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Case report

Single-stage bilateral distal femur replacement for traumatic distal femur fractures

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ABSTRACT

Treatment of periprosthetic distal femur fractures and comminuted intraarticular distal femur fractures with previous arthritis remains a difficult challenge for orthopedic surgeons. Previous case series have shown that distal femur replacement (DFR) can effectively compensate for bone loss, relieve knee pain, and allow for early ambulation in both of these fracture patterns. Owing to the typical low-energy mechanism of these injuries, a bilateral injury treated with DFR is rarely encountered. We present a patient with traumatic open left Rorabeck III/Su III periprosthetic distal femur fracture and closed right intraarticular distal femur fracture (AO fcation 33-C2) with end-stage arthrosis treated with single-stage bilateral DFR. We suggest that in patients with similar injuries, single-stage bilateral DFR can provide the benefits of early mobilization and accelerated recovery.

Introduction

Periprosthetic distal femur fractures and comminuted intraarticular distal femur fractures with bone loss and previous arthritis are both difficult challenges for orthopedic surgeons. Incidence of periprosthetic distal femur fractures is 0.3-2.5% after primary total knee replacement (TKR) and 1.6-38% after revision TKR and will only become more common as the number of TKR procedures continues to increase [1,2]. Supracondylar native distal femur fractures make up approximately 3-6% of all femur fractures and are often complex, intraarticular, and comminuted [3]. Both these fractures have similar challenges for management, which include short distal segments for fixation, osteoporotic bone, concern for extensive blood loss with exposure, and varus collapse without the support of both columns. Surgical treatment options for both these injuries are also similar and include flexible or rigid intramedullary devices, external fixators, locked plates, and distal femur replacement (DFR) [3-6].

Multiple classification systems for periprosthetic distal femur fractures have been proposed to help guide the treatment, including those developed by Rorabeck (Table 1) and Su (Table 2) [1,7]. Previous case series detailing DFR for Rorabeck III/Su III fractures have shown that although complications are common, DFR is an acceptable treatment option when other fixation methods are not possible and when early ambulation is prioritized [8-10]. Similarly, these benefits have also been seen in the treatment of comminuted intraarticular distal femur fractures deemed not reconstructable because of inadequate bone stock to allow for open reduction internal fixation or intramedullary nail placement (AO classification 33-C2 and 33-C3 fractures) [11,12]. For both circumstances, DFR offers benefits of earlier mobilization, faster recovery, and not relying on bone healing which is usually compromised in these patients [2,6].

Given the success of DFR in appropriately selected patients with Rorabeck III/Su III periprosthetic distal femur fractures and comminuted intraarticular distal femur fractures with arthrosis, we adopted this treatment strategy for a patient with such fractures bilaterally [10,11]. Owing to the typical low-energy mechanism of these injuries, the use of single-stage bilateral DFR is infrequently

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Table 1
Rorabeck classification of periprosthetic distal femur fractures.

Type I	Nondisplaced and prosthesis intact
Type II	Displaced and prosthesis intact
Type III	Loose or failing prosthesis

encountered. To our knowledge, there are no cases in the literature detailing this situation. This report focuses on this patient's preoperative injuries, surgical techniques used, and outcomes. The patient provided informed consent to be included in this case report. The patient has been followed up for 1 year postoperatively and has not required a return trip to the operating room or had any surgical complications.

Case history

An 80-year-old female with past surgical history of left TKR in 2005 at an outside facility presented to our hospital after being involved in a motor vehicle collision resulting in open left periprosthetic distal femur fracture (Fig. 1) and a closed comminuted right intraarticular distal femur fracture with preexisting end-stage arthrosis (Fig. 2). Past medical history included squamous cell carcinoma of the bladder diagnosed a few months earlier, and the patient had undergone hysterectomy and cystectomy with ileal conduit to the neobladder at an outside facility. She also had a history of anemia and end-stage right knee arthritis, for which she was planning a TKR later in 2017. BMI was 29.5 (height, 1.65 meters; weight, 80.3 kilograms). When she arrived in the trauma bay, she was found to have deformity of the bilateral distal femurs with a 2-cm wound over the left anterior knee that probed to the bone. She was treated with cefazolin 2 grams every 8 hours upon arrival based on our institutional open fracture antibiotic protocol which was continued for 24 hours after irrigation, debridement, and closure of her open fracture. Starting on her first admission day, enoxaparin 30 mg twice daily was used for DVT prophylaxis, and mupirocin ointment was used for nasal decolonization. Before her injury, she was active as the primary caretaker for her husband and did not use any assistive devices for ambulation.

