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Case report

Single stage bilateral flexible intramedullary fixation of periprosthetic distal femur fractures

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ABSTRACT

We present a patient with bilateral Rorabeck II/Su III periprosthetic distal femur fractures treated successfully with bilateral single stage flexible intramedullary fixation. Flexible intramedullary fixation of Rorabeck II/Su III periprosthetic distal femur fractures provides the benefits of shorter operative time, lower blood loss, and preservation of bone stock compared to plate fixation and distal femur replacement. We suggest that for patients with similar injuries flexible intramedullary fixation can be a viable treatment option.

Introduction

Supracondylar distal femur fractures are one of the most common and difficult fractures to manage following total knee arthroplasty (TKA) with rates of 0.3%-2.5% after primary and 1.6%-38% after revision TKA [1]. Previous reports have shown that the majority (94%) of these injuries result from low energy mechanisms with challenges to management including short distal segments for fixation, poor bone stock, elderly patients with multiple comorbidities, concern for extensive blood loss with exposure, and varus collapse without both column support [2,3]. Treatment of these injuries was primarily nonoperative in the past, but this paradigm has now shifted due to unacceptably high rates of malunion/nonunion with nonoperative treatment [1,4].

There are multiple classification systems for periprosthetic distal femur fractures to help guide treatment including the Rorabeck and Su classifications (Tables 1 and 2) [5,6]. A wide variety of surgical treatment options for these fractures have been advocated in the literature including flexible or rigid intramedullary devices, external fixators, fixed angle devices, locked plates, and distal femur replacement [1,2,7,8]. Ritter provided a case series of 22 patients with periprosthetic distal femur fractures treated with Rush rods in which all patients went onto union and ambulated 3-4 months postoperatively. Based on this series he recommended routine treatment of these fractures with Rush rods and protected weight bearing until union was demonstrated on radiographs with the primary benefits being high union rates, minimal need for distal bone stock to achieve fixation, and minimal complications [7]. A later study comparing treatment options for these fractures confirmed these benefits of lower operative time and estimated blood loss compared to intramedullary nailing, traditional plating, and minimally invasive plating techniques [9].

Despite the benefits of flexible intramedullary fixation with Rush rods, this treatment option has become less common over the years due to the increased risks for shortening and rotational malalignment due to vulnerability to compression and rotational forces [9,10]. Intramedullary nails and locking plates have become the most common treatment options; however, a recent meta-analysis reported complication rates of nails and plates to be 53% and 35%, respectively, and advocated for individualized treatment due to limitations of our current classification systems [8]. In this case report, we describe a patient with bilateral Rorabeck II/Su III

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periprosthetic distal femur fractures with insufficient distal bone stock to perform intramedullary nails, anemia, making bilateral plating and its associated increased blood loss a greater risk, and extensive bilateral comminution to the middle of the femoral shafts leaving short proximal segments for distal femoral replacements. We treated her with bilateral single stage Rush rod fixation with a satisfactory result. The patient provided informed consent to be included in this case report.

Case history

A 65-year-old recently retired nurse with past surgical history of left TKA in 2002 and right TKA in 2003 at an outside facility presented to our hospital after being involved in a motor vehicle collision resulting in open left and closed right periprosthetic distal femur fractures (Figs. 1 and 2). Preinjury knee flexion was 90° on the right and 70° on the left. Past medical history included hypertension and osteoporosis treated with a bisphosphonate by her primary care provider. When she arrived to the trauma bay, she was found to have deformity of the bilateral distal femurs with a 0.5 × 0.5 cm wound over the left lateral knee that probed to the bone. She was treated with antibiotics upon arrival based on our institution's open fracture antibiotic protocol. Prior to her injury the patient was an active community ambulator who used a cane occasionally.

