

TREATMENT OF ACETABULAR DEFECTS WITH POROUS METAL AUGMENTS IN REVISION HIP SURGERY

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ABSTRACT

Porous metal augments have been used successfully for management of large acetabular defects during revision hip arthroplasty. This study analyzes and compares the clinical and radiographic outcomes of porous metal augments in cemented and uncemented acetabular revisions, all performed at the same institution. In the period 2015-2017, 36 patients with 37 large acetabular defects were treated with porous metal augments in cemented and uncemented acetabular revisions. Postoperatively, patients were monitored for two years on average period of 24-36 months.

Acetabular augments were used when preoperative and intraoperative findings indicated the presence of large acetabular defects that can hinder the stability of the revision implants. We used lateral approach, 36 mm femoral head, and cementless or cemented acetabular cup depending on local bone quality. Postoperatively, all patients followed total hip arthroplasty precautions, with weight bearing as tolerated regimen with use of crutches during 6 weeks after surgery. The follow-up was radiological and clinical. We used HHS. At a mean follow-up of two years (range 24-36 months) one patient had reinfection and one patient had infection. None of the patients shown signs of aseptic augment or acetabular cup loosening. Porous metal augments show comparable excellent radiographic and clinical short-term outcomes, when combined with cemented or uncemented cups in revision hip arthroplasty. They allow good bone ingrowth, adequate implant contact and good stability. Complications were related to infection and not related to the augments itself.

Keywords: porous metal augments, acetabular defects, revision hip surgery

INTRODUCTION

From all causes of total hip arthroplasty revisions, aseptic implant loosening is the main cause, especially acetabular cup. Wear debris reaction in combination with the loose prosthesis may result in large acetabular osteolytic defects. Periprosthetic joint infection may also cause osteolytic defects, which can hinder proper stability of the revision implant and present a major

challenge during surgery. The management of severe acetabular defects in revision hip surgery is a substantial challenge. Paprosky et al. [1] classified these defects into 3 categories (Table 1). Historically, this challenge was addressed initially with the use of large structural allografts with a loosening and migration rate of up to 70% [2]. The current construct options to overcome these

defects include jumbo cups, structural allografts, anti – protrusio cages, augments and shells. The presence of acetabular defects necessitates special management during revision surgery. Small and contained defects could be managed successfully with uncemented, often screw stabilized, cups with or without bone graft [3, 4] or with cemented cups and impaction bone grafting. For larger uncontained defects that prevent acetabular rim support and hinder the revision cup stability, a buttress may be needed to support the revision cup, bring down the hip to its anatomic center, and also to conserve the acetabular bone by allowing placement of smaller cups. Both structural allografts and porous metal augments have been used as a buttress material, and superior results have been reported for the metal augments [5, 6]. In the original article by Paprosky et al. [1] the most common defect found was 2b, which showed destruction of the dome and/or medial wall and absence of the superior rim, but retention of the anterior and posterior columns. The porous metal augments are with completely porous structure made from commercially pure titanium. It provides a modulus of elasticity similar to a bone, and a coefficient of friction that allows for an impressive initial scratch fit. Their surface porosity is thought to promote the rapid osseointegration needed for stability and long-term mechanical support, because of reduced relative motion between components and native bone [7]. This primary stability also depends on bone mineral density (BMD), "snug fit" between cup and acetabular bone when press-fit, and the surface porosity of components [8]. The purpose of this study is to evaluate the clinical and radiographic results of such combination for the reconstruction of acetabular defect in revision hip arthroplasty.

