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Effect of Preoperative Modifiable Psychological and Behavioural Factors on Early Outcome Following Total Knee Arthroplasty in an Indian Population

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Abstract

Background Non-surgical factors have been found to have significant impact on outcome following Total Knee Arthroplasty (TKA). The study was conducted to know the independent effect of each of the four interacting psychological factors: anxiety, depression, pain catastrophizing and kinesiophobia on early outcome following TKA in an Indian population.

Materials and Methods 104 consecutive patients undergoing TKA were included in the study and followed up at 6 weeks, 6 months and one year. Preoperatively, Hospital Anxiety and Depression Scale was used to diagnose and quantify anxiety and depression, pain catastrophizing and kinesiophobia were assessed using Pain Catastrophizing Scale and Tampa Scale for Kinesiophobia, respectively. Outcome was assessed on the basis of Knee Society Score and Knee Injury and Osteoarthritis Outcome Score. Regression analysis was done to know independent effect of each factor on outcome scores.

Results Nine (8.7%) patients were found to have undiagnosed psychopathology. The patients with psychopathologies were found to have significantly worse knee outcome scores on follow-up, although the rate of improvement in knee symptoms and function was not significantly different from those without psychopathology. The degree of Anxiety correlated with worse knee pain and stiffness up to 6 months while it correlated with poor knee function for a longer duration. The degree of depression and pain catastrophizing correlated with worse knee pain, stiffness and function at all visits while kinesiophobia didn't show correlation independent other factors.

Conclusion Psychopathology was found to be associated poor knee outcome scores with degree of preoperative depression and pain catastrophizing as significant independent predictors as poor outcome, whereas the effect of degree of anxiety on knee pain and stiffness was found to wane over time. Kinesiophobia didn't show any independent correlation.

Keywords Pain catastrophizing · Kinesiophobia · Anxiety · Depression · Total knee arthroplasty · Psychological factors · Psychopathology

Introduction

Total Knee Arthroplasty (TKA) is a standard of care for patients with end-stage knee arthritis [1] in elderly patients. The incidence of complications necessitating revision following TKA as determined by national joint registries

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(3.5–7%) [2, 3] is significantly lower than the patients who show suboptimal outcome on patient-reported outcome measures (PROM). The patient satisfaction rate following TKA also varies between 80 and 93% [4, 5]. It has also been observed that a substantial number of patients with poor satisfaction have well fixed and well aligned implants without any perioperative or postoperative complications. The outcome following TKA depends on a multitude of different factors, including age, BMI, education, sex, preoperative mental and physical function status, socio-economic status, comorbidities, ethnicity; [6] in addition to surgical factors such as implant selection, surgical technique and postoperative complication.

The rehabilitation after knee replacement is also dependent upon the will and cooperation of the patient [7], suggesting a role of psychological factors in determining postoperative outcome.

Psychiatric conditions such as depression [6, 8–10] and anxiety [9] have been shown to influence the functional outcome following TKA. Pain catastrophizing comprises a specific set of pain-related cognitive and emotional processes which expresses the degree to which an individual experiences the feelings of helplessness when in pain, one's tendency to ruminate about the pain and the propensity to magnify/diminish the threat value of pain [11] and has been shown to influence functional targets postoperatively [12]. Depression and pain catastrophizing exert their influence on pain via multiple interacting and overlapping pathways and result in adoption of maladaptive patient behaviour to pain [11] but have shown only moderate correlation suggesting catastrophizing as a factor independent of depression. Kinesiophobia, i.e. fear of movement is a state where an individual experiences excessive, irrational, and debilitating fear of physical movement and activity as a result of a feeling of susceptibility to painful injury or re-injury. Based on the cognitive fear-avoidance model [13], it results in the development of long-term inactivity leading to stiffness. Anxiety, depression, pain catastrophizing and kinesiophobia are modifiable factors and taking appropriate interventions for these may help to improve outcome following TKA.

This study was conducted to assess the independent effect of each of the four interacting psychological factors: anxiety, depression, pain catastrophizing and kinesiophobia on early outcome following TKA in Indian population.

Methods

This prospective study was carried out at our Institute after obtaining an approval from the Institute's Ethics Committee. The patients undergoing primary TKA for primary osteoarthritis of knee were included in the study. The exclusion criteria were defined as follows: history of any known previous psychiatric disorder, patient refusal, presence of a comorbidity other than osteoarthritis of knee that could affect the level of actual physical activity, osteoarthritis secondary to trauma, and history of any prior surgical intervention on the knee to be operated. Patients with any detectable major radiological malalignment/loosening or surgical complications were to be excluded. 121 consecutive patients undergoing TKA from November 2013 to June 2014 were considered for the study. Four patients were excluded due to a known psychiatric disorder. 13 patients refused to participate in the study. Informed written consent was obtained from all patients. These patients were operated by the same team of surgeons and followed a similar postoperative treatment regimen. None of the patients showed any major malalignment or loosening in the follow-up period. All patients were followed up for 1 year. None of the patients were lost to follow-up.

