# Twenty-five-Year Results After Charnley Total Hip Arthroplasty in Patients Less than Fifty Years Old

## A Concise Follow-up of a Previous Report*

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**Abstract:** We report the updated results for a previously evaluated cohort of patients who were less than fifty years old when they underwent Charnley total hip arthroplasty with cement. The original cohort consisted of ninety-three total hip arthroplasties performed in sixty-nine patients. The patients were followed for a minimum of twenty-five years after surgery or until death. The present report describes the findings of the radiographic and functional follow-up, which was performed for forty-two of the forty-three living patients.

At the time of the latest follow-up, twenty-nine (31%) of the ninety-three total hip replacements had been revised or removed. Eighteen acetabular and five femoral components were revised secondary to aseptic loosening. The combined prevalence of radiographic failure or revision because of aseptic loosening was 13% for the femoral components and 34% for the acetabular components. Comorbid medical conditions significantly hindered results on each functional subscale ($p < 0.05$).

This study demonstrates the durability of cemented total hip replacements in a young patient population. Sixty-nine percent of the original hip replacements were functioning well at the latest follow-up examination or at the time of death, and only 5% required more than one revision arthroplasty.

**Level of Evidence:** Therapeutic study, Level IV (case series [no, or historical, control group]). See Instructions to Authors for a complete description of levels of evidence.

## Background

### *Summary of Results of Original Publication*

The purpose of the present study was to evaluate the results twenty-five to thirty years (average, twenty-five years and eight months) after Charnley total hip arthroplasty in a previously reported group of patients who were less than fifty years old at the time of the index arthroplasty, with expanded data on patient function and radiographic follow-up[1,2]. This series of patients represents a consecutive, nonselected group of patients.

In the original cohort, Charnley total hip arthroplasty was performed in ninety-three hips in sixty-nine patients. The average age at the time of the index operation was forty-two years (range, eighteen to forty-nine years). Thirty-five patients were women, and thirty-four were men. The diagnoses at the time of surgery are found in Table I. A Charnley hip prosthesis (Thackray, Leeds, England, or Zimmer, Warsaw, Indiana) was used in all patients. A stainless-steel polished flatback or narrow femoral stem (modified to a thinner diameter in four hips) with a 22-mm-diameter head and an ultra-high molecular weight polyethylene acetabular component were inserted with cement (Figs. 1-A, 1-B, and 1-C). The cement was hand-packed, and the operations were per-

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**Original Publication*

Callaghan JJ, Forest EE, Olejniczak JP, Goetz DD, Johnston RC. Charnley total hip arthroplasty in patients less than fifty years old. A twenty to twenty-five-year follow-up note. *J Bone Joint Surg Am.* 1998;80:704-14.

