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Comparison of Midterm Clinical and Radiographic Results Between Total Knee Arthroplasties Using Medial Pivot and Posterior-Stabilized Prosthesis—A Matched Pair Analysis

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A B S T R A C T

Background: Despite the theoretical advantage of a knee design that can more reliably replicate the medial pivot (MP) of the natural knee, only a few clinical studies have compared the clinical results between the MP prosthesis and another design of prosthesis. We compared the midterm results of total knee arthroplasty (TKA) using an MP prosthesis vs a posterior-stabilized prosthesis via a matched-pair analysis; we included results related to patellofemoral joint symptoms.
Methods: The midterm clinical and radiographic results of 125 consecutive patients (150 knees) who underwent a TKA with the ADVANCE MP prosthesis were compared with those of a control group who had undergone a primary TKA with a posterior-stabilized prosthesis.
Results: Values of the Knee Society's Knee Scoring System, Western Ontario and McMaster Universities Osteoarthritis Index, and Kujala and Feller scoring systems, as well as the range of motion after TKA, did not significantly differ between the 2 groups. No differences in femorotibial angle and component position, including the patella component, were observed between the 2 groups. No significant differences in the change of patella tilt angle and the postoperative patellar translation were observed between the 2 groups.
Conclusion: Patients with the MP prosthesis experienced satisfactory pain relief and a functional recovery, providing results similar to those of the posterior-stabilized prosthesis, including the resolution of patellofemoral joint symptoms.

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Although most contemporary designs for total knee arthroplasty (TKA) prostheses have provided satisfactory pain relief and improved function in most patients, they have yet not reproduced the kinematics of the normal knee, such as femoral rollback and screw-home movement [1–3]. In addition, posterior-stabilized prostheses with cam-post mechanisms can subsequently lead to central post impingement, patellar clunk syndrome, and obligatory bone loss [4].

A medial pivot (MP) prosthesis was developed specifically to replicate the normal knee kinematics with minimal medial side motion and lateral side anterior-posterior translation [1,5–8] and to generate fewer polyethylene wear particles with a large contact area in the medial compartment [9,10]. Despite the theoretical advantage of a knee design that can more reliably replicate the MP of the natural knee, only a few clinical studies have compared the clinical results between the MP prosthesis and another design of prosthesis [11,12]. The previous studies did not have large sample sizes, long follow-up periods, and high rate of follow-up. We thought that a well-designed study would be required to compare the midterm results between MP and another prosthesis.

The combination of femoral rollback and MP motion is considered to be the key motion for high flexion of the knee joint [3,13,14]. However, it is still unclear which restoration of the posterior femoral translation and MP motion is more important for gaining better clinical results including high knee flexion after TKA using the posterior-stabilized or MP prostheses.

The restoration of tibiofemoral kinematics after TKA can minimize the alteration of patellofemoral kinematics [15]. Medial pivot motion following TKA may reduce patellofemoral contact pressure [15]. A single radius of the femoral component in the MP prosthesis has the effect of optimizing the lever arm of the quadriceps muscle [7]. Another advantage of the MP prosthesis is that it is not necessary to resect the femoral notch bone to house the post, unlike posterior-stabilized prostheses. The design characteristics of the MP prosthesis may result in a decreased risk of patellofemoral problems such as anterior knee pain [4,16]. However, the clinical results related to the influence of the MP prosthesis on the patellofemoral joint after TKA are not fully understood compared with the tibiofemoral kinematics.

We compared the midterm clinical rating scores and radiographic results of TKA using an MP prosthesis vs a posterior-stabilized

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prosthesis. A matched-pair analysis was used as the method of comparison. The clinical rating scores included the Knee Society's Knee Scoring System (KSS), the Western Ontario and McMaster Universities Osteoarthritis (WOMAC) Index, and clinical scores related to the patellofemoral joint symptoms, and the radiographic results included an evaluation of the patella position. It was hypothesized that the clinical and radiographic results, and the complication and revision rates of MP prosthesis would be comparable to or better than the posterior-stabilized prosthesis, especially in patellofemoral joint symptoms.

Patients and Methods

All consecutive patients who underwent a TKA with the ADVANCE MP prosthesis (Wright Medical, Arlington, TN) between March 2002 and December 2008 were included in the study group. During this period, 153 arthroplasties were performed in 128 patients. Three patients were lost to follow-up before the end of 2 years, leaving 150 arthroplasties in 125 patients. For each patient reviewed, we matched a control patient who had undergone a primary TKA with a PFC Sigma (Johnson & Johnson Professional Inc, Raynham, MA) from the database because it was the most commonly used prostheses in our institutions. The MP prosthesis had been selected sporadically by the surgeons during the study period, but there had been no specific indication to select ADVANCE MP prosthesis or the PFC Sigma prosthesis. The matches were made according to age, gender, body mass index (BMI), diagnosis, preoperative range of motion (ROM), severity of preoperative deformity, and operating period. The study was approved by the institutional review board of our hospital.

The average age of the study group (MP group) was 66.7 years (range, 42-83 years). Of this total, 121 were female and 4 were male. The mean BMI was 26.4 kg/m^2 (range, 18.7-36.8 kg/m^2). Preoperative diagnoses included osteoarthritis in 139 knees, rheumatoid arthritis in 5 knees, and spontaneous osteonecrosis in 6 knees. The follow-up period averaged 5.2 years (range, 2.0-12.7 years). No significant differences were found in the demographics between the study and control groups in terms of age, gender, BMI, side, diagnosis, preoperative ROM, and follow-up period (Table 1).

