

Distal Femur and Proximal Tibia:
Pearls of Treatment

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Disclosure

- Educational Consultant
– AO, Stryker, Biomet
- Royalties
– Biomet
- Design Team
– Biomet
– Synthes

Distal Femur Fractures

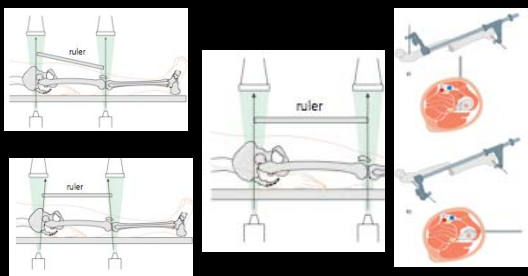
Goals of Treatment

- **1) Anatomical reduction of the joint surface**
- **2) Restoration of alignment:**
 - Mechanical Axis
 - Length
 - Rotation
- **3) Minimal surgical trauma**

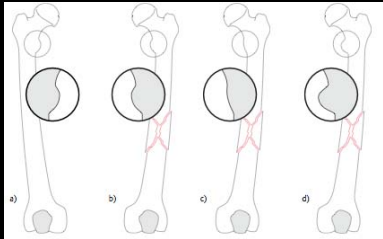
Goals of Treatment

- **Stable fixation** of the meta-diaphyseal fracture
- **Avoid complications:** malunion, nonunion, infection, arthrofibrosis
- **Allow early movement** and rehabilitation

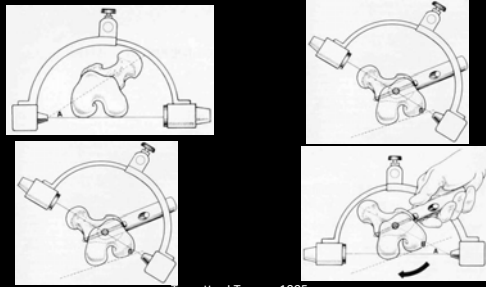
Achieving goals



Achieving goals



Achieving goals



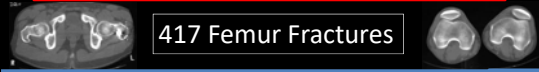
Tornetta, J Trauma 1995

Intramedullary Nailing of Diaphyseal Femur Fractures Secondary to Gunshot Wounds: Predictors of Postoperative Malrotation

Neeraj M. Patel, MD, MPH, MBS,* Richard S. Yoon, MD,* Matthew B. Cantlon, MD,*
John D. Koerner, MD,† Derek J. Donegan, MD,† and Frank A. Liporace, MD*

J Orthop Trauma • Volume 28, Number 12, December 2014

Nail entry		
Antegrade	9.68 ± 7.23	4.80 ± 3.78
Retrograde	6.93 ± 5.30	6.06 ± 5.25



417 Femur Fractures

Femoral malrotation after intramedullary nailing in obese versus non-obese patients

John D. Koerner¹, Neeraj M. Patel², Richard S. Yoon³, Mark J. Gage⁴, Derek J. Donegan⁵, Frank A. Liporace^{6,7*}




No Difference: DFV - based on BMI

Courtesy Paul Tornetta III

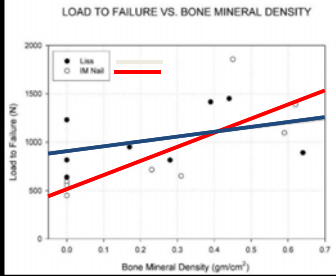
SOLVED - Summary

- 126 Patients
- Malalignment >5°
 - 22% Nails
 - 32% Plates
 - Valgus Common (p = 0.05)
- No difference
 - WB, ROM, revision, outcomes
- Improvement over time
 - Surgical Learning Curve
- Revision
 - 5% Nails
 - 8% Plates
- Hardware removal
 - 15% Nails (90% screws)
 - 10% Plates



Biomechanical Evaluation of the Less Invasive Stabilization System, Angled Blade Plate, and Retrograde Intramedullary Nail for the Internal Fixation of Distal Femur Fractures

Michael Zlowodzki, MD,* Scott Williamson, BS,† Peter A. Cole, MD,* Lyle D. Zardiackas, PhD,† and Philip J. Kregor, MD‡
(J Orthop Trauma 2004;18:494-502)



LOAD TO FAILURE VS. BONE MINERAL DENSITY

Legend: LISS (black squares), IM Nail (open circles)

AXIAL LOADING:

IMN < LISS
LOAD-TO-FAILURE
LOW BMD

IMN > LISS
LOAD-TO-FAILURE
HIGH BMD

Retrograde IMN Technique

Position

- Supine, radiolucent flat table
 - Jackson, OSI®
- Knee triangle
 - Knee flexion allows entry portal
- Free drape to ASIS
 - Proximal locking

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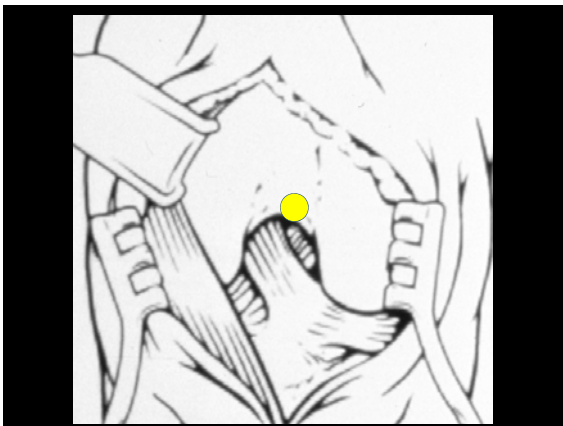
Entrance portal

