



# The Inverted Double Cup Construct to Address Severe Acetabular Bone Defects in Revision Total Hip Arthroplasty

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## INTRODUCTION

Revision total hip arthroplasty (THA) cases with substantial acetabular bone loss can require complex and expensive treatment strategies:

- Roughly 40,000 revision THA surgical cases are performed in the United States every year, and the case number has been projected to continually increase through the year 2030<sup>1</sup>.
- There is a need for novel techniques to reduce revision THA case costs and improve patient outcomes.

Evaluating degree of acetabular bone loss:

- **American Academy of Orthopaedic Surgeons (AAOS) Classification of Acetabular Bone Loss<sup>2</sup>:**

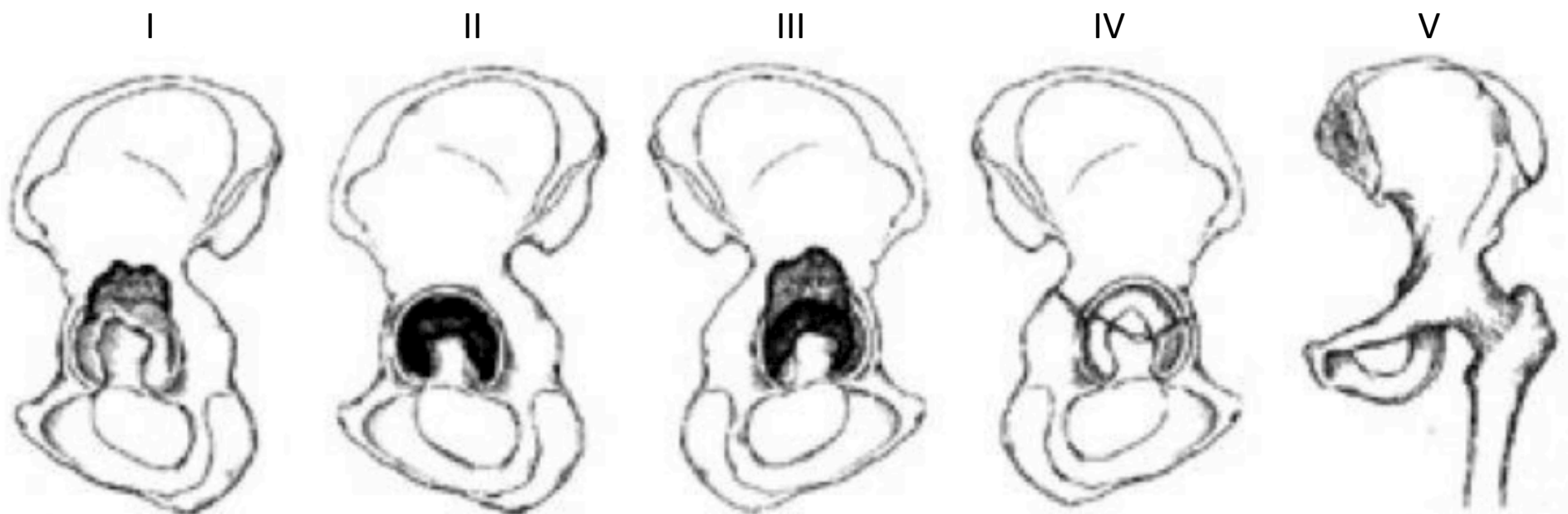


Figure from D'Antonio et al. (1989) Clinical Orthopaedics and Related Research

- Type I (Segmental): Loss of part of the acetabular rim or medial wall.
- Type II (Cavitary): Volumetric loss in the bony substance of the acetabular cavity.
- Type III (Combined Deficiency): Combination of segmental bone loss and cavitory deficiency.
- Type IV (Pelvic Discontinuity): Complete separation between the superior and inferior acetabulum.
- Type V (Arthrodesis).

