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Case Report

Massive Periacetabular Osteolysis Treated With Acetabular Cup Retention and Cemented Screw Fixation

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A B S T R A C T

Management of periacetabular osteolysis is a challenging dilemma in revision total hip arthroplasty. When the acetabular shell is well-fixed, the surgeon may prefer to retain the cup to minimize further bone loss. However, filling the surrounding defect can be difficult if the area of involvement is massive. In this case, holes were created in the existing acetabular cup for supplemental pelvic screws, which were placed using computed tomography navigation, and then the areas of osteolysis were filled with cement. The patient recovered uneventfully, and he was satisfied with the outcome at 4 years postoperatively. Thus, pelvic screw placement with cement augmentation could be a viable option for a stable cup with surrounding osteolysis. Patient selection should be considered carefully as the long-term outcomes of this procedure are unknown.

Introduction

Management of aseptic periacetabular osteolysis with a well-fixed acetabular shell is a challenging surgical dilemma. Indications for surgery may include symptomatic eccentric wear [1], acetabular locking mechanism disruption [2], pseudotumor formation, progressive bone loss [3,4], and involvement of the weight-bearing dome or posterior column/ischium. The goals of surgery are to ensure minimal micromotion, restore the center of rotation, prevent fractures, and provide structural rigidity before loosening occurs [5]. However, the optimal method of fixation to achieve these goals remains open to investigation. Techniques reported in the literature include liner exchange with impaction grafting [1,6] versus complete acetabular component revision [4,5,7].

The Harrington technique was originally described in 1981 for metastatic periacetabular defects [8]. The area of osteolysis was reconstructed by cementing retrograde threaded pins into the iliac wing from the acetabulum [8]. The pins act as rebar (reinforcement bars). Modifications of the technique include antegrade pins, screws instead of pins, and more advanced cup designs [9-14]. Patient outcomes have generally been satisfactory, although longevity data are somewhat limited by patient survival. The technique is most often used in patients with advanced metastatic disease with large areas of periacetabular osteolysis. There are few reports in the literature where the modified Harrington technique was applied to revision total hip arthroplasty (THA). This report describes application of a cement and screw construct to address massive aseptic osteolysis in the setting of a stable THA acetabular shell.

Case history

Background

In September 2020, a 77-year-old male presented to the arthroplasty clinic with insidious low back and right hip pain for over a year. He underwent right THA in the 1990s at an outside hospital, and up to this point, he experienced no issues with it. His past medical history was significant for hypertension, paroxysmal atrial fibrillation status after implantable cardioverter-defibrillator placement, coronary artery disease, aortic valve replacement, and chronic kidney impairment after nephrectomy for renal cell carcinoma. As an avid fly fisherman, the patient was still active and desired to get back to that level of activity without pain. On examination, the patient demonstrated a slight antalgic gait, limited hip internal rotation to neutral, no apparent leg-length inequality, and intact neurovascular examination.

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Radiography revealed severe osteolysis about the acetabular component superolaterally, medially, and inferiorly with the femoral head eccentrically located in the cup, demonstrating polyethylene wear (Fig. 1). Computed tomography (CT) further demonstrated near destruction of the iliac wing, ischium, pubis, as well as the greater trochanter of the ipsilateral femur and replacement with soft-tissue tumor (Fig. 2). Remarkably, the acetabular shell did appear to have 2 primary areas of ongoing fixation including a bony pillar to the ilium. A CT-guided biopsy was performed that showed lymphocytic infiltration with metallic debris, confirming the diagnosis of particulate debris-related osteolysis. Infection was also ruled out on biopsy. Laboratory results demonstrated a normal serum white blood cell count, normal erythrocyte sedimentation rate, and an elevated C reactive protein level.

