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ORIGINAL ARTICLE

Does total knee arthroplasty affect overactive bladder symptoms in female patients?

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Abstract

Introduction and hypothesis In the current study we hypothesized that total knee arthroplasty might improve the overactive bladder symptoms by providing pain relief and improving physical function.

Methods One hundred patients who underwent total knee arthroplasty were preoperatively evaluated for overactive bladder and 47 patients that met inclusion criteria were included in this study. All the patients included in the study were assessed both preoperatively and at the 3rd month postoperatively using the Overactive Bladder-Validated 8 (OAB-V8) questionnaire for overactive bladder symptoms, the Oxford Knee Score (OKS) for pain and physical function, and the International Physical Activity Questionnaire-Short Form (IPAQ-SF) for physical activity.

Results The mean age of the patients was 65.4 ± 7 (56–83) years. The OAB-V8, OKS and IPAQ-SF scores significantly improved at the 3rd month postoperatively compared with the initial assessment. All the OAB-V8 domains, namely, frequency, urgency, nocturia, and urgency urinary incontinence, significantly improved following total knee arthroplasty.

Conclusions Our results showed that following total knee arthroplasty, overactive bladder questionnaire scores significantly improved at the 3rd month postoperatively.

Keywords Osteoarthritis · Overactive bladder · Total knee arthroplasty · Treatment

Introduction

Overactive bladder (OAB) is defined as "urinary urgency, usually accompanied by frequency and nocturia, with or without urgency urinary incontinence (UUI), in the absence of urinary tract infection (UTI) or other obvious pathology" [1]. OAB is a common condition throughout the world. A population-based survey study showed that the prevalence of OAB in women aged ≥18 years in five countries was 12.8% and it tended to increase with age [2].

Knee osteoarthritis (KOA) is another common disease, with symptomatic KOA being reported at a rate of 18.7% in women aged ≥45 years [3]. It has been shown that the prevalence of symptomatic KOA increases with age, and it is higher in women [4]. The osteoarthritis of the knee causes pain and loss of function [5] and is one of the most common causes of disability [6]. In the presence of severe, persisting pain and loss of function despite nonsurgical treatment, which includes exercise, weight loss, and pharmacological therapy, total knee arthroplasty (TKA) is indicated in KOA treatment to reduce knee pain and improve physical function [7].

Several epidemiological studies have shown the positive association between musculoskeletal disorders and OAB [8, 9]. The mechanism that can explain this co-occurrence is not clear. However, we know that both KOA [5] and OAB [10] have common risk factors, namely, obesity and increased age. In addition, studies in the literature show that the most common symptoms of KOA, including impaired physical activity [11] and chronic pain [12], are associated with OAB. It is possible that these factors may contribute to the close relationship between KOA and OAB. However, the effect of improvement in physical activity and pain on OAB symptoms are not well studied. In addition, in clinical practice, our observation is that a number of patients state that their OAB symptoms have improved or disappeared after TKA. Therefore, we hypothesized that OAB symptoms could be

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improved with pain relief and increased physical activity and questioned whether reduction in pain and increased physical activity following TKA have an impact on OAB symptoms.

To the best of our knowledge, there are no reports in the literature on the effects of TKA on OAB symptoms. In the current questionnaire-based study, we prospectively assessed the impact of improvement in chronic pain and physical activity on OAB symptoms in female patients who underwent TKA for KOA.

Patients and methods

The current prospective cohort study was approved by the local ethics committee (Ethics Committee Ruling number: 2011-KAEK-252021/04–18) and conducted in accordance with the principles of the Declaration of Helsinki. Written informed consents for both surgery and the study were obtained from all the patients.

From April 2021 to July 2021, a total of 100 consecutive female patients were evaluated by two of the authors of this study working as an orthopedic surgeon and underwent TKA owing to radiologically proven KOA and severe pain lasting for more than 1 year. Both of the surgeons who performed TKA procedures are experienced and they had performed at least 200 cases prior to the current study. No major complication (> grade 2) according to the Clavien–Dindo Classification [13] developed in the postoperative period. None of patients received postoperative physical therapy or transcutaneous electrical nerve stimulation, which might influence the results. In the current study we only focused on female patients to avoid the potential effect of benign prostate hyperplasia on storage symptoms in male patients.

