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Contemporary Outcomes of Primary Total Hip Arthroplasty in Patients with Inflammatory Arthritis

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Abstract

Introduction: Contemporary outcomes of primary total hip arthroplasties (THAs) with highly cross-linked polyethylene (HXLPE) liners in patients with inflammatory arthritis have not been well studied. This study examined the implant survivorship, complications, radiographic results, and clinical outcomes of THA in patients with inflammatory arthritis.

Methods: We identified 418 hips (350 patients) with a primary diagnosis of inflammatory arthritis who underwent primary THA with HXLPE liners from 2000 to 2017. 68% had rheumatoid arthritis, 13% ankylosing spondylitis, 7% juvenile rheumatoid arthritis, 6% psoriatic arthritis, 5% systemic lupus erythematosus, and 1% scleroderma. Mean age was 58 years, 66% were female, and mean BMI was 29 kg/m^2. Uncemented femoral stems were used in 77% of cases. Uncemented acetabular components were used in all patients. Competing risk analysis was used accounting for death. Mean follow-up was 4.5 years.

Results: The 10-year cumulative incidence of any revision was 3%, and was highest in psoriatic arthritis patients (16%). The most common indications for the 15 revisions were dislocations (8) and periprosthetic joint infections (PJI; 4, all on DMARDs). The 10-year cumulative incidence of reoperation was 6% with the most common indications being wound infections (6 cases, 4 on DMARDs) and postoperative periprosthetic femur fractures (2 cases, both uncemented stems). The 10-year cumulative incidence of complications not requiring reoperation was 13% with the most common being intraoperative periprosthetic femur fracture (15 cases, 14 uncemented stems, p=0.13). Radiographic evidence of early femoral stem subsidence was observed in 6 cases (all uncemented stems). Only 1 stem ultimately developed aseptic loosening. Harris hip scores substantially improved (p<0.001).

Conclusion: Contemporary primary THAs with HXLPE in patients with inflammatory arthritis had excellent survivorship and good functional outcomes regardless of fixation method. Dislocation, PJI, and periprosthetic fracture were the most common complications in this contemporary inflammatory arthritis cohort.

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Keywords

primary total hip arthroplasty; highly cross-linked polyethylene; rheumatoid arthritis; ankylosing spondylitis; survivorship

INTRODUCTION

Inflammatory arthritis embodies a collection of chronic autoimmune diseases that can lead to progressive and irreversible destruction of the hip[1]. Over the past two decades, increased utilization of disease modifying anti-rheumatic drugs (DMARDs) has been associated with a concomitant reduction in the annual number of total hip arthroplasties (THAs) performed in this population[2]. Despite these advancements in medical management, some patients still require THA[3] and inflammatory arthritis currently remains the underlying etiology for 1–3% of primary THAs reported in clinical studies and national registries[4, 5].

Outcomes following modern THA are generally excellent[6].

However, data on the clinical outcomes and implant survivorship of contemporary THAs in patients with inflammatory arthritis are limited and often restricted to a single underlying etiology[7]. Furthermore, the optimal method of implant fixation in these patients remains controversial. Older studies support cemented femoral and acetabular components[8], while more recent studies have demonstrated satisfactory results with uncemented[9] or hybrid implants[10] for certain diagnoses.

The purpose of this study was to examine the implant survivorship, complications, radiographic results, and clinical outcomes of contemporary primary THAs with highly cross-linked polyethylene (HXLPE) bearings in patients with inflammatory arthritis. Subgroup analyses were performed to examine implant survivorship according to underlying diagnoses and method of implant fixation as well as the relationship between DMARD use and infection-related complications.

PATIENTS AND METHODS

Following Institutional Review Board approval (ID 19–010436), ethical approval and informed consent, patients who underwent primary THA with a HXLPE liner and metal or ceramic femoral head for a primary underlying diagnosis of inflammatory arthritis from 2000 to 2017 were retrospectively identified using our institutional total joint registry. Patients with a history of previous hip surgery or concomitant diagnoses of avascular necrosis of the femoral head, native septic arthritis, post-traumatic arthritis, developmental dysplasia of the hip, and/or hip fracture were excluded. Furthermore, patients with inflammatory arthritis who underwent hemiarthroplasty, hip resurfacing, or THA with hard-on-hard bearing surfaces (e.g. metal-on-metal or ceramic-on-ceramic) or conventional PE during this period were also excluded.

