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Arthroplasty in Patients with Rare Conditions

Gunshot Wound to the Hip Resulting in a Femoral Head and Acetabulum Fracture Treated With Open Reduction and Internal Fixation and Bipolar Hemiarthroplasty

Murphy P. Martin III, MD, Matthew W. Cole, MD, Akshar H. Patel, MD, William F. Sherman, MD, MBA *

Department of Orthopaedic Surgery, Tulane University School of Medicine, New Orleans, LA, USA

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ABSTRACT

Combined fractures of the femoral head and acetabulum due to ballistic injuries are rare injuries, especially in the elderly. We present a case of a 70-year-old female who sustained a gunshot wound to the left hip, resulting in a comminuted femoral head fracture and posterior wall acetabular fracture. She was treated with open reduction and internal fixation of the acetabulum, as well as bipolar hemiarthroplasty for treatment of her femoral head fracture. At her 18-month follow-up visit, the patient was doing well and had no complaints.

Introduction

Firearms-related violence in the United States is a public health epidemic associated with significant cost, morbidity, and mortality [1]. From 2003 to 2012, there were 313,045 individuals who died from firearms-related injuries with an estimated yearly societal cost of $48 billion [2,3]. When compared to the prepandemic years, studies performed at level I trauma centers during the initial months of the COVID-19 pandemic demonstrated a significant increase in the daily mean number of firearm-related and nonaccidental orthopaedic injuries [4,5]. Musculoskeletal trauma to the hip and pelvis has been associated with a unique constellation of injuries involving bone and soft tissue when associated with firearm-related injuries [6,7].

Concurrent femoral head and acetabular fractures are rare injuries and have been classically described after high-energy blunt trauma [8,9]. When possible, femoral head and acetabular fractures are treated with internal fixation, with the goal of preserving the native hip joint. Ballistic injuries to the hip joint can be associated with fractures of the femoral head and acetabulum and are treated with a similar methodology. In the elderly patient, however, fractures of the femoral head and neck are often treated with arthroplasty, to allow for early mobility and weight-bearing and minimizing the risks of avascular necrosis [10].

In this report, we present an elderly patient who sustained a gunshot wound (GSW) to the hip resulting in a comminuted femoral head and posterior wall acetabular fracture, which was treated with hemiarthroplasty (HA) and internal fixation of the acetabulum. After being informed of this unique case, the patient elected to provide information about her medical condition for publication in medical literature, and written informed consent was obtained for publication.

Case history

Preoperative care

The patient is a 70-year-old female with a past medical history of being overweight with a BMI of 29.5 kg/m^2, diabetes mellitus, and peripheral vascular disease who presented to our institution after

* Corresponding author. Department of Orthopaedic Surgery, Tulane University School of Medicine, 1430 Tulane Avenue, New Orleans, LA 70112, USA. Tel.: +1 504 982 0252.
E-mail address: swilliam1@tulane.edu

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sustaining a single GSW to the left posterior hip during a home invasion. She complained of pain in the left hip and inability to bear weight. She reported a modest preinjury activity level as an independent community ambulator with no prior history of hip pain. Physical examination revealed an open ballistic wound to the posterior hip and no neurovascular deficits. Radiographs (Fig. 1) and computerized tomography (CT) scans (Fig. 2) of the pelvis and hip were obtained, which demonstrated a comminuted fracture of the femoral head, along with a fracture of the posterior wall of the acetabulum and a fracture through the fovea acetabuli and anterior wall along the tract of the projectile. Three-dimensional CT reconstruction images were acquired to further characterize the femoral head and acetabular fracture fragments (Fig. 3).

Intraoperative care

After discussing the risks and benefits of operative treatment, informed consent was obtained, and the patient was taken to the operating room. She was positioned laterally on a radiolucent operating table with a bean bag. A Modified Gibson approach was used for exposure using a straight lateral incision. After identification and neurolysis of the sciatic nerve and division of the short external rotator tendons, inspection of the retroacetabular surface revealed a cavitary lesion and fracture of the posterior acetabular wall (Fig. 4). An anterior arthrotomy through the Watson-Jones interval was created to preserve the posterior capsular attachments, and the hip joint was dislocated anteriorly using this interval. The comminuted fracture of the femoral head was visualized and then resected through an associated fracture line in the subcapital region of the femoral neck (Fig. 5). A femoral neck osteotomy was then created in the standard fashion, distal to the zone of injury (Fig. 6).

