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ORIGINAL STUDY

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How does kinesiophobia affect short- and long-term gait parameters in individuals with total knee arthroplasty surgery?

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Delays in weight transfer due to various fears after Total knee arthroplasty (TKA) surgery negatively affect recovery. Therefore, the presence of kinesiophobia is essential for the success of the treatment. This study was planned to investigate the effects of kinesiophobia on Spatio-temporal parameters in patients who underwent unilateral TKA surgery.

This study was a prospective and cross-sectional study. Seventy patients with TKA were assessed preoperatively in the 1st week (Pre1W) and post-operatively in the 3rd month (Post3M) and 12th month (Post12M). Spatiotemporal parameters were assessed using the Win-Track platform (Medicapteurs Technology, France). The Tampa kinesiophobia scale and Lequesne index were evaluated in all individuals. A significant relationship was found between the Pre1W, Post3M, and Post12M periods and Lequesne Index scores (p<0.01), and this relationship was in favor of improvement. In the Post3M period, kinesiophobia increased compared to the Pre1W period, and kinesiophobia decreased effectively in the Post12M period (p<0.01). The effect of kine-siophobia was evident in the first postoperative period. In the correlation analyses between spatiotemporal parameters and kinesiophobia, significant negative correlations were observed (p<0.01) in the early postoperative period (Post3M).

Evaluating the effectiveness of kinesiophobia on Spatio-temporal parameters at different time intervals before and after TKA surgery may be necessary for the treatment process.

Keywords: Total knee arthroplasty; kinesiophobia; spatiotemporal parameters; Win-Track; gait parameters; osteoarthritis.

INTRODUCTION

Osteoarthritis (OA) is the most common joint disease in the world and Turkey. Pain occurring with movement is an important clinical finding *(1-3)*. In particular, limitations in functional capacity

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and difficulty with activities of daily living are observed *(4)*. TKA is a standard, elective surgical treatment for end-stage knee OA. When surgical results are evaluated, it has high success rates. However, a significant proportion of TKA patients report significant dissatisfaction with persistent postoperative pain, functional limitations, and reduced quality of life *(5-7)*. Our study emphasizes the importance of periodically evaluating patient-centred outcomes in clinical practice. Because these measures provide crucial information on whether surgical and postoperative rehabilitation interventions effectively improve patients' real-world "quality of life" experiences, it was stated that personal factors are also effective in the rehabilitation process and physiological factors. Among these factors, the tendency toward kinesiophobia is very high in the literature *(6-9)*. Kinesiophobia refers to an irrational and debilitating fear of physical movement arising from the possibility of painful injury or re-injury. It usually occurs after surgery and may support the development of chronic pain and affect early recovery findings. It is essential to determine the presence and severity of kinesiophobia as it is associated with functional outcomes in the rehabilitation process *(10)*. Gait analysis is also important in terms of objectively presenting surgical success and changes in the individual's gait. This study aimed to investigate the effects of kinesiophobia on Spatio-temporal parameters in patients who have undergone TKA surgery.

MATERIALS AND METHODS

This study began after approval of the Firat University Non-Interventional Research Ethics Committee meeting dated 23/01/2020 and numbered 2020/02-10. Seventy patients diagnosed with knee OA by a specialist physician and decided to have unilateral TKA surgery with no other neurological or musculoskeletal disease that could affect walking were included in our study. Those enrolled in a postoperative physical therapy program who could not stand for at least 10 minutes before the operation completed the 3-stage evaluation protocol (due to 3-step 3-steps being longer than the platform) and assistive device users were excluded from the study. All patients received a surface replacement with a

