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Understanding Kinesiophobia: Predictors and Influence on Early Functional Outcomes in Patients with Total Knee Arthroplasty

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Abstract: Kinesiophobia (fear of movement) has been recognized as a significant barrier to recovery and rehabilitation in patients after total knee arthroplasty (TKA). Our goal was to identify predictors of kinesiophobia and examine its correlation with early functional outcomes in TKA recipients. On the first and fifth postoperative days (POD1 and POD5), we evaluated pain using the International Pain Outcomes Questionnaire (IPO-Q) and created multidimensional pain composite scores (PROs). Functional status on POD 5 was determined by the Barthel index, 6-minute walking test, and knee range of motion. Kinesiophobia was measured on POD5 using the Tampa Scale for Kinesiophobia (TSK) and multivariable logistic regression was used to assess factors associated with kinesiophobia. Among 75 TKA patients, 27% exhibited kinesiophobia. The final regression model highlighted PRO1 (OR = 1.6, CI = 1.1–2.5), PRO2 (OR = 2.1, CI = 1.3–3.5), and education level (OR = 0.6, CI = 0.04–10.6) as significant kinesiophobia predictors. On POD5, those with kinesiophobia showed increased dependency, slower gait, and poorer knee extension recovery. Pain is a significant predictor of kinesiophobia after TKA. Furthermore, kinesiophobia has a significant impact on early functional outcomes after surgery. Using composite pain scores for pain evaluation offers a more comprehensive approach to understanding the connection between pain and kinesiophobia.

Keywords: kinesiophobia; TKA; pain; functional recovery

1. Introduction

Total knee arthroplasty (TKA) is an effective treatment option for patients with end-stage knee osteoarthritis providing pain relief, functional improvement, and health-related quality of life. Due to increasing levels of obesity, population aging, and growth in sports-related injuries, the incidence of TKA is high [1]. Between 2000 and 2014, the estimated annual numbers of primary TKA increased by 148% in the United States. Based on this data Sloan et al. showed that the projected growth for TKA procedures will reach 935,000 annually by 2030 in the US [2].

The primary outcomes of the procedure are to improve the patient's mobility in the early postoperative period, enhance their functionality, alleviate pain significantly, and enhance self-confidence due to improved functionality [3].

However, TKA is a painful procedure. The number of patients reporting moderate-severe pain after TKA remained relatively constant, with 58% reporting moderate-severe pain on postoperative day 1 (POD1), which only decreased to 43% by postoperative day 3 (POD3) [4]. Pain in the postoperative period affects rehabilitation and increases the risk of complications in the acute phases and of developing chronic pain after surgery. Furthermore, up to 20% of patients are dissatisfied with the results of their surgery due to persistent pain and disability [5].

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Additional psychological factors, such as pain catastrophizing, pain-related fear of movement, and depression have been identified as contributors to prolonged pain and disability in individuals with different musculoskeletal conditions [6]. Patients may delay arthroplasty surgery due to the fear of acute postoperative pain [7]. Pain catastrophizing is a term used to describe the tendency to magnify the threat value of pain stimuli and to feel helpless in the context of pain. This can lead to an inability to inhibit pain-related thoughts during or after a painful encounter [8]. Kinesiophobia, on the other hand, is an excessive and debilitating fear of physical movement and activity due to a feeling of vulnerability from a painful injury or re-injury [9]. It is gaining more attention since it can lead to illness behavior and create a vicious cycle of pain and disability [10]. High levels of kinesiophobia after TKA negatively affect short [11–13] and long-term [6,10,13–17] functional outcomes. Investigating the presence of kinesiophobia early after surgery can help arrange personalized treatment for this vulnerable group of patients.