Given the patient's severe groin pain and impending failure of the acetabular cup, operative treatment was recommended. However, the degree of pelvic osteolysis was severe. The authors anticipated that cup removal would leave a massive bone defect. Either a custom implant or a jumbo cup and cage construct with augments would be required. Given the small quantity of remaining bone, obtaining adequate fixation to these new implants would be very limited. Therefore, cup retention was preferred. The procedure would include burring new holes into the existing cup and placing pelvic screws using CT-guided computer-assisted navigation. The next decision was how to fill the remaining defect. Bone impaction grafting was considered, but the area of osteolysis was felt to be too large. Therefore, cement augmentation was proposed. Cement would allow increased immediate stability without the risk of resorption. Risks, benefits, and alternatives to surgery were discussed with the patient and his family, and he gave informed consent to proceed.

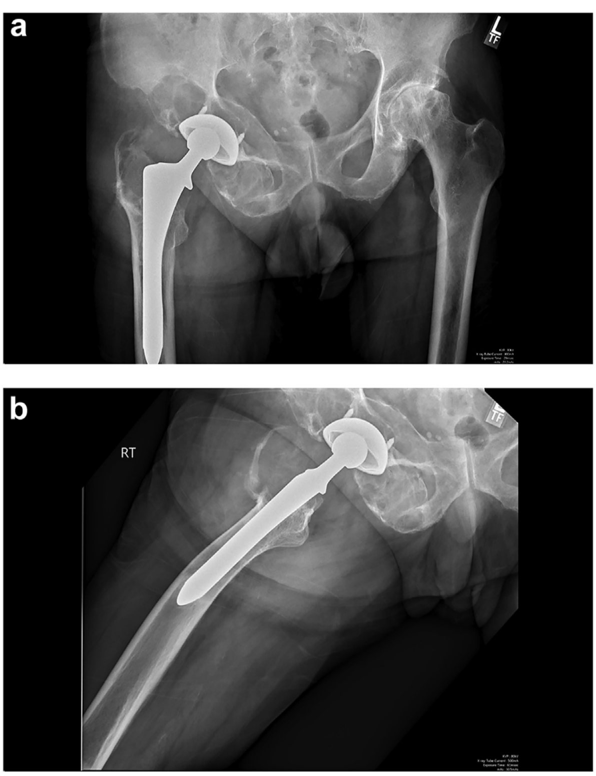

Figure 1. Preoperative antero-posterior (AP) (a) and lateral (b) radiographs of the patient presented here, demonstrating extensive periacetabular as well as proximal femoral osteolysis.

Operative technique

On the day of surgery, the patient was positioned in standard lateral position on a radiolucent table to facilitate O-arm (Medtronic, Inc., Dublin, Ireland) use. The previous anterolateral incision was incised and extended a few centimeters proximally in line with gluteus maximus muscle fibers. Abundant scar tissue and fibrosis was encountered during the approach and throughout the procedure. We followed a posterior approach. The short external rotators were taken off the posterior greater trochanter, and the superior 50% of the gluteus sling was taken down for assistance with exposure. A posterior capsulotomy was performed. The extensive synovitis inside the joint and from within the posterior aspect of the trochanter was debrided. The bone around the acetabulum was extremely thin, as gentle placement of a retractor violated the outer cortex and allowed some of the osteolytic debris to escape. This was debrided and sent for culture and pathology. The hip was then dislocated, and the cobalt-chrome femoral head was removed. The trunnion looked clean with no macroscopic evidence of corrosion. The acetabular component was then exposed, and the liner was removed without difficulty using a quarter-inch osteotome. The retaining snap-ring was removed.

The acetabular shell was inspected and appeared to be in adequate condition. Fixation was tested manually and found to be stable, as demonstrated by the preoperative CT scan. We decided to preserve the cup, as obtaining fixation and stable ingrowth of a new implant would be challenging with such severe bone loss. The dome hole cover was removed, and a metal-cutting burr was used to enlarge this hole to about 10-mm diameter for access to the osteolysis directly behind the prosthesis.