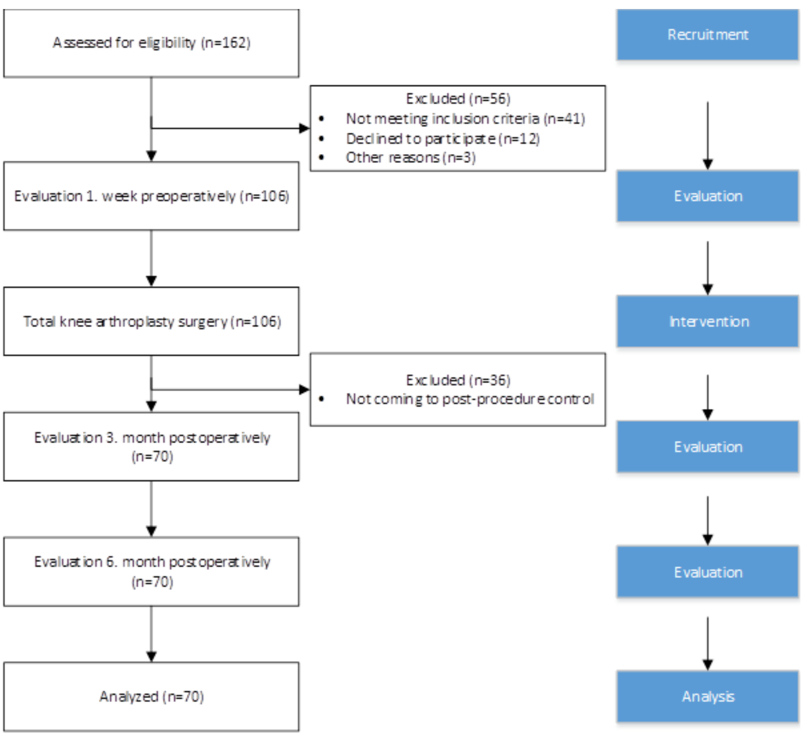

Fig. 1. — Flowchart of the study.

prosthesis (Smith Nephew) fixed with bone cement. None of the patients received a surface replacement of the patella. After surgery, patients received antibiotics to prevent infection.

Multiple assessment tools are used in physical therapy and rehabilitation practices, including gait parameters, the Tampa Kinesiophobia Scale, and the Lequesne Algofunctional Index of Knee. The diagnosis of knee osteoarthritis was made according to the American College of Rheumatology (ACR) criteria. All outcomes were collected at one week preoperatively (Pre1W) and 3 (Post3M), and 12 (Post12M) months postoperatively (Fig. 1).

Gait parameters: The Win-Track platform (MEDICAPTEURS Technology, France) is a tool used to measure plantar pressure and gait parameters during barefoot walking. The platform measures 1610mm×652mm×30mm in length, width, and height, respectively, and is 9 mm thick. The Win-Track platform measures the patient's static posture and dynamic gait parameters. This system loads data into a computer that performs automatic step identification and parameter calculations. Three attempts were made, with the participant taking at least three steps on the platform (Fig. 2). To avoid aiming, participants were asked to look ahead and walk on the platform at a comfortable pace. In addition, weight distributions were recorded while standing static on the platform (Fig. 3). With the platform, forefoot pressure analysis, hindfoot pressure analysis, total weight transfer, maximum plantar pressure, step cycle duration, single-support phase, swing phase, step length, foot angle, cadence, and gait cycle distance measurements were made.

Tampa Kinesiophobia Scale: The Turkish version of the Tampa Kinesiophobia Scale (TKS) was evaluated. The TKS is a 17-item scale that measures fear of movement/re-injury. The scale includes parameters about injury/re-injury and fear-avoidance in work-related activities *(13)*.

The Lequesne Index: The Lequesne index questions night pain, morning stiffness, pain when walking, pain when getting up from a chair without the help of the arms, maximum walking distance, and daily life activities *(14)*.

"SPSS 22.0 for Windows" statistical program was used to analyze all parameters. Shapiro-Wilk

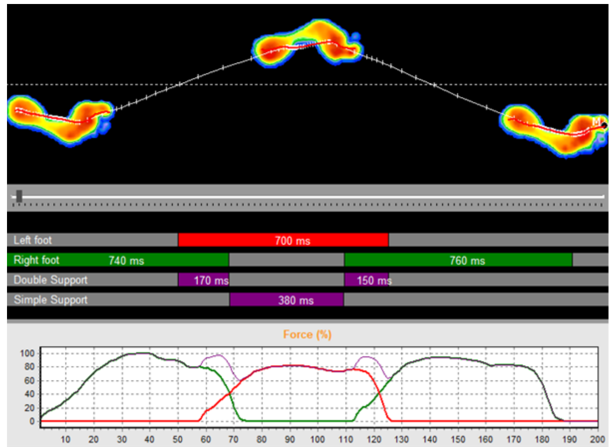

Fig. 2. — Analysis of the parameters of spatiotemporal gait on the Win-Track platform.

