Comparison of Mobile-Bearing and Fixed-Bearing Total Knee Arthroplasty

A Prospective Randomized Study

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Abstract: The purpose of this prospective randomized study was to compare the postoperative recovery and early results of 2 groups of patients undergoing total knee arthroplasty: 107 patients received an established fixed-bearing posterior-stabilized prosthesis (Legacy Posterior Stabilized [LPS]), and 103 patients the meniscal-bearing prosthesis (Meniscal Bearing Knee [MBK]). Surgical procedures were the same for both groups except for posterior cruciate ligament management, which was sacrificed in the LPS group and spared but completely released from the tibia in the MBK group. At an average follow-up of 36 months, knee, function, and patellar scores were comparable in both groups. The LPS group showed a significantly higher maximum flexion than the MBK group (112° vs 108°). Using a fixed-bearing or a mobile-bearing design did not seem to influence the short-term recovery and early results after knee arthroplasty. **Key words:** total knee arthroplasty, mobile bearing, knee prosthesis, meniscal-bearing knee, posterior stabilized, prospective randomized.

Total knee arthroplasty (TKA) has become a successful and reproducible operation for elderly, disabled patients with knee osteoarthritis in the past 30 years [1,2]. Based on the initial success, the indications to TKA were expanded to younger and more active patients [3-5]. However, long-term wear and loosening became recognized causes of early and late implant failure [6,7]. The introduction of the mobile-bearing polyethylene surfaces reflects the efforts to minimize wear while dealing with complex function and kinematics [8-11].

Laboratory data from joint simulator and computerized simulation analysis using static and dynamic finite element models seem to suggest that mobile-bearing designs are advantageous in reducing linear polyethylene wear caused by delamination and pitting [12-17]. However, clinical studies have not yet proven better results or increased knee function for mobile-bearing design series when compared with fixed-bearing designs [18-23].

As modern mobile-bearing knee designs are introduced in the market, there is a need for controlled prospective randomized trials to determine if any clinical difference exists between the results of fixed-bearing and mobile-bearing designs [11,23,24]. Only a few trials have compared the clinical performance of modern fixed-bearing and mobile-bearing TKAs; the results of these studies are controversial [23-27].

The purpose of the present study was to compare the early clinical results and possible complications of a new designed mobile-bearing knee prosthesis with an established fixed-bearing posterior stabilized (PS) device.

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Materials and Methods

Implant Types

The fixed-bearing implant that was used in the present study was the Legacy Posterior Stabilized (LPS; Zimmer, Warsaw, Ind) (Fig. 1) which represents the evolution of the Insall-Burstein II prosthesis (Zimmer) [28]. The mobile-bearing prosthesis was the Meniscal-Bearing Knee (MBK, Zimmer) (Fig. 2). The MBK prosthesis has complete femorotibial conformity throughout motion owing to the fixed radius of the posterior femoral condyles with a magnitude that changes with the prosthetic size [29-31]. The radius ratio is 1 to 1 in the sagittal and frontal planes (Fig. 3). The femoral component (Fig. 2) has femoropatellar and femorotibial surfaces separated by 2 condylo-trochlear grooves. The tibial CoCr tray has an anterior stop to prevent anterior subluxation of the plastic insert and a central guiding mechanism in the form of a "mushroom" that fits into a slot of the polyethylene undersurface to prevent "flip-up" (Fig. 4). The polyethylene insert is allowed to rotate internally and externally for a total of about 25° and to glide anteroposteriorly 4.5 mm. The femoropatellar joint has the same design for the LPS and the MBK. The trochlea is deep, elongated distally, and anatomic with right and left femoral components that articulate with a 3-pegged all-polyethylene dome implant [30].

