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Long-term results of total knee arthroplasty in young and active patients with posterior stabilized design

Morteza Meftah [b,*], Peter B. White [a], Amar S. Ranawat [a], Chitranjan S. Ranawat [a]

[a] Orthopaedic Surgery, Hospital for Special Surgery, 535 E. 70th Street, 6th floor, New York, NY 10021, United States
[b] Orthopaedic Surgery, NYU Langone Medical Center, Hospital for Joint Disease, United States

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ABSTRACT

Background: The aim of this study was to evaluate long-term quality and performance of cemented posterior-stabilized (PS) total knee arthroplasty (TKA) in young and active patients with gap balancing technique.
Methods: Between January 2000 and October 2001, 55 TKAs (21 rotating platform [RP] and 34 fixed bearing [FB]) in 41 patients, 60 years and younger, with University of California Los Angeles (UCLA) activity score of five and above were included in this study and prospectively followed. Clinical assessments included Western Ontario and McMaster Universities (WOMAC), Knee Society, UCLA activity score, and Patient Administered Questionnaire (PAQ). Radiographic measurements included component positioning, patellar tilt and thickness, radiolucency, loosening or osteolysis.
Results: At a mean follow-up of 12.3 ± 0.5 years (11 to 13), there was no instability, malalignment, or patellofemoral maltracking. Sixty eight percent of patients were still participating in regular recreational activities at the final follow-up. The mean satisfaction score was 9.1 ± 1.9 and 8.5 ± 2.1 in RP-PS and FB-PS groups, respectively. There was no malalignment or osteolysis, no revision for osteolysis or loosening. One patient in the FB-PS group underwent open reduction and internal fixation for a peri-prosthetic fracture. Overall Kaplan–Meier survivorship was 98%.
Conclusion: The PS TKA in young and active patients can provide long-term durability and high quality of function.
Level of evidence: III

1. Introduction

The aim of total knee arthroplasty (TKA) for treatment of advanced knee arthritis is to restore function and improve quality of life [1,2]. With the current success of TKA, the indications have expanded to include younger patients with higher expectations [3,4]. The improvement in surgical techniques and implant designs provide higher quality of function and allows more strenuous physical activity in younger patients.

Cemented TKA in elderly population has shown excellent survivorship [5–8]. Longevity and survivorship of knee implants is an important factor for determining the performance of TKA [8]. Although several studies have reported results of TKA in young and active patients with short-term follow-up or older models of knee implants [9–12], little data are available on the long-term quality and function after TKA with posterior stabilized (PS) design in young and active patients. The aim of this study was to evaluate long-term radiographic results, clinical outcomes and quality of function with PS-TKA in young and active patients.

2. Materials and methods

Between January 2000 and October 2001, 392 consecutive cemented TKAs (PFC Sigma, DePuy, Warsaw, IN) were performed by the senior surgeon (***): 210 rotating platform (RP-PS) and 182 fixed bearing (FB-PS) as two consecutive cohorts of patients. Patients were included in this study if they were young (≤60 years-old) and active, (University of California Los Angeles (UCLA) score greater than five) [9]. Fifty five TKAs met our inclusion criteria: 21 RP-PS (15 patients) and 34 FB-PS (26 patients). PFC Sigma is a modular implant with identical femoral components for both FB and RP designs. The polyethylene was 1020 resin Gamma-irradiated Vacuum Foil (GVF) in all cases, which has improved wear characteristics as compared to prior designs [13]. The rotating platform is a unidirectional mobile bearing design with a polished chromium-cobalt tibial tray. Pre-operative diagnoses were primary osteoarthritis (34 patients, 83%), post-traumatic arthritis (four patients, 10%) and rheumatoid arthritis (three patients, 7%). All 41 patients were followed prospectively for a minimum of 11 years. At the last follow-up, one patient (one TKA) was deceased in the RP-PS group; none of the patients were lost to follow-up. In the FB-PS group, no one was deceased or lost to follow-up. The final cohort for analysis included 54 TKAs (40 patients): 20 cases in the RP group and 34 cases in the FP

* Corresponding author. Tel.: +1 646 797 8700; fax: +1 646 797 8777.
E-mail address: MeftahM@hss.edu (M. Meftah).

