

Revision total hip arthroplasty in juvenile chronic arthritis

17 revisions in 11 patients followed for 4–12 years

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Background Revision total hip arthroplasty (THA) in patients with juvenile chronic arthritis (JCA) is complicated by the young age of the patient, poor bone stock and small physical proportions. We report the complications and outcome of a prospective series of 17 revision THAs in Charnley class C JCA patients.

Methods 15 acetabular components and 10 femoral components were revised. 13 cementless cups, 2 reconstruction/roof rings and cemented cups, and 4 cemented and 6 cementless femoral stems were implanted. 2 proximal femoral allografts and 1 strut allograft were used. Age at revision was 32 (21–53) years. Follow-up averaged 7 (4–12) years.

Results 2 patients with cemented femoral stems developed loosening, osteolysis and fracture. Both were successfully revised to long-stem cementless implants with strut/proximal femoral allografts. 1 loose, worn cementless cup with osteolysis was revised. 1 patient with a peri-operative infection and late acetabular fracture had a loose, non-revised cementless cup. 1 case of sciatic nerve palsy occurred after revision using a reconstruction ring. 1 late infection necessitated resection arthroplasty. Harris hip scores improved from 53 (34–85) to 76 (47–96).

Interpretation Revision THA in JCA has a substantial complication rate, even in experienced hands. The problem of obtaining long-term stable fixation, osteolysis, and replenishment of lost bone stock are major difficulties.

Total hip arthroplasty (THA) in juvenile chronic arthritis (JCA) provides significant relief of pain, and improved range of motion and function (Scott et al. 1984, Lachiewicz et al. 1986, Ruddlesdin et al. 1986, Witt et al. 1991, Maric and Haynes 1993, Torchia et al. 1996, Chmell et al. 1997, Lehtimaki et al. 1997, Haber and Goodman 1998, Kumar and Swann 1998). The procedure is, however, complicated by the patient's young age, small stature, insufficient bone stock and abnormal bony anatomy, which are the result of a chronic inflammatory process during growth (Rahimtoola et al. 2000). These factors limit the longevity of THA in JCA and may compromise subsequent revision surgery. Revision operations in JCA are particularly difficult because the original acetabulum is frequently small and dysplastic; the revised acetabulum is larger, with thin walls and poor bone stock. Furthermore, whereas the original femoral medullary canal is often extremely narrow with thin cortices, the femur undergoing revision is thin-walled and more capacious, making the use of standard or custom long-stem implants hazardous due to the risk of fracture and prosthetic failure.

To date, there have been no study series reporting the outcome of revision THA in patients with JCA. We report the clinical and radiographic outcome of a series of 17 THA revisions in 11 patients followed prospectively for 4–12 years.

Material and methods

All patients with juvenile chronic arthritis undergoing revision total hip arthroplasty by the senior author (SBG) were followed prospectively over a 20-year period. Of the 22 revision cases in 15 patients, 5 hips in 4 cases were excluded from this review. 2 patients (2 hips) refused further clinical and radiographic follow-up because of their overall disability and long traveling distance, and 2 patients (3 hips) had more recent surgery with less than 2 years of follow-up. This resulted in a series of 17 revision arthroplasties (5 bilateral, 6 unilateral, 1 hip revised twice) performed in 11 patients (7 women) with an average of 7 (4–12) years of follow-up (Table 1). The average age at time of surgery was 32 (21–53) years. The average height was 161 (142–175) cm and average weight was 54 (38–84) kg.

9 of 11 patients (12 hips) were diagnosed with polyarticular juvenile rheumatoid arthritis, and the 2 remaining patients (3 hip operations; one hip revised twice) were diagnosed with juvenile ankylosing spondylitis. All patients were on non-steroidal anti-inflammatory medication prior to surgery. The medication was discontinued for 10 days before surgery and up to 6 weeks afterwards if possible, because of the risk of intraoperative bleeding from anti-platelet effects and possible interference with bone graft incorporation due to these drugs. No patient was taking corticosteroid medication at the time of surgery. All patients were rated as Charnley class C (both hips arthritic as well as one or more major weight-bearing joint), and had major difficulties in performing their daily activities. The indication for surgery was aseptic loosening with severe functional impairment and disabling pain.

