



## Case report

# Peri-implant fracture after dual-plating knee arthrodesis for failed total knee arthroplasty: case series

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## ABSTRACT

Knee arthrodesis is an option in the setting of failed total knee arthroplasty. Dual-plate fixation is a described technique to obtain knee fusion in this scenario. Literature on the complications of knee arthrodesis with dual-plate constructs is limited. We present 3 cases who underwent dual-plate knee arthrodesis complicated by peri-implant femur fracture.

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## Introduction

Knee arthrodesis after failed total knee arthroplasty (TKA) has been shown to be a viable limb salvage procedure [1–3]. Indications for knee arthrodesis include failed 2-stage exchange for peri-prosthetic joint infection (PJI) in comorbid patients (most common indication), severe instability, extensive soft tissue loss, quadriceps mechanism dysfunction due to neural compromise or atrophy causing significant functional deficits, irreparable or failed reconstructions of the extensor mechanism complex, and extensor mechanism deficiency in the setting of infection [4–8]. A previous report from the Danish national registry demonstrated a 0.26% incidence of knee arthrodesis over a 17-year period [9]. Over the past decade, the relative utilization of knee arthrodesis compared to

above-knee amputation (AKA) in the United States for failed treatment of PJI has declined [10]. However, in the appropriately selected patient knee arthrodesis can decrease the need for future surgeries, provide better function compared to AKA, alleviate pain, provide a more stable limb to mobilize with, and decrease the need for extensive postoperative rehabilitation [5,6,10,11].

After making the decision to perform a knee arthrodesis, the particular technique to achieve a stable tibiofemoral fusion is determined based on a multitude of factors, including remaining bone stock, soft tissue status surrounding the knee, leg length discrepancy, available implants, and surgeon experience. Fusion methods typically described include external fixation (uniplanar external fixators, biplanar fixators, and circular fixators), internal fixation (long intramedullary nails [IMNs], short IMNs, intercalating IMNs, dual plating, and independent cannulated screws), or hybrid fixation techniques. Recent trends favor intramedullary fixation techniques to achieve knee fusion compared to external fixation devices [3]. Complications, irrespective of arthrodesis technique, are common and range from 20% to 84% in the literature [1,3,12].

Knee arthrodesis utilizing a dual-plating technique was first described in 1913 for the treatment of tuberculosis of the knee [13]. Since then, there are very limited data on the outcomes of knee fusion with a dual-plate construct. Theoretical advantages include combining debridement and implantation with the same incision,

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obviates complications from pins from external fixators, the ability to achieve compression at the site of arthrodesis, the ability to place plates and screws in the setting of surrounding hardware (eg, long femoral stem from adjacent total hip arthroplasty [THA] or antegrade femoral IMN), the ability to contour plates in patients with significant extra-articular deformity, and the ability to more easily remove hardware in the setting of persistent infection compared to intramedullary devices [14]. Disadvantages include the need for prolonged weight-bearing restrictions, potential for limb shortening if adequate bone stock is not available, subcutaneous hardware prominence, and difficulty with wound closure after utilization of an anterior plate.

There are limited data on the dual-plating technique to achieve tibiofemoral fusion. One of the earliest and largest reports to date of the dual-plating technique by Lucas and Murray included 18 patients. None of the patients included had previously undergone TKA. They reported 94.4% union rate, with 1 patient needing a revision procedure to achieve fusion. Five patients necessitated delayed hardware removal [15]. Figgie et al. reported their experiences with knee arthrodesis after failed TKA in the rheumatoid arthritis population using a multitude of techniques. Twenty-seven knees were included, of which 2 had undergone fusion with the dual-plating technique. Average follow-up was 5 years. One of the 2 dual-plating knees was found to have persistent drainage that was treated with removal of hardware and medial gastrocnemius rotational flap [16]. In another report of 11 patients managed with dual-plating knee fusions, 100% fusion rate at an average of 5.6 months was reported. All patients were treated with cylinder cast and weight bearing as tolerated. Two complications were reported including 1 persistent infection necessitating removal of hardware and 1 femoral stress fracture that went on to a nonunion, requiring intramedullary fixation to achieve fracture union. This is the only known record of peri-implant fracture to date after knee arthrodesis with dual plates. The authors concluded that the dual compression plating technique is a

