

Trabecular Metal Augments for Reconstruction of Acetabular Bone Defects in Revision Total Hip Replacement; Early Radiological and Clinical Outcomes

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Abstract

Background: The amount of total hip arthroplasty [THA] surgeries conducted yearly is on the rise, and this trend is also noticeable in revision hip procedures. However, reconstructing acetabular defects during revision THA can be difficult. Successful revision surgery requires achieving press-fit of the implant, bridging bony defects, and restoring the center of rotation of the hip. Various approaches have been implemented to attain these objectives. **Aim:** to evaluate early functional and radiological outcomes in patients undergoing revision THA with acetabular defects using trabecular metal augments for reconstruction of the acetabulum. **Patients and methods:** A prospective cohort study was conducted in Benha university hospital including twenty patients undergoing revision THA with acetabular defects that necessitate reconstruction between April 2019 and December 2022 in using trabecular metal augment. **Results:** The average age of the patients examined was 59 years old. The majority of the patients were found to have a Paprosky type 2B defect [45%] according to classification. Out of the total patients, 55% [11 patients] had excellent results as per the Oxford Hip Score, 40% [8 patients] showed good results, and only 5% [1 patient] showed fair results. The average time of postoperative follow-up was 16 months. **Conclusion:** porous metal augments are considered a valuable method in the management of acetabular defect due to its modularity and the ability to reconstruct different types of defects with no fear of bone resorption.

Keywords: Trabecular Metal Augment; Acetabular defects and Paprosky Classification.

1. Introduction

The yearly number of revision hip surgeries and total hip arthroplasties [THA] is increasing [1]. Obtaining a press-fit implant, bridging any bone abnormalities, and restoring the hip's center of rotation might be difficult during the restoration of acetabular deformities during revision THA. Various methods have been utilized to accomplish these goals. A suitable shell can provide sufficient stability for people with modest oval deformities. However, those with greater oval faults may require jumbo components to attain stability [2].

Allografts, cemented shells, rings, or cages, high-center-of-rotation shells, cup-cage constructions, and elliptical shells are further approaches for reconstructing acetabular defects in revision THA. However, poor primary stability and host-bone contact below 50 percent may limit osseous fixation and cause early failure. The use of cages and reinforcement rings may fail due to breakage or loosening, while graft resorption and late failure may occur when allograft bone is utilized with earlier designs of acetabular components [3].

Antiprotusio devices and cages in conjunction with cemented acetabular components have been used to treat these problematic conditions, but their mid- and long-term results have been poor. Custom triflange acetabular components [CTACs] from Zimmer Biomet are a promising option, especially in situations of chronic pelvic discontinuity [4]. However, this procedure is expensive, needs a six-week manufacturing time, and may not match the original defect if bone loss happens during the removal of the old component [5].

Various studies indicate that the use of modular trabecular metal augments combined with a porous tantalum acetabular component for severe acetabular bone loss has demonstrated encouraging mid-term effects [5,6].

2. Patients and methods

Pre-operative Evaluation

A prospective cohort study was conducted in Benha university hospital including twenty patients undergoing revision THA with acetabular defects that necessitate reconstruction. A written consent was

obtained, and the patients were informed about the surgical procedure.

Inclusion criteria: Patients who are undergoing rTHA with loose acetabular component with acetabular defects [Paprosky type II and type III "A,B"] [13] that necessitate reconstruction. **Exclusion criteria:** Patient with pelvic discontinuity

All patients were subjected to personal history, present illness history, past history, general examination and local neurovascular assessment of the affected limb, Abductor muscle status was tested using Trendelenburg test and Leg-length discrepancy was evaluated. All patients were examined radiologically by X-Ray and CT Scan to clarify type of the defects. Laboratory assessment including CBC, ESR, CRP, R.B.S, HbA1C, Urine analysis, Urea and electrolyte were done.

The study was done after being approved by the Institutional Ethics Committee of Faculty of Medicine, Benha University [study code [MD 7-1-2020]]

Operative Intervention

All patients were operated upon while lying in a lateral position. The patients received combined spinal [subarachnoid] anesthesia, and epidural anesthesia. IV Tranexamic acid [15 mg/kg] was taken routinely in the OR and intravenous antibiotic a double dose [2 gm] of third generation cephalosporin intravenously with the induction of anesthesia.

Through the posterior approach, Old incisions were used whenever possible. However, skin incision was modified in many occasions to allow for posterior approach or incorporate draining sinuses. The sciatic nerve was located and palpated frequently.

