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Case Report

The Use of Calcium Sulfate/Hydroxyapatite Bone Graft Substitute to Restore Acetabular Bone Loss in Revision Total Hip Arthroplasty

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ABSTRACT

Acetabular bone loss is not uncommon when performing revision total hip arthroplasty. This can create a challenge, especially on the acetabular side. In the present report, our patient presented with aseptic loosening of the acetabular component. The patient had a Paprosky IIIA acetabular defect that was reconstructed with stacked acetabular augments in addition to a highly porous acetabular cup. The remaining bone defects were addressed through the use of a calcium sulfate/hydroxyapatite bone graft substitute. We set out to describe how to reconstruct severe acetabular bone loss with a combination of acetabular augments in addition to an injectable bone graft substitute as a novel method to address a complex clinical scenario.
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Introduction

With the number of primary total hip arthroplasties (THAs) on the rise, the number of revision arthroplasties will continue to increase as well [1]. One of the most common reasons for revision THA is aseptic loosening [1]. The management of severe acetabular bone loss creates a conundrum in restoring the hip center of rotation, obtaining press-fit fixation, and avoiding further aseptic loosening. Paprosky IIIA and IIIB acetabular defects will often require additional bone grafting to help support long-term fixation [2]. Debates continue for the optimal bone graft. Options for bone grafting include allograft cancellous chips with impaction grafting, injectable bone graft substitutes, and structural bone grafts. The ability of the graft to best fill the defect in addition to incorporate into the patient's host bone remain paramount to the choice of the optimal bone graft.

With regards to managing bone defects, the ease of use of an injectable bone graft provides an attractive option for revision THA. Previous reports on bone graft options using tricalcium phosphate/hydroxyapatite in revision scenarios have demonstrated variable results with regard to incorporation of the bone graft [3]. Due to the slow degradation of this graft, there are concerns about graft incorporation in addition to vascularity. The use of calcium sulfate/hydroxyapatite bone graft applications allows for biphasic resorption with the potential for increased vascularization and incorporation into the patient's bone.

We are not aware of any published reports on the use of a novel calcium sulfate/hydroxyapatite injectable bone graft substitute to help restore bone stock, incorporate into the native bone, and help avoid aseptic loosening. The purpose of the present report is to demonstrate the results following revision THA with the use of a porous acetabular augment and cup with the use of calcium sulfate/hydroxyapatite injectable bone graft to achieve reliable long-term fixation.

The patient was informed that information regarding her case would be submitted for publication, and she provided written informed consent.

Case history

A 49-year-old female presented for revision of her right THA. She underwent a staged THA 3 years ago at an outside hospital for avascular necrosis. She developed aseptic loosening of her acetabular component and was revised at the outside hospital. Within 1 week of her revision surgery, she developed aseptic loosening of her acetabular component and was unable to bear weight on the right lower extremity. She was transferred to our tertiary referral