Tip of Blumensaat's line on lateral

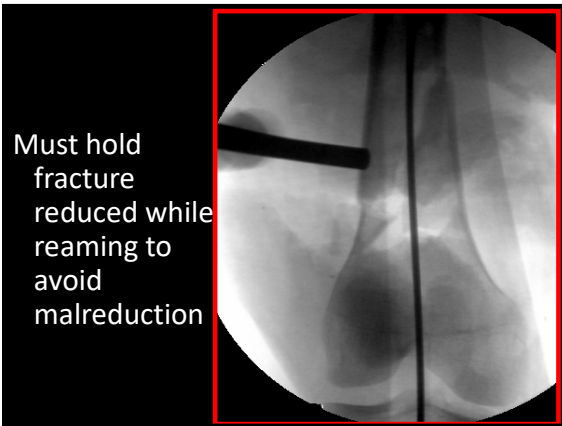


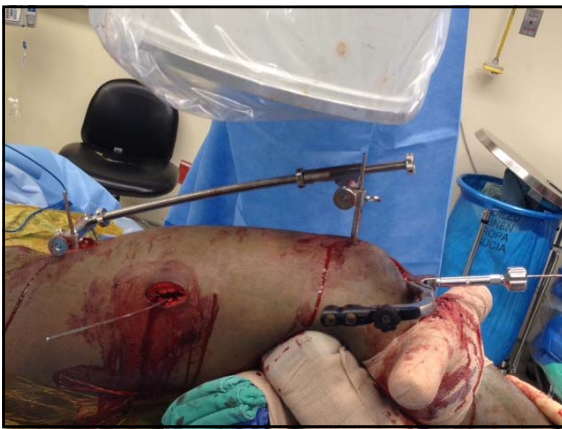
Just medial to center on AP



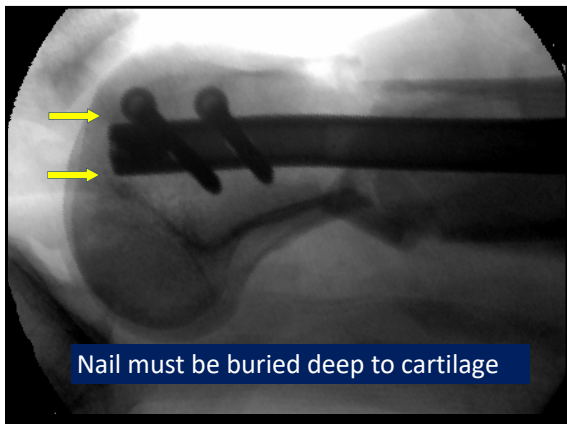












Evaluation of Distal Femur Fractures

Don't forget the CT scan!

- 38% of supracondylar/intercondylar distal femur fractures have a coronal plane fracture (Nork et al, *J Orthop Trauma*, 87:564, 2005)
- Most precisely diagnosed via CT scanning

Intra-articular Simple Split

- Usually require open reduction
- Rigid fixation
- Intercondylar spits
- Address joint FIRST

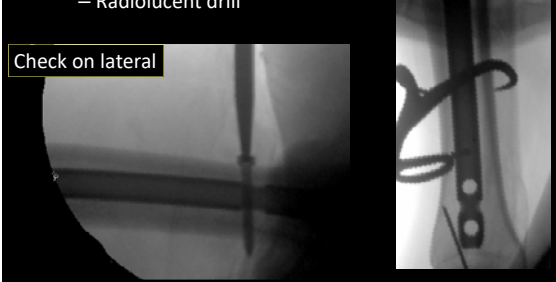
One anterior to nail

One posterior to nail

Proximal locking

- Free hand technique
 - Radiolucent drill

Check on lateral



Proximal locking

- Femoral artery branches cross anterior more than 4 cm distal to lesser
- Femoral nerve branches cross proximal to lesser trochanter and start 4cm distal to piriformis
- Lock near lesser trochanter
 - Less risk to neurovascular structures

Tornetta, 1998

Is There an Optimal Proximal Locking Screw Length in Retrograde Intramedullary Femoral Nailing?
Collinge C, Yoon RS, Liporace FA - JOT 2015


	Measured length	"best" screw length (5mm increments)?	Difference between measured and "best" screw lengths for 5mm increments	"best" screw length (2.5mm increments)?	Difference between measured and "best" screw lengths for 2.5mm increments	"best" screw length (2mm increments)?	Difference between measured and "best" screw lengths for 2.5mm increments
>1cm Prox LT	35.1 (2.3)	35	-0.2 (1.6)	35	-0.3 (2.3)	36	0.64 (2.3)
Level of LT	31.3 (1.5)	35	3.3 (1.5)	32.5	0.7 (1.5)	32	0.27 (1.5)
>1cm Distal LT	30.6 (2.4)	30	1.1 (2.4)	32.5	1.8 (2.3)	32	1.1 (2.4)

When you can't do IMN...

GOALS

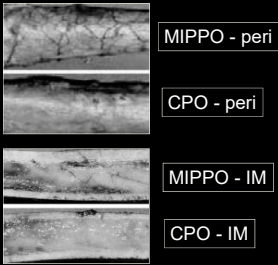
- Biologic preserving !!!
 - Respect soft tissues
- Restoration of:
 - Mechanical axis
 - Length
 - Alignment / Rotation

Biologic Felony

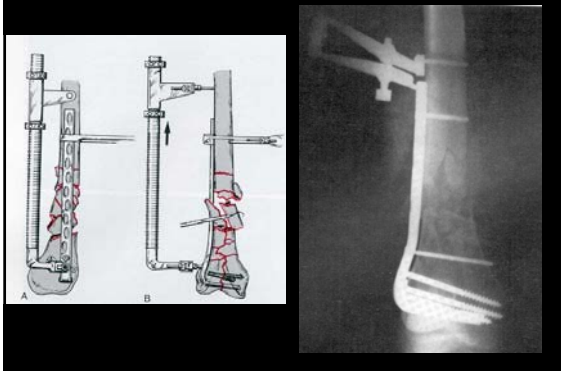


Saving the Blood Supply

- 10 cadaveric femurs
- CPO vs MIPPO
 - 16 hole LC-DCP
- Dye injection
- ALL MIPPO specimens w/ intact nutrient and perforating arteries



