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Advantages of Simultaneous Cementless Bilateral Unicondylar Knee Arthroplasty Compared to Staged Surgery

Ali Şahin, MD, Şahin Çepni, MD, Enejd Veizi, MD, Yasin Erdoğan, MD, Ahmet Fırat, MD, Kasım Kılıçarslan, MD

Department of Orthopedics and Traumatology, Ankara City Hospital, Ankara, Türkiye

Background: Unicondylar knee arthroplasty (UKA) is an effective procedure, which reduces pain, increases range of motion, and improves function. UKA could be performed simultaneously or in staged sessions. This study aimed to compare bilateral cementless UKA performed simultaneously and in staged sessions in terms of complications, hemoglobin levels, transfusions, and functional outcomes.

Methods: Patients undergoing bilateral UKA for symptomatic medial compartment osteoarthritis were retrospectively analyzed. Of the 73 patients who met the inclusion criteria, 40 underwent surgery simultaneously and 33 underwent surgery in separate sessions. Operative time, length of hospital stay, change in hemoglobin, need for blood transfusion, complications, and functional outcomes were assessed.

Results: There was no statistically significant difference between the two groups in demographic data. Simultaneously operated patients had a significantly shorter hospital stay and shorter operative time. Statistically significant improvements in clinical scores were noted in both groups. The degree of improvement in functional scores did not differ between the groups. There was no difference between the two groups in terms of complication rates, but the number of periprosthetic tibial fractures was higher in the simultaneous group.

Conclusions: Simultaneous bilateral cementless UKA was more advantageous in terms of cumulative hospital stay and total operation time with similar clinical results when compared to a staged procedure. While the overall complication rate was similar, the rate of periprosthetic fractures was 5% in the simultaneous group.

Keywords: *Unicondylar knee arthroplasty, Simultaneous surgery, Periprosthetic fracture*

Unicondylar knee arthroplasty (UKA) is an effective treatment for osteoarthritis in the medial compartment.[1,2] At least 20% of patients who undergo primary knee arthroplasty have bilateral osteoarthritis and require a second contralateral operation in subsequent years.[3,4] Simultaneous bilateral surgeries reduce hospital costs, length of hospital stay, and rehabilitation time for patients.[3,5] According to the literature, however, simultaneous bilateral total knee arthroplasty (TKA) and UKA result in increased intraoperative blood loss, have longer operative time, and higher complication rates (revisions, mortality, and transfusions).[6,7]

Meta-analyses of national registries show that staged bilateral TKA is considered a safer treatment modality compared with simultaneous procedures.[8,9] As a result, the trend toward staged surgery has increased among surgeons in recent years. However, this view may not apply to UKA. Compared with TKA, UKA is a less invasive, less traumatic procedure with less intraoperative bleeding, requir-

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Correspondence to: Enejd Veizi, MD
Department of Orthopedics and Traumatology, Ankara City Hospital, Ankara 06000, Türkiye
Tel: +90-543-979-99-59, Fax: +90-312-552-60-00
E-mail: dr.nad89@hotmail.com

ing a shorter overall hospital stay.[10,11] Cementless UKA is a procedure that, thanks partially to new and more practical instrumentation, has increasingly gained in popularity last decade.[12,13] The popularity is also due to the fact that good osteointegration is obtained with porous coating and no additional time is required intraoperatively to ensure a lack of cement spillover.[14] Nevertheless, periprosthetic fractures are known to be more frequent in cementless surgery.[15,16] A couple of previous studies have compared staged and simultaneous bilateral UKA, but these studies have mainly focused on cemented implants.[17,18]

The main objective of this study, therefore, was to report and compare the clinical results of staged and simultaneous bilateral cementless UKA in terms of perioperative and postoperative complications, overall surgical time, hospital stay, change in hemoglobin levels, and need for transfusion. The secondary objective of this study was to assess patient satisfaction with their surgical modality though a simple questionnaire.

METHODS

Patient Selection

The study was approved by the Ethics Committee of Ankara City Hospital (No. E1-21-1641). All patients gave their consent to participate. Inclusion criteria were patients who underwent staged or concurrent bilateral UKA between April 2014 and March 2020 with symptomatic bilateral, Kellgren-Lawrence grade 4, isolated medial compartment osteoarthritis and were implanted a cementless mobile-bearing implant. Further inclusion criteria were a minimum follow-up of 2 years and the presence of plain anteroposterior and lateral radiographs at the last follow-up visit. Patients failing to show up for the second postoperative visit, those who had undergone a revision surgery for whatever reason on one of the operated knees, those who had had their contralateral knee operated in another center (for the staged group), and patients whose data regarding operation time was lacking were excluded from this study. All demographic and descriptive data were obtained from hospital records by an independent researcher (YE). The study enrolled 73 patients with bilateral UKA who met these criteria.

