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Fixed-Bearing versus Mobile-Bearing Unicondylar Knee Arthroplasty: Comparison of Patients with Similar Component and Mechanical Axis Alignment

Sabit-İnsörtlü ve Mobil-İnsörtlü Unikondiler Diz Artroplastisi: Benzer Komponent ve Mekanik Eksen Dizilimine Sahip Hastaların Karşılaştırması

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ABSTRACT

Aim: Unicondylar knee arthroplasty (UKA) is among the treatment options for patients with arthritis limited to one compartment of the knee. Fixed-bearing (FB) and mobile-bearing (MB) inserts are present. This study aimed to compare functional and clinical outcomes and revision rates of patients operated with FB-UKA and MB-UKA.
Material and Methods: A total of 131 knees of 118 patients underwent cemented UKA, with a mean follow-up period of 80.58±31.31 months for FB-UKA and 97.66±29.24 months for MB-UKA. Clinical and functional evaluation was performed by the Knee Society Score (KSS) and Western Ontario and McMaster Universities Arthritis Index (WOMAC) score, at the last follow-up visit. The factors affecting the radiological and functional results, complication, and revision rates were examined under three main titles; i) surgeon-related, ii) patient-related, and iii) component alignment-related factors.
Results: There was no significant difference between the groups in terms of age, gender, body mass index, and side. Regarding the KSS scores, 9 (6.87%) knees were within acceptable limits, 62 (47.32%) knees were found to be good, and 60 (45.80%) knees were found to be excellent. No statistically significant difference was found between groups (p=0.497). Regarding the WOMAC scores, the MB-UKA group had significantly lower pain (p=0.049) and stiffness (p=0.014), but similar functional (p=0.591) scores. There was no statistically significant difference regarding revision rates (p=0.931).
Conclusion: Similar clinical, functional, and radiological results and low revision rates were found. In terms of pain and joint stiffness, a significant difference was found between groups, in favor of MB-UKA.
Keywords: Knee; fixed-bearing; mobile-bearing; unicondylar.

ÖZ

Amaç: Unikondiler diz artroplastisi (UDA), dizin bir kompartmanı ile sınırlı artritli hastalar için tedavi seçenekleri arasındadır. Sabit-insört (Sİ) ve mobil-insört (Mİ) eki mevcuttur. Bu çalışmada, Sİ-UDA ve Mİ-UDA ile ameliyat edilen hastaların fonksiyonel ve klinik sonuçlarının ve revizyon oranlarının karşılaştırılması amaçlandı.
Gereç ve Yöntemler: Toplam olarak, 118 hastanın 131 dizine çimentolu UDA uygulandı ve ortalama takip süresi Sİ-UDA için 80,58±31,31 ay ve Mİ-UDA için 97,66±29,24 ay oldu. Klinik ve fonksiyonel değerlendirme, Knee Society Skor (KSS) ve Western Ontario and McMaster Universitesi Artrit Indeks (WOMAC) skoru ile son takip ziyaretinde yapıldı. Radyolojik ve fonksiyonel sonuçlar, komplikasyon ve revizyon oranlarını etkileyen faktörler üç ana başlık altında incelendi; i) cerrahla ilgili, ii) hastayla ilgili ve iii) bileşen hizalamayla ilgili faktörler.
Bulgular: Gruplar arasında yaş, cinsiyet, vücut kitle endeksi ve yan açısından anlamlı bir fark yoktu. KSS skorlarına göre 9 (%6,87) diz kabul edilebilir sınırlar içinde, 62 (%47,32) diz iyi olarak ve 60 (%45,80) diz ise mükemmel olarak bulundu. Gruplar arasında istatistiksel olarak anlamlı bir fark bulunmadı (p=0,497). WOMAC skorları ile ilgili olarak, Mİ-UDA grubu anlamlı olarak daha düşük ağrı (p=0,049) ve sertlik (p=0,014), ancak benzer fonksiyonel skorlara (p=0,591) sahipti. Revizyon oranları açısından istatistiksel olarak anlamlı bir fark yoktu (p=0,931).
Sonuç: Benzer klinik, fonksiyonel ve radyolojik sonuçlar ve düşük revizyon oranları bulundu. Ağrı ve eklem sertliği açısından gruplar arasında Mİ-UDA lehine anlamlı bir fark bulundu.
Anahtar kelimeler: Diz; sabit-insörtlü; mobil-insörtlü; unikondiler.