- **Paprosky Classification of Acetabular Bone Loss<sup>3</sup>:**

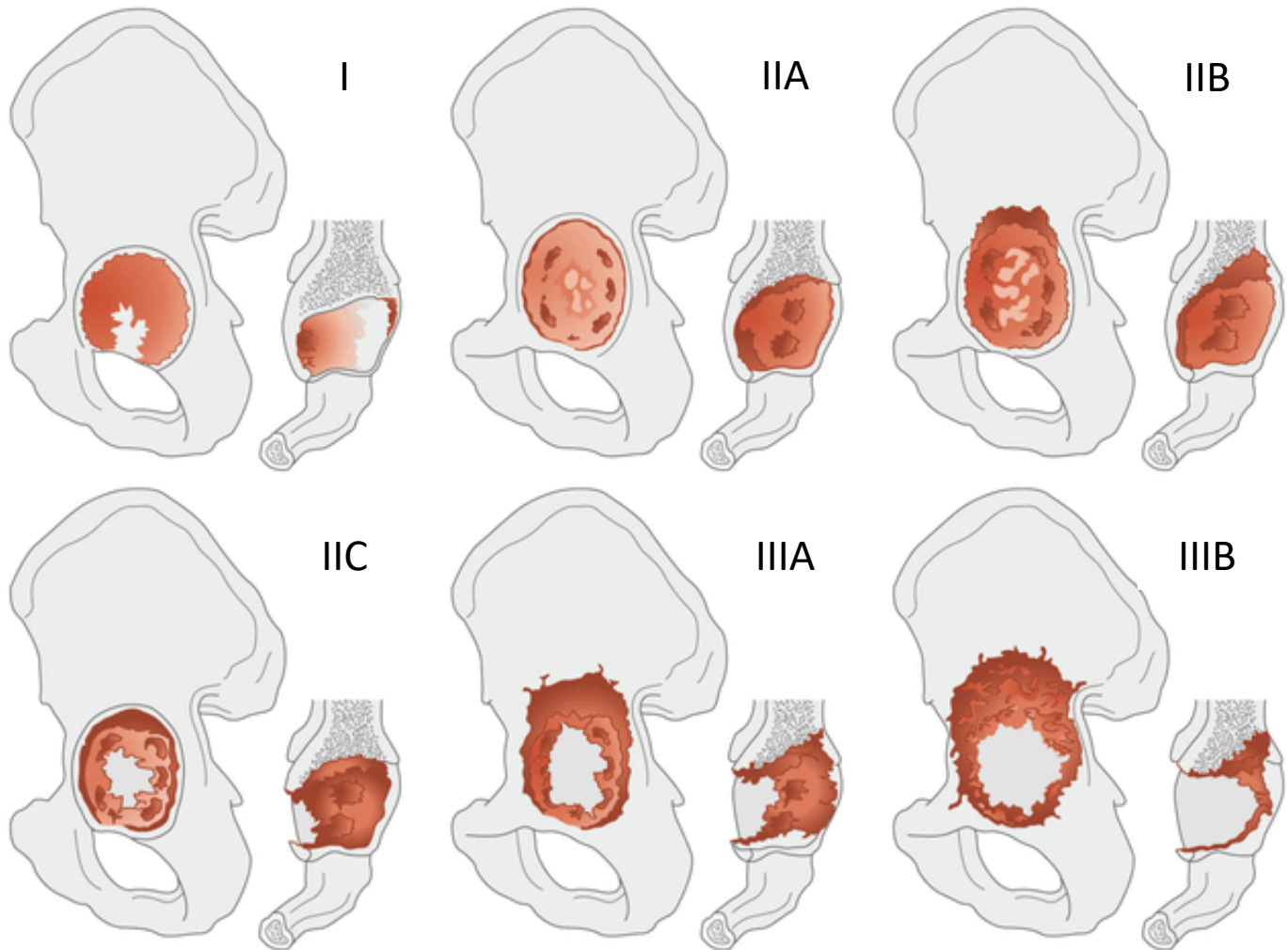
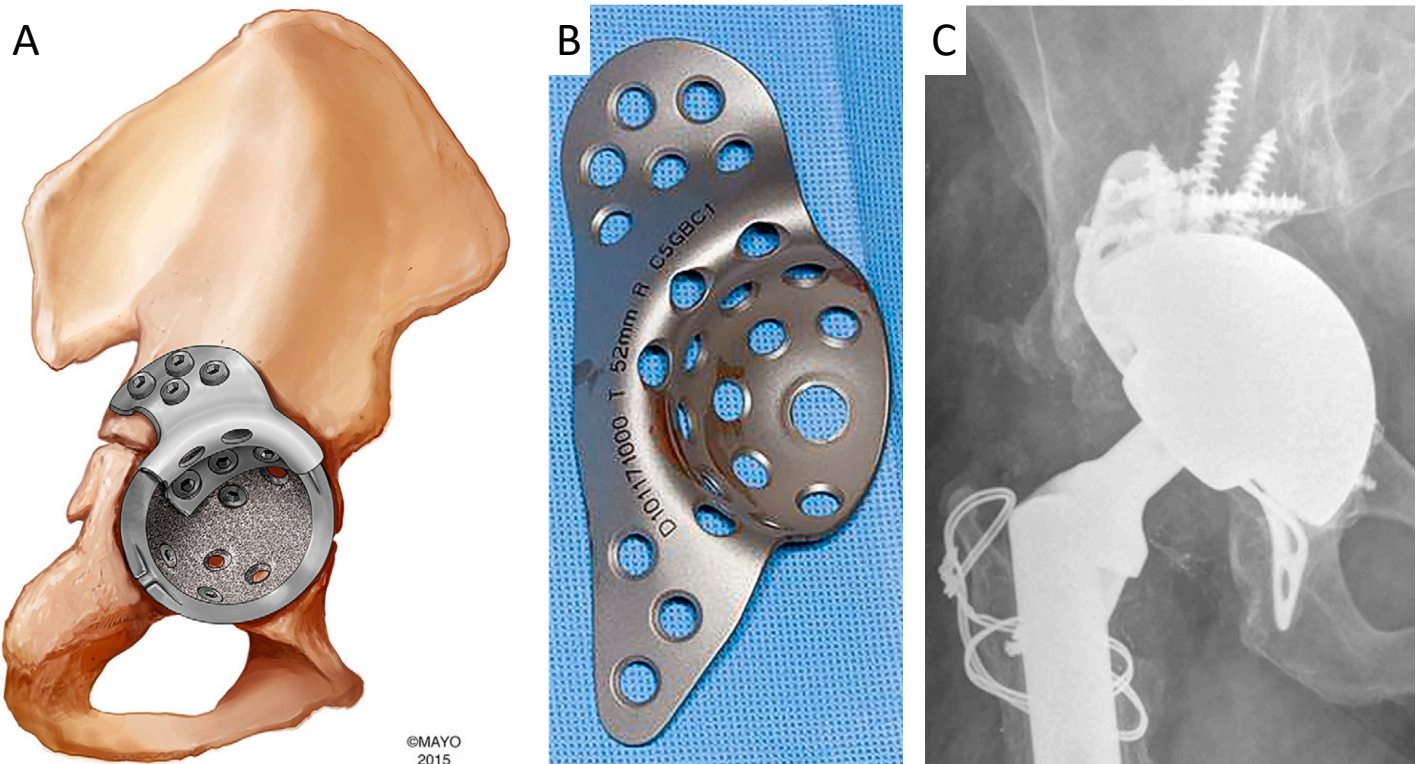


