Two-stage knee arthrodesis using a cemented modular tumour replacement system for recalcitrant septic proximal tibial non-union: a case report

Pablo S Corona,1 Francisco Soldado,2 Carles Amat,1 Xavier Flores1
1 Reconstruction and Septic Division, Department of Orthopedic Surgery, Hospital Universitario Vall d’Hebron, Universidad Autonoma de Barcelona, Barcelona, Spain
2 Pediatric Surgery and Microsurgery Division, Department of Orthopedic Surgery, Hospital Universitario Vall d’Hebron, Barcelona, Spain

ABSTRACT
Knee arthrodesis is an alternative to amputation for treating recalcitrant septic non-union of the proximal tibia with bone loss, soft-tissue compromise, and knee-joint involvement. Nonetheless, arthrodesis is difficult to achieve if bone loss is massive, and the septic environment can result in failed bone fusion. We report on a 77-year-old man with massive bone loss secondary to recalcitrant septic non-union who underwent radical bone resection, followed by knee arthrodesis using a cemented modular intercalary megaprosthesis in conjunction with a microvascularised flap in 2 stages.

Key words: arthrodesis; infection; knee joint; tibial fractures

INTRODUCTION
Massive bone defects of the tibia secondary to post-traumatic infected non-unions are difficult to treat. Refractory cases often necessitate amputation despite attempts to salvage the limb.1 If the infected non-union is near the knee joint, knee fusion can be an alternative option. Knee arthrodesis is usually indicated for non-revisable total knee arthroplasty secondary to infection.2-4 If bone loss is massive, bone contact may not be adequate for successful fusion, and vascularised fibular grafting5 or bone transport6 are resorted to. These methods are technically demanding and associated with high complication and reoperation rates as well as extended periods of weight-bearing restriction. A ‘functional’ arthrodesis may provide knee stabilisation before bone union, using a knee arthrodesis prosthesis7 or modular nails.8,9

We report on a 77-year-old man with recalcitrant infected non-union of the proximal tibia, with knee involvement, massive bone loss, and severely compromised skin status. He underwent radical bone resection in conjunction with the use of a microvascular flap, followed by knee stabilisation using a modular cemented intercalary arthrodesis device.
CASE REPORT

In February 2010, a 77-year-old man presented with knee pain and inability to walk secondary to infected non-union of a proximal right metaphyseal tibial fracture. The patient had undergone previous treatments elsewhere, and his medical records were inaccessible. In 1993, the patient had sustained a pathological proximal tibial fracture caused by hyperparathyroidism (osteitis fibrosa cystica), for which the adenomatous gland was removed. He had undergone more than 14 surgical procedures including anterior and posterior iliac crest grafting, contralateral non-vascularised fibular grafting, and use of a gastrocnemius flap.

The patient had an unfavourable nutritional status and chronic renal failure (serum creatinine of 2.5 mg/dl). There was a discharging sinus and a scarring skin defect of 8x3 cm at the anterior proximal tibia, with residual of multiple skin incisions (Fig. 1). The causative agent was methicillin-resistant *Staphylococcus aureus*. The knee was flexed and unstable. There was no neurovascular deficit. Radiographs of the tibia revealed non-union of the proximal tibial metaphysis, osteomyelitic changes of the entire proximal tibial diaphysis, and a tibial nail (Fig. 2). The knee was in flexion contracture and exhibited posterior subluxation and advanced degenerative changes. The knee joint was unsalvageable. Options offered were limb salvage and above-knee amputation. The patient chose limb salvage in a 2-stage procedure.

Infected and necrotic bone and soft tissue was extensively debrided, using a hydro-scalpel device and the Reamer-Irrigation-Aspiration System (Synthes, Paoli, USA). The patellar tendon was noted to be necrotic, and the tibial tuberosity was involved in the septic process. The proximal epiphysis, metaphysis, and diaphysis of the tibia together with the nail were removed (Fig. 3). The final resection totalled 16 cm. The extensor mechanism was also removed. The bone defect was filled with an antibiotic-loaded bone cement spacer, supplemented with 4 g of vancomycin powder per 40 g of polymethylmethacrylate bag (Fig. 4). The skin defect was excised and covered with and an anterolateral thigh free flap from the ipsilateral thigh. The limb was protected with a thermoplastic splint, and weight bearing was not allowed. The serum creatinine level reached 3.4 mg/dl, and normalised after 4 days. The flap healed well, as did the donor site.

