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SYMPOSIUM: ADVANCED TECHNIQUES FOR REHABILITATION AFTER TOTAL HIP AND KNEE ARTHROPLASTY

Is Recovery Faster for Mobile-bearing Unicompartmental than Total Knee Arthroplasty?

Adolph V. Lombardi Jr. MD, Keith R. Berend MD, Christopher A. Walter DO, Jorge Aziz-Jacobo MD, Nicholas A. Cheney DO

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Abstract How does unicompartmental compare with total knee arthroplasty in durability, incidence of complications and manipulations, recovery, postoperative function, and return to sport and work? We matched 103 patients (115 knees) treated with a mobile-bearing unicompartmental device through July 2005 to a selected group of 103 patients (115 knees) treated with cruciate retaining total knee arthroplasty for bilaterality, age, gender and body mass index. Patients who underwent a unicompartmental surgery had better range of motion at discharge and shorter hospital stay than those who had a total knee arthroplasty (77° versus 67° and 1.4 versus 2.2 days). At 6 weeks, Knee Society functional scores and range of motion were higher for unicompartmental than total knees (63 versus 55 and 115° versus 110°). Patient-perceived Oxford scores were similar between groups (unicompartmental 5.4 versus total 4.1). Average times to return to work and sport were similar for both groups. Minimally invasive unicompartmental knee arthroplasty demonstrated better early ROM, shorter hospital stays, and improved functional scores. No advantage was seen in terms of return to work, return to sport, or Oxford scores. The data suggest minimally invasive unicompartmental arthroplasty using a rapid recovery protocol allows patients a faster return to a more functional level than total knee arthroplasty.

Level of Evidence: Level III, therapeutic study. See the guidelines online for a complete description of level of evidence.

Introduction

As the understanding of medial compartment osteoarthritis has grown, the indications for unicompartmental knee

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Each author certifies that his 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.

A. V. Lombardi Jr. (✉), K. R. Berend, J. Aziz-Jacobo
Joint Implant Surgeons, Inc., 7277 Smith's Mill Road, Suite 200, New Albany, OH 43054, USA
e-mail: LombardiAV@joint-surgeons.com

A. V. Lombardi Jr., K. R. Berend
Department of Orthopaedics, The Ohio State University, Columbus, OH, USA

A. V. Lombardi Jr.
Department of Biomedical Engineering, The Ohio State University, Columbus, OH, USA

A. V. Lombardi Jr., K. R. Berend
Mount Carmel Health System, New Albany, OH, USA

C. A. Walter
Grandview Hospital Orthopedic Residency Program, Dayton, OH, USA

N. A. Cheney
Doctors Hospital Orthopedic Residency Program, Columbus, OH, USA

arthroplasty (UKA) have broadened from those of Kozinn and Scott [19], which included weight limited to less than 82 kg (180 lbs), age older than 60 years, no more than minimal erosive changes in the patellofemoral articulation, and absence of anterior knee pain. In 1993 Stern, Becker and Insall [36] reported that when the selection criteria of Kozinn and Scott [19] were applied strictly, only 6% (13 of 228) of knees in their prospective evaluation of 165 consecutive patients undergoing primary knee arthroplasty met the criteria for UKA. Yet from the Swedish registry, Robertsson et al. [33] reported 20% of patients had isolated medial compartment osteoarthritis. Indications for mobile-bearing UKA have been expanded by the Nuffield Orthopaedic Care Centre [5] to include full thickness medial cartilage loss, anterior disease with preserved posterior bone, fully correctable and full thickness lateral cartilage, and an intact anterior cruciate ligament while disregarding traditional limitations of age, weight, patellofemoral disease and anterior knee pain.

Several studies have compared UKA with TKA, examining aspects ranging from survival and cost to functional outcomes and patient satisfaction (Table 1) [1, 3, 11–14, 18, 20, 22, 25, 32, 34, 40–42]. Most studies report UKA provides better functional outcomes, earlier recovery, ease of revision and lower costs, [1, 11–14, 20, 22, 25, 32, 34, 40–42] while Koskinen et al. [18] in a study from the Finnish registry raise concerns that higher revision rates of UKA negate its benefits. However, multiple authors have studied the long-term results of mobile-bearing UKA and found the survivorship at 10 years equivalent to that for TKA [7, 9, 23, 28, 30, 37].

