Bone transport of the tibia with a motorized intramedullary lengthening nail — a case report

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Bone resection and subsequent bone transport and bone lengthening is a well-established treatment for a tibial non-union with shortening (Rozbruch et al. 2008). To our knowledge, this is the first description in the literature of bone transport and subsequent bone lengthening of the tibia only by use of a motorized intramedullary nail.

A 53-year-old male twisted his leg while downhill skiing and sustained an OTA classification 43-A2.3 (4) closed fracture of the distal tibia and fibula (Marsh et al. 2007). Both fractures were treated with open reduction and locking plates in January 2009. A non-union developed with loosening of the osteosynthesis, and 7 months after the initial operation the patient was reoperated with bone allograft and exchange of the plates and screws. The non-union did not heal. The patient was referred to our institution 20 months after the first reoperation. At this time, the tibial plate was loose, with broken screws (Figure 1). The tibia had a varus deformity of 16 degrees and was 2.2 cm shortened (Figure 1). The non-union site was tested clinically and found to be loose.

We operated the patient 24 months after the first reoperation. After removal of all previously inserted implants and screws, except a distal AP screw, the non-union site was found at surgery to be atrophic. The non-union site (3.1 cm bone segment) was resected to vital bone. The fibula was osteotomized at the level of the tibial resection. A proximal percutaneous tibial osteotomy was performed 9 cm from the knee joint line. A custom-made motorized tibial lengthening nail (Fitbone TSA (Tibial Segment Actuator) was inserted. The nail had a length of 35 cm and was capable of 4 cm of bone transport initially and 2 cm of bone lengthening subsequently. The nail had 8 degrees of anterior bending, starting 40 mm from the proximal tip of the nail. The nail was locked with 2 proximal and 2 distal locking screws to the tibia. In addition, a screw was inserted into a sliding hole in the middle part of the tibia, allowing bone transport of the middle tibial segment (Figure 2). A tibio-fibular screw was inserted distally to protect the distal tibio-fibular joint. Acute shortening of the bone defect was not performed. A radiograph taken immediately after surgery showed that 3.1 cm of bone had been resected. Bone transport was initiated 10 days postoperatively at a rate of 1 mm daily (Figure 3). There were no clinical signs of infection and the white blood cell and C-reactive protein levels were normal before surgery. However, biopsies of the resected bone were cultured and showed growth of coagulase-negative staphylococci, which were sensitive to dicloxacillin. Dicloxacillin was therefore administered orally for 3 months.

4 weeks postoperatively, 3.3 mg of recombinant BMP-7 (eptotermin alfa, Osigraft; Stryker) was administered percutaneously to the docking site. A loose proximal locking screw was exchanged at the same surgery and intraoperative fluoroscopy showed that the fibula osteotomy was still loose, allowing lengthening of the fibula. Partial weight bearing was allowed from 2 months postoperatively when the proximal tibia had been lengthened 5 cm (3 cm of bone transport plus 2 cm of leg lengthening). The docking site was united 5 months postoper-

