Two Year Follow-up of the Preservation Unicompartmental Knee Implant

Rajeev K. Jain, MD • Lorraine T. Neville, PA • Kace A. Ezzet, MD • Robert S. Sterling, MD • Raymond L. Horwood, MD • Clifford W. Colwell, Jr, MD

Received: 9 March 2010/Accepted: 13 April 2011/Published online: 14 June 2011
© Hospital for Special Surgery 2011

Abstract Reported results of unicondylar knee arthroplasty (UKA) have mixed reviews in comparison with results of tri-compartmental knee arthroplasty (TKA). We prospectively evaluated the short-term results (2 years) of a newer design of a UKA implant (Preservation UKA) with a cobalt–chromium femoral component and an all polyethylene tibial component. Seventy-two patients with intact ligaments and loss of only medial articular cartilage received the Preservation prosthesis. Data were obtained using WOMAC, Knee Society score (KSS), and standard radiographs. WOMAC scores improved by 24 points and KSS improved by 33 points at 2-year follow-up. Mean flexion increased by 4° to 126° at 2 years. On X-ray, only one patient had a radiolucency. No fractures occurred. Two knees were revised due to clinical symptoms of medial

compartment pain. This 2-year follow-up study of the Preservation UKA shows promising early results. Long-term data would be necessary to compare results with TKA or other unicompartmental replacements.

Keywords preservation implant • unicondylar knee arthroplasty

Introduction

The long-term clinical results of total knee arthroplasty (TKA) are well documented in the literature showing 90–95% survivorship at more than 15 years [1–4]. As the number of TKA increases and the age of the TKA patient decreases, more bone preserving procedures are being utilized.

Unicompartmental knee arthroplasty (UKA) is not a new procedure. However, the long-term results have been less than satisfying based on early design. In 1976, Insall and Walker reported a failure rate of 30% [5]. In 1978, Laskin published a 2-year follow-up using the Marmor modular knee reporting 35% fair to poor results [6]. Laskin defined fair to poor results as those requiring daily use of analgesic medication. In the past, failures have been due to non-specific operative indications, uneven patient selection, thin polyethylene, lack of uniform surgical technique, and inadequate fixation of implant [7].

Changes and refinements in UKA design, instrumentation, patient selection, and technique have shown promise compared with past results. Outcomes and survivorship of UKA are comparable to traditional TKA [8, 9]. The purpose of our prospective study was to evaluate the 2-year outcome of the Preservation UKA using clinical, radiographic, and subject-based outcome measures. We did not evaluate in this study the potential advantages or disadvantages of this particular design as compared to other unicompartmental designs.

Material and Methods

This was a multicenter, prospective, unblinded outcomes study, which enrolled 85 patients of whom 71 patients

Each author certifies that he or she has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

Each author certifies that his or her institution has approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

R. K. Jain, MD
Midwest Orthopaedic Institute SC,
Sycamore, IL, USA

L. T. Neville, PA • C. W. Colwell, Jr, MD (✉)
Shiley Center for Orthopaedic Research & Education at Scripps Clinic,
11025 North Torrey Pines Road, Suite 200,
La Jolla, CA 92037, USA
e-mail: cliffcolwellmd@yahoo.com

K. A. Ezzet, MD
Scripps Clinic,
La Jolla, CA, USA

R. S. Sterling, MD
University of Maryland Affiliated Hospitals,
Baltimore, MD, USA

R. L. Horwood, MD
Fairview General & Lakewood Hospital,
Cleveland, OH, USA

received 72 UKAs performed between 2003 and 2006. This study was approved by the institutional review board and patients signed an informed consent to participate. Patients were included in the study if they were 40–75 years of age, were able to understand and cooperate with follow-up visits, had articular cartilage loss confined to the medial compartment with a preserved lateral compartment, had preserved lateral and patellofemoral compartments on radiology exam, and had intact knee ligaments. Patients were excluded if they had an existing condition that would compromise participation, had a history of poor compliance with medical treatment, were women who were pregnant or planning to become pregnant, were known drug or alcohol abusers or had mental disorders, were having a revision of existing unicompartmental implant, had significant symptoms emanating from the patellofemoral joint, had ligament laxity or instability of the knee, had inflammatory disease or neuropathic disease, had evidence of previous sepsis, had a preoperative flexion contracture of 15° or greater, had a preoperative flexion of less than 90° , had a preoperative limb deformity of greater than 15° varus or valgus, or weighed in excess of 100 kg (Figs. 1 and 2).