The patient was taken to the operating room within 24 hours for irrigation and debridement of her open fracture with placement of bilateral knee-spanning external fixators to provide stability during resuscitation and optimization for definitive surgery. Postoperatively the patient was optimized by our geriatric trauma service. Preoperative computed tomography scans were obtained demonstrating well-fixed implants with minimal distal bone bilaterally. Due to the minimal amount of bone remaining in contact with the implants and the goal to preserve bone stock, we recommended fixation with bilateral single stage Rush rod placement. The patient was taken to the operating room on the third day post injury for the aforementioned procedure without complications (Figs. 3 and 4).

The technique is as follows: the patient is placed supine on a radiolucent table. The entire lower extremity is prepped and draped. A 2-3 cm longitudinal incision is made through the skin and quadriceps tendon just proximal to the patella using the previous total knee incision. An elevator (Crego elevator works well) is then placed through the quadriceps tendon and under the anterior flange of the femoral component. The elevator then levers against the anterior femoral cortex and anteriorly translates the distal femur correcting the extension deformity. This elevator, held by an assistant, maintains the reduction on the lateral fluoroscopic view as the rods are placed. Two longitudinal 2-3 cm incisions are made, one medial and one lateral, in line with the shaft of the femur on a lateral view approximately 2-3 cm distal to the joint line. A pointed awl is placed through these incisions and used to make 2 perforations in the femoral cortex, one medial and one lateral, as close as possible to the femoral prosthesis (the metal of the femoral component is felt with the awl). Using image intensification on a lateral view the awl is parallel with the posterior femoral cortex of the distal fragment, and on the anteroposterior view the awl is angled approximately 45° to the femoral shaft. Rod lengths are determined fluoroscopically by laying the rod on the thigh, so that the rods will end roughly at the level of the lesser trochanter. Two Rush rods of the largest diameter are then bent 30°-40° using a table-top plate bender about 5-8 cm from the curved end, the same distance from the end of each Rush rod. Staggered length Rush rods are used to avoid a stress riser that would occur with rods of the same length. The rods have a beveled pointed tip that contacts the endosteal cortex as they are gently tapped up the femoral canal. Either the medial or lateral rod is placed through the distal femur and then into the canal under fluoroscopic guidance. Then the second rod is placed on the other side in the same manner. The rods are tapped sequentially advancing one rod a few centimeters before tapping the other rod a few centimeters until they are fully seated against the distal femoral cortex and roughly at the level of the lesser trochanter proximally. The fracture translates medially and laterally as the rods are sequentially advanced until the rods are fully seated. The rods themselves reduce the fracture in regards to varus/valgus and medial/lateral translation. After the fracture has healed, the distal curved part of the rod seems to be mildly tender in some patients but not enough to require removal.

Postoperatively the patient was made non-weightbearing to the bilateral lower extremities and placed in knee immobilizers to be worn full time for 8 weeks. She was continued on calcium, vitamin D, and Fosamax. A prescription for teriparatide was provided to improve bone stock and accelerate healing; however, her insurance would not pay for this. She was seen by her primary care provider for endocrine workup and had vitamin D and thyroid stimulating hormone values within normal limits. She was followed in clinic with serial radiographs and was made partial weight bearing to the right lower extremity at 2.5 months and full weight bearing at 4 months postoperatively. Based on persistent gaps at the fracture sites, she had delayed healing of the left femur fracture and was allowed to begin partial weight bearing at 4 months and weight bearing as tolerated at 8 months postoperatively after achieving radiographic and clinical union of both fractures (Figs. 5 and 6). She recently presented for 18-month postoperative follow-up. She ambulates in the community and uses a cane for stability for longer distances. She achieved knee range of motion (ROM) 0°-90° on the right and 0°-70° on the left which was reportedly equal to the patient's preoperative ROM. She has no pain on the right and mild pain on the left after standing for multiple hours. She does have some prominence of the right lateral Rush rod that has not affected her daily activities and she has been offered hardware removal and has declined.

