The Journal of Arthroplasty 31 (2016) S110–S114

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Primary Arthroplasty

Long-Term Clinical and Radiographic Outcomes of Porous Tantalum Monoblock Acetabular Component in Primary Hip Arthroplasty: A Minimum of 15-Year Follow-Up

Ivan De Martino, MD [a, *], Vincenzo De Santis, MD [b], Peter K. Sculco, MD [a], Rocco D'Apolito, MD [b], Lazaros A. Poultsides, MD [a], Giorgio Gasparini, MD [c]

[a] Adult Reconstruction and Joint Replacement Division, Department of Orthopaedic Surgery, Hospital for Special Surgery, New York, New York
[b] Orthopedic Surgery Division, Department of Geriatrics, Neurosciences, and Orthopedics, Catholic University of the Sacred Heart, Agostino Gemelli University Hospital, Roma, Lazio, Italy
[c] Orthopedic Surgery Division, Department of Medical and Surgical Sciences, University of Catanzaro Magna Græcia, Catanzaro, Calabria, Italy

ARTICLE INFO

Article history:
Received 30 September 2015
Received in revised form
18 November 2015
Accepted 1 December 2015
Available online 17 December 2015

Keywords:
total hip arthroplasty
porous tantalum monoblock cup
aseptic loosening
cementless fixation
osseointegration
osteolysis

ABSTRACT

Background: The porous tantalum monoblock cup has demonstrated excellent short-term and midterm clinical and radiographic outcomes in primary THA, but longer follow-up is necessary to confirm the durability of these results into the second decade. The purpose of this study is to report the clinical and radiographic outcomes for this monoblock cup with a minimum 15-year follow-up.
Methods: From June 1998 to December 1999, 61 consecutive patients (63 hips) underwent primary THA with a tantalum monoblock acetabular component. All patients were followed clinically and radiographically for a minimum of 15 years. At a mean of 15.6 years (range, 15-16 years) of follow-up, 5 patients had died, and 4 had been lost to follow-up, leaving 52 patients (54 hips) for analysis. The underlying diagnosis that led to the primary THA was primary osteoarthritis in 43 hips, avascular necrosis in 4, developmental hip dysplasia in 3, rheumatoid arthritis in 3 and post-traumatic osteoarthritis in 1.
Results: One cup was revised for deep infection; at surgery, the cup showed osseointegration. At a mean follow-up of 15.6 years (range, 15-16 years), the survivorship with cup revision for aseptic loosening as end point was 100%. There was no radiographic evidence of loosening, migration, or gross polyethylene wear at last follow-up. The mean Harris Hip Scores improved from 47 points preoperatively to 94 points.
Conclusion: The porous tantalum monoblock cup in primary THA demonstrated excellent clinical and radiographic outcomes with no failures because of osteolysis or loosening at a minimum follow-up of 15 years.

Periprosthetic wear particle-induced osteolysis and subsequent aseptic loosening of the acetabulum is one of the most important factors limiting the long-term survival of total hip arthroplasty (THA) [1-5]. To decrease polyethylene (PE) wear rate, osteolysis, and aseptic loosening, cementless monoblock acetabular components were introduced as an alternative to cementless modular and cemented all-PE acetabular components in primary THA [6-8]. Monoblock cups consist of nonmodular acetabular components in which the PE liner is compression molded directly into the metallic shell, eliminating the liner locking mechanism and dome screw holes. These characteristics eliminate micromotion and wear at the interface between the metallic shell and the PE liner (backside wear) [6-8]. The lack of dome holes for screw fixation increases the surface area for bone ingrowth and eliminates pelvic entrance points for wear particle that may lead to periprosthetic osteolysis [6-8]. Disadvantages of a monoblock cup include the inability to assess cup seating, exchange a PE liner, enhance fixation with screws, or change the position of an elevated liner rim at final implantation [7,8]. The porous tantalum

Investigation was performed at the Department of Geriatrics, Neurosciences, and Orthopedics, Agostino Gemelli University Hospital, Catholic University of the Sacred Heart, Rome, Italy.

No author associated with this paper has disclosed any potential or pertinent conflicts which may be perceived to have impending conflict with this work. For full disclosure statements refer to http://dx.doi.org/10.1016/j.arth.2015.12.020.

* Reprint requests: Ivan De Martino, MD, Adult Reconstruction and Joint Replacement Division, Hospital for Special Surgery, 535 East 70th Street, New York, NY 10021.

http://dx.doi.org/10.1016/j.arth.2015.12.020
0883-5403/

Table 1
Studies of Porous Tantalum Monoblock Cups in Primary Hip Arthroplasty.

Study (Y)	Number of Primary Hips	Mean Age of Patients (y)	Mean Follow-Up (Range)	Cup Revised for Loosening and Osteolysis (Rate)
Gruen et al[a] (2005) [13]	414	65	2.75 (2-4.8)	0 (0%)
Mulier et al (2006) [14]	40	48	3.8	0 (0%)
Komarasamy et al (2006) [15]	112	57	2.7 (1.5-4.5)	0 (0%)
Macheras et al (2006) [16]	86	63	7.3 (7-7.5)	0 (0%)
Malizos et al (2008) [17]	240	56	5 (3-9.3)	0 (0%)
Macheras et al (2009) [18]	156	60	8-10	0 (0%)
Xenakis et al[a] (2009) [19]	253	61	5	0 (0%)
Noiseux et al (2014) [20]	383	62	3.5 (2-10)	0 (0%)
Wegrzyn et al (2015) [21]	45	60	12 (11-13)	0 (0%)
De Martino et al (present study)	54	63	15.6 (15-16)	0 (0%)