MATERIALS AND METHODS

From 2015 to 2017 37 acetabular revisions with porous metal augments were performed (Grip-tion TF augments DePuy Synthes). All patients were identified from our institution database programs using the current terminology codes for the revision THA (total hip arthroplasty) procedures with augments. The indication for revision was aseptic loosening in 21 patients, 2-stage revision for infection in 14 patients (one bilateral hip infection) and in one patient primary hip augment insertion was performed due to malunion after acetabular fracture. Average patient weight 72 kg (52-98). Based on Paprosky et al. classification [1], the preoperative antero-posterior radiographs of these cases showed that 18 hips were classified as Paprosky type 2B defects, 9 hips as type 2C defects, 8 as type 3A and 2 hips were classified as type 3B defects (Table 2). A lateral approach was used in all cases. Patients were instructed to partially weight bear for 6 weeks post-operatively. Patients were followed up at intervals of 6 weeks, 6 months, and yearly thereafter. Twenty of 37 patients were woman (21 hips) and 16 were men. The mean age was 67.6 years (53–71 years) (Table 3). Postoperative anteroposterior pelvic and lateral hip radiographs obtained at the last follow-up visit were evaluated. Moore's classification describes radiographic signs suggestive for osseointegration of uncemented shells [9]. This system was modified by Gross et al to assess the probability of osseointegration of the shell and augment construct [10]. This modified classification considers augments to be unstable if (1) >3 mm migration compared with the early postoperative radiograph; (2) a radiolucent line at the augment-bone interface; (3) radiolucent lines around all screws; or (4) screw fracture. The revision surgery was performed by one surgeon through a lateral approach. The acetabular component of the implant was revised with cemented cup and augment in one hip and uncemented cup and augment, as well, in 36 hips. Cup selection and fixation methods were based primarily on the surgeon's own preference. We have used acetabular augments when preoperative radiographic or intraoperative clinical findings indicated that augment should be necessary to achieve acetabular implant stability and to restore the hip center of rotation. After removing the old cups, the fibrous tissue and the old cement mantle, if any, the acetabular defects were debrided. Once the acetabulum has been exposed evaluated preparation for the acetabular construct can begin.

Table 1

Type	Femoral Head Center Migration	Kohler's Line	Teardrop	Ischial Osteolysis
1	None	Intact	Intact	None
2A	Mild (<3 cm)	Intact	Intact	None
2B	Moderate (<3 cm)	Intact	Intact	Mild
2C	Mild (<3 cm)	Disrupted	Moderate lysis	Mild
3A	Severe (>3 cm)	Intact	Moderate lysis	Moderate
3B	Severe (>3 cm)	Disrupted	Severe lysis	Severe

Paprosky Classification of Acetabular Bone Loss

We start with riming the acetabulum at a level that will restore the appropriate center of rotation. When adequate rim contact has been obtained excluding the defect region, preparation of the acetabular defect to accept the augment starts. Once the acetabular cavity has been prepared, acetabular trial is placed into prepared bed at the correct center of rotation and rasp is used for preparing the acetabular defect. The rasp is used manually with strike plate and mallet blows. If the defect has been prepared satisfactorily and adequate bone contact is obtained, the augment can be placed initially, followed by the shell. Then the augment is inserted and secured in position with 3-4 screws. In addition, at the time of insertion of the shell and augment, the surgeon should decide whether cement fixation or mechanical fixation, using a bone screw can be placed through one of the screw holes in the shell and also through the hole in augment. In a cemented revision case, the acetabular cavity and the remaining defect was impacted with milled fresh frozen bone allograft, according to the technique of Schreurs et al. [11] For the uncemented revision cases, after acetabular preparation was done and the augment was secured in place, most cases had bone impaction grafting before the cup shell was fixed with 2-3 screws. Postoperatively-all patients followed THA precautions with weight bearing as tolerated regimen with use of crutches during 6 weeks after surgery. The follow-up was clinical according Harris Hip score (HHS) and radiological with preoperative, immediate postoperative 6 months and 1- year postoperative digital antero-posterior pelvis and lateral hip radiographs.

