Chapter 8
Antiprotrusio Cages for Acetabular Revision

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Introduction

The bone defect determines the surgical technique in acetabular revision surgery. Different studies report the necessity of restoring acetabular anatomy and the anatomical center of rotation of the hip to enable stable prosthetic component fixation, especially in revision surgery for cases with deficient bone stock [1]. Loss of acetabular bone also makes it difficult to place a new component in an optimal position on bone of sufficient strength and quality as to provide secure fixation [2]. Uncemented sockets have some limitations in acetabular revision, especially when the loss of bone stock is more extensive, comprising more than 50% of the weight-bearing surface; in this situation, primary stability cannot be achieved without the use of structural allografts. Several techniques have been proposed to compensate for acetabular deficiency, including bone grafting in conjuction with cemented [3, 4] or uncemented cups [5], Müller reinforcement metal rings [6] and tantalum augments [7–11]. Antiprotrusio cages are considered when the extent and geometry of the bone loss do not favour an uncemented porous socket. Various antiprotrusio cages are available. The Burch-Schneider antiprotrusio cage (BSAC) has been the most used and the one with the most published clinical data (Fig. 8.1). Other acetabular reinforcement designs include the Ganz cup, the Link cage, the Contour cage and the Gap cup.

An antiprotrusio cage that was larger than the Müller acetabular reinforcement ring was developed by Burch and Schneider [12]. The Swiss orthopedic surgeon Dr. Hans-Beat Burch created the cage after becoming involved in the treatment of a

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E. García-Rey, E. García-Cimbrelo (eds.), *Acetabular Revision Surgery in Major Bone Defects*, https://doi.org/10.1007/978-3-319-98596-1_8

Fig. 8.1 The Burch-Schneider antiprotusio cage (BSAC)

patient with an older, unhealed acetabular fracture. The prototype was developed especially for the treatment of this patient and implanted by Dr. Burch in 1974 in the Cantonal Hospital of Fribourg, Switzerland. Dr. Robert Schneider from Biel, Switzerland, took up the idea of bridging acetabular defects and developed it further, emphasizing the necessity of proximal screw fixation of the implant to the iliosacral joint, and suggested impacting the distal plate in the ischial bone. Steel was initially used as the implant material. Since 1987, titanium has become available for this type of acetabular component. Primary stability of the implant is achieved by fixation of the proximal flange to the ilium with screws while, distally, the flange is inserted into the ischium. In order to restore the centre of rotation to an ideal level, the implant should generally be placed in the acetabular floor (which is preserved in most cases). If necessary, defects in the acetabular roof are compensated by bone grafts (structural or morcellised), which should then be secured by screws that are directed through the anchorage holes of the flange in a horizontal or slightly descending direction. Finally, the polyethylene inlay is cemented in place at an optimal inclination of 40° with a 10–15° antetorsion, independently of the cage position.

Since the introduction of antiprotrusio cages for acetabular revision surgery of different bone defects at the beginning of the eighties, their use has been more or less widespread [13]. In North America the cages were considered a cemented reconstruction and their use was restricted after the disappointing results of cemented revisions at mid-term follow up become known [14].

Meanwhile, reasonable midterm results with antiprotrusio cages were reported from Europe when used in the presence of marked bone loss [15, 16]. That conceptual facet made the reinforcement device an extraordinary tool. The advantages of antoprotrusio cages are that the reinforcement device seems to protect grafts from overstress, distribute load, help to restore the appropriate centre of rotation of the hip and support the cemented polyethylene cup [17, 18]. With experience, more has been learned about the limitations of antiprotrusio devices. They are more difficult to implant than hemispheric cups. A wide approach is needed and it is not exempt from serious neurovascular complications [19]. Most designs have no potential for biologic bone ingrowth and, with time, particularly in younger patients, they may fail.

