Comparison of Fixed Bearing and Mobile Bearing Total Knee Arthroplasty Using Identical Femoral Component

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Background: *The theoretical advantages of Mobile bearing (MB) prosthesis does not appear to be documented in terms of functional outcomes compared to Fixed bearing (FB) designs. Rarely that two identically designed knee prostheses were compared in the literature.*
Objective: *Compare clinical and functional results of MB and FB prostheses using identical femoral components at intermediate term follow-up.*
Material and Method: *Total knee arthroplasties (TKA) performed between January 2004 and December 2006 at Nopparat Rajatanee hospital were retrospectively reviewed. The American Knee Society scoring system and functional score were used for outcome measurement.*
Results: *There were 102 and 103 patients in FB and MB group respectively. At the average follow-up of 75 months for FB and 73 months for MB group, the knee scores and functional scores of both groups had obviously improved from the preoperative period. However, no statistically significant differences were noted between the two groups. One patient in the MB group developed infected loosening 5.1 years after the operation and had two stages revision successfully done.*
Conclusion: *MB prosthesis has no clinical advantage over FB at intermediate term follow-up despite using identical femoral component.*

Keywords: *Mobile bearing total knee arthroplasty, Fixed bearing, Identical femoral component*

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Despite the established excellent results of fixed bearing (FB) total knee arthroplasty (TKA) have been reported[1,2] long-term results in young active individuals are still questionable. Mobile bearing (MB) prosthesis was introduced to answer these questions. Theoretically, increased conformity and decreased contact stress may result in reduction of polyethylene wear, thus minimize implant loosening. Rotation of polyethylene insert may compensate minor malrotation and thus improves knee kinematics.

Over the past decade, studies were published to answer the proposed superiority of MB over FB counterpart. A large number of studies compared two types of implant on many aspects including knee kinematics[3-5], contact stress analysis[6], nature of osteolysis[7], rate of lateral retinacular release[8] and functional outcome[9-13]. Moreover, several systematic reviews[14,15] and meta-analysis[16,17] had been done but none of them supported the advantages of MB over FB prosthesis.

Due to excellent long-term clinical results[18], Low Contact Stress (LCS, Depuy) was the most common MB prosthesis used for comparison. However, the differences between design and kinematics of LCS compare to other prostheses may affect the result of surgery. Kinematics of posterior cruciate sacrificing prosthesis (LCS) is differing from posterior cruciate retaining (CR) and posterior stabilized (PS) prosthesis. The posterior cruciate ligament (PCL) promotes femoral rollback in normal knee and in CR implant whereas in PS implant, these function performed by cam/post mechanism. Contrary to CR and PS implant, the kinematic study of LCS revealed anterior femorotibial translation during deep flexion[19]. Other differences are femoral component geometry, i.e. mono-radius or multi-radius posterior femoral condyle, depth of patellar groove as well as tibial tray design, i.e. symmetrical or anatomic. In order to minimize these variations, the "identically designed prosthesis" should be used for comparison. However, there were

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very few studies comparing these prostheses. The purpose of the present study was to compare clinical result between two identical MB and FB prostheses at the intermediate term follow-up.

Material and Method

The LegacyPS mobile bearing prosthesis (LPS-MB, Zimmer, Warsaw, Ind) was introduced to Thailand in late 2003. It is a PS design and shares the same femur as LegacyPS fixed bearing (LPS) routinely used in our department. Sizing and dimensions of both tibial trays are identical. Both implants also share the same surgical technique and instrumentation. The only difference is rotation of polyethylene insert in MB prosthesis (Fig. 1, 2). Hence, the indications for LPS-MB are the same as LPS.

Between January 2004 and December 2006, 233 primary TKAs in 184 patients had been performed at Nopparat Rajatanee Hospital by the senior author (SW). Inclusion criteria are primary TKAs using either LPS-MB or LPS prostheses. Exclusion criteria were previous history of infection and previous surgery on the index knee, revision TKA, post traumatic arthritis with or without previous open reduction and internal fixation, extra-articular deformity that require osteotomy during TKA. All patients were informed regarding the differences between LPS-MB and LPS. The "proposed" advantages of MB over FB were explained based on scientific evidences at that moment. The expense of MB is twenty percent more expensive than FB prosthesis. The final selection of prostheses was made by the patients' preferences. Institutional review board and ethic committee of our hospital approved this research proposal and allowed the study to be done.