A detailed discussion of risks and advantages/disadvantages is routine in our institution. Patients eligible for simultaneous procedures are always given a choice of undergoing a simultaneous procedure or a staged procedure. Ultimately, patient preference is routinely followed. Eighty-two patients were initially eligible for the study. One patient died due to a work-related accident, 4 patients were lost to follow-up, and 4 patients had not given their consent for their data to be used in clinical studies. The remaining 73 patients were then divided into two groups on the basis of the preferred surgical method. Group I included patients who underwent simultaneous bilateral UKA and group II included patients who underwent staged bilateral UKA. Forty patients were included in group I and 33 in group II. Preoperative comorbidities, American Society of Anesthesiologists (ASA) score,[19] operative time, length of hospital stay, postoperative hemoglobin levels, and transfusion requirements were recorded. Operative time was calculated as the time between tourniquet inflation and final wound dressing. Hospital time was calculated from the day of surgery up to (and including) the day of discharge, so admission (or not) a day before did not influence the final calculation. Hemoglobin levels and transfusion requirements were retrieved from medical data in the hospital system.

Surgical Procedure

Surgical indications were symptomatic bilateral end-stage isolated medial compartment osteoarthritis with at least 90° knee flexion, < 15° knee extension, no instability, and a < 10° varus malalignment. Contraindications included posttraumatic arthritis, inflammatory disease, and a nonfunctional anterior cruciate ligament.[20] All operations were performed by or strictly supervised by one main surgeon who attended all the procedures during the years (AF). Using a pneumatic tourniquet, all patients were operated under spinal or epidural anesthesia, according to the attending anesthesiologist's experience/preference. For simultaneous cases, both legs were painted and draped in a sterile way at the same time. Two grams of cefazolin were administered as a prophylaxis 30 minutes before surgery, followed by 3 doses of 1 g of cefazolin every 8 hours during the first 24 postoperative hours. Before and 3 hours after surgery, 1 g of tranexamic acid was administered intravenously. Patients with contraindications such as cardiac arrhythmias or a high risk of venous thrombosis were not given tranexamic acid, either orally or intravenously.

After anesthesia, the tourniquet was inflated, and operation time calculation was started and noted on the anesthesiologist's follow-up sheet. The knee was approached with a mini medial parapatellar incision without inverting the patella. All patients were treated with a cementless Oxford Phase 3 medial unicondylar implant assisted by the Microplasty surgical set (Oxford Knee, Biomet, Swindon, UK). The integrity of the anterior cruciate ligament was checked and then the tibial guide was positioned. After the vertical cut and horizontal cuts were

performed, a femoral intramedullary guide was used to complete femoral component preparation. Trial implants were inserted, and a mobile bearing was selected according to the intra-articular gap. Upon achieving the desired balance, the original components were implanted. The tourniquet was released, and bleeding control was achieved. A Hemovac drain was placed, and the fascia and the overlaying tissues were closed in a standard fashion. For simultaneous cases, the operation on the contralateral knee was started as soon as the fascia of the first knee was closed. A medical assistant would close the overlaying tissue while the main team would perform the same surgery on the other knee. Operation time was considered over when the final dressing of the knee (or knees) was completed.

Group I patients underwent sequential surgery. Staged surgeries (group II) were performed with an average of 3.8 months (range, 2–6 months) between procedures. The timing of surgery was determined by patient choice, clinical condition, and anesthetic recommendations (increase in ASA score, history of a venous thrombosis, history of complications due to anesthetic drugs, etc.).

Postoperative Rehabilitation

A drain and compression bandage were applied to each patient. The drain was removed on the second postoperative morning. All patients received a daily dose of 40 mg/0.4 mL subcutaneous enoxaparin, starting on the first postoperative night and continued until discharge. The enoxaparin was continued during the first postoperative month and then stopped. All patients were mobilized and allowed to bear full weight on the first day, with concomitant muscle-strengthening exercises and range of motion.

