

# Open Periprosthetic Knee Fracture: A Case Report and Review of the Literature

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## Abstract

**Introduction:** With the increase in knee and hip implants, these periprosthetic fractures will become more common especially as the population ages. Open periprosthetic fractures are rare and severe injuries and are more likely to be seen in high-energy injuries. They present challenges to the treating physician due to soft tissue damage, contamination of the existing implants, and the effects of polytrauma in the geriatric patient. **Methods:** Case review report and review of literature. **Results:** A 72-year-old woman was involved in a motor vehicle collision with multiple injuries including an open periprosthetic tibia and femur fracture. This was treated with initial washout and removal of loose tibial component with placement of a cement spacer. The knee was treated with staged revision using a protocol like that used after prosthetic joint infection. After complete soft tissue healing, the patient underwent successful revision with a megaprosthesis. The literature on open periprosthetic fractures is reviewed. **Discussion and Conclusion:** Open periprosthetic fractures present multiple challenges to the orthopedic surgeon. In the presences of poly trauma and soft tissue injury, we present an approach using staged surgery like that used for prosthetic joint infection.

## Keywords

periprosthetic fracture, poly trauma, revision knee replacement, geriatric population, staged reconstruction

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## Introduction

With the increasing implantation of hip and knee arthroplasties, there has been a steady rise in periprosthetic fractures (PPFXs). There are well over 700 000 new total knee arthroplasties performed annually in the United States, with a PPFX rate of around 2.5%.<sup>1,2</sup> Although the overall numbers of total hip arthroplasty is lower, the rate of periprosthetic fracture may be higher due to the number of insertional PPFXs at the time of index surgery and those associated with revision surgery. The overall number of PPFXs is felt to be increasing over time with projection models showing projected increases of 4.6% every decade.<sup>3</sup>

Although most PPFX are due to low-energy falls, high-energy fractures also occur and are often associated with concomitant injuries.<sup>4,5</sup> The rate of high-energy injuries is felt to be about 7% of all PPFXs.<sup>6</sup> High-energy fractures are also more likely to be open than low-energy fractures. Open PPFXs present the surgeon with difficult decisions and competing treatment options. First, patients are often elderly and involved in multi-system polytrauma. Preexisting frailty makes it difficult for a

patient to tolerate multiple surgeries and severe metabolic insults. Secondly, the open wound and fracture around the prosthesis place the surgery at higher risk for wound complications and subsequent development of deep periprosthetic joint infection (PJI). Bone loss and damage to vascularity, especially in osteoporotic bone, further make options involving fixation challenging. And lastly, soft tissue damage presents challenges regarding soft tissue coverage, which can already be more difficult in older patients with comorbidities such as vascular disease, venous stasis, or acquired coagulation disorders from certain medications.

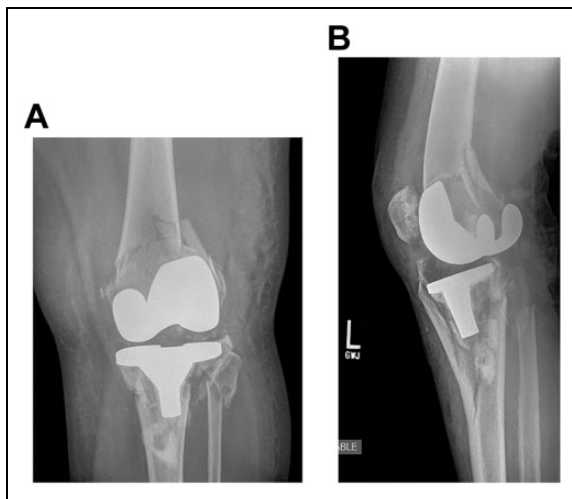
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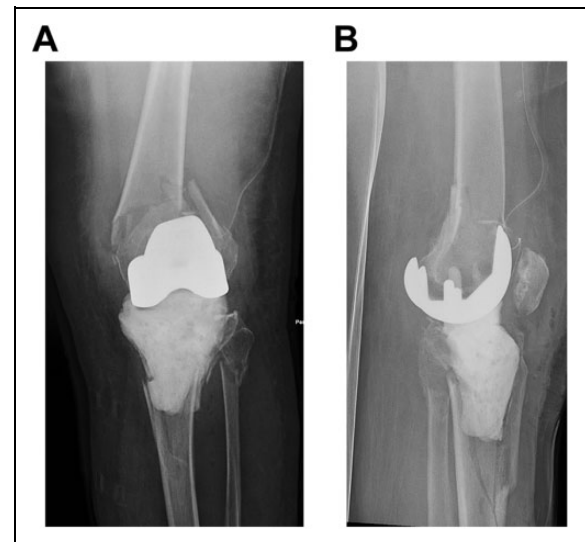
**Figure 1.** A and B, Anteroposterior and lateral views of the knee at injury, demonstrating comminuted tibial and femoral periprosthetic femur fractures with gross loosening and subsidence of the tibial component.

