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Case report

Preoperative optimization for vascular involvement complicating revision total hip arthroplasty

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ABSTRACT

Vascular complications in revision total hip arthroplasty may occur in cases where the components of the hip implant migrate through the acetabular wall, through the iliopectineal line of the pelvis, and into the pelvic cavity. This migration may lead to substantial intrapelvic vascular compromise, drastically increasing the surgical complexity and potential risk for morbidity and mortality in these surgical cases. Here, we present a case of a 78-year-old woman with significant acetabular protrusio, which resulted in intraoperative compromise of the external iliac artery with rapid extravasation. As a result of prudent preoperative planning, interdisciplinary collaboration, and precautionary measures, significant patient morbidity and mortality was averted.

Level of Evidence: Level V, Case Report.

Introduction

Vascular complications in revision total hip arthroplasty (rTHA) may occur in cases where components of the implant migrate through the acetabular wall and into the pelvic cavity. Severe acetabular component protrusion may promote the formation of adhesions to one of the many neurovascular structures and organs within the abdomen and pelvis, increasing the risk for tears, compression, and in some rare cases, gastrointestinal fistula formation [1]. Although severe acetabular protrusion with concomitant vascular compromise remains to be rare, the intraoperative risks accrued by the surgeon may potentially be fatal for the patient. In a case series of 246 rTHAs by Epinette et al. [2], 4 cases were complicated by vascular etiologies, of which 2 resulted in fatalities, demonstrating the high risk of mortality in this patient population. Here, we present a case of severe intrapelvic migration of the acetabular component after THA requiring revision. This case was complicated by an iatrogenic arterial bleed of the external iliac artery (EIA). Furthermore, we describe the life-saving precautionary measures used in this case and highlight the importance of a multidisciplinary surgical approach to complex surgical cases.

Case history

A 78-year-old woman presented with a 2-year history of right hip pain, with radiation to the groin. She is status after right total hip arthroplasty 6 years ago, which was complicated by a postoperatively diagnosed intraoperative transverse acetabular fracture and left untreated. The cup was left in mild protrusion, and migration was noticed on subsequent postop images. The patient did not follow-up for a period of 4 years, until refractory pain, disability, and shortening of the limb was appreciated. During this time, the patient attempted multiple forms of conservative management, including physical therapy, anti-inflammatory medications, ambulatory assistive devices (walker), and activity modification but found them to be ineffective. The patient also endorsed a past medical history of ovarian, colon, and bladder cancer, delayed gastric emptying, disseminated intravascular coagulation syndrome, blood clots, bowel and bladder incontinence, bowel resection, and a

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hysterectomy. She also reported occasional alcohol use but denied any past tobacco or intravenous drug use. Given the patient's comorbidity profile, morbidity and mortality associated with revision THA was high. The risks and limited benefits associated with surgical intervention were discussed at length; however, given the substantial pain and failed conservative interventions, the patient desired to proceed with revision arthroplasty.

Physical examination and radiographic assessment

The patient ambulates with the assistance of a walker and has an antalgic short leg gait. A well-healed surgical scar is present over the patient's right hip but is otherwise unremarkable. Bilateral lower extremity varicose veins are present but without lower extremity lymphedema, pitting edema, or calf tenderness. There is tenderness to palpation over the region of the greater trochanter with radiation toward the groin. Right hip flexion and extension is limited to 0-50°, with internal and external rotation with her knees bent at 90° restricted to 20° and 10°, respectively. Abduction is to 20° and adduction to 10°. Both hips are stable to anterior and posterior stress with no sign of subluxation or dislocation on examination. A leg-length discrepancy of 25 mm was also noted on clinical examination. She was neurovascularly intact. Radiographic assessment demonstrated superior and medial migration of a failed right THA into the pelvic cavity (Fig. 1a and b).

Vascular evaluation

Owing to the extensive acetabular component protrusion and past history for abdominal and pelvic surgeries, vascular surgery was consulted. Advanced imaging was obtained to evaluate the extent of intrapelvic and vascular involvement of the prosthesis. Venous duplex ultrasound was remarkable for chronic venous disease in the right lower extremity, and the external iliac vein was not visualized well, due to chronic compression. Color Doppler demonstrated a torturous EIA with newly developed collaterals. Computed tomography angiogram (CTA) demonstrated encroachment of the acetabular cup on the right EIA (Fig. 2). However, both 2D and 3D reconstruction CTAs were unable to fully assess the extent of vessel adhesion owing to artifact from the metal implant (Fig. 3). After discussing the case with vascular surgery, the patient was scheduled for an intraoperative right lower extremity angiogram followed by a right rTHA.