Indirect Reduction of Metaphyseal Component



Effect of Keeping Periosteum

- Maintenance of b.s.
- Higher union rates
- Lower complications
- Less bone grafting

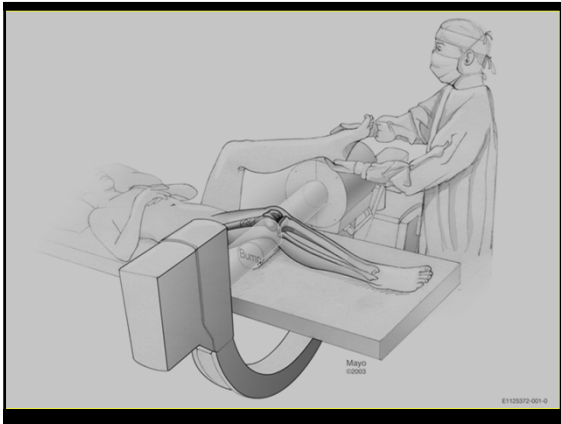


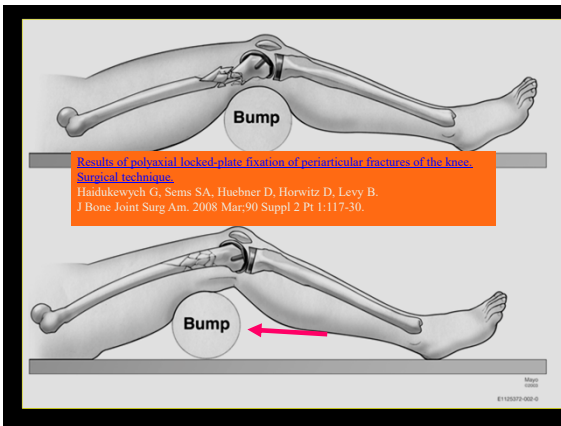
(Wenda, Injury, 1997; Krettek, Injury 1997; Krettek, Unfallchirurg, 1996; Bolhofner JOT 1996; Kinast & Bolhofner, Clin Orthop, 1989)

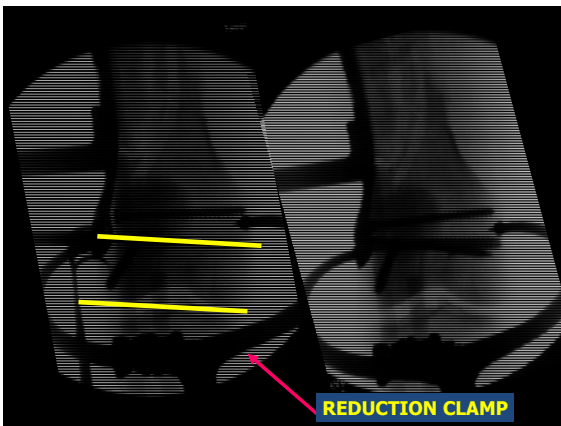
Non-articular or Simple Split

- Lateral approach
- *****Limited surgical dissection**
- *Percutaneous plate insertion*
- *Metaphysis Indirect Reduction*
 - Bumps
 - Femoral Distractor
 - Percutaneous Pins
 - External fixator









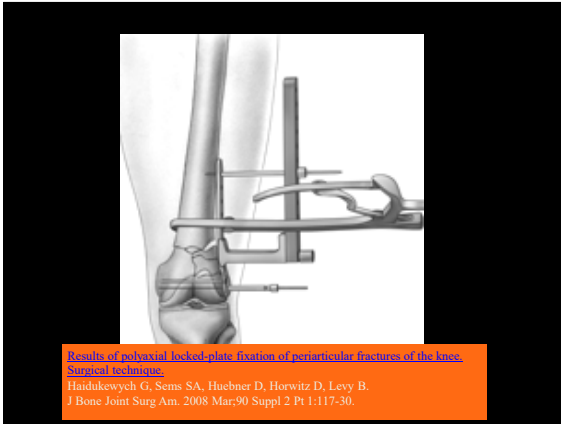


Plate Placement Problems

- Prior to complete plate fixation, must confirm appropriate location *distally and proximally!!!*

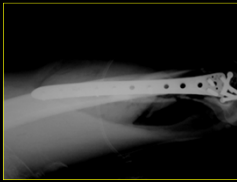

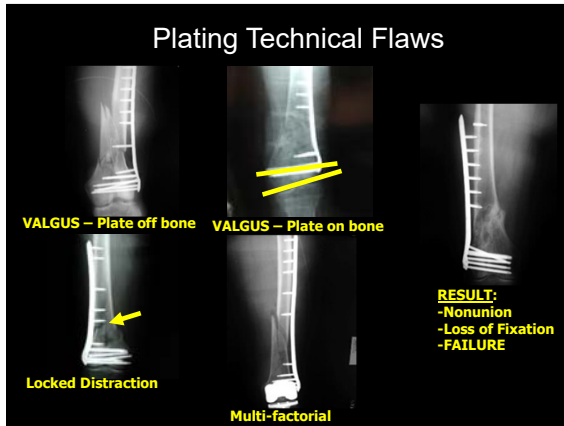
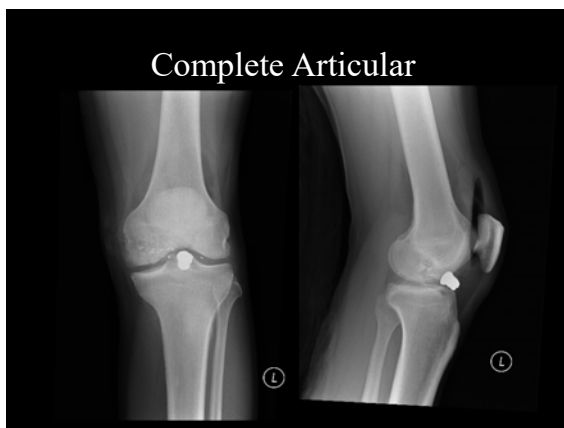


