Intermediate-Term Results With a Modified Antiprotrusio Cage in Acetabular Revision Surgery

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Abstract

A modified antiprotrusio cage and cemented cup were implanted in 11 patients who required acetabular revision surgery. Acetabular defects were classified as combined in 8 hips, pelvic discontinuity in 2, and cavitary in 1. Cancellous allograft was used in all patients, and 4 required structural allografts. Mean operative time was 324 minutes (range, 273-434 minutes), and mean estimated blood loss was 1168 mL (range, 500-4000 mL).

Mean clinical and radiographic follow-up was 6.1 years (range, 2-8.8 years). Aseptic loosening occurred in 2 hips, 1 of which was revised. There were no dislocations, no deep infections, and no neurovascular injuries. Mean postoperative Harris hip score was 76 (range, 49-97).

In a comparison with historical controls, this cage, which facilitates anteversion of the cemented cup, was found to improve hip stability. Massive defects and poor ischial fixation were common in the cases of loosening.

Antiprotrusio devices have been used in acetabular revision surgery since the mid-1970s. Common features include a metal shell that protects the underlying bone graft and allows for implantation of a cemented acetabular component. For the sake of this discussion, these devices are divided into rings, which provide for screw fixation in the ilium only, and cages that allow for iliac and ischial fixation by screws or by slotting of the ischial flange into bone.

The most commonly reported rings were designed by Müller and Ganz. The acetabular reinforcement ring by Müller (Protek, Berne, Switzerland) is a titanium ring with a superiorly placed lip with multiple holes for fixation with 6.5-mm fully treaded screws. The Ganz ring (Zimmer, Warsaw, Ind) also involves a titanium shell but adds a hook that is placed inferiorly into the obturator foramen. These rings have provided reasonable results in cavitary defects but have had unacceptable failure rates in the treatment of medial segmental defects and pelvic discontinuities.[1-3]

The Bürch-Schneider cage (Protek, Berne, Switzerland) consists of a hemispherical titanium shell with a superior and inferior flange and multiple holes for screw fixation. Most commonly, an all-polyethylene socket is cemented into the cage. Bone graft is used to fill gaps between the cage and host bone. With follow-ups as long as 12 years and survivorship ranging from 64% to 100%, this device has been a workhorse component at several centers for acetabular revisions not amenable to other techniques,[4-12] particularly for combined segmental and cavitary deficiencies, massive cavitary defects, and pelvic discontinuities. Although generally good results have been reported with the Bürch-Schneider device, aseptic loosening, hip instability, infection, and neurovascular injuries have been reported with its use.

The antiprotrusio cage used in our study (Contour Reconstruction Ring; Smith & Nephew, Memphis, Tenn) has 2 flanges for fixation to the iliac wing with screws and an inferior flange for ischial fixation. This cage has a threaded center hole for implant insertion and a posterior-superior buttress that allows for independent positioning of the cemented socket relative to the metal shell (Figure 1). This study was performed to assess clinical and radiographic outcomes with this device in comparison with first-generation cages and rings.

Materials and Methods

After obtaining institutional review board approval, we conducted a retrospective clinical and radiographic analy-

Figure 1. Reconstruction cage with 2 flanges for iliac fixation, ischial flange for distal fixation, and posterior-superior buttress. Image courtesy of Smith & Nephew.

