Catastrophizing and depressive symptoms as prospective predictors of outcomes following total knee replacement

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Several recent reports suggest that pain-related catastrophizing is a risk factor for poor acute pain outcomes following surgical interventions. However, it has been less clear whether levels of catastrophizing influence longer-term postoperative outcomes. Data were analyzed from a relatively small number (n=43) of patients who underwent total knee replacement and were followed for 12 months after their surgery. Previous research has suggested that high levels of both catastrophizing and depression are associated with elevated acute postoperative pain complaints among patients undergoing knee surgery. In this sample, catastrophizing and depression at each of the assessment points were studied as prospective predictors of pain (both global pain ratings and pain at night) at the subsequent assessment point over the course of one year. The predictive patterns differed somewhat across measures of pain reporting; depressive symptoms were unique predictors of greater global pain complaints, while catastrophizing was a specific and unique predictor of elevated nighttime pain. While surgical outcomes following total knee replacement are, on average, quite good, a significant minority of patients continue to experience long-term pain. The present findings suggest that high levels of catastrophizing and depression may promote enhanced pain levels, indicating that interventions designed to reduce catastrophizing and depressive symptoms may have the potential to further improve joint replacement outcomes.

Key Words: Arthroplasty; Catastrophizing; Depression; Knee replacement; Pain

Total knee arthroplasty (TKA) is an increasingly common treatment for advanced osteoarthritis or other types of arthritis of the knee. In the United States, more than 500,000 TKAs are performed each year; based on current trends, annual rates of knee replacement are expected to exceed 3.5 million within the next 25 years (1). The 2007 report of the Canadian Joint Replacement Registry revealed that TKA rates in Canada have increased 140% over the past decade, and are close to per capita TKA rates in the United States (2). In general, rates of surgical 'success' exceed 80%, although success is rarely defined by complete pain relief. Indeed, it is clear that a substantial number of TKA recipients persistently complain of significant pain despite normal radiographs, unremarkable physical examinations and even self-reported 'good' outcomes (3-6). Numerous surveys regarding post-TKA quality of life have documented ongoing 'average' rates of mild to moderate pain at

La catastrophisation et les symptômes de dépression comme prédicteurs prospectifs d'issues après une arthroplastie totale du genou

Selon plusieurs rapports récents, la catastrophisation liée à la douleur est un facteur de risque d'issues négatives de douleur aiguë après une intervention chirurgicale. Cependant, il n'est pas établi aussi clairement si le taux de catastrophisation influe sur les issues postopératoires à plus long terme. Les données étaient analysées à partir d'un échantillon relativement limité (n=43) de patients qui avaient subi une arthroplastie totale du genou et avaient été suivis pendant 12 mois après leur opération. Des recherches antérieures indiquent que des taux élevés de catastrophisation et de dépression s'associent à un taux élevé d'allégations de douleur postopératoire aiguë chez les patients qui subissent une arthroplastie. Dans cet échantillon, on a étudié la catastrophisation et la dépression à chacun des points d'évaluation à titre de prédicteurs prospectifs de la douleur (à la fois les évaluations globales de la douleur et la douleur nocturne) au point d'évaluation suivant tout au long de l'année. Les motifs prédictifs différaient quelque peu entre les mesures de déclaration de douleur. Ainsi, les symptômes de dépression étaient des prédicteurs uniques d'allégations de douleur globale plus aiguë, tandis que la catastrophisation était un prédicteur spécifique et unique d'intense douleur nocturne. Tandis qu'en moyenne, les issues chirurgicales après une arthroplastie totale du genou sont plutôt positives, une forte minorité de patients continue de souffrir de douleurs à long terme. D'après les présentes observations, des taux élevés de catastrophisation et de dépression peuvent promouvoir des taux de douleur plus vive, ce qui laisse supposer que des interventions conçues pour réduire les symptômes de catastrophisation et de dépression pourraient améliorer les issues après une arthroplastie.

six months (7), one year (8), two years (9) and three years (10) postsurgery. The most recent reviews and long-term follow-up studies suggest that, one year after TKA, up to one-fourth of patients continue to report substantial pain and functional limitations. For example, a British study of more than 600 TKA patients five to eight years postsurgery indicated that 26% reported ongoing moderate to severe pain (11). Collectively, it is quite clear that pain remains a significant long-term problem for a number of patients after knee replacement, with wide individual variability in the course of pain-related outcomes over time (eg, some patients report minimal pain shortly after surgery, while others describe ongoing moderate to severe pain that persists for years). Psychosocial processes such as emotional distress and social support appear to be important in shaping the long-term course of post-TKA outcomes (7), but research in this area remains in its infancy.

