

# PROSPECTIVE MATCHED-PAIR ANALYSIS OF HYDROXYAPATITE-COATED AND UNCOATED FEMORAL STEMS IN TOTAL HIP ARTHROPLASTY

A CONCISE FOLLOW-UP OF A PREVIOUS REPORT\*

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**Abstract:** This prospective study was performed to examine the results of total hip arthroplasty with a tapered uncemented femoral component with and without hydroxyapatite coating in a matched-pair group of patients. Since our original publication in 1996, no femoral component was revised in either group. After a mean clinical and radiographic follow-up of 9.8 years, all femoral components were stable, with no evidence of progressive radiolucency or osteolysis. Ten acetabular components were revised because of aseptic loosening and wear. Our study demonstrated no clinical or radiographic advantage, during the first decade after implantation, to the use of hydroxyapatite on this design of femoral component in primary total hip arthroplasty.

**Level of Evidence:** Therapeutic study, Level II-1 (prospective cohort study). See Instructions to Authors for a complete description of levels of evidence.

## Background

### Summary of Results of Original Publication<sup>1</sup>

Fifty-two pairs of patients treated consecutively with total hip arthroplasty by multiple surgeons at a single institution were retrospectively identified by matched-pair analysis and then studied prospectively. Half of the patients received a femoral component that was porous-coated proximally with hydroxyapatite (Taperloc; Biomet, Warsaw, Indiana), and the other half (the controls) received an identical component without hydroxyapatite. A 28-mm femoral head was used in all hips. Identical cementless plasma-sprayed but not hydroxyapatite-coated hemispherical acetabular implants (Universal cup; Biomet) were used in both groups. The patients were matched for age, sex, weight, diagnosis, Charnley class<sup>2</sup>, operative approach, bone quality, femoral head size, type of acetabular component, and duration of follow-up.

At the time of the original follow-up, at a mean of 2.2 years (range, two to 3.4 years) postoperatively, the mean scores

according to the system of Merle d'Aubigné and Postel<sup>3</sup>, as modified by Charnley<sup>4</sup>, for pain, function, and motion were 5.6, 5.5, and 5.6 points, respectively, in the group that had received a hydroxyapatite-coated femoral component and 5.6, 5.6, and 5.6 points, respectively, in the group that had received a non-hydroxyapatite-coated component. None of these differences were significant. There had been no revisions in either group. Radiographs indicated stable fixation in both groups, and no differences in the radiographic parameters of loosening between the two groups were noted. The overall clinical results were excellent for both groups and, within the relatively short time frame of the original study, there appeared to be no clinical or radiographic advantage to the use of hydroxyapatite in this primary total hip arthroplasty.

In the present study, we examined the results in the same cohort of patients after they had been followed clinically and radiographically for a mean of 9.8 years.

## Methods

### Demographic Data

The present study included forty-three pairs of surviving patients. Nine pairs of patients from the original cohort were excluded because of the death of one of the members of the pair. All components were well fixed and functioning at the time of death. The demographic features of the forty-three pairs of surviving patients are shown in Table I.



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### Original Publication

\*Rothman RH, Hozack WJ, Ranawat A, Moriarity L. Hydroxyapatite-coated femoral stems. A matched-pair analysis of coated and uncoated implants. *J Bone and Joint Surg Am.* 1996;78:319-24.

**TABLE I Demographic Data on the Matched Hydroxyapatite-Coated and Non-Hydroxyapatite-Coated Groups**

	Hydroxyapatite-Coated Implants	Non-Hydroxyapatite-Coated Implants
No. of patients	43	43
Age* (yr)	66.8 ± 6.2	65.7 ± 5.9
Weight* (kg)	79 ± 27.9	78 ± 27.2
Osteoarthritis†	43	43
Charnley class <sup>2</sup> †		
A	20	20
B	13	13
C	10	10
Operative approach†		
Modified Hardinge	3	3
Transtrochanteric	40	40
Duration of follow-up* (yr)	9.2 ± 4.8	10.1 ± 4.6

\*The values are given as the mean and standard deviation. †The values are given as the number of patients.

### Follow-up

The duration of clinical and radiographic follow-up averaged 9.2 years (range, five to thirteen years) for the hydroxyapatite-coated stems and 10.1 years (range, five to fourteen years) for the non-hydroxyapatite-coated stems.

### Functional Evaluation

Preoperative functional evaluation was performed with use of the Charnley<sup>4</sup> modification of the Merle d'Aubigné and Postel scale<sup>3</sup>. In recent years, the Harris hip score<sup>5</sup> has been used at our institution for functional evaluation. Therefore, the functional status of the patients will be reported according to either of these functional evaluation systems, depending on which one was in use at the time of the patient's evaluation.

### Radiographic Evaluation

Serial anteroposterior and frog-leg lateral radiographs of the surgically treated joint were reviewed on two separate occasions by specialty-trained orthopaedic surgeons. All changes around the uncemented femoral component were documented with use of the system suggested by Engh et al.<sup>6,7</sup>. The component was considered to have subsided if it had settled  $\geq 5$  mm<sup>8</sup>. Radiographs were also evaluated for the presence of heterotopic ossification and, when present, classified according to the system of Brooker et al.<sup>9</sup>.

### Statistical Analysis

The changes in the hip scores as well as the difference in the hip scores between the two groups were evaluated with the Student t test, and significance was determined with use of a 95% confidence level. Statistical analysis of power (97% power to detect differences with regard to postoperative pain, function, and motion between the two groups, given the sample size) indicated that the sample size was adequate.