Table 2

Based on Paprosky et al. classification

2B	18 acetabula
2C	9 acetabula
3A	8 acetabula
3B	2 acetabula

Table 3

Patients data

Number of revisions	37 revisions
Patients gender	20women;16 men
Indications for revision	Aseptic loosening 21 Septic loosening 14 (one bilateral) Primary endoprosthesis replacement 1(acetabular fracture)
Mean age	67,6 years (range 53-71)
Average patient weight	72 kg (52-98)
Follow-up	24 months (range 24-36)

RESULTS

The mean follow-up for 37 revision total hip arthroplasties was 2 years (24-36 months). As the latest review, no patients were lost. At the time of revision surgery femoral components were implanted in 3 patients with primary stems, 5 patients have stable femoral stem and 29 patients were treated with modular revision femoral stems. In four hips extensive trochanteric osteotomies were performed. The mean size of the gription shell was 56 mm and the mean size of gription augments was 20 mm (Table 4). 21 hips got impaction grafting with milled fresh frozen bone allograft.

The deceased patients had been assessed radiographically and clinically at 1- year follow-up and were functioning well with no signs of implant migration or loosening (Fig. 1). At the most recent follow-up 35 hips were determined to be stable and clinically successful. No progressive linear osteolytic lucencies were evident around acetabulum, so we defined them as stable. One hip augmentation failed because of recurrent infection and the other one failed, because of infection with cup migration and subsequent loosening. This patient later underwent a resection arthroplasty. The patient with recurrent infection had stable acetabulum. The failed augment was noticed in type 3A defect with evidence of osteolysis around the screws and breakage has occurred in 2 of 4 screws. The complication after the revision arthroplasty was an infection. Clinically, patients improved Harris Hip score 32 (range 14-48) to a mean postoperative score of 84 (36-98). The success rate was 94,5%.

Table 4

Used implants and grafting	No	No	impaction grafting	
Pinnacle multi-hole shell 52mm	2	Gription TF augments 50/52: 15 mm	1	
54mm	3	50/52: 20 mm	1	
56mm	17	54/56: 10mm	3	
58mm	5	54/56: 15mm	6	
60mm	4	54/56: 20mm	9	3
62mm	4	54/56: 30mm	2	7
64mm	1	58/60: 20mm	6	3
66mm	1	58/60: 30mm	3	2
			3	3
		62/64: 20mm		
		62/64: 30mm	2	2
		66/68: 30mm	1	1

