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Pain Coping Skills Training for Patients with Elevated Pain Catastrophizing who are Scheduled for Knee Arthroplasty: A Quasi-Experimental Study

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Abstract

Objectives—To (1) describe a behavioral intervention designed for patients with elevated pain catastrophizing who are scheduled for knee arthroplasty, and (2) use a quasi-experimental design to evaluate the potential efficacy of the intervention on pain severity, catastrophizing cognitions, and disability.

Design—Quasi-experimental non-equivalent control group design with a 2 month follow-up.

Setting—Two university-based Orthopedic Surgery departments.

Participants—Adults scheduled for knee replacement surgery who reported elevated levels of pain catastrophizing. Patients were recruited from two clinics and were assessed prior to surgery and 2 months following surgery.

Intervention—A group of 18 patients received a psychologist directed pain coping skills training intervention comprising 8 sessions and the other group, a historical cohort of 45 patients, received usual care.

Main Outcome Measures—WOMAC Pain and Disability scores as well as scores on the Pain Catastrophizing Scale.

Results—Two months following surgery, the patients who received pain coping skills training reported significantly greater reductions in pain severity and catastrophizing, and greater improvements in function as compared to the usual care cohort.

Conclusion—Pain catastrophizing is known to increase risk of poor outcome following knee arthroplasty. The findings provide preliminary evidence that the treatment may be highly efficacious for reducing pain, catastrophizing, and disability, in patients reporting elevated

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catastrophizing prior to knee arthroplasty. A randomized clinical trial is warranted to confirm these effects.

Keywords

knee; arthroplasty; distress; pain; arthritis; catastrophizing

Patients with severe knee arthritis typically report that pain is their most bothersome symptom.[1;2] Knee arthroplasty is generally an effective surgical procedure for patients with painful knee arthritis who have not responded to conservative treatment.[1] These large group level effects on pain intensity indicate that knee replacement surgery is highly effective at reducing pain for many. However, there are a substantial number of patients who experience little pain improvement or, in some cases, worse pain following knee arthroplasty. For example, Brander and colleagues reported that 19% of patients in their cohort of 116 patients reported moderate to severe pain 6 months following surgery[3] while Hawker and colleagues reported similar estimates 2 to 7 years following arthroplasty.[4] Murray and colleagues found that 30% of their large cohort of 1429 patients reported moderate or severe pain 1 year after knee arthroplasty.[5]

A substantial body of research has since been devoted to identifying predictors of persistent pain or poor function.[6] Among the most consistent and powerful are psychological predictors, and a burgeoning body of literature suggests that pain catastrophizing is among the most important, if not the most important, psychological predictor of poor outcome.[7–11] Although the specific mechanisms by which catastrophizing might influence pain have not yet been determined, a number of such mechanisms have been suggested.[12] For example, it is possible that catastrophizing could have a direct influence on the neurophysiological mechanisms involved in pain processing.[13] Finally, it has been proposed that catastrophizing may also lead to social responses (e.g. increases in attention from a concerned spouse) that may heighten patients' focus on and rumination about pain.[14]

The two purposes of this study were to: (1) describe a pain coping skills training intervention that our team developed specifically for a subgroup of patients scheduled for knee arthroplasty who also had high levels of pain catastrophizing, and (2) conduct a quasi-experimental study to evaluate the efficacy of this intervention on a consecutively recruited sample of patients, comparing the outcomes to a usual care cohort of patients with similarly high levels of pain catastrophizing but who did not receive pain coping skills training. Quasi-experimental studies are appropriate for use when innovative interventions are developed and compared to a reasonable control condition to obtain an initial estimate of efficacy and to determine if a randomized clinical trial is warranted.[15] Because our study was preliminary in nature, we chose not to declare a single primary outcome variable but rather to examine effects on three important outcomes: self-reported pain severity, function and pain catastrophizing. To our knowledge, this is the first study to test the effects of a pain coping intervention in patients with knee arthroplasty.