With the above selection criteria, 418 hips (350 patients) were included in this study. Etiologies of inflammatory arthritis included rheumatoid arthritis (RA) in 286 hips (68%), ankylosing spondylitis (AS) in 53 hips (13%), juvenile rheumatoid arthritis (JRA) in 29

hips (7%), psoriatic arthritis (PA) in 24 hips (6%), systemic lupus erythematosus (SLE) in 23 hips (5%), and scleroderma (SC) in 3 hips (1%). Baseline demographics and operative characteristics of the study population are demonstrated in Table 1. Eight patients (2%) died within two years of index THA and 32 patients (7.6%) had less than 2 years of follow-up. For the remaining 274 patients (78%), the mean follow-up was 4.5 years (range, 2 – 18 years).

Acetabular components were uncemented in all patients. Femoral components were uncemented in 320 hips (77%) and cemented in 98 hips (23%). The HXLPE liners (≥50 kGy of radiation) utilized at our institution during this time were Trilogy Longevity Crosslinked (Zimmer-Biomet; Warsaw, IN) in 135 cases (32%), Pinnacle Marathon (DePuy Synthes; Warsaw, IN) in 131 cases (31%), Pinnacle ALTRX (DePuy Synthes) in 97 cases (23%), Trident X3 (Stryker; Mahwah, NJ) in 41 cases (10%), Trident Crossfire (Stryker) in 13 cases (3%), and Reflection (Smith & Nephew; Memphis, TN) in 1 case (0.2%).

The primary outcomes investigated were implant survivorship free of any revision and survivorship free of any reoperation. Secondary outcomes included evaluation of complications, radiographic results, and clinical outcomes via Harris hip score (HHS)[11]. A subset analysis was performed to evaluate differences in survivorship between patients with uncemented versus hybrid constructs and among specific types of inflammatory arthritis. Finally, we examined the association of DMARD utilization and infection-related complications.

Radiographic Analysis

Radiographs were evaluated for evidence of implant loosening, osteolysis, or polyethylene wear >1 mm at latest follow-up. Radiographic analysis with a minimum of 2 views of the hip (anteroposterior and cross-table lateral) was completed for all patients by one of the authors who is a fellowship-trained orthopedic surgeon (B.M.W.). A second fellowship-trained orthopedic surgeon also was able to evaluate and concur regarding radiographic assessment (M.P.A). Fixation of cemented and uncemented femoral components was assessed by the criteria established by Harris et al.[12] and Engh et al.[13], respectively. Acetabular component loosening was defined as a change in cup position, cup migration >2 mm, or screw breakage[14].

Statistical Methods

The data are reported as the mean and standard deviation (SD) for continuous variables that were distributed normally and median and range for continuous variables with a skewed distribution. Revision, reoperation, and complications were considered as time-to-event outcomes, and competing risks analyses were used for revision and reoperation outcomes, with death as the competing event. At least one revision or reoperation event had to have occurred within a group in order for any cumulative incidence function to be estimated. Cumulative incidence functions between groups for both outcomes were statistically compared using Gray's Test[15]. As a complementary analysis, hazard ratios (HR) for implant fixation were estimated by fitting cemented and uncemented status of the femoral component as a covariate in Fine and Gray sub-distribution hazard for

