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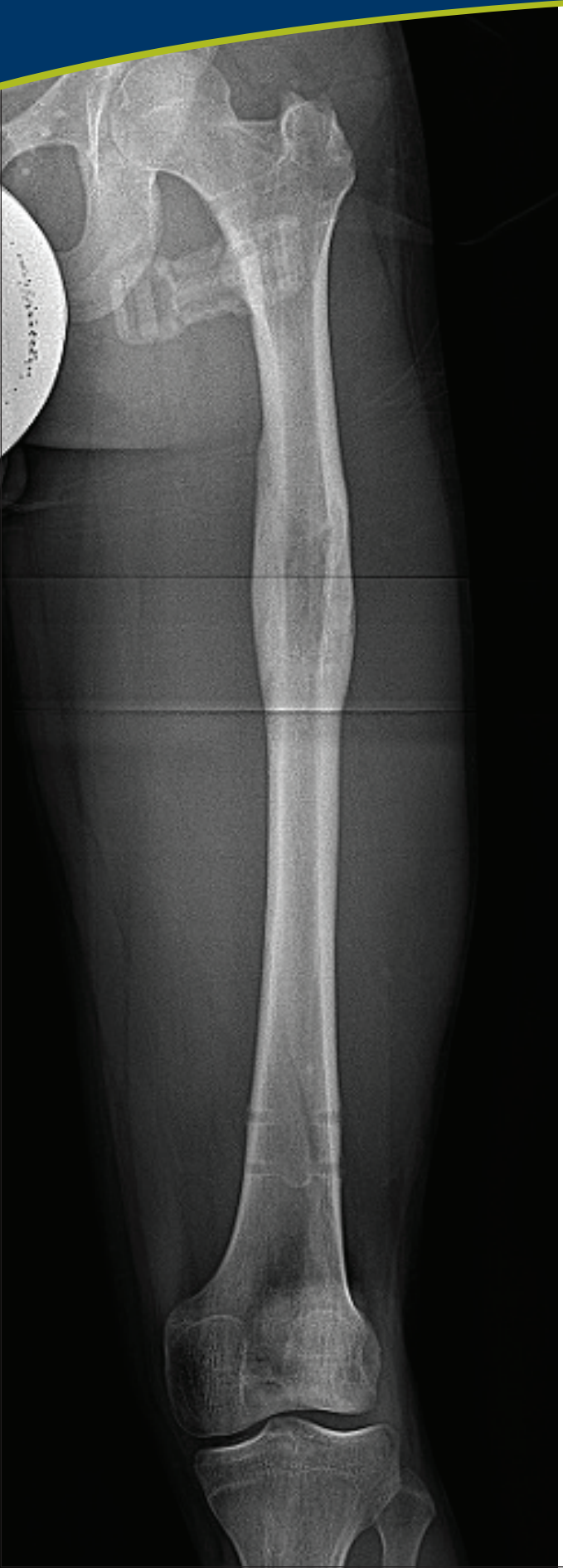

Case Report

Antegrade Femur Lengthening with the PRECICE Limb Lengthening Technology

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ELLIPSE

ABSTRACT

This is a case illustrating a 4.5 cm femur lengthening for congenital LLD. The PRECICE internal lengthening nail was used and the recovery was fast with normal unassisted walking at 4 months.

PATIENT HISTORY

The patient is a 25 year old male with congenital LLD of 4.5 cm and without deformity. No previous treatment was rendered. The patient and the family were not interested in limb lengthening using external fixation at earlier points in his life.

PREOPERATIVE CLINICAL PHOTOS AND RADIOGRAPHS

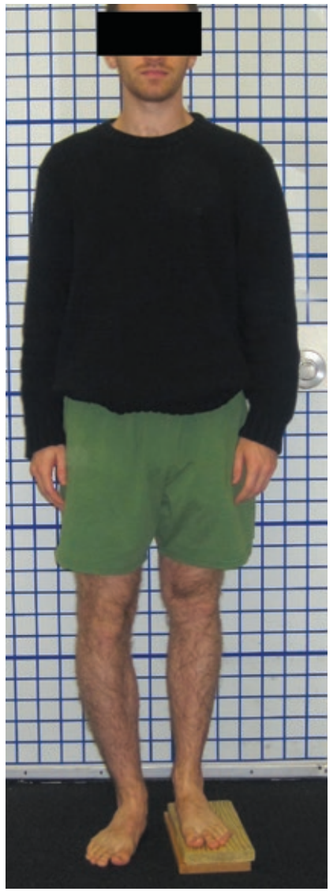

Figure 1A

Figure 1B

Figure 1: (A,B) Front and back view showing left lower extremity shortening of 4.5 cm.