The acetabulum was then exposed through the anterior arthrotomy, revealing another cavitary bone defect along the path of the projectile, traversing a portion of the anterior leaflet of the acetabular cartilage. The anterior wall of the acetabulum was intact. There were only mild cartilaginous changes of the acetabular cartilage overall, corresponding with her age. The projectile tract through the bony and soft tissues was then debrided and irrigated thoroughly.

Attention was then turned to fixation of the posterior wall of the acetabulum. The fractures were reduced using standard techniques and fixated using the DePuy Synthes Pelvic Reconstruction system with two 3.5-mm Spring-Hook Plates (Johnson and Johnson, Raynam, MA) and a limited contact dynamic compression plate posterior wall buttress plate. After fixation, there remained an uncontained cavitary lesion traversing the posterior wall of the acetabulum, into which a calcium phosphate bone void filler was implanted, in order to provide structural support to the comminuted fracture. The anterior cavitary lesion was treated in a similar fashion with a Abryx Montage calcium phosphate bone void filler (Abryx Montage, Irvington, NY). With the cavitary defects thus contained, and the posterior wall stabilized, we proceeded with HA.

The hip was taken into a position of flexion, adduction, and external rotation to deliver the femoral neck osteotomy into the anterior aspect of the exposure. The femoral canal was prepared, and after trialing, a 145-mm DePuy Synthes Summit Porocoat High-Offset Tapered press-fit femoral stem was implanted with a metal DePuy Synthes Summit 48-mm outer-diameter and 28-mm inner-diameter cobalt-chromium bipolar head, which was impacted onto the trunnion, and the hip was then reduced. Satisfactory stability and soft-tissue tension were obtained. The exposure was then closed in standard fashion, with repair of the anterior arthrotomy, posterior short external rotators through drill holes, and primary closure of the iliotibial band. Standard radiographs were obtained immediately after the operation (Fig. 7).

Postoperative care

The patient was admitted to a hospital and continued on 24 hours of intravenous antibiotic therapy with cefazolin. She was

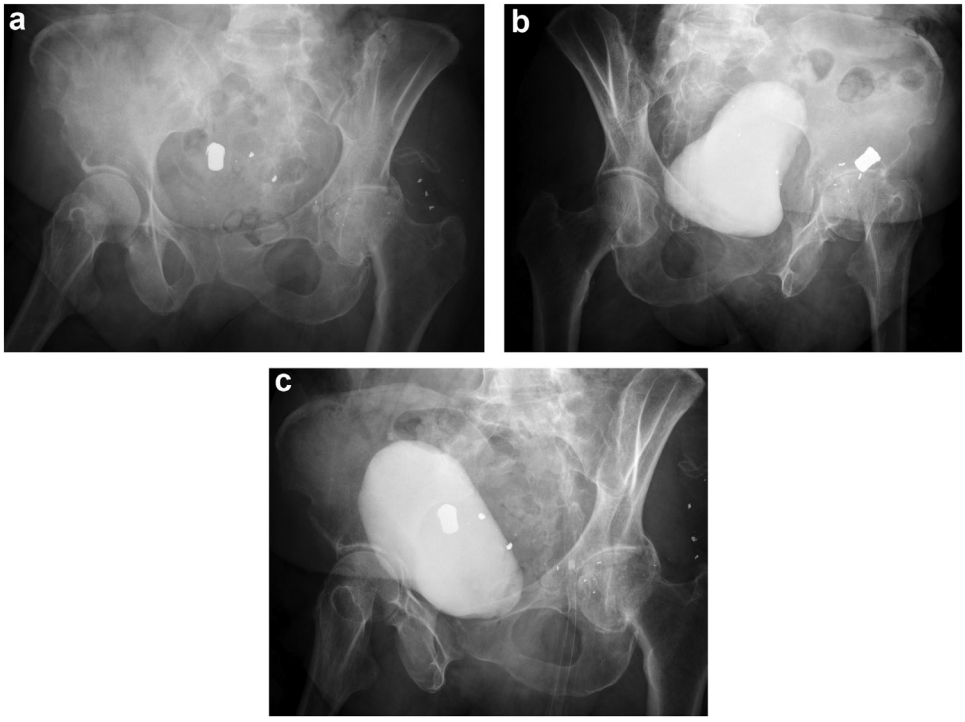

Figure 1. Initial radiographs include (a) anteroposterior (AP) pelvis and Judet views, (b) left iliac oblique, and (c) left obturator oblique, to characterize the resulting fracture pattern.

