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ADJUSTABLE SOLUTIONS
FOR ORTHOPEDICS

Case Report

Tibia Lengthening with the PRECICE Limb Lengthening Technology

S. Robert Rozbruch, MD
Hospital for Special Surgery
New York, NY, USA

ELLIPSE

ABSTRACT

This is a case illustrating a 6.5 cm tibia lengthening done for lower extremity shortening related to the hip and proximal femur. The presence of a complex hip replacement prosthesis and hip joint instability led to choice of the tibia for lengthening. The PRECICE internal lengthening nail was used and the recovery was excellent. Gastroc-soleus recession was performed to prevent impending ankle equinus contracture.

BRIEF CLINICAL HISTORY

The patient is a 37 year old female with a complicated history of hip pathology from childhood. This included femoral head necrosis, fracture, and growth arrest. Ultimately, she was treated with a custom total hip replacement (THR) by a hip specialist who referred the patient for evaluation and treatment of LLD. The THR had problems of instability and was a constrained articulation. The overall LLD was 7 cm and she was comfortable wearing a shoe lift for short distances.

PREOPERATIVE CLINICAL PHOTOS AND RADIOGRAPHS

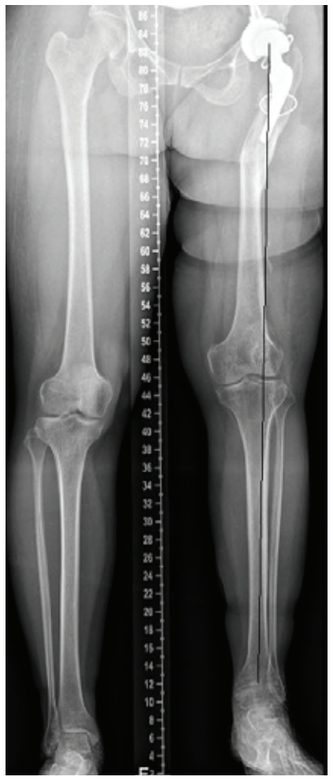

Figure 1A

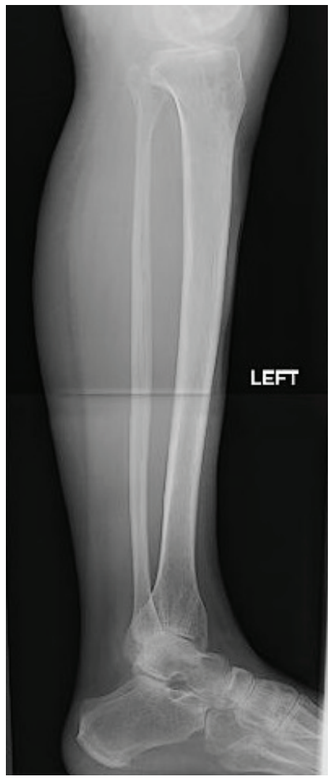

Figure 1B

Figure 1: (A,B) X-rays showing LLD of 7 cm coming from the femur and hip. Tibia is normal. Note lateral MAD.

Figure 2A

Figure 2B

Figure 2C

Figure 2: (A–C) Front, side and back views showing short left lower extremity and a small left hip flexion contracture.

PREOPERATIVE PROBLEM LIST

- LLD 7 cm
- Short femur
- Ipsilateral THR with proximal femur deformity and instability
- Impending ankle equinus contracture

Figure 3

Figure 3: AP pelvis x-ray showing custom made THR and proximal femur deformity. Note there is a constrained articulation.

TREATMENT STRATEGY

- Avoid lengthening the femur, as it presents the risk of hip dislocation.
- Lengthen tibia and fibula with PRECICE Nail.
- Perform gastroc-soleus recession since patient is at high risk for developing an equinus contracture of the ankle.

BASIC PRINCIPLES

- It is risky to lengthen the femur when there is hip instability. The proximal femur deformity contributes to this instability. Femur lengthening will increase risk of hip dislocation and displacement of the prosthesis.
- Tibia lengthening eliminates the risk to the hip.
- Tibia lengthening will cause there to be a knee height discrepancy similar to the situation of using a shoe lift. This does not appear to be a clinical problem for walking.
- Tibia lengthening has a tendency to deform into valgus and procurvatum. At the osteotomy level, if there is space between the nail and the cortex to the concavity of the anticipated deformity, then blocking screw(s) should be inserted. The concavity of valgus deformity is the lateral edge of the bone. The concavity of procurvatum deformity is the posterior edge of the bone.
- The fibula should be stabilized to the tibia at the knee and ankle to prevent distal and proximal migrations respectively.