Technical Data

Between 1996 and 2004, the BSAC was implanted in 96 patients (53 women and 38 men), undergoing acetabular revision in our institution. Cause of the revision was aseptical loosening (62 patients), sepsis (14 patients), severe osteolysis (10 patients), acetabular malposition (6 patients) and others (4 patients). The mean age at surgery was 67.3 years (range, 35–85 years). Including criteria were to use a BSAC in revision acetabular surgery whenever there is deficient acetabular stock (Fig. 8.2). Eleven patients passed away from causes unrelated to the operation and 17 patients have been lost to follow-up. Of the remaining 68 hips, three cages had to be removed: two due to deep infection and one due to aseptic loosening. Thus, the complete cohort consists of 65 hips (61 patients) that were available for clinical and radiological review at an average follow-up of 8.1 years (range 5–13 years). The right hip was operated in 42 cases and the left hip in 54 cases. The revised acetabular component was cemented in 36% of cases and uncemented in 54%. The femoral component was revised in 48% of cases. Preoperative bone defects were assessed according to Paprosky classification [20]: type 2A (nine hips); type 2B (31 hips); type 2C (20 hips); type3A (25 hips): and type 3B (11 hips).

A standard operative technique was employed in all cases. Most patients were operated on by the senior author (A.C.-M.), and, in most cases (86%), the anterolateral approach was used. A posterolateral approach with extended femoral osteotomy was carried out (14%) when the femoral component had to be revised, as well. The acetabular cavity was always meticulously prepared. Bone grafting was performed in 38 cases (39.5%; 29 allograft, 7 autologous, and 2 combined autoallograft). The BSAC was adapted to the acetabular defect and surrounding bone after the bone graft was placed to fill the defect. In all cases, the cage was placed by driving its inferior flange into the inferior acetabulum so that it lodged in the ischium. This trick is not easy. In our series inferior flange was finally, lodged outside the ischium in more than 35% of cases. The superior flange was fixed to the

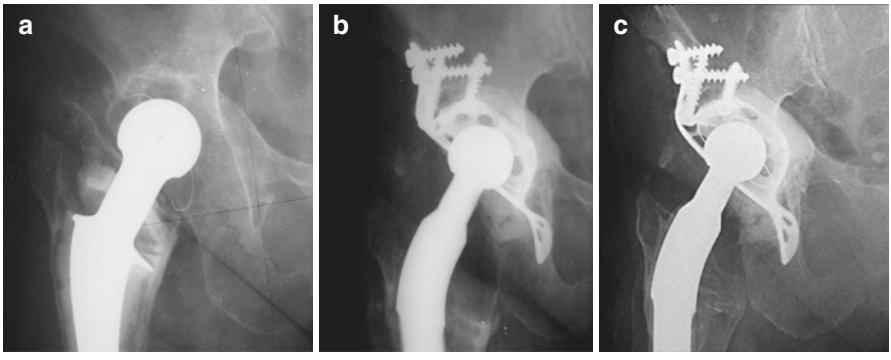

Fig. 8.2 (**a**) Radiograph showing aseptic loosening both components in a 69 year-old woman with rheumatoid arthritis. (**b**) Post-operative radiograph with a BSAC without graft and Wagner stem. (**c**) X-ray control at 12 years. Good clinical situation

