The results of patients with rheumatoid arthritis who had revision hip arthroplasty have been studied infrequently. The purpose of this study was to review the authors’ clinical and radiographic experiences and outcomes with revision hip arthroplasty. Revision total hip arthroplasties were done on 28 patients (30 hips). All hips had morselized bone grafting and four hips had bulk allografts for segmental defects. The mean age of the patients at the time of surgery was 50 years (range, 20–74 years). Patients were followed up for 4 to 15 years (mean, 7 years). At the latest followup, 14 hips (13 patients) of the 30 hips (47%) had good and excellent Harris hip score ratings. Mechanical failures included six hips (five patients) that had revision arthroplasty and two hips (two patients) that had resection arthroplasty. Six other hips (five patients) had poor Harris hip score ratings. The Kaplan-Meier survivorship curve for failure of the acetabular component revealed an 89% chance of survival at 60 months and a 44% chance of survival at 108 months. Based on the results of this study, revision hip arthroplasty for acetabular loosening with a cementless acetabular prosthesis has a low rate of success in patients with rheumatoid arthritis.

Success rates greater than 90% for primary total hip arthroplasty have been reported in various large series with 5 to 10 years followup in patients with rheumatoid arthritis (10%–20% of most series).7,19,20,21,23,29,30,36,40,41 A recent literature search revealed only one study specifically examining outcomes of revision arthroplasty in patients with rheumatoid arthritis.31 Raut et al31 reported good clinical results in 43 of 47 hips at a mean followup of 7 years (range, 2–19 years) with 45 cemented stems reported to be well fixed (96%). However, 15 cemented sockets (37%) were determined to be loose radiologically in their study. Their conclusions questioned additional acetabular fixation in patients with rheumatoid arthritis.
In other studies reporting on revision hip arthroplasty, there have been small numbers of patients with rheumatoid arthritis (usually a subgroup of a larger study involving fewer than five patients). These studies have not allowed adequate determination of outcomes to guide additional treatment.

Because of the paucity of information concerning this subject and with no study analyzing the results of cementless acetabular fixation in patients with rheumatoid arthritis, this investigation was done. The purpose of this report was to examine the results of cementless acetabular revision total hip arthroplasty in patients with rheumatoid arthritis.

**MATERIALS AND METHODS**

**Patients**

Between July 1, 1984 and December 31, 1995, 406 revision hip arthroplasties were done on 364 patients at the authors’ institution. Of these, 38 hips were revised (34 patients) in patients with rheumatoid arthritis. One patient (one hip) was excluded from this study because revision was done after a bipolar hemiarthroplasty, rather than revision of a total hip replacement. Other patients excluded from this study were two patients (three hips) who had revision of the femoral component only, both of whom had clinical and radiographic success (Harris hip scores of 92, 95, and 96 points at 5-, 11- and 12-year followups). Another patient who was excluded (two hips) had an acetabular polyethylene liner insert change. Two other patients (two hips) were lost to followup within 1 year of the procedure. This left 28 patients (30 hips) who had revision of acetabular components or acetabular and femoral components. There were 18 women and 10 men with a mean age at revision arthroplasty of 50 years (range, 20–84 years). The reason for revision surgery was aseptic loosening in all patients. Twenty-two patients (23 hips) had adult-onset rheumatoid arthritis and six patients (seven hips) had juvenile-onset rheumatoid arthritis.

**Operative Technique**

An anterolateral approach was used in all patients and all patients received a cementless acetabular socket (Howmedica, Rutherford, NJ, currently Stryker-Howmedica- Osteonix, Allendale, NJ). The surgical technique was the same for the two senior authors throughout the study. Twelve hips (11 patients) had a cemented stem implanted and 18 hips (17 patients) had a cementless stem implanted (PCA-E-Series, Howmedica). For the sockets, impacted, morselized, allograft bone was used to fill cavitory defects in all patients. Bulk allograft was not used in any patient where at least 50% of the cup made contact with host bone. For segmented defects, four patients required the use of ancillary bulk allograft bone. In all cups, the fixation was secured by press-fitting a cup that was underreamed by 1 or 2 mm, with the additional use of one to three ancillary cancellous bone screws. The acetabular components remained the same throughout the study. The femoral head size of the prostheses also differed, as 17 of 30 hips were fitted with 26-mm heads and the remaining 13 hips received 32-mm femoral heads.

