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ORIGINAL ARTICLE

Femoral Osteolysis Around the Unrevised Stem During Isolated Acetabular Revision

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Abstract Many surgeons treat progressive femoral osteolysis in association with a well-fixed stem with bone grafting but in uncontained proximal defects the graft could get into the joint, raising a question regarding whether the osteolysis can be treated by simple débridement without bone grafting. We investigated whether the curetted proximal osteolysis around an unrevised femoral component progressed in size and whether this lesion would have a deleterious effect on fixation of the femoral component in patients with isolated acetabular revision. We prospectively followed 21 patients (24 hips) who underwent acetabular revision and curetting of femoral osteolysis. The minimum followup was 3 years (mean, 4.3 years; range, 3–7.4 years). By the latest followup, no hips had major progression of the osteolytic defect through the followup period and none had any new osteolytic lesions. All hips were judged stable and to have well-fixed acetabular cups and femoral stems. Provided a femoral component is bone ingrown with osseointegration sufficient to provide long-term stability, the osteolytic defect is in the proximal aspect of the femur, and the defect is uncontained, simple curettage may preserve femoral implant stability and may prevent progression of osteolysis to another Gruen zone for at least 3 to 7 years.

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Introduction

Osteolysis around the femoral stem is a well-recognized complication and one of the most frequent causes of failure in THA [5, 24, 26]. In general, osteolytic lesions worsen with time, although the rate of progression is variable [24, 25]. The development of circumferential porous coating in cementless stems has been accompanied by a unique problem to these stems. The surgeon may be faced with limited proximal osteolysis in a well-fixed femoral component during revision of a failed acetabular component. Although it is obvious revision generally should be performed when the osteolytic lesion is associated with a loose femoral component, the controversy arises when femoral osteolysis is accompanied by a well-fixed stem. Surgical options are to revise the stem or to débride with bone grafting [17]. Some investigators have recommended treating femoral osteolysis in association with a well-fixed stem with bone grafting [3, 17]. However, it would be reasonable to be concerned about grafted bone escaping into the joint if the defect was not contained, and these studies do not describe femoral osteolysis treated by simple débridement without bone grafting after isolated acetabular revision.

We asked whether the proximal osteolysis around an unrevised femoral component could be halted by revision of the acetabular component and débridement of the femoral osteolytic lesion without bone grafting in a well-fixed femoral stem. We also asked whether this approach would have a deleterious effect on fixation of the femoral component in patients with isolated acetabular revision.

Materials and Methods

We retrospectively reviewed 107 patients (131 hips) treated by revision THA between August 2000 and December 2004. These included revision of the femoral component in eight hips (6%), revision of the acetabular component in 45 hips (34%), and revision of both components in 78 hips (60%). Among these, femoral osteolysis occurred in 76 hips (58%). These hips were treated as follows: revision of the femoral component in 40 hips (52.7%) when the femoral osteolysis was associated with stem loosening, bone grafting into the osteolytic lesion in eight hips (10.5%) when the femoral stem was well fixed and the osteolytic defect was well contained, and simple curettage of femoral osteolysis when the femoral component was well fixed and the osteolytic lesion was not contained during isolated acetabular revision in 28 hips (25 patients; 36.8%). These 25 patients make up our study group. We followed these patients prospectively at the time of scheduled visits to evaluate femoral osteolysis. In all hips, the femoral and acetabular components were cementless and were judged clinically and radiographically well fixed at the time of revision. The indication for revision in all hips was polyethylene liner failure and resulting extensive osteolysis around the acetabulum. The revision surgery was the first revision for all hips. The underlying diagnosis at the time of primary arthroplasty was osteonecrosis in 19 hips (79%) and osteoarthritis in five (21%). There were 14 men and seven women with a mean age of 47.1 years (range, 26–68 years), a mean height of 164.6 cm (range, 155–177 cm), and a mean weight of 61.9 kg (range, 50–75 kg) at the time of revision. The left hip was involved in six patients and the right hip in 12; both hips were involved in three. The average interval between initial arthroplasty and index acetabular revision was 8.2 years (range, 4.9–12.3 years) Two patients (two hips) died from causes unrelated to surgery, and two patients (two hips) were lost to followup before the end of the minimum 3-year followup period (mean, 4.3 years; range, 3–7.4 years); this left 21 patients (24 hips) as the subjects. These 21 patients were followed a minimum of 3.9 years (mean, 8.3 years; range, 3.9–12.3 years) after the primary arthroplasty. None of the four patients who died or were lost to followup showed progression of femoral osteolysis by the time of their last evaluation (8–23 months). All patients provided informed consent for participation, and our Institutional Review Board approved the protocol.