Discussion

Although Rush rods were used previously in the treatment of periprosthetic distal femur fractures, it has become uncommon with treatments such as locked plates, intramedullary nails, and distal femur replacement taking its place [2,7]. This trend has been made evident in multiple publications that either do not list Rush rods as a treatment option for these injuries or state that flexible intramedullary fixation is outdated due to difficulty with controlling rotational and axial alignment [3,6,10,11-13]. Benefits of this technique are technical simplicity, minimal exposure, and relatively inexpensive implants. In this case report, we suggest

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

Table 2
Su classification of periprosthetic distal femur fractures.

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

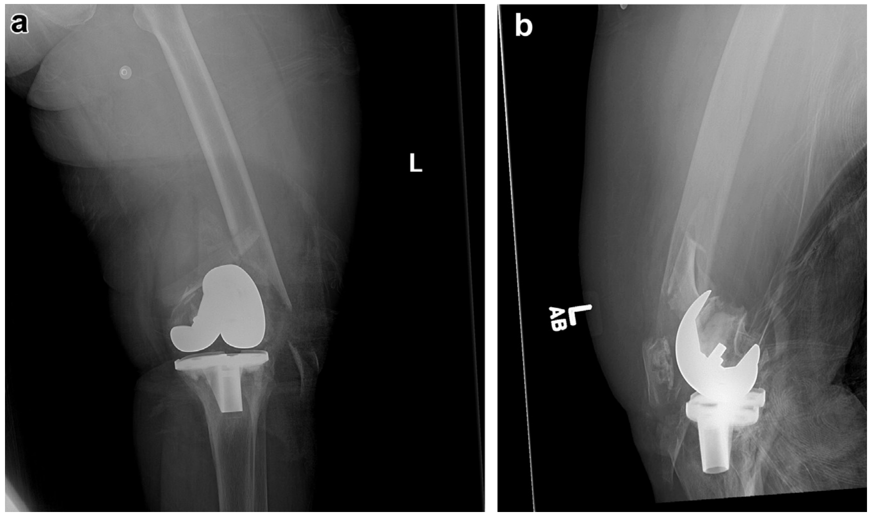

Figure 1. Anteroposterior (AP) (a) and lateral (b) radiographs of the left knee at the time of injury.

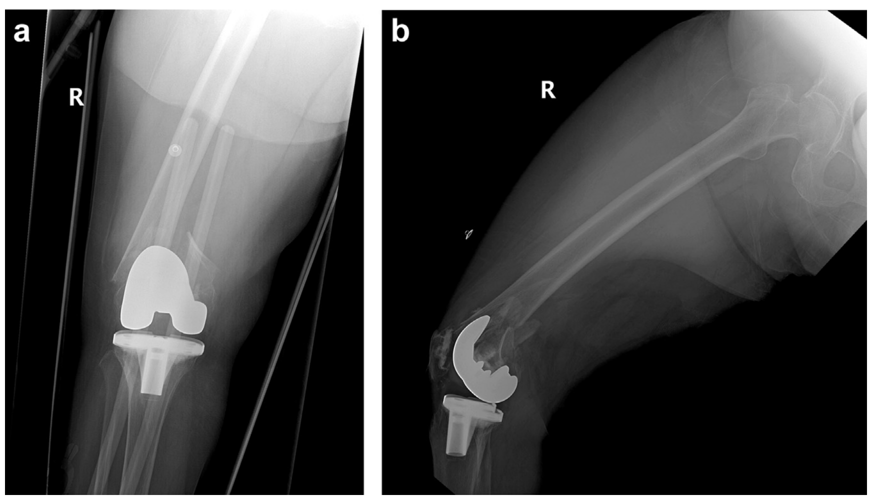

Figure 2. AP (a) and lateral (b) radiographs of the right knee at the time of injury.

