

Pain catastrophizing and related influencing factors in pre-operative total knee arthroplasty in Lanzhou, China : a cross-sectional study

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Research Article

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Abstract

Background

The pain catastrophizing of preoperative total knee arthroplasty (TKA) patients is influenced by many factors and have not been well characterized in the literature. Therefore, the present study aims to investigate the current state and risk factors of pro-operative pain catastrophizing in subjects undergoing TKA.

Methods

This descriptive cross-sectional study was conducted at the orthopaedics ward of two tertiary hospitals in Lanzhou, China. The Chinese version of the Pain Catastrophizing Scale (PCS), the SF-36 (the physical function domain), the Numerical Rating Scale (NRS), the Oxford Knee Score (OKS), the Hospital Anxiety and Depression Scale (HADS) and the Life Orientation Test-Revised (LOT-R) were used.

Results

The study included 360 participants. Among all participants, pro-operative TKA patients' pain catastrophizing was at a high level, with a mean score of 24.92 (SD 12.38). The stepwise multiple linear regression analysis showed that anxiety ($\beta = 0.548$, $P < 0.01$), education level ($\beta = -0.179$, $P < 0.01$), physical function ($\beta = -0.156$, $P < 0.01$), and pain intensity during activity ($\beta = 0.105$, $P = 0.015$) are influencing factors for pain catastrophizing, which could explain 51.2% of the total variation in pain catastrophizing ($F = 95.149$, $P < 0.01$).

Conclusion

Anxiety is the most important variable influencing pain catastrophizing in pro-operative TKA patients, and lower education levels, poor physical function and stronger pain intensity during activity were also associated with higher pain catastrophizing.

Introduction

Total knee arthroplasty (TKA) is considered a common surgical option in patients with end-stage osteoarthritis of the knee and is more effective for relieving pain, stiffness, mobility restrictions, and improving quality of life than non-surgical treatment[1, 2]. The number of TKA procedures has increased substantially in the past 20 years and is expected to continue to grow worldwide as the obesity epidemic expands and the population ages[1, 3]. For example, between 1992 and 2011, the number of primary TKAs performed in the United States more than tripling from 203,600 to 645,100[4].

Although the majority of patients undergoing primary TKA do well, 10%-34% patients after TKA suffer from persistent pain[5]. And persistent chronic pain will increase the patient's health burden, negatively impact quality of life and reduce the satisfaction of surgery[6]. This outcome cannot be fully explained by gender, level of education, comorbidities, body mass index, social support, or other surgical factors[5, 7]. There is growing evidence that the potential impact of preoperative psychological distress, such as pain catastrophizing, anxiety, depression and poor coping skills are related to the development of persistent pain after TKA[8–11], and the role of pain catastrophizing is increasingly being considered.

Pain catastrophizing is characterized by an excessive focus on pain symptoms (rumination), an exaggerated rating of the threat value of pain (magnification) and the awareness to be unable to control the pain (helplessness)[12, 13]. Catastrophizing in a pain context can reduce the patient's compliance with the training program and appears to have a

negative impact on the severity of pain after TKA[12]. A growing amount of evidence demonstrates that preoperative pain catastrophizing has a negative impact on TKA patients, which can lead to persistent pain and poor function[14, 15]. In a systematic review, Sorel et al. examined the influence of preoperative psychological distress on pain and function after TKA, which demonstrated that preoperative pain catastrophizing has a negative impact on pain and function[11]. Burns et al. provided moderate-level evidence for pain catastrophizing as an independent predictor of chronic pain persisting ≥ 3 months following TKA[10]. Riddle et al. indicated that the risk of chronic postsurgical pain in patients with high levels of pain catastrophizing was more than twice than in patients with low level of pain catastrophizing[16]. Additionally, the results of a previous study demonstrated that the pre-operative level of pain catastrophizing in patients determine, in combination with other variables, the length and inter-individual variation in hospital stay after TKA[17].

However, as far as we are concerned, no previous study had explored the risk factors of pain catastrophizing in preoperative TKA. Therefore, the present study aims to investigate the current state and risk factors of pre-operative pain catastrophizing in subjects undergoing TKA. The results of this study may provide evidence for further study in making intervention strategies for the patients with pain catastrophizing undergoing TKA.

