

Short-Term Functional Outcomes of Unicompartmental versus Total Knee Arthroplasty in an Asian Population

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Abstract: Unicompartmental and Total Knee Arthroplasty (UKA and TKA) are both established surgical options for the treatment of medial compartment osteoarthritis of the knee. However, the superiority of one over the other remains controversial. Our retrospective study aims to compare short-term functional outcomes in similar patients who underwent either TKA or UKA. Pre- and post-operative range of motion (ROM), the Oxford Knee Score (OKS), Knee Society Knee Score (KSKS), and Knee Society Function Score (KSFS) were used as outcome measures. Our sample included 57 patients, among which 27 underwent TKA and 30 underwent UKA, including one patient who underwent bilateral UKA. At 1 year, there were no differences in the OKS, KSKS, or KSFS scores between the two groups. There was a significantly better range of motion in patients who underwent UKA compared to TKA (122.9 ± 11.7 degrees vs 109.9 ± 13.9 degrees, $p < 0.001$). Functional outcomes following UKA and TKA were found to be similar. Hence, in view of its lower morbidity and shorter length of hospital stay, UKA may be considered over a TKA for the treatment of medial compartment osteoarthritis whenever deemed appropriate.

Keywords: arthroplasty; knee replacement; osteoarthritis; range of motion; treatment outcome



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1. Introduction

Osteoarthritis, also known as degenerative joint disease, affects the entire joint organ as it develops. The knee joint is divided into three major compartments: the medial compartment, the lateral compartment, and the patellofemoral compartment [1]. In the knee, osteoarthritis can present with loss and destruction of articular cartilage, subchondral bone damage, osteophyte formation, synovial and infrapatellar fat pad inflammation, degeneration of ligaments and menisci, and joint capsule hypertrophy [2]. A Total Knee Arthroplasty (TKA) is indicated for symptomatic multicompartmental osteoarthritis refractory to conservative measures [3], whereas a Unicompartmental Knee Arthroplasty (UKA) is indicated when there is an isolated single compartment involvement, most commonly the medial compartment [4]. Whereas disease-modifying agents are available for the treatment of inflammatory conditions such as rheumatoid arthritis, no proven disease-modifying agents are available that effectively arrest natural progression or reverse structural defects of osteoarthritis [5–7]. Hence, these surgical procedures are essential, and it is necessary to be less invasive in performing them. For this reason, UKA has gained popularity as it does not require removing healthy joint surfaces, which is required while performing a Total Knee Arthroplasty (TKA).

Because UKA cannot be offered to those who are unlikely to benefit, Kozinn and Scott first suggested guidelines for patients suitable for medial UKA, with strict indications regarding age, activity level, weight, and arthritic involvement of the patellofemoral joint [8]. Many publications have since demonstrated that such stringent criteria result in only a few patients being able to reap the benefits of a medial UKA and have therefore

extended the indications to include patients who are obese, young, or with patellofemoral arthrosis [9–11]. In particular, the Oxford group has demonstrated excellent results even in patients who did not fulfil the criteria described by Kozinn and Scott [12,13].

The benefits of a UKA over a TKA are that it has lower morbidity, faster recovery, shorter length of stay, and better cost-effectiveness when compared to TKA [14,15]. These findings have been validated in recent studies [16–18]. In general, given a choice between UKA and TKA, most surgeons prefer UKA for younger patients who have less severe arthritis and a better pre-operative function. This is also reflected in various studies comparing UKA and TKA [19]. Because it is important to have patients with a similar pre-operative function and disease severity for comparison, we aim to include radiographically matched patients undergoing either a UKA or TKA in an Asian population and evaluate the differences in early postoperative outcomes. We hypothesize that irrespective of UKA or TKA, both groups of patients will show improvement in a range of motion, functional outcome scores, and pain after 1 year.