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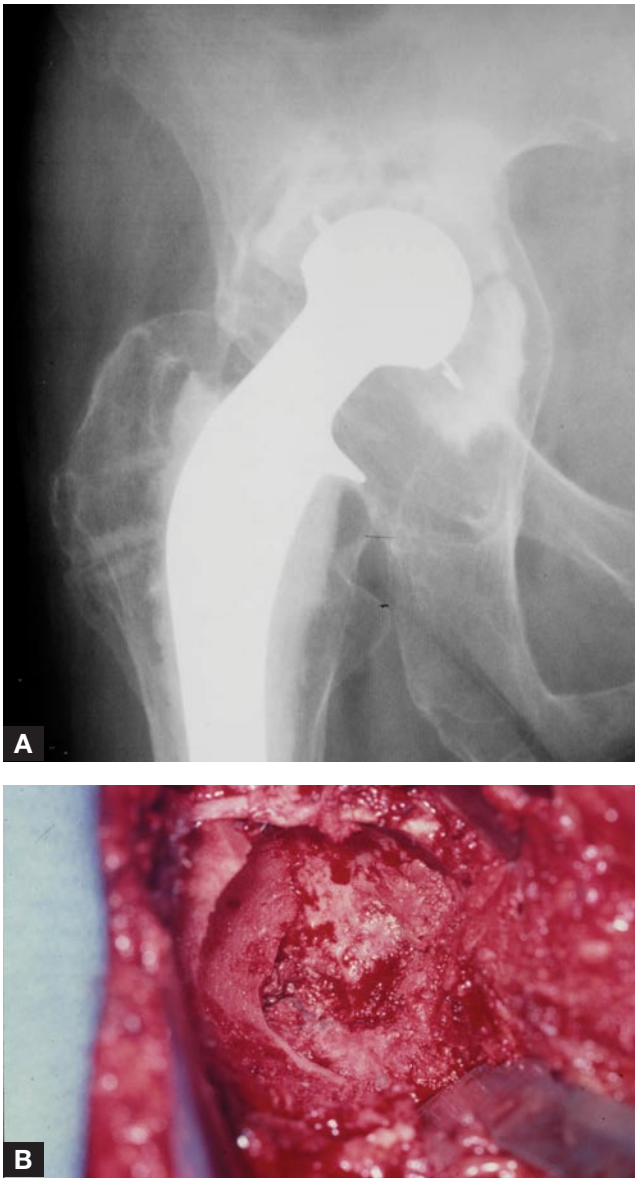

Figure 2. Preoperative (A) and intraoperative (B) photographs of superior and medial cavitary defect.

Figure 3. Vigorously impacted cancellous allograft in place.

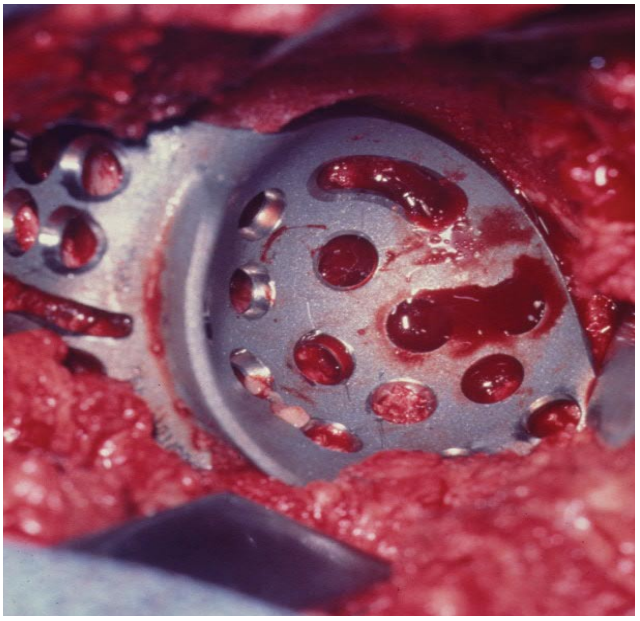

Figure 4. Antiprotrusio cage implanted.

sis of all available patients treated with a modified antiprotrusio cage used in acetabular revision surgery at our institution between 1997 and 2004. Two surgeons (see Acknowledgments) and I revised 11 hips (11 patients). Mean clinical and radiographic surveillance was 6.1 years (range, 2-8.8 years).

Of the 11 patients, 8 were women and 3 men. Mean weight was 72 kg (range, 49-95 kg), mean height was 170 cm (range, 157-196 cm), and mean age was 75 years (range, 51-87 years). Surgical indications included aseptic loosening of both components (6 patients), isolated acetabular aseptic loosening (4), and massive periacetabular osteolysis without loosening (1). One prosthesis was dislocated at time of revision, and 1 patient had an ipsilateral periprosthetic femur fracture. This group had undergone a mean of 2 previous hip surgeries (range, 1-3) before acetabular revision.