Clinical Evaluation

For staged UKAs, total operative time was determined by adding the duration of the two individual operations and the same was performed with the hospital stay. Postoperative hemoglobin levels were calculated using hemoglobin levels measured on the morning of the first postoperative day. The overall score was based on the arithmetic mean of the hemoglobin levels measured in the staged group before and after the two procedures. Adverse events such as death, pulmonary embolism, deep vein thrombosis, myocardial infarction, cardiac arrhythmias, and complications such as deep joint infections, superficial wound infections, and periprosthetic fractures were recorded. Relative safety for this study was defined as a significant difference in peri- and postoperative complication rates, transfusion need, and overall clinical scores.

Functional outcomes were assessed both before and after surgery using the Oxford Knee Score (OKS)[21] and the Knee Society Score (KSS).[22] Pain was measured with a visual analog scale (VAS). Functional scores and pain scores were obtained separately for the right and left knees, and the arithmetic mean of the two scores was used for the final total score. Patients were followed up at 1, 2, 3, 6, and 12 months postoperatively and annually thereafter. Data from the last follow-up were included in the study. In line with the secondary objective of this study, at the second postoperative year's visit, the patients were asked to assess their satisfaction with the surgical modality they underwent and if they would choose differently if given the choice again. The answers were noted and analyzed.

Statistical Analysis

The suitability of the numerical variables to the normal distribution was assessed graphically (branch-leaf plot and histogram) and using the Shapiro-Wilks test. Numerical variables (age, body mass index [BMI], follow-up time, etc.) were summarized as medians (interquartile range), and categorical variables (sex and ASA score) were summarized as frequencies (percent). Fisher's exact test and Pearson's chi-square test were used for categorical variables in group comparisons, and the Mann-Whitney *U*-test was used for numerical variables. Wilcoxon paired two-sample test results were provided in the comparison of preoperative and postoperative values. IBM SPSS statistics ver. 21.0 was used for statistical analyses (IBM Corp., Armonk, NY, USA). The statistical significance was $p \leq 0.05$.

RESULTS

The mean age was 56.9 ± 6.6 years and 58.4 ± 7.3 years for group I and II, respectively, and the majority of patients in both groups were female (87.5% and 84.8%, respectively). The simultaneous group had a mean follow-up time of 36.6 ± 17.0 months, whereas the staged group had a mean follow-up time of 36.1 ± 14.4 months. Age, sex, mean follow-up time, BMI, and preoperative ASA scores were similar between groups ($p > 0.05$). All data are shown in Table 1.

The simultaneous group had a mean operative time of 118 ± 8.0 minutes, which was significantly shorter than 135.0 ± 14.4 minutes in the staged group ($p < 0.001$). The operation time was calculated as the time from tourniquet inflation until the last dressing and bandage of the wound so that it was not influenced by anesthesia time, draping, and skin preparation. Hospital stay was also longer in the staged group ($p = 0.001$). There was no difference between the groups in terms of preoperative and postoperative

hemoglobin levels and complications. No patient in either group required blood transfusions. There were 5 complications (2 minor and 3 major) in the simultaneous group and 4 complications (2 major and 2 minor) in the staged group. In both groups, all minor complications were superficial wound infections. Local debridement and oral antibiotics were used for treatment. Symptomatic deep vein thrombosis was detected in 1 patient in each group and treated medically. Coronary spasm developed in 1 patient in the staged group on the second postoperative day. The patient was referred to the cardiology department for further treatment. Periprosthetic tibia fracture was detected in the first 10 days postoperatively in 2 patients in the simultaneous group (Fig. 1). While treatment with a proximal buttress plate was sufficient for 1 of the cases, the other patient was treated with a constrained TKA due to failure of the medial collateral ligament. Relative data are shown in Table 2.

Table 1. Demographic Characteristics by Group

Variable	Group I (n = 40)	Group II (n = 33)	*p*-value
Sex			0.747*
Male	5 (12.5)	5 (15.2)	
Female	35 (87.5)	28 (84.8)	
Age (yr)	56.9 ± 6.6	58.4 ± 7.3	0.556†
BMI (kg/m^2)	31.6 ± 3.7	31.0 ± 3.3	0.277†
Follow-up time (mo)	36.6 ± 17.0	36.1 ± 14.4	0.921†
ASA score			0.801‡
1	13 (32.5)	10 (30.3)	
2	23 (57.5)	18 (54.5)	
3	4 (10.0)	5 (15.2)	

Values are presented as number (%) or mean ± standard deviation. Group I: simultaneous surgery group, Group II: staged surgery group.
BMI: body mass index, ASA: American Society of Anesthesiologists.
*Fisher exact test. †Mann-Whitney *U*-test. ‡Pearson chi-square test.