revision and reoperation. Furthermore, the indications for revision and reoperation were also described according to the underlying diagnosis and compared using the Fisher's Exact Test. Survivorship free from complications that did not lead to revision or reoperation in the overall cohort was estimated using the Kaplan-Meier method[16]. After all complications, including both intraoperative and postoperative complications, were analyzed, Kaplan-Meier rates for only the postoperative complications were produced as well. The Fisher's Exact Test was used to compare the risk of intraoperative periprosthetic femur fracture between cemented and uncemented femoral components. HHSs were also calculated and summarized at the preoperative timepoint as well as 3 postoperative timepoints: 2 years, 5 years, and 10 years. Differences in postoperative HHSs were compared to preoperative scores using the paired T-Test. Supplemental analyses were performed to evaluate the overall risk of periprosthetic femur fracture, dislocation, and revision for PJI. Rates of periprosthetic femur fracture were based on Kaplan-Meier survival estimates and calculated for the overall cohort and according to the method of femoral component fixation. The log-rank test was used to compare the overall periprosthetic femur fracture incidence curves between patients with cemented and uncemented femoral components. Time-to-event analyses for dislocation and revision for PJI were adjusted for death as a competing risk. In addition to the overall estimate, cumulative incidences of dislocation were also reported by surgical approach. The risk of dislocation for each surgical approach was compared via Gray's Test. The relationship between DMARD utilization and any infection-related complication occurring within 1 and 2 years were analyzed and compared using the Fisher's Exact Test.

RESULTS

Implant Survivorship

The overall 10-year cumulative incidence of any revision was 3.1% (95% confidence interval (CI)=1.7%, 5.8%). Of the 15 revisions, the most common indications were dislocations (8 cases) and periprosthetic joint infections (4 cases). In patients revised for dislocation, the index procedure approach was posterolateral in 5 cases (5/218) and anterolateral in 3 cases (3/133). All four patients who underwent revision for PJI were on ≥1 DMARD, but DMARD use was not associated with 2-year risk of revision for PJI (p=0.15). The remaining indications for revision included aseptic loosening of an uncemented femoral component (1), Vancouver B_2 periprosthetic femur fracture (1, uncemented stem), and psoas tendon impingement (1).

The 10-year cumulative incidence of any revision was 3.1% (95% CI=1.0%, 9.5%) and 3.2% (95% CI=1.6%, 6.7%) in patients with cemented and uncemented femoral stems, respectively (p=0.64; Figure 1). There was no difference in the 10-year cumulative incidence of revision (p=0.08; Figure 2) or the causes of revision (Table 2) based on type of inflammatory arthritis.

The overall 10-year cumulative incidence of any reoperation was 6.1% (95% CI=3.8%, 9.6%). Indications for the 9 cases that underwent reoperation without revision were delayed wound healing or superficial wound infections (6), postoperative periprosthetic femur fractures treated with open reduction and internal fixation (1 Vancouver B_1 and 1 Vancouver C, both uncemented stems), and traumatic rupture of the hip abductor mechanism (1).

There was no difference in the 2-year reoperation rate for any infection-related complication between patients who were on DMARDs (n = 4/248, 1.6%) and those who were not (n = 2/170, 1.2%; p=0.24).

The 10-year cumulative incidence of any reoperation was 4.1% (95% CI=1.6%, 10.9%) and 7.1% (95% CI=4.1%, 12.1%) in patients with cemented and uncemented femoral stems, respectively (p=0.31; Figure 3). The 10-year cumulative incidence of reoperation was significantly associated with type of inflammatory arthritis (p=0.02; Figure 4) although the complication that led to reoperation was not (p=0.84; Table 3).

Complications

The 10-year cumulative incidence of complications not leading to revision or reoperation was 13.1% (95% CI=9.4%, 16.7%). The most common complication was intraoperative periprosthetic fracture (16 cases) involving the femur (15) or acetabulum (1).

The second most common complication was dislocation (9 cases). The approach was posterolateral in 6 cases (6/218), anterolateral in 2 cases (2/133), and direct anterior in 1 case (1/63). Six patients sustained more than 1 dislocation.

Nonoperative wound complications occurred in 8 patients and was not associated with DMARD use (p=0.48). Nonoperative postoperative periprosthetic femur fractures occurred in an additional 5 cases and included Vancouver A_G (4) and Vancouver B_1 (1) patterns.

