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ORIGINAL ARTICLE

# Bilateral unicompartmental knee arthroplasty: one stage or two stages?

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## Abstract

**Background** Bilateral unicompartmental knee arthroplasty (UKA) may be performed as one- or two-stage procedure. Previous reports suggest that UKA provides a more rapid functional recovery than total knee arthroplasty. However, little data exist on whether bilateral UKA can be performed without increasing the perioperative risk compared with unilateral cases.

**Methods** We retrospectively compared 51 patients treated between January 2014 and March 2017 with single-stage UKA (group A) with 51 patients who underwent unilateral procedure (group B) to evaluate perioperative complications. We noted no statistically significant difference between the two groups in terms of gender, age and body mass index.

**Results** Patients who underwent single-stage bilateral UKA had longer operating room time with respect to single procedure (93.2 min vs. 50.7 min). However, the bilateral group had a shorter cumulative operating room time (93.2 min) compared to the unilateral group (101.5 min) with a statistically significant difference ($p < 0.05$). Average hemoglobin loss at discharge was 3.1 points for group A and 2.4 for group B, with a statistically significant difference ($p < 0.05$).

**Conclusion** Our results demonstrated that bilateral simultaneous UKA does not increase the risk for perioperative complications. Total blood loss at discharge is statistically higher in bilateral UKA rather than unilateral UKA; however, cumulative hemoglobin loss is statistically lower in bilateral group. Patients can benefit from a single hospital admission and anesthetic time, while the shorter total inpatient stay and lower blood loss can reduce hospital costs in cases of bilateral surgery.

**Level of evidence IV** Retrospective study.

**Keywords** Unicompartmental knee arthroplasty · Bilateral · Soft-tissue sparing surgery · Two-stage UKA

## Background

At least 20% of patients undergoing a primary knee arthroplasty are affected by bilateral osteoarthritis (OA) and are destined to undergo a second contralateral surgery within a few years from the first one [1, 2]. Then, undergoing a simultaneous bilateral surgery instead of a two-stage procedure would reduce patients' management costs, hospital length of stay and rehabilitation time [3–6]. Despite these benefits, concerns arose about simultaneous bilateral procedures due to massive blood loss, longer operative time, and higher complication, revision, mortality and transfusion rates, both for total knee arthroplasty (TKA) [7–10] and for unicompartmental knee arthroplasty (UKA).

Several reports suggest that UKA has a quicker functional recovery than TKA with decreased length of stay and fewer failures at long-term follow-up [11–13]. Coupled with smaller incision surgery and less blood loss [11], UKA has been perceived as a minimally invasive and safer surgery compared to TKA. Despite an abundance of the literature on staged versus simultaneous TKA, there are few published data on the safety of bilateral simultaneous UKA.

We therefore addressed the following questions: (1) Is there an increased risk of perioperative complications with bilateral simultaneous versus unilateral UKA? (2) Is there a difference in operative times between bilateral simultaneous and unilateral UKA? (3) Is there a difference in blood loss and rate of blood transfusion?

It is our opinion that patients with bilateral disease necessitating arthroplasty will achieve a quicker return to function with single-stage bilateral UKA than with staged surgery. Two-stage surgery necessitates patients mobilizing on a painful arthritic knee while awaiting their second operation

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with a longer overall period before they can be free of pain and achieve maximal function.

## Methods

We performed a retrospective review of clinical records between January 2014 and March 2017 identifying 51 patients who had undergone bilateral simultaneous UKA (medial bilateral, lateral bilateral or medial + lateral) (group A); we compared this group with the same number of patients who had undergone unilateral UKA (group B), both medial and lateral. No statistical significant difference was reported between the two groups in terms of age, gender and body mass index (BMI). We reported a statistically significant difference in the American Society of Anesthesiology (ASA) score between groups A and B (2.19 vs. 1.99, respectively) (Table 1). The average age of the patients in group A was 70.4 years (52–84 years) and in group B was 68.5 years (35–86 years). BMI of patients in group A was 29.4 and in group B was 28.9. Women were more represented in both groups (38 in group A and 32 in group B).