Patients were evaluated preoperatively, at 3–4 weeks, at 3 months, at 1 year, and at 2 years postoperatively. The

Fig. 1. **a** Preoperative anterior–posterior radiograph view of knees. **b** Preoperative maximum flexion lateral radiograph of right knee

Fig. 2. **a** Postoperative anterior–posterior radiograph of knees. **b** Postoperative maximum flexion lateral radiograph of right knee

Knee Society score and WOMAC score were obtained at each follow-up visit. Radiographs, including standard anteroposterior, lateral, and merchant views, were obtained at each follow-up visit except the 3–4 weeks visit.

We used the Knee Society criteria for TKA [10] in our analysis of digital radiographs (Stentor, Inc., Foster City, CA). The anteroposterior radiograph was centered at the knee. Measurements recorded were the tibiofemoral angle and the femoral valgus angle. All femoral angles greater than 90° were recorded as a valgus angle. The tibial angle was the angle between the proposed anatomic axis of the tibia and a line parallel to the undersurface of the tibial prosthesis. On the lateral view the posterior angle formed by the undersurface of the tibia and the tibial axis were measured to define the posterior slope. The femoral flexion angle was defined by a line drawn along the axis of the femur on the lateral view and a line perpendicular to the distal femoral cut of the prosthesis [10, 11]. Osteolysis around the implants was classified as mild, moderate, or severe if present. Mild was defined as narrowing of the joint space with small area of radiolucency around the stem of the implant. Moderate was defined as radiolucent lines along the implant for more than 50% of the interface. Severe was defined as

radiolucent areas accompanied by bony sclerosis with loosening of the implants seen [12].

The Preservation unicompartmental knee (DePuy Orthopaedics, Inc, Warsaw, IN) is comprised of a cobalt–chromium alloy femoral component and an all polyethylene tibial component. The tibial component is manufactured from ultra high molecular weight polyethylene, which is free of calcium stearate and is sterilized in a vacuum.

The technique advocated by the manufacturer was used in performing the UKA with one modification. Only one or two pins were used in the tibial cutting block to secure the tibial cutting guide. We did not add the vertical cutting guide pin based on our and others experience with fractures of the medial tibial plateau. Thus, a pin was not placed in the vertical slot as advocated by the manufacturer's guide. The tibial and femoral components were sized based on the area of the patient's tibial and femoral surface specifically to cover the anterior aspect of the femur without impingement of the patella. The least amount of bone was resected to accommodate the components without “overstuffing” the compartment.

Descriptive statistics (means of continuous variables and frequencies of categorical variables) were calculated using SPSS (Version 13.0 for Windows, SPSS Inc, Chicago, IL).

Results

Three centers participated in this multicenter prospective study. A total of 85 patients were initially enrolled, 13 patients were found to have bi- or tri-compartmental disease not seen on the preoperative radiographs and were excluded. Of the 72 knees receiving the UKA prosthesis, 70 were available for follow-up at the 2-year interval. Two patients (two knees) died of unrelated causes. Of the 70, 57 completed a minimum of 2 years of follow-up. Nine of the 13 patients that did not return for follow-up had co-morbid conditions that prevented their ability to return to the office, two had moved out of the area and were unwilling to return for follow-up, and two had been revised prior to the 2-year timeframe.

The patient population described in Table 1 all had isolated medial compartment disease without significant patellofemoral disease. The surgical approach was medial parapatellar in 58 knees and midvastus in 14 knees. Average

tourniquet time was 65 min (range, 46–119). Intra-operative visual inspection revealed one patient to have a compromised anterior cruciate ligament but it was felt to be adequate for UKA. Forty knees had grade 1 chondromalacia patellae, 26 had grade 2, and six had grade 3. Eight knees had a narrowed lateral compartment, 62 had a normal lateral compartment, and two had a widened lateral compartment.

Postoperatively patients had an average length of hospital stay of 3 days (range, 1–4 days). At discharge, 55 patients were using a walker, 13 were using crutches, and three were not using an assistive device. Range of motion over time did not improve significantly (Table 2).

Knee Society scores improved 37% preoperative to 2-year follow-up (Table 3). WOMAC scores improved 65% preoperative to 2-year follow-up. Of particular interest, the Knee Society pain scores improved by 56% and the WOMAC pain score improved by 75% at 2 years. Likewise the function scores showed an improvement of 29% on the Knee Society rating scale and 65% on the WOMAC rating scale for the same time period.