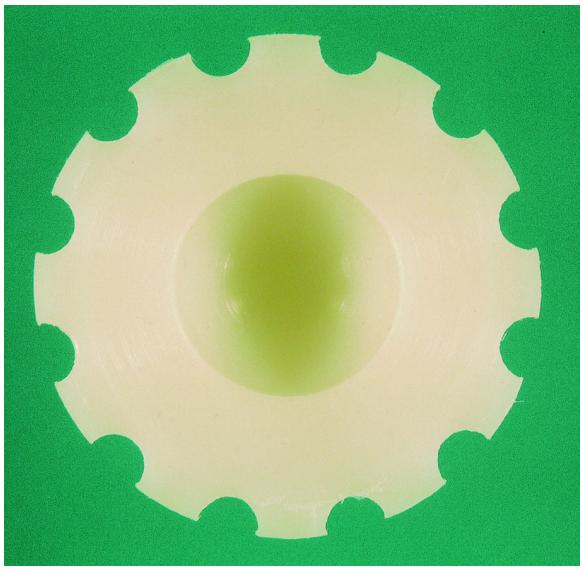

Fig. 1-A

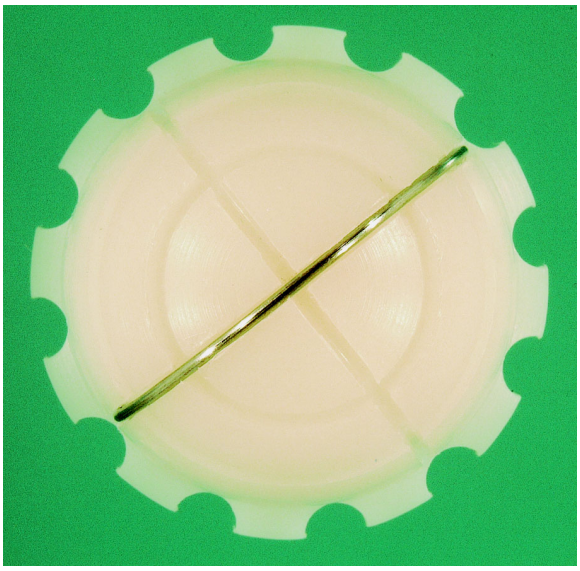

Fig. 1-B

The standard Charnley low-friction hip replacement. **Figs. 1-A and 1-B** Standard all-polyethylene large socket, which had an outer diameter of 44 mm. **Fig. 1-A** Deep surface. **Fig. 1-B** Lateral surface.

formed through the transtrochanteric approach. No antibiotics were used perioperatively.

## Methods

Radiographs were made at a minimum of twenty-five years (average, twenty-five years ten months) postoperatively for fifty-seven of fifty-eight hips in the living patients. Observations and serial measurements were based on anteroposterior pelvic radiographs made early in the postoperative period and usually at five-year intervals thereafter until the latest follow-up visit. Radiographic analysis of heterotopic ossification, femoral cement grade, and osteolysis, and the determination of loosening of the acetabular and femoral components were performed with use of the same methods reported in earlier follow-up studies of the same patient cohort[3-9]. Any radiolucency between the prosthesis and the cement in zone 1 of Gruen et al.[4], regardless of width, was recorded as debonding. We quantified debonding according to the system described by Berry et al.[10]. Linear and volumetric wear were determined by a comparison of the initial and final postoperative radiographs (as well as serial radiographs) with use of a modification of the digital edge-detection tech-

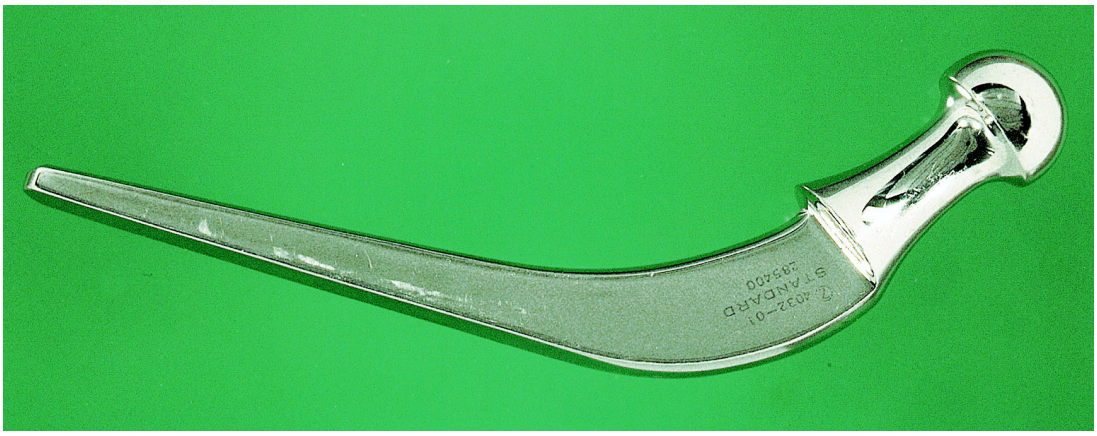


Fig. 1-C

Standard first-generation stainless-steel polished flatback femoral component (45-mm offset).

**TABLE I Diagnosis at Time of Surgery**

| Diagnosis | No. of Hips |
|---|---|
| Developmental dysplasia | 28 |
| Osteoarthritis | 11 |
| Posttraumatic arthritis | 11 |
| Septic arthritis | 11 |
| Rheumatoid arthritis | 8 |
| Slipped capital femoral epiphysis | 8 |
| Osteonecrosis | 7 |
| Poliomyelitis | 4 |
| Legg-Calvé-Perthes disease | 2 |
| Other | 3 |

nique described by Shaver et al.[11]. All patients completed a self-administered Western Ontario and McMaster University Osteoarthritis Index (WOMAC) test[12] (paper questionnaire form), and Harris hip scores[13] were calculated for each patient at his or her current level of function (after one or more revisions, where applicable).