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center, where radiographs and computed tomography scans were obtained to evaluate her acetabular bone loss as well as her femoral component positioning. She underwent a complete workup to rule out a potential infection. Her C-reactive protein was less than 10 mg/L, and her erythrocyte sedimentation rate was less than 35 mm/hr. She underwent hip aspiration that demonstrated her cell count was 2800/uL and her neutrophil percentage was 65% with a negative gram stain. Her anteroposterior radiograph of the hip demonstrated that the hip was dislocated with complete loss of fixation of the acetabular cup (Fig. 1). Her revision construct did not utilize any adjuvant screw fixation into the ilium, ischium, or pubis. The previous surgeon attempted to cement in a cementless cup to obtain fixation. There was significant loss of the superolateral acetabular bone. Without the superolateral bone support for the acetabular cup fixation, this increased the likelihood for the revision construct to fail. Further imaging with computed tomography scans demonstrated an uncontained defect to the acetabular medial wall (Figs. 2 and 3) on both the coronal and axial images. There was also a large cystic defect in the anterior acetabulum seen on the axial views (Fig. 3). The patient underwent revision of the acetabular component in the lateral decubitus position using a posterolateral approach. At the time of the revision surgery, acetabular augments were used to restore the deficient superolateral acetabular bone (Smith and Nephew, Memphis, TN). Given the poor bone quality, locking screw fixation was used in the augments. Stacked augments were used in order to address the severe amount of bone loss. These were cemented together with Palacos R + G bone cement (Heraeus, Boston, MA) to unite the construct. With the severe cystic defect to the anterior acetabulum and the medial wall defect, Cerament bone graft substitute was used to help restore the bone stock (BoneSupport, Boston, MA). Cerament is a bioresorbable synthetic bone-graft substitute consisting of 60% calcium sulfate and 40% hydroxyapatite with an initial porosity of 40 to 50% and a mean pore size of <1 mm. Prior to the injection of Cerament, the bone was prepared with a burr to get a bleeding bone surface. Hydrogen peroxide-soaked sponges were applied to the bone surfaces to allow for a dry bone bed prior to injection. A total of 20 cc was injected into the defect in addition to the posterior column. Once the bone graft substitute had solidified, a highly porous acetabular cup was placed with locking screw fixation (REDAPT Modular Cup, Smith and Nephew, Memphis, TN). The acetabular cup was further united to the previously placed augments using bone cement (Palacos R + G, Heraeus, Boston, MA). The patient's femoral stem, DePuy Corail (DePuySynthes, Warsaw, IN) was retained as it was found to be well-fixed and in an appropriate version. A new 40-mm Biolox Delta Ceramic head (DePuy Synthes, Warsaw, IN) fitted with a titanium sleeve was placed on the femoral trunnion.

The initial postoperative radiographs demonstrate the revised acetabular component with the stacked augments (Figs. 4 and 5). In addition, the Cerament bone graft substitute can be seen along the posterior column in addition to the medial wall and anterior acetabular defects (Figs. 4 and 5). The patient was kept partially weight-bearing for 6 weeks and then progressed to full weight-bearing. The patient returned for her 1-year follow-up. She was pain-free involving the right hip. Radiographs demonstrated no signs of any loosening or component migration (Figs. 6 and 7). There was good restoration of bone stock to the previous acetabular defects following the Cerament injection. There was lucency in DeLee and Charnley Zone 2 of the acetabulum [4]. She returned 2

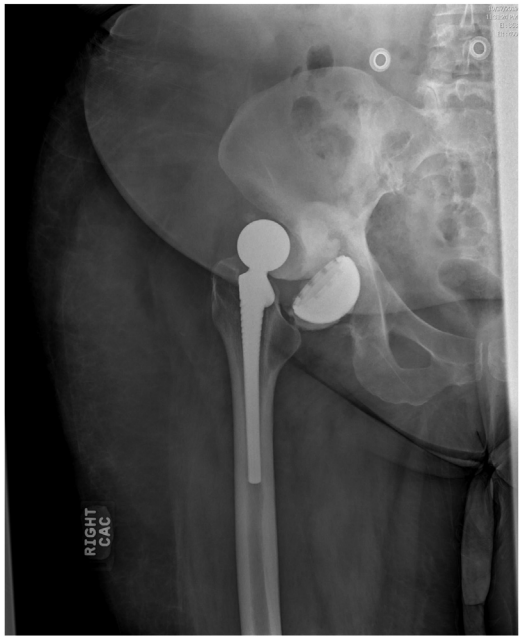

Figure 1. AP hip radiograph with aseptic loosening of the acetabular cup. AP, anteroposterior.