Surgical technique and components

All of the revision arthroplasties were performed using a posterior approach. Trochanteric osteotomy and soft tissue release were used as necessary, to gain wide exposure for reconstruction. 8 of the hips had revision of both the acetabular and femoral components, while 7 hips had revision of the cup alone and 2 hips had revision of the stem alone. Thus, 15 hips had acetabular reconstruction. In 2 hips, combined segmental and cavitary acetabular deficiencies necessitated the use of a

roof or reconstruction ring, cemented cup and cancellous allograft bone. In the remaining 13 hips, a cementless cup with screws was used in addition to allograft cancellous bone. 10 hips in 7 patients underwent revision of the stem. In 4 of the 10 hips, a cemented stem was implanted with a proximal femoral allograft (2 hips) or a strut allograft (1 hip). In the remaining 6 hips, a cementless stem was used (Figure 1).

All patients received broad-spectrum cephalosporins, low-molecular-weight heparin when available, thromboembolic stockings and sequential compression devices. No specific prophylaxis was used to prevent heterotopic ossification. In general, protected weight bearing with walker or crutches was recommended for 6–12 weeks postoperatively because of general weakness and unsteadiness after surgery.

Analysis of clinical outcome

A self-administered questionnaire encompassing the questions for the Harris hip score (Harris 1969) was answered by the patient, and clinical and radiographic evaluation by the surgeon and the same physiotherapist was undertaken preoperatively and at follow-up visits at 6 weeks, 3 months, 6 months, 12 months, and annually thereafter. The pre- and postoperative range of motion, strength and gait were assessed and documented by the same physiotherapist throughout the study. The Harris hip scores were calculated at the preoperative visit and at the most recent clinical visit.

Analysis of radiographs

Anteroposterior, cross-table 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. They were examined for loosening, migration, and other outcome variables outlined below according to established grading systems.

Radiolucent lines around the femoral component were classified into 7 Gruen zones. 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 subsidence of more than 5 mm or continuous demarcation around the stem, and prob-

Juvenile chronic arthritis patients undergoing revision total hip replacement

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1A	M	167	43	AS	L	NA	4	F	3	49	28	S+PFA	13.5	1	NA	NA	NA	56	75
1B	M	167	43	AS	L	3	4	B	2	64	28	C+SA	3	1	56	HG-II	0	34	71
2A	F	155	48	AS	L	3	3	B	3	61	22	AML/CDH	13.5	0	46	Trilogy	0	46	67
2B	F	155	48	AS	R	3	NA	A	2	70	26	NA	NA	NA	54	HG-II	0	53	83
3	F	142	48	JRA	R	NA	2	F	2	72	22	AML/CDH	10.0	1	NA	NA	NA	51	79
4	M	160	64	JRA	R	3	4	B	3	132	28	AML+PFA	12.0	1	58	HG-II	0	42	61
5A	F	160	46	JRA	R	3	1	B	2	140	28	AML	13.5	0	60	HG-II	0	53	87
5B	F	160	46	JRA	L	3	1	B	2	148	28	AML	13.5	0	54	HG-II	0	46	87
6A	F	152	45	JRA	R	3	1	B	2	56	22	CDH/M	7.5	0	40	HG-I	0	57	^a
6B	F	152	45	JRA	L	3	1	B	2	54	22	CDH/M	7.5	0	MR	44 poly	1	57	^a
7	F	147	38	JRA	L	3	NA	A	3	97	22	NA	NA	NA	56	HG-II	0	40	47
8	F	157	52	JRA	L	3	NA	A	4	58	28	NA	NA	NA	BSR	46 poly	1	50	52
9	F	163	65	JRA	R	3	NA	A	4	50	28	NA	NA	NA	60	Trilogy	0	44	68
10A	M	175	84	JRA	R	3	NA	A	2	146	32	NA	NA	NA	56	HG-II	0	57	96
10B	M	175	84	JRA	L	3	2	B	2	85	28	S	13.5	0	56	HG-II	0	58	96
11A	M	173	61	JRA	L	3	NA	A	2	66	26	NA	NA	NA	54	Trilogy	0	85	85
11B	M	173	61	JRA	R	3	NA	A	2	76	26	NA	NA	NA	56	HG-II	0	65	85
Mean		161	54							84								53	76
SD		10	14							35								11	15

A Patient no.

