RESEARCH ARTICLE

Comparison of Functional Outcomes of Two Knee Arthroplasty Techniques (Total Knee Arthroplasty and Unicompartmental Knee Arthroplasty) for the Treatment of Osteoarthritis, simultaneously done in the Same Patients

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Abstract

Objectives: This study aims to provide a comprehensive comparative analysis of functional outcomes between Unicompartmental Knee Arthroplasty (UKA) and Total Knee Arthroplasty (TKA) in patients diagnosed with bilateral knee osteoarthritis. Both procedures were performed simultaneously on separate knees to evaluate their respective efficacy.

Methods: The study included 25 patients (18 women and 7 men) with a mean age of 59.6 years, all meeting the criteria for administering UKA on one knee and TKA on the other. Radiographic and clinical data were collected over a two-year period, with assessments conducted at 6 months, 1 year, and 2 years postoperatively. Data included age, gender, and body mass index, medical history, surgical procedures, and various scores and measurements related to knee function.

Results: The UKA group exhibited significant improvements in functional scores compared to the TKA group. Specifically, the Western Ontario and McMaster Universities Osteoarthritis Index score for the UKA knee was 24.5% higher than that of the TKA knee, indicating better functional outcomes. Radiographically, the tibio-femoral angle was more than two times greater in the UKA method, while the Varus angle was significantly greater in the TKA method. No post-operative complications were reported.

Conclusion: This study underscored the safety and efficacy of both UKA and TKA procedures in the treatment of bilateral knee osteoarthritis. UKA demonstrated superior functional outcomes, while TKA displayed distinct advantages in radiographic alignment. Individual patient characteristics and preferences should guide the selection of the most appropriate surgical approach.

Level of evidence: IV

Keywords: Functional outcome, Osteoarthritis, Surgical approach, Total Knee Arthroplasty, Unicompartmental Arthroplasty

Introduction

Osteoarthritis (OA) is the most common disease affecting the joints in adults and the elderly around the world.[1] Among the spectrum of joint diseases, OA of the knee emerges as a prominent challenge for the elderly, giving rise to both disability and discomfort among those afflicted.[2] The precise pathogenesis of OA has not yet established completely.[2] The treatment options range from non-surgical interventions carried out in the community (including lifestyle changes and patient education) to surgical procedures involving joint replacement procedures (e.g., unicompartmental knee arthroplasty or total knee arthroplasty) and joint-sparing techniques.[3] If non-surgical treatment options fail to produce satisfactory results, surgical options, such as unicompartmental and total knee arthroplasty, will be recommended for patients including.[4]

Knee arthroplasties first became common during the 70s and 80s and are now generally considered an effective and

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cost-effective treatment for end-stage OA, which is becoming more prevalent recently, according to evidence.[5] A debate persists within the medical community, oscillating between the advocacy for unicompartmental knee arthroplasty (UKA) for isolated medial compartment OA and the endorsement of total knee arthroplasty (TKA).

For the treatment of end-stage OA, TKA has always been the gold standard, while the less invasive alternative, UKA, has only recently gained popularity among surgeons.[5,6] Emerging studies posit that the UKA approach yields fewer complications, reduced blood loss, and swifter recovery.[7,8] There is little prospective data comparing the post-operative characteristics of the two methods; therefore, the present study aimed to evaluate and compare the results of UKA and TKA approaches for the treatment of OA by performing both surgeries on the same patient but on different knees, in order to analyze outcomes.

Materials and Methods

This cross-sectional, retrospective chart review was conducted from April 2019 to May 2020. The current study aimed to evaluate the functional outcomes of patients diagnosed with bilateral knee OA who underwent simultaneous TKA on one knee and UKA on the contralateral knee at the Orthopedics Clinic of Imam Hossein Hospital in Tehran between 2019 and 2020 [Figure 1].

Figure 1. Bilateral osteoarthritis in patient

All patients visiting the Imam Hossein Clinic over 2019-2020 with a confirmed diagnosis of OA in both knees and meeting the criteria for TKA on one knee and UKA on the other were included [Figure 2]. On the other hand, exclusion criteria encompassed comorbidities (e.g., cancer, cardiovascular or renal failure, and any prior open or closed knee interventions) and a history of knee trauma. Patients with localized knee lesions, such as septic arthritis, were also excluded. As the patients were candidates for receiving TKA on one knee and UKA on the other, no randomization was needed. All the surgeries were performed using a midline incision and Subvastus approach, with the fixation of a tourniquet and the implementation of a kinematic principle.

