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EFFECTS OF MOBILE- AND FIXED-BEARING TIBIAL INSERTS ON CLINICAL RESULTS OF KNEE ARTHROPLASTY: A RETROSPECTIVE STUDY

TOTAL DİZ ARTROPLASTİSİNDE, HAREKETLİ VE SABİT TASARIMLI TİBİAL İNSERT KULLANIMININ KLİNİK SONUÇLARA ETKİSİ: RETROSPEKTİF ÇALIŞMA

Mehmet Fevzi ÇAKMAK[1], Levent HOROZ[1]

[1]Kırşehir Ahi Evran University, Faculty of Medicine, Department of Orthopedics and Traumatology, Kırşehir, Türkiye

ORCID IDs of the authors: M.F.Ç. 0000-0001-9338-8232; L.H. 0000-0002-7052-207X

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ABSTRACT

Objective: Total knee replacement (TKR) procedures are widely used in cases of advanced knee osteoarthritis, and satisfactory results are achieved. Although the fixed-bearing (FB) design has been reported as the gold standard by many authors, the mobile-bearing (MB) design has been argued to have more harmonious articulation and to cause less contact stress on the joint surface. This study aims to compare mobile-bearing and fixed-bearing total knee replacement designs and presenting the clinical outcomes.

Material and Methods: The study includes 212 patients who've undergone MB and FB implants with identical design, had at least three years of follow-ups, and had their range of motion, pain scores, implant survival, and functional scores recorded.

Result: When comparing the MB and FB designs, the MB group has 106 cases with an average age of 63.1±8.0, and the FB group has 116 cases with an average age of 63.9±7.0 years; no significant difference was observed between the groups. Also, no significant difference was observed regarding Knee Society scores (KSS), range of motion (ROM), or visual analogue scales (VAS) between the first year and last follow-up. The mean follow-up times of the two groups are 62.4 months (range=38-92) for the MB group and 66.8 months (range=40-88) for the FB group. Each group also had similar complication rates.

Conclusion: The clinical and functional results for both the MB- and FB-design total knee prostheses are excellent. Despite the many theoretical advantages of MB total knee replacement, this study shows little significant difference in the early functional outcomes between MB and FB prostheses. The study concludes neither MB- or FB-design TKR to have clinically superiority.

Keywords: Total knee replacement, mobile bearing, fixed bearing, prosthesis loosening, prosthesis survival

ÖZET

Amaç: Total diz replasmanı prosedürü ileri evre diz osteoartriti vakalarında yaygın olarak kullanılmakta ve tatmin edici sonuçlara ulaşılmaktadır. Sabit tasarımlı dizaynlar birçok yazar tarafından altın standart olarak bildirilmişken, hareketli tasarımlı dizaynların daha uyumlu eklemleşmesi ve buna bağlı eklem yüzeyinde düşük temas stresinin olduğu düşünülmektedir. Bu çalışmanın amacı, mobil ve sabit insert total diz protezi tasarımlarını karşılaştırmak ve klinik sonuçları bildirmektir.

Gereç ve Yöntem: Çalışmaya hareketli ve sabit tasarımlı özdeş implantlar uygulanan ve en az üç yıl takip edilen 212 hasta dahil edildi. Hastaların eklem hareket açıklığı, ağrı skorları, implant sağ kalımı ve fonksiyonel skorları kaydedildi.

Bulgular: Hareketli ve sabit tasarımlı dizaynlar karşılaştırıldığında sırasıyla gruplardaki olgu sayısı 106 ve 116 iken, ortalama yaş 63,1±8,0 ve 63,9±7,0 idi ve anlamlı fark izlenmedi. Birinci yıl ve son takipte Diz Cemiyeti skoru (KSS), eklem hareket açıklığı and vizuel analog skala (VAS) açısından anlamlı fark izlenmedi. İki grubun ortalama takip süreleri sırasıyla 62,4 (38-92) ve 66,8 (40-88) ay idi. Komplikasyon oranları her grup için benzerdi.

Sonuç: Hareketli ve sabit tasarımlı total diz protezlerinin klinik ve fonksiyonel sonuçları mükemmeldir. Hareketli insert tasarımlı total diz protezinin birçok teorik avantajına rağmen, bu çalışma iki grup arasında erken fonksiyonel sonuçlarda çok az anlamlı fark gösterdi. Çalışma sonucunda, hareketli ve sabit tasarımlı total diz protezlerinin klinik olarak birbirinden üstün olmadığı görüşüne varılmıştır.