Preoperatively, urinalysis was performed to exclude UTI in all the patients. None of the patients had active UTI. Patients were questioned about prior medical and/or surgical OAB treatment and recurrent UTI. Recurrent UTI was defined as ≥2 UTI in 6 months or ≥3 UTI in 12 months. Postvoid residual (PVR) volume was measured by suprapubic ultrasonography. None of the patients had >100 ml PVR volume. The presence of OAB was evaluated using the Overactive Bladder-Validated 8 (OAB-V8) questionnaire [14], in which the patients were asked eight questions regarding urinary frequency (Q1), urgency (Q2, Q3, Q7), nocturia (Q5, Q6), and incontinence (Q4, Q8). The participants were allowed to choose one of the six responses rated from 0 to 5 indicating the severity of the symptom. A total score of ≥8 in OAB-V8 indicates that OAB is the probable diagnosis. Patients with a total score of ≥8 in OAB-V8 were included in the study. Patients with a total score of <8 in OAB-V8, patients with a history of recurrent UTI and OAB treatment including medication (anticholinergic and/or beta-3 agonist treatment) or bladder wall injection of botulinum toxin A for the last 12 months, and history of sacral neuromodulation were excluded. Flowchart of the study is represented in Fig. 1.

A total of 47 patients who met the inclusion criteria were included in the study, and they were also asked to complete this questionnaire at the 3rd month postoperatively to assess changes in their OAB symptoms. During this period, no patients were given any pharmacological treatment for OAB. According to their OAB-V8 evaluation at

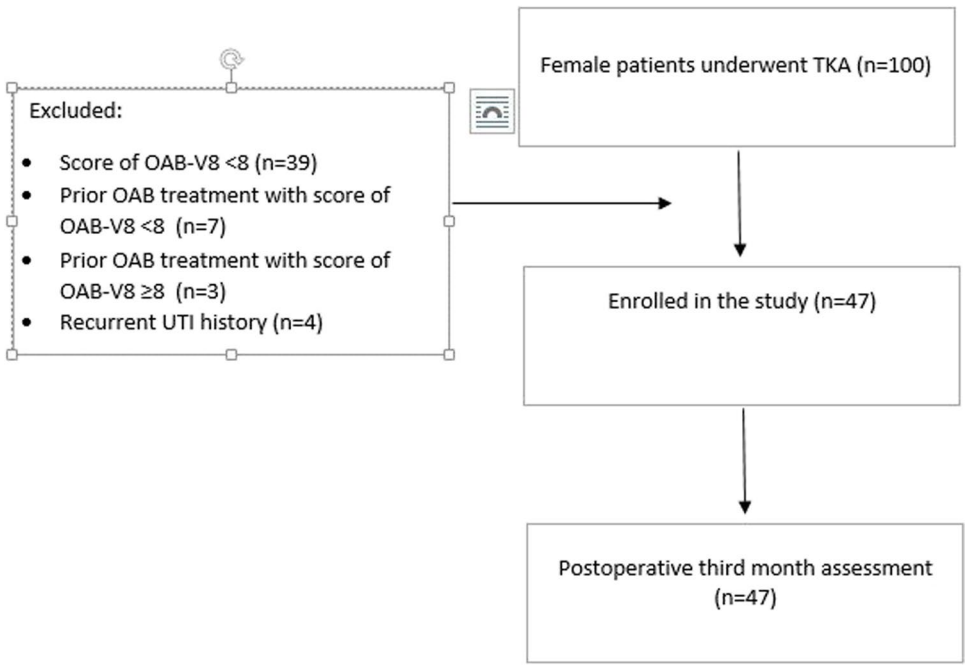

Fig. 1 Flowchart of patient enrollment and the study process

the 3rd month postoperatively, the patients with a score of <8 were defined as cured, patients whose scores decreased by ≥1 were defined as improved, those whose scores did not change were defined as stable, and those whose scores increased by ≥1 were defined as worsened. The patients were divided into two groups: cured or improved and stable or worsened.

