Original Research
Revision Total Hip Arthroplasty in Patients With Avascular Necrosis

Steven Y. Wei, MD
John J. Klimkiewicz, MD
Max Lai

Jonathan P. Garino, MD
Marvin E. Steinberg, MD

Abstract

This retrospective study compared the results of revision total hip arthroplasty (THA) in patients with avascular necrosis to patients with osteoarthritis. Twenty-two revision THAs (34 components) in 19 patients with avascular necrosis were compared with 35 revision THAs (55 components) in 31 patients with osteoarthritis. All of the procedures were performed by a single surgeon between 1981 and 1994, and all patients had a minimum of 2 years of follow-up. At the time of revision surgery, the average age was 54 years for the avascular necrosis patients and 67 years for the osteoarthritis patients (P<0.002). Clinical and radiographic follow-up was performed for an average of 7 years (range: 2-12 years).

Six (18%) components in the avascular necrosis group and nine (16%) components in the osteoarthritis group required re-revision for aseptic loosening an average of 7 years after the original revision (range: 2-11 years). Statistical analysis demonstrated no significant difference between the two groups in regard to the incidence of failure, time to failure, Harris Hip Score, and radiographic appearance. Contrary to expectations derived from the literature on primary THA, no difference was found between the outcome and survivorship of revision THA in patients with avascular necrosis and patients with osteoarthritis, despite a significant difference in age.

Results of revision total hip arthroplasty (THA) are inferior to those of primary hip replacement; the incidence of both failures and complications is increased relative to the index procedure. Outcome studies for cemented revision THA have indicated that the incidence of re-revision ranges from 9% at 4 years to 29% at 8 years.1-10 In these same reports, the number of complications such as perioperative femoral fractures, dislocations, infections, thromboembolic disease, heterotopic ossification, and trochanteric nonunions was increased compared with primary THA. Most authors also have expressed concern regarding the increased incidence of radiographic failure in asymptomatic or minimally symptomatic patients at relatively short follow-up after revision surgery.

The incidence of repeat revisions for cementless and hybrid hip revision procedures ranges from 5% at 2 years to 10% at 5 years.11-12 These results, while superior to their cemented counterparts, lack suitable follow-up for equal comparison. In addition, cementless hips have been associated with a higher incidence of thigh pain than cemented prostheses.

No reports focusing entirely on revision THA in patients with avascular necrosis exist in the literature, although several studies included these patients in their follow-up.13,14,15,19 Kavanagh et al4 reported a 5% incidence of re-revision for avascular necrosis patients, but details regarding the number of patients and their length of follow-up were not provided, nor did the other authors analyze the avascular necrosis patients separately.

Several studies have specifically examined the results of primary THA in patients with avascular necrosis. In a review of 27 such reports from 1974-1994, all but 2 showed that avascular necrosis patients have a higher incidence of failure than age-matched con-
trols with other diagnoses. On the other hand, Garino and Steinberg demonstrated that with modern techniques and devices, the results of primary THA in younger avascular necrosis patients are comparable to those of older osteoarthritis patients.

This retrospective study compares the results of revision THA in patients with avascular necrosis to patients with osteoarthritis.

**Materials and Methods**

All revision THAs performed by the senior author (M.E.S.) between 1981 and 1994 were reviewed. A total of 95 revision THAs were performed in 83 patients during this period. Thirty-two revisions were performed in 27 patients with avascular necrosis, and 42 revisions were performed in 37 patients with osteoarthritis. Revisions involving components not routinely used by the senior surgeon (used less than five times over the 14-year period of this study) were excluded. In addition, patients with <2 years of follow-up were excluded. This left 22 hips (17 acetabular and 17 femoral components) in 19 patients in the avascular necrosis group and 35 hips (24 acetabular and 31 femoral components) in 31 patients in the osteoarthritis group for comparison.

Risk factors for avascular necrosis included a history of steroid use (10 cases in 8 patients), alcohol use (5 cases in 5 patients), and trauma (4 hips in 4 patients). Three hips in 2 patients with no identifiable risk factors were considered idiopathic.

Prior to revision, all patients had significant disabling groin or thigh pain, resulting in moderate to severe functional limitation in both walking and activities of daily living. Failure of conservative therapy, which consisted of the maximal use of assistive devices and medication, was a prerequisite for revision surgery.

All of the revision THAs were performed using a standard posterolateral approach. Two avascular necrosis and 3 osteoarthritis patients required a trochanteric osteotomy for adequate exposure. One hip in each group required the use of a protrusio ring. Six avascular necrosis and 10 osteoarthritis cases required bone grafting. Most bone grafting involved morcellized allograft and occasionally autograft for a contained acetabular defect. Two hips required structural allograft for the femur, and a third hip required structural autograft for the acetabulum.