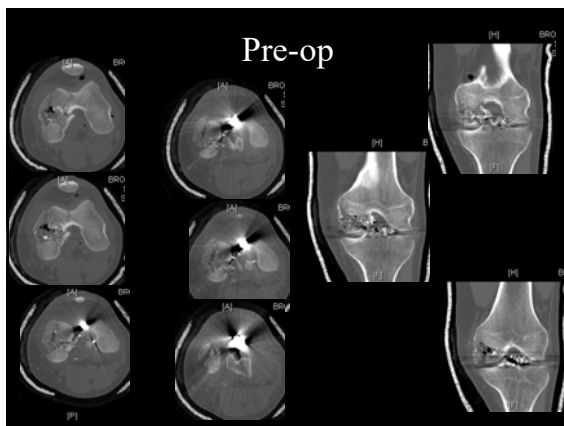
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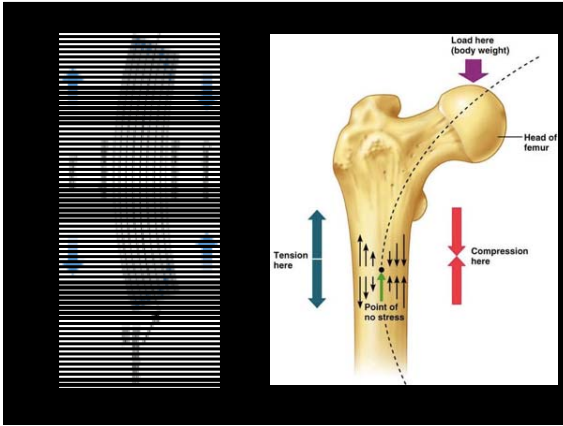
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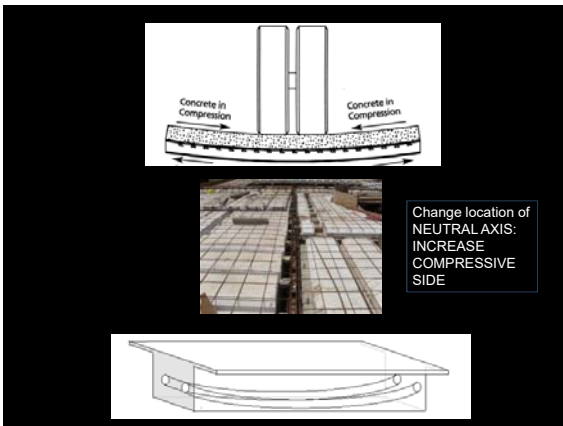