Urinary incontinence was identified based on the sum of the answers of the two questions (Q4, Q8) on urine leakage being ≥1. According to the sum of the answers to Q4 and Q8 at the 3rd month postoperatively, the patients with a score of 0 were defined as cured, patients whose scores decreased by ≥1 were defined as improved, those whose scores did not change were defined as stable, and those whose scores increased by ≥1 were defined as worsened.

The Oxford Knee Score (OKS) questionnaire [15], which includes 12 questions, was completed by all the patients included in the study to evaluate pain and function both preoperatively and at the 3rd month postoperatively. Each of the 12 questions in the questionnaire is scored from 0 (most severe symptoms) to 4 (least severe symptoms). The sum of the scores from all the items produce an overall score of OKS. The functional component score is obtained from Q2, Q3, Q7, Q11, and Q12 and the pain component score from Q1, Q4, Q5, Q6, Q8, Q9, and Q10.

To examine the physical activity levels of the patients with an OAB-V8 score of ≥8, the International Physical Activity Questionnaire-Short Form (IPAQ-SF) was used. The responses to this questionnaire were converted to metabolic equivalent task minutes per week (MET-min/week). Physical activity levels are classified into three categories according to the total MET scores: <600 MET-min/week, inactive; 600–3,000 MET-min/week, moderately active; and > 3,000 MET-min/week, active [16]. IPAQ-SF was completed by all the participants preoperatively and at the 3rd month postoperatively. At the postoperative assessment, the patients whose physical activity level improved categorically were defined as improved and those with no changes were defined as stable.

Surgical technique

All the patients underwent surgery under spinal anesthesia in the supine position. A thigh tourniquet was used routinely. The surgical site was prepared to be sterile, and all the total knee procedures were undertaken using a medial parapatellar approach. A tricompartmental posterior cruciate-sacrificing TKA was performed in all the patients using the robotic-assisted kinematic alignment technique. The patients were allowed to bear full-weight with a walker 1 day after the operation after drain removal. The stitches were removed after the second week. The walker was discontinued once the patient had achieved good knee control.

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) v. 16.0 for Windows (SPSS Inc. Chicago, IL, USA). The Kolmogorov–Smirnov test was used to evaluate the normality distribution of the data. The Wilcoxon signed-rank test or the Chi-squared test was conducted to evaluate postoperative changes compared with the preoperative period. The groups were compared using the Mann–Whitney *U* test or the Chi-squared test. A value of $p < 0.05$ was considered statistically significant.

Results

According to the preoperative assessment, 47 of the 100 patients with an OAB-V8 score of ≥8 and who met the inclusion criteria were included in the study. The mean age of the patients was 65.4 ± 7 (56–83) years. The assessment of UUI according to Q4 and Q8 of OAB-V8 showed that 34 of the 47 patients had UUI preoperatively. The baseline characteristics of the patients are summarized in Table 1.

Preoperatively, the mean total score of OAB-V8 was 14.2 ± 4.4. Forty-two of the 47 patients had a mild (9–20 score of OAB-V8) and 5 had a moderate (21–30 score of OAB-V8) symptoms. Both the OAB-V8 and OKS scores and the IPAQ-SF score significantly improved at the 3rd month postoperatively compared with the initial assessment. The

Table 1 Baseline characteristics of the patients

Variables	OAB group ($n = 47$)
Age (years)	65.4 ± 7 (56–83)
BMI (kg/m^2)	31.9 ± 4.8 (21.5–44.1)
Normal (18.5–24.9), *n* (%)	4 (8.5)
Overweight (25–29.9), *n* (%)	14 (29.8)
Obese (30–39.9), *n* (%)	26 (55.3)
Morbidly obese (≥40), *n* (%)	3 (6.4)
TKA laterality, *n* (%)	
Right	32 (68.1)
Left	12 (25.5)
Bilateral	3 (6.4)
Comorbidities, *n* (%)	37 (78.7)
Hypertension	27 (73)
Diabetes mellitus	15 (40.5)
Coronary artery disease	3 (8.1)
Pulmonary diseases	4 (10.8)
Others	6 (16.2)
Patients with UUI, *n* (%)	34 (72.3)