### *Statistical Analysis*

The Kaplan-Meier method was used to evaluate the survival of the implant with regard to revision, radiographic loosening, or both[14-16]. Survivorship curves, with corresponding confidence intervals, were generated with failure defined according to six commonly cited end points. The Wilcoxon rank-sum and Kruskal-Wallis tests were used to analyze nonparametric categorical variables by comparing various radiographic and clinical results, including wear and functional scores, with loosening and revision. The Spearman correlation coefficient was used to compare wear with measures of function. Cement grade was compared with loosening and revision, with use of the Fisher exact test for categorical variables. The log-rank test was used to analyze the association of osteolysis, femoral debonding, and decade of life at the time of implantation with loosening and revision. The Wilcoxon rank-sum test was used to compare WOMAC scores and normative data.

## Results

At the time of clinical follow-up at a minimum of twenty-five years after the index arthroplasty, forty-five patients (sixty hips) were alive and twenty-four patients (thirty-three hips) had died. The average age of the forty-five living patients was sixty-six years and eleven months. The average duration from the insertion of the prosthesis to the time of death was nineteen years and three months. Two living patients (two hips) were excluded from the final follow-up analysis because a resection arthroplasty had been performed as a result of infection. Therefore, fifty-eight hips in forty-three patients were eligible for inclusion in this study. One patient refused participation in the study. At the time of the last follow-up, the total hip replacement in this patient had not been revised and was functioning well but the acetabular component was noted to have radiographic signs of probable loosening. The study group, therefore, comprised forty-two of the forty-three eligible patients with at least twenty-five years of follow-up.

### *Revision of the Original Prosthesis*

Of the ninety-three original hips, twenty-nine (31%) had had either a revision or resection arthroplasty at the time of latest clinical follow-up. The revision or resection was performed because of aseptic loosening in twenty-two hips (24%), infection in four (4%), fracture of the femur in two (2%), and recurrent dislocation in one hip. Of the sixty hips in the forty-five patients who were alive twenty-five years after the index operation, twenty-two hips (37%) had had a revision or resection arthroplasty. The reason for revision or resection was aseptic loosening in sixteen (27%), infection in three (5%), fracture of the femur in two (3%), and recurrent dislocation in one hip (2%). No patient required more than two revision operations. Since the time of the minimum twenty-year follow-up, two additional revisions were performed; one hip was revised because of aseptic loosening of the acetabular component and one, because of periprosthetic femoral fracture (Table II).

### *Function*

Functional evaluations were completed for forty-two patients with at least twenty-five years of follow-up since the time of the index arthroplasty (see Appendix). No significant differences were detected among the hips that had been revised, those that had not been revised, and those that had not been revised but had a radiographically loose component with respect to the median scores on the WOMAC subscales or the median Harris hip score.

When the median WOMAC score for each subscale was analyzed, the study group was found to have significantly

**TABLE II Number of Revisions at Time of Final Follow-up**

| Outcome | All Hips (N = 93) | Hips of Patients Who Were Alive ≥25 Years Following Index Surgery (N = 60) |
|---|---|---|
| Original prosthesis retained | 64 (69%) | 38 (63%) |
| Revision* | | |
| One | 22 (3, 18, 0, 1) | 16 (2, 13, 0, 1) |
| Two | 5 (2, 1, 1, 1) | 4 (1, 1, 1, 1) |
| Three | 0 | 0 |
| Resection arthroplasty† | 2 (2, 0, 0, 0) | 2 (2, 0, 0, 0) |

*The numbers of hips according to the different reasons for revision (infection, aseptic loosening, dislocation, and femoral fracture) are in parentheses. †Both hips that had a resection arthroplasty had an attempt at reimplantation before the resection.

