



Case Report

Revision Total Knee Arthroplasty for Ballistic Component Damage From an Intra-articular Missile

Andrew A. Palosaari, MD ^{a, b, *}, Peter Z. Berger, MD ^a, Benjamin D. Gross, BS ^b,
Safa C. Fassihi, MD ^a, Joshua C. Campbell, MD ^a

^a Department of Orthopaedic Surgery, George Washington School of Medicine and Health Sciences, Washington, DC, USA

^b Department of Orthopedic Surgery, Icahn School of Medicine at Mount Sinai, New York City, NY, USA

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ABSTRACT

Gunshot wounds (GSWs) and total knee arthroplasty (TKA) are increasingly common, yet a GSW to a TKA is a rare injury. A 60-year-old man sustained an intra-articular GSW to a prior TKA. The patient was scheduled for irrigation and debridement with polyethylene liner exchange. Intraoperatively, the new polyethylene liner was unable to engage the tibial tray. Damage to the locking mechanism on the tibial tray was suspected so total revision proceeded. Upon inspection of the explanted components, it was noted that a bullet fragment offline from the missile trajectory had blocked the locking of the polyethylene liner in the tibial tray. Expedient antibiotics should be given and meticulous debridement should be performed to avoid unnecessary total component revision.

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Introduction

Total knee arthroplasty (TKA) is one of the most performed orthopaedic procedures [1], with approximately 1.52% of US adults (4.7 million individuals) currently living with a TKA [2]. Gunshot wounds (GSWs) to the lower extremity occur at a rate of over 21,000 per year [3]. Although ballistic injury to a prosthetic hip has been reported [4], there have been no prior reports of intra-articular GSW to a TKA. Gun violence more commonly affects younger populations [3], and as TKAs are performed in progressively younger patients [5], more individuals may be at risk of sustaining ballistic damage to a prosthetic knee.

Ballistic intra-articular injury to a TKA places the patient at risk for numerous complications, including infection, component damage, lead toxicity, and accelerated wear of bearing surfaces from intra-articular debris. In this case, the polyethylene insert was damaged, and ballistic debris became lodged in the locking mechanism preventing the replacement insert from locking into place and necessitating revision TKA.

The patient was informed that his case would be submitted for publication, and he provided written consent.

Case history

A 60-year-old man with hypertension and bipolar disorder presented to a level-I trauma center after sustaining a GSW to his right knee while walking outside. He reported immediate pain but was able to ambulate. His surgical history was notable for right TKA performed 9 years prior for valgus osteoarthritis that failed conservative management. The patient reported no pain, stiffness, or other complaints related to the affected knee prior to sustaining this injury. Physical examination demonstrated 2 wounds on the medial and lateral aspects of the right knee. Knee flexion was limited to 100° with a firm endpoint; extension was 0°; and straight leg raise against resistance was intact. The extremity was neurovascularly intact. Initial radiographs demonstrated a TKA without evidence of hardware failure. Ballistic debris were seen predominantly in the lateral knee compartment and to a lesser extent within the polyethylene component (Fig. 1 a, b, and c). No fractures were present, and workup was otherwise unremarkable. At this point, it was deemed that hardware failure and possible infection should be reevaluated in clinic instead of pursuing immediate operative intervention. The patient was discharged on oral antibiotics and instructed to follow-up in the orthopaedic clinic the

* Corresponding author. 2300 M St, Washington, DC 20037, USA. Tel.: +1 310 318 4551.

E-mail address: andrewpalosaari@gmail.com



Figure 1. (a) Initial anteroposterior, (b) lateral, and (c) skyline radiographs of the right knee.

following day. The patient did not attend this appointment and returned to the emergency room 4 days later with complaints of increased pain, swelling, and wound drainage from his entrance and exit wounds.

Various treatment options were considered including observation, antibiotics, arthroscopic irrigation and debridement, and open surgical management. Based on imaging and the presumed trajectory of the bullet, it was deemed that the polyethylene component of his TKA was likely disrupted and that there was possible damage to the locking mechanism on the tibia. Given the wound drainage, it was discussed with the patient that his knee could be infected. The patient was advised that surgery would be required to

replace the polyethylene component and possibly revise both tibial and femoral stem components. After an in-depth discussion of the risks and benefits of the procedure, especially with regards to a possibly infected knee, the patient agreed to proceed with open irrigation and debridement with possible polyethylene exchange or revision TKA based on intraoperative findings.