Concerning the presence of comorbidities, the most common was hypertension (52.9% in group A and 66.6% in group B), followed by diabetes and obesity.

The indications for UKA were primary or secondary medial/lateral OA or avascular necrosis (AVN) with intact cruciate ligaments with a correctable deformity on X-rays. All patients underwent long-leg X-rays in weight-bearing, axial view of patella and Rosenberg views.

The selection criteria were symptomatic OA or AVN and ASA of 3 or below. BMI and age were not exclusion criteria.

Group A had only 1 case of AVN, compared to group B in which we reported 6 cases of AVN. Fifty cases of group A were represented by primary OA, compared to group B in which there were 45 primary OA cases and 2 post-traumatic. Forty-three cases in group A were medial UKA, 5 were lateral UKA, and 3 were medial and lateral. Forty cases of group B were medial and 11 lateral.

We used a minimally invasive mini-midvastus approach. The patella was subluxed and not everted, with subsequent inspection of the cruciate ligaments, lateral compartments and patellofemoral articulation in order to confirm surgical indication for UKA. A tibial guide was used to perform the tibial bone cuts: The first oblique cut was done at 15°–20° to the antero-posterior axis, and the second horizontal cut was made in two degrees of varus to the mechanical axis and between 0° and 7° of posterior slope. All surfaces were cleaned of sclerotic bone and drilled prior to component cementation. No tourniquet was applied in any surgery. Wounds were irrigated with pulsatile lavage systems using normal saline solution. Drains were applied at discretion of the surgeon on the basis of blood loss during surgery.

We used different types of prosthesis: Sigma High Performance Partial Knee (DePuy, Warsaw, USA) in 80 patients, Hermes Uni (Ceraver, Paris, France) in 5 patients, GKS One Nichel-Free (Permedica, Merate, Italy) in 6 patients, iBalance UKA (Arthrex, Munich, Germany) in 3 patients and Allegretto (Zimmer, Warsaw, USA) in 8 patients. All patients were treated by the senior author (FV).

Antibiotic prophylaxis with 2 grams of cefazolin was given preoperatively to all patients and then repeated 1 g every 8 h for the next 24 h. One gram of tranexamic acid was given preoperatively and 3 h after surgery (except for patients with contraindications, such as cardiac arrhythmia or high risk of venous thrombosis). In single procedures, we used drains only in patients with contraindications for tranexamic acid. Transfusions of homologous blood were administered when hemoglobin concentration was under 8 g/dL or in the presence of anemia symptoms. Postoperatively, all patients received chemoprophylaxis with oral rivaroxaban for 35 days after surgery in addition to mechanical compression boots for deep vein thrombosis (DVT) prevention. Postoperatively, the patients performed passive range of motion

**Table 1** General data, operating times and blood loss (at 1, 2 and 3 postoperative day) of the two groups of patients. In two-stage group, operating time and blood loss are doubled, as if the patient underwent the same surgery twice

| | Single-stage UKA (51 patients) | Two-stage UKA (51 patients) | *p* value |
|---|---|---|---|
| Sex | 38 women (75%) | 32 women (63%) | *chisq* 0.201 |
| Age (average) | 70.4 C.I. (68.031–72.791) | 68.5 C.I. (65.365–71.693) | *ttest* 0.342 |
| BMI (average) | 29.47 C.I. (28.074–30.867) | 28.97 C.I. (27.494–30.457) | *ttest* 0.626 |
| ASA score (average) | 2.19 C.I. (2.075–2.304) | 1.99 C.I. (1.892–2.099) | *ttest* 0.013 |
| Operating time (minutes, average) | 93.24 C.I. (88.027–98.442) | **50.7 × 2 = 101.56 C.I. (48.247–53.321)** | *ttest* 0.023 |
| Average blood loss (1 day) | 2.34 g/dl C.I. (2.045–2.633) | **1.4 g/dl × 2 = 2.80 C.I. (1.147–1.660)** | *ttest* 0.115 |
| Average blood loss (2 day) | 2.89 g/dl C.I. (2.610–3.182) | **2.31 g/dl × 2 = 4.62 C.I. (2.051–2.571)** | *ttest* 0.000 |
| Average blood loss (3 day) | 3.13 g/dl C.I. (2.787–3.467) | **2.47 g/dl × 2 = 4.95 C.I. (2.190–2.758)** | *ttest* 0.000 |
| Transfusion | 4 (8%) | 0 | *chisq* 0.041 |