Additional 90-day medical complications included deep vein thrombosis (4), atrial fibrillation with rapid ventricular response (4), and gastrointestinal bleed (2). One patient with atrial fibrillation also had persistent wound drainage managed conservatively.

Cumulative incidences of the three most common complications (dislocation, periprosthetic femur fracture, and PJI) were separately calculated. The 5-year cumulative incidence of any dislocation was 3.6% (95% CI=2.2%, 6.1%) and occurred similarly between patients with posterolateral, anterolateral and direct anterior approaches (p=0.66). The 10-year cumulative incidence of any periprosthetic femur fracture was 6.8% (95% CI = 3.6%, 9.9%) and was not significantly different between patients with uncemented and cemented femoral components. However, there was a clear clinical trend with 20 of 23 periprosthetic femur fractures occurring in patients with uncemented stems. The cumulative incidence of PJI was 1.0% (95% CI=0.4%, 2.7%) at 10 years.

Radiographic Results

Radiographic evidence of acetabular component loosening or surrounding osteolysis was not observed in any patient, and no patient demonstrated polyethylene wear exceeding 1 mm. Early femoral stem subsidence by a mean of 1.4 ± 1.1 cm was observed in 6 cases, and these were all uncemented. Only one stem demonstrated evidence of aseptic loosening at latest follow-up in a patient who has yet to be revised due to lack of clinical symptoms. None of these patients were revised at most recent follow-up. The remaining cemented and uncemented femoral stems appeared well-fixed at latest follow-up.

Clinical Outcomes

The HHS improved from a preoperative mean of 50 ± 14 to 90 ± 12 at 2 years ($p<0.001$), 91 ± 10 at 5 years ($p<0.001$), and 83 ± 13 at 10 years ($p<0.001$).

DISCUSSION

In a contemporary THA cohort with HXLPE bearings, patients with inflammatory arthritis demonstrated excellent implant survivorship, good clinical outcomes, and no bearing surface wear-related complications at mid-term follow-up, regardless of the underlying diagnosis or the method of implant fixation.

The 10-year cumulative incidences of any revision and reoperation were low, and similar between uncemented and cemented femoral fixation methods. The optimal method of fixation in this population remains controversial as the majority of available studies in the literature are difficult to extrapolate to contemporary practices due to the inclusion of older implant designs[17] and dated fixation techniques[18]. In two separate systematic reviews, Zwartelé et al.[19, 20] found no evidence to support either cemented or uncemented fixation over the other in patients with RA. Similarly, the results of our study support the selective utilization of modern uncemented or hybrid fixation techniques for primary THA in patients with various types of inflammatory arthritis.

The leading cause of revision in this study was dislocation, with a 5-year cumulative incidence of 4%, and was not related to approach ($p=0.66$). Patients with inflammatory arthritis have been shown to be at a significantly increased risk of dislocation after primary THA compared to patients with osteoarthritis (OA)[21] and this may be related to poor soft tissue quality or other systemic health changes associated with medication regimen or the disease itself[22]. Regardless, inflammatory arthritis has been associated with early and late dislocation following elective primary THA[23].

In this study, the overall 10-year risk of revision for PJI was low (1%), which is similar to previously reported 10-year survival free from PJI in patients with OA[24]. However, infection-related complications (namely wound healing issues) were the leading cause of reoperation. While some studies have reported an increased risk of PJI following primary THA in patients with inflammatory arthritis[25], others have found a similar risk of PJI compared to THA performed for other diagnoses[26]. Perioperative utilization of DMARDs may be a potential risk factor for PJI in patients with inflammatory arthritis[27] although other findings refute this[28]. While no significant differences were found in the risk of infection-related complications between patients who were on DMARDs and those who were not, all patients who required revision for PJI were on at least one DMARD. The similar risk of infection-related complications in this study between these groups may have been related to appropriate cessation of these medications during the perioperative period.