METHODS

Design

This quasi-experimental (i.e., non-randomized) study compared treatment outcome between two independent cohorts, one that received the pain coping skills training and one that received usual care.

Participants

Pain coping skills training cohort—Participants in the pain coping skills group were consecutively recruited between April and September, 2009 from two sites: (1) Virginia Commonwealth University Medical Center, Richmond, Virginia or (2) Duke University Medical Center, Durham, North Carolina. The patients had already consented to have knee arthroplasty and were consented to participate in the current study two to six weeks prior to their scheduled surgery. Patients were eligible to participate if they: (1) were scheduled for primary (not revision) unilateral knee arthroplasty and (2) scored a 16 or higher on the Pain Catastrophizing Scale (PCS). We found in a previous study that patients who scored a 16 or higher on the PCS had an increased risk of poor outcome following surgery.[9] Patients were excluded if they could not speak or read English or if they did not sign a consent form. To identify patients who were eligible, we asked patients who met the other inclusionary criteria to complete the PCS. We screened a total of 56 patients for the study, of which 24 scored a 16 or higher on the PCS. Of the 24 patients who screened positive, a total of 18 (75%) consented to participate in the study.

Usual care cohort—Participants in the usual care cohort study also consented to participate prior to surgery. These patients participated in a prospective cohort study conducted between December, 2005 and April, 2008 at Virginia Commonwealth University Medical Center, Richmond, Virginia. The study was designed to determine the association between various psychological measures and outcome following knee arthroplasty.[9]

Patients were recruited if they were scheduled for primary (not revision) unilateral knee arthroplasty. Patients were excluded if they could not speak or read English or if they did not sign a consent form. A total of 157 patients were recruited to complete both the baseline data and 2 month follow-up forms and 139 (89%) actually completed follow-up data. A total of 45 of these 139 patients (32.3%) scored a 16 or higher on the PCS and thus qualified for the current study. The demographic and knee symptom characteristics of the patients in the pain coping skills cohort and the usual care cohort are summarized in Table 1.

Measures

Participants in both cohorts completed three key questionnaires in addition to the demographic data summarized in Table 1.

Pain Catastrophizing Scale—The Pain Catastrophizing Scale (PCS) is a 13-item scale with scores ranging from 0 (no catastrophizing) to 52 (severe catastrophizing). The PCS was designed to capture the extent of a patient's negative or exaggerated orientation to pain and it addresses primary constructs of rumination, magnification and helplessness.[16] Psychometric properties of the PCS have been studied extensively in a variety of patient populations having painful disorders, and found to be good to excellent.[16–18] In addition, the PCS has been shown to be sensitive to psychosocial interventions designed to increase the use of adaptive coping strategies and decrease the use of maladaptive coping strategies, such as pain catastrophizing.[19–22]

WOMAC Pain and Disability Scales—The 5-item WOMAC Pain scale ranges from 0 (no function-related pain) to 20 (severe function-related pain) and asks respondents to rate the intensity of their pain experienced during routine daily activities. Intensity is rated on a five-point Likert scale from “none” to “extreme.” The WOMAC Disability Scale is a 17 item scale that assesses the extent of a person’s difficulty in performing routine daily activities. The scale ranges from 0 (no knee related functional loss) to 68 (maximal knee related functional loss).[23] The WOMAC has been studied extensively and its scales have

been shown to be reliable and valid for quantifying the extent of both pain and disability in patients undergoing knee arthroplasty. [23–26]

Procedures

Ethical approval of the study was obtained from the IRBs of both institutions and all patients read and signed consent forms prior to participation. After patients consented, they completed all baseline questionnaires. Patients in the coping skills condition then received an 8 session pain coping skills training protocol. Patients in the usual care cohort received no additional care for pain coping. Approximately two months following surgery, all patients were asked to complete a packet of post-treatment questionnaires. For patients in the coping skills training condition, post-treatment questionnaires were collected following completion of the coping skills training which occurred, on average, 67 (SD, 18) days following surgery. Post-surgical questionnaires for the usual care cohort were collected at a mean of 59 (SD, 20) days following surgery. These differences were not significant (independent t-test = 1.37, p= 0.18). All patients completed their questionnaires without assistance from the investigative team.