To date, a definite strategy has not been established for how to approach polytrauma PPFs in the geriatric population. In this case report, we seek to describe a staged method of treating a high-energy open PPF involving the distal femur and proximal tibia in an elderly patient.

## Case Report

A 72-year-old woman involved as a passenger in a head-on motor vehicle collision was transferred to our emergency department by helicopter as a level-1 trauma from an outside hospital. She sustained multiple injuries, including closed fractures of multiple ribs and the sternal body with a left pneumothorax and pulmonary contusion, a closed 2-part intertrochanteric fracture of the left femur (AO/OTA 31A1.2), an open GustiloType IIIA displaced right pilon fracture (AO/OTA 43C2) with a 6-cm wound, an open GustiloType I left metacarpal fracture with a 1-cm wound, and an open GustiloType IIIA periprosthetic fracture around the left knee involving the distal femur (AO/OTA 33A3.2) and tibia (AO/OTA 41C3.3) with a 4-cm wound. The open fracture extended from the distal end of the previous total knee incision and was grossly without major contamination. The tibial implant was exposed. The fractures rendered her with a floating knee. On radiographs, she had a cemented knee replacement with both distal femur and proximal tibia fractures. The tibial component was deemed loose based on radiographic findings of loss of bony support, subsidence, and gross malalignment (Figure 1).

Her initial resuscitation included 5 U of packed red blood cells and 4 U fresh frozen plasma in the intensive care unit. A damage control approach was undertaken for initial management of her orthopedic injuries. Later that night, she underwent irrigation and debridement of her right open ankle pilon fracture with external fixation. The left hand underwent irrigation and debridement with percutaneous pinning. The left periprosthetic tibia fracture



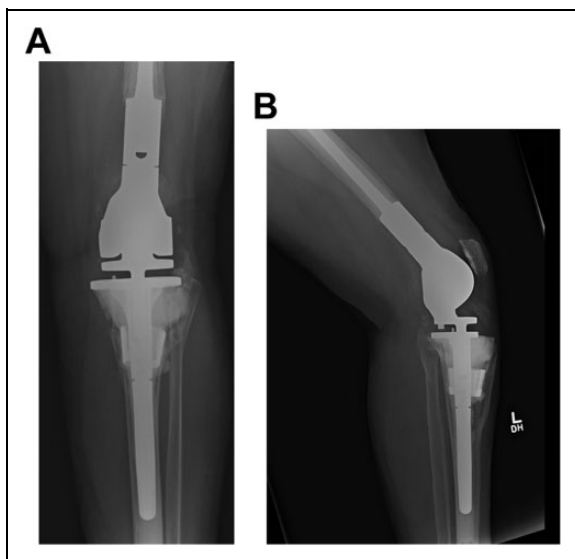
**Figure 2.** A and B, Anteroposterior and lateral views of the knee after initial debridement and placement of tibial antibiotic-laden cement spacer.

