High Complication Rate in Revision Total Hip Arthroplasty in Juvenile Idiopathic Arthritis

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Abstract

Background Revision total hip arthroplasty (THA) in patients with juvenile idiopathic arthritis (JIA) is challenging as a result of the patient's young age, systemic disease, multiple affected joints, small proportions, and bone loss. The intermediate- to long-term results of these surgeries remain unknown.

Questions/purposes The purpose of this study is to determine the (1) functional outcomes; (2) surgical complications; and (3) frequency of reoperation or revision after revision THA for JIA.

Methods We reviewed the records of all patients from one center who underwent revision THA for JIA who had a minimum of 5 years of followup (mean, 9 years; range, 5–19 years). This resulted in a series of 24 revision THAs in 15 patients. All patients were Charnley Class C. Age at revision averaged 35 years (range, 21–53 years). The 20 acetabular and 12 femoral revision components included 15 cementless cups, five reconstruction/roof rings with a

cemented cup, and four cemented and eight cementless femoral stems.

Results The Harris hip scores improved from 54 (range, 34–85) to 77 (range, 37–100) ($p < 0.001$). Complications included two proximal femoral fractures associated with severe osteolysis and one sciatic nerve palsy in a patient with severe acetabular deficiency. A total of seven hips (29%) required reoperation or revision surgery, including three for infection (one early and two late) and four for mechanical loosening.

Conclusions Revision THA in JIA is very challenging owing to patients' small proportions and compromised bone stock. The intraoperative and early complication rates are relatively high. Prognosis for long-term survivorship is guarded; limiting factors include periprosthetic osteolysis associated with older implants that used conventional polyethylene and cemented stems.

Level of Evidence Level IV, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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Introduction

Juvenile idiopathic arthritis (JIA) is recognized as a heterogeneous group of diseases in which the common factor is persistent arthritis in one or more joints starting under the age of 16 years. JIA frequently affects the hip; in approximately one-third of children, progressive destruction of the hip will occur leading to pain and deformity [26, 31]. THA in JIA can provide relief of pain and improved function [4, 15, 21, 22, 24, 32, 35, 37, 39]. The small size and weight of most patients with JIA and their relatively low activity level make them less vulnerable to wear of the prosthetic

joint surfaces. However, there are several factors in JIA that limit the longevity of THA such as small and abnormal anatomical structure of the femur and acetabulum, growth and remodeling of bone in young patients, generalized osteoporosis from disuse and steroid use, and severe soft tissue contractures that make the surgery technically demanding. Revision operations in JIA are particularly difficult because the original femoral medullary canal is often extremely narrow with thin cortices and the femur undergoing revision is thin-walled and more capacious, increasing the risk of fracture and prosthetic failure. On the acetabular side, excessive anteversion, hypoplasia, and severe loss of bone stock may require structural and morsellized bone grafts. Previously, we reported the outcome of revision THA in 17 JIA revisions in 11 patients followed prospectively for 4 to 12 years [13].

In the present series, we have added more patients to that series and present longer followup on the original group. In this report, we determine the (1) functional outcomes; (2) surgical complications; and (3) frequency of reoperation or revision after revision THA for JIA at a minimum followup of 5 years (mean, 9 years; range, 5–19 years).

Patients and Methods

All patients with JIA undergoing total joint arthroplasty are followed prospectively in our clinic with periodic examinations by an orthopaedic surgeon and physical therapist. We identified all patients with JIA who underwent revision THA by one surgeon (SBG) between 1991 and 2007. Nineteen patients met these inclusion criteria. Four patients (five hips) were lost to followup at a mean of 1 year (range, 0–3 years) and were believed to have had intact implants at that time, leaving a total of 24 revision THAs in 15 patients (six bilateral, nine unilateral, and three hips revised twice) for review. The minimum followup was 5 years (mean, 9 years; range, 5–19 years). There were six men and nine women, and the mean patient age at the time of surgery was 35 years (range, 21–53 years). The mean body mass index of patients was 21 kg/m² (range, 15–29 kg/m²). Twelve of 15 patients (18 hips) were originally diagnosed with polyarticular juvenile rheumatoid arthritis, and the three remaining patients (six hip operations; one hip revised twice) were diagnosed with juvenile ankylosing spondylitis. The indications for revision surgery were aseptic loosening in 22 hips and reimplantation for septic loosening in two hips. The operations were the first revision in 17 hips, second revision in five hips, and third revision in two hips.

This series includes a total of 11 patients (17 hips) from our earlier series [13], presented here with additional followup, along with five hips in four patients who were not

included in that report. In the interval between our original series and the present report, one patient had a second operation on one of her two revised hips and a second patient had a contralateral hip revised.