While patients can expect a durable implant with good long-term survivorship, achievement of short-term goals has come under increased focus [4, 6, 16, 21, 29, 31, 42]. To enhance patient outcomes with knee arthroplasty, we suggest a multimodal approach to optimize functional recovery must be implemented. We have outlined our approach to rapid recovery protocols in prior studies [6, 21]. This perioperative approach decreases hospital length of stay and number of readmissions. Combined with a minimally invasive surgical approach this rapid recovery protocol has demonstrated improved knee range of motion, as well as clinical and pain scores in total knee arthroplasty [21]. Applied to a UKA model we would expect similar outcomes in range of motion, clinical and pain scores, as well as functional recovery with early return to both work and sporting activities. As our understanding of anteromedial osteoarthritis advances and surgeons further their experience with mobile-bearing UKA, these implants will be increasingly applied to patients who continue to work and engage in recreational activities [5]. Patients want smaller incisions, shorter hospital stays, and earlier achievement of functional goals. Additionally, patients can expect a return to sports on a limited basis is a reasonable goal after undergoing knee arthroplasty [10, 24].

With the availability of a mobile-bearing UKA device in July 2004 and use with expanding indications, we questioned if our results with this device could compare with those achieved with TKA. How does UKA compare with TKA in terms of durability, incidence of complications and manipulations, recovery, postoperative clinical function, patient-perceived outcomes, return to sport and return to work?

Materials and Methods

From July 2004 to July 2005, we performed 852 primary knee arthroplasties in 701 patients. Patients selected for medial UKA had anteromedial primary osteoarthritis (with normal lateral compartment; patellofemoral osteoarthritis was not an exclusion for UKA), intact cruciate ligaments, flexion deformity less than 15° and varus deformity less than 15°, and correctable deformity in a valgus stress AP radiograph. Using these criteria, 103 patients (115 knees) were selected to undergo medial UKA. Patients selected for TKA had unicompartmental or more extensive osteoarthritis. During the study period, 2 patients (2 knees) underwent lateral UKA with a fixed bearing device. One patient underwent simultaneous medial UKA on one side and TKA on the contralateral side and is included in the study. The remaining 596 patients (735 knees) underwent total knee arthroplasty. All 103 patients with 115 medial UKA during the study period were matched to 103 patients with 115 TKAs for age, gender, BMI, bilaterality, and diagnosis (primary osteoarthritis) (Table 2). Post hoc power analysis revealed sufficient power to detect the variables studied at 80%. Twelve patients in the TKA group had both knees replaced as did 12 patients in the UKA group. These were performed simultaneously in 11 patients for each group and in a staged fashion in one in each group. One patient had a UKA on one side and a TKA on the other side performed at the same time. The primary diagnosis was osteoarthritis in all patients except one UKA patient who had posttraumatic arthritis. Preoperative ROM was measured with a long-arm goniometer under the supervision of the senior authors (AVL, KRB). Preoperative clinical assessment was performed by the senior authors (AVL, KRB) using the Knee Society clinical rating system [15].

We used a less invasive approach with medial parapatellar incision for both procedures. UKA was performed without extension to the vastus medialis obliquus and without patella eversion. All patellae were resurfaced in the TKA group. We used the Oxford Phase III mobile-bearing unicompartmental knee prosthesis (Biomet Inc, Warsaw, Indiana) for all UKA and the Vanguard cruciate retaining