Material And Methods

Study Design

This descriptive cross-sectional study was conducted from July to December 2020 at the orthopaedics ward of two tertiary hospitals in Lanzhou, China. The study was approved by the Medical Ethical Committee of Lanzhou University second hospital (Approval Number: 2020A-126).

Inclusion criteria: 1) have a diagnosis of primary knee osteoarthritis, 2) scheduled for primary unilateral TKA secondary knee osteoarthritis, 3) have the ability to speak, write, and understand Chinese language, 4) at least 18 years old, 5) informed written consent. Exclude criteria: 1) prior knee surgery or a scheduled for revision or unicompartmental knee arthroplasty, 2) cognitive and/or neurological disorders that prevented patients from understanding the questionnaires and surveys, 3) complicated with other serious chronic diseases (e.g., cancer, heart failure, kidney failure).

Following study enrollment, every patients completed six questionnaires under the guidance of the well-trained investigators, at the first day of their arrival at the hospital, within prior to patient's surgery. All the data were filled out by the patients themselves independently within 30 minutes, and the investigators were present throughout the visit if participants required explanation or clarification. Participants were verbally given unified guide about the questionnaires. A total of 370 structured questionnaires were distributed and ten of which were ultimately excluded due to incomplete or missing information. In total, 360 valid questionnaires were collected.

Dependent Measure

Pain catastrophizing

Pain catastrophizing was measured by the Chinese version of the Pain Catastrophizing Scale (PCS)[18]. The scale includes 13 items, which describe the thoughts and feelings that patients may experience when they are in pain. The scale was composed of three dimensions: rumination (4 items), magnification (3 items), helplessness (6 items). Patients rate their recent pain-related thoughts using a 5-point Likert scale range from 0 ("not at all") and 4 ("all the time"). The PCS total score is calculated by summing the 13 items that varies from between 0 (no catastrophizing) and 52 (severe catastrophizing), a higher score indicating a higher perceived level of catastrophizing. A PCS score of 30 or more as a cut-off point for pain catastrophizing was proposed by Sullivan[13]. This cutoff was used in previous study with ≥ 16 representing a high degree of pain catastrophizing[19, 20]. Our study utilized a cutoff of ≥ 38 to represent a high degree of pain catastrophizing and which was based on a Chinese study[18], in that the PCS was linguistically translated and

culturally adapted, and the meaning of the original version was sufficiently maintained by idiomatic translation. The Chinese version of PCS has shown high internal consistency with Chronbach's alpha reported to be 0.93 among patients with chronic pain.

Independent Measures

Sociodemographic information

The sociodemographic information including age, gender, weight, height, marital status, educational levels, type of residence, work status and pain durations.

Physical function

The SF-36 is a widely used generic scale consisting of 36 items in 8 sections to evaluate 8 different domains. The participants' physical function was assessed by the physical function (PF) domain in the Chinese version of the SF-36[19]. The PF domain is composed of 10 items and is scored on a scale from 0 to 100, with higher scores representing better physical function.

Pain Intensity

Pre-operative knee pain intensity was measured by a Numerical Rating Scale (NRS), with 0 representing no pain and 10 being worst imaginable pain. These pain scores reflected the participant's either pain at rest or pain during activity.

Oxford Knee Score

The Chinese version of the Oxford Knee Score (OKS) is a self-reported joint-specific questionnaire of pain and function associated with the knee[21]. The scale is composed of 12 items on a 5-point Likert's scale, of which the total score ranges from 0 to 48, with lower scores indicating better functional status.

Symptoms of anxiety and depression

The individual anxiety and depressive symptoms of the participants was evaluated by the Hospital Anxiety and Depression Scale (HADS), which is composed of two 7-item subscales, including anxiety and depression[22]. The responses for 14 items range from 0 to 3. The scores of the two subscales is calculated by the mean scores of the corresponding items for the scores ranging from 0 to 21. A score on subscale is classified into three categories: within the normal range (0-7), suspected anxiety/depression (8-10), and presence of anxiety/depression (≥ 11). The HADS is reliable and valid in Chinese populations, with Cronbach alpha coefficients for the two subscales of 0.76 and 0.79[23].

