Trifocal Tibial Bone Transport Using a Magnetic Intramedullary Nail

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ABSTRACT

Case: A patient sustained a pathologic fracture secondary to chronic osteomyelitis of the tibia. Treatment involved resection of bone and soft tissue, leaving a 15-cm diaphyseal tibial defect. We designed a construct to allow for trifocal bone transport using a magnetic intramedullary lengthening nail connected to cables secured to the proximal tibia, nail, and transport segments.

Conclusion: This case details the successful use of trifocal cable-assisted bone transport through a magnetic lengthening intramedullary nail. This technique can be used to reconstruct diaphyseal bone defects that are longer than the stroke length of the magnetic nail.

BACKGROUND

- Distraction osteogenesis is an effective technique for reconstruction of bony defects resulting from trauma, infection, or tumor. Use of an external fixator is common and effective,[1] but not without significant complications, including pin site infections, cellulitis, and joint stiffness.[2]
- The PRECICE Intramedullary Limb Lengthening System uses an externally remote-controlled, telescopic, locking nail implanted within the bone. This method forgoes the external fixator and instead uses an external controller that generates a magnetic force to elongate the nail. The PRECICE system has been used in more than 1,000 cases, with more than 250 published reports of outcomes with less pain and lower complication rates than external fixation.[1,3] To date, the PRECICE nail has primarily been used in distraction osteogenesis for limb lengthening, with only a few case reports on its utility in segmental bone transport.[4,5]
- We present a case report of plate-assisted trifocal tibial bone transport for reconstruction of a 14-cm diaphyseal defect using cable transport with a magnetic intramedullary lengthening nail.

CASE REPORT

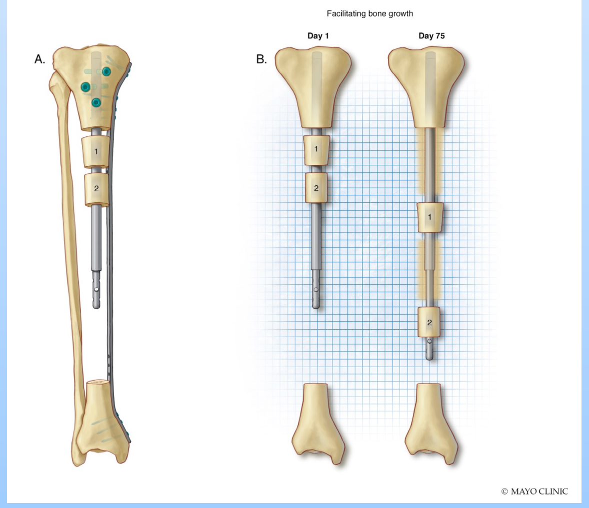

Figure 1: Transport apparatus. (A) Illustration demonstrating the medial plate, magnetic lengthening nail, and two transport segments.

(B) Note the positioning of the fully retracted magnetic nail equidistant between the distal end of the distal transport segment and the proximal end of the distal tibia. Thus as the nail is lengthened and approaches the distal tibia, the distal transport segment will have travelled twice the distance of the proximal transport segment, resulting in two equally sized segments of regenerate bone.

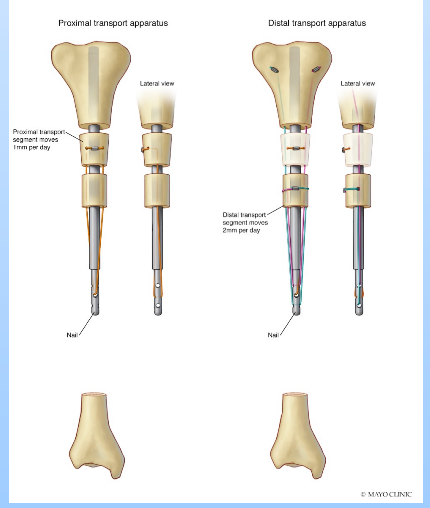

Figure 2: Intramedullary cable apparatus. The proximal transport segment is secured to the end of the magnetic nail via a simple cable loop, passing through the anterior-to-posterior interlocking hole in the nail. The cables then ascend in an intramedullary fashion through the distal transport segment, and through a drill hole on either side of the proximal transport segment. The cable is then crimped to itself on the periosteal surface of the bone.