useful technique and recommended staggering the plates to prevent late stress fractures [17]. Kuo et al. published their experience with 3 patients using 2 locking large fragment plates. All patients were noted to have successful fusions and be ambulatory at 2 years, despite 1 patient having an active infection at the time of arthrodesis [18]. Another recent report included a total of 43 knee fusions, 9 of which underwent fusion with a dual-plating construct of which 7 (77.8%) went on to fusion. This was compared to 81.5% fusion rate seen after management with intramedullary fixation. Despite a relatively high rate of fusion with dual-plate fixation, the rate of complications following arthrodesis with plate fixation was 40% [8]. The most recent published case series of knee arthrodesis included 20 knee fusions. Three were performed with dual plates, all of which had a single-stage irrigation & debridement (I&D) and fusion for PJI. Two of the 3 cases failed; 1 from persistent infection and the other secondary to aseptic nonunion. Three dual-plate revision knee arthrodeses were also performed after failing a previous fusion attempt with an external fixator. Two of the 3 revision fusion cases went on to successful fusion and 1 failed due to persistent infection resulting in an AKA [19].

### Case histories

There are limited data on the complications specific to the dual-plating technique in the current literature and only 1 reported case of peri-implant fracture after knee arthrodesis with a dual-plate construct. We present 3 cases of knee fusions with the dual-plate method that resulted in peri-implant distal femur fractures.

#### Case 1

The first patient is a 55-year-old woman with a medical history significant for chronic obstructive pulmonary disorder, obesity (body mass index 38.1), alcoholic cirrhosis, chronic opioid use,



**Figure 1.** Prearthrodesis radiographs. Anteroposterior (a) and lateral (b) radiographs showing extensive articular surface erosion and bone loss with varus deformity.

tobacco abuse, and borderline personality disorder who slipped in the bathroom and was found to have a right traumatic knee dislocation and associated tibia plateau fracture for which she underwent closed reduction and application of a spanning external fixator. She developed a pin site infection that led to osteomyelitis and subsequent right knee septic arthritis. This was treated with external fixator removal, and I&D of the knee. Operative cultures at that time grew MSSA and she was treated with 6 weeks of intravenous (IV) antibiotics. She presented to the emergency room a short time after completing IV antibiotics with altered mental status secondary to sepsis. Patient declined further surgical intervention at that time and was placed on an additional 6 weeks of IV antibiotics, followed by chronic suppressive oral antibiotics. She continued to have debilitating chronic pain in her right knee from erosive changes as a result of her septic arthritis (Fig. 1a and b). Options were discussed including AKA and 2-stage knee arthrodesis. The patient elected to move forward with the 2-stage arthrodesis. Although knee arthrodesis was the planned second stage, an articulating spacer was chosen to attempt to improve soft tissue pliability to assist with exposure for the following procedure. Successful application of an articulating antibiotic spacer followed by another 6 weeks course of IV antibiotics was completed. The patient then underwent knee arthrodesis with a dual-plate construct consisting of 2 large fragment 4.5-mm plates (12-hole and 14-hole) with a combination of locking and nonlocking screws (Fig. 2a and b). She was

made non-weight-bearing with a knee immobilizer postoperatively. The patient was doing well until she sustained a ground-level fall with acute onset of thigh pain on postoperative day 41. Radiographs confirmed peri-implant distal femur fracture (Fig. 3a and b). This was treated with placement of a 460 mm  $\times$  10 mm antegrade femoral IMN and retention of the 2 large fragment plates (Fig. 4a and b). Revision of screws was also performed as needed to accommodate the nail. The patient was kept non-weight-bearing in a knee immobilizer and discharged to a skilled nursing facility on postoperative day 8. The patient was ambulating with a walker and noted to have interval consolidation at her fracture site 4 months postoperative (Fig. 5a and b).

