



## Early results of Trabecular Metal augment for acetabular reconstruction in revision hip arthroplasty

Ibrahim ELGANZOURY, Ayman Abdelaziz BASSIONY

From Ain Shams University Hospital, Cairo, Egypt

The management of acetabular bone defects presents a challenge in revision total hip arthroplasty (THA). The aim of this study was to assess the early clinical and radiological outcome of revision of acetabular components using trabecular metal cups and augments for acetabular reconstruction.

The study included 18 consecutive patients with failed acetabular components after total hip arthroplasty, with acetabular defects that were revised using porous tantalum acetabular components and augments. The mean follow-up was 18 months (range : 12-24).

At the most recent follow-up, 6 patients (33%) were graded as having an excellent result, 9 (50%) a good result, 3 (17%) a fair result according to the HHS. The hip centre was restored to its normal position. There were no cases of hip dislocation. One patient had a partial sciatic nerve palsy which had resolved two months postoperatively.

Based on these early clinical and radiological results, TM acetabular components and augments for acetabular defects (Paprosky II and III) appear to be a promising solution for this complex situation. We continue to monitor these patients, and a larger series with longer follow-up will be required to determine the long-term outcome of these augments.

**Keywords :** revision hip arthroplasty : trabecular metal augments : acetabular defects.

### INTRODUCTION

As the indications for total hip arthroplasty (THA) increase, particularly in younger patients,

the number of revision procedures will increase in the future. Loss of acetabular bone stock results from removal of bone during the original procedure, subsequent prosthetic failure, and osteolysis resulting from reaction to wear particles of cement and polyethylene, and further bone damage often occurs during removal of loose prosthetic components (29).

The treatment of acetabular bone defects presents a challenge in revision total hip arthroplasty. Small, contained defects can be successfully reconstructed with porous-coated hemispheric cups with or without supplementary allografts (30). With larger uncontained defects, a cementless cup will not engage with sufficient host bone to provide primary stability, even with additional screws (13). The surgical options include extra-large hemispheric cups (8,33), high hip center placement (7), impaction grafting with cement (25), structural allografts (26) bilobed oblong cups (6) and reconstruction cages (14,15).

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■ Ibrahim Elganzoury, MD, Assistant Professor of orthopaedic surgery.

■ Ayman Abdelaziz Bassiony, MD, Assistant Professor of orthopaedic surgery.

*Orthopaedic Departement, Ain Shams University Hospital, Cairo, Egypt.*

Correspondence : Ayman Abdelaziz Bassiony, Orthopaedic Departement, Ain Shams University, Cairo, Egypt.

E-mail : aymanbassiony@yahoo.com

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Modular porous trabecular metal (tantalum) augments were recently developed to achieve biological fixation and provide coverage and mechanical support for an uncemented hemispheric acetabular component. These cups and augments are manufactured in multiple sizes and shapes to accommodate various bony defects (22). The purpose of this study was to analyze the early clinical and radiographic results obtained in a consecutive series of 18 cases with acetabular defects in revision total hip arthroplasty reconstructed by means of trabecular metal (TM) modular augments.

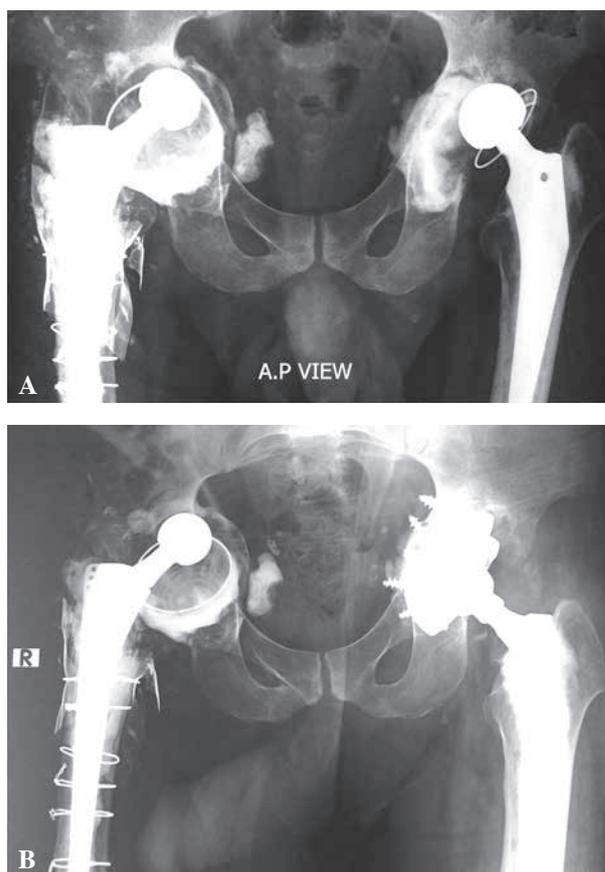
### PATIENTS AND METHODS

This prospective study included 18 patients who underwent revision of loose acetabular components of total hip arthroplasty with associated acetabular defects, followed by reconstruction by means of trabecular metal augments (Trabecular Metal Acetabular Augment and Restrictor®; Zimmer, Warsaw, USA).

