Gunshot injuries to the hip can be devastating, leading to posttraumatic arthritis and presenting a surgical challenge at the time of total hip arthroplasty (THA) due to the presence of metallic fragments and damaged soft tissues. However, there are few reports of gunshot-related posttraumatic arthritis. The purpose of this study was to describe the features and report the early outcomes of THA in 4 patients who developed posttraumatic arthritis from gunshot injuries to their hips 2, 10, 18, and 26 years after their initial injury, respectively. All 4 patients underwent successful THA without complications. None of the patients had undergone a revision procedure at a mean 26-month (range, 12-48 months) follow-up. The authors believe that primary THA is a safe and effective procedure to reduce pain and improve function for gunshot-related posttraumatic arthritis in patients in whom nonoperative management failed.
Gunshot wounds to the hip joint are among the most devastating and difficult injuries to treat. This may be due to the concentrated vasculature surrounding the hip region as well as the joint’s proximity to intrapelvic structures. The overwhelming majority of gunshot injuries occur in the urban setting. As described in this report, in most instances surgical treatment of such injuries focuses on initial stabilization, assessment of neurovascular function, and fracture fixation. Recovery of the bullet is a secondary priority and in many cases is not necessary and may lead to unnecessary soft tissue damage.

Although retained bullets are viewed as benign and are generally recommended to be left intact in the symptom-free patient, marked morbidity and disability from retained bullets adjacent to joints have occasionally been reported. These include infection, foreign body reaction, mechanical damage of the joint cartilage, proliferative synovitis, and plumbism. One particular factor to consider for infection is the trajectory of the bullet. A bullet that passes into the hip joint is unlikely to lead to an infection; however, an intra-abdominal trajectory that subsequently enters the hip joint represents a high risk for infection. In many cases, posttraumatic arthritis may require joint arthroplasty; however, there are few reports on total hip arthroplasty (THA) in patients who have sustained gunshot wounds to the hip.

The purpose of this study was to describe the features and report the clinical outcomes of 4 patients who developed posttraumatic hip arthritis from gunshot wounds and who were treated by a primary THA performed by 3 experienced adult reconstructive surgeons (V.J.R., S.F.H., M.A.M.).

**CASE REPORTS**

**Patient 1**

A 35-year-old man with a history of a gunshot wound of the right hip presented to the orthopedic clinic reporting intratable right hip pain. The initial injury had occurred approximately 24 months earlier. The bullet had traveled through his right forearm and proceeded to penetrate his right hip. At the time of injury, the patient underwent percutaneous screw fixation of his femoral neck secondary to a femoral neck fracture and open reduction and internal fixation of the right forearm. On presentation to the clinic, the patient was observed to have an antalgic gait and ambulated with a cane. Physical examination revealed pain with flexion, internal rotation, and external rotation of the right hip, which was rated at 7 points on a visual analog scale (VAS). The patient was able to flex the hip to approximately 60°, internally rotate to approximately 5°, and externally rotate to approximately 10°, and he had a Harris Hip Score (HHS) of 68 points. Anteroposterior radiographs of the pelvis and lateral views of the right hip demonstrated a 4 lag screw configuration (Figure 1) and ballistic fragments within the acetabulum and femoral neck. A femoral neck nonunion was noted with collapse of the fracture into varus.

Because the patient had developed advanced hip arthritis, had severe hip pain, and was not responding to nonoperative management, he was offered a right THA. At the time of surgery, infection was ruled out by cultures. Following removal of the prior hardware, the femoral head was removed, the acetabulum was prepared, and an Osteonics cup (Stryker Orthopaedics, Mahwah, New Jersey) was placed and fixed with 2 screws. Peripheral osteophytes were removed and a neutral polyethylene liner was placed. An Accolade TZMF femoral stem (Stryker Orthopaedics) was implanted with the appropriate-sized stem and head combination. The projectile was not removed intraoperatively. The postoperative course was uncomplicated and the patient underwent standard rehabilitation protocols, including muscle strengthening and range of motion exercises.

At 2-year follow-up (Figure 2), physical examination revealed hip flexion to 110°, external rotation to 30°, internal rotation to 20°, and abduction to 40°. The HHS had improved to 89 points, and the patient was doing well.

