months (n=43)</th>
<th>Follow-up 12 months (n=46)</th>
<th>Follow-up 24 months (n=48)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain Rating Index</td>
<td>17.8±8.1*</td>
<td>10.1±8.3</td>
<td>8.4±9.3</td>
<td>7.6±8.7</td>
</tr>
<tr>
<td>Visual analogue scale</td>
<td>6.8±1.9*</td>
<td>3.3±2.7</td>
<td>2.7±3.0</td>
<td>2.2±2.3</td>
</tr>
<tr>
<td>Present pain intensity</td>
<td>2.9±1.1*</td>
<td>1.5±1.2</td>
<td>1.2±1.1</td>
<td>1.1±1.0</td>
</tr>
</tbody>
</table>

Results presented as mean ± SD. *Denotes significant difference (P<0.05) from other time periods using Bonferroni post hoc tests.

### TABLE 3
Preoperative and postoperative Pain Catastrophizing Scale scores

<table>
<thead>
<tr>
<th></th>
<th>Preoperative (n=55)</th>
<th>Follow-up 3 months (n=43)</th>
<th>Follow-up 12 months (n=46)</th>
<th>Follow-up 24 months (n=48)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCS-R</td>
<td>5.0±3.3</td>
<td>4.3±3.5</td>
<td>4.0±4.5</td>
<td>4.5±4.0</td>
</tr>
<tr>
<td>PCS-M</td>
<td>1.4±2.1</td>
<td>1.8±1.9</td>
<td>1.7±2.0</td>
<td>2.1±2.1</td>
</tr>
<tr>
<td>PCS-H</td>
<td>3.4±4.7</td>
<td>3.6±3.6</td>
<td>3.2±3.9</td>
<td>3.1±4.3</td>
</tr>
<tr>
<td>PCS-T</td>
<td>9.8±8.7</td>
<td>10.0±8.2</td>
<td>8.8±9.6</td>
<td>9.8±9.3</td>
</tr>
</tbody>
</table>

Results presented as mean ± SD. PCS-H Pain Catastrophizing Scale – Helplessness; PCS-M Pain Catastrophizing Scale – Magnification; PCS-R Pain Catastrophizing Scale – Ruminating; PCS-T Pain Catastrophizing Scale – Total.

All data obtained from the questionnaires, along with personal data from the hospital database, were placed in a Microsoft Office Excel version 4.0 (Microsoft Canada Co) spreadsheet, and analyzed using SPSS version 9.0 (SPSS Inc, USA). Preoperative and postoperative scores were compared using ANOVA Bonferroni post hoc tests. Predictive statistics were performed using receiver operating characteristic (ROC) curves to determine which preoperative variables predicted the long-term pain outcomes. Those patients with persistent pain were compared with those patients with no pain at 24 months, using the Mann-Whitney U test for nonparametric data. A P<0.05 was used as the level of significance.

### RESULTS

Response rate
The two questionnaires used in the present study were self-administered and mailed out. Of the initial 55 patients who filled out the questionnaire preoperatively, 49 (89%) returned them filled out at three months, of which 43 (88%) were complete. At 12 months, 51 (93%) of the questionnaires were filled out, of which 46 (90%) were complete. At 24 months, 52 (95%) of the patients filled out questionnaires, of which 48 (92%) were complete.

Descriptive statistics
Mean scores for age, length of stay and comorbidities are presented in Table 1. The patients’ mean age was 69 years, mean length of stay was six days and mean number of comorbidities was two. Twenty-seven (49%) of 55 patients underwent spinal anesthesia and 28 (51%) underwent general anesthesia. There were no differences among any of the outcome measures as a function of type of anesthesia (spinal versus general).

### TABLE 3
Preoperative and follow-up catastrophizing scores

<table>
<thead>
<tr>
<th></th>
<th>Preoperative (n=55)</th>
<th>Follow-up 3 months (n=43)</th>
<th>Follow-up 12 months (n=46)</th>
<th>Follow-up 24 months (n=48)</th>
</tr>
</thead>
<tbody>
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<td>8.4±9.3</td>
<td>7.6±8.7</td>
</tr>
<tr>
<td>Visual analogue scale</td>
<td>6.8±1.9*</td>
<td>3.3±2.7</td>
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<td>2.2±2.3</td>
</tr>
<tr>
<td>Present pain intensity</td>
<td>2.9±1.1*</td>
<td>1.5±1.2</td>
<td>1.2±1.1</td>
<td>1.1±1.0</td>
</tr>
</tbody>
</table>