Some common reasons for performing a TKA include pain in the knee due to severe OA, with or without severe deformity that does not improve with conservative therapy; young patients with systemic arthritis who have lost their functional abilities; severe patellofemoral arthritis in the elderly, where TKA results are superior to patellectomy. On the other hand, some indications for UKA are low-weight elderly individuals with involvement of a single knee compartment affected by OA, who may require TKA if left untreated with UKA, and young patients with single-compartment involvement in the knee.

Post-surgery, patients were scheduled for follow-up appointments at 6 months, 1 year, and 2 years, during which side effects were recorded. Completed surveys after the 2-year follow-up point were preserved for subsequent analysis. Data entry and recording were performed by a third- or fourth-year orthopedic resident, and knee radiographs were obtained to evaluate tibio-femoral and Varus angles over the 2-year period. Radiographic views included posterior, lateral, skyline (alignment), and long leg, with angle measurements conducted using PACS software 5.2.0.0 by an orthopedic resident [Figure 3].

Ethical considerations were strictly observed. Informed consent was obtained from each patient or their legal guardians, and no additional charges were incurred beyond routine billing. Patients or their relatives were informed of the possibility of study withdrawal at any research stage. All patient information, including medical records, was kept confidential. This study received approval from the Ethics Committee of Shahid Beheshti University of Medical Sciences (IR.SBMU.MSP.REC.1400.594).

Data collected for each patient included age at the time of operation, gender, body mass index (BMI), medical history, which knee received TKA and which received UKA, smoking status, Knee Society Score (KSS), Oxford Knee Score (OKS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and radiographic measurements in the anteroposterior position, skyline, standing lateral, and long leg views for calculating the tibio-femoral angle. Incidences of side effects, such as infection, component loosening, fracture, and subluxation, were documented. All patients provided written consent. Additional details, including occupation, length of time off work before surgery, post-operative return-to-work time, changes in physical activity and work duration, and reasons for work cessation, were gathered through pre-designed questionnaires. The standard patient-reported outcome measures (PROMs) were filled out by the patients at the two-year follow-up point when visiting the orthopedic clinic. If they did not attend the clinic at the two-year mark, the questionnaires were completed over the phone.

Standard descriptive statistics were employed to characterize epidemiological and baseline characteristics. The non-paired t-test and Mann-Whitney-Wilcoxon test were used for normally and non-normally distributed data, respectively, to compare the UKA and TKA groups. Data analysis was performed using SPSS 22 software. The Kolmogorov-Smirnov test assessed data normality, with means and standard deviations used for normally distributed data, and medians and interquartile ranges for non-normally distributed data. Qualitative data were presented as percentages and frequencies, supported by charts and frequency bars. The Mann-Whitney and Chi-square tests were employed for non-normally distributed data and bipolar variables, respectively, to evaluate differences between the TKA and UKA.

Figure 2. Bilateral treatment in a patient

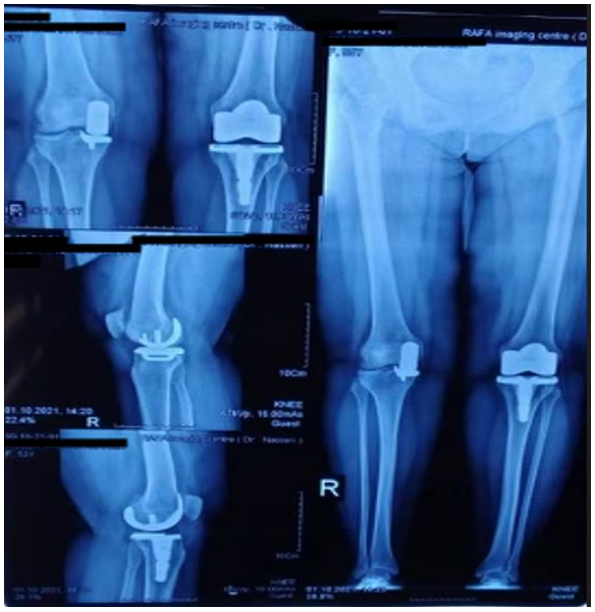

Figure 3. Post-operative result of the patient

Results

A total of 25 patients were included in this study, consisting of 18 women and 7 men. All patients met the criteria for undergoing TKA in one knee and UKA in the other. The entire cohort fell within the 55-65-year age group, with a mean age of 59.6 years. The average BMI among the patients was calculated to be 28.44. On average, patients had experienced knee-related disability or dysfunction for a mean duration of 2.08±0.64 years. Follow-up assessments were conducted at the 2-year post-operative mark, either in person or via telephone interviews. Patients were encouraged to provide any radiographs or documents related to their condition, either physically or electronically. The mean time to return to daily activities following surgery was 2.08 months.

