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Tibial lengthening with a motorized magnetic intramedullary nail after combined plating and titanium mesh cage for distal femur periprosthetic fracture nonunion

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Abstract

Fifty-seven years old female presented with resistant nonunion and limb length discrepancy (LLD) following distal periprosthetic fracture. The report described the experiences treating these conditions and literature review about the topic. Nonunion in periprosthetic distal femoral fractures can be challenging to the orthopedic surgeon and can result in a significant LLD. With the patient described herein, a combined technique with plating and titanium mesh cage and subsequent tibial lengthening with a motorized lengthening nail was used to address these conditions.

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Full Text

Introduction

Risk factors for periprosthetic femur fractures include trauma, patient-specific problems, and technical issues related to hip replacement.[1] Rates of periprosthetic femur fractures have been documented as 0.9% following a primary total hip replacement Total Hip Arthroplasty (THA) and 4.2% following revision THA.[2] Surgical fixation methods such as retrograde intramedullary nailing and locking plating have a significantly lower risk for developing nonunion or requiring revision surgery than traditional plating methods.[3] Varus collapse with or without implant failure is the most common mode of failure following distal femur fracture fixation

with locking plates. Supplementing lateral distal locking plate with medial plate had been proposed to avoid this unfavorable outcome. Medial plating of the distal femur was limited by the need for extensive soft-tissue dissection and the proximity to the femoral artery. Supplementation of the lateral distal femur locking plate fixation with a titanium mesh cage (TMC) was another alternative. TMC reduces soft-tissue damage and adds biomechanical stability similar to medial plating. TMC proposed to avoid varus failure of the distal femur locking plate fixation.[4] Limb length discrepancy (LLD) can be treated with distraction osteogenesis using motorized intramedullary limb lengthening nailing systems.[5],[6],[7],[8] Femoral and tibial lengthening can be accomplished successfully with intramedullary limb lengthening nailing systems. The reported accuracy and precision were up to 96% and 86%, respectively.[9]

This report aimed to report a complex case of periprosthetic distal femur nonunion treated with combined lateral distal femur locking plate and TMC to avoid varus collapse with subsequent staged tibial lengthening with a motorized tibial nail.

Case Report

A 57-years old female patient with left distal femur periprosthetic fracture (Type c, according to Vancouver classification) has been reported. The fracture located 4.4 cm distal to the tip of the femoral stem. The patient had multiple unsuccessful attempts of open reduction and internal fixation of her distal femur fixation. The 1patient developed nonunion with implant failure, varus collapse, and shortening of the affected limb 9 months after the index surgery [Figure 1]. She had a left THA, right THA, and right TKA (Total knee Arthoplasty). The patient is a weightlifter, and she was on undisclosed doses of anabolic steroids. The LLD was due to distal femur nonunion and the multiple revision surgeries of left THA.{Figure 1}

The patient had resistant nonunion of the distal femur periprosthetic fracture despite the multiple operative surgical procedures to achieve bone union. The surgical procedures included revision open reduction and internal fixation, bone marrow injection, bone morphogenetic protein II (INFUSE©, Medtronic, MN, USA) and cancellous bone chips were performed to achieve bone healing.

Fifteen months later, the patient presented for the first time to the senior author's clinic with nonunion, varus deformity of the distal femur, limited knee range of motion (0°–30°). The patient reported erythema around the previous incisions. The treating surgeon staged the treatment with hardware removal, bone biopsy to rule out infection, and postoperative computed tomography (CT) to understand the anatomy of the distal femur. The second stage included nonunion repair and revision fixation combined with autogenous bone grafting. Implant removal went uneventful except for one embedded screw that was left in place. Calcium sulfate (Stimulan Beads®, Biocomposites Ltd., Keele, UK) was mixed with vancomycin (1 g) and tobramycin (1.2 g) powder. The beads were applied to the nonunion site. Bone biopsy and cultures were negative for infection.

One month later, she underwent the second stage of the surgical intervention using a TMC to correct the bone defect on the medial side and lateral distal femur locking plating [Figure 2]. Quadricepsplasty was performed in order to restore the patient's range of motion and to minimize the shear forces on the fixation [Figure 3]. The reamer/irrigator/aspirator (RIA) was used to harvest autologous bone graft from the ipsilateral tibia. Bone graft (30 cc) was applied to the anterior and medial bone defect. The patient was compliant with the postoperative protocol. The continuous passive motion machine was used for 6 weeks postoperatively. The patient was instructed to stay nonweight-bearing for 6 weeks postoperative. Progressive weight-bearing was allowed as callus formation was visualized on the radiographic images in the following months.{Figure 2}{Figure 3}

