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F. Cozzolino
M. Mariconda
L. Costa
D. Scognamiglio
A. Cozzolino
D. Marinò
C. Milano

A comparative study on medium-term results of cementless acetabular components with metal-on-metal and metal-on-polyethylene articulations

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F. Cozzolino • M. Mariconda (✉) • L. Costa • D. Scognamiglio • A. Cozzolino • D. Marinò • C. Milano
Department of Surgery, Orthopaedics, Traumatology, Microsurgery and Rehabilitation, Federico II University of Naples,
Via S. Pansini 5, Building 12,
I-80131 Naples, Italy
Tel.: +39-081-7462798
Fax: +39-081-7463895
E-mail: maricond@unina.it

Abstract The purpose of this study was to evaluate the medium-term clinical and radiological outcomes of two metal-backed acetabular cups with metal-on-metal and metal-on-polyethylene joint couples, in patients unselected for age. Seventy-five metal-on-polyethylene CLS expansion cups were implanted in 70 patients and 66 metal-on-metal Fitek cups were implanted in 65 patients. The average age at surgery in the two groups was 63 years (range, 25 to 72 years) and 58 years (range, 32 to 68 years), respectively. Data regarding 64 of 75 CLS cups (85%) and 58 of 66 Fitek cups (88%) were collected at a minimum 36-month and maximum 144-month follow-up. The Harris hip score showed excellent results in 86% of the CLS cups, good results in 7%, and fair results in 7%. No poor results were recorded. For metal-on-metal acetabular components, excellent results were recorded in 84% of the cups, good results in 8%, fair results in 5%, and poor results in 3%. Fifty-five patients with 57 of 64 CLS cups (89%) and 50 patients with 51 of 58 Fitek cups (88%) were fully satisfied with their prosthesis. No acetabular reconstructions were revised for aseptic loosening. No radiolucent lines greater than 2 mm were observed, either about CLS or Fitek cups, and low incidence of osteolysis and polyethylene wear was noted in metal-on-polyethylene articulations. Post-operative three-phase bone scanning was obtained in 51 patients and this examination did not show increased uptake in blood pool or bone phase indicating aseptic loosening of CLS and Fitek cups. In conclusion, we found similar rates of excellent and good results using two acetabular components with different bearing surfaces, in patients of unselected age. Therefore, the less expensive implant should be selected for total hip arthroplasty in elderly or low-demand patients.

Key words Total hip replacement • Acetabulum • Polyethylene • Prosthesis design

Introduction

The introduction of joint couples made of materials different from polyethylene in total hip arthroplasty is aimed to reduce particulate debris generated from the wear of the polyethylene bearing surface. The debris is thought to be largely responsible for periprosthetic osteolysis and aseptic loosening of total hip prostheses, particularly the early failure of cemented acetabular components in young and physically active patients [1]. The polyethylene wear rate shows a decrease with increasing age, averaging 0.16 mm per year in patients younger than 50 years and 0.065 mm per year in patients older than 70 years of age [2]. As a consequence, the

durability of acetabular cups implanted in younger patients is lower when compared with that observed in older patients [2, 3]. An 18-year survivorship analysis of total hip arthroplasties in patients less than 50 years of age showed a time-related increase of aseptic loosening and revision of cemented acetabula, with a 13% rate of revision for mechanical failure and a 37% rate of radiographic aseptic loosening [1].

Second-generation metal-on-metal articulations were introduced in clinical practice in the 1980s to prevent the problem of polyethylene wear in young patients. Indeed, a 14-year follow-up study on retrieved McKee-Farrar prostheses [4] found low wear rates in metal-on-metal articulations. Thus, the use of alternative bearing surfaces is justified in young and high-demand patients, but in the elderly the cost-effectiveness of hip arthroplasty must be carefully evaluated.

The aim of the present study was to report the medium-term results of two metal-backed acetabular components with metal-on-metal or metal-on-polyethylene bearing surfaces, in patients unselected for age.

