Adult Femur Lengthening Algorithm

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HOSPITAL FOR SPECIAL SURGERY

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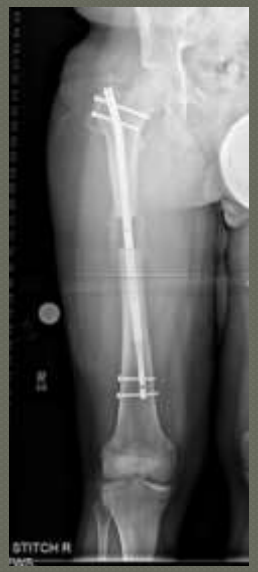
Disclosures

Small Bone Innovations: consultant and royalties

Smith and Nephew: consultant

Treatment options

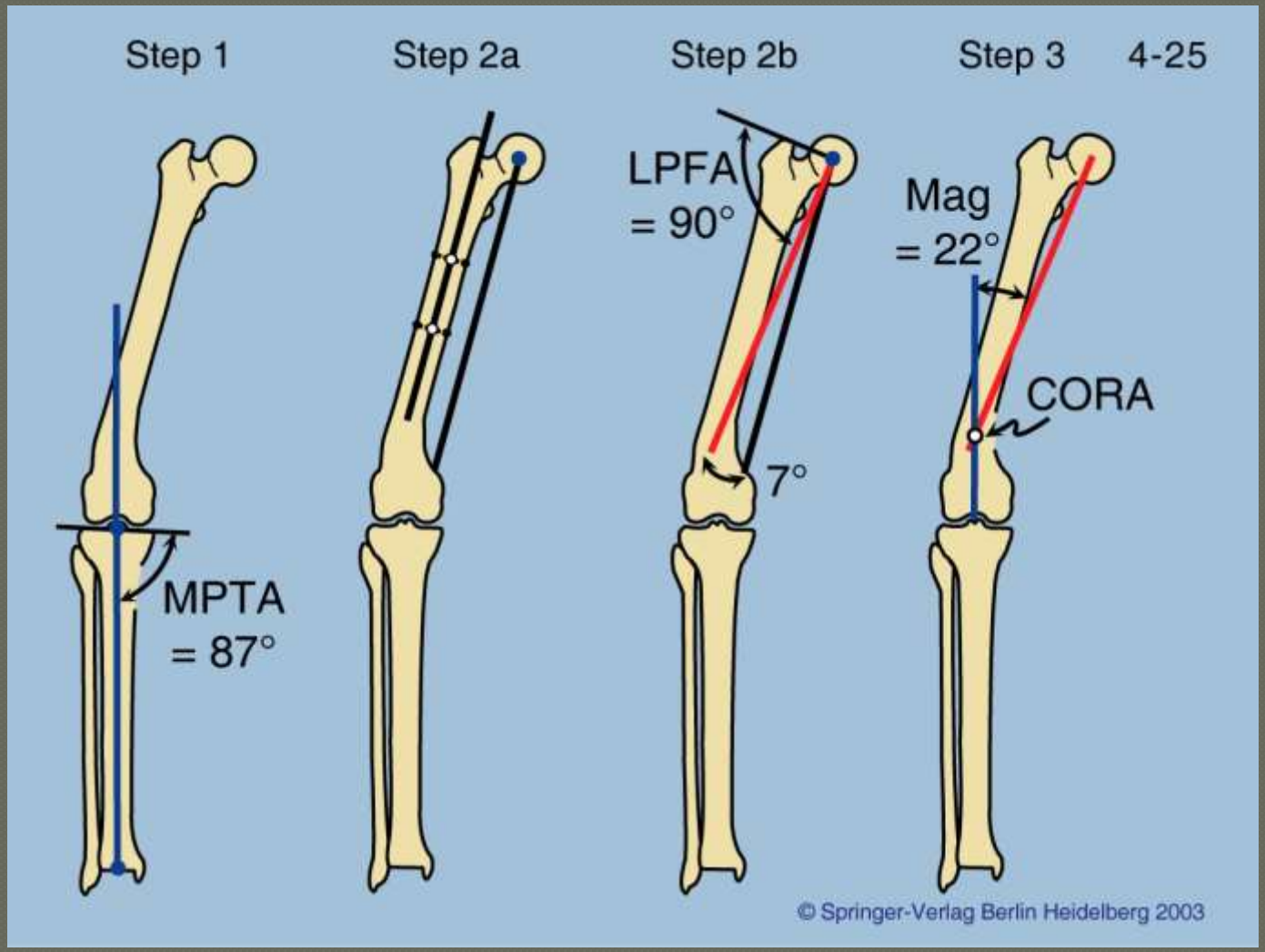
- External Fixation
- IntegratedFixation
  - LON
  - LATN
  - LAP
- Internal lengthening nail
  - Piriformis
  - Trochanteric entry
  - retrograde



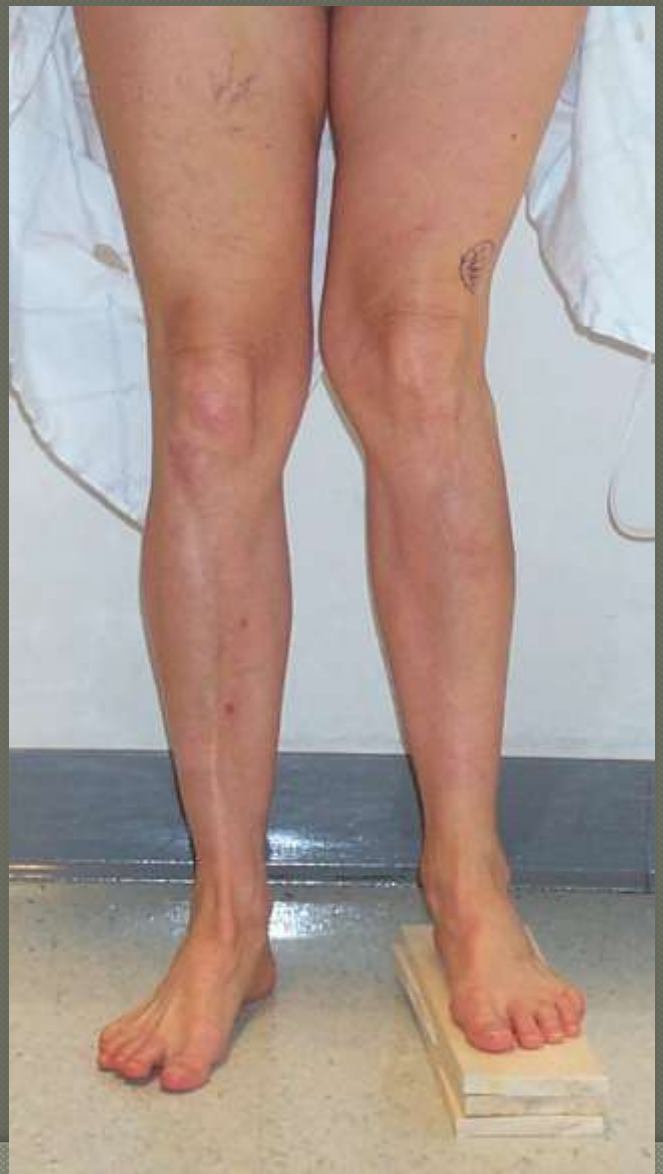
External Fixation

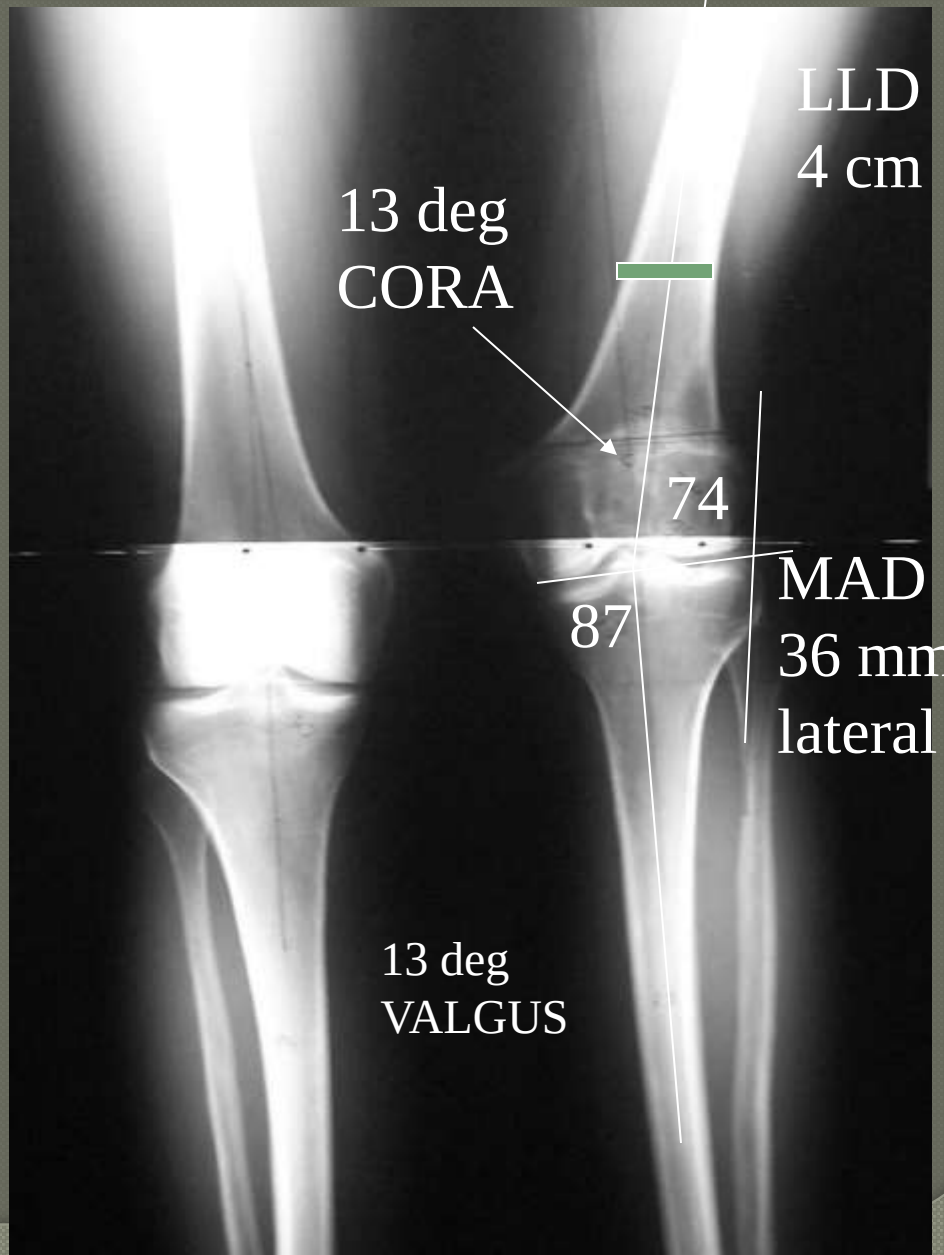
- Historical
- Indications
  - When other techniques are contraindicated
- Pros
  - Quick surgery
  - Minimally invasive
  - Little blood loss
  - versatile
- Cons
  - Pin site problems
  - Long EFI

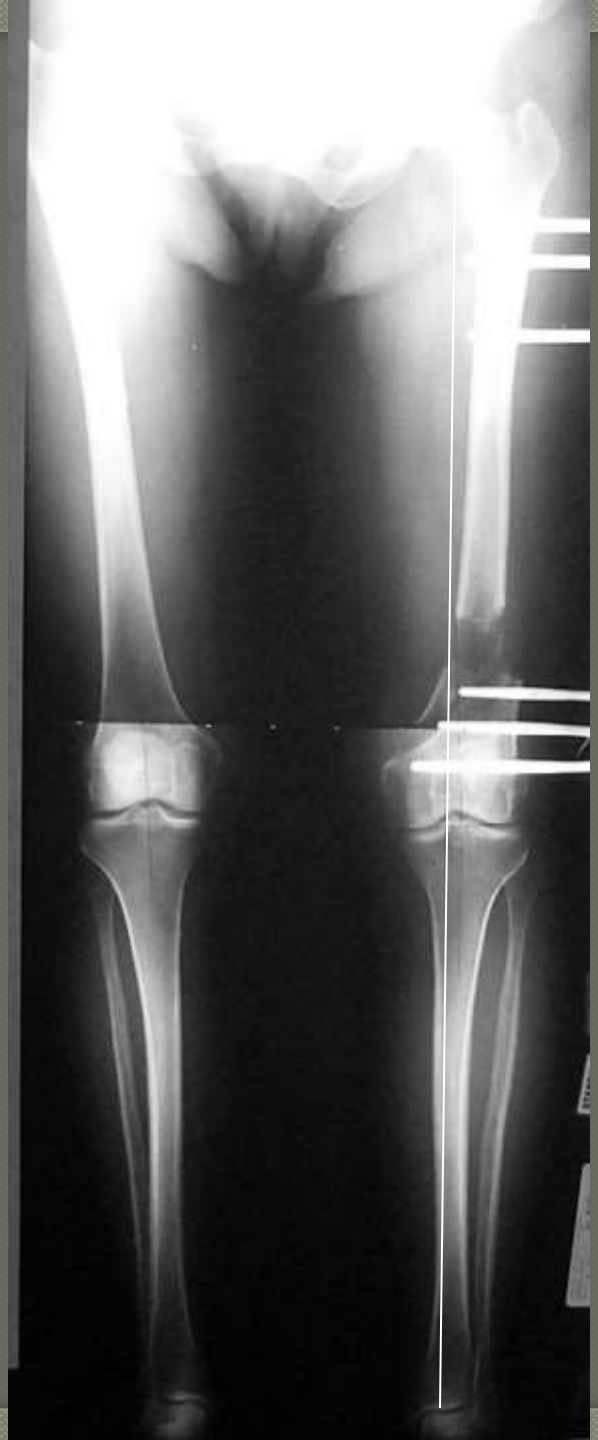
Normal tibia and Varus femur

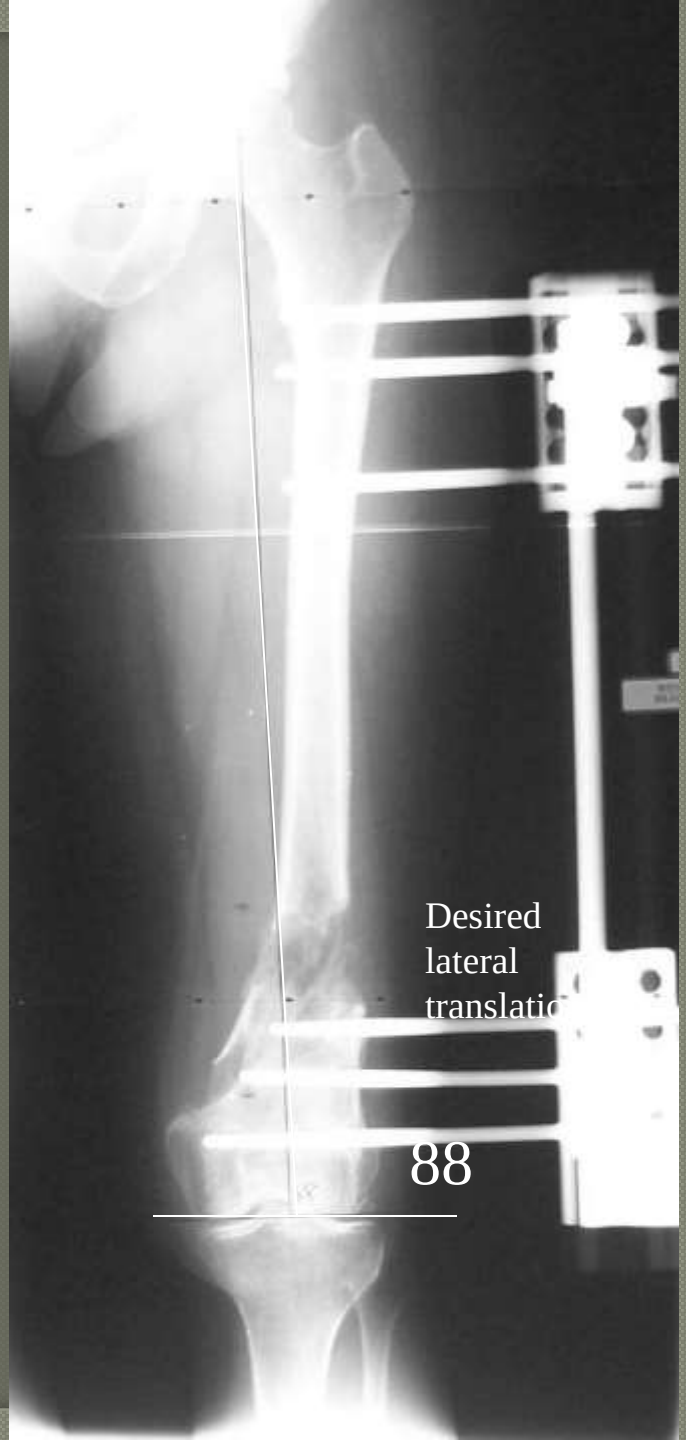


Normal tibia, valgus femur

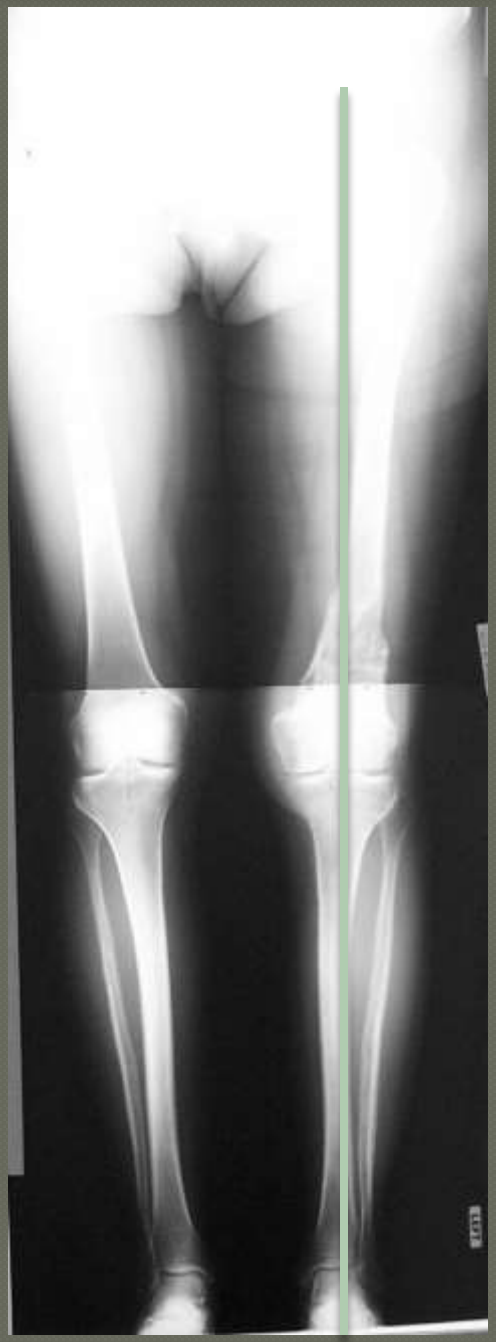


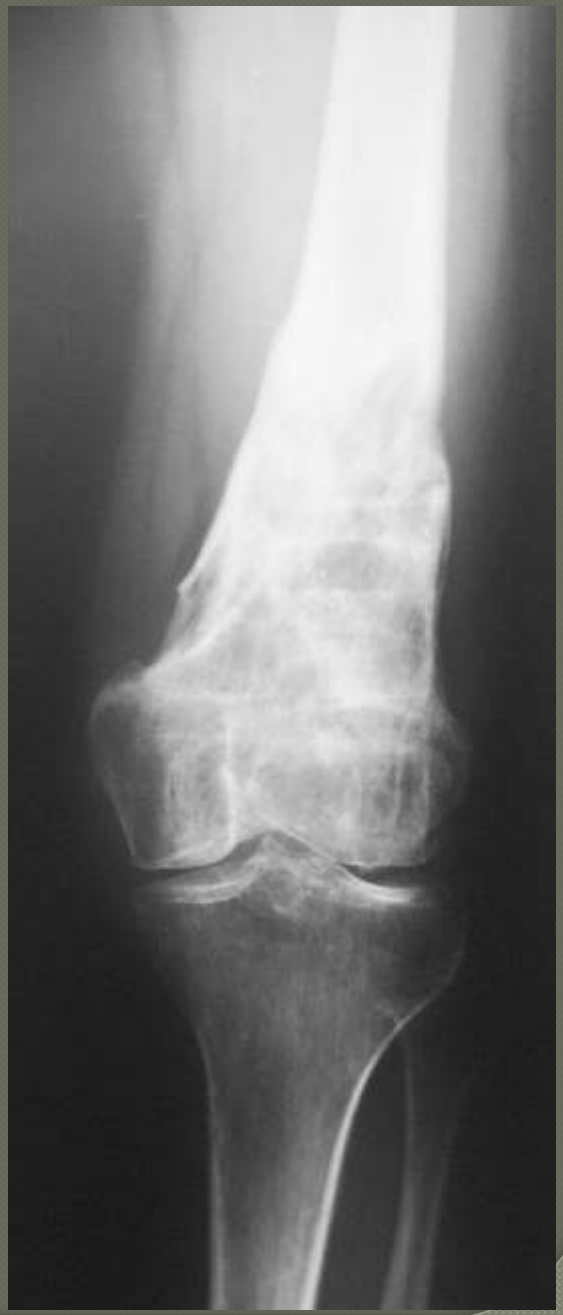






Desired lateral translatio





Integrated Fixation

- Lengthening over nail (LON)
- Lengthening and then plating (LAP)
- Lengthening and then Nailing (LATN)