The patient were counseled regarding her LLD (55 mm). The LLD were measured clinically and radiologically using CT Scanogram. The patient was offered nonoperative management due to her complex surgical history. The patient declined nonoperative management and opted to proceed with the surgical correction of her LLD. The lengthening procedure was performed 9 months after distal femur nonunion repair. The plan was to correct the LLD by tibial lengthening. A 245 mm × 10.7 mm PRECICE© Nail (NuVasive Technologies. San Diego, CA, USA) was used for the tibial lengthening [Figure 4]. The tibia lengthening was done in a standard technique. The procedure included fibular osteotomy, fixation of the proximal and the distal tibiofibular joints, progressive canal reaming, followed by nail insertion. An external remote controller was used for nail distraction. A total of 55 mm of tibia lengthening was achieved. The distraction rate and rhythm were 0.75/day and 0.25/8 h, respectively. The distraction was performed over 10 weeks (days). Forty pound (40 LB) partial weight-bearing was allowed during the distraction phase and weight-bearing as tolerated during the consolidation phase. The patient was not fully compliant with weight-bearing instructions. The patient developed nondisplaced incomplete distal tibial fracture and fibular fracture during the consolidation stage. The fracture was treated nonoperatively with cam boot and nonweight-bearing for 6 weeks. The fracture was healed uneventful without any complication. The patient was very satisfied at the end with the equalization of her LLD. Seven months later, she presented with symptomatic hardware prominence relating to her nail and rigid ankle equinus contracture. The gastrocnemius recession was performed to correct her lack of neutral dorsiflexion. A 3.5 mm left distal tibia syndesmotic screw was removed 10 months later. At 52 months of follow-up [Figure 5], the patient denies any difficulty ambulating or limping. No systemic signs of infection or major clinical concerns were noted.{Figure 4}{Figure 5}

Discussion

Nonunion with or without implant failure is common after distal femur lateral locking plates in Vancouver C periprosthetic distal femur fractures. This report presented a complex case of distal femur periprosthetic fracture nonunion complicated with LLD. The prior surgical procedures resulted in distal femur bone defect and nonunion. Furthermore, the patient had extensive scarring on the medial side due to prior attempt of medial plating of the distal femur. The bone defect was more profound on the medial side. The distal femoral bone defect was treated with TMC. TMC can be utilized as an alternative in treatment tibial and femoral bone defects.[10],[11] TMC provides structural support to the bone defects.[12],[13] TMC was used to supplement the distal femur lateral locking plate in this case. TMC helped to avoid varus failure of the distal femur locking plate fixation.[4]

Knee extension contracture is a common complication in distal femur nonunion. The lack of knee motion allowed more shearing forces across the mobile distal femur nonunion. The shearing forces favor the path of least resistance which is the distal femur nonunion in this case.[14] Knee extension contracture was a complication occurred in the current case. The surgeon performed a Judet quadricepsplasty[15] as part of his surgical plan for the distal femur nonunion. The idea was to minimize the shearing forces across the distal femur nonunion. The contracture release was done gradually without damaging the integrity of the vastus medialis, vastus lateralis, or rectus femoris muscles. This procedure was necessary to improve the patient's knee joint functional capacity, protect the internal fixation, and achieve bone union.

Intramedullary bone graft harvesting is an alternative to an iliac crest graft. It can be performed using an RIA (reaming, irrigation, aspiration) system.[16],[17] This technique can harvest a large volume of high-quality bone autograft with less postharvesting pain compared to iliac crest bone grafting.[18],[19] The surgeon was concerned about the quality of bone regenerate during tibial lengthening following RIA due to endosteal vascular disruption. Studies recorded new bone formation to begin 6 weeks post-RIA and continue up to 3 months later.[20] Staging the tibia lengthening procedure 9 months after RIA was adequate time for bone formation during intramedullary lengthening nail.

Tibial lengthening with a motorized nail has several advantages over lengthening with external fixation. Tibial lengthening with a motorized nail has several advantages over lengthening with external fixation, as no pin site infection and quicker restoration of ankle/knee range of motion. However Both methods had a similar cost.[21] Due to the patient's active lifestyle, the surgeon opted for this treatment over lengthening with external fixation. Tibial lengthening in this patient complicated with ankle equinus contracture. Ankle equinus contracture is a well-recognized complication with tibia lengthening.[22] Intensive physical therapy for ankle range of motion and gastrosoleus stretching was utilized to avoid ankle equinus contracture. Day time cam boot and ankle–foot orthosis during night were used as well. Despite all of these nonoperative efforts, the patient developed ankle equinus contracture. Operative treatment with gastrocnemius recession was needed in this patient. Gastrocnemius recession is a well-documented and effective treatment for ankle equinus contracture following tibial lengthening.[23],[24]

In conclusion, tibial lengthening with intramedullary lengthening nail was successful in correcting the LLD following periprosthetic distal femur nonunion. Supplementing lateral distal femur locking plate fixation with TMC and utilization of the RIA system to obtain a viable bone graft were effective treatment to achieve bone healing in resistant distal femur periprosthetic fracture nonunion.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given consent for her images and other clinical information to be reported in the journal. The patient understands that her name and initial will not be published, and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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