Demographic data were collected for all patients involved in the study. Charlson Comorbidity Index [14] was used to determine the comorbidity load among subjects. Undiagnosed psychopathology, i.e. anxiety and depression was identified using Hospital Anxiety and Depression Scale (HADS) [15] which is a 14-item self-assessment scale with 7 items relating to anxiety and depression each to give Anxiety and Depression Subscale scores for each patient. Any patient scoring $\geq 8/21$ in either of subscale scores was classified in psychopathology group. Pain catastrophizing was assessed preoperatively using pain catastrophizing scale (PCS), a 13-item self-report questionnaire as described by Sullivan et al. [16] Kinesiophobia was assessed using 17-item Tampa Scale for Kinesiophobia (TSK) [17].

Postoperative outcome was assessed at 6 weeks, 6 months and 1 year following surgery using Knee Society Score [18] and Knee Injury and Osteoarthritis Outcome Score (KOOS) [19]. KOOS is a self-administered scoring system which assesses the outcome in 5 components: pain (KOOS-P), symptoms (KOOS-S), activities of daily living (KOOS-ADL), sport and recreation function (KOOS-SR), and knee-related quality of life (KOOS-QoL). KSS assesses the outcome in two subcomponents: 7-item Knee Symptom Score for knee pain, stiffness and stability (KSS-KS); and 3-item Functional Score (KSS-FS). Validated Hindi translations of all the scales were used for the patients who could not understand English.

Statistical Analysis

Taking the prevalence patients with Psychological comorbidity as 30% as shown in previous study [6], the minimum sample size was determined to be 84 (Absolute precision taken as ± 10%). All analysis was done using statistical software Stata v.12.0. Baseline demographics were expressed as mean ± SD. Independent sample t test and Fisher exact

or Pearson Chi-square test as appropriate were used to determine the demographic difference between the groups, with significance set at 5% level. The correlations between continuous variables were assessed by Pearson correlation coefficient. Multiple linear regression analysis was done to assess the independent contribution of each individual factor on the outcome.

Results

Of the total 104 patients who completed the study, 77 were females. The mean age of the patient sample at the time of surgery was 64.3 ± 8.6 years. (Table 1).

Psychopathology

Five (4.8%) patients have depressive symptoms, two (1.9%) patients have clinical anxiety, and two (1.9%) have depressive symptoms with anxiety. Hence, a total of nine patients were diagnosed with psychopathology giving an incidence of 8.7% for undiagnosed psychopathology in patients undergoing TKA. No statistically significant difference was observed between the psychopathology and non-psychopathology groups in terms of baseline demographic factors and comorbidity load (Table 1). Psychopathology group showed significantly higher levels of pain catastrophization and kinesiophobia.

Psychopathology group showed significantly lower scores in all components of KSS and KOOS at all visits except for KOOS-QoL component for which statistically significant difference was demonstrable only at 6 months and beyond. No statistically significant difference was observed in rate of improvement in knee scores (change scores) in follow-up visits (Tables 2, 3).

A higher HADS-Anxiety Subscale scores at 6 weeks was significantly associated with worse knee pain, stiffness and function. At 6 months, higher HADS-A scores correlated

Table 1 Baseline demographic data

	Total	Psychopathology		
	($N = 104$)	Yes ($n = 9$)	No ($n = 95$)	p
Gender				
Male	27	0	27	0.06
Female	77	9	68	
Side				
Left	41	4	37	
Right	24	0	24	
Bilateral	39	5	34	
Age				
Mean $\pm$ SD	64.3 ± 8.6	62.8 ± 10.7	64.4 ± 8.4	0.59
CCI				
Mean $\pm$ SD	3.4 ± 0.9	3.3 ± 1.3	3.4 ± 0.9	0.96
PCS				
Mean $\pm$ SD	30.2 ± 10.9	42.0 ± 11.8	29.1 ± 10.2	< 0.001
TSK				
Mean $\pm$ SD	44.9 ± 5.8	50.2 ± 2.3	44.4 ± 5.7	0.003