**Patient 2**

A 34-year-old man with a history of a gunshot wound to the right hip in 1992 presented to the clinic in 2010 reporting a 10-year history of right hip pain, which had recently begun to worsen (Figure 3). Visual analog scale score for pain was reported by the patient to be 9 points. The pain was throbbing and sharp and was relieved by rest. The patient had an antalgic gait and ambulated with a cane; he was able to walk 1 to 3 blocks at a time. The patient reported pain when walking up or
downstairs and had difficulties performing activities of daily living. The right leg was observed to be 2 inches shorter than the left. Right hip flexion was measured to be 60°, abduction 0°, internal rotation 0°, and external rotation 20°. The HHS was 68 points. Anteroposterior and lateral radiographs revealed femoral head subluxation, lateral femoral head osteolysis, and the presence of multiple bullet fragments.

A right THA was performed after nonoperative management failed. A long posterolateral approach using a previous surgical scar was used. A Pinnacle Solid Grippion cup (DePuy Orthopaedics, Warsaw, Indiana) was placed medially to the outer table of the floor of the acetabulum and a corresponding Pinnacle Metal liner (DePuy Orthopaedics) was placed. The femur was reamed and a SROM ZTT Proximal Sleeve (DePuy Orthopaedics) with porous microstructure was fitted. All osteophytes were removed, and there was no impingement following reduction of the hip and assessment of stability and range of motion. The presence of infection was ruled out by examining cultures and sensitivity of joint fluid intraoperatively.

At 18-month follow-up, the patient was pain free and able to ambulate with the support of a cane (Figure 4). Physical examination revealed hip flexion to 80°, abduction to 30°, external rotation to 30°, and internal rotation to 15°. The HHS had improved to 88 points.

Patient 3

A 48-year-old man with a history of a gunshot wound and bullet removal 18 years earlier presented with right hip pain (Figure 5). The pain had begun 5 years before presentation and was reported to be gradual. The patient also reported lower back pain. Pain of the right hip was localized to the buttock, groin, lateral aspect of the thigh, and knee and was severe. On the VAS, the pain was approximately 3 points at rest and 7 points with activity. The patient reported pain when walking up and down stairs and had difficulties performing activities of daily living. The right leg was observed to be 2 inches shorter than the left. Right hip flexion was measured to be 100°, abduction 40°, internal rotation 20°, and external rotation 40°. The HHS was 69 points. Radiographs of the right hip revealed Ficat and Arlet stage IV osteonecrosis of the femoral head with remnants of the bullet fragments in the head and secondary degenerative arthritis.

A right THA was performed using a long posterolateral approach after ruling out infection. A Trident HA PSL cluster cup (Stryker Orthopaedics) was placed in the prepared acetabulum. Fixation was further enhanced with application of an acetabular dome hole plug and cancellous bone screws. A corresponding Trident X3 Polyethylene elevated liner (Stryker Orthopaedics) was placed inside a metal shell and locked into place. All osteophytes were removed to ensure no impingement. The femur was reamed and an Accolade TMZF HA (Stryker Orthopaedics) hydroxylapatite-coated femoral stem was fitted along with a Biolox Delta femoral head (Ceramtec, Laurens, South Carolina). The hip was reduced, with stability and range of motion of the hip deemed acceptable.

Twelve months postoperatively, the patient was pain free and able to ambu-
late while fully bearing weight (Figure 6). The patient walked with a mild limp and a right-stiffened gait. Physical examination revealed hip flexion to 95°, abduction to 40°, external rotation to 40°, and internal rotation to 20°. The HHS was improved to 94 points.

Patient 4
A 49-year-old man presented in 2008 with increasing left hip pain after sustaining a gunshot wound to the left hip in 1982. The patient had a comminuted segmental proximal femoral fracture involving the base of the femoral neck and the intertrochanteric and subtrochanteric regions (Figure 7). On presentation to the clinic, he characterized his pain as 8 on the VAS with worsening symptoms. He had difficulties with many activities of daily living, including walking, sitting, standing, climbing stairs, rising from a chair, and putting on shoes and socks. Physical examination revealed 2 healed entry and exit wounds and a well-healed lateral incision. He walked with an antalgic gait and had a positive Trendelenberg test result. Range of motion was flexion to 85°, extension to 0°, abduction to 35°, adduction to 30°, internal rotation to 0°, and external rotation to 10°, with a painful and restricted Patrick’s test. Approximately 15 mm of shortening was present. The neurovascular status was intact. The HHS was 65.