We used the Harris-Galante™ II porous-coated acetabular cup (Zimmer, Inc, Warsaw, IN) in all primary THAs. The outer diameter of the primary acetabular component averaged 53 mm (range, 46–60 mm). The polyethylene thickness averaged 7.0 mm (range, 3.3–10.3 mm). Twenty femoral components were cementless HG MultiLock™ hip prostheses and four were cementless Harris-Galante™ stems (all manufactured by Zimmer).

In all hips, we revised the shell because of severe metal damage or extensive osteolysis of the acetabulum, although the cup was well fixed. We performed all revision procedures with an anterolateral approach. We revised all acetabular components with larger-diameter cementless components and modular polyethylene liners. The acetabulum was underreamed by 2 mm and press-fit into place. We performed bone grafting for all osteolytic acetabular lesions. The osteolytic lesion around the femoral component was removed with angled curettes, and tissue samples routinely underwent pathologic evaluation. We did not bone graft the defects in the femur to avoid graft in uncontained defects from escaping into the hip. All femoral heads were replaced with 28-mm cobalt-chrome heads. We used the InterOp™ cup (Sulzer Orthopedics, Inc, Austin, TX) in eight hips and the Trilogy® acetabular component (Zimmer) in 16 hips. The Durasul™ (Sulzer Orthopedics) highly cross-linked polyethylene liner was used in eight hips and the Longevity® (Zimmer) highly cross-linked liner was used in 16 hips. The external diameter of the acetabular component averaged 60.8 mm (range, 54–67 mm). The average thickness of the polyethylene liner was 10.6 mm (range, 7.3–14.3 mm).

The postoperative rehabilitation protocol was the same for all patients, who were allowed progressive weightbearing as tolerated on the third day after surgery. Patients did not receive any antiosteolytic medications including bisphosphonate during followup.

We assessed each patient clinically and radiographically before and after revision surgery at 4 weeks, 3 months, 6 months, 12 months, and annually thereafter. We obtained preoperative and postoperative Harris hip scores [12]. Thigh pain was rated as none, slight, mild, moderate, or severe using the same criteria as for the pain category of the Harris hip score [12].

Standard radiographs included an anteroposterior view of the pelvis and anteroposterior and lateral views of the proximal part of the femur. Radiographs taken 4 weeks after index surgery served as the baseline for all subsequent comparisons. We considered an acetabular component radiographically loose when migration had occurred or a circumferential radiolucency of 2 mm could be measured. We measured cup migration on serial radiographs, and a linear change greater than 3 mm or a rotational change 8° or greater was considered migration [19]. Radiographic evaluations of the socket were done using DeLee and Charnley zones [6]. Osteolysis was defined as the radiographic appearance of any focal area of bone resorption 2 mm wide or greater that was not evident on the radiograph obtained immediately after surgery [27]. We measured the size of the area of osteolysis on the anteroposterior radiograph as the greatest diameter of the lesion in the horizontal and vertical axes [18]. A correction factor for magnification, based on the known diameter and the measured radiographic diameter of the femoral head, was applied to all measured radiographic calculations. All measurements were made by one blinded observer (CHJ). To check reproducibility, a second blinded observer (KJL) also measured the osteolytic lesion in five hips. The intraobserver and interobserver measurements errors of osteolysis size were 2% and 3%, respectively. We identified lesion location using the zones defined by Gruen et al. [11]. All hips showed focal osteolysis proximal to the lesser trochanter around the femoral stem at the time of the revision, mainly in Gruen Zones 1 and 7. Lesions did not span more than one Gruen zone. We compared the latest followup radiograph and the initial postoperative radiograph after revision to determine progression of the osteolytic lesion. If the osteolysis increased its initial postoperative area by more than 50% or greater than 1 cm^2, we defined the osteolysis as having progressed. If the osteolysis decreased by more than 50% of its immediate postoperative area or greater than 1 cm^2, we defined the osteolysis as having regressed [13, 15]. Osteolysis with an area change less than 50% and less than 1 cm^2 was considered stabilized. Bone graft consolidation around the acetabulum was evaluated using the method of Peters et al. [21], and linear polyethylene wear was measured with a radiographic digitizer according to the method of Livermore et al. [16]. Femoral component fixation was graded as radiographic ingrowth, stable fibrous, or unstable according to the criteria of Engh et al. [8–10]. We defined instability of the femoral stem as subsidence greater than 3 mm, a change of position, or a continuous radiolucent line wider than 2 mm [9].