Materials and methods

Between 1988 and 1997, 141 primary total hip arthroplasties with metal-backed cementless acetabular components were performed at the Orthopaedics Clinic of Federico II University of Naples. Sixty-six prostheses had a metal-on-metal articulation and 75 had a metal-on-polyethylene articulation. All the metal-on-metal acetabular components were hemispheric Fitek cups with Ti shell, Ti fiber metal outer mesh, polyethylene substratum, and cobalt-chromium metal articulation surface molded into the polyethylene. These acetabular cups were implanted with press-fit stabilization or using additional screws through the shell. The cementless acetabular components with metal-on-polyethylene articulation were CLS expansion cups. These cups have a titanium alloy metal back divided into 6 lobes, on which are several rows of teeth. The expansion is obtained by elastic recoil of the titanium shell and through a cone-shaped threaded expander. When the cup is expanded, the teeth of the shell engage into the acetabular bone. Both metal-on-metal and metal-on-polyethylene acetabular components were used in conjunction with 28-mm cobalt-chromium femoral heads and CLS femoral stems.

The 66 total hip arthroplasties with Fitek cup were performed in 65 patients from 1994 through 1997. The average age of the patients was 58 years (range, 32–68 years). There were 41 women and 24 men. The preoperative diagnosis was osteoarthrosis in 49 (74%) hips, dysplasia arthrosis in 8 (12%) hips, avascular necrosis in 7 (11%) hips, and hip fracture in 2 (3%) hips.

The 75 CLS cups were implanted in 70 patients between 1988 and 1997. The average age in this group was 63 years (range, 25–72 years); 49 patients were women and 21 were men. The indication for total hip arthroplasty was osteoarthrosis in 55 (73%) hips, avascular necrosis in 10 (13%) hips, dysplasia arthrosis in 5 (7%) hips, hip fracture in 3 (4%) hips, and rheumatoid arthritis in 2 (3%) hips.

All patients received thromboembolic prophylaxis with calcium heparin or low molecular weight heparin. No routine prophylaxis against ectopic ossifications was used. All 141 total hip arthroplasties were performed in conventional operating rooms using a lateral approach.

Forty-three (57%) CLS components in 41 patients were available at a minimum 36 and average 80 months of follow-up (range, 36–144 months); 38 (57%) Fitek components in 38 patients were available at a minimum 36 and average 45 months of follow-up (range, 36–72 months). The follow-up clinical evaluation was assessed on the Harris hip scale [5]. According to the scale, the result was rated as excellent (90–100 points), good (80–89 points), fair (70–79 points), or poor (<70 points). Furthermore, all patients were asked if going back in time they would have undergone the same procedure again.

Anteroposterior (AP) pelvic radiographs and computed tomographs were obtained at the time of clinical evaluation. Inclination angle and possible migration of the acetabular cup as well as polyethylene wear were assessed according to Massin et al. [6]. Acetabular radiolucent lines and osteolysis were measured using the zones described by DeLee and Charnley [7]. Only radiolucent lines wider than 2 mm occupying at least 50% of each zone were considered indicative of acetabular loosening. Heterotopic ossification was assessed using the classification of Brooker et al. [8]. Tomography was performed to analyze bone integration of the cup and possible screw-associated osteolytic lesions. Three-phase bone scanning was carried out in 51 (65%) of the 79 patients available for follow-up. With this method, an increased uptake in blood pool and bone phase suggests possible loosening of the cup [9].

Twenty patients with 21 CLS (28%) and 19 patients with 20 Fitek (30%) acetabular components did not participate in the follow-up, but were interviewed by telephone, at least 36 months after the operation. The interview concerned pain in the hip, use of walking supports, possible reoperations, and degree of satisfaction for the treatment received. Nine patients with 11 CLS cups (15%) and 8 patients with eight Fitek cups (12%) could not be reached or refused to answer any question about the prosthesis. On the whole, it was possible to obtain minimum 36-month follow-up data on 64 of 75 CLS cups (85%) and 58 of 66 Fitek cups (88%).

Results

The follow-up evaluation with the Harris hip score showed excellent results in 37 of 43 CLS cups (86%), good results in 3 (7%), and fair results in 3 (7%). No poor results were recorded. As regards the Fitek components, excellent results were found in 32 of 38 cups (84%), good results in 3 (8%), fair results in 2 (5%), and poor results in 1 (3%). The poor result was observed in a patient with a 4-year follow-up, who complained of severe pain in the hip and limp. This patient had an acetabular inclination angle of 60° and endosteal bone formation at the tip of the femoral stem.