**TABLE III Comparison of Radiographic and Survivorship Data at a Minimum Follow-up of Twenty Years and Twenty-five Years***

| | 20-Yr Follow-up | 25-Yr Follow-up |
|---|---|---|
| No. of living patients (no. of hips) | 54 (72) | 45 (60) |
| No. of patients who died (no. of hips) | 15 (21) | 24 (33) |
| No. of hips that had revision or resection | | |
| Total for all patients | 27 | 29 |
| Total for living patients | 20 | 22 |
| No. of hips with complete follow-up (excluding resections) | 50 of 52 | 42 of 43 |
| Results in living patients at time of follow-up *(no. of hips)* | | |
| Revision surgery | 20 | 22 |
| Revision because of aseptic loosening of acetabular component | 16 | 13 |
| Revision because of aseptic loosening of femoral component | 4 | 4 |
| Evidence of radiographic loosening of acetabular component | 30 | 32 |
| Evidence of radiographic loosening of femoral component | 9 | 9 |

*Since the time of the twenty-year follow-up, two additional revisions had been performed: one because of periprosthetic femoral fracture and one because of loosening of the acetabular component. Five additional acetabular components demonstrated radiographic loosening. Note that two patients with loose but unrevised acetabular components died since the last follow-up period.

poorer values than those of a selected group of normal subjects who were more than fifty-five years old[17]. The median WOMAC physical function, pain, and stiffness scores for the study group were 15.00, 2.00, and 2.00, respectively, which were significantly greater than the mean normative values of 1.8, 0.01, and 0.40, respectively ($p < 0.001$ for each).

The influence of comorbid medical conditions upon each of the studied functional outcomes was examined. The number of comorbid medical conditions and the presence of a musculoskeletal comorbidity had significant effects ($p < 0.05$) on each WOMAC subscale score and the Harris hip score (see Appendix).

### *Radiographic Results*

Of the original ninety-three hips (excluding the seven that had been revised because of infection, periprosthetic fracture, or dislocation), thirty-two had loosening of the acetabular component (it was definite in twenty-four and probable in eight) and eighteen of those had been revised. Twelve hips had definite loosening of the femoral component, and five of those had been revised. Ten hips had possible loosening of the acetabular component, and no hip had possible femoral loosening. Since the time of the twenty-year follow-up, in addition to the two hips that had a revision, five acetabular and three femoral components demonstrated radiographic loosening (late debonding of >1 mm). The combined prevalence of definite or probable radiographic loosening of the femoral component and aseptic loosening of the femoral component that necessitated revision was 13% (twelve hips) overall and 16% (nine hips) in the group with a minimum follow-up of twenty-five years. The combined prevalence of definite or probable radiographic loosening of the acetabular component and aseptic loosening of the acetabular component that necessitated revision was 34% (thirty-two hips) overall and 41% (twenty-four hips) in patients with a minimum follow-up of twenty-five years.

Radiographic results are presented in detail in the Appendix. Acetabular loosening and revision because of loosening were significantly associated with acetabular wear ($p < 0.05$). Acetabular wear was not related to current measures of physical function. No significant associations were detected between the age at the time of surgery and component loosening, need for revision surgery, or wear. Debonding of <2 mm was not related to the need for revision of the femoral component. The grade of the cement around the femoral component had no significant influence on the survival of the femoral component.

### *Survivorship Analysis*

Of the original ninety-three prosthetic hips, sixty-four (69%) were functioning at the latest follow-up evaluation or at the time of death of the patient. Of the sixty hips in the living patients, thirty-eight (63%) were functioning with the index prosthesis in place at least twenty-five years after placement (Figs. 2-A through 2-F). We were unable to show a significant relationship between the decade of life at the time of initial surgery and the prevalence of aseptic loosening or revision of either component. Table III summarizes the changes in revision and radiographic survivorship since the twenty-year follow-up evaluation.