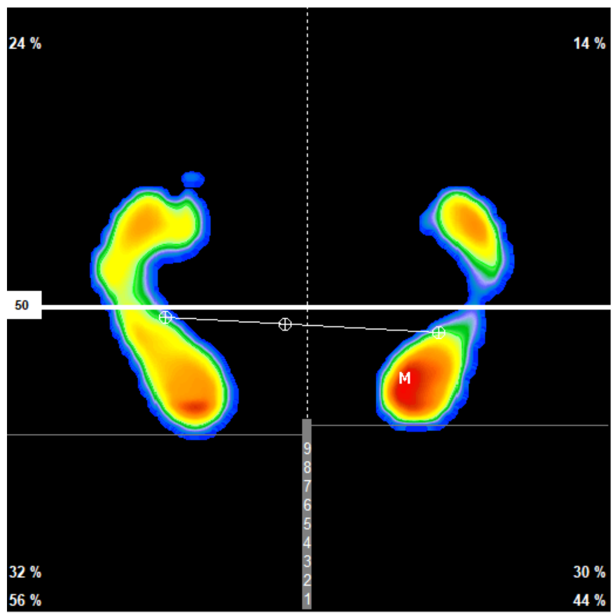

Fig. 3. — Analysis of weight distribution in static stance on Win-Track platform

Normality analysis was performed to evaluate the normal distribution of the data. According to the Skewness and Kurtosis values (between -2 and +2), it was determined that our data did not show a normal distribution. The Friedman test was used to compare the groups. The Wilcoxon test was used to evaluate the significance of binary parameters with each other. Statistically, $p<0.05$ values were considered significant. The obtained data are presented in tabular form as arithmetic mean±standard error (SD, (Minimum-Maximum). The Pearson correlation test was used to examine the relationships between parameters. In the posthoc power analysis performed using the G-Power 3.1.9.4 program to determine that the sample size was sufficient, the effect size was found to be 0.5 (high), and the power was 0.98 at the 95% confidence interval, at a significance level of 0.05. These values indicate that the sample size is at the desired level.

RESULTS

The mean age of the patients included in the study was 62.9±6.5 years, and the mean body mass index was 27.9±3.25. Of the 70 patients, 28 (40%) were male, and 42 (60%) were female. The majority of our patients were married (75.7%), lived in the city (78.6%), and had low educational levels (42.9% illiterate). Other demographic characteristics of the patients are shown in Table I.

For the Lequesne Index and TKS scores evaluated in the Pre1W, Post3M, and Post12M periods, there were statistically significant differences between Pre1W-Post3M, Pre1W-Post12M, and Post3M-Post12M periods (p<0.01, Table II).

While cadence, single-support phase, swing phase, and foot angle values of the operated side of the participants increased in the Post3M period, they decreased in the Post12M period. There was a statistically significant difference between the periods (p<0.05, Table II).

Gait cycle duration and step length values decreased for the participants in the Post3M period but increased in the Post12M period. There was a statistically significant difference between the periods (p<0.05, Table II).

When the operated side total weight transfer and forefoot pressure analysis of the participants was evaluated, while it decreased in the Post3M period, it increased in the Post12M period, and the values were statistically significant. On the healthy side, the opposite happened; weight transfer increased in the Post3M period and decreased in the Post12M period.

When the hindfoot pressure analysis of all cases was evaluated, the hindfoot pressure increased gradually from the Pre1W period to the Post12M period on the operated side. The opposite was confirmed on the non-operated side. When the Post3M-Post12M and Pre1W-Post12M periods were compared for both the operated and healthy sides, statistically significant differences were found (p<0.01, Table II).

The maximum plantar pressure value on the operated side of the participants decreased in the Post3M period and increased in the Post12M period. On the healthy side, the opposite was true. There was a statistically significant difference between the Pre1W-Post3M and Post3M-Post12M periods on operated sides (p<0.01, Table II).