Including the patients with CLS cups interviewed by telephone, 55 patients with 57 out of 64 cups (89%) were fully satisfied with their prostheses, and if necessary they would have

undergone the same operation again. Fifty patients with 54 cups (84%) had no pain or mild pain, and 49 patients with 52 cups (81%) could walk without support. No acetabular revisions were recorded in this group. As for the metal-on-metal acetabular components, 50 patients with 51 out of 58 cups (88%) were fully satisfied with their result and going back in the time they would have had the same operation again. Forty-six patients with 47 cups (81%) were pain-free or complained of mild pain in their hips, and 46 patients with 47 cups (81%) could walk with no support. Also in the Fitek group, no reoperations related to acetabular revision were reported.

On radiographs (Figs. 1, 2), the average inclination angle was 41° for the CLS cups and 43° for the Fitek cups. For the metal-on-polyethylene acetabular components, radiolucencies of less than 2 mm were found in zone 1 in 5 cups (12%), in zone 2 in 5 cups (12%), and in zone 3 in 6 cups (14 %). Three cups had complete periacetabular lucencies. Of the Fitek components, 4 (11%) had radiolucent lines of less than 2 mm in zone 1, 3 (8%) in zone 2, and 4 (11%) in zone 3. Only one acetabulum showed complete peripheral radiolucency. No CLS or Fitek cups had lucencies greater than 2 mm. There was neither evidence of migration nor grade IV heterotopic ossification in any cup. Significant polyethylene wear occurred in two CLS acetabular components, one of which had periacetabular osteolysis in zones 1 and 2. Tomography did not reveal screw lysis and showed good bone integration (Fig. 1c) in all but three CLS and one Fitek components.

In all the patients in whom three-phase bone scanning was obtained, this examination did not show increased uptake in blood pool or bone phase (Fig. 1d).