- Pros
  - Decreased time in external fixation
- Cons
  - 2 surgeries
  - Still wear ex fix

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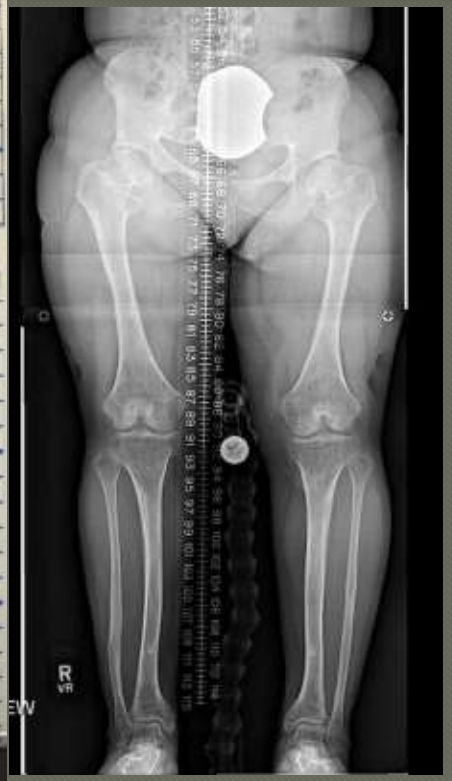
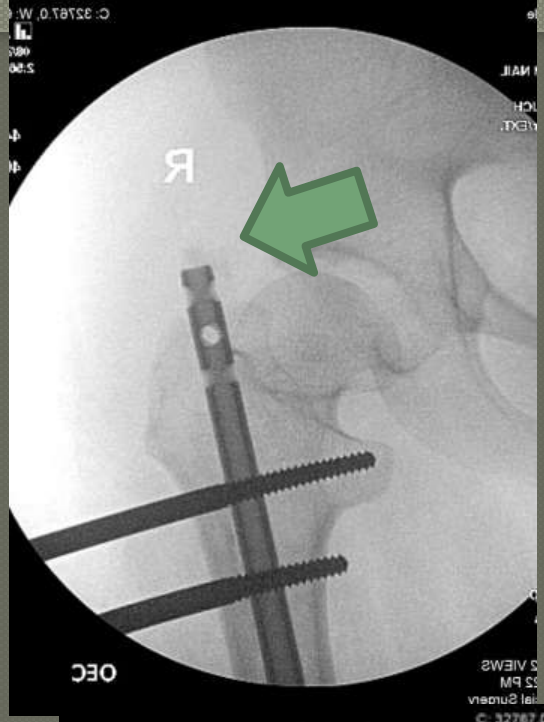
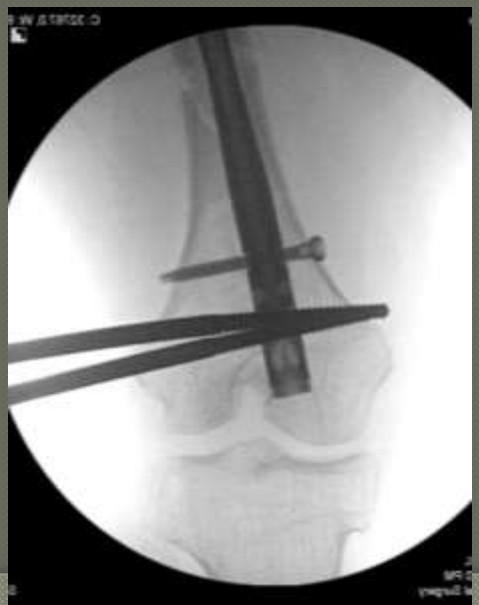
CLINICAL RESEARCH

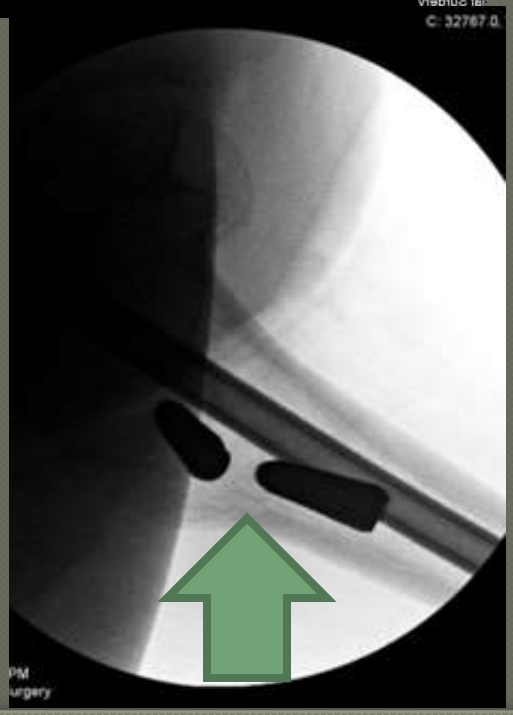
Femoral Lengthening with Lengthening over a Nail has Fewer Complications than Intramedullary Skeletal Kinetic Distraction

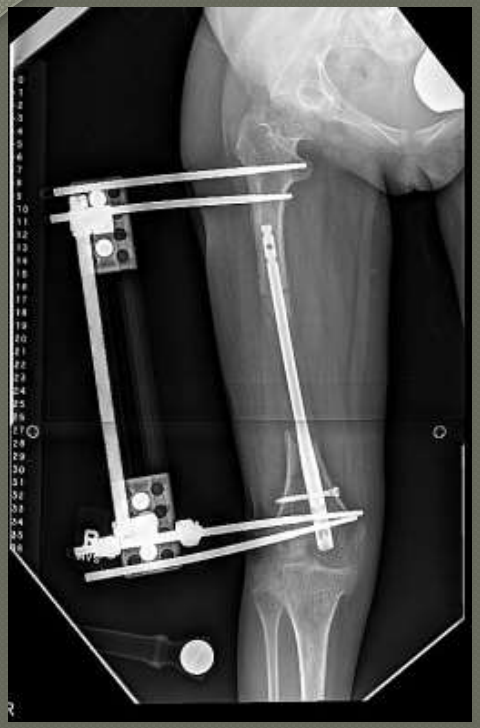
Shahab Mahboubian DO, MPH, Matthew Seah MBChB,
Austin T. Fragomen MD, S. Robert Rozbruch MD

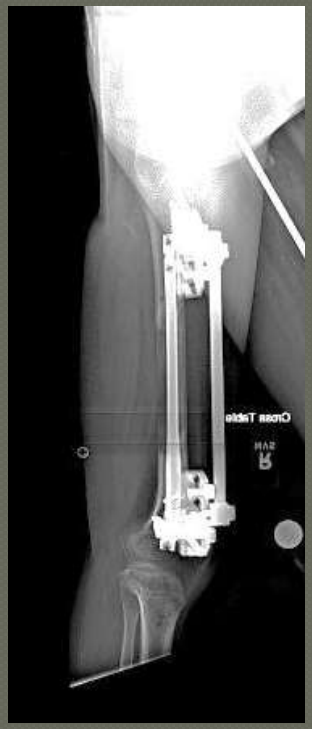


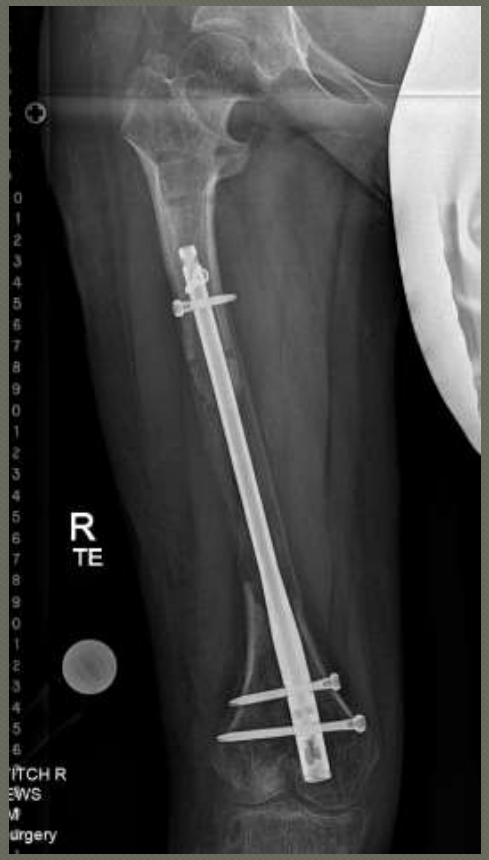












10 cm lengthening

Lengthening of the Femur Over an Existing Intramedullary Nail

Han Jo Kim, MD, Austin T. Fragomen,* Keith Reinhardt, MD,* James J. Hutson, Jr, MD,† and S. Robert Rozbruch, MD‡*

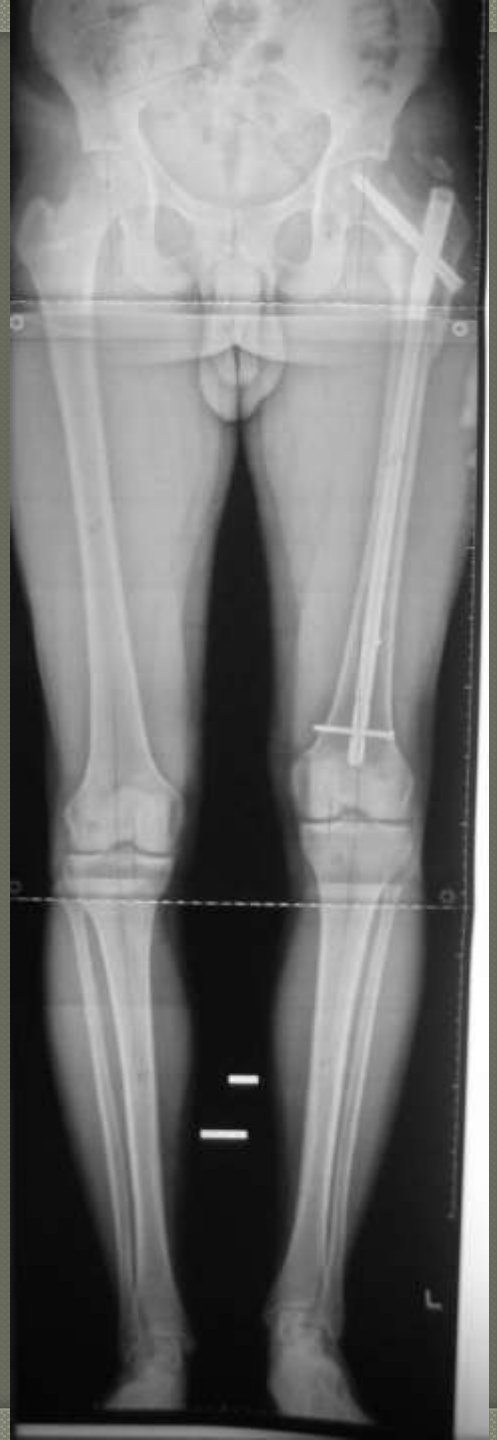
Summary: Leg length discrepancies can occur despite successful union of femur fractures after intramedullary nailing (IMN). Often, the leg length discrepancy can result in significant disability to the patient, altered gait biomechanics, pelvic obliquity, and pain. Therefore, a successful clinical result for such deformities after IMN involves addressing the leg length inequality. Femoral reconstruction with an osteotomy around an existing intramedullary nail was introduced to address axial deformity correction and limb lengthening without changing or removing a previously inserted IMN. This technique uses the principles of lengthening over an IMN. The presence of the nail has minimized the time needed for the external fixator because the nail supports the regenerate bone or osteotomy during the consolidation phase. With this technique, surgery is minimized by avoiding the need for exchange nailing.

Key Words: posttraumatic deformity, Ilizarov, femur, osteotomy, intramedullary nail

(*J Orthop Trauma* 2011;25:681–684)

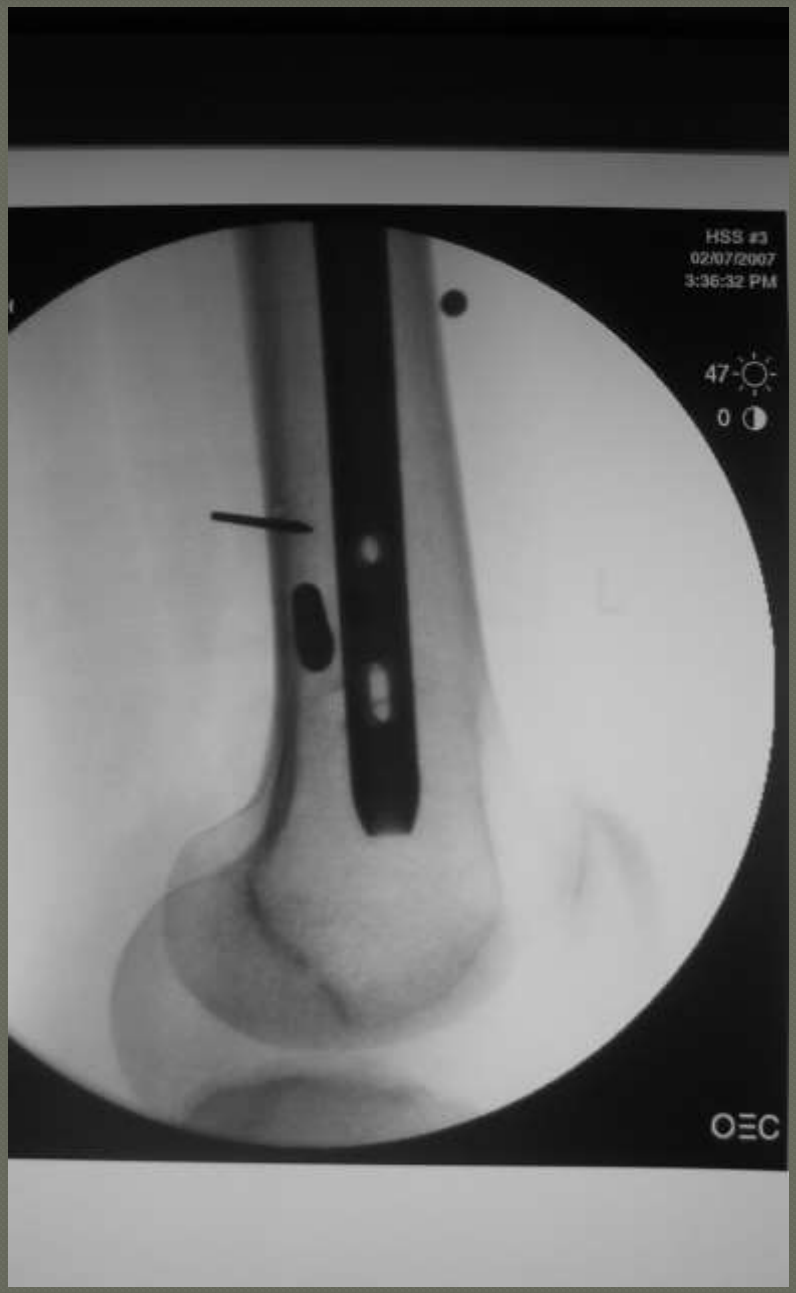
When angular deformities result, the mechanical axis can be significantly affected, leading to asymmetric joint loads across the hip, knee, and ankle as well as alterations in the lever arms of muscle (ie, extension/flexion deformities). This can lead to quadriceps weakness as well as increased energy expenditure for gait.[1] Axial deformities that result in a significant leg length discrepancy and/or rotational deformities can also be problematic for the patient and may lead to hip, knee, and low back pain; awkward gait; and extensor mechanism weakness if left untreated.[1,3–5]

Correcting these malunions can be challenging, and often reoperation can lead to significant morbidity for the patients. The abductors can become more scarred and weakened and sometimes the deformity can persist despite efforts for correction. This has led to a novel technique in which bony deformity can be corrected without nail removal obviating the need to surgically violate the hip abductors in anterograde nailing. In the case of retrograde nails, there is no need to perform an arthrotomy, split the patella tendon, or evert the patella.[7]