Operative details

Under tourniquet control, all TKAs were performed by minimally invasive surgical technique using mini-midvastus approach without patella eversion. The MIS™ instrumentation was used to minimize soft tissue dissection. Posterior cruciate ligaments were resected in all cases. Distal femoral resection was performed using intramedullary guide then proximal tibia was resected using extramedullary guide. The 5-in-1 resection block was placed at 3° external rotation to posterior condylar axis for femoral finishing. The tibial finishing blocks are differing between LPS and LPS-MB. All implants were cemented using antibiotic loaded bone cement. Parapatellar soft tissue was debrided and/or released if necessary to obtain good patellofemoral tracking. Rarely that patella was resurfaced.

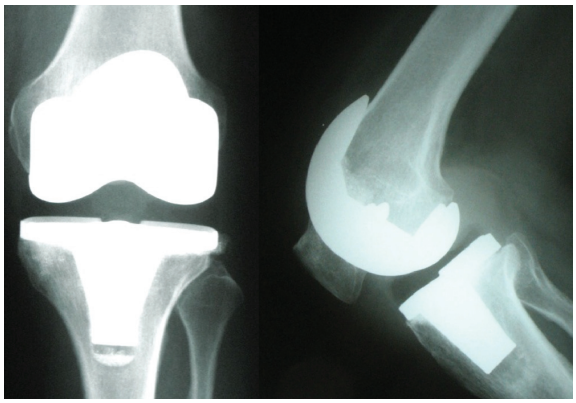

Fig. 1 Anteroposterior and lateral X-ray view of Legacy® FB.

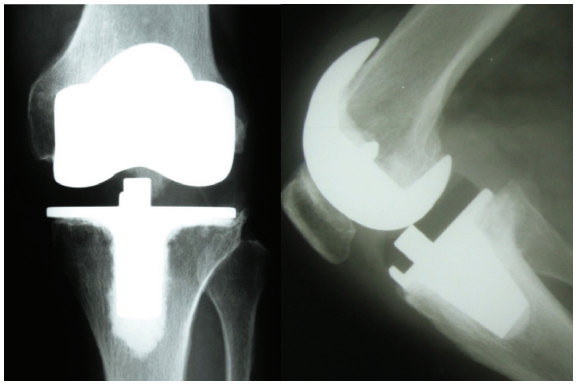

Fig. 2 Anteroposterior and lateral X-ray view of Legacy® MB.

Postoperatively, knee was kept in bulky dressing. Cold packs were applied for 24 hours. Vacuum drain was clamped most of the time with intermittent release. After 24 hours, the bulky dressing was removed and drain was allowed to release. All patients received prophylactic antibiotic (Ceftriazone) but no thrombolytic agent was administrated. Active assisted range of motion exercise was encouraged the day after surgery until 90° flexion was obtained. Full weight bearing ambulation with walker was started thereafter.

Patients were followed at 2 weeks, 1, 3, 6 months and then annually. The American Knee Society scoring system and functional score were used to evaluate patients outcome[20]. Radiological examinations were performed at early postoperative period, three months and one year after operation and then annually. Patients that were lost to follow-up

for more than 1 year were contacted by phone and appointment had been made for clinical and radiologic assessment at the outpatient department.

Statistical analysis was performed using t-test, Chi-square and Fisher's exact test. P-value of less than 0.05 was considered significant.

Results

Of the 233 TKAs performed during the study period. Fourteen knees were excluded from the present study. Seven knees previously had high tibial osteotomy. Two knees were arthroscopically debrided and five knees were traumatic arthritis. Therefore, 219 TKAs were eligible for comparison. At the latest follow-up, two patients (2 knees) deceased, unrelated to surgery. Twelve patients (5%) were loss to follow-up.

Study groups consisted of 102 FB and 103 MB prostheses. Demographic data were demonstrated in Table 1. No statistical difference was noted in terms of age, sex, BMI, side, diagnosis, patient categories, and preoperative Knee Society score and functional score. The average follow-up period was 75.5 for FB and 73.3 months for the MB group (p = 0.708). The mean operative times of the two groups was 146 and 149 minutes for FB and MB respectively (p = 0.589) (Table 2).