Results presented as mean ± SD. *Denotes significant difference (P<0.05) from other time periods using Bonferroni post hoc tests.
Using repeated measures ANOVA tests, a statistically significant decrease was found in both the mean PRI scores and VAS scores from the preoperative time period, compared with the follow-up time period at three, 12 and 24 months, respectively (P<0.01). The mean preoperative PRI score was 17.8, which decreased to 10.1 after three months, 8.4 after 12 months and 7.6 after 24 months. The mean preoperative VAS score was 6.8 and decreased to 3.3 after three months, 2.7 after 12 months and 2.2 after 24 months. There were no statistically significant differences among any of the follow-up period PRI or VAS scores, indicating that after three months, reductions in pain had reached a plateau.

Using repeated measures ANOVA tests, it was found that the PCS-T scores did not change significantly between the preoperative and follow-up time periods (P>0.05). The mean preoperative PCS-T score was 9.8. The mean PCS-T was 10.0 after three months, 8.8 after 12 months and 9.8 after 24 months. The PCS-R, PCS-M and PCS-H scores also remained unchanged despite surgical intervention.

Predictive analyses

The pain outcome data were skewed, and violated the assumptions of parametric statistical analysis. Therefore, nonparametric ROC curves were used to examine the discriminative and predictive ability of preoperative pain, preoperative catastrophizing scores and comorbidities on postoperative pain outcomes. The pain outcomes at 24 months were chosen as the dependent variable because surgical outcomes stabilized by that time, and the best response rate of our mail-in questionnaires (87%) was obtained after that period.

ROC curve analysis demonstrated that the preoperative PCS-T score predicted individuals who still had pain according to the PRI at 24 months (Figure 1). The area under the curve was 0.713 (P<0.05). Preoperative PCS-R scores predicted PRI scores at 24 months, with an area under the curve of 0.696 (P<0.05) (Figure 2). Preoperative PCS-M and PCS-H scores did not provide significant discrimination of pain outcomes. Preoperative PRI scores also predicted the patients who would report pain at 24 months according to the PRI, with an area under the curve of 0.720 (P<0.05) (Figure 3). The absolute number of comorbidities predicted the presence of...
The area under the curve was 0.714 (P<0.05).

To confirm the ROC curve analyses, patients with persistent pain (PRI>0; n=36) and no pain (PRI=0; n=12) at 24 months according to the PRI were compared using the nonparametric Mann-Whitney U test (Table 4). Because ROC curves are based on sensitivity and specificity, the sample was dichotomized into definitive ‘pain’ and ‘no pain’ groups, rather than arbitrarily dichotomizing the population as having mild or moderate pain. Patients with persistent pain at 24 months had significantly higher preoperative PCS-R scores (5.6 versus 3.3, P<0.05), PCS-T scores (11.4 versus 4.9, P<0.05) and PRI scores (19.6 versus 13.5, P<0.05). There were no significant differences in age, sex or length of hospital stay between these two groups. Those patients with and without pain at 24 months, as measured on the VAS, were compared using the Mann-Whitney U test (Table 5). Patients with persistent pain at 24 months had a significantly higher number of comorbidities (2.2 versus 1.2, P<0.05). No other differences between the no pain and the persistent pain groups could account for the observed difference in preoperative comorbidities.

**DISCUSSION**

As expected, there was a dramatic decrease in pain scores after TKA. The pain scores decreased significantly within the first

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**TABLE 4**

Demographics and preoperative and catastrophizing Pain Rating Index (PRI) scores for pain and no pain groups at 24 months postsurgery