Lengthening Over an Existing IMN

LLD 3 cm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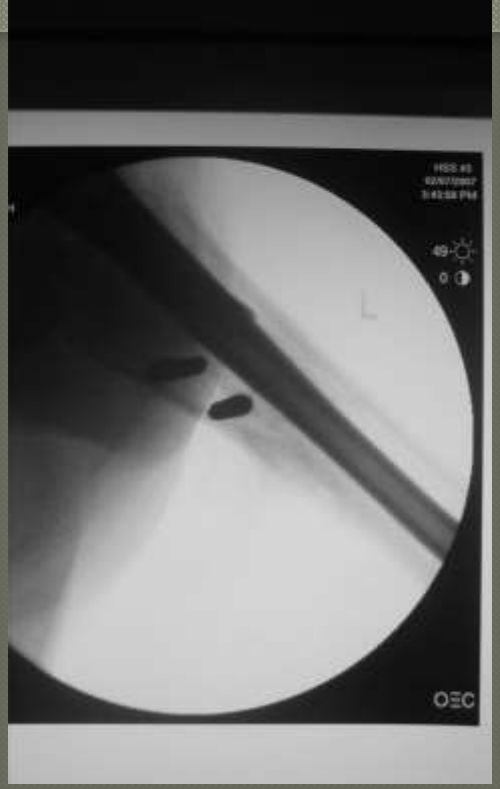
49
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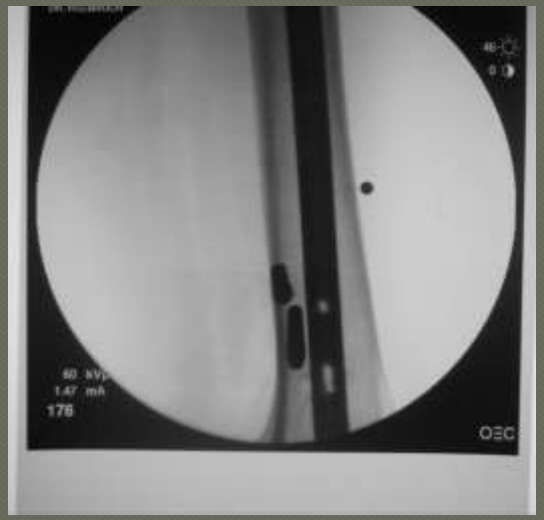
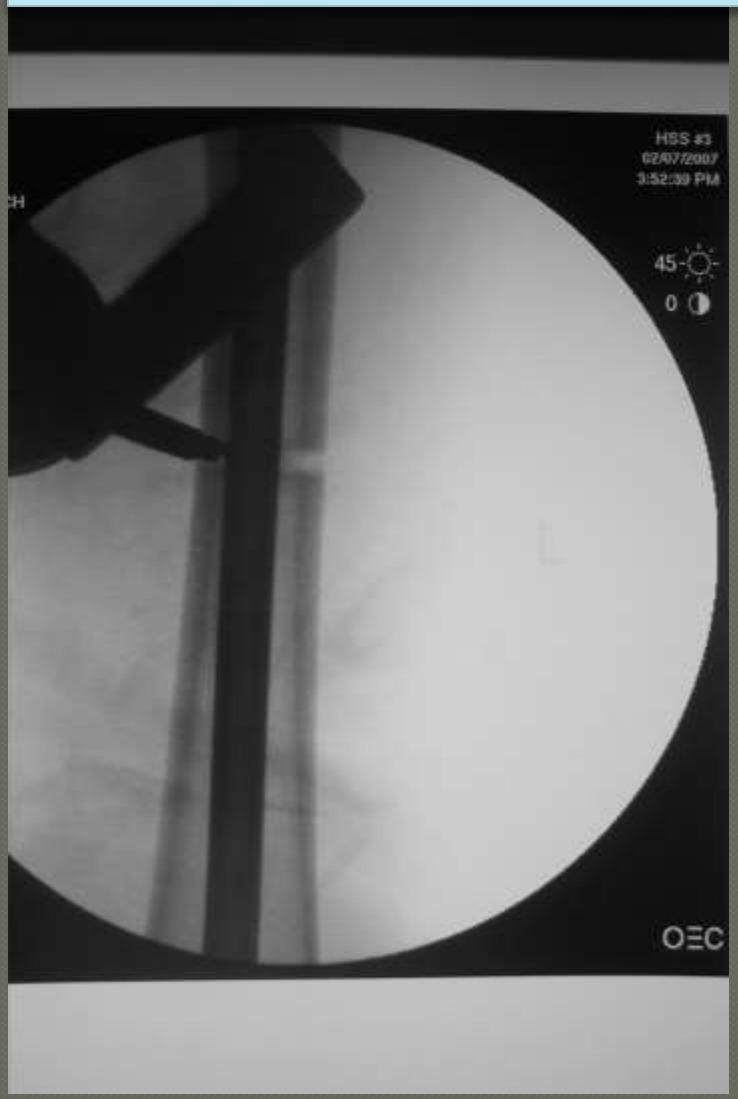
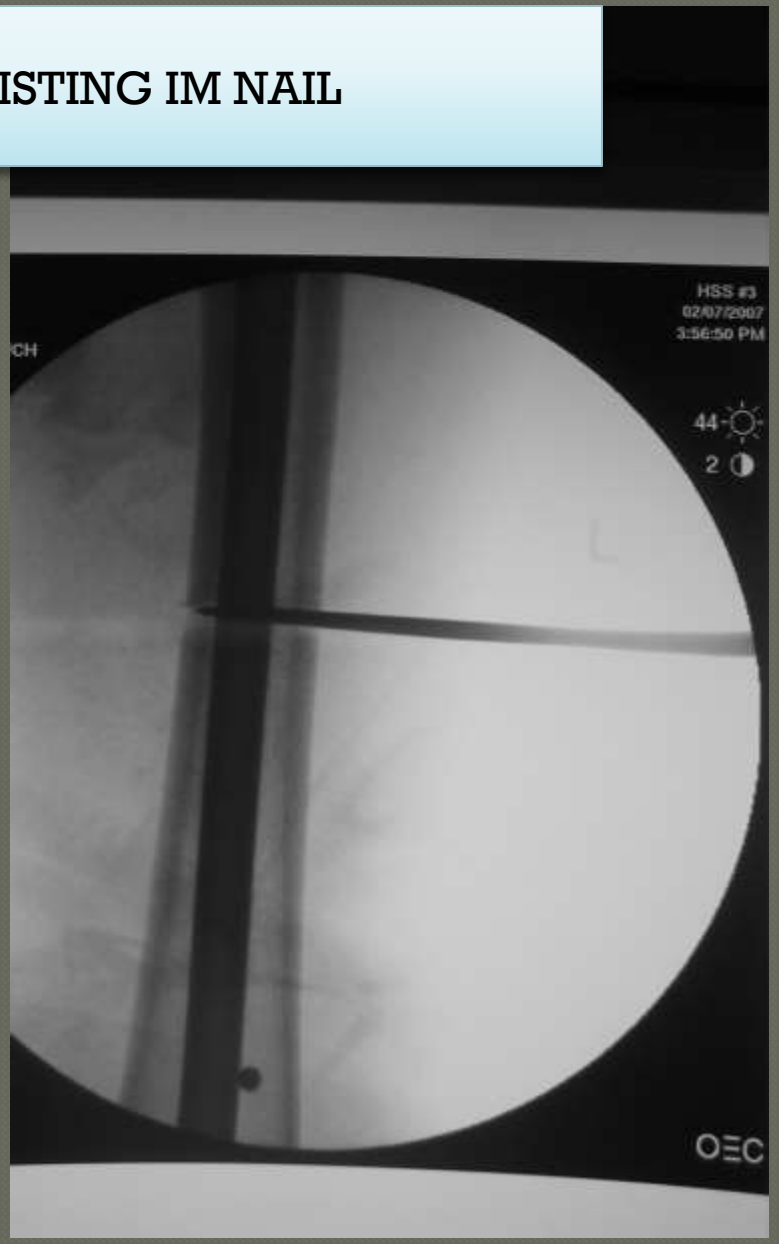
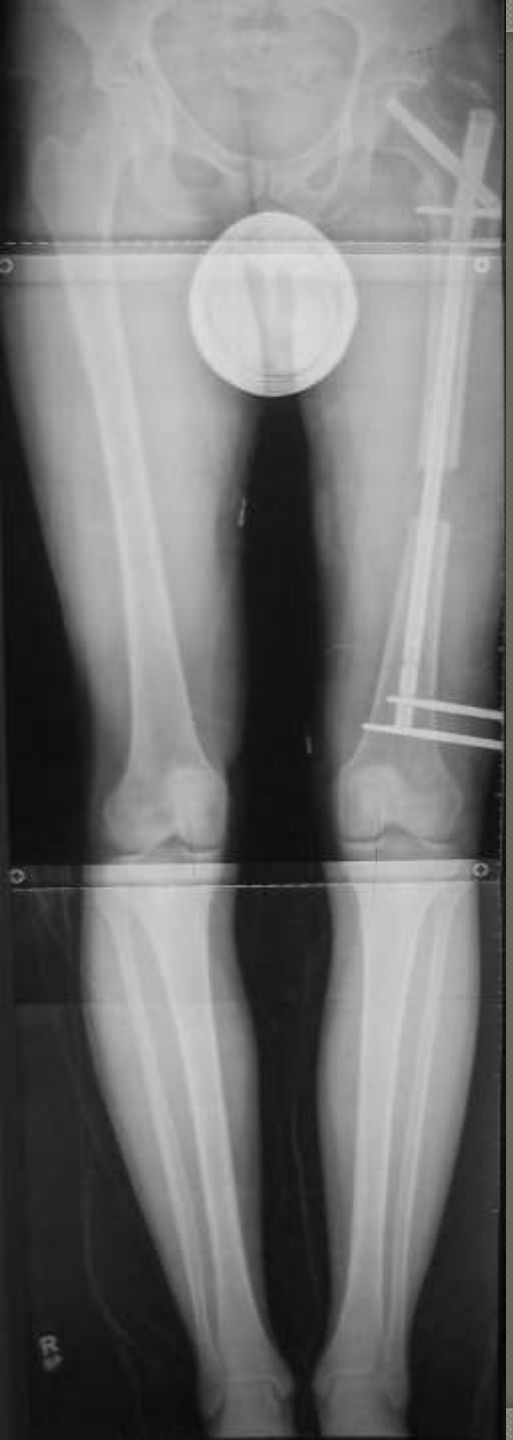
OEC


46
0
1.47 mA
176
OEC

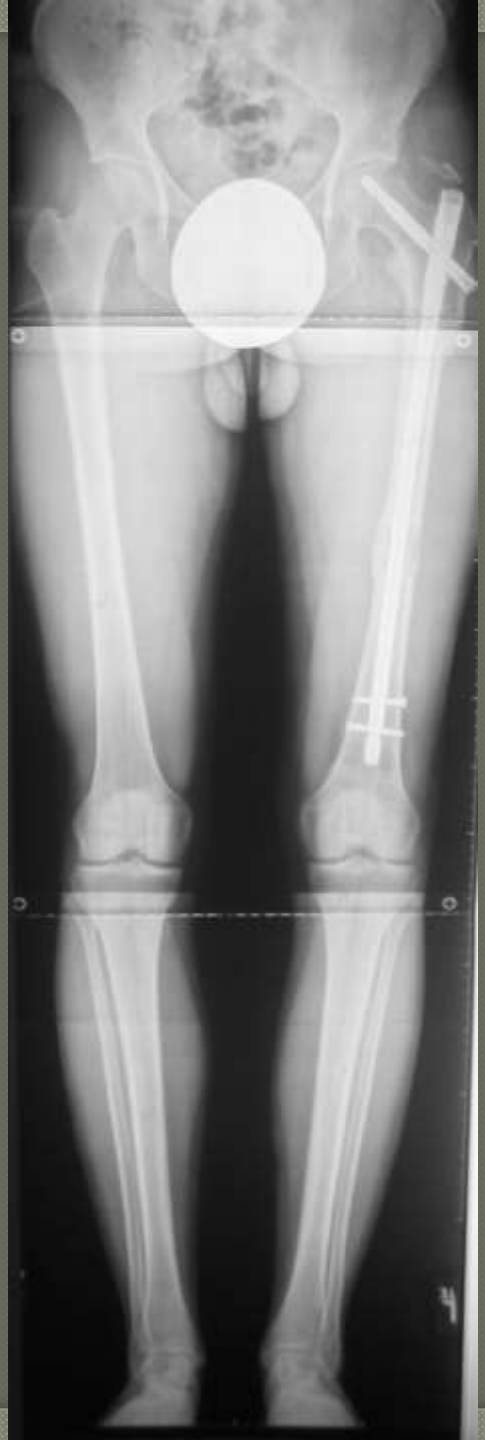
CUT BONE AROUND EXISTING IM NAIL

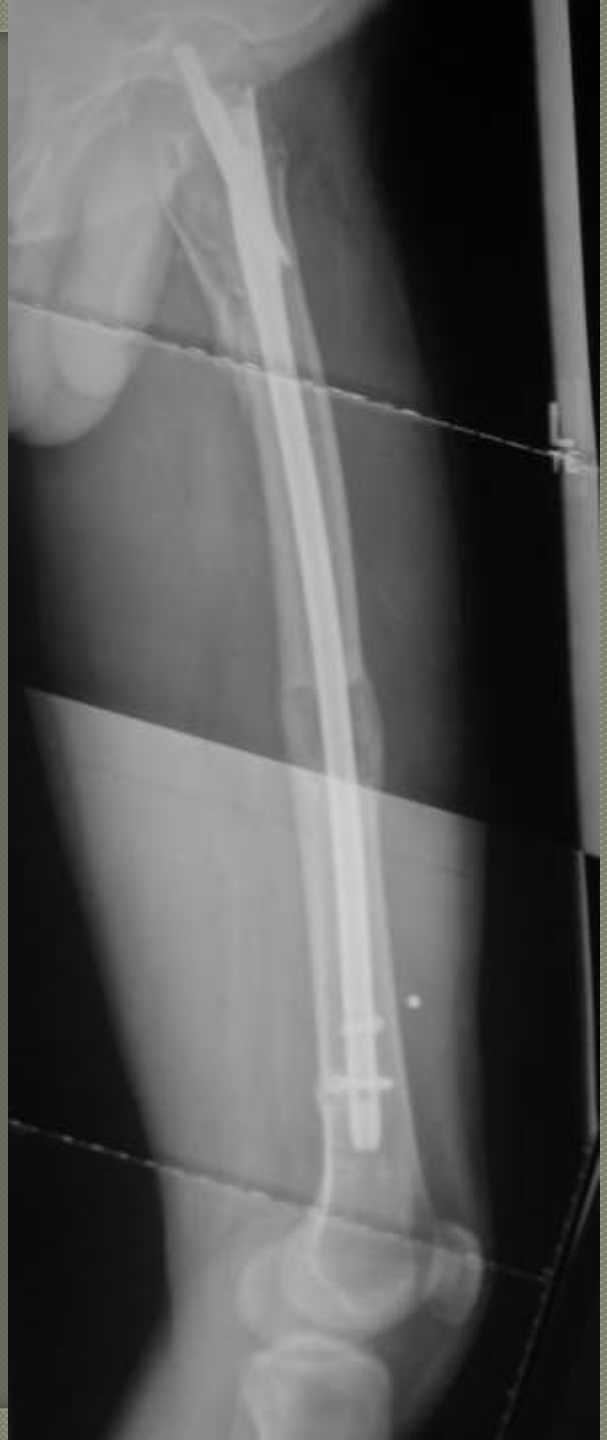




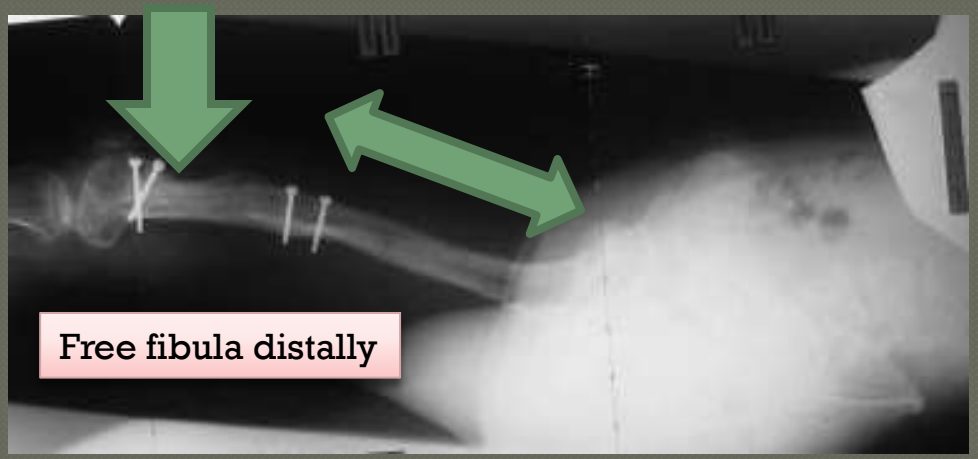


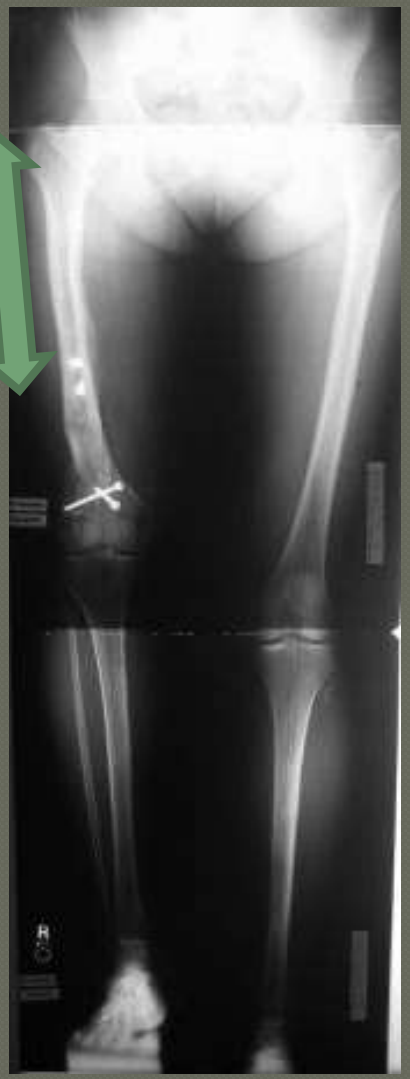
2.5 mo



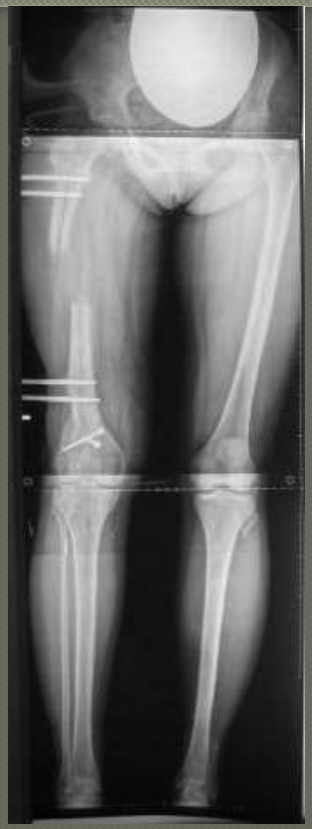


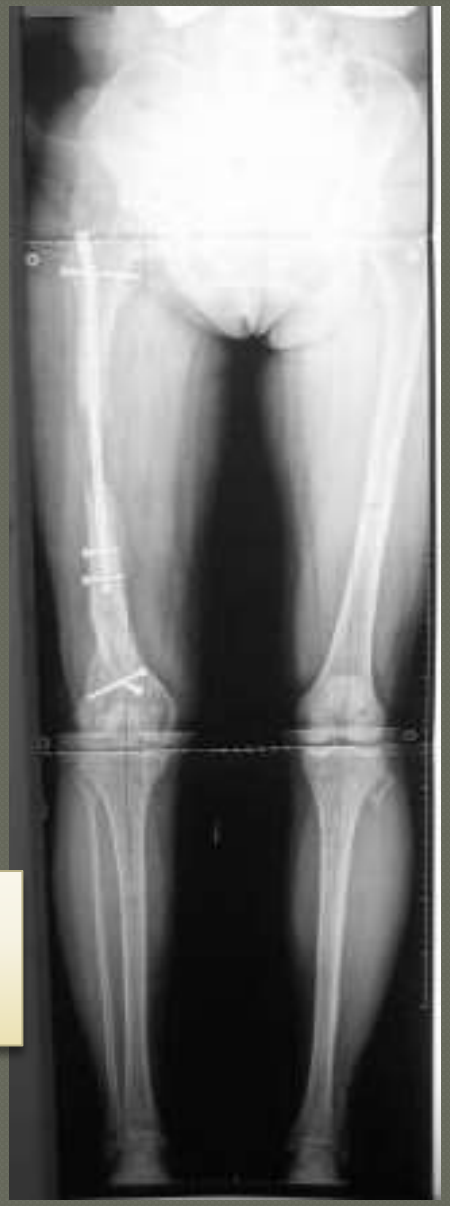
LLD 7 cm, old osteomyelitis

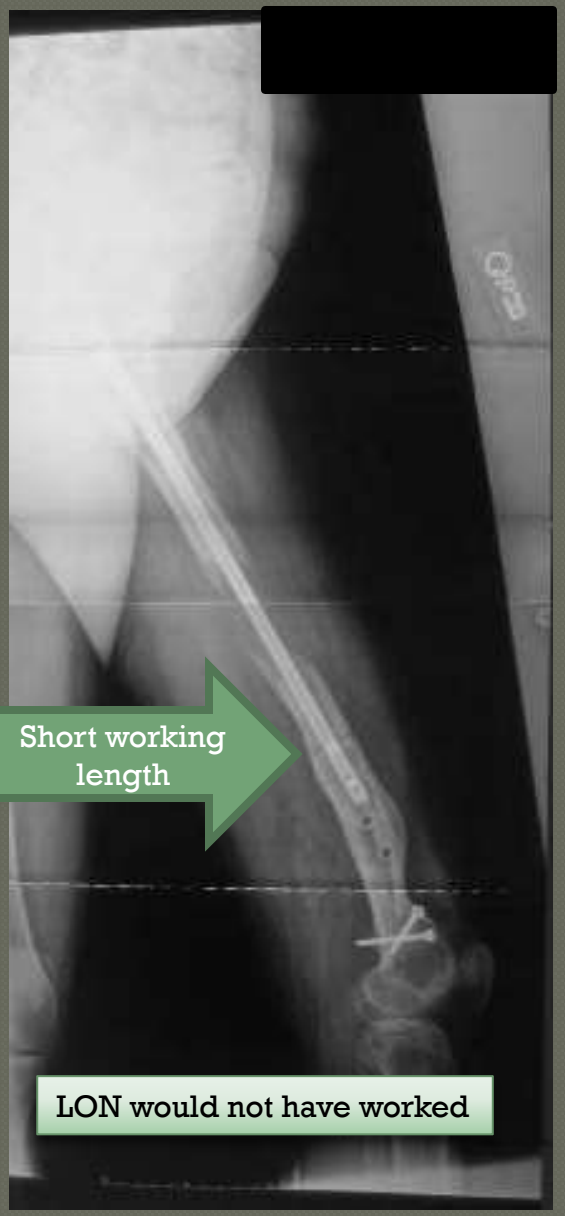




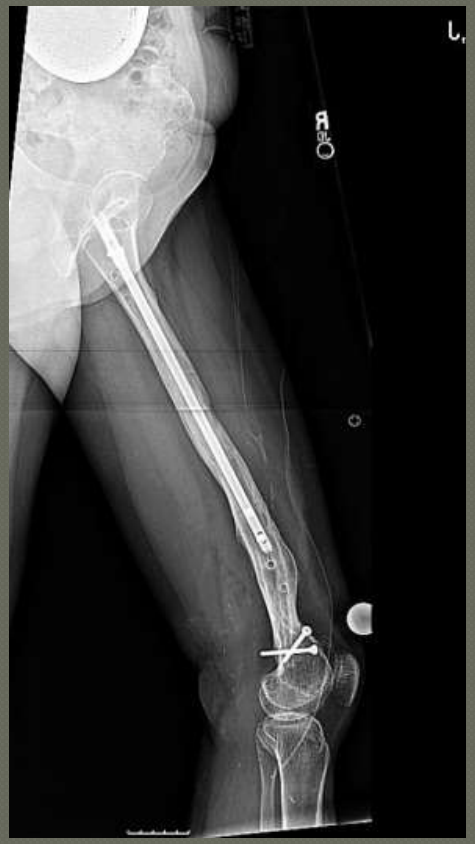
LATN

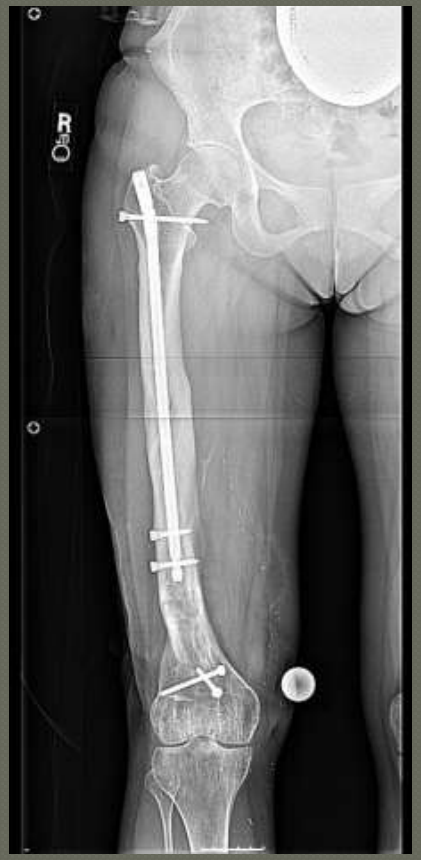


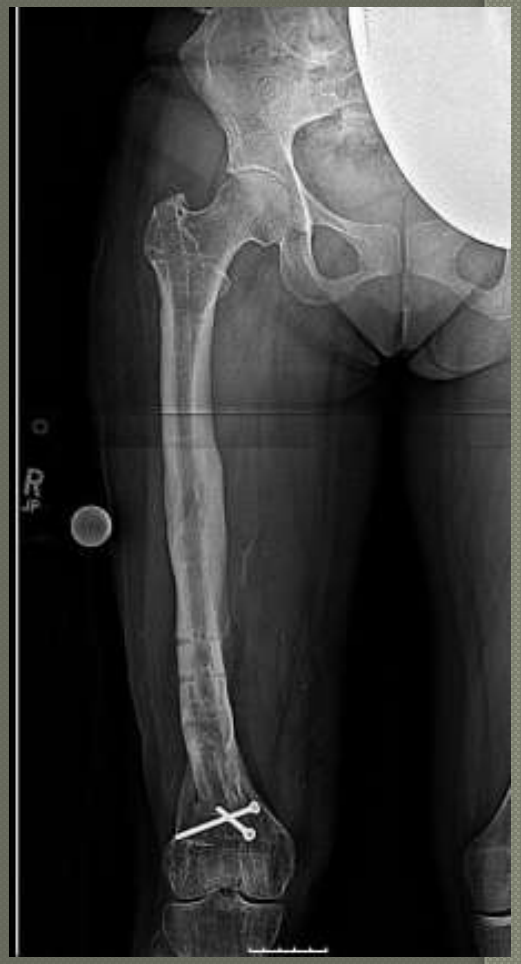




Pins placed out of nail path
Poor control of alignment
Acute correction needed at nail insertion







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CLINICAL RESEARCH

Does Lengthening and Then Plating (LAP) Shorten Duration of External Fixation?