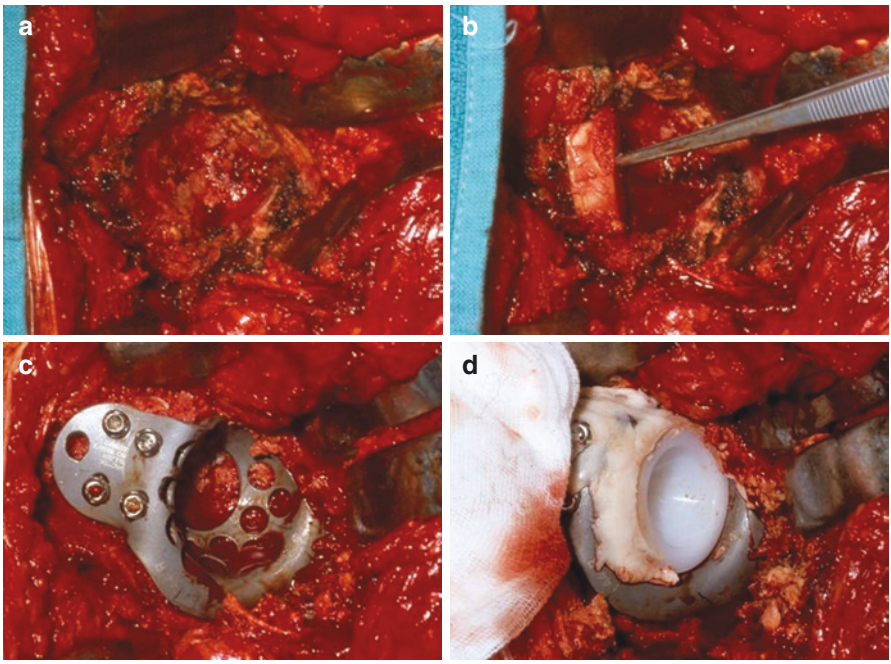

Fig. 8.3 (**a**) The failed acetabular component is removed and the acetabular bed was thoroughly debrided until achieving healthy and bleeding bone beds. (**b**) Bone grafting. The specific type of graft used is determined by the shape and size of the defect. (**c**) Cage placement. (**d**) Cementing all-poly into the cage. The socket can be oriented slightly independant of the cage position

outside of the ilium with 3–6 cortical screws. A size 44 antiprotrusio cage was implanted in 38 hips, a size 50 in 51 hips, a size 56 in 3, and the largest, a size 62, in 4 hips. An all-polyethylene cup (28- and 32-mm diameter low profile UHMW polyethylene cups; Sulzer Orthopaedics, Baar, Switzerland) was cemented into the cage (Fig. 8.3). The patients were mobilised after 3–7 days depending on their bone quality, and remained on crutches for not less than 3 months. Antibiotic prophylaxis (1 g cefazolin every 6 h) was administered for 48 h. Routine preventive measures for thromboembolism were employed under the strict protocol of our hospital Haematology Department.

Clinical results were evaluated using the Merle d'Aubigné-Postel score [21]. Patients were asked to express their subjective opinion on the outcome of the operation as in Johnston et al. [22]. Clinical failure was defined as re-revision or removal of the cup, pain (grade 4 or worse), or both. Thigh pain was not considered evidence of clinical acetabular failure, whereas groin and buttock pain were recorded as signs of clinical failure resulting from acetabular loosening [23]. Any radiolucent line around the cup was assessed according to the three DeLee-Charnley zones [24].

Of 68 cages, three had to be removed: two for deep infection and the other for aseptic loosening after 7 years and it was revised with another BSAC. The mean preoperative Merle D'Aubigné score of 8.8 points had increased to 15.1 points at

final follow-up. Differences between the preoperative and postoperative scores as evaluated with the Wilcoxon test for paired samples were highly significant ($P < 0.001$) for both for the overall Merle D'Aubigné score as well as for pain, hip motion, and walking ability. The results were excellent and good in 69% of the hips, regular in 22% and fair in 9%. In addition, 46 patients stated that they were very satisfied, 13 were satisfied, and 6 were dissatisfied. Overall, about 71% of patients reported satisfactory results. Radiographic analysis showed that the mean inclination of the antiprotrusio cage was 47.3° (range, 27–72°) after implantation and that the mean inclination at follow-up was 46.9°. The mean proximal and medial migrations of the antiprotrusio cage were 0.8 mm and 0.9 mm respectively. Using the Nunn technique [25] the hip rotation centre was descended an average of 4.3 mm and lateralised an average of 1.3 mm in the post revision study. In the most severe cases (Paprosky 2C, 3A and 3B) the respective corrections were 7.8 mm and 0.8 mm. Broken screws were seen in two cases and an inferior flange fracture in one case. Although both are criteria of definite loosening, there was no cage migration nor had pain been reported. Three cages were considered loose according to Gill criteria [26], indicating a mechanical failure index of 6.1% for the whole series at the end of follow-up. Although graft remodelling is difficult to evaluate with the antiprotrusio cage, according to Gerbert criteria [27], 76.3% of the grafts appeared to have incorporated, 21.6% seemed not to have changed and 2.1% showed resorption. The Kaplan-Meier survivorship analysis [28], using estimated radiological loosening and revision for mechanical failure of the antiprotrusio cage as the survivorship endpoint, showed a survival rate of 92.4% (95% confidence interval, 85.1–99.8%) after 13 years for the antiprotrusio cage.