Despite the growing interest in the relation of kinesiophobia and TKA, there are limited studies about the etiology and psychological pattern of kinesiophobia in the literature. To the best of our knowledge, there are only two studies that examine the risk factors for the onset of kinesiophobia following TKA. Cai et al. showed that female sex, older age, lower levels of education, negative coping styles, lower self-efficacy, and pain were predictors of kinesiophobia after surgery [18]. Degirmenci et al. demonstrated that the choice of anesthesia techniques during total knee arthroplasty (TKA) significantly influences the development of postoperative kinesiophobia [19]. This study found that patients who received regional anesthesia and deep sedation were able to recover and move more confidently during the early postoperative period, while those who received regional anesthesia and light sedation experienced anxiety and fear, which made them hesitant to move [19]. Studies have highlighted the importance of kinesiophobia as a risk factor for higher pain intensity following TKA [10,11,15–17]. However, due to the lack of standardized pain measurements and the predominant use of unidimensional pain analysis, the relationship between patient-reported outcomes (PROs) and kinesiophobia has not been thoroughly investigated in any single study to date. PROs are reports coming directly from a patient, about how they feel or function about a health condition and its therapy without interpretation by healthcare professionals or anyone else. PROs can relate to symptoms, signs, functional status, perceptions, or other aspects such as convenience and tolerability. PROs are not only important when more objective measures of disease outcome are not available but also to represent what is most important to patients about a condition and its treatment [20]. Gewandter et al. suggested that the inclusion of multiple domains in the outcomes can be a significant advantage as it provides a more thorough evaluation of the experiences of the individuals under study, rather than relying on a single factor that may not be sufficient in describing their overall experience [21].

This study aimed to investigate the factors associated with kinesiophobia following TKA and to examine the relationship between kinesiophobia and early functional outcomes in TKA patients.

2. Materials and Methods

Setting

This observational study was conducted at the Clinic for Orthopaedic Surgery and Traumatology, University Clinical Center Serbia in Belgrade over a period of 6 months. The study followed the principles of the Helsinki Declaration and was approved by the local ethics committee (Number 2017-004244-37). Patients who had undergone TKA were 18 years or older, could communicate, and provided written consent were invited to participate in the study. Written consent explained that the study aimed to improve pain treatment for patients after TKA in the future, and confirmed that no changes were made to the standard medical care at the moment.

Surgical technique, anesthesia, pain management, and postoperative rehabilitation program

The surgical procedure for TKA involved the insertion of tricompartmental prostheses using a standard medial parapatellar approach, with the use of cruciate-substituting designs. A femoral

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tourniquet at 300 mmHg was employed to achieve a bloodless surgical field. A compression bandage was applied from the toes to the mid-thigh at the end of the surgery. Spinal anesthesia with 10-15 mg levobupivacaine 0.5% or general anesthesia with propofol and fentanyl was administered during the procedure. Local infiltration anesthesia was not used in our study group. The regular protocol for pain management involved scheduled assessment of pain, and administration of non-opioid drugs (such as Paracetamol, Ketorolac, Metamizol) and weak opioids (Tramadol) based on the severity of the pain reported by patients, and following the WHO's approach to the use of analgesics based on pain severity. The pain was assessed at least once per shift. This treatment approach was implemented from POD1 to POD5.

All patients followed a standardized postoperative rehabilitation program beginning on POD1. Assisted ambulation and regular exercise to restore strength and mobility of the operated knee were performed 2 times a day for 20-30 minutes.

Experimental Procedure

Patients were evaluated on POD1 and POD5. On POD1, patients were assessed regarding demographic and clinical data comprising of gender, year of birth (age), weight and height, intensity, and location of chronic pain before surgery. Furthermore, the type of anesthesia and duration of surgery were recorded. Health-related quality of life during the last week before TKA was rated with the use of the EuroQol-5D (EQ5D) index score. An EQ5D index score of 0 indicates the worst possible health state and a value of 1 indicates full health [22].

Pain

In this analysis, pain was assessed on POD1 and POD5 using both pain scores and pain-related functional interference in the activities of daily living, which were combined in a composite score of PROs. The validated International Pain Outcomes Questionnaire (IPO-Q) was used to evaluate pain-related PROs [23]. This questionnaire evaluates the following domains: severity of pain and relief from treatments; interference of pain with physical activities in and out of bed; negative affect due to pain (anxiety and helplessness); adverse effects (AE) (nausea, fatigue, dizziness, itch); perception of care (wish for more pain treatment, satisfaction with pain treatment, participation in decisions about pain treatment and receipt of information about treatment). Pain and pain-related physical and affective interference were quantified by patients using an 11-point numerical rating scale (0 = null, 10 = worst possible). The patient's perception of care was assessed with yes or no or percentage scales. Patients related all questions to the time since surgery. The data were collected by surveyors who underwent training before they approached patients. To reduce interviewer bias, patients completed the questionnaire independently with no assistance from family or staff. However, if a patient requested help, the surveyor could assist.