2. Materials and Methods

2.1. Patient Selection

Retrospectively, consecutive patients with medial-sided osteoarthritis who underwent a UKA or TKA from 2017 to 2018 were followed up from our hospital's knee registry and included in this study. The study with reference no. 2019/00237 was approved by the Domain Specific Review Board (DSRB), National Healthcare Group (NHG), Singapore. The inclusion criteria were: (i) an age of less than 70 years; (ii) Ahlback grade 1–4 medial compartment tibiofemoral arthritis; (iii) no radiological evidence of osteoarthritis in the lateral compartment; (iv) varus deformity of less than 15 degrees; (v) fixed flexion deformity of less than 15 degrees; and (vi) intact anterior cruciate ligament on preoperative examination. Patients who had an inflammatory joint disease, spontaneous osteonecrosis of the knee leading to osteoarthritis, and patellofemoral lateral facet wear of an Ahlback grade 3 or more were excluded. After applying these criteria, a total of 27 TKA patients and 30 UKA patients, including one patient who underwent a bilateral UKA, were selected for the study.

2.2. Operative Parameters

The TKAs were performed as per protocol [20] by two fellowship-trained adult reconstructive knee surgeons who offer a TKA regardless of the radiological and clinical disease pattern. All surgeries were performed using a computer navigation technique and with a cemented posterior stabilized implant, and with the removal of the infrapatellar fat pad but without patella resurfacing. The TKA implants used included the NexGen (Zimmer Biomet, Warsaw, IN, USA) in 17 patients, Legion (Smith and Nephew, London, UK) in 8 patients, and Persona (Zimmer Biomet, Warsaw, IN, USA) in 2 patients. The medial UKAs were performed as per protocol [21] by 2 different surgeons in the same institution, both of whom routinely offer a UKA for suitable patients. The procedure does not involve disturbing the infrapatellar fat pad or the undersurface of the patella. The majority of the UKAs performed (25 knees in 24 patients) utilized a mobile bearing implant, and the Oxford Unicompartmental Knee (Zimmer Biomet, Warsaw, IN, USA), among which 13 were uncemented and 12 were cemented. Five patients had a cemented fixed bearing implant—the SIGMA (Depuy Synthes, Warsaw, IN, USA)—and one patient had the cemented ZUK (Zimmer Biomet, Warsaw, IN, USA) implant. Postoperatively, all the UKA and TKA patients followed the same supervised physiotherapy and rehabilitation protocol, with full weight-bearing and ambulatory exercises as tolerated.

2.3. Outcome Measures

An independent healthcare professional assessed the patients preoperatively and 1 year after surgery. Functional outcomes were assessed using the Knee Society Score (KSS) and Oxford Knee Score (OKS), which were routinely collected. The KSS comprises 2 parts: the Knee Society Knee Score (KSKS) and the Knee Society Function Score (KSFS), each of

which are 100 points, with a maximum total of 200 points [22]. The Oxford Knee Score is a patient-reported outcome measure that consists of 12 sections on the patient's knee pain and function. The maximum score in each section is 4, and a score of 48 represents the best outcome [23]. Both the KSS and OKS have been demonstrated to show good cross-cultural adaptability and have been validated for use in an Asian, multi-ethnic population; hence, they are used in our institution as part of our knee registry outcomes assessment [24,25]. The range of motion of the knee was assessed with a goniometer, and the arc of motion was calculated by subtracting the degree of fixed flexion contracture from the maximum flexion. The demographic data collected were age, gender, and body mass index (BMI). Medical co-morbidities were quantified using the Charlson Comorbidity Index.

2.4. Statistical Analysis

Statistical analysis was performed using Stata, version 13 (StataCorp LP, University City, TX, USA), with statistical significance being defined as a *p*-value of <0.05. The normal distribution of data was checked using the Shapiro–Wilk test. For analyzing demographical data, the Student's unpaired *t*-test was used for continuous variables such as age and BMI, whereas the chi-squared test was used for categorical values such as gender. The Mann–Whitney *U*-test was used for analyzing the Charlson Comorbidity Index. In addition, two-tailed unpaired *t*-tests were also used to evaluate the differences in postoperative functional outcomes between the UKA and TKA groups. The presence of any complications was also recorded.

3. Results

The selected sample included 57 patients, among whom, 27 patients underwent TKA (Figure 1a,b) and 30 patients underwent UKA (Figure 1c,d), including one patient who underwent a bilateral UKA. With regards to the demographical data, there were no differences in age, gender, BMI, or Charlson comorbidity index between the two groups (Table 1). In addition, there were no differences in the pre-operative range of motion, OKS, KSKS, and KSFS between the TKA and UKA groups (Table 2). Post-operatively, at 1-year follow-up, there were no differences in the KSKS, KSFS, and OKS between the two groups. However, the UKA group demonstrated a significantly greater range of motion than the TKA group (122.9 ± 11.7 degrees vs 109.9 ± 13.9 degrees, $p < 0.001$) (Table 3).



