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Unicompartmental Knee Prosthesis versus Total Knee Prosthesis in Medial Compartment Arthrosis of the Knee: Comparison In Terms Of Duration of Surgery, Duration of Hospital Stay, Pain, and Bleeding

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Abstract: The present study aimed to compare total knee prosthesis (TKA) and unicompartmental knee prosthesis (UKP) in terms of duration of hospital stay, duration of surgery, and postoperative pain and bleeding. Patients who underwent TKP (129 patients) or UKP (96 patients) between 2015 and 2016 were retrospectively reviewed. Degree of pain was measured in all patients by Visual Analog Scale. Duration of surgery, duration of postoperative hospital stay and amount of blood transfusion postoperatively were retrieved from hospital records. The median duration of hospital stay was 3 days for the patients undergoing UKP and 5 days for the undergoing TKP. The median duration of surgery was 74 minutes for the patients undergoing UKP and 56 minutes for the patients undergoing TKP. The median VAS score at the postoperative 8th hour was 6 for the patients undergoing UKP and 7 for the patients undergoing TKP. The need for blood transfusion was 9.8-fold higher in the patients undergoing TKP. UKP is a preferable surgical option owing to limited need for postoperative blood transfusion, lower pain scores, and short duration of hospital stay. The major disadvantage of UKP is longer duration of operation time than TKP.
Keywords: knee arthroplaty, unicompartmental knee prosthesis, total knee prosthesis

INTRODUCTION

Surgical interventions commonly performed for the treatment of knee osteoarthritis include high tibial osteotomy, unicompartmental knee prosthesis (UKP), and total knee prosthesis (TKP) [1]. In recent years, surgical interventions that provide patients with less pain as compared with TKP and result in less blood loss due to decreased tissue trauma have become prominent as the context of "minimal invasive arthroplasty". Accordingly, within this context, UKP has aroused substantial interest following successful outcomes published in the literature [2].

Although there is no sufficient data on the long-term outcomes of UKP as compared with TKP, UKP is being increasingly performed with low morbidity rates [3].

In the literature, there are numerous studies comparing TKP with UKP in terms of clinical and radiological characteristics. In the present study, however, these two methods were compared from another point of view excluding clinical and radiological characteristics. Accordingly, the present study aimed to compare TKP and UKP in terms of duration of hospital stay, duration of surgery, and postoperative pain and bleeding, which are critical for both patients and surgeons.

PATIENTS AND METHODS

Ethical committee approval was obtained before this study. Patients who underwent TKP or UKP between 2015 and 2016 were retrospectively reviewed from the medical records. Patients with a complete file and with a Visual Analogue Scale (VAS) score were included. Patients (n=5) with comorbidities likely to increase the risk of postoperative bleeding were excluded. Advanced-stage patients with a coronal deformity of >10 degrees and with a flexion contracture of >15 degrees were also excluded. In this way, patient groups having as common indications as possible for TKP and UKP were tried to be established.

Degree of pain was measured in all patients by VAS [4] at the postoperative 8th hour. Narcotic analgesic was not given to any of the patients after the surgery. As the routine pain control protocol, diclofenac sodium (75 mg/3 mL; Diplomec, Abdi Ibrahim Pharmaceuticals, Istanbul, Turkey), infusion solution of paracetamol (10 mg/mL; Perfalgan, Bristol-Myers Squibb, France), and in those with extremely severe pain, tramadol hydrochloride (50mg/mL 2mg/kg;

Constramal, Abdi Ibrahim Pharmaceuticals, Istanbul, Turkey) were used. Duration of surgery (in minutes), duration of postoperative hospital stay (in days), and amount of blood transfusion postoperatively were retrieved from the hospital records. Blood transfusion in the form of erythrocyte suspension was performed in the patients with postoperative hemoglobin concentration decreased by ≥2 g/dL.

Statistical Analysis

Data analysis was performed using the Statistical Package for the Social Sciences (version 22.0; IBM Corp., Armonk, NY, USA) and MedCalc version 14 (Acacialaan 22, B-8400 Ostend, Belgium) statistical software program. Normality of data was tested by Shapiro-Wilk test and homogeneity of variance was evaluated using Levine's test. For the comparison of independent two groups in terms of quantitative data, bootstrapped independent-samples t-test and Mann-Whitney U test with Monte Carlo simulation were used. Homogeneity of categorical variables was evaluated by chi-square test. Comparison of categorical variables between the groups was evaluated using Pearson's chi-square test in combination with Monte Carlo simulation as well as Fisher's exact test. Odds ratios were used to determine the most significant risk factor among significant categorical risk factors. Logistic regression analysis was performed using backward bootstrap method to determine the cause-effect relationship of the categorical response variable with the explanatory variables in paired categories. The relation between the real classification and the classification performed based on the cut-off value calculated according to the variables was investigated by the Receiver Operating Characteristics (ROC) curve analysis and defined as sensitivity and specificity. Quantitative variables were expressed as mean, standard deviation, median, and minimum and maximum, whereas categorical variables were expressed as number and percentage. The variables were analyzed within 95% confidence interval and a p value of <0.05 was considered statistically significant.