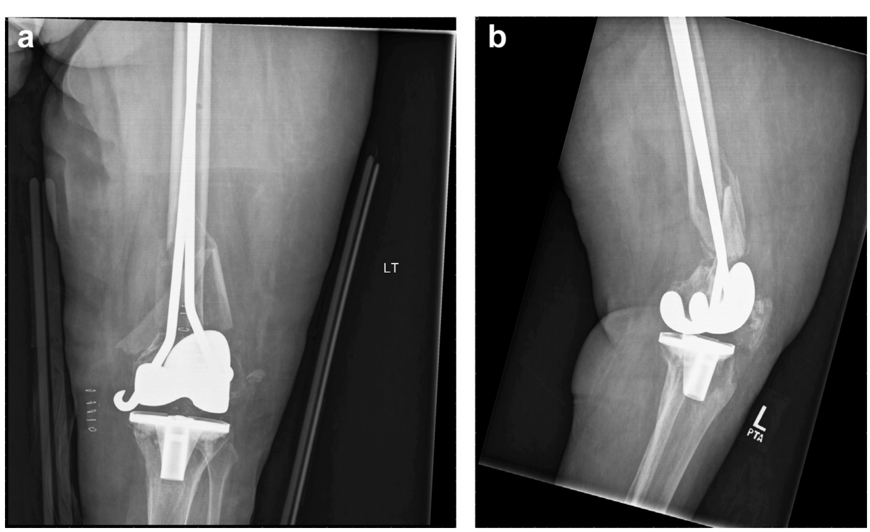

Figure 3. AP (a) and lateral (b) radiographs of the left knee postoperatively.

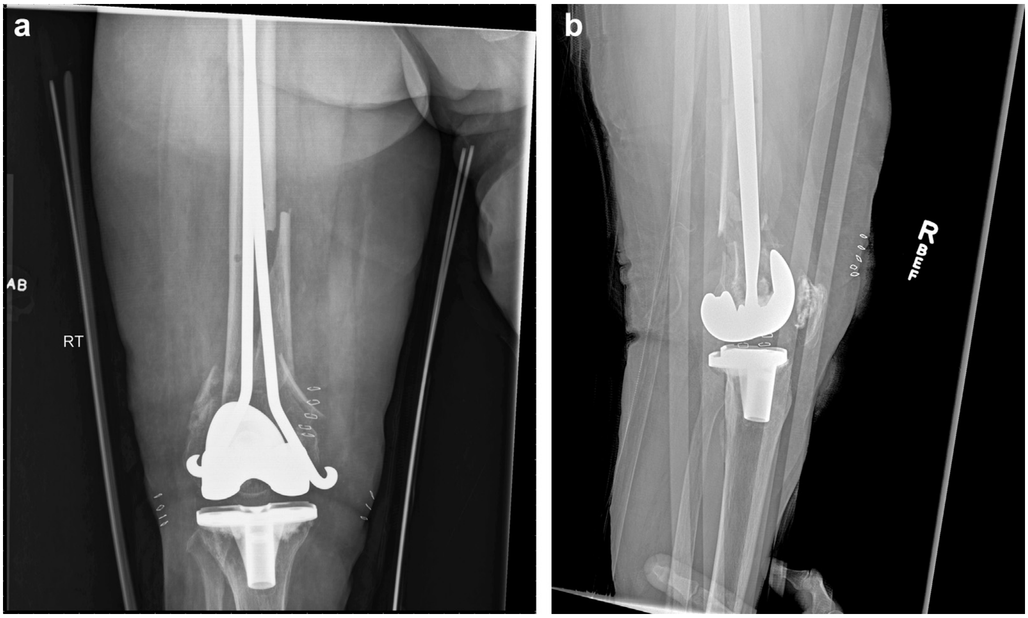

Figure 4. AP (a) and lateral (b) radiographs of the right knee postoperatively.

that Rush rod fixation can be a suitable treatment option for Rorabeck II/Su III distal femur fractures in patients with poor bone quality and minimal distal bone stock by preserving bone and minimizing blood loss.

