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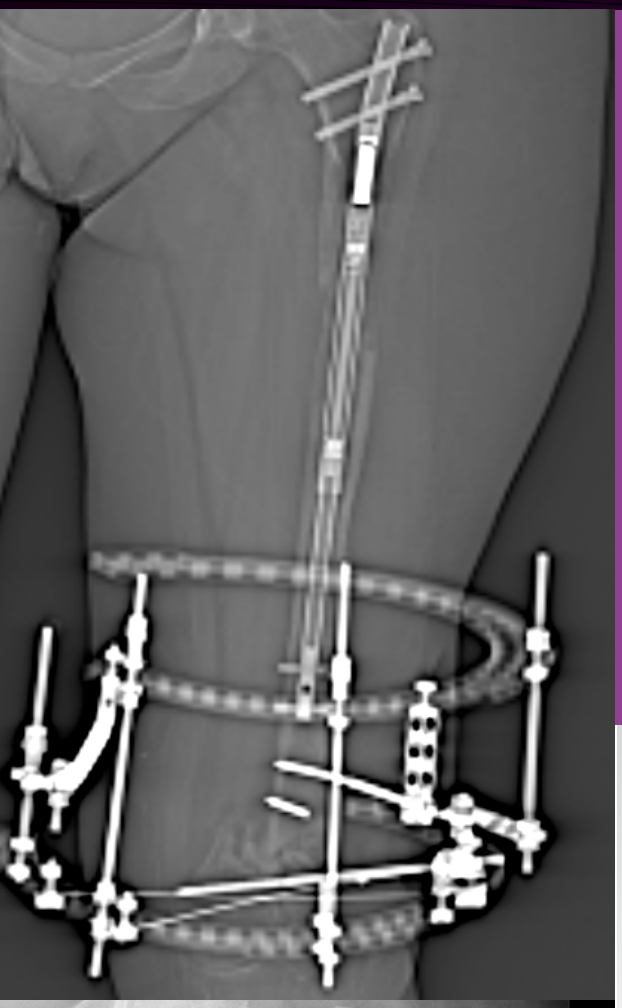
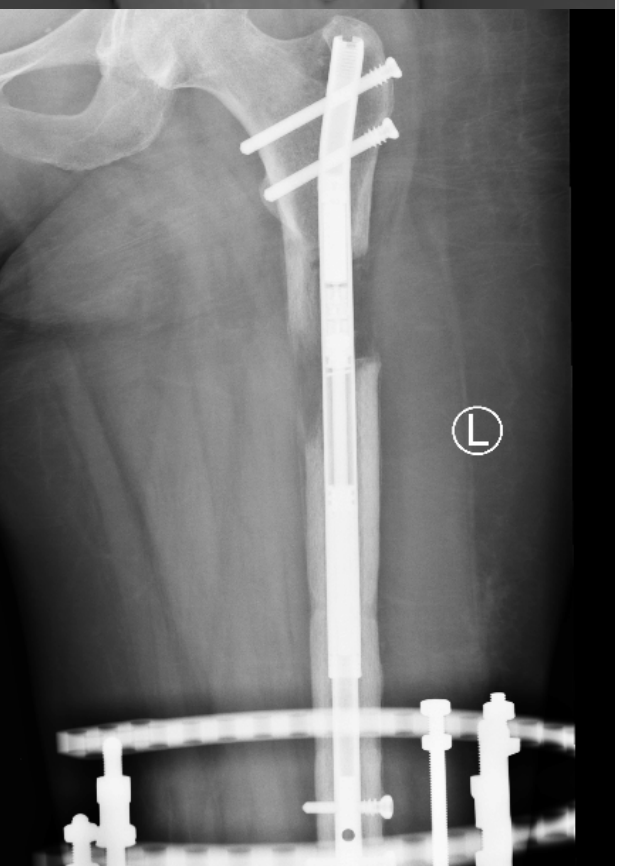




CASE REPORT

Bone transport utilizing the PRECICE® Intramedullary Nail for an infected nonunion in the distal femur

Robert D. Fitch, M.D.
Duke University Health System

CONDITION	Infected nonunion of the distal femur
PRODUCT	PRECICE® Intramedullary Nail
SURGEON	Robert D. Fitch, M.D.