Nonsteroidal antiinflammatory medications and arthritic disease-modifying medications were discontinued for at least 10 days before surgery and up to 6 weeks afterward if possible because of the risk of intraoperative bleeding and possible interference with bone ingrowth, bone graft incorporation, or wound healing. All patients were rated as Charnley Class C (multiple joints in need of arthroplasty and significant medical comorbidity). Preoperative functional status showed complete dependency in four patients, partial dependence in seven patients, and independent function in four patients.

Surgical Technique and Components

All of the revision arthroplasties were performed using a posterior approach. Trochanteric osteotomy (two sliding trochanteric osteotomies, two extended trochanteric osteotomies) and soft tissue releases (iliopsoas tendon, gluteus maximus tendon, capsule) were used to gain wide exposure for reconstruction as needed. Eight of the hips had revision of both the acetabular and femoral components, whereas 12 hips had revision of the cup alone and four hips had revision of the stem alone. Therefore, 20 hips had acetabular reconstruction. In all revised sockets, we first attempted to place a cementless component with numerous screws for additional fixation. In five hips, combined segmental and cavitary acetabular deficiencies necessitated the use of three roof rings and two reconstruction rings, a cemented polyethylene cup, and structural allograft or morsellized cancellous allograft to obtain a stable construct (Figs. 1, 2). In the remaining 15 hips, a cementless cup with screws was used in addition to morsellized cancellous allograft bone. Twelve hips in eight patients underwent revision of the stem. In four of the 12 hips, a cemented stem was implanted with proximal femoral allografts (two) or strut allografts (two). These cases were performed early in the series in patients with severe bone deficiencies. In the remaining eight hips, a cementless stem was used with a strut allograft (one), cancellous allografts (three), and no grafting in four hips (Fig. 3). All patients received broad-spectrum cephalosporin antibiotics, low-molecular-weight heparin when available, thromboembolic stockings, and sequential compression devices. No specific prophylaxis was used to prevent heterotopic ossification. In general, protected weightbearing with walker or crutches was recommended for 6 to 12 weeks postoperatively and an abductor brace with flexion limit at 70° was used in all patients for 6 weeks to prevent dislocation.

Fig. 1A–B (A) Preoperative radiograph of a painful cementless acetabular component with eccentric head placement (indicating extensive polyethylene wear) and severe periprosthetic osteolysis.

The stem is cemented and well fixed. (B) Eight years postoperatively, followup radiographs show a well-fixed roof ring and cemented cup. A sliding trochanteric osteotomy was performed to enhance exposure.

Analysis of Clinical Outcome

A self-administered questionnaire encompassing the questions for the Harris hip score [17] was answered by the patients, and clinical and radiographic evaluation by the surgeon and the same physical therapist was undertaken preoperatively and at followup visits at 6 weeks, 3 months, 6 months, 12 months, and annually thereafter. The pre- and postoperative ROM, strength, and gait were assessed and documented by the same physical therapist (SI) throughout the study. The Harris hip scores were calculated at the preoperative visit and the most recent clinical visit.

Analysis of Radiographs

AP, crosstable, and frog lateral radiographs were taken before surgery and at 6 weeks, 3 months, 6 months, and 1 year after the operation and annually thereafter as indicated. These were examined for loosening, migration, and other outcome variables outlined subsequently according to established grading systems. Radiolucent lines around the femoral component were classified into seven Gruen zones [14]. The change in distance from the center of the head to the lesser trochanter was used to determine the axial subsidence of the stem. In hips with a cemented femoral component, definite loosening of cemented stems was defined as a change in the position (migration) of the stem or cement, prosthesis or cement fracture, or new radiolucent lines at the cement-prosthesis interface. Probable loosening was the presence of a continuous radiolucent line around the entire cement mantle without migration, and possible loosening was an incomplete radiolucent line surrounding 50% to 99% of the cement mantle [2].

Analysis of stability of cementless femoral components was performed using the criteria of Engh and Bobyn [8] and Engh et al. [9]: bone ingrowth, stable fibrous ingrowth, and unstable implants. The femoral component was considered unstable if serial radiographs showed a progressive change in the position of the femoral component and/or progressive axial subsidence of more than 5 mm. The location of radiolucent lines around the acetabular component was classified into three DeLee and Charnley zones [7]. The stability of the acetabular component was assessed by determining the vertical and horizontal migration using the interteardrop line. Components that had tilted more than 5° or had migrated 2 mm or more or had a continuous radiolucent line greater than 2 mm in width were considered unstable. Acetabular and femoral defects were classified according to the grading system of the American Academy of Orthopaedic Surgeons [6, 16]. The radiographic classification of each case was performed by an orthopaedic surgeon not involved in the cases, and the classification was confirmed with the surgeon postoperatively after review of the surgical details, the medical record, and the radiographs.