A probe was used to identify the borders of the mass. It was apparent that there was a medial wall defect with no bone palpable medially through this dome hole. A series of curettes and suction irrigation were used to remove about 150 mL of osteolytic debris from behind the acetabular shell, along the anterior rim of the cup at the junction of the superior ramus, and along the pubic root.

Due to the tenuous host bone attachment of the existing shell, supplemental fixation and retroacetabular support was deemed important. However, given the massive bone loss, there were limited options to gain further fixation to host bone. Therefore, CT navigation was utilized. A 2-cm incision was made over the iliac crest, and the CT navigational array was attached. The field was covered with sterile drapes. The O-arm was brought in for a spin. Then we proceeded with fixation of the cup to the remaining pelvic bone stock. Using a metal cutting burr, 2 holes were created in the dome of the acetabular shell for placement of screws. In order to obtain the appropriate trajectory for these screws, a stab incision was made distally in the posterolateral thigh. The CT-navigation probe and drill guide were inserted. This technology differs from traditional fluoroscopy or augmented fluoroscopy in the sense that orthogonal views are updated in real time. When the surgeon moves their hand holding the drill or probe, the image simultaneously moves three-dimensionally to show the projected screw path. Two 6.5 $\times$ 70-mm cancellous screws (Depuy Synthes, Raynham, MA) were drilled and inserted into the solid bone of the ilium about the posterior superior iliac spine with excellent purchase (Fig. 3a).

Excision was then continued by creating a superior ramus cortical window and curetting out the lesion until normal bone was encountered. Tissue was sent to pathology. The defect was irrigated copiously. Three additional holes were burred into the acetabular component. Liquid cement was introduced with a Toomey syringe and cut chest tube. The cement was advanced into the inferior-most hole in the cup and pressurized manually. This was followed closely by screw placement into the ischium using CT navigation (Fig. 3b).

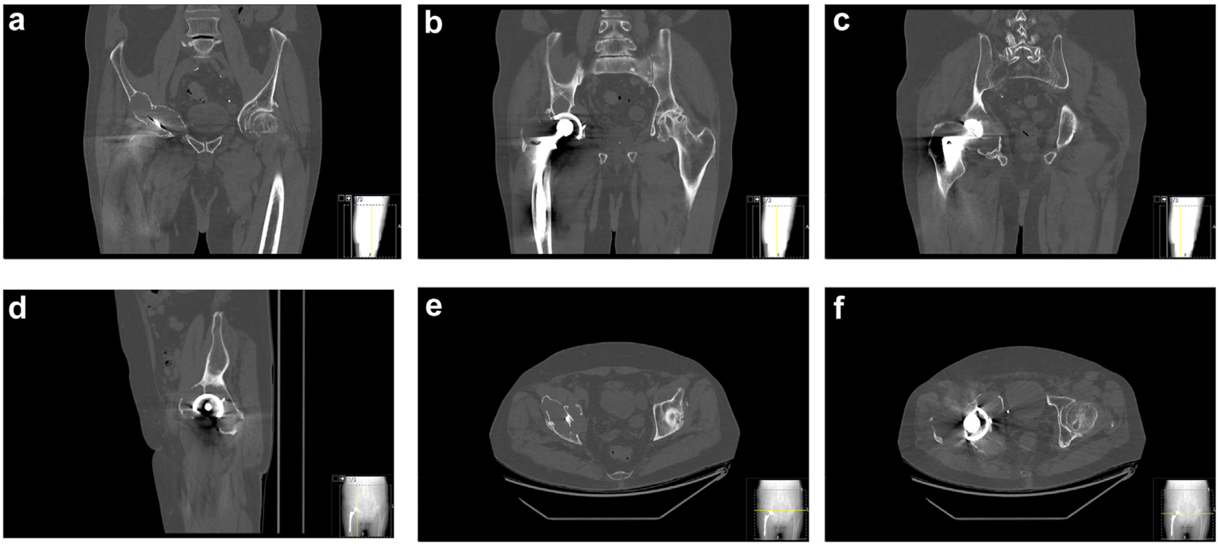

Figure 2. Preoperative computed tomography scan of this patient further illustrating the extent of osteolysis on coronal (a-c), sagittal (d), and axial (e and f) slices. The patient underwent a separate CT-guided biopsy that confirmed the diagnosis of particulate debris-related osteolysis.