RESULTS

The present study included 96 patients (67 females and 29 males) who underwent UKP and 129 patients (87 females and 42 males) who underwent TKP. The comparison of the study parameters between the groups are presented in Table 1. The mean age was 55.35±6.11 years in the patients undergoing UKP and 67.92±7.47 years in the patients undergoing TKP. UKP was unilateral in 53 patients and bilateral in 43 patients. TKP was unilateral in 58 patients and bilateral in 71 patients. The median duration of hospital stay was 3 days (range, 2-9 days) for the patients undergoing UKP and 5 days (range, 3-12 days) for the patients undergoing TKP. The median duration of surgery was 74 minutes (range, 42-132 minutes) for the patients undergoing UKP and 56 minutes (range, 19-118 minutes) for the patients undergoing TKP? The median VAS score at the postoperative 8th hour was 6 (range, 3-9) for the patients undergoing UKP and 7 (range, 1-10) for the patients undergoing TKP. Postoperative blood transfusion was required in 15 (15.6%) of the patients undergoing UKP and in 74 (57.36%) of the patients undergoing TKP. Multiple logistic regression analysis of these outcomes revealed that the need for blood transfusion was 9.8-fold higher in the patients undergoing TKP (Table 2).

Moreover, the cut-off values of the data in the TKP and UKP groups were quantified to strengthen the statistical outcomes. The cut-off value was 4 days for duration of hospital stay, 7 point for VAS, and 39 minutes for duration of surgery. The accuracy of diagnosis together with sensitivity and specificity of the outcomes was investigated by the ROC curve analysis. Accordingly, duration of surgery was significantly shorter in the patients undergoing TKP than in the patients undergoing UKP (p<0.001), whereas duration of hospital stay and VAS score were lower in the patients undergoing UKP (p<0.001; Table 3).

In both groups, the patients undergoing unilateral or bilateral procedure in the same session were also compared in terms of study parameters (Table 4). While VAS score was significantly lower in the patients undergoing unilateral UKP than in the patients undergoing bilateral UKP (p<0.001), no significant difference was determined between the patients undergoing unilateral and bilateral UKP in terms of duration of hospital stay (p=0.419) and need for blood transfusion (p=0.261). In the patients undergoing TKP, duration of hospital stay was shorter, and VAS score and need for blood transfusion were significantly lower in those undergoing unilateral procedure than in those undergoing bilateral procedure (p<0.001). In both UKP and TKP groups, duration of surgery was longer in those undergoing bilateral procedure than in those undergoing unilateral procedure (Table 4).

Table-1: **Comparison of the study parameters between the study groups**

Parameters	**UKP n=96**	**TKP (n=129)**	**Total (n=225)**	**p**
Age, years, Mean±SD	55.35±6.11	67.92±7.47	62.56±9.30	0.001
Gender, n (%)				
Male	29 (30.21)	42 (32.56)	71 (31.56)	0.772
Female	67 (69.79)	87 (67.44)	154 (68.44)	
Duration of hospital stay, days, Median (min-max)	3 (2-9)	5 (3-12)	5 (2-12)	<0.001
VAS score, Median (min-max)	6 (3-9)	7 (1-10)	6 (1-10)	<0.001
Duration of surgery, minutes, Median (min-max)	74 (42-132)	56 (19-118)	62 (19-132)	<0.001
Need for blood transfusion, n (%)				
Present	15 (15.63)	74 (57.36)	89 (39.56)	<0.001
Absent	81 (84.38)	55 (42.64)	136 (60.44)	
Surgery side				
Unilateral	53 (55.21)	58 (44.96)	111 (49.33)	0.140
Bilateral	43 (44.79)	71 (55.04)	114 (50.67)	

UKP, unicompartmental knee prosthesis; TKP, total knee prosthesis; SD, standard deviation; min-max: minimum-maximum.