After surgery, the patients were kept in balanced suspension for 2 to 3 weeks and then began non-weightbearing ambulation with crutches for 6 weeks. At Week 6, patients were advanced to 50% weight-bearing for another 6 weeks, and then allowed weight-bearing as tolerated at 12 weeks.

**Data Collection**

A prospective clinical and radiographic study was done with the help of a computerized database. This study was approved by the Institutional Review Board Committee for the Protection of the Rights of Human Subjects. The database was supplemented as necessary with a careful review of hospital outpatient records to analyze demographic data including corticosteroid use, associated diseases or medical conditions, arthritic involvement of other joints, and height and weight (obesity index). All of the patients were examined clinically and radiographically by all of the coauthors, and the clinical data were obtained at the time of revision surgery and at the most recent followup. Final followups were done by two of the authors (ADR, BD) who were not operating surgeons.

Harris hip scores were used to evaluate each hip for the level of function at the most recent followup. A score of 80 to 100 points was considered good function and a clinical success, and a score less than 80 points was considered poor function and a clinical failure. Clinical outcome also was evaluated subjectively based on whether the patient was satisfied with the revision surgery at the last followup.

Use of corticosteroids was assigned, according to dosage, to two categories to assess the associa-
tion between use and eventual clinical and radiographic outcomes. These categories were based on accepted levels of corticosteroid use from published studies. Category 1 included patients who had taken less than 2 g prednisone (or equivalent other corticosteroid medication) in their lifetime or had never taken corticosteroids. Category 2 included patients who had taken more than 2 g prednisone or its equivalent corticosteroid in their lifetime. The degree of multiple joint arthritis was described using Charnley types A, B, and C (one joint, bilateral joints, and multijoint involvement, respectively). The effect of obesity was assessed by determining the patient’s obesity index:

For women, 

\[
\text{Obesity Index} = \frac{\text{Weight in kilograms} \times 100}{[\text{Height in centimeters} - 150] \times 0.67}
\]

and for men,

\[
\text{Obesity Index} = \frac{\text{Weight in kilograms} \times 100}{[\text{Height in centimeters} - 160] \times 0.71}
\]

Patients with an index greater than 120 were considered obese.

**Radiographic Analysis**

The radiographic review included plain radiographs (anteroposterior and lateral views) obtained before surgery, after surgery, and during the annual followups. Three of the coauthors (MAM, ADR, BD) interpreted the radiographs in a blinded manner for all patients and had complete agreement, concerning classification of acetabular bone stock and osteolysis, and progressive radiolucencies. The quality of the acetabular bone stock at revision arthroplasty was evaluated using two classification systems: the American Academy of Orthopaedic Surgeons system, and the system of Gustilo and Pasternak. The American Academy of Orthopaedic Surgeons system distinguishes two regions of bone defects. Segmental defects (Class I) are not contained and involve bone loss of the acetabular rim, and cavitary defects (Class II) are contained bone deficiencies that do not involve the rim. This system additionally stratifies defects as combined deficiencies (Class III) that involve segmental and cavitary defects, pelvic discontinuity (Class IV), in which the superior and inferior parts of the acetabulum are not connected, and hip arthrodesis (Class V). In the Gustilo and Pasternak system, classification of defects include those having minimal loosening and acetabular wall defects (Class I), marked enlargement and wall thinning without wall defects (Class II), local wall defects in anterior, posterior, superior, or central regions (Class III), or massive defects of two or more walls of the acetabulum (Class IV).