Figure from Gollwitzer et al. (2014) European Surgical Orthopaedics and Traumatology

- Type I: Minimal deformity, intact rim.
- Type IIA: Superior bone lysis with intact superior rim.
- Type IIB: Absent superior rim, superolateral migration.
- Type IIC: Localized destruction of medial wall.
- Type IIIA: Bone loss from 10AM-2PM around the rim, superolateral cup migration.
- Type IIIB: Bone loss from 9AM-5PM around the rim, superomedial cup migration.

Current strategies for revision THA after acetabular bone loss:

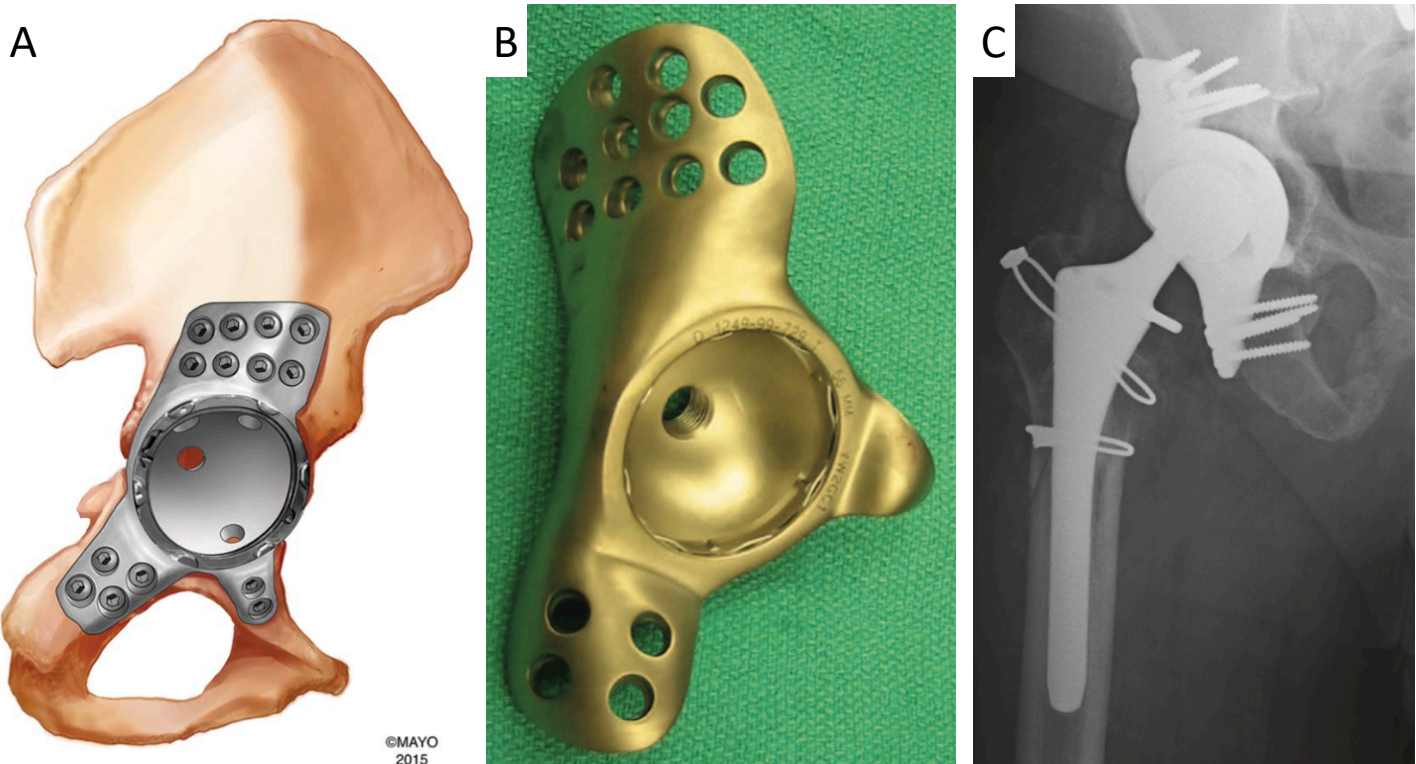
- **Cup-Cage Construct:** Highly porous acetabular cup component with a cage that spans area(s) of discontinuity<sup>5</sup>.