Bold values indicate two-staged group that are doubled

and they underwent a full weight-bearing on postoperative day one.

Complications occurring during the initial postoperative period of 30 days were recorded. We recorded the major complications traditionally associated with joint arthroplasty as death, pulmonary embolism, proximal DVT, myocardial infarction and cardiac arrhythmia. Minor complications included superficial wound infection and distal DVT.

Statistical analysis of the data was performed with the statistical software STATA. The Student's *t* test was used to compare averages of continuous variables of the two groups. In particular, the *t* test can be used to determine if two sets of data were significantly different from each other (for example to determine whether there was a significant difference in operating time or BMI or age between the two groups). The Chi-square test was used to compare the proportions of non-continuous variables relative to the two groups (for example sex).

The level of significance chosen was 95%. The test is significant if the $p$ value $\leq 0.05$.

## Results

All 102 patients were ASA grade 1, 2 or 3. Group A had 37 patients with ASA grade 2 and 14 with ASA grade 3. Group B had 34 patients with ASA grade 2, 13 patients with ASA grade 3 and 4 patients with ASA grade 1. The mean hemoglobin preoperatively level was 13.9 for group A and 14.3 for group B. The mean hemoglobin loss in 1 postoperatively day was 2.4 for group A and 1.4 for group B; the mean hemoglobin loss in 2 postoperatively day was 0.5 for group A and 0.9 for group B; the mean hemoglobin loss in 3 postoperatively day was 0.2 for groups A and B. Four patients in group A required blood transfusions; no patients in group B received blood transfusions.

Bilateral UKA patients were characterized by a higher blood loss, compared to patients undergoing unilateral UKA. The average hemoglobin level at discharge was 10.8 for group A and 11.8 for group B. The average blood loss at discharge was statistically significant different between the two groups, with 3.1 points for bilateral UKA and 2.4 for unilateral UKA ($p = 0.004$). However, group A had a smaller cumulative hemoglobin loss (3.1) compared to the group B ($2.4 \times 2 = 4.8$). Moreover, the rate of blood transfusion was higher in group A (7.8%) rather than in group B (0%) (Table 1).

The bilateral UKA group had a longer total operating room time (93.2 min) compared with the unilateral group (50.7 min). However, group A had a shorter cumulative operating room time (93.2 min) compared to the group B ($50.7 \times 2 = 101.5$ min), with a statistically significant difference ($p = 0.023$) (Table 1). Statistical analysis showed that patients with longer operative time (> 90 min) had higher blood loss (Table 2).

We encountered no patient with DVT or pulmonary embolism, confusion or delirium; there were no intensive care admissions or deaths in the initial 30 days postoperatively.

Complication rate was similar between the two groups. We reported 1 intraoperative fracture of the tibial plateau in group A, treated with osteosynthesis (the only major complication), 1 cystocele, 1 transient ischemic attack and 1 mild kidney insufficiency drug related (minor complications of group A), 2 regional pain syndromes in group B, 1 treated with drugs and 1 associated with arthrofibrosis and treated with manipulation under anesthesia.