The bone around the acetabular prosthesis was examined for osteolysis and radiolucencies in the three zones defined by DeLee and Charnley. Significant osteolysis or radiolucencies of at least 2 mm in all three zones were considered indications of radiographic failure (Figs 1, 2). Radiolucent and radiosclerotic lines were recorded using the method of Gruen et al for the femoral component.

**Data Analysis**

Success rates were calculated and stratified by multiple clinical and radiographic parameters such as age groups older and younger than 50 years, obesity index (greater than and less than 120), acetabular bone stock classes, femoral head size, and other demographic factors. The data were tabulated using an Access 7.0 database (Microsoft Corporation, Redmond, WA). Descriptive statistics were calculated. Parametric and non-parametric statistical analyses of the results were done using the computer program for Epidemiologic Analysis (PEPI) Software Package Version 2.03 (USD, Incorporated, Stone Mountain, GA). Statistical significance was determined using Pearson’s chi square test (using Yates correction). Using reoperation or postoperative death as the criteria for failure, a Kaplan-Meier survivorship analysis was done to estimate the probability that the implant would fail as a function of time since the initial revision procedure.

**RESULTS**

**Clinical Results**

The mean followup after revision was 84 months (range, 48–180 months). Of the 28 patients (30 hips), five patients (six hips) had repeat revision arthroplasties (20%) and two patients (two hips) had resection arthroplasties (7%). Three of the repeat revision arthroplasties were necessary because of loosening of the acetabular component, two because of massive osteolysis around the cup, and one for a loosened femoral stem. One of the resection arthroplasties was done because of loosening...
of both components and massive osteolysis, and the other because of massive osteolysis around the cup. Six hips (20%) in five patients were clinical failures based on Harris hip scores less than 80 points. One additional patient (one hip) died after revision surgery from a pulmonary embolism. One patient (one hip) had a deep hip infection at 6 years necessitating two-stage reimplantation. Overall, 16 of the 30 hips (53%) had unsuccessful clinical or radiologic results or both. The relationship between results and various parameters are shown in Table 1.

The Kaplan-Meier survivorship curve for failure of the acetabular component revealed an 89% (95% confidence interval, 89 ± 6.3 [standard error %]) chance of survival at 60 months and a 44% chance of survival at 108 months (95% confidence interval, 44 ± 14.7 [standard error %]) (Fig 3).

Operative Technique Results
The size of the prosthetic femoral head used did not have an impact on outcome as eight of 17 (47%) 26-mm heads and six of 13 (46%) 32-mm heads were successful (p = 1.00).

Radiographic Results
Of the clinically successful hips, there were two additional acetabular cups with complete radiolucencies that were categorized as impending radiographic failures. The six hips that had low Harris hip scores (less than 80 points) but which had not been revised all had complete radiolucencies. The 12 other hips had no evidence of
any progressive radiolucencies around the cups in any of the three acetabular zones.

Hips were less acetabular bone deficiency had higher success rates; 53% of American Academy of Orthopaedic Surgeons Class II hips were successful (nine of 17 hips) and only 39% of American Academy of Orthopaedic Surgeons Class III hips were successful (five of 13 hips). Gustilo and Pasternak Class I and Class II hips had a 56% success rate (nine of 16 hips) whereas Class III and Class IV had only 36% success (five of 14 hips) (Table 2).

Radiographic results of femoral stem fixation showed that none of the six cemented stems and one of the 18 cementless stems (5.6%) had evidence of stem loosening.

