Primary Femoral & Acetabular Fixation Options in the 1990s

Porous-Coated Total Hip Arthroplasty in the Young

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When Sir John Charnley pioneered total hip replacement in the 1960s, he secured the artificial acetabular and femoral components with polymethylmethacrylate bone cement. Proponents of cemented total hip arthroplasty (THA) claim that the stiffness of the cemented construct is well-matched to the host bone. However, long-term results have demonstrated that the cement interface can limit the longevity of the artificial joint. Over time, debonding between the bone-cement or cement-prosthesis interface can result in particle generation and component loosening that require revision surgery.

Younger patients comprise a particularly challenging joint replacement population. The young, who are typically more active, tend to impose greater loading on their artificial joints than do older patients. The anticipated life span of a younger individual also creates the need for a prosthesis with greater longevity.

While increased activity over a longer period of time makes the young more demanding than their older counterparts, young patients are less likely to suffer from the osteoporotic bone loss and declining bone quality associated with advanced aging. Consequently, prosthetic designs that eliminate the cement interface and capitalize on the improved host bone quality would seem ideally suited for the younger patient population. Porous-coated prosthetic designs achieve both of these objectives.

Porous-coated prosthetic components incorporate porous surfaces for bone ingrowth. When placed in close apposition to host bone, the porous surface affords biologic fixation as the bone grows into and interdigitates with the prosthesis surface. This construct creates a secure means of fixation that eliminates the need for bone cement. In our clinical experience this fixation has proven to be very durable.

This article presents clinical outcome data on porous-coated THA in younger patients requiring joint replacement, discusses the theoretical considerations that make porous-coated arthroplasty attractive for younger patients, and reviews the literature.

Clinical Experience

We began using porous-coated components for THA at our institute in 1977. For the present study, 101 arthroplasties in 93 unselected patients (38 men and 55 women) aged 50 years (mean age: 39 years) were reviewed. All patients were treated with an extensively porous-coated femoral component and a hemispheric porous-coated cup. The preoperative diagnosis was osteoarthritis in 59 hips (59%), rheumatoid arthritis in 16 (16%), osteonecrosis in 15 (15%), and developmental dysplasia of the hip in 11 (11%).

Ninety hips in 83 patients had a minimum of 5 years of follow-up (mean: 10.3 years). Sixteen reoperations that were performed included 6 isolated cup revisions, 6 isolated liner exchanges, 3 stem revisions, and 1
TABLE 1
Total hip arthroplasty in the young: porous-coated series

<table>
<thead>
<tr>
<th>Author</th>
<th>Average Age (years)</th>
<th>Average Follow-Up (years)</th>
<th>No. Hips Reviewed</th>
<th>Overall Acetabular Failure Rate (%)</th>
<th>Annual Acetabular Failure Rate (%/yr)</th>
<th>Overall Femoral Failure Rate (%)</th>
<th>Annual Femoral Failure Rate (%/yr)</th>
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<tr>
<td>Mont et al18</td>
<td>36</td>
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*Senior author's experience.

Fig 1: Femoral revision rates for cemented and porous-coated stems among studies with average follow-up of 4.6 to 10.3 years.

Fig 2: Acetabular revision rates for cemented and porous-coated cups among studies with average follow-up of 4.6 to 10.3 years.

LITERATURE REVIEW

For the literature review, young patient populations were defined as those with a mean age <50 years. While clinical outcome is influenced by a complex range of variables such as surgical technique, prosthesis design, and patient characteristics, to compare similar clinical studies, 25 studies that included patients with a variety of preoperative disease diagnoses were selected. Studies limited to patients with osteonecrosis were excluded.

Six of the studies reviewed detailed the performance of porous-coated implants with an average follow-up of 4.6 to 10.3 years (Table 1), and 19 studies detailed results with cemented components (Table 2). Six of the cemented studies feature an average follow-up of 5.6 to 9.5 years, while 13 studies have an average follow-up of 11 to 20 years. For the present review, only the porous-coated and cemented components in each study were examined and threaded cups were excluded. To compare these studies, both femoral and acetabular failure rates were considered.

In all of our analyses, failure was defined as revision of a component for any reason. Radiographically loose components were not included in the failure definition because of the subjective nature of the assessment. Pending revisions also were excluded.

For each study, the overall acetabular failure rate was calculated by dividing the number of acetabular revisions by the number of hips available for follow-up. The overall femoral revision rate was determined in a similar manner.

Because the average follow-up duration varied among studies, an annual failure rate was computed by dividing the overall failure rate by the average follow-up. An independent Sample t-test was used to check for significant differences among groups. A P value of .05 was considered statistically significant. When several studies reported the outcome of the same patient population at different follow-up intervals, only the longest follow-up data were included in the statistical analysis.

Examination of the overall femoral failure rates among studies with comparable follow-up (between 4.6 and 10.3 years) (Fig 1) revealed that, the cemented femoral revision rate was consistently >5%, while the porous-coated revision rate was <5%. When annual femoral failure rates were compared, a significant difference between the cemented and porous-coated groups (P=.008) was noted. The annual femoral failure rate for the porous-coated stems averaged 0.46% per year, while the annual femoral failure rate for the cemented stems was three-and-one-half times higher, averaging 1.61% per year. A comparison of the porous-coated series with all cemented series

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also demonstrated a significant difference in annual femoral revision rates ($P=0.049$).

On the acetabular side, there was considerable variation among revision rates (Fig. 2). The average annual failure rate was lower for the porous-coated acetabular components than for the cemented components (0.84% per year versus 1.76% per year for studies with comparable follow-up, and 0.84% per year versus 1.53% per year among all studies). Nevertheless, the differences were not statistically significant ($P=0.10$ for studies with comparable follow-up and $P=0.11$ among all studies).

Because this analysis considered only overall component revision rates and follow-up duration, it does not include the possible influence of other variables such as patient age at the time of surgery, nor does it consider the influence of hip surgery performed before joint replacement. For studies with comparable follow-up, the average age of 31.8 years at the time of surgery among patients with cemented implants was significantly lower than the average age of 42.8 years among the porous-coated series ($P=0.013$). Among all of the studies, the age difference between groups was marginally significant ($P=0.054$).

**CONCLUSION**

Published studies as well as our personal experience indicate that porous-coated THA is superior to cemented THA when patient outcome with comparable follow-up time is examined. Although we presently do not have 11- to 20-year outcome data for porous-coated THA, we do not anticipate increased revision rates with increased follow-up.

On the femoral side, revisions typically occur soon after the THA and result from a failure to achieve bone ingrowth. In the literature, femoral component failure often is related to undersizing the femoral stem and failing to achieve close apposition between the porous-coated implant surface and the host bone. A wider variety of implant sizes and improved preoperative templating have substantially reduced the occurrence of component undersizing. We have not observed an extensively porous-coated prosthesis loosen after stable distal fixation was achieved.

On the acetabular side, we have noted highly variable failure rates among first-generation porous-coated cup designs. We anticipate that second- and third-generation design improvements will eliminate those features contributing to cup failure and will extend the long-term success of porous-coated acetabular components.

Based on our clinical experience and our analysis of comparable follow-up studies, we conclude that porous-coated THA is a reliable and reproducible procedure yielding superior results among younger patients. Consequently, we advocate the use of porous-coated components for younger individuals requiring THA.

**REFERENCES**


5. Chandler HP, Reineck FT, Wixon RL, McCarthy JC. Total hip replacement in patients...