Anahtar Kelimeler: Total diz protezi, hareketli insert, sabit insert, protez aşınması, protez sağkalımı

Corresponding author/İletişim kurulacak yazar: Mehmet Fevzi ÇAKMAK – mehmet.cakmak@ahievran.edu.tr

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INTRODUCTION

Total knee replacement (TKR) applications are widely used in cases of advanced knee osteoarthritis, and satisfactory results are achieved (1). The literature reports a 20+ year survival rate of up to 90-95% (2). While the TKR procedure has been supported by many studies in which satisfactory results were obtained in patients, which type of design is more successful remains unclear.

The clinical success of fixed-bearing (FB) design total knee arthroplasty has been reported as the gold standard by many accepted authors in the literature. Publications are found to have reported excellent results for FB prostheses of various condylar designs, different tibial surfaces, and with or without patellar surface changes, as well as cases in which the posterior cruciate ligament was cut or preserved in situ (3). Meanwhile, fewer publications are found to provide similar results for mobile-bearing (MB) design TKRs (4-6). However, MB designs have some theoretical advantages over FB designs. MB tibial inserts are considered to have a more harmonious articulation and therefore cause less contact stress at the articular surface. This mobility also results in a reduction of stress at the bone-implant interface. Therefore, polyethylene has been argued to be able to wear down slower and primary prosthesis survival to last longer. Polyethylene has also been argued to be able to tolerate mild femoral and tibial rotation errors without adverse effects on patellar alignment. Based on this, knee pain has also theoretically been predicted to be less (4).

Despite these theoretical advantages MB prostheses have, no documented improvement appears to exist regarding functional outcomes compared to FB designs (5-9).

The aim of this study is to reveal the clinical and radiological short-term results of knee replacement surgery in two mostly identical ways, the only difference being whether the tibial insert is mobile or fixed and which is better in terms of prosthesis survival.

MATERIALS and METHODS

Study population

The study population comprises an archive of total knee arthroplasties performed in the orthopedics and traumatology clinic of the third-level hospital where the study has been conducted.

Study design and participants

This study is a retrospective study that includes a total of 278 patients who underwent total knee arthroplasty in an orthopedics and traumatology clinic between January 2015-January 2020. The participants were selected according to standard protocols, and those who did not meet the criteria were excluded from the study. The study includes 212 patients who underwent MB or FB implants of identical design and had at least three years of follow-ups. One week before surgery, a physical exam occurred after the pre-operative anesthesia exam. The participants' demographic information, implant selection, and measurement planning were recorded before the operation.

Inclusion criteria

- 40-80 years old
- Having undergone MB- or FB-design total knee prosthesis due to last stage gonarthrosis.

Exclusion criteria

- Less than three years of follow-ups
- Unmanaged neurological/psychiatric disorder(s)
- Chronic renal insufficiency
- Presence of drug addiction or substance abuse for any reason

One day before surgery, informed consent was obtained from the participants after being briefed on the surgical, rehabilitation, and treatment protocols. Standard inpatient evaluations were followed on the first, second, and third days of the postoperative period. The surgical results of the patients were reevaluated, and the patient study also recorded control data.

The files of the patients who underwent TKR surgery in the clinic between 2015-2020 were reviewed and evaluated according to the inclusion and exclusion criteria. The data of the patients who continued their follow-ups regularly for one year after surgery and who had at least three years of follow-ups were analyzed.

This retrospective study has identified two groups:

Group 1: MB tibial insert design implant group following standard TKR surgical procedures.

Group 2: FB tibial insert design implant group following standard TKR surgical procedures.

Surgical technique

Participants were prepared for surgery under spinal anesthesia in the supine position with the application of lateral support. A midline incision was made following standard sterilization procedures, and the skin and subcutaneous tissue were dissected. Arthrotomy was initiated 5 mm lateral to the vastus medialis muscle of the joint capsule and 3 cm above the patella and completed by leaving a 5 mm tissue layer between the patella and capsule. The tourniquet, prepared before the operation, was not used at the start of the surgery but was inflated after the completion of the incisions, and the washing procedure was then begun. Cruciate ligaments were excised. For both prostheses, intramedullary alignment was used for the femur and extramedullary alignment for the tibia. Tibial and femo-

ral cuts are made according to a previously determined design. Appropriate soft tissue releases were applied to adjust the alignment in both groups. These are inflated once the cuts are completed, and the washing process begins. Following the implantation and completion of the cement reaction, the tourniquet is deflated, and bleeding control is achieved. No drain is used. Following implantation, the capsule and soft tissues are closed up. All patients receive 24 h of antibiotics. Low-dose warfarin is used for thromboprophylaxis.