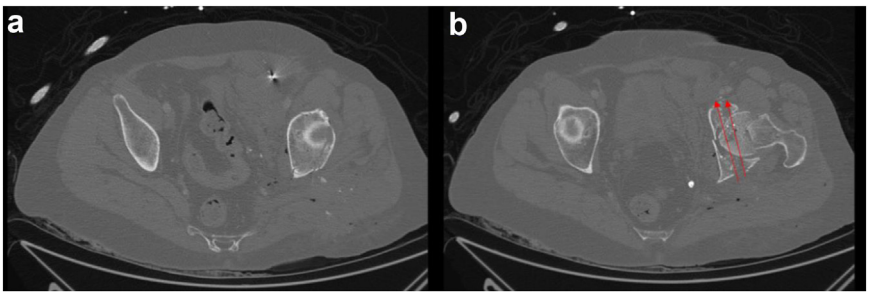

Figure 2. Axial CT scan demonstrating (a) a superior cross-section of the acetabular sourcil, which was affected by the posterior wall fracture, but without cavitary lesions from the projectile and (b) an inferior cross-section the path of the projectile,(represented by the 2 red arrows), from posterior to anterior, traversing the anterior wall, femoral head, and posterior acetabular wall.

made touch-down weight-bearing for 6 weeks and then allowed to advance as tolerated. The physical therapy team was consulted postoperatively for mobilization, and global hip precautions were provided as this patient had a dual approach for fixation. No heterotopic ossification prophylaxis was utilized.

At 18 months postoperatively, the patient returned for a follow-up visit and had no complaints. Radiographs were obtained at this time for routine monitoring and to confirm proper positioning of hardware (Fig. 8).

Discussion

There are several considerations worth noting, which may be useful to the orthopaedic surgeon encountering similar ballistic injuries as the need for concurrent open reduction and internal fixation (ORIF) as well as arthroplasty in a patient's eighth decade of life is rare. Proper imaging is required to characterize the pattern of any GSW injuries. When initial radiographs are equivocal, further imaging may be particularly helpful to delineate the bullet pathway as well as the fracture pattern. In our patient, it was difficult to