The antiprotrusio cage used in this study is made of commercially pure titanium and has a roughened surface finish. Three sizes (outer diameters of 50, 56, and 62 mm) are available for the right and left sides. In our series, we used six 56-mm cages and five 62-mm cages; these were implanted on the right side in 6 patients and on the left in 5 patients.

All surgeries were performed through a posterolateral approach, combined with a standard trochanteric osteotomy (in 3 patients), a trochanteric slide with the vastus lateralis attached to the trochanteric fragment (5 patients), and an extended trochanteric osteotomy incorporating the lateral cortex of the femur for improved femoral exposure (2 patients). Intravenous antibiotic and chemical prophylaxis for deep venous thrombosis were routinely used.

Once the failed acetabular component and the overlying membrane were removed, the acetabular defect was

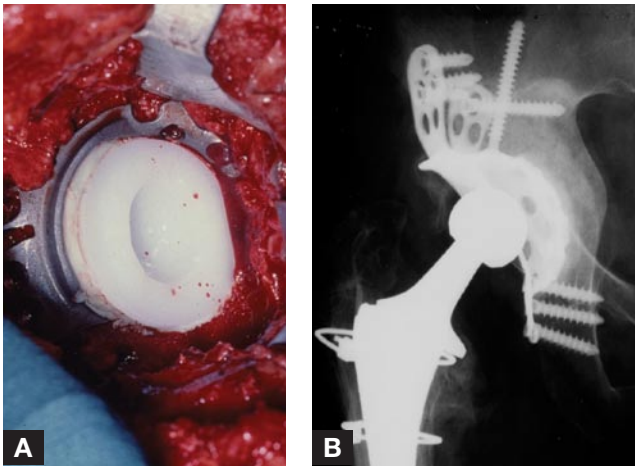

Figure 5. Intraoperative (A) and postoperative (B) radiographs of cage with cemented all-polyethylene cup. Note 3 bicortical ischial screws for distal fixation.

assessed (Figures 2A, 2B). The cage was chosen when less than 50% of host bone was available for fixation of an uncemented hemispherical acetabular component. Acetabular defects were classified according to the criteria of the American Academy of Orthopaedic Surgeons (AAOS)[13] and Paprosky and colleagues.[14] According to the AAOS criteria, the defects were type 2 (cavitary) in 1 hip, type 3 (combined segmental and cavitary) in 8 hips, and type 4 (pelvic discontinuity) in 2 hips. No patient previously received pelvic irradiation. According to the Paprosky criteria, there were five 3B defects, three 3A defects, one 2C defect, and one 2A defect; 1 patient had inadequate radiographs for Paprosky classification.

Contained cavitary and medial segmental defects were filled with cancellous allograft chips, vigorously impacted (Figure 3). These chips either were supplied as premorselized chips or were obtained from fresh-frozen femoral heads morselized with a bone mill. Mean amount of cancellous allograft used per patient was 132 cm^3 (range, 60-300 cm^3). Dome or posterior column segmental defects were filled with contoured femoral heads (4 hips) reamed with female reamers to match the defect and fixed with partially threaded titanium screws. No whole acetabular or distal femoral allografts were used.

Once a hemispherical bed was constructed, the cage was contoured with bending irons and implanted (Figure 4). Initial screw fixation was obtained through the dome screw holes. Next, screws were placed through the 2 cephalad flanges into the ilium, and ischial fixation was achieved with screws when possible. Mean number of screws used was 8 (range, 6-10). Ischial screws were used in 10 patients, and the ischial flange was slotted into the bone in the 11th patient. The sciatic nerve was protected during exposure and before cage placement.

