Original article

Bilateral simultaneous unicompartmental knee arthroplasty versus unilateral total knee arthroplasty: A comparison of the amount of blood loss and transfusion, perioperative complications, hospital stay, and functional recovery

J.H. Ahn*, D.M. Kang, K.J. Choi

Department of orthopedic surgery, Dongguk university, Ilsan hospital, 814 Siksadong, Ilsan, Goyangci, Kyunggi-do, Korea

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Background: Unicompartmental knee arthroplasty (UKA) is a good alternative treatment option to total knee arthroplasty (TKA) for single compartment knee osteoarthritis. Several recent reports suggest that UKA results in more rapid functional recovery than TKA, together with fewer complications. Few performed a comparison of bilateral simultaneous UKA and unilateral TKA.

Hypothesis: Bilateral simultaneous UKA would result in fewer perioperative complications, less blood loss, less transfusion and faster recovery of short-term clinical outcomes, compared with unilateral TKA patients.

Material and methods: In a retrospective trial, the bilateral simultaneous UKA (bUKA) cases were matched one to one with a cohort of unilateral TKA (uTKA) cases according to age, body mass index, gender, Kellgren-Lawrence grade of knee osteoarthritis and American Society of Anesthesiologists score. In bilateral simultaneous UKA group, patients had KL grade 4 of bilateral knee osteoarthritis, and in unilateral TKA group, patients had KL grade 4 of unilateral knee osteoarthritis. The transfusion requirements, estimated blood loss (EBL), duration of hospital stay, incidence of complications, and knee clinical scores of the bUKA and uTKA groups were compared at the 6-month short-term follow-up.

Results: Patients were categorized into the bUKA group (n = 52) and uTKA group (n = 52). The number of patients requiring transfusion and the amount of EBL was smaller in the bUKA group (P < 0.001 for transfusion and P = 0.043 for EBL). The duration of hospital stay was shorter and the number of complications was smaller in the bUKA group (P < 0.001 for hospital stay and P = 0.028 for complications). The clinical outcomes were also superior in the bUKA group (P < 0.001).

Conclusions: Bilateral simultaneous UKA shows fewer perioperative complications, less blood loss, less transfusion, and better functional outcomes at 6 months postoperatively than unilateral TKA. The data suggest that bilateral simultaneous UKA can be performed safely, and results in acceptable clinical outcomes.

Level of evidence: III, case-control study.

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1. Introduction

Unicompartmental knee arthroplasty (UKA) is a good alternative treatment option to total knee arthroplasty (TKA) for single compartment knee osteoarthritis, especially in the medial compartment [1,2]. Several reports suggest that UKA results in more rapid functional recovery than TKA, together with a decreased length of hospital stay and fewer complications at short-term follow-up [3–6]. Taken together with the smaller incision and less blood loss, UKA is a minimally invasive and safer method than TKA [7–12].

Many patients in need of knee arthroplasty have bilateral pain and require surgery to both knees. The safety of bilateral simultaneous TKA remains a matter of debate. Simultaneous TKA has the advantages of a single anesthetic, shorter hospital stay, and increased cost effectiveness without increasing the rate of perioperative complications [13]. However, other studies reported increased perioperative complication rates, including pulmonary
embolism, major cardiac events, and transfusion in bilateral simultaneous TKA [14,15].

Regarding the safety of bilateral simultaneous UKA, that of simultaneous and staged UKA [16–19], and simultaneous bilateral and unilateral UKA [20], have been compared. In most previous studies of UKA and TKA, unilateral UKA was compared with unilateral TKA [3–8,10,12,21,22]. Few performed a comparison of bilateral simultaneous UKA and unilateral TKA.

Unilateral TKA has long been considered a safer treatment option for knee osteoarthritis compared with bilateral simultaneous TKA [14,15]. To evaluate the safety of bilateral simultaneous UKA, bilateral simultaneous UKA was compared with unilateral TKA using matched pairs. The purpose of the present study was to compare the rates of perioperative complications, blood loss, transfusion and short-term clinical outcomes in bilateral simultaneous UKA with matched controls undergoing unilateral TKA. The hypotheses of this study were that:

- bilateral simultaneous UKA would result in fewer perioperative complications, less blood loss and less transfusion than unilateral TKA;
- patients undergoing bilateral simultaneous UKA would exhibit faster recovery of short-term clinical outcomes compared with unilateral TKA patients.