There were 13 men and 5 women. The average age at operation was 50 years (range : 45-62). The minimum follow-up was 12 months (mean : 18 ; range : 12-24). The indication for revision was aseptic loosening of acetabular component in all patients. Revision of the acetabular component only was done in 8 hips while revision of both components was done in ten hips. Patients presenting with infection, pathological defects or pelvic discontinuity were excluded from this study. The mean time from the index procedure to revision was 8 years (range : 5-14).

Preoperatively, acetabular bone deficiency was assessed based on antero-posterior and lateral X ray views and was categorized using the classification of Paprosky *et al* (23). Ten cases were graded type IIIA, two as Type IIIB and six as IIB. Mean preoperative leg length discrepancy was 4 cm, with a range from 2 to 6 cm. All patients underwent routine pre-operative blood investigations to exclude infection (ESR and CRP).

A posteroateral approach was used in all cases. The surgical technique began with acetabular exposure. Femoral stem stability was assessed intra-operatively and was found to be correct in eight cases. The loose acetabular component and any remaining cement were removed. Fibrous tissue was removed from the acetabular bed. The remaining superior, inferior, and anterior bone was assessed. The preoperative assessment of the defect was confirmed at operation. The teardrop was identified and served as an inferior cup-positioning land-

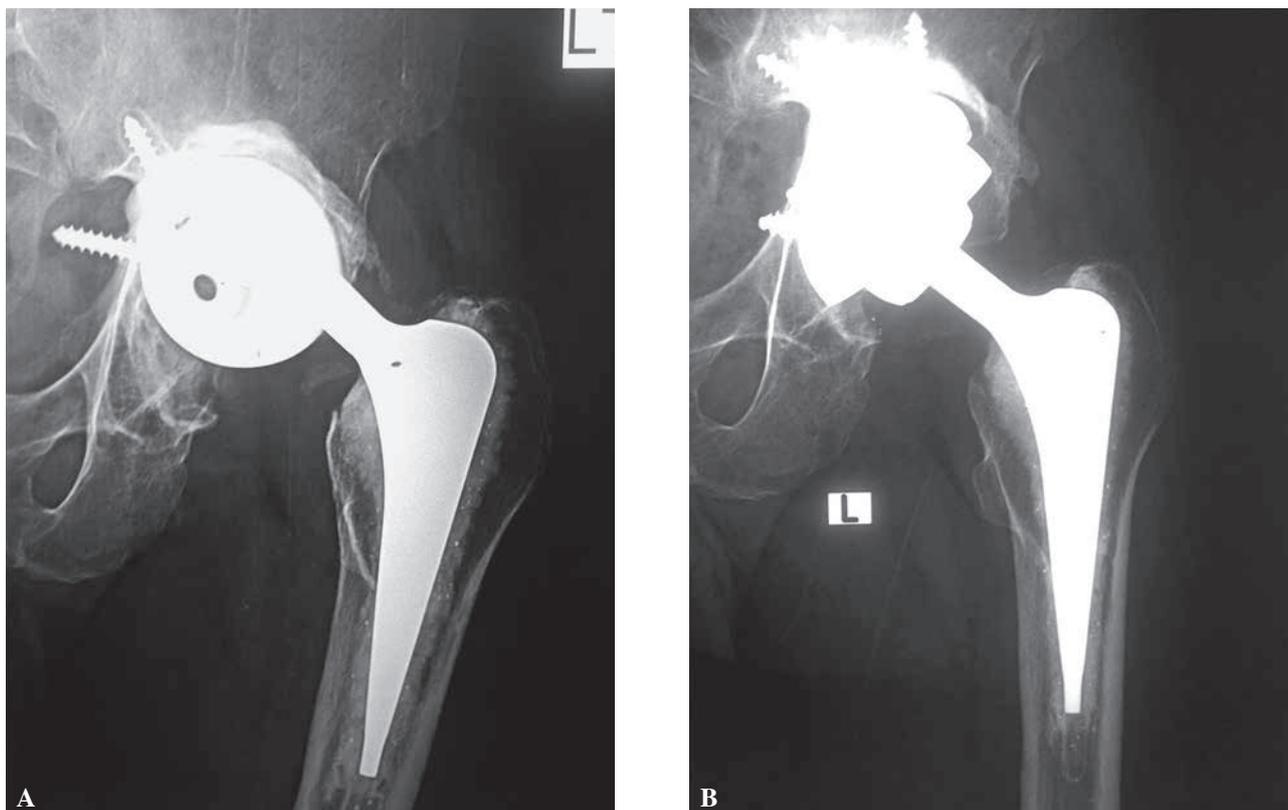


**Fig. 1.** — A : 53-year-old male patient with loose left THA and Paprosky III b acetabular defect. B : Post operative radiograph with restoration of the hip center.