Compared with preoperative values, there was a significant improvement in KSS clinical, KSS functional, OKS, and VAS scores in both groups in the postoperative period ($p < 0.001$). The changes in these scores were similar between groups for both preoperative KSS and OKS and postoperative KSS and OKS, as well as in the preoperative and postoperative periods ($p > 0.05$). Preoperative VAS scores were comparable between groups, but postoperative scores were significantly higher in patients operated on with a simultaneous procedure. Despite being statistically significant, the change was too small to be clinically significant and it should be interpreted accordingly. All data are shown in Table 3.

At the second postoperative follow-up visit, patients were asked whether they would undergo the same procedure again or choose a staged/simultaneous procedure instead depending on the procedure they had already undergone. Only 36% of the patients in the staged group indicated that they would choose the staged method again, whereas 70% of the patients in the simultaneous group indicated that they would choose the same method again (Fig. 2).

DISCUSSION

The main finding of this study is that simultaneous bilateral unicondylar procedures required a shorter overall cumulative hospital stay and shorter operative time,

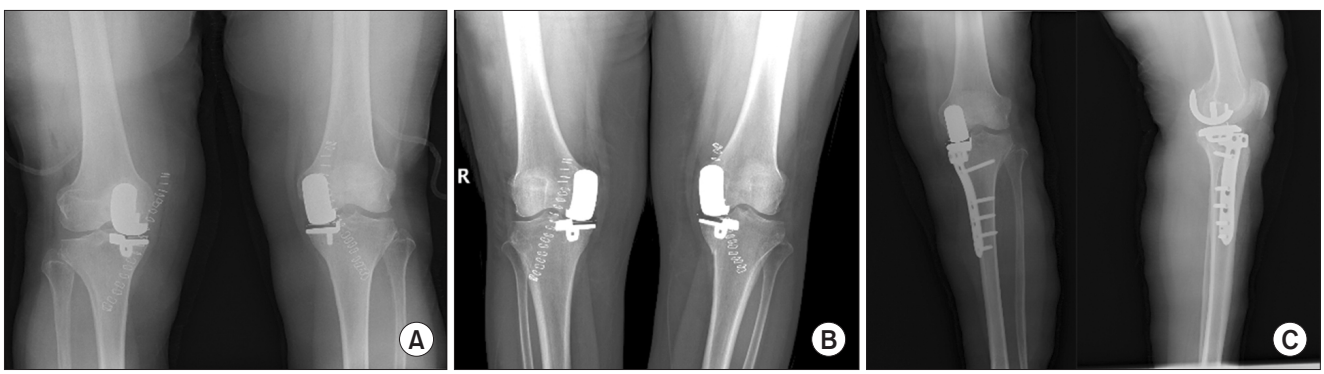

Fig. 1. (A) The early postoperative radiograph of a 56-year-old woman (body mass index, 34 kg/m^2) operated simultaneously on both knees with a unicondylar implant. (B) The same patient's radiograph 2 weeks after surgery. Note the nondisplaced fracture on the tibial metaphysis. (C) The patient was treated with fracture reduction and a buttress plate.

Table 2. Comparison of Operation Time, Length of Hospital Stay, Hemoglobin Level, and Complications between Groups

Variable	Group I (n = 40)	Group II (n = 33)	*p*-value
Operation time (min)	118.3 ± 8.0	135.0 ± 14.4	< 0.001*
Length of hospital stay (day)	3.9 ± 1.0	4.7 ± 0.9	0.001*
Preoperative hemoglobin (g/dL)	13.4 ± 0.9	12.9 ± 1.0	0.068*
Postoperative hemoglobin (g/dL)	12.1 ± 0.9	11.6 ± 1.3	0.127*
Hemoglobin change (g/dL)	1.3 ± 0.7	1.2 ± 0.9	0.346*
Periprosthetic fracture	2 (5.0)	0	0.193†
Complication	5 (12.5)	4 (12.1)	> 0.999†
Superficial wound infection (minor)	2 (5.0)	2 (5.0)	
Deep vein thrombosis (major)	1 (2.5)	1 (2.5)	
Coronary spasm (major)	0	1 (2.5)	
Periprosthetic fracture (major)	2 (5.0)	0	

Values are presented as mean ± standard deviation or number (%). Group I: simultaneous surgery group, Group II: staged surgery group.
*Mann-Whitney *U*-test. †Fisher exact test.