Two acetabular components were used for the revisions analyzed in this study: the cemented all-polyethylene Müller (Zimmer, Warsaw, Ind) and the cementless Harris-Galante Porous (HGP) (Zimmer) cups. Cemented cups were used exclusively until 1987, and unless contraindicated, press-fit cups were implanted after 1987. The Müller sockets were implanted using tobramycin-impregnated cement, and the HGP acetabuli generally were oversized by 1-2 mm. In the avascular necrosis group, 10 Müller and 7 HGP cups were used, and in the osteoarthritis group, 14 Müller and 10 HGP cups were implanted.

Two cemented femoral prostheses were used during the study period: the monoblock Harris Design-2 (HD-2) (Howmedica, Rutherford, NJ) and the modular Harris Precoat (Zimmer) stems. The HD-2 was used primarily in cases performed before 1987, and the Harris Precoat was used primarily in cases performed after 1987. Both types of femoral components were implanted using tobramycin-impregnated cement. Ten HD-2 and 7 Harris Precoat stems were used in the avascular necrosis group, and 17 HD-2 and 14 Harris Precoat stems were implanted in the osteoarthritic group.

Postoperatively, patients generally were allowed to bear partial weight and were progressively mobilized until discharged from the hospital. Full weight bearing was generally begun 6 weeks after surgery. Patients with structural bone graft were maintained at toe-touch weight bearing until evidence of graft incorporation was demonstrated radiographically. Unless contraindicated, all patients were placed on aspirin for 6 weeks for deep venous thrombosis prophylaxis.

After the initial postoperative evaluations, patients underwent follow-up annually. A complete clinical evaluation was performed by the senior author at each follow-up visit, and radiographs were obtained every 2 years. Pre-and postoperative function was assessed clinically with the Harris Hip Score. For the purpose of this investigation, only the most recent Harris Hip Score was used to evaluate postoperative function. Standard anteroposterior and lateral views were obtained for radiographic assessment. The most recent radiograph for each patient was compared with the immediate postoperative film (Fig 1).

The criteria developed by Harris et al were used to identify radiographically loose femoral components. This definition includes stems that had migrated or that had a progressive radiolucent zone >2 mm surrounding the entire bone-cement or cement-prosthesis interface. In addition, radiographs were examined for heterotopic ossification, which was described using the Brooker classification.

Socket migration was assessed by measuring the vertical distance between the inferior margin of the acetabular component and the ipsilateral teardrop, as well as the horizontal distance between Kohler's line and the medial aspect of the acetabular component. Acetabular components that had migrated or that had a progressive radiolucent line >2 mm around the prosthesis or the cement mantle were labeled as radiographic failures.

Statistical analysis was performed using the chi-square test and the unpaired, two-tailed Student's t test.

**Results**

At the time of revision surgery, the average patient age was 54 years (range: 34-70 years) for the avascular necrosis group and 67 years (range: 37-81 years) for the osteoarthritis group; this difference was statistically significant (P=.002). The mean time from the...
index procedure to the revision was 10 years for both avascular necrosis (range: 4-18 years) and osteoarthritis (range: 2-18 years) patients. Average length of clinical and radiographic follow-up was 7 years after the original revision for both the avascular necrosis (range: 2-11 years) and osteoarthritis (range: 2-12 years) groups.

Prior to revision, the average Harris Hip Score was 40 (range: 2-83) for the avascular necrosis group and 37 (range: 13-71) for the osteoarthritis group. At most recent follow-up of the surviving hips, the Harris Hip Score had increased to an average of 82 (range: 30-100) for the avascular necrosis patients and 81 (range: 51-100) for the osteoarthritis patients. The mean change in the Harris Hip Score was 41 (range: -4 to 84) and 44 (range: -5 to 76) for the avascular necrosis and osteoarthritis groups, respectively. There was no significant difference between the change in the scores of the two groups using the t test ($P > .05$).

Of the 34 revised components in the avascular necrosis group, 6 (18%) implants required re-revision for aseptic loosening an average of 7 years after the original revision. The failed components included 4 HD-2 and 2 Harris Precote stems. None of the cups failed due to aseptic loosening. One additional patient with a late infection of a Müller socket and an HD-2 femur underwent a resection arthroplasty.

Of the 55 revised components in the osteoarthritis group, 9 (16%) components required re-revision for aseptic loosening an average of 7 years after the first revision. The involved implants were 5 HD-2 and 3 Harris Precote stems, and 1 HGP socket. No failures in this group were attributable to infection, and none of the failures involved a Müller cup. Although the osteoarthritis patients were significantly older than the avascular necrosis patients, statistical analysis demonstrated no significant difference in the incidence of failure or time to failure due to aseptic loosening between the two groups ($P > .05$).