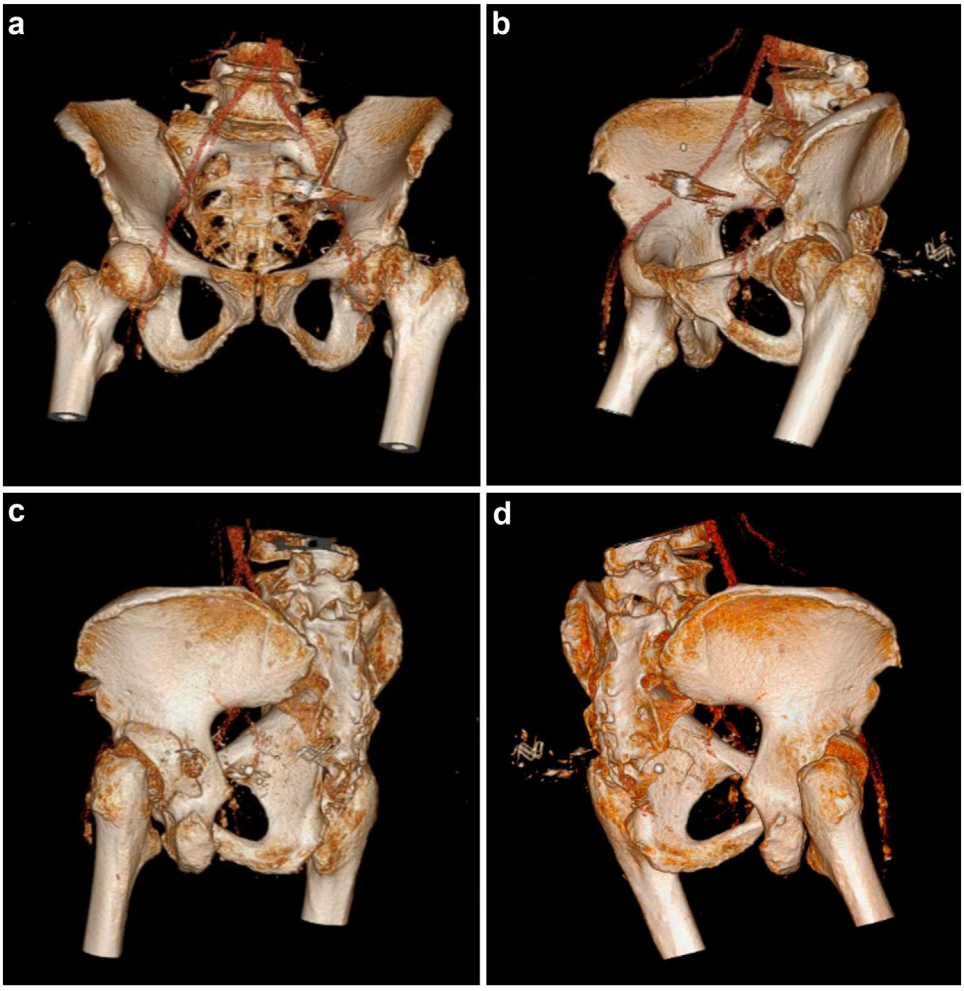

Figure 3. Three-dimensional CT reconstruction images were acquired to further characterize the femoral head and acetabular fracture fragments. These images demonstrate (a-c) fractures of the posterior wall and (d) fracture through the quadrilateral plate.

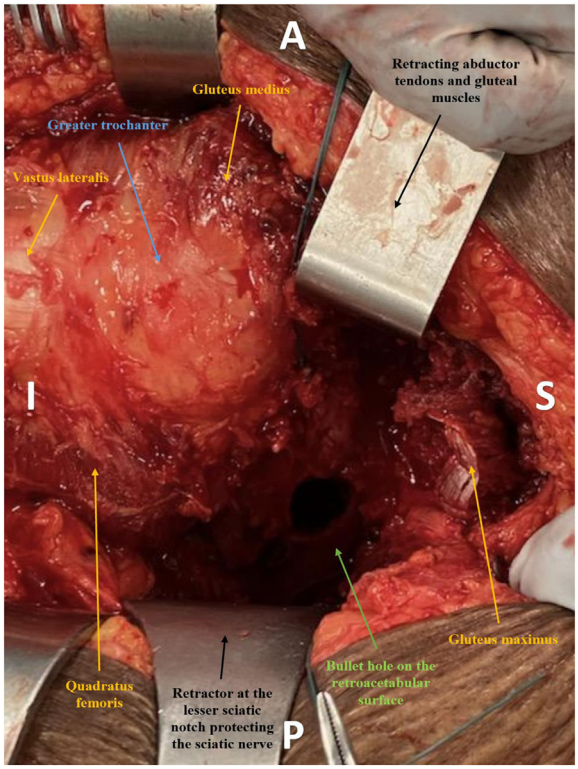

Figure 4. After performing a Modified Gibson approach for exposure through a straight lateral incision with identification and neurolysis of the sciatic nerve, the short external rotator tendons were divided. Gross inspection of the retroacetabular surface demonstrates a cavitary lesion and fracture of the posterior acetabular wall intraoperatively. A, anterior; I, inferior; P, posterior; S, superior.