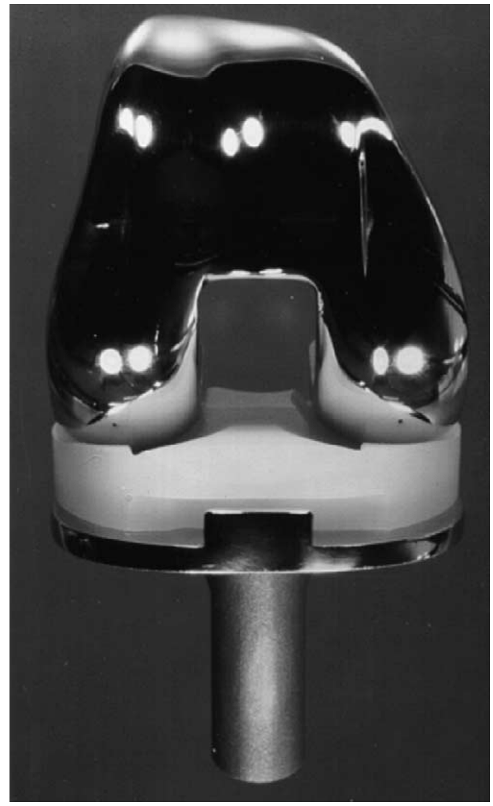

Fig. 2. Frontal view of the MBK. On the femoral component is possible to evaluate the 2 condylo-trochlear grooves.

Fig. 1. Legacy Posterior Stabilized prosthesis. The view from the back shows the cam and post positions and the locking mechanism type of the modular tibial baseplate.

Patient Randomization

In January 1999, we set up a prospective, randomized trial involving all osteoarthritic patients undergoing primary TKA. Approval was obtained from the institutional review board, and all patients provided informed consent. No patient refused to participate. Patient randomization was performed in the morning of surgery and was accomplished with use of a randomized numbers table. Patients with even numbers were assigned to the fixed design and patients with an odd number were assigned to receive the mobile-bearing design. A power calculation was performed with use of a confidence level of 95% and power ($1 - \beta$) of 0.8. With an estimated prevalence of good and excellent results of 90% and an anticipated difference of 5 points, 25 knees would be required in each group to show a significant difference. In an effort to minimize the chance of type 2 error, we decided to recruit more than 100 patients per group to have

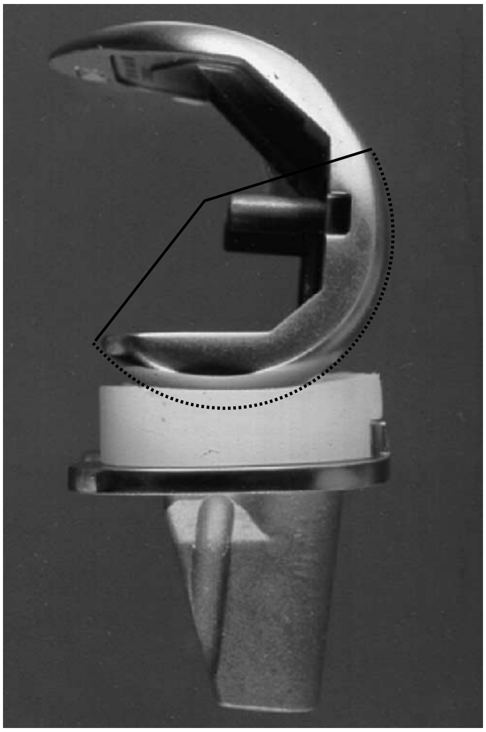

Fig. 3. Lateral view of the MBK. The distal and posterior femoral condyles are spherical and match the polyethylene-bearing surface with a 1:1 ratio.

high statistical power level in the case of smaller differences between the 2 groups than anticipated.