Significance: $p < 0.05$

Table 2 Pain and stiffness outcome between the groups

	KOOS-Pain			KOOS-Stiffness			KSS Knee Score		
	PP	Non-PP	p	PP	Non-PP	p	PP	Non-PP	p
6 weeks									
	68.9 ± 9.7	86.5 ± 6.3	0.001	65.7 ± 17.2	95.0 ± 7.2	0.001	53.1 ± 14.1	76.3 ± 9.6	0.001
B ($p*$)	15.7 ± 2.2 (**0.001**)			24.2 ± 3.3 (**0.001**)			11.3 ± 3.3 (**0.001**)		
6 months									
	66.7 ± 17.2	92.7 ± 4.7	0.001	80.6 ± 11.0	99.3 ± 3.0	0.001	78.1 ± 6.2	88.6 ± 3.5	0.001
B ($p*$)	23.3 ± 2.2 (**0.001**)			23.3 ± 2.2 (**0.001**)			8.0 ± 1.4 (**0.001**)		
©(6mth)									
	28.7 ± 11.4	26.5 ± 9.1	0.49	19.8 ± 12.7	23.4 ± 10.1	0.33	42.0 ± 3.1	39.3 ± 11.3	0.484
B($p*$)	-4.5 ± 3.6 (**0.21**)			1.9 ± 4.0 (**0.644**)			-1.0 ± 4.2 (**0.81**)		
1 year									
	68.0 ± 15.0	96.0 ± 3.6	0.001	74.6 ± 16.7	99.5 ± 4.4	0.001	78.3 ± 6.6	92.3 ± 3.0	0.001
B ($p*$)	25.1 ± 1.9 (**0.001**)			22.9 ± 2.3 (**0.001**)			15.0 ± 1.1 (**0.001**)		
©(1 yr)									
	32.4 ± 11.9	29.8 ± 9.1	0.43	19.8 ± 12.7	23.1 ± 11.0	0.40	45.8 ± 5.2	42.7 ± 10.2	0.381
B ($p*$)	-5.9 ± 3.9 (**0.13**)			1.6 ± 4.3 (**0.71**)			-1.2 ± 4.1 (**0.77**)		

Significance: $p < 0.05$ (in bold)

PP Psychopathology Group, *Non-PP* Non-Psychopathology Group, p pre-regression p-value, B(p) Unstandardized Coefficients(post-regression p-value); ©(6mth): Change in score at 6 months; ©(1 yr): Change in score at 1 year

Table 3 Functional outcome between the groups

	KOOS-ADL			KOOS-Sports and Recreation			KOOS Quality of Life			KSS Function Score		
	PP	Non-PP	p	PP	Non-PP	p	PP	Non-PP	p	PP	Non-PP	p
6 weeks	75.9±9.7	93.3±3.4	0.001	59.4±8.8	70.1±12.7	0.016	50.7±6.3	66.4±11.4	0.001	34.4±42.2	77.7±16.4	0.001
B (p*)	16.1±1.7 (**0.001**)			11.3±4.9 (**0.02**)			2.5±3.6 (**0.48**)			31.0±7.1 (**0.001**)		
6 months	82.2±8.4	94.8±2.4	0.001	64.4±8.8	77.5±9.5	<0.001	63.1±14.1	82.1±8.4	0.001	76.7±13.2	94.4±14.9	0.001
B (p*)	11.0±1.1 (**0.001**)			18.7±3.2 (**0.001**)			12.1±2.9 (**0.001**)			13.0±5.8 (**0.03**)		
©(6mth)	21.6±8.1	24.3±12.2	0.51	41.1±9.9	37.8±8.9	0.29	29.9±11.2	36.6±11.1	0.08	70.6±21.3	62.9±15.8	0.18
B (p*)	1.9±4.7 (**0.68**)			−2.6±3.5 (**0.46**)			3.6±4.3 (**0.41**)			−11.5±6.3 (**0.07**)		
1 year	79.7±9.8	97.3±3.3	0.001	65.0±14.4	88.0±4.5	0.001	63.1±14.1	91.7±4.6	0.001	76.7±13.2	99.7±3.1	0.001
B (p*)	17.2±1.6 (**0.001**)			22.6±1.9 (**0.001**)			26.4±2.2 (**0.001**)			20.9±1.7 (**0.001**)		
©(1 yr)	23.9±9.3	26.3±11.9	0.55	48.9±9.9	47.6±10.0	0.72	41.0±14.7	44.9±12.3	0.37	71.7±21.8	68.1±1.6	0.53
B (p*)	1.2±4.6 (**0.80**)			−1.0±3.9 (**0.81**)			2.5±4.9 (**0.60**)			−5.7±6.4 (**0.37**)		

Significance: $p < 0.05$ (in bold)

PP Psychopathology Group, *Non-PP* Non-Psychopathology Group, *p* pre-regression *p*-value, B(*p*) Unstandardized Coefficients(post-regression *p*-value); ©(6mth): Change in score at 6 months; ©(1 yr): Change in score at 1 year

significantly with worse knee pain, function and knee-related quality of life but not stiffness. HADS-Anxiety Subscale score didn't show any significant correlation with pain and stiffness at 1 year although it correlated significantly with worse KOOS Daily Life Activity Score (Tables 4, 5).

HADS-Depression Subscale score showed significant correlation with worse knee pain, stiffness and function at all visits. Poor sports & recreation function and knee-related quality of life scores correlated significantly with higher HADS-D scores at 6 months and beyond (Tables 4, 5).

Pain Catastrophization

PCS scores show significant correlation with knee pain, stiffness, function and quality of life at 6 months and beyond. At 6 weeks, PCS scores correlated significantly with poor knee pain, stiffness and knee-related quality of life but not function (Tables 4, 5).