Patient History

A 30-year-old-female presented with infected nonunions of the left distal femur and proximal tibia after fractures sustained during a motorcycle accident one year prior to presentation. In addition, she had a large distal femoral bone defect with an overlying sinus tract of the anterior thigh. Prior to her presentation, the fracture was internally fixed with a lateral plate and screw construct and an antibiotic cement spacer filling the bone defect. Additionally, she previously underwent musculocutaneous flap coverage of an anterior thigh wound.

On physical exam, there was a 2cm diameter wound over the anteromedial mid-thigh muscle flap, tracking deep to the bone. Hip and knee range of motion were significantly limited secondary to pain and stiffness. Motor and sensory exams were normal.

Radiographs of the left femur revealed the lateral distal femoral plate and associated screws, as well as an antibiotic cement spacer, filling the bone defect at the metaphyseal-diaphyseal junction, which measured 38mm x 31mm at maximum dimensions.

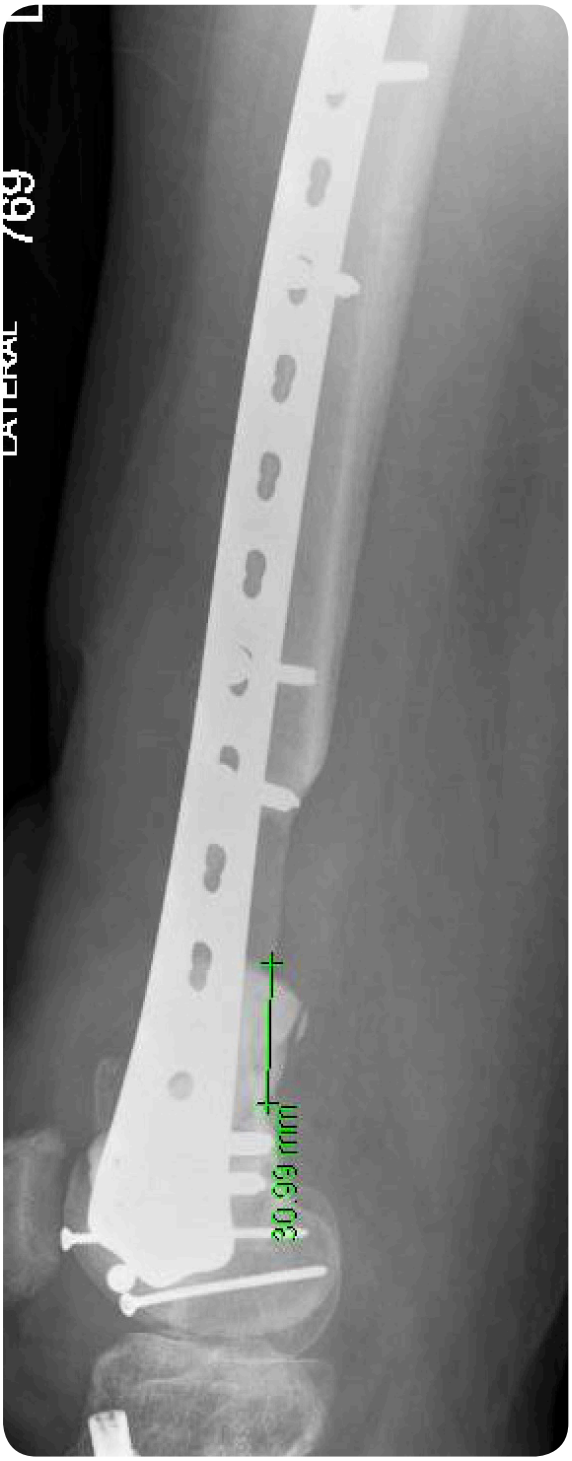
The assessment and problem list for the left femur were:

1. Anterior thigh wound with communication to underlying bone
2. Infected nonunion of the distal femoral metaphysis
3. 38mm x 31mm bone defect of the distal femur

Before addressing definitive fixation and bone defect, the nonunion site was thoroughly irrigated and debrided and treated with antibiotic beads. All hardware was removed and a temporary external fixator was placed. A rotational flap was then performed to provide adequate coverage to the anterior thigh.

The distal femoral diaphyseal nonunion site was debrided and a transverse cut was made with a saw, leaving a 70mm x 70mm bone defect with viable bone ends on either side.