Between January 1999 and December 2000, the senior author performed 210 consecutive primary total knee arthroplasties in 197 patients. A fixed-bearing total knee prosthesis (LPS) was implanted in 107 knees (99 patients) and a mobile-bearing total knee prosthesis (MBK) was implanted in 103 knees (98 patients). Seventeen patients underwent a staged (average interval, 10 months; range, 8-14 months) bilateral knee arthroplasty with an LPS on one side and the MBK on the other. Patients in the 2 groups did not significantly differ in demographic parameters and preoperative deformities (Table 1). Average age was 69.5 years for patients in the LPS group and 71 years for patients in the MBK group. Body mass index was 27.5 for both groups. Five patients in the LPS group and 6 in the MBK group have had a previous high tibial osteotomy on the involved knee.

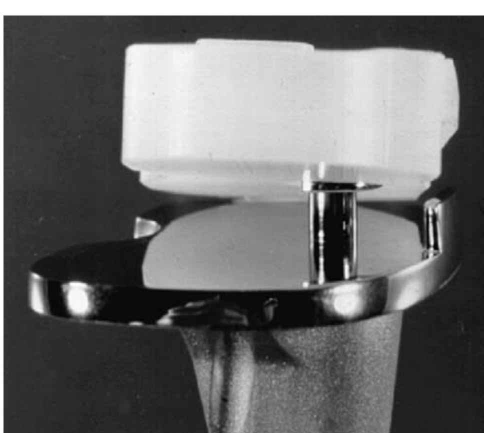

Fig. 4. The "mushroom" of the MBK tibial tray engages a slot in the bearing undersurface with a snap-on mechanism to avoid spin-out.

Operative and Postoperative Protocol

All the procedures were performed through a standard medial para-patellar approach by the senior author (PA). Distal femoral resections were performed in the LPS knees removing 9 to 10 mm of bone from the most prominent condyle, whereas for the MBK a −2 mm distal cutting guide was used to maximize the preservation of the joint line and the femoral insertion of the posterior cruciate ligament. Femoral anteroposterior resection was performed in all cases adjusting the rotation according to the transepicondylar axis. Tibial resection was performed using an extramedullary guide with 7° of posterior slope in the sagittal plane. The posterior cruciate ligament was excised and substituted in all patients of the LPS group whereas in the MBK knees it was retained and completely superiosteally released from the tibia to avoid kinematic conflict in flexion caused by the high conformity of the implant [30]. All the patellae in both groups were resurfaced with 3-pegged all-polyethylene dome implants. All implants were cemented.

Postoperatively, knees were placed in a continuous passive motion machine and began full weight-bearing walking with crutches or a walker on the first postoperative day.

Table 1. Preoperative Parameters

Parameters	MBK Group	LPS Group
Average age (y)	71.0	69.5
Male (%)	14.0	19.0
Female (%)	86.0	81.0
BMI	27.5	27.5
Varus deformity	87	90
Valgus deformity	16	17
Previous high tibial osteotomy	5	6
Knee Society category		
A	30	25
B	60	65
C	13	17

Preoperative demographic data for the MBK and LPS groups. BMI indicates body mass index.

Hospital discharge was allowed when the patients were able to actively bend the knee at least to 90° and to walk independently with crutches. The mean duration of hospitalization was 8 days (range, 6-11 days) in both groups.

Postoperative Assessments

Clinical and radiographic follow-up (FU) was performed at 1, 3, and 6 months, and 1 year after the operation, and yearly thereafter. The mean duration of FU was 36 months (range, 30-48 months). Clinical data recorded for each FU evaluation were "double blinded": neither the examiner nor the patient knew the type of implant during the evaluation. Preoperative and FU ratings according to the Knee Society scoring system were obtained for all patients [32]. In addition, a visual analogue scale was used to specifically assess the severity of pain. Patients were instructed to indicate the intensity of the pain by marking a 10-cm line anchored with terms describing pain intensity and ranging from 0 (no pain) to 10 (intolerable pain) [32]. Patients were also specifically asked for clicking sensation in the knee and for side preference in the 17 cases of bilateral involvement. Patellofemoral joint function was specifically investigated using a patellar scoring system described by Kim et al [33] that considers the anterior knee pain, quadriceps strength, ability to raise chair, and stair climbing with a final score that ranges from a minimum of 1 to a maximum of 30 points.