underwent irrigation and debridement. The tibial component was completely loose and this was removed with devitalized tibial bone fragments. The tibia fracture was severely comminuted, with distal extension of fracture fragments into the tibial diaphysis. The femoral component remained fixed to the comminuted distal femoral bone. Resection arthroplasty of the tibial implant was performed with placement of a proximal tibial antibiotic-laden polymethylmethacrylate spacer comprised of 2 g of vancomycin and 2.4 g gentamicin (Figure 2). She then underwent further resuscitation in the intensive care unit. She was not felt to be maximized for hip fracture fixation at this time per the intensive care team.<sup>7</sup>

Three days later, she was treated with definitive fixation of the left intertrochanteric hip fracture using a short cephalomedullary nail. The following day she was extubated and subsequently transferred out of the intensive care unit. Due to her bilateral injuries, she was made non-weight-bearing on both lower extremities with instruction for slide board transfers. Due to the complex wound over the left pretibial region, it was felt that revision arthroplasty, which would require a megaprosthesis, would need to wait until the soft tissue envelope had fully healed and be done in a staged manner. She received prophylactic antibiotics before and after her open fracture and surgeries but did not receive long-term antibiotics because the treating surgeon did not think her mechanism was consistent with the typical pattern of a PJI. After 14 days of admission, she was transferred to a regional long-term acute care facility. At this time, she was changed from a long leg splint to a knee immobilizer for soft tissue rest.

Three months after injury, the external fixator was removed and she began weight-bearing. At this time, a slow healing wound over her pretibial area still existed. This was treated with local wound care and gradually healed with granulation tissue.

At 5 and a half months following the injury, her soft tissue envelope over the knee was completely healed and felt to be ready for definitive revision surgery. Because clinical suspicion was



**Figure 3.** A and B, Anteroposterior and lateral views of the knee 1 year after complex revision knee replacement.

low and both the erythrocyte sedimentation rate and C-reactive protein levels were normal and the pin sites had fully healed, an aspiration was not performed. The proximal tibial spacer was removed, and a complex left revision total knee replacement was performed. A distal femoral replacement was chosen for the femoral side (Guardian limb salvage system, Microport Orthopedics Inc) due to lack of remaining host bone and lack of ligamentous integrity. There was no obviously infected tissue at the time of reimplantation, thus no cultures were taken. On the tibial side, the antibiotic-laden bone cement block was removed and a cemented revision stem with supplemental cone (Optetrak Logic Tibial Metaphyseal Cone, Exactech) was used for reconstruction (Figure 3). The tibial tubercle was well healed and did not require reconstruction. The knee was stiff after reconstruction with 0-80 degree motion. Primary closure was obtained without need for flap coverage. She was permitted to fully weight bear as tolerated on this extremity postoperatively without restrictions. She was discharged home on postoperative day 2. Physical therapy commenced postoperative day #1, with the focus placed on knee range of motion and quadriceps and hamstring strengthening. At her first follow-up 3 weeks postrevision, she was walking with assistance of a walker and only was 5° short of full knee extension. A month following, her ambulatory capacity continued to improve, as she was only using a cane in her opposite hand for gait assistance. At one year after her injury, she was pleased with her outcome. Her Knee Injury and Osteoarthritis Score Jr was 92.<sup>8</sup> Her knee range of motion was 0° to 110° with full active extension. Her long-standing weight-bearing radiograph is shown in Figure 4, which demonstrates restoration of neutral mechanical alignment of her left limb.

## Discussion

Our case report describes a high-energy left knee injury to an elderly patient with multiple concomitant injuries. She was



**Figure 4.** Full-length weight-bearing standing radiographs one year after surgery demonstrating recreation of a neutral mechanical axis.

treated initially with damage control orthopedics and resuscitation. In polytrauma patients, the fatality rate of the elderly is about 3 times that of younger patients.<sup>9</sup> In studying high-energy femur fractures in the elderly, Hahnhaussen et al concluded that minimizing mortality should consist of early fracture fixation while proactively monitoring for fatal associated conditions such as chest trauma, pulmonary decline, and coagulopathies.<sup>4</sup>