2. Material and methods

2.1. Inclusion and exclusion criteria

Institutional review board approval was obtained for this retrospective trial (2015.11.12, IRB number 2015–118). The surgical database was searched to identify retrospectively all patients who had undergone bilateral simultaneous UKA and unilateral TKA between January 2012 and September 2015. Inclusion criteria were patients who underwent bilateral simultaneous UKA and unilateral TKA for Kellgren-Lawrence (KL) grade 4 of medial knee osteoarthritis and persistent knee pain despite 6 months of conservative treatment. In bilateral simultaneous UKA group, patients had KL grade 4 of bilateral knee osteoarthritis, and in unilateral TKA group, patients had KL grade 4 of unilateral knee osteoarthritis. Exclusion criteria were post-traumatic arthritis, rheumatoid arthritis, osteonecrosis, revision arthroplasty and component augmentation during procedure. Fifty-three and ninety-eight patients underwent bilateral simultaneous UKA and unilateral TKA, respectively. Among the 53 patients who had undergone bilateral simultaneous UKA, one was excluded due to post-traumatic arthritis (n = 1). Among the 59 patients who had undergone unilateral TKA, 13 were excluded due to post-traumatic arthritis (n = 1), rheumatoid arthritis (n = 2), osteonecrosis (n = 2), revision arthroplasty (n = 3) and component augmentation (n = 5).

Therefore, 52 bilateral simultaneous UKA cases were matched one to one with a cohort of 85 unilateral TKA cases according to age (within 5 years), body mass index (BMI) (within 2.0 kg/m²), gender, KL grade of knee osteoarthritis and American Society of Anesthesiologists (ASA) score [23]. Patients were categorized into the bilateral simultaneous UKA (bUKA) group (n = 52) and the unilateral TKA (uTKA) group (n = 52).

2.2. Surgical technique

The procedures were performed by one senior surgeon (J.H.A.) in all of the cases. All the surgeries were performed under spinal anesthesia.

2.2.1. Bilateral simultaneous UKA

A fixed-bearing Unicompartmental High-Flex Knee System (Zimmer, Warsaw, ID, USA) was implanted in all patients. Under tourniquet control, a standard midline incision and medial parapatellar arthroscopy through a minimally invasive, quadriceps-sparing surgical exposure were used. After resecting the tibia, the distal femoral cut was made with the knee in extension, ensuring the proximal tibial cut and distal femoral cut were parallel. The posterior femoral resection then created a flexion gap equal to the extension space. The thickness of the polyethylene was adjusted to ensure a well-balanced knee capable of full extension with about 2 mm medial laxity. Both the femoral and tibial components were cemented in all cases.

2.2.2. Unilateral TKA

Posterior cruciate substitution total knee prostheses (Genesis II Oxinium, Smith & Nephew, Memphis, TN, USA) were implanted in all patients. Under tourniquet control, a standard midline skin incision and a mid-vastus approach were used in all cases. During distal femoral resection, the coronal femoral alignment was set using an intramedullary guide according to the anatomical–mechanical axis angle, to achieve a cut perpendicular to the mechanical axis. The external rotation of the femoral cuts was determined with the plane parallel to the femoral posterior condyle. The position of the proximal tibial cut was determined, with a 4-degree posterior slope and a 2 mm resection referenced off the medial tibial plateau. The femoral component was then evaluated and soft tissue balance was assessed.

2.2.3. Postoperative care

All patients had a drain inserted and compressive dressing was applied. On the second postoperative day, the drain was removed and the dressings were reduced. In all patients, low-molecular weight heparin was used for postoperative deep vein thrombosis (DVT) chemoprophylaxis. Prophylactic aspirin for cardiovascular disease was discontinued at least 10 days before surgery, and resumed 1 week after surgery. The use of tranexamic acid was not applied in this study.

All patients were allowed to move with full weight bearing from the second postoperative day onwards.