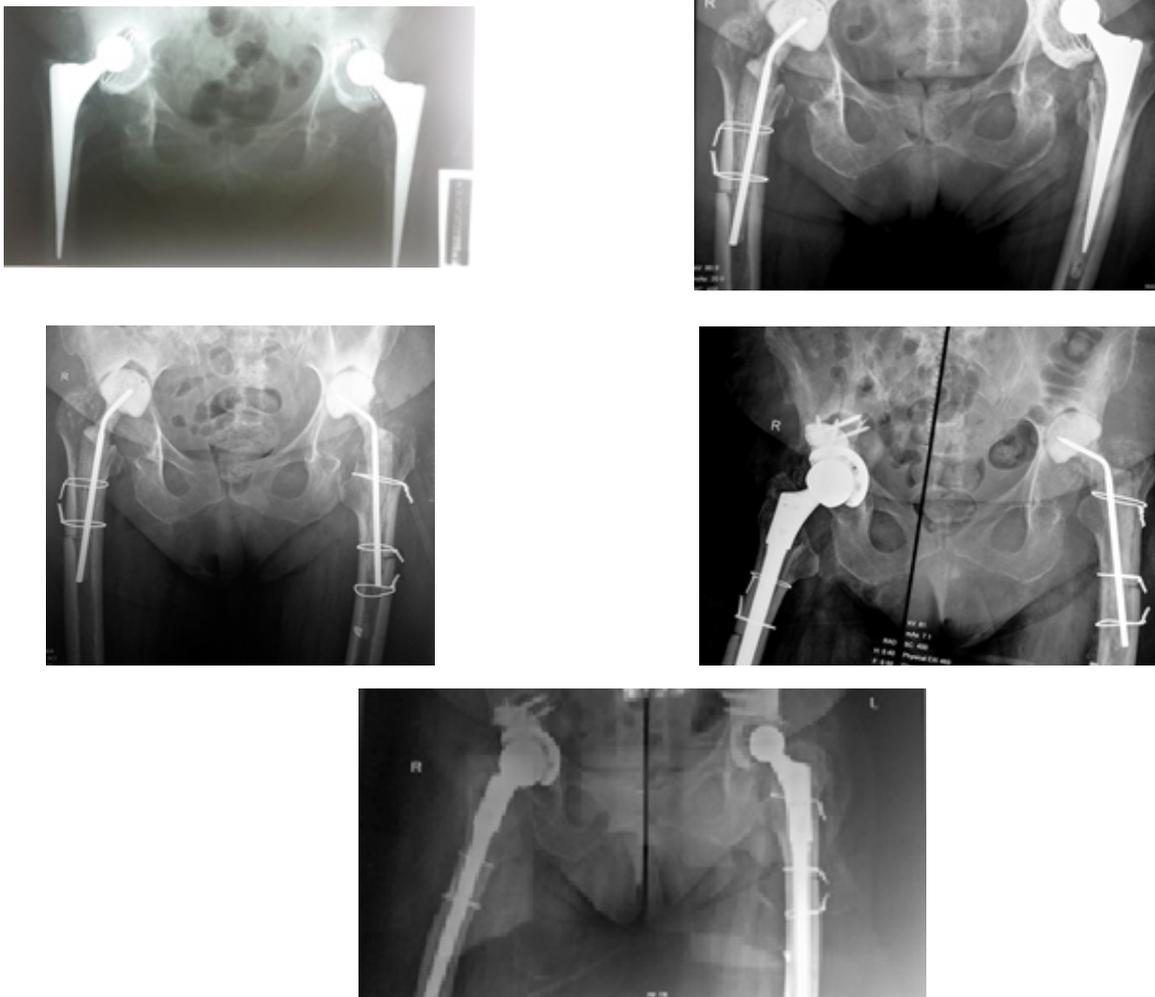


Fig 1. Radiographic follow-up of a cemented and uncemented revision cases. Bilateral septic loosening with large acetabular defects. Extirpation of prosthesis with extended femoral osteotomy, application of MMA spacers and implantation of revision hip prosthesis with augments for acetabular defects



Fig 2. Preoperative radiograph with large superior acetabular defect with aseptic cup loosening. Postoperative radiograph demonstrates stable fixation of augment with acetabular component

DISCUSSION

Traditional porous coated acetabular implants have proven to be an effective solution for

most revision total hip arthroplasties in which adequate bone is available to support an acetabular component and provide contact for bone ingrowth [12, 13, 14]. Severe defects remain a challenge. The use of cages and traditional implants

have worked well in less severe defects, and the use of bulk allograft with a cage has provided a solution for hips in which contact cannot be made with 50% of the host bone [15, 16]. However, as the severity of the defect and the length of time in situ increases, such implants may fall. Recent short-term reports regarding gription metal acetabular components in revision cases have shown promising results [17]. In contrast to a cage, porous metal implants provide a highly porous surface conducive to bone ingrowth [18]. Porous metal augments provide a modulus of elasticity similar to a bone, and a coefficient of friction that allows an impressive initial scratch fit. Therefore, porous tantalum enables physiological transfer of load, from implant to host bone, minimization of stress shielding, and preservation of limited bone stock [19]. These implants have ability to use locking screws to fixate the augment to host bone (Fig 3). Locking screws help prevent the screw from becoming loose and backing out of the augment. This minimizes the risk of compromising the fixation as a result of screw migration. Morselized allograft, structural allografts, and metal augments can be used together to obtain optimal stability of the hemisphere if needed.



Fig. 3. Fixation options and position of the augment with shell.