Ryhor Harbacheuski MD, Austin T. Fragomen MD, S. Robert Rozbruch MD

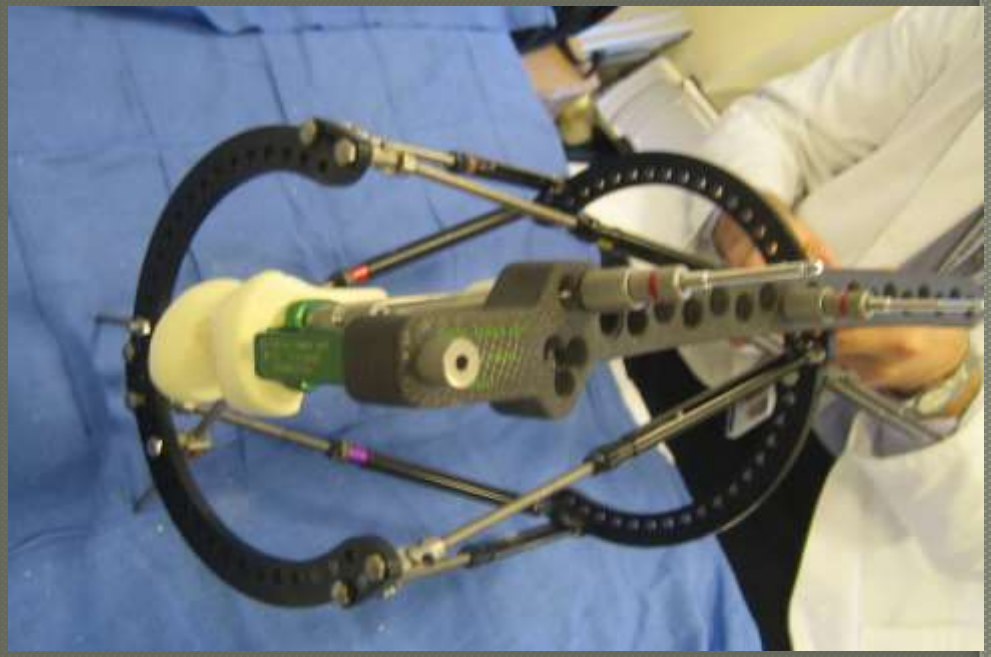
Received: 18 June 2011 / Accepted: 3 November 2011 / Published online: 15 November 2011

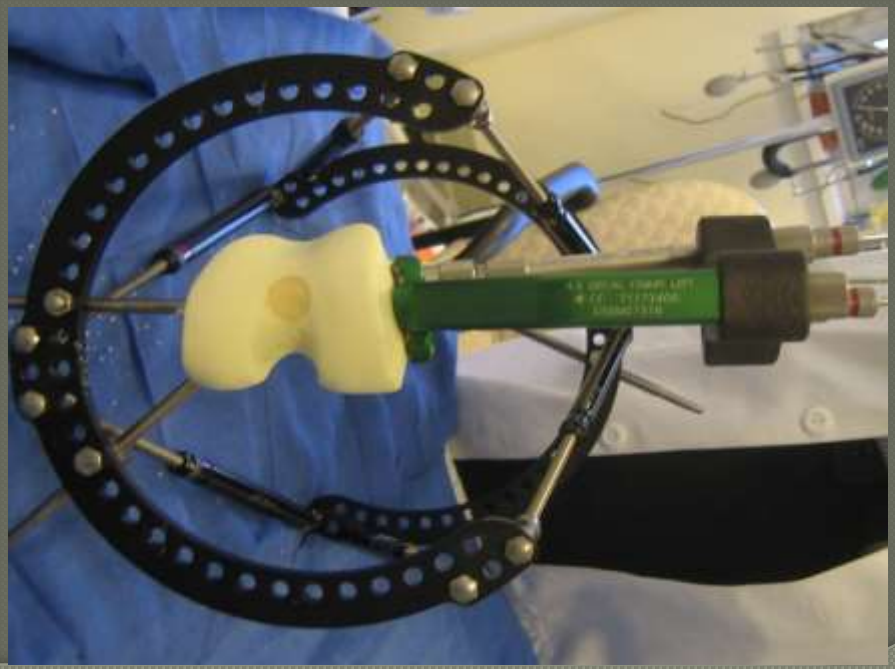
Abstract

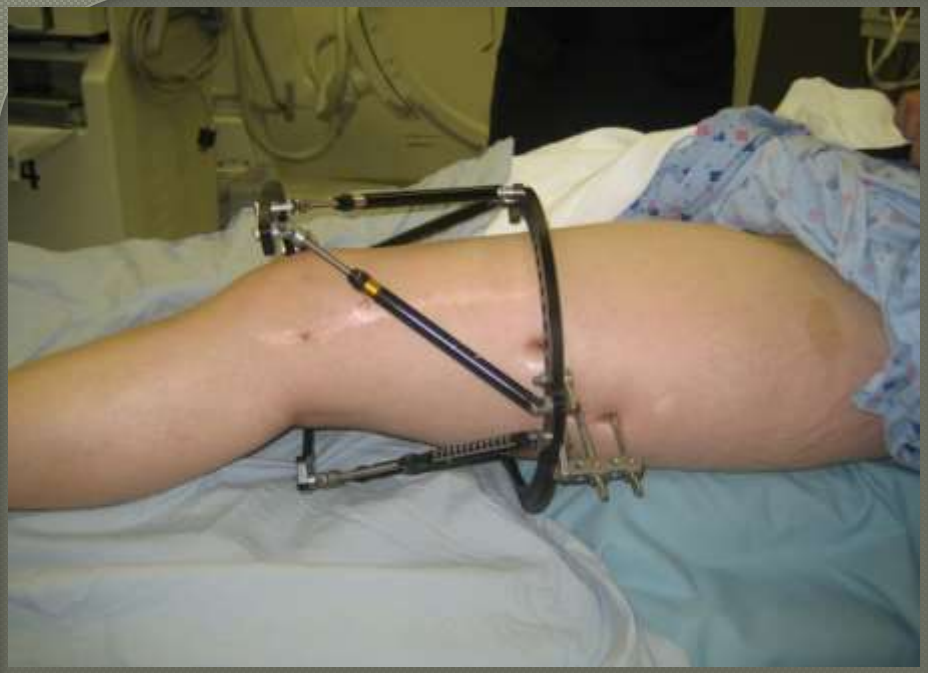
Background Classic bone lengthening requires patients wear external fixation for the distraction and consolidation phases and there is fracture risk after frame removal. Our technique of lengthening with the Taylor Spatial Frame™ and then insertion of a locked plate allows earlier removal of the external fixator during consolidation. Plate insertion is accomplished through a clean pin-free zone avoiding contamination and before frame removal maintaining bone

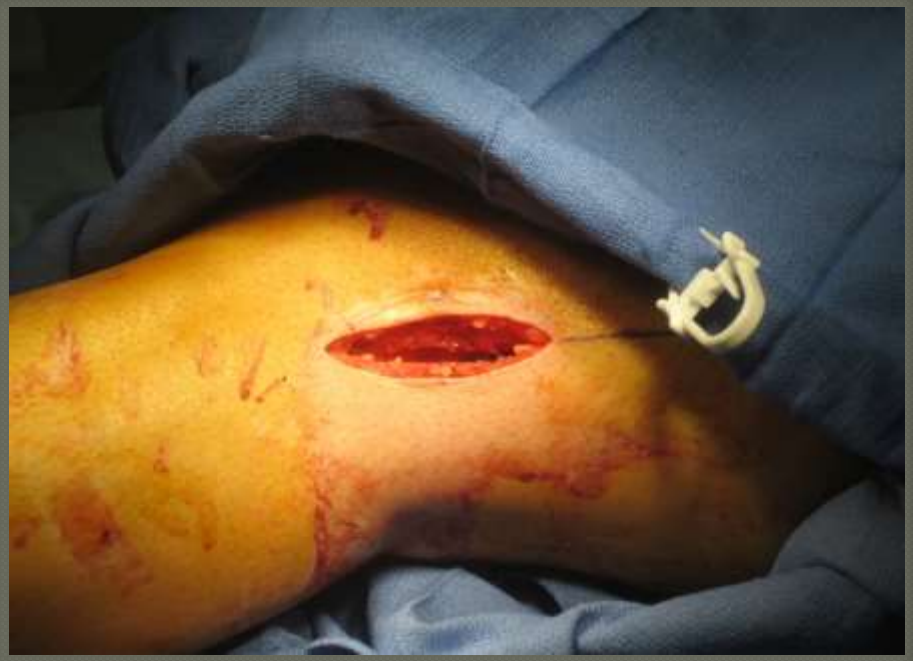
27 extremities in each group. We compared time wearing the frame, bone healing index, external fixation index, joint ROM, alignment, and complications.

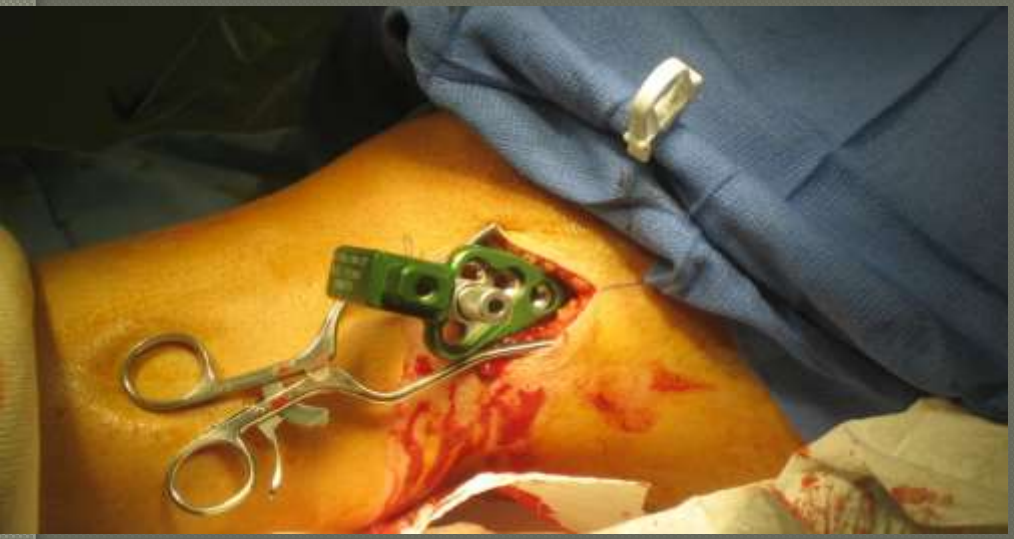
Results The time wearing the frame and external fixation index were lower in the LAP group (4.5 versus 6.2 months and 1.5 versus 2 months/cm). Deviation from normal alignment was observed in seven and six patients in the LAP and classic group, respectively. Varus malalignment in two patients in the LAP group was associated with plate