Optimism and pessimism

Optimism and pessimism were assessed by the Chinese version of the Life Orientation Test-Revised (LOT-R)[24]. This scale consists of 10 items, which are divided into optimism (3 items), pessimism (3 items) and filler items (4 items). Subjects respond to each item using an 5-grade Likert Scale, ranging from 0 (not at all agreement) to 4 (very agreement). The two subscale scores can be calculated, and the total score is the result of adding the optimism to the inverted pessimism score. The LOT-R has satisfactory psychometric properties (Cronbach's alpha=0.78) for the measurement of optimism and pessimism.

Statistical Methods

Statistical analyses were performed using the SPSS 25.0 (IBM Corp., Armonk, NY, USA). Count data was presented as frequency and percentage (%), measurement data was described by means \pm standard deviation (SD). Independent 2 samples t-test and ANOVA was used to compare the pain catastrophizing score in different demographic characteristics of

the patients. Pearson correlation analysis was applied to analyze the correlation between variables. Multivariate linear stepwise regression analysis was utilised to assess the factors associated with pain catastrophizing. For all analyses, $P < 0.05$ was regarded as statistically significant.

Results

Participant sociodemographic characteristics and their influence on pain catastrophizing

The total pain catastrophizing score of pro-operative TKA patients was (24.92 ± 12.38), and the scores of each dimension were rumination (9.00 ± 4.04), magnification (5.08 ± 2.91) and helplessness (10.83 ± 6.31). 360 patients were screened and 70 of these had a PCS score ≥ 38 . The descriptive statistics of the relevant influencing factors of pain catastrophizing were shown in Table 1. ANOVA analysis result in Table 2 revealed that there was a significant difference among pro-operative TKA patients with different gender ($F = -2.412$, $P = 0.016$), education level ($F = 9.934$, $P < 0.01$), marital status ($F = 2.088$, $P = 0.038$), address ($F = -2.847$, $P = 0.005$), medical insurance type ($F = 8.869$, $P < 0.01$) and working status ($F = -3.734$, $P < 0.01$) in score of pain catastrophizing.

Relationships between the study variables

Pearson's correlation analysis result in Table 3 demonstrated that pain catastrophizing was significantly negatively correlated with physical function ($r = -0.416$, $P < 0.01$), and significantly positively correlated with OKS ($r = 0.516$, $P < 0.01$), pain intensity at rest ($r = 0.375$, $P < 0.01$), pain intensity during activity ($r = 0.407$, $P < 0.01$), anxiety ($r = -0.662$, $P < 0.01$), and depression ($r = 0.596$, $P < 0.01$).

Factors influencing pro-operative pain catastrophizing among TKA patients

The diagnosis of colinearity indicates that there was no multicollinearity in all independent variables. Taking pain catastrophizing as the dependent variable, the statistically significant variables in Table 2 and Table 3 were included as independent variables in the stepwise multiple linear regression equation for analysis. The model was statistically significant ($F = 95.149$, $P < 0.01$), which explained 51.2% of the total variance of pain catastrophizing. Anxiety ($\beta = 0.548$, $P < 0.01$), education level ($\beta = -0.179$, $P < 0.01$), physical function ($\beta = -0.156$, $P < 0.01$), and pain intensity during activity ($\beta = 0.105$, $P = 0.015$) were the influencing factors of pain catastrophizing (Table 4).

Discussion

The study explored the current state of pain catastrophizing and its influencing factors among pro-operative TKA patients. The results indicated that the pain catastrophizing of pro-operative TKA patients in our study was higher (24.92 ± 12.38) than that in a previous studies of pro-operative TKA patients in Norway (18.2 ± 12.10)[25], the United States (12.0 ± 10.70)[20] and Germany (14.5 ± 8.3)[26]. The result showed that anxiety, education level, physical function, and pain intensity during activity were influencing factors of pain catastrophizing. At the univariate level, we also found that pain catastrophizing was correlated with gender, marital status, address, medical insurance type and working status.

The results of our study revealed that Chinese pro-operative TKA patients had higher levels of pain catastrophizing, which is similar to the study of Chinese scholar Wang (2013)[27]. The different results could be due to differences in sample size and sociodemographic characteristics of the participants. In addition, differences in regional and cultural backgrounds could also affect the results of the level of pain catastrophizing. A previous study found that African-Americans reported higher pain catastrophizing than white Americans[28]. And another study showed that Chinese undergraduates reported higher levels of pain catastrophizing compared to European Canadian undergraduates students[29].