2.3. Perioperative complications, blood loss, transfusion and clinical outcomes

The record of the hospital stay was reviewed to obtain information concerning complications, the number of patients requiring readmission within 90 days, the amount of perioperative blood loss, the lowest postoperative hemoglobin (Hb) level recorded, transfusion requirements, and the duration of hospital stay. The amount of perioperative blood loss was estimated by calculating estimated blood loss (EBL) using Gross’ formula [24]. Admission record and progress record of follow-up visits through the first 180 days were reviewed to determine short-term clinical outcomes and additional postoperative complications. Patients who had low Hb (below 8 g/dl) or combination of low Hb (below 8.5 g/dl) and symptoms (low blood pressure, raised heart rate, dizziness) were transfused. However, in some patients blood transfusion was given even up to Hb of 9 g/dl due to either persistent symptoms.

Clinical outcomes were evaluated by one senior surgeon (J.H.A.), using pre and postoperative objective knee scores and functional scores in the Knee Society (KS) clinical rating system [25] and the range of motion of the knee joint. The progress of functional recovery was monitored by the time taken by the patient to achieve independent ambulation without walking aids for a distance of 50 m. The time required to climb at least 20 steps was also monitored.
2.4. Statistical analysis

Statistical analysis was performed using SPSS version 19.0.0. Differences in the continuous variables (age, BMI, ASA score, amount of blood loss, Hb level, duration of the hospital stay, preoperative knee alignment angle, knee scores, range of motion of knee joint, and time for independent ambulation and climbing the stairs) were compared by paired t-test. For paired t-test, the average values of both knees in bilateral simultaneous UKA were used in preoperative knee alignment angle, KS objective score, the range of motion and the range of increased ROM, respectively. Differences in non-parametric variables (gender, transfusion requirements, number of patients requiring readmission within 180 days, and incidence of complications) were compared using Fisher’s exact test. The significance level was set at P<0.05.

The sample size for the present study was calculated based on data from a previous study [8]. From this previous study, the value of postoperative hematocrit, which was used for calculating EBL in our study was used for the calculation of the sample size. The postoperative hematocrit was 39±4% in UKA group, and 36±4% in TKA group, respectively. A standard of 80% power, type I error rate of 5% and effect size of 0.56 was applied. Using G*Power 3.1 calculation software, the sample size calculations from the underlying t-tests resulted in a sample size of 52 cases for each group.

3. Results

Patients’ demographics are shown in Table 1. There was no significant difference in age, gender, BMI, ASA score, KL grade of knee osteoarthritis, KS objective and functional scores at the time of surgery between both groups. Compared with the bUKA group, the uTKA group showed greater varus knee deformity and limited knee ROM preoperatively (Table 1).

The mean preoperative Hb level was similar in the two groups, but the lowest mean postoperative level was higher in the bUKA group by 1.2 g/dl (P = 0.001) (Table 2). The number of patients requiring transfusion (9/52 (17.3%) in bUKA and 44/52 (84.6%) in uTKA) and the amount of EBL (716.1 ± 482.0 ml in bUKA and 1121.1 ± 446.5 ml in uTKA) were smaller in the bUKA group (P<0.001 for transfusion and P = 0.043 for EBL).

The duration of hospital stay was shorter, and the number of complications was smaller in the bUKA group (P<0.001 for hospital stay and P = 0.028 for complications). There was one complication (superficial wound problem) in the bUKA group (complication rate, 1.9%). There were seven complications in the uTKA group, comprising three superficial wound problems, two deep vein thromboses and three pulmonary edemas (complication rate, 13.5%). There was no significant difference in the number of patients requiring readmission between the two groups (P = 0.558).

Regarding early recovery, the times required for independent ambulation and climbing stairs were shorter in the bUKA group (P<0.001). The knee ROM at 6 months postoperatively was greater in the bUKA group (P<0.001), while the increased range (gain) of knee ROM after surgery showed no difference between both groups (P = 0.541).

The bUKA group had higher scores for later outcome measures than the uTKA group in terms of the KS objective and functional scores at 6 months postoperatively (Table 2). The change in score (preoperatively to 6 months postoperatively) indicated improved KS objective and functional scores in both the bUKA and uTKA groups (P<0.001 in both groups).

