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Effect of Using Mobile Bearing on the Incidence of Anterior Knee Pain in Primary Total Knee Arthroplasty Without Patellar Resurfacing

A Randomized Controlled Clinical Trial

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Background: Anterior knee pain (AKP) remains a major complication following total knee arthroplasty (TKA). Mobile bearing (MB) is an alternative to fixed bearing (FB), supposing it has theoretical advantages in increasing the range of motion, reducing wear, and reducing anterior knee pain incidence when the patella is not resurfaced.

Materials & Methods: This research is a double-blinded, randomized controlled clinical trial, conducted between July 2021 and March 2024. It included 76 patients who underwent unilateral primary total knee arthroplasty without patellar resurfacing. Patients were randomized into 2 groups; the first used a MB, and the second used a FB. Patients were followed for 18 months. The 2 groups were compared based on the incidence and severity of anterior knee pain, knee range of motion, Knee Society Score, and patient satisfaction assessment according to the Forgotten Joint Scale (FJS-12).

Results: AKP occurred in 5 patients in the MB group and 6 in the FB group. We did not find a statistically significant difference between the 2 groups ($P = 0.744$). However, the severity of anterior knee pain according to the Visual Analog Scale (VAS) in the MB group was statistically significantly lower compared with the FB group ($p < 0.05$). We did not observe any statistically significant differences between the 2 groups in clinical and functional outcomes, or the complications rate.

Conclusion: Using a MB does not reduce the incidence of anterior knee pain after primary total knee arthroplasty without patellar resurfacing. However, it could contribute to reducing the severity of this pain if it occurs for other reasons. Therefore, we recommend conducting further studies to determine the causes of anterior knee pain.

Level of Evidence: Therapeutic Level I. See Instructions for Authors for a complete description of levels of evidence.

Introduction

Severe knee arthritis causes significant functional disability. Therefore, treatment is recommended, and many options are available[1,2]. None of the treatment modalities has been as effective as total knee arthroplasty (TKA) in advanced knee arthritis[3].

The knee joint has a complex motion pattern in all planes, and many implants have been developed to replicate that motion[4], including a mobile-bearing polyethylene component provides a range of rotational freedom. The primary goals of knee joint replacement can be achieved by a fixed-bearing or mobile-bearing (MB) component. They both have high survival rates and long-term durability[5,6]. Another theoretical advantage of the MB component is that it corrects mild rotational mismatch between femoral and tibial components which could decrease contact stresses at the patellofemoral joint[7]. This might decrease anterior knee pain (AKP).

Patellofemoral disorders are known causes of AKP[6,8]. However, the component rotational movement carries a higher risk of disassociation from the tibial tray, while mobile-bearing implants require greater ligamentous and soft tissue support, fixed-bearing implants are more forgiving[9,10]. Only 75% to 92% of TKA patients are satisfied with their outcomes[11]. The most common cause of low satisfaction is persistent pain, of which AKP has an incidence between 5% and 10% after TKA[12,13]. It is present to some degree in satisfied patients. Some studies

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reported that one-third of all patients have AKP 1 year after the surgery[14]. Therefore, the aim of this study was to determine if using a mobile-bearing design reduces the incidence of anterior knee pain and compare its outcomes with fixed-bearing implants in patients undergoing primary TKA without patellar resurfacing.

Materials and Methods

This study is a randomized, double-blinded, controlled trial. It was approved by our institutional review board. Written informed consent was obtained from all participants. In total, 76 participants were enrolled between July 2021 and March 2024 and followed up for 18 months. All the methods were conducted according to the CONSORT 2010 statement[15]. The study included patients undergoing unilateral primary TKA for primary osteoarthritis knees; exclusion criteria are presented in Table I. Participants were randomized into 1 of 2 groups. The randomization process was computer-generated using Statistical Package for the Social Sciences (SPSS) software and performed by a research fellow not involved in patient care.

The participants were allocated to the MB and fixed-bearing (FB) groups in a 1:1 ratio. Hence, 38 patients were included in the MB group and 38 in the FB group.