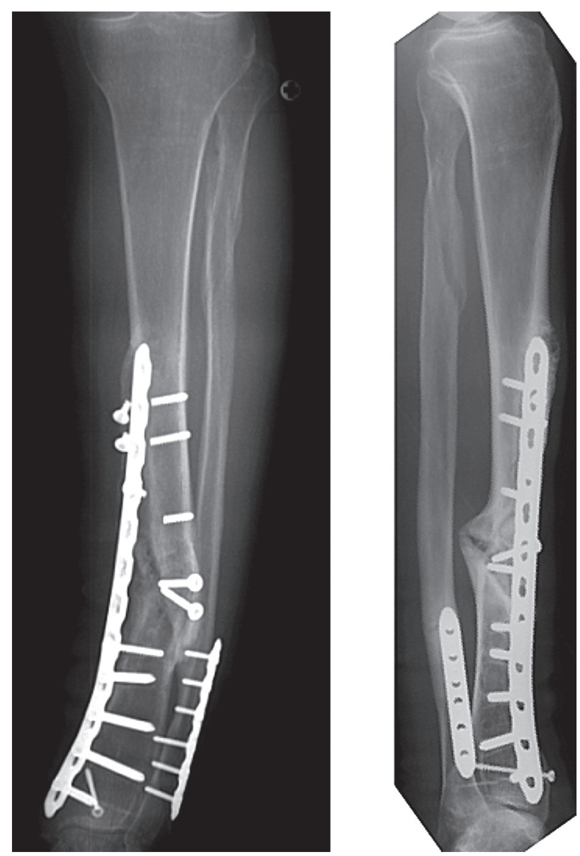

Figure 1. Frontal plane varus deformity without sagittal plane deformity of the tibia, with leg-length discrepancy of 2.2 cm in patient with tibial non-union.

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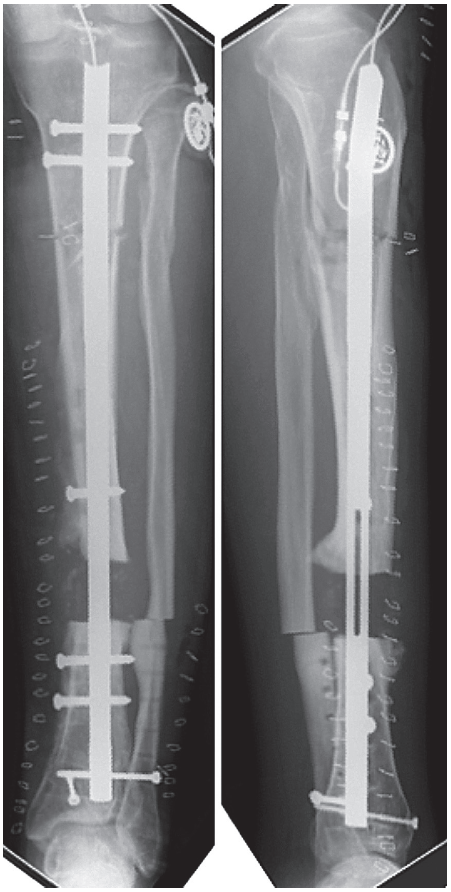

Figure 2. Immediately postoperatively, showing tibial bone gap after bone resection. The bone transport and lengthening nail is inserted in the tibia after proximal tibial osteotomy and distal fibula osteotomy.