Results

No hips had progression of the osteolytic defect during the followup period and none had new lesions (Fig. 1). At the time of revision, the average osteolytic lesion size was 80.3 mm^2 (range, 27.4–116.3 mm^2) in Zone 1 on the anteroposterior radiographs. At the latest followup, the average size of these lesions was 84.9 mm^2 (range, 29.4–121.6 mm^2). No hip increased or decreased its initial postoperative osteolytic area by more than 50% or greater than 1 cm^2 in Zone 1. At the time of revision, the osteolytic lesions observed in Zone 7 on the anteroposterior radiographs averaged 63.6 mm^2 (range, 13.7–178.3 mm^2). At the latest followup, these lesions averaged 67.8 mm^2 (range, 13.7–184.3.8 mm^2). All hips had stabilized osteolytic lesions in Zone 7.

At the last followup, all femoral components remained osseointegrated and stable with endosteal spot welds, and none had circumferential radiolucent lines or signs of subsidence. All acetabular components were bone ingrown. Four cups (17%) had a radiolucent line less than 1 mm at the bone-cup interface in Zone 1. We found the average annual linear wear of polyethylene to be 0.03 mm per year (range, 0–0.06 mm per year). All of the grafts had been incorporated into the host bone in the acetabulum. No new areas of osteolysis were seen in any femur or acetabulum.

The average Harris hip score improved from 62 points (range, 45–83 points) before revision to 92.8 points (range, 82–99 points) at the final examination. Groin pain improved in most patients. Preoperatively 12 patients were asymptomatic, seven had moderate pain, and two had minimal pain. At the latest followup, all patients were asymptomatic. No patients had thigh pain preoperatively and postoperatively. There were no dislocations, nerve palsies, early or late infections, intraoperative fractures, or any clinical evidence of venous thrombosis.

Discussion

Most surgeons treat progressive femoral osteolysis in association with a well-fixed stem with bone grafting. However, in the presence of uncontained proximal defects treated during the course of acetabular revision, graft could get into the joint, raising a question regarding whether the osteolysis can be treated by simple débridement without bone grafting. Our primary purpose therefore was to clarify whether femoral osteolytic lesions could be halted by revision of the acetabular component and débridement of femoral osteolytic lesions without bone grafting in a well-fixed femoral stem. We then asked whether this approach would have a deleterious effect on fixation of the femoral component in patients with isolated acetabular revision because of the potential influence of osteolytic lesions on long-term fixation of the femoral stem.

Limitations of our study include the small number of patients (21 patients, 24 hips) and the relatively short-term followup after revision surgery (an average of 4.3 years). The technique of measurement of the osteolytic lesion could be criticized because the lesion size was small and uncontained, although previous authors [3, 17] used a similar approach. The lack of detailed histologic analysis of the osteolytic lesions calls into question whether these lesions represented stress shielding or infection. We defined an osteolytic lesion as the radiographic appearance of any focal area of bone resorption 2 mm wide or greater that was not evident on the radiograph obtained immediately after surgery. Well-circumscribed lesions and the lack of trabeculae on radiographs represented osteolytic defects.