With the leg maximum stretched and internally rotated, the scarred external rotators were detached and reflected posteriorly. The preceding acetabular component was removed along with debridement and excision of fibrous tissue.

Preparation of the bony bed for fixation of the augments. Impaction bone grafting was used in five cases where the segmental defect was associated with a cavitary one [cases number 1, 3, 4, 7, 12].

Cemented [Zimmer ZCA] High cross-linked all-poly cup [Longevity HCLP] was used in nine cases. seven cases had MOP bearing and 36 mm head. The other two [case 2, 9] had COP with 36 mm head. Cementless cup [Zimmer] was used in eleven cases. Eight of them had MOP bearing with 36 mm head and 2 cases had COP with 32

mm head and one cases had COP With 36mm head.

Closure of the wound by Reattachment of the posterior soft tissues including short external rotators to the greater trochanter was done. The iliotibial band was then closed after application of suction drain. Skin closure using skin clips

Post-operative care

Postoperative antibiotic regimen was given as ceftriaxone 2 gm infusion every 24 hours for 48 hours. In the infected cases, antibiotics were given according to the results of intra operative samples. Low molecular weight heparin 40 I.U. once daily started 12 hours after the surgery and maintained for one month. Proton pump inhibitors were given till discharge. Hemoglobin concentration was assessed for every case at least 6 hours after the last transfused blood unit. Blood transfusion was given if HB concentration was less than 9 gm/dl.

Static quadriceps and hamstring exercises and straight leg raising. The timing of postoperative partial weight bearing was variable according to the structural integrity of the acetabular reconstruction. cases started full weight bearing at 6 weeks.

Post-operative Evaluation

Clinical evaluation

All patients were followed up at 2 weeks, 6 weeks, 12 weeks, 6 months then annually thereafter to assess incision condition, ROM, abductors strength. Patients progressed to full weight bearing at the 6 weeks.

Radiological evaluation

All post-operative patients received anteroposterior and cross-table lateral plain X-ray examinations at two, six, twelve weeks, six months, and subsequently annually. Moore's categorization system describes the radiographic indications of osseointegration in non-cemented shells. Gross et al. updated this approach to assess the likelihood of osseointegration of the shell and augment build. According to this new categorization, augmentations are deemed unstable if there is more than 3 mm of migration from the early postoperative radiograph, a radiolucent line at the augment-bone interface, radiolucent lines surrounding all screws, or screw breakage [6]. The HCOR following surgery is measured relative to the inter-teardrop line and, if available, the contralateral natural HCOR.

Functional outcomes will be measured with oxford hip score [OHS][7].

The evaluation of complications was carried out, which encompassed complications that occurred during the operation, soon after the operation, and during the follow-up period.

Statistical methods

For data management and statistical analysis, version 25 of SPSS [IBM, Armonk, New York, USA] was utilized. Normality of data was evaluated, and different statistical tests were performed dependent on the kind of data and number of groups being compared. Student's t-test was utilized to compare the means of two sets of parametric data, whilst the Mann-Whitney U-test was utilized for continuous nonparametric data. ANOVA was used to compare more than two groups of parametric data, whereas the Kruskal-Wallis test was applied to continuous nonparametric data. Correlation between different parameters was examined using Pearson and Spearman rank correlation coefficient [r] test. A P value of less than 0.05 was deemed statistically significant [S].

3. Results

Patient Characteristics

The twenty patients had revision components for a failed previous hip intervention with age ranging from 49 to 70 years with mean 59 years. there were twelve males and eight females. The infected cases underwent revision of the component after debridement with removal of the component and their laboratory study being negative. Patients were evaluated clinically using OHS and at the last follow up.

The mean follow up period was 18 months [rang, 12-30 months]. Paprosky classification was used to classify the acetabular defects, 9 patient Paprosky type 2B defect and 6 patients with Paprosky type 2C defects and 5 patients with Paprosky type 3A defect. The body mass index [BMI] in current study was 28.9 [rang, 23.1-37.4] Table (1).

Table (1) Patients' characteristics of the studied patients.

patient characteristic	Study group "n. = 20"	
Age [mean]	49 to 70 years with mean 59	
Sex	Male	12 60%
	Female	8 40%
Medical history*	HTN	4 20%
	D.M.	4 20%
	Rheumatoid	1 5%
BMI [mean]	28.9 [rang, 23.1-37.4].	