37.98 mm

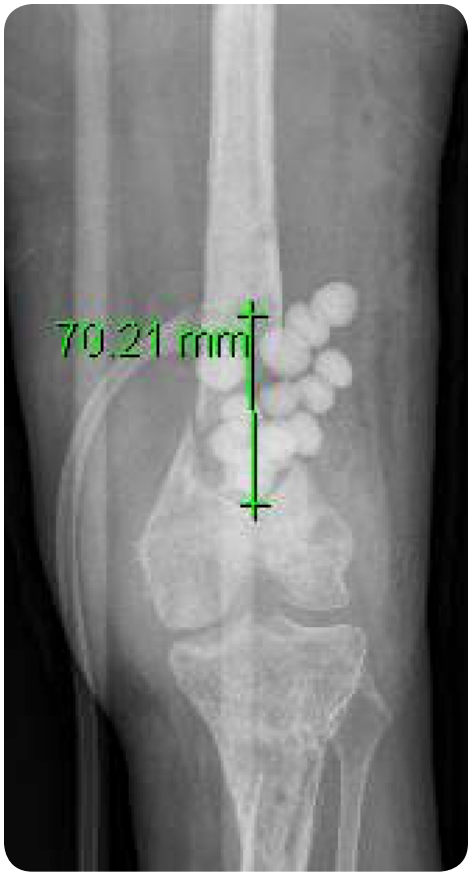

769
30.99 mm

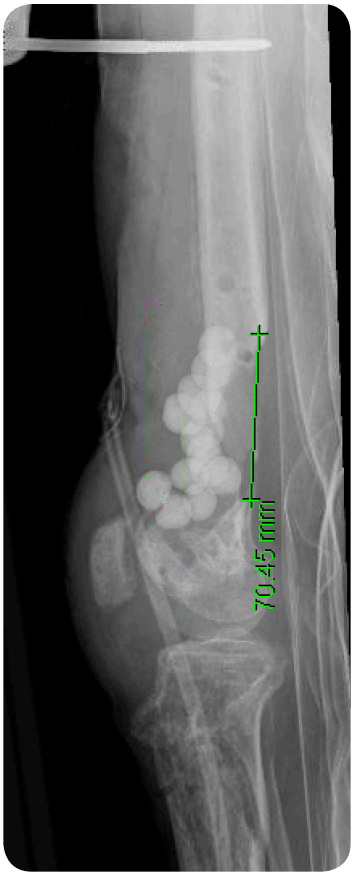
Preoperative Planning

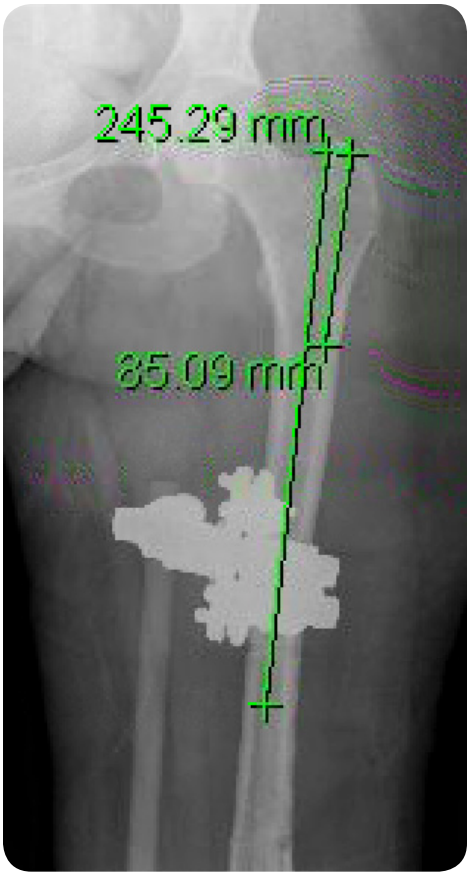
Once the infection was eradicated, definitive surgical management was initiated. Given the significant bone defect of 70mm x 70mm once completely debrided, it was decided to use bone transport for definitive management, using the PRECICE® Intramedullary Nail and a circular frame distally.

Based on preoperative templating measurements of the femur, a 10.7mm x 245mm nail was chosen. The proximal osteotomy was then planned. Accounting for 50mm of the distal segment of the nail needed for stability, 30mm of the starting length of the telescopic portion proximally, and planned 70mm correction, the proximal osteotomy needed to be less than 95mm from the proximal aspect of the femur (245mm nail –(50+30+70)=95mm). This osteotomy was planned at 85mm from the tip of the nail, distal to the lesser trochanter.

In addition, a circular frame was templated to compress the distal femur at the same rate as the PRECICE nail lengthening proximally.