### Table 1. Relationships Between Results and Various Parameters

<table>
<thead>
<tr>
<th>Category</th>
<th>Stage Stratification</th>
<th>Successes</th>
<th>Total</th>
<th>Success Rate (percent)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td></td>
<td>14</td>
<td>30</td>
<td>0.467</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>&gt; or = 50 years</td>
<td>4</td>
<td>14</td>
<td>0.296</td>
<td>p = 0.247</td>
</tr>
<tr>
<td></td>
<td>&lt; 50 years</td>
<td>9</td>
<td>16</td>
<td>0.563</td>
<td></td>
</tr>
<tr>
<td>Obesity</td>
<td>Obesity index &gt; 120*</td>
<td>2</td>
<td>5</td>
<td>0.4</td>
<td>p = 1.00</td>
</tr>
<tr>
<td></td>
<td>Obesity index &lt; 120*</td>
<td>12</td>
<td>25</td>
<td>0.48</td>
<td></td>
</tr>
<tr>
<td>Steroids</td>
<td>I</td>
<td>13</td>
<td>25</td>
<td>0.52</td>
<td>p = 1.00</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>1</td>
<td>3</td>
<td>0.33</td>
<td></td>
</tr>
<tr>
<td>Femoral</td>
<td>26 mm</td>
<td>8</td>
<td>17</td>
<td>0.471</td>
<td>p = 1.00</td>
</tr>
<tr>
<td>Head size</td>
<td>32 mm</td>
<td>6</td>
<td>13</td>
<td>0.46</td>
<td></td>
</tr>
</tbody>
</table>

*See text for definition.*
Complications
One patient experienced dislocation of the hip in the recovery room and a closed reduction was done. The patient also had an infection of the hip develop that required irrigation and debridement, although the prosthesis was salvaged. The patient died 2 years later. Another patient has had two dislocations of the hip since surgery. A closed reduction was done and the patient was placed in an abduction brace. This patient had an additional revision at 1 year after surgery. A deep hip infection developed in another patient that required irrigation and debridement and the prosthesis also was salvaged. The patient was doing well at the 4-year followup (Harris hip score of 86 points). The two patients who had resection arthroplasties are doing well clinically at 7 and 12 years followup (Harris hip scores greater than 80 points). One patient died 1 month after the original revision surgery from a pulmonary embolism.

DISCUSSION
The best method for fixation for revision hip arthroplasty for patients with rheumatoid arthritis remains to be determined. A previous report by Raut et al,32 revealed excellent or satisfactory clinical results for 79 of 87 hips (91%) using cemented fixation, but radiographically there was a high failure rate on the acetabular side (37%, 15 of 41) at a similar followup (mean, 7 years, 4 months) to the current study. The current study had similar acetabular failure rates (37%, 11 of 30 cups), using cementless fixation of the acetabular component at a followup mean of 7 years (range, 4–15 years).

Although there were only 28 patients (30 hips) in the current study, this represents the largest group of cementless acetabular revisions in patients with rheumatoid arthritis. These numbers do not make the conclusions drawn in this study less valid. There are problems with acetabular fixation for these patients, whether cementless (current study) or cemented fixation is used. The poor results found in both studies may be attributed in part to rheumatoid disease. Although some of the cases were variable for differing degrees of bone loss, use of bone graft, and activity of rheumatoid disease in all of these variable subgroups, the results were worse than for other diagnoses. Young

<table>
<thead>
<tr>
<th>TABLE 2. Relationships Between Results and Acetabular Bone Stock Class</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bone Stock Classification</strong></td>
</tr>
<tr>
<td>AAOS6</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Gustilo and Pasternak16</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

AAOS = American Academy of Orthopaedic Surgeons
patient age may have played a role (mean age, 50 years in the current study). However, in studies\textsuperscript{3,26,29} of patients with other diagnoses in this same age group, the results are consistently superior.

The current study also highlights the relatively high morbidity in doing revision hip arthroplasty on patients with rheumatoid arthritis. Not only was the overall 7-year clinical and radiologic followup success rate low (45\%), but there were multiple perioperative and postoperative complications. Early major complications included one death attributable to a pulmonary embolus, three dislocations (10\%), and two postoperative infections.

Radiographic results of femoral stem fixation were satisfactory; none of the six cemented stems and 5.6\% (one of 18) of the cementless stems had evidence of stem loosening. These results also are similar to those of Raut et al\textsuperscript{12} who had an incidence of 5.1\% cemented stem loosening.