IMAGES DURING TREATMENT

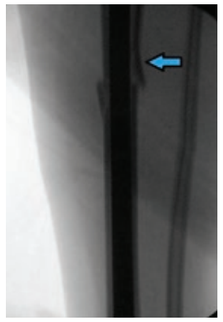

Figure 4A

Figure 4B

Figure 4C

Figure 4D

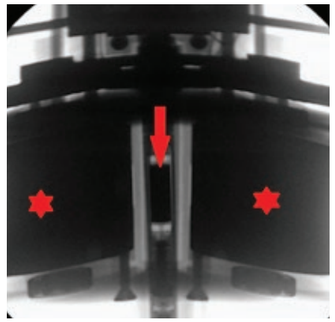

Figure 4E

Figure 4: Intra-operative fluoroscopy images (A) AP view after insertion of nail. There does not appear to be space between the lateral border of the nail and the lateral cortex (blue arrow) at the osteotomy level. For this reason, a blocking screw was not inserted. (B) Lateral view after insertion of the nail. There does not appear to be space between the nail and the posterior cortex (orange arrow) at the osteotomy level. For this reason, a blocking screw was not inserted. (C) A syndesmosis screw is inserted to prevent proximal migration of the distal fibula. The oblique screw placement provides superior resistance to a proximal pull on the fibula. (D) Insertion of proximal tibia-fibula screw posterior to the IM nail. The transverse orientation does not provide optimal resistance against the fibula being pulled distally (Figure 6A). A preferable orientation for this screw is demonstrated by the brown line. (E) The external magnet controller (EMC) (stars) is placed over the magnet in the IM nail (red arrow).

Figure 5A

Figure 5B

Figure 5: (A) Bipedal standing x-ray at end of distraction (70 days after surgery) showing equal leg lengths. Note MAD position relative to preoperative (Figure 1A). Mild increase in valgus did occur. (B) Front view at 3 months showing equal leg lengths. Note the mark on skin for EMC placement.

Figure 6A

Figure 6B

Figure 6: Radiographs 3 months after surgery with excellent bone formation. (A) AP view shows distraction gap of 65 mm and is seen in the rod between the yellow stars. Note the proximal fibula has pulled distally despite the screw (green arrow) (B) Lateral view showing excellent alignment.

TECHNICAL PEARLS

- Use rotation markers to prevent rotational deformity. Place rotational pins parallel to each other.
- Correct preoperative rotational deformity (not present in this case) by placing the rotational pins with the amount of angular deformity to be corrected. Use an intra-operative goniometer. After the osteotomy, correct the rotation and make the pins parallel.
- Varus or valgus deformity (not in this case) can be corrected by performing the osteotomy at the apex of deformity, to acutely correct the deformity and then insert nail.
- Rotate osteotomy around the intramedullary (IM) nail before insertion of locking screws to assure a complete osteotomy.

AVOIDING AND MANAGING PROBLEMS

- Avoid propagation of the osteotomy to optimize the angular control of the nail. In this case, the small lateral propagation (Figure 4A) of the osteotomy led to mild valgus.
- If the canal diameter is greater than the IM nail at the osteotomy site, blocking screws should be inserted to prevent deformity. They work by narrowing the IM canal. Blocking screws are to be inserted in the concavity of the anticipated deformity.
- Mark the location of the magnet in the nail on the skin. The external magnet controller must be placed directly over the magnet within the nail to actuate a distraction.
- Pre-drill the osteotomy before reaming. This decreases pressure in the IM canal during reaming and protects against fat embolism syndrome.
- The gastroc-soleus recession helps prevent equines contracture. Tibia lengthening of greater than 13% and 42 mm are predictors that the patient will need a gastroc-soleus recession for equinus contracture.
- Proximal and distal tibia-fibula stabilization is necessary to prevent unwanted fibula migration. Distal migration of the proximal fibula stretches the LCL and the biceps femoris insertion and this can lead to knee flexion contracture. Proximal migration of the distal fibula can lead to ankle deformity, stiffness, and pain. Oblique screw placement provides optimal resistance to fibular migration (Figures 4C,D).

OUTCOME CLINICAL PHOTOS AND RADIOGRAPHS

Figure 7A

Figure 7B

Figure 7: (A,B) AP and lateral x-rays 12 months after surgery. MPTA is 88 degrees.

Figure 8A

Figure 8B

Figure 8: (A,B) AP and lateral x-rays 14 months after initial surgery and one week following nail removal.

References and Suggested Reading

Kirane Y, Fragomen AT, Rozbruch SR. Precision of the PRECICE® Internal Lengthening Nail. *Clin Orthop Rel Res.* 2014;472(12):3869-78.

Rozbruch SR, Zonshayn S, Muthusamy S, Borst EW, Nguyen JT. What risk factors predict usage of gastrocsoleus recession during tibial lengthening? *Clin Orthop Relat Res.*

Rozbruch SR, Birch JG, Dahl MT, Herzenberg JE. Motorized intramedullary nail for treatment of limb length discrepancy. *J Am Acad Orthop Surgeons.* 2014;22(7):403-9.

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Phone: (+1) 949-837-3600 | Fax: (+1) 949-837-3664

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The Ellipse PRECICE® Intramedullary Limb Lengthening (IMLL) 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 of the femur and tibia. 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 mm diameter implant 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 mm diameter implant or weighing in excess of 57 Kg for the 8.5 mm diameter implant. 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. U.S. and International Patents Issued and Pending.

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