After discussing the risks, benefits, and alternatives to different treatment options, the patient was taken to the operating room within 24 hours of arrival for irrigation and debridement of her open fracture. The on-call operative team planned open reduction internal fixation of the open left periprosthetic distal femur fracture after obtaining radiographs and computed tomography scan that made the fracture appear amenable to fixation. After making a lateral approach to the left femur, her fracture was found to be more comminuted than anticipated, and the bone-prosthesis interface was not intact. An intraoperative decision was made to close the lateral incision and place an external fixator with referral to the arthroplasty service for evaluation for a possible DFR. Pin site care consisted of placement of chlorhexidine-soaked gauze that was changed daily. This external fixator placement allowed for stability of the fracture site and decompression of the zone of injury to assist with pain control. For the right distal femur fracture, closed reduction was performed with placement of a knee immobilizer. On postoperative day 1, the patient was hypotensive and transfused with 2 units of packed red blood cells for hemoglobin to reach 6.5 g/dL. Risks, benefits, and alternatives of treatment options were discussed with the patient and her family. She elected for bilateral DFR with the primary benefit of early mobilization. With the trauma team's assistance, the patient was transfused with an additional unit of packed red cells with posttransfusion hemoglobin level of 9.7 g/dL. The decision was made to allow a week in between procedures to allow this patient with low physiologic reserve to recover before a repeat general anesthesia and surgery. In addition, the implants required for the procedure took a few days to be obtained as these are not routinely used at our institution.

Once the patient was optimized and all implants were available, the patient was taken to the operating room on the 7th day after admission. She received 2 grams of preoperative cefazolin. Her left lower extremity was addressed first, and no tourniquet was used. The external fixator was removed, and pin sites were debrided and washed with betadine. The previous lateral approach to the distal femur was used. The femoral component was removed and noted to have minimal bone attached. The tibial component was also noted to be loose, and it was removed along with the surrounding cement without difficulty. The wound was copiously debrided and irrigated. A fresh distal femoral cut was made at a level just outside the area of fracture propagation. The resected bone and implant were used to help estimate the appropriate implant size. Left DFR was performed using Orthopedic Salvage System (Biomet, Warsaw, IN) implants (Fig. 3). We began by obtaining proximal control and reconstructed distally until satisfactory leg length and range of motion were obtained. Cement with added gentamycin (0.5 grams per 40-gram bag) was used to secure the femoral and tibial components. A cable was placed around the distal femur to provide further reinforcement in this area because of the patient's osteopenic bone. The patient was found to be hemodynamically stable, and we brought our attention to the right lower extremity. The patient received another 2 grams of cefazolin and was transfused 1 unit of packed red blood cells intraoperatively. The right lower extremity was prepped and draped, and a tourniquet was placed and elevated to 300 mm Hg for 71 minutes. A standard anterior approach with medial parapatellar arthrotomy was used. The comminuted intraarticular distal femur fracture was noted to have significant comminution and bone loss. Right DFR was performed using Orthopedic Salvage System (Biomet, Warsaw, IN) implants by the same technique and using the same cement with gentamycin as the contralateral side (Fig. 4). She was given 1 unit of packed red cells intraoperatively with postoperative hemoglobin level of 9.1 g/dL. Two additional doses of cefazolin (2 grams) were given 8 and 16 hours after the operation.