Initial treatment of high-energy native femoral and tibial fracture is most commonly with an initial external fixator followed by delayed fixation. The use of an external fixator in the face of periprosthetic fracture where future long-stemmed revision prosthesis are subsequently needed is worrisome to the arthroplasty surgeon, as the pin tracts will communicate with the intramedullary canal and may lead to PJI, a catastrophic complication. The strategy implemented in this case was a 2-stage approach, much like that used to treat PJI.<sup>10</sup> The contaminated, devitalized bone and loose implant was removed and a temporary spacer placed using antibiotic impregnated bone cement. After allowing for appropriate soft tissue healing, delayed reconstruction was conducted. Certainly, the shortest delay possible between stages is desirable to allow the elderly patient to begin to weight bear as tolerated and rehabilitate. Soft tissue coverage and swelling should be monitored at regular intervals to allow for the earliest revision possible. In this case, considerable time was needed to achieve full healing of the tibial wound.

The type of spacer used is debatable. In our case, the easily removed loose prosthesis was taken out at initial debridement and replaced with antibiotic cement. Another option would be removal of all implants and possibly the entire distal femur and use of a large static spacer with a rod type of construct. Conceivably, this could allow for weight-bearing, although this can also lead to loosening with a very large defect. It is possible that a more rigid internal device could allow for better soft tissue rest and faster healing. In our case, one debridement was performed, sequential debridement could have also have been pursued, allowing for a more robust internal spacer to be placed.

Our treatment algorithm in this situation is similar to the 2-stage approach used by arthroplasty surgeons for infected joint replacement, with the first stage focused on debridement and antibiotic spacer placement and the subsequent staged reconstruction after infection eradication and soft tissue healing. Although the merits of 1-stage versus 2-stage reconstruction are debated for PJI, an intact soft tissue envelope is necessary to perform a 1-stage reconstruction. This was not possible in our case given the large internal degloving of the pretibial region around the tibial tubercle. We have followed a protocol for these injuries base on the healing of the soft tissue envelope to guide secondary reconstruction. Much like in an open fracture in an area with soft tissue compromise, the skin must be healed before the second procedure can be performed.<sup>11</sup> Another possible option in this case would be the use of tissue transfer such as a rotation gastrocnemius flap to cover the wound either prior to or at the time of secondary reconstruction.<sup>12</sup> In our case, the remaining eschar was healed with secondary intent. Earlier flap coverage could also be considered, which may allow for faster recovery at the expense of another surgical procedure.

Our case was also complicated by the simultaneous distal femur and proximal tibia PPFs. This so-called “floating knee” injury is usually treated with intramedullary nail or plate fixation of both femur and tibia, but that was not possible in this case due to the limits imparted by the knee implants as well as the extensively comminuted nature of the fracture pattern. Fortunately, in this case, the tibial tubercle remained intact, enabling for subsequent successful revision surgery. Fracture of the tubercle and loss of the extensor mechanism would have made reconstruction even more challenging.

Despite the increasing incidence of PPFs in all populations, we found little literature addressing open geriatric PPFs patients in particular. One case report describes an isolated open periprosthetic patella fracture. This was treated with tension band wiring with successful healing.<sup>13</sup> Another case report describes an open distal femur PPF that was treated with debridement and intramedullary nailing.<sup>14</sup> This case, however, went on to develop PJI 5 months after the injury. A final case report described an open femoral Vancouver C PPF that was treated with open reduction and internal fixation. The authors describe the merits of early fixation and mobilization.<sup>15</sup>

This case report describes a high-energy, open periprosthetic fracture about the knee including both the femur and tibia in an elderly individual. Staged reconstruction was used, mirroring protocols employed for infected total joint

arthroplasty. This complex case provided a significant treatment challenge, but successful reconstruction was achieved by following the principles of both open fracture and PJI management. The strategies employed in this case can be an important aspect for the surgical armamentarium when presented with challenging patterns of geriatric fractures.


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