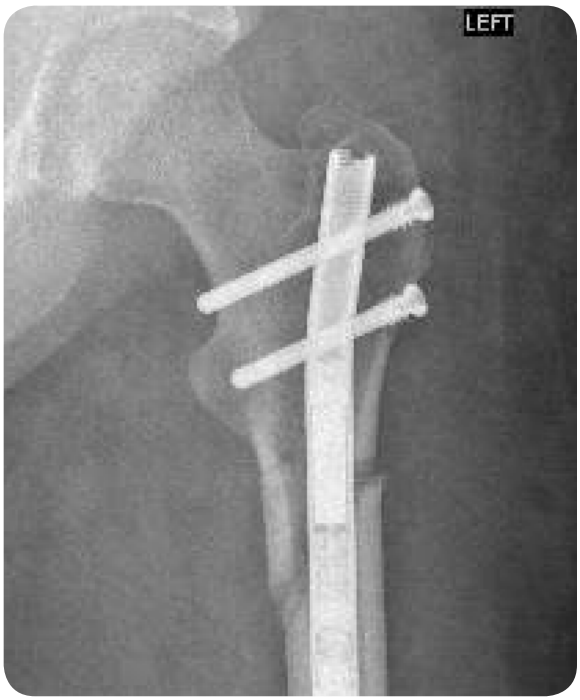


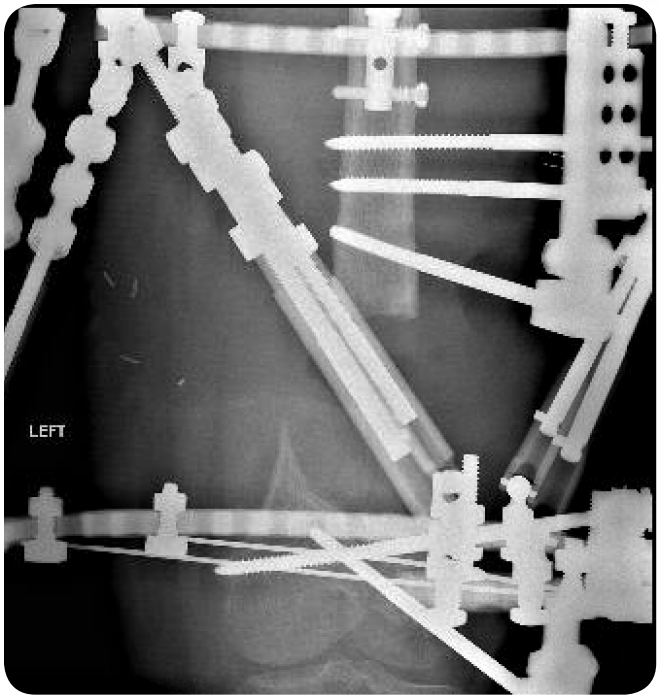


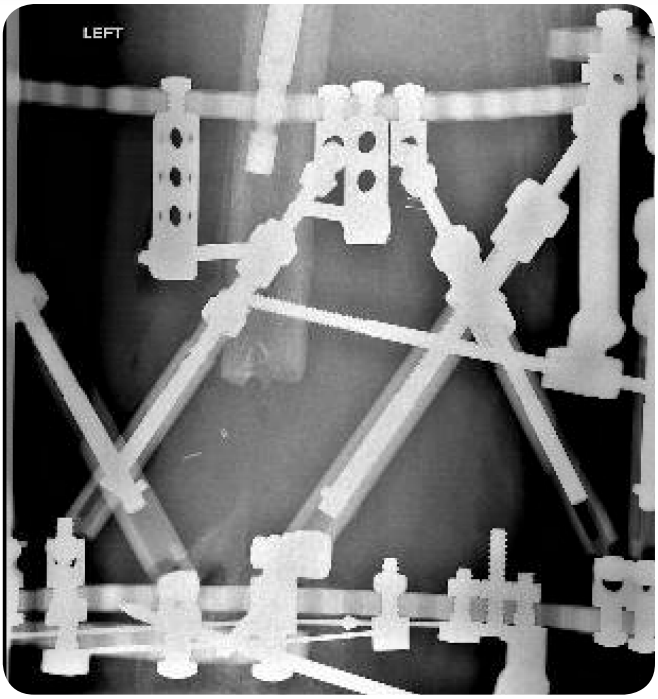


Operative Procedure

After induction of general endotracheal anesthesia, the patient was laid supine on a flat, radiolucent table and was prepped and draped in the standard, sterile fashion. After identification of the greater trochanteric starting point, a guide wire was passed down the femoral medullary canal. Attention then turned to the osteotomy site. This was identified under fluoroscopy and a 4cm lateral incision was made with dissection carried down to the bone. Using a 3.5mm drill, multiple holes were made circumferentially and an osteotome was used to complete the osteotomy cut. The medullary canal was then sequentially reamed to 12.5mm and the PRECICE® nail was then passed. Proximal and distal interlocking screws were inserted. After the nail placement was completed, a circular frame was placed over the distal femoral nonunion site.