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One psychological variable that has repeatedly been shown to influence pain-related outcomes across a variety of domains is catastrophizing, a negative cognitive and affective response to pain (12). The construct of catastrophizing incorporates magnification of pain-related symptoms, excessive attentional focus on pain, rumination about pain, feelings of helplessness when in pain and pessimism about pain-related outcomes (13). In cross-sectional studies in osteoarthritis patients, catastrophizing correlates with higher pain severity (14,15), higher levels of observed pain behaviours and functional limitations during standardized activity tests (15), and lower pain threshold and tolerance (16). In addition, several knee surgery studies have reported prospective associations of catastrophizing with short-term negative outcomes. For example, in patients undergoing ligament repair, higher preoperative catastrophizing scores predicted more severe postoperative pain over the course of the first postsurgical week (17). In addition, a study of TKA patients noted that higher preoperative levels of catastrophizing were associated with longer times to achieve postsurgery functional targets such as 90° flexion (18).

The current literature lacks dynamic study of the interplay between catastrophizing and pain over the course of recovery from knee replacement. Research in samples of patients with other pain conditions has suggested that negative affective and cognitive processes may act to impede recovery following pain-reducing interventions (eg, in sciatica patients undergoing surgery or conservative management [19]). If similar effects operate following TKA, these associations could have potentially important pain management implications. In addition, many previous studies of catastrophizing have not controlled for more general measures of distress (12). Because some studies have found that depression (20-22) is related to fewer improvements in pain and function after joint replacement, and because depression and catastrophizing are significantly intercorrelated (12), we believed it was important to include measures of both catastrophizing and depression in our predictive models. In the present report, we assess prospective relationships over a one-year post-TKA period between catastrophizing, depressive symptoms and knee pain. We evaluated both global pain ratings and ratings of pain at night, because disrupted sleep has negative long-term consequences for pain-related outcomes (23,24).

METHODS

Participants

Participants with intractable knee pain who were scheduled for unilateral knee replacement were recruited from the Johns Hopkins Department of Orthopedic Surgery (Baltimore, Maryland, USA). The study protocol called for a brief set of questionnaires to be administered to patients at five time points – presurgery, as well as one month, three months, six months and 12 months postsurgery. Because of research staffing constraints, only a small number of patients were recruited; a total of 43 patients provided data for at least two time points, and were thus eligible for inclusion in the present sample. Sample sizes for each assessment point were as follows: presurgery, n=20; one month postsurgery, n=29; three months postsurgery, n=38; six months postsurgery, n=38; and one year postsurgery, n=32. Although these sample sizes were small, the inclusion of repeated assessments and the use of longitudinal data-analytic techniques

that used all available data while accounting for missing observations helped to improve study power.

Measures

Data were derived from questionnaires completed by patients during clinic visits; at each time point, subjects completed the measures listed below.

Coping Strategies Questionnaire catastrophizing subscale: The Coping Strategies Questionnaire (CSQ) catastrophizing subscale assesses the frequency of catastrophizing cognitions and emotions in the context of pain (eg, “when I feel pain...I worry all the time about whether it will end”) (25). Respondents rated items from 0 (‘never’ use that strategy) to 6 (‘always’ use that strategy). The six-item CSQ catastrophizing subscale is a commonly used measure of catastrophizing (12); it possesses good psychometric properties and, in the present sample, had a Cronbach’s alpha of 0.88.

Center for Epidemiological Studies Depression Scale: The Center for Epidemiological Studies Depression Scale (CES-D) is a widely used self-report measure that assesses depressive cognitions, dysphoric mood and vegetative symptoms (26). It contains 20 items; respondents rate how frequently in the previous week they experienced each symptom. Cronbach’s alpha for the CES-D was 0.79 in the present sample.

Pain severity: Two types of pain ratings were analyzed – overall pain severity (0 to 100) in the past 48 h, and nighttime pain (ie, “pain at night while trying to sleep”, also rated from 0 to 100). Nighttime pain was included as an outcome variable because several recent studies have highlighted important inter-relationships between catastrophizing and sleep/fatigue in the context of pain (27-30). Recall of recent pain (over the past 24 h to 48 h) and, similarly, brief pain items are commonly used and well-validated outcome measures (31,32).