Postoperatively, the patient was made weight-bearing as tolerated to both lower extremities and worked with physical therapy daily. She was standing on postoperative day 1 and walking a few steps using a walker on postoperative day 5 when she was discharged to a rehabilitation facility. She was seen on postoperative day 10 for first follow-up and was walking approximately 100 feet per day. At her 6-week postoperative follow-up, she was walking 2 miles daily using a walker. We allowed full activity as tolerated with the goal of the patient being able to build up her conditioning as soon as possible. We considered this benefit of increased activity worth the possible increased risk of aseptic loosening with a high level of activity at this early stage. She recently presented for 1-year postoperative follow-up. She walks 1-2 miles per day and uses a cane for longer distances for stability. She denies pain in either leg, although she occasionally reports "tightness" in the legs upon waking in the morning which resolves with activity. She is driving, maintaining her home, and living independently. Her surgical

Table 2
Su [1] classification of periprosthetic distal femur fractures.

Type I	Fracture proximal to femoral component
Type II	Fracture originating at the proximal aspect of femoral component and extending proximally
Type III	Any part of the fracture distal to the anterior flange of the femoral component

Figure 1. Anteroposterior and lateral radiograph of the left knee at the time of injury.

incisions are well healed without evidence of infection. She achieved knee range of motion from 0° to 110° bilaterally. One-year postoperative radiographs were obtained demonstrating unchanged alignment of her previously placed protheses with no signs of loosening (Figs. 5 and 6).

Discussion

Both native and periprosthetic distal femur fractures have been associated with poor outcomes and 1-year mortality approaching 25%, compared with hip fractures [13-15]. Satisfactory outcomes for these fractures before the advent of DFR included union in 6 months, lack of knee pain, range of motion from 0° to 90° (or nothing less than that before injury), and return to prefracture ambulatory status [16]. In this case report, we discuss a patient with each of these injuries who was treated with single-stage bilateral DFR with a satisfactory outcome at 1-year follow-up based on these criteria. To our knowledge, this is the only report in the literature of a patient treated with single-stage bilateral DFR. This is likely due to the high proportion of unilateral injuries as periprosthetic distal femur fractures usually have a low-energy mechanism and are related to osteoporosis—7% high energy vs 94% low energy [4]. This patient's case supports that single-stage bilateral DFR can lead to satisfactory functional outcomes in patients with similar injuries. This case also emphasizes the importance of multidisciplinary optimization which was performed between the orthopedic surgery, anesthesiology, and geriatric trauma services at our institution.

Results of treatment with DFR for periprosthetic distal femur fracture and complication rates vary in the literature with the majority of this information coming from small case series. Mortazavi et al. reported on a series of 20 patients treated with DFR and found a 50% complication rate which included urinary tract infection, intravenous line sepsis, symptomatic pulmonary embolism, peroneal nerve palsy, and recurrent fractures. In this series, there was a 25% reoperation rate, all for additional femur fractures requiring either implant revision or open reduction internal fixation [8]. In contrast, Streubel et al. reported on 61 patients with periprosthetic distal femur fractures treated with open reduction internal fixation and found complication rates of 11% delayed healing, 13% nonunion, 11% construct failures, and 7% deep infection [17]. Based on these earlier case series, DFR was considered an option in patients with a loose prosthesis and significant distal bone loss when no other options were possible [8,18].

Figure 2. Anteroposterior and lateral radiograph of the right knee at the time of injury.