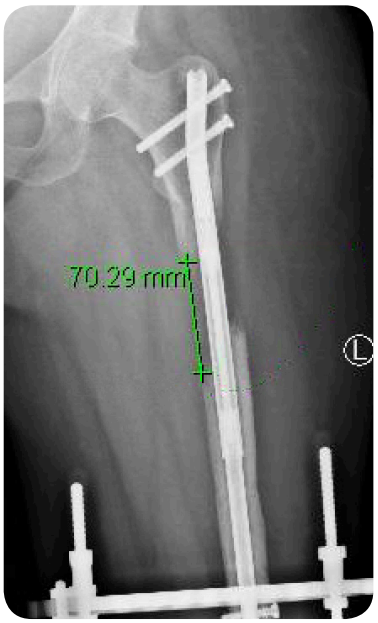


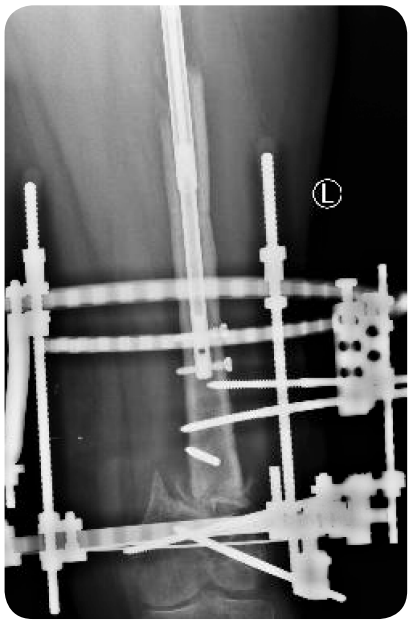


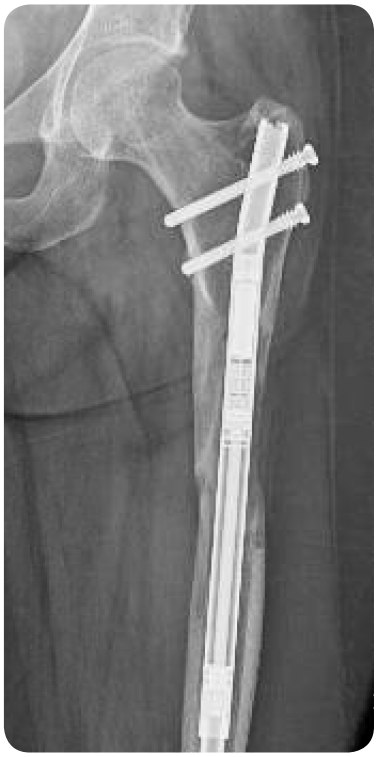


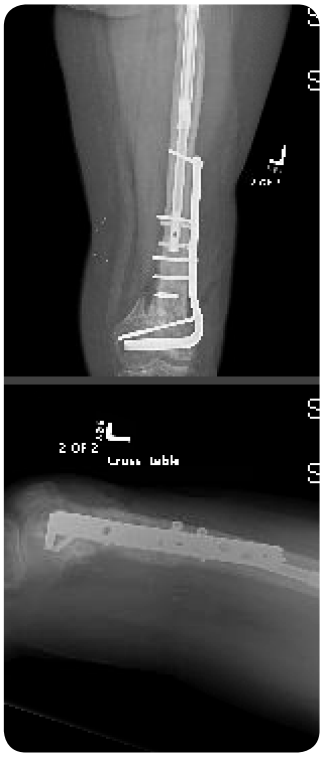
Postoperative Management

Oral venous thromboembolic prophylaxis medication was started one day after surgery and continued indefinitely due to history of deep vein thrombosis and documented bilateral upper extremity thromboses prior to admission. The PRECICE® nail was programmed to extend 1mm/day until goal of 7cm was reached. The circular frame over the distal femur was programmed at an equal daily rate of compression. The patient was initially non-weight bearing for 2 weeks and then advanced to toe-touch weight bearing for an additional 6 weeks before full weight-bearing was permitted once at least 2 cortices of regenerate bone were seen on radiographs.