Table 3. Comparison of KSS, OKS, and VAS Values in Groups

Variable	Group I (n = 40)	Group II (n = 33)	*p*-value*
Preoperative KSS clinical	58.3 ± 9.2	57.2 ± 10.2	0.833
Postoperative KSS clinical	94.8 ± 4.8	92.1 ± 9.2	0.274
p-value†	< 0.001	< 0.001	
Preoperative KSS functional	51.4 ± 11.4	49.8 ± 13.0	0.512
Postoperative KSS functional	91.1 ± 8.9	84.4 ± 16.8	0.266
p-value†	< 0.001	< 0.001	
Preoperative OKS	20.0 ± 5.5	18.2 ± 5.4	0.230
Postoperative OKS	45.2 ± 2.7	42.1 ± 6.9	0.071
p-value†	< 0.001	< 0.001	
Preoperative VAS	5.9 ± 1.0	5.5 ± 1.1	0.150
Postoperative VAS	0.5 ± 0.6	1.2 ± 1.4	0.008
p-value†	< 0.001	< 0.001	

Values are presented as mean ± standard deviation. Group I: simultaneous surgery group, Group II: staged surgery group.
KSS: Knee Society Score, OKS: Oxford Knee Score, VAS: visual analog scale.
*Mann-Whitney *U*-test group comparison. †Wilcoxon test for preoperative and postoperative comparison.

while having similar complication rates. Clinical scores improved with both treatment modalities and pain was significantly lower in patients undergoing simultaneous surgery. Some studies in the literature have reported that simultaneous bilateral TKA increases perioperative and all-cause mortality.[23,24] We studied our patients with simultaneous and staged bilateral UKA based on this theory. In addition, simultaneous bilateral UKA has advantages such as shorter operative time and hospital stay. All 16 clinical trials included in a meta-analysis by Kwan

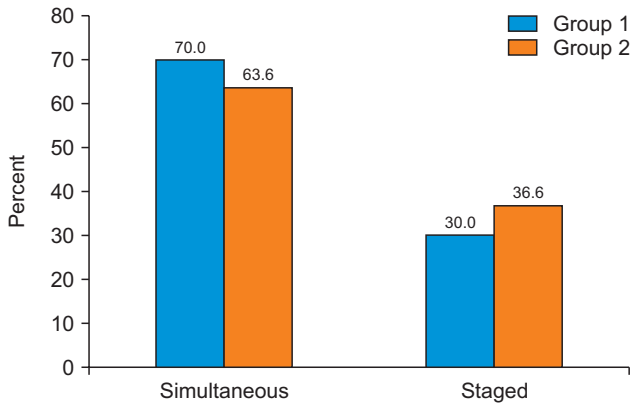

Fig. 2. Patient replies in percentage at 2 years postoperatively on whether they would undergo the same procedure again or choose the other procedure instead. Group I: sequential surgery group, Group II: staged surgery group.

et al.[17] showed that bilateral UKA improved clinical and radiological outcomes when performed simultaneously or in a staged fashion. In the present study, we found that KSS, OKS, and VAS scores improved significantly in both groups compared with the preoperative period.

Compared with stepwise procedures, simultaneous procedures are generally expected to result in a shorter overall hospital stay. In their study, Chan et al.[25] reported cumulative anesthesia times of 114 minutes in the simultaneous group and 129 minutes in the staged group. In the present study, the cumulative anesthesia duration was slightly shorter in the simultaneous group than in the staged group (117.5 minutes vs. 135 minutes). We calculated the operative time as the timeframe from tourniquet inflation until the last dressing of the wound so that it would not be influenced by anesthesia time, draping, and skin preparation. The operation on the contralateral knee was started as soon as the fascia of the first knee was closed, and this is the main reason for the difference in our operative time. According to Feng et al.,[26] the hospital stay was 4.2 ± 0.7 days in the simultaneous group and 7.5 ± 1.5 days in the staged group. In the present study, the cumulative hospital stay was statistically significantly shorter in the simultaneous group than in the staged group. We calculated hospitalization time from the day of surgery up to (and including) the day of discharge, so admitting the patient a day before did not influence the calculation. In this aspect, simultaneous surgery might be regarded as a "single" surgery; therefore, admission was shortened for group I, while the staged procedures were two separate surgeries.