## Discussion

The number of bilateral TKA performed in the USA over the past two decades has more than doubled and almost tripled among the female population [14]. The majority of the work on bilateral knee arthroplasty has focused on TKA with conflicting evidence within the literature with regards to the

**Table 2** Statistical analysis showed that patients with operating times > 90 min (group 1) had higher blood loss than those with operating time < 90 min (group 0)

| Group | Obs | Mean | SE | SD | 95% CI | 95% CI |
|---|---|---|---|---|---|---|
| Two-sample *t* test with equal variances | | | | | | |
| 0 | 28 | 2.796429 | .2149494 | 1.137405 | 2.355389 | 3.237468 |
| 1 | 23 | 3.530435 | .2496191 | 1.197131 | 3.012757 | 4.048113 |
| Combined | 51 | 3.127451 | .1694993 | 1.210467 | 2.787002 | 3.4679 |
| Diff. | | −.7340062 | .327732 | | −1.392608 | −.0754041 |
| Diff = mean (0) − mean (1) | | | $t = -2.2397$ | | | |
| Ho: diff = 0 | | | Degrees of freedom = 49 | | | |
| Ha: diff < 0 | | | Ha: diff ! = 0 | | Ha: diff > 0 | |
| Pr ($T < t$) = 0.0148 | | | Pr ($T > t$) = 0.0297 | | Pr ($T > t$) = 0.9852 | |

risks involved with bilateral surgery. Single-stage bilateral surgery in patients over the age of 70 has been shown to demonstrate no difference with regards to perioperative complications and better functional outcomes at 6 months and 1 year [15]. Further studies have demonstrated single-stage bilateral surgery to be safe with good clinical results and no increase in complications [16–19]. Other studies have found no increase in mortality between unilateral and bilateral TKA but demonstrated an increased rate of complications in bilateral cases, predominantly thromboembolic, although a lower infection rate.

Single-stage surgery offers the benefits of a single anesthetic, reduced total anesthetic time, shorter total hospital stay, shorter total recovery time, convenience to the patient and reduced costs.

There are fundamental differences between TKA and UKA, which mean that data from TKA studies cannot be directly extrapolated to UKA. UKA is a less invasive procedure with a shorter incision and less blood loss, is less invasive to the medullary canals and involves less bone cement. There are few studies looking specifically at bilateral UKA. UKA may be more appropriate for single-stage surgery due to the less invasive nature of the procedure and the shorter surgical and anesthetic times. Our literature review (Table 3) found only 6 reports about bilateral simultaneous UKA, of which 5 are comparative studies with a control group.

One such study comparing one-stage with two-stage UKA reported a significant increase in major complications in the one-stage bilateral UKA group, and it was advised that such surgery may be undertaken with caution [20]. Pulmonary embolus and proximal DVT were the major complications encountered; however, in this study patients did not receive chemical thromboprophylaxis and were treated only with intraoperative mechanical calf pumps and early mobilization.

Berend et al. [3] retrospectively compared 141 patients (282 knees) treated with staged UKA with 35 patients (70 knees) treated with simultaneous UKA. No patient experienced DVT, pulmonary embolism, confusion or death. None needed blood transfusions or intensive care admissions.

In a report by Akhtar et al. [21], 38 patients (76 knees) underwent single-stage UKA. ASA grade of 3 or below was the only mandatory patient selection index. Only 3 complications (7.9%) happened. One of them was a tibial plateau fracture, and two were superficial suture granulomas.

Ma et al. [22] reported on the results of 36 bilateral simultaneous UKA versus 45 two-stage UKA. They had 1 bearing dislocation, 1 superficial wound infection and 1 DVT for the bilateral group and 1 bearing dislocation, 1 lateral arthritis, 1 superficial wound infection and 2 DVT in the two-stage group.

The most important work in this field was that of Romagnoli et al. [23] who compared a group of 191 bilateral simultaneous UKA with 299 unilateral UKA. They reported no difference in complication rate, revision rate and mortality between the two groups. They had more transfusions in the bilateral group (10.9 vs. 3.8%). Finally, Chen et al. [4] reported on 124 single-stage UKA versus 47 two-stage UKA. They had no difference in complication rates and functional outcomes.