- A. Illustration of a half cup-cage construct with screw fixation through the superior and inferior acetabulum and additionally through the cage and cup into bone superiorly.
- B. Full cup-cage construct.
- C. Right hip anteroposterior radiograph of a full cup-cage construct for a Paprosky type IIIB defect and pelvic discontinuity.

Figures from Sculco et al. (2017) The Journal of Bone and Joint Surgery

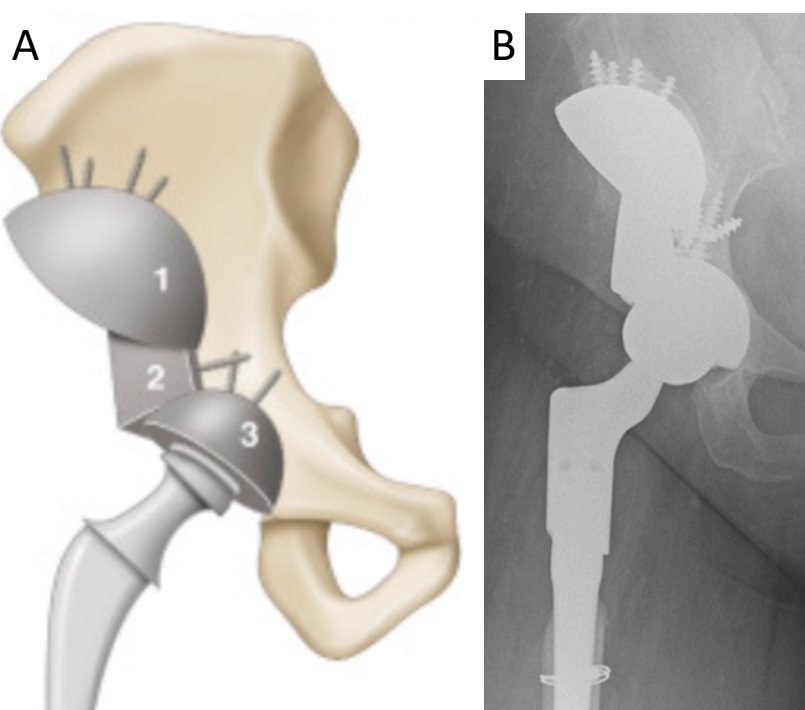
- **Custom Triflange Cage:** Custom-designed porous titanium acetabular spanning component with iliac, ischial, and pubic flanges that provide contact between implant and bone for stability<sup>5</sup>.



- A. Illustration of a custom triflange cage with iliac, ischial, and pubic flanges.
- B. Custom triflange cage.
- C. Right hip anteroposterior radiograph of a triflange cage with screw fixation.

Figure A from Migaud et al. (2019) Orthopaedics & Traumatology: Surgery & Research  
Figure B & C from Goodman and Engh (2016) The Bone & Joint Journal

- **Double-Cup Construct:** A trabecular metal revision shell is used as a super-augment to buttress a superior-medial or superior-lateral defect for an acetabular cup in the anatomic hip center of rotation<sup>8</sup>.



- A. Illustration of a double-cup assembly. A trabecular metal (TM) cup supports on the cup migration zone (1) with an interposed screwed tantalum roof reinforcement (2). A press-fit TM cup (3) resides in the location of the native acetabulum.
- B. Right hip anteroposterior radiograph of a superior double-cup construct and secondary buttress augment.

Figure A from Migaud et al. (2019) Orthopaedics & Traumatology: Surgery & Research  
Figure B from Webb et al. (2017) The Journal of Arthroplasty

- **Custom Modular Constructs**

## OBJECTIVE

In this presentation, we describe a patient that experienced severe bone loss at the superior aspect of the acetabulum after undergoing primary right hip hemiarthroplasty. The patient was treated with a **novel revision THA acetabular construct** that is cost-effective compared to other available acetabular cup constructs.