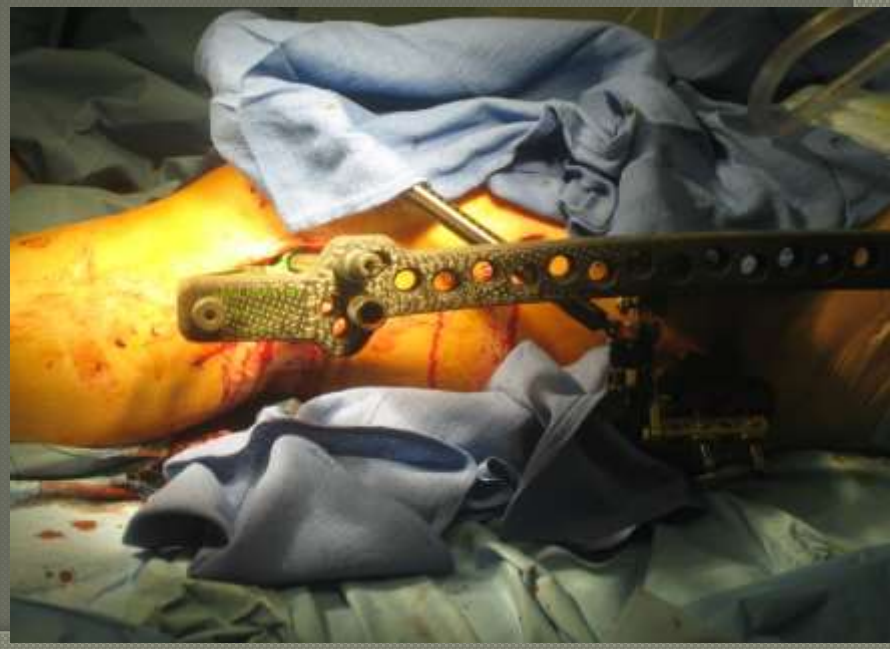




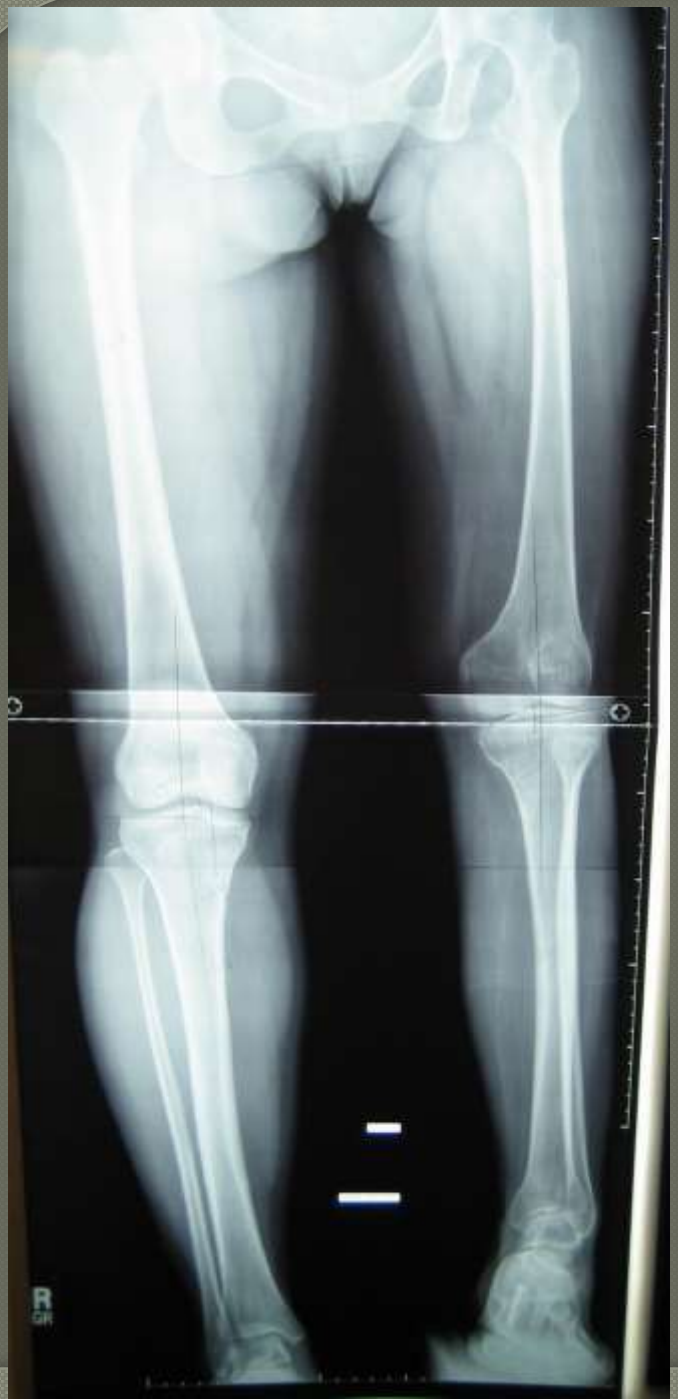


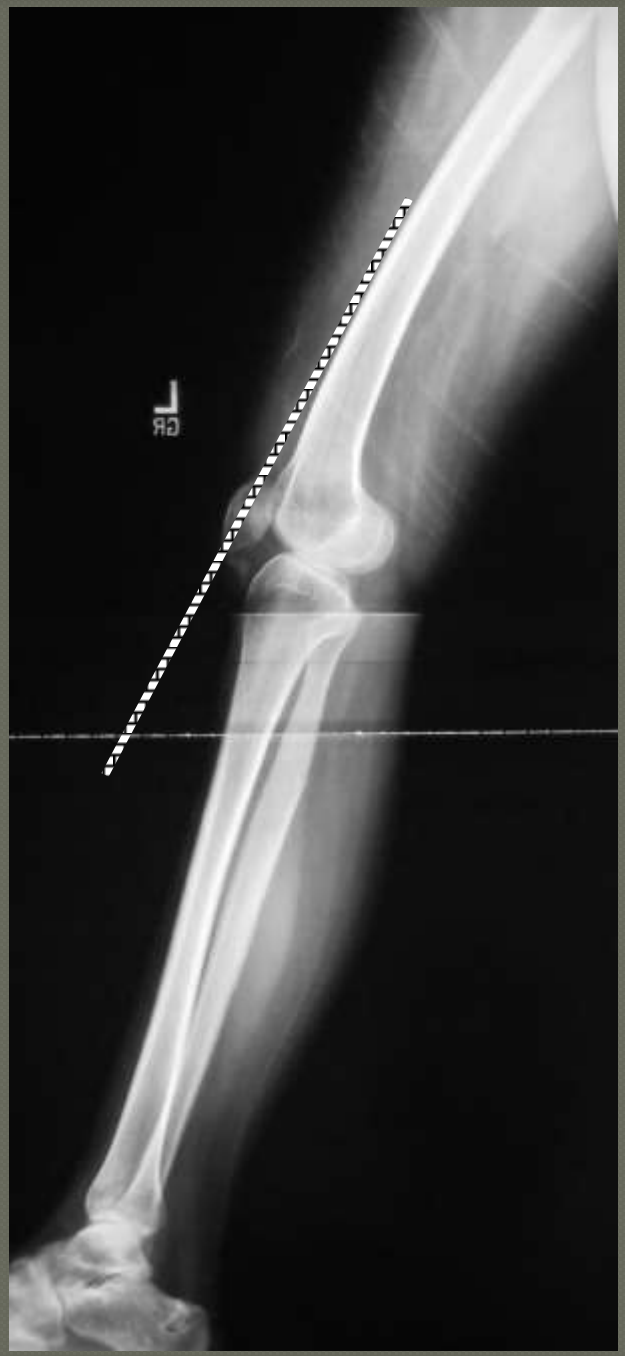


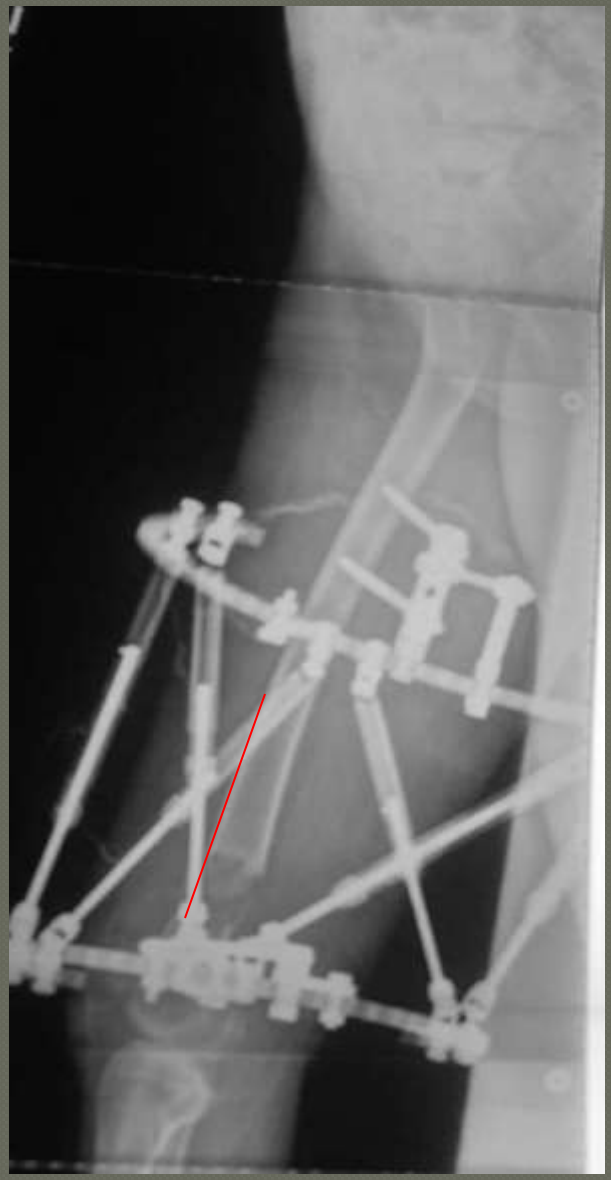


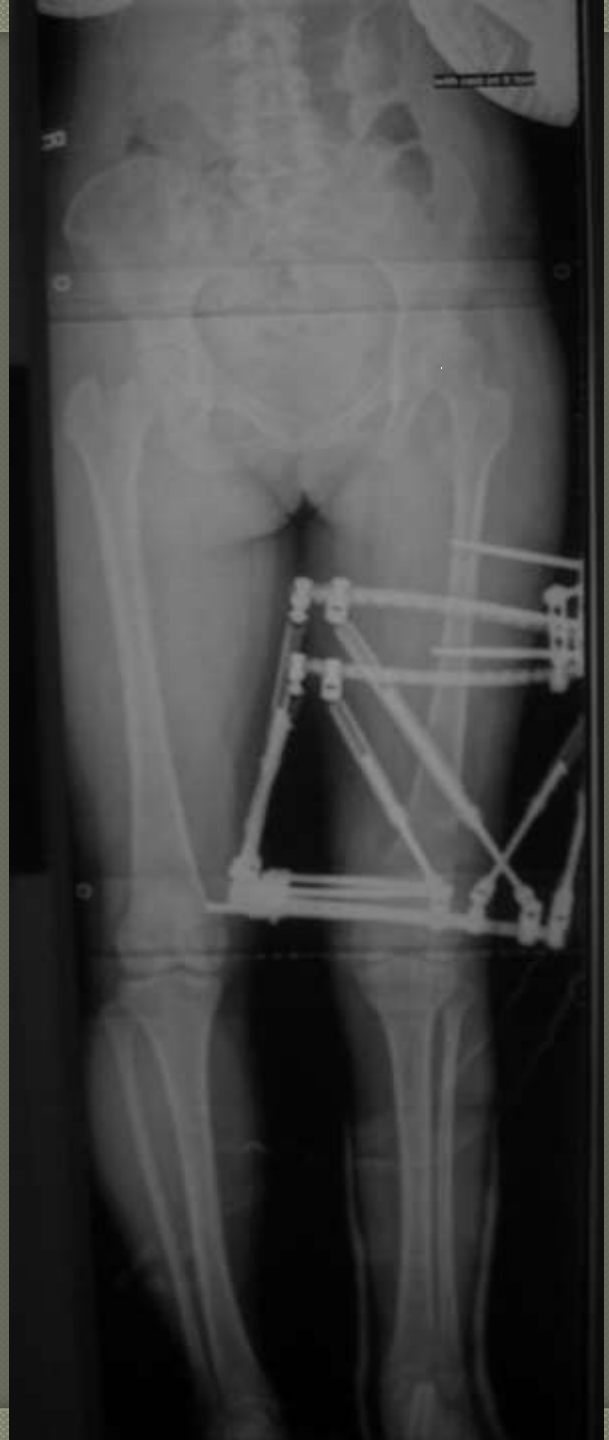


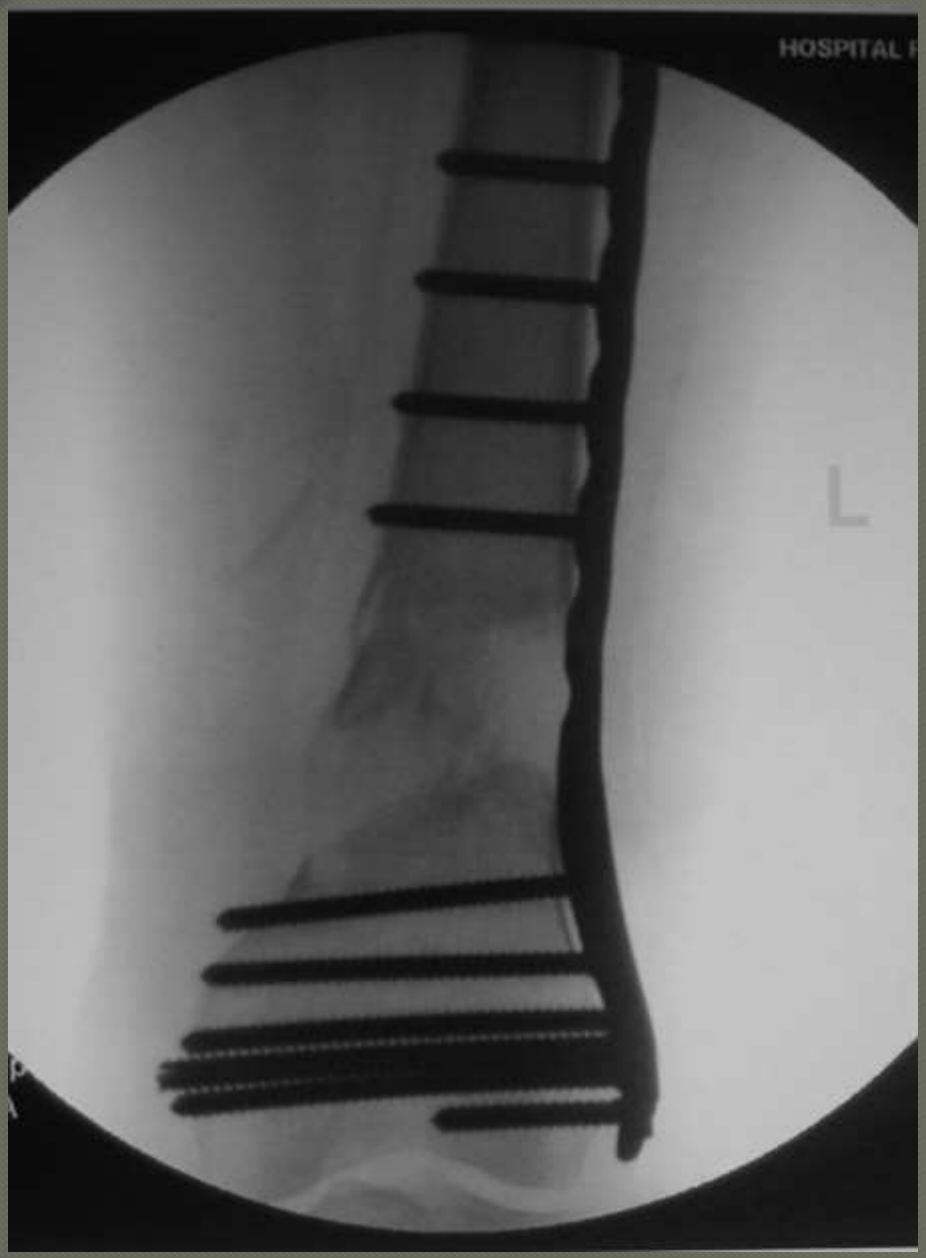
Polio
LLD
Fexion deformity
Weak quads







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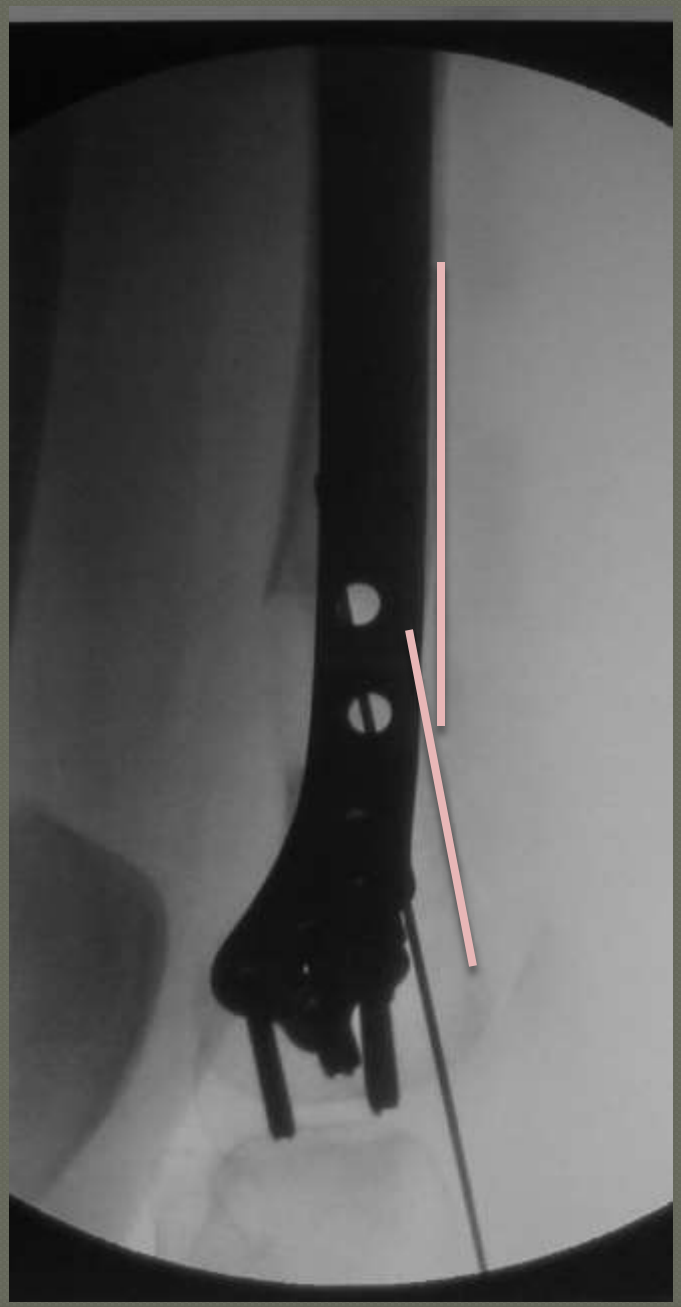
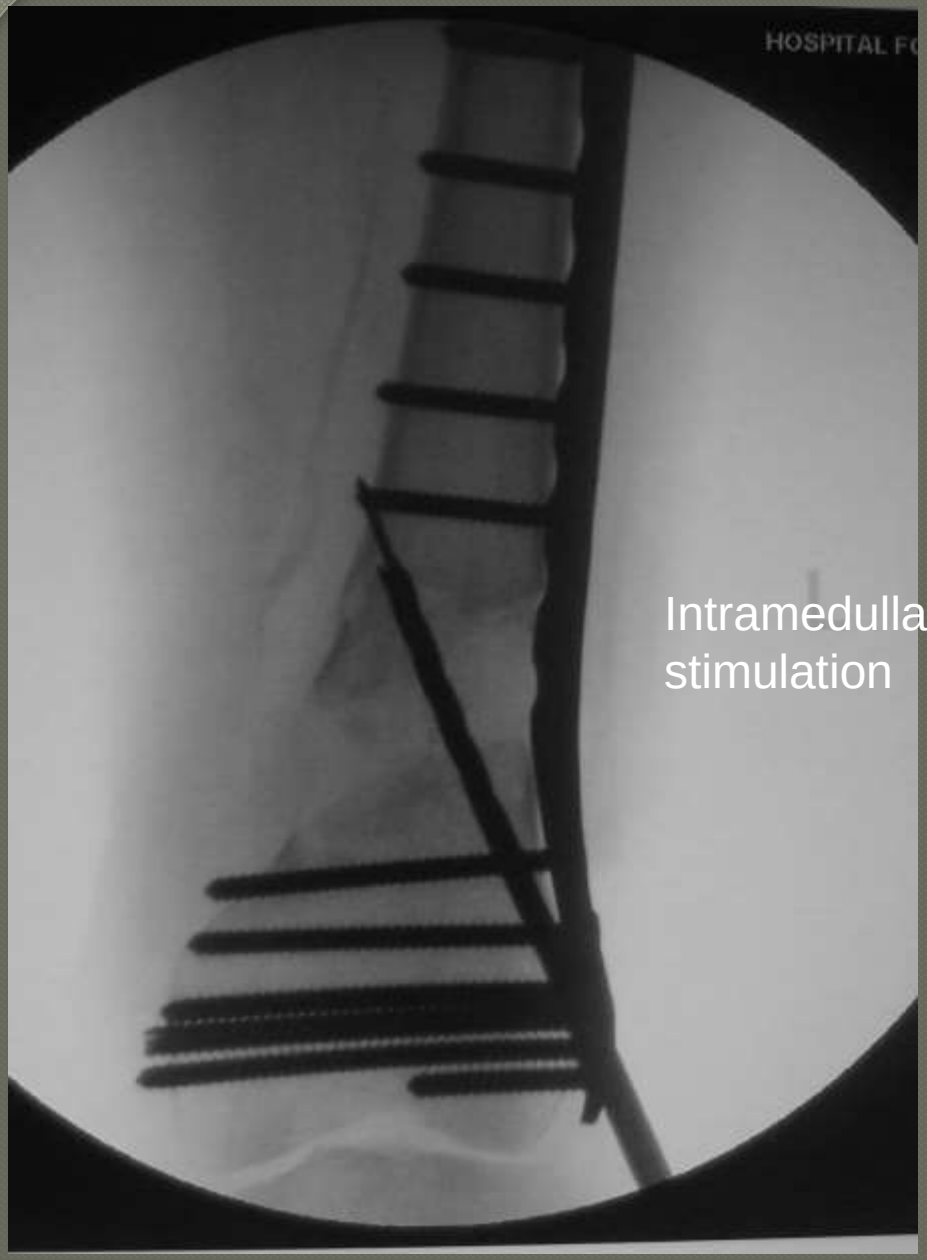
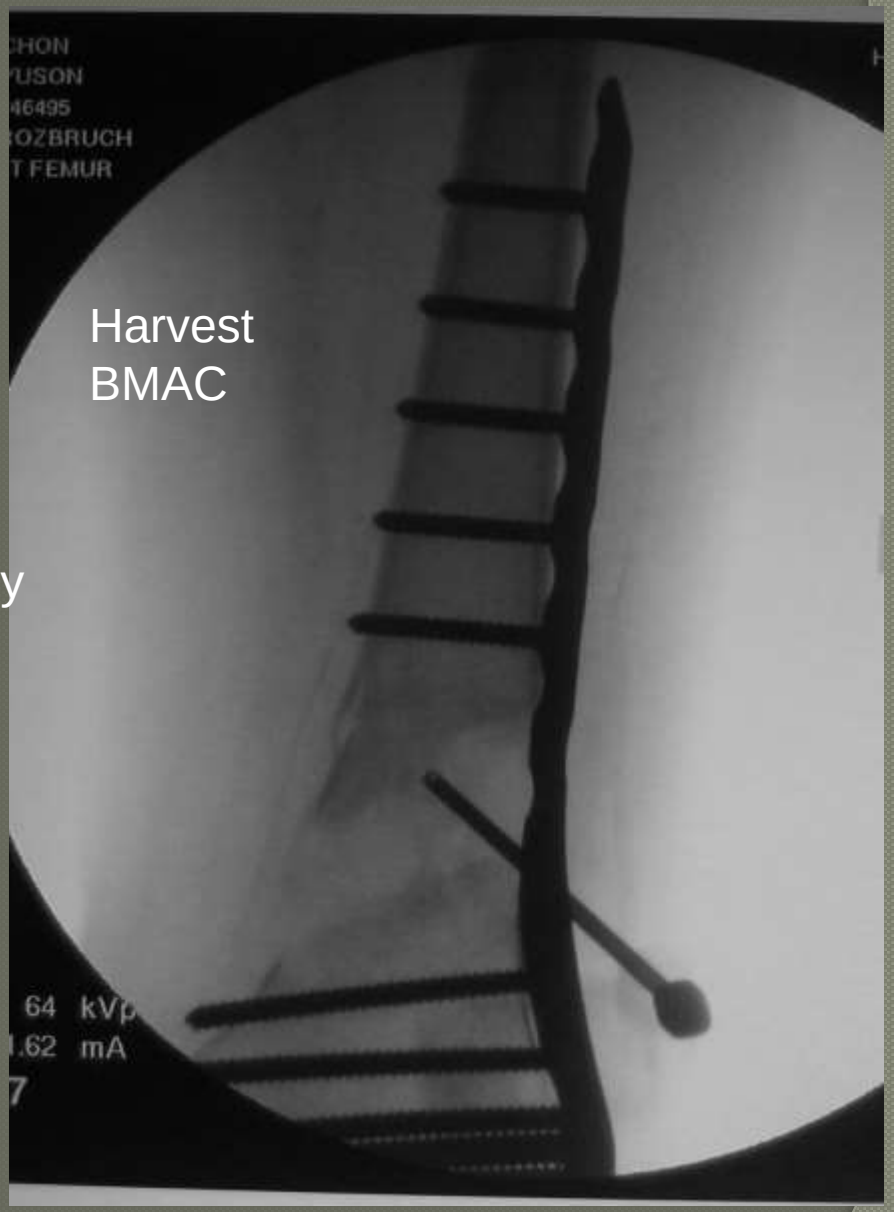
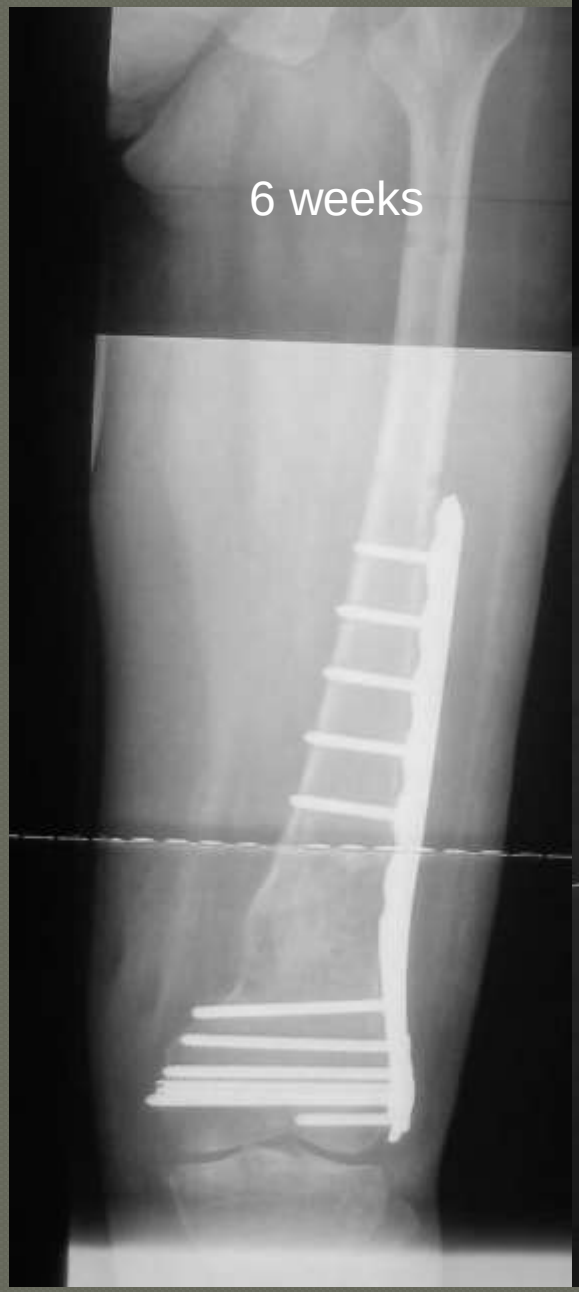