Our only major complication was the tibial plateau fracture which happened in group A: We think this complication cannot be related to the type of the procedure (single-stage versus two-stage procedure), rather than to a technical error during surgery.

Concerning length of hospital stay, simultaneous bilateral and unilateral UKA do not differ in terms of time spent in surgical units (3 days), while the rehabilitation length of stay is just slightly longer in bilateral group. This difference is not relevant at a clinical level, since undergoing a second surgery would imply a much longer total hospitalization time.

## Conclusion

Our results now can answer to our initial questions:

1. Bilateral simultaneous UKA does not increase the risk for perioperative complications;
2. Single-stage bilateral UKA increases operating room times but not cumulative operating room times;
3. Total blood loss at discharge is statistically higher in bilateral UKA rather than unilateral UKA; however, cumulative blood loss is lower in bilateral group. Patients with longer operative time (> 90 min) had a statistically significant blood loss.

In conclusion, our data support the current literature: If chemical prophylaxis is given, bilateral procedure does not increase the risk of DVT. Bilateral simultaneous UKA is a safe procedure; it may be planned safely even in older patients, with a low risk of major complications and blood transfusions. Patients can benefit from a single hospital admission and anesthetic time, while the shorter total inpatient stay and lower blood loss can reduce hospital costs in cases of bilateral surgery.

**Table 3** Update literature review

| Authors | Cases (all medial UKA) | Type of prosthesis | Type of study | Complications | Follow-up | Functional outcomes |
|---|---|---|---|---|---|---|
| Berend et al. (CORR 2011) [3] | 35 SS UKA vs. 141 TS UKA | Oxford mobile bearing | Retrospective comparative | 1 arthroscopy to remove a drain, 1 manipulation under anesthesia for arthrofibrosis in TS UKA. Cardiac and pulmonary issues (except PE) and superficial infections were similar for the 2 groups | 90 days | SS UKA had higher KSS function score at 90 days |
| Romagnoli et al. (Int Orthop 2015) [23] | 191 SS UKA vs. 299 TS UKA | Not specified | Retrospective comparative | No difference between the 2 groups: 1 VTE, 3 PE, 3 flebitis, 2 prosthesis infections, 3 superficial infections, 5 manipulation under anesthesia and other minor complications. Mortality rates were similar | 6 months | Not evaluated |
| Ma et al. (Chin Med J 2016) [22] | 36 SS UKA vs. 45 TS UKA | Oxford mobile bearing | Retrospective comparative | 1 bearing dislocation, 1 superficial infection and 1 VTE for SS UKA group. 1 bearing dislocation, 1 lateral osteoarthritis, 1 superficial infection and 2 VTE for the TS UKA group. No statistical significant difference was encountered between the 2 groups | 50 months | OKS was worse for SS UKA group at 1-month follow-up |
| Chan et al. (JBJS (Br) 2009) [20] | 159 SS UKA vs. 80 TS UKA | Oxford mobile bearing | Retrospective comparative | 8.2% of major complications for the SS UKA group (76.9% were VTE): 1 death for PE. No major complications for the TS UKA group. They did not use chemical venous thromboprophylaxis | 30 days | Not evaluated |
| Akhtar et al. (Knee 2014) [21] | 38 SS UKA | Oxford mobile bearing | Retrospective | 1 plateau tibial fracture and 2 superficial suture granuloma | 30 months | OKS improved from 14 to 34 |
| Chen et al. (Bone Joint J 2013) [4] | 124 SS UKA vs. 47 TS UKA | Missing | Retrospective comparative | No significant difference in complication rates | 2 years | No difference in outcomes |

## Compliance with ethical standards

**Conflict of interest** All authors declare that they have no conflict of interest.

**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

**Informed consent** Informed consent was obtained from all individual participants included in the study.

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