Two revisions occurred in our series. The first patient was revised to a TKA 10 months postoperatively for continued pain. At the time of the index surgery, severe medial compartment arthritis with sparing of the lateral and patellofemoral joints was noted. After surgery the patient complained of persistent anterior knee pain, particularly with stair climbing and other bent knee activities. Radiographs did not reveal any abnormalities in the patellofemoral and lateral compartments or evidence of component malposition, loosening, or fracture. At the time of revision, intra-operative inspection revealed superficial erosions in the patellofemoral joint with softening of the articular cartilage without full thickness defects or exposed bone. The lateral compartment appeared well preserved. At 1 year following revision to a TKA the patient still reported moderate pain.

The second patient was revised to a TKA 7 months after the index surgery. The patient complained of continued pain and suffered from recurrent effusions. The patient had a strong family history of rheumatoid arthritis. At the time of revision, a considerable synovial inflammatory process was noted and the anterior cruciate ligament appeared to be attenuated. Two months after the revision to TKA, the patient no longer experienced effusions and was satisfied with pain relief.

Three additional patients had a reoperation but retained their implants. The first patient underwent a closed manipulation for arthrofibrosis 9 weeks after the primary operation. The patient had preoperative motion from 0° to 120°. After the UKA the knee maximum motion was 7–90° as measured

Table 1 Demographics describing the patients in the study at the time of index surgery

Attribute	Number of knees
Gender	
Male	41 (57%)
Female	31 (43%)
Diagnosis (per knee)	
Osteoarthritis	69 (96%)
Avascular necrosis (AVN)	2 (3%)
Post-traumatic arthritis	1 (1%)
Age in years—mean (range)	68 (45–88)
BMI—mean (range)	28.5 (21–42)

Table 2 Range of motion attained at study time points

Time point	Range of motion (ROM $\pm$ standard deviation)	Range of motion (range of ROM)
Preoperative	122 $\pm$ 9.6°	95–150°
1 year postoperative	127 $\pm$ 8.1°	113–150°
2 years postoperative	126 $\pm$ 6.9°	112–140°

Table 3 Knee Society rating scale and WOMAC rating scale scores presented preoperative and 1 year and 2 years postoperative indicating the change in score over 2 years

Knee Society scores	Preoperative mean (range)	1 year postoperative mean (range)	2 years postoperative mean (range)	Change preoperative to 2 years postoperative
Total	55 (30–92)	89 (57–100)	88 (35–100)	33 (37%)
Pain	18 (0–45)	41 (10–50)	41 (10–50)	23 (56%)
Function	60 (20–100)	85 (40–100)	85 (30–100)	25 (29%)
WOMAC scores				
Total	37 (98–65)	13 (90–49)	13 (90–58)	24 (65%)
Pain	8 (2–16)	3 (0–12)	2 (0–8)	6 (75%)
Function	26 (4–45)	8 (0–33)	9 (0–42)	17 (65%)

under anesthesia with passive flexion. Post-manipulation the patient achieved near full extension to 130°. At 2 years after surgery, the patient had 0–120° of motion. Had we not achieved adequate flexion with our manipulation, we would have considered arthroscopic treatment as a secondary procedure. The second patient had an arthroscopic removal of loose cement in the posteromedial corner of the knee 14 weeks after the index procedure performed through a medial parapatellar incision. This began causing pain and discomfort 10 weeks after surgery. The supposition is that the cement may have been left behind due to limited exposure. The patient has had no further operations and has done well clinically. The third patient had arthroscopic surgery performed for a lateral meniscus tear. At the 3-month follow-up visit, the patient reported increasing lateral knee pain. The patient admitted to a single knee twisting episode but could not state whether pain began before or after that incident. Also of note, this patient was overcorrected showing a preoperative valgus angle of 4° and a post-op valgus angle of 8°. MRI examination showed a tear in the anterior horn with preservation of the posterior horn. This pattern of tear could have been iatrogenic from the exposure or possibly related to the twisting episode. The patient elected to have surgery and underwent reoperation at 4 months after the index procedure. Patient was doing well at the 2-month post-arthroscopic follow-up visit but by the 1-year follow-up visit the pain had returned. At that time radiographs showed narrowing of the lateral joint space suggesting onset of lateral compartment arthritis. The patient did not wish any additional surgery and was not available for further follow-up due to her subsequent death of an unrelated cause.