The underlying pathophysiology of disease and the chronic utilization of steroids and various DMARDs may affect the biomechanical properties of bone in patients with inflammatory arthritis[29–31]. The rate of intraoperative and postoperative periprosthetic femur fractures in this study was relatively high (7%) and occurred in patients with both cemented

and uncemented femoral components (p=0.16). In contrast, the risk of aseptic loosening was low. Rud-Sorenson et al.[32] found that the cumulative risk of revision due to aseptic femoral component loosening was actually lower in patients with RA (3.2%) compared to patients with OA (4.3%) at 14 years (adjusted RR = 0.54; p=0.02). The selective implant fixation methods and inclusion of only modern implants may explain the lower incidence of aseptic loosening observed in our study at mid-term follow-up.

There were limitations of this retrospective investigation. Foremost, the method of femoral implant fixation for each patient was not randomized, which could have led to differences in patient characteristics between each fixation method group. For example, younger patients with better bone quality may have been more likely to have uncemented fixation while patients with more dysmorphic proximal femurs may have been more likely to have cemented fixation. Also, while the utilization of DMARDs was determined for all patients in this study, the perioperative management of these medications, including the timing of cessation of these medications around surgery, was not able to be ascertained for all patients. Despite this limitation, the risk of infection-related complications was similar between patients who were on DMARDs and those who were not on these medications. In addition, the majority of patients in this study had RA and there were relatively fewer patients with each other type of inflammatory arthritis. Therefore, the frequency and leading causes of reoperations and revisions in the less-represented subgroups, particularly the SC group, may be different with a larger sample size. Finally, while there was no significant difference found in rates of intraoperative or postoperative periprosthetic femur fractures between cemented and uncemented stems, this could represent a Type II error, and may become significant with a larger sample size.

Contemporary primary THA with HXLPE bearings in patients with inflammatory arthritis led to excellent mid-term implant survivorship and good functional outcomes regardless of the specific type of inflammatory arthritis or the method of femoral fixation. Dislocation, PJI, and periprosthetic femur fracture were the most common complications of contemporary primary THA in this patient population. Conversely, the cumulative incidence of aseptic loosening at mid-term follow-up appears to be lower than previously reported, which may be related to improvements in modern implant designs and surgical technique. Nevertheless, given the potential for compromised soft tissue and bony integrity in this population, surgeons should consider strategies to mitigate the risk of instability and periprosthetic fracture in patients undergoing primary THA with inflammatory arthritis. In particular, surgeons should carefully assess bone quality both pre and intraoperatively, and have a low threshold to use cemented femoral fixation to help mitigate periprosthetic fracture risk. Although the association between DMARDs and infection-related complications remains unclear, the perioperative utilization of various DMARDs in patients with inflammatory arthritis should continue to be closely monitored and strategically managed given the immunosuppressive nature of these medications.

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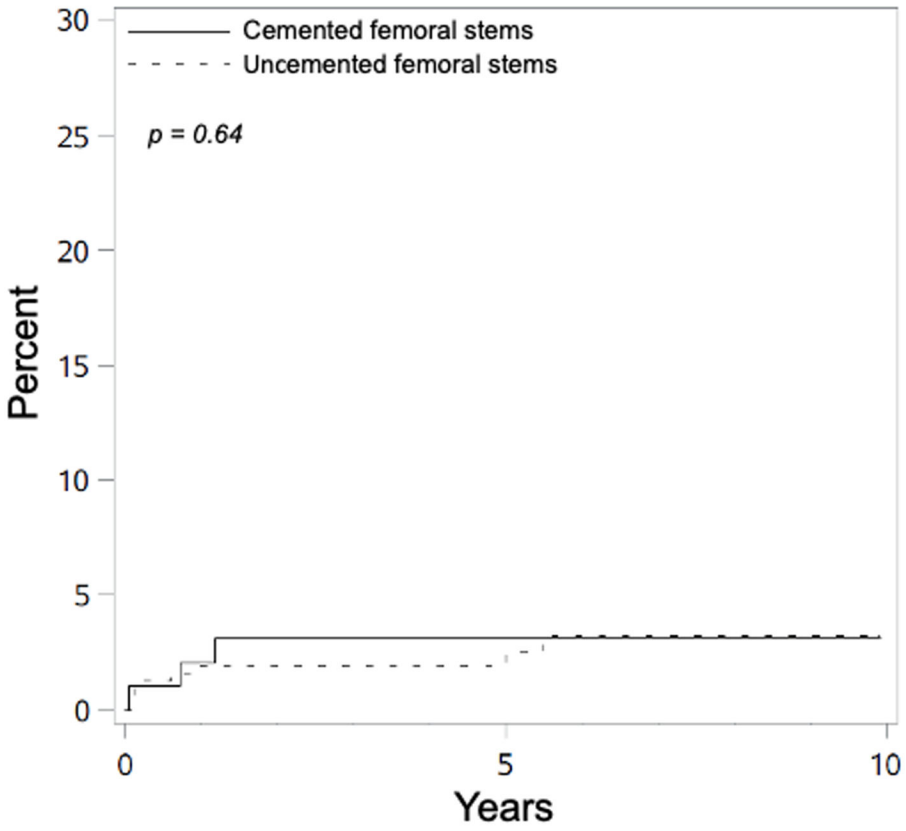