After the operation, the first outpatient clinical follow-up occurs in the third month, the second in the sixth month, and the third one year later after the standard inpatient evaluation on the first day, with standard follow-ups then occurring annually.

The patients are provided range of motion (ROM) therapy on the joint on the 1st, 2nd, and 3rd days post-operation using the standard rehabilitation program.

Superficial and deep soft tissue complications and treatments performed during the 1st, 2nd, and 3rd days of the patients' post-operation hospitalization are recorded in the same system.

Primary outcomes involve the Knee Society score (KSS) and prosthesis survival. Secondary outcomes involve visual analogue scales (VAS), ROM, and complications.

The patients' functional KSS, ROM, and VAS values are recorded during the annual checkups during the postoperative period (10).

Patients who are called in for their final checkup have anteroposterior x-rays taken. A bone defect classification is assessed based on this and according to the Aori classification, and the stability between the components and the bone interface are evaluated. The prosthesis survival times of patients who lose stability and undergo revision are recorded (11).

This study was approved by the Kirsehir Ahi Evran Faculty of Medicine Clinical Research Ethics Committee (Date: 05.09.2023, No: 15/98).

Power analysis

Power analysis was performed to determine the sample size, with an effect size of d=0.75, Power (1-β)=0.90, and allocation ratio=1 being assumed. As a result, the minimum sample size has been calculated as 39 people in each group.

Statistical analysis

The analyses were conducted using the software program SPSS ver. 26 (IBM SPSS Corp., Armonk, NY, USA). The variables' normality of the data was examined using the Kolmogorov-Smirnov test. The Mann–Whitney U test was used to compare two independent groups, while the Friedman test was used for repeated measurements of more than two groups. In the case of significant differences, Bonferroni-corrected p-values were considered for multiple comparisons. Relationships between categorical variables were examined using chi-square tests. A significance level of $p<0.05$ is considered statistically significant for all analyses.

RESULTS

According to the research groups, no significant difference was observed among the patients in terms of age, gender, or the side operated upon ($p>0.05$) However, the body mass index (BMI) values were determined to be dissimilar between the groups. A statistical difference was found between the groups, with BMI being significantly higher in the FB group ($p<0.05$). The mean follow-up times of the two groups are 64.4 (38-92) and 66.8 (40-88) months, respectively. The mean follow-up times are similar for the two groups (Table 1).

Table 1: Demographic data

	MB	FB	p
Male **Female**	42 64	48 68	0.403
Side - Right **Side - Left**	56 50	56 60	0.339
Age	63.1±8.0	63.9±7.0	0.266
BMI	31.2±2.1	37.2±1.9	<0.001
Mean (range) number of Follow-up months	64.4 (38-92)	66.8 (40-88)	0.078

MB: Mobile bearing, FB: Fixed bearing, BMI: Body mass index

According to the research groups, no significant difference was observed in terms of the VAS and KSS values measured during the 1st year and final follow-up post-surgery. However, significant differences were identified between the ROM values measured during the 1st year and final follow-up post-surgery ($p<0.05$). Prosthesis survival was similar in the MB and FB groups, both at 103/106 (97.1%; Table 2).

When examining the osteolysis areas in the femur and tibia according to the Aori classification in the final checkups, the two groups were found to be similar (Table 3).

The complication rates are similar for each group (Table 4). Revision surgery was performed in two patients in the FB group as a result of persistent pain. Revision surgery was needed in 1 patient in the MB group due to per-

Table 2: Clinical results at first year and last follow-up

	MB group	FB group	p
VAS score, mean ± SD (1st year checkup)	1.7±1.4	1.8±1.5	0.922
VAS score, mean ± SD (last follow up)	1.5±1.3	1.7±1.5	0.783
KSS score (1st year)	91.8±2.1	91.4±1.8	0.846
KSS score (last follow up)	93.4±1.8	92.8±1.5	0.821
ROM (1st year)	114.9±1.8°	105.6±1.6°	0.004
ROM (last follow-up)	116.8±2.2°	108.8±1.4°	0.006
Prosthesis survival	103/106 (97.1%)	113/116 (97.4%)	0.893