Vascular endovascular approach

The patient was brought to the hybrid operating suite and placed in the supine position on a hybrid operating table. Under ultrasound guidance, a stiff sheathed guidewire was inserted into the right common femoral artery and advanced into the aorta. Ipsilateral access was chosen considering a lot of manipulation would be required for removal of the hardware. Right lower extremity angiography demonstrated patency of the right iliofemoral system including the aorta, right common iliac, EIA, and common femoral arteries leading into the superficial and profunda femoral arteries. An area suspicious for stenosis adjacent to the acetabular component was identified. The vascular access sheath was secured to the patient with 3-0 nylon suture, protected using gauze and Tegaderm dressing, and the patency of the sheath was maintained using a pressurized saline drip. As an additional precautionary measure, a vascular graft was placed on the surgical field. Using standard orthopaedic positioning device, the patient was placed in the left lateral decubitus position.

Orthopaedic surgical approach

A modified Kocher-Langenbeck incision was made, through the lateral aspect of the hip. Scar tissue was removed, exposing the femoral and acetabular components. Intraoperative examination was significant for severe intrapelvic cup protrusion and restricted mobility, effectively limiting safe dislocation or manipulation of the hip. A cable was placed distally, and an extended trochanteric osteotomy was performed. The hip remained poorly mobile despite the extended trochanteric osteotomy due to the unusual positional relationship of the femoral head and cup, and dislocation of the stem was not possible. The neck of the femoral stem was cut using a metal cutting burr, and the stem was safely removed (Fig. 4). After attempting to manipulate the acetabular cup, pulsatile arterial bleeding was observed. The patient was turned to the supine position, and the vascular team was called back in to emergently address the tear.

Vascular repair

With the patient placed back into the supine position, sterility was reobtained at the right femoral artery access site. Angiography demonstrated brisk extravasation around the junction of the right EIA and circumflex femoral artery, likely resulting from a traction injury. The vascular stent graft was inserted and

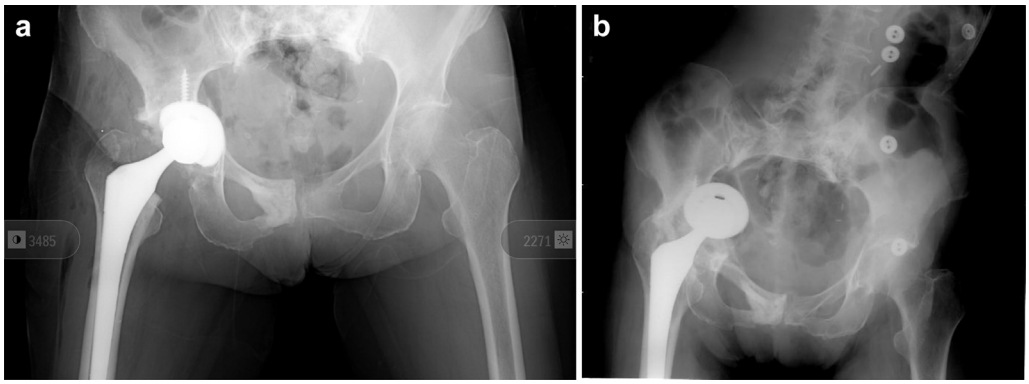

Figure 1. (a) Anteroposterior (AP) pelvis from immediate postop: radiograph demonstrates right acetabular protrusion, intraoperative fracture, and thinning of the right acetabular wall. (b) AP pelvis from initial patient presentation: radiograph demonstrates evidence of right THA failure with severe acetabular protrusion.