The Treatment

The coping skills training protocol was based on the extensive research that has already been done by Keefe, Jensen and others on patients with chronic non-surgical painful conditions.[19;20;22;27–31] Our overall goal was to customize the intervention to account for the unique needs, interests and concerns of patients who are undergoing knee arthroplasty surgery. Along these lines the intervention addressed the typical recovery of physical function following knee arthroplasty,[32] the common concerns of patients during the recovery period[33] and strategies for coping with pain following knee arthroplasty. The intervention was delivered by psychologists with experience and training in using pain coping skills training.

The intervention was designed to be provided in 8 sessions; 1 in-person session approximately 1 month prior to surgery, 6 weekly telephone-based sessions with 3 prior to surgery and three during the 3 weeks following surgery and one in-person session approximately 1 month following surgery. All patients received 8 sessions prior to the two month follow-up. A schedule of 8 sessions over an approximately 2 month period has been shown to be effective in several coping skills trials.[31;34–39] Use of telephone-based sessions is a relatively new development in behavioral research and is a cost-effective and practical approach for patients, like those following knee arthroplasty who have difficulty with mobility and travel.[40;41].

To introduce the training, a simplified version of Melzack and Wall's gate control model of pain was used to illustrate that the experience of pain is a complex event influenced by thoughts, feelings and behaviors.[42] Pain coping strategies were described as skills that can be mastered through home practice. The first applied skill is relaxation training, using a protocol and relaxation tape described by Surwit. [43] This form of relaxation involved concentrating on muscle tension signals and using them as cues to relax. In addition to this form of relaxation exercise, pleasant imagery was another skill taught, with the rationale that is an additional form of relaxation as well as a form of distraction.[44] Patients practiced using pleasant imagery and changing from one image to another. A couple of ‘pure form’ distraction techniques also were provided as additional pain coping tools. These techniques involve brief, intensive focus on salient physical or auditory stimuli in the client’s immediate environment.[44]

Activity-rest cycling and pleasant activity scheduling[45–47] were used to reduce pain and to enable patients to pace and increase their activity level. In activity-rest cycling, patients identify activities in which they overexert themselves (e.g., housework or shopping), learn to break those up into periods of activity and rest (e.g., 45 minutes of housework followed by 10 minutes of rest), and gradually increase their activity level as they decrease rest. Patients identified activities they enjoy such as reading, doing crafts and hobbies, or visiting friends and set and recorded weekly activity goals.

Cognitive-restructuring was used to help the patient recognize the relationships between thoughts, feelings and behavior.[48] These techniques were used to teach patients to identify irrational, maladaptive thoughts and to replace these with alternative, rational coping thoughts. A self-instructional training intervention developed by Turk et al.[49] was used to help the patient utilize calming self-statements when dealing with severe pain. In addition, basic problem-solving skills involving problem identification, generation of coping alternatives, evaluation of coping alternatives, and selection and implementation of a problem solution were presented and practiced.

In the final session, each patient developed a written maintenance plan that included the list of pain coping skills learned during the study and how they might apply these skills in dealing with future challenges. All content was presented using an investigator developed manual and all patients were given a user friendly patient manual to facilitate training and integration of content.

Our overall goal was to customize the intervention to address the types of catastrophizing-related issues faced by patients who are undergoing knee arthroplasty surgery. Table 2 lists examples of the types of concerns reported by patients in our study and the types of coping skills used to address the concerns. Concerns varied depending on timeframe relative to surgery and the Table is organized to reflect these varying themes.

A single Psychologist provided coping skills training at each site. The Psychologists at Duke University Medical Center (FJK and DM) completed years of extensive training in the implementation of similar protocols, have used similar protocols in other trials and provides training to other Psychologists participating in trials of pain coping skills training. Prior to using the protocol on patients, the Psychologist at Virginia Commonwealth University Medical Center (WTN) attended a 2 day training program and discussed and practiced each treatment session in the protocol during weekly telephone conferences with FJK and DM using role play and feedback.