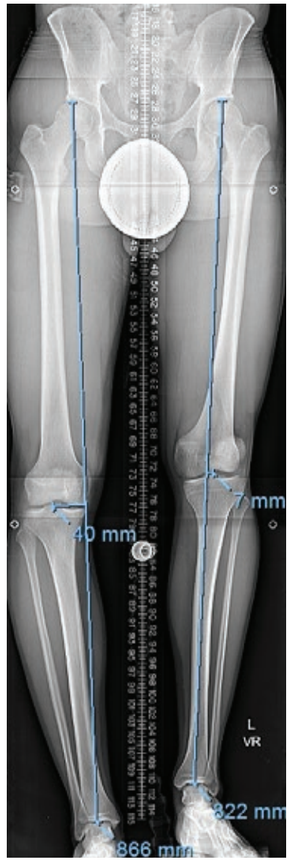

Figure 2A

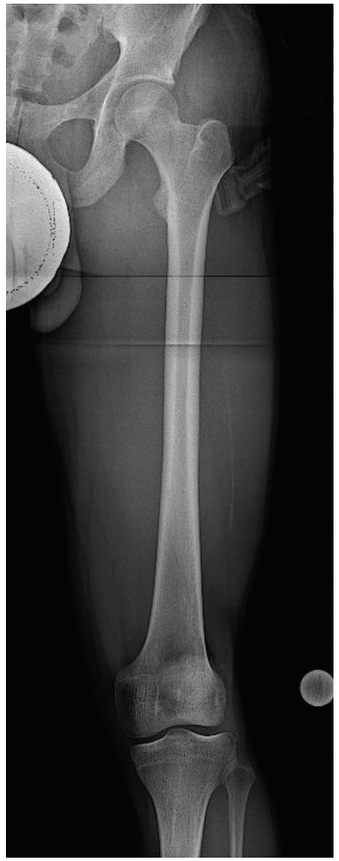

Figure 2B

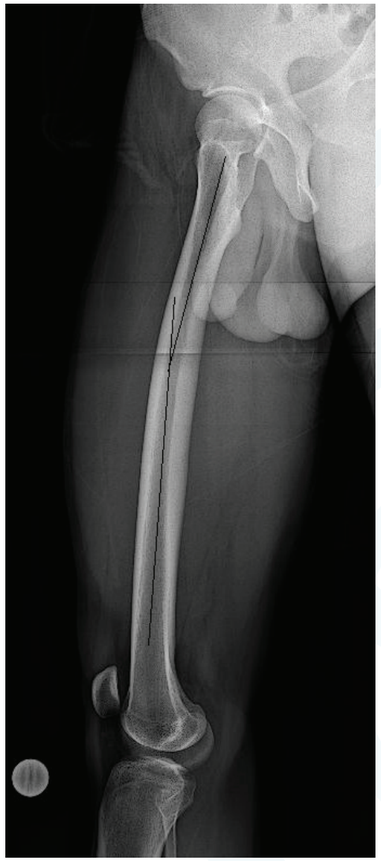

Figure 2C

Figure 2: Preoperative x-rays (A) Standing x-ray shows LLD of 4.4 cm. MAD is normal. (B) AP femur showing small IM canal. (C) Lateral femur showing normal anterior bow with apex 15 cm distal to tip of trochanter. (D) Merchant view of knees showing normal patella alignment.