Regarding complication rates, Boniforti and Romagnoli[27] found no difference between simultaneous UKA and staged UKA. Feng et al.[26] discovered a complication rate of 10.3% in the simultaneous group and a complication rate of 9.3% in the staged group, with no statistically significant difference between the two groups. Malahias et al.[28] reported an overall complication rate of 7% for bilateral UKA and found no difference in complication rates between staged and simultaneous procedures in their meta-analysis. In the present study, the complication rate was 12.5% in the simultaneous group versus 12.1% in the staged group. Although the difference was not statistically significant, periprosthetic fracture was not observed in the staged group, while there were 2 cases in the simultaneous group. This could be attributed to the fact that patients were allowed full weight-bearing from the first postoperative day. While a unilaterally operated patient can rely on the other knee for support on the first painful days, a simultaneously operated patient does not have the same luxury. Previous studies comparing the two treatment modalities (or just reporting on simultaneous cases) have mostly focused on postoperative blood loss and cost-effectiveness of the procedure[17,29,30] and the majority of these studies utilized cemented implants.[31] A larger study cohort might be more successful in showing whether a simultaneous cementless UKA procedure has a higher risk of periprosthetic fracture.

Biazzo et al.[32] found a statistically significant difference between the two groups, with a mean hemoglobin level of 3.1 g/dL in the simultaneous group and 2.4 g/dL in the staged group. Chen et al.[4] reported that the mean hemoglobin change rate in the simultaneous group was 1.45 g/dL versus 1.30 g/dL in the staged group, with no significant difference between them. Although the simultaneous group had a greater decrease in mean hemoglobin level at the end of the second day, there was no statistically significant difference between the two groups in the present study. This could be related to the use of intravenous tranexamic acid, which is nowadays a routine procedure during arthroplasty. We also achieved bleeding control prior to fascia and wound closure, which is another factor that might have helped preserve the hemoglobin levels. No patient required a transfusion. Many studies have found no difference in postoperative functional outcomes between patients with simultaneous and staged UKA.[3,4] In their meta-analysis, Chen et al.[18] found no significant difference in postoperative OKS between the simultaneous and staged groups. The median change in VAS scores at the end of the first year in the present study was 6 in the simultaneous group and 5 in the staged group. Although this situation was statistically significant in favor of the simultaneous group, we believe that it has no practical clinical implications.

The small questionnaire at the end of the second postoperative year showed that 36% of the patients in the staged group indicated that they would choose the staged method again, whereas 70% of the patients in the simultaneous group indicated that they would choose the same method again. We believe this simply has to do with the cumulative pain that patients undergoing a stagged procedure experienced. Our experience in this study could be used to counsel future patients experiencing a dilemma on whether to choose a simultaneous or a stagged bilateral procedure.

Our study has some limitations. First, it is a retrospective study, which leaves it prone to bias. Second, the average follow-up time was not very long, and it did not include radiological evaluation. The fact that the great majority of the patients was female, accordingly with lower bone mass, was another drawback of the study. This has surely led to a selection bias, making the results of our study mainly valuable for female patients. Furthermore, we could not standardize our regional anesthesia procedure since multiple attending physicians were responsible from that department during the years. This might have an effect on final clinical pain scores. Finally, a higher patient number could have yielded more meaningful results. Despite these limitations, we believe that our study will help clinicians make decisions between simultaneous and staged surgery for bilateral medial knee osteoarthritis with an indication for UKA.

Simultaneous bilateral cementless UKA was more advantageous in terms of cumulative hospital stay and total operation time with similar clinical results when compared to a staged procedure. While overall complication rate was similar, there was a 5% rate of periprosthetic fractures in the simultaneous group.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

ORCID

Ali Şahin https://orcid.org/0000-0002-2399-404X
Şahin Çepni https://orcid.org/0000-0001-6850-7439
Enejd Veizi https://orcid.org/0000-0002-1289-4959
Yasin Erdoğan https://orcid.org/0000-0001-6862-9671
Ahmet Fırat https://orcid.org/0000-0001-9182-7270
Kasım Kılıçarslan https://orcid.org/0000-0003-3852-4128

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