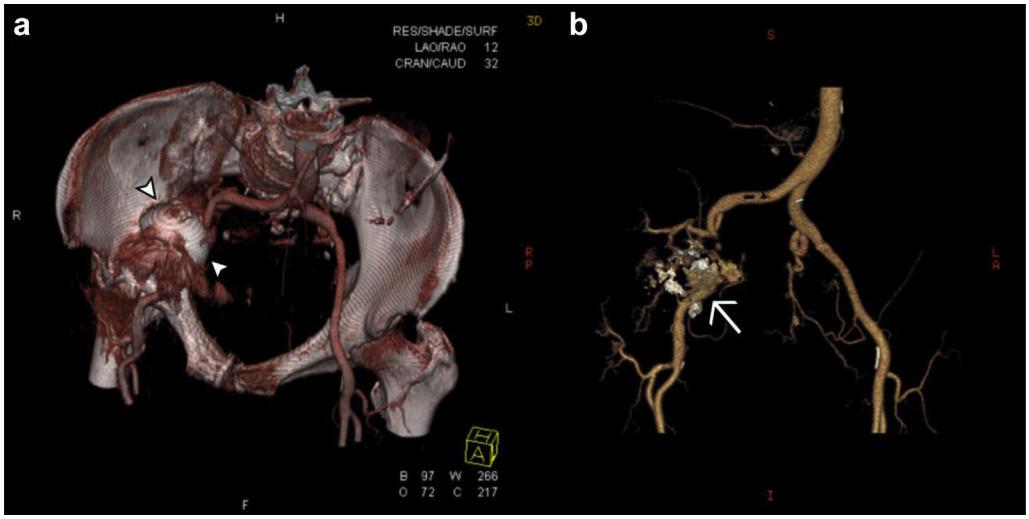

Figure 2. 3D CTA reconstruction: CTA reconstructions of the (a) pelvis and (b) vasculature. The white arrowheads are demonstrating the acetabular protrusion with encroachment of the right EIA (a), while the white arrow represents the region obstructed by artifact (b).