#### Case 2

The next patient is a 67-year-old man with a medical history significant for ankylosing spondylitis, hepatitis C, nonischemic cardiomyopathy, chronic left bundle branch block, depression, hypogonadism, as well as multifocal MSSA joint infections (left elbow, left wrist, right shoulder, and lumbar spine) resulting in multiple hospitalizations for sepsis. He also had a history of left ACL reconstruction. He was experiencing significant pain from end-stage left knee arthritis. Continued conservative management was recommended. The patient later had an intra-articular hyaluronic acid injection by his primary care physician which was complicated by septic arthritis of the knee. He underwent I&D



**Figure 2.** Postarthrodesis radiographs. Anteroposterior (a) and lateral (b) radiographs after dual-plate knee fusion using 12-hole and 14-hole plates medially.



**Figure 3.** Injury radiographs. Anteroposterior (a) and lateral (b) radiographs after a ground-level fall with peri-implant distal femur fracture.



**Figure 4.** Postoperative IMN radiographs. Anteroposterior (a) and lateral (b) radiographs after undergoing intramedullary fixation of peri-implant fracture.



**Figure 5.** Four-month postoperative radiographs. Anteroposterior (a) and lateral (b) radiographs 4 months postoperative showing interval callus bridging and bony consolidation at previous per-implant fracture site.

followed by IV antibiotics. Postoperatively, the patient developed a recurrent MSSA knee infection with associated thigh and calf abscesses, for which a repeat I&D was performed. IV antibiotics were continued for 6 weeks with transition to PO antibiotics indefinitely. The patient was complaining of persistent pain from arthritic sequelae of his septic arthritis and a 2-stage knee arthrodesis with articulating antibiotic spacer was recommended

(Fig. 6a-c). Preoperative labs and aspiration were negative for infection and he underwent resection arthrodesis and placement of articulating antibiotic spacer (Fig. 7a and b). Intraoperative cultures were negative at that time. He expressed the desire to avoid additional courses of intravenous antibiotics and was thus kept on PO antibiotics. At approximately 6 months from placement of antibiotic spacer he underwent preoperative infectious



**Figure 6.** Prearthrodesis radiographs. PCA (a), anteroposterior (b), and lateral (c) radiographs showing valgus deformity and joint space narrowing after having recurrent MSSA septic knee arthritis.





**Figure 7.** Postarticulating spacer radiographs. Anteroposterior (a) and lateral (b) radiographs after stage 1 articulating antibiotic spacer.

work-up in preparation for knee arthrodesis. Estimated sedimentation rate and C-reactive protein were noted to be elevated and knee aspiration grew out *Candida parapsilosis*. Options were

discussed including knee fusion with dual-plate construct vs AKA. It was decided to undergo knee arthrodesis with 2 large fragment 4.5-mm plates (10-hole and 12-hole) (Fig. 8a and b).