Radiological Results

All patients were radiographically examined for restoration of center of rotation, inclination of acetabular component, location of the stem, position of the trabecular metal augment, repair of acetabular deformities, and evidence of steointegration. The radiographs acquired immediately after surgery and sequentially over the follow-up period.

All patients showed radiographic signs of osteointegration. According to Moore classification of osteointegration, 3 cases showed 5 signs, 12 cases showed 4 signs and 5 patients had 3 sign of osteointegration. one patient [case 3] started to have radiolucent line in zone 1 this line was stable and didn't extend in the next follow-up visit.

IBG were observed in this series. It was used in five patients in combination with cemented polyethylene cup. All cases show incorporation of bone graft and stable augments with osteointegration. RLL appeared in a single case [case 3] in zone 1 that didn't progress or needed revision.

Functional Results

OHS has improved in this study from 12.85 preoperatively to 38.9 at the latest follow up visit. According to OHS grading, 11 cases [55%] were excellent at the last follow up. 8 cases had a good result and one patients ended up with a fair result Table (2).

Results of Complications

There were two patients [10%] with post-operative infection for which debridement was done after three weeks with no recurrence of infection. one patient [case 3] started to have radiolucent line in zone 1 this line was stable and didn't extend in the next follow-up visit. It didn't affect the result of the patient which was excellent according to OHS grading. Another patient had sciatic nerve affection in the form of neurotmesis and patient refused to do exploration. No dislocation occurred post-operatively.

Table (1) Continue			
	2B	9	45%
Paprosky classification	2C	6	30%
	3A	5	25%
Follow Up duration/ months [mean \pm SD]	18 months [rang, 12-30 months].		
* more than one disease in the same patient			

Table (2) Grading of OHS at last follow up visit.

OHS grade	Number of patient	Percentage [%]
Fair	1	5%
Good	8	40%
Excellent	11	45%
Toral	20	100%

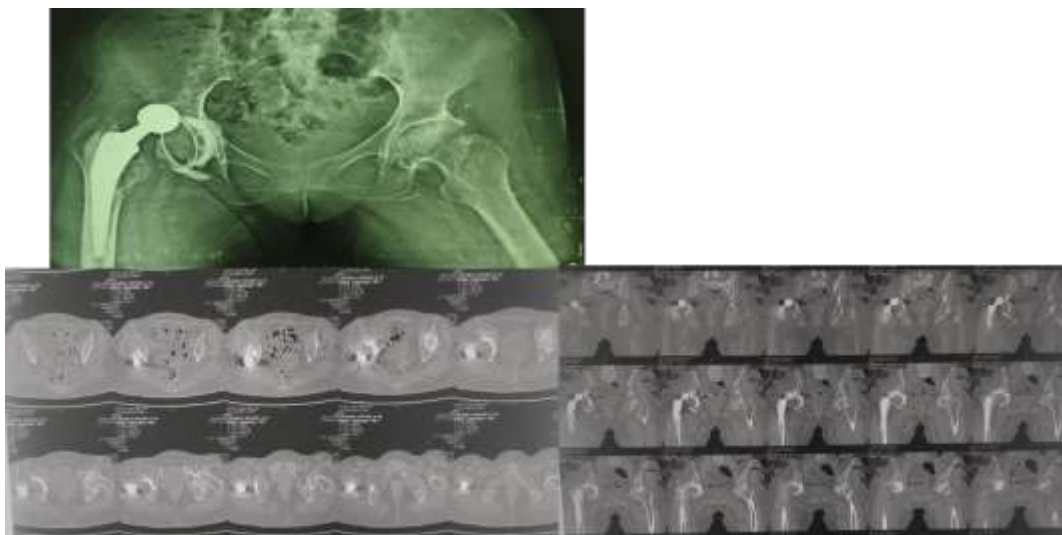


Fig. (1): pre-operative x-ray and C.T. of female patient 48 years old with failed total hip replacement with Paprosky type 2C acetabular defect.



Fig. (2): A: intra-operative photo for trial augment and trial cup, B: intra-operative photo for the augment



Fig. (3) A: immediate post. Operative x-ray, B: follow up x-ray after 3 months, C: follow up after 6 months and D: follow up after 12 months.



Fig. (4) Clinical photos for the patient after 12 months with unassisted full weight bearing and good abduction rang.