## PATIENT HISTORY

**63-year-old man who presented with worsening right hip pain and inability to walk five years after undergoing a right hip hemiarthroplasty to treat a right hip fracture.**

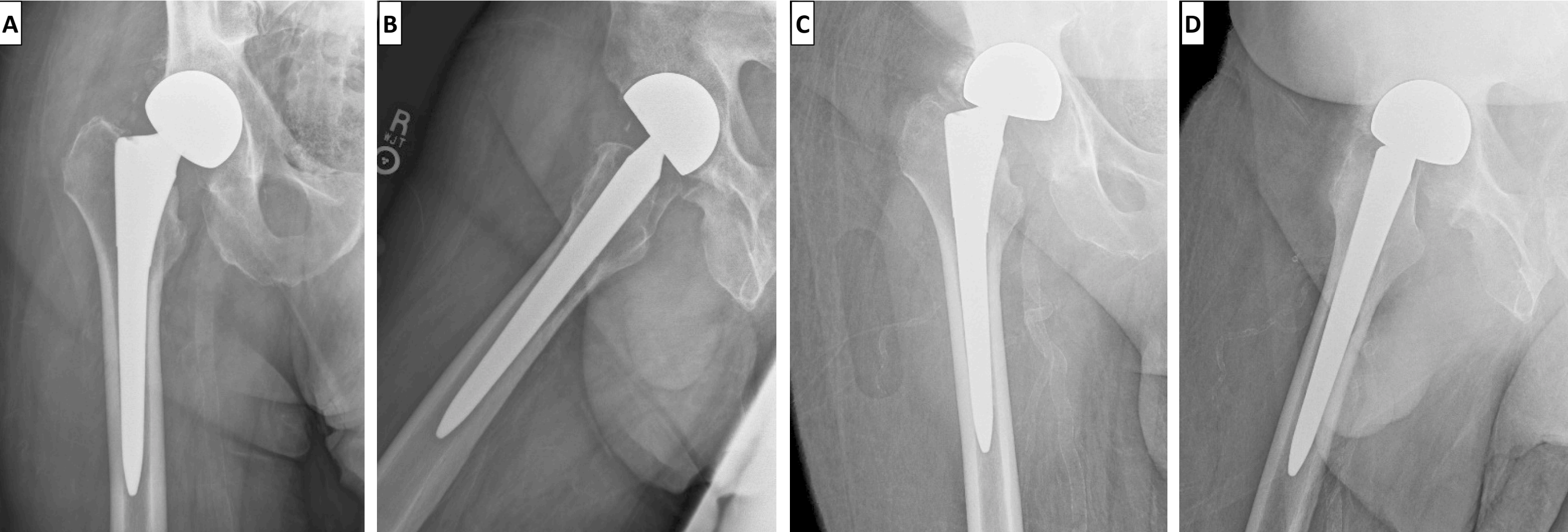
- Past Medical History: Hypertension, insulin-dependent diabetes mellitus, dialysis-dependent renal failure, cirrhosis, peripheral artery disease, Monckeberg's medial calcinosis, obesity, multi-factorial dementia, alcohol use disorder, high-dose opiate dependence.
- Past Surgical History:
  - Right forefoot amputation (all toes)
  - Left leg below-knee amputation (BKA)

- **Right Hip Surgical History:**

- **Five years prior to presentation:** The patient sustained a right hip fracture after falling at home when recovering from the right forefoot amputation. The patient subsequently underwent a right hip hemiarthroplasty at an outside hospital.
- **Three years prior to presentation:**
  - The patient presented to an outside hospital and reported ongoing chronic right hip pain and inability to ambulate that began after recovering from the right hip hemiarthroplasty.
  - A bone scan showed loosening of the right femoral stem, intense activity around the acetabular area at the bone/prosthetic interface, posterior acetabulum, and ischium. A labeled indium scan showed asymmetric activity in the acetabulum.

The patient was seen at various outside centers that declined to operate and was recurrently lost to follow-up at those centers before initial presentation.