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INTRODUCTION

Unicondylar knee arthroplasty (UKA) is among the treatment options of patients with end-stage knee osteoarthritis (OA) more than in the past, particularly in patients where the arthritis is limited to one compartment of the knee. Although other comparable treatment options in the treatment of single-compartment arthritis are high tibial osteotomy (HTO) and total knee arthroplasty (TKA), advantages of this technique, particularly over TKA, include a smaller incision, less blood loss, greater range of motion (ROM), lower perioperative morbidity, and greater preservation of anatomy and kinematics (1-6). Minimally invasive UKA (MIUKA), on the other hand, is performed with a smaller incision and approach that protects the suprapatellar extensor mechanism compared to the conventional UKA approaches.

Two different polyethylene insert designs are present depending on the surgeon's preference; fixed-bearing (FB) and mobile-bearing (MB) designs (7-9). Good clinical outcomes have been reported in the literature for both concepts. While MB designs are known with a more congruent weight bearing, therefore less contact stresses and polyethylene wear (10-13), FB designs have superior long-term clinical outcomes (7,14). The choice of UKAs with MB design has gained popularity. But according to the results of a recent meta-analysis comparing these two design concepts, sufficient long-term clinical, radiological, and kinematic outcome results and a strong consensus are not present in the literature (15).

In this study, it was aimed to compare functional and clinical outcomes and revision rates of patients operated with MB-UKA and FB-UKA while considering post-operative radiological alignment factors, patient and surgeon-related variables. Our hypothesis was to generally obtain good radiological and functional results in both groups, as well as to find better functional results in patients operated with MB-UKA.

MATERIAL AND METHODS

The approval of the institutional ethics committee was obtained (Medical Park Bursa Hospital, 22.05.2020, 223). The study was carried out retrospectively in line with the principles of the Declaration of Helsinki. 150 knees of 132 patients who underwent cemented MIUKA were included. While Journey Uni™ (Smith and Nephew) and Triathlon® PKR (Stryker Orthopedics, Mahwah, NJ) were preferred for FB-UKA, Uniglid® Mobile Bearing (Corin Ltd, Cirencester, UK) and Unicompartmental High Flex Knee System™ (ZUK; Zimmer, Winterthur, Switzerland) were preferred for the MB-UKA. All surgeries were performed by a single orthopedic surgeon at Bursa Bahar Hospital and Bursa Medical Park Hospital, between 2008 and 2018.

14 patients (19 knees) were excluded from the study because 3 patients died during the follow-up period, 3 had revision surgery after a traumatic injury to the knee and 8 patients left the follow-up. While 81 of the remaining 131 knees (118 patients) were reconstructed with a FB-UKA, 50 knees were reconstructed with an MB-UKA.

Inclusion criteria were; i) radiologically diagnosed anteromedial knee OA (Ahlback (16) grade 3 or higher), ii) 15-degree or less varus deformity, iii) patients ≤65 years of age, iv) active and passive knee flexion greater than 90 degree, v) fixed flexion contracture less than 10 degree.

Patients with patellofemoral joint symptoms, full thickness chondral damage on the patellar or trochlear surface, absence of an intact anterior cruciate ligament (ACL) or posterior cruciate ligament (PCL), lateral compartment pathologies (any chondral or meniscal pathology), avascular necrosis of tibia or femur and valgus alignment were excluded. Those with a follow-up period of less than 24 months were not included in the study.