The radiographs were evaluated according to the Knee Society roentgenographic evaluation system. Preoperative and postoperative long-standing roentgenograms of the knee were used to determine overall limb alignment. Fluoroscopic positioning in anteroposterior and lateral views was used to study the components' interfaces for radiolucent lines. Skyline views of the patellofemoral joint were obtained at 45° of flexion, using the technique of Merchant et al [34].

Statistical evaluation was performed using Student *t* test and Fisher exact test test. Statistical significance was considered for *P* values less than .05.

Results

Clinical Results

Results for each parameter of the Knee Society scoring system for both groups obtained from the clinical evaluation at 6 months and 1, 2, 3, and 4 years (61% of the patients in the LPS group and 63% in the MBK group were available at the fourth-year FU) are shown in Table 2. Three patients (3 knees) of the LPS group were deceased, for causes unrelated to the operation on the knee, after reaching their third-year FU evaluation. There were no intraoperative complications in either group, and 1 (in the LPS group) of 210 knees required 2-stage revision surgery for late septic loosening (24 months) caused by coagulase-negative *Staphylococcus aureus*.

Preoperatively, the knee score averaged 39 ± 11.5 (range, 20-58) in the LPS group and 41 ± 10 (range, 20-67) in the MBK group (*P* = .48). Postoperative results improved similarly in both groups. At an average FU of 36 months, the knee score improved to a mean of 93 ± 5.5 (range, 64-100) in the LPS group and 93 ± 5.7 (range, 70-100) in the MBK group (*P* = .44). At an average FU of 36 months there were 87% of excellent results, 9% of good, 2% of fair, and 2% of poor results for the LPS group and 83% of excellent results, 14% of good, 3% of fair, and no poor result for the MBK group. The 2 poor results in the LPS group were due to one case of late septic tibial loosening and one case post high tibial osteotomy with residual mild pain and poor maximum flexion.

Preoperatively, the mean flexion contracture was 4° (range, −3° to 15°) in the LPS group and 3° (range, −3° to 12°) in the MBK group (*P* = .96). At 36 months FU, mean knee extension improved to 0° (range, −5° to 3°) in the LPS group and 0° (range, −8° to 10°) in the MBK group (*P* = .30). Maximum knee flexion averaged 99° (range, 88°-125°) in the LPS group and 102° (range, 80°-130°) in the MBK group preoperatively (*P* = .10). The average flexion at 36 months FU was 112° (range, 93°-130°) in the LPS group and 108° (range, 75°-130°) in the MBK group (*P* = .025). Patients in both groups had a great improvement in pain relief after TKA. At last FU, 84% of the patients in the LPS group and 84% of the patients in the MBK group had no pain. Mild occasional pain was present in 14% of the patients in the LPS group and in 13% of the patients in the MBK group. One patient in the MBK group had moderate knee pain. One patient in the LPS group who developed septic loosening complained of severe pain.

There was no difference between the LPS and MBK TKAs with respect to the Knee Society functional score preoperatively or at 36 months FU (*P* = .40 and *P* = .71). Preoperatively, the functional score averaged 49 (range, 10-64) in the LPS group and 43 (range, 20-58) in the MBK group. At 36 months FU, the mean functional score was 79 in the LPS group (range, 45-100) and 80 (range, 25-100) in the MBK group. There were