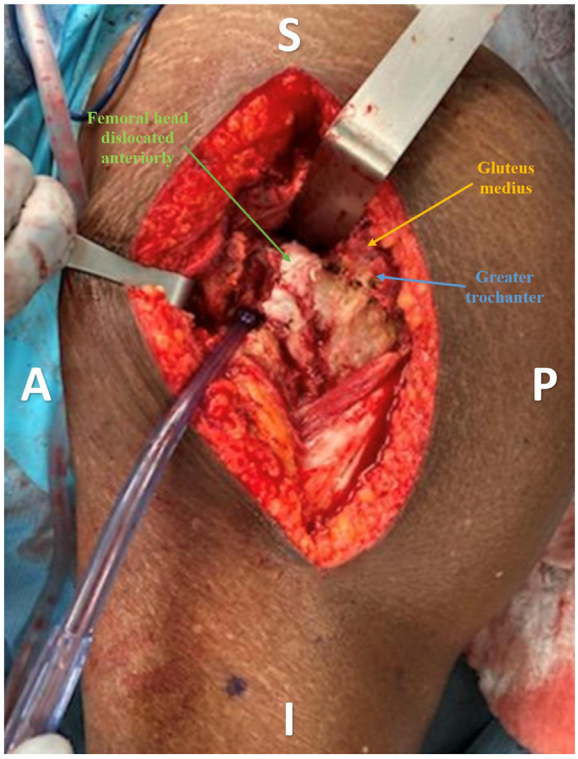

Figure 5. A comminuted fracture of the femoral head was visualized intraoperatively. After resection, the femoral head demonstrates an associated fracture line propagating through the subcapital region. A, anterior; I, inferior; P, posterior; S, superior.

Figure 6. Comminuted femoral head after resection and removal.

radiographically discern from anteroposterior and Judet views if there was fracture extension into the femoral neck. For that reason, we chose to obtain a CT scan of the pelvis with 3-dimensional reconstruction images to further assess the extent of injury. Not only were we able to track the ballistic pathway with advanced imaging, we also used this imaging for preoperative planning. From these images, we determined the patient had only sustained a femoral head fracture without extension into the femoral neck, which was confirmed intraoperatively.

The exposure required for both fixation and reconstruction of the hip must be carefully planned. In the setting of a posterior wall acetabular fracture, posterior exposure of the hip joint is required. Thus, the use of a Kocher-Langenbeck or Modified Gibson exposure must be considered. The Modified Gibson exposure utilizes a straight, longitudinal laterally-based incision. A notable advantage of the Modified Gibson approach is that it uses a single exposure to perform each procedure, thus avoiding the need for dual exposures or sacrificing the posterior capsular tissues if a posterior-exposure-only approach was utilized. The proximal dissection involves using the intramuscular plane between the tensor fascia lata and gluteus maximus, from which it differs from the Kocher-Langenbeck in that the gluteus maximus is not split. In addition to a more cosmetic incision and avoidance of possible disruption of the neurovascular supply of the anterior gluteus, another benefit of the Modified Gibson exposure is that access to the anterior hip joint is afforded, by development of the Watson-Jones interval, partial release of the abductor tendon (Hardinge-type exposure), or through a trochanteric osteotomy. In our case, access to the anterior hip joint for arthrotomy allowed for removal of ballistic fragments and for arthroplasty through an anterior interval. In addition, simultaneous access to the anterior hip for arthroplasty and posterior hip for posterior wall fracture fixation through 1 incision allows for preservation of the posterior capsular tissues. Division of the posterior capsular tissue risks devitalization of the posterior wall fragments and contributes to the instability of the hip joint in the presence of a posterior wall fracture.

In light of the comminution of the femoral head, reconstruction of the proximal femur is required, as internal fixation is not possible in this case with severe bone loss, especially in elderly patients. HA and total hip arthroplasty (THA) as reconstructive procedures are the 2 mainstays of treatment options. The location of the cavitary defects from the projectile in the acetabular cartilage should be carefully assessed. Due to the destruction of the osteochondral surface of the weight-bearing dome of the acetabulum, the sourcil, defined as the