In terms of radiographic measurements, the mean tibio-femoral angle was 176.68±0.43 in the TKA knee group and 174.1±0.76 in the UKA knee group (P<0.001), indicating that the UKA method led to lower tibio-femoral angle compared to TKA. Likewise, the mean Varus angle was 3.42±0.40 in the TKA knee group and 7.84±1.53 in the UKA knee group (P<0.001), signifying a difference in Varus alignment between UKA and TKA [Table 1].

Table 1. varus tibiofemoral angle between Tka and UKA

	Procedure	Mean	Interquartile range	SD
Tibiofemoral angle	*Tka*	176.6	176.5-177	0.43
	Uka	174.1	173-175	0.76
Varus degree	*Tka*	3.42	3.0-3.5	0.4
	Uka	7.4	6.5-9	1.53

None of the 25 patients reported post-operative complications, such as infection or fracture. Patients completed three surveys for each knee: WOMAC, OKS, and KSS. The mean WOMAC score for the TKA knee was 66.32±2.17, while it was 82.6±2.22 for the UKA knee (P<0.001), indicating a significant 24.5% lower WOMAC score for the UKA knee compared to the TKA knee [Table 2].

The mean OKS score for the TKA group was 10.0±0.65, whereas it was 8.28±0.46 for the UKA group (P<0.001), signifying a significant 17.2% lower OKS score for the UKA knee compared to the TKA knee [Table 2].

Furthermore, the mean KSS score for the TKA group was 83.12±3.59, while for the UKA group, it was 86.80±2.75 (P<0.001), revealing a significant 4.5% lower KSS score in the UKA knee compared to the TKA knee [Table 2].

In summary, patients in the UKA group exhibited a 17.2% reduction in OKS score, a 24.5% decrease in WOMAC score, and a 4.5% decline in KSS score compared to those in the TKA group. Additionally, the tibio-femoral angle exhibited a higher value in the UKA method than in the TKA method, while the Varus angle was greater in the TKA method.

Table 2. Oks Womac and Kss score between tka and uka post op

	TKA			UKA			
Questionnaire	***Mean***	***SD***	***Interquartile range***	***Mean***	***SD***	***Interquartile range***	***P***
Oks	10.0	0.65	10.0-10.0	8.28	0.46	8.0-9.0	*<0.001*
Womac	66.32	2.17	65.0-67.0	82.60	2.22	81.0-84	*<0.001*
Kss	83.12	3.59	80.0-86.0	86.80	2.75	85.0-88	*<0.001*

Discussion

This cross-sectional study provides a comparative analysis of two surgical approaches for OA: total knee arthroplasty (TKA) and unicompartmental knee arthroplasty (UKA). Among the 25 enrolled patients with bilateral knee OA, one knee qualified for UKA and the other for TKA surgery. Over the two-year follow-up period, no post-operative complications or subsequent arthroplasties were required, attesting to the safety and efficacy of both procedures.

Comparative assessments revealed subtle differences between the two techniques. Specifically, TKA demonstrated a 24.5% lower score in the WOMAC survey, a 4.5% reduced score in the KSS survey, and a 17.2% higher score in the OKS survey, underscoring distinct functional outcomes. Radiographically, TKA resulted in a tibio-femoral angle approximately twice that of the UKA group, while the Varus angle was significantly greater in the UKA method compared to TKA.

Literature comparisons elucidate further insights. Several studies have examined the disparities between UKA and TKA methods, although limited in number.[9-11] Costa et al.[10] conducted a study involving 34 patients with a mean age of 77, akin to our cohort. They performed TKA on one knee and UKA on the other, employing the KSS for comparison. Their results did not yield a statistically significant difference between UKA and TKA. Both knees in their study were suitable for the UKA procedure; however, with patient consent, TKA was administered on one knee. The extended follow-up period spanning between 2 to 7 years may account for the convergence of results between the two methods. It is worth noting that the follow-up durations varied among patients in their study.

Dalury et al.[11] carried out a study that was similar to our study. In their study, one knee in each patient was deemed suitable for TKA, while the other was a candidate for UKA. They utilized the KSS as the primary evaluation metric. Patients were informed of the rigorous measures adopted to determine whether UKA or TKA was appropriate for each knee, aligning closely with our study design. Moreover, both studies similarly analyzed patient functional and radiographic characteristics post-surgery. The follow-up period for the TKA group was 46 months, whereas it was 42 months for the UKA group. No significant differences were observed between the two groups. Consistent with our findings, the UKA group exhibited a superior range of motion compared to the TKA group. In response to inquiries regarding knee function, 11 out of 23 patients experienced no differences between their knees, while more than half (12 patients) found the UKA knee to function better than the TKA knee. This observation was in line with our results. We also employed three surveys, particularly emphasizing the functional component of the WOMAC survey, akin to their approach. Taken together, both our study and that by Dalury et al. suggest that meticulous execution of the UKA method can lead to superior outcomes compared to TKA.