The clinical scores have been recorded in charts and our database, and they were collected from detailed reviews of chart and data. The clinical results were evaluated at the preoperative and final follow-up periods using various clinical scoring systems, including the Knee Society's KSS and the WOMAC Index. Clinical results related to patellofemoral joint symptoms were evaluated using the Kujala [17] and Feller [18] scoring systems. The 2 scoring systems have been commonly used to evaluate subjective symptoms and functional limitations in patellofemoral disorders and TKAs [19]. A long-armed goniometer was used to measure ROM. The KSS and ROM had been measured by independent orthopedic surgeons during preoperative and follow-up visits.

Preoperative and final follow-up anteroposterior and lateral radiographs were obtained to assess the limb alignment and component positioning. Measurements were taken from these images using a picture-acquiring communication system. Afterward, the measurements were evaluated to provide radiographic results including the femorotibial angle and the method used by the American Knee Society to determine the α, β, γ, and δ angles (Fig. 1) [20]. The preoperative and postoperative patella tilt angle was measured in the Merchant view, with the knee joint flexed at 45° [21]. A positive value indicated that the opening was toward the medial side of the patella. The preoperative and postoperative patellar translations were also measured in the Merchant view. A positive value indicated the lateral translation of the patella compared with the femoral trochlea or sulcus of the femoral component (Fig. 2). To reduce observational bias, we analyzed intra- and interobsever reliabilities of radiographic measurements. Two independent investigators of orthopedic surgeons repetitively performed all radiograhic measurements with a time intervla of 2 weeks. The intraobserver and interobserver reliabilities of all measurements were assessed. These reliabilities were confirmed by intraclass correlation coefficient values exceeding 0.7 for all measurements.

The presence of complications or the need for any additional surgery following the primary TKA was reviewed. The midterm survival rates were also analyzed.

Statistical Analysis

The clinical and radiographic results preoperatively and at the final follow-up visit were compared between the MP and posterior-stabilized groups (Student t test). Changes in the clinical scores and ROM and radiographic measurements at the last follow-up vs the baseline were also compared. The complication rate was compared between the MP and posterior-stabilized groups (χ^2 test). The midterm survival

Table 1
Demographics of the MP Knee and PCL-Substituting Groups.

Parameters	Study Group (MP)	Control Group (PCL Substituting)
No. of cases	150	150
No. of patients	124	138
Age (y)	66.7 ± 7.1	66.7 ± 6.5
Gender (female/male)	120/4	136/2
BMI (kg/m^2)	26.4 ± 3.2	25.9 ± 4.4
Side (right/left)	72/78	80/70
Diagnosis (osteoarthritis/rheumatoid arthritis/osteonecrosis)	139/5/6	143/4/3
Follow-up periods (y)	5.2 ± 2.7	5.1 ± 3.6

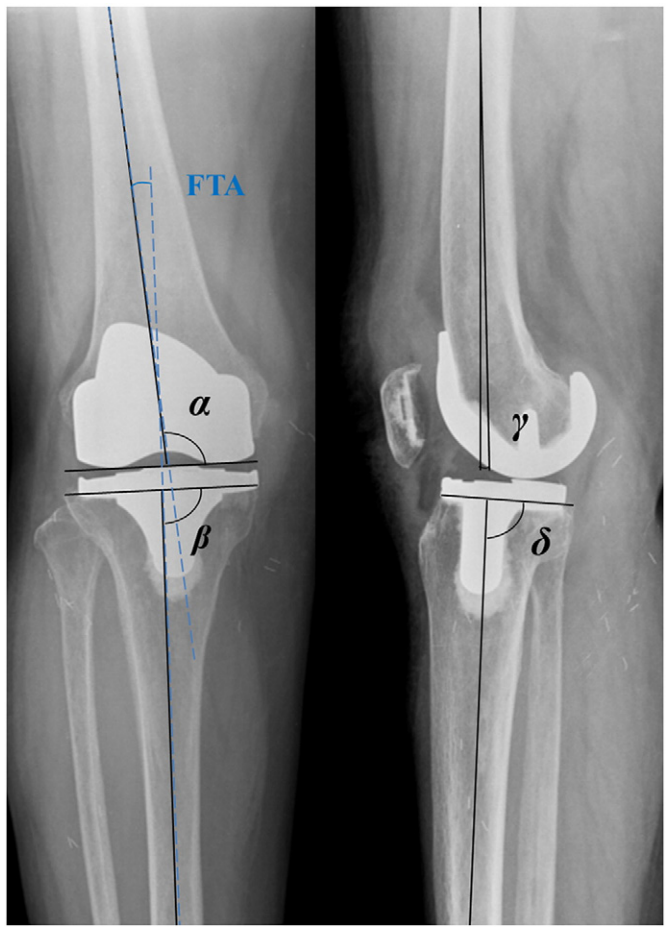

Fig. 1. The roentgenographic evaluation method of the American Knee Society is shown. The *femorotibial angle* (FTA) was defined as the angle between the femoral and tibial anatomical axes. The α and β *angles* were defined as the coronal femoral and tibial component angles. The γ and δ *angles* were defined as the sagittal femoral and tibial component angles.