In the present study, the authors found that 94.5% of the cups and augments were in situ and radiographically stable at mean of 2 years follow-up. We are encouraged by these short-term results, as well as those reported by other authors. As for acetabular defects, when assessing the acetabular defects before the revision surgery, the preoperative radiographs might

underestimate the size or even the presence of acetabular defects that may come as a surprise during surgery. In our opinion having acetabular augments available during all acetabular revision surgeries is recommendable and can help in improving the outcome. We report that the combination of porous titanium augments and shells confers favorable clinical and radiographic results. This approach allows anatomical cup placement, good initial stability, and a simple surgical procedure. However, there are several limitations. A limitation of this study is that it is a retrospective consecutive series without a control group. A prospective control study with a larger sample size is needed to further evaluate the results of the combined use of titanium augments and shells with comparison with other methods in reconstructing acetabular defects in revision hip surgery. Ideally, a prospective randomized trial comparing the effect of an alternate revision technique would be conducted. Moreover, the longer-term follow-up results for this reconstruction method need further assessment. Finally, in this study, the extent of acetabular defect was restricted to the superior acetabular rim and medial wall. The teardrop of the acetabulum was intact. The high cost, incapacity to restore bone stock for future revisions, and lack of long-term data are other criticisms of the augments and shell technique. Despite these limitations, there is no potential for reabsorption. The micro porosity of the material favors biological fixation of the implant and feeds the expectation of achieving long-lasting stability [20].

CONCLUSION

Porous titanium augments combined with titanium shells show satisfactory clinical and radiographic outcomes for the reconstruction of acetabular defects in revision hips surgery at a mean 2 years of follow-up. This approach confers anatomical cup placement and a high rate of stable fixation. Acetabular augments are composed of highly interconnected porous metal. Physical characteristics are similar to trabecular bone with high coefficient of friction, low modulus of elasticity and 70-80% porosity. These properties allow bone ingrowth, adequate implant contact and good stability. Complications were related to infection and not related to the augments itself.

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Резиме

ТРЕТМАН НА АЦЕТАБУЛАРНИ ДЕФЕКТИ СО НАДГРАДБА ОД ПОРОЗЕН МЕТАЛ

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Надградбата со порозен метал во третманот на големи ацетабуларни дефекти успешно се користи во ревизиската ендопротетска хирургија на колкот. Во овој труд се анализира и се компарира клиничкиот и радиографскиот резултат на надградбата со порозен метал на ацетабулумот од колкот при имплантација на цементни и безцементни ревизиони ацетабуларни капи, сите изведени во истата установа. Во периодот 2015–2017 година, 36 пациенти со 37 големи ацетабуларни дефекти беа третирани со надградба од порозен метал и имплантирано цементни и безцементни капи. Постоперативно пациентите беа следени две години, во просек 24–36 месеци. Ацетабуларна надградба беше применета кога предоперативниот и интраоперативниот наод укажуваше на присуство на голем ацетабуларен дефект, кој ја попречува стабилноста на ревизискиот имплант. Користевме латерален пристап, 36 мм феморална глава и цементна или безцементна ацетабуларна капа, во зависност од локалниот коскен квалитет. Постоперативно сите пациенти ги следеа препораките за делумно оптоварување на оперираната нога со помош на две потпазувни патерици во период од 6 недели. Следењето на резултатите од оперативната интервенција беше радиолошки и клинички. Го користевме Харис Хип Скорот (HHS), со среден период на следење од две години, просек (24–36 месеци). Кај еден пациент се повтори инфекцијата и кај еден пациент се појави инфекција. Ниту еден од пациентите не пројави знаци за олабавување на металната надградба или ацетабуларната капа. Надградбата на ацетабуларните дефекти со порозен метал покажа солидни радиографски и клинички резултати при краток период на следење. Тие обезбедуваат добро коскено сраснување, адекватен контакт со имплантот и негова добра стабилност. Компликациите беа во релација со инфекцијата, а не со самите надградби.

Клучни зборови: надградба од порозен метал, ацетабуларни дефекти, ревизиска хирургија на колк