There have been six acute infections (6.2%), which were treated with debridement and antibiotics without further problems in four cases while two cases required two- stage revision. There were 11 dislocations (11.4%), 6 during the first 3 months and 5 late dislocations. Nine were treated by closed reduction and two needed open reduction. One patient developed recurrent dislocation, which was treated by replacing the socket with a constrained cemented component. There was another revision for aseptic loosening of the polyethylene socket after 1 year that was revised with another cemented socket. There were six sciatic nerve palsies, three temporary and three definitive.

Discussion

Bone defects determine the surgical technique in acetabular revision surgery. Cementless cups have been widely used in revision surgery for these patients, and several series have reported good results [29–32]. However, other series have reported poor results for revisions associated with massive bone defects greater than 50% (Paprosky grade 3B) [33, 34–36]. Various techniques have been described for managing large acetabular defects, including placement of an large uncemented acetabular component [37], placement a cup at a high hip centre [38], oblong or

bilobed cups [39–41] and impacted bone graft and cement [3, 4]. Antiprotusio cages, one of the systems used for handling these situations, have been used for a long time, especially in Europe, and the long-term experience to provide sufficient data to explore the results and define their current indications even though comparison of cage results is difficult because patient populations are mixed, are treated with different devices and present varying degrees of bone loss.

Berry and Müller [2] report a 24% failure rate 5 years after implantation, but, bone grafts were not used in the early series. Gill et al. [26, 42] published on the use of acetabular reinforcement devices. Their most recent study included 37 hips in 35 patients. Bulk structural allograft was used in association with 30 BSAC and seven Müller reinforcement rings. The mean follow-up period was 7.1 years. Excellent or good patient satisfaction was reported by 91.9%. No survivorship data were given. The BSAC can be used with morcellised or bulk graft, protecting the graft from forces which may contribute to its failure. All series report the best results using metal rings in association with grafting [2, 16, 42–44]. Healing and probable graft incorporation, without significant resorption, have usually been seen [17, 45]. A recent study by van der Linde [46] reported the outcome of using ring or cage devices. The series included 42 hips in 40 patients. Using a criterion similar to ours, the authors used some type of reinforcement device for all acetabular revisions whenever there was deficient acetabular stock, including type I and II (AAOS) defects. They reported four failures: three due to infection, and one due to aseptic loosening. Their survival was 90.5% at a mean follow-up of 10 years. After an average follow-up period of 7.3 years, Winter et al. [47] observed no cage loosening or migration and incorporation of the cancellous allograft into host bone in 38 cases. They concluded that a close fit between the graft and the acetabulum in addition to mechanical stability was crucial to their successful results. Recently, Regis et al. [48] have published excellent results in one of the series with greater follow-up in patients with severe Paprosky 3A and 3B defects. The cumulative survival rates at 18.9 years with removal for any reason or X-ray migration of the cage and aseptic or radiographic loosening as the end points were 80.0% and 84.6% respectively.

Postoperative implant instability is more frequent after prosthesis revision, reaching 23%. Dual mobility technology has proven its efficacy in preventing dislocations. Schneider et al. [49] suggest an original technique for surgical acetabular revision associating acetabular reconstruction antiprotrusio cages and cemented dual mobility cups. In their series had a dislocation rate of 10.4%. A constrained cemented cup was suggested in selected cases [29, 50].

Using the Nunn technique [25], the hip rotation centre was descended an average of 4.3 mm and lateralised an average of 1.3 mm in our series. Overall, and only considering the most severe cases (Paprosky 2C, 3A and 3B defects) the respective corrections were 7.8 mm and 0.8 mm. Although no attempt was made to implant the component at the level of the anatomical centre of rotation, there was an improvement in the vertical hip centre. In their series, Schneider et al. [49] obtain better corrections although using different reconstruction devices. A mean lowering