Table 2. Clinical Results in the MBK and the LPS Groups

	Preoperative		6 mo		1 y		2 y		3 y		4 y	
Parameters	MBK	LPS	MBK	LPS	MBK	LPS	MBK	LPS	MBK	LPS	MBK	LPS
Total knee score	43	39	90	90	92	91	92	91	91	91	93	93
Pain												
None (%)	4.0	1.5	81.5	92.0	86.0	85.5	87.5	87.0	88.0	88.0	84	84
Mild (%)	10.0	20.0	19.0	6.5	12.5	11.5	12.5	13.0	12.0	12.0	13	14
Moderate (%)	36.5	36.0	0	2.0	1.0	2.5	0	0	0	0	3	2
Severe (%)	49.5	43.0	0	0	0	0	0	0	0	0	0	0
VAS score	8.0	8.0	2.5	2.5	1.1	1.0	0.8	0.8	1.0	0.8	0.8	0.8
Average ROM	3-99	4-102	0-108	1-112	0-110	1-114	0-110	1-114	0-110	1-114	0-108	0-112
AP stability (<5 mm) (%)	96.0	88.0	100	97.0	100	97.0	100	97.0	100	97.0	95.5	98.0
ML stability (<5°) (%)	62.0	78.0	97.0	93.0	98.0	93.0	98.0	93.0	98.0	93.0	83.0	87.5
Total function score	43	49	81	80	84	82	85	83	84	82	80	79
Walking distance												
Cannot walk (%)	1.5	0	0	0	0	0	0	0	0	0	0	0
<1 Block (%)	15.0	63.5	4.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
1-5 Blocks (%)	69.5	29.0	13.0	11.0	8.0	9.0	8.0	9.0	8.0	9.0	9.0	10.0
5-10 Blocks (%)	13.0	5.0	57.0	52.0	43.0	49.0	43.0	49.0	43.0	49.0	44.0	49.5
Unlimited (%)	1.5	2.0	26.0	35.0	47.0	40.0	47.0	40.0	47.0	40.0	45.0	38.5
Walking support												
No Support (%)	56.0	59.0	89.0	93.0	89.5	93.5	93.0	94.0	94.5	95.5	94.0	95.0
1 Cane (%)	40.0	32.0	8.0	5.0	9.5	5.5	7.0	6.0	5.5	4.5	6.0	5.0
1 Crutch (%)	4.5	9.0	3.0	1.5	1.0	1.0	0	0	0	0	0	0
2 Crutches (%)	0	0	0	0	0	0	0	0	0	0	0	0
Stairs												
Normal (%)	81.0	88.0	98.0	94.0	98.0	96.0	98.0	96.0	98.0	96.0	96.0	94.0
Normal with support (%)	7.0	6.0	2.0	4.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.5
1 Step no support (%)	7.0	4.0	0	2.0	0	2.0	0	2.0	0	2.0	1.0	2.5
With support (%)	5.0	2.0	0	0	0	0	0	0	0	0	0	0
Patellar score total	13	14	25	26	28.0	27.5	28	27.5	28	27.5	27.5	27.0

Preoperative postoperative data at the various FU for knee, function, and patellar scores in MBK and LPS groups. VAS indicates visual analogue scale; AP, anteroposterior; ROM, range of motion; ML, medial-lateral.

70% of excellent results, 19% of good, 10% of fair, and 1% of poor results for the LPS group and 76% of excellent results, 12% of good, 12% of fair, and no poor result for the MBK.

Forty-one knees in the LPS group and 46 (45%) knees in the MBK group were able to walk unlimited distances. One knee in the LPS group and 2 knees in the MBK group could walk more than 10 blocks. The walking distance was 5 to 10 blocks in 53 knees in the LPS group and 45 knees in the MBK group. Walking distance was less than 5 blocks in 11 knees in the LPS group and 9 knees in the MBK group. One patient in each group was housebound because of significant medical problems unrelated to their knee arthroplasty. Stair climbing and descent was normal in 100 (94%) knees in the LPS group and 99 (96%) knees in the MBK group. In 4 knees in the LPS group and 3 knees in the MBK group, a bannister was used to manage stairs. Ambulation required no support in 102 (95%) knees in the LPS group and 96 (94%) knees in the MBK group. Five knees in the LPS group and 7 knees in the MBK group required a cane for long walks or regular walking.