mark. A Hohmann retractor was placed in the obturator foramen which represents the level of inferior extent of the true acetabulum. Gentle reaming in the anatomic hip position re-established the center of rotation to expose bleeding bone. A trial acetabular shell was placed for sizing and positioning.

The defect was prepared to accept an augment of suitable size such that it had good contact with the remaining host bone and provided the required support for the hemispheric trial cup. This reaming was done with a reamer that matched the diameter of the augment chosen.

Trial augments were tested to create a stable construct in the superior-inferior and anterior-posterior planes (augments can be placed in various orientations, depending on defects and remaining bone). The augment was fixed with multiple 6.5 mm screws directed in a perpendicular fashion. Augments are available in different sizes



**Fig. 2.** — A : 49-year-old male patient with loose left THA and Paprosky III b acetabular defect. B : Radiograph 20 months post operative showing a stable cup and augment with restoration of the hip center.

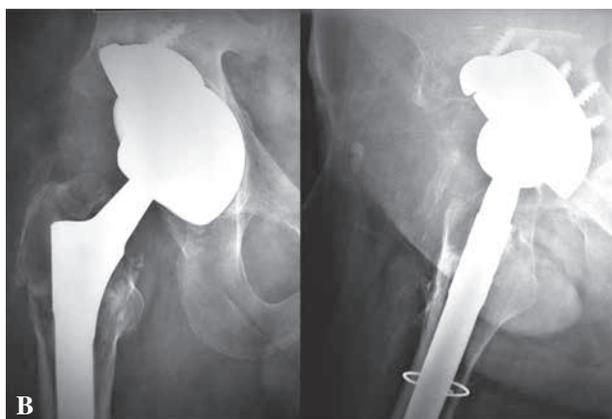
ranged from 50 to 70 mm in 10, 15, 20, and 30 mm thicknesses. In the study group we used the size of 20 mm in 12 cases and 15 mm in the remaining cases. Bone cement was applied in a doughy state across the concave surface of the acetabular augment that would contact the cup. Care was taken to limit the cement to this location and prevent cement from extruding into the depths of the acetabulum where it might impede bone ingrowth into the trabecular metal augment. Fixation to all areas in contact with the host bone remained uncemented. The augment was now prepared to accept a cup.

A trabecular metal acetabular component was used in all cases with size ranging from 54 to 62 mm. Extended trochanteric osteotomy was used in 7 out of ten cases that required revision of the femoral component.

Postoperatively weight bearing was restricted for 6 weeks, then partial weight was allowed for the following 6 months. For patients who had extended trochanteric osteotomy, full weight bearing was delayed till evidence of union.

Clinical evaluations were performed at all follow-up intervals using the Harris hip score (HHS) (18). A score of 90 to 100 was considered as excellent, 80 to 90 as good, 70 to 80 as fair, and below 70 as poor. Success of revision was defined as an increase in the scores of 20 or more points, a stable cup, with no additional surgery on the acetabulum (11).

Radiological evaluation was done on antero-posterior and lateral radiographs at all follow-up intervals. Radiolucent lines adjacent to the acetabular component and/or augments were identified as described by DeLee and Charnley (9). Acetabular hip center, and migration of acetabular component were considered using the method proposed by Callaghan *et al* (5). The vertical distance from the center of the femoral head to the interteardrop line and the horizontal distance to the perpendicular to this line at the teardrop figure were calculated. A normal hip center is reported to be 12 to 14 mm above the interteardrop line and 33 to 43 mm lateral to the acetabular teardrop (4). A high hip center was arbitrarily defined as



**Fig. 3.** — A : 52-year-old male patient. Preoperative radiograph with loose right THA and Paprosky II b acetabular defect. B : Follow-up radiograph after 24 months showing stable acetabular cup-augment construct.

having the center of rotation on an anteroposterior radiograph greater than 35 mm proximal to the interteardrop line (24). A component was described as radiographically unstable if a 1 mm or greater lucent line occurred across all 3 acetabular zones or if any measurable cup migration occurred (32). Loosening was characterized by a change in the component abduction angle of greater than  $10^\circ$  or in the horizontal or vertical position of greater than 6 mm

observed in successive radiographs, after correcting for magnification (27).