<table>
<thead>
<tr>
<th></th>
<th>No pain (n=12)</th>
<th>Pain (n=36)</th>
<th>Mann-Whitney U test</th>
<th>Area under ROC curve</th>
<th>95% CI for ROC curve</th>
<th>Asymptomatic significance ROC curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>69.2±7.6</td>
<td>69.6±7.9</td>
<td>P=0.551</td>
<td>–</td>
<td>–</td>
<td>P&gt;0.10</td>
</tr>
<tr>
<td>Comorbidities, n</td>
<td>1.9±1.2</td>
<td>2.0±1.5</td>
<td>P=0.971</td>
<td>–</td>
<td>–</td>
<td>P&gt;0.10</td>
</tr>
<tr>
<td>Length of stay, days</td>
<td>5.5±1.3</td>
<td>5.7±1.7</td>
<td>P=0.660</td>
<td>–</td>
<td>–</td>
<td>P&gt;0.10</td>
</tr>
<tr>
<td>Preoperative PRI</td>
<td>13.5±6.3</td>
<td>19.6±8.1</td>
<td>P=0.023</td>
<td>0.72</td>
<td>0.56–0.88</td>
<td>P=0.02</td>
</tr>
<tr>
<td>Preoperative VAS</td>
<td>6.5±2.0</td>
<td>6.9±1.9</td>
<td>P=0.576</td>
<td>–</td>
<td>–</td>
<td>P&gt;0.10</td>
</tr>
<tr>
<td>Preoperative PRI</td>
<td>2.6±1.1</td>
<td>2.9±1.0</td>
<td>P=0.380</td>
<td>–</td>
<td>–</td>
<td>P&gt;0.10</td>
</tr>
<tr>
<td>Preoperative PCS-R</td>
<td>3.3±2.1</td>
<td>5.6±3.7</td>
<td>P=0.043</td>
<td>0.70</td>
<td>0.54–0.86</td>
<td>P=0.04</td>
</tr>
<tr>
<td>Preoperative PCS-M</td>
<td>0.4±0.7</td>
<td>1.8±2.5</td>
<td>P=0.098</td>
<td>–</td>
<td>–</td>
<td>P&gt;0.10</td>
</tr>
<tr>
<td>Preoperative PCS-H</td>
<td>1.3±1.5</td>
<td>3.9±5.2</td>
<td>P=0.334</td>
<td>–</td>
<td>–</td>
<td>P&gt;0.10</td>
</tr>
<tr>
<td>Preoperative PCS-T</td>
<td>4.9±3.5</td>
<td>11.4±9.8</td>
<td>P=0.028</td>
<td>0.71</td>
<td>0.56–0.87</td>
<td>P=0.03</td>
</tr>
</tbody>
</table>

Results presented as mean ± SD unless otherwise stated. PCS-H Pain Catastrophizing Scale – Helplessness; PCS-M Pain Catastrophizing Scale – Magnification; PCS-R Pain Catastrophizing Scale – Rumination; PCS-T Pain Catastrophizing Scale – Total; PRI Present pain intensity; ROC Receiver operating characteristic; VAS Visual analogue scale

**TABLE 5**

Demographics and preoperative and catastrophizing scores for pain and no pain groups based on the visual analogue scale (VAS) of the McGill Pain Questionnaire at 24 months postsurgery

<table>
<thead>
<tr>
<th></th>
<th>No pain (n=11)</th>
<th>Pain (n=37)</th>
<th>Mann-Whitney U test</th>
<th>Area under ROC curve</th>
<th>95% CI for ROC curve</th>
<th>Asymptomatic significance ROC curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>72.2±8.1</td>
<td>68.6±7.6</td>
<td>P=0.280</td>
<td>0.71</td>
<td>0.56–0.87</td>
<td>P=0.033</td>
</tr>
<tr>
<td>Comorbidities, n</td>
<td>1.2±1.0</td>
<td>2.2±1.4</td>
<td>P=0.105</td>
<td>–</td>
<td>–</td>
<td>P&gt;0.10</td>
</tr>
<tr>
<td>Length of stay, days</td>
<td>5.5±1.2</td>
<td>5.7±1.7</td>
<td>P=0.668</td>
<td>–</td>
<td>–</td>
<td>P&gt;0.10</td>
</tr>
<tr>
<td>Preoperative PRI</td>
<td>14.5±7.2</td>
<td>19.1±8.1</td>
<td>P=0.029</td>
<td>0.71</td>
<td>0.56–0.87</td>
<td>P=0.033</td>
</tr>
<tr>
<td>Preoperative VAS</td>
<td>6.1±2.0</td>
<td>7.0±1.9</td>
<td>P=0.220</td>
<td>–</td>
<td>–</td>
<td>P&gt;0.10</td>
</tr>
<tr>
<td>Preoperative PRI</td>
<td>2.6±1.3</td>
<td>2.9±0.9</td>
<td>P=0.379</td>
<td>–</td>
<td>–</td>
<td>P&gt;0.10</td>
</tr>
<tr>
<td>Preoperative PCS-R</td>
<td>4.4±2.9</td>
<td>5.2±3.6</td>
<td>P=0.711</td>
<td>–</td>
<td>–</td>
<td>P&gt;0.10</td>
</tr>
<tr>
<td>Preoperative PCS-M</td>
<td>1.5±2.3</td>
<td>1.4±2.3</td>
<td>P=0.668</td>
<td>–</td>
<td>–</td>
<td>P&gt;0.10</td>
</tr>
<tr>
<td>Preoperative PCS-H</td>
<td>1.6±1.8</td>
<td>3.7±5.1</td>
<td>P=0.561</td>
<td>–</td>
<td>–</td>
<td>P&gt;0.10</td>
</tr>
<tr>
<td>Preoperative PCS-T</td>
<td>7.5±6.0</td>
<td>10.4±6.6</td>
<td>P=0.694</td>
<td>–</td>
<td>–</td>
<td>P&gt;0.10</td>
</tr>
</tbody>
</table>