### Results

#### Functional Outcome

Total hip arthroplasty provided significant pain relief and improvement in function in both groups of patients. In the hydroxyapatite-coated group, the mean Merle d'Aubigné and Postel pain and function scores were 2.3 and 3.3 points preoperatively and 5.9 and 5.6 points at the time of the latest follow-up ( $p < 0.001$ ). In the non-hydroxyapatite-coated group, the mean pain and function scores were 2.6 and 3.1 points preoperatively and 5.7 and 5.6 points at the most recent visit. The mean Harris hip score at the time of the latest follow-up was 93.2 points (range, 78 to 99 points) in the hydroxyapatite-coated group and 91.7 points (range, 71 to 99 points) in the non-hydroxyapatite-coated group. There was no significant difference in the preoperative hip scores between the two groups ( $p = 0.32$ ). Although, at the time of follow-up, there was a slight trend for better pain scores in the group with a hydroxyapatite-coated stem, with the numbers available, the follow-up scores for pain and function were not significantly different between the groups ( $p = 0.568$ ).

#### Radiographic Outcome

Postoperative radiographs made at a minimum of five years postoperatively were available for all patients. One hydroxyapatite-coated stem, which was thought to be slightly undersized, had subsided  $>5$  mm. Radiographic analysis showed no difference in the degree of fixation between the two groups. All femoral stems demonstrated bone ingrowth, with no evidence of radiolucency or osteolysis in either group. Distal pedestal formation without radiolucency was seen around one stem in each group, and distal pedestal formation associated with nonprogressive radiolucency was present around one non-hydroxyapatite-coated stem. No calcar atrophy was seen in either group. Spot welding was seen with all stems, although it could not be accurately quantified because of radiographic variables such as penetration, rotation, and magnification. Progressive shedding of particles was seen in one hip with a stable,

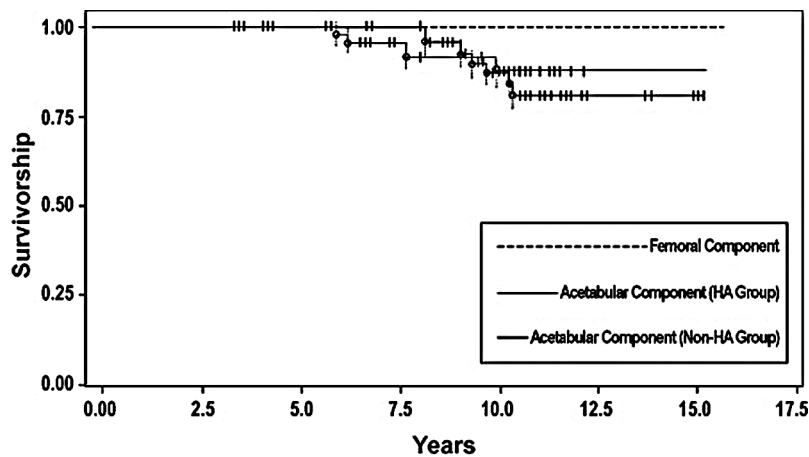


Fig. 1

Kaplan-Meier survival estimates with 95% confidence intervals, with revision or radiographic loosening of the femoral and acetabular components as the end points, in the two groups of patients. No femoral component in either group failed. The reason for the failure and ultimate revision of all ten acetabular components (four implanted with a hydroxyapatite-coated femoral stem and six implanted with a non-hydroxyapatite-coated femoral stem) was aseptic loosening. At the time of the latest follow-up, there was no evidence of radiolucency around any acetabular component. HA = hydroxyapatite.

bone-ingrown non-hydroxyapatite-coated femoral stem.

Of the non-revised cups, six implanted with a hydroxyapatite-coated femoral stem and five implanted with a non-hydroxyapatite-coated stem were associated with nonprogressive radiolucency (in one zone only). No cup was radiographically loose at the time of the latest follow-up.

#### Revisions and Reoperations

No femoral component was revised in either group, whereas ten acetabular components were revised: four (9%) in the hydroxyapatite-coated group and six (14%) in the non-hydroxyapatite-coated group (Fig. 1). All ten cups were revised because of aseptic loosening, and eight of them had accelerated polyethylene wear and were associated with periacetabular osteolysis.

#### Complications

Three hips in each group had heterotopic ossification. In the hydroxyapatite-coated group, one hip had Brooker Grade-1 ossification and two hips had Brooker Grade-3. In the non-hydroxyapatite-coated group, two hips had Brooker Grade-1 ossification and one hip had Brooker Grade-3. Moderate thigh pain was present in one patient in each group. There were no dislocations in either group.

#### Conclusions

This study demonstrated that excellent long-term clinical and radiographic outcomes can be expected after the use of an uncemented proximally porous-coated tapered femoral component. The hydroxyapatite coating on this femoral stem did not confer detectable advantages with regard to clinical and radiographic outcomes. Although our findings are in agreement with those in some published reports<sup>1,10-12</sup>, they differ from

those of others, which advocated the use of hydroxyapatite coating on femoral stems<sup>13-19</sup>. Hydroxyapatite coating is thought to accelerate bone ingrowth and, by providing “early” fixation and stability, minimize subsidence<sup>20-26</sup>. In this study, the only detected subsidence of >5 mm occurred in a patient with an undersized hydroxyapatite-coated stem.

In contrast to the excellent survival of the stem, there was a high prevalence of failed acetabular components in this study. We attribute the poor performance of the uncemented Universal cups to a thick metal shell and a relatively thin polyethylene liner that resulted in accelerated polyethylene wear.

Despite the high rate of cup failure, no aseptic loosening of femoral components or femoral osteolysis was seen in either group. Thus, at a mean of 9.8 years and with the numbers available, hydroxyapatite coating on this femoral stem design had no demonstrable advantages. ■

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