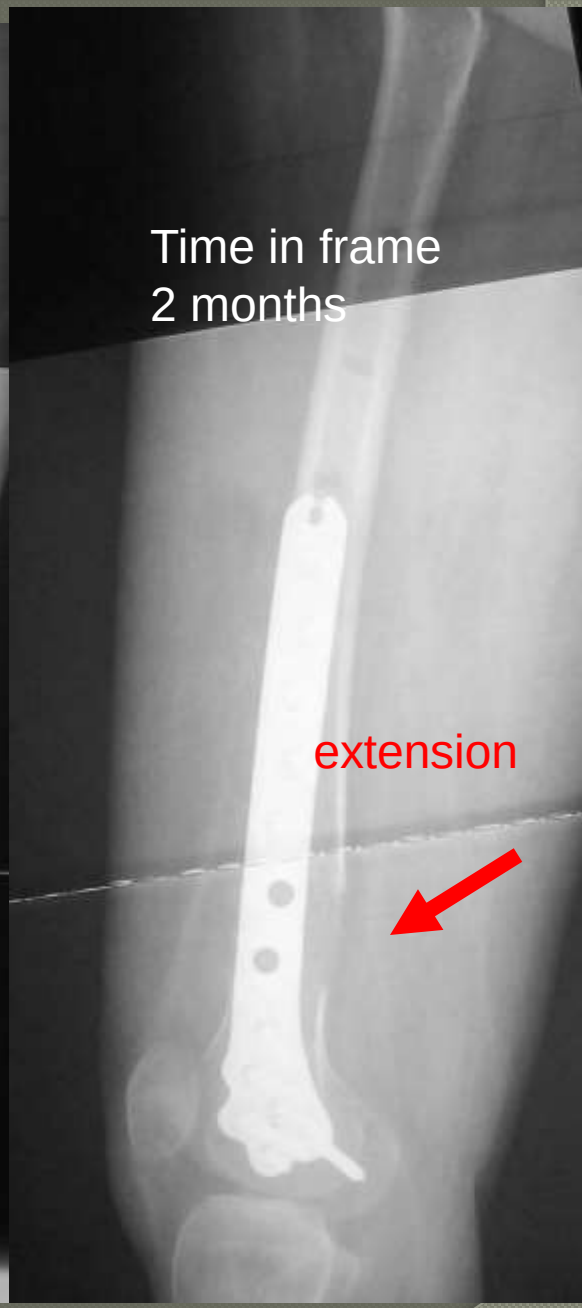


Intramedullary stimulation



Harvest BMAC

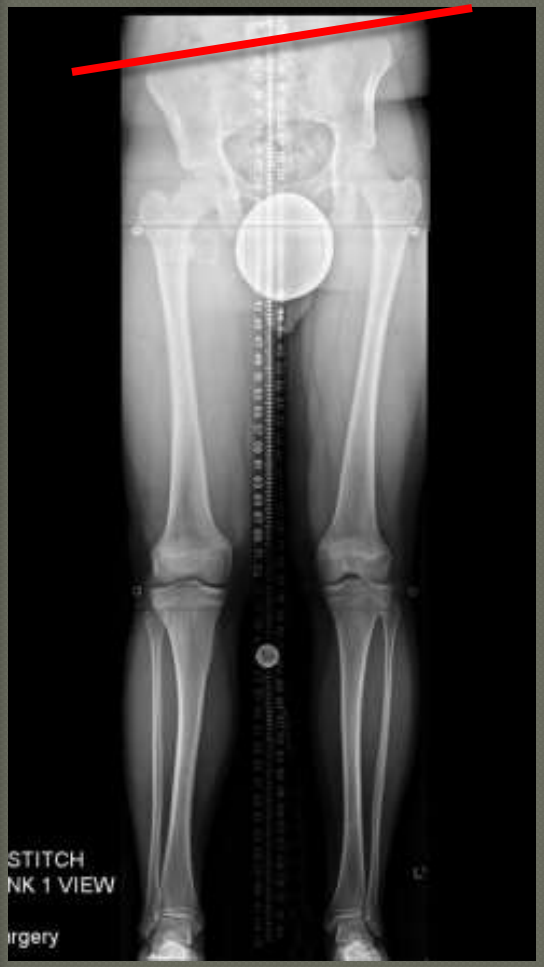

6 weeks

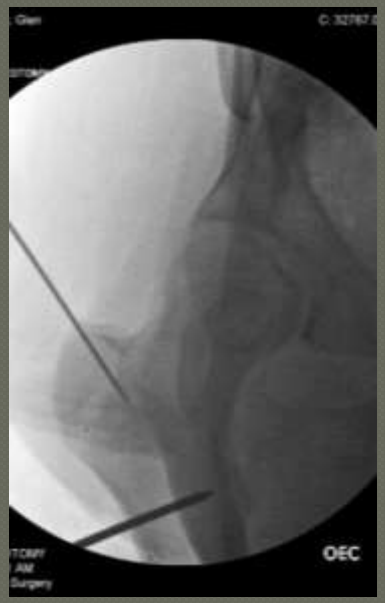

Time in frame
2 months
extension

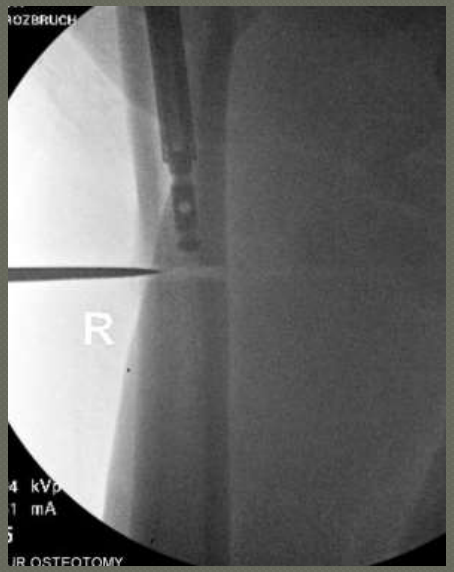
Internal Lengthening Nail

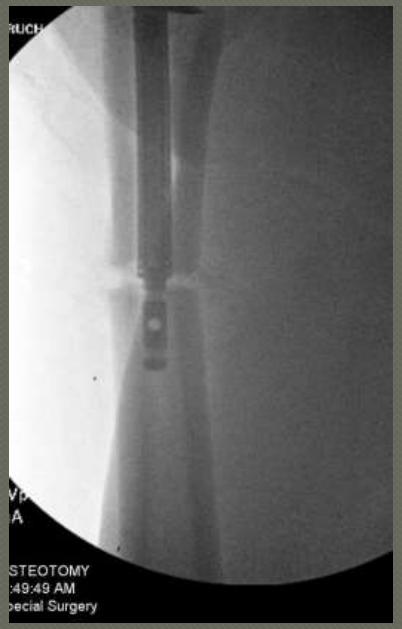
- Requirements
  - Reliable mechanism for rate and rhythm
- IM canal must be suitable
  - Size
  - Geometry
- Deformity
  - Correct with nail
  - Correct with plate @ different level
- Pros
  - No ex fix
  - No pin problems
    - Pin infections
    - Soft-tissue tethering
  - Better joint ROM
  - Very accurate
- Cons
  - Invasive
  - Infection risk
  - Blood loss

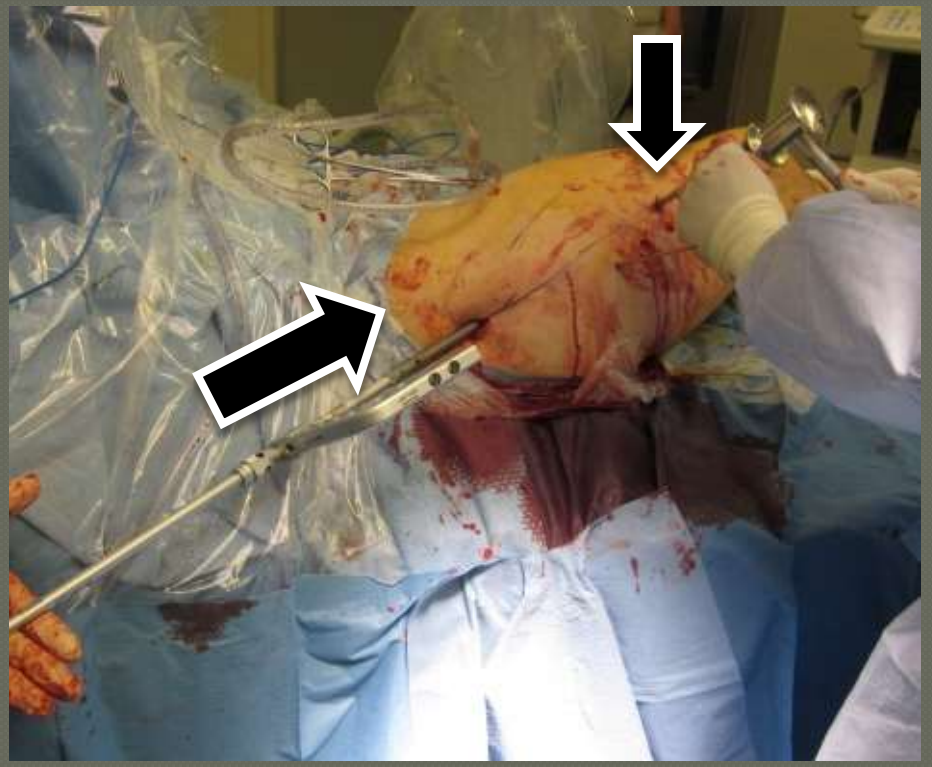
Motorized internal lengthening IM nail

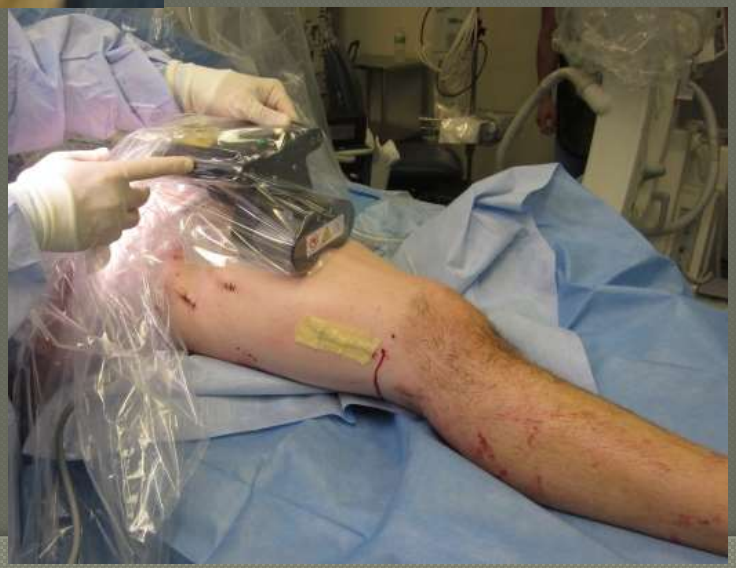


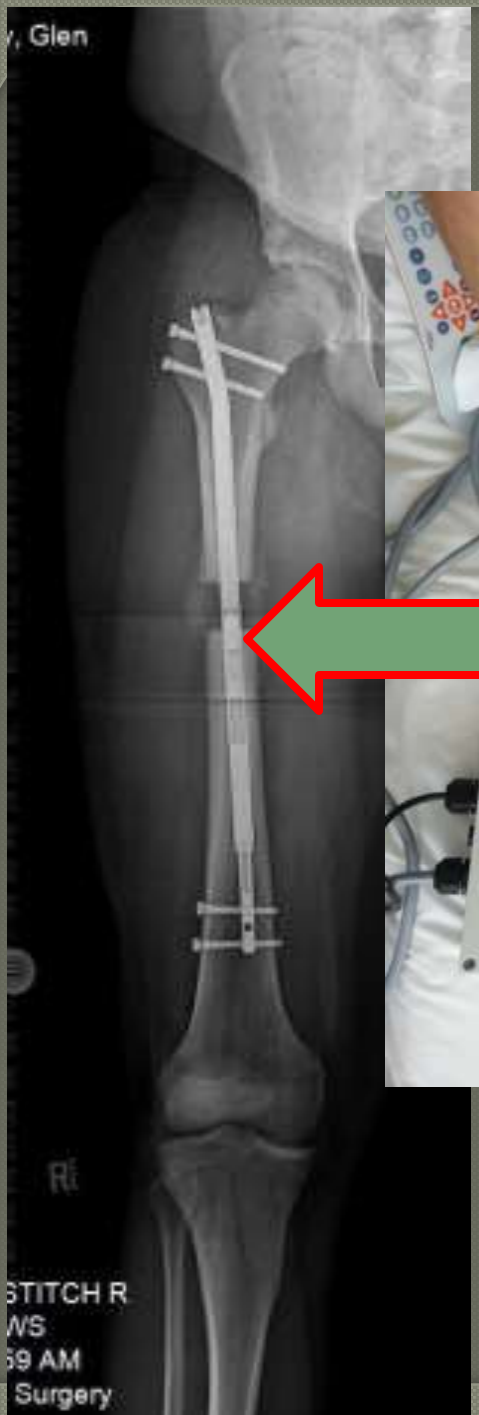


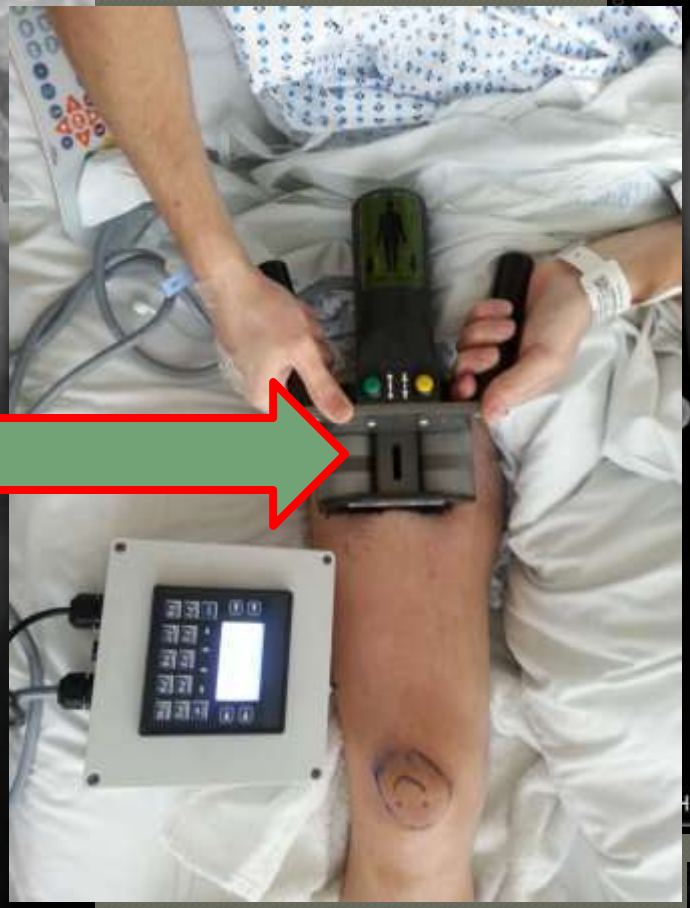


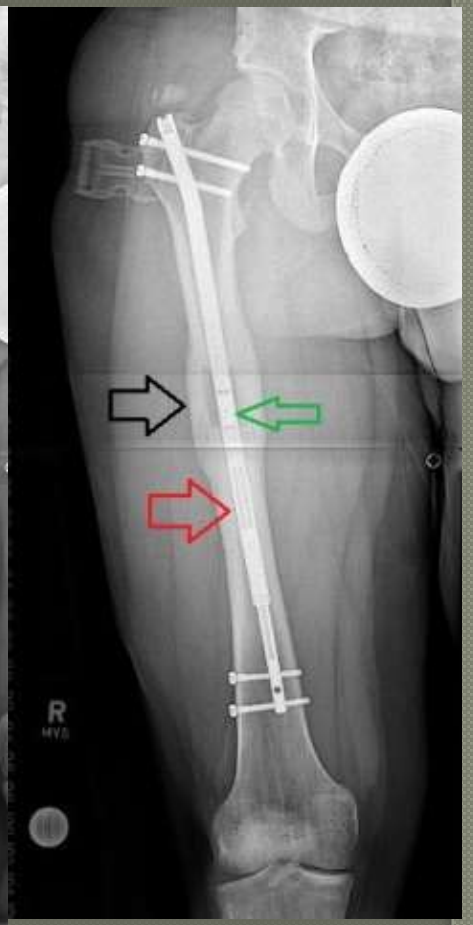










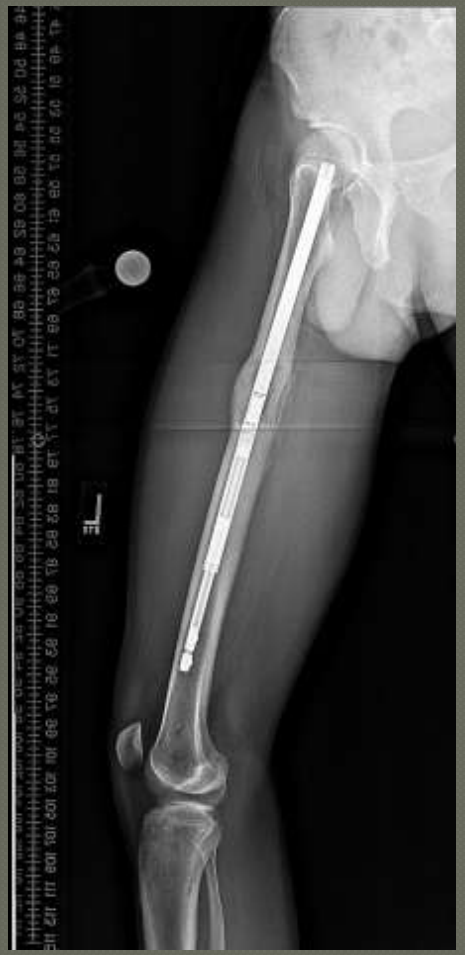


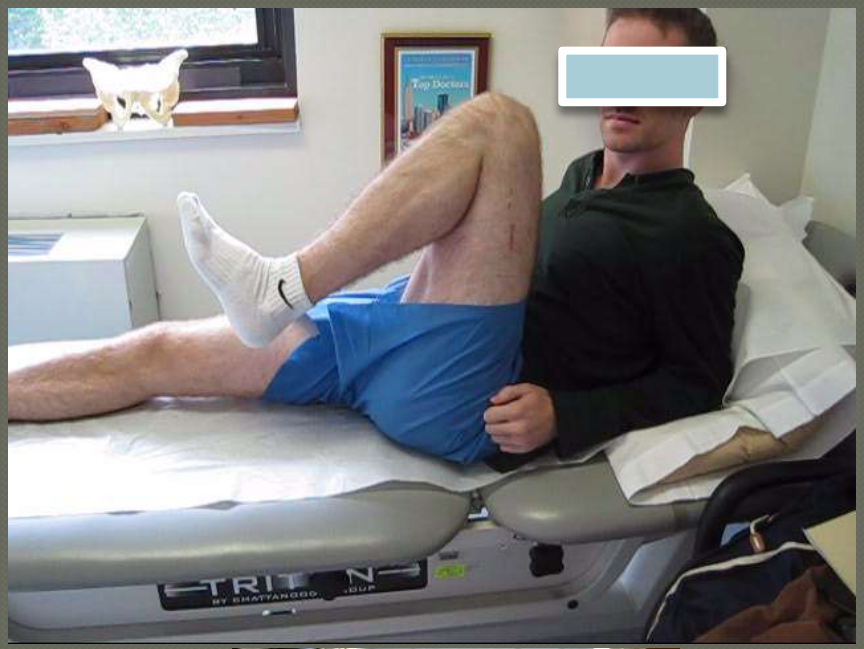
Trochanteric Entry
Good for adolescent
< 18 yrs.

LLD = 4.5 cm
25 y/o male
Congenital LLD

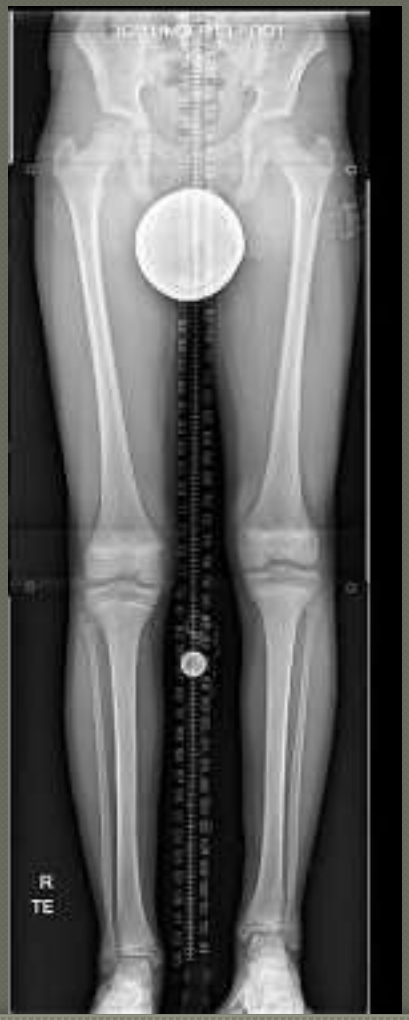
3 months postop!