Table 1. Studies comparing unicompartmental with total knee arthroplasty

Study	UKA	TKA	Findings
Rougraff et al., 1991 [34]	120; Tibia I & II; age > 55	81; PCA, Variable Axis, Brigham, Anametric, Duopatellar	UKA had 92% survival at 10 years; UKA had better ROM and ambulatory function than TKA
Laurencin et al., 1991 [20]; simultaneous UKA/TKA	23; Brigham, Unicondylar	23; Kinematic, PFC, Duopatellar	UKA more frequently provide a subjectively "better" knee, with increased ROM
Newman et al., 1998 [25]; prospective randomized	50; St. Georg	52; Kinematic CR	At 5 years, 2 UKA & 1 TKA revised. More UKA able to flex $\geq$ 120° and more excellent results
Robertsson et al., 1999 [32]; Swedish Registry	10,624; St. Georg, Link, Marmor, Richard, PCA, Duracon	15,437; AGC, Freeman-Samuelson, PCA, Duracon, Kinemax, Scan	Cumulative 10-year revision rate: UKA 16%, TKA 12%; UKA 2-day shorter hospital stay, fewer complications, UKA implant cost = 57% of TKA cost
Weale et al., 2001 [41]	31; Oxford Phase I/II	130 AGC	Equal Oxford scores; UKA better ability to descend stairs; UKA higher revision rate (6% vs. 1% TKA at 3 years) but easier revision surgery
Ackroyd et al., 2002 [1]	488; St Georg	531; Kinematic CR	No difference in survival at 10 years; ROM > 90° UKA 94% versus TKA 84%; UKA more rapid recovery and better result offset by easier although slightly higher revision rate
Yang et al., 2003 [43]; matched by age, preoperative ROM, arthritis severity	50; Miller-Galante, PFC; minimally invasive	50; NexGen, PFC Sigma; traditional incision	UKA had less blood loss, quicker rehabilitation, earlier ambulation, shorter hospital stay, better postoperative ROM, and reduced hospital cost
Hassaballa et al., 2003 [13]; Oxford score only	80; St. Georg	113; Kinemax Plus CR	UKA had better kneeling ability than TKA or PFR (60 Avon)
Hassaballa et al., 2004 [12]; Oxford score versus actual	53; St Georg	38; Kinemax Plus CR	Better ROM after UKA likely increases ability to kneel; for all groups, lower perceived versus actual ability to kneel suggests need for better patient education
Hassaballa et al., 2007 [11]; Oxford score versus actual	70; St. Georg	113; Kinemax Plus CR	UKA patients appeared to perform kneeling and descending stairs better than those with TKA or PFR
Amin et al., 2006 [3]; matched by age, gender, BMI, preop ROM, preop KSS	54; Oxford	54; PFC	5-year survivorship: 88% UKA versus 100% TKA; UKA had greater active ROM but overall clinical outcomes are similar
Walton et al., 2006 [40]	183; Oxford Phase III; minimally invasive	142; variety of devices; standard medial parapatellar approach	Mini-incision UKA had better Oxford and modified Grimby scores, and greater return to sporting activity
Manzotti et al., 2007 [22]; BMI < 30, matched by age (> 60), gender, preoperative ROM, arthritis severity	34; UC-Plus Solution; minimally invasive 9 cm incision	34; Search CR; computer-assisted 12 cm incision	Superior results with UKA with better Knee Society functional and GIUM scores, plus financial benefits; no implant revisions in either group at minimum 3 years
Koskinen et al., 2008 [18]; Finnish Registry	1886: Oxford, Duracon, Miller-Galante II	48,607; AGC; Duracon, Nexgen	15-year survival rate: UKA 60% versus TKA 80%; UKA hospital cost savings do not cover cost of extra revisions.
Hopper and Leach [14], 2008	34; Oxford	141; PFC	UKA patients had significantly faster and greater return to sport rate, took part in more and longer sporting sessions

UKA = unicompartmental knee arthroplasty; TKA = total knee arthroplasty; BMI = body mass index; ROM = range of motion; AGC = Anatomic Graduated Component; PCA = Porous Coated Anatomic; CR = cruciate retaining; PFR = patellofemoral replacement; PFJ = patellofemoral joint; PFC = Press Fit Condylar; GIUM = Italian UKR Users Group.

Table 2. Preoperative demographics

Variable	UKA group	TKA group	p Value
Knees	115	115	
Gender			NS
Males	38 (37%)	38 (37%)	
Females	65 (63%)	65 (63%)	
Bilaterality			NS
Unilateral	90	90	
Simultaneous	11	11	
Staged	1	1	
Simultaneous UKA/TKA	1	1	
Age (years)	61 (±10.3; 40–85)	62 (±10.0; 41–85)	0.8327
Body mass index (kg/m^2)	31 (±5.1; 20–48)	31 (±5.1; 20–46)	0.6201
Preoperative tibiofemoral alignment			**0.0000**
Varus	107 (93%)	77 (67%)	
Neutral (5°–10° valgus)	8 (7%)	20 (17%)	
Valgus	0 (0%)	18 (16%)	
Range of motion (degrees)	117 (±8.1; 95–125)	112 (±10.0; 80–125)	**0.0001**
KS pain score (0 to 50)	13 (±8.5; 0–45)	11 (±9.2; 0–45)	0.1149
KS clinical score (0 to 100)	57 (±9.6; 35–95)	52 (±11.4; 19–90)	**0.0001**
KS functional score (−20 to 100)	54 (±12.3; 20–100)	49 (±16.7; −20–100)	**0.0152**