Figure 1.
Cumulative incidence of any revision THA at 10 years by method of femoral component fixation with death as a competing risk.

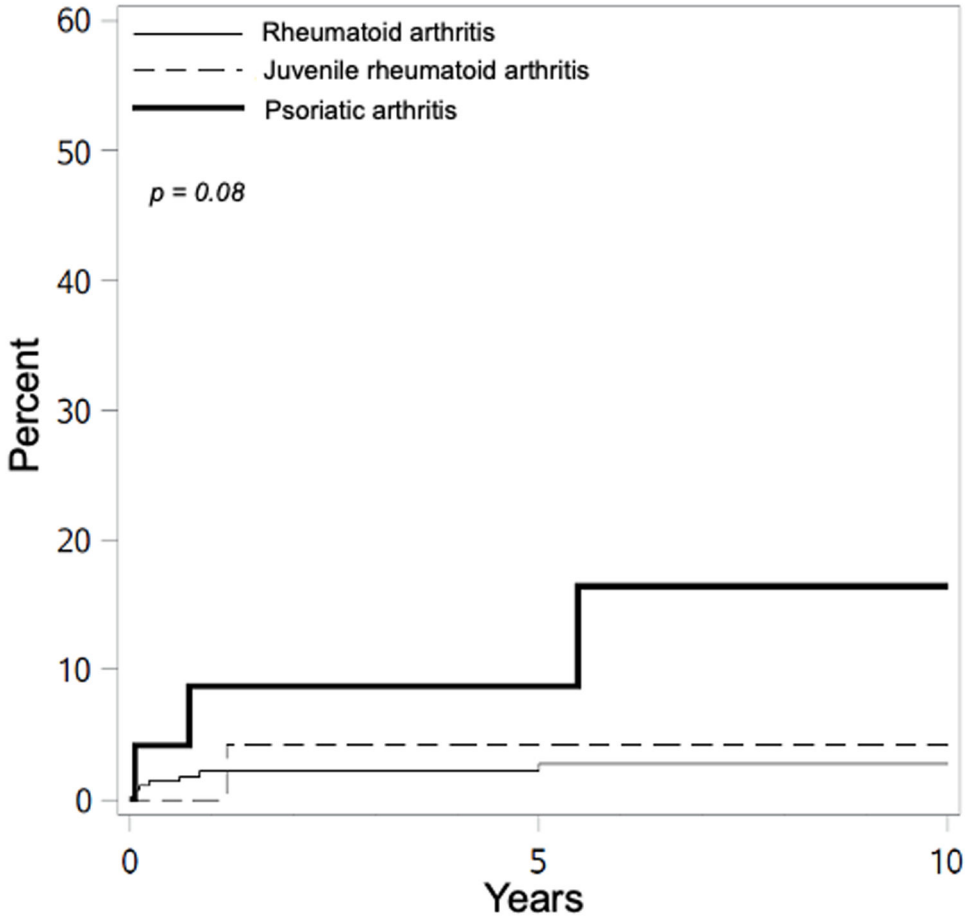

Figure 2.
Cumulative incidence of any revision THA at 10 years by underlying diagnosis with death as a competing risk.

