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Clinical and Radiographic Outcomes of Total Hip Arthroplasty With a Specific Liner in Small Asian Patients: Influence of Patient-Related, Implant-Related, and Surgical Factors on Femoral Head Penetration

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ABSTRACT

Background: We evaluated the clinical and radiographic outcomes, including femoral head penetration, of total hip arthroplasty performed using a specific polyethylene (PE) liner in small Asian patients at 10 years after the index surgery. In addition, we investigated whether femoral head penetration was affected by patient-related, implant-related, and surgical factors.

Methods: Between August 2002 and June 2005, for cementless primary total hip arthroplasty, we used acetabular PE liners that were manufactured from GUR 1050 resin, machined from isostatic compression-molded bar stock, and sterilized with a gamma ray irradiation in argon gas. We assessed 82 hips in 78 patients who received these liners.

Results: The mean Harris hip score improved from 41.0 preoperatively to 84.5 at 10 years postoperatively. Periprosthetic osteolysis was observed in 7 hips (9.8%). No acetabular component migration was detected, and no revision surgery was performed 10 years postoperatively. The mean steady-state wear rate was 0.031 mm/y, which was lower than the wear rate for other conventional PE liners of the previous studies. Among the patient-related, implant-related, and surgical factors, sex was significantly associated with the mean steady-state wear rate, with a higher rate in male patients than in female patients.

Conclusion: PE acetabular liners used in small Asian patients show similar clinical outcomes and reduced wear compared with those of other liners. In addition, sex is significantly associated with the mean steady-state wear rate, and the steady-state wear rate is higher in male patients than in female patients.

One of the major reasons for revision surgery after total hip arthroplasty (THA) is aseptic loosening secondary to periprosthetic osteolysis caused by wear particles, mainly from ultra-high molecular weight polyethylene (PE) acetabular liners [1,2]. Periprosthetic osteolysis is known to be triggered by host inflammatory responses to PE wear particles, which induce phagocytosis by macrophages and trigger secretion of bone-resorptive cytokines [3]. These responses result in bone resorption around the implant, and in most cases, revision surgery is required. The incidence of osteolysis increases as the rate of PE wear increases. A literature review of conventional PE estimated that the threshold of osteolysis is a PE wear rate of 0.1 mm/y [4]. Hence, an improvement in wear behavior is necessary to prolong the life of artificial hip joints.

For reducing the amount of wear, implant factors, such as material characteristics of the articulating bearing surfaces (eg, PE resin) and the manufacturing method of PE liners (eg, sterilization technique, dose of gamma ray irradiation, and barrier packaging) are important [5–7]. In addition, it is well known that the PE wear behavior of artificial hip joints is determined by an interplay of multiple factors, including patient-related factors (eg, sex, age, and body mass index [BMI]), implant-related factors (eg, implant design, femoral head material, femoral head size, and liner thickness), and surgical factors (eg, alignment of the acetabular component) [7–9].

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Between August 2002 and June 2005, for cementless primary THA, we used acetabular PE liners that were manufactured from GUR 1050 resin, machined from the isostatic compression-molded PE bar stock, and sterilized with gamma ray irradiation in argon gas. In the present study, we evaluated the clinical and radiographic outcomes, including femoral head penetration, of THAs performed using these PE liners in Asian patients with a small acetabulum at 10 years after the index surgery. In addition, we investigated whether femoral head penetration was affected by patient-related, implant-related, and surgical factors.

Materials and Methods

Institutional review board's approval was received for this study. All patients provided written informed consent.

Patients

Between August 2002 and June 2005, 85 hips in 81 patients underwent cementless primary THA at our department. The patients were evaluated prospectively, and the data were reviewed retrospectively at 10 years postoperatively. Three patients were lost to follow-up at 10 years postoperatively. Hence, we could analyze 82 hips in 78 patients (follow-up rate, 96.3%). The preoperative demographic data of the patients are summarized in Table 1.