Cain et al [14] in 1986 defined a successful outcome for the treatment of periprosthetic distal femur fractures as having union at 6 months, lack of knee pain, ROM from 0° to 90° (or no less than preinjury), and return to prefracture ambulatory status. Our patient had a delayed union of the left femur fracture, but otherwise had a successful clinical outcome for both fractures based on these criteria. The left side was open, had more periosteal stripping, and had a 3 × 5 cm cortical piece which was removed explaining the delay in healing. Compared to patients in prior case reports of bilateral periprosthetic distal femur fractures treated with open reduction and internal fixation with plates, our outcomes are equivalent, even with less distal bone stock than either of these reported patients [15,16]. Another treatment option for our patient would have been bilateral distal femur replacement which may have allowed immediate weight bearing; however, the fracture extended proximally to the mid shaft leaving a short proximal segment for fixation. Our patient was relatively young and there was concern over long-term durability of a distal femoral replacement

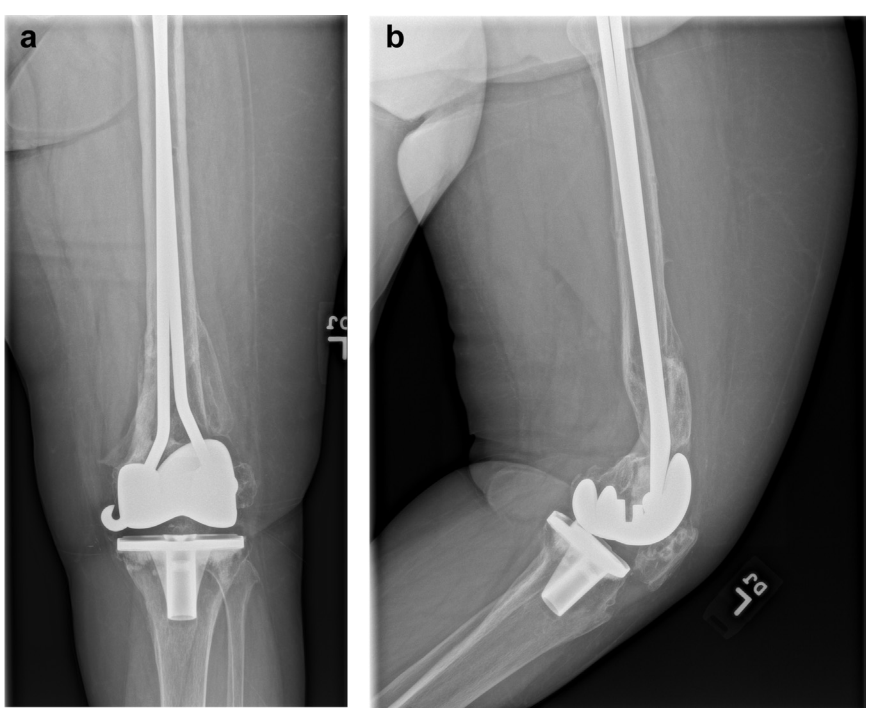

Figure 5. AP (a) and lateral (b) radiographs of the left knee at 18-mo postoperative follow-up.

