



A Comparative Study of Four Bearing Couples of the Same Acetabular and Femoral Component: A Mean Follow-Up of 11.5 Years

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ABSTRACT

We present a retrospective evaluation of 1369 hip arthroplasties performed using the Bicon-Plus cups and SL-Plus stems, differing only in the bearing combination. Four bearing combination groups were used: metal-on-polyethylene (MoP) group with 587 hips, ceramic-on-polyethylene (CoP) group with 161 hips, metal-on-metal (MoM) group with 322 hips and ceramic-on-ceramic (CoC) group with 299 hips. The mean follow-up was 11.5 years (4.1 to 15.0). Radiological evaluation was performed on implants failed due to aseptic loosening. The survival for prosthesis with revision for any reason at ten years was 96.1% (95% confidence interval (CI) 94.3 to 97.9) for MoP, 98.1% (CI 95.9 to 100) for CoP, 90.2% (CI 86.8 to 93.6) for MoM, and 95.6% (CI 93.0 to 98.2) for CoC. Survival for aseptic loosening was also determined.

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The type of bearing couple seems to be the major limitation for longevity of well-fixed hip implants [1]. In addition to the traditional metal-on-polyethylene (MoP) and ceramic-on-polyethylene (CoP) bearings, alternatives like metal-on-metal (MoM) and ceramic-on-ceramic (CoC) were developed. The use of alternative bearings was introduced to meet the challenges imposed by demographic trends [2–4]. Moreover, the number of patients living an active life-style and performing sport activities after total hip arthroplasty is increasing so the expectations of the life quality following the surgery are becoming higher [5]. According to the Norwegian arthroplasty register from 1987 to 2007, 81% of the implanted bearings have had the MoP articulation, 16.2% CoP, 2.2% CoC and 0.6% MoM [2]. To date clinical studies fail to show better survivorship of second-generation MoM to MoP total hip prostheses [6]. On the other hand, D'Antonio et al [7] reported fewer revisions and less osteolysis for CoC compared to MoM bearings.

In order to properly assess the effectiveness of each bearing, studies with mid-term and long-term follow-up are required. To show the contribution of bearing couple on the survival, groups of patients with the same type of acetabular and femoral component and differing only in the type of bearing should be compared, as many factors can influence the failure of a hip prosthesis [8]. It is also

desirable to perform the study on a large group of patients in order to ensure statistically important results. Recently we have reported the survival at ten years for three bearing couples [9]. In this study four bearing couples are compared accompanied with a detailed radiographic analysis.

Patients and Methods

This study was approved by our institutional review board. From January 1997 to December 2007, 1499 hip arthroplasties with the same cementless acetabular cup and the same cementless femoral stem were performed at our hospital. Hip arthroplasties were divided into four groups according to the bearing couple: metal-on-polyethylene (MoP), ceramic-on-polyethylene (CoP), metal-on-metal (MoM) and ceramic-on-ceramic (CoC). The choice of bearing couple was at the discretion of the surgeon.

Patient Demographics

Data on the patients (gender, age, initial diagnosis, previous operations on the hip, complications, reason for revision and clinical outcome) were retrospectively obtained from the hospital data base. Details on patient data in each study group are presented in Table 1. In MoP group 737 prostheses were implanted in 690 patients; among these, we have chosen the group with the same type of femoral head comprising 587 prostheses implanted in 554 patients. In other groups the numbers are as follows: the CoP group (161 prostheses in 160 patients), the MoM group (322 prostheses in 307 patients) and the CoC group (299 prostheses in 274 patients).

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Table 1

Demographic Patient Data and Diagnoses for Study Groups With Different Bearings (Metal-On-polyethylene, MoP, Metal-On-metal, MoM, Ceramic-On-Polyethylene, CoP, and Ceramic-On-Ceramic, CoC).

Data/Diagnosis	Bearing Type			
	MoP	CoP	MoM	CoC
No. of patients	554	160	307	274
No. of hips	587	161	322	299
No. of hips for the study	441	117	252	263
Male:female (%)	24:76	34:66	35:65	49:51
Mean age at surgery (years) (range)	69.4 (43 to 84)	67.3 (43 to 79)	59.9 (29 to 80)	58.5 (36 to 74)
Initial diagnosis (No. of hips (%))				
OA ^a	501 (85.3%)	149 (92.5%)	242 (75.2%)	236 (78.9%)
AFHN ^a	38 (6.5%)	4 (2.5%)	30 (9.3%)	27 (9.0%)
PTOA ^a	17 (2.9%)	3 (1.9%)	14 (4.3%)	16 (5.4%)
Other ^b	31 (5.3%)	5 (3.1%)	36 (11.2%)	20 (6.7%)
Previous hip operations (No. of hips (%))				
Nothing	565 (96.2%)	157 (97.6%)	290 (90.1%)	273 (91.3%)
Osteosynthesis	13 (2.2%)	2 (1.2%)	8 (2.5%)	13 (13%)
Osteotomy	8 (1.4%)	2 (1.2%)	22 (6.8%)	10 (3.3%)
Other	1 (0.2%)		2 (0.6%)	3 (1%)

^a OA, osteoarthritis; AFHN, aseptic femoral head necrosis; PTOA, posttraumatic osteoarthritis.

^b RA, rheumatoid arthritis; OASD, osteoarthritis secondary to dysplasia; PD, Perthes disease; AS, ankylosing spondylitis.

Out of 1295 patients (1369 hips), 288 patients (296 hips) died for reasons unrelated to the surgery, leaving 411 patients (441 hips) in MoP group, 116 patients (117 hips) in CoP, 241 patients (252 hips) in MoM and 239 patients (263 hips) in CoC group available for analysis.

