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Mid-Term Clinical and Radiographic Outcomes of Porous Tantalum Modular Acetabular Components for Hip Dysplasia

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ABSTRACT

It is still challenging to perform successful cementless cup fixation during total hip arthroplasty for hip dysplasia. In this multicenter study we evaluated the clinical results of porous tantalum modular acetabular cups (TM cups) in 45 dysplastic hips with a mean follow-up period of 9.8 years. The mean Japanese Orthopaedic Association hip score improved from 48.2 preoperatively to 92.1 at the most recent follow-up. All of the cups were radiographically stable with no evidence of progressive radiolucencies or osteolysis regardless of bone grafting. Sixteen hips with bone grafts showed the integration of grafted bone without any radiolucencies. There were no revisions of TM cups. The use of TM cups for dysplastic hips provided satisfactory 10-year clinical and radiographic results.

Acetabular fixation in total hip arthroplasty (THA) applied to dysplastic hips has been a difficult problem [1–10]. The high friction and highly porous structure of trabecular metal may prove advantageous for attaining cementless fixation in dysplastic hips [3,4]. Several reports have documented favorable mid-term results for the monoblock trabecular metal (TM) cup [3–6]. However, there are still no reports on the mid-term results of modular TM cups for hip dysplasia. We conducted this study to determine the mid-term clinical and radiographic results following the use of modular TM cups (Trabecular Metal Acetabular Cup System, Zimmer Inc, Warsaw, IN, USA) in dysplastic hips.

Materials and Methods

This study was approved by local institutional review boards and performed in accordance with the ethical standards of the 1964 Declaration of Helsinki as revised in 2000. All patients agreed to participate in the clinical trial. Between January 2004 and May 2006, 68 patients (69 hips) underwent primary THA using the modular TM cups. We included patients who had at least one dysplastic hip, and excluded patients with hip concerns because of rheumatoid arthritis and avascular necrosis, as well as those who were lost to follow-up or who died. Dysplastic hips were classified using the Hartofilakidis et al [11] classification.

All of the operations were performed by senior surgeons (YN, NM) at two independent facilities. Surgical procedures were performed using an anterolateral approach with the patients placed laterally. The acetabulum was prepared with hemispherical reamers. The diameter of the final reamer was determined by the operating surgeon in each case (1-mm under-reaming, matched-size reaming, or 1-mm over-reaming). A press-fit elliptical uncemented TM Modular Cup (Zimmer) was implanted in all hips (Fig. 1). The initial stability of the acetabular prosthesis was manually evaluated intraoperatively, and was considered to be satisfactory in all cases. Morselized bone grafts were packed between the cup and the superior part of the dysplastic acetabulum if deemed necessary by the operator. For the morselized bone grafts, bone particles from autogenous femoral heads and bone dust from acetabular reamers were used. In all cases, full weight-bearing and ambulation were allowed 2 days after surgery. In all cases, a 26-mm femoral head was used. All polyethylene used in this study was of the highly cross-linked type (Longevity, Zimmer). All of the femoral components were uncemented. Three different uncemented femoral components were used.

Clinical assessment was evaluated by two of the authors; YN was the operating surgeon while HI was surgeon. Both were blinded to the radiographic results at the time of the evaluation. The Japanese Orthopaedic Association standard for evaluation of hip joint function (JOA hip score) was used to assess function clinically both preoperatively and at the most recent follow-up [12,13]. The JOA hip score is a 100-point scale that comprises the subcategories of pain (0–40 points), range of movement (ROM; 0–20 points), ability to walk (gait; 0–20 points), and activities of daily living (ADL; 0–20 points). Higher scores indicate better condition. Scores at final follow-up were compared to

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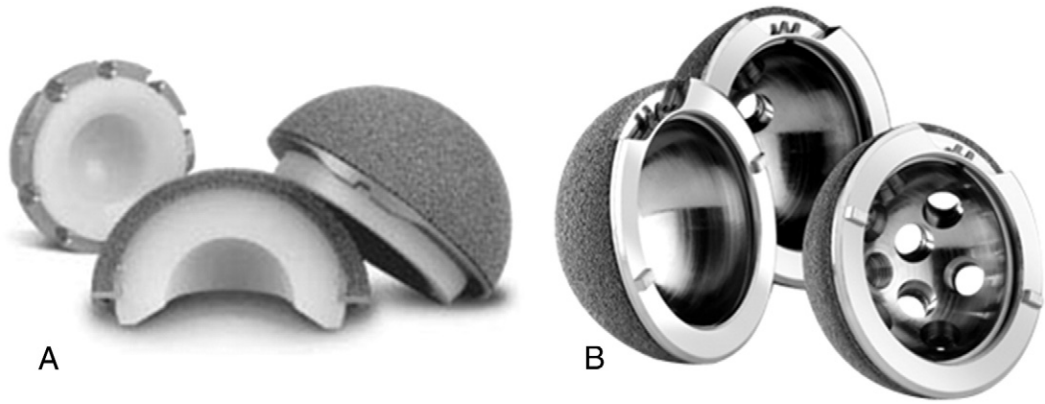

Fig. 1. Trabecular metal acetabular cup. (A) Photograph of a monoblock type. (B) Photograph of a modular type.

preoperative scores. Patients were carefully monitored for complications, including infection, fracture, sciatic nerve palsy, deep vein thrombosis, and dislocation.