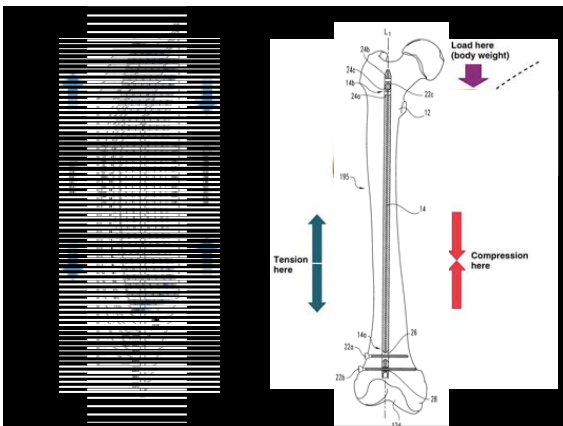


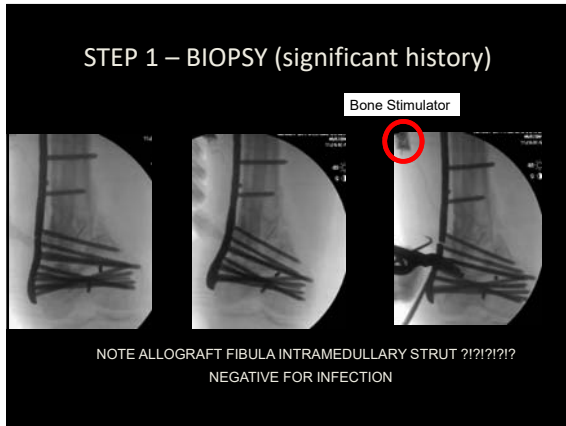


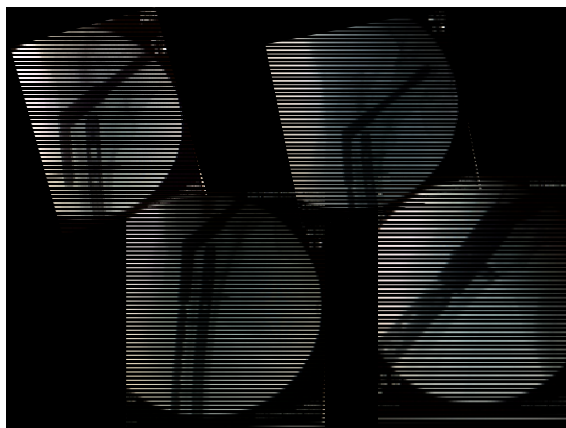


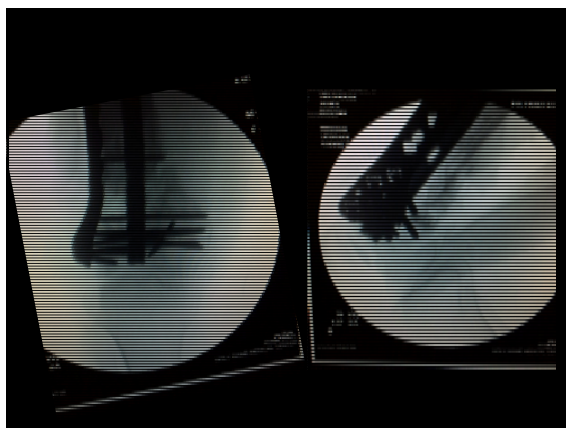


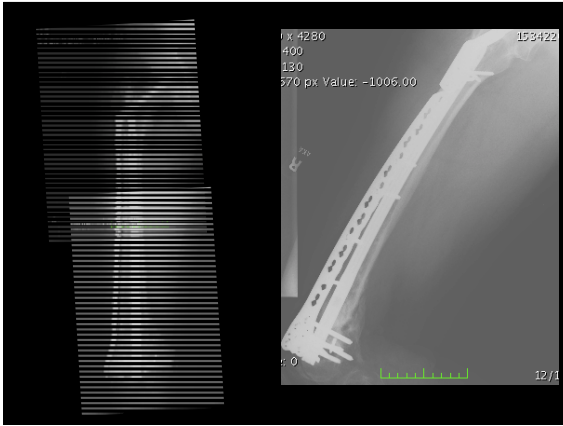


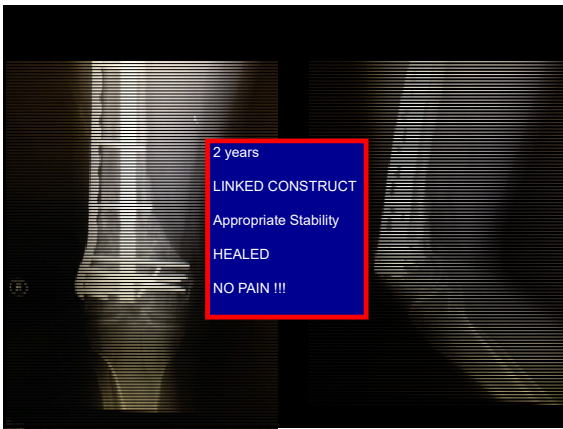


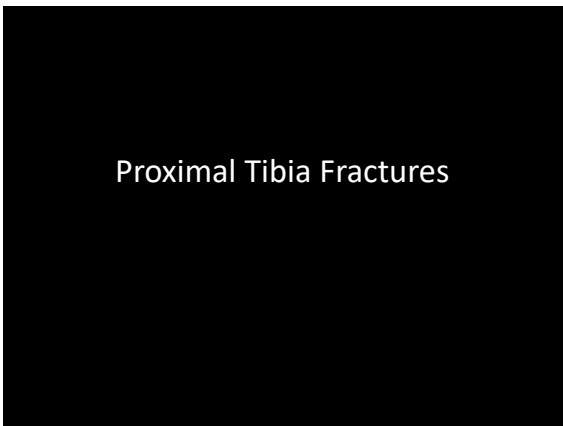






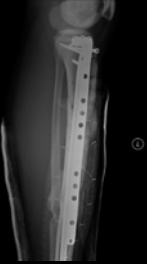







Options with IMN

- Starting hole location
- Nail in extension / Suprapatellar
 - Proximal fx' s
- Femoral distractor / Ex-fix
- Blocking screws
- Fibula plating
 - Distal fx' s
- Percutaneous clamping
- Limited combination plating




Starting Point - Considerations

- Too Low- cortex perforation
- Too High- articular penetration
- Too medial/lateral- meniscal damage
- Safe zone: 23mm wide / 9mm lateral to midline



Proximal Fractures- Malalignment

- Valgus
 - PEs
 - Starting point
- Procurvatum
 - Patella tendon
- Accentuated with flexion of knee



Lang GJ et al Clin. Orth 1995
Gibbons et al. J.O.T 1995

Lateral Starting Point

- **Lateral starting point**
 - 14 proximal tibial shaft fractures
 - Avg. anterior displ 3.0mm
 - Avg. coronal alignment 2 deg valgus
 - One nonunion

Buehler KC, et al. JOT 1997

Femoral Distractor/Exfix

- Indirect fracture reduction before IM nailing



Techniques: Blocking Screws



Blocking screws

- Acutely
 - Aid reduction
 - Proximal
 - Distal
- Malunion correction
- Concavity of proximal frag
- Restricts canal

Beware w/ osteoporosis, GSW's, unrecognized fx lines

Blocking screws

- Acutely
 - Aid reduction
 - Proximal
 - Distal
- Malunion correction
- Concavity of proximal frag
- Restricts canal

Beware w/ osteoporosis, GSW's, unrecognized fx lines

Proximal Third Tibial Shaft Fractures

Blocking Screws

- 12 patients with proximal tibia fractures treated with IMN and blocking screws
- 11/12 had less than 5 degrees of angular deformity

Ricci WM, et al., JOT, 2001



Techniques: Nailing In Extension

- Medial parapatellar approach
- Laterally sublux patella
- Straight awl using trochlear groove as a conduit
- Awl must be directed anteriorly
 - 25 proximal tibia fractures
 - None with more than 5 degrees anterior angulation
 - 23/25 with less than 5 degrees angulation in coronal plane

-Tornetta P, et al, Clin Orth 1996

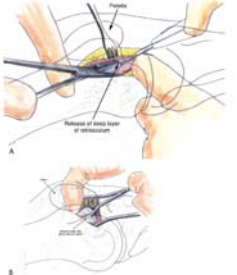
Semi-extended (suprapatellar) IMN

J Orthop Trauma, 2010 Nov;24(11):659-71.
Suprapatellar versus infra-patellar intramedullary nail insertion of the tibia: a cadaveric model for comparison of patellofemoral contact pressures and forces.
Gardino MK, Coombs D, Powell S, DiPaolantonio TG.

- Increased contact pressure → Cartilage Apoptosis ???
- 4.5 MPa – point of death !!!
- ~1.84 MPa – patella
- ~2.13 MPa – femoral condyle
 - OBSERVED

Alternative to suprapatellar IMN

J Orthop Trauma. 2010 Nov;24(11):704-8.
Extra-articular technique for semiextended tibial nailing.
Kubiak EN, Widmer BJ, Horowitz DS.