B Sex

C Height (cm)

D Weight (kg)

E Diagnosis

AS: ankylosing spondylitis;

JRA: juvenile rheumatoid arthritis;

F Side

G Acetabular defect: grading of the acetabular defect according to the classification of the American Academy of Orthopaedic Surgeons;

H Femoral defect: grading system of the femoral defect according to the classification of the American Academy of Orthopaedic Surgeons;

I Revised: the component revised;

F: femoral;

A: acetabular;

B: both

J Number of THR: the number of hip replacements including this revision;

K Follow-up in months;

L Femoral head size in mm;

M Type of femoral stem; strut: strut allograft;

C: Centralign

M: Muller

S: Solution

SA: strut allograft;

PFA: proximal femoral allograft;

N Femoral component size;

O Femoral component cementless (0) or cemented (1);

P Acetabular component size;

MR: Mueller roof ring

BSR: Burch-Schneider ring

Q Type of acetabular component;

R Acetabular component cementless (0) or cemented (1);

S Preoperative Harris hip score;

T Harris hip score at last follow-up;

^a this patient's final Harris hip score could not be calculated because of severe systemic illness.

NA: not applicable.

Figure 1. Case 5. Bilateral THR in a patient with bilateral failed resurfacing arthroplasties.

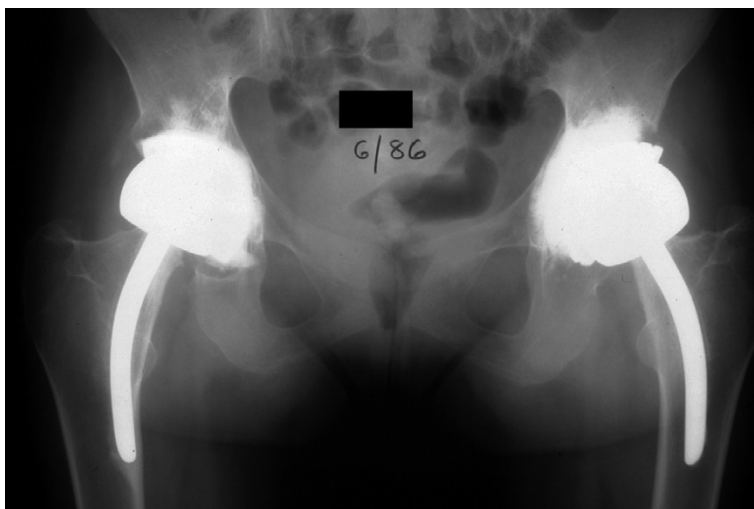


Figure 1 A. This patient has juvenile rheumatoid arthritis and underwent bilateral staged resurfacing arthroplasty several years previously.



Figure 1 B. 5 years later, the left hip was painful and the limb had shortened. Radiographs showed that the left femoral component had subsided and migrated into varus. The right hip was not painful, despite the extensive acetabular periprosthetic osteolysis.

able loosening as subsidence of 2–5 mm or a radiolucent line surrounding 50% of the stem or more, according to Barrack et al. (1992). Non-progressive incomplete radiolucent lines less than 1 mm in width in the bone-cement interface were ignored. Analysis of stability in cementless femoral components was performed using the criteria of Engh and Bobyn (1986) and Engh et al. (1987): 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. Heterotopic ossification was graded using the system of Brooker et al. (1973).

The location of radiolucent lines around the acetabular component was classified into 3 Charnley zones (DeLee and Charnley 1976). The stability of the acetabular component was assessed by determination of vertical and horizontal migration. The components that had tilted more than 5 degrees or had migration of 2 mm or more, or a continuous radiolucent line more than 2 mm in width, were considered unstable.

In order to avoid interobserver variation, all radiographic measurements were performed independently by one observer (K-J O), an experienced orthopedic surgeon who was not involved in the surgical procedures. Acetabular and femoral defects

were classified according to the grading system of the American Academy of Orthopaedic Surgeons (D'Antonio et al. 1989, Haddad et al. 2000). The radiographic classification of each case by the observer was confirmed with the surgeon postoperatively after review of the surgical details, the medical record and the radiographs.



Figure 1 C. The left hip was revised using a cementless porous-coated acetabular cup with screws and impacted cancellous allograft bone chips, and a cementless extensively porous-coated femoral component. A sliding trochanteric osteotomy was used for enhanced exposure.