Surgical Technique and Postoperative Management

One experienced surgeon performed the operations. The operations were performed using the same intraoperative protocol. All patients were given 1 g of ceftriaxone 20 to 30 minutes before the incision, then 1 g twice daily for 48 hours after surgery. The procedures were done under spinal or epidural anesthesia. A medial parapatellar approach was used in all cases using a tourniquet. The prostheses used in all patients were cemented DePuy Synthes PFC Sigma models with a cruciate sacrificing design, featuring identical patellar sulcus and no patellar resurfacing. Intramedullary alignment was used for the femoral and tibial cuts. In both groups, tibial preparation was performed first. Care was taken during bone resections to balance flexion and extension gaps. Three_ of external rotation relative to the posterior condyles were used intraoperatively to choose the appropriate femoral rotation for each patient. Optimal patellar tracking was ensured by appropriate soft tissue balancing. In patients with tightness of the lateral retinaculum, causing subluxation of the patella, the "no thumb" test was performed. When there was still doubt, the tourniquet was deflated, and the patella tracking was reassessed; only then was a release of the lateral retinaculum performed. Drains were routinely used in all patients; they were removed 48 hours postsurgery. During hospitalization, subcutaneous low-molecular-weight heparin (Enoxaparin 2000 IU) was administered 12 hours postoperatively and then once daily at 4000 IU. Apixaban 2.5 mg was given orally twice daily and continued for 3 weeks after discharge[16]. The postoperative rehabilitation program was identical in both group's protocols. After the first 24 hours, all the patients were encouraged to walk as tolerated using a walker and to start active and passive range of motion (ROM) exercises.

TABLE I Exclusion Criteria

We included all patients who were going unilateral primary total knee arthroplasty except for:

- Patients who were inability or unwillingness to cooperate in the follow-up program
- BMI more than 35
- Patients having a fixed varus or valgus or flexion deformity of more than 15
- Patients who have Charcot joints
- Patients having a major neurological or musculoskeletal disorder that would adversely affect normal gait or weight-bearing
- Patients with malignant neoplasms and autoimmune diseases
- Patients classified as the ASA as grade 4 or 5
- Previous patellectomy
- Patients with severe osteoarthritis in the opposite knee
- Patients with intraoperative complications such as intraoperative fractures or vascular injuries
- Post-traumatic and secondary knee arthritis patients
- Revisions and complex primary cases
- Patients with an active infection or a history of lower limp infection

ASA = American Society of Anesthesiologists, and BMI = body mass index.

Outcome Measures

A blinded independent examiner assessed clinical outcomes. All clinical outcome parameters were assessed preoperatively and postoperatively at 6 weeks, 3, 6, 12, and 18 months.

The primary outcome measure was anterior knee pain (AKP) occurrence at the final follow-up. (A questionnaire assessment of AKP). We asked the following questions "Do you have anterior knee pain when standing up from a chair, climbing stairs, or squatting?". If the answer was yes, the presence of AKP was registered and the severity of pain was evaluated according to a Visual Analog Scale (VAS)[17].

Secondary outcome measures were Knee Society Scores (KSS)[18], range of motion (ROM), and Forgotten Joint Score (FJS)[19]. The Knee Society scores were used for clinical and functional evaluations. The knee range of motion was assessed using a goniometer. The FJS scoring system is based on a 12-item questionnaire concerning patients' ability to forget their artificial joints in everyday life (i.e. lack of awareness of the knee) because this could be considered to be the ultimate goal after arthroplasty[20].

All adverse events, including infections and VTE, etc. that occurred during the 18 months following surgery were documented.

Sample Size

A pre hoc power analysis was done for the primary outcome measure of AKP. Using a medium effect size of 0.5, a power of 0.8, and an alpha error of 0.05, we determined that 64 participants were needed for the study. To account for a 20%

expected dropout rate, 12 participants were needed, so 76 were enrolled in the study and randomly allocated into 2 groups.

Statistical Analysis

The results between the 2 groups were compared using the independent t-test or nonparametric Mann-Whitney *U* test for continuous variables and the χ^2 test for categorical variables, and the results within a group (preoperatively and postoperatively) were compared using the paired t-test, with $p < 0.05$ considered significant. All data were analyzed using the SPSS, version 28 (IBM).

Results

Patients

Seventy-six patients completed the study, with 38 patients in each group. No patients were lost during the follow-up period, and all patients attended all follow-up visits.

The characteristics of the studied sample did not show any statistically significant differences in age, gender, and body mass index (BMI), as presented in Table II.

All patients included in the study had varus deformity, and the average femorotibial angle in the MB group was 2.89°, compared with 2.13° in the FB group, and there was no statistically significant difference between the 2 groups ($p = 0.324$), as presented in Table II.

Outcome Measures

Five of the 38 patients (13.1%) with MB inserts and 6 of the 38 patients (15.7%) with FB inserts experienced persistent anterior knee pain. There was no statistically significant difference between the 2 groups ($p = 0.744$). However, the difference between the 2 groups occurred when the severity of this pain was evaluated according to the VAS scale in movements that increase pressure on the patellofemoral joint, such as standing up from a chair, climbing stairs, and squatting. The severity of AKP resulting from the above activities that increase pressure on the patellofemoral joint was statistically significantly lower in the MB group ($p < 0.05$), as provided in Table III.