Kinesiophobia

TSK scores didn't show significant correlation with knee pain, stiffness and function at 6 months and beyond. However, at 6 weeks, TSK scores correlated significantly with worse KSS symptoms and function scores (Tables 4, 5).

Discussion

Our study has shown psychopathology to be associated with significantly worse knee pain, symptoms and function with no statistically significant difference in the rate of improvement similar to the results of previous studies [6, 9, 10, 20–24]. Lingard et al. [20] observed only knee pain to be significantly worse in psychologically distressed patients but not knee function.

Our study has demonstrated the incidence of undiagnosed psychiatric illness to be 8.7%. An Indian study [25] has determined the incidence of undiagnosed depression in patients presenting to Orthopaedics clinic or out patient department to be 13.8%. A recent meta-analysis [26] found the weighted mean prevalence of preoperative depression in patients undergoing arthroplasty to be 22.9%.

The degree of anxiety assessed by HADS-A score correlated with knee function at 1 year but not with pain and stiffness, although it was found to influence knee pain and stiffness for shorter duration only (up to 6 weeks for all three and up to 6 months for pain and function). Previous studies with follow-up ≤ 6 months by Lopez-Olivio et al. [27] and Riddle et al. [28] didn't show anxiety to be associated with postoperative pain at 6 months follow-up unlike Noiseux et al. [29] and Feeney [24]. Studies by Brander et al. [9, 23] showed trait anxiety to be a significant predictor of worse

knee pain and function at 1 year but of worse knee function only at a longer follow-up of 5 years. Hence, anxiety has a longer lasting influence on knee function unlike knee pain and stiffness.

The degree of depression as assessed by HADS-D score showed significant correlation with knee pain, symptoms and function at all visits. The results are in line with studies by Fisher et al. [10] and Caracciolo et al. [22] Brander et al. [9] also showed depression to be a significant predictor of poor postoperative function but not pain at 5-year follow-up. Hence, over a longer follow-up, knee pain might improve in patients with higher degree of depression but they will continue to have poorer knee function. Of the five studies [27, 28, 30–32] which have studied depression along pain catastrophizing and other coping mechanisms, the studies by Sullivan et al. [30, 31] and Riddle et al. [28] didn't show degree of depression to be a significant independent predictor of outcome following TKA unlike the study by Lopez-Olivio et al. [27] which showed degree of depression to be a significant predictor of knee function independent of pain catastrophizing. Edwards et al. [32] showed depression to be a significant independent predictor of postoperative pain at 12 months but didn't evaluate knee function. The discrepancy from the results of our study may be due to use of different tools for assessing depression as well as knee outcome (WOMAC scores which have a higher MCID [33] than KOOS) and shorter follow-up duration in all but one study [31].

It was observed in our study that pain catastrophization levels were a significant independent predictor of knee pain and symptoms as has been seen by previous authors also [28, 30–32, 34]. In our study with a follow-up of 1 year, pain catastrophization was also a significant predictor for knee function. It has been seen in earlier studies with follow-up periods ≤ 6 months [28, 30] that pain catastrophization had no significant correlation with knee function but a study [31] with longer follow-up of 12 months showed pain catastrophization levels to be significant predictor of knee function (independent of depression) which is similar to our findings.

Kinesiophobia was not a significant independent predictor of knee pain, stiffness and function in our study similar to results of previous study by Sullivan et al. [30, 31] and Riddle et al. [28] Studies by Kocic et al. [35] and Doury-Panchout et al. [36] showed kinesiophobia as a significant predictor of poor knee pain and function but these studies didn't evaluate pain catastrophizing, anxiety and depression.

Strengths

This study has evaluated independent influence on TKA of the four major psychological and behavioural factors showing significant interactions amongst themselves. All previous