Six weeks of intravenous daptomycin (6 mg/kg/day) through a peripherally inserted central catheter was administered as recommended by...
the microbiologist. The patient consented to an additional surgery to place a permanent intercalary device, using a modular tumour replacement system. Failure of this was likely to result in trans-femoral amputation. 14 weeks after the index procedure, infection had been eradicated and inflammatory markers had normalised, and so the second-stage procedure was performed.

The flap was raised (Fig. 5) using a lateral hinge to protect the vascular anastomosis. Intra-operative frozen sections were negative for infection. The cement spacer was removed. The canals were thoroughly reamed and irrigated. To reconstruct the segmental tibial bone defect and stabilise the knee, a combined system was used. The cemented Endo-Model Knee Fusion Nail (Waldemar Link, Hamburg, Germany) was used to achieve 5º of femoral valgus and 5º of flexion at the knee level and combined with the cemented Megasystem-C (Waldemar Link, Hamburg, Germany) diaphyseal spacer (Fig. 6). Both systems use the same strong coupling mechanism and therefore are compatible. As the spacer is straight, combining it with the nail achieves the valgus and flexion positions recommended for any knee fusion.²⁻⁴ A fibular osteotomy was performed to lengthen the limb, and to correct residual deformities. The stems were fixed with vancomycin- and gentamycin-loaded bone cement. The joint space defect was also filled with antibiotic-loaded cement. Proper rotation was set, and the cement was allowed to cure. The wound was irrigated again, and flap closure was performed. The operative procedures lasted 67 minutes.

Full weight bearing with crutches was commenced after 48 hours. The wound healed well, and the patient was discharged after 8 days. At the 19-month follow-up, the patient had no complaints. He had returned to normal daily activities, with no evidence of infection. The prosthesis was in a good position (Fig. 7), with no evidence of loosening or fracture. Owing to a limb-length discrepancy of 2 cm, a 1.5-cm shoe lift was used. 17 years after the initial fracture, the patient was highly satisfied with the outcome.

DISCUSSION

In recalcitrant periarticular septic non-union where the soft-tissue envelope is compromised, bone loss is massive, and the joint is destroyed and painful, amputation is a realistic option. For patients with massive segmental defects and concomitant extensor mechanism impairment, options are limited to knee arthrodesis and transfemoral amputation. The use of the Endo-Klinik cement-fixed ‘arthrodesis nail’ achieved good results in treating periprosthetic knee infection.⁸ The use of a modular intercalary prosthesis avoided amputation in an 81-year-old woman with

Figure 4 The massive bone defect is filled with an antibiotic-loaded cement spacer.

Figure 5 The anterior skin defect is covered with an ipsilateral anterolateral thigh free flap.

Figure 6 The modular intercalary megaimplant is inserted to stabilise the knee without bony fusion, supplanting the massive tibial bone defect.
a septic failed total knee replacement, with massive bone loss and extensor mechanism deficit.\textsuperscript{11} The use of a Stanmore knee arthrodesis prosthesis achieved knee stabilisation in 10 patients with massive bone loss secondary to tumour resection or failed septic total knee arthroplasty.\textsuperscript{7}

To achieve knee arthrodesis in limbs with massive bone defects, other options include vascularised fibular grafting\textsuperscript{5} and bone transport.\textsuperscript{6} These methods are technically demanding, and associated with high complication rates. Moreover, they are not realistic in elderly patients with comorbidities, as repeated surgeries and prolonged non-weight-bearing impose a heavy burden.

In our patient, all affected bone tissue was radically excised in the first stage, and reconstruction with knee fusion was performed in the second stage. The reconstruction was quick and easy to perform, as no attempt was made to facilitate bone union. Because the implant stem was cemented, the patient could mobilise immediately following the procedure. Nonetheless, the durability of this implant remains unknown. Its fixation is limited to short segments within the femur and tibia, and therefore stress concentrates at the tips of the implants and may lead to pain, loosening, or fracture.\textsuperscript{11}

DISCLOSURE

No conflicts of interest were declared by the authors.