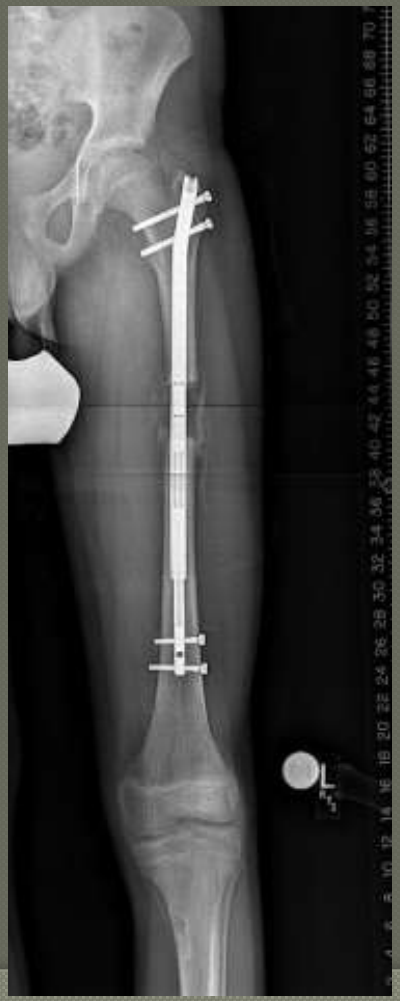
Troch entry
Nail can lead
To varus

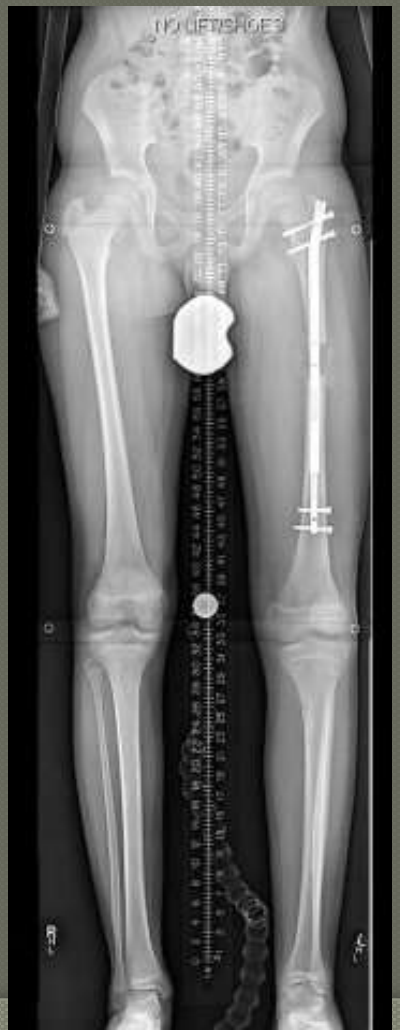


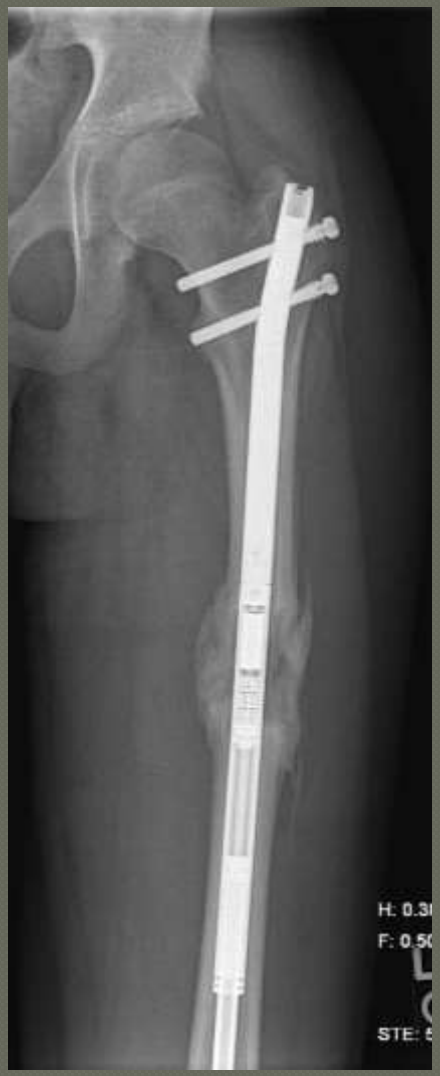


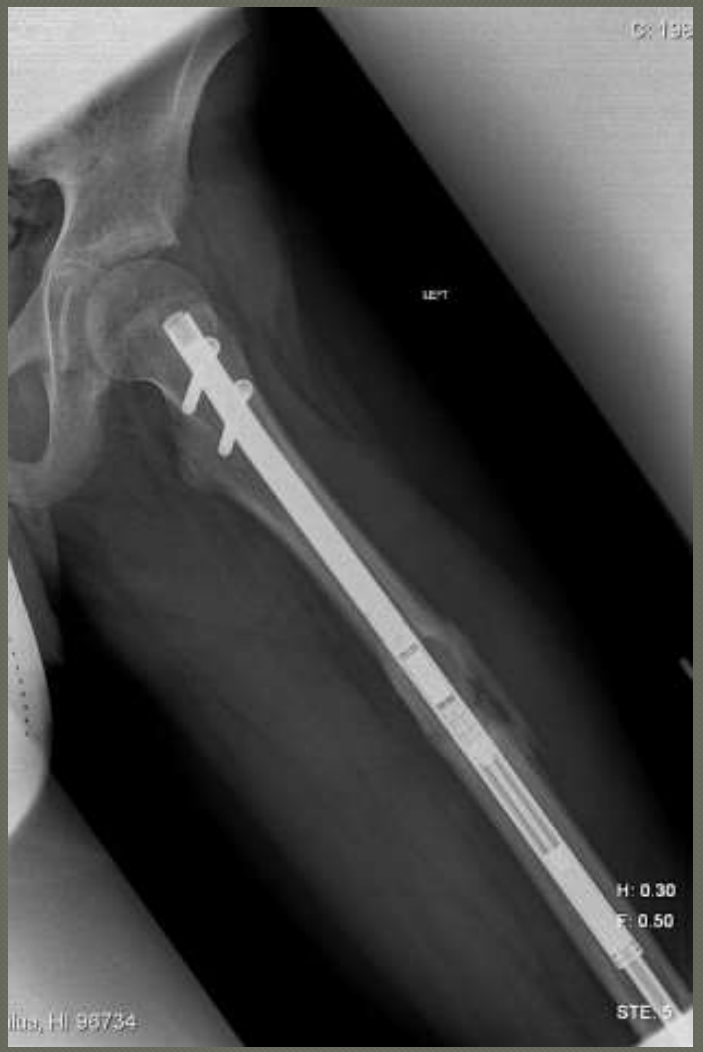
12 year old male with congenital LLD

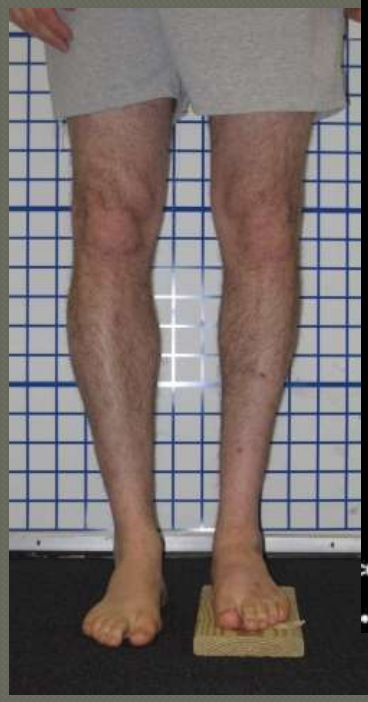


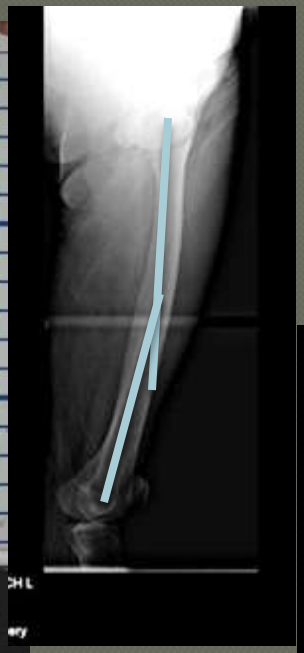




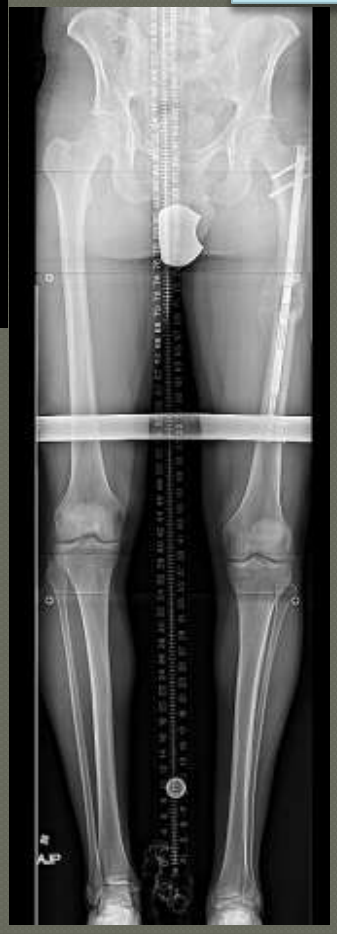


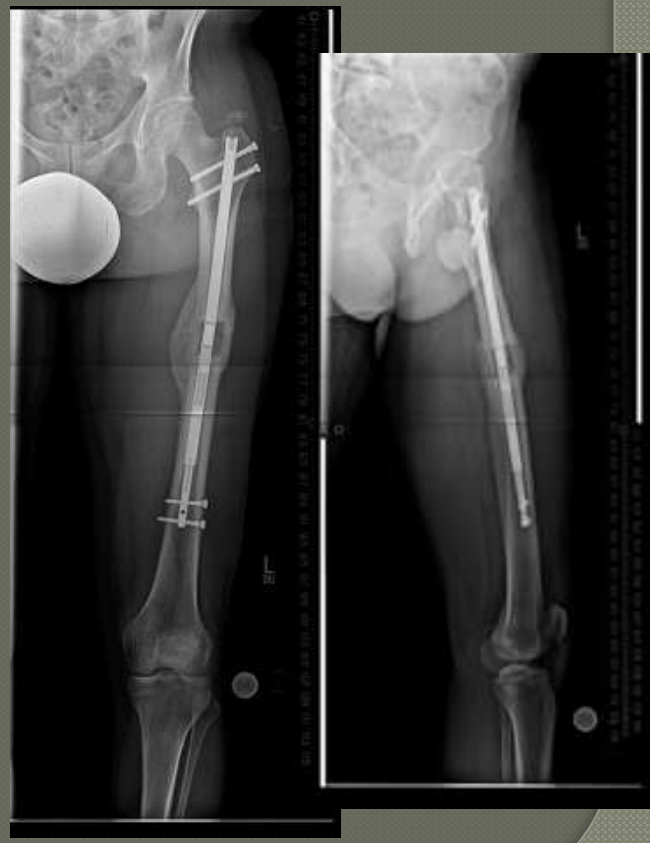

H: 0.30
F: 0.50



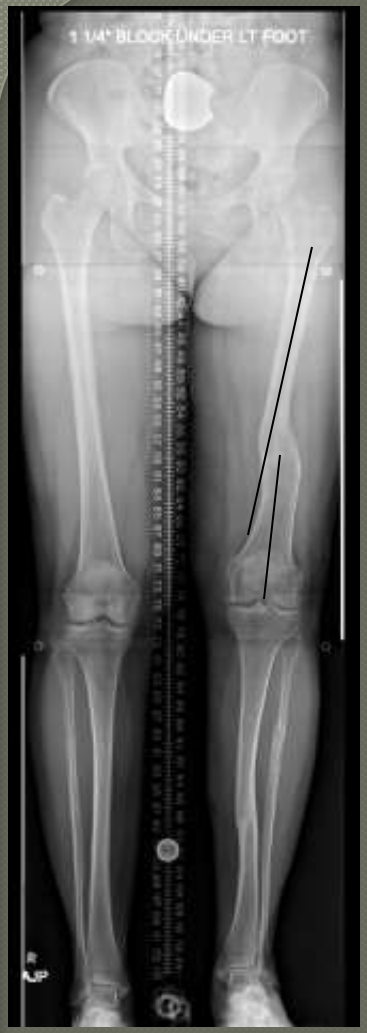


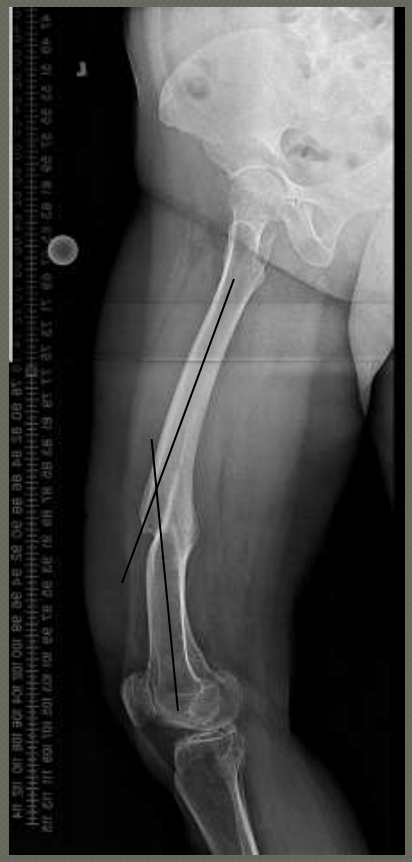
Piriformis Entry- my preference
In adult

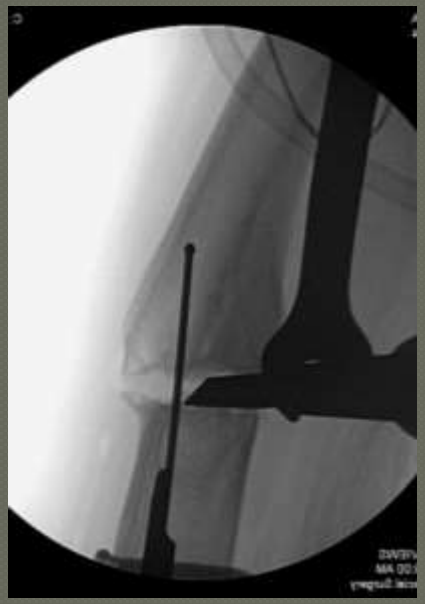




Clubfoot, LLD 1 inch

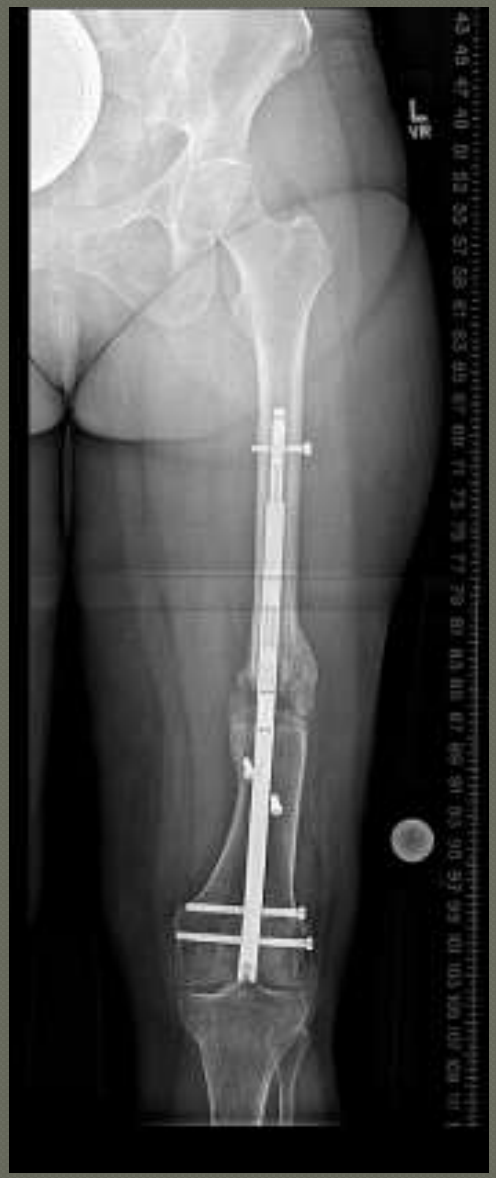


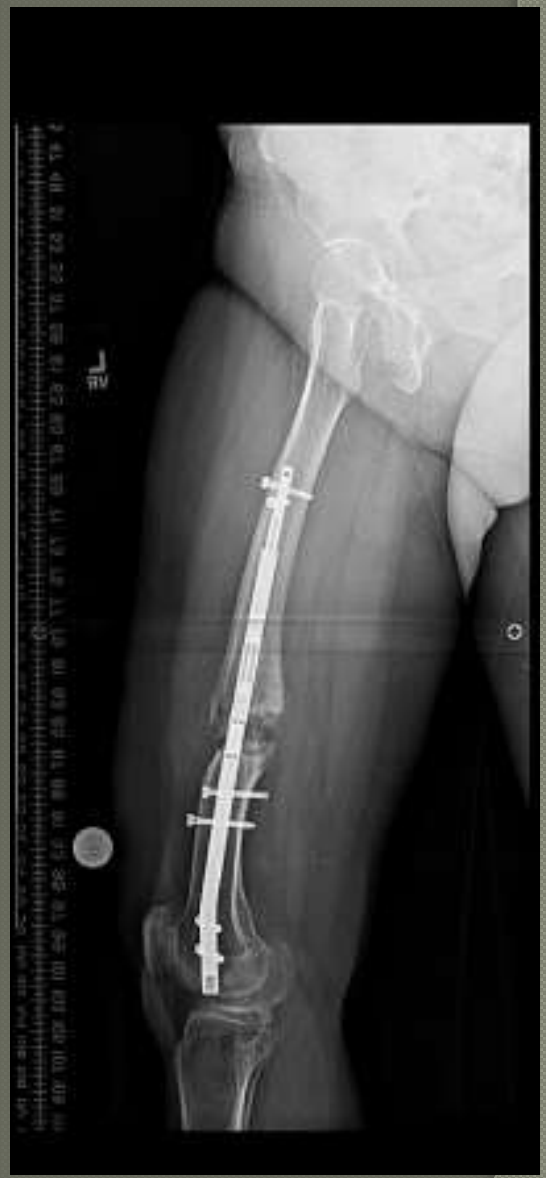




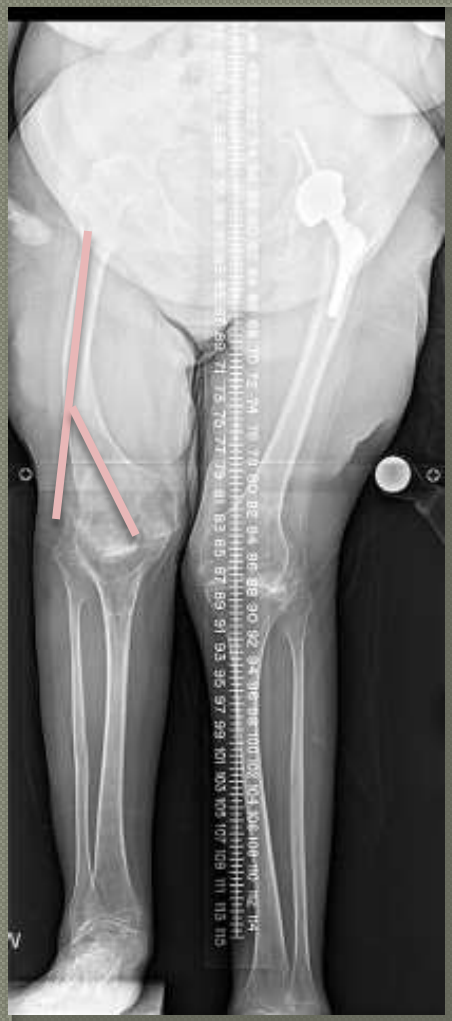
Malunion, LLD 3 cm
AP translation & PC deformity

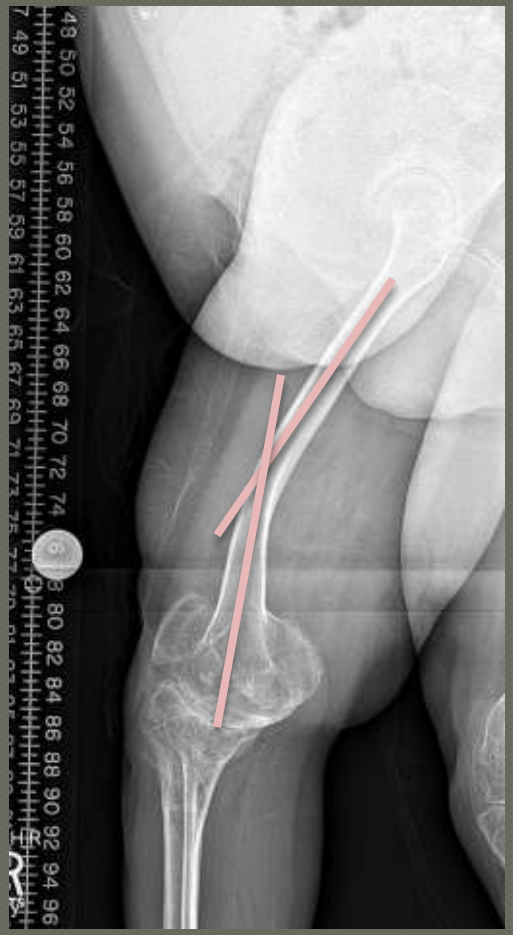
Osteotomy, translate with Osteotome, pass wire, Ream