Table 4 Relationship between Psychological factors and Pain and Stiffness

	KOOS-Pain				KOOS-Stiffness				KSS Knee Score			
	r (p)	B (β)	ρ (p^*)	R^2	r (p)	B (β)	ρ (p^*)	R^2	r (p)	B (β)	ρ (p^*)	R^2
6 Weeks												
HADS-A	−0.19 (0.052)	−1.13 (−0.22)	−0.22 (0.028)	0.387	−0.29 (0.003)	−1.65 (−0.23)	−0.22 (0.03)	0.327	−0.44 (<0.001)	−3.12 (−0.43)	−0.42 (<0.001)	0.448
HADS-D	−0.33 (<0.001)	−1.07 (−0.33)	−0.37 (<0.001)		−0.38 (<0.001)	−1.54 (−0.33)	−0.36 (<0.001)		−0.08 (0.42)	−0.05 (−0.01)	−0.01 (0.89)	
PCS	−0.27 (0.006)	−0.374 (−0.50)	−0.36 (<0.001)		−0.38 (<0.001)	−0.43 (−0.40)	−0.28 (0.005)		−0.53 (<0.001)	−0.78 (−0.72)	−0.51 (<0.001)	
TSK	−0.23 (0.02)	0.31 (0.22)	0.17 (0.11)		−0.25 (0.01)	0.28 (0.14)	0.10 (0.33)		−0.29 (0.003)	−0.85 (0.41)	−0.31 (0.002)	
6 Months												
HADS-A	−0.21 (0.03)	−1.15 (−0.19)	−0.22 (0.03)	0.563	−0.25 (0.01)	−0.55 (−0.13)	−0.15 (0.13)	0.535	−0.35 (<0.001)	−0.67 (−0.23)	−0.22 (0.03)	0.330
HADS-D	−0.54 (<0.001)	−1.90 (−0.49)	−0.57 (<0.001)		−0.55 (<0.001)	−1.33 (−0.50)	−0.57 (<0.001)		−0.29 (0.003)	−0.52 (−0.28)	−0.31 (0.002)	
PCS	−0.47 (<0.001)	−0.64 (−0.71)	−0.55 (<0.001)		−0.49 (<0.001)	−0.34 (−0.55)	−0.44 (<0.001)		−0.44 (<0.001)	−0.017 (−0.39)	−0.28 (0.006)	
TSK	−0.14 (0.17)	0.79 (0.46)	0.39 (<0.001)		−0.26 (0.008)	0.22 (0.19)	0.16 (0.11)		−0.32 (0.001)	0.07 (0.08)	0.06 (0.57)	
1 Year												
HADS-A	−0.21 (0.03)	−0.62 (−0.10)	−0.12 (0.24)	0.525	−0.15 (0.14)	−0.11 (−0.02)	−0.02 (0.83)	0.505	−0.12 (0.22)	−0.02 (−0.01)	−0.01 (0.91)	0.740
HADS-D	−0.57 (<0.001)	−1.96 (−0.51)	−0.58 (<0.001)		−0.53 (<0.001)	−1.86 (0.50)	−0.56 (<0.001)		−0.79 (<0.001)	−1.48 (−0.71)	−0.80 (<0.001)	
PCS	−0.42 (<0.001)	−0.38 (−0.43)	−0.36 (<0.001)		−0.45 (<0.001)	−0.46 (−0.53)	−0.42 (<0.001)		−0.36 (<0.001)	−0.17 (−0.36)	−0.40 (<0.001)	
TSK	−0.24 (0.01)	0.16 (0.10)	0.08 (0.42)		−0.22 (0.02)	0.24 (0.15)	0.13 (0.22)		−0.11 (0.26)	0.12 (0.13)	0.15 (0.13)	

r (p): Pearson Correlation Coefficient (p-value); B (β): Unstandardized Coefficients (Standardized Coefficients); ρ (p^*): Partial Correlation (post-regression p-value); Significance: $p < 0.05$