In all groups women were prevailing with a predominant diagnosis of osteoarthritis (OA). The next two most common diagnoses were: aseptic femoral head necrosis (AFHN) and posttraumatic osteoarthritis (PTOA). Other diagnoses were: rheumatoid arthritis (RA), osteoarthritis secondary to dysplasia (OASD), Perthes disease (PD) and ankylosing spondylitis (AS). The mean patient age at the time of surgery was approximately 68 years for MoP and CoP group, and approximately 59 years for MoM and CoC group. The majority of patients in each group had no previous operations on the affected hip. Previous operations comprised osteosynthesis following the proximal femoral fracture, osteotomy and other operations. The postoperative surgical and medical complications that occurred during the hospitalization were analyzed.

Clinical outcomes were assessed using the adopted UCLA activity score [10,11]. The score was sent to all patients that were included in the study at the final follow-up time. The overall response was 64%. The number of hips available for the study of activity was as follows: MoP (250 hips), CoP (73 hips), MoM (178 hips) and CoC (188 hips).

The mean duration of the follow-up was 11.0 years (4.1 to 15.0) for MoP, 13.5 years (6.6 to 14.9) for CoP, 13.0 years (8.9 to 15.0) for MoM and 10.0 years (5.2 to 12.0) for CoC. The overall mean follow-up for all hips was 11.5 years (4.1 to 15.0).

Implant

The acetabular component was Bicon-Plus cup (Plus Orthopedics, Rotkreuz, Switzerland, now Smith&Nephew Orthopaedics). The cup consists of a biconical threaded shell made of commercial pure titanium and a polyethylene insert made of ultra-high-molecular-weight polyethylene (UHMWPE) (RCH-1000, Quadrant PHS Deutschland GmbH, Vreden, Germany) according to International Organization for Standardization (ISO) standard 5834-1/2. Polyethylene was gamma-radiation sterilized (cobalt-60) while sealed in a threefold punch in a nitrogen atmosphere. The dose (between 25 and 37 kGy) induced some cross-linking. The combination of

polyethylene insert with a 28-mm-diameter metal femoral head (Lima, Udine, Italy, stainless steel 316L) was denoted as MoP bearing. In MoM and CoC bearing combinations, additional metal and ceramic inlay, respectively, was placed inside the polyethylene insert (so called sandwich principle). In MoM bearings, the inlay was made of Sikomet SM21 Co-28Cr-6Mo low-carbon-alloy (ISO 5832-12) and was used in combination with a 28-mm-diameter metal head made of the same material. In CoC bearings, ceramic inlay made of high-grade aluminum-oxide ceramics (Al₂O₃) BIOLOX® forte (ISO standard 6474) was used with 28-mm-diameter femoral head made of the same material. The ceramic heads made of same material were used for articulation with UHMWPE insert in CoP bearing couples.

The femoral component was SL-Plus stem (Plus Orthopedics), a cementless, rectangular, dual-taper straight stem made of Ti-6Al-7Nb (ISO 5832-11) (Plus Orthopedics AG, now Smith&Nephew Orthopaedics).

Operative Technique

Arthroplasties were performed by surgeons through a direct lateral or anterolateral approach. All patients received prophylactic antibiotics prior to surgery. Postoperatively, low-molecular-weight heparin was given routinely for prophylaxis against deep-vein thrombosis and its complications.

Radiographic analysis of failed implants due to aseptic loosening

Anteroposterior radiographs of the pelvis with both hips in the visual field taken prior to revision surgery were analyzed and compared with radiographs taken immediately after primary surgery (Fig. 1). The radiographs were evaluated for osteolysis, implant migration and cup inclination. Osteolysis and radiolucencies were analyzed in three acetabular zones based on DeLee and Charnley [12] and in seven femoral zones based on Gruen [13]. Osteolysis was classified as linear or expansile according to the criteria suggested by Zicat et al [14]. Cup migration of more than 3 mm, or cup inclination of more than 5° was considered as positive signs for acetabular loosening [15]. The subsidence of femoral stem was detected according to Migaud et al [16] for Zweymüller stems. We also evaluated acetabular component positioning with an emphasis on abduction angle. The abduction angle was defined as an angle between the line drawn through the acetabular teardrops or obturator line and the face of the cup [17].

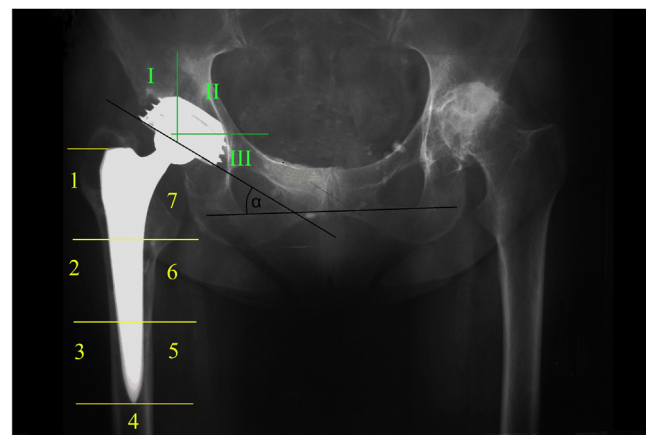


Fig. 1. Anteroposterior radiograph of the pelvis with both hips. Distribution of osteolysis according to the zone of DeLee and Charnley [12] and Gruen [13], with an abduction angle (α) of the cup.

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