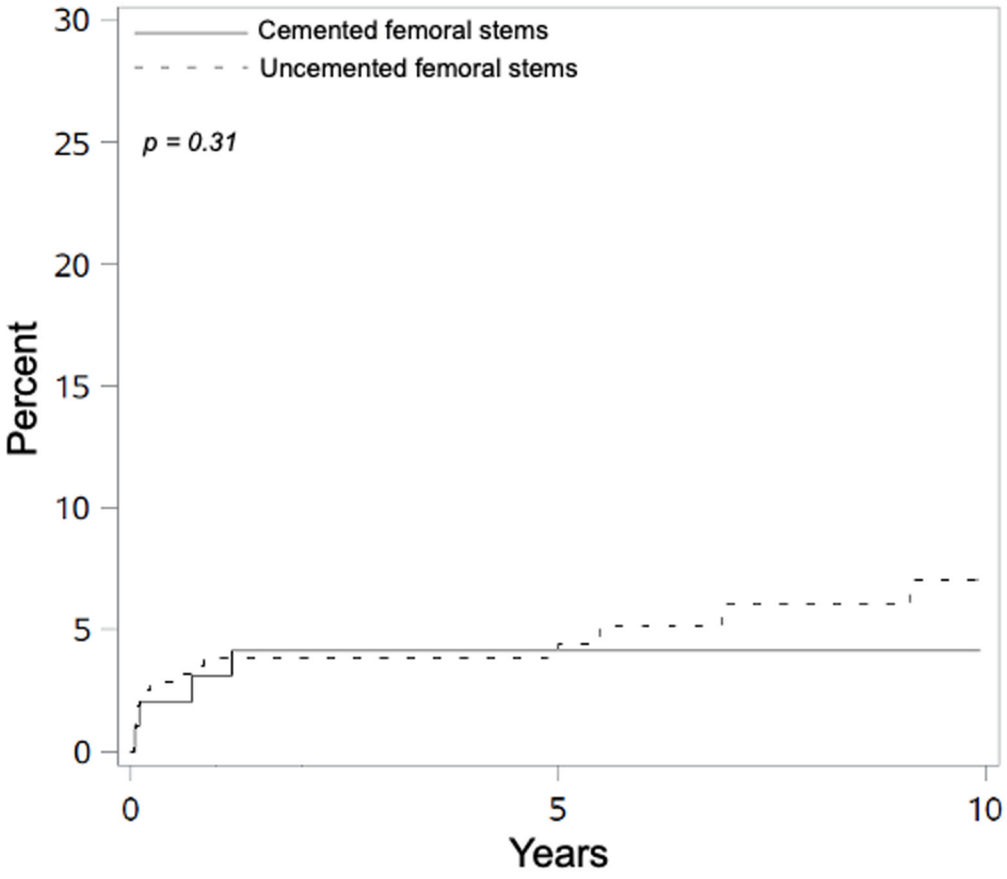

Figure 3:
Cumulative incidence of any reoperation THA at 10 years by method of femoral component fixation with death as a competing risk.