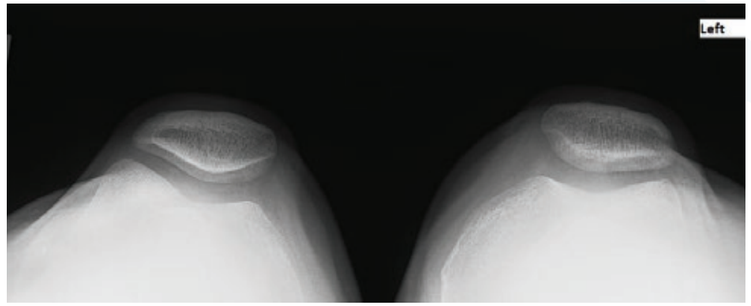

Figure 2D

TREATMENT STRATEGY

- Femoral lengthening using an intramedullary limb lengthening nail
- Antegrade approach
- Osteotomy at the apex of the femur anterior bow on the lateral x-ray
- Iliotibial band (ITB) tenotomy

BASIC PRINCIPLES

- Osteotomy to be completed at the apex of the anterior bow to allow for a longer, straight nail to be inserted.
- Piriformis or trochanteric entry can be used based on surgeon preference.

  NOTE: Patients less than 19 years of age should have trochanteric entry to avoid avascular necrosis.
- Nail length choice and osteotomy location requires planning: The goal is to have at least 5 cm of thick part of the nail in the distal segment at the end of distraction for optimal stability. During distraction, the thick part of the nail is pulled out of the distal segment.

  In this case, a 305 mm nail was used. Subtract the starting length of the small diameter telescoping part of the nail (30 mm), the planned lengthening (45 mm), and the minimum length of the thickest part in the distal segment (50 mm).

  305 - (30 + 45 + 50) = 130 mm

  The osteotomy must be less than 180 mm from the proximal end of the bone. In this case, 150 mm was chosen without a problem.
- Reaming 1.5 to 2 mm over the diameter of the nail should be done. In this case, the bone was reamed to 12.5 mm to accommodate a 10.7 mm nail.
- Although lengthening should ideally be done along the mechanical axis of the femur, when using an IM nail, lengthening is along the anatomic axis. Theoretically, this could increase valgus alignment.
- In a normally aligned limb, intramedullary lengthening along the anatomical axis of the femur results in a lateral shift of the mechanical axis by approximately 1 mm for each 1 cm of lengthening. In practical terms, this is not a substantial problem. Compare figures 2A to 5A and you will notice no increase in valgus. During lengthening, mild varus of the bone offsets the medialization of the distal femur.