There was no statistically significant difference between the MB and FB groups in terms of median ROM ($p = 0.951$, 116.00° (105-125) vs. 116.05° (105-122), respectively) Table III.

Regarding clinical and functional results, the Knee Society Knee Score (KSKS) and Knee Society Function Score (KSFS) improved significantly between the preoperative and last follow-up evaluation in both groups: from 33.4 points to 87.8 points ($p = 0.001$) and from 33.2 points to 89.8 points ($p = 0.001$), respectively, in the MB group and from 32.8 points to 88.6 points ($p = 0.001$) and from 34.4 points to 87.2 points ($p = 0.001$), respectively, in the FB group. However, the comparison study between the 2 groups postoperatively did not show any statistically significant differences according to the KSKS ($p = 0.734$), as well as according to the KSFS ($p = 0.312$) Table III.

The patient satisfaction measures were similar ($p = 0.426$) between patients with MB and FB inserts according to FJS-12 (Table III).

As for the complications, we had 5 cases of superficial wound infection in the MB group and 2 cases in the FB group. A neurological injury occurred in a patient from the FB group. There was a significant motor and sensory injury to most of the dermatomes and myotomes of the lower extremity, proven by electromyogram. The patient's neurological examination was normal immediately after the surgery, and his symptoms occurred after withdrawing the epidural catheter on the second day after the surgery. After conducting the necessary neurological consultation, it was decided to observe the patient, as there was later an improvement in most of the patient's movements, and only a foot drop remained.

Discussion

This research studied the effect of using a mobile-bearing component on the incidence of anterior knee pain in patients undergoing primary total knee arthroplasty without patellar resurfacing. All patients included in this study had primary knee osteoarthritis with similar degree of varus deformity and were very similar in terms of their demographic characteristics. In addition, 1 surgeon performed all surgical procedures. The same surgical technique and the same prosthetic joint design were used for all cases and from the same

TABLE II Patient Demographics and Characteristics

	Total	MB Group	FB Group	p
Age (yr)	66.17 ± 7.07	65.68 ± 7.57	66.66 ± 6.60	0.552
Gender (no. of patients, %)				
Men	17 (22.4)	11 (28.9)	6 (15.8)	0.169
Women	59 (77.6)	27 (71.1)	32 (84.2)	
BMI (kg/m^2)	30.90 ± 2.38	30.59 ± 2.29	31.21 ± 2.45	0.256
Femorotibial angle (°)	5.32 ± 2.541	5.03 ± 2.890	5.61 ± 2.138	0.324

BMI = body mass index. *Note*: Values are given as the mean ± SD or as the count with the percentage in parentheses. P values are given the difference between treatment groups.

TABLE III Primary and Secondary Outcomes

	MB Group	FB Group	p
AKP (no. of patients, %)			
Yes	5 (13.2)	6 (15.8)	0.744
No	33 (86.8)	32 (84.2)	
AKP during standing up from a chair (VAS 0-10 mean)	2.80 ± 0.447	4.83 ± 0.408	**0.003**
AKP during stairs climbing (VAS 0-10 mean)	2.80 ± 0.447	4.67 ± 0.816	**0.005**
AKP during squatting (VAS 0-10 mean)	2.00 ± 0.001	4.00 ± 0.001	**0.002**
ROM (mean)	116.00 ± 4.230	116.05 ± 3.187	0.951
KSKS (mean)	87.89 ± 9.360	88.63 ± 9.445	0.734
KSFS (mean)	89.87 ± 10.748	87.24 ± 11.781	0.312
FJS-12 (mean)	81.87 ± 18.185	78.61 ± 17.381	0.426

AKP = anterior knee pain, FJS = Forgotten Joint Scale, KSKS = Knee Society Knee Score, KSFS = Knee Society Function Score, ROM = range of motion, and VAS = Visual Analog Scale. *Note*: Values are given as the mean ± SD or as the count with the percentage in parentheses. P values are given the difference between treatment groups. Bold denotes statistically significant values.

manufacturer. All patients underwent the same postoperative rehabilitation protocol. This contributed to increasing the validity and reliability of the study and reducing the effect of bias.