## Conclusions

Compared with the findings in our previous reports on this cohort of young patients who underwent Charnley total hip arthroplasty, acetabular component loosening continued to progress with time. An additional hip (1%) had a revision because of acetabular component loosening, and an additional five hips (5%) showed radiographic signs of acetabular com-

ponent loosening. However, no further progression of femoral component loosening occurred. Early debonding of <2 mm with this polished femoral implant did not progress, and few femoral components (two that had a fracture of a small-diameter stem, two that had subsidence after advanced debonding, and one that had aseptic loosening in a grade-D cement mantle) had a revision because of aseptic loosening in this active population. Even with early debonding of this polished implant, revision because of femoral loosening was uncommon. Wear

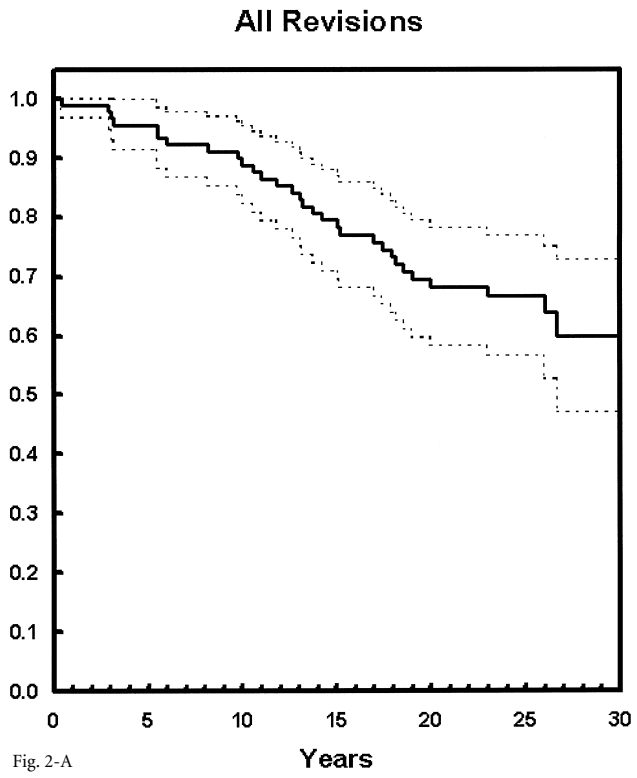


Fig. 2-A

**Figs. 2-A through 2-F** Survivorship curves, with 95% confidence intervals, as determined with the Kaplan-Meier method. **Fig. 2-A** Survivorship curve, with revision for any reason as the end point, demonstrating a probability of survival of 60% ± 7% at thirty years.

of the acetabular component, which was significantly associated with the need for acetabular revision and radiographic signs of acetabular loosening, was the long-term problem associated with this implant, especially in this younger population. Although the original Charnley flatback prosthesis is no longer used, the results with this device should be considered a standard for comparison with the results of newer designs used in this younger age-group.

This study also demonstrated that total hip replacements in this relatively young patient population have excellent long-term function and durability. The functional results in the study group, as measured by the WOMAC scores, were significantly poorer than the reported values for selected indi-

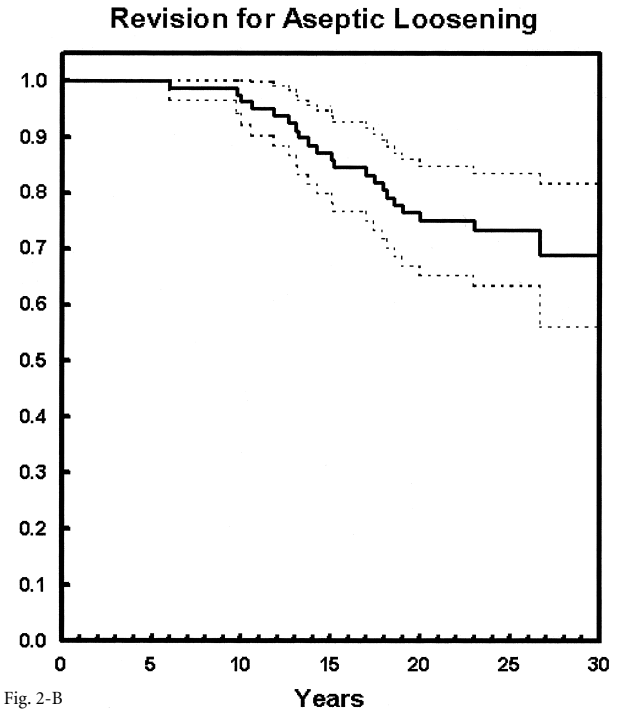


Fig. 2-B

Survivorship curve, with revision of either component because of aseptic loosening as the end point, demonstrating a probability of survival of 69% ± 7% at thirty years.