Figure 1. Pre- and Post-operative images. (a) Preoperative antero-posterior view X-ray image of the right knee of a patient with medial compartment osteoarthritis who was planned for Total Knee Arthroplasty (TKA). (b) Post-TKA X-ray image of the same patient. (c) Preoperative antero-posterior view X-ray image of the left knee of a patient with medial compartment osteoarthritis who was planned for Unicompartmental Knee Arthroplasty (UKA). (d) Post-UKA X-ray image of the same patient.

Table 1. Patient Demographics.

Patient Characteristic	TKA ¹ (n = 27)	UKA ² (n = 30)	p-Value
Mean age, years (\pm SD ³)	63.4 (\pm 4.7)	61 (\pm 5)	0.063
Gender (Male: female)	10:17	11:30	0.428
Mean BMI ⁴ (kg/m ²)	27.5	28.7	0.399
Mean Charlson Comorbidity Index (\pm SD)	2.4 (\pm 1.0)	2.6 (\pm 1.3)	0.447

¹ Total Knee Arthroplasty; ² Unicompartmental Knee Arthroplasty; ³ standard deviation; ⁴ body mass index; a probability value of <0.05 is considered statistically significant.

Table 2. Pre-operative Range of Motion and Functional Scores.

Outcome Measures	TKA ¹ (n = 27)	UKA ² (n = 31)	p-Value
Range of motion, degrees (\pm SD ³)	110.7 (\pm 12.8)	111.0 (\pm 13.1)	0.940
KSKS ⁴	49.4 (\pm 16.2)	55.7 (\pm 10.7)	0.081
KSFS ⁵	60.9 (\pm 18.8)	53.6 (\pm 15.7)	0.108
OKS ⁶	28.4 (\pm 6.7)	24.8 (\pm 7.1)	0.055

¹ Total Knee Arthroplasty; ² Unicompartmental Knee Arthroplasty; ³ standard deviation; ⁴ Knee Society Knee Score; ⁵ Knee Society Function Score; ⁶ Oxford Knee Score; a probability value of <0.05 is considered statistically significant.

Table 3. Post-operative Range of Motion and Functional Outcomes.

Outcome Measure	TKA ¹ (n = 27)	UKA ² (n = 31)	p-Value ⁷
Range of motion, degrees (\pm SD ³)	109.9 (\pm 13.9)	122.9 (\pm 11.7)	<0.001
KSKS ⁴	88.2 (\pm 10.6)	86.6 (\pm 7.5)	0.492
KSFS ⁵	76.5 (\pm 15.4)	83.0 (\pm 17.8)	0.143
OKS ⁶	43.5 (\pm 3.9)	41.7 (\pm 5.5)	0.157

¹ Total Knee Arthroplasty; ² Unicompartmental Knee Arthroplasty; ³ standard deviation; ⁴ Knee Society Knee Score; ⁵ Knee Society Function Score; ⁶ Oxford Knee Score; ⁷ a probability value of <0.05 is considered statistically significant.

There were no reoperations in the UKA group; however, one patient who underwent TKA required manipulation under anesthesia at 4 months post-surgery for a stiff knee with a range of motion arc of 75 degrees. Among those who underwent UKA, one patient, who had a cemented mobile-bearing UKA, had a radiolucent line in the proximal tibia which was observed in the radiographs. However, this turned out to be asymptomatic and the radiolucency was stable at the 1-year follow-up.

4. Discussion

There is widespread controversy regarding the optimal surgical option for the treatment of isolated medial compartment osteoarthritis of the knee. Our study aimed to identify two groups of patients with similar baseline characteristics that were treated differently and compare their outcomes at 1 year. Even though their pre-operative KSS scores were similar, the range of motion in patients who underwent a UKA was significantly greater than those who had a TKA. Similar to other studies in the literature, patients who were treated with a UKA had a better range of motion even though the functional outcomes are comparable with TKA [26,27]. This is of particular importance in our Asian population who frequently perform high-flexion activities such as squatting and kneeling in their activities of daily living. In a separate Asian study, Ha et al. established that Asian patients' satisfaction after Total Knee Arthroplasty is positively correlated with the knee range of motion [28]. As such, particular emphasis needs to be given to expectations of the range of motion during patient counselling before surgery. We feel that in our Asian population where high flexion is important, a UKA may provide more satisfaction (despite equivalent objective functional outcomes) than a TKA.