In this study, we found that the participants with lower education levels were more likely to have pain catastrophizing than individuals with higher education attainment. This finding was consistent with prior studies demonstrating that lower

education level was correlated with higher pain catastrophizing scores[20]. A study in patients with lumbar spinal stenosis also found that those with the higher level of education presented with significantly lower pain catastrophizing scores than those with less education[30]. Previous studies showed that the level of education determines the individual's conceptualization of the disease and their cognitive assessment of physical symptoms and that chronic pain patients with lower education levels were more likely to possess maladaptive pain beliefs and coping strategies[31, 32]. Another potential explanation for the present findings may be that individuals with lower education levels may be particularly disadvantaged to acquiring and assimilating medical knowledge by which to understand and address their pain problem[33].

The current study found anxiety to be the most important factor influencing pain catastrophizing in pro-operative TKA patients. This finding is similar to previous result indicating an association between anxiety and pain catastrophizing related to a chronic pain population, and anxiety as an important factor mediated the relationship between pain catastrophizing and prescription opioid misuse[34]. A recent study by Fillingham et al[35] concluded that screening for preoperative anxiety and referral for treatment may improve patient outcomes and reduce opioid consumption following TKA. Furthermore, considering the higher incidence of anxiety in pro-operative TKA patients[36], developing targeted interventions for anxiety may be important to improve pain catastrophizing. Therefore, healthcare professionals should consider anxiety when assessing pain catastrophizing for pro-operative TKA patients.

We also found that physical function were significant risk factors for pain catastrophizing, consistent with other finding that poor physical function was associated with high pain catastrophizing[20]. Birch et al[37] also found that patients with high levels of preoperative pain catastrophizing have lower physical function. Similarly, in a study by Sullivan et al[38]., that authors indicated that pain catastrophizing could predict both pain and function 12 months after TKA. Another study by Bierke et al[39]. also showed that patients with high pain catastrophizing scores have a significantly lower total KOOS score preoperatively and 6 months postoperatively. On the one hand, patients with TKA have long-term knee osteoarthritis before surgery, and chronic knee joint pain that is repetitive, progressing, and aggravated after movement, which may leads to a feeling of helplessness in pain control. On the other hand, individuals with a higher levels of pain catastrophizing are likely to engage in avoidance and fear of movement and physical activity[40, 41]. None of these studies investigated the causal relationship between pain catastrophizing and physical function.

Similar to previous studies[42, 43], our study found that patients with stronger pain intensity during activity were more likely to experience pain catastrophizing. The result was consistent with a recent study by Larsen et al[44], and authors also pointed out preoperative clinical pain intensity, high levels of pain catastrophizing thoughts, and impaired conditioned pain modulation may predict long-term postoperative pain 12 months after TKA. A review by Quartana et al indicated[45] a relationship of catastrophizing and pain intensity. It has been speculated that patients with stronger pain intensity may over-conceive and exaggerate the impact of pain on their own health and, thus, more likely to develop pain catastrophizing.

Study Limitations

There are some limitations of this study that need to be viewed. First, our study are cross-sectional. Therefore, the causal relationship between pain catastrophizing and other variables in pro-operative TKA patients cannot be explained. In addition, the study was performed in two tertiary hospitals in China, and the results may not be generalizable to other groups. Further, we have only examined a few of the pro-operative factors, and only used quantitative research methods, which make it difficult to understand other factors that may also influence pain catastrophizing.

Conclusion

In conclusion, in current study, we found that the level of pro-operative TKA patients' pain catastrophizing is high. Influencing factors of pain catastrophizing include anxiety, education level, physical function and pain intensity during

activity. Considering that some of those factors could be modified; thus, it was necessary to take into consideration them when formulating targeted interventions for the management of pain catastrophizing in pro-operative TKA patients.

Declarations

Ethics approval and consent to participate

This cross-sectional study was performed in line with the principles of the Declaration of Helsinki and was approved by the Medical Ethical Committee of Lanzhou University second hospital (2020A-126). All participants gave an informed consent prior to participation.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request. Human subject protection requirements, appropriate data privacy as well as institutional requirements must be met.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

All authors have participated in the conception and design of the study. TM, JHP, XFW and JRZ contributed to the study design, and MT and JHP was responsible for data collection. CXL and BLY conducted the data analysis. All authors read and approved the final manuscript.