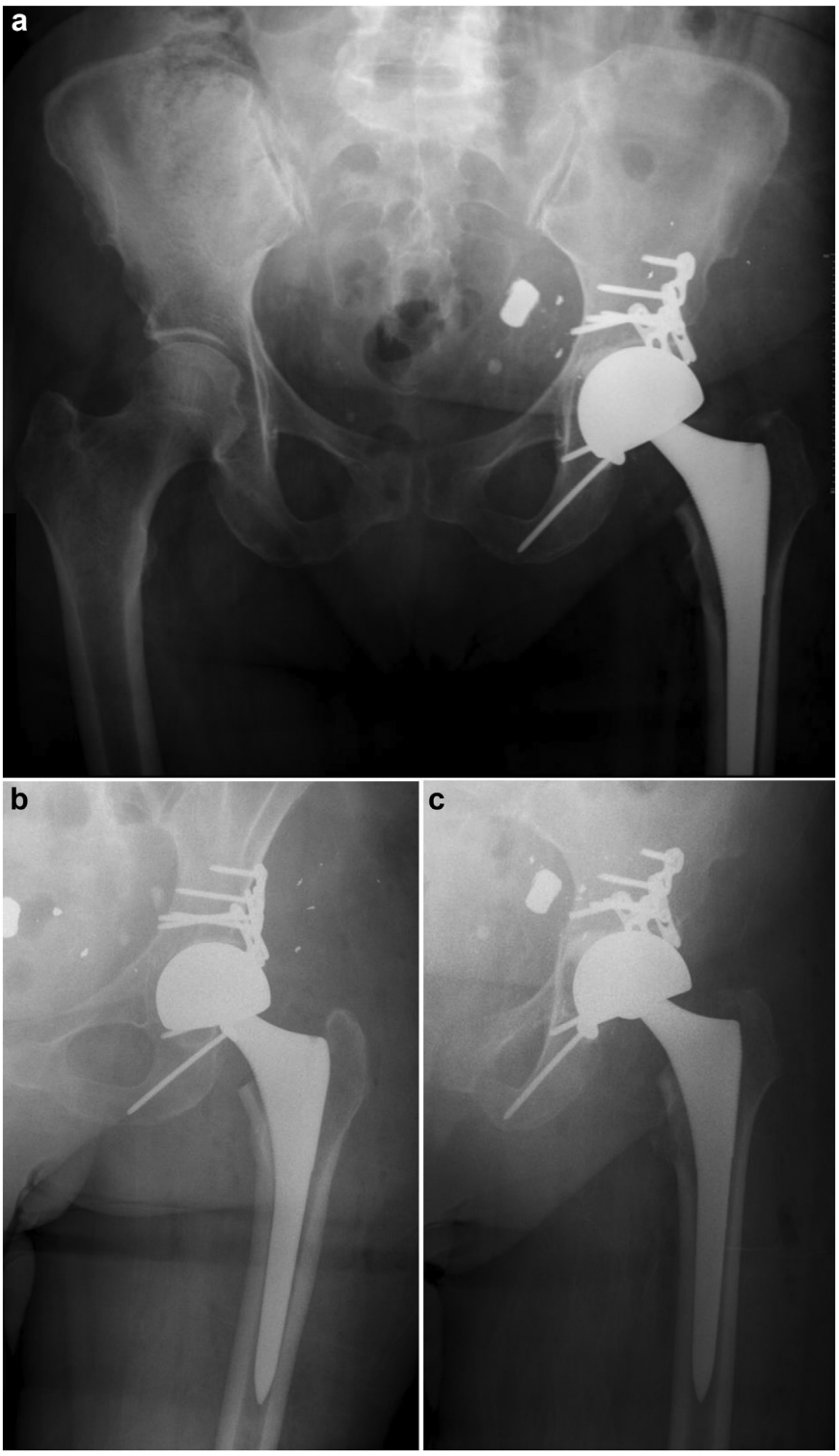

Figure 7. Immediate postoperative imaging was obtained after the operation and included (a) AP pelvis, (b) AP left hip, and (c) lateral left hip.

cranial 10 mm of the acetabulum, would make THA preferable. In our patient, the cavitary defects were well below this margin. If preparation of the acetabulum and impaction of an acetabular prosthesis are considered, the structural integrity of the acetabular columns must also be assessed. Acetabular reconstruction would inherently address the osteochondral lesions and potentially decrease the risk of reoperation for degenerative diseases. However, due to the involvement of the quadrilateral plate in addition to the posterior wall fracture and cavitary defects in the bone from the ballistic missile, the risks of acetabular preparation and prosthetic implantation were felt to outweigh the benefits. The risks of component loosening from the multiple-fracture acetabulum and instability associated with THA for treatment of acute femoral neck fractures were also critically evaluated. For these reasons, and minimal preexisting degenerative disease, HA was felt to represent the most reasonable option for this patient's treatment.