Table 5 Relationship between Psychological factors and Functional Outcome

	KSS Function Score				KOOS Activities of Daily Life				KOOS-Sports and Recreation				KOOS Quality of Life			
	r (p)	B (β)	ρ (p*)	R²	r (p)	B (β)	ρ (p*)	R²	r (p)	B (β)	ρ (p*)	R²	r (p)	B (β)	ρ (p*)	R²
6 Weeks																
HADS-A	−0.43 (<0.001)	−3.14 (−0.22)	−0.21 (0.036)	0.342	−0.20 (0.04)	−0.85 (−0.21)	−0.20 (0.04)	0.353	−0.16 (0.10)	−1.85 (−0.24)	−0.21 (0.04)	0.219	−0.58 (<0.001)	−3.39 (−0.46)	−0.47 (<0.001)	0.512
HADS-D	−0.29 (0.003)	−2.04 (−0.22)	−0.25 (0.012)		−0.47 (<0.001)	−1.18 (−0.45)	−0.47 (<0.001)		−0.22 (0.02)	−0.93 (−0.18)	−0.20 (0.055)		0.006 (0.95)	0.28 (0.06)	0.08 (0.44)	
PCS	−0.39 (<0.001)	0.003 (0.001)	0.001 (0.99)		−0.24 (0.015)	−0.13 (−0.22)	−0.17 (0.10)		−0.21 (0.04)	−0.62 (−0.53)	−0.34 (0.001)		−0.58 (<0.001)	−0.56 (−0.51)	−0.41 (<0.001)	
TSK	−0.43 (<0.001)	−1.31 (−0.33)	−0.24 (0.02)		−0.09 (0.34)	0.21 (0.18)	0.13 (0.19)		−0.07 (0.47)	0.95 (0.43)	0.28 (0.005)		−0.40 (<0.001)	0.44 (0.21)	0.17 (0.08)	
6 Months																
HADS-A	−0.34 (<0.001)	−2.40 (−0.25)	−0.22 (0.03)	0.195	−0.18 (0.07)	−0.48 (−0.16)	−0.17 (0.09)	0.464	−0.10 (0.93)	−1.06 (−0.17)	−0.19 (0.07)	0.484	−0.46 (<0.001)	−2.66 (−0.42)	−0.47 (<0.001)	0.608
HADS-D	−0.18 (0.06)	−0.87 (−0.14)	−0.15 (0.15)		−0.46 (<0.001)	−0.79 (−0.41)	−0.47 (<0.001)		−0.55 (<0.001)	−2.08 (−0.52)	−0.57 (<0.001)		−0.31 (0.002)	−0.92 (−0.23)	−0.32 (0.001)	
PCS	−0.35 (<0.001)	−0.41 (−0.29)	−0.19 (0.06)		−0.40 (<0.001)	−0.31 (−0.69)	−0.50 (<0.001)		−0.09 (0.35)	−0.50 (−0.54)	−0.42 (<0.001)		−0.60 (<0.001)	−0.70 (−0.74)	−0.58 (<0.001)	
TSK	−0.24 (0.015)	0.28 (0.10)	0.07 (0.496)		−0.14 (0.16)	0.35 (0.41)	0.32 (0.001)		0.12 (0.25)	1.02 (0.58)	0.44 (<0.001)		−0.194 (0.05)	0.96 (0.54)	0.46 (<0.001)	
1 Year																
HADS-A	−0.19 (0.049)	−0.27 (−0.06)	−0.07 (0.52)	0.561	−0.23 (0.02)	−0.71 (−0.18)	−0.21 (0.043)	0.549	−0.19 (0.06)	−0.75 (−0.14)	−0.19 (0.07)	0.658	−0.26 (0.009)	−0.55 (−0.09)	−0.11 (0.28)	0.567
HADS-D	−0.58 (<0.001)	−1.72 (.023)	−0.61 (<0.001)		−0.62 (<0.001)	−1.50 (−0.58)	−0.63 (<0.001)		−0.65 (<0.001)	−2.09 (−0.60)	−0.70 (<0.001)		−0.63 (<0.001)	−2.22 (−0.57)	−0.63 (<0.001)	
PCS	−0.47 (<0.001)	−0.36 (−0.49)	−0.41 (<0.001)		−0.38 (<0.001)	−0.25 (−0.42)	−0.36 (<0.001)		−0.45 (<0.001)	−0.53 (−0.66)	−0.57 (<0.001)		−0.44 (<0.001)	−0.28 (−0.31)	−0.28 (0.006)	
TSK	−0.26 (0.008)	0.15 (0.11)	0.10 (0.36)		−0.14 (0.16)	0.29 (0.25)	0.22 (0.03)		−0.11 (0.28)	0.65 (0.43)	0.41 (<0.001)		−0.33 (0.001)	−0.14 (−0.08)	−0.07 (0.47)	

r(p): Pearson Correlation Coefficient (p-value); B(β): Unstandardized Coefficients(Standardized Coefficients); ρ(p*): Partial Correlation(post-regression p-value); Significance: p < 0.05

studies have simultaneously studied up to 3 of these factors leaving scope for confounding.

Secondly, this study has utilized validated disease specific patient-reported simple scoring systems for diagnosis and quantification of psychological factors improving its accuracy. Many previous studies have utilized Mental Component Score of SF-36(SF36-MCS) [20, 21] or patient self-reporting [10] for the diagnosis of psychopathology. While SF36-MCS is a non-specific diagnostic tool with a tendency to overestimate the psychological distress, self-reporting might underestimate the psychopathology burden. Being short and simple, these scales can be used in an outpatient setting for convenient identification of patients requiring appropriate intervention before surgery for these factors.

Thirdly, the inclusion of patients with undiagnosed psychopathology has eliminated any influence of treatment for psychiatric ailments on the outcome.

Limitations

The follow-up period is limited to 1 year only which may preclude reporting of any further improvement. However, previous studies [20, 37–39] have demonstrated maximum improvements in the first 6 to 12 months postoperatively with limited further improvement thereafter.

Secondly, the use of KSS which has a higher intra- and inter-observer error [6] as well as higher MCID curtailing accuracy. Simultaneous use of KOOS has overcome this limitation to a certain extent.

Thirdly, the psychological factors have not been evaluated postoperatively. One previous study [22] demonstrated significant difference between pre- and postoperative HADS scores whereas two previous studies [34, 40] have shown PCS and TSK scores to remain constant postoperatively. However, since the rate of improvement postoperatively is not significantly different in those with psychiatric distress, any intervention has to be made preoperatively only minimizing the utility of postoperative scores for psychiatric distress.

Conclusions

Our study has shown pain catastrophizing and depression to correlate independently with poor knee pain, stiffness and function while kinesiophobia fails to show any influence independent of other factors. Anxiety appears to influence knee pain and stiffness negatively for a short duration only with subsequent recovery while the influence on knee function is longer lasting.

Since there is no significant difference in postoperative rates of improvement, any intervention for psychopathology must be initiated and completed before the surgical

intervention for improving preoperative knee symptoms and function, and the presence of psychopathology should not be a contraindication for TKA as the patients with psychopathology continue to show similar improvement albeit from a lower base.