4. Discussion

The reconstruction of acetabular bone stock defects encountered during hip arthroplasty is a challenging task for the surgeon especially in large defects; Paprosky type II and III. By searching the literature, one can easily recognize the fact that there is no single gold standard method for reconstructing these defects. Decision heavily depends on surgeon preference and experience.

The long-term complications of the previously standard techniques such as cages[8], rings[9], bulk grafts[10] and extra-large cups[11] have led the surgeons to look for alternative materials to option for acetabular reconstruction.

A prospective research was conducted between April 2019 and March 2023 to

evaluate the clinical and radiological effects of using trabecular metal augments for the restoration of acetabular defects during revision hip arthroplasty.

The twenty patients had revision components for a failed previous hip intervention with age ranging from 49 to 70 years with mean 59 years. there were twelve males and eight females. The infected cases underwent revision of the component after debridement with removal of the component and their laboratory study being negative. Patients were evaluated clinically using OHS and at the last follow up. The mean follow up period was 18 months.

9 patients with Paprosky type 2B defect, 6 patients with Paprosky type 2C defect, and 5 patients with Paprosky type 3A defect were

included in the current study. In this research, OHS has improved from 12.85 preoperatively to 38.9 at the most recent follow-up visit. According to OHS grading, 11 cases [55%] were excellent at the last follow up. 8 cases had a good result and one patients ended up with a fair result.

The findings of this research were similar to those of Lochel et al. study, which involved 60 patients [62 hips] with a mean age of 64.6 years [ranging from 28 to 85] who had undergone acetabular revision using a combination of a trabecular metal shell and augment. Follow-up was 10.2 years [7.2 to 12.5]. most cases had type IIIA defect. The study included 15 men and 36 women. HHS increased from 55 preoperatively to 81 points postoperatively [1].

Abolghasemian et al. conducted a research on 34 patients, 20 of whom were female and 14 of whom were male, who had revision hip replacement surgery utilizing a TM acetabular shell with one or two augments. The average age of patients at the time of surgery was 69.3 years [range: 46 to 86 years], and the average follow-up length was 64.5 months [range: 6-107 months]. The mean Oxford hip score increased from 15.4 before to revision to 37.7 at the final follow-up [14].

Alexander et al. performed revision total hip surgery using trabecular metal augments for acetabular defect reconstruction in 37 patients, including 15 men and 19 women, with an average age of 64 years [ranging from 37 to 97 years]. The follow-up period ranged from 24 to 55 months, with a mean of 34 months. The Paprosky classification showed that 19 defects were classified as Type 3A, eight as Type 3B [two of which required a posterior column plate due to a pelvic discontinuity], four as Type 2A, two as Type 2B, and one as Type 2C. The mean improvement in Oxford hip score was 80.3, with a standard deviation of 16.6, and the minimum improvement was 33.3 [15].

In this series, all patients showed radiographic signs of osteointegration and showed one patient [case 3] started to have a radiolucent line in zone 1 this line was stable and didn't extend in the next follow-up visit. It didn't affect the result of the patient which was excellent according to OHS grading.

According to Whitehouse et al., trabecular metal augments were employed in 53 acetabular revisions, and the findings indicated a 92% survival rate with a median follow-up period of 9 years. Porous metal augments have grown in popularity as an alternate way for attaining biologic attachment and preventing graft resorption over time [16].

After 7 years of follow-up, Garbuz et al. found that the radiographic failure rate for bulk allografts utilized in acetabular defect repair was 45 percent. At 12 years of follow-up, the risk of acetabular revision was as high as 25 percent. Patients in whom the bulk allograft supported more than 50 percent of the cementless acetabular component usually had poor long-term results. Additionally, this method has significant disadvantages, including the danger of disease transfer, the need for tissue bank infrastructure, the complexity of graft preparation, and the chance of resorption [17].

Complications

Occurred such as a patient had sciatic nerve affection in the form of neurotmesis and patient refused to do exploration. There were two patients with post-operative infection for which debridement was done after three weeks with no recurrence of infection. No dislocation occurred post-operatively. These results are close to the results of other studies.

5. Conclusion

The promising early results of using this technique for acetabular reconstruction convinced more surgeons to start using this system in revision surgeries. Given its modularity and the ability to reconstruct different types of defects with no fear of bone resorption, porous metal augments are considered a valuable method in the acetabular defect management. Augments are stable at short term follow-up, can be used in different types of defects, technically easy and there is no fear of resorption.

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