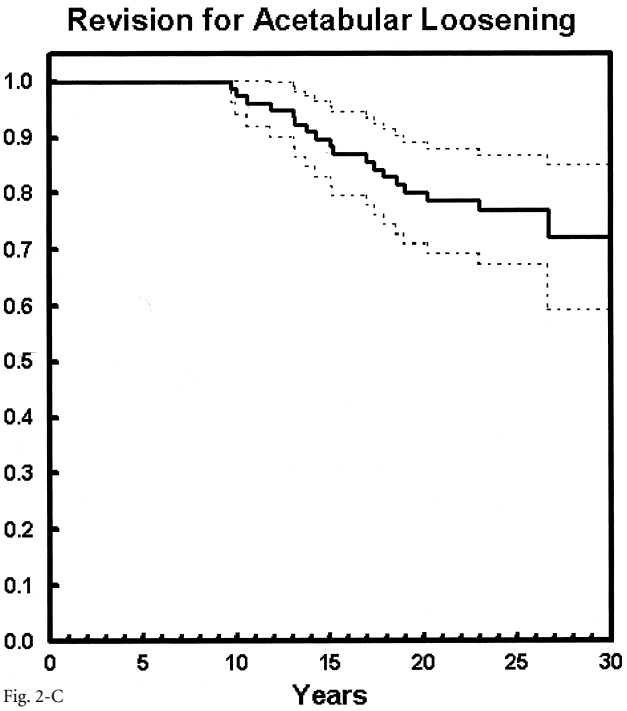


Fig. 2-C

Survivorship curve, with revision of the acetabular component because of aseptic loosening as the end point, demonstrating a probability of survival of 72% ± 7% at thirty years.