Patient-reported outcomes and composite scores

Multidimensional composite scores were created based on ratings obtained from the IPO-Q. For POD1 and POD5, continuous PROs were extracted from the questionnaires and combined to form composite scores, as described by Hofer D et al. [24]. Three subscores were generated to assess pain intensity, pain-related interference, and side effects. The Pain Composite Score (PCS) was calculated using the formula: worst pain * (% time in severe pain * 100) + least pain * (1 - % time in severe pain / 100). The Pain Interference Total Score (PITS) was calculated as the mean of pain-related interference with activities in bed, breathing deeply/coughing, sleep, and pain-related anxiety and helplessness. The Pain Side Effects (PSE) composite score was calculated from the scores for dizziness, drowsiness, nausea, and itching. The Composite Patient Reported Outcome (PRO) score was obtained by averaging the PCS and PITS scores summarizing pain intensities and pain-related factors [24].

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Kinesiophobia

On POD5 kinesiophobia was measured with the Tampa Scale for Kinesiophobia (TSK). The TSK is a 17-item questionnaire designed to assess a patient's fear of movement or (re)injury [25]. Each point has a 4-point Likert scale, scoring alternatives from „strongly disagree" to „strongly agree". The total score on the TSK ranges from 17 to 68 [26]. We used a pre-validated cut-off score of 37 on the TSK to categorize knee replacement patients into two groups: those with no or low degree of kinesiophobia (TSK‹37) and those with a high degree of kinesiophobia (TSK≥37) [25,27].

Functional outcome measures

On POD5, a functional assessment was conducted, which included three tests: knee range of motion (ROM), Barthel Index, and the 6-minute walking test (6-MWT). The Barthel Index is an ordinal scale used to assess a person's ability to perform ADL. It involves scoring 10 variables related to mobility and ADL, with a higher score indicating greater independence [28]. The 6-MWT measures functional walking capacity. During the test, the patients were asked to walk for 6 minutes, and the distance covered in meters was recorded [29]. Knee ROM was assessed using a universal goniometer, and the average peak knee flexion and extension were recorded from three trials. Health-related quality of life after TKA was rated using the EQ-5D index score.

Statistics

Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL) version 22.0. Data were visually analyzed with histograms, Q–Q plots, and Kolmogorov–Smirnov tests for normality of distribution. Categorical data were presented as absolute numbers and percentage of patients, continuous data by mean and 95% confidence intervals (CI) of the mean or mean ± SD (standard deviation), and NRS scores by a median with interquartile range. The chi-square test was applied to test relationships between categorical variables. A two-sided independent samples t-test was used to compare the mean values of normally distributed data between 2 groups. Ordinal data were compared by the 2-sided Mann–Whitney U test.

Univariable and multivariable logistic regression analyses were performed to assess the factors associated with kinesiophobia. Variables with p-value < 0.20 in the unavailable analysis were retained and included in the multivariable regression for which the backward selection method was used. In the backward method, the model started with all variables in the equation. Using criteria for removal, variables that did not contribute to the solution were removed one at a time. The variable with the smallest partial correlation was taken out first. Steps proceed until no remaining variables are qualified for removal [30].

No collinearity problem was detected for any of the models. In all instances, a p-value <0.05 was considered statistically significant.

3. Results

3.1. Baseline characteristics of the study group

A total of 81 patients were recruited for the study. During the study period, 3 patients declined to fill out the requested questionnaires, and 3 patients were excluded due to deep vein thrombosis. Therefore, 75 patients were included in the study analysis.

The patients were categorized into two groups based on their degree of kinesiophobia: a high kinesiophobia group (n=20) and a low kinesiophobia group (n=55).

Patient characteristics and clinical data concerning the TSK groups are summarized in Table 1. The groups showed significant differences only in the level of preoperative pain and education level regarding baseline characteristics (Table 1).

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Table 1. Baseline characteristics of study patients.

	Low Degree of Fear of Movement	High Degree of Fear of Movement	p
Number of patients 75	55 (73%)	22 (27%)	
Gender†			
Male	14 (19%)	6 (7%)	0.922
Female	41 (55%)	14 (19%)	
Age(y.) §	67.75 ± 7.78	67.25 ± 9.11	0.817
Weight(kg) §	167.08 ± 11.65	169.85 ± 9.21	0.346
BMI(kg/m²)§	28.83 ± 5.01	28.36 ± 5.37	0.727
Marital status†			
Married	50 (67%)	19 (25%)	0.923
Single	5 (7%)	1 (1%)	
Education†			
Primary school or above	17 (23%)	1 (1%)	
Secondary school	27 (36%)	17 (23%)	0.017
Faculty	11 (15%)	2 (2%)	
Duration of anesthesia§	138 ± 35.60	136.5 ±36.31	0.951
Type of anesthesia†			
General	24 (32%)	5 (7%)	0.231
Spinal	31 (41%)	15 (20%)	
Intensity of chronic pain before admission‡	5 (2-10)	7 (4-9)	0.034
EQ5D preoperative	0.467 ± 0.267	0.599 ±0.209	0.052