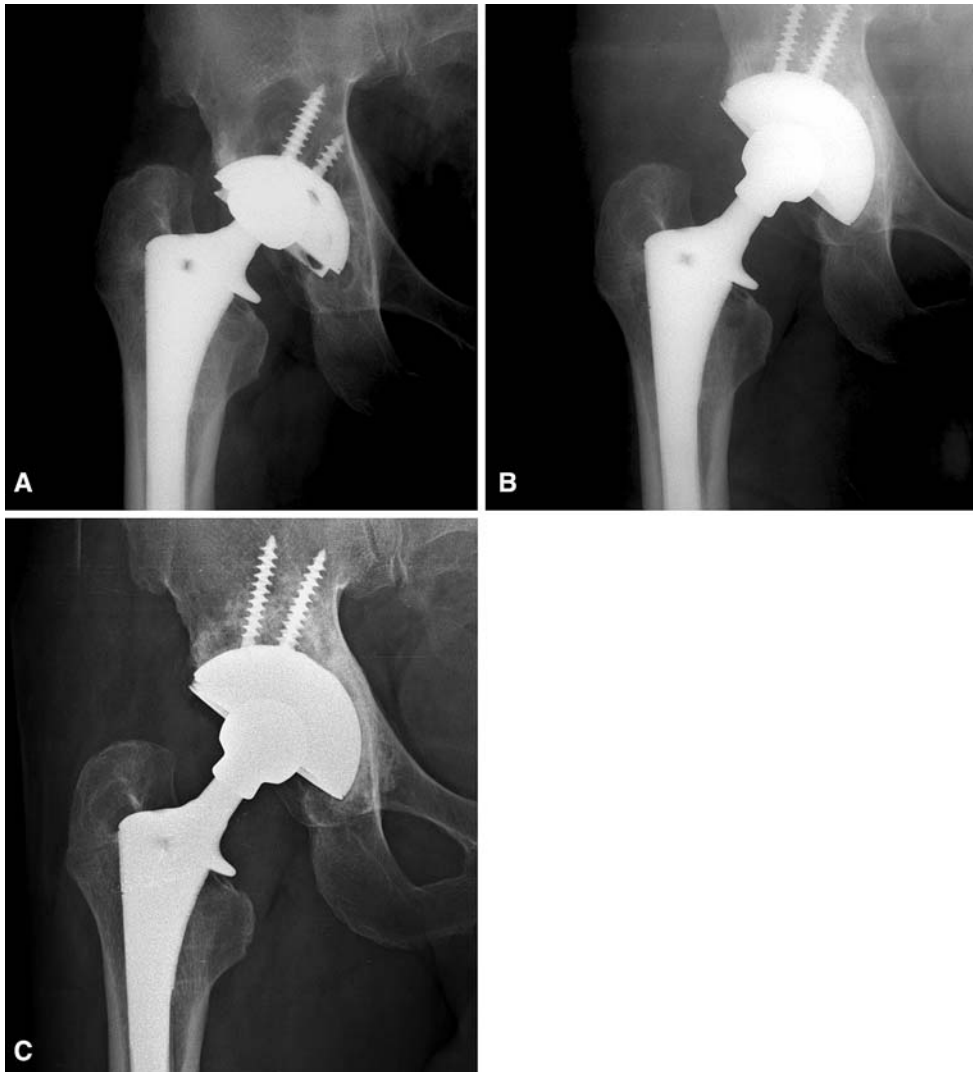

Fig. 1A–C A 54-year-old man underwent THA with cementless acetabular and femoral components because of nontraumatic osteonecrosis of the femoral head of his right hip. (**A**) A radiograph obtained 7.4 years after the primary THA shows excessive polyethylene wear and diffuse osteolysis in the supraacetabular region of the right hip. A small osteolytic lesion of the right femur in Zones 1 and 7 can be seen. (**B**) An anteroposterior radiograph obtained 4 weeks after revision surgery shows the revised cementless socket. The polyethylene liner was exchanged for one with a 28-mm inner diameter, and the acetabular osteolytic lesion was treated with bone grafting. However, the cementless femoral stem was retained and the osteolytic lesion of the proximal femur was treated only with curettage because the defect was too small and uncontained to prevent bone graft from escaping into the hip. During surgery, the femoral component was stable. (**C**) A radiograph obtained 4.5 years after revision of the right acetabular component shows well-fixed femoral and acetabular components, no further progression of femoral osteolysis, and no new acetabular or femoral lesion.

All histologic analyses of curetted lesions revealed aggregates of macrophages with polyethylene debris. We also did not use a control group to compare outcomes with bone grafting versus outcomes without bone grafting. We did not add bone graft when the defect was not contained. The same types of revision procedures were performed in all hips: insertion of cementless acetabular component, highly cross-linked polyethylene exchange, modular cobalt-chrome head change, and packing the acetabular defect with cancellous bone graft. Bone graft was added when the femoral defect was contained. Finally, we did not have an additional control group that was treated nonoperatively. However, the natural history of femoral osteolytic lesions seems to progress with time [24, 25].