The distal transport segment is anchored in two locations at the proximal tibia. Two separate cables travel down through medullary canal of each transport segment, and then separately through one of the medial-to-lateral interlocking holes in the distal aspect of the nail. These cables then ascend back up into the distal transport segment and are secured to it by passing back out through a drill hole onto the periosteal surface of the bone and then crimped together.

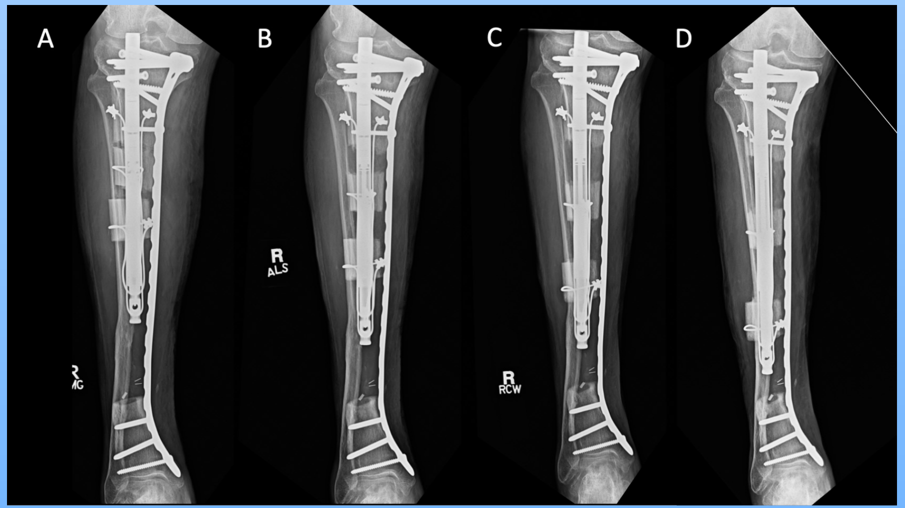

Figure 3: Transport. AP radiographs taken at postop day 14 **(A)**, 35 **(B)**, 52 **(C)**, and 65 **(D)** demonstrate consistent transport of both segments.

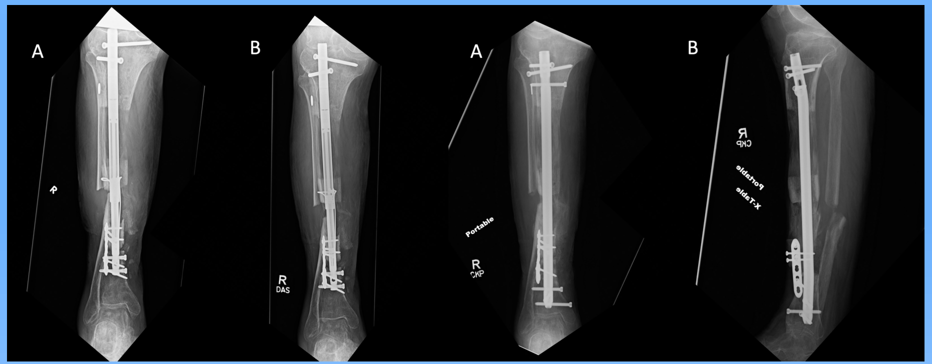

Figure 4 (Left): Final distraction. AP radiographs demonstrating final distraction after docking of the distal transport site at time of surgery **(A)** and after complete distraction through the nail **(B).**
(Right): Nail exchange. AP **(A)** and lateral **(B)** radiographs following nail exchange to a standard cannulated, statically locked nail.