Radiographic Results

Preoperative radiographic evaluation showed medial compartment arthritis in all knees. The average preoperative valgus angle was 1.77°. Postoperatively at 2 years the average valgus angle was 4.86°. The values for femoral angle, tibial angle, alignment (valgus angle), femoral flexion, and tibial slope are shown in Table 4. No component was found to be loose and no evidence of osteolysis was noted during the follow-up period.

The radiographic evaluation did show that the majority of knees were corrected to neutral alignment. However, nine of 38 were overcorrected beyond the 7° of valgus; four were corrected to 9° and five were corrected to 8°. The operative records for these patients did not reflect any extensive medial releases. Because of exclusion of severe malalignment, no extensive medial release should have been done in this series.

Discussion

The purpose of our study was to evaluate the 2-year outcome of the Preservation UKA using clinical, radiographic, and subject-based outcome measures. One of the reasons to conduct this research is to ensure no catastrophic failures, which would steer us away from this design. If early results look promising, surgeons would comfortably continue utilizing this design. These positive results need to continue to be monitored long-term. The controversy over UKA is due in large part to the continued success and excellent survivorship of TKA [13]. Many reasons for UKA

Table 4 Radiographic measurements showing the mean±standard deviation of the femoral, tibial, and valgus angle and the slope at each time period measured

Time period	Femoral angle (degrees ± standard deviation)	Tibial angle (degrees ± standard deviation)	Alignment-valgus angle (degrees ± standard deviation)	Femoral flexion (degrees ± standard deviation)	SLOPE (degrees ± standard deviation)
Preoperative			1.77±3.11		83.31±3.74
3 months, N=72 knees	99.76±2.09	86.45±2.98	5.14±2.73	4.07±7.09	78.85±16.85
1 year, N=70 knees	100.07±2.04	86.02±2.79	5.37±2.47	2.14±6.93	76.98±19.75
2 years, N=57 knees	99.08±2+24	85.54±2.17	4.86±3.06	2.38±6.44	83.04±5.00

have been cited in the literature, such as restoration of normal knee kinematics [14], better ROM, better ambulation, less blood loss, fewer transfusions, higher knee scores, similar patient satisfaction and pain relief, as well as quicker recovery, shorter hospital stay, and less expense [8, 14].

This study is limited by having lost 16% (11) of patients to follow-up and 3% (two) already revised at 2 years. The short period of 2 years is not adequate to discuss long-term outcomes of this implant. This implant was not compared with other unicompartmental implants, so we cannot comment on advantages or disadvantages of this implant over other unicompartmental implants.

The early reports on UKA have been less than encouraging. Insall and Aglietti reported disappointing results with a 28% revision rate at 5 to 7 years [15]. Laskin reported a total failure rate (defined as needing further surgery or patient having no improvement at all) of 20% in his series with a follow-up of at least 2 years [6]. The high failure rates reported by Insall and Aglietti were attributed to prosthesis design, surgical technique, patellofemoral management, and overcorrection leading to lateral compartment degeneration. Another problem encountered was tibial component settling or subsidence. They also reported that results deteriorated with time. Our results with only two revisions in the short-term are much improved over past results reported [14, 16]. Instrument design, changes in surgical technique, and attention to mechanical axis correction have all contributed to better results. There are additional reports of improved results with the newer designs and improved surgical techniques [16–18].

Stress fractures of the tibial plateau have been a recent finding in UKA [19–21]. We did not have any stress fractures in this series; however, four patients undergoing UKA prior to this study sustained a stress fracture of their medial tibial plateau, which led us to modify the original technique of pinning the tibial guide. We previously placed a guide pin in a vertical slot and, once the resection level was determined, one or two more pins were placed in the cutting block. The stress fractures all involved the pin hole from the vertical slot. Previous reports attributed fracture to minimally invasive surgical instruments whose design resulted in excessive drilling of the tibial peg close to the inferomedial cortex of the proximal tibia [19]. Another case report of tibial stress fracture after UKA attributed the fractures to drilling four holes for the placement of guide pins and holes for tibial preparation [20]. We now routinely use only one pin in the tibial block and do not place a pin in the vertical slot. If using more than three guide pins in the placement of the tibial block, the surgeon should be aware of the potential for a stress fracture and should monitor their patients carefully [20].

Our present follow-up of the Preservation unicompartmental knee indicates a well-functioning prosthesis with the currently reported 2-year results. The modification in the application of the tibial cutting guide is important as the previous technique may have contributed to past tibial plateau stress fractures. However, we are mindful that our results are still short to intermediate term and will require longer follow-up. We will continue to monitor our cohort to

determine if our results remain favorable or deteriorate with time. We are encouraged by these results and continue to use this implant for the indications included in this study. Longer follow-up in the 10–20-year range is imperative to the orthopedic community.