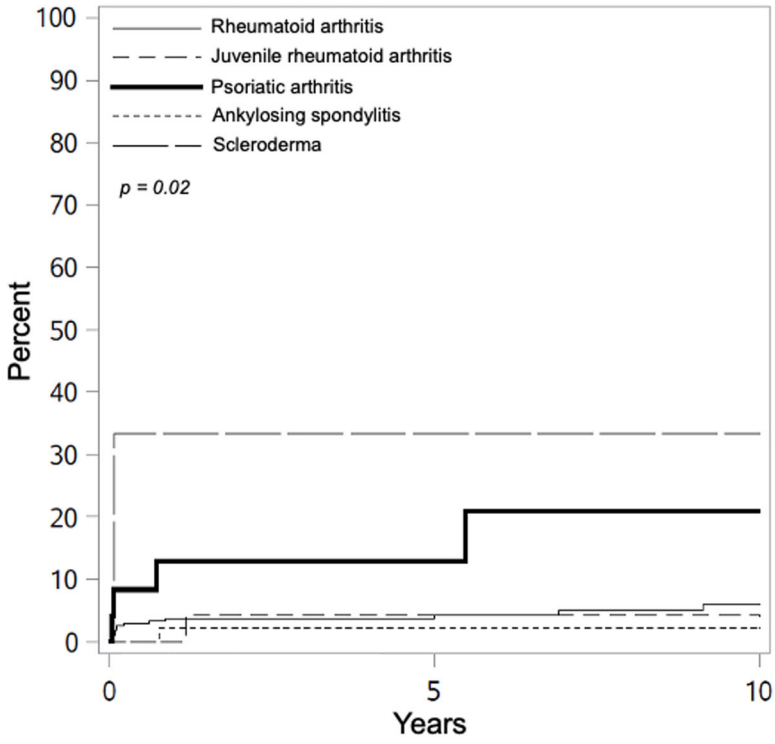

Figure 4.
Cumulative incidence of any reoperation THA at 10 years by underlying diagnosis with death as a competing risk.

Table 1.

Baseline Characteristics

Age (year), mean (SD)	58 (14.8)
Female, No. (%)	277 (66.3%)
BMI (kg/m^2), mean (SD)	29 (7)
Approach, No. (%)	
Posterolateral	218 (52.1%)
Anterolateral	133 (31.8%)
Direct anterior	63 (15.1%)
Transtrochanteric	4 (1%)
Operative Time (minutes), Median (range)	106 (34–280)
Length of Stay (days), Median (range)	3 (0–17)
Femoral Head Material, No. (%)	
Cobalt-chrome	271 (64.8%)
Ceramic	147 (35.2%)
Femoral Head Size, No. (%)	
28 mm	91 (21.8%)
32 mm	142 (34%)
≥36 mm	185 (44.3%)

SD = standard deviation

Table 2.

Causes of Revisions by Underlying Diagnosis*

	No. (%) Revisions					
	RA (n = 286)	**JRA (n = 29)**	**PA (n = 24)**	**AS (n = 53)**	**SC (n = 3)**	**SLE (n = 23)**
Dislocation	7 (70%)	0 (0%)	1 (33%)	--	--	--
Periprosthetic joint infection	2 (20%)	1 (50%)	1 (33%)	--	--	--
Periprosthetic femur fracture	1 (10%)	0 (0%)	0 (0%)	--	--	--
Aseptic loosening	0 (0%)	1 (50%)	0 (0%)	--	--	--
Other	0 (0%)	0 (0%)	1 (33%)	--	--	--
Total no. revisions	10	2	3	--	--	--

RA = rheumatoid arthritis; JRA = juvenile rheumatoid arthritis; PA = psoriatic arthritis; AS = ankylosing spondylitis; SC = scleroderma; SLE = systemic lupus erythematosus

* p=0.12

Table 3.

Causes of Reoperations by Underlying Diagnosis*

	No. (%) Reoperations					
	RA (n = 286)	**JRA (n = 29)**	**PA (n = 24)**	**AS (n = 53)**	**SC (n = 3)**	**SLE (n = 23)**
Dislocation	7 (44%)	0 (0%)	1 (25%)	0 (0%)	0 (0%)	--
Periprosthetic joint infection^	4 (25%)	1 (50%)	2 (50%)	0 (0%)	1 (100%)	--
Periprosthetic femur fracture	3 (19%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	--
Aseptic loosening	0 (0%)	1 (50%)	0 (0%)	0 (0%)	0 (0%)	--
Other	2 (13%)	0 (0%)	1 (25%)	1 (100%)	0 (0%)	--
Total no. reoperations	16	2	4	1	1	0

RA = rheumatoid arthritis; JRA = juvenile rheumatoid arthritis; PA = psoriatic arthritis; AS = ankylosing spondylitis; SC = scleroderma; SLE = systemic lupus erythematosus

^ Superficial and deep infections

* p=0.84