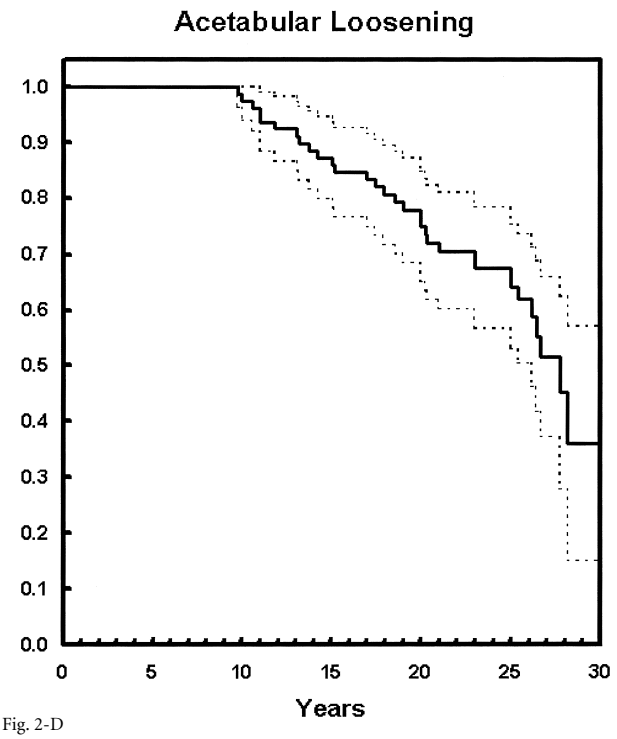


Fig. 2-D

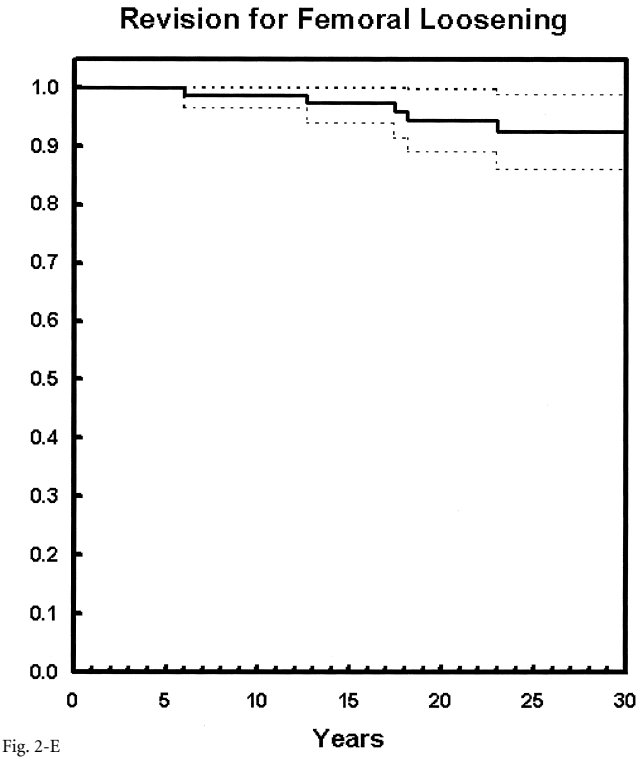


Fig. 2-E

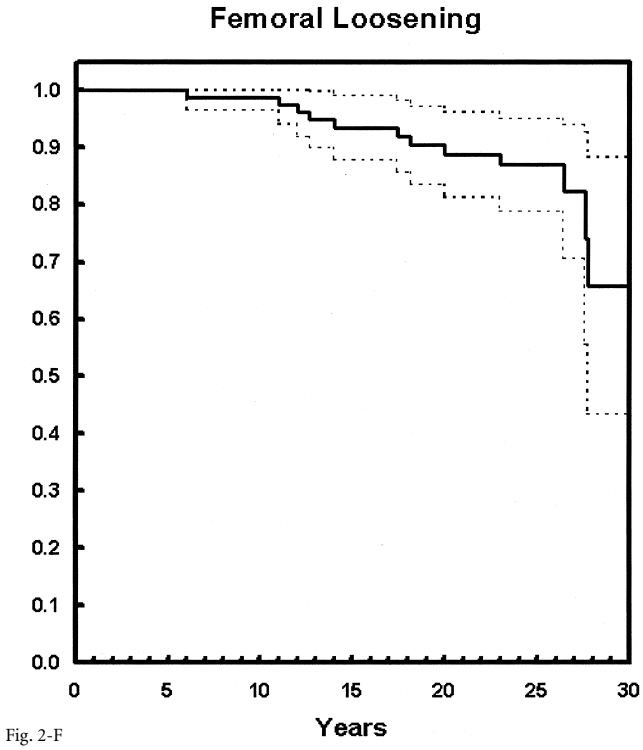


Fig. 2-F

**Fig. 2-D** Survivorship curve, with definite or probable radiographic loosening of the acetabular component or revision because of aseptic loosening as the end point, demonstrating a probability of survival of 36% ± 11% at thirty years.

**Fig. 2-E** Survivorship curve, with revision of the femoral component because of aseptic loosening as the end point, demonstrating a probability of survival of 93% ± 3% at thirty years.

**Fig. 2-F** Survivorship curve, with definite or probable radiographic loosening of the femoral component or revision because of aseptic loosening as the end point, demonstrating a probability of survival of 66% ± 11% at thirty years.

viduals who were more than fifty-five years old without lower-extremity symptoms. Unfortunately, normative data for the WOMAC scales on subjects specifically matched for age and musculoskeletal comorbidity, which would have provided more meaningful comparisons with the study patients, were not available. Our results highlight the fact that revision surgery or radiographic evidence of loosening without revision did not hinder the functional results in this patient cohort. In contrast, medical and musculoskeletal comorbidities were found to have a significant effect on the functional outcomes in these patients.

Thus, more than half (63%) of the sixty hips in the remaining living patients who had a total hip arthroplasty in the early 1970s when they were less than fifty years old were functioning twenty-five to thirty years after implantation, and only 7% required more than one revision.

## Appendix

eA Tables showing the functional outcomes, comorbidities, and radiographic results for the study patients are available with the electronic versions of this article, on our

web site at www.jbjs.org (go to the article citation and click on "Supplementary Material") and on our quarterly CD-ROM (call our subscription department, at 781-449-9780, to order the CD-ROM). ■

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