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Disease Progression After Unicompartmental Arthroplasty: Add a Compartment or Revise to Total Knee Arthroplasty?

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ABSTRACT

Background: Five percent to 7% of unicompartmental knee arthroplasties (UKA) require revision for disease progression in untreated compartment(s), most commonly to total knee arthroplasty (TKA). TKA requires removal of bone and usually the anterior cruciate ligament. Preserving the UKA and converting to a bicompartmental arthroplasty (BCA) by performing a second UKA is an alternative.
Methods: The results of 73 UKA-BCA patients were compared to 75 patients treated by UKA-TKA revision. Knee Society, Knee Osteoarthritis Outcome Score Joint Replacement, and patient satisfaction scores were collected by a blinded therapist. Patients were asked about their implant preference and recovery. Twenty-two UKA-BCA revision patients had a UKA (6) or TKA (16) in the contralateral knee; thus, a direct comparison of UKA-BCA to both UKA and TKA was possible.
Results: Of the UKA-BCA patients, 69 (94%) had excellent or good, 2 (3%) fair, and 2 (3%) poor outcomes with 1 patient requiring revision to TKA. Of patients with a TKA in the contralateral knee, 13 (81%) preferred the UKA-BCA replacement and 3 (19%) preferred the TKA. All patients said the UKA-BCA revision recovery was similar or easier than their initial UKA. Of UKA-TKA revisions, 59 (79%) had excellent or good, 9 (12%) fair, and 7 (9%) poor outcomes. There was 1 wound infection and 1 re-revision in the UKA-BCA group and 1 wound infection and 3 re-revisions in the UKA-TKA group. The Knee Osteoarthritis Outcome Score Joint Replacement and Knee Society Scores were better for UKA-BCA compared to UKA-TKA.
Conclusion: UKA-BCA is a successful treatment for disease progression following UKA.

Unicompartmental knee arthroplasty (UKA) is a focused and customized way to treat knee arthritis compared to total knee arthroplasty (TKA). The goal of UKA is to relieve pain and improve function using the most limited and tissue-sparing implant and procedure possible. Compared to TKA, UKA provides better restoration of the joint line and kinematics, which can result in improved postoperative function [1–4]. UKA requires less bone resection than TKA and preserves both cruciate ligaments. UKA is an outpatient procedure and may provide more complete return of function, more rapid recovery, less blood loss, and a lower risk of complications compared to TKA [1,3–8].

However, there are technical concerns, about the difficulty of converting a unicompartmental arthroplasty to a bicompartmental arthroplasty (UKA-BCA), particularly in balancing the knee with the prior UKA implant. Implant loosening, subsidence, and disease progression in the previously untreated compartments can occur after UKA [9–11]. Revision surgery from UKA-TKA can be a challenge. Some surgeons are hesitant to perform UKA and some patients want only TKA. Most surgeons only offer TKA and not a second UKA (UKA-BCA) for revision when disease progression occurs after UKA.

Adding a second UKA to treat disease that developed in uninvolved compartments was described in the first report of UKA [12,13]. It was the anticipated and recommended revision strategy.

JWP certifies that he has no commercial associations (consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest with this article. There was no external funding source for this study.

The author certifies that he has Institutional Review Board approval for this study. The investigation was conducted in conformity with ethical principles of research and that informed consent was obtained.