Analysis

Characteristics of the two cohorts were computed and then compared using t-Tests for continuous variables and Pearson Chi square tests for categorical variables. ANCOVA was used to compare the outcomes for the two groups after adjusting for baseline differences. Models were generated for WOMAC Pain and WOMAC Disability measures as well as the PCS scores obtained at baseline and at 2 months following surgery. Cohen's d effect sizes were reported to describe the magnitude of the treatment effect.[50] SPSS version 17.0.2 was used for all analyses.

RESULTS

A total of 45 patients from the usual care cohort and 18 patients from the pain coping skills cohort were included in the study (see Table 3). Of the 18 patients recruited for pain coping skills training, 15 completed the training. For the three remaining patients, two canceled their surgery and one dropped out of the study after the first training session.

Patients in the pain coping skills group demonstrated a mean improvement in WOMAC Pain scores of 6.9 (sd = 4.7) points while patients in the usual care cohort achieved a mean improvement of 2.6 (sd = 4.8) points (see Table 3). Baseline adjusted discharge score differences among groups for WOMAC Pain were significant at p = 0.017 (F = 6.02, df=1,60). For WOMAC Disability, the pain coping skills cohort improved by 23.5 (sd = 12.4) points while the usual care cohort improved by 11.2 (sd = 13.9) points for a difference among groups of 12.3 WOMAC points. Group differences for baseline adjusted WOMAC Disability discharge scores were significant at p =0.023 (F = 5.44, df=1,60).The pain coping skills cohort improved by 19.6 (sd = 9.6) points on the PCS while the usual care cohort improved by 9.3 (sd = 10.0) points, a difference of 10.3 PCS points among groups. The baseline adjusted difference in discharge PCS scores was significant at p = 0.003 (F = 9.96, df=1,59). Baseline, follow-up and change scores for the two groups of patients, along with Cohen's d effect sizes appear in Table 3.

DISCUSSION

We found that improvement in self reported function and function-related pain following pain coping skills training was substantial relative to the usual care group. The mean improvements in WOMAC Disability scores were 14.3 points greater for the pain coping skills group relative to the usual care group. For the WOMAC Pain scale, the mean difference between groups was 4.2 points. These mean differences are substantially larger than the minimal clinically important difference of approximately 10% of the scale (7 points for WOMAC Disability and 2 or 3 points for WOMAC Pain) reported for WOMAC scores.[51–53] These findings suggest that the pain coping skills intervention holds strong promise for future clinical application. However, our quasi-experimental design precludes firm conclusions regarding the efficacy of the intervention. A definitive trial is clearly warranted based on these preliminary findings.

Pain catastrophizing scale scores demonstrated similar changes to WOMAC scores. Patients in the pain coping skills group had mean change scores that were 10.3 points higher than the usual care group. It is possible that the more dramatic improvements in pain and functional status in the pain coping skills group was mediated by the greater improvements in pain catastrophizing, but our sample size was not large enough to examine this issue. Smeets and colleagues found that pain catastrophizing mediated changes in disability and pain in a randomized trial comparing a cognitive behavioral and a physical treatment to a waiting list group of patients with low back pain.[54] We suspect that a similar mechanism may mediate effects found in our study; a more definitive study with a larger sample size is needed to test this hypothesis. Clinical trials could also include measures of process variables hypothesized to mediate the effects of catastrophizing on pain, such as measures of neurophysiogiocal responses, cognitive and behavioral coping efforts,[12;13] and responses of significant others to pain and then determine the extent to which any treatment-related associations between changes in catastrophizing and pain are mediated by these variables. This type of process research tells not only *if* treatments, such as Pain Coping Skills training, are effective, but can help us to understand *why* these treatments work.[55]