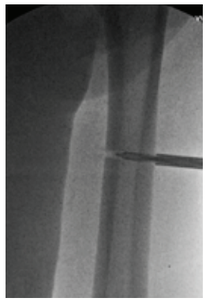

Figure 3A

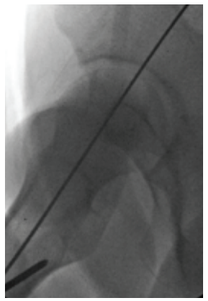

Figure 3B

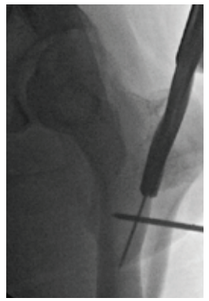

Figure 3C

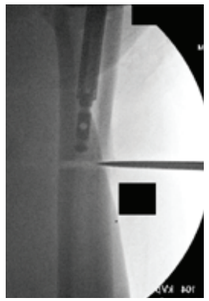

Figure 3D

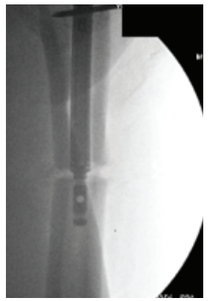

Figure 3E

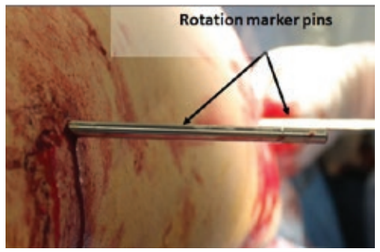

Figure 3F

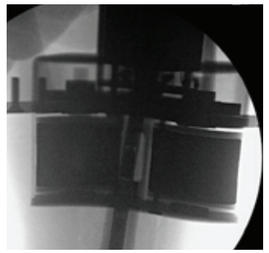

Figure 3G

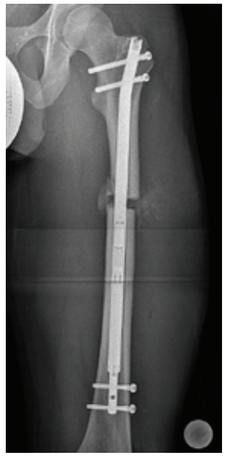

Figure 3H

Figure 3: Intraoperative C-arm x-ray images (A) Multiple drill holes are made at intended site of osteotomy. (B) Proximal rotational pin is placed posterior to intended path of the nail. A second rotational pin marker is inserted into the distal femur beyond the anticipated end of the nail. Guide wire is inserted into center of trochanter. (C) Cannulated reamer opens path into IM canal. Note the proximal rotation marker. (D) After reaming with flexible reamers 1.5–2 mm over the diameter if the IM nail, the solid nail is inserted without guide wire up to the osteotomy site. The osteotomy is then completed with an osteotome. (E) The IM nail is then passed across the osteotomy. (F) The proximal and distal rotational marker pins are used to assure optimal rotational alignment. (G) The external magnet controller (EMC) is applied over the magnet in the nail. The skin is marked so that the EMC can be reliably placed for distraction. (H) One week after distraction started showing distraction gap of 7 mm. Note the cloud of new bone already seen.

IMAGES DURING TREATMENT

Figure 4A

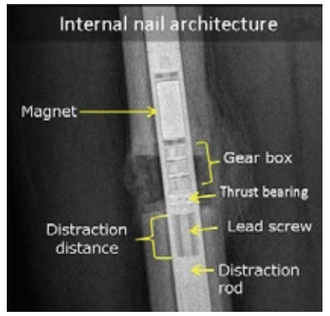

Figure 4B

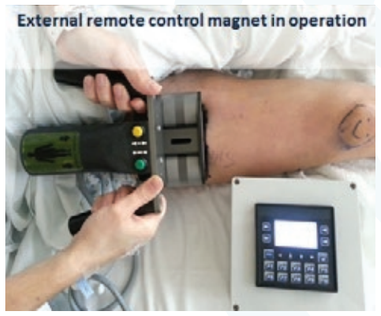

Figure 4C

Figure 4: (A) Picture of the PRECICE Nail. (B) Anatomy of the PRECICE nail on x-ray. (C) Placement of the EMC on the thigh over the magnet in the nail for distraction (see Figure 3G).

TECHNICAL PEARLS

1. Use rotation markers to prevent rotational deformity. Place rotational pins parallel to each other.
2. 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.
3. 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.
4. Rotate osteotomy around the IM nail before insertion of locking screws to assure a complete osteotomy.
5. Dr. Rozbruch prefers to insert the distal interlocking screws to prevent malrotation. The leg and rod are rotated to get "perfect circles" needed for freehand distal locking screw insertion. Then the leg is carefully positioned using the rotational pins as guides and the proximal interlocking screws are easily inserted using the jig.