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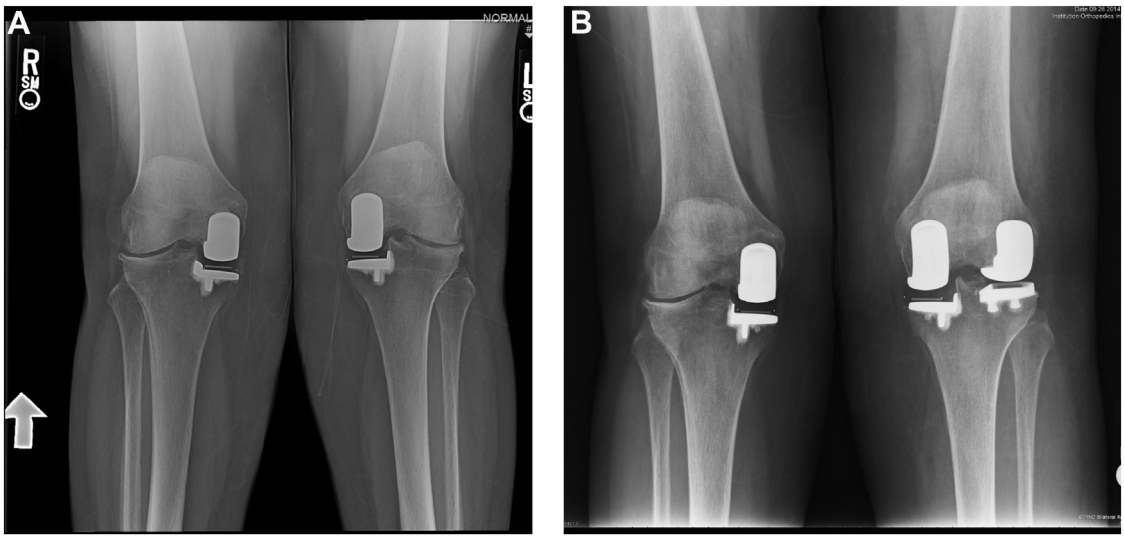

Fig. 1. (A) This AP radiograph shows a 63-year-old man with a successful lateral UKA and now medial compartment arthritis. (B) The patient was treated successfully with a medial UKA for the disease progression in the medial compartment. AP, anteroposterior; UKA, unicompartmental knee arthroplasty.

The early knee prostheses, such as the Marmor modular prosthesis (Richards Manufacturing Co, Memphis, TN) and the polycentric knee prosthesis, implanted 2 femoral condylar resurfacing components facing 2 tibial polyethylene plateaus, positioned from either side of the preserved tibial spine and cruciate ligaments. They were used for TKA and UKA [12,13]. Total condylar femoral and central-stemmed tibial components became the more common approach, particularly after patellar resurfacing became customary. Later, BCA knee arthroplasty and anterior cruciate retention TKA had few advocates [12–16]. TKA using independent bicruciate retaining components has been described as follows: (1) difficult to align, (2) difficult to balance ligaments, (3) more likely to subside without the support of the entire tibial plateau, and (4) not entirely reliable due to dependence on the cruciate ligaments, which might have doubtful structural integrity [10]. As TKA has become safer and more successful, it has become the commonly accepted procedure for treating disease progression following UKA [11]. TKA avoids the need for additional surgery for disease development in yet a third compartment.

There are proponents of primary BCA surgery because of its more natural kinematics and implant-to-bone stress transfer [17,18]. This study, however, focused only on sequentially performing UKA to create a BCA. There are concerns that matching the initial UKA might be difficult and that re-revision to TKA might be required and difficult. The cumulative re-revision rate has been reported as higher for UKA-BCA compared to UKA-TKA revision. Admittedly, the limited data available on sequential UKA-BCA were based on a prior generation of implants and predicate techniques that were not as reliable as current offerings [11].

This study addressed 3 questions: (1) What are the outcomes of performing UKA-BCA for disease progression after UKA? (2) How does UKA-BCA compare to UKA-TKA from a patient satisfaction and preference standpoint? (3) What are the hazards and complications of UKA-BCA compared to UKA-TKA?

Methods

The author obtained Institutional Review Board approval and patient consent for this prospective study. These UKA-BCA and UKA-TKA cases were drawn from 1,579 ambulatory UKA procedures. Patients were informed about their revision options and provided their written informed consent for both the surgery and study participation. Each patient received the procedure for which they were consented. No intraoperative decision changes were made. Each patient was consented only for UKA-BCA or UKA-TKA but not both procedures.

All UKA procedures were performed by the author on an ambulatory basis over a 30-year period from 1986 to 2016. The indications for UKA surgery were the following: (1) knee pain in 1 compartment that did not improve after extensive nonoperative treatment, (2) radiographic evidence of isolated medial, patellar, or lateral compartment disease with at least 100° flexion and <10° flexion contracture, (3) <10° of varus or valgus, (4) no pain from untreated compartment(s), and (5) no clinical evidence of anterior cruciate ligament insufficiency.