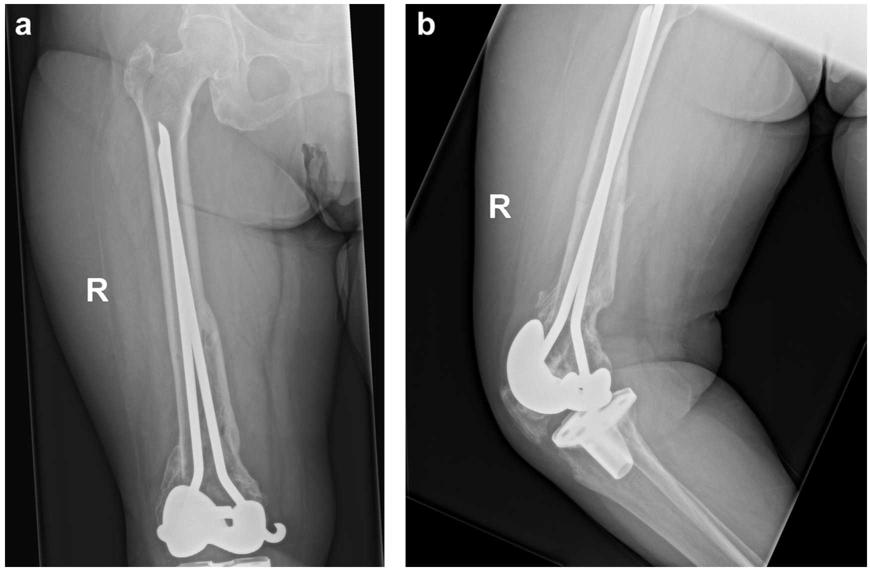

Figure 6. AP (a) and lateral (b) radiographs of the right knee at 18-mo postoperative follow-up.

and ramifications of an infection which would more likely lead to an amputation with a shorter residual limb.

Osteoporosis is a key risk factor predisposing to periprosthetic distal femur fractures as the majority (94%) of these injuries are low energy [2]. Medications such as bisphosphonates and teriparatide have been shown to possibly help decrease the risk of these injuries and the need for revision of total joint arthroplasties. A recent meta-analysis showed a decreased risk of TKA revision (relative risk 0.45) in patients taking long-term bisphosphonates compared to patients not taking them; however, this article cautioned that more high-quality studies are needed [17]. The protective effect of bisphosphonates is thought to be due in particular to short-term improved bone mineral density in the periprosthetic metaphyseal bone, the area often most vulnerable to early failure [18]. In our patient's case, she sustained a high energy trauma and was already being appropriately treated with bisphosphonates for pre-existing osteoporosis. We prescribed teriparatide to more rapidly and effectively restore bone loss and help accelerate our patient's fracture healing; however, this was not approved by insurance. A previous case series of 3 patients treated with teriparatide for osteoporotic femur fractures, including proximal periprosthetic femur fractures, showed earlier callus formation with healing times going from 12 to 16 weeks to an average of 8 weeks [19]. Another study looking at the effect of teriparatide on peritrochanteric femur fractures showed potential improved early functional outcomes compared to patients treated with bisphosphonates [20]. More studies are needed to further delineate the relationship between use of these medications and accelerated bone healing in periprosthetic fractures.

Rush rod fixation of these fractures has multiple advantages and is particularly useful in patients with osteoporosis when more rigid constructs may "cut out" and fractures may occur at the proximal extent of the fixation. Additionally, very minimal remaining bone on the femoral prosthesis is necessary to obtain fixation. Both posterior cruciate ligament retaining and posterior cruciate ligament sacrificing femoral prostheses allow fixation. In general, this technique is more of a consideration in fractures that are length stable, because in comminuted fractures shortening may occur. No bracing is necessary and 20-30 pounds weight bearing is allowed immediately after surgery. Weight bearing is progressed to 50% at 6 weeks and 100% at 8 weeks as comfort allows.

Limitations of this study are the relatively short follow-up of 18 months; however, the patient has achieved clinical and radiographic union and has returned to preinjury functional status. As with all case reports, the outcome of 1 patient cannot be generalized to all populations and situations; however, it does support that flexible intramedullary fixation can be an effective treatment option in appropriately selected patients.

Summary

Flexible intramedullary fixation can be a suitable treatment option for bilateral Rorabeck II/Su III periprosthetic distal femur fractures with minimal distal bone stock. We present a patient with open left and closed right Rorabeck II/Su III periprosthetic distal femur fractures treated with single stage flexible intramedullary fixation with satisfactory outcome. We suggest that in patients with similar injuries, flexible intramedullary fixation can effectively preserve bone and provide adequate fixation while minimizing blood loss in patients with a secure prosthesis and minimal distal bone stock.

Acknowledgments

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