In addition, correlation analyses of all Spatio-temporal parameters in Pre1W, Post3M, and Post12M periods were examined to evaluate the relationship with TKS in our study. Negative significant correlations between the operated side maximum plantar pressure and TKS operated side single-support phase, and TKS were present in all periods. There were significant correlations between forefoot pressure analysis and TKS, hindfoot pressure analysis and TKS in the post3M period. There were significant correlations between gait cycle distance and TKS, nonoperated side foot

Table I. — General information of the participants

		n	%
Gender (Years)	**Female**	42	60
	Male	28	40
Falling Story	**Yes**	2	2.85
	No	68	97.15
Marital status	**Married**	53	75.7
	Single	5	7.1
	Widow	12	17.1
Residence	**Urban**	55	78.6
	Rural	15	21.4
Education	**İlliterate**	30	42.9
	Primary Education	18	25.7
	Secondary Education	13	18.6
	University	9	12.9
Assistive Device	**Available**	11	15.7
	Unavailable	59	84.3

n: number.

Table II. — Functional scores of the patients

		Mean ± SD (Min-max)			p		
		Pre1W	**Post3M**	**Post12M**	**Pre1W Post3M**	**Pre1W Post12M**	**Post3M Post12M**
TAMPA Index		51.2±5.9 (37-62)	51.98±5.46 (38-64)	28.07±7.86 (17-40)	0.001**	0.001**	0.001**
Laquesne Index		15.92±2.87 (10-21)	11.37±2.70 (5-16)	5.24±2.29 (1-10)	0.001**	0.001**	0.001**
Cadence (number/minute)		77.78±18.88 (15.1-120)	81.64±20.64 (16.1-120.2	69.25±18.14 (14.5-92.3)	0.001**	0.003**	0.001**
Gait Cycle Distance (mm)		913.20±209.39 (569-1510)	794.81±166.92 (510-1438)	974.62±185.52 (604-1564)	0.001**	0.001**	0.001*
Total Weight Transfer % (SS)	Opere	44.57±6.03 (32-60)	43.21±4.07 (31-53)	50.34±3.51 (39-59)	0.03*	0.001**	0.001**
	Non-Opere	55.42±6.03 (40-68)	56.35±4.33 (47-69)	49.65-3.51 (41-61)	0.134	0.001**	0.001**
Forefoot Pressure Analysis % (SS)	Opere	21.78±4.30 (13-33)	20.37±3.96 (14-29)	22.74±4.08 (11-33)	0.007**	0.056	0.001**
	Non-Opere	22.51±6.38 (9-33)	23.21±5.44 (9-35)	22.80±3.94 (9-34)	0.213	0.690	0.311
Hindfoot Pressure Analysis % (SS)	Opere	25.10±6.53 (14-40)	25.45±5.01 (12-38)	27.45±4.30 (16-42)	0.972	0.001**	0.001**
	Non-Opere	30.62±6.70 (19-47)	30.58±6.52 (16-46)	26.88±4.45 (13-38)	0.856	0.001**	0.001**
Maximum plantar pressure (g/cm²)	Opere	1269.70±257.95 (946-2201)	1164.34±190.47 (906-2014)	1312.88±278.02 (889-2183)	0.001**	0.909	0.001**
	Non-Opere	1313.31±242.83 (867-2082)	1329.54±210.74 (1020-2101)	1311.35±206.49 (1000-1947)	0.705	0.286	0.209
Step Cycle Duration (ms)	Opere	817.85±476.76 (510-2980)	762.14±126.11 (540-1010)	671.14±110.47 (460-940)	0.001**	0.001**	0.001**
	Non-Opere	806.42±476.22 (530-2980)	663.64±104.15 (500-850)	691.42±89.73 (570-900)	0.001**	0.021*	0.001**
Single-support phase (ms)	Opere	52215±153.10 (180-990)	493.91±152.51 (260-1040)	313.37±118.59 (190-870)	0.001**	0.001**	0.001**
	Non-Opere	384.58±120.61 (180-730)	329.14±104.22 (175-640)	267.51±86.06 (170-610)	0.001**	0.001**	0.001**
Swing phase (ms)	Opere	1865.71±612.88 (1150-3650)	1984.57±654.11 (1240-4000)	1710±527.96 (1020-3400)	0.001**	0.001**	0.001**
	Non-Opere	1914.14±654.31 (1220-4010)	1798.28±643.37 (1100-3800)	1979.42±640.77 (1340-4120)	0.001**	0.001**	0.001*
Step length (mm)	Opere	463.52±122.65 (241-769)	375.31±96.52 (202-719)	490.40±111.55 (264-812)	0.001**	0.002**	0.001**
	Non-Opere	440.67±122.55 (250-741)	391.81±83.27 (205-719)	509.21±79.52 (340-752)	0.001**	0.001**	0.001**
Foot angle (degrees)	Opere	4.90±3.01 (0.81-16.84)	5.78±2.85 (0.77-14.8)	3.29±1.70 (1.05-9.40)	0.001**	0.001**	0.001**
	Non-Opere	5.82±3.22 (1.19-13.9)	7.31±3.23 (1.96-18.14)	4.07±2.14 (1.03-9.41)	0.001**	0.001**	0.001**

SD: Standart Deviation, mm: Millimeter, ms: Milliseconds, g: gram, cm: centimeter, Pre1W: Preoperatively at 1. Week, Post3M: Postoperatively at 3. Month, Post12M: 12. Month, *p < 0.05, **p < 0.001.

Table III. — Correlation analysis of kinesiobia and spatiotemporal parameters

			Tampa Kinesiophobia Scale	Tampa Kinesiophobia Scale	Tampa Kinesiophobia Scale
			Pre1W	**Post3M**	**Post12M**
Cadence		**r**	-0.007	-0.053	-0.065
		p	0.953	0.664	0.594
Gait Cycle Distance		**r**	0.037	0.065	0.322**
		p	0.761	0.593	0.007
Total Weight Transfer	Opere	**r**	0.114	-0.025	-0.071
		p	0.346	0.836	0.561
	Non-Opere	**r**	-0.114	0.001	0.071
		p	0.346	0.993	0.561
Forefoot Pressure Analysis	Opere	**r**	-0.209	-0.358**	0.041
		p	0.082	0.002	0.738
	Non-Opere	**r**	-0.117	0.356**	-0.062
		p	0.333	0.002	0.609
Hindfoot Pressure Analysis	Opere	**r**	0.215	0.260*	-0.081
		p	0.073	0.030	0.507
	Non-Opere	**r**	0.029	0.309**	0.096
		p	0.810	0.009	0.430
Maximum plantar pressure	Opere	**r**	-0.264*	-0.290*	-0.423**
		p	0.027	0.015	0.001
	Non-Opere	**r**	0.207	0.057	0.288*
		p	0.085	0.637	0.016
Step Cycle Duration	Opere	**r**	-0.415**	-0.212	-0.081
		p	0.001	0.078	0.506
	Non-Opere	**r**	-0.371**	-0.079	0.124
		p	0.002	0.516	0.305
Single-support phase	Opere	**r**	-0.277*	-0.347**	-0.308**
		p	0.020	0.003	0.009
	Non-Opere	**r**	-0.183	-0.213	-0.326**
		p	0.129	0.076	0.006
Swing phase	Opere	**r**	-0.052	0.009	-0.233
		p	0.668	0.938	0.052
	Non-Opere	**r**	-0.026	-0.036	-0.086
		p	0.833	0.768	0.477
Step length	Opere	**r**	0.081	0.045	0.158
		p	0.504	0.713	0.191
	Non-Opere	**r**	0.092	0.053	0.229
		p	0.451	0.662	0.056
Foot angle (degrees)	Opere	**r**	0.121	0.143	-0.147
		p	0.320	0.238	0.224
	Non-Opere	**r**	-0.010	0.075	-0.239*
		p	0.932	0.535	0.046

Pre1W: Preoperatively at 1. Week, Post3M: Postoperatively at 3. Month, Post12M: 12. Month, r: correlation value , *p < 0.05, **p < 0.001.

angle and TKS in the post12M period ($p<0.05$; TableIII).

DISCUSSION

Our gait parameters and kinesiophobia data reflect the functional status of patients before and after surgery. Few studies in the literature analyze gait parameters and kinesiophobia together in the preoperative and postoperative short and more extended periods after TKA. In our study, similar to the literature, low education level and female-patient ratio were high in patients with TKA *(9,15-17)*. In our study, although there was a gradual decrease in gait pathologies after the TKA procedure, there was an altered/distorted gait pattern in the acute period after surgery; however, kinesiophobia increased. In the long term, improvement in gait parameters was observed with the reduction of kinesiophobia. Another important aspect of this study is the comprehensive evaluation of different outcome tools across three-time points.

Many studies show that kinesiophobia negatively affects the healing process for up to one year *(9,16-19)*. Our study found that kinesiophobia increased in the early postoperative period (Post3M) and decreased effectiveness in the Post12M period. From the literature, we believe that decreasing kinesiophobia in the Post12M period positively affects recovery.

Consistent with the literature, Lequesne Index scores decreased gradually from the preoperative period to the early and late postoperative period *(20,21)*.

Individuals with unilateral TKA usually have asymmetric lower extremity movement patterns *(22,23)*. In our study, consistent with the literature, it was determined that weight transfer (total weight transfer, forefoot pressure, maximum plantar pressure) on the TKA side decreased in the Pre1W and Post3M periods. In addition, the difference between weight transfer amounts decreased in the long term (Post12M). In addition, it was determined that weight transfer on the TKA side decreased in the early postoperative period (Post3M) compared to the preoperative period and increased during the long-term recovery period (Post12M). This situation was correlated with incomplete recovery and kinesiophobia (*(24)*, Table III).

Spatio-temporal parameters are among the essential data for evaluating functional outcomes after TKA surgery. In patients with TKA, conditions such as low-speed walking with short steps, increased cadence, and an increased difference between two stride lengths during walking (shorter stride on the healthy side than on the operated side) are frequently observed *(25-27)*. By the literature, the spatiotemporal data in our study deteriorated in the early period (Post3M) and improved in the Post12M period. We think this is due to incomplete recovery in the early postoperative period and kinesiophobia *(16-19)*. With the decrease in the effect of kinesiophobia, significant improvements were detected in the gait analysis parameters performed in the long postoperative term (Post12M).

Wu et al. *(28)* found that the swing phase of the operated side increased compared to the swing phase of the non-operated side ($p= 0.017$) in their analysis of the early postoperative period (14th day). They also measured the step length of the operated side and found it increased ($p= 0.297$) compared to the step length of the non-operated side. In our study, we measured the operated side swing phase and found it increased compared to the non-operated side swing phase. The operated side step length decreased compared to the non-operated side step length in the Post3M period. While some changes in measurements may be secondary to the disease, it may be a compensatory condition developed to reduce the burden of the osteoarthritis-affected side *(29)*.

Foot angulation increases in patients with TKA due to balance problems. One of the compensatory conditions for lack of balance is the outward angulation of the foot *(30,31)*. Due to the incomplete healing of individuals and the enlargement of the surface area due to kinesiophobia, foot angulation in the Post3M period was higher than in the Pre1W period. With the effect of surgery, foot angulation decreased in the long term (Post12M). We think that this is due to the completion of the individual's recovery process, the improvement of their balance, and the reduction of the effect of kinesiophobia in the long term.

This study has some limitations. Foot and knee radiological measurements were not evaluated. By increasing the sample size, our subsequent study will compare Spatio-temporal parameters with foot and knee radiological measurements. Thus, this will provide more critical data to the clinic. The strengths of our research are the comprehensive assessment of participants across three-time points.

CONCLUSION

We observed that the gait parameters of the patients were worse in the postoperative period (Post3M) than before the surgery (Pre1W). The long-term results showed that this was the period with the most improvement (Post12M). These objective results may support the adoption of the idea that the effectiveness of treatment is achieved in the long term in patients undergoing TKA. In addition, they are investigating Spatio-temporal parameters after TKA is important for clinical practice and monitoring the success of the surgery. Our results confirm that patients undergoing TKA are characterized by significant improvements in functional status and a progressive reduction in gait pattern abnormalities. In addition, evaluating Spatio-temporal parameters at different time intervals before and after TKA surgery may be essential to see the effectiveness of kinesiophobia in recovery.

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