Preoperatively, the patellar score averaged 14 (range, 0-20) in the LPS group and 13 (range, 0-19) in the MBK group (P = .40). At final 36 months average FU, the mean patellar score was 27.1 in the LPS group (range, 17-30) and 27.4 (range, 16-30) in the MBK group (P = .71). Ten (9%) of 107 patients with the LPS knee arthroplasty and 9 (9%) of 103 patients with the MBK knee arthroplasty had mild anterior knee pain. The remaining patients in both groups had no anterior knee pain. Thirty-two (30%) knees in the LPS group and 21 (20%) knees in the MBK had asymptomatic mild patellofemoral crepitation throughout range of motion. None of the knees had loosening of the patellar component, clunk syndrome, or patellofemoral instability.

Seventeen patients with bilateral TKA with the MBK on one side and the LPS on the other were asked for subjective preference of one knee over the other. There was no statistical difference in subjective preference between the 2 implants: 5 patients preferred the LPS knee, 4 the MBK, and for 8 patients there were no preference. All patients (but the septic failure) were satisfied with their result.

Subjective feeling of clicking in the replaced knee was present at 36 months FU in 4% of the LPS group and 8% of the MBK group (P = .065) with none associated with significant functional impairment or patient discomfort.

Radiographic Results

There were no significant radiographic differences between the LPS and MBK groups that would affect the outcome of the TKA (Table 3). Alignment on the mechanical axis preoperatively averaged 6.5° varus (range, 20° varus to 15° valgus) in the LPS group and 6.5° varus (range, 24° varus to 25° valgus) in the MBK group (P = .9). Valgus deformity was present preoperatively in 8 knees in the LPS group and 11 knees in the MBK group. All the remaining knees had a preoperative varus deformity. The mean mechanical axis at an average FU of 36 months was 0° ± 1.5° (range, 3° varus to 3° valgus) for the LPS group and 0° ± 2° (range, 4° varus to 4° valgus) for the MBK group (P = .10). The femoral valgus angle averaged 95.5° (range, 94°-100°) in the LPS group and 95.5° (range, 94°-100°) in the MBK group (P = .9). The mean tibial angle on the anteroposterior view was 91° (range, 89°-94°) in the LPS TKAs and 90° (range, 88°-92°) in the MBK TKAs (P = .6). On the lateral radiograph, femoral component flexion angle averaged 4° (range, 0°-7°) in the LPS group and 4.5° (range, 3°-6°) in the MBK group (P = .7). In the LPS group, the tibial slope angle averaged 83.5° (range, 80°-87°), whereas the average was 84.5° (range, 80°-88°) in the MBK group (P = .73).

Table 3. Radiographic Results

Parameters	MBK Groups	LPS Groups
Overall alignment (mechanical axis)		
Preoperative		
Varus >5° (%)	75.0%	77.0%
Varus 3°-5°	8.0%	15.0%
0° ± 2°	4.0%	1.0%
Valgus 3°-5°	7.0%	2.0%
Valgus >5°	6.0%	5.0%
Postoperative		
Varus >5	0%	0%
Varus 3°-5°	6.0%	3.0%
0° ± 2°	83.0%	90.0%
Valgus 3°-5°	11.0%	7.0%
Valgus >5°	0%	0%
Femoral component alignment		
Anteroposterior (α angle)	95.5°	95.5°
Sagittal (γ angle)	4.5°	4.0°
Tibial component alignment		
Anteroposterior (β angle)	90.0°	91.0°
Sagittal (σ angle)	82.5°	82.5°
Radiolucent line (overall)	27.0%	29.0%
Radiolucent line (tibial side)		
1 Zone	23.5%	21.5%
2 Zones	4.1%	5.5%
>2 Zones	0%	0%
Radiolucent line (femoral side)		
1 Zone	3.1%	2.1%
2 Zones	1.0%	1.0%
>2 Zones	0%	0%
Patella tilt >5	17.0%	14.0%°
Patella subluxation >5°	14.0%	11.0%
Patellar height (Caton index)		
Preoperative	1.0	1.0
Last FU	1.0	1.0