Surgical Method

All cases were performed under spinal or epidural anesthesia and tourniquet hemostasis. A 6-8 cm anteromedial longitudinal incision covering 1/3 of the distal patella was performed. By preserving the vastus medialis, the patella was shifted laterally and the joint was reached. After ACL integrity was evaluated, the medial meniscus was completely excised. The tibial block incision was made by removing a 7 mm thick bone block using an extramedullary guide. A vertical incision was made in the sagittal plane. The tibial component size was determined by measuring the cut area of the removed bone block. Femoral cuts were made under the guidance of the tibial cuts while the knee flexed to 90°. Trial components and insert were placed to control the alignment and gaps in flexion and extension. Components were cemented in all cases. In the FB-UKA, the tibia and insert were first placed in one piece, then the femoral component; in the MB-UKA, the tibial component, insert and femoral component were placed respectively (Figure 1).

Rehabilitation

All patients underwent an intensive rehabilitation program that allows mobilization and full weight-bearing on the day of surgery, aiming to quickly achieve maximum flexion, full extension, and increase quadriceps muscle strength.

Pre-operative radiological evaluation was a routine with an orthoroentgenogram, weight-bearing lateral radiographs, and magnetic resonance imaging (MRI) to rule out any lateral compartment or cruciate ligament pathology.

Preoperative clinical scores were not available due to the retrospective nature of the study. Clinical and functional evaluation was performed at the last follow-up visit, with the Knee Society Score (KSS) (17), and Western Ontario and McMaster Universities Arthritis Index (WOMAC) score (18),

Figure 1. 6-8 cm anteromedial longitudinal incision was sufficient for MIUKA surgery, starting from 1/3 of the distal patella and preserving the vastus medialis muscle

which consists of three parts questioning pain, stiffness, and physical function. Complications (such as polyethylene wear, insert dislocation, progression in OA, aseptic loosening, and postoperative pain) and revisions during the follow-up were all noted. The factors affecting the radiological and functional results, complication, and revision rates of patients underwent MB- and FB-UKA were examined under three main titles: *i) Surgeon-related factors:* Given that the surgeon's experience will increase over the 10-year study period, the distribution of MB- and FB-UKA preferences in MIUKA patients were compared. *ii) Patient-related factors:* Age, gender, and body mass index (BMI). *iii) Component alignment-related factors:* Femoral component alignment (FCA), tibial component alignment (TCA), and mechanical axis angle (MAA) on post-operative orthoroentgenogram, anteroposterior (AP), and lateral radiographs (Figure 2) according to 5 (femoral component coronal and sagittal alignment, tibial component coronal and sagittal alignment, and mechanical axis) of the 17 Oxford alignment criteria (Table 1, 19).

Statistical Analysis

Statistical analyzes were performed using SPSS v.18.0 for Windows (SPSS Inc., Chicago, IL, USA) package program. Normal distribution was verified using the Kolmogorov-Smirnov test. Skewness and kurtosis values were controlled. Data were expressed as mean±standard deviation. According to the distribution of variables, independent t-test and Mann-Whitney U tests were used to compare quantitative data. Categorical data were compared with Chi-square and Fisher's exact tests. For all analyses, statistical significance was set at $p<0.05$.

RESULTS

There was no significant difference between the groups in terms of age, gender, BMI, and side variables (Table 2). The MB-UKA group had a longer mean follow-up time than the group with FB-UKA (97.66±29.24 vs 80.58±31.31, p=0.002). Considering the surgeon's experience factor, the distribution of the two groups in the first five years and the last five years were compared. While 32 MB- and 42 FB-UKAs were operated in the first five years, 18 MB- and 39 FB-UKAs were operated in the last five years, without a significant difference (p=0.210). Post-operative radiological evaluation of the FCA, TCA, and MAA did not show any significant difference between the groups (Table 3). Based on these findings, the patient, surgeon, and component alignment related factors were all found to be similar for both groups.