At latest follow-up, the average Knee Society score improved from 44 to 93 for FB and from 44 to 92 for the MB group. Average functional score improved from 40 to 74 for FB group and from 42 to 75 for the MB group. Postoperative alignment of TKAs in both groups were comparable (p = 0.888). Sixty percent had knee well aligned according to the Knee Society scoring system and forty percent were within 1° outlier. Flexion contracture and ML stability were not significantly different (p = 0.858 and 0.871). Of the FB group, 67 knees were pain free and 23 knees had mild pain whereas in the MB group 65 knees were pain free and 24 knees had mild pain (p = 0.866). About 50% of patients in both groups had range of motion between 100° and 120° while 46% had motion more than 120°. These results were not significantly different (p = 1.000) (Table 2).

There was no spin out in the MB group. One patient in the MB group developed infected loosening 5.1 years after the operation and had 2 stages revision successfully done thereafter. Culture revealed Klebsiella pneumonia sensitive to Amikacin. There was no reoperation in the FB group. The Kaplan-Meier survivorship analysis using revision for any reason as the end point for failure revealed 100% survival for FB group and 99% survival for the MB group at 6 years.

Table 1. Demographic characteristics of the patients

	FB group (n = 102)	MB group (n = 103)	p-value
Age (y)	67.19 (51-83)	65.11 (35-80)	0.057
Sex [n (%)]			0.593
Male	6 (5.9)	9 (8.7)	
Female	96 (94.1)	94 (91.3)	
BMI [mean ± SD (range)]	27.29±4.09 (19.63-37.10)	26.99±3.75 (18.37-38.66)	0.576
Side [n (%)]			0.889
Right	57 (55.9)	56 (54.4)	
Left	45 (44.1)	47 (45.6)	
Diagnosis (n)			1.000
OA	92	92	
RA	6	7	
ON	3	3	
Other	1	1	
Knee scores* [mean±SD (range)]	44.57±10.96 (21-68)	44.70±11.92 (5-69)	0.935
Function scores* [mean±SD (range)]	40.74±13.54 (0-60)	42.31±13.86 (0-70)	0.411
Patient categories (n)			0.841
A	63	61	
B	33	37	
C	6	5	

* The American Knee Society scoring system[20]

Table 2. Clinical results at last follow-up

	FB group (n = 102)	MB group (n = 103)	p-value
Follow-up period (m)	75.56 (55-90)	73.31 (56-87)	0.708
Total operative time (min)	146.73 (80-225)	149.36 (60-270)	0.589
Number patella replaced	5	7	
Total Knee score*			
Pain			0.866
None	67	65	
Mild	23	24	
ROM [n (%)]			1.000
<100°	4 (3.9)	5 (4.9)	
100°-120°	52 (51.0)	51 (49.5)	
>120°	46 (45.1)	47 (45.6)	
Stability ML <5° [n (%)]	78 (76.5)	77 (74.8)	0.871
No Flexion contracture [n (%)]	83 (81.4)	85 (82.5)	0.858
Alignment [n (%)]			0.888
5°-10°	58 (56.9)	60 (58.3)	
1° outlier	44 (43.1)	43 (41.7)	
Total functional score*			
Walking [n (%)]			0.997
Unlimited	28 (27.5)	30 (29.1)	
>10 blocks	57 (55.9)	57 (55.3)	
Unable	2	2	
Stairs [n (%)]			0.828
Normal	24 (23.5)	25 (24.3)	
Rail	71 (69.6)	73 (70.9)	
Unable	7	5	
Walking aids (n)			1.000
Cane	20	21	
Walker	4	4	

* The American Knee Society scoring system[20]

Discussion

Whether MB prosthesis is superior to FB counterpart is still questionable. To answer that question, comparisons between the two implants have been conducted continuously for more than a decade. Numbers of earlier studies compared LCS implant to other new designed FB implants despite the different design concepts and kinematics[9,10,12,13]. After newly designed MB prostheses were introduced to the market, usage of LCS for comparison had declined. Later studies compared new MB to the well-established FB. Aglietti P et al[11] compared MBK (Meniscal-Bearing Knee, Zimmer) to LPS. They found no clinical and radiological difference between the two designs at an average 3 years follow-up. Being CR design, the MBK has different kinematics compared to cam/post mechanism of LPS. Moreover, the femoral geometry of MBK is monoradius while LPS is multiradius. Kim JS et al[21] compared PFC SigmaRP to Medial Pivot Knee (Wright medical) and found worse clinical outcome and higher complication rate of Medial Pivot Knee at 2.6 years. The different kinematics and design concept were not mentioned as variables in both studies.