Fig. 1: Imaging After Primary Right Hip Hemiarthroplasty



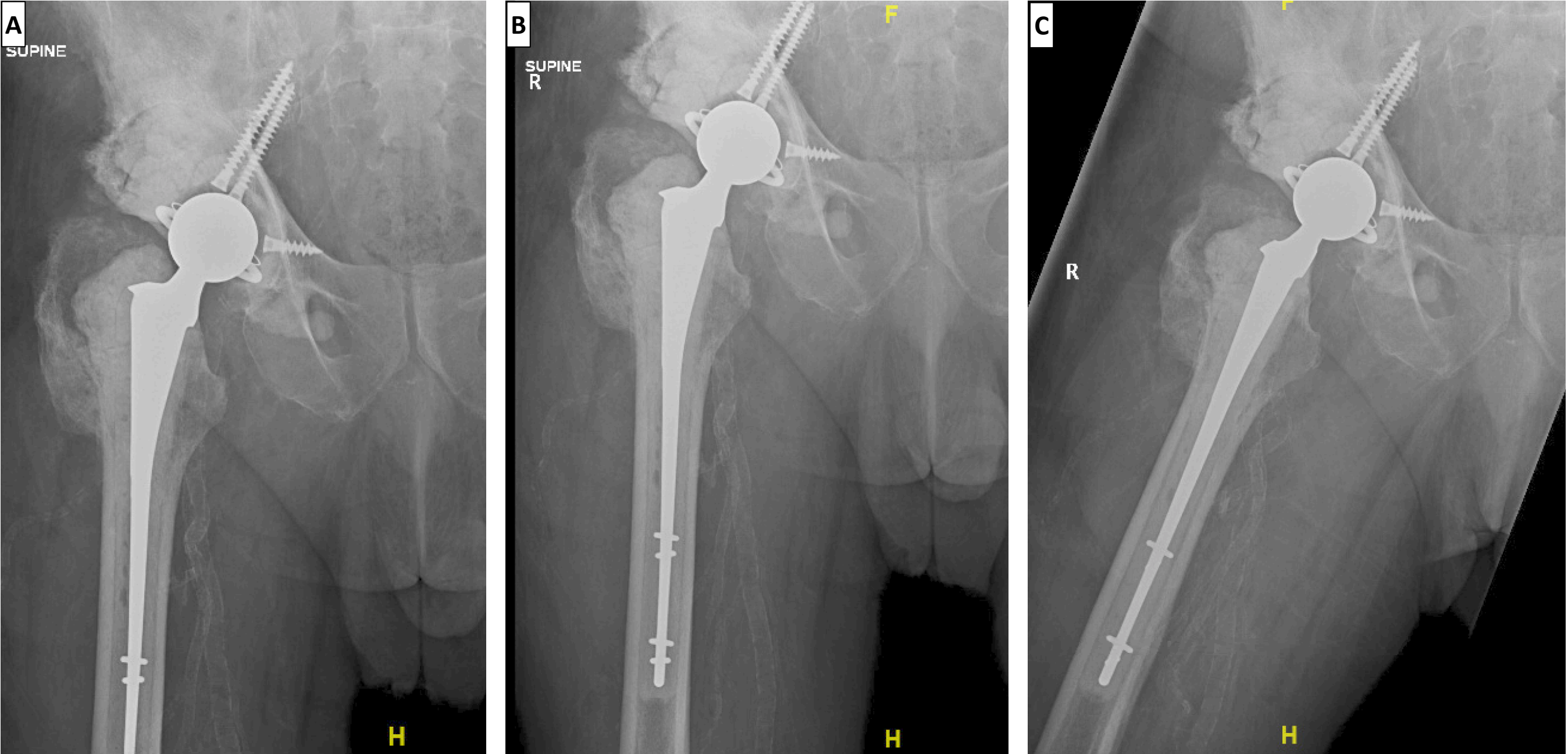
**A – B.** Right hip anteroposterior (A) and lateral (B) radiographs 1 year after primary right hip hemiarthroplasty. No osteolysis or loosening visualized.  
**C – D.** Right hip anteroposterior (C) and lateral (D) radiographs 3 years after primary right hip hemiarthroplasty. No osteolysis observed. The hemiarthroplasty is superiorly located relative to the native acetabulum and left hip (not shown). The right lesser trochanter is at the level of the right superior ramus. There is heterotopic bone formation along the lateral aspect of the acetabular cup.

- **At presentation:**
  - Patient reported chronic severe right hip pain associated with any movement. He was able to stand, pivot, and transfer with assistance, but was unable to ambulate.
  - There was a leg-length discrepancy of 3.2 cm between the left and shortened right leg.
  - Right hip aspiration studies revealed a white blood cell count of 21,250 with 86% neutrophils, Synovasure<sup>®</sup> +, alpha defensin +, and synovial CRP elevation to 37.8.

The decision was made to proceed with a **planned 2 stage right THA revision** given the likelihood of infection, continued superior migration of the bipolar head, and ongoing right hip pain.

- **First stage right hip revision, 9 months prior to second stage:** The patient underwent the first stage of the right THA revision with resection of the primary hemiarthroplasty implants, radical debridement, and insertion of a cemented constrained Prostalac<sup>®</sup> THA.

Fig. 2: Imaging After the First Stage of the Right THA Revision



**A – C.** Right hip anteroposterior radiograph (A) showing superior pelvic screw placement, right hip anteroposterior radiograph (B) showing full length of the femoral stem components, and right hip lateral radiograph (C) immediately following primary right hip bipolar hemiarthroplasty removal. Cement is visualized across the eroded acetabular dome and into the inferior iliac wing. Cement is replacing the greater trochanter and extends down the length of the femoral stem. The acetabular component has 3 screws.