Statistics

The clinical and radiographic data were analyzed using SPSS Version 10.0 for Windows (SPSS Inc, Chicago, IL, USA). For continuous variables, a two-tailed paired t-test was used for comparison of pre- and postoperative measurements. Kaplan-Meier survivorship analysis was calculated. The end points for the analysis were another revision procedure or the death of the patient.

Fig. 2A–D (A) Preoperative radiograph of a painful cementless THA with acetabular plastic wear and osteolysis. The cup has migrated medially destroying the acetabular bone stock. (B) Obturator oblique view shows superior and medial cup migration, destroying the anterior column. (C) Iliac oblique view shows extensive loss of bone

in the posterior column. (D) Postoperative AP radiograph showing rebuilding of the acetabulum bone stock using a structural allograft stabilized with two malleolar screws, cancellous impaction bone allograft, a reconstruction ring, and a cemented liner. A sliding trochanteric osteotomy was also performed.

Results

Hip Score

Harris hip scores were calculated although this score has not been validated for patients with JIA, and the score is

heavily influenced by global disability as seen in Charnley Class C patients [16]. The Harris hip scores improved from 54 (range, 34–85) to 77 (range, 37–100) ($p < 0.001$). Twenty-nine percent of the hips (seven hips) had a good or excellent score (80–100 points), 29% of hips (seven hips) had a fair rating (70–79 points), and 42% had a poor rating

Fig. 3A–D (A–B) Preoperative radiographs of a painful hybrid THA. There is definite loosening of the cemented femoral component, which has subsided. Femoral osteolytic lesions are also visible. (A) AP view; (B) frog lateral view. (C–D) Radiograph taken 7 years

postoperatively shows a long modular fully porous-coated femoral stem. Previously, an extended femoral osteotomy with fixation was performed to aid in cement extraction. (C) AP view; (D) frog lateral view.

(fewer than 70 points). Before surgery, 12 hips (50%) had marked to severe pain with serious limitations to total disability, nine hips (37%) had moderate pain with some limitation of ordinary activity, and three hips (13%) had mild to slight pain. At the last followup, nine hips (38%) had no pain, eight hips (33%) had slight to mild pain, five hips (20%) had moderate pain, and only one hip still had severe pain.

Complications

Two patients had intraoperative fracture femurs because of severe osteolysis. Both had successful intraoperative wiring and had stable femoral implants. One patient underwent complex revision of the acetabulum with a reconstruction ring and bone graft. A sciatic nerve palsy was diagnosed immediately postoperatively and has not improved. There

was one acute infection and two late infections. There was one late dislocation at 8 years postoperatively that was treated successfully by closed reduction.

Reoperations/Revisions

Seven hips (29%) required reoperation or revision surgery, including three for infection (one early and two late) and four for mechanical loosening. One patient had deep infection in the first week postoperatively, which was successfully treated by débridement and systemic antibiotics. Two patients had late infection at 3 years and 5 years postoperatively. One patient eventually had successful two-stage excision reimplantation; all intraoperative cultures were negative. The second patient died many years after surgery as a result of progression of JIA to a lupus variant with multiple systemic organ failure. One of her two hips became infected with multiple organisms and was excised 5 years postoperatively. For survivorship analysis, two femoral components have been excluded because the patient died from progression of disease (see previously). Two cemented femoral components had definite signs of implant loosening, severe osteolysis with periprosthetic fracture, and were revised successfully to a long-stem cementless implant with a strut graft at 6 and 7 years postoperatively. None of the others are loose radiographically.

Survivorship analysis with stem revision or radiographic failure as the end point was 83% at a mean followup of 10 years (range, 5–19 years). For cementless femoral components, the survivorship was 100% at a mean followup 11 years (range, 5–19 years). The survivorship of cemented stems (all with structural or strut allografts) was 50% (two of four) at a mean followup of 8 years (range, 5–11 years). Two of four radiographically loose acetabular reconstructions have been revised. The survivorship of acetabular components with radiographic failure or cup revision as the end point was 76% at mean followup of 10 years (range, 5–19 years). The survivorship of a reconstruction/roof ring with a cemented polyethylene cup was 75% at a mean followup of 8 years (range, 5–12 years) and the survivorship of cementless cups was 77% at a mean followup of 10 years (range, 5–19 years).

Discussion

Revision hip surgery presents unique challenges in patients with JIA because the patients usually have small proportions with narrow femoral canals (limiting implant options), numerous contractures, and compromised bone stock. Intraoperative femoral fracture through osteolytic lesions coupled with thin native cortices may necessitate

special prostheses and placement of strut allografts. The diagnosis is uncommon, and so few surgeons have extensive experience in treating the special problems that arise in these patients. Nevertheless, substantial clinical improvements can be achieved in these patients after successful revision hip surgery. The purposes of this study were to determine the (1) functional outcomes; (2) surgical complications; and (3) frequency of and reasons for reoperation in patients with JIA who have undergone revision THA. The intermediate- to long-term reoperation rate was relatively high in this group, primarily as a result of polyethylene wear and periprosthetic osteolysis, loosening of cemented stems, and late infections.