All procedures were performed without a tourniquet through medial or lateral parapatellar incisions. The same skin incision that was used for the primary UKA was used, when possible, for the revision. If the original arthroplasty was a lateral UKA performed through a lateral incision, a medial parapatellar approach was used (Fig. 1A and B). Patients with a UKA that was unsatisfactory in any way underwent revision to TKA and their data were not included in this report. This report only includes procedures performed for disease progression after a successful UKA. UKA-BCA was offered if symptoms were limited to only one additional compartment. If symptoms involved 2 compartments, revision to TKA was performed instead of UKA-BCA. Two patients, however, received a combined medial and patellofemoral prosthesis (Deuce; Smith & Nephew, Memphis, TN) (Fig. 2A and B) [19]. These 2 patients were included as UKA-BCA rather than UKA-TKA because the original UKA was left in place. There were no patients with clinical evidence of anterior cruciate insufficiency.

Patients were evaluated by clinical and radiographic follow-up in alternate years. Patients were examined and interviewed by a physical therapist who was not involved in their care and was blinded to which procedure the patients had received. Twenty-two of the 73 patients had either a TKA (16) or UKA (6) in the contralateral knee. These patients were asked to compare their UKA-BCA to their TKA and primary UKA. They were asked: Which is your preferred knee? If they had a preference, they were asked the reasons for their preference [15]. Also, they were asked to compare the recovery experience for UKA-TKA and UKA-BCA as easier, the same, or more difficult.

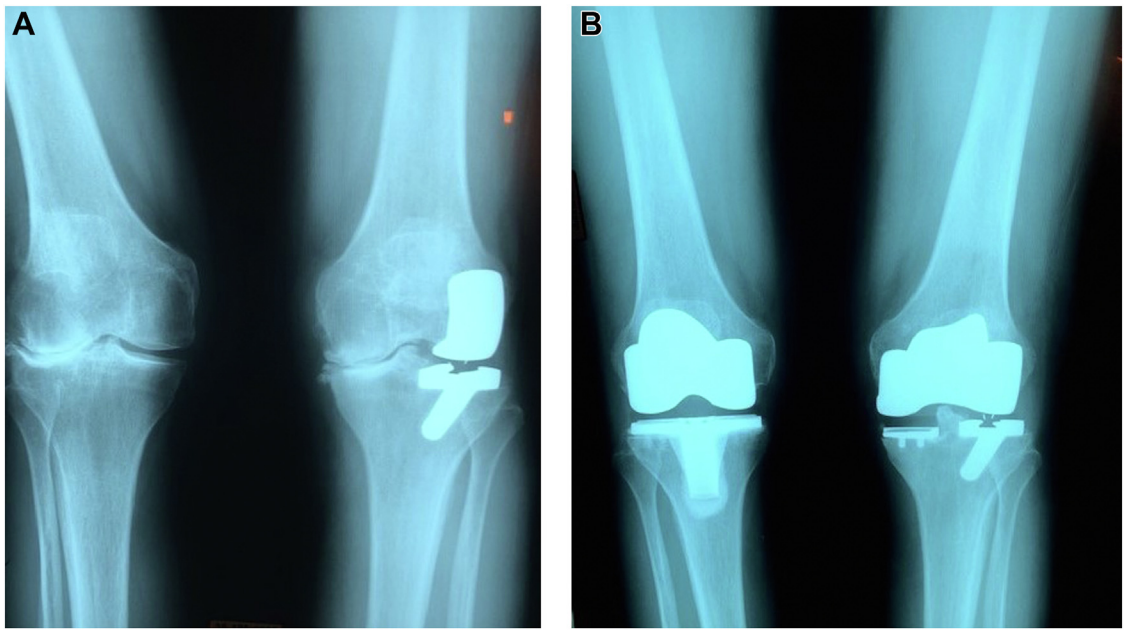

Fig. 2. (A) This AP knee radiograph shows a 67-year-old woman with a successful left lateral UKA. The patient had disease progression her left knee patellofemoral and medial compartments and painful right knee arthritis. (B) The patient's left knee was treated by adding medial and patellofemoral arthroplasties. The patient received a right total knee prosthesis for tricompartmental arthritis.