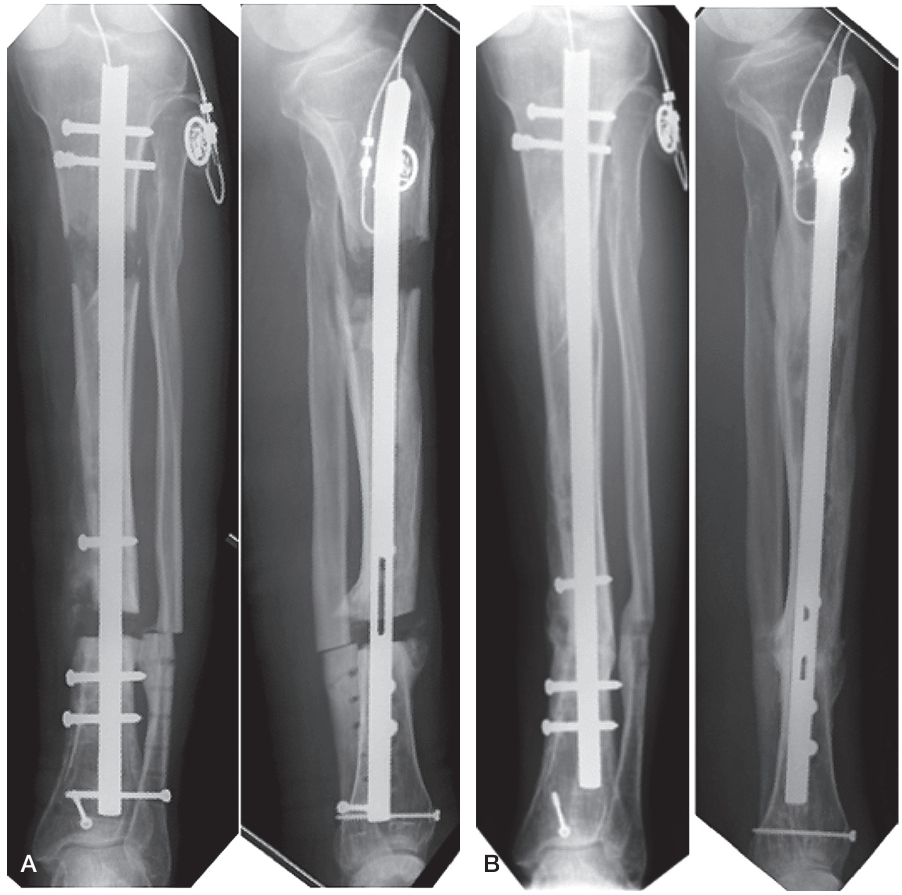

Figure 3. A. 1 month after surgery. B. 13 months after surgery.

atively, and full weight bearing was allowed at this time. Healing time for the regenerate was 45 days/cm of bone lengthening. The distal tibio-fibular screw bothered the patient and was removed at 6 months postoperatively. The nail was removed 15 months postoperatively. At the latest follow-up, 18 months after nail insertion and 3 months after nail removal, the patient had no pain or restrictions in daily activities. Motion of the knee and the ankle on the operated side was equal to that on the healthy side. Motion of the knee was from full extension to 140 degrees of flexion and motion of the ankle was from 15 degrees of dorsal flexion to 30 degrees of plantar flexion. An AP radiograph showed no mechanical axis deviation in the operated leg compared to the healthy leg. There was equal leg length. There was a 3-degree varus deformity in the frontal plane. There was no deformity in the sagittal plane on the lateral radiograph. The posterior proximal tibial angle (PPTA) and the anterior distal tibial angle (ADTA) equalled the preoperative values of 78 degrees (PPTA) and 83 degrees (ADTA). There have not been any clinical signs of infection.

Discussion

Bone resection and subsequent bone transport and bone lengthening is a well-established treatment for a tibial nonunion with shortening (Rozbruch et al. 2008). To our knowledge, this is the first description of bone transport and subsequent bone lengthening of the tibia only by use of a motorized intramedullary nail.

When external fixation is used for bone transport, the stability of the bone transport segment is provided by wires or half-pins placed in different planes and at different levels of the tibia (Orbay et al. 1992). In our case, the intramedullary nail provided stability of the bone transport segment in the sagittal and frontal planes. The locking screw inserted through the sledge in the nail provided rotational stability to the bone transport segment and it also allowed the bone segment to be transported into the bone defect. Complications related to limb lengthening with external fixators are well described (Paley 1990). The use of an intramedullary nail for bone transport instead of an external fixator probably facilitates early full joint motion, as the skin and muscles are not transfixated. Pin problems do not occur. Patient satisfaction and quality of life during and after the lengthening procedure favor the use of intramedullary bone transport (Krieg et al. 2011). The disadvantages of using the motorized Fitbone include the need for removal of the nail due to the internal motor unit. However, the time for removal is not urgent due to discomfort from an external fixator. The risk of deformity or refracture of the bone regenerate or of the bone docking site should therefore be minimal after nail removal.

With the nail technique, all axis correction must be done at the time of surgery. In our case, the 3-degree varus deformity occurring at surgery also resulted in a final varus deformity of 3 degrees. With the TSA Fitbone used having the ability to provide 4 cm of bone transport and 2 cm of bone lengthening, the bone defect should start at a minimum of 20 cm from the tip of the 35 cm long nail. The tibia must be able to take a nail with a diameter of 11 mm, and the proximal osteotomy should be at least 7 cm from the tip of the nail to provide a sufficiently stable locking condition. Although bone biopsies obtained preoperatively unexpectedly showed bacterial growth, we only recommend that the technique should be used when there are no clinical signs of infection.

We chose to implant recombinant BMP-7 at the docking site, as recombinant BMP-7 has been shown to be as effective as autogenous bone graft in treating tibial non-unions (Friedlaender et al. 2001). Another option would have been to use autogenous bone graft.

SK and KC did the preoperative planning, the surgery, and the postoperative follow-up. SK wrote the manuscript.

No competing interests declared.

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