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Table 1
Demographic of the two cohorts.

	RP-PS	FB-PS
	Mean ± SD (range)	Mean ± SD (range)
Age (years)	54.5 ± 7.2 (35 to 60)	54.2 ± 7.7 (34 to 60)
BMI	33.3 ± 7.2 (20.9 to 50)	30.8 ± 10.2 (17 to 48)
Male/female	6/8	10/16

RP-PS: rotating platform posterior stabilized; FB-PS: fixed bearing posterior stabilized; SD: standard deviation.

group. The mean age at the time of surgery was 54.5 and 54.2 years old in the RP-PS and the FB-PS respectively (Table 1).

A standard medial parapatellar approach using gap balancing technique, extension first, was utilized in all cases with appropriate soft-tissue balance [14]. Standardized mechanically-based technique using intra-medullary femoral and extra-medullary tibial alignment rod were used in all cases. Tibial slope was set for three degrees. After proximal tibial and distal femoral cuts, the gap was assessed in extension with a spacer block. Appropriate soft-tissue balancing was performed to obtain a symmetric gap. The tibial base plate was sized to cover the cut tibial surface and matched to the anteroposterior width of the lateral tibial condyle. It was then externally rotated so that the extramedullary alignment rod was in the middle of the distal tibia with anterior edge of the medial aspect of the tibial base plate inside the anteromedial tibial condylar cortex [15]. The femoral rotation was based on the parallel to the tibial cut technique with the use of a tensor (lamina spreader) [14]. All components (femur, tibia and patella) were cemented. One pack of heated (100 °F for 30 min) polymethylmethacrylate bone cement and one pack at room temperature were vacuum-mixed using modern cementation techniques (Simplex, Stryker, Mahwah, MJ). Cement was applied both over dried cancellous bony using pressurization technique, and implant surfaces.

Physical examination at the time of follow-up included range of motion, pain, crepitation (with or without pain), evaluation of stability in coronal plane at 0, 30, and 90° of flexion by two observers (senior surgeon and an arthroplasty fellow) with varus/valgus stress tests. Clinical assessments included the Western Ontario and McMaster Universities (WOMAC) [16] osteoarthritis index, the Knee Society pain score (KSS) [17], the Knee Society functional score (KSFS), and the UCLA activity score. All patients also completed the Patient Administered Questionnaire (PAQ) [18] to evaluate post-operative knee pain (such as location for anterior knee pain), crepitation, and satisfaction on a visual analogue scale (VAS) from 0 (unsatisfied) to 10 (fully satisfied). PAQ also contains detailed questions regarding recreational activities, such as running, tennis, golfing, and skiing [18].

Radiographic measurements included overall alignment for component positioning, patellar tilt and thickness, assessment for any radiolucency, loosening or osteolysis using the post-operative, one year, three to five years and 10 years follow-up anteroposterior, lateral and Merchant radiographs according to criteria defined by the Knee Society [19].

Descriptive statistics including mean, standard deviation (SD), confidence interval (CI), mean standard error, and Kaplan–Meier survival analyses were performed using SPSS 21 (SPSS Inc. Chicago).

Table 2
Clinical results at final follow-up in the two groups: 31 patients (41 knees) in the RP-PS, and 29 patients (38 knees) in the FB-PS.

	RP-PS	FB-PS
	Mean ± SD (range)	Mean ± SD (range)
Pre-operative KSS	53.8 ± 11 (38 to 69)	49.7 ± 13 (22 to 69)
Post-operative KSS	93.8 ± 6.1 (88 to 100)	92.8 ± 8.2 (68 to 100)
Pre-operative KSFS	44 ± 12 (30 to 60)	50 ± 11 (35 to 80)
Post-operative KSFS	93.5 ± 8.8 (70 to 100)	88 ± 18 (58 to 100)
Pre-operative ROM	97.5 ± 14.2 (70 to 120)	103.5 ± 12.5 (60 to 120)
Post-operative ROM	117.5 ± 8.7 (95 to 120)	114.4 ± 13.5 (90 to 130)
Post-operative WOMAC score	31.5 ± 14 (24 to 83)	28 ± 18 (24 to 83)
Post-operative UCLA score	5.3 ± 1.5 (5 to 9)	4.4 ± 3 (5 to 9)
Post-operative satisfaction score	9.1 ± 1.9 (3 to 10)	8.5 ± 2.1 (2 to 10)

SD: standard deviation; KSS: Knee Society pain score; KSFS: Knee Society functional score; ROM: range of motion; WOMAC: Western Ontario and McMaster Universities score; UCLA: University of California Los Angeles activity score.