At skyline views, 15 (14%) knees with the LPS knee arthroplasty and 18 (17%) knees with the MBK knee arthroplasty had a lateral patellar tilt more than 5° and 12 (11%) knees with the LPS knee arthroplasty and 15 (14%) knees with the MBK knee arthroplasty had a lateral patellar subluxation more than 5 mm (range, 5-10 mm). Patellar height (Caton index) [35] was 1 ± 0.5 preoperatively on average and 1.0 ± 0.5 postoperatively in the MBK group and 1 ± 0.5 preoperatively and 1 ± 0.5 postoperatively in the LPS group. No implants showed any evidence of migration.

There was no difference in the Knee Society roentgenographic scoring system for radiolucent lines between the 2 groups (P = .46). Nonprogressive radiolucencies were seen in 25 knees in the LPS group and 27 knees in the MBK group. In the LPS group, a nonprogressive radiolucency was seen at the bone-implant interface in 3 patellae, 25 tibial components, and 3 femoral components. In the MBK knees, a nonprogressive radiolucency was seen at the cement-implant interface of 2 patellae, 27 tibiae, and 4 femoral components.

Osteolysis was detected only around the tibial component stem in the patient with a failed LPS for deep infection. No detectable wear was found on the weight-bearing films in all the patients examined.

Discussion

The results of fixed-bearing TKA have been successful with long-term survival rates of approximately 95% at 10 to 15 years of FU [1,2]. These results were obtained in an elderly population with low activity levels. Problems of wear and loosening become an important concern especially when the indication to TKA was expanded to a younger, more active population [5,6]. Mobile-bearing knee arthroplasty was introduced in the late 1970s encouraged by several potential advantages compared with conventional fixed-bearing TKA [8,9]. This knee arthroplasty design aimed to reduce surface and subsurface bearing stresses and at bone-implant surfaces by maximizing the conformity between the tibial and femoral surfaces and allowing mobility of the bearing [8,9]. Long-term results of mobile-bearing TKA is now available for few designs with similar survivorship rates to that of the best fixed-bearing series [10,11,22].

Our study was undertaken to assess the safety and efficacy of a new mobile-bearing device (MBK). For this purpose we compared it to an established fixed-bearing posterior-substituting TKA (LPS) that in our opinion represents the modern TKA gold standard. The MBK is a mobile-bearing TKA which has a polyethylene insert that is free to rotate and glide anteroposteriorly, thus allowing full conformity between the polyethylene insert and the spherical femoral condyles throughout range of motion. In the present study the MBK demonstrated its safety because no complications were found in all cases at 36 months average FU. There were no cases of bearing dislocations or soft tissue impingements as previously reported for other anteroposterior-gliding mobile-bearing designs [19,36]. Clinical, functional, and radiological results were equivalent to the established LPS prosthesis demonstrating the efficacy of the MBK prosthesis in improving the performances of the replaced knee. Results at short-term FU were excellent for both groups with a relatively high percentage of patients not having pain at the final FU (84%). Absence of significant pain at 12 months after TKA is reported in the literature to be in around 87% of the patients [37].