* † The values are given as the number of patients with the percentage in parentheses; § the values are given as the mean± standard deviation (SD); ‡ the values are given as numerical rating scale scores by median with interquartile range (IQR); EQ5D= EuroQol-5D.

3.2. Analysis of group differences regarding outcome

A significant difference in PROs at POD1 and POD5 was observed. Patients with kinesiophobia demonstrated significantly worse pain outcomes on the composite score of IPO-Q compared to patients without kinesiophobia on POD1 and POD5. Patients with kinesiophobia had also a lower percentage of pain relief, wished for more analgesics, and reported more interference of pain with activities out of bed on POD5. There was also a difference in EQ-5D on POD5 between the groups (Table 2).

3.3. Predictors of kinesiophobia

Univariable regression analysis revealed that patients who reported lower educational levels had greater pain intensity before surgery, and were more likely to develop kinesiophobia. As far as pain-related PROs are concerned, our results revealed that higher scores of composite scores of IPO-Q were associated with higher kinesiophobia scores. Furthermore, a lower percentage of pain relief, wish for more pain treatment, interference of pain with activities out of bed, and higher scores on EQ-5D on POD5 were also related to higher kinesiophobia scores (Table 3).

Table 4 displays the results of the multivariable regression analysis. The final model included lower education, PRO1, and PRO2 as significant predictors. With the independent variables added, the overall model was statistically significant ($\chi 2$= 26.661, p <.001). The model explained 43.7% (Nagelkerkes R^2) of the variance of kinesiophobia and correctly classified 82.7% of cases. The strongest predictor of kinesiophobia was PRO2 on POD 5, whose odds ratio (OR) was 2.064 when

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adjusted for PRO1 and lower education level. PRO1 was identified as the second strongest predictor of kinesiophobia.

Table 2. Comparison of PROs between the TKA patients with or without kinesiophobia.

	Low Degree of Fear of Movement	High Degree of Fear of Movement	p-Value
POD1			
PRO1†	1.95 (1.30-2.79)	3.44 (2.35-4.21)	0.001
POD5			
PRO2†	0.36 (0.14-0.64)	1.76 (0.80-3.05)	0.000
Pain interfering with activities out of bed†	1 (0-3)	3 (1-5)	0.047
Percentage of pain relief±	86.48 ± 17.82	68.75±18.212	0.001
Desire more pain treatment			
Yes	3 (4%)	6 (8%)	0.003
No	52 (69%)	14 (19%)	
Participation in decisions regarding pain treatment	9 (9-10)	9 (4.25-10)	0.518
Satisfied with the result of pain treatment	9 (9-10)	9.5 (8.25-10)	0.644
EQ5D ‡	0.749 ± 0.141	0.572 ± 0.218	0.000

† The values are given as numerical rating scale scores by a median with interquartile range (IQR); the values are given as the mean± standard deviation (SD); PRO1- composite score of patient-reported outcome measure on POD1; ‡PRO2 composite score of patient-reported outcome measure on POD5; EQ5D= EuroQol-5D.

Table 3. Univariable prediction model of kinesiophobia.

	OR	95% CI	p-value
Education			.039
Primary school or under	0.324	0.026-4.011	0.380
High school	3.463	0.682-17.573	0.134
College	-	-	-
EQ5Dpreoperative	-0.087	0.009-0.860	0.037
Intensity of chronic pain before surgery	1.359	1.016-1.817	0.038
PRO1	1.655	1.157-2.367	0.006
PRO2	2.112	1.315-3.393	0.002
Percentage of pain relief	0.974	0.950-0.998	0.037
Pain interfering with activities out of bed	1.272	1.015-1.549	0.037
Desire more pain treatment	0.135	0.030-0.607	0.003
EQ5D POD5	00.014	0.001-3.78	0.011

OR: Odds ratio; 95% CI confidence interval.