## RESULTS

After a mean follow-up of 18 months (range : 12 to 24) the mean Harris hip score improved from 40 pre-operatively (20 to 70) to 80 post-operatively (50 to 95). At the most recent follow-up, 6 patients (33%) were graded as having an excellent result, according to the HHS, 9 (50%) a good result, 3 (17%) a fair result. The revision surgery was considered successful in all cases ; no patient was subjected to further surgery.

The mean revision cup diameter was 58 mm (range : 54-62 mm) and the augment height used was 20 mm in 12 cases and 15 mm in the remaining cases. The average preoperative limb-length discrepancy was 4 cm ranging from 2 to 6 cm shorter on the involved side ; it improved postoperatively to an average discrepancy of 0.5 cm (range : 0.0 cm to 1.0 cm).

Extended trochanteric osteotomy done in 7 cases and united in a mean period of 10 weeks (range : 8 to 15 weeks).

At the final follow-up, radiographs showed no evidence of cup loosening or change of cup orientation or abduction angle. No progressive radiolucent lines in any of the three acetabular zones were found at the cup bone and augment bone interface. There was radiographic evidence of full contact between the acetabular component and the augment with the peripheral bone. The hip centre was restored within the normal average.

There were no cases of hip dislocation. One patient had a sciatic nerve palsy which was partial and had resolved after two months. There were no cases of deep vein thrombosis, pulmonary embolism, or acetabular/pelvic fractures.

## DISCUSSION

Acetabular revision is a technically demanding operation. This study was conducted to evaluate the early clinical and radiological results of acetabular defect reconstruction with trabecular metal augments and shells. The results of this study, although

limited by its number of cases and its short term follow-up, show that acetabular composite stability can be achieved when using tantalum acetabular components and modular tantalum augments. The rate of success with this technique is similar to that achieved with the custom-made triflange cup (10) and higher than that reached with conventional or extra large cementless cups supplemented by screws, morsellized or structural allografts, and reconstruction rings or cages (12,13).

The existing bone stock and the type of defect are significant factors in surgical decision making when undertaking revision of acetabular components. The intent is to restore anatomy and to achieve stable fixation of the new acetabular component(s). Unlike more traditional metal options, trabecular metal has a porosity akin to bone and confers a more favourable mechanical environment in which bone graft materials (depending on their nature) can function ; this may be osteoconductive, osteoinductive or a combination thereof (15-17).

Trabecular metal has a porosity similar to bone and provides an environment more favourable to bone graft remodeling than conventional metals (24,25) ; it has also been shown to have excellent ingrowth potential (3).

The use of TM augments is gaining popularity in the management of bone loss in acetabular reconstruction. The TM augment is used to fill the defect. The reconstruction is then completed using a cementless cup. In a study using TM augments and cementless cups, Nehme *et al* (22) reported good early to medium-term results. Similarly, in a series of 28 hips with a Paprosky type IIIA defect and 13 hips with a type IIIB defect, Sporer and Paprosky (27) found no failures from aseptic loosening. Weeden and Schmidt (32) also reported no revisions for aseptic loosening when reviewing 43 Paprosky type IIIA or type IIIB acetabular revisions at a mean follow-up time of 3 years. Lakstein *et al* (20) found an 8% failure rate at 4 years on average when TM cups without augments were used in patients with < 50% host bone contact.

Tantalum has excellent mechanical and biologic compatibility with host bone and can be manufactured with a high-friction surface to optimize the primary stability of the component (21). The charac-

teristics of the porous structure, in conjunction with the bioactivity of material surface, is shown to induce bone ingrowth with complete osseointegration of the scaffold at 4 to 6 months (1-2). The short-term clinical results of tantalum components for the revision of failed acetabula in total hip arthroplasty are encouraging (28-27-31).

The primary goal of revision hip surgery is to obtain a stable, durable reconstruction. Secondary goals include reconstituting bone stock, restoring the hip center of rotation to the anatomical location, and minimizing leg-length discrepancies. Although several cementless techniques (high hip center placement, jumbo cups, oblong cups) may achieve stable acetabular reconstruction in the presence of major (Paprosky type 3) bone loss, bone stock is not reconstituted, and the hip center of rotation may not be returned to the normal location (19). This method restored the hip center to near normal in all patients and corrected leg length discrepancy to an acceptable range (mean of 0.5 cm) and provided stable acetabular reconstruction. Good to excellent results with this method were obtained in nearly 83% of cases.

Analysis of this consecutive series of acetabular revisions with the TM acetabular component and augments demonstrates promising early results. Continued follow-up will be essential to determine the long-term performance of tantalum shell and augments in revised acetabular components.

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