Implants

All patients received a cementless THA system (Biomet Inc, Warsaw, IN) consisting of a porous-coated (plasma-sprayed), titanium alloy acetabular component with 4 peripheral fins and 3 screw holes (Mallory Head), and a collarless, porous-coated (plasma-sprayed), titanium alloy femoral stem (Bi-Metric). The distributions of the acetabular component size and liner thickness are summarized in Table 2. The most common size of the acetabular component was 50 mm (43.9%), and a component smaller than 52 mm was used in 74 hips (91.2%). The most common liner thickness was 5.8 mm (46.3%), and a component thinner than 6.8 mm was used in 78 hips (95.1%). In Asian populations, the small acetabulum limits the acetabular component size and liner thickness. Hence, the acetabular component size and liner thickness were much smaller in the present study than in previous studies on Western populations [10–13]. The acetabular component had the Ringloc-type locking mechanism to fix the liner. For bearing coupling, a cobalt–chromium (CoCr) alloy femoral head (diameter, 26 or 28 mm) and an acetabular PE liner (ArCom; manufactured from GUR 1050 resin, machined from isostatic compression-molded PE bar stock, and sterilized with a gamma ray irradiation of 33 kGy in argon gas) were used. The 28-mm femoral head was used when the acetabular component size was ≥50 mm.

Table 1
Preoperative Demographic Data.

Items, All Patients	Patients N = 82, (%)
Sex	
Male	10 (12.2)
Female	72 (87.8)
Age, y (range 23-79; mean 59.5 ± 9.9)	
<60	30 (36.6)
60≦	52 (64.4)
Diagnosis	
Osteoarthritis	71 (86.6)
Osteonecrosis	11 (13.4)
Charnley category	
A	28 (34.1)
B	54 (65.9)
Side	
Right	45 (54.9)
Left	37 (45.1)
Characteristics	
Body height, cm[a]	154.4 ± 7.4 (140-180)
Body weight, kg[a]	54.6 ± 9.0 (38.5-80)
Body mass index, kg/m^2[a]	27.8 ± 4.2 (24-44.5)

[a] Values are presented as means ± standard deviations.

Table 2
Distributions of the Acetabular Component Size and Liner Thickness.

Items, All Patients			Patients, N = 82 (%)
Size of the Cup, mm	Head Diameter, mm	Liner Thickness, mm	
46	26	5.8	17 (20.7)
48	26	5.8	21 (25.6)
50	28	6.8	36 (43.9)
52	28	6.8	4 (4.9)
54	28	8.8	2 (2.4)
62	28	11.8	2 (2.4)

Surgical Procedure

All surgeries were performed by 3 surgeons from our institutions, and the posterior approach was used. All acetabular and femoral components were implanted in a press-fit manner. One to 3 screws were used for additional stability of the acetabular components. Patients underwent routine postoperative management to prevent infection and deep vein thrombosis, including intravenous administration of broad-spectrum antibiotics, administration of low-molecular-weight heparin, use of thromboembolic deterrent stockings, and intermittent calf compression. Partial weight bearing was allowed 1 week after the surgery, and full weight bearing was allowed 3 weeks after the surgery.

Clinical Evaluation

For clinical evaluation, demographic data, clinical scores, and complications were retrospectively reviewed from the medical records. Clinical performance was evaluated before surgery and at 10 years after surgery, using the evaluation chart of hip joint function presented by the Japanese Orthopaedic Association (JOA score) [14]. The JOA score consists of the following 4 categories: pain (40 points), range of motion (20 points), gait (20 points), and activities of daily living (20 points) [15]. The sum of the points in these 4 categories can be used as an approximate estimate of hip function, with a total score of 100 points indicating a perfect score, which is considered normal. Fujisawa et al [16] reported an excellent correlation between the JOA and Harris hip scores (HHSs) (coefficient of correlation = 0.843). Therefore, we calculated the equivalent HHS using the following regression formula: HHS = JOA score × 0.979 + 4.363.

Radiographic Evaluation

All radiographs were assessed by 2 independent observers (HO and TM) who were blinded with regard to all patient-related information. Anteroposterior non–weight bearing pelvic and femoral digital radiographs were obtained at 3 weeks, 6 months, and 1, 3, 5, 7, and 10 years postoperatively. The distance between the x-ray tube and the imaging plate was set to 100 cm, and the center of the x-ray beam was directed at the cranial end of the pubic symphysis. To assess the acetabular component orientation, the following parameters were measured: (1) height of the femoral head center (measured perpendicular to the interteardrop line [vertical