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Table 4. Multivariable prediction model of kinesiophobia.

	OR	95% CI	p-value
PRO2	2.064	1.236-3.347	0.005
PRO1	1.631	1.067-2.478	0.025
Education			
Primary school or under	0.655	0.040-10.610	0.045
High school	6.310	0.840-47.421	
College	-	-	

OR: Odds ratio; 95% CI confidence interval.

3.4. Influence of kinesiophobia on recovery after TKA

Regarding functional outcomes on POD5 patients with kinesiophobia revealed significantly higher dependency levels as expressed with the Barthel score, had a slower gait speed on the 6 MWT, and showed worse recovery of knee extension. (Table 5).

Table 5. Functional outcomes.

	B	95% CI	p-value
6MTW	-0.340	-32.102;-13.371	0.000
BARTHEL	-0.376	-16.939;-4.561	0.000
EXTENSION	-0.270	-10.283;-0.944	0.019
FLEXION	-0.061	-11.090;6.499	0.604

6MWT = 6-minute walking test.

4. Discussion

In this study, we observed a kinesiophobia incidence of 27% which is close to the rates reported in earlier studies in TKA patients in Serbia (22%) [16] and China (24%) [18]. We observed a higher prevalence of kinesiophobia among participants with lower education levels. Our finding aligns with previous research, which also suggested that individuals with a lower education level tend to exhibit higher levels of kinesiophobia [18,28–30]. This can be possibly explained by the fact that individuals with higher levels of education have a better understanding of the advantages of physical activity (PA), being influenced by a healthier social network, having a higher socio-economic status, and enjoying better access to resources that support engagement in PA [30].

The most important finding of our study was the confirmed link between pain-related PROs (PRO1 and PRO2) and the development of kinesiophobia. To the best of our knowledge, those results are the first one that highlights the relationship of both the intensity of postoperative pain, and the physical and emotional interference caused by pain after TKA, as they are associated with the presence of kinesiophobia. Prior studies on TKA patients primarily relied on pain scores and used single-dimensional measures to assess pain [18,19]. Moreover, research on risk factors for kinesiophobia after TKA found a direct link between high pain intensity levels within the first 24 hours after surgery and increased levels of kinesiophobia [18]. We obtained a more comprehensive understanding of the impact of pain on various aspects of a person's life. This approach provides a broader perspective compared to using a single measure, which may not fully capture the patients' pain experience [21].

To evaluate the influence of kinesiophobia on early functional outcome we measured the 6-MTW, knee ROM, and Barthel index. Our study's findings support previous research regarding the 6-MWT and its relation to kinesiophobia. Doury-Panchout et al. demonstrated that patients without kinesiophobia walked a significantly greater distance during the 6-MWT compared to those with kinesiophobia [15]. Additionally, Guney Deniz et al. found a positive correlation between higher TSK scores and improved 2-MWT scores [12]. Similarly, Degirmenci et al. discovered that higher TSK scores were associated with better 2-MWT scores and Timed Up and Go (TUG) test results on POD 2 and POD 5 [12]. Based on our findings, it appears that there might be an inverse correlation between

active knee extension and kinesiophobia, while no correlation was observed with knee flexion. However, it is important to note that not all studies align with these results. Active knee flexion was found to be correlated with TSK in several studies [12,16,19,32]. In contrast, Doury-Panchout et al. did not observe any notable disparity in maximum passive flexion and maximum active extension on the day of discharge between high-TSK and low-TSK groups [15]. Similarly, Filardo et al. found no connection between high-TSK and low-TSK concerning active or passive ROM [33]. Also, our study revealed the negative relationship between higher levels of kinesiophobia and functional independence as measured with the Barthel index on POD5.

5. Conclusions

Our research findings reveal a high prevalence of kinesiophobia after TKA, highlighting its importance during post-operative care. Moreover, our study identifies pain as a significant predictor of kinesiophobia and its impact on poor functional outcomes after surgery. Notably, composite scores for pain evaluation prove to be superior to unidimensional scales, offering a more comprehensive approach to understanding the connection between pain and kinesiophobia. To enhance patient care and treatment outcomes we recommend the implementation of composite pain assessment tools in clinical practice. By identifying individuals prone to kinesiophobia through multidimensional pain assessment, healthcare professionals can adjust strategies to improve outcomes and post-surgery recovery. Further research is expected to show the influence of improved pain treatment strategies on kinesiophobia levels in patients after TKA.

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