UKA = unicompartmental knee arthroplasty; TKA = total knee arthroplasty; KS = Knee Society.
Bolded values are p = 0.05 or lower.

prosthesis (Biomet Inc) for all TKA. All patients underwent the same multimodal rapid recovery preoperative and postoperative protocols as previously published by the senior authors (AVL, KRB) [4, 21]. Routine discharge criteria included medical stability, achievement of physical therapy and ambulatory goals, and adequate pain control. These goals are established for all primary arthroplasty patients entering the system regardless of surgical intervention. The average followup was 31 months (range, 1 to 52 months). One patient from each group expired during the followup period, with both deaths unrelated to the arthroplasty procedure.

The discharge note was reviewed and length of stay, ROM prior to discharge, hemoglobin concentration at discharge, distance walked, transfer capacity, discharge disposition and whether or not patient had met physical therapy goals by discharge were noted. Discharge goals were defined as the ability to walk at least 150 feet, ability to transfer either independently or with no more than standby assistance, and ability to negotiate as many stairs as will be required at home. ROM was determined by the hospital physical therapist using long-arm goniometric measurement. Patients were seen initially at 6 weeks postoperatively. The followup was performed by either of the two senior surgeons (AVL, KRB). Clinical outcomes were evaluated using the Knee Society clinical rating system [10] and Lower Extremity Activity Scale [35]. We attempted to interview all patients by telephone or by mail using the Oxford knee score [8]. We recorded time elapsed to return to work and to return to sports, and any serious complications of further surgery.

We compared differences in the continuous variables (age, followup duration, BMI, ROM, length of stay, return to work, return to sport and clinical scores) between groups using non-paired, two-tailed Student t test. We compared differences in the non-parametric variables (survival, incidence of manipulation and complications, ability to meet discharge goals and discharge disposition) between the two groups using Pearson's chi-square test.

Results

Similar numbers (p = 0.1958) of patients underwent revision in the two groups: seven UKA (6%) and 3 TKA (3%). Two UKA were revised for tibial collapse/fracture at 7 and 22 months, two for tibial loosening at 24 and 25 months, one for early sepsis at 2 months in a patient who initially required incision and drainage for hematoma, and two for unexplained pain at 6 and 35 months. Five UKA revisions were to CR-TKA, one to a posterior stabilized and one to an unknown device at another center. All 3 TKA revisions were for instability at 11, 13 and 48 months. The two earlier revisions were to posterior stabilized devices and the latter involved only change to a thicker cruciate retaining insert. Rates of serious complications requiring additional surgery were similar between groups, with 3 UKA treated with arthroscopy (two for removal of loose body and one synovectomy and chondroplasty of the patellar due to pain) and 4 TKA treated with incision and drainage (3 for wound dehiscence and one for superficial sepsis). The need for manipulation was greater ($p = 0.0072$) for TKA than UKA: 7 (6%) in the TKA group and none in the UKA group.

While mean operative times were similar and estimated blood loss was low for both groups, hemoglobin concentration at discharge was higher ($p = 0.0000$) in UKA patients than TKA patients (12.1 g/dL versus 11.3 g/dL, respectively). No patients in either group required intraoperative blood transfusion, and only two TKA patients required a single unit of blood each during their inpatient stay. Hospital stays were shorter ($p = 0.0000$) for the UKA group than for the TKA group (1.4 days versus 2.2 days) (Table 3). A larger number of patients ($p = 0.0000$) in the UKA group were discharged on the first postoperative day (71 versus 28). The mean ROM prior to discharge for the UKA group was better ($p = 0.0000$) than the TKA group (average 77° versus 67°, respectively). Patients in the UKA group were able to walk longer ($p = 0.0000$) distances than those in the TKA group (186 feet versus 137 feet, respectively). Fewer UKA than TKA patients ($p = 0.0002$) required admission to a skilled nursing facility (six versus 26). More ($p = 0.0124$) patients in the UKA group were able to go home with or without outpatient physical therapy compared to the TKA group (77 versus 63). UKA patients required less ($p = 0.0030$) help ambulating, with 84 needing either no or standby assistance compared to 69 in the TKA group.