Data reduction and analysis

To assess the prospective contributions of catastrophizing to pain outcomes, a repeated measures analysis was performed using data from all follow-up time points from baseline to 12-month follow-up. For longitudinal data of this type, mixed model or generalized estimating equation (GEE) approaches to data analysis are typically preferred to standard ANOVA techniques because they take into account missing data and within-subject correlations. Therefore, GEEs were used to model the correlation structure of the repeated measures within each patient. In each GEE model, the predictor variables of primary interest were the CSQ catastrophizing subscale and total CES-D score, assessed at the previous time point, as predictors of pain at the subsequent time point. Thus, these models represent what are typically referred to as ‘lagged analyses’, evaluating the prospective effects of the predictor variables on future values of the dependent variables. In each model, time and pain at the previous time point were also included as predictors, permitting the evaluation of the prospective association between catastrophizing and subsequent pain, independent of previous pain levels (in effect, to study the association between catastrophizing and changes in pain). For each model, the effect of catastrophizing is presented before and after the inclusion of depressive symptomatology scores. Findings from the reverse model, with pain as a prospective predictor of

TABLE 1
Pain, catastrophizing and depression scores at each study time point

Variable	Pre-surgery	Postsurgery				
		1 month	3 months	6 months	12 months	
Global daily pain (0–100)**	58.8±23.0	29.8±26.6	21.0±25.9	13.3±19.9	11.0±19.7	
Nighttime pain (0–100)**	40.7±32.1	31.5±29.8	18.1±23.7	11.6±19.6	8.9±16.8	
CSQ catastrophizing subscale (0–36)	3.8±3.9	4.5±6.4	4.4±5.1	4.0±5.4	3.8±5.4	
CES-D (0–60)*	12.1±6.8	13.9±7.5	11.8±7.4	9.8±6.6	7.8±5.3	

Data presented as mean ± SD. * $P<0.01$; ** $P<0.001$ for the repeated measures test of changes over time. CES-D Center for Epidemiological Studies Depression Scale; CSQ Coping Strategies Questionnaire

catastrophizing, are not presented because catastrophizing levels did not change significantly over the course of the 12-month follow-up.

RESULTS

Sample characteristics

Fifty-eight per cent of the participants were women, and the mean ($\pm$ SD) age of the sample was 71.7±7.0 years. Data collection proved most difficult at the presurgery time point (ie, the sample size was smallest then); those subjects who provided presurgical data did not differ from those who provided only postsurgical data with respect to age, sex and measures of pain, catastrophizing, and depression at three months postsurgery (ie, where the sample size peaked) (all $P<0.30$). Table 1 presents the values at each time point for pain, catastrophizing and depressive symptoms. As expected, ratings of both global and nighttime pain decreased substantially from presurgery values over the course of a one-year follow-up ($P<0.001$), and levels of depressive symptoms also declined over the follow-up period ($P<0.01$). In contrast, catastrophizing did not change significantly over the course of the study ($P>0.40$). Catastrophizing and CES-D scores were significantly positively associated at each time point, with intercorrelations ranging from $r=0.36$ ($P<0.05$) at three months to $r=0.71$ ($P<0.001$) at six months, and a mean correlation coefficient of 0.56.

Predicting global pain ratings

In the GEE analysis predicting global daily pain scores over the one-year follow-up period, previous pain score was a robust predictor of future pain scores, as expected. Catastrophizing was a significant ($P<0.05$) prospective predictor (ie, higher catastrophizing was associated with higher daily pain severity) of daily pain severity in the model that did not include depressive symptoms as a predictor, but when CES-D scores were included in the model, only CES-D scores emerged as significant predictors of subsequent daily pain ratings ($P<0.05$). A detailed presentation of these effects is shown in Table 2.