Alternative to suprapatellar IMN

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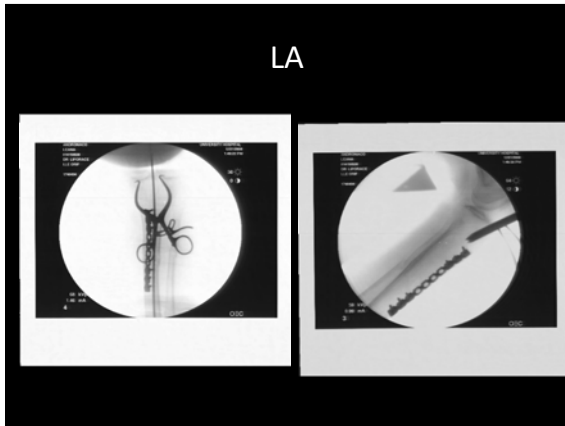
FIGURE 3. Identification and release of the medial superficial retinacular tissues (A). Release of the inferior deep retinacular bands (B) is critical to allow for the easy subluxation of the patella, which then reveals an easy access to the trochlea, which is demonstrated at the tip of the Kelly clamp (C). Note the intact synovium draped over the trochlea.

What about comminution & osteoporosis...

- Large canal – limited stability
- Hoop stresses – fx propogation
- Blocking screw “cut-out”
- Pre-existing knee stiffness / contracture











JOT 2015


**Intramedullary Nailing and Adjunct Permanent Plate
Fixation in Complex Tibia Fractures**

Richard S. Yoon, MD, Mark J. Gage, MD,* Derek J. Donegan, MD,† and Frank A. Liporace, MD**

<ul style="list-style-type: none">• 100% high energy<ul style="list-style-type: none">-Segmental-Proximal 1/3• 100% union• NO change in alignment from surgery → healing	<p><u>COMPLICATIONS</u></p> <ul style="list-style-type: none">-1 ROHG III B-1 infection
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Articular Injuries

1st Step is “soft tissue” reduction with Spanning
Ex Fix



Knee Spanning Ex-Fix

- Fixation Points
 - Femur
 - Lateral
 - Anterior
 - Tibia
 - Anterior Subcutaneous border



Where to place exfix?

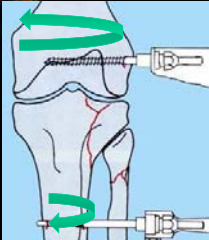



Definitive Plates Overlapping Provisional External Fixator Pin Sites: Is the Infection Risk Increased?
Shah, Chirag; Babb, Patricia; McAndrew, Christopher; Brimmo, Oluabusola; Badarudeen, Sameer; Tornetta, Paul; Ricci, William; Gardner, Michael
Journal of Orthopaedic Trauma. 28(9):518-522, September 2014.

Femur Anterior vs Lateral
DOESN'T MATTER!
I LIKE ANTERIOR FOR DISTRACTOR

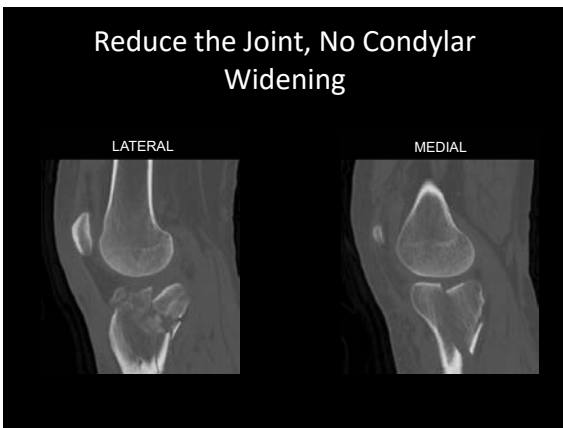
Infection Risk?