At 6 weeks followup, the mean ROM for the UKA group was better ($p = 0.0016$) than for the TKA group (average, 115° versus 110°, respectively). While KS clinical score was equivalent for both groups at 6 weeks (UKA average 85 versus TKA average 84), the functional score was higher ($p = 0.0018$) for the UKA group than the TKA group (63 versus 55, respectively).

At final followup (Table 4), while mean ROM for the UKA group was higher ($p = 0.0001$) than for the TKA group (120° versus 114°), improvement from preoperative level was no different (UKA average 2.8° versus TKA average 2.4°; $p = 0.8089$). Mean KS pain, clinical and

Table 3. Perioperative results

Variable	UKA group	TKA group	p Value
Operative time (minutes)	76 (±17.1; 48–157)	81 (±21.8; 49–181)	0.1015
Estimated blood loss (cc)	52 (±25.9; 25–250)	51 (±17.7; 20–100)	0.7554
Hemoglobin level at discharge (g/dL)	12.1 (±1.2; 9.5–14.9)	11.3 (±1.1; 8.6–13.7)	**0.0000**
Length of stay (days)	1.4 (±0.7; 1–4)	2.2 (±0.9; 1–4)	**0.0000**
Range of motion at discharge (degrees)	77 (±18.4; 40–120)	68 (±11.4; 40–95)	**0.0000**
Walking distance at discharge (feet)	187 (±93; 20–500)	137 (±76; 8–400)	**0.0000**
Transfers			
Independent or standby assistance	84 (73%)	69 (60%)	**0.0030**
Contact guard or moderate assistance	15 (13%)	34 (30%)	
Not noted	16 (14%)	12 (10%)	
Physical therapy goals at discharge			
Goals met	72 (63%)	49 (43%)	**0.0001**
Goals not met	24 (21%)	53 (46%)	
Not noted	19 (16%)	13 (11%)	
Disposition upon discharge			
Home, with outpatient or no physical therapy ordered	77 (67%)	63 (55%)	**0.0124**
Home, with in home physical therapy	24 (21%)	24 (21%)	
Skilled nursing/rehabilitation facility	26 (23%)	6 (5%)	**0.0002**
Not noted	2 (2%)	8 (7%)	
6-week range of motion (degrees)	115 (±11.4; 75–135)	110 (±13.1; 50–125)	**0.0016**
6-week KS pain score (0 to 50)	38 (±11.3; 0–50)	38 (±11.0; 10–50)	0.6978
6-week KS clinical score (0 to 100)	85 (±12.4; 45–100)	84 (±12.8; 40–100)	0.4680
6-week KS functional score (−20 to 100)	63 (±20.9; 45–100)	55 (±19.0; 30–100)	**0.0015**

UKA = unicompartmental knee arthroplasty; TKA = total knee arthroplasty; KS = Knee Society.

Bolded values are p = 0.05 or lower.

Table 4. Postoperative results

Variable	UKA group	TKA group	p Value
Followup (months)	30 (±12.1; 1–52)	32 (±10.4; 2–52)	0.2960
Manipulations	0 (0%)	7 (6%)	**0.0072**
Revisions	7 (6%)	3 (3%)	0.1958
Range of motion at most recent (degrees)	120 (±7.8; 85–135)	115 (±11.4; 70–140)	**0.0001**
Range of motion improvement from preoperative (degrees)	2.8 (±10.8; –35–25)	2.4 (±14.8; −40–35)	0.8089
KS pain score at most recent (0 to 50)	44 (±10.4; 10–50)	46 (±11.3; 0–50)	0.8320
KS pain score improvement from preoperative	32 (±12.6; −10–50)	34 (±14.1; −20–50)	0.2316
KS clinical score at most recent (0 to 100)	92 (±12.0; 48–100)	90 (±13.9; 40–100)	0.2824
KS clinical score improvement from preoperative	35 (±13.8; −10–55)	38 (±13.9; 40–100)	0.1074
KS functional score at most recent (−20 to 100)	80 (±22.2; 20–100)	76 (±22.2; 20–100)	0.2157
KS functional score improvement from preoperative	26 (±23.3; −50–70)	27 (±26.3; −70–110)	0.7475
Lower extremity activity scale (0 to 18)	11.5 (±2.8; 6–18)	9.5 (±2.4; 6–14)	**0.0024**
Oxford score (0 to 48)	5.4 (±5.6; 0–24)	4.3 (±5.8; 0–30)	0.2667
Return to work (weeks)	8.2 (±6.2; 1–32)	8.0 (±5.6; 0–32)	0.8172
Return to sports (weeks)	11.3 (±11.3; 0–52)	10.9 (±10.3; 0–52)	0.8180