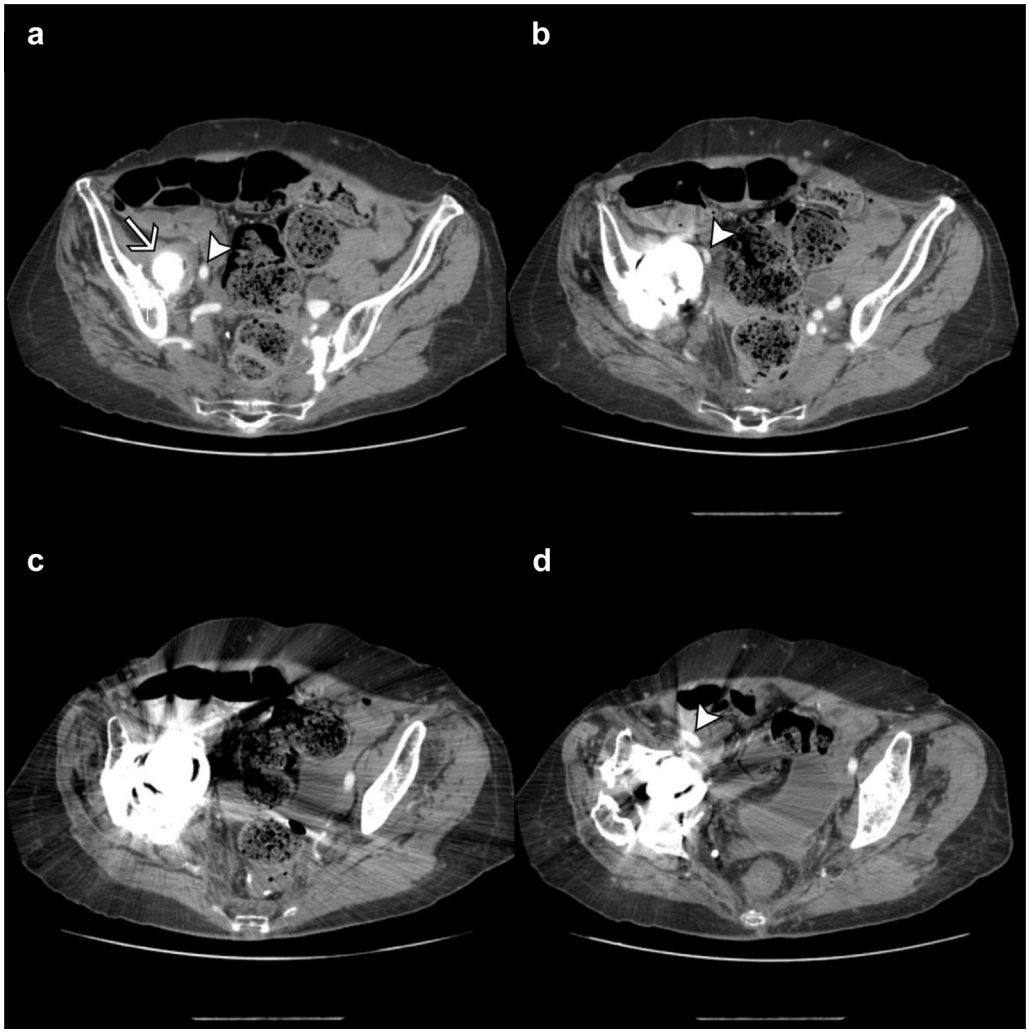

Figure 3. CTA of the pelvis: CT demonstrates acetabular protrusion (white arrow; a) with encroachment of the right EIA (white arrowhead; b and d). The right EIA becomes obscured by the artifact produced from the metal acetabular implant (c).

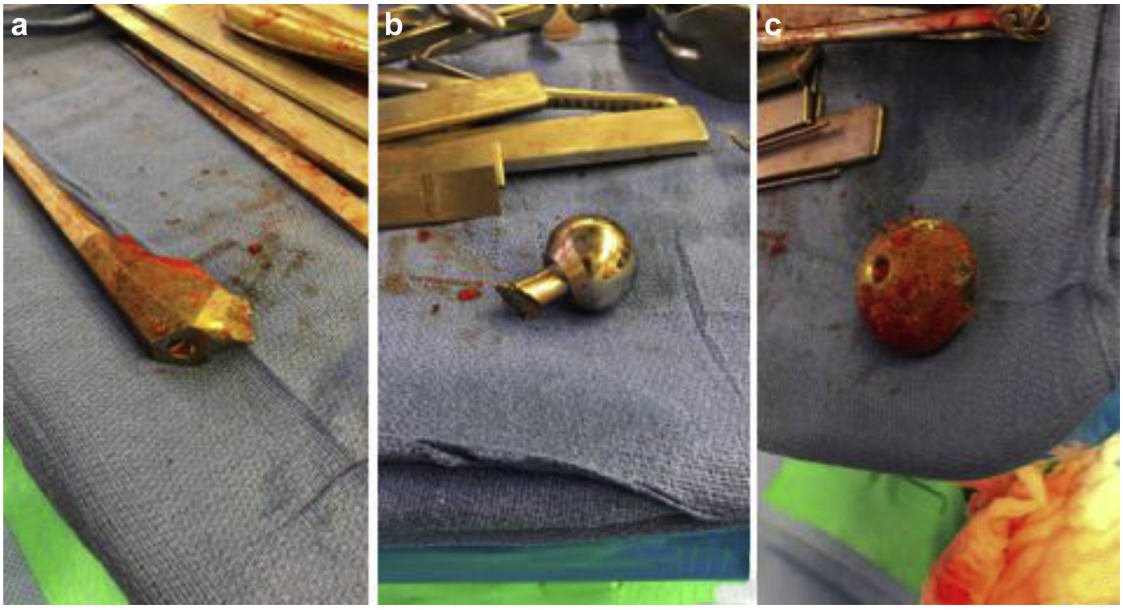

Figure 4. Implant removed from the patient: femoral stem component cut (a), femoral head component (b), acetabular component (c).

deployed across the area of extravasation spanning from the EIA to the circumflex femoral artery. It was subsequently ironed out by a noncompliant balloon. Out of an abundance of caution, the repair was extended with the use of a 10-cm stent graft. Angiography was performed to confirm cessation of blood extravasation (Fig. 5).