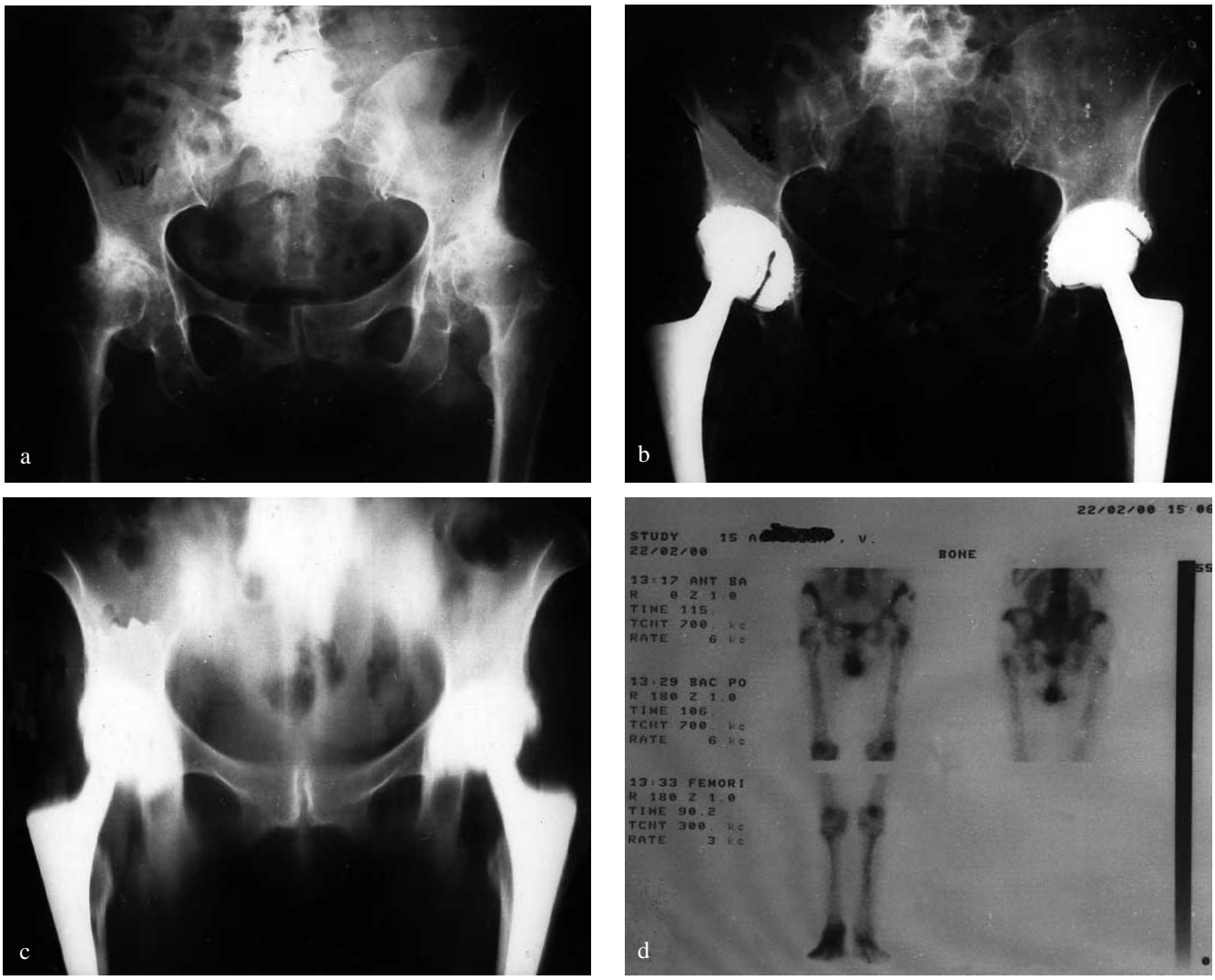

Fig. 1a-d *Patient with bilateral metal-on-polyethylene CLS acetabular components*. **a** Preoperative radiographic view. **b** Follow-up radiograph (*right side:* 6 years postoperative; *left side*: 5 years postoperative) show good bone integration of the cup. **c** Postoperative tomography. **d** Postoperative scintigraphy showing no increased uptake in the hips

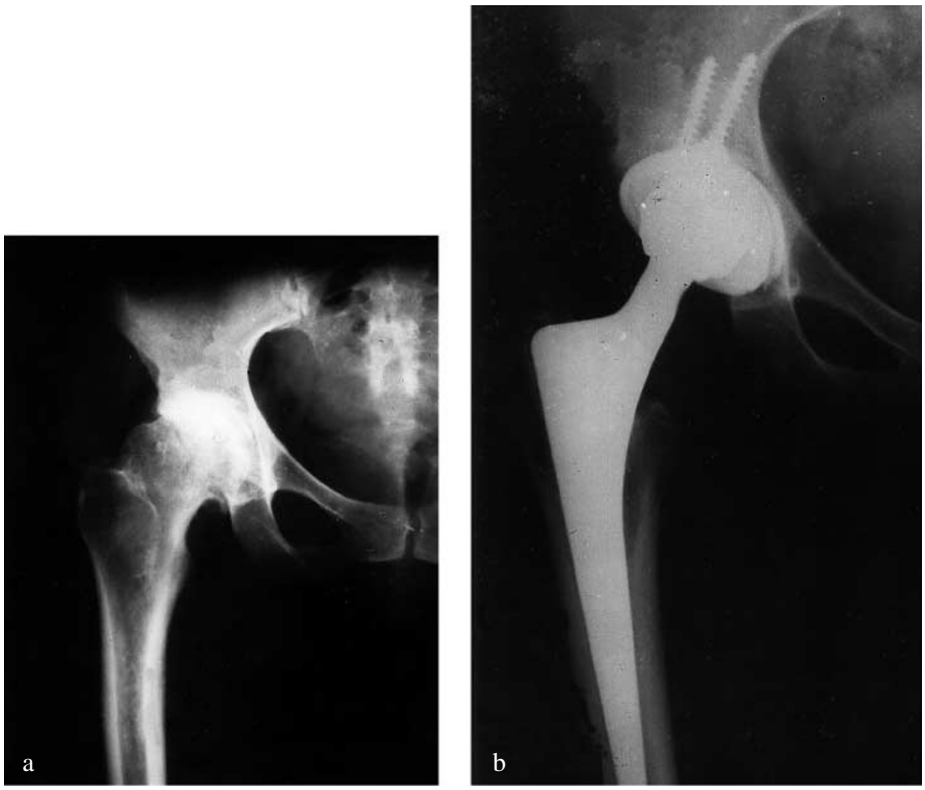

Fig. 2a,b *Patient with metal-on-metal Fitek acetabular component*. **a** Preoperative radiographic view. **b** Five-year postoperative radiographic view showing good bone integration of the cup and no lysis around the screws