References

1. Rand J, Riggi K. (2001). Results of posterior cruciate-preserving total knee arthroplasty. In J. Insall & W. Scott (Eds.), *Surgery of the knee* (3rd ed., Vol. 2, pp. 1629–1659). Philadelphia: Churchill Livingstone.
2. Clarke H D, Scuderi G R. (2001). Revision total knee arthroplasty: Planning, management, controversies, and surgical approaches. *Instr Course Lect*, 50, 359–365
3. Font-Rodriguez D E, Scuderi G R, Insall J N. (1997). Survivorship of cemented total knee arthroplasty. *Clin Orthop Relat Res*, 345(345), 79–86
4. Rodricks D J, Patil S, Pulido P, Colwell C W, Jr. (2007). Press-fit condylar design total knee arthroplasty. Fourteen to seventeen-year follow-up. *J Bone Joint Surg Am*, 89(1), 89–95
5. Insall J, Walker P. (1976). Unicondylar knee replacement. *Clin Orthop Relat Res*, 120(120), 83–85
6. Laskin R S. (1978). Unicompartmental tibiofemoral resurfacing arthroplasty. *J Bone Joint Surg Am*, 60(2), 182–185
7. Laskin R S. (2001). Unicompartmental knee replacement: Some unanswered questions. *Clin Orthop Relat Res*, 392(392), 267–271
8. Berger R A, Nedeff D D, Barden R M, Sheinkop M M, Jacobs J J, Rosenberg A G, Galante J O. (1999). Unicompartmental knee arthroplasty. Clinical experience at 6 to 10 year followup. *Clin Orthop Relat Res*, 367(367), 50–60
9. Murray D W, Goodfellow J W, O'Connor J J. (1998). The oxford medial unicompartmental arthroplasty: A ten-year survival study. *J Bone Joint Surg Br*, 80(6), 983–989
10. Ewald F. (1989). The knee society total knee arthroplasty roentgenographic evaluation and scoring system. *Clin Orthop Relat Res*, 248(248), 9–12
11. Swank M, Stulberg S D, Jiganti J, Machairas S. (1993). The natural history of unicompartmental arthroplasty. An eight-year follow-up study with survivorship analysis. *Clin Orthop Relat Res*, 286(286), 130–142
12. Berry D J. (2004). Recognizing and identifying osteolysis around total knee arthroplasty. *Instr Course Lect*, 53, 261–264
13. Rougraff B T, Heck D A, Gibson A E. (1991). A comparison of tricompartmental and unicompartmental arthroplasty for the treatment of gonarthrosis. *Clin Orthop Relat Res*, 273(273), 157–164
14. Patil S, Colwell C W, Jr., Ezzet K A, D'Lima D D. (2005). Can normal knee kinematics be restored with unicompartmental knee replacement? *J Bone Joint Surg Am*, 87(2), 332–338
15. Insall J, Aglietti P. (1980). A five to seven-year follow-up of unicondylar arthroplasty. *J Bone Joint Surg Am*, 62(8), 1329–1337
16. Borus T, Thornhill T. (2008). Unicompartmental knee arthroplasty. *J Am Acad Orthop Surg*, 16(1), 9–18
17. Berger R A, Meneghini R M, Jacobs J J, Sheinkop M B, Della Valle C J, Rosenberg A G, Galante J O. (2005). Results of unicompartmental knee arthroplasty at a minimum of ten years of follow-up. *J Bone Joint Surg Am*, 87(5), 999–1006
18. McAllister C M. (2008). The role of unicompartmental knee arthroplasty versus total knee arthroplasty in providing maximal performance and satisfaction. *J Knee Surg*, 21(4), 286–292
19. Yang K Y, Yeo S J, Lo N N. (2003). Stress fracture of the medial tibial plateau after minimally invasive unicompartmental knee arthroplasty: A report of 2 cases. *J Arthroplasty*, 18(6), 801–803
20. Brumby S A, Carrington R, Zayontz S, Reish T, Scott R D. (2003). Tibial plateau stress fracture: A complication of unicompartmental knee arthroplasty using 4 guide pinholes. *J Arthroplasty*, 18(6), 809–812
21. Rudol G, Jackson M P, James S E. (2007). Medial tibial plateau fracture complicating unicompartmental knee arthroplasty. *J Arthroplasty*, 22(1), 148–150