Evidence from randomized clinical trials suggest that pain coping skills training holds promise particularly for patients with chronic musculoskeletal pain. For example, Carson and colleagues found that pain coping skills training resulted in significant improvements over usual care and arthritis education in joint pain ratings and coping efficacy in patients with rheumatoid arthritis.[56] Smeets and colleagues found that a cognitive behavioral treatment emphasizing pain coping was as effective as a combined treatment of exercise and pain coping and more effective than a wait listed control group at reducing pain and disability.[54] There is strong evidence from multiple systematic reviews that pain coping

skills training and other forms of cognitive behavioral therapy are effective in treating patients with various forms of chronic pain.[57–59] Patients with chronic pain often develop maladaptive thought patterns (i.e., catastrophizing) and behaviors (i.e., guarding or inactivity, perhaps due to fear of movement) that contribute to physical and emotional suffering. The primary goal of these interventions is to aid the patient in reconceptualizing his or her view of pain and role in the process of healing so as to promote increased activity and engagement in usual activities (i.e., pain self-management) rather than passive avoidance.

Limitations

Quasi-experimental designs are viable alternatives to randomized clinical trials particularly when innovative interventions are developed and preliminary testing of the intervention is appropriate prior to making a large financial investment in a more definitive trial. As Campbell and Stanley note, the non-equivalent control group design, as was used in this study, must not be confused with the randomized trial in which patient are randomly assigned to different interventions.[60] Because patients in our study were not assigned randomly to the two treatment conditions, we cannot be certain that the differences noted were due to the intervention or to pre-treatment differences among the groups. For example, as noted in Table 1, none of the baseline characteristics were significantly different among the two groups. However, the pain coping group had consistently higher WOMAC Pain, Disability and Pain Catastrophizing Scale scores and there were some differences in marital status and race/ethnicity between the treatment groups. While these differences were not statistically significant, they may have had an influence on the outcome, particularly given the small sample sizes in the study. Another internal validity threat to quasi-experimental designs is history. Our usual care group was treated from one to four years prior to the pain coping skills cohort. While surgical and implant procedures may have varied over the study period, we are unaware of evidence indicating that differences we found may have been due to differences in surgical technique over this relatively short time interval.

Conclusions

Despite the limitations in the design of our study, we found what appears to be very promising effects of pain coping skills training for knee arthroplasty patients with elevated pain catastrophizing. Mean differences in WOMAC Pain, WOMAC Function and Pain Catastrophizing Scale scores between the treatment groups far exceeded clinically important differences. The findings indicate that a definitive trial of pain coping skills training for the subset of knee arthroplasty patients with elevated pain catastrophizing is warranted, particularly because current practice guidelines do not acknowledge the potential effects of catastrophizing in these patients. Despite the preliminary nature of the findings, the results provide an empirical basis for the potential importance of assessing and addressing pain catastrophizing prior to and following surgery.

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Abbreviations

PCS	Pain Catastrophizing Scale
WOMAC	Western Ontario and McMaster Universities Arthritis Index

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Table 1

Characteristics of the patient samples

	Pain Coping Skills Cohort (n=18)	Historical Cohort (n=45)	t-Test or Pearson chi- square Test (p value)
Age (y)	63.8 (11.5)	60.8 (9.9)	−1.0 (0.31)
Sex			
Male	6 (33%)	12 (26.7%)	
Female	12 (67%)	33 (73.3%)	0.01 (0.93)
Marital Status			
Married	7 (38.9%)	27 (60%)	
Not Married	11 (61.1%)	18 (40%)	2.3 (0.13)
Education			
Less than high school	3 (17.6%)	6 (13.6%)	
High School	6 (35.3%)	12 (27.3%)	
Some college	4 (23.5%)	14 (31.8%)	
College degree or higher	4 (23.5%)	12 (27.3%)	0.75 (0.86)
Race/ethnicity			
Black	9 (50.0%)	13 (30.2%)	
White	8 (44.4%)	28 (65.1%)	
Native American	1 (5.6%)	1 (2.3%)	2.1 (0.35)
Baseline WOMAC Pain Score	13.1 (3.6)	11.2 (3.7)	−1.5 (0.14)
Baseline WOMAC Disability Score	41.5 (11.0)	35.3 (12.8)	−1.8 (0.07)
Baseline Pain Catastrophizing Scale Score	29.3 (8.9)	25.8 (11.1)	−1.25 (0.22)