A standard medial parapatellar approach under tourniquet was undertaken in line with the prior anterior incision. After extensive synovectomy, the polyethylene component was removed after it was noted to be damaged and elevated laterally with evidence of bullet penetration (Fig. 2a and b). The femoral component was noted to have scuffing from the bullet but was deemed acceptable

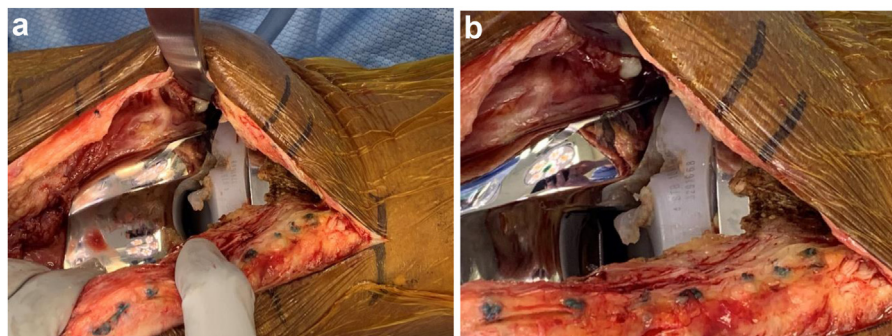


Figure 2. (a) The damaged polyethylene as exposed following a medial parapatellar approach with the patient in the supine position. (b) Magnified view of the damaged polyethylene component with the patient in the supine position.

for component retention. All ballistic fragments were removed, and the entry and exit wounds and soft tissue around the tibia were debrided. Following thorough irrigation, replacement of the polyethylene component was repeatedly unsuccessful despite thorough inspection of the tibial component and locking mechanism. As such, it was deemed that the locking mechanism was likely damaged, and revision of the component was required.

Given the stiffness of the patient's knee, it was felt that an isolated tibial revision would not be feasible, and a dual-component exchange would be required. The femoral and tibial components were removed, and revision was performed with press-fit fluted stems and cemented revision components. Significant soft tissue release was required to adequately mobilize the femur, resulting in balanced flexion and extension but slightly excessive medial and lateral laxity. A varus/valgus-constrained polyethylene component was thus selected as the tibial bearing surface. Intraoperative x-rays were deemed unnecessary due to confidence that all bullet fragments were removed. Lastly, the arthrotomy, anterior incision, and ballistic wounds were closed.

Close inspection of the explanted tibial component revealed an abnormality in the medial aspect of the posterolateral corner of the implant, an area out of presumed trajectory of the bullet (which was expected to traverse medial-laterally across the entrance and exit wounds). A dental pick was used to pry a small ballistic fragment from under the locking mechanism (Fig. 3a and b). Upon closer inspection of the damaged polyethylene component, the bullet fragment was noted to have tracked along the tibial component, following the course of the implant lip to this location (Fig. 4a-c).

Immediate postoperative radiographs revealed well-positioned prosthetic components with no remaining ballistic fragments. Standard postoperative care for revision TKA was provided. The patient was determined to be at high risk for wound complications and was started on a 1-week course of cephalexin, 500 mg per os 4 times per day. His postoperative course was unremarkable, and he was discharged home on the second postoperative day with prescriptions for outpatient physical therapy and 2 weeks of enoxaparin, 40 mg daily, followed by 4 weeks of aspirin, 325 mg daily, for venous thromboembolism prophylaxis.

The patient was seen in clinic at 2, 6, 10, and 12 weeks, and 3 and 9 months postoperatively. His recovery was unremarkable at 12 weeks postoperatively, with no signs of wound infection or component failure (Fig. 5a and b). He reported having been unable to attend physical therapy due to the outbreak of coronavirus disease 2019, yet at 9 months he had no flexion contracture and terminal flexion to 115°. However, he did report severe knee pain concerning for infection at this time, so his joint was aspirated and inflammatory markers were obtained. Markers were unremarkable except for an elevated D-dimer. He was instructed to return to clinic

in 2 weeks for repeated evaluation of his pain, but he did not show up. There was no further correspondence with the patient.