The screwhead was held until the cement was dry. Two additional screws were placed using a similar technique posteromedially into the quadrilateral plate and anteromedially along the superior pubic ramus. A cortical window was made on the ilium above the cup, and curettage, suction, and irrigation were used to remove additional osteolytic debris in this location. We used this window to backfill the acetabular component with cement for increased structural rigidity of the cup and new iliac screws.

A new 40-mm inner-diameter cross-linked polyethylene acetabular liner (Depuy Synthes, Raynham, MA) was opened and roughened with a burr to improve the cement bond. It was then cemented into place with about 5° of additional anteversion. After trialing with various 40-mm heads for stability, offset, and leg length, we selected a new 40-mm ceramic head with titanium sleeve with +5 neck length, impacted this onto the trunnion, and reduced the hip.

Lastly, the proximal femur osteolytic lesion was curetted back to normal healthy bone, and that defect was then packed with cement (Fig. 3c and d). The wound was copiously irrigated. The posterior capsule was repaired, followed by short external rotators and the gluteal sling. Stimulan beads (Biocomposites, Inc., Wilmington, NC) were made with the addition of 1-g vancomycin and 1.2-g tobramycin, and they were placed deep to the fascia for local antibiotic delivery for infection prophylaxis. The fascia was then closed, followed by the subcutaneous layer, and the skin was closed with staples. An incisional wound

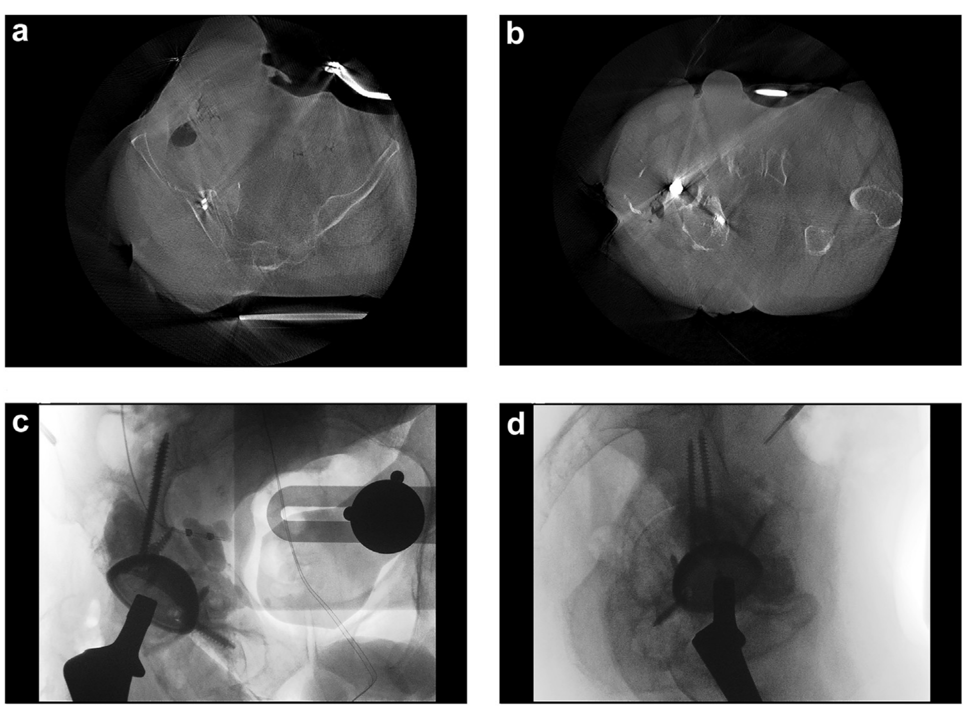

Figure 3. Intraoperative computed tomography imaging shows the placement of screws in the posterior ilium (a) and the ischium (b). Screw placement was confirmed via intraoperative antero-posterior (AP) (c) and lateral (d) fluoroscopic images as well.

vacuum dressing was placed for additional wound-healing benefit.