A cemented, all-polyethylene cup with 20° posterior elevation was placed next, in approximately 20° of anteversion as compared with the patient's torso in the lateral position on the operating table (Figures 5A, 5B). Antibiotic

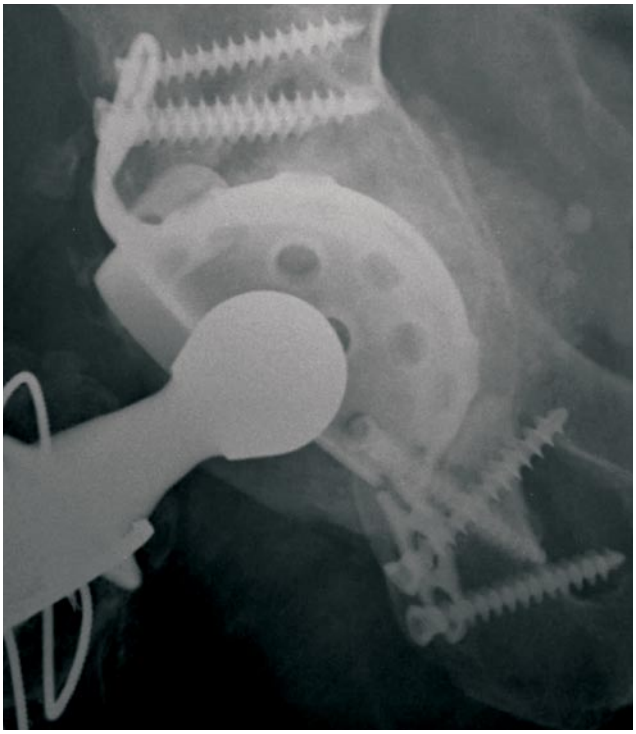

Figure 6. Broken ischial flange without other evidence of loosening. Patient was asymptomatic at 7.5-year follow-up.

powder was added to the cement in 7 patients (tobramycin in 6, vancomycin in 1). Retained femoral components included 1 Charnley long stem (Thackray, Leeds, UK), 1 Calandruccio Titan (Wright Medical, Arlington, Tenn), 1 McCutchen (Wright Medical), and 1 HNR (Stryker, Kalamazoo, Mich). Revised femoral components were converted to 4 Solution stems (DePuy, Warsaw, Ind), 2 Echelon stems (Smith & Nephew), and 1 Spectron long stem (Smith & Nephew). Nine patients received a 28-mm femoral head, 1 patient received a 32-mm head, and 1 patient received a 22-mm head. Postoperative management included restricted weight-bearing for a mean of 12 weeks (range, 0-30 weeks). An abduction orthosis was also used in 7 patients, at the discretion of the operating surgeon.

After obtaining written informed consent from the patients, I clinically evaluated them with Harris hip scores.[15] Preoperative and postoperative anteroposterior radiographs of the pelvis were assessed for vertical and horizontal change in hip center according to the method of Peters and colleagues.[6]

Immediate and most recent postoperative radiographs were compared for radiolucencies, osteolysis, and hardware failure. Radiolucencies were classified according to the zones of DeLee and Charnley.[16] Osteolysis was defined as an expansile radiolucency more than 2 mm thick not seen on the immediate postoperative radiograph. Cage loosening was assessed according to the criteria of Gill and colleagues.[5] Acetabular component abduction angle was measured on the anteroposterior radiograph of the pelvis using the wire marker in the all-polyethylene cup and the transischial line as a horizontal reference. Heterotopic

ossification was graded using the system of Brooker and colleagues.[17]

Results

Mean operative time was 5.4 hours (range, 4.6-7.2 hours). Mean estimated intraoperative blood loss was 1168 mL (range, 500-4000 mL). Mean total transfusion requirement (intraoperative, postoperative) was 5.4 units of packed red blood cells (range, 2-12 units).

Mean acetabular abduction angle was 43° (range, 32°-58°). Mean hip center change was 17 mm distal (range, 5-33 mm) and 8 mm lateral (range, 3 mm medial–22 mm lateral).

Radiolucencies were seen in zone III in 2 patients, zone II in 1 patient, and in all 3 zones in 1 patient. The lucencies isolated to 1 zone were not progressive and did not involve the screws (possibly loose, type I). The patient with a complete radiolucency also had proximal migration of the cage of 14 mm and loss of ischial screw fixation (definitely loose, type III). No focal osteolysis was seen in any patient. One patient developed an asymptomatic fracture of the ischial flange; however, there were no associated radiolucencies, no migration of the cage over time, and no fractured screws (Figure 6).