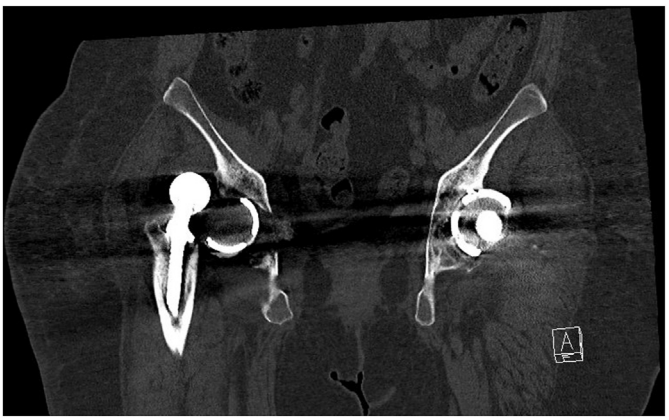

Figure 2. CT coronal plane cuts demonstrating medial bone loss to the anterior column. CT, computed tomography.

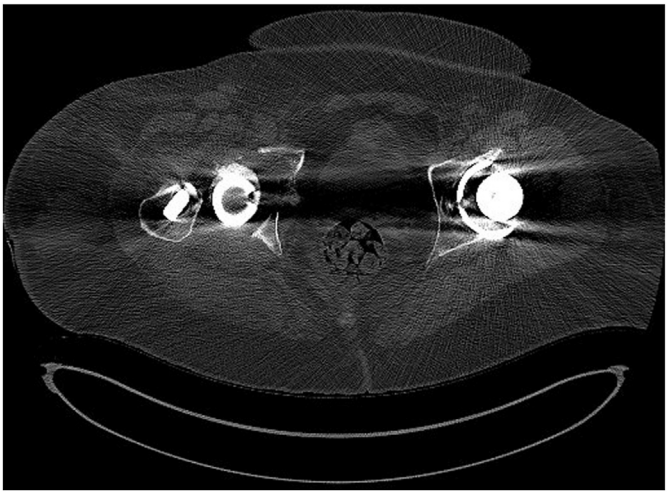

Figure 3. CT axial plane cuts demonstrating medial bone loss to the anterior column. CT, computed tomography.

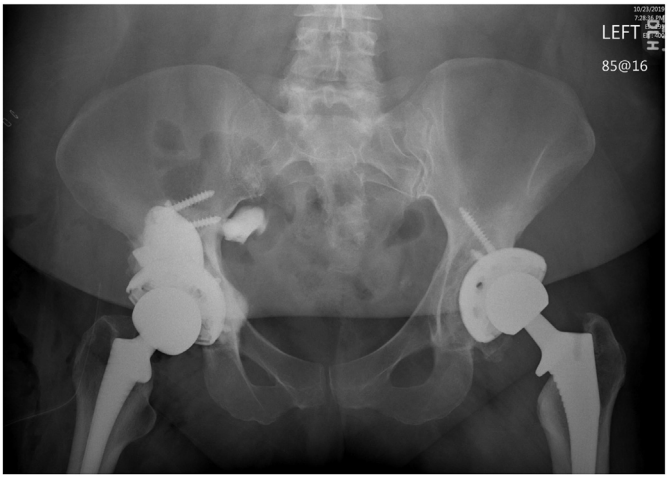

Figure 4. AP pelvis radiograph demonstrating the stacked acetabular augments with revision acetabular cup. There is bone graft to the medial anterior column defect and posterior column defect. AP, anteroposterior.

years after her revision surgery for revision of the contralateral acetabular component due to aseptic loosening. There were no signs of any loosening of the implants and no progression of the radiolucency and remained pain-free involving the right hip (Fig. 8).

Discussion

The management of severe acetabular bone defects in Paprosky IIIA and IIIB can be challenging. The use of combined acetabular augments with a highly porous acetabular cup has shown good results [5]. Alternative options to address these severe acetabular defects have included cup/cage, antiprotrusio cages, jumbo cups, and custom triflanges [6,7]. Issues seen with the use of anti-protrusio cages involve the lack of biologic fixation resulting in a high rate of aseptic loosening [7]. While custom triflange constructs can result in good long-term survival rates with regards to aseptic loosening, there is associated morbidity and cost associated with their use given the prolonged time required for manufacturing [8,9]. The other issue associated with the use of both the cup/cage and custom triflange construct are the need to get adequate exposure of the posterior column and ischium. This can incur injury to the sciatic nerve that isn't seen as frequently with the use of the acetabular augment and porous acetabular cup due to the fact that there is not a need to get exposure to the ischium with this construct [10,11].