Five patients from the MB group had AKP (13.2%), compared with 6 patients from the FB group (15.8%), and there was no statistically significant difference between the 2 groups ($P = 0.744$). However, when the pain severity was evaluated according to the VAS scale in movements that increase pressure on the patellofemoral joint, such as standing up from a chair, climbing stairs, and squatting, we noticed that pain severity was statistically significantly lower in the MB group ($p < 0.05$). This finding indicates that other causes of AKP must be detailed and each of them studied independently. Moreover, the use of mobile polyethylene does not prevent the occurrence of this pain. It may reduce the severity of pain if it occurred for other reasons that have been mentioned in other studies, such as patient's gender, presence of AKP before surgery, stuffed patellofemoral joint due to femoral component anterior translation, or components rotational malpositioning[21]. The contribution of mobile polyethylene to reduce the severity of AKP can be explained by the fact that its rotation gives the ability to achieve good alignment of the patellofemoral track in mild cases of component malposition[22,23].

These findings are consistent with several comparative studies, despite differences in their method of assessing this pain, for example, in the study[24] by Breugem et al., it was found that the incidence of AKP was statistically significantly lower in MB patients. Other studies also found that using mobile polyethylene reduces the incidence of AKP when climbing up and down stairs, making their functional condition better[25,26]. Wyatt et al.[27] reported in a study published in 2013 that the rates of surgical reoperation for patellar resurfacing due to AKP in patients undergoing TKA without patellar resurfacing were higher in FB patients. It was observed in other studies that there was no difference between the 2 components in the incidence of AKP[28,29].

The functional and clinical conditions improved significantly for all patients postoperatively, but no significant difference was found between the groups. This finding is comparable with the previous literature. Baktir et al.[30] noted in their study that there was an advantage in the MB group over the FB group in terms of the clinical condition of the knee postoperatively according to the KSKS, but this was not associated with an advantage in functionality and patient satisfaction. As for Lizaur-Utrilla et al.[31], it was noted that there was an advantage in the MB group in terms of the functional state of the knee after surgery according to the KSFS. The researchers explained that the reason for this was that the ROM for the patients in the MB group after 3 to 6 months of surgery was better than the ROM for the patients in the FB group, and this enhanced their functional abilities later. Ruckenstuhl et al.[32] found an advantage in the MB group in increasing the ROM of the knee, but this advantage did not translate into an advantage in functional and clinical aspects.

We could not detect a difference in patient satisfaction comparing the MB with the FB knee according to FJS-12, which could be explained by the similar functional outcomes in the 2 groups, and that is consistent with relevant literature except for the study[31] by Lizaur-Utrilla et al. The main factor in this was the degree of flexion and ROM of the knee 3 to 6 months after surgery, as the values were better in the MB group, which led to improved functional ability in patients, as we mentioned previously, thus increasing their satisfaction with the surgical procedure.

Regarding postoperative complications, there were no statistically significant differences between the 2 groups. However, the follow-up period for the cases was not long enough to study important complications such as survival rates, wear rates, and revision rates. During our follow-up period, we had 7 cases of superficial wound infection (5 in the MB group and 2 in the

FB group), all of which were treated with antibiotic administration and local care of the wound. In addition, a nerve injury occurred in 1 patient in the FB group. Such nerve injury may occur after operations in which epidural anesthesia is performed and often occurs after withdrawal of the epidural catheter, due to a hematoma formation in cases where the patient suffers from pathological disorders in blood clotting or due to the use of anticoagulants[33]. Therefore, it is necessary to adhere to giving reduced doses of anticoagulants when there is an epidural catheter, to stop these anticoagulants for a period before withdrawing the catheter, and then to return them after a period that varies according to the patient's condition and the type of anticoagulants used[34,35].

We acknowledge several limitations in our study, including the broad exclusion criteria that made our results inapplicable to more complex cases of knee arthritis. In addition, an experienced senior with extensive experience in this field performed all surgeries, and therefore, less experienced surgeons may not obtain the same results. The study focused exclusively on a specific type of implant: the cemented DePuy Synthes PFC Sigma models with a cruciate-sacrificing design, all produced by the same manufacturer. As a result, the findings may not be applicable to other types of implants or those from different manufacturers. Owing to the relatively short follow-up period, we were not able to study the effect of using both types of polyethylene compounds on the wear rate and survival rate.

Conclusion

Using a mobile bearing does not reduce the incidence of anterior knee pain after primary total knee arthroplasty without patellar resurfacing. However, it contributes to reducing the severity of this pain if it occurs for other reasons. Therefore, we recommend conducting further studies to determine the causes of anterior knee pain.

Availability of Data and Materials

All data and material are available for review if requested by the reviewers/editors. ■

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