Table-2: Results of multiple logistic regression analysis. Need for blood transfusion is 9.8-fold higher in TKP patients

	B	**SE**	**p**	**Odds Ratio**	**95% CI for Odds Ratio**	
					Lower	**Upper**
Blood transfusion (present)	-2.285	0.63	<0.001	9.83[a]	2.86	33.83
Age (>60 years)	-3.056	0.64	<0.001	21.25	6.10	73.96
Duration of hospital stay (>4 days)	-2.908	0.64	<0.001	18.33	5.21	64.48

SE, standard error; CI, confidence interval. [1]Need for blood transfusion was 9.8-fold higher in the patients undergoing total knee prosthesis.

Table-3: **Age-based cut-off values in the unicompartmental knee prosthesis (UKP) and total knee prosthesis (TKP) groups**

	UKP		**TKP**		**AUC±SE**	**p**
	n	**%**	**n**	**%**		
Duration of hospital stay						
≤4	82	85.4[a]	26	20.2	0.895±0.023	<0.001
>4	14	14.6	103	79.8[b]		
VAS						
≤7	76	79.2[a]	68	52.7	0.661±0.036	<0.001
>7	20	20.8	61	47.3[b]		
Duration of surgery						
>39	96	100[a]	78	60.5	0.749±0.032	<0.001
≤39	0	0	51	39.5[b]		

UKP, unicompartmental knee prosthesis; TKP, total knee prosthesis; AUC, area under the curve; SE, standard error; VAS, visual analog scale. [1]Specificity; [2]Sensitivity. Diagnostic accuracy: excellent: an AUC of 0.9-1.0; very good: an AUC of 0.8-0.9; good: an AUC of 0.7-0.8; sufficient: an AUC of 0.6-0.7; bad: an AUC of 0.5-0.6; test not useful: an AUC of <0.5.

Table-4: **Comparison of the patients undergoing unilateral or bilateral procedure in the same session in each group in terms of study parameters**

	Unilateral	Bilateral	p
UKP			
Need for blood transfusion, n (%)			
Absent	47 (88.7)	34 (79.1)	0.261
Present	6 (11.3)	9 (20.9)	
Duration of hospital stay, days, Median (min-max)	3 (2-9)	3 (2-7)	0.419
VAS score, Median (min-max)	5 (3-8)	7 (4-9)	<0.001
Duration of surgery, minutes, Median (min-max)	57 (42-94)	103 (72-132)	<0.001
TKP			
Need for blood transfusion, n (%)			
Absent	46 (79.3)	9 (12.7)	<0.001
Present	12 (20.7)	62 (87.3)	
Duration of hospital stay, days, Median (min-max)	5 (3-6)	7 (4-12)	<0.001
VAS score, Median (min-max)	5 (1-10)	9 (3-10)	<0.001
Duration of surgery, minutes, Median (min-max)	31 (19-57)	68 (45-118)	<0.001

UKP, unicompartmental knee prosthesis; TKP, total knee prosthesis; min-max: minimum-maximum; VAS, visual analog scale.

DISCUSSION

Unicompartmental knee prosthesis and TKP are different surgical procedures performed for quite different indications in gonarthrosis patients. Recently, however, they are frequently compared by both the surgeons and the patients with the expressions "half prosthesis" and "whole prosthesis" particularly in cases without advance-stage disease.

Unicompartmental knee prosthesis was first begun to be used in 1970s. Although the studies conducted in that period were disappointing, recent studies have yielded quite successful outcomes with the innovations in the prosthesis design, correct indication, and developments in surgical techniques [5]. Based on these developments, UKP has been increasingly performed in recent years. In the USA, 6,570 UKP implants were used in 1998 and this number increased to 44,990 in 2005 [6].

It is accepted that UKP surgery is associated with smaller incision and minor muscle dissection and thereby with less postoperative pain, shorter duration of hospital stay, and lower amount of blood loss [7]. Many studies have reported lower rate of cost owing to these advantages of UKP [8-10]. In the present study, direct cost estimation was not performed; however, duration of hospital stay, pain, and need for blood replacement, which are among the main determinants of cost, were investigated and this may contribute to a future study on cost analysis.