[a] Multicenter study.

monoblock acetabular component (Hedrocel; Implex Corp, Allendale, NJ, and currently marketed as Trabecular Metal Natural Cup System; Zimmer TMT, Parsippany, NJ) was initially introduced in 1997 (Fig. 1). This monoblock cup has a hemiellipsoid outer geometry with the equatorial diameter 2 mm larger than the polar diameter. The ultra-high molecular weight high-density PE (UHMW-PE, GUR 1020 resin; molded by PPD-Meditech; Waterville, Quebec, Canada) liner is directly compression molded into the tantalum shell to a depth of 1-2 mm, thus leaving 2-3 mm of porous tantalum for tissue ingrowth [9,10]. The cup is sterilized in nitrogen gas with nominal 30 KGy of cobalt gamma radiation [9]. Porous tantalum is not plasma spray, fiber–metal, or beaded type coating but a highly porous 3-dimensional structure with unique mechanical properties [9-11]. The porous material has a high coefficient of friction that enhances initial fixation and reduces micromotions at the bone–implant interface [9-11]. High volumetric porosity (average 80%), fully interconnected pores (550 μm), and a low modulus of elasticity (3 GPa), which is closer in value to that of cancellous bone (0.1-1.5 GPa), compared with titanium (110 GPa), all enhance the potential for bone ingrowth and produce a more physiologic load transfer with diminished stress shielding [11,12].

Short-term and midterm clinical and radiographic outcomes of the monoblock tantalum cup have been excellent [13-21], but long-term (minimum 15 year) follow-up is lacking and such results are necessary to confirm the durability of this design. The purpose of this study is to determine the long-term clinical and radiographic outcomes of porous tantalum monoblock acetabular components in primary THA.

Materials and Methods

After obtaining institutional review board approval, we retrospectively evaluated the records of 61 consecutive patients who underwent primary THA using a porous tantalum monoblock cup at a single institution from June 1998 to December 1999. During the study period, the tantalum monoblock cup was used whenever acetabular bone stock was deemed sufficient for peripheral rim fixation. Patients with severe acetabular dysplasia (Crowe type III or IV) [22] or acetabular segmental or rim nonsupportive defects were managed using a modular acetabular component with screws. All patients were followed clinically and radiographically for a minimum of 15 years. Five patients (5 hips) died before the 15-year follow-up all with primary components in place, and 4 patients (4 hips) were lost to follow-up leaving 52 patients (54 hips) available for analysis (85.7%). The patient cohort included 33 women and 19 men with a mean age of 63 years (range, 48-81 years) at the time of surgery. Mean body mass index was 26 kg/cm^2 (range, 17-32 kg/cm^2). There were 30 right hips and 24 left hips. The underlying diagnosis that led to the initial primary THA was primary osteoarthritis in 43 hips, avascular necrosis in 4, developmental hip dysplasia in 3, rheumatoid arthritis in 3, and post-traumatic osteoarthritis in 1. A posterolateral approach was performed in all patients by an experienced surgeon at a single institution. The acetabulum was prepared with hemispherical reamers. Owing to the hemiellipsoid outer geometry of the cup, the diameter of the final reamer was 1 mm smaller than the outer diameter of the acetabular component allowing for a 1-mm peripheral press-fit [7,8]. A 28-mm diameter femoral head comprised either cobalt–chrome (36 hips) or zirconia ceramic (18 hips) was used in all cases. The choice of femoral component fixation was based on patient's age, bone quality, and morphology of the proximal femur. There were 45 cementless titanium femoral components and 9 cemented cobalt-chrome femoral components implanted. The target cup position was 15°-20° of anteversion and 40°-45° of inclination.

Patients were evaluated clinically using the Harris Hip Score (HHS) system [23] and radiographically at the preoperative visit, 4 weeks postoperatively, and then at 3, 6, and 12 months, and then yearly thereafter until a follow-up of minimum 15 years was achieved. All patients were seen within 6 months of data collection for this study. Radiographic review was performed by a fellowship-trained orthopedic surgeon not involved in the surgery. Radiographs, consisting of an anteroposterior (AP) view of the pelvis and

Table 2
Studies of Other Monoblock Cups in Primary Hip Arthroplasty.

Study (Y)	Monoblock Acetabular Component Type	Number of Primary Hips	Mean Age of Patients (y)	Mean Follow-Up (y)	Cup Revised		
					Loosening (Rate)	Osteolysis (Rate)	Wear (Rate)
Poultsides et al (2012) [28]	Elliptical (Implex)	258	61	11 (10-15)	0 (0%)	0 (0%)	0 (0%)
Wegrzyn et al (2015) [21]	Elliptical (Implex)	41	59	12 (11-13)	1 (2%)	0 (0%)	0 (0%)
Garavaglia et al (2011) [29]	Morscher press-fit cup (Sulzer Orthopaedics)	253	69	10	0 (0%)	0 (0%)	0 (0%)
Gwynne-Jones et al (2009) [30]	Morscher press-fit cup (Sulzer Orthopaedics)	108	57	11.2 (9-13)	0 (0%)	0 (0%)	0 (0%)
Berli et al (2007) [31]	Morscher press-fit cup (Sulzer Orthopaedics)	280	71	14.7 (13.5-17)	7 (2.5%)	1 (0.3%)	3 (1%)
Ihle et al (2008) [32]	RM Classic cup (Mathys)	93	52	19.3 (17.4-20.9)	5 (5.3%)	7 (7.5%)	0 (0%)