Discussion

Although millions of individuals in the United States are living with TKAs today [2], to the authors' knowledge, this is the first reported case of an intra-articular GSW to a TKA. Surgery was deemed necessary due to intra-articular debris, intra-articular lead contamination, uncertainty of the structural integrity of the implant, and possible infection.

Prophylactic antibiotic treatment of an intra-articular GSW is encouraged [6]. While a systematic review of the literature was unable to show that antibiotics are of benefit for the treatment of fractures sustained by low-velocity ballistic projectiles [7], intra-articular injuries merit special attention [6,8]. Bullets do not "autosterilize," [9,10] and historically, the rate of infection for intra-articular GSW has been reported at 5%-11% [11]. Two case series totaling 32 patients with intra-articular GSWs have shown that prophylactic antibiotics alone have been effective at preventing infection [11,12]. Given the possibility of a salvage operation such as amputation if an infection spreads within a prosthetic joint, the surgeon should have a low threshold for use of prophylactic antibiotics.

A spreading infection [13], mechanical symptoms [14], lead poisoning [15,16], or arthropathy [17] may necessitate surgical intervention in the form of debridement or revision. The presence of residual debris which may lead to accelerated wear of the implant, osteolysis, and delayed implant failure [18] should also be considered. In some cases, when only non-weightbearing component surfaces are damaged, arthroscopic debridement may be adequate as has been shown in the case of a GSW to a total hip arthroplasty [4]. When considering debridement, either open or arthroscopic techniques can be used as both have been shown to be equally effective in cases of intra-articular GSWs if meticulous debridement is achieved [19]. Regardless of chosen surgery and technique, if an infection is suspected, treatment should be expeditious.

In our case, we had a high suspicion for infection and damage to the implant, so pursued component revision. While our initial plan was to only replace the polyethylene liner, we proceeded with total revision because, intraoperatively, it was deemed that the locking mechanism on the tibial tray was damaged. On postoperative inspection, bullet fragments were found under the lip of the tibial tray at a location outside the bullet's presumed trajectory through the patient's medial and lateral wounds. A dental pick was used to pry these fragments off the tibial tray. If these fragments were found in their unique location and removed *in vivo*, it is possible

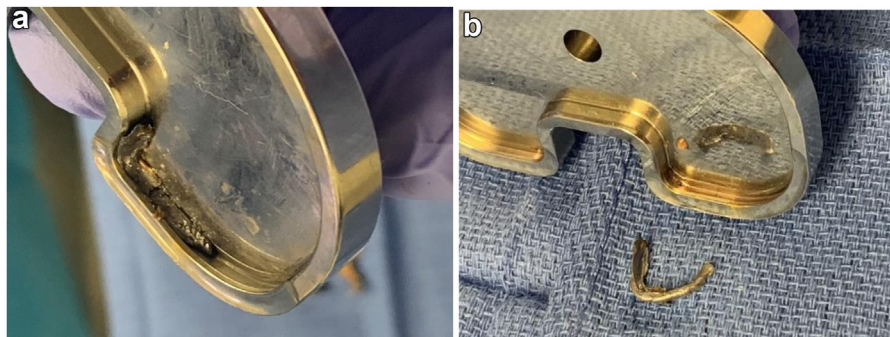


Figure 3. (a, b) The damaged tibial tray following component explant.