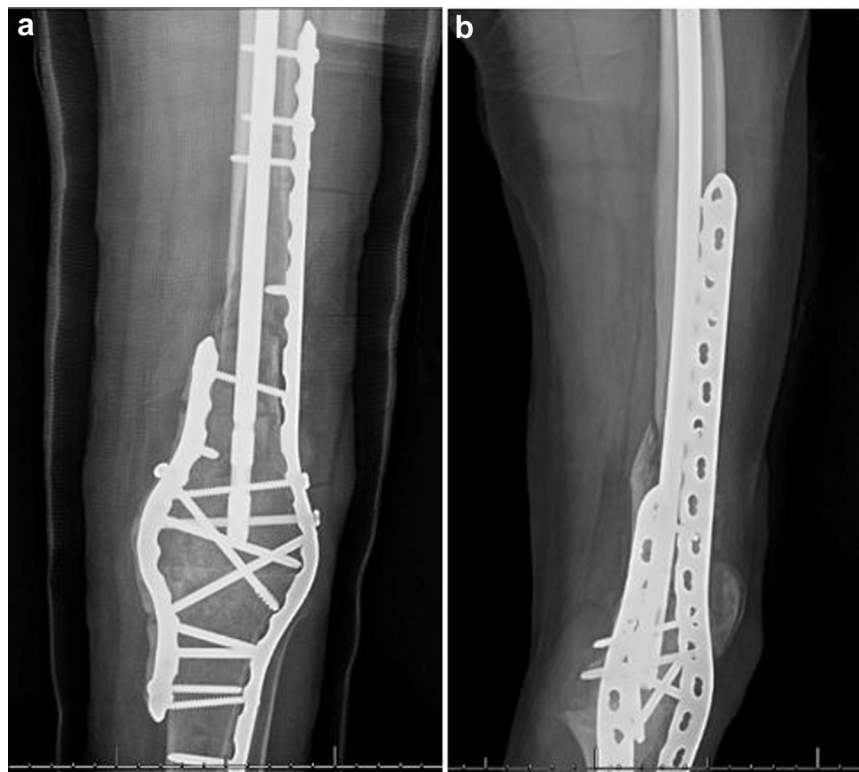
**Figure 8.** Postarthrodesis radiographs. Anteroposterior (a) and lateral (b) postoperative radiographs after dual-plate knee fusion with 10-hole and 12-hole large fragment plates.



**Figure 9.** Injury radiographs. Anteroposterior (a) and lateral (b) radiographs showing distal femoral peri-implant fracture after leg struck the ground while transferring.

Postoperatively, the patient was kept in extension, made non-weight-bearing, and started on another 6-week course of IV antibiotics with antifungals. This was followed by chronic PO

antibiotic and antifungal suppression. Unfortunately, on post-operative day 9 he was attempting to transfer when he lost control of his leg causing it to strike the ground resulting in immediate



**Figure 10.** Postoperative revision plating and IMN radiographs. Anteroposterior (a) and lateral (b) radiographs after revision of the lateral plate to a 22-hole large fragment plate with additional intramedullary nail fixation.



**Figure 11.** Hardware failure from chronic knee and peri-implant fracture nonunions. Anteroposterior (a) and lateral (b) radiographs showing peri-implant fracture nonunion and subsequent lateral plate failure.

pain. Radiographs revealed a distal femoral peri-implant fracture (Fig. 9a and b). He was taken back for revision ORIF with exchange of the lateral plate to a 22-hole 4.5-mm locking plate. In addition,

an 11 mm × 440 mm long antegrade femoral IMN was placed (Fig. 10a and b). He went on to develop nonunions of both the knee fusion and fracture site with hardware failure (Fig. 11a and b),



**Figure 12.** Postoperative revision IMN and bone grafting radiographs. PCA (a), anteroposterior (b), and lateral (c) radiographs after revision IMN and hardware removal. 13 × 700 mm nail was utilized. Retained broken hardware is noted at the medial aspect of the distal femur.