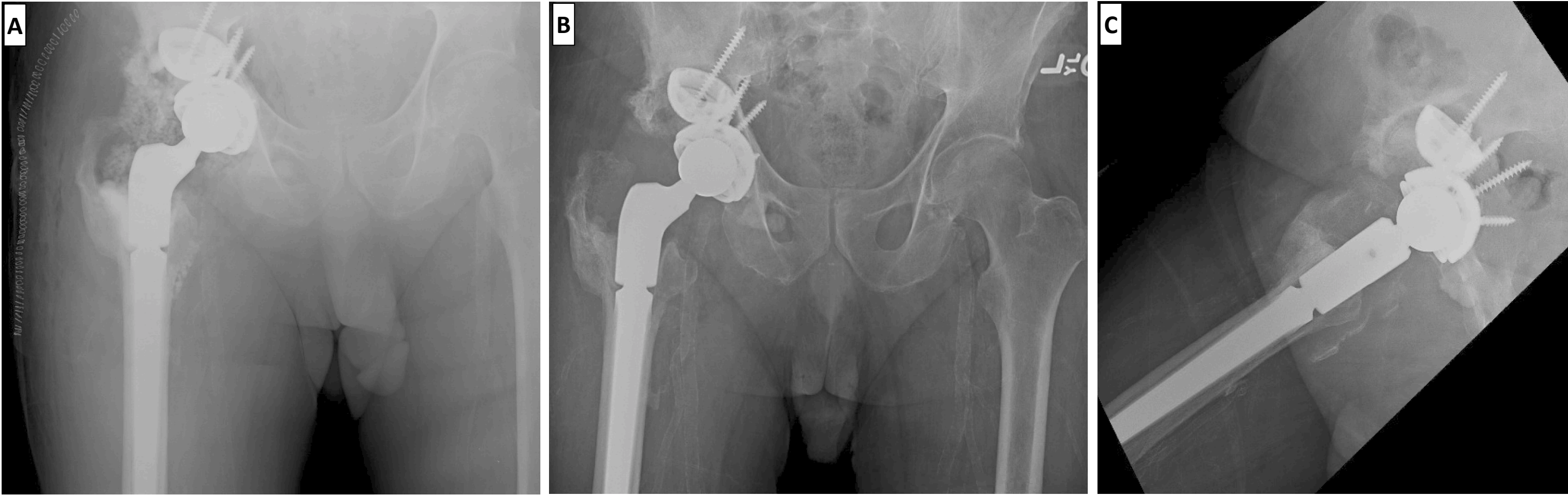
- **Immediately prior to the second stage of the right THA revision:** The patient was ambulating with a walker and left leg BKA prosthesis. He was still experiencing right hip pain that worsened with range of motion and weight bearing. Right hip aspirate revealed no evidence of infection.

## SURGICAL TECHNIQUE

To fill the superior pseudo-acetabular defect created by the superior migration of the primary hemiarthroplasty bipolar head, an **inverted acetabular cup was used in lieu of an acetabular reconstruction cage to create a buttress for a superior aspect of the anatomic acetabulum:**