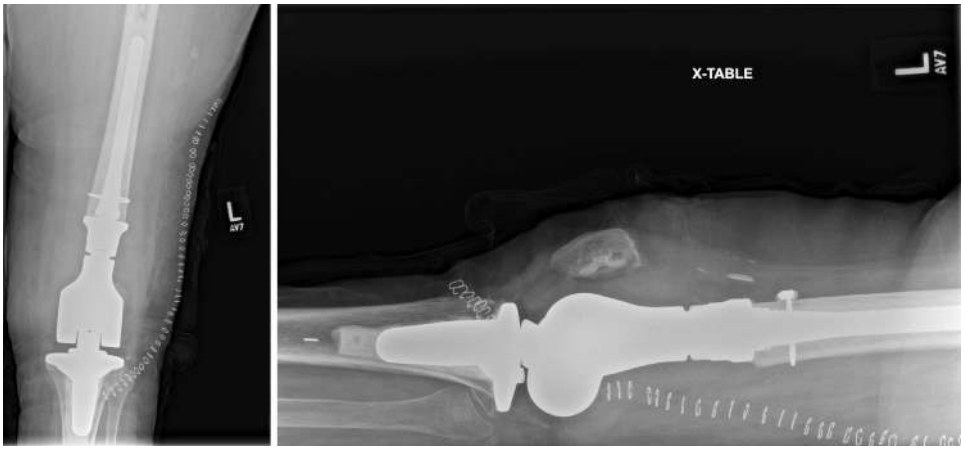

Figure 3. Anteroposterior and lateral radiograph of the left knee after operation.

More recent studies on DFR treatment for periprosthetic distal femur fractures have shown fewer complications with patients achieving earlier ambulation and frequently returning to preoperative activity levels and independent living like our patient. Jassim et al. reported on a series of 11 patients treated with DFR, with 3 patients having complications (anemia, cellulitis, peroneal nerve palsy) and none requiring reoperation at 33-month average follow-up [9]. Girgis et al. reported on 14 patients treated with DFR and had 2 patients with complications (vascular injury, infection), and only one of these required reoperation with an average follow-up period of 27 months [10]. Similarly, Rao et al. reported on 12 patients treated with DFR and had 2 complications (one pulmonary embolism and one lung infection), with no repeat trips to the operating room and an average follow-up period of 20 months [19]. In regard to long-term implant survival, a previous study showed 5-, 10-, 15-, and 20-year implant survival rates of 78.3%, 70.1%, 61.6%, and 38.3%, respectively, with DFR in oncology patients [20]. Although complication rates are lower in more recent case series, additional studies with longer follow-up and larger numbers of patients are needed to better determine the complication rates associated with DFR for patients with periprosthetic distal femur fractures.

Similar to periprosthetic distal femur fractures, native distal femur fractures with preexisting arthrosis are a challenge for orthopedic surgeons to treat as they are often intraarticular with bone loss due to comminution in patients with multiple medical comorbidities and poor bone stock [21]. Surgery has become the standard of care for displaced distal femoral fractures with treatment options including intramedullary nails, screw fixation, periarticular locked plating, and DFR [3]. There have been a few case series in the literature detailing outcomes of DFR for comminuted distal femur fractures with bone loss, although none of that had a patient with single-stage DFR. Bettin et al. reported on a group of 18 patients treated with DFR for native distal femur fracture and had 2 complications including one femur fracture requiring revision and one early infection that was successfully treated with revision of components. In this study, all patients were either very or extremely satisfied at the average follow-up of 2.3 years [6]. Rosen and Strauss reported on 24 patients treated with DFR for primary distal femur fracture and had no complications at mean follow-up of 11 months, with 71% returning to preoperative ambulatory function [12]. These studies concluded that DFR is a viable treatment option for elderly patients with comminuted intraarticular distal femur fractures with preexisting arthrosis that allows for immediate weight-bearing, with most patients returning to preoperative functional status at baseline [6,12].

Limitations to this study include relatively short follow-up time of 1 year postoperatively; however, this is consistent with previous