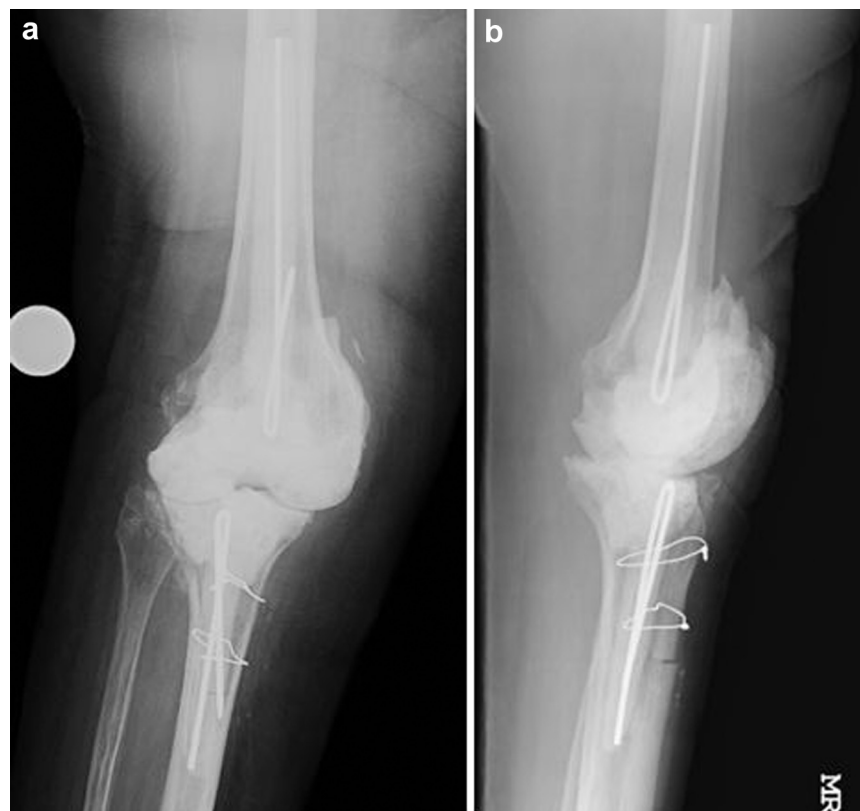


**Figure 13.** Primary TKA radiographs. Anteroposterior (a) and lateral (b) immediate postoperative radiographs of TKA performed at outside facility.

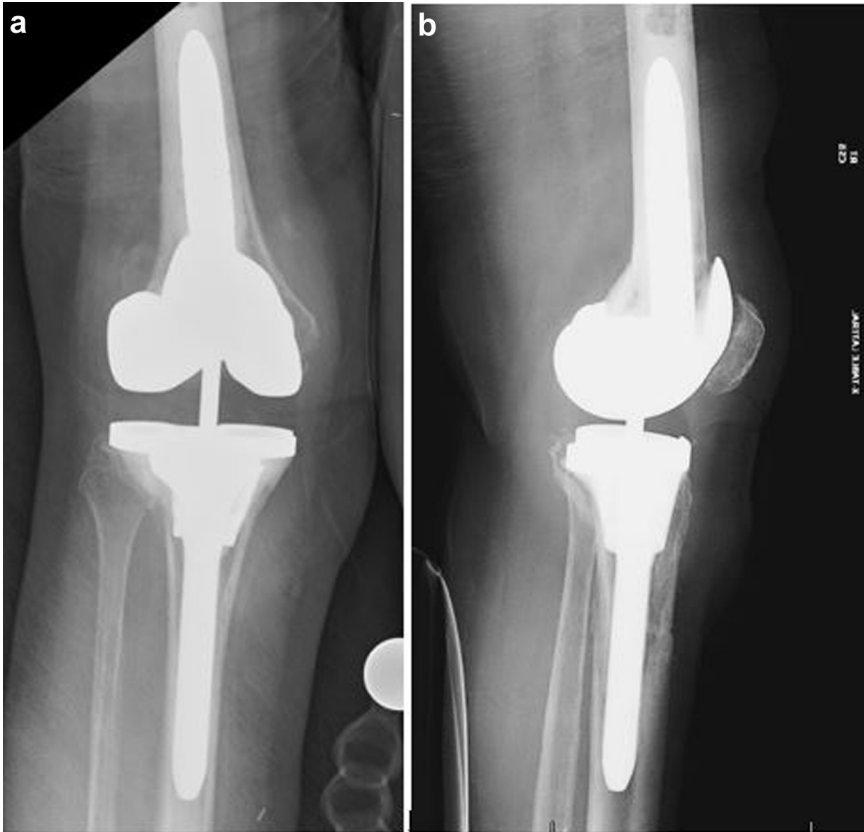
which was treated with removal of all hardware, bone grafting, and revision IMN with a 13 mm × 700 mm IMN (Fig. 12a-c). The patient passed away 3 months later secondary to complications related to his congestive heart failure.