Regarding the postoperative KSS scores, 9 (6.87%) knees were within acceptable limits, 62 (47.32%) knees were found to be good and 60 (45.80%) knees were found to be excellent. However, when the groups were compared, no statistically significant difference was found (p=0.497). Regarding the postoperative WOMAC scores, MB-UKA

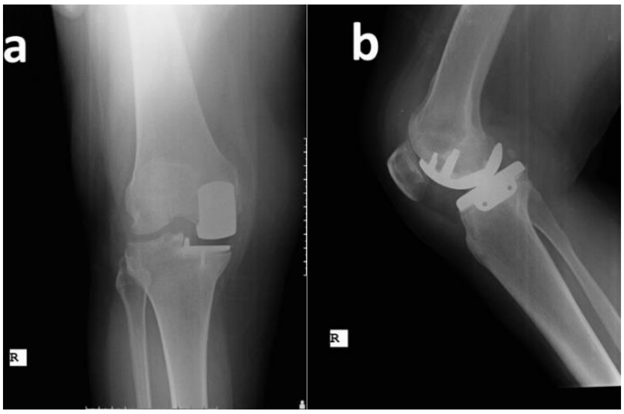

Figure 2. Postoperative **a)** anteroposterior and **b)** lateral radiography of a patient with MB-UKA

Table 1. Radiological evaluation of femoral and tibial components, and mechanical axis alignment according to the Oxford alignment criteria (20)

	Good	Medium	Bad
Femoral component	<10° varus/valgus **and** <5° flexion/extension angle	<10° varus/valgus **or** <5° flexion/extension angle	≥10° varus/valgus **and** ≥5° flexion/extension angle
Tibial component	<10° varus/valgus **and** 5-7° posterior slope	<10° varus/valgus **or** 5-7° posterior slope	≥10° varus/valgus **and** ≥7° posterior slope
Mechanical Axis	170-180°	5-10° deviation	≥10° deviation

Table 2. Demographic characteristics of the groups

	FB-UKA (n=81)	MB-UKA (n=50)	p
Age (years), mean±SD [min-max]	57.51±5.91 [44-65]	55.68±5.16 [46-65]	0.084
Gender, n (%)			
Male	10 (12.35)	9 (18.00)	0.372
Female	71 (87.65)	41 (82.00)	
Side, n (%)			
Right	52 (64.20)	30 (60.00)	0.631
Left	29 (35.80)	20 (40.00)	
Follow-up period (months), mean±SD [min-max]	80.58±31.31 [58-107]	97.66±29.24 [75-123]	**0.002**
BMI group, n (%)			
Normal	26 (32.10)	24 (48.00)	0.262
1st degree obese	33 (40.74)	13 (26.00)	
2nd degree obese	3 (3.70)	2 (4.00)	
Overweight	19 (23.46)	11 (22.00)	

FB-UKA: fixed-bearing unicondylar knee arthroplasty, MB-UKA: mobile-bearing unicondylar knee arthroplasty, SD: standard deviation, BMI: body mass index

Table 3. Clinical and radiological results, and revision rates of the groups

	FB-UKA (n=81)	MB-UKA (n=50)	p
KSS, mean±SD [min-max]	78.56±6.68 [75.1-82.4]	79.4±7.22 [75.0-86.7]	0.497
WOMAC Pain Score, mean±SD [min-max]	2.7±1.38 [2-3.5]	2.32±1.24 [2-3.3]	**0.049**
WOMAC Functional Score, mean±SD [min-max]	6.05±4.27 [1.9-12.1]	5.06±2.16 [2.4-8.3]	0.591
WOMAC Stiffness Score, mean±SD [min-max]	2.07±1.47 [1.0-4.3]	1.46±1.09 [0.2-2.9]	**0.014**
Mechanical Axis Alignment, n (%)			
Medium	8 (9.88)	4 (8.00)	0.718
Good	73 (90.12)	46 (92.00)	
Femoral Component Alignment, n (%)			
Bad	3 (3.70)	0 (0.00)	
Medium	44 (54.32)	20 (40.00)	0.074
Good	34 (41.98)	30 (60.00)	
Tibial Component Alignment, n (%)			
Medium	5 (6.17)	1 (2.00)	0.406
Good	76 (93.83)	49 (98.00)	
Revision to TKA, n (%)			
No	78 (96.30)	48 (96.00)	0.931
Yes	3 (3.70)	2 (4.00)	