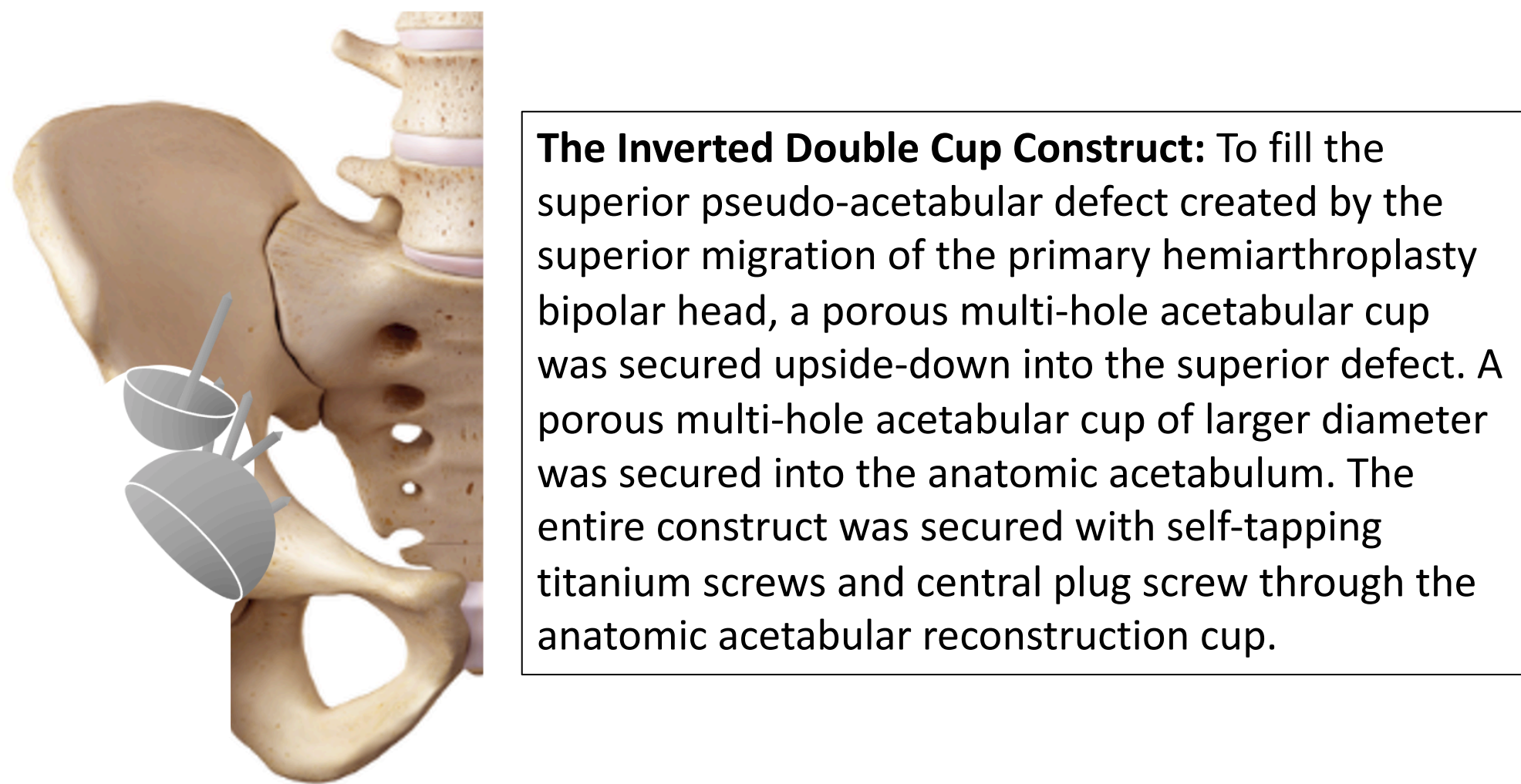
1. Both the superior pseudo-acetabular defect and native acetabulum were reamed independently in 1 mm increments.
2. A porous multi-hole acetabular cup was inserted upside-down (i.e. inverted) into the superior defect and impacted into position.
3. A porous multi-hole acetabular cup of larger diameter was inserted into the anatomic acetabulum and impacted into position.
4. The entire construct with both cups was axially impacted with hemisphere to hemisphere contact of the inverted cup and anatomic acetabular cup, creating a buttress construct.
5. The construct was then secured with 1 self-tapping titanium screw through the inverted cup, and 5 self-tapping titanium screws in and about the inverted and anatomic acetabular cups, all of which obtained solid bone purchase.
6. Defects between the 2 cups were filled with acetabular bone reaming remnants and 5 mL of Cerament bone graft substitute.
7. A central plug screw was placed into the anatomic acetabular reconstruction cup.
8. A constrained acetabular cup was placed into the anatomic acetabular cup, impacted, and locked into position.

Fig. 3: Imaging After the Second Stage of the Right THA Revision with Inverted Double Cup Construct



**A.** Pelvic anteroposterior radiograph immediately after the second stage of the right hip THA revision with inverted double cup construct and femoral endoprosthesis.  
**B – C.** Pelvic anteroposterior (B) and right hip lateral (C) radiograph 6 weeks after the second stage of the right hip THA revision with inverted double cup construct and femoral endoprosthesis. Inverted acetabular shell position unchanged in comparison to immediate post-operative radiographs. Resorption of antibiotic beads and decreased immediate post-surgical changes. No evidence of hardware complication.

Fig. 4: Illustration of the Inverted Double Cup Construct



**The Inverted Double Cup Construct:** To fill the superior pseudo-acetabular defect created by the superior migration of the primary hemiarthroplasty bipolar head, a porous multi-hole acetabular cup was secured upside-down into the superior defect. A porous multi-hole acetabular cup of larger diameter was secured into the anatomic acetabulum. The entire construct was secured with self-tapping titanium screws and central plug screw through the anatomic acetabular reconstruction cup.

6 weeks post-operatively: The patient's post-operative pain was improving. Intra-operative cultures were negative. The patient had been cleared for full weight bearing but had not begun ambulating during recovery.

## SUMMARY

1. In this presentation, we describe a patient that successfully underwent a right total hip arthroplasty revision using the inverted double cup construct after significant acetabular bone loss.
2. The inverted double cup construct may be a cost-effective alternative to expensive implants in order to fill large bone defects about the acetabulum and stabilize acetabular components in revision total hip arthroplasty.

## REFERENCES

- References**
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Thank You ☺

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