#### Case 3

The last patient is a 69-year-old woman with a history of coronary artery disease status post coronary artery bypass grafting, as



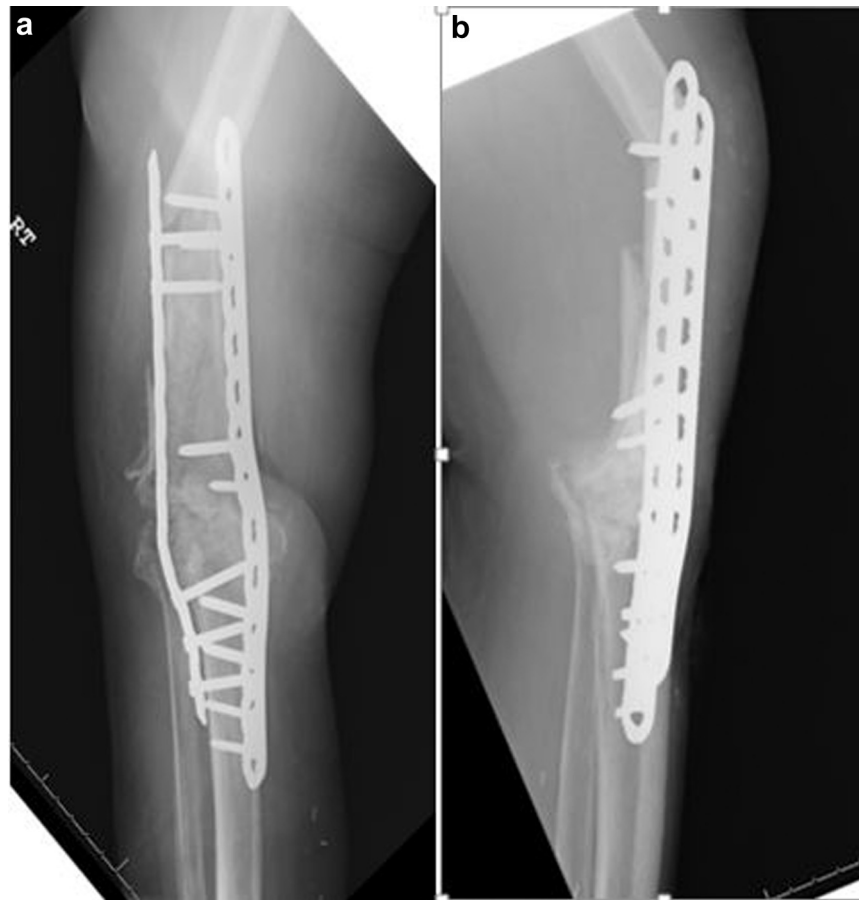
**Figure 14.** Postarticulating spacer radiographs. Anteroposterior (a) and lateral (b) radiographs after stage 1 articulating antibiotic spacer.



**Figure 15.** Post-reimplant radiographs. Anteroposterior (a) and lateral (b) radiographs after stage 2 revision TKA.



**Figure 16.** Postarthrodesis radiographs. Anteroposterior (a) and lateral (b) postoperative radiographs after dual-plate knee fusion with 12-hole and 14-hole large fragment plates.