To address the acetabular bone loss, this remains a challenge. Using allograft cancellous chips and impaction grafting, this can be

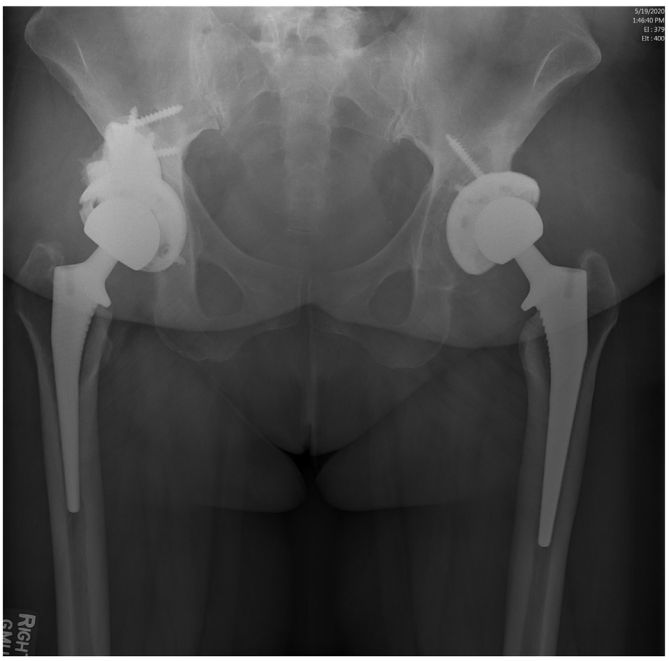

Figure 6. AP pelvis radiograph at 1 year postoperatively demonstrating incorporation of the bone graft. AP, anteroposterior.

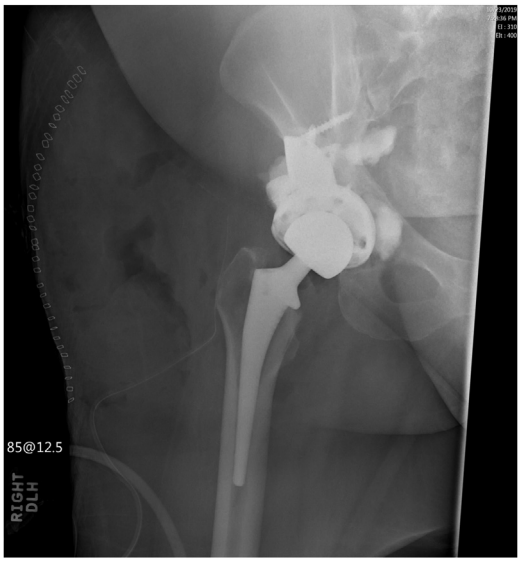

Figure 5. AP hip radiograph demonstrating the stacked acetabular augments with revision acetabular cup. There is bone graft to the medial anterior column defect and posterior column defect. AP, anteroposterior.

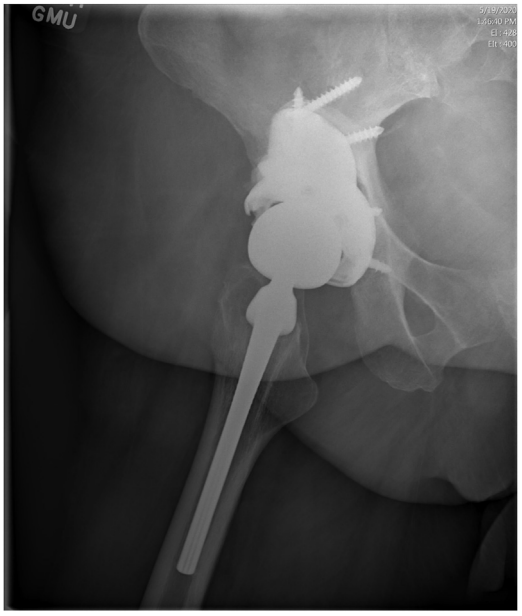

Figure 7. False profile radiograph at 1 year postoperatively demonstrating incorporation of the bone graft.