Revision procedure

After the vascular intervention, the patient was repositioned and draped. A metal cutting burr was used to remove the previously placed screws, freeing the cup. The retractors were then placed exposing the acetabulum, which revealed a large medial defect and an anterior wall and column deficiency (3A per the Paprosky classification [3,4]). The acetabulum was reamed from a size 50 mm to 56 mm until a satisfactory rim fit was obtained. The acetabulum was then irrigated, and 120 g of bone graft was impacted into the acetabular defect. A Redapt 56-mm fully porous acetabular shell with multiple screw holes was impacted in place and multiple screws were placed. Owing to the large acetabular defect, the cup was augmented with a Zimmer Trabecular Metal 58 mm cup-cage construct, and a Polar Cup 43-mm liner was cemented into the construct in proper abduction and anteversion. The hip prosthesis was exchanged for a Redapt monoblock size 15,

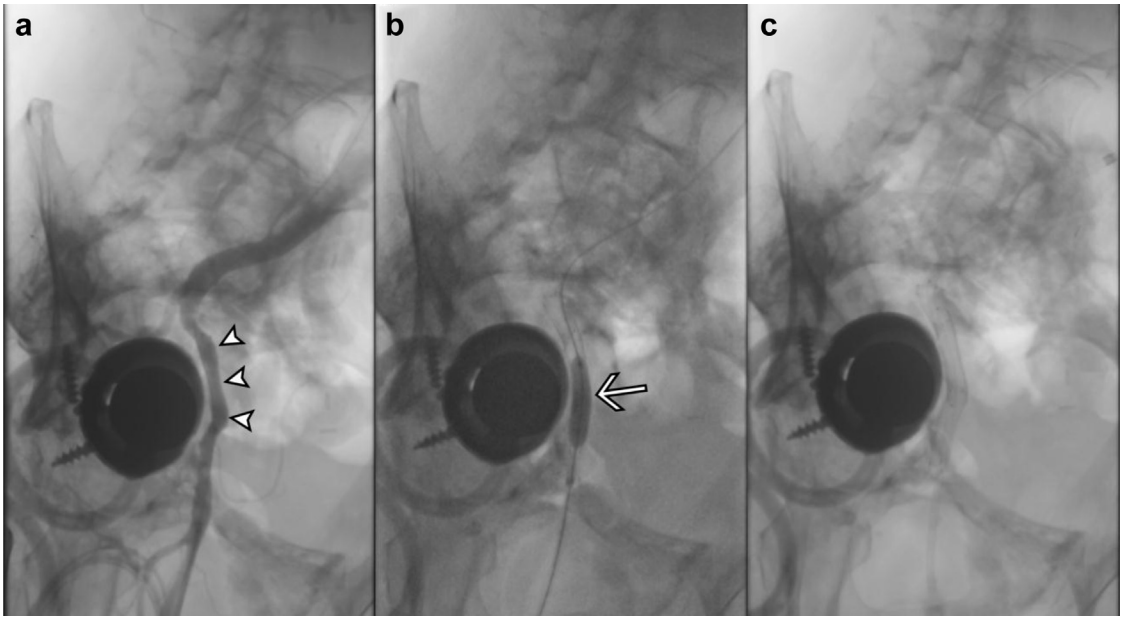

Figure 5. Intraoperative fluoroscopy: intraoperative fluoroscopy centered over the right hip with contrast demonstrating the close proximity of the right EIA (white arrow; a) with the previously failed right total hip implant. Also demonstrated is graft balloon deployment (white arrow; b), and successful graft placement across the EIA vasculature (c).

240 mm stem and a cobalt-chrome 12/14 taper 28 mm, 0 offset head. The remainder of the surgery proceeded in a standard fashion and without further complications. At the end of the surgery, a secondary angiography was performed to visualize patency of the graph. A duplex ultrasound was performed postoperatively to confirm vascular perfusion of the right lower extremity. In total, the operative time, from vascular incision to orthopaedic closure, required 7 hours and 29 minutes with a total estimated blood loss of 2000 mL.

Postoperative care

The patient was placed on foot flat weight bearing for the first 6 weeks and progression to partial weight bearing for 6 more weeks for a total of 12-weeks. The patient's postoperative course was otherwise unremarkable. Her right lower extremity remained well perfused without vascular compromise or signs of limb ischemia. Functionally, the patient's hip showed only a 10° deficit in flexion (90° vs 100°) and internal rotation (10° vs 20°) when compared to the contralateral limb. Moreover, the patient was able to continue ambulating with her walker and progressed to a can in her latest follow-up visit. Follow-up standard radiographs demonstrated a well-fixed and well-positioned right THA (Fig. 6).