**Figure 17.** Injury radiographs. Anteroposterior (a) and lateral (b) radiographs showing peri-implant femur fracture.

well as previous right TKA and THA at outside facilities referred for further evaluation of painful TKA and THA (Fig. 13a and b). Infectious work-up revealed MRSA infections of both the right TKA and right THA. She was also noted to have left foot osteomyelitis, right shoulder septic arthritis, and right wrist septic arthritis that underwent formal I&Ds. She had right hip and knee articulating antibiotic spacers placed followed by 6 weeks of IV antibiotics (Fig. 14a and b). Six months later preoperative infectious work-up was negative and the right knee was reimplanted (Fig. 15a and b). She presented 3 months later with a draining sinus and extensor mechanism disruption. Single-stage explant and knee arthrodesis vs AKA was discussed and the patient elected to move forward with knee fusion. This was performed with a dual-plate construct utilizing 2 large fragment 4.5-mm plates (12-hole and 14-hole) (Fig. 16a and b). Intraoperative cultures showed coagulase negative staph + diphtheroids in broth only. She completed another 6 weeks of IV antibiotics; however, at 5.5 weeks postop the patient noted an atraumatic pop in her thigh while transferring from her wheelchair. Radiographs revealed peri-implant femur fracture at the proximal portion of the knee fusion hardware (Fig. 17a and b). This was addressed by lateral plate removal and placement of a new 22-hole large fragment 4.5-mm lateral plate (Fig. 18). The femoral component of the previous hip articulating spacer remained well fixed. Four months following this, she presented back to clinic with 3 draining sinuses and exposed hardware. Radiographs were concerning for knee fusion nonunion. AKA was recommended and later performed. She has been fitted for a prosthesis and remains on chronic PO antibiotic suppression at the time of her last follow-up visit.

## Discussion

We present these 3 cases to highlight a specific complication of peri-implant femur fracture after undergoing knee arthrodesis with a dual-plate construct. Based on an exhaustive review of the literature pertaining to dual-plate fixation for knee fusions, there is only 1 report of peri-implant femur fixation. Nichols et al. described a femoral stress fracture in 1 of their 11 patients. The fracture was originally treated nonoperatively; however, it went on to nonunion and was eventually treated with an intramedullary IMN [14]. For comparison purposes, 12 total knee arthrodesis cases, including the 3 cases presented here, were performed at our institution during the study period (October 2016 to January 2019). Eight of these cases underwent knee arthrodesis with an intramedullary device. There were no knee fusions performed with an external fixation device. Four of the 12 patients had knee fusions using the dual-plate construct, with 3 going on to peri-implant fracture. The 1 successful dual-plate knee arthrodesis case was noted to be functioning well at 1-year follow-up.

In review of the 3 cases presented above, it is worth noting the low energy mechanism that caused the peri-implant fracture in each case. The first case was due to a ground level fall, the second case resulted after the leg struck the ground from a seated position, and the third case occurred while transferring with no apparent traumatic event. This reflects the poor bone quality in this patient population from their chronic deconditioning, history of infection, and numerous medical comorbidities. Being mindful of the risk of peri-implant fracture, efforts should be focused on achieving adequate fixation, while decreasing stress concentration at the



**Figure 18.** Postoperative revision ORIF radiographs. PCA radiograph after revision of the lateral plate to a 22-hole large fragment plate. Stable ipsilateral antibiotic hip spacer is also seen.

junction of the bone and plate. Locked screws allow for creation of a fixed-angle construct and increased fixation in osteoporotic bone. In all 3 cases the constructs were staggered ~2–3 cm in an attempt to decrease stress concentration. Despite these efforts, a concentration of stress at the bone-implant junction occurred leading to peri-implant fractures. Although there is potential for retrospective critiques of the techniques used, these cases highlight the particular vulnerability of this fusion construct to error and complication.

## Summary

In review of the current literature, successful management with dual plating is possible; however, our recent experience has significantly colored our indications and our recommendation for its use. Peri-implant fracture in the setting of a knee arthrodesis is a difficult complication to manage, often in the setting of patients with multiple comorbidities and poor bone quality. Although we previously believed that a dual-plate knee fusion had theoretical advantages our experience with these 3 cases has caused us to rethink this conclusion. We currently favor other methods of fixation, particularly in the setting of significant osteopenia.

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