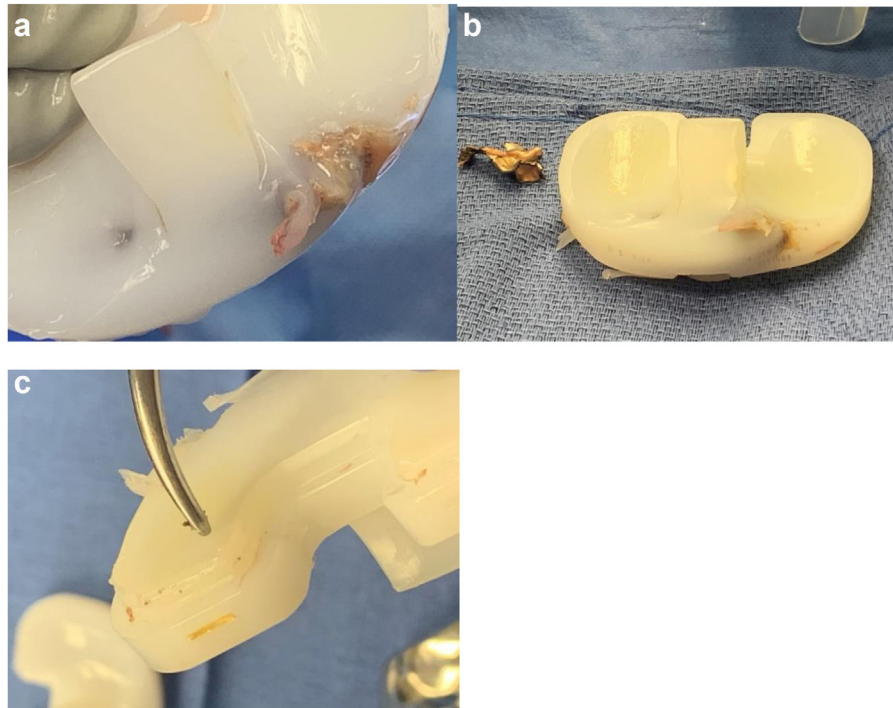


Figure 4. (a, b) The polyethylene liner with visible ballistic damage on the tibial articulating surface, viewed from an anterior and (c) posterior angles.

that only polyethylene liner exchange without total revision may have been adequate. This underscores the importance of the availability of a fine instrument, intraoperatively, for meticulous debridement of implanted components. Further, this presentation highlights the possibility that ballistic fragments become lodged in

areas offline from the bullet's presumed trajectory. Identification and removal of such fragments may minimize total revision surgery.

Summary

This is the first reported case of a GSW to a prosthetic knee joint. A high index of suspicion for infection, intra-articular debris, and component damage should be maintained that warrants expeditious surgery. Prophylactic antibiotics are advised. A fine instrument should be made available for meticulous debridement of implanted components and areas offline from presumed bullet trajectory should be examined. Awareness of this rare presentation and our treatment approach may help minimize total component revision in similar cases.

Conflicts of interest

The authors declare there are no conflicts of interest.

For full disclosure statements refer to <https://doi.org/10.1016/j.artd.2023.101172>.

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).

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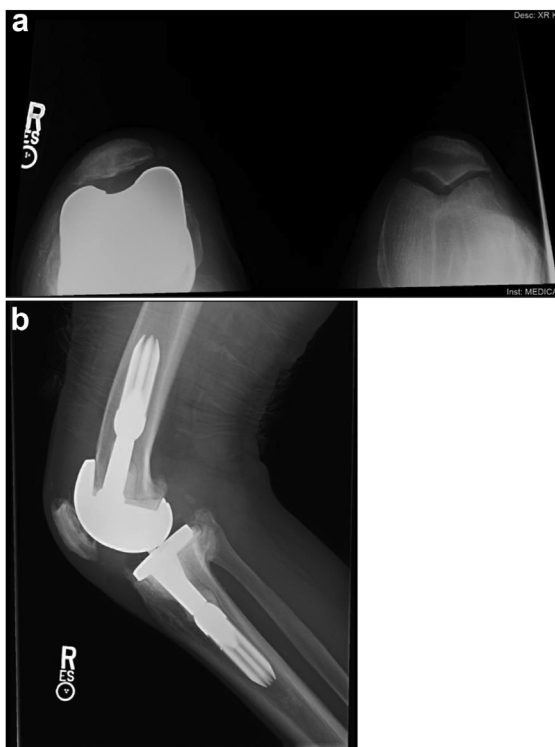


Figure 5. (a) Bilateral skyline and (b) lateral radiographs of knees at 12-week follow-up showing stable prosthesis without failure or excessive residual debris.

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