MB: Mobile bearing, FB: Fixed bearing, VAS: Visual Analogue Scale, SD: Standard deviation, KSS: Knee Society score, ROM: Range of motion

Table 3: Radiographic results

Radiolucent lines	MB	FB
Overall, n (%)	10 (9%)	9 (8%)
Tibia (n)		
0–4 mm	6	7
5–9 mm	3	2
≥ 10 mm	1	-
Aori classification		
Type 1	4	5
Type 2a	3	3
Type 2b	2	1
Type 3	1	-

MB: Mobile bearing, FB: Fixed bearing, n: number

Table 4: Complications

	MB group	FB group
Overall, n (%)	3 (2.8%)	3 (2.5%)
Aseptic loosening	1	-
Deep infection	1	1
Persistent pain	1	2

MB: Mobile bearing, FB: Fixed bearing, n: number

sistent pain. While revision was performed in one patient because of aseptic loosening, one patient had significant loosening findings in radiology (Aori type 3). A periprosthetic joint infection (PJI) occurred in one patient from each group, as well as one case where someone had undergone two-stage revision surgery due to this.

DISCUSSION

FB-designed TKR has been used for many years, and publications are found in the literature to have reported excellent long-term results with follow-up periods of 10 to 17 years (12-15). However, aseptic loosening developments still occur at an undesired level (16-18). To make up for this, MB-designed knee arthroplasty was promoted in the late 1970s with several potential advantages over conventional FB (19, 20).

Despite the many theoretical advantages of MB total knee replacement, this study has shown little significant difference in early functional outcomes between MB and FB prostheses. These results are supported by several other studies showing no significant difference in outcomes between FB and MB implants (4-8).

Another theoretical advantage of the MB prosthesis is the improved functional performance of the knee. This study found no difference between the two groups in terms of residual pain, functional outcome, or range of motion, which is consistent with similar studies in the literature (21-25).

Similar to Harrington et al.'s study, the current study noted ROM values to be slightly better in the MB group at the 1st year checkup. Contrary to Harrington et al., however, although the difference in the final checkup had decreased, it did not become statistically insignificant (26).

Ranawat et al.'s short-term follow-up study found that, after the bilateral TKR procedure, no significant difference occurred in terms of clinical or functional results. These results are largely consistent with those of the current study (7). However, another multicenter study found better results in MB designs regarding functional knee scores during the 1st-year checkup (24).

Another advantage of the MB design is that the tibia can be aligned under the femur by itself, thus minimizing malposition in the tibial component. This has been hypothesized to be able to improve patellofemoral tracking and reduce patellofemoral pain; however, the current study was unable to prove this.

Another hypothesis is that MB TKRs minimize component loosening and polyethylene wear. The present study found no significant difference regarding polyethylene wear or related osteolysis and component loosening, and the literature generally reports results in line with this (5, 22). In fact, Huang et al. reported significantly more osteolysis to have occurred in their MB design patient group They argued that, as a possible cause of this osteolysis, which is more prominent on the femoral side, smaller polyethylene particles may occur due to abrasion between both the compatible articular surface and

the tibial baseplate surface, and that they may undergo phagocytosis (27).

When evaluated in terms of postoperative late period pain, studies have examined many scores such as the KSS pain score, Oxford knee pain score, Western Ontario and McMaster Universities Arthritis Index (WOMAC) pain scale, and VAS and generally found no significant differences between the MB and FB designs (5, 8, 23, 24, 30-34).

The potential disadvantages of the MB design include higher implant costs and insert dislocations (28, 29). This dislocation has been reported in the literature, but no significant differences could be detected (24, 35, 36). The current study did find insert dislocation to have occurred in one patient in the MB group, but the problem was solved with one large insert change without the need for component revision.

The major limitation of this study is its retrospective nature. The second major limitation is the use of similar types of prostheses from different brands. In addition, although the groups in this study had an average follow-up of five years, even longer follow-up periods may be required to understand whether one design is more successful against loosening.

CONCLUSION

In conclusion, the current study's participants had a mean follow-up period of five years, no significant difference found regarding function, pain, ROM, or signs of radiological loosening between the MB- and FB-design total knee arthroplasty. The study feels that having the surgeon synthesize the patient's characteristics and experience when choosing the appropriate implant would be appropriate.

Ethics Committee Approval: The study has ethical approval from the Kırşehir Ahi Evran Faculty of Medicine Clinical Research Ethics Committee (Date: 05.09.2023, No: 2023-15/98).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer Review: Externally peer-reviewed.

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