We found no hips had further progression of the osteolytic lesion to another Gruen zone and none had new lesions. There may be several reasons for the lack of progression of existing osteolysis and lack of new lesions after revision of acetabular components in our patients. As reported by Schmalzried et al. [23], sites without bone ingrowth become effective joint spaces, and osteolysis progresses and expands as long as wear particles are produced when cementless fixation is used. Wan and Dorr [25] also noted poor fixation is directly correlated to the occurrence and progression of osteolysis. We observed stable osseous ingrowth in all femoral components at revision and at the latest followup in our patients. Polyethylene wear is directly correlated to the occurrence and progression of osteolysis [14, 25, 26]. Advances in polyethylene preparation have resulted in the development of highly cross-linked polymers that have substantially reduced secondary oxidation and wear of polyethylene in the laboratory [20] and clinically [7]. We used these liners in all hips at revision. The average annual wear rate of polyethylene liners in our patients was 0.03 mm per year. Wan and Dorr [25] reported the incidence of osteolysis was 4% if annual linear wear was less than 0.1 mm. Some investigators [1, 2, 22] suggested the risk of osteolysis after

Table 1. Published outcomes for patients with proximal femoral osteolysis

Study	Number of hips	Lesional treatments for femoral osteolysis	Length of followup (years)*	Progression of osteolytic lesions
Maloney [17]	15	Débridement and grafting	6.2	No progression
Wan and Dorr [25]	72	No treatment	> 5	Slow progression (0.89 mm/year)
Chang et al. [4]	7	Curettage and bone grafting	5.9	Not available
Benson et al. [3]	17	Curettage and bone grafting	> 2	Regression of osteolytic lesion
Hozack et al. [13]	154	28 hips (allograft-bone paste), 126 hips (no treatment)	2–5	No progression
Current authors	21	Débridement	4.3	No progression

* Values are presented as means.

revision was less because of the decompression effect of hip pressure during revision surgery. Therefore, we speculate our patients' lesions did not progress further and they had no new lesions because the level of prosthetic wear was reduced when we replaced their polyethylene liners with highly cross-linked polyethylene liners, because of hip decompression, and because of solid acetabular and femoral component fixation.

We found nonprogressive osteolytic lesions had no deleterious effect on fixation of the femoral stem after simple curettage without bone grafting. Progression of any individual osteolytic lesion in the proximal femur is crucial to long-term fixation of femoral stems when stems fixed primarily to the proximal metaphyseal bone, such as stems with proximal circumferential porous coating, are implanted. Comparison of our observations to those of other studies is not possible because the results of simple curettage with proximal femoral osteolysis have not been reported previously. Some authors have recommended proximal osteolysis in association with a well-fixed stem be surgically treated with bone grafting (Table 1). Maloney [17] performed débridement and bone grafting in 15 patients who had proximal femoral osteolysis with osseointegrated femoral components. Contained lesions appeared to radiographically consolidate, implants remained radiographically stable, and the lesions tended not to increase during the 5- to 8-year followup period. Benson et al. [3] reported similar findings: 15 of 17 lesions treated by grafting regressed. No new lesions were identified, and there were no stem failures. Wan and Dorr [25] evaluated the natural history of the progression and size of defects of femoral focal osteolysis without any treatment of the lesion. They reported lesion growth rate was very slow with focal defects averaging 0.89 mm per year. There are no guidelines for when it is appropriate to add bone graft to uncontained small osteolytic lesions of the proximal femur around unrevised femoral stems in isolated acetabular revisions. The concern is to prevent bone graft from escaping into the hip. Our findings at a minimum of 3 years after surgery suggest simple curettage of uncontained osteolytic lesions in well-fixed femoral components halts lesion growth and prevents formation of new femoral and acetabular lesions. Nonprogressive osteolytic lesions apparent at the latest followup did not influence the stability of the femoral component. Simple curettage without bone grafting into the osteolytic lesion has the potential advantage of reducing complications associated with harvesting the autograft and reducing the chance of disease transmission through the allograft. Bone grafting carries the hazards of increased duration of surgery and increased blood loss. However, because of the small number of patients and wide range of lesion sizes (27.4–116.3 mm^2 in Zone 1 and 13.7–178.3 mm^2 in Zone 7) in our patients, we cannot provide firm recommendations regarding the size of lesions that should be treated without bone grafting.

Provided a femoral component is bone ingrown with osseointegration sufficient for providing long-term stability, an osteolytic defect is in the proximal aspect of the femur, and the defect is uncontained, simple curettage may preserve femoral implant stability and may prevent progression of osteolysis to another Gruen zone for at least 3 to 7 years.

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