In the present study, pain assessment was performed by VAS, which is an easily applicable and universally valid test. As the test has no language, it is performed all over the world with reliable outcomes [4]. The surgical procedure was performed under regional anesthesia in some of the patients included in the study. In regional anesthesia, sensation of pain does not exist for a certain time after surgery. For this reason, VAS pain scores of the patients were obtained at the postoperative 8th hour. This time may not be enough for a patient undergoing surgical procedure with peripheral nerve block; however, none of the patients in the present study had peripheral nerve block. Many studies have been conducted about bleeding and preventive methods in arthroplasty patients. In these studies, comparing pre- and post-operative hemoglobin and/or hematocrit concentrations and need for blood transfusion were the most common parameters used to determine bleeding status [11]. In the present study, need for blood transfusion was predetermined as the criterion for bleeding status. The same criteria were applied to all patients and erythrocyte transfusion was performed in the patients with hemoglobin concentration decreased by 2 mg/dL after surgery from pre-operative value before surgery. In the present study, duration of surgery was defined as the time from the initiation of the surgery following anesthesia to the skin closure. As the duration of surgery would vary among surgeons, the study included the patients of 5 different surgeons. Thus, personal differences such as fast surgeon or slow surgeon were avoided.

In a study published in 2016 by Shankar *et al.* [12], UKP and TKP were compared in terms of cost and they found that duration of hospital stay and duration of surgery were shorter and need for blood transfusion was lower in the patients who underwent UKP. Earlier studies have also demonstrated lower blood loss, shorter duration of surgery, and shorter duration of hospital stay in patients undergoing UKP [13,14]. In the present study, duration of UKP surgery was found to be significantly longer. Except this finding, the results of

the present study were in line with those reported in the literature. At this point, the question is why UKP takes longer time? Zhang *et al.* [15] reported that duration of surgery becomes shorter and complication rate decreases after 25 UKP procedures. In the present study, we included the surgeries performed in 2015 and 2016. Despite the fact that UKP has been performed in our clinic for about 5 years, we are in the opinion that there might be two reasons for the operation duration of UKP being longer than that of TKP. Firstly, UKP is more technical and secondly, surgeons are more familiar to and experienced in TKP, which has been performed for much longer time.

Brown *et al.* [3] compared total (n=2,235) and unicompartmental (n=605) knee arthroplasty surgeries and reported that the need for blood transfusion was 8.5-fold higher and duration of hospital stay was longer in TKP. Schwab et al. [16] investigated the amount of bleeding according to hemoglobin concentrations and reported higher amount of bleeding in TKP patients and stated that even anemic patients did not pose a risk for UKP. Similarly, in the present study, need for blood transfusion was 9.8-fold higher in the patients undergoing TKP than in those undergoing UKP.

One of the advantages of UKP as compared with TKP is short duration of hospital stay. In a study conducted in 2017, it was defended that arthroplasty surgeries were increasingly performed and cost of arthroplasty increased, and therefore duration of hospital stay needed to be shortened to reduce the cost [17]. In a study conducted in 2014 in Wales and England including 101,330 patients who underwent knee arthroplasty, lower rates of postoperative morbidity and mortality and shorter hospital stay were reported in patients undergoing UKP than in those undergoing TKP [18]. In the present study, the mean duration of hospital stay was 3.5 days for UKP and 5.8 days for TKP indicating that UKP was more cost effective.

Although UKP is agreed to be a minor surgery as compared to TKP considering all above-mentioned studies, the question is whether this alone makes UKP more efficient? Many studies have demonstrated that the degree of knee flexion is higher after UKP as compared with TKP [19]. In a study conducted in 2017, 65 TKP patients were compared with 65 UKP patients using the "Forgotten Joint Score" and UKP patients were reported to be more compliant in performing the activities of daily living and to have better functional outcomes [20].

However, although UKP is less invasive and has faster recovery period, it remains behind TKP with high revision and reoperation rates in the long term [21,22]. Single-center design of the present study can be considered as the major limitation. In fact, investigating particularly the duration of surgery in larger, multi-center studies would give outcomes that are more accurate. Moreover, quantitative parameters such as hemoglobin and hematocrit values could have been used as bleeding parameters. However, this could not be performed due to the problems in the medical records. We are planning to combine the data from this study with radiological and clinical long-term outcomes, which are thought to be analyzed as the second phase of this study.

CONCLUSION

There are domains that TKP and UKP surgeries are superior to each other. We think that, UKP is a preferable surgical option for both the surgeon and the patients owing to limited need for postoperative blood transfusion, lower pain scores, and short duration of hospital stay. The major disadvantage of UKP is the difficulty of surgical technique and unpredictable long-term outcomes. Although UKP and TKP are surgical options that are not comparable and have different indications, we think that TKP will remain as the first method of choice in surgical treatment of go arthrosis for years.

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