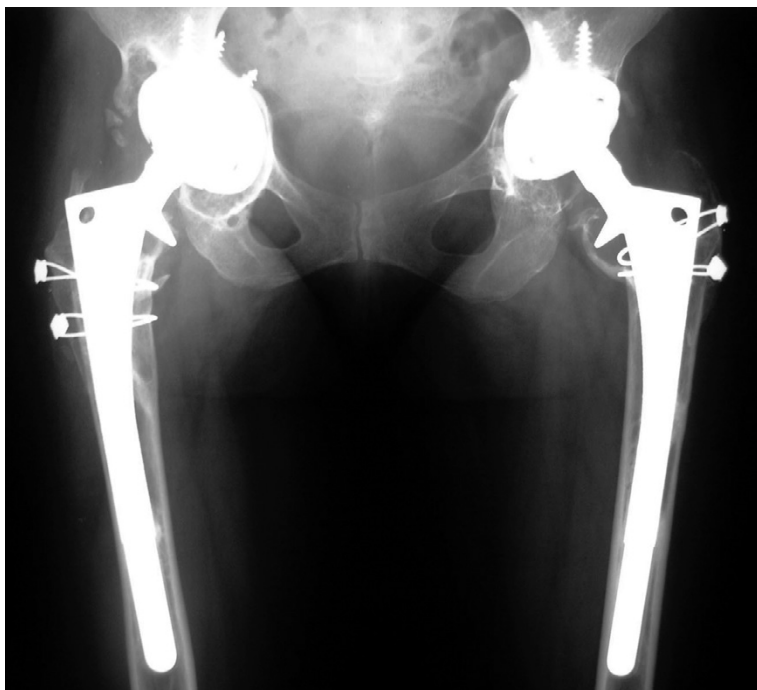


Figure 1 D. The right hip was reconstructed in a similar fashion to the left hip at a later time.

Statistics

The clinical and radiographic data were analyzed

statistically using SPSS version 10.0 for Windows. For continuous variables, a two-tailed t-test was used for comparison of pre- and postoperative measurements.

Results

Clinical outcome

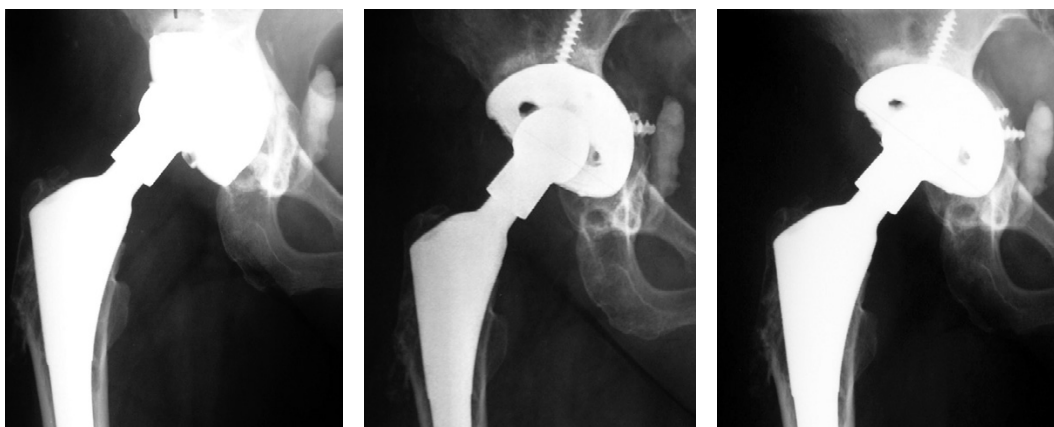
In JCA patients, the Harris hip score is markedly affected by the systemic nature of the patient's disease and the multiple joint involvement. Nevertheless, the scores improved from an average of 53 (34–85) points preoperatively to 76 (47–96) points postoperatively after revision surgery ($p < 0.001$). The changes in range of motion were not statistically significant.

Radiographic results

On the acetabular side, 1 cementless cup was radiographically loose and had migrated medially. This patient had a perioperative infection which was successfully treated with antibiotics, and a late fall in which an undisplaced periprosthetic acetabular fracture was sustained (see details under complications). The cup was not revised, according to the patient's wishes. 1 other cementless cup was revised because of loosening associated with substantial

polyethylene wear and periprosthetic osteolysis. This cup articulated with a well-fixed non-modular cementless stem with a 32-mm femoral head. All

Figure 2. Case 9. Revision of a loose acetabular component in a patient with juvenile rheumatoid arthritis.



Preoperatively, a painful, loose cementless acetabular component was seen. The patient had previously undergone revision of a loose cemented acetabular component.