Discussion

Here, we present a case of acetabular protrusion complicated by the involvement of a major arterial vasculature of the pelvis. An interdisciplinary approach, which involved careful preoperative planning and a focus on precautionary measures, ultimately prevented a fatal outcome.

We used a novel precautionary protocol to mitigate the intraoperative risk of severe hemorrhage and ultimately avoided a catastrophic outcome. Despite obtaining preoperative 3D reconstruction CTAs and color Doppler ultrasound, visualization of the vasculature was unable to appreciate the severity of vascular involvement with the failed rTHA. After discussion with a vascular surgeon, a single-stage surgical approach involving vascular surgery and angiography immediately before rTHA was selected. This technique would improve the surgical survival for 4-fold through: (1) improved vascular visualization before rTHA, (2) allowed for precautionary placement of a vascular access sheath, (3) avoided arbitrary stent placement within the pelvic cavity, and (4) avoided the potential surgical complexity of repairing a stented vessel.

Figure 6. Five-month follow-up AP pelvis demonstrating a well-fixed right THA.

While intrapelvic acetabular cup migration is rare, the complications can be very serious. Shoenfeld et al. [5] found the risk of mortality during THA with vascular complication to be 7% and loss of limb to be 15%. In addition, they found the main risk factors for vascular injury to be revision procedures, left-sided procedures, and intrapelvic migration of the acetabular component. In rTHA, vascular injuries are more frequent owing to displacement and fibrosis of vasculature. In addition, metallosis or infection leading to inflammation can cause adherence of more vasculature and has been postulated to increase the risk for vascular injury [6]. Considering the iliac vessels, particularly the EIA and vein, are located just medial to the acetabulum, they are at greater risk of damage during procedures involving revision of an intrapelvic acetabular cup [7]. The vessels most likely involved in vascular injury during rTHA are, in descending order: the EIA, the common femoral artery, the external iliac vein, the internal iliac artery, and the gluteal vessels [6]. Injury to the internal iliac artery and the superior gluteal artery is much less common as they run farther away from the acetabular wall [1].

al-Salman et al. [8] cite 2 particular reasons that hemorrhage-related morbidity and mortality are so high during rTHA. First, bleeding is predominately contained within the pelvis, which masks bleeding severity and can delay prompt recognition. Second, once hemorrhage is recognized, vascular access is restricted and requires significant efforts for rapid patient repositioning, vascular exposure, and surgical repair. Similarly, al-Salman et al. [8] advocate for the initial preoperative identification of iliac vessel involvement and a subsequent medial extraperitoneal exposure and repair of these vessels before proceeding with the removal of the displaced acetabular prosthesis. Through this preliminary exposure, it may be possible to prevent major hemorrhagic complications [5,8]. As evidenced by this case, CTA with venous return can be a useful imaging modality to examine the local vasculature, presence of abnormalities, and proximity to implants [6]. However, it must also be appreciated that there is a paucity of literature examining the clinical role of advanced vascular imaging in the setting of complex rTHA.

Summary

Despite the poor outcomes reported in the literature, prophylactic measures may drastically reduce the mortality and morbidity rate in patients with complex rTHAs. Thus, the authors recommend that all rTHA candidates with severe acetabular protrusion, defined as a significant migration of the acetabular component into the pelvis with or without pelvic discontinuity, especially the ones that lack a bony “shell” around the acetabular component, should undergo an evaluation with a preoperative CTA. Consultation with a vascular surgeon should be dependent on the results of the CTA and the comfort of the orthopaedic surgeon. Moreover, for patients with a high suspicion of vascular compromise particularly those with a suspicious CTA, surgical history significant for abdominal, or pelvic procedures, an interdisciplinary approach in the operating room is integral for the patient safety. Both orthopaedic and vascular surgeons must place greater focus on precautionary and contingency measures for patients with potentially severe vasculature compromise. However, further research is warranted to establish classification criteria for which patients should receive a comprehensive preoperative vascular evaluation and of those, who will benefit most from precautionary preventative endovascular interventions.

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