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Tables

Table 1 Descriptive statistic of the study variables (N=360)

	Pain catastrophizing	Physical function	Pain intensity		Oxford Knee Score	Anxiety	Depressive	Optimism	Pessimism
			At rest	During activity					
Mean	24.92	37.18	3.66	7.26	27.56	7.50	6.66	8.27	6.45
SD	12.38	20.33	2.14	1.82	8.19	4.37	4.54	2.05	2.17
Range	0-52	0-95	0-10	1-10	3-48	0-21	0-21	0-12	0-12

Table 2 Participants' characteristics and pain catastrophizing (N=360)

	Variable	n(%)	Catastrophizing score	Statistic	
			Mean±SD	t/F	P
Gender	Male	61 (16.9)	21.46±13.40	-2.412	0.016
	Female	299 (83.1)	25.63±12.11		
Age	≤60	63 (17.5)	26.54±12.58	2.355	0.096
	60~	211 (58.6)	25.42±12.21		
	≥70	86 (23.9)	22.51±12.46		
Education level	Illiteracy	118 (32.8)	29.46±11.33	9.934	≤0.01
	Primary school	122 (33.9)	23.81±12.29		
	Middle school	54 (15.0)	23.43±12.02		
	High school and above	66 (18.3)	20.08±12.29		
Marital status	Married	305 (84.7)	25.50±12.43	2.088	0.038
	Divorced or widowed	55 (15.3)	21.73±11.70		
BMI[kg/m ²]	≤18.5	8 (2.2)	31.00±10.37	1.646	0.178
	18.5~	117 (32.5)	26.04±13.22		
	24~	160 (44.4)	24.74±11.50		
	≥28	75 (20.8)	22.91±12.84		
Address	Rural area	216 (60.0)	26.42±12.26	-2.847	0.005
	County town and Urban area	144 (40.0)	22.67±12.56		
Medical insurance type	Own expense	5 (1.4)	27.00±11.42	8.869	≤0.01
	SMI and URMI	133 (36.9)	21.41±12.93		
	NRCMI	222 (61.7)	26.98±12.24		
Working status	Yes	94 (26.1)	20.89±11.623	-3.734	≤0.01
	No	266 (73.9)	26.34±12.34		

Note. ANOVA analysis was used to compare the mean score of pain catastrophizing among different groups of pro-operative TKA patients. SMI, Staff Medical Insurance; URMI, Urban Residents Medical Insurance; NRCMI, New Rural Cooperative Medical Insurance

Table 3 Pearson correlation coefficients among the study variables (N=360)

	1	2	3	4	5	6	7	8	9
Pain catastrophizing (1)	1	-0.416**	0.516**	0.375**	0.407**	0.662**	0.596**	0.028	-0.038
Physical function (2)		1	-0.629**	-0.0360**	-0.442**	-0.359**	-0.401**	-0.009	-0.014
OKS (3)			1	0.532**	0.609**	0.575**	0.552**	0.001	0.033
Pain intensity at rest (4)				1	0.618**	0.408**	0.400**	-0.013	-0.054
Pain intensity during activity (5)					1	0.384**	0.399**	-0.060	-0.041
Anxiety (6)						1	0.833**	0.015	0.026
Depression (7)							1	0.048	0.129*
Otimism (8)								1	0.223**
Pessimism (9)								*	1

Note. OKS,Oxford knee score. ** $P \leq 0.01$, * $P \leq 0.05$ (two-tailed)

Table 4. Multiple linear regression analyses predicting pain catastrophizing (N=360)

Dependent variable	Independent variable	<i>B</i>	<i>SE</i>	β	<i>t</i>	<i>P</i>
Pain catastrophizing	(Constant)	16.096	2.889		5.571	≤ 0.01
	Anxiety	1.553	0.116	0.548	13.357	≤ 0.01
	Education level	-2.039	0.425	-0.179	-4.802	≤ 0.01
	Physical function	-0.095	0.026	-0.156	-3.691	≤ 0.01
	Pain intensity during activity	0.713	0.291	0.105	2.451	0.015

Note. B = standardized beta; SE=Standard error

$R=0.719$, $R^2=0.517$, Adjusted $R^2=0.512$, $F=95.149$, $P<0.01$