OUTCOME CLINICAL PHOTOS AND RADIOGRAPHS

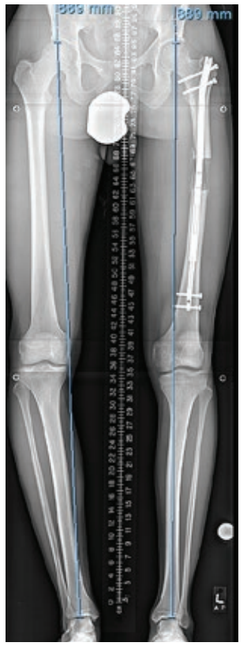

Figure 5A

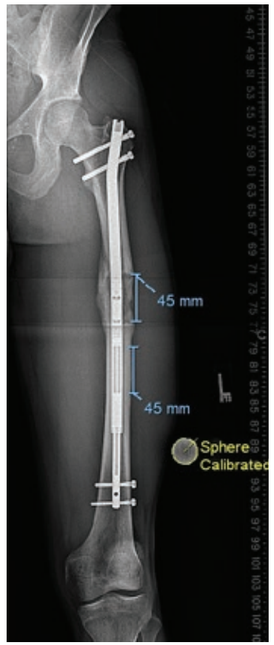

Figure 5B

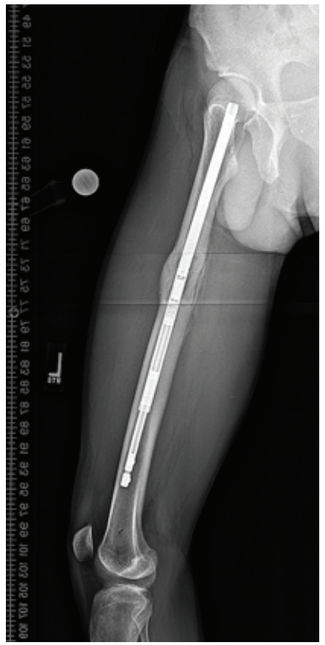

Figure 5C

Figure 5: (A) Bipedal standing x-ray at end of distraction (50 days after surgery) showing equal leg lengths. Note MAD position relative to preoperative (Figure 2A). Increase in valgus did not occur. (B,C) AP and lateral x-ray of femur 4 months after surgery showing excellent bone healing progression of 4.5 cm regenerate. Note straightening of the anterior bow of the femur. Note mild varus due to proximal propagation of osteotomy on medial cortex. Full weight bearing was allowed.

Figure 6A

Figure 6B

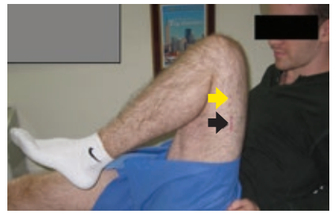

Figure 6C

Figure 6: Clinical photos 4 months after surgery (A) Front view showing equal leg lengths and no deformity. (B) Side view showing full knee extension. (C) Knee flexion to 130 degrees. Note the percutaneous insertion of distal locking screws (yellow arrow) and the incision for routine release of the iliotibial band (black arrow).

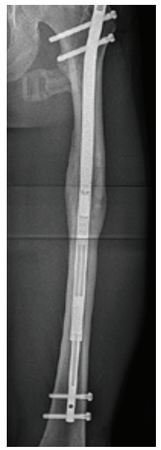

Figure 7A

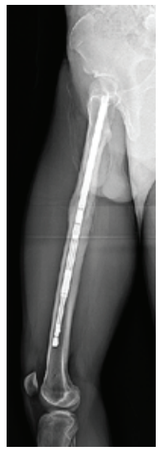

Figure 7B

Figure 7: (A,B) AP and lateral x-rays 7 months after surgery.

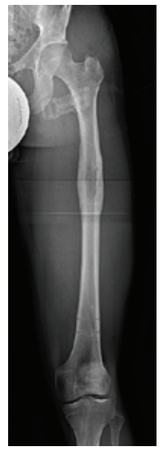

Figure 8A

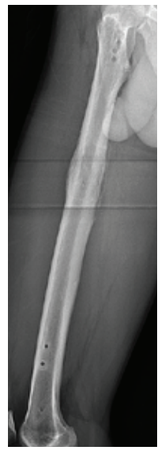

Figure 8B

Figure 8: (A,B) AP and lateral x-rays 10 months after initial surgery and one week following nail removal.

AVOIDING AND MANAGING PROBLEMS

1. Avoid propagation of the osteotomy to optimize the angular control of the nail. In this case the small proximal medial propagation of the osteotomy led to mild varus.
2. 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.
3. 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.
4. Pre-drill the osteotomy before reaming. This decreases pressure in the IM canal during reaming and protects against fat embolism syndrome.
5. The ITB tenotomy helps prevent knee contracture during distraction.

References and Suggested Reading

Burghardt RD1, Paley D, Specht SC, Herzenberg JE. The effect on mechanical axis deviation of femoral lengthening with an intramedullary telescopic nail. *J Bone Joint Surg Br.* 2012;94(9):1241-5.

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

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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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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