Radiographs revealed a well-healed proximal femoral fracture with varus and posterior angulation of the femoral neck and extension in the subtrochanteric region. Three threaded pins remained in the femoral head and neck. No other hardware or shrapnel was present. The patient had no relief from all nonoperative measures and chose to undergo THA.

 Templating of the radiographs revealed THA to be challenging because of the angular deformity and widened canal. Therefore, surgery was performed with a cementless Peri-Apatite-coated titanium acetabular component (Trident; Stryker Orthopaedics) and a cemented chrome-cobalt femoral component (Accolade C; Stryker Orthopaedics). There was no evidence of infection, but dense scarring and adhesions were present, making mobilization of the hip more difficult. Cultures taken in the operating room were subsequent-ly negative. The threaded pins were imbedded in bone and could not be removed in a routine fashion. A screw removal set with a hollow core was used to free the pins. On cementing, the holes were occluded to improve pressurization. Postoperative radiographs revealed satisfactory position and cement interfaces (Figure 8).

At 4-year follow-up, the patient had no pain or limp and had returned to all activities of daily living and light recreational activities. Range of motion was flexion to 110°, extension to 0°, abduction to 45°, adduction to 35°, internal rotation to 15°, and external rotation to 30°. The HHS had improved to 90 points.

Discussion
The long-term effects of gunshot wounds to the hip joint are not well documented. As seen in these 4 cases, gunshot trauma to the hip joint is a risk factor for the development of premature degenerative joint disease. The purpose of this case series was to report the early outcomes of THA from posttraumatic arthritis due to gunshot wounds. The authors found that these 4 patients required THA to relieve
hip pain and improve function at a mean of 14 years (range, 2-26 years) from index traumatic injury. All of these patients achieved excellent clinical and radiographic outcomes at a mean 26-month (range, 12-48 months) follow-up.

There were several limitations to this study, including the small sample size and the short follow-up. Broader quality of life measures and patient satisfaction metrics were not evaluated. Also, activity levels were not evaluated. However, due to a lack of reports about this patient population, the authors believe that their outcomes are valuable to evaluate outcomes of primary THA in these patients.

There are few reports on the outcomes of THA due to posttraumatic gunshot-related end-stage hip arthritis. Rehman et al described the case of a 38-year-old man who presented with a 2-year history of progressive hip pain 10 years after a gunshot injury to his right hip. Clinically, the patient had limited and painful range of motion with 20° of fixed flexion contracture, and radiographs revealed a bullet fragment inside the hip joint with severe degenerative arthritis. The patient underwent an uneventful THA and was able to bear full weight on his right leg at 8-month follow-up.

The mechanism of joint destruction after a gunshot injury to the hip may be affected by a combination of factors. As described by Rehman et al, this may be due to the motion of irregular joint surfaces that may be formed after the initial injury; the presence of intra-articular debris from small pieces of bone, cartilage, and bullet fragments; and partial extension of bullet fragments into the joint. In addition, the exposure of a bullet to synovial fluid may lead to dissolution of the leaded fragments due to the presence of hyaluronic acid and the low pH of synovial fluid. The effects of gunshot injury to other joints have been known to cause lead toxicity and synovitis. Although leaving the bullet and ballistic fragments intact is the current recommendation, this subject has not been recently revisited. Given the great advances in minimally invasive and arthroscopic surgery, the question of removal or nonremoval of a missile may have clinical importance. The current patients were treated surgically for their gunshot-related injuries. In 3, the missile and its fragments were addressed by nonremoval at time of debridement and repair, with 1 patient eventually undergoing elective removal of the bullet at a later time secondary to painful symptoms. Cases in which the missile was removed following injury during surgical debridement have been documented.

In some instances, removal of the bullet was performed arthroscopically with no complications postoperatively. A 2-year follow-up of such a case indicated no pain or disability of the hip. This is in contrast to current patient 1, who began to experience severe arthritic hip pain within 2 years of injury and was later found to have nonunion and collapse of the fracture site. This difference may be secondary to the severe destruction of vital vasculature supplying the femoral head and neck, which may have been prevented from undergoing revascularization secondary to retained ballistic fragments.

**Conclusion**

Gunshot wounds to the hip can be challenging and devastating long-term prob-
lems. Retained intra-articular missile fragments may be associated with increased morbidity and premature joint degeneration.\(^4,6,7\) In this small series of patients, the authors have shown that failed attempts to treat these patients nonoperatively can be addressed with successful THA to reduce pain and improve function and range of motion at short-term follow-up. Further studies with longer follow-up are needed.

**References**