Overall, 14 (29%) of 48 femoral components were re-revised for aseptic loosening, while only 1 (2%) of 41 acetabular components failed secondary to aseptic loosening; this difference was statistically significant ($P < .05$). Although the incidence of failure for the HD-2 femur (33%) was greater than for the Harris Precote stem (24%) in both groups, the follow-up for the former was almost twice as long. Only 1 (6%) HGP socket was re-revised, and none of the Müller cups failed secondary to aseptic loosening.

A recent review of HD-2 and Harris Precote femurs in primary THA was performed at our institution. Preliminary results showed only a 3% failure rate of the HD-2 stems after an average of 12 years (range: 10-14 years). However, the Harris Precote demonstrated a higher failure rate (5%) at an average follow-up of only 6 years (range: 3-10 years). These results are consistent with other recent studies of these two prostheses. Unfortunately, the higher-than-expected failure rate for the Harris Precote stems was unknown at the time of use.

One HD-2 stem in each group failed radiographically (Fig. 2). This represented 3% of the avascular necrosis components and 2% of the osteoarthritis implants. None of the unrevised cups were loose by radiographic criteria. In addition, heterotopic ossification was noted in two avascular necrosis and four osteoarthritis hips. One avascular necrosis and three osteoarthritis hips demonstrated Brooker grade one
ossification, one avascular necrosis patient had grade three heterotopic ossification, and one osteoarthritis patient had grade two heterotopic ossification.

None of the patients developed a symptomatic pulmonary embolus, nor were there any perioperative deaths. Likewise, none of the trochanteric osteotomies developed a clinically significant nonunion.

**DISCUSSION**

Although there are no reports in the literature that specifically examined revision THA in avascular necrosis patients, numerous studies reviewed the results of the index procedure in such patients. Most of these studies, as summarized by Mont and Hungerford, revealed a higher incidence of failure among avascular necrosis patients than among age-matched controls with other hip conditions. The incidence of revision among avascular necrosis patients was as high as 39% at 8 years for cemented hips and 21% at 7 years for cementless designs.

Only 2 of 27 reports reviewed by Mont and Hungerford found the results for avascular necrosis patients to be comparable to those of patients with other diagnoses. Specifically, Katz et al reported a 5% incidence of revision for cemented prostheses at 4 years, and Phillips et al reported that their cementless implants did not require any revisions at 5 years. In a more recent study using both cemented and hybrid designs, Garino and Steinberg also reported promising results in avascular necrosis patients. After 5 years of follow-up, their data revealed that 4% of components had been revised and that 2% of components were loose radiographically.

The avascular necrosis patients in the present study were, on average, 13 years younger than the osteoarthritis patients and represent one of the youngest cohorts of revision THA patients in the literature. Although a retrospective study, all of the procedures for both patient groups were performed contemporaneously by a single surgeon using a similar distribution of components and a standardized intramedullary and postoperative protocol. However, because of the individualized nature of revision surgery, deviations from the routine were required. Most notably, five hips required a trochanteric osteotomy for adequate exposure, and approximately a fourth of the cases used bone graft. Despite these deviations, the avascular necrosis and osteoarthritis groups represented an equivalent population of patients, except for their significant age difference.

The 18% and 16% incidence rates of component failure in the avascular necrosis and control groups, respectively, an average of 7 years after the initial revision were somewhat higher than what would be expected with today's techniques and devices. The incidence of failure, however, was consistent with other reports during the period between 1981 and 1994. Reports in the literature have cited the incidence of clinical and radiographic failure for cemented revisions to be as high as 40% at approximately 5 years.

No significant difference was noted in the clinical outcome in the two groups as measured by the change in the hip scores. The final Harris Hip Score averaged 82 in the avascular necrosis group and 81 in the osteoar-
thritis group, representing satisfactory outcomes. In addition, statistical analysis revealed no significant difference between the incidence of failure and the time to failure due to aseptic loosening between the two groups.

**CONCLUSION**

Contrary to the literature on the results of primary THA, this retrospective study of revision THA found no significant difference between patients with avascular necrosis and patients with osteoarthritis.

**REFERENCES**


**EDITORIAL DISCUSSION ORTHOPEDICS:** In that the data reported here are contrary to the literature, can you offer an explanation for the difference?

Wei et al: It should be noted that this article deals specifically with the results of revision THA in patients with avascular necrosis compared to those with osteoarthritis. The data show no significant differences in outcome between these two groups. To the best of our knowledge, this has not been the subject of previously published reports in the literature, and therefore our observations have been neither confirmed nor contradicted to date by other publications.

There are, however, a number of reports comparing the results of primary THA in avascular necrosis to other conditions. The majority of these studies, especially the older ones, do show inferior results in patients with avascular necrosis. Several factors have been cited as possible explanations for this difference, including the fact that avascular necrosis patients are generally younger and more active than most individuals undergoing THA and may have metabolically compromised bone. However, three of the more recent references cited found little difference in outcome between avascular necrosis and other conditions. Because of the many variables, we would hesitate to extrapolate data from primary THA to revision THA.