Results

The patient was followed every 6 weeks with radiographs of the femur. At 6 months, lengthening was completed and the distal nonunion site had sufficiently compressed. Two cortices of regenerate bone were noted on both AP and lateral radiographs. At nine months, the circular frame was removed and given the lack of healing at the distal nonunion site, a lateral plate was placed, along with iliac crest bone graft. At most recent follow-up she had 0-50 degrees of knee range of motion and has started working with physical therapy. The plan remains to leave the intramedullary nail in place until complete healing of the regenerate, likely 16-18 months.

Discussion

Infected nonunions of long bones represent an ongoing challenge for the orthopaedic surgeon, especially when large bone defects are involved. Autologous bone grafting or free tissue transfer of these defects has high morbidity, extended graft incorporation time, and variable success rates given the poor vascularity and disrupted soft tissue envelope at the nonunion site.[1]

In contrast, bone transport utilizes the principles of distraction osteogenesis through a new osteotomy site of healthy bone, with minimal soft tissue and vascular disruption, to produce regenerate bone while compressing the previous nonunion site bone defect.[2] Historically, bone transport has been performed with extensive circular frames and external fixation devices which are not without their own complications such as pin site infections, joint stiffness, and discomfort to the patient for long periods. Recently, intramedullary devices have gained popularity with limb lengthening procedures; however, their application to bone transport has not been extensively studied yet.[3] Early studies show that when combined with external fixation devices, intramedullary implants reduce the period of time the patient is in the external fixator.[4]

Although complicated by an additional tibial bone defect, poor patient compliance, including continued tobacco use, this case represents an example of the potential use of PRECICE® intramedullary nailing for bone transport. The patient achieved appropriate lengthening, with well healed regenerate bone, and required a much smaller external fixation device.

References and Suggested Reading

1. Yin P, Zhang L, Li T, et al. Infected nonunion of tibia and femur treated by bone transport. *J Orthop Surg Res* 2015;10(1):49.
2. Horas K, Schnettler R, Maier G, et al. A novel intramedullary callus distraction system for the treatment of femoral bone defects. *Strategies Trauma Limb Recon* 2016;11(2):113-21.
3. Calder PR, Laubscher M, Goodier WD. The role of the intramedullary implant in limb lengthening. *Injury* 2017;48(S1):S52-58.
4. Kocaoglu M, Eralp L, ur Rashid H, et al. Reconstruction of segmental bone defects due to chronic osteomyelitis with use of an external fixator and an intramedullary nail. *J Bone Joint Surg Am* 2006;88(10):2137-45.

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The PRECICE® System is composed of an implantable intramedullary nail, locking screws, reusable instruments, and a hand-held External Remote Controller (ERC). The PRECICE nail is a sterile single use device that is surgically implanted using the instruments and locking screws. The ERC is used daily after implantation to non-invasively lengthen or shorten the implant to a prescribed length. The PRECICE System is intended for limb lengthening, open and closed fracture fixation, pseudoarthrosis, mal-unions, non-unions, or bone transport of long bones. Contraindications include infection or pathologic conditions of bone such as osteopenia which would impair the ability to securely fix the device, metal allergies and sensitivities, patients whose distance from the surface of the treated limb to the intramedullary canal is greater than 51 mm for the 10.7 and 12.5 mm diameter implants or greater than 38 mm for the 8.5 mm diameter implant, patients with an irregular bone diameter that would prevent insertion of the PRECICE nail, patients in which the PRECICE nail would cross joint spaces or open epiphyseal growth plates, patients in which there is an obliterated medullary canal or other conditions that tend to retard healing such as blood supply limitations, peripheral vascular disease or evidence of inadequate vascularity, patients unwilling or incapable of following postoperative care instructions, patients weighing in excess of 114 kg for the 10.7 and 12.5 mm diameter implants (models A-G, H, J, K, U, V, and X) or weighing in excess of 57 kg for the 8.5 and 10.7 mm diameter implants models (A-G, H, J, K, U, N, M ,P, Q, V, and X). The implantable device is only to be used by a trained licensed physician. Please refer to the PRECICE IMLL System instructions for use for complete Important Safety Information. Caution: Federal law restricts this device to sale by or on the order of a physician.

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