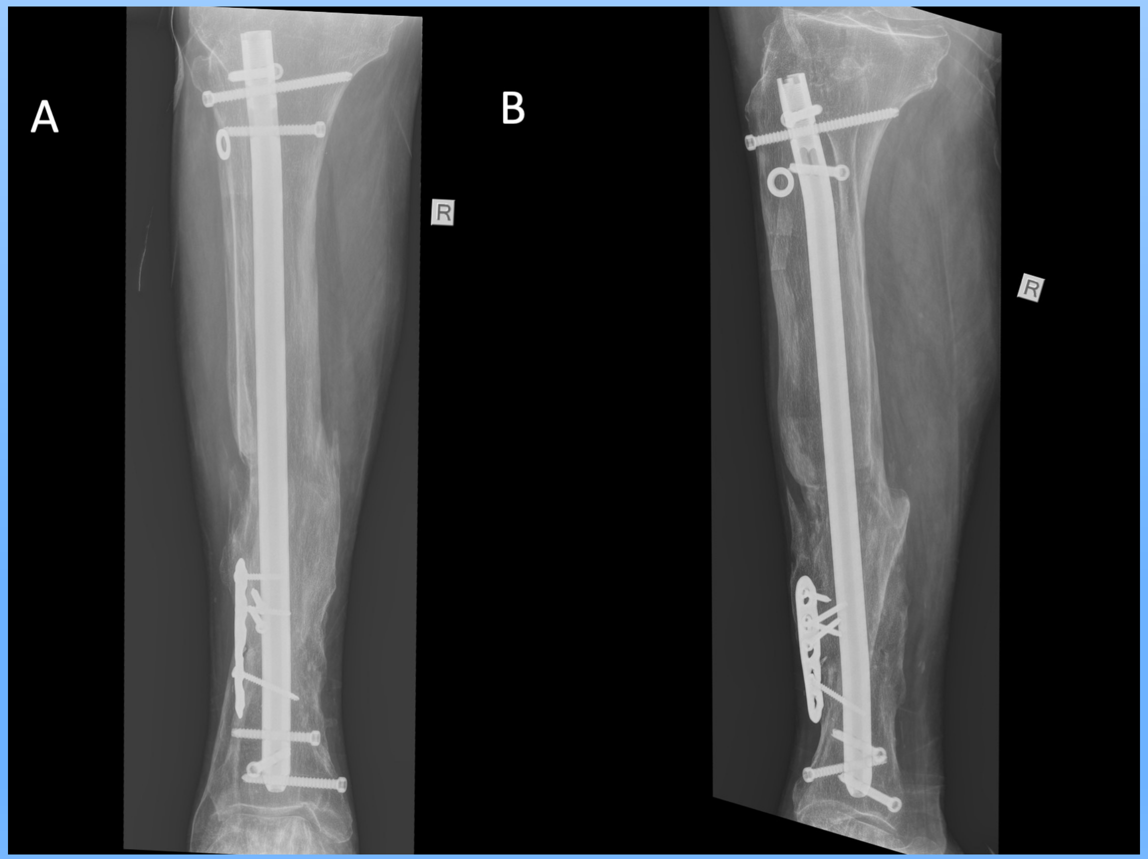

Figure 5: 2.5-year follow-up. Anteroposterior **(A)** and lateral **(B)** radiographs at last follow-up demonstrating union of both docking sites and continued consolidation of the regenerate bone. Areas of the regenerate cortex are continuing to mature, and thus, the nail has been left in situ.

DISCUSSION/CONCLUSIONS

- Distraction osteogenesis is an effective method of reconstruction of critical bone defects but use of external fixation involves significant risk of complications including pin site infection, joint stiffness, and subsequent fracture.
- Intramedullary nail use may decrease the risk of infection and treatment duration. A multifocal approach could further decrease treatment times.
- We illustrate the successful use of a magnetic intramedullary lengthening nail to reconstruct a tibial defect 14 centimeters in length, using cables to perform trifocal transport.
- Final radiographs 2.5 years after initial surgical resection demonstrate continued consolidation of the regenerate and healing of both docking sites, but the quality of the regenerate has not yet reconstituted a complete, mature cortex, possibly due to the patient's age and trifocal transport technique.
- The patient's dramatic recovery highlights the potential use of a magnetic intramedullary lengthening device for reconstruction of diaphyseal bone defects, even those longer than the stroke length of the magnetic nail.
- Further study is warranted to define complications and limitations of this technique.

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