Postoperative course

Postoperatively, the patient was admitted to the hospital. He was weight-bearing as tolerated with posterior hip precautions without an abduction pillow, which is our normal practice. Physical and occupational therapy started on postoperative day 1, and he was discharged home on postoperative day 2. The incisional wound vac was removed in clinic on postoperative day 4 due to a clog in the tubing and was replaced by a dry dressing. He was seen in clinic again for 2-week, 6-week, 3-month, 6-month, and 9-month visits with no clinical or radiographic complications (Fig. 4). The patient was contacted by telephone at 2-year and 4-year follow-up, as he had moved. He reported intermittent pain for 1 year after surgery that had now completely resolved. The patient was limited by back pain to an ambulation distance of one block. Overall, however, the patient was very pleased with his outcome on the right hip.

Discussion

This report describes a case of massive periacetabular osteolysis treated with successful cup retention and placement of cement-augmented iliac, ischial, and pubic screws using intraoperative CT scan with computer-assisted navigation. This represents a rare application of the modified Harrington technique—developed for oncologic cases—to aseptic osteolysis. Advantages of this cemented screw technique include (a) the ability to retain and reinforce a stable acetabular cup and (b) the relatively low cost and wide availability of the reconstruction materials (screws and bone cement). [6,9,10]

When deciding how to address aseptic periacetabular osteolysis, the first question is whether to revise the acetabular cup. Clear indications for removal include a loose or poorly positioned implant, or a situation in which a new liner cannot be placed. When the cup is well-fixed, both liner exchange and complete acetabular cup revision have been widely used in the literature. Results of smaller comparative studies are mixed: Cup retention with liner exchange can lead to a higher revision rate [2], lower revision rate [7], or no difference [15], compared to full acetabular component revision. Of note, these studies utilized bone grafting into the defects as opposed to cement and screw augmentation. In the current case, the patient had widespread pelvic osteolysis, but the cup still appeared to be well-fixed to the only remaining supporting columns of bone. The authors felt that removing the cup would destroy the minimal remaining bone stock, and any subsequent revision shell would have a limited chance of ingrowth for a durable result. For these reasons, the shell was retained.

After deciding to maintain the cup, the next consideration is how to fill the large surrounding defect. Options include autograft, allograft, or other synthetic materials [16]. Autograft usage may be limited in large defects due to inadequate size/supply, donor-site morbidity, and decreasing bone quality with old age [16]. Allograft is the most widely used method given advantages in availability and avoidance of donor-site morbidity. In addition, incorporation of the allograft over time may enhance bone stock if a future revision procedure is necessary [16]. In several studies, liner exchange with allografting behind a retained acetabular shell has provided good radiographic and/or clinical outcomes [5,7,17-22]. However, CT evaluation in one study demonstrated only 30% defect fill and 24% healing of graft to host bone at mean 1-year follow-up [6]. Disadvantages of allograft include lack of osteogenic cells, decreased osteoinductive factors, immune response, and infection risk [16]. For this particular patient, the affected area was enormous and partially uncontained. The authors expected a higher risk of graft resorption due to the defect size. In addition, allograft bone requires time to incorporate, whereas cement provides immediate structural support.