Compliance with Ethical Standards

References

1. Genêt, F., Schnitzler, A., Lapeyre, E., Roche, N., Autret, K., Fermanian, C., & Poiraudeau, S. (2008). Change of impairment, disability and patient satisfaction after total knee arthroplasty in secondary care practice. *Ann Readapt Med Phys, 51*, 671–676, 676–682. English, French.

2. Baker, P. N., van der Meulen, J. H., Lewsey, J., Gregg, P. J., & National Joint Registry for England and Wales. (2007). The role of pain and function in determining patient satisfaction after total knee replacement: data from the National Joint Registry for England and Wales. *J Bone Joint Surg Br, 89,* 893–900.

3. Kurtz, S. M., Ong, K. L., Schmier, J., Mowat, F., Saleh, K., Dybvik, E., et al. (2007). Future clinical and economic impact of revision total hip and knee arthroplasty. *Journal of Bone and Joint Surgery. American Volume, 89*(Suppl 3), 144–151.

4. Kim, T. K., Chang, C. B., Kang, Y. G., Kim, S. J., & Seong, S. C. (2009). Causes and predictors of patient's dissatisfaction after uncomplicated total knee arthroplasty. *Journal of Arthroplasty, 24,* 263–271.

5. Thambiah, M. D., Nathan, S., Seow, B. Z. X., Liang, S., & Lingaraj, K. (2015). Patient satisfaction after total knee arthroplasty: an Asian perspective. *Singapore Medical Journal, 56*(5), 259–263.

6. Ellis, H. B., Howard, K. J., Khaleel, M. A., Bucholz, R. (2012). Effect of psychopathology on patient-perceived outcomes of total knee arthroplasty within an indigent population. *J Bone Joint Surg Am 94,* e84(1–8). https://doi.org/10.2106/jbjs.k.00888. (PMID: 22717836).

7. Flanigan, D. C., Everhart, J. S., & Glassman, A. H. (2015). Psychological factors affecting rehabilitation and outcomes following elective orthopaedic surgery. *Journal of American Academy of Orthopaedic Surgeons, 23*(9), 563–570.

8. Singh, J. A., O'Byrne, M. M., Colligan, R. C., & Lewallen, D. G. (2010). Pessimistic explanatory style: a psychological risk factor for poor pain and functional outcomes two years after knee replacement. *The Journal of Bone and Joint Surgery, 92,* 799–806.

9. Brander, V., Gondek, S., Martin, E., & Stulberg, S. D. (2007). Pain and depression influence outcome 5 years after knee replacement surgery. *Clinical Orthopaedics and Related Research, 464,* 21–26.

10. Fisher, D. A., Dierckman, B., Watts, M. R., & Davis, K. (2007). Looks good but feels bad: factors that contribute to poor results after total knee arthroplasty. *Journal of Arthroplasty, 22*(6 Suppl 2), 39–42.

11. Edwards, R. R., Cahalan, C., Mensing, G., Smith, M., & Haythornthwaite, J. A. (2011). Pain catastrophizing and depression in the rheumatic diseases. *Nature Reviews Rheumatology, 7,* 216–224.

12. Kendell, K., Saxby, B., Farrow, M., & Naisby, C. (2001). Psychological factors associated with short term recovery from total knee replacement. *British Journal of Health Psychology, 6,* 41–52.

13. Leeuw, M., Goossens, M. E. J. B., Linton, S. J., Crombez, G., Boersma, K., & Vlaeyen, J. W. S. (2007). The fear-avoidance model of musculoskeletal pain: current state of scientific evidence. *Journal of Behavioral Medicine, 30*(1), 77–94.

14. Deyo, R. A., Cherkin, D. C., & Ciol, M. A. (1992). Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. *Journal of Clinical Epidemiology, 45*(6), 613–619.

15. Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta Psychiatrica Scandinavica, 67*(6), 361–370.

16. Sullivan, M. J. The Pain Catastrophizing Scale: User Manual.

17. Miller, R. P., Kori, S. H., & Todd, D. D. (1991). The tampa scale: A measure of kinisophobia. *The Clinical Journal of Pain, 7*(1), 51.

18. Insall, J. N., Dorr, L. D., Scott, R. D., & Scott, W. N. (1989). Rationale of the Knee Society clinical rating system. *Clinical Orthopaedics and Related Research, 248,* 13–14.

19. Roos, E. M., & Lohmander, L. S. (2003). The knee injury and osteoarthritis outcome score (KOOS): From joint injury to osteoarthritis. *Health Qual Life Outcomes, 1,* 64.

20. Lingard, E. A., & Riddle, D. L. (2007). Impact of psychological distress on pain and function following knee arthroplasty. *Journal of Bone and Joint Surgery. American Volume, 89,* 1161–1169.

21. Ayers, D. C., Franklin, P. D., Trief, P. M., Ploutz-Snyder, R., & Freund, D. (2004). Psychological attributes of preoperative total joint replacement patients. *Journal of Arthroplasty, 19*(7 Suppl. 2), 125–130.

