San Francisco Trauma Course 2025

Proximal 1/3 Tibia Fractures
Nail vs. Plate Fixation

Christian Krettek, Hannover Germany

Problems

instability / malalignment

Proximal

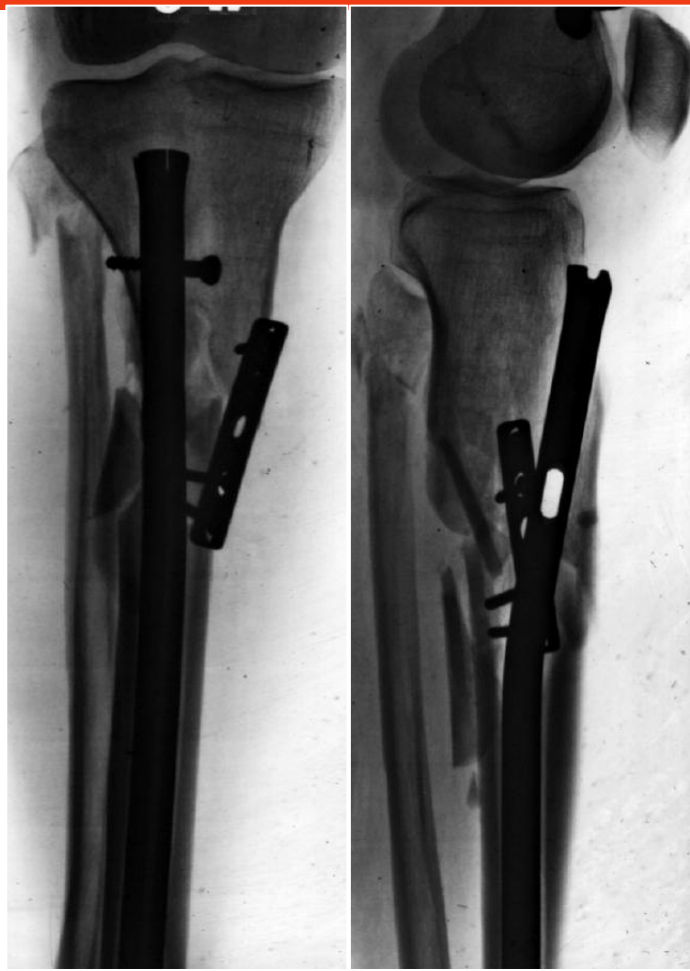
- Tornetta, CORR 1996
- Henley, JOT 1993
- Ahlers, UCH 1992
- Freedman & Johnson, CORR 1995
  up to 58% > 5°

Midshaft

Freedman CORR 1995
7% > 5°

Distal

Freedman & Johnson CORR 1995
8% > 5°
Robinson JBJS-B 1995
6% malalignment



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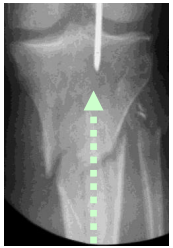
#3 Understand Tibia Excentricity and it‘s implication for Starting point

Tibia excentric bone



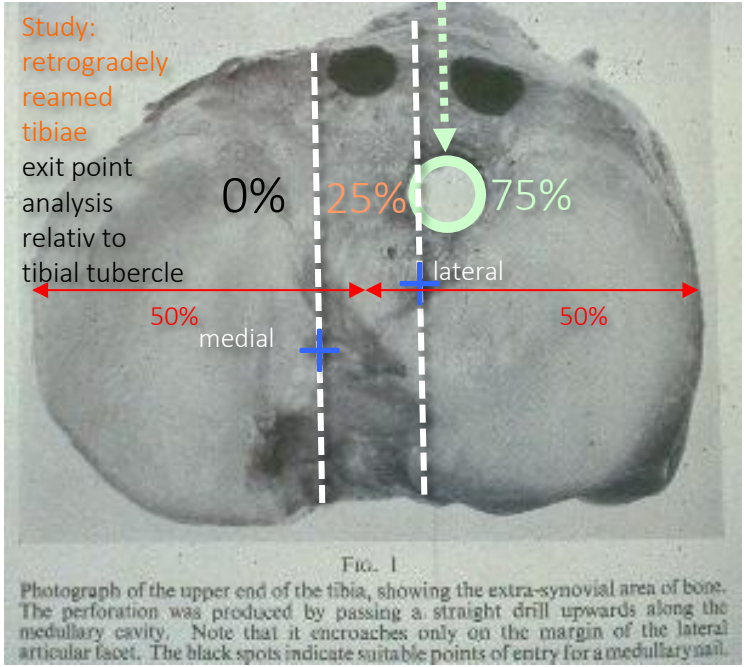