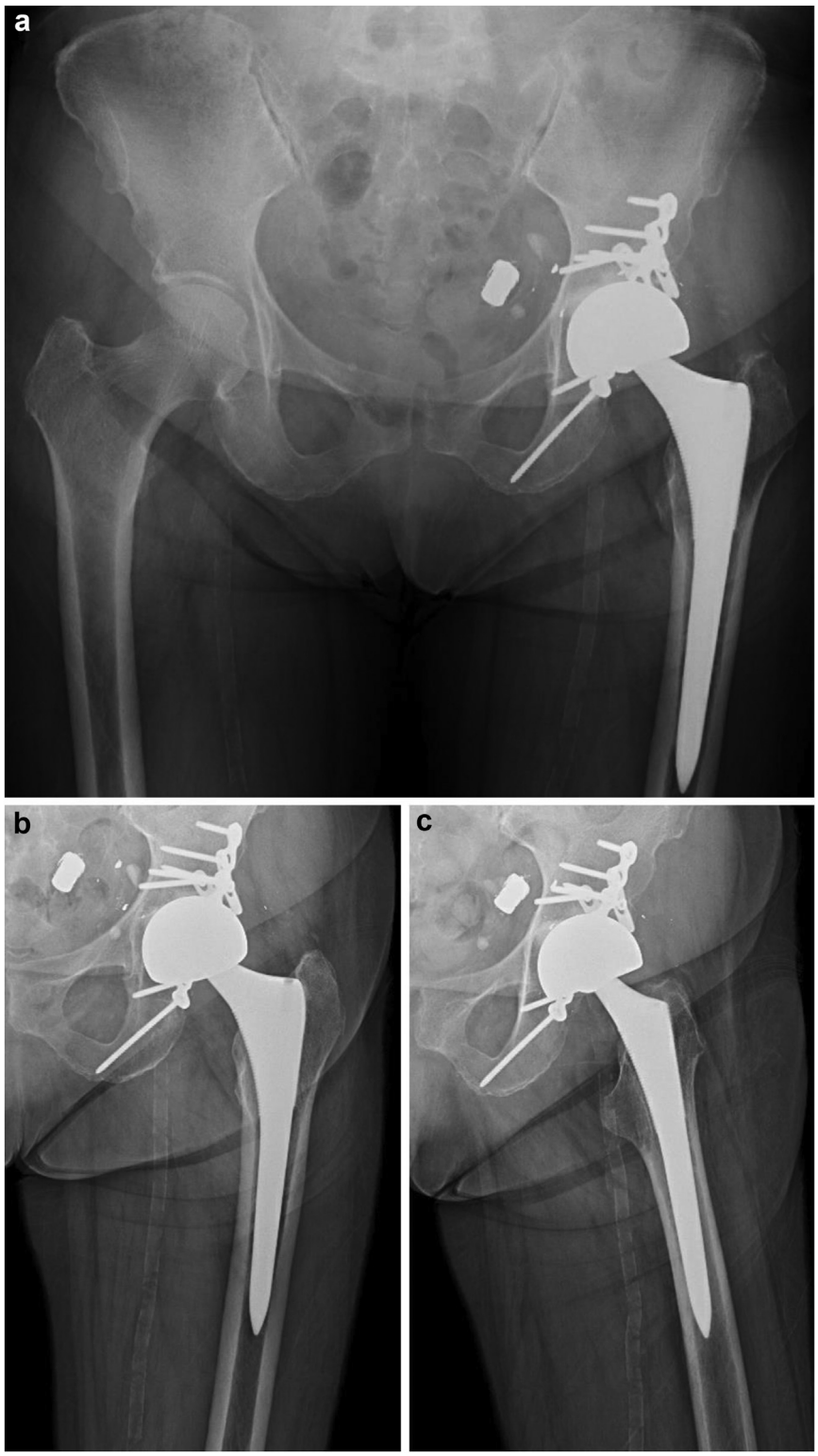

Figure 8. During the patient's 18-month postoperative visit, radiographs were obtained for routine monitoring and included (a) AP pelvis, (b) AP left hip, and (c) lateral left hip.

A major consideration in this case was immediate vs delayed arthroplasty due to concerns of contamination from the bullet. In a 2014 study investigating wound contamination following a low-velocity GSW, Weinstein et al. reported all bullet tracks were grossly contaminated by foreign materials brought into the wound from clothing or debris regardless of bullet size or jacket type [11]. However, when investigating characteristic patterns of wound ballistics, Stefanopoulos et al. noted low-velocity GSWs (defined as <2000 ft/sec) have less muscle necrosis and soft-tissue injury to the extremity than high-energy ballistic trauma [12]. Additionally, Nguyen et al. demonstrated infections from low-velocity GSWs were infrequent in the setting of standard perioperative antibiotics for operatively treated fractures in addition to a single dose of intravenous antibiotics being sufficient for soft-tissue injuries without an associated fracture