FB-UKA: fixed-bearing unicondylar knee arthroplasty, MB-UKA: mobile-bearing unicondylar knee arthroplasty, KSS: knee society score, WOMAC: Western Ontario and McMaster Universities Arthritis Index, TKA: total knee arthroplasty, SD: standard deviation

patients had significantly lower pain (p=0.049) and stiffness (p=0.014), but similar functional (p=0.591) scores with the FB-UKA patients (Table 3).

A revision was necessary for only 5 of the 132 UKA patients and performed with a TKA procedure without the need for stem or augmentation. Two (4.0%) patients with MB-UKA and three (3.7%) with FB-UKA were revised. There was no statistically significant difference in revision rates between the groups (p=0.931). While the reason for the revisions in the MB-UKA group was insert dislocation (Figure 3) after a hyperflexion episode; of the 3 patients in the FB-UKA group, 2 had aseptic loosening of the femoral component and one had ongoing pain without radiological signs of loosening (Table 3).

DISCUSSION

While the long-term successful results of UKA are known in the literature, the importance of patient, surgeon, and implant related factors has been reported (20-24). In this study, we found similar good clinical, functional, and radiological results, and low revision rates in both designs. MB-UKA showed superior clinical results than FB-UKA in the assessment of joint stiffness and pain, supporting our hypothesis.

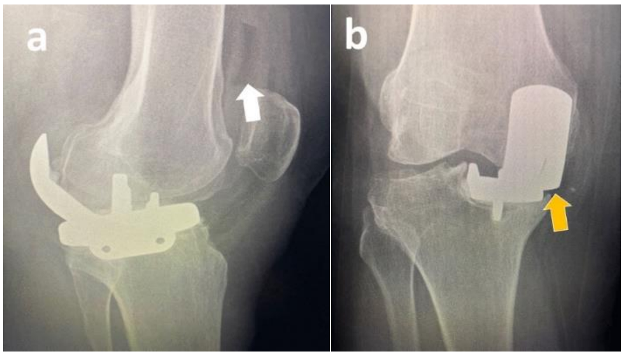

Figure 3. In a patient with MB-UKA, a complication of insert dislocation developed in the postoperative period. **a)** The insert has migrated into the suprapatellar area (white arrow) **b)** Since the insert is not in place, an incongruent tibiofemoral joint is present (orange arrow)

Post-UKA functional outcome, pain, and stiffness assessment have been a constant research topic. While UKA is compared in itself as MB and FB design prostheses, as well as with TKA. However, the evaluation of UKA by comparing it with TKA is controversial. Although UKA seems to be minor surgery and provides faster recovery than TKA, the revision was reported to be three times higher than TKA in the literature (20). Even if there is no mechanical or radiological problem in patients with intense pain after UKA, revision surgery (TKA) can be decided quickly (19). UKA tends to be performed on younger and more active patients than TKA, which is why functional comparison of UKA and TKA may be misleading (24). For these reasons, we compared UKA patients among themselves, as MB-UKA versus FB-UKA. It has been shown in various in-vivo and in-vitro studies in the literature that MB-UKA reconstructs the natural knee kinematics more closely and reduces contact stresses when compared to FB-UKA (10-13). The less joint stiffness and less pain we found in our results might be due to these known biomechanical benefits of MB-UKA design. Contrarily, in a recent meta-analysis made on the data of 1861 patients, it was shown that patients who operated with FB-UKA had better clinical and functional scores and greater ROM measurements (15). However, the shortcoming of this meta-analysis was that it did not take into account the component alignment and the mechanical axis alignment of the leg. After the UKA surgeries, problems in this regard can be encountered frequently, and this may adversely affect long-term functional results. The most common incorrect component placement we detected radiologically in the post-operative period of MIUKA surgery in our previous study were as follows; placement of the femoral component in flexion, presence of a gap in the posterior wall of the femoral component, and posterior protrusion of the tibial component (25). Kennedy et al. (26) reported that superior clinical results were obtained when the mechanical axis fell in the center of the knee or slightly medial to the center. Therefore, in our study, we compared the postoperative mechanical axis distribution of the groups, as well as the femoral and tibial component alignments, and we found that the groups had an equal distribution in terms of these parameters. We think that these data we determined are a very strong aspect of our study.