Various studies recently tried to compare clinical results of mobile-bearing and fixed-bearing TKAs [23-27,38,39]. Kim et al [23] compared the AMK fixed-bearing TKA to the LCS meniscal-bearing TKA implanted in the same patients in 116 bilateral simultaneous procedures. At an average FU of 7.4 years the authors were not able to find any significant differences in Knee Society scores, survivorship, and subjective preference. Kohn et al [25] reported short-term results of the Interax TKA comparing 116 knees of the fixed-bearing version and 48 of the mobile version at an average FU of 1.5 years without showing any significant difference between the 2 groups. Price et al in a prospective multicentric trial compared the results at 1 year FU of the posterior cruciate-retaining AGC fixed-bearing prosthesis (Biomet Merck, Bridgend, UK) to the mobile-bearing TMK prosthesis (Biomet Merck) performed in the same patients in 39 simultaneous bilateral procedure. They found significantly better results in the mobile-bearing group for Knee Society pain scores and subjective preference although there was one revision in the TMK group because of bearing dislocation [24]. Lavernia et al studied the clinical results within the first postoperative year in a consecutive series of 82 AMK and 64 LCS. They did not find statistical differences in any score with respect to bearing mobility [26]. Two recent studies evaluated the performance of the patellofemoral joint in TKA comparing fixed-bearing or mobile-bearing knees [38,39]. Ranawat [27] reported similar clinical results evaluating the patellofemoral joint in 100 fixed-bearing PFC compared with 100 mobile PFC at 1 year FU. Kobori et al [38] studied the in vivo patellar kinematics of various types of fixed and mobile TKAs and found that subjects having a mobile-bearing TKA experienced more similar patellar tilt angle, throughout flexion, to the normal knees.

In the last decade, various laboratory studies showed potential advantages of mobile-bearing prosthesis over the fixed counterparts [12-17]. Knee simulator and retrieval studies have shown reduced rate of linear wear for the mobile high-conforming implants compared with various standard fixed-bearing types [12,13]. Finite element analysis of mobile and fixed TKAs in both static and dynamic conditions have consistently shown less polyethylene contact stresses for the mobile versions for each tested pattern of motion [14-17,40-43]. Under simulated conditions of torque stresses or component malrotations, the mobile varieties have shown to be more forgiving in terms of contact stresses distribution and peaks than the fixed-bearing ones [16,40]. In fixed-bearing TKA there is always a compromise between conformity and freedom of motion: as articular contact stresses are reduced, a kinematics penalty is paid. Recently, a cadaver study by D'Lima et al [40] using an Oxford rig showed that increasing the implant conformity in the mobile-bearing designs was not detrimental to kinematics. In vivo kinematics studies did not show any particular advantage of the mobile-bearings for rollback and axial rotation patterns, weight-bearing maximum flexion, and condylar lift-off [11,44-46]. Fluoroscopic study of MBK kinematics during various activity was performed by Walker et al in 19 patients. The authors found that during deep knee bending there was an average tibial rotation of 6° with 3 mm of posterior lateral rollback [31]. Gait analysis comparing 10 MBKs to 10 IB-II showed better quadriceps function with reduction of the extension moment and less medial loading due to reduction of the adduction moment for the MBK group [47]. Mechanical failure due to bearing dislocation is a described disadvantage of using a mobile-bearing

TKA [10,18-20,48]. Volumetric wear rate is another controversial disadvantage of mobile-bearings because it is unknown whether, despite low linear wear rates, a greater or lesser volume of particles is produced in vivo because of the larger contact area [49-51].

Our study has shown that using a fixed-bearing or a mobile-bearing design, when all the other variables are controlled, did not seem to influence the outcome in short-term FU. The strength of the present study is that it was a prospective controlled randomized trial enrolling a homogenous population for both groups with no differences in any preoperative parameter with the FU examinations performed in a double-blinded fashion. A statistical power study was performed to obtain the required population for a valuable statistical analysis. Surgical procedures were standardized being performed all by the same senior author (PA) and using the same instruments. Postoperative recovery, rehabilitation protocol, and medical prophylaxes were the same for both groups. All the patients were evaluated for each FU without any patient lost to FU and with only 3 deceased patients at the latest evaluation.

On the other hand, there are several limits of this investigation such as the relative short FU and the advanced average age of the population in both groups that did not allow evaluation of subtle functional differences. Moreover, the scoring systems that we used in our study are perhaps not ideal to investigate performance of modern TKA and with their use could be difficult to show significant differences between well-performing implants. Hypothetically, longer-term FU of mobile-bearing knees results may reveal a significant advantage over fixed-bearing TKA results as the fatigue threshold of relatively incongruent polyethylene is exceeded [11,52,53]. Conversely, long-term FU may show decline in mobile-bearing knees performance over time.

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