The Knee Osteoarthritis Outcome Score Joint Replacement (KOOS) JR and Knee Society Scores (KSS) were used as patient-reported outcome measures [20,21]. Patient satisfaction information was collected using a single question: Overall, how satisfied are you with the results of your knee arthroplasty surgery? A 5-point Likert scale ranging from very satisfied (5) to very unsatisfied (1) was used [22].

Statistical Analysis

All statistical analyses were performed using a commercially available statistical software program (Statistical Analysis Systems; JMP Pro 16.2, Cary, NC). Significance levels and the specific tests used are provided.

Fisher's exact 2-sided test was used for satisfaction results. The 2-sided *t*-test was used to determine the significance of changes in the KOOS JR scores. A minimally important clinical difference (MCID) calculation was performed using both distribution based anchor based methods using patient satisfaction. A 14-point difference in KOOS JR reaches MCID (21). MCID was calculated only for KOOS JR.

Results

Table 1 compares the demographics of the UKA-BCA and UKA-TKA groups. Overall, 155 patients with an initially successful UKA were treated with additional surgery for disease progression: 79 underwent UKA-TKA and 76 were treated by addition of a second UKA replacement converting the UKA to a BCA (UKA-BCA). The integrity of the existing arthroplasty was tested by placing a probe under both components of the unicompartmental arthroplasty. This was a manual test done in both flexion and extension. This testing was done in addition to the radiographs and symptom questions. In addition to the manual stress tests of Lachman maneuver and anterior drawer, a probe was placed on the anterior cruciate ligament directly to ascertain its integrity. There was 1 polyethylene exchange.

The mean follow-up of the revision cases was 12 years (range 5-28). The mean follow-up for the entire series was 14 years (range 5-35). The mean follow-up for the UKA-BCA was 15 years (range 5-28). The mean follow-up for UKA-TKA was 13 years (range 5-28). Three UKA-BCA patients were lost to follow-up (2 deaths and 1 incomplete information). Four UKA-TKA patients were lost to follow-up (2 deaths and 2 incomplete information). The mean age at primary arthroplasty was 54 years (range 32-79). The mean age at revision surgery was 61 years (range 46-83). The mean body mass index (BMI) was 27 kg/m^2 (range 20-39). There were 80 men (52%), 73 (47%) women, and 2 (1%) nonbinaries.

The most common UKA implant used was the ZUK 117 (75%) (Zimmer, Warsaw, IN). This was cemented in all cases. Other implants were the Oxford 6 (4%) (Zimmer Biomet), LCS 9 (6%) (DePuy, Warsaw, IN), and the Townley 22 (15%) (BioPro, Lapeer, MI). The LCS and Townley were either cemented or cementless. The Oxford was cemented. The tibia was metal backed in all cases.

Unicompartmental Knee Arthroplasty-Bicompartmental Arthroplasty

Seventy-three patients underwent UKA-BCA. The KOOS JR and KSSs found 60 (82%) excellent, 9 (12%) good, 2 fair (3%), and 2 (3%) poor outcomes. The 2 (3%) poor outcomes were due to continued pain: one patient accepted the poor outcome and the other underwent a second revision to TKA. There was 1 wound infection treated successfully with antibiotics. All the UKA-BCA procedures were outpatient with primary implants. An MCID was reached for 94% of UKA-BCA patients using KOOS JR.

Unicompartmental Knee Arthroplasty-Total Knee Arthroplasty

Seventy-five patients underwent UKA-TKA. The KOOS JR and KSSs found 49 (65%) excellent, 10 (14%) good, 9 (12%) fair, and 4 (5%) poor outcomes with 3 (4%) re-revisions. There was 1 infection treated by a 1-stage revision to TKA. A primary TKA was used in 38 (50%) and a revision implant either with a stem,

Table 1
Preoperative Demographic Comparison of UKA-BCA and UKA-TKA.