Studies evaluating the need for revision after UKA, reported the aseptic loosening and OA progression as the most common causes (9,27). van der List et al. (28), in their systematic review comparing MB- and FB-UKA in this respect, found aseptic loosening in the MB-UKA group and OA progression in the FB-UKA group as the most common cause of revision. However, a more recent meta-analysis study reported high aseptic loosening in FB-UKAs, similar to our results (15). Similarly in a meta-analysis study by Barret et al. (29), which included 96 294 knees, they found that aseptic loosening of the tibial component occurred at a lower rate in UKA patients who underwent cementless robotic-assisted surgery with an MB insert.

Insert dislocation, an urgent complication, was the only cause of revision surgery in the MB-UKAs. This is a unique complication to MB-UKAs. Undersized bearing, medial collateral ligament over-release, component malalignment, and flexion-extension imbalance were blamed as the most likely causes. The rate of development of these complications in MB-UKAs has been reported between 0.64% and 6.5% in the literature (15), consistent with our rates (4.0%). Because of the insert dislocation risk in MB-UKA, Kuyucu et al. (30) reported that FB-UKA should be preferred primarily in obese patients. In our study, the mean BMI of patients who underwent revision was found to be high without a significant difference.

The revision rate for surgeons who apply 12 to 30 UKA per year is 1.5% per year, while the same rate is 1% per year for surgeons who perform more than 30 UKA per year. According to these results, the expected result has been shown, and an inversely proportional relationship between experience and revision rate is present (31). Here, we performed TKA for revision surgery in 4 of our patients in the first five years. The need for only one revision in the last five years of the 10-year follow-up period emphasizes the importance of the surgeon's experience. Because of these findings, the size of the groups operating in the first five years (32 MB-, and 42 FB-UKAs) and the last five years (18 MB-, and 39 FB-UKAs) were compared in order not to cause a bias in the surgeon's experience factor, but no significant difference was found.

We think that our strengths are the similar group distribution, long follow-up period, and high sample size. However, our study also has some weaknesses. One of the main limitations of our study is that it has a retrospective study design. Since there are similar retrospective studies in the literature, prospective randomized controlled studies are needed on this subject. Another limitation is the wide time distribution in the follow-up periods. Besides, groups are significantly different regarding the follow-up period. Since long-term results are very important in prosthetic surgeries, that difference may have been effective in our clinical/functional results and the number of revisions. Lastly, although all surgeries were performed by a single surgeon, the preferred prostheses within the groups had the same type of insert but were not from a single company.

CONCLUSION

In conclusion, MB- and FB-UKAs have both similar good clinical, functional, and radiological results, and low revision rates. A significant difference was found in favor of MB-UKA in terms of pain and joint stiffness. Although similar revision rates were found, insert dislocation for MB-UKA and loosening of the femoral component for FB-UKA were the main revision causes. Obesity seemed to be an important parameter for revision surgery risk.

Ethics Committee Approval: The study was approved by the Clinical Researches Ethics Committee of Medical Park Bursa Hospital (22.05.2020, 223).

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Author Contributions: Idea/Concept: MS, TG; Design: MS, TG; Data Collection/Processing: MS, SE; Analysis/Interpretation: SE; Literature Review: SE; Drafting/Writing: SE; Critical Review: TG.

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