Mean Harris hip score was 76 (range, 49-97). Mean Harris hip subscores were 36 (pain), 21 (function), 11 (activities), 3 (deformity), and 5 (range of motion).

Two patients developed aseptic loosening. One case was revised 3 times before the patient underwent resection arthroplasty for deep infection. The other patient was not symptomatic enough to warrant further surgery. Both failures occurred in Paprosky 3B defects and had marginal ischial fixation with 2 unicortical screws each.

Four patients had a trochanteric nonunion at last follow-up; 2 of these nonunions had been present before acetabular revision. Clinically insignificant heterotopic ossification was found in 6 patients (3 had Brooker grade I, and 3 had grade II).

Other medical complications included urinary retention (1 patient). There were no deep infections, no neurovascular injuries, and no dislocations.

Discussion

Antiprotrusio cages have been used in acetabular revision surgery when the amount of host bone is inadequate for an uncemented hemispherical ingrowth component. Although how much bone is adequate is controversial, most authors recommend considering an alternative method if less than 50% of the host bed is available for uncemented fixation.[18,19]

Techniques other than antiprotrusio cages include oblong sockets, custom triflanged components, and porous tantalum augments combined with a hemispherical tantalum shell. Oblong sockets are primarily indicated for superior segmental defects only. Custom triflanged components are limited by cost and by the delay between preoperative imaging and manufacture. Porous tantalum holds promise because of the favorable modulus of elasticity of the material and the adaptability with the modular augments for a variety of defects; however, follow-up is short at this time, and bone stock is not augmented by these devices.

Over the past 3 decades, the Bürch-Schneider cage has been used with generally good results. Harris hip scores reported with its use range from 74 to 83 (mean, 79).[2,3,8-11] The aseptic loosening rate ranges from 0% to 12% at follow-ups ranging from 2.8 to 12 years.[2-12] The major limiting factor for this device has been aseptic loosening, as there is no ingrowth potential at the interface between the cage and host bone.

Some authors have detailed relatively high rates of infection, neurovascular injury, and dislocation. Udomkiat and colleagues[12] reported 7 dislocations in 18 patients (39%), which they attributed to muscle weakness from multiple previous operations. Berry and Müller[4] reported 1 femoral artery injury and 2 partial sciatic nerve palsies in 42 patients (7%), though no ischial screws were used. This group also had 5 deep infections (12%); however, prophylactic antibiotics were administered in only 22 patients.

Our antiprotrusio cage study showed similar clinical results and overall survivorship. Our mean Harris hip score of 76 is a reflection of the patient population that required this type of device—our patients had multiple previous operations and subsequently impaired overall function.

In our series, the 2 patients with aseptic loosening had a few features in common. They were treated early in our experience with this device for severe acetabular defects (Paprosky 3B). Each patient had 2 unicortical ischial screws for distal fixation. Although we still prefer screws for ischial fixation, we believe that densely impacted cancellous graft and rigid distal fixation with at least 2 bicortical screws (preferably 3) are required for long-term success. When distal fixation is not possible, porous tantalum components combined with modular augments and/or an antiprotrusio cage (so-called cup cage) may be a better choice.

Despite using ischial screws, we did not encounter any sciatic or other neurovascular injuries. Some authors have recommended slotting the ischial flange into the bone to avoid possible sciatic nerve injury and lateralization of the hip center.[18] With careful dissection along the posterior column and relaxation of the nerve by flexing the ipsilateral knee and extending the hip during acetabular exposure and preparation, ischial screws can be used safely.

The posterior-superior buttress of the cage in this study allows for a more horizontal and anteverted position for the cemented acetabular component. Mean acetabular abduction angle was 42° in our series, and there were no postoperative dislocations despite routine use of a posterolateral approach and a 28-mm head in most patients. Use of an abduction brace in the majority of our patients may have contributed to the lack of instability as well.

In summary, the modified antiprotrusio cage provided comparable results with similar devices used for difficult acetabular revisions. Rigid ischial fixation with screws

appears to be advantageous in terms of intermediate-term success with antiprotrusio cages, but lack of bone ingrowth will ultimately limit cage longevity. Improved stability was seen, perhaps because of more reliable cup placement, in a small series of patients.

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