This was taken shortly after revision of the acetabular component using a cementless cup and screws and extensive bone grafting using impacted cancellous allograft chips.

4 years postoperatively, showing a stable acetabular component and formation of a new medial acetabular wall from the grafted bone.

other acetabular reconstructions have been stable (Figure 2).

The 2 fully cemented femoral stems (without allografts) have both become loose, subsided and have been associated with femoral fractures (see details below). Both stems have been revised. The remaining femoral stems are stable.

Heterotopic ossification was noted in 6 hips (grade I in 4 hips, grade II in 1, and grade III in 1).

Complications

2 hips with revision cemented femoral stems loosened, subsided and were associated with extensive osteolysis. These cases subsequently sustained periprosthetic femoral fractures (1 minor nondisplaced cortical crack and 1 major displaced fracture). The first case (case 3 in the Table) was revised successfully using a cementless long-stem prosthesis with strut graft. The second case (1) was revised using a proximal femoral allograft and cementless long-stem prosthesis, cemented into the allograft portion only (Figure 3). Both re-revisions are doing well (1 and 5 years postoperatively).

1 patient (no. 8) underwent complex revision of the acetabulum with a reconstruction ring and bone graft. The sciatic nerve abutted the posterior aspect of the ring because of a large uncontained defect of the posterior column. A neurolysis was performed intraoperatively and the nerve was mobilized; how-

ever, a peroneal nerve palsy was diagnosed postoperatively, and has not improved.

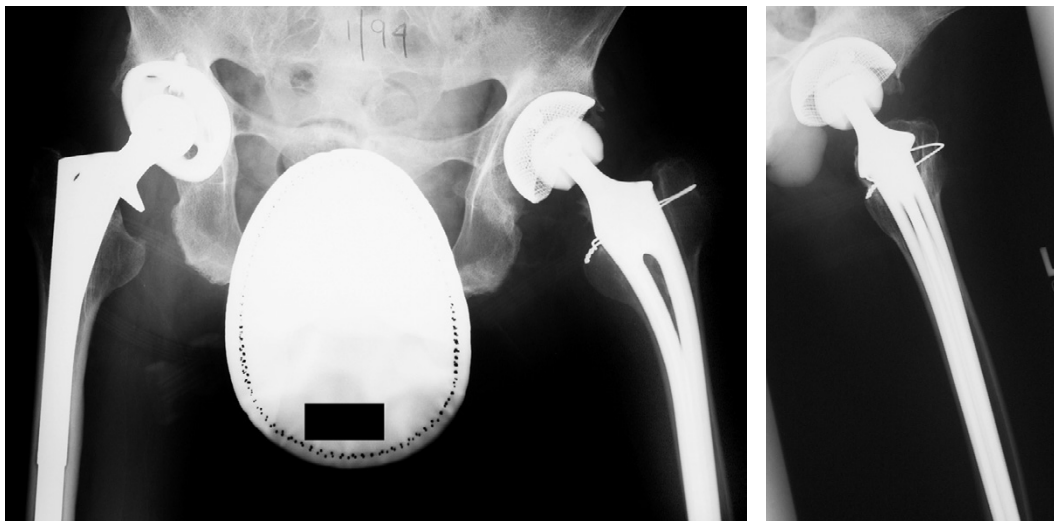
1 patient (2A) with acetabular revision with cancellous autograft and allograft and a cementless cup had a deep infection with *Pseudomonas aeruginosa* postoperatively. The hip was debrided after 1 month and the patient was given systemic antibiotics. 8 years later, the patient fell and sustained a nondisplaced periprosthetic fracture of the medial wall of the acetabulum. This was treated nonoperatively with protected weight bearing for 3 months. The acetabular component has migrated several mm medially and has a complete circumferential radiolucent line, but the hip is stable and the patient does not want further surgery.

1 patient (10A) had acetabular loosening due to severe polyethylene wear and periprosthetic osteolysis, and has recently undergone revision with a structural bone graft, roof ring and cemented cup. It is noteworthy that his primary hip had a non-modular implant with a 32-mm femoral head.

1 patient (6) with 2 well-functioning revision THAs died many years after surgery, due to progression of her JRA to a lupus variant with multi-system organ failure. 1 hip became infected with several organisms and was excised 4.5 years postoperatively.