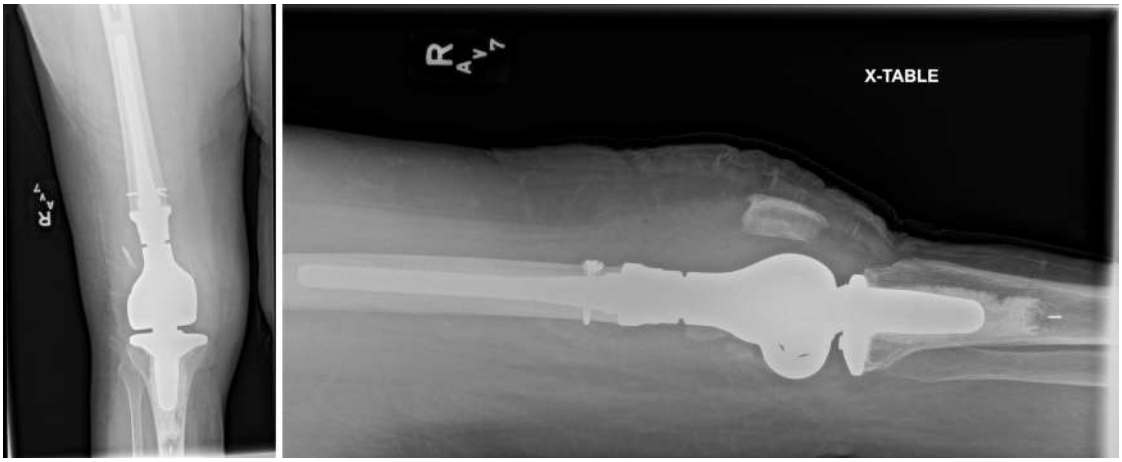

Figure 4. Anteroposterior and lateral radiograph of the right knee after operation.

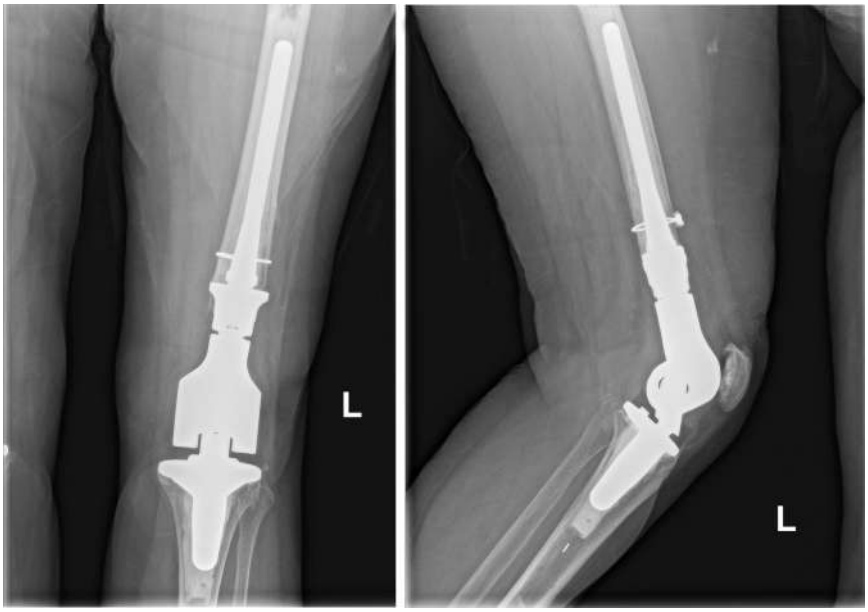

Figure 5. Anteroposterior and lateral radiograph of the left knee at 1-year postoperative follow-up.

studies. A previous report showed that follow-up periods for DFR for periprosthetic distal femur fractures are usually <48 months because of the frail elderly nature of these patients [22]. In addition, in a retrospective case series of 52 patients (54 fractures) with distal femur fractures treated with hinged prosthesis, 22 patients had died, 6 had further operation, and 2 needed revision in the first year. This study concluded that these types of implants have a high probability of survival in this patient population and usually last the lifetime of the patient [11]. Another limitation of the study was lack of preinjury radiographs to evaluate for notching and malpositioning of the prosthesis which are known risk factors for periprosthetic fractures. The patient had not been having pain in the left TKR before her injury and reported a normal range of motion.

Summary

Bilateral DFR can be a viable treatment option for Rorabeck III/Su III periprosthetic distal femur fractures and comminuted intraarticular distal femur fractures with previous arthritis. We present a patient with open left Rorabeck III/Su III periprosthetic distal femur fracture and closed right comminuted intraarticular distal femur fracture (AO Classification 33-C2) with end-stage arthrosis after trauma successfully treated with single-stage bilateral DFR. We suggest that in elderly patients with similar injuries, bilateral DFR can effectively compensate for bone loss, relieve knee pain, provide stability, and allow for early mobilization resulting in satisfactory patient outcomes.

Figure 6. Anteroposterior and lateral radiograph of the right knee at 1-year postoperative follow-up.

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