Variable	UKA-BCA	UKA-TKA	*P* Value
Number of patients	76	79	
Lost to follow-up	3	4	
Mean age, y (range)	62 (46-82)	60 (47-83)	.34
Mean follow-up, y (range)	15 (5-28)	13 (5-28)	.12
Male/female/nonbinary	40/35/1	40/38/1	.4
Mean BMI, kg/m^2 (range)	27 (22-39)	27 (20-39)	.9
Revisions	1	3	
Mean preop KOOS JR scores	51	51	>.9

UKA, unicompartmental knee arthroplasty; BCA, bicompartmental arthroplasty; TKA, total knee arthroplasty; BMI, body mass index.

Table 2
Summary of Postoperative Results.

Variable	UKA-BCA	UKA-TKA	*P*-Value
KOOS JR (mean postoperative score)	92	80.5	<.0001
KOOS JR (improvement from preoperative score)	43	29	<.0001
Knee Society Score (mean postoperative score)	92	79	<.0001
Good or excellent results	94%	79%	.0070
Mean implant cost	$3,100	$4,900	

UKA, unicompartmental knee arthroplasty; BCA, bicompartmental arthroplasty; TKA, total knee arthroplasty.

cone, or a buildup was used in 37 (50%). Sixty-seven (90%) UKA-TKA procedures were inpatient and 8 (10%) were outpatient. The MCID was reached for 79% of UKA-TKA patients using KOOS JR.

KOOS JR and Knee Society Scores

The mean KSS was 92 for the UKA-BCA group and 79 for the UKA-TKA group. Of 16 patients (81%) with a TKA in one knee and a BCA in the other knee, 13 preferred the UKA-BCA and 3 (19%) preferred the TKA. There were 6 patients with a UKA in one knee and a UKA-BCA in the other. Two preferred their UKA and 4 (67%) said their BCA was equally preferred to their UKA. The reasons provided (more than one reason accepted) were the following: feels more natural (17), feels more stable (18), less noise (17), easier recovery (22), had more motion (19), and had more function (21). Seventy of 73 (96%) patients compared their recovery from UKA-BCA as the same as from UKA and no patient said their UKA-BCA recovery was more difficult compared to TKA.

For KOOS JR scores, peak scores over time were used for group comparisons. The mean preoperative KOOS JR scores for both groups was 51 (range 42-62, SD = 11.5). The mean KOOS JR score was 94 (range 64-98, SD = 8.5) after the primary UKA. For the UKA-BCA group, the average peak KOOS JR score was 92 (range 61-99, SD = 9.5). For the UKA-TKA group, the average peak KOOS JR score was 80.5 (range 65-96, SD = 7.75). The peak scores in the UKA-BCA group are statistically significantly higher than those in the UKA-TKA group (2-sided *t*-test, $P < .0001$) (Table 2). The MCID of 14 was reached for the comparison using the improvement in preoperative compared to postoperative KOOS JR scores between the UKA-BCA and UKA-TKA groups (43 compared to 29; Table 2). The mean KSS was higher in the UKA-BCA (92) group compared to the UKA-TKA (79) (Table 2).

The median satisfaction score was 4 (satisfied, interquartile range 4-5). Ninety-four percent of patients were satisfied with the index UKA procedure. In the UKA-BCA group, 94% (69/73) of patients were highly satisfied or satisfied. In the UKA-TKA group, 79% (59/75) of patients were satisfied or highly satisfied. This difference in satisfaction (94% versus 79%) is statistically significant ($P = .0070$).

The mean implant cost for a UKA-BCA was $3,100. The mean implant cost for a TKA was $4,900, including the cost of stems, cones, or augments when needed. The procedure time for UKA-TKA was a mean 20 minutes longer (range 0-61) compared to UKA-BCA procedure.