[13]. While Pazarci et al. demonstrated a significantly higher risk of infection after THA if there was a concomitant bowel injury and contamination of the hip joint with intestinal flora, Bell et al. documented staged THA as a viable treatment option for a 39-year-old patient with concomitant bowel injury in addition to comminuted femoral head and neck fractures with retained intraarticular bullet fragments [14,15]. For all GSW patients, orthopaedic surgeons must account for the internal bullet track, contamination, and external debris. In our patient's case, these factors were all considered as well as her age and comorbidities. After extensive intraoperative debridement, it was felt the benefits of stabilization and HA were her most optimal surgical option.

The choice of arthroplasty, THA vs HA, remains unclear as the decision between the 2 is often made taking into consideration the age and comorbidities of the patient and the patient's functional status before their injury [16]. A meta-analysis by Migliorini et al. comparing THA and HA demonstrated that in elderly individuals, HA had less dislocations and shorter surgical duration than THA [17]. However, THA had less acetabular erosion than HA [17].

Another consideration for treatment of femoral neck fractures with THA or HA is the use of cemented vs uncemented fixation. A recent meta-analysis by Nantha Kumar et al. demonstrated that the use of cemented HA significantly reduced the risk of intraoperative and postoperative periprostatic fractures when compared to uncemented HA [18]. However, there was an increase in operative time and time under anesthesia with cemented fixation [18]. Moskal et al. demonstrated that cemented fixation was associated with a lower risk of revision, especially in patients older than 65 years [19]. The same study demonstrated better short-term outcomes such as pain and independent walking with cemented fixation [19]. However, the surgeon in this case felt this was not a typical fragility fracture. The bone stock in the femur was Dorr Type B, and with the length of the case for acetabular fixation, it was felt that a shorter operative time was in the best interest of the patient [20,21].

While several studies have demonstrated HA to be superior to ORIF for treatment of elderly patients with femoral neck fractures, there has not been a definitive study to demonstrate a superior choice between unipolar and bipolar implants for HA [22,23]. Studies have demonstrated a higher dislocation rate and a higher incidence of acetabular erosion with the use of unipolar implants than with bipolar implants [24,25]. However, it has also demonstrated equivalent clinical outcomes and a low revision rate for both implants at short-term (1 year) and medium-term (5 year) follow-up [24,25]. With the potential for less acetabular erosion, the decision was made by the surgeon in this case to proceed with a bipolar HA.

While ORIF is the treatment of choice for acetabular fractures in young patients, for elderly patients, no definitive guideline has been established for the treatment of an acetabular fracture [26]. In 1 study, O'Toole et al. documented a 1-year mortality rate as high as 25% after ORIF for an acetabular fracture in elderly patients older than 60 years and a 28% conversion rate to arthroplasty at 2.5 years [27]. Acute or delayed THA is another possible alternative technique for fixation of an acetabular fracture. However, studies for acute THA following an acetabular fracture demonstrate a high rate of complications including deep vein thrombosis, aseptic loosening, heterotopic ossification, and infection [26,28]. While acute THA has the advantage of avoiding a second surgery, the same study reported better functional outcomes for delayed THA than for acute THA following an acetabular fracture [28].

Summary

Ballistic injuries to the femoral head and acetabulum are rare in elderly patients and require techniques such as dual approaches for fixation of fractures as well as arthroplasty.

KEY POINTS

- Ballistic injuries often have significant soft-tissue concerns.
- Bone defects caused by projectiles often require grafting.
- Gunshot wounds in the elderly are not common and require a different approach due to blood supply and bone quality compared with those in younger patients.
- Hemiarthroplasty and total hip arthroplasty each have a role in this setting, and careful consideration should be given to determine the best option for the patient.

Understanding the challenges caused by bone loss and comminution as well as patient comorbidities is paramount in decision-making to provide optimal care.

Conflict of interest

Dr. Murphy P. Martin III is an unpaid consultant for DePuy Synthes and Prosidyan.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2022.06.006.

Informed patient consent

The authors confirm that informed consent has been obtained from the involved patient or if appropriate from the parent, guardian, power of attorney of the involved patient; and, they have given approval for this information to be published in this article.

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