Discussion

The foreign body reaction to polyethylene debris generated from metal-on-polyethylene bearing surfaces is a foremost concern for the long-term survival of acetabular components in total hip arthroplasty, as it can be responsible for osteolysis and aseptic loosening of the cup. Rapid wear of the polyethylene especially can be observed in young and physically active patients, who place high demands on their hip prostheses. Indeed, metal-on-polyethylene total hip arthroplasty is not as successful in younger patients when compared with the same procedure in older patients [1–3]. To obviate the problem of polyethylene wear in total hip replacement, metal-on-metal articulations have been introduced [10]. Metal-on-metal prostheses have low volumetric wear compared with that of metal-on-polyethylene implants [11] and their use is justified in young patients, in whom the durability of an implant is of paramount importance. Conversely, the selection of a hip prosthesis in elderly and low-demand patients should be made after a careful cost-benefit analysis, as high-demand cementless components are expensive [12]. Indeed, choosing the prosthesis on the basis of the demands a patient is expected to place on his or her implant has been shown to reduce the costs of hospitalization [13]. To perform this cost-benefit analysis, clinical and radiographic results of different implants must be evaluated.

This study was undertaken to analyse the medium-term results of acetabular components with different bearing surfaces, coupled with the same femoral stem, in patients of unselected age, to highlight possible advantages of metal-on-metal on traditional metal-on-polyethylene articulation. Both bearing surfaces were inserted in widely used press-fit titanium acetabula. Although in this study the follow-up of the metal-on-polyethylene cups was longer than the metal-on-metal components, our results did not indicate substantial difference in the outcome for these two different articulations. We found high rates of excellent and good results with both acetabular components, similar to previous medium-term follow-up studies. Indeed, metal-on-polyethylene articulations have been proven to give good results in acetabular cups with screw fixation [2, 14, 15], as well as in CLS expansion cups [16]. Even in the elderly, cementless metal-on-polyethylene acetabular components are safe and effective [17], and an inverse relationship between polyethylene wear rate and age has been reported [2]. The follow-up of second-generation metal-on-metal articulations is not as long as metal-on-polyethylene articulations, but satisfactory medium-term results have been reported [18, 19]. Dorr et al. [18] stated that the medium-term mechanical failure rate with metal-on-metal total hip replacement is as good as that reported with metal-on-polyethylene total hip replacement. To the best of our knowledge, there is a lack of published results regarding the Fitek cups with metal-on-metal articulation.

We did not find, either about CLS or Fitek cups, radiolucent lines greater than 2 mm, and low incidence of osteolysis and polyethylene wear in metal-on-polyethylene articulations was found at radiography. As a consequence, no aseptic loosening of the acetabular components was observed in the patients with radiographic follow-up. These results are in keeping with the radiographic findings of previous studies on cementless acetabular components [2, 14]. Furthermore, since increased uptake on three-phase bone scan was not noted in any of the acetabula examined in our study, cup loosening not radiographically detectable was not likely to be occurred.

The main limitations of our study are retrospective design, lack of randomization on enrollment, and use of two different acetabula for two different bearing surfaces. However, the lack of longitudinal design cannot obscure the excellent follow-up result with both the acetabular components. The lack of randomization did not correspond to different baseline characteristics of the two groups, with respect to age, gender, and pathology. Finally, although different cups were tested with metal-on-metal and metal-on-polyethylene articulations, both implants failed to show high incidence of aseptic loosening. Thus, the outcome evaluation of the two joint couples was not influenced by different characteristics of the acetabular cups. The strengths of our study are large sample size, high percentage of patients with follow-up visit or telephonic interview, and careful imaging assessment. To the best of our knowledge, this is the first study to analyze three-phase bone scan findings in a so large number of patients undergone total hip arthroplasty.

In conclusion, we found similar rates of excellent and good results using metal-on-metal or metal-on-polyethylene titanium acetabular components in patients of unselected age. Therefore, the less expensive implant should be selected for total hip arthroplasty in elderly or low-demand patients.

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