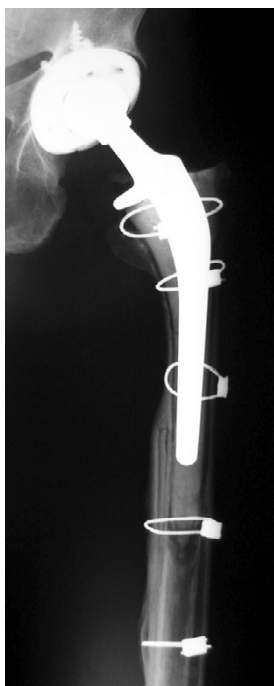
There were no dislocations or deep-vein thromboses.

Figure 3. Case 1. Painful total hip replacement in a patient with ankylosing spondylitis.



This patient had a painful, cementless left hip replacement. The femoral component consisted of a very short body with three long prongs that were compressed together prior to insertion into the femoral medullary canal. Note the severely deficient femoral bone stock.

Frog lateral view of the left hip.



Both components of the hip were revised with a cementless acetabular component and screws, and a cemented femoral component and strut graft. The femoral component loosened, subsided and was later associated with a femoral fracture.



The femoral component was revised to a long-stem fully porous-coated implant and a proximal femoral allograft. As seen in this figure, the allograft had healed to the host bone.



Lateral view of the final reconstruction.

Discussion

In young patients, THA will not usually last a lifetime. Although JCA patients are frequently lighter in weight and less active than those with osteoarthritis, initial prosthetic fixation is difficult because of abnormal anatomical development of the hip, small-proportioned more fragile bones with narrow medullary canals and thinner cortices, and limited sizes of implants (Scott et al. 1984, Lachiewicz et al. 1986, Witt et al. 1991, Maric and Haynes 1993, Torchia et al. 1996, Chmell et al. 1997, Lehtimäki et al. 1997, Haber and Goodman 1998, Kumar and Swann 1998). Revision surgeries in younger patients with chronic arthritis are even more complicated because of the additional loss of bone stock. As a result of continued prosthetic wear, osteolysis, and implant failure, increasing numbers of young patients with JCA will require complicated revision surgeries.

To date, there have been no studies which examine the outcome of revision total hip replacement in young patients with chronic arthritis. In this regard, our current series of 17 revisions in 11 patients with an average of seven years of follow-up, though small in number, is unique.

Observations from our series have resulted in a change in our surgical technique for future reconstructions. Firstly, as for primary total hip replacement in patients with chronic arthritis and small anatomic proportions, we no longer cement revision femoral stems. In both primary and revision cases, it is difficult to centralize the prosthesis and obtain an adequate cement mantle circumferentially; subsequent failure of the cemented femoral stem is accompanied by cement fracture, subsidence and osteolysis, further jeopardizing bone stock. Although cementless primary and revision stems are technically challenging, gradual reaming with smaller-sized reamers, the use of longer modular cementless stems, the taking of intraoperative radiographs to confirm adequate prosthetic fit, and the application of strut grafts in recent cases have provided a sound reconstruction and helped restore lost bone stock.

Secondly, on the acetabular side, excessive anteversion, hypoplasia and severe loss of bone stock often require structural and morselized bone grafts for bone defects. We prefer to use cementless cups

in primary and revision cases of younger patients with chronic arthritis. However, if one cannot easily place the cup in the correct orientation on at least 70% firm host bone and obtain a satisfactory peripheral rim fit and adequate screw fixation, we use a roof ring or reconstruction cage. These devices protect the healing bone graft, come in numerous small sizes with more screw holes than modular acetabular shells, and allow subsequent cementing of a polyethylene liner in the desired degree of anteversion. Because of the patient's young age and small pelvis, the use of a roof ring rather than reconstruction ring is usually preferred, because the ischium is often small and adequate purchase of the inferior flange is difficult to obtain.

Thirdly, because of small pelvic proportions, excessive acetabular anteversion and bone loss, the sciatic nerve is vulnerable to injury—especially in cases in which a structural graft or ring is used posteriorly. We identify the location of the nerve by palpation during exposure and reconstruction; in addition, retractors are positioned to avoid impingement of the sciatic nerve.

Finally, despite preoperative planning, changes in the surgical plan are often made during the reconstructions. The surgeon must have access to a variety of small-sized reamers, implants and bone graft options to obtain a stable articulation.

Author contributions

All authors participated in gathering and analyzing the data. In addition, the radiographs were assessed by K-JO. All range of motion measurements were done by SI.

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