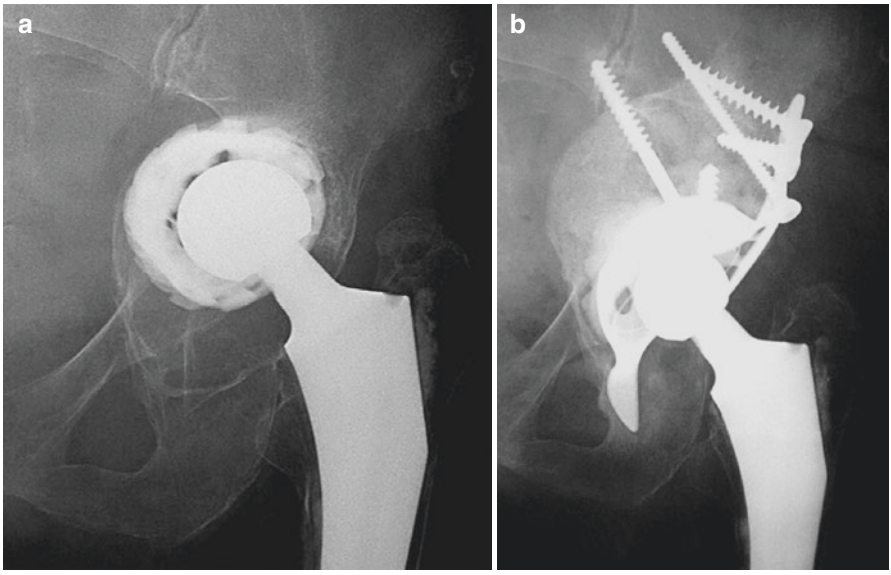

Fig. 8.4 (**a**) Anteroposterior radiograph showing a failed THA with pelvic discontinuity in a 72 year–old man, 12 years after surgery. (**b**) 5 years after revision with BSAC and morcellised bone allograft

of 15.6 mm and a 9.4 mm lateralization compared to the preoperative position. Our findings have also been supported by other series and have lead some authors to use BSAC in situations of pelvic discontinuity [2, 17]. Pelvic discontinuity is always difficult to solve. In the current series four patients had pelvic discontinuity; acetabular defect size was estimated to choose an appropriate anti-protrusion cage to span the defect from ilium to ischium and the defect filled with morcellised allograft (Fig. 8.4). Bulk allografts and the Burch-Schneider cage were effective in the management of 18 pelvic discontinuities and associated periprosthetic bone deficiency, with a cumulative 72.2% survival rate at 16.6 years [51]. All patients show a good result at the end of the study period.

There are few references to models other than the Burch-Schneider antiprotusio cage. Recently, Vigdorchik et al. [52] reports a series of 42 Contour cages with a follow-up of 42.5 months. The clinical outcomes are similar to those with the BSAC, with comparable rates in regard to complications, loosening, and failure [53]. The biomechanical analysis of retrieved antiprotrusio cages (APC) gives interesting with radiographic and clinical data to determine which factors influence or predict APC failure. Hosny et al. [54] reports 100% revision free surviving hip at mean follow-up of a 49 months using a GAP II cage and impaction bone grafting.

The most important problem with cages is that they are not made of a material that allows osseo-integration and, consequently, there is a high incidence of hardware failure due to screw breakage or ischial flange migration [50, 55]. New

materials, like tantalum, could provide greater long-term success than the traditional antiprotusio cages because they would permit bony ingrowth and so achieve stability [8–11]. Early and mid-term results with this material are encouraging; however, there are no long-term results as yet [56, 57].

Today, it is difficult to propose the current indications for these new implants but we would suggest that antiprotrusio cages are a resourceful option for cases in which there can be no confidence in initial or secondary stability of a reconstruction with porous-coated uncemented devices, and there is pelvic discontinuity, a need to protect allografts, an irradiated host bone or the patient is elderly subjects with little functional strain.

Based on our long-term results, we can conclude that use of a BSAC in acetabular revision surgery provides a viable treatment option for the reconstruction of different bone defects, including pelvic discontinuity, it has proven clinical efficacy and good mid to long term survival. Antiprotrusio cages are a valuable tool providing successful stability at mid and long-term reconstruction of severe acetabular bone deficiencies in revision hip replacement, but always providing that three basic principles are maintained in their use: initial mechanical stability, restoration of the hip centre of rotation and the use bone grafting in the acetabular bone deficiencies.

Funding Support No benefits in any form have been received or will be received from a commercial party related directly to the subject of this article. No funds were received in support of this study.

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