Liu et al.[12] conducted a meta-analysis focusing on the functional aspects of both methods. This extensive analysis involved 9 primary cohorts and 954 patients. Their results demonstrated that UKA generally exhibited superior functionality compared to TKA. Furthermore, diverse surveys were employed at different time intervals. For instance, KSS survey scores favored UKA over TKA at 6 months and 1 year post-surgery. Additionally, WOMAC scores over a 5-year interval were lower for TKA when compared to UKA.

Vasso et al.[13] conducted a meta-analysis that examined obesity as a risk factor for recurrent operation in the UKA. This study encompassed data from 17 studies involving 44,000 patients. The utilization of both KSS and OKS revealed a consistent trend: obesity exhibited an inverse correlation with implant survival, increasing the likelihood of recurrent surgery. Specifically, KSS scores were significantly lower in the UKA group among patients with higher BMI. In our study, the BMI range fell between 25 and 35, with no patient surpassing a BMI of 35. This underscores the potential benefits of weight loss interventions for high BMI patients, reducing the incidence of side effects and the necessity for recurrent surgery. Another meta-analysis demonstrated that the flexion rate was superior in patients undergoing the UKA method compared to TKA.[14-16]

Kievit et al.[9] focused solely on the return-to-work period. Their study included 157 UKA patients and 167 TKA patients. The study highlighted the varying durations required for patients undergoing each procedure to resume work. The results indicated that the UKA group returned to work significantly sooner than the TKA group. However, this parameter could not be directly assessed in our study due to the simultaneous operation of both knees. Nevertheless, the comparison of mean return-to-work periods revealed that our study's mean of 2.08 months was significantly shorter for the UKA group than that in Kievit et al.'s study.

This study had some limitations. The total number of patients included in this and similar studies was less than

300. Therefore, further studies with larger sample sizes are essential for a more comprehensive comparison between UKA and TKA. One limitation of PROMs in bilateral cases is that many of the functional outcomes cannot be attributed to one leg specifically. This is especially true for WOMAC since it does not differentiate between the legs in the functional measures.

Long-term follow-up of patients was notably absent in this and similar studies. While follow-ups of 5 years or more are rarely observed, it is important to consider that the rate of recurrent surgery may increase beyond this timeframe. Future studies should aim for extended follow-up periods to capture potential late-stage outcomes.

It is recommended to conduct validation studies for the surveys and questionnaires used in research projects. This ensures that these instruments remain reliable and accurately capture the intended metrics. When designing surveys and questionnaires, it is crucial to take into account the psychological aspects that may influence self-reported responses. Designing surveys that minimize potential biases from external factors will enhance the validity and reliability of the collected data.

Conclusion

According to the results of this study, during the two-year follow-up period, it was observed that the knee that had undergone TKA surgery gained 17.2% higher scores on the OKS and 24.5% and 4.5% lower scores on WOMAC and KSS, respectively. No post-operative complications were observed in the follow-up period, and none of the patients needed surgery.

Hereby, the authors declare their adherence to the Consolidated Standards of Reporting Trials (CONSORT) guidelines in reporting the results of this research entitled "Comparison of Functional Outcomes of Two Knee Arthroplasty Techniques (Total Knee Arthroplasty and Unicompartmental Knee Arthroplasty) for the Treatment of Osteoarthritis, simultaneously done in the Same Patients Referring to the Orthopedic Clinic Of Imam Hossein Hospital, Tehran, Iran during 2019-2020."

The study was designed, conducted, and reported in compliance with the CONSORT guidelines, with the aim of ensuring clarity, transparency, and completeness in reporting our findings. We acknowledge the significance of CONSORT guidelines in enhancing the quality of clinical trial reporting and facilitating critical appraisal.

In adherence to CONSORT, we have provided detailed information regarding the study design, participant enrollment, and randomization (where applicable), intervention protocols, outcome measures, statistical methods, and results. Additionally, we have presented a flow diagram illustrating the progress of participants through each stage of the study.

We recognize the importance of adhering to CONSORT guidelines to uphold the integrity and validity of clinical research. Therefore, we have diligently ensured that our study is reported accurately and comprehensively in accordance with CONSORT recommendations.

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Authors Contribution:

Mohsen Latifpoor, data gathering, and analysis.
Mohammad Mahdi Sarzaeem, and Farzad Amouzadeh Omrani,responsible for conceptualization, methodology, Supervision of the study.
Sina Raissi Dehkordi, Preparation of the manuscript, critical revision.

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Declaration of Informed Consent: there is no information (names, initials, hospital identification numbers, or photographs) in the submitted manuscript that can be used to identify patients

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