Predicting nighttime pain

In the GEE analysis predicting nighttime pain scores over the one-year follow-up period, previous nighttime pain score was, again, a highly significant predictor of future nighttime pain scores. Catastrophizing was a significant ($P<0.05$) prospective predictor of nighttime pain in the models with and without depressive symptoms. In contrast to the model predicting global pain ratings, CES-D scores did not emerge as significant

TABLE 2
Results of generalized estimating equation model assessing predictors of global daily pain ratings

Assessing predictors of global daily pain ratings				
Predictor variable	Standard			P
	Estimate	error	t	
Model without CES-D scores				
Time	1.4	3.2	0.4	0.67
Pain at previous time point	0.48	0.07	6.7	<0.001
Catastrophizing at previous time point	4.6	1.9	2.4	0.02
Model with CES-D scores				
Time	1.7	3.2	0.5	0.60
Pain at previous time point	0.43	0.08	5.8	<0.001
Catastrophizing at previous time point	2.1	2.2	0.9	0.35
CES-D at previous time point	0.67	0.30	2.2	0.03

CES-D Center for Epidemiological Studies Depression Scale

TABLE 3
Results of generalized estimating equation model assessing predictors of nighttime pain ratings

Predictors of nighttime pain ratings				
Predictor variable	Estimate	Standard	t	P
		error		
Model without CES-D scores				
Time	−4.0	3.4	−1.2	0.24
Nighttime pain at previous time point	0.35	0.08	4.4	<0.001
Catastrophizing at previous time point	6.4	2.2	2.9	0.005
Model with CES-D scores				
Time	−3.9	3.5	−1.1	0.27
Nighttime pain at previous time point	0.32	0.08	3.8	<0.001
Catastrophizing at previous time point	5.1	2.5	2.0	0.04
CES-D at previous time point	0.40	0.33	1.2	0.24

CES-D Center for Epidemiological Studies Depression Scale

predictors of future nighttime pain scores (Table 3). The addition of a time $\times$ catastrophizing interaction was nonsignificant, suggesting that the association between catastrophizing and subsequent nighttime pain was relatively constant across the study period.

DISCUSSION

The present study was the first to simultaneously evaluate the predictive influence of catastrophizing and depression on post-TKA pain over a period of one year postsurgery. Interestingly, and consistent with at least one previous study of orofacial pain (33), catastrophizing was unaltered following large changes in the severity of clinical pain (ie, despite the substantial resolution of knee pain, reported levels of catastrophizing did not decrease while depressive symptoms, as measured by the CES-D, diminished steadily). This suggests a substantial stability, or 'trait' component, to the construct of catastrophizing, and hints that high levels of catastrophizing may warrant intervention in their own right (12).

Consistent with previous reports (21,22,34), we observed that individual differences in depressive symptoms at one time point predicted global daily pain ratings at the next time point following TKA. Moreover, the moderate overlap between reports of catastrophizing and depression was evident in the finding that inclusion of depressive symptoms in the model substantially reduced the predictive power of catastrophizing. Interestingly, however, a similar effect did not emerge for the model predicting nighttime pain, and catastrophizing remained a unique prospective predictor even after the inclusion of

CES-D scores. One explanation for this differential pattern of findings may lie in previous reports that catastrophizing is associated with poor sleep and symptoms of insomnia (35,36), above and beyond the general effects of distress and depression (36). If catastrophizing specifically results in greater time awake at night (eg, longer sleep latency and more frequent awakenings), then high-catastrophizing participants would be expected to remember and report greater nighttime pain. Alternatively, expectations could play a role; daytime, use-related pain may be generally expected by patients post-TKA, but it may be solely the high catastrophizers who anticipate nighttime pain, which may then influence their sleep and pain experience over the course of the night.

Collectively, overwhelming evidence suggests that cognitive and affective factors are intimately involved in the pain experience (12,37-39). In previous studies, high levels of catastrophizing have been associated with a variety of deleterious pain-related outcomes, including the onset of phantom limb pain after amputation (40), the development of chronic back or neck pain (41,42), enhanced neural responses to

painful stimulation (43,44), and greater health care costs in individuals with chronic pain (45). The present report, although limited by its small sample size and substantial missing data, adds to the existing literature by suggesting that ongoing catastrophizing and depression may act to inhibit the long-term pain-reducing effects of TKA, with catastrophizing and depression promoting enhanced levels of nighttime pain and daily pain, respectively. Although these results await replication in a larger sample, such findings suggest that catastrophizing and depression may be productively targeted post-TKA as a means of improving long-term pain-related outcomes. Logical next steps in this line of research involve study of the potential analgesic effects of catastrophizing- and depression-reducing interventions such as cognitive behavioural therapy (46) at a variety of time points before or after TKA.

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