Table 2

Summary of types of patient concerns reported during the pre-operative period, the immediate post-operative period and the later postoperative period along with the primary coping skills taught to deal with the reported concerns

Themes During The Pre-operative Period	Paraphrased Examples of Related Patient Concerns	Primary Coping Skills*
Uncertainty about outcomes of surgery	I've had so many shots, manipulations, pills, and physical therapy attempts, I just don't know if this surgery is going to do the trick	Coping Thoughts; Communicating with Health Care Providers; Goal Setting
Worries and practical concerns about functional limitations	I just feel like I am such a burden to my family	Coping Thoughts; Communicating with Family Members and Friends
	I am the only one available for housework	Problem Solving; Activity-Rest Cycling; Communicating with Family Members and Friends
	I can't drive myself to all of these appointments, but I don't want to ask my family to drop everything for me.	Problem Solving; Communicating with Family Members and Friends
Pain and Pain Management	I'm so frustrated, I can't plan on anything because I don't know when the pain is going to hit, or how bad it is going to be.	Progressive Muscle Relaxation; Mini- Practices; Coping Thoughts; Activity- Rest Cycling; Distraction/Refocusing;
Sleep	The pain is keeping me up nights	Coping Thoughts; Progressive Muscle Relaxation; Distraction/ Refocusing; Communicating with Health Care Providers
Themes During the Immediate Post-Operative Period (up to 2 weeks following surgery)		
Pain, Swelling, and Fatigue	I never thought the pain would continue like this after surgery	Coping Thoughts; Progressive Muscle Relaxation; Mini-Practices; Distraction/Refocusing
Themes During the Later Post-Operative Period (2 weeks to 6 weeks following surgery)		
"Slow" progress	The docs said it may take up to six months, but I never really expected to take that long	Coping Thoughts; Activity-Rest Cycling; Pleasant Activity Scheduling; Goal Setting; Communicating with Health Care Providers
	I really feel like I can push further than my docs or PTs are telling me…what they don't know won't hurt them.	Activity-Rest Cycling; Communicating with Health Care Providers.
Setbacks	Guess what Doc? Now my right knee is shot! Looks like I will never get to enjoy myself	Coping with Setbacks (reviewing CST and applying beneficial skills)

*Gate Control Theory as a skill is "applied" throughout - the model is inherent in each skill and its application to deal with each patient concern.

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Table 3

Key outcome measures collected at baseline and follow-up

	Pain Coping Skills Cohort (n = 15)	Historical Cohort (n = 45)	Adjusted Mean Difference (95% CI)	F test (degrees of freedom)	Cohen's d Effect size[§]
WOMAC Pain					
Baseline	12.9 (3.4)	11.2 (3.7)			
Follow-up[*]	6.0 (4.1)	8.6 (3.7)	**2.8 (0.5, 5.1)**	**6.02 (1)**	0.74
Change score	6.9 (4.7)	2.6 (4.8)			
WOMAC Disability					
Baseline	41.8 (8.5)	35.3 (12.8)			
Follow-up[+]	18.3 (12.2)	24.1 (10.9)	**7.7 (1.1, 14,3)**	**5.44 (1)**	0.71
Change score	23.5 (12.4)	11.2 (13.9)			
Pain Catastrophizing					
Baseline	29.7 (8.7)	25.8 (11.1)			
Follow-up[‡]	10.1 (9.4)	16.5 (12.9)	**9.1 (3.3, 14.9)**	**9.96 (1)**	0.96
Change score	19.6 (9.6)	9.3 (10.0)			

[*] p = 0.017 for differences among discharge scores for the two groups after adjusting for baseline differences.

[+] p = 0.023 for differences among discharge scores for the two groups after adjusting for baseline differences.

[‡] p = 0.003 for differences among discharge scores for the two groups after adjusting for baseline differences

[§] Cohen's d effect sizes were based on adjusted scores for the two groups.