Given the drawbacks of impaction grafting, cement augmentation was proposed. Pin and cement placement (eg, modified

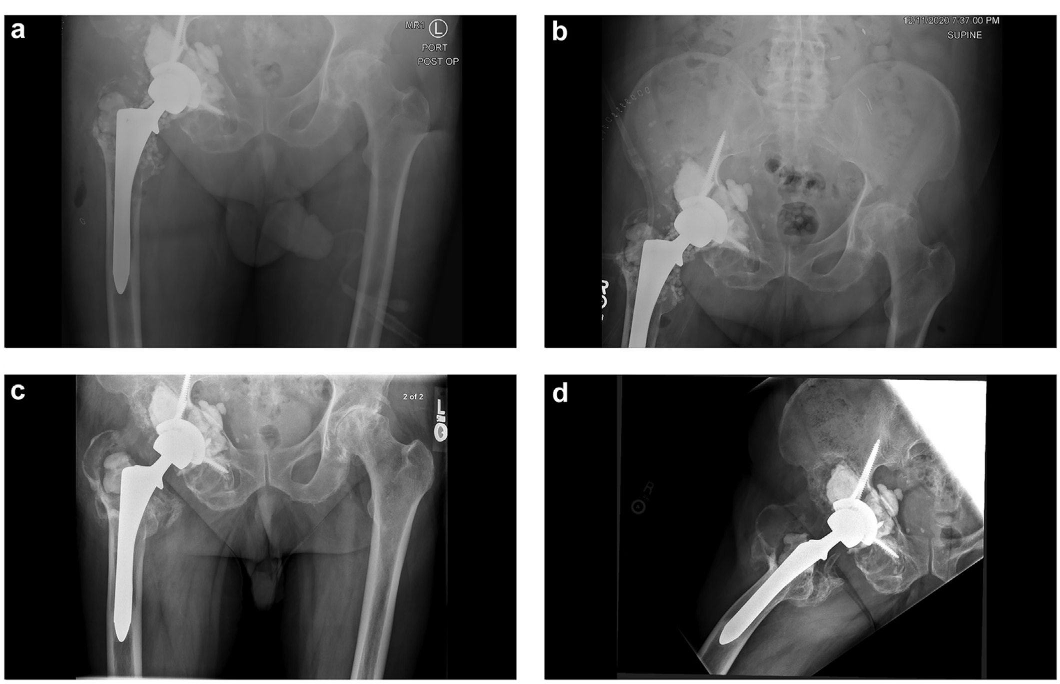

Figure 4. Postoperative single antero-posterior (AP) view radiographs were obtained in the recovery area on the day of surgery (a and b). Latest AP (c) and lateral (d) radiographs obtained at 9 months postoperatively demonstrate stable fixation and implant position without complication. A small amount of cement penetrated the medial wall defect without clinical consequence.

Harrington technique) has been used in oncology cases for decades. Biomechanical data show that cemented screws are stronger than cement or screws alone [14]. Patients generally demonstrate improved mobility, although significant complications have been reported in this high-risk population [9-11,23]. Recent interest in this type of procedure has been spurred by advancements in intraoperative imaging and navigation [24-27]. The present case illustrates the potential application of CT-guided, computer-assisted navigation (O-arm) in revision THA.

Summary

Polyethylene wear in THA can lead to massive acetabular osteolysis. Removal of a well-fixed cup is technically challenging and may cause further bone loss. This is a case report of a single patient who underwent screw placement through a retained cup, followed by cement augmentation. He reported no complications at 4-year follow-up and was satisfied with the procedure. Further study is needed to determine the limits and long-term outcome of this technique. However, this provides a proof-of-concept that cemented screw fixation could be a viable option for extensive periacetabular osteolysis.

Conflicts of interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Scott T. Ball, MD, is a paid consultant for OrthAlign Inc and is in speakers bureau/gave paid presentations for OrthAlign Inc and receives royalties from Restor3D.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2024.101595.

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).

CRediT authorship contribution statement

Isabella T. Wu: Writing – review & editing, Writing – original draft. **Cary S. Politzer:** Writing – review & editing, Writing – original draft. **Frank Chiarappa:** Writing – review & editing, Writing – original draft, Conceptualization. **Scott T. Ball:** Writing – review & editing, Writing – original draft, Conceptualization.

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