UKA = unicompartmental knee arthroplasty; TKA = total knee arthroplasty; KS = Knee Society.
Bolded values are p = 0.05 or lower.

function scores at most recent followup were similar for both groups, as was the improvement from preoperative levels. The Lower Extremity Activity Scale [35] was higher (p = 0.0024) for the UKA group than the TKA group (11.5 versus 9.5, respectively) with 11 corresponding to "I am up and about at will in the house and outside. I work outside the house in a moderately active job." Oxford scores in the UKA group were similar to those for the TKA group. Return to work and return to sports averaged 8 (range, 1 to 32) and 11 weeks (range, 1 to 52) in both groups.

Discussion

With availability to the American market of a mobile-bearing UKA device for use with expanding indications, we sought to determine how our results with minimally invasive UKA would compare with those we achieve with less invasive TKA using an identical rapid recovery protocol. We compared matched groups of UKA with TKA, examining durability, incidence of complications and manipulations, recovery, postoperative clinical function, patient-perceived outcomes, return to sport and return to work.

Limitations of this study include that it was a retrospective cohort study, not performed prospectively. There was a substantial bias towards patients with indications for UKA having higher ROM and activity level preoperatively, as correlates with less severe arthritic changes. However, we attempted to perform UKA in all reasonable candidates for the procedure, and TKA in all others with the belief that if a patient is a candidate for UKA and undergoes the procedure, they will have a faster recovery than those undergoing TKA who fall outside the indications.

Our early results with the mobile-bearing UKA device showed acceptable survivorship and outstanding function for the treatment of anteromedial osteoarthritis of the knee. Our rates of revision (UKA 6% versus TKA 3%) are similar to those reported by Weale et al. [41], who noted rates of 6% with UKA and 1% with TKA at 3 years, but suggested revision surgery was easier from a UKA device. We also observed a higher number of TKA than UKA (7 versus none, respectively) required manipulation under anesthesia to regain motion. Since evaluating these results we have implemented a change in the surgical technique for UKA, specifically attempting to reduce posterior tibial slope. Excessive posterior tibial slope has been associated with early failure of UKA as described in the study by Aleto et al. [2]. Secondly, careful preparation of the tibial keel slot, using a toothbrush type saw blade to reduce the incidence of fracture or damage to the posterior cortex or deep cancellous bone of the tibia has been implemented. Additionally, alphanumeric tibial baseplates that allow for a higher contact area and better fit of the implant on the cut surface of the proximal tibia became available after the end of the timeframe of this study (fall 2006). These potentially reduce stress overload of the tibial cancellous bone, necrosis and collapse. Last, the anatomic meniscal bearings became available after the end of the timeframe of this study. With these changes in mind we now have completed 983 medial UKA with this mobile-bearing device in 817 patients using the expanded indications of the Nuffield Centre [5], and have enjoyed survivorship of 98%. The average time to failure in this initial experience was 17 months. Included in our overall series to date of 983 mobile-bearing UKA are 600 knees that would have minimum 17 month followup. Therefore, we are confident the changes to the technique and small refinements to the implant design have decreased the early failure and increased the excellent outcomes we have seen.

While several authors reported no difference in the Knee Society overall scores or KS functional scores at 4, 5, or 10 years postoperatively, little has been published on the early functional outcomes of UKA as compared to TKA [1, 3, 16, 25, 34, 41]. This study demonstrated the difference with improved early functional outcomes on multiple levels. Our cohorts both demonstrated high overall KS score at both early and final followup with the UKA group showing better functional scores early.

Several authors have suggested age and BMI are important factors in deciding whether a UKA is a reasonable choice of implant [9, 17, 19, 26, 27, 38, 39]. Our cohorts were matched for these factors in order to control for this bias.

Ultimately it is our goal to return our patients to a condition better than their preoperative condition as safely and rapidly as possible. The faster the patient is recovered and functional, the faster they are able to participate meaningfully in society and the smaller burden they place on the overall system. Applied to the appropriate patient this procedure demonstrates a more rapid recovery compared with TKA. In patients who previously would have undergone a TKA for medial or combined medial and patellofemoral osteoarthritis, the UKA allows them a faster return to a more functional level.

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