Table 3
Sporting activity based on PAQ results in the two groups at the final follow-up.

Activity	Overall (40 patients)	RP-PS (14 patients)	FB-PS (26 patients)
	% (# of patients)	% (# of patients)	% (# of patients)
Walking[a]	20% (8)	14% (2)	23% (6)
Running	2.5% (1)	7% (1)	0% (0)
Swimming	15% (6)	14% (2)	14% (4)
Golf	15% (6)	21% (3)	11% (3)
Tennis	7.5% (3)	7% (1)	7% (2)
Dancing	2.5% (1)	0% (0)	4% (1)
Gym workout	35% (14)	43% (6)	30% (8)

PAQ: patient administered questionnaire.
[a] Walking = more than 1 mile/day.

3. Results

The mean follow-up was 12.3 ± 0.5 years (range 11 to 13 years). There was no instability on physical examination at the final follow-up in either group. The mean Range of Motion (ROM) in RP-PS and FB-PS improved from 97° and 103° pre-operatively to 117° and 114° post-operatively, respectively. Clinical results based on KSS were good to excellent (scores of 80 or above) in 93% of RP-PS and 95% of FB-PS knees (Table 2). Two patients in the RP-PS group (two knees, 10%) and two patients in the FB-PS group (three knees, 9%) had mild anterior knee pain that did not require surgical intervention. The mean satisfaction score was 9.1 ± 1.9 and 8.5 ± 2.1 in RP-PS and FB-PS groups, respectively.

Sixty-eight percent of patients (78%, 11 patients in RP-PS and 65%, 17 patients in FB-PS) were still participating in routine recreational activities such as dancing (2.5%), running (2.5%), tennis (7.5%), swimming (15%), and golf (15%) on a regular basis at the final follow-up (Table 3). Upon radiographic evaluation, there was no malalignment or osteolysis in any of the TKAs (Table 4). Non-progressive radiolucency was seen at the tibial zone 1 in one of the RP-PS and three of the FB-PS knees (overall 7%).

There was no revision, infection, or spinout (dislocation of the tibial insert in rotating platform design). One patient in the FB-PS group underwent open reduction and internal fixation for a peri-prosthetic fracture; with good clinical results at final follow-up. The overall Kaplan–Meier survivorship at 12 years for any reason was 98% (95% CI: 0.94 to 1.0) and for mechanical failure was 100% (95% CI: 0.96 to 1.0).

4. Discussion

In recent decades, cemented TKA has been proven to provide relief of pain and improve function with excellent survivorship [6,8,20]. With recent expansion of indications in younger and more active patients, several studies raise concerns regarding component loosening and lower survivorship due to higher activity and function [21–24]. Paxton et al. [24] showed two-fold higher revision TKA in patients younger than 55 years as compared to the older cohort of patients (relative risk = 2.56). Other reports of short to midterm results of cemented TKA in young and active patients have been encouraging [10,11,21,

Table 4
Results of radiographic assessments in the two groups.

	RP-PS	FB-PS
	Mean ± SD (range)	Mean ± SD (range)
Femoral angle	95° ± 2° of valgus	94° ± 3° of valgus
Femoral flexion	3° ± 3°	4° ± 2°
Tibial angle	89° ± 2° varus	88° ± 2° varus
Tibial slope	87° ± 4°	85° ± 4°
Patellar tilt	1.3° ER ± 3.9° (11° ER − 9° IR)	2° ER ± 4° (10° ER − 7° IR)
Change in patellar thickness	−0.3 mm ± 0.5	−0.9 mm ± 0.8

RP-PS: rotating platform posterior stabilized; FB-PS: fixed bearing posterior stabilized.