Results presented as mean ± SD unless otherwise stated. PCS-H Pain Catastrophizing Scale – Helplessness; PCS-M Pain Catastrophizing Scale – Magnification; PCS-R Pain Catastrophizing Scale – Rumination; PCS-T Pain Catastrophizing Scale – Total; PRI Present pain intensity; ROC Receiver operating characteristic; VAS Visual analogue scale

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Figure 4) Receiver operating characteristic curve indicating the ability of comorbidities (extracted from chart data) to discriminate between patients with pain (n=37) and no pain (n=11) at 24 months after surgery, as reported on the visual analogue scale (McGill Pain Questionnaire).
three months postoperatively, and continued to decrease over
the next two years at a slower rate, reaching a final plateau.
This was in keeping with previous literature, using standard
validated outcome questionnaires, in that the standardized
effect size for the outcome of TKA is large and occurs shortly
after surgery (10). The remainder of the subjective improve-
ment occurs over a two-year interval, at which time a plateau
is reached on the timeline graph (4).

Our predictive analyses demonstrated that initial pain, as
measured by the PRI, predicted which patients had a worse
pain outcome after 24 months. This is consistent with other
pain literature that reported presurgical pain is a significant
determinant of postsurgical physical and emotional distress
(5). It is interesting to note that heightened pain presurgery
is often a consequence of the prolonged waiting times associated
with TKA (33). Prolonged waiting times may be the result of
hospital wait lists, or surgeon-specific preferences to delay sur-
urgery for as long as patients can tolerate their pain. Patients
with increased wait times for TKA and worsening preoperative
pain may have a worse outcome after surgery (34).

Furthermore, we found that a psychological variable, cat-
strophizing, did not significantly change after TKA. This
would suggest that catastrophizing may be a trait-like variable
that remains stable unless specific psychological intervention
also takes place (22). The PCS-R was the best predictor of
the PRI subscale of the MPQ. This may be related to the
increased attention and consequent increased sensory flow of
pain signals. Attention to pain symptoms has been discussed
as a possible mechanism contributing to altered central
thresholds of excitability, or the amplification of pain signals
(35). As a function of the tendency to focus excessively on
pain sensations, catastrophizers’ central neural mechanisms
may become more sensitized, yielding a chronic hyperalgesic
state (22).

The only other variable that affected postoperative pain
outcomes was the number of preoperative comorbidities the
patient had. There is a heavier psychological burden on patients
with multiple medical problems, and this may lead to altered pain
experiences when compared with patients who suffer from iso-
lated OA of the knee (36). There is some support in the current
literature for this hypothesis, although further research is
needed to clarify this (36,37).

The modest sample size of the present study calls for cau-
tion in the interpretation of findings. Although separate analy-
yses were conducted to assess the predictive value of
preoperative pain, pain catastrophizing and comorbidities, it is
clear that these variables interact with each other and have
an impact on pain outcomes. The present sample was not suffi-
ciently large to permit examination of summative or interac-
tive effects of these variables. A larger scale study is planned to
address these issues in the near future.

Another potential weakness of the present study is the lack
of pain measures in the perioperative period. However, this was
not the main focus because immediate postoperative pain is
almost entirely related to surgery itself, and is compounded by
the use of postoperative pain management protocols. We chose
to focus on the persistence of pain after healing of the surgical
site to determine the final long-term pain-related outcome.
The relation between immediate postoperative pain and its
management, and long-term persistent pain should be
addressed in future studies.

Increased attention to psychological factors in orthopedic
surgery, specifically TKA, may lead to better outcomes, includ-
ing pain management and quality of life (38). When patients
were asked what concerned them the most following surgery,
they said it was the postoperative pain experience (39). The
major clinical implication of this study is that a preoperative
self-administered questionnaire may help identify a group of
‘high-risk’ patients for persistent pain after TKA. Preoperative
interventions to reduce catastrophic thinking in these patients
may help reduce their pain following surgery. Other preopera-
tive interventions have already been shown to decrease the
amount of perioperative anxiety that patients experience, and
may lead to improved outcomes (40).

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