Discussion

This prospective study was conducted to determine the outcomes of performing UKA-BCA for disease progression after UKA and also to assess patient satisfaction, preference, and complications for UKA-BCA compared to UKA-TKA. UKA-BCA is a successful procedure. It was performed for 73 patients, resulting in 1 infection that cleared with antibiotics and 2 failures from continued pain. There was 1 re-revision to TKA. UKA-BCA was more successful from a patient satisfaction, patient-reported outcome measure, and preference standpoint compared to UKA-TKA. Also, performing a second UKA is more cost effective than a revision to TKA. Needing to perform a third operation is a potential concern but this only happened once in this series.

There are limitations to this study. One highly experienced surgeon (JWP) performed all procedures. Also, a patient bias toward the more limited UKA procedure is likely, which is performed on an outpatient basis. There may be a surgeon's bias in favor of BCA. There also may not be a bias in favor of BCA, as the surgeon's fee is lower for UKA-BCA compared to UKA-TKA. It should be noted that findings in this study might not apply to patients with elevated BMI and other comorbidities.

The unicompartmental procedures were 100% outpatient but the revision to TKA was 90% inpatient. The satisfaction for the outpatient procedures was higher, with 22% of unicompartmental patients reporting an easier recovery. We now perform almost all primary TKA procedures as outpatient procedures in the ambulatory surgical center. For revision procedures, however, the procedures are still often performed at the hospital but increasingly, the patients can meet the discharge criteria and go home the same day. Coding and cost considerations are still impactful for the acceptance of revision TKA at ambulatory surgical centers. Adding a second unicompartmental procedure is coded and billed as a primary procedure and is eligible and acceptable for ambulatory surgical center care.

The UKA-TKA and UKA-BCA groups were the same with respect to comorbidities. All the patients in this series were preselected as appropriate candidates for ambulatory surgery at the time of their unicompartmental arthroplasty. Patients with BMI over 40 kg/m^2, and those with preoperative opioid use and/or mental health issues were excluded for procedures in both cohorts, as well as for their primary surgery.

Adding a second UKA is demanding. Matching a second component to the first requires accurate preoperative planning and execution in selecting and placing the implant. All the procedures were performed correctly. These results may not be generalizable to other surgeons and centers. The outcomes were collected by an examiner blinded to the procedure performed to help control bias. The number of patients was limited but UKA failure by disease progression is not common; this is the second-largest reported series of patients treated by adding a second UKA to the first (UKA-BCA) [11].

There are reports of a higher cumulative chance of re-revision when adding a second UKA to the first for disease progression. One report found a 17% re-revision chance with UKA-BCA compared to 7% for UKA-TKA [11]. Reports on BCA are very promising but these are for simultaneous BCA rather than sequential, as in the present study [6,8,18].

Revision TKA had a higher chance of re-revision compared to UKA-BCA. This is likely because the UKA-TKA is a more extensive procedure. Bone loss can occur with removing the UKA. Also, revision TKA is performed more often as an inpatient procedure. Adding a second UKA is more cost effective because it is a shorter surgery, an outpatient procedure, and the cost of a primary UKA implant is lower compared to both primary and revision TKA implants. The costs of revision implants can become very high when cones, augments, or stemmed components are required. The Robotic MAKO system is used at our ambulatory surgery center and hospital both for primary and revision cases. The clinical and survivorship value of robotics will be subtle and determined over time. A future study is planned when 10 years of data are collected.

Conclusions

UKA-BCA is a successful yet demanding revision procedure to treat disease progression following UKA. It has better outcomes and greater patient preference and satisfaction than a UKA-TKA revision. The primary conclusion of this paper is that adding a second unicompartmental implant is a successful procedure and a valid alternative to revision to TKA (UKA-TKA). The collateral conclusions are that the UKA-BCA can be performed as outpatient procedures and the costs are less than UKA-TKA. The primary conclusion has relevance, as it is not obvious that UKA-BCA is a valid procedure. The more standard approach is UKA-TKA. The rationale for UKA-TKA is that this choice might be technically less demanding than matching the existing UKA and that avoiding a third operation is more likely with UKA-TKA.

The KOOS JR, KSSs, and patient satisfaction outcomes were greater for the UKA-BCA patients. UKA-BCA did not have a higher chance of re-revision compared to UKA-TKA.

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