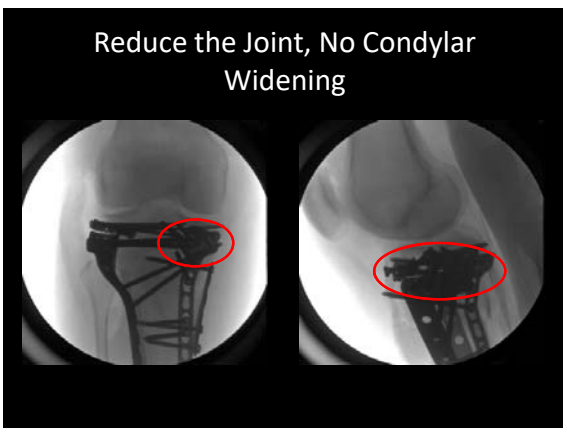
24 % Overlapping vs 10% NOT Overlapping



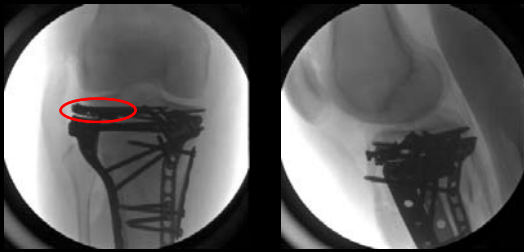
Femoral Distractor Useful



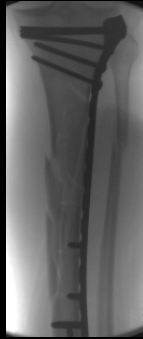




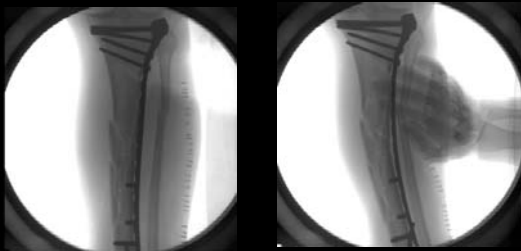
Fragment Specific Fixation



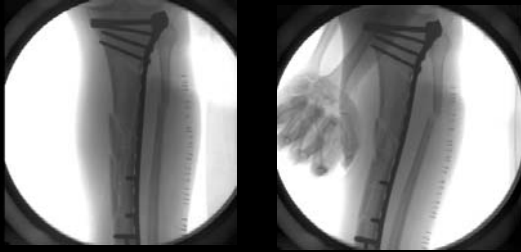
Ensure Meta-Diaphyseal Stability



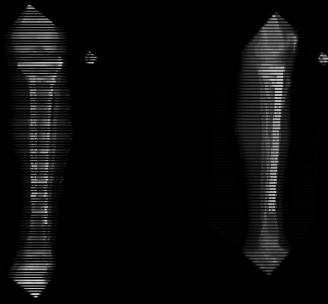
Instability can also be BONY



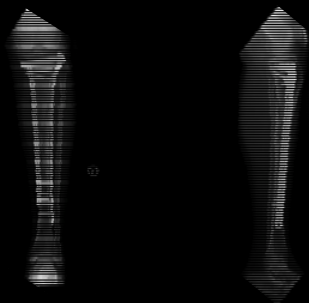
Instability can also be BONY



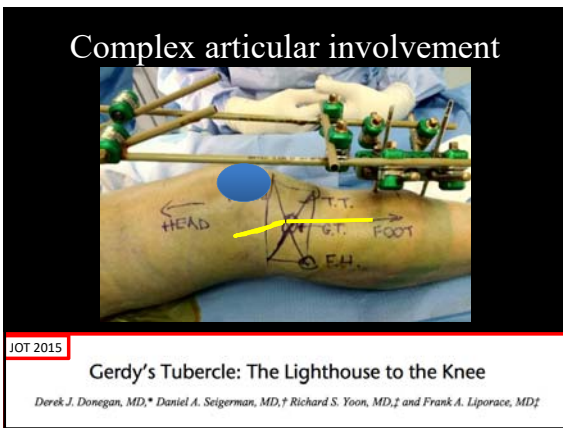
Ensure Meta-Diaphyseal Stability

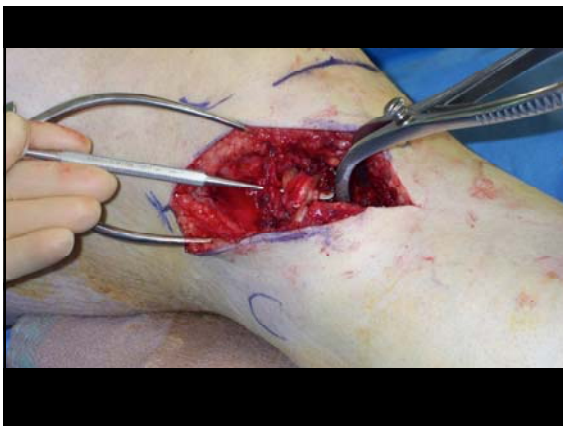


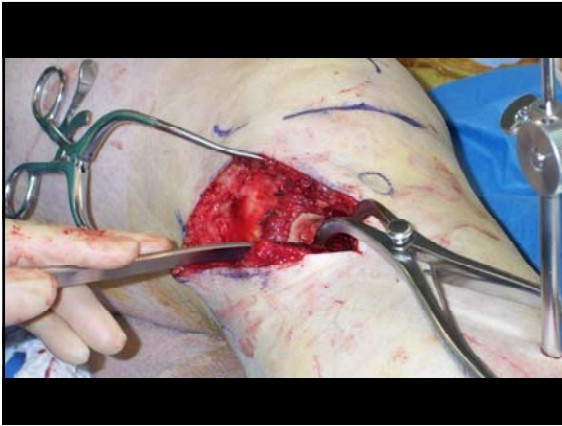
5 months

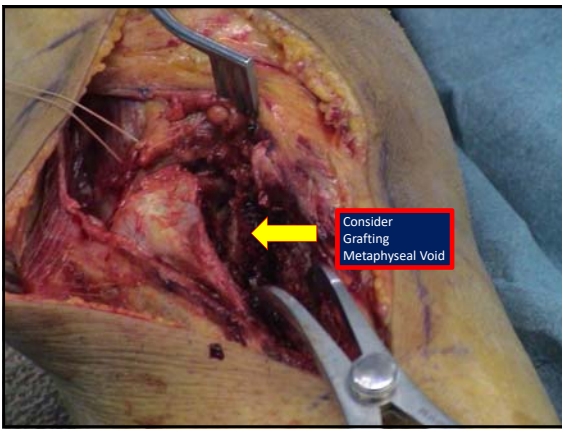


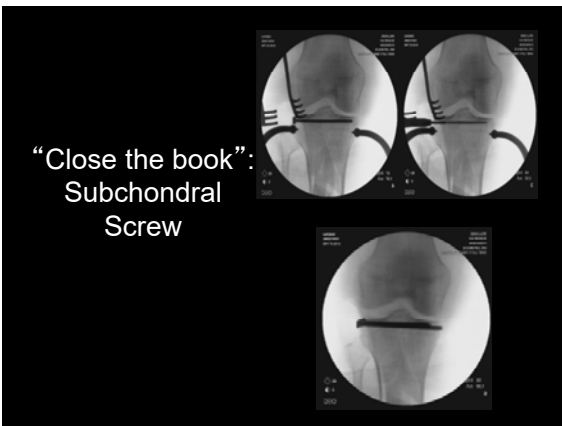


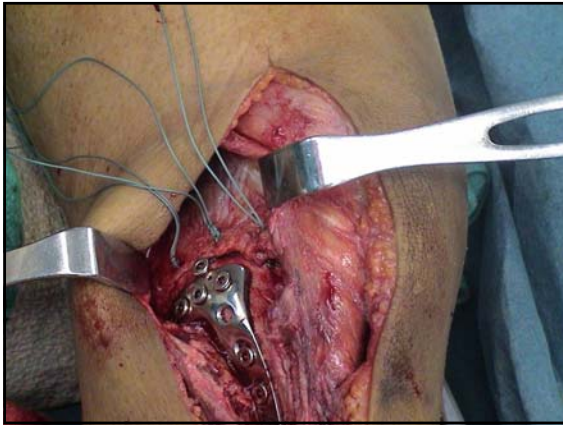






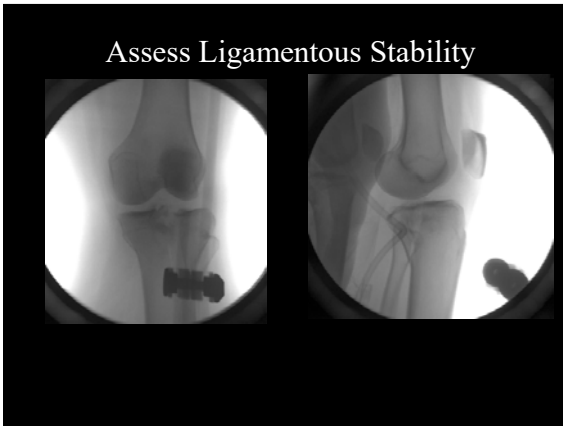