Postoperatively, anterior-posterior radiographs of the pelvis were obtained in all patients using standard technique. Each patient was laid supine with the feet taped to a foam block to maintain neutral femoral rotation. The radiographic beam was centered on the symphysis pubis and the hip was corrected for rotation. Radiographic measurements were obtained using the Fuji Film Synapse Medical Image Processing System (Fujifilm, Tokyo, Japan). All measurements were corrected for magnification, determined in each radiograph by measuring the diameter of the known implanted femoral head. Anterior-posterior standardized pelvic radiographs were obtained in all cases at 6 weeks; 3, 6, and 12 months; 2, 3, and 5 years; and at final postoperative follow-up. Two of the authors (TK and JT, each with more than 15 years of experience) who were blinded to patient characteristics and were not the operating surgeons reviewed all radiographs and made all radiographic observations. Anterior-posterior radiographs were used to assess the position of the cup (cup inclination), cup center-edge (CE) angle, radiolucent line, osteolysis, cup migration, and implant loosening. Cup inclination was determined using a horizontal reference line drawn through the base of the teardrops. The cup-CE angle, defined as the angle between the vertical line and the line drawn from the cup center and lateral edge of the line drawn from the cup center and lateral edge of the acetabulum, was measured to assess the extent of bony coverage [14,15]. Radiolucent lines and osteolytic lesions in the three acetabular zones of DeLee and Charnley [16] were recorded. Cup migration was defined as a change in the position of the acetabular component of more than 2 mm or a change in cup inclination of more than 5° [17]. The cup was considered to be loose only if there was more than 3 mm of migration in the vertical or horizontal directions or more than a 3° change in inclination [18,19]. Cups were regarded as failed if revision for loosening was required or they were deemed mechanically unstable based on migration or an inclination change on radiographs. The periacetabular gap was digitally measured and was considered to be positive when the maximum gap was >1 mm on the initial postoperative radiograph [8]. We determined whether and when the gap was filled. The corrected width of the gap, its location, and changes over time were recorded. The grafts were evaluated in patients with morselized bone grafting. The grafted bone was considered to be integrated if there was trabecular continuity between host bone and the grafts, and absorption of the grafts was confirmed if the grafted bone, which was visible immediately after surgery, had disappeared.

The data were stored until review by an independent blinded observer. Statistical analyses were carried out using JMP 9.0.2 (SAS Institute, Cary, NC, USA). The data were analyzed using the Wilcoxon rank sum test. Differences at $P < 0.05$ were considered to be statistically significant. Intra-observer and inter-observer variances were expressed using interclass correlation coefficients (ICC): ICC < 0.20 for slight agreement; 0.21–0.40 for fair agreement; 0.41–0.60 for moderate agreement; 0.61–0.80 for substantial agreement; and >0.80 for almost perfect agreement [20].

Results

Fifty patients (51 hips) were available for the study since three patients were lost at the final follow-up and four patients died. The mean duration of follow-up was 9.8 years (range, 7–10 years). Six patients were men, 44 were women, and the mean age was 61 years (range, 33–79). Based on the Hartofilakidis et al classification [11], 32 hips in our group had type A hip dysplasia, 18 had type B, and one had type C. Two patients had undergone prior surgery (femoral varus osteotomy) for hip dysplasia. Patient demographic data are summarized in Table 1.

The cup sizes used were 44 mm for three hips, 46 mm for 16, 48 mm for 15, 50 mm for 12, and 52 mm for four. A mean of 2.1 screws (range, 1–4 screws) was used to fix the component. The final reamer diameter was 1 mm smaller than the polar diameter of the acetabular component in one hip, the same size in 10 hips, and 1 mm larger in 41 hips. The VerSys stem (Zimmer) was used in 41 hips, the K-MAX (Kyocera, Osaka, Japan) in two, and the S-ROM (Depuy, Warsaw, IN, USA) in two.

The mean JOA hip score improved from 48.2 points (range, 25–76) before surgery to 92.1 points (range, 74–100) at the most recent follow-up examination, demonstrating significant improvement ($P < 0.01$). There were no other major complications in this series, such as infection, fracture, sciatic nerve palsy, deep vein thrombosis, and dislocation. There have been no revisions during a mean follow-up period of 9.8 years (minimum 7 years).

The mean cup inclination on the initial postoperative radiograph was 42.1° ± 5.1° (range, 35.8°–52.7°). The mean cup-CE angle was 19.6° ± 7.2° (range, 7.3°–30.5°). No radiolucent lines were observed.

Table 1
Patient Demographics.

Gender (n)		
	Male	6
	Female	44
Age, mean (range) (y)		61 (33–79)
Height, mean (range) (cm)		152.4 (141–165)
Weight, mean (range) (kg)		55.4 (35–84)
BMI(weight/height^2) (range)		23.93 (18–35.8)
Hartofilakidis classification		
	Type A	32
	Type B	18
	Type C	1