Although, in general, the success rate of revision hip arthroplasty for patients with all diagnoses does not approach the success rate of primary total hip arthroplasty, there are multiple reports of high success rates at mean 5- to 10-year followups in patients who had revision hip arthroplasty. Leopold et al\textsuperscript{25} reported on 138 consecutive cementless acetabular revisions in 131 patients with primary osteoarthritis. The Kaplan-Meier survivorship of these components was 84\% at 11.5 years. In another study\textsuperscript{3} from the same institution, of 74 consecutive primary hip replacements in patients younger than 50 years, there was a Kaplan-Meier 10-year survival of the acetabular prostheses of 98.8\%. Other reports using the Porous Coated Anatomic cup have shown high failure rates in patients with primary osteoarthritis.\textsuperscript{18,39} Hastings et al\textsuperscript{18} found a 13\% acetabular failure rate at a mean followup of 10.3 years in a study of 100 hips (89 patients).

Although not entirely analogous to the revision situation, the various studies of primary total hip arthroplasty for patients with rheumatoid arthritis also have found high failure rates on the acetabular side. Poss et al\textsuperscript{28} reported excellent function at the 7-year followup (96\%, 133 of 138 cups), but concluded that with longer followup, mechanical loosening of the acetabular component might be a significant problem. Unger et al\textsuperscript{40} at a followup of 12.1 years of 83 hips, found that seven cups needed revision and 11 others had radiologic loosening resulting in a combined failure rate of 30\%. Lachiewicz et al\textsuperscript{24} found similar rates of failure of acetabular components in patients with juvenile rheumatoid arthritis (26\% in 83 hips at followup at a mean of 6 years). Results may be improved with the use of cementless sockets. Cracchiolo et al\textsuperscript{7} did 40 uncemented total hip arthroplasties in patients with rheumatoid arthritis and had no clinical and radiographic failures at a mean followup of 3.7 years (range, 2–6 years).

In the current study, despite the fact that a stable interface was achieved at surgery in all patients with cementless acetabular components with greater than 50\% of host bone contact and the use of morselized bone grafting, there still was a 53\% acetabular failure rate. This is in contradistinction to the use of morselized bone grafting for acetabular protrusion in primary hip arthroplasties as reported by Rosenberg et al.\textsuperscript{33} They had a 90\% survival rate at 12 years in 20 hips. Other options that could have been used would have included the use of various cementing techniques, with or without structural allografts or protrusion rings.\textsuperscript{12,34,35} These studies have shown variable failures rates of these other techniques, so it is not known whether they would have improved the results found in the current study. Another technique that might be more successful would be the use of impacted allograft bone in conjunction with cups that are inserted with cement. Slooff et al\textsuperscript{38} reported excellent clinical and radiographic results for 78 of 88 (89\%) hips that had revision surgery at a mean followup of 70 months in patients with osteoarthritis. Additional studies are necessary to determine the best techniques and fixation methods for the acetabulum for patients with rheumatoid arthritis having revision hip arthroplasty.
Some of the poor results in the current study must be attributed to the Porous Coated Anatomic prosthesis which has had problems with premature acetabular polyethylene wear. However, the results in this study still are inferior to those achieved with this prosthesis for patients with other diagnoses from the authors’ institution. From the database of 406 revision surgeries using Porous Coated Anatomic cups in patients with hip osteoarthritis, the acetabular revision rate was 8% at a similar followup (7-year mean), which is superior to the acetabular revision rate of 37% for patients with rheumatoid arthritis in the current study.

Poor bone quality and deficient acetabular structures combined with the Porous Coated Anatomic cup were critical risk factors for acetabular socket survival after revision surgery in patients with rheumatoid arthritis. These findings highlight the need for early revision in patients with rheumatoid arthritis who may have impending radiographic failure or osteolysis so that as much acetabular bone stock can be preserved as possible. Therefore, regular radiographic followups of patients with rheumatoid arthritis are important to allow for early diagnosis and treatment. Acetabular revision in patients with rheumatoid arthritis is a difficult procedure with high morbidity rates. The development of treatment protocols in this patient group are evolving with cross-linked polyethylene, or various ceramic and metal interfaces or both, leading to more successful outcomes in the future.

References