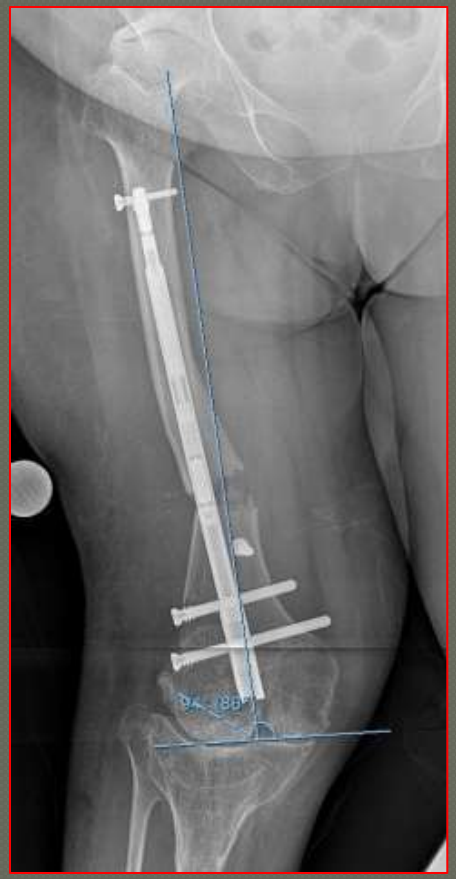


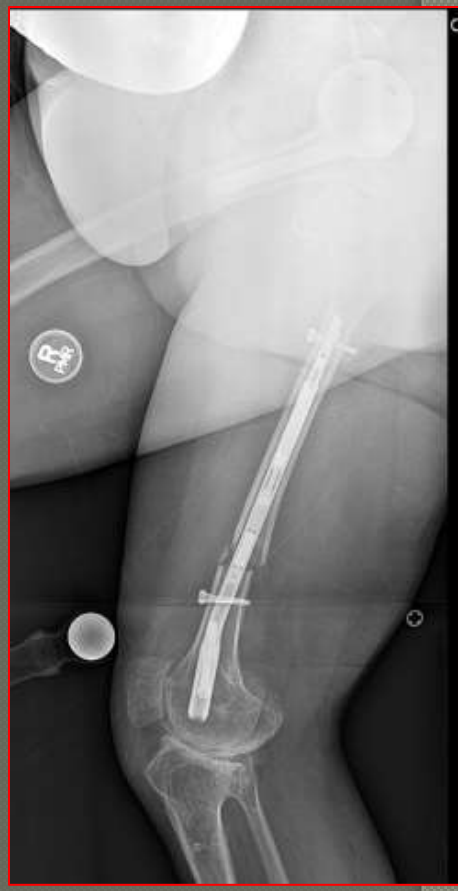


Blocking screws needed to narrow canal









5 cm LLD; varus, procurvatum

Precision of the Precice® Internal Lengthening Nails

Yatin Kirane, MBBS, D.Ortho, MS, PhD
Austin T. Fragomen, MD
S. Robert Rozbruch, MD

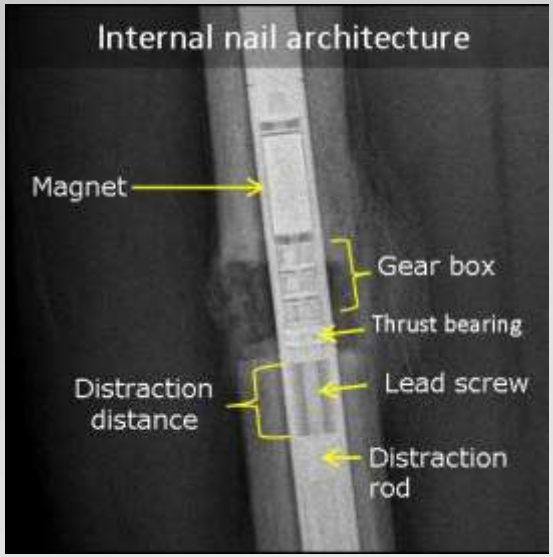
Limb Lengthening and Complex Reconstruction Service
Hospital for Special Surgery, New York, NY

Presented at LLRS July 2013
Accepted to CORR

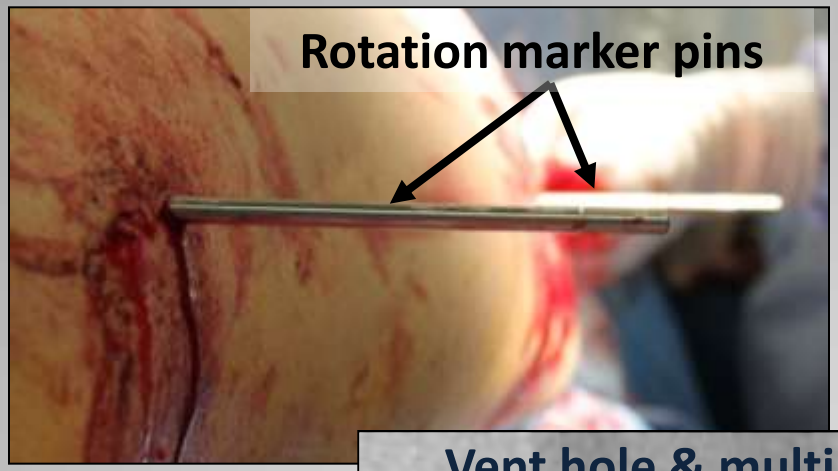
Precice® Nail Ellipse Technologies Inc., Irvine, CA

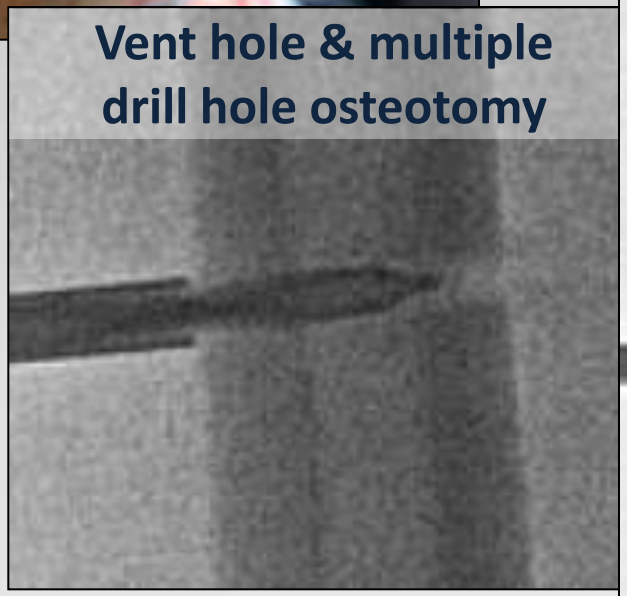
Precice® Nail

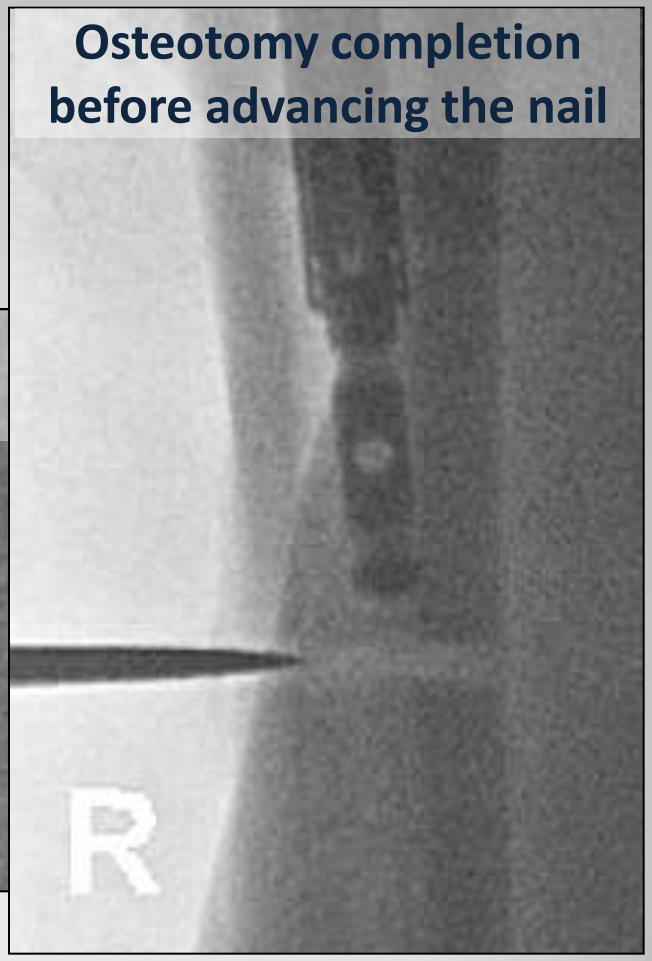
- Telescopic, magnet-operated device
- Recent FDA approval
- Clinical efficacy not established



Surgical Technique

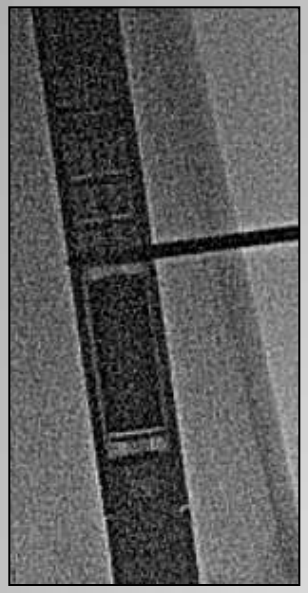


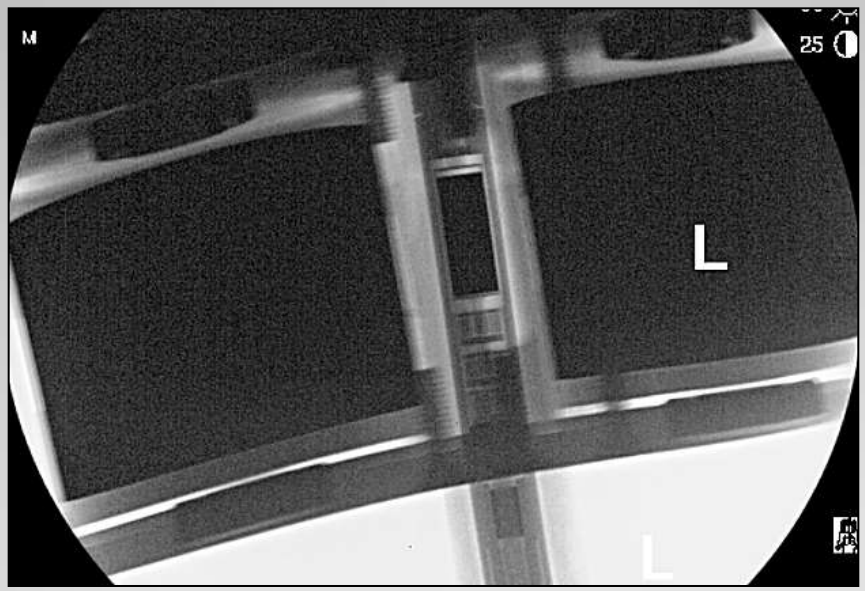




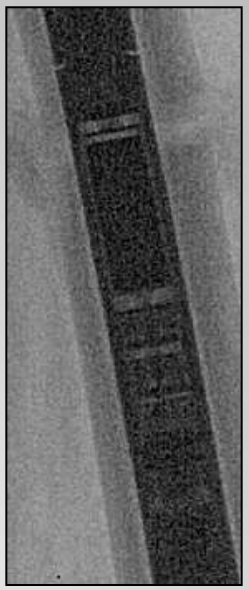
Intraop Magnet Localization & Distraction

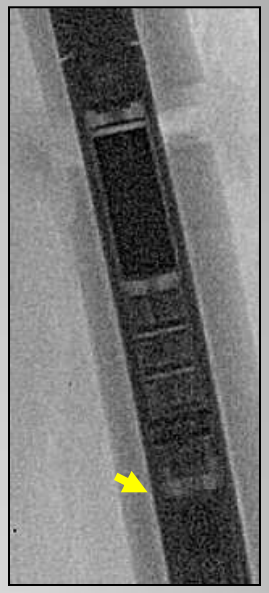
Localization of the internal magnet





Intraop distraction





Methods

- 17 femur and 8 tibia lengthening cases
- Medical records were reviewed for:
  - Patient characteristics
  - Etiology
  - Surgery details
  - Distraction process
  - Bone alignment
  - Adjacent joint range of motion (ROM)
  - Any complications

Primary Outcome Variables

I. **Accuracy of Lengthening**
   - Distraction distance & accuracy measured using a calibrated digital radiology system (PACS, OnePacs LLC, New York, NY)

$$A)\ \%\ Error = \frac{Distraction\ prescribed\ -\ Lengthening\ measured}{Distraction\ prescribed} X\ 100$$

$$B)\ Accuracy\ of\ distraction\ =\ 100 - \%\ Error$$

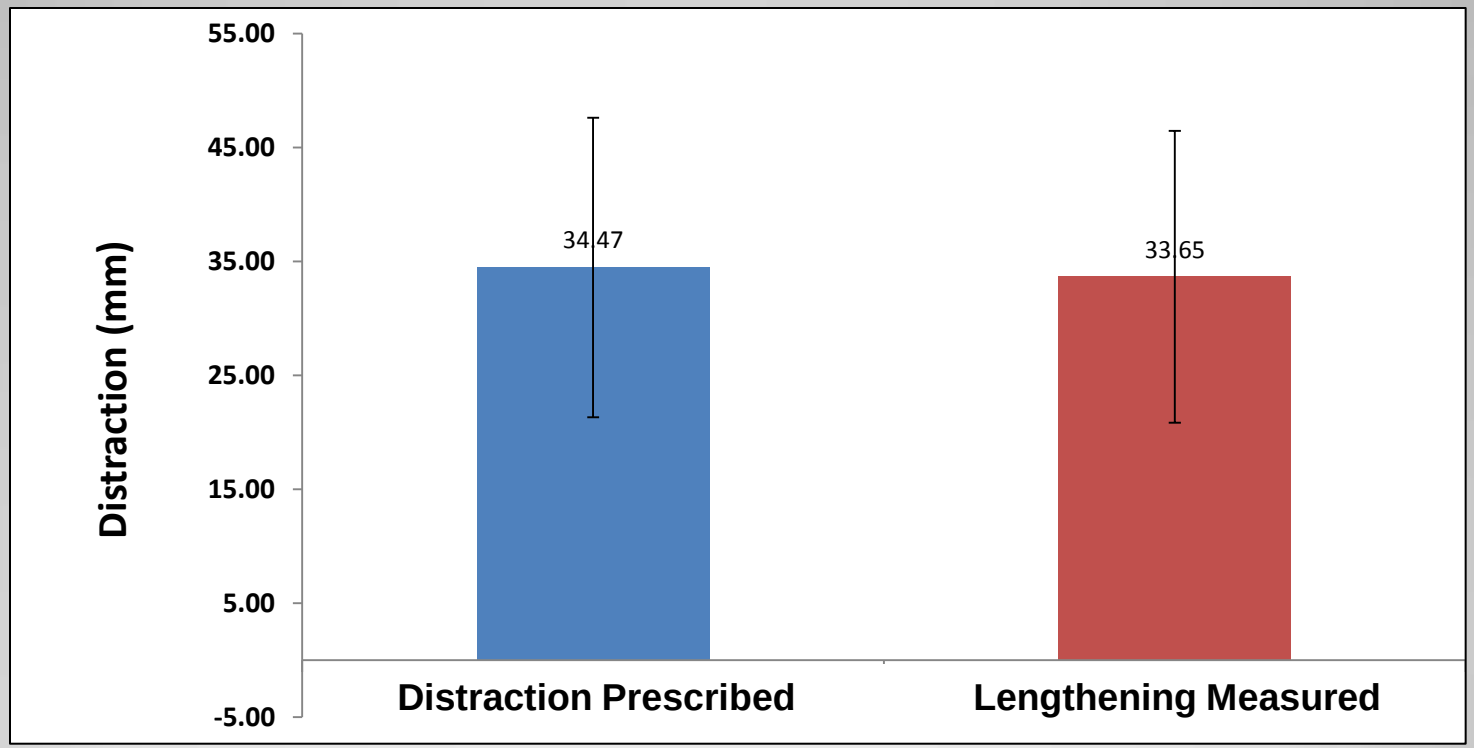
II. **Change in bone alignment**

III. **Effect on adjacent joint ROM**

I. Accuracy of Lengthening

At 19 weeks follow-up (range, 1-42 weeks):

- Average lengthening was **33.65 mm** (range, 14mm-61mm)
- Accuracy was **99.3% ± 0.23%**



II. Absolute Change in Bone Alignment

BONE	ANGLE	ABSOLUTE CHANGE (degrees)	
		Mean	Range
Femur	Lateral distal femoral angle (LDFA)	2	0-4
	Procurvatum/Recurvatum	6	0-12
Tibia	Medial proximal tibial angle (MPTA)	3	0-6
	Procurvatum/Recurvatum	3	1-5

- Intentional reduction of femur bow (5/17)
- Blocking screws (4/17 femur & 6/8 tibia)

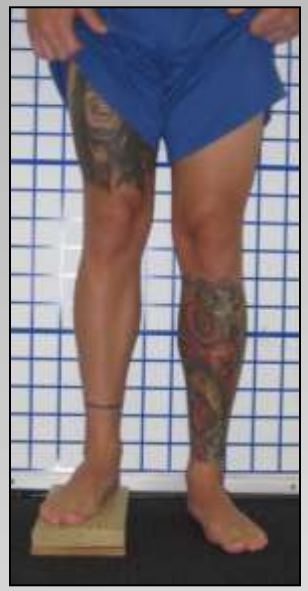
III. Joint ROM

- Hip, knee and ankle ROM well maintained
- Temporary loss of motion in early postop period

MOTION	ABSOLUTE LOSS (degrees)	
	Mean	Range
Knee Flexion	13	0-30
Knee Extension	0	0-2
Ankle Dorsiflexion	3	0-15
Ankle Plantarflexion	6	0-20

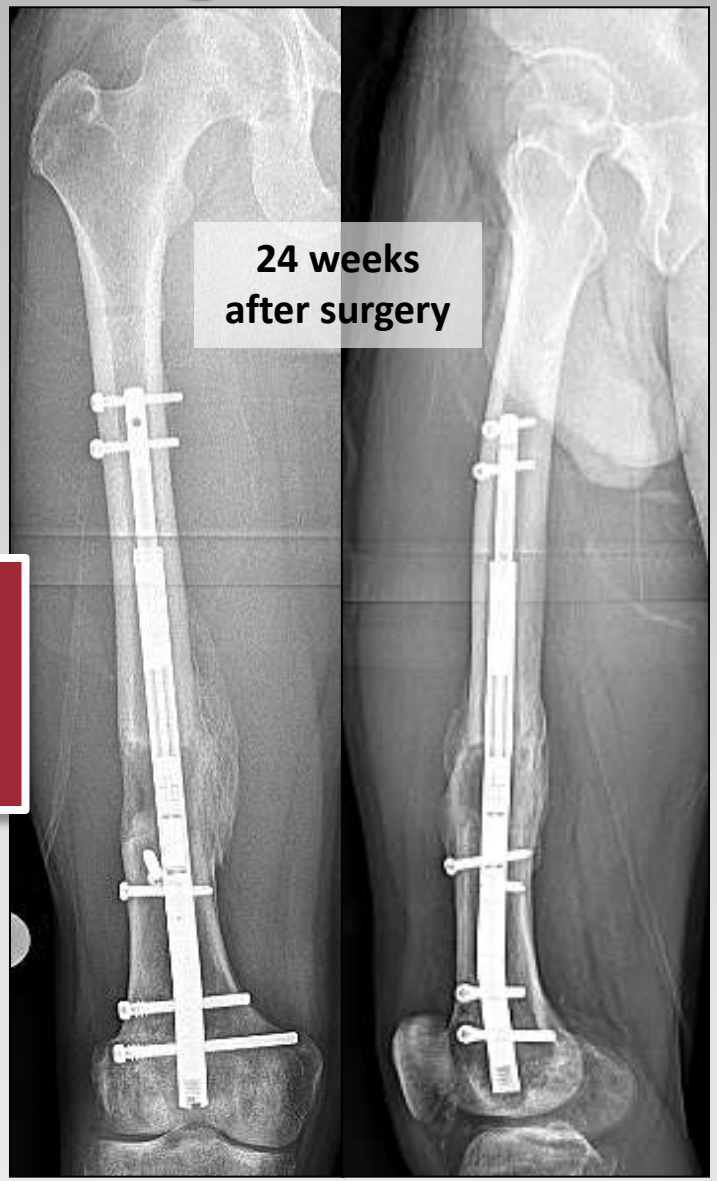
- ITB release (10/17 femur)
- Gastrocnemius recession (5/8 tibia)

Example : Retrograde Femur



- 30M
- 3.6 cm LLD
- 7° genu valgum (MAD 14 mm lateral)
- 10° ER deformity
- Post-traumatic growth arrest after R femur Fx
- Lower back and R LL pain

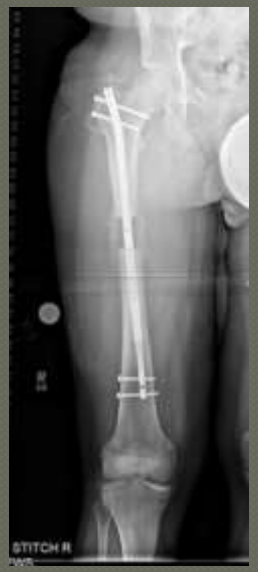
Example : Retrograde Femur



-Blocking screws
-To narrow canal
-Placed in concavity of anticipated deformity

Treatment options

- External Fixation
- IntegratedFixation
  - LON
  - LATN
  - LAP
- Internal lengthening nail
  - Piriformis
  - Trochanteric entry
  - retrograde



Thank You

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www.hss.edu/limblengthening