The limitations of this study include the small number of patients in this series and the loss of five hips in four patients to long-term followup. Some of these patients may have been revised elsewhere, so from that standpoint, the survivorship numbers here should be considered best-case estimates. Many of these cases reflect the use of older implants with limited sizes and noncrosslinked polyethylene and the use of structural (rather than strut) allografts, which currently are rarely performed. Some of the stems were cemented; this technique is no longer used by the senior author (SBG) for patients with JIA. Finally, the Harris hip score has not been validated for patients with juvenile arthritis.

Despite these limitations and high complication rates, revision hip surgery was generally associated with relief of pain and improved functional outcome. Seventy-one percent of patients had no or slight pain postoperatively and improved functional status (27%). However, only 30% of patients had good/excellent Harris hip scores and the remaining 70% of patients had fair or poor ratings because of multiple joint involvement, chronic stiffness and contractures, and medical comorbidities (all patients were Charnley Class C), which affect walking distance and the need for ambulatory supports.

The prevalence of perioperative complications after revision THA in this series is similar when compared with other diagnoses. The prevalence of intraoperative fracture was 13% compared with 4% to 6% in cemented revision [3, 5] and 18% to 21% for cementless reconstruction [3, 11] for all diagnoses. The incidence of sciatic nerve injury in this series was 7% (one patient who required a reconstruction ring) compared with 3% after revision THA for all diagnoses [34]. In the series reported by Goodman and colleagues [12], there was a reported prevalence of sciatic nerve palsy of 10% (six cases) after use of a reconstruction ring with bulk allograft. All six cases were associated with placing the inferior flange of the cage on the top of ischium, close to the sciatic nerve. We preferred to use a roof ring if possible to avoid this complication, especially in patients with JIA with a small pelvis. The prevalence of

early and late deep infection in this series was high (13% [three of 24 hips]). Normally the prevalence of periprosthetic infection is high in patients with JIA (3%–5%) [1, 35, 36, 39] when compared with patients with osteoarthritis (less than 1%) undergoing primary THA because of lower immune status of patients with JIA.

Primary cemented THA in JIA has demonstrated in other reports an aseptic loosening rate of 19% to 57% at 5 to 10 years followup [4, 23, 27, 38]. The survivorship of cementless primary THA in patients with JIA was reported to be 96% to 100% for the femoral stem and 88% to 90% for the acetabular cup at 5 to 13 years followup [20, 21, 30]. Thus, reoperations and revision procedures in this challenging, young patient population is relatively common, a finding we confirmed. For cemented stems, the failure rate in the present series was approximately 50% higher than revision THA using a contemporary cementing technique for all other diagnoses (radiographic failures were 13%–32% at 10–15 years followup) [18, 19, 25, 29]. The survivorship of cemented revision femoral stems in JIA was unfavorable because of poor bone stock and small anatomic proportions that make it difficult to centralize the prosthesis and obtain an adequate cement mantle circumferentially; subsequent failure of the cemented femoral stem was accompanied by cement fracture, subsidence, and osteolysis, further jeopardizing bone stock. Alternatively, the survivorship of revision using cementless femoral components in patients with JIA was excellent possibly because of new implant designs, long modular stems, and extended porous-coated implants with the use of strut grafts as needed to restore bone stock. On the acetabular side, excessive anteversion, hypoplasia, and severe bone loss often require morsellized or even structural allografts to reconstruct bone defects. The main cause of failure of cementless cups was loosening resulting from wear and osteolysis associated with the use of small cup sizes with conventional polyethylene. The survivorship of revision cementless acetabular components and roof/reconstruction rings in this series was similar. The latter is comparable with other series and all diagnoses (42%–87% at 5–10 years followup) [10, 28, 33].

Revision THA in patients with JIA is challenging. Although the patients generally experience improvement in pain and function, complications are frequent as are reoperations and revisions when compared with revision THA for other indications. These procedures are made more difficult because of the presence of chronic disability, joint contractures, osseous abnormalities, and severe bone loss on both femoral and acetabular sides and because many of these patients have small, fragile femurs. Careful preoperative planning is necessary to ensure that appropriately sized implants are available for surgery. Restoration of lost bone stock (as outlined previously) will facilitate

subsequent revision surgeries in this young population. Newer, smaller-sized cementless implants and alternative bearing surfaces may lead to improved outcomes for these patients in the future.

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