22. Caracciolo, B., & Giaquinto, S. (2005). Self-perceived distress and self-perceived functional recovery after recent total hip and knee arthroplasty. *Archives of Gerontology and Geriatrics, 41,* 177–181.

23. Brander, V. A., Stulberg, S. D., Adams, A. D., Harden, R. N., Bruehl, S., Stanos, S. P., et al. (2003). Predicting total knee replacement pain: a prospective, observational study. *Clinical Orthopaedics, 416,* 27–36.

24. Feeney, S. L. (2004). The relationship between pain and negative affect in older adults: anxiety as a predictor of pain. *Journal of Anxiety Disorders, 18*(6), 733–744.

25. Kohli, C., Kishore, J., Agarwal, P., & Singh, S. V. (2013). Prevalence of unrecognised depression among outpatient department attendees of a rural hospital in Delhi, India. *Journal of Clinical and Diagnostic Research, 7,* 1921–1925.

26. Scott, J. E., Mathias, J. L., & Kneebone, A. C. (2011). Depression and anxiety after total joint replacement among older adults: A meta-analysis. *Aging Ment Health, 20,* 1243–1254.

27. Lopez-Olivio, M. A., Landon, G. C., Siff, S. J., Edelstein, D., Pak, C., Kallen, M. A., et al. (2011). Psychosocial determinants of outcomes in knee replacement. *Annals of the Rheumatic Diseases, 70,* 1775–1781.

28. Riddle, D. L., Wade, J. B., Jiranek, W. A., & Kong, X. (2010). Preoperative pain catastrophizing predicts pain outcome after knee arthroplasty. *Clinical Orthopaedics and Related Research, 468,* 798–806.

29. Noiseux, N. O., Callaghan, J. J., Clark, C. R., Zimmerman, M. B., Sluka, K. A., & Rakel, B. A. (2014). Preoperative predictors of pain following total knee arthroplasty. *Journal of Arthroplasty, 29*(7), 1383–1387.

30. Sullivan, M., Tanzer, M., William, S., Fallaha, M., Keefe, F. J., Simmonds, M., et al. (2009). Psychological determinants of problematic outcomes following Total Knee Arthroplasty. *Pain, 143*(1–2), 123–129.

31. Sullivan, M., Tanzer, M., Reardon, G., Amirault, D., Dunbar, M., & Stanish, W. (2011). The role of presurgical expectancies in predicting pain and function one year following total knee arthroplasty. *Pain, 152,* 2287–2293.

32. Edwards, R. R., Haythornthwaite, J. A., Smith, M. T., Klick, B., & Katz, J. N. (2009). Catastrophizing and depressive symptoms as prospective predictors of outcomes following total knee replacement. *Pain Research and Management, 14*(4), 307–311.

33. Dowsey, M. M., & Choong, P. F. M. (2013). The utility of outcome measures in total knee replacement surgery. *International Journal of Rheumatology, 2013,* 506518. https://doi.org/10.1155/2013/506518. **(PMID: 24288541)**.

34. Forsythe, M. E., Dunbar, M. J., Hennigar, A. W., Sullivan, M. J., & Gross, M. (2008). Prospective relation between catastrophizing and residual pain following total knee arthroplasty: two-year follow-up. *Pain Research & Management, 13*(4), 335–341.

35. Kocic, M., Stankovic, A., Lazovic, M., Dimitrijevic, L., Stankovic, I., Spalevic, M., et al. (2015). Influence of fear of movement on total knee arthroplasty outcome. *Annali Italiani di Chirurgia, 86,* 148–155.

36. Doury-Panchout, F., Metivier, J. C., & Fouquet, B. (2015). Kinesiophobia negatively influences recovery of joint function following total knee arthroplasty. *European Journal of Physical and Rehabilitation Medicine, 51,* 155–161.

37. Biring, G. S., Masri, B. A., Greidanus, N. V., Duncan, C. P., & Garbuz, D. S. (2007). Predictors of quality of life outcomes after revision total hip replacement. *Journal of Bone and Joint Surgery. British Volume, 89*(11), 1446–1451.

38. Ng, C. Y., Ballantyne, J. A., & Brenkel, I. J. (2007). Quality of life and functional outcome after primary total hip replacement: A five-year follow-up. *The Journal of Bone and Joint Surgery, 89*(7), 868–873.

39. Maloney, W. J., Schurman, D. J., Hangen, D., Goodman, S. B., Edworthy, S., & Bloch, D. A. (1990). The influence of continuous passive motion on outcome in total knee arthroplasty. *Clinical Orthopaedics and Related Research, 256,* 162–168.

40. Roth, M. L., Tripp, D. A., Harrison, M. H., Sullivan, M., & Carson, P. (2007). Demographic and psychosocial predictors of acute perioperative pain for total knee arthroplasty. *Pain Research & Management, 12*(3), 185–194.