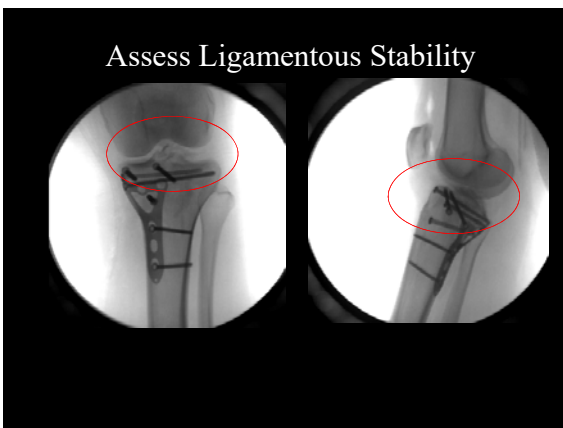








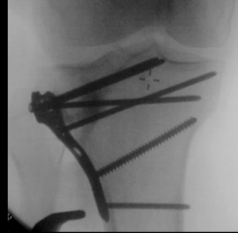




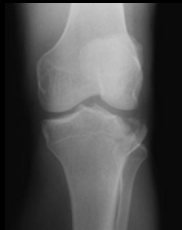
Filling the Void

- Compressive strength required
- Biologic properties secondary

- Calcium sulphates
- Calcium phosphates
- Bone Graft



Support Reduction with k-wires from opposite side or pass through to be flush laterally



Courtesy Bill Ricci, MD



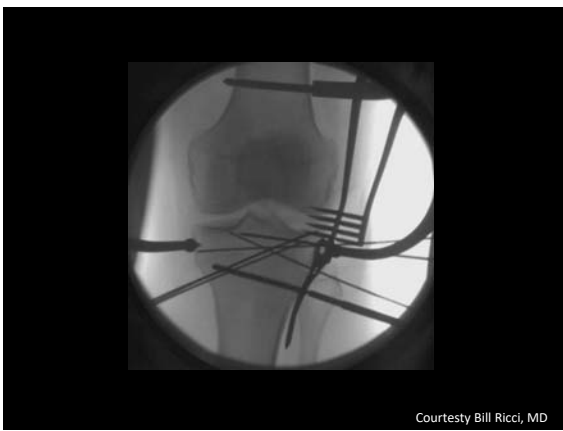
Courtesy Bill Ricci, MD



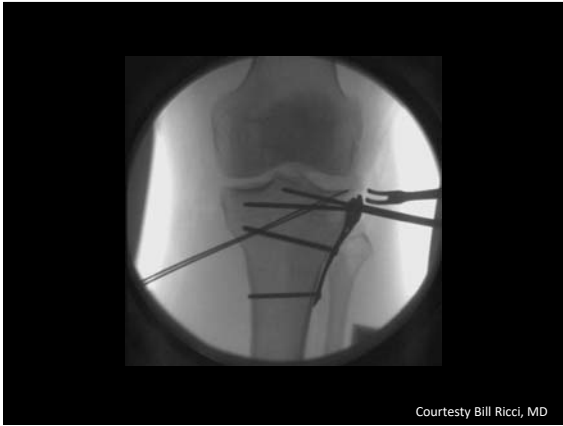




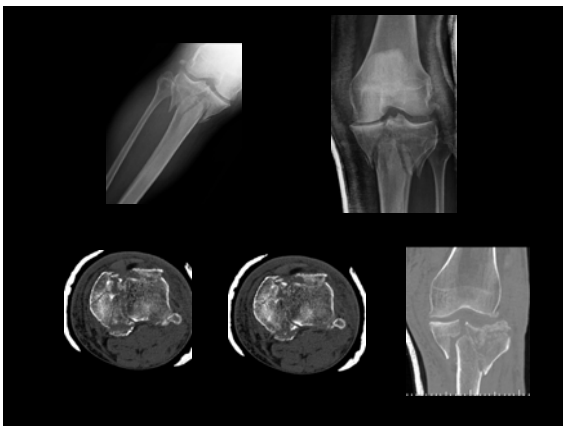




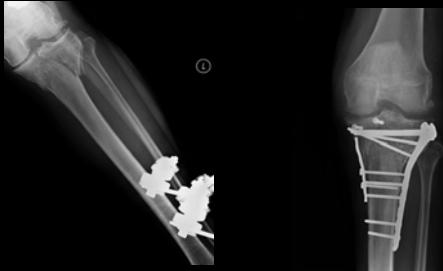








Double Plating – Medial Buttress



Take Home Points

- Soft tissue is Primary
- Need to restore
 - Mechanical Axis
 - Meniscus
 - Articular Surface
- Don't Forget the Medial Side
- Recognize Ligamentous Instability
- Be Biologically Friendly