Both UKA and TKA were performed as per established protocols [20,21]. Even though we removed the infrapatellar fat pad to enhance surgical exposure during TKA, its removal

is considered controversial. An earlier study by Meneghini et al. suggested that the removal of the infrapatellar fat pad may not have any significant effect on patellar tendon contracture, range of motion, Knee Society Score, or function scores; however, the same authors mentioned that its removal was linked to patients being twice as likely to experience postoperative pain [29]. It should also be noted that studies have linked preserving the infrapatellar fat pad to better patient-reported outcome scores at 1-year post-surgery, as measured by both the OKS and EuroQol 5 Dimensions (EQ5D) questionnaire [30]. Hence, the removal of the infrapatellar fat pad needs to be considered with caution.

In our UKA cohort, patients did not fulfil the criteria established by Kozinn and Scott, as we believe, like other authors, the indications for a UKA have expanded to include young and fit patients, and we do not believe patellofemoral arthrosis is a contraindication to UKA. Our study confirms that these patients have good outcomes at the 1-year follow-up, consistent with that reported by the Oxford group, who have shown good results in the young, overweight, and active patients in whom UKA was previously considered to be contraindicated [31]. Newer literature also suggests that patellofemoral arthrosis and anterior knee pain are not contraindications to UKA, with the only exception being that of lateral patellofemoral facet bone loss and grooving [32–34].

Apart from an increased range of motion, the other benefits of UKA are well-reported and include the preservation of bone stock, maintenance of the kinematics of the knee, and a shorter recovery period for patients [26,35]. Thus, based on the results of our study, we feel that UKA can be preferred over TKA in patients with medial osteoarthritis of the knee, provided they are suitable for both UKA and TKA, and especially if surgeon expertise is available. The literature suggests UKA revision rates are higher among low-volume surgeons who perform UKAs that comprise less than 20% of their caseload [36].

In our short follow-up period of 1 year, no patients underwent revision surgery, however, consideration needs to be given to revision rates and outcomes of revision of a failed UKA when compared with that of TKA. Though there are challenges with revising a UKA, a TKA revision is certainly more technically demanding as it will involve more bone loss. Hence for the young patient, a UKA may be more suitable as a first-line surgical option.

The limitations of our study are its small sample size and relatively short follow-up. Because the Oxford group has established that the most improvement in function and Oxford scores occur within the first year after joint arthroplasty [23], which was also validated by various other studies [9], we considered it reasonable to assess patients after 1 year to proceed with this study. However, further follow-up could have given more information about long-term stability and complications. Data comparing intraoperative parameters such as blood loss or operating time are not provided which may have increased the significance of this study. The use of different prosthesis may have also influenced our results and is considered a limitation of this study. The other limitation is that the UKAs and TKAs were performed by different groups of surgeons and hence, surgeon training and expertise may have varied. However, there may be an advantage to this in eliminating bias because of the clinical research concept of surgeon equipoise [37]. In other words, each treatment has been offered by a surgeon who firmly believes in the superiority of that treatment over another. The strength of our study is in its relatively homogenous cohort with similar baseline characteristics. This is difficult to achieve, and some studies have employed the use of statistical methods such as propensity score weighted regression to account for the inherent differences in age, BMI, or gender in their study cohort [38].

5. Conclusions

This study shows that for Asian patients under the age of 70 years, UKA achieves equivalent functional outcomes to TKA, with the benefits of an increased range of motion at a 1-year follow-up. Hence, in view of its less invasiveness, lower morbidity, and shorter length of hospital stay, UKA may be chosen over TKA whenever deemed appropriate for the treatment of medial compartment osteoarthritis. However, only larger prospective studies

can validate our findings and further explore the potential advantages and disadvantages of UKA and TKA for the treatment of medial compartment osteoarthritis.

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