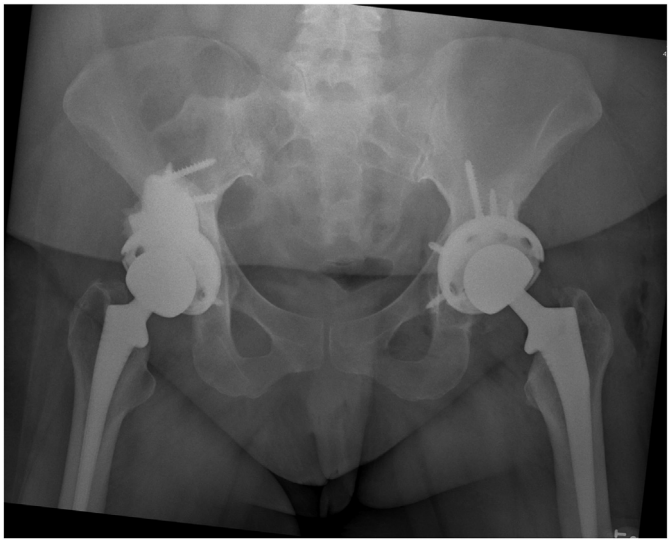

Figure 8. AP pelvis radiograph at 2 years postoperatively demonstrating incorporation of the bone graft. AP, anteroposterior.

time-consuming and a challenge to get sufficient fill in the void and prevent graft resorption. When compared to allograft bone graft, injectable bone graft substitutes or bone void fillers show improved bone formation and solid structural support as they can contour to the bone defects and allow for intimal bone contact with the prepared defect [12]. The biphasic nature of Cerament with the calcium sulfate allows for early absorption and acts as a carrier of bone progenitor cells. The hydroxyapatite is not absorbed and acts as a conduit for long-term bone defect filling. In addition, Cerament has not been associated with allergic reactions, abnormal wound healing, or infections [12].

To our knowledge, this case represents the first time using Cerament bone graft substitute to fill massive acetabular defects in revision THA. In our view, the use of the acetabular augment with a highly porous cup with the use of injectable bone graft provides a reliable alternative to impaction grafting or tricalcium phosphate/hydroxyapatite and cup/cage or custom triflange constructs. The versatility of the augments to restore the uncontained acetabular defects in addition to the use of the injectable bone graft substitute to contour to the bony anatomy and restore the contained acetabular defects allows for a reliable and time-saving construct. Further long-term follow-up is needed to ensure that the success of the early-term results translates into excellent long-term survival rates.

Summary

The management of complex acetabular defects at the time of revision THA remains a challenge. Restoring the bone in younger patients remains paramount should they need additional surgery in the future. The use of injectable bone grafts provides another option for the reconstruction surgeon as a tool to address these complex cases.

Conflicts of interest

S. Duncan is a paid consultant for Smith and Nephew and OrthAlign and receives research support from Smith and Nephew, Medtronic, Apex, Zimmer/Biomet, and Stryker; and he has stock options in MiCare; he serves as an editorial/governing board for Journal of Arthroplasty and Journal of the American Academy of Orthopaedic Surgeons; he is a board/committee member of Board of Councelors American Academy of Orthopaedic Surgeons; the other author declares no potential conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2023.101217.

Informed patient consent

The author(s) confirm that written informed consent has been obtained from the involved patient(s) or if appropriate from the parent, guardian, power of attorney of the involved patient(s); and, they have given approval for this information to be published in this case report (series).

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