Comparisons between two identical prostheses had rarely been reported in the literatures. Kim YH et al[22] performed simultaneous bilateral TKAs in the same patient, PFC sigma in one leg and SigmaRP in the other (Depuy). Both devices were CR design. They found no significant difference at a mean 5.6 years follow-up. Lädermann A et al[23] compared 52 PFC sigma to 50 SigmaRP prostheses both of which were PS design. At average follow-up of 7.1 years, no significant difference was demonstrated between the two groups. In addition, Harrington MA et al[24] compared 72 PFCsigma to 68 SigmaRP prostheses.

Unfortunately, the devices were mixing between CR and PS. Criteria for choosing the device was unclear depending on surgeon's discretions. However, they found no the significant difference at two years follow-up.

The present study is among the very few studies that compared two identical prostheses from the same manufacturer and have follow-up time greater than 5 years. The authors do not report radiologic results because both groups were performed with same surgical technique and same instrumentations. Thus, variations between two groups were minimized. At the intermediate term report, previous studies failed to demonstrate any difference of radiologic result between FB and MB groups[10-12,20,21,23-25].

In terms of clinical outcome, the authors' results support previous studies that MB does not appear to be have an advantage over FB prostheses even using identically designed implants. Long-term follow-up may be necessary to answer whether MB is more durable than FB.

Potential conflicts of interest

None.

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การศึกษาเปรียบเทียบผลการผ่าตัดข้อเข่าเทียมชนิดผิวข้อหมุนได้และหมุนไม่ได้โดยใช้ผิวข้อฟีเมอร์เดียวกัน

ศักรินทร์ วงศ์เลิศศิริ, เจริญวัฒน์ อุทัยจรัสรัศมี

ภูมิหลัง: *จากการศึกษาที่ผ่านมา ข้อได้เปรียบทางทฤษฎีของข้อเข่าเทียมแบบผิวข้อหมุนได้เทียบกับแบบหมุนไม่ได้ยังคงไม่สามารถพิสูจน์ได้อย่างชัดเจน นอกจากนั้นการศึกษาเปรียบเทียบโดยใช้ข้อเข่าเทียมที่ออกแบบเหมือนกันทุกประการก็มีปรากฏน้อยมาก*

วัตถุประสงค์: *เพื่อศึกษาเปรียบเทียบผลการผ่าตัดข้อเข่าเทียมชนิดที่ผิวข้อหมุนได้กับชนิดหมุนไม่ได้โดยข้อเข่าเทียมทั้งสองชนิดถูกออกแบบเหมือนกันทุกประการยกเว้นการหมุน ติดตามผลการรักษาในระยะปานกลาง*

วัสดุและวิธีการ: *ศึกษาย้อนหลังการผ่าตัดข้อเข่าเทียมระหว่าง 1 มกราคม พ.ศ. 2547 ถึง 31 ธันวาคม พ.ศ. 2549 ในโรงพยาบาลนพรัตนราชธานี ซึ่งใช้ข้อเข่าเทียมที่กำหนดไว้เท่านั้น การประเมินผลใช้เกณฑ์การให้คะแนนตาม The American Knee Society scoring system*

ผลการศึกษา: *กลุ่มผู้ป่วยที่ใช้ข้อเข่าเทียมชนิดผิวข้อหมุนไม่ได้มีจำนวน 102 ราย ส่วนกลุ่มผู้ป่วยที่ใช้ข้อเข่าเทียมหมุนได้มีจำนวน 103 ราย เมื่อติดตามผลการรักษาเฉลี่ยที่ 73 เดือน คะแนนข้อเข่าทั้งสองกลุ่มดีขึ้นชัดเจนเทียบกับก่อนผ่าตัด แต่ดัชนีชี้วัดทุกตัวไม่แตกต่างกันอย่างมีนัยสำคัญเมื่อเปรียบเทียบกันระหว่างสองกลุ่ม ข้อเทียมชนิดหมุนได้ติดเชื้อและหลวม 1 ราย ต้องทำการผ่าตัดแก้ไขใหม่ผลการผ่าตัดประสบความสำเร็จดี*

สรุป: *เข่าเทียมชนิดผิวข้อหมุนได้ ให้ผลการรักษาไม่แตกต่างกับชนิดหมุนไม่ได้ เมื่อติดตามการรักษานานปานกลาง แม้จะใช้ข้อเทียมที่ถูกออกแบบเหมือนกันทุกประการแล้วก็ตาม*