4. Discussion

The most important finding of the present study was that bilateral simultaneous UKA resulted in fewer perioperative complications, less blood loss, less transfusion, and better functional outcomes at 6 months postoperatively than unilateral TKA (Table 3). Thus, our hypothesis is confirmed.
Because UKA is usually performed in younger and less obese patients, bilateral simultaneous UKA patients were matched with unilateral TKA patients according to age, BMI, gender, KL grade and ASA score in the present study. The parameters for matching were obtained from previous studies [3,8,9] that compared UKA and TKA by matched-pair analysis. We expected this matched analysis to reduce the possible bias due to patients’ preoperative health status.

Regarding perioperative complications of UKA, a previous study [16] reported no difference in perioperative complications between simultaneous and staged UKA. In a systematic review [7] of the postoperative outcomes of UKA and TKA, UKA had a significantly lower probability of postoperative complications than TKA. In a previous study by Liddle et al. [4] with a large number of patients from a national registry, UKA also resulted in fewer perioperative complications than TKA. Similarly, in the present study, bilateral simultaneous UKA resulted in fewer perioperative complications than unilateral TKA. In contrast, Winder et al. [9] reported that a bilateral simultaneous UKA group had a risk of complications similar to that of a matched group of bilateral simultaneous TKA patients. Ninety-day complications in the UKA group included 1 wound infection and 1 deep vein thrombosis (3.5%). The TKA group had 2 complications including 1 superficial wound infection and 1 pulmonary embolism (1.79%) (P = 0.60). The possible explanation for this difference is the smaller number of UKAs (n = 28) in this study, compared with our work (n = 52).

Regarding blood loss and transfusion in bilateral simultaneous UKA, Ma et al. [17] reported no difference in transfusion requirements between bilateral simultaneous UKA and bilateral staged UKA. Also, the mean reduction in Hb level postoperatively was greater in the simultaneous group, but this did not translate into a significant increase in the number of patients requiring blood transfusion [19]. In contrast, Romagnoli et al. reported that blood and Hb losses, and the use of transfusion of allogeneic and autologous blood units, were higher in the simultaneous bilateral group [20]. In a comparison of unilateral UKA and TKA, blood loss and transfusion rates were lower in unilateral UKA than unilateral TKA [8,12]. In the present study, blood and Hb losses, and the requirement for transfusion, were lower in bilateral simultaneous UKA than in unilateral TKA (Table 2). Because unilateral TKA is frequently performed for knee osteoarthritis, bilateral simultaneous UKA may be considered safe in terms of blood loss and transfusion.

Good short-term clinical outcomes following UKA as well as lower complication rates than TKA have been reported [3,5–8,10,12]. A previous matching study [3] revealed that unicompartmental arthroplasty using a rapid recovery protocol resulted in a more rapid return to a higher functional level than total knee arthroplasty. Also, in a meta-analysis of randomized controlled trials, UKA was superior to TKA regarding short-term outcomes and postoperative complications [7]. Patients undergoing UKA had a shorter hospital stay and a lower 30-day readmission rate compared to TKA patients [6]. Most previous studies compared unilateral UKA and TKA in terms of short-term clinical outcomes. In our study, bilateral simultaneous UKA was superior to unilateral TKA in various short-term functional outcomes, including independent ambulation and climbing stairs (Table 2).

This study had several limitations, including its retrospective and non-randomized design. The limitations of this study also include the small number of subjects and the short-term follow-up. The small sample size (n = 52) resulted in limited statistical power, which may have limited the significance of the results. Another limitation is that in this matched study, the preoperative knee alignment and knee ROM were not considered in matching controls. Greater varus alignment and limited knee ROM were found in patients undergoing TKA compared to those receiving UKA. An important limitation was the absence of assessment of the survival and revision rates after UKA and TKA. In a previous study, TKA showed higher survival and lower revision rates compared with UKA, whereas in our study, only short-term outcomes were assessed.

The strength of this study was the focus on matched controls. This strict matching between two groups was intended to minimize the difference in preoperative patient factors, and prevent any resulting bias.

To conclude, the short-term follow-up and the small sample size in this study may have the limitation in evaluating the difference between bilateral simultaneous UKA and unilateral TKA. However, bilateral simultaneous UKA shows fewer perioperative complications, less blood loss, less transfusion, and better functional outcomes at 6 months postoperatively than unilateral TKA. The data suggest that bilateral simultaneous UKA can be performed safely, and results in acceptable clinical outcomes.

Disclosure of interest

The authors declare that they have no competing interest.

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