Data are presented as mean ± standard deviation or number (%)

BMI body mass index, *TKA* total knee arthroplasty, *OAB* overactive bladder, *UUI* urgency urinary incontinence

postoperative evaluation of the OAB-V8 domains revealed significant improvement in all the domains, namely frequency (3.1 vs 2.5, $p=0.001$), urgency (4 vs 2.2, $p<0.001$), nocturia (4 vs 3, $p<0.001$), and UUI (3.1 vs 1.9, $p<0.001$). The comparison of the preoperative and postoperative results of the questionnaires are shown in Table 2.

According to the OAB-V8 questionnaire, 10 patients (21.3%) were cured, 19 patients (40.4%) improved, 16 patients (34%) were stable, and 2 patients (4.3%) worsened. In cured patients preoperative and postoperative total score of the OAB-V8 questionnaire were 12.8 ± 2.8 (10–18) and 3.8 ± 2.2 (0–6) whereas in improved patients they were 16.7 ± 5 (11–30) and 10.1 ± 3.1 (8–18) respectively. In 2 patients who worsened, postoperative total score of OAB-V8 increased only one point compared with preoperative assessment. The mean change in total score of OAB-V8 in cured or improved patients was 7.5 ± 3.8 (3–16). Table 3 presents the comparison between the cured or improved and stable or worsened groups in terms of age, body mass index, preoperative and postoperative OKS scores, and preoperative and postoperative IPAQ-SF scores.

At the 3rd month postoperatively evaluation of UUI, it was observed that 5 patients (14.7%) were cured, 15 (44.1%) had improved, 13 (38.2%) were stable, and 1 (2.9%) had worsened. In 13 patients with no preoperative UUI, de novo UUI was not observed at the third month assessment.

Discussion

In the current prospective cohort study, our primary goal was to evaluate the effect of pain relief and the improvement in physical activity on OAB symptoms using a validated patient self-reported questionnaires including OAB-V8, OKS, and IPAQ-SF. We tested our hypothesis in 47 female patients who underwent TKA for KOA. At the 3rd month postoperatively of TKA, as expected, pain and physical activity questionnaire scores had significantly improved. Interestingly, we found that OAB questionnaire scores significantly improved. A total of 29 patients whose total score of OAB-V8 questionnaire had decreased had more improved pain and physical activity scores.

The underlying cause of OAB is not well established. However, several potential factors, including low physical activity, may contribute to the OAB pathophysiology. In a study including 6,424 women aged ≥40 years, it was reported that the risk of OAB was higher among less physically active women [11]. In another study, it was shown that women with a high level of physical activity were 31% less likely to develop storage symptoms than those with a low level of physical activity. However, the association between activity and storage symptoms was not significant ($p=0.29$) [17]. In addition, women with a high level of physical activity have a lower prevalence of UUI [18–20]. It was found

Table 2 Comparison of the preoperative and 3rd-month postoperative OAB-V8, OKS, and IPAQ-SF scores

Questionnaires	Preoperative	3rd month postoperatively	*p* value
OAB-V8	14.2 ± 4.4	9.6 ± 4.3	**< 0.001**
Q1	3.1 ± 1	2.5 ± 0.9	**0.001**
Q2	1.3 ± 1	0.9 ± 0.8	**0.006**
Q3	1.3 ± 0.9	0.7 ± 0.9	**< 0.001**
Q4	1.5 ± 1.2	1 ± 0.9	**< 0.001**
Q5	2 ± 0.8	1.6 ± 0.8	**0.001**
Q6	1.9 ± 0.8	1.4 ± 0.8	**< 0.001**
Q7	1.3 ± 1.1	0.7 ± 0.9	**< 0.001**
Q8	1.7 ± 1.4	0.9 ± 1	**< 0.001**
OKS	13.2 ± 3.6	40.2 ± 4.4	**< 0.001**
Pain subscale	6.7 ± 2.3	15.7 ± 2.6	**< 0.001**
Function subscale	6.5 ± 2	24.5 ± 2.3	**< 0.001**
IPAQ-SF (MET-min/week)	1,954.7 ± 1,167.9	3,321.5 ± 1,300.6	**< 0.001**
Inactive, *n*(%)	7 (14.9)	2 (4.3)	**0.001***
Moderately active, *n* (%)	30 (63.8)	15 (31.9)	
Active, *n* (%)	10 (21.3)	30 (63.8)	

Data are presented as mean ± standard deviation or number (%)

OAB-V8 Overactive Bladder-Validated 8, *OKS* Oxford Knee Score, *IPAQ-SF* International Physical Activity Questionnaire-Short Form

p values were determined using the Wilcoxon signed-rank test

*Chi-squared test

Bold font indicates statistical significance

Table 3 Comparison between the cured or improved and stable or worsened patients

Variables	Cured or improved group ($n=29$)	Stable or worsened group ($n=18$)	p value
Age (years)	66.3 ± 7.3	62.9 ± 6.5	0.215
BMI (kg/m^2)	31.5 ± 3.9	32.5 ± 6.1	0.592
Diabetes mellitus, *n* (%)			
Yes	10 (34.5)	5 (27.8)	0.632*
No	19 (65.5)	13 (72.2)	
PVR volume (ml)	47.9 ± 18.2	51.7 ± 19.7	0.583
Preoperative OAB-V8	15.4 ± 4.7	12.2 ± 3.2	**0.007**
Postoperative OAB-V8	7.9 ± 4.1	12.3 ± 3.2	**<0.001**
Preoperative OKS	12.9 ± 3.7	13.8 ± 3.3	0.359
Preoperative OKS-pain	6.3 ± 2.1	7.3 ± 2.6	0.257
Preoperative OKS-function	6.6 ± 2.3	6.4 ± 1.4	0.929
Postoperative OKS	42.1 ± 3.4	37 ± 4.1	**<0.001**
Postoperative OKS-pain	16.6 ± 2.2	14.2 ± 2.6	**0.004**
Postoperative OKS-function	25.6 ± 1.7	22.8 ± 2	**<0.001**
Preoperative IPAQ-SF (MET-min/week)	1,662.8 ± 1,159	2,425 ± 1,048	**0.034**
Postoperative IPAQ-SF (MET-min/week)	3,648.3 ± 1,372.1	2,795 ± 1,000.1	**0.012**
Alteration in physical activity, *n* (%)			
Stable	10 (34.5)	14 (77.8)	**0.004***
Improved	19 (65.5)	4 (22.2)	

Data are presented as mean ± standard deviation or number (%)

BMI body mass index, *PVR* postvoid residual, *OAB-V8* Overactive Bladder-Validated 8, *OKS* Oxford Knee Score, *IPAQ-SF* International Physical Activity Questionnaire-Short Form

p values were determined using the Mann–Whitney *U* test

*Chi-squared test

Bold font indicates statistical significance

that women with urinary incontinence (UI) had a weaker grip strength and slower usual walking speeds [21]. Moreover, Matsumoto found an improvement in urgency and the total OAB symptom score following a 12-week physical exercise program [22]. It is known that KOA is one of the most common causes of physical disability in the elderly population, and TKA successfully increases functional performance [5]. In our study, our patients did not undergo any exercise programs during the perioperative period and we aimed to evaluate the effect of increased physical activity following TKA on OAB symptoms. We observed that the patients whose symptoms were cured or improved had higher postoperative physical activity levels than the stable group or the worsened group and improvement in the physical activity level category and physical function domain of OKS was significantly higher in the cured or improved groups. These results may suggest that increasing the physical activity level might improve the OAB symptoms.

The effect of chronic pain on OAB symptoms is another issue discussed in the international literature [12]. Thu et al. reported that the rate of pain in the lower extremities was over 30% in patients with OAB and the severity of pain and the symptoms of OAB correlated positively [23]. Another study reported that knee pain and severity of pain were significantly associated with UUI [21]. It was speculated that these findings might be associated with central sensitization [12, 21, 23]. Osteoarthritis was shown to cause the up-regulation of neuropeptide, which played an important role in triggering and maintaining central sensitization [24]. In an animal study, it was reported that bladder overactivity was caused by the intrathecal infusion of a neuropeptide called nerve growth factor, which is involved in central sensitization [25]. In addition, few studies have reported that osteoarthritis-related pain relief by either arthroplasty or pain killers causes a significant decrease in neuropeptide-containing afferents [26, 27]. These findings from previous studies suggest that pain and pain relief might have an effect on OAB symptoms. In the current study, we used questionnaires to test our hypothesis that pain relief might improve the OAB symptoms. Our results showed that following TKA, the pain subscale of the OKS and the OAB-V8 score significantly improved. The patients whose OAB symptoms disappeared or improved had less postoperative pain and more improvement in the pain domain of OKS. Findings from the current study support our hypothesis that pain relief might improve the storage symptoms.

To the best of our knowledge, no study has evaluated the effect of knee osteoarthritis treatment by TKA on OAB. However, there are a few studies that assessed UI rates following total hip arthroplasty. Baba et al. reported that the improvement rate in UI was higher in the anterior approach, whereas the aggravation of UI symptoms was more common after the posterior approach to primary total hip arthroplasty. They assumed that before surgery, the internal obturator muscle, which is connected to the levator ani muscle, might be atrophied owing to hip joint dysfunction, and following total hip arthroplasty with the anterior approach, the tension of the internal obturator muscle and the pelvic floor muscle increased, improving UI [28]. In another study, at the 3rd month postoperatively after total hip arthroplasty, the cure and improvement rates were determined to be 76%, 100%, and 50% in stress, mixed, and urgency UI groups respectively. The authors stated that their results suggested a relationship between pelvic floor function and hip joint function and might explain hip dysfunction-related UI [29]. In that study, the authors noted that both pain and physical function evaluated using the Western Ontario and McMaster Universities Osteoarthritis Index significantly improved following total hip arthroplasty. However, in contrast to our study, they did not mention the effects of pain and physical function on voiding symptoms. Although pelvic floor function improved following total hip arthroplasty, TKA is not expected to affect pelvic floor function. Therefore, we consider that improvement in pain and physical function may have contributed to the results of that study.

Physical activity and pain are the possible factors that contribute to the relationship between musculoskeletal disorders and OAB. However, to the best of our knowledge, no studies have evaluated the effect of improvement in physical activity and pain on OAB symptoms. We found that following TKA, scores of pain, physical activity, and OAB symptoms significantly improved. In the light of our findings, we believe that improving chronic pain and physical activity may play a role in the treatment of OAB in patients with KOA or maybe with the other musculoskeletal disorders.

However, this study has several limitations. First, we did not have a control group including the patients with KOA who did not undergo TKA. Second, we did not determine the sample size. Third, we did not employ objective measures such as bladder diary, and only the OAB-V8 questionnaire was used to diagnose OAB. In addition, the patients with an OAB-V8 score of <8 were not assessed again postoperatively. Therefore, we do not have any data on de novo OAB following TKA. Last, most of the subjects had mild OAB symptoms and our follow-up period was only 3 months after the operation; thus, the benefit of the operation in terms of OAB symptoms in the long term and in the patients with severe symptoms remains unclear.

Conclusion

To our knowledge, this is the first study investigating the effect of TKA on OAB symptoms. Our results showed that following total knee arthroplasty, OAB questionnaire scores had significantly improved at the 3rd month postoperatively.

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Author contributions C. Senel: project development, manuscript writing/editing;Y.O. Kizilay: project development, data collection;K. Turan: data collection;S. Ongun: data collection, data analysis;E. Tuzel: data analysis, manuscript writing/editing.

Declarations

Ethics of approval statement The authors declare that the study was approved by local ethics committee (Bursa Yüksek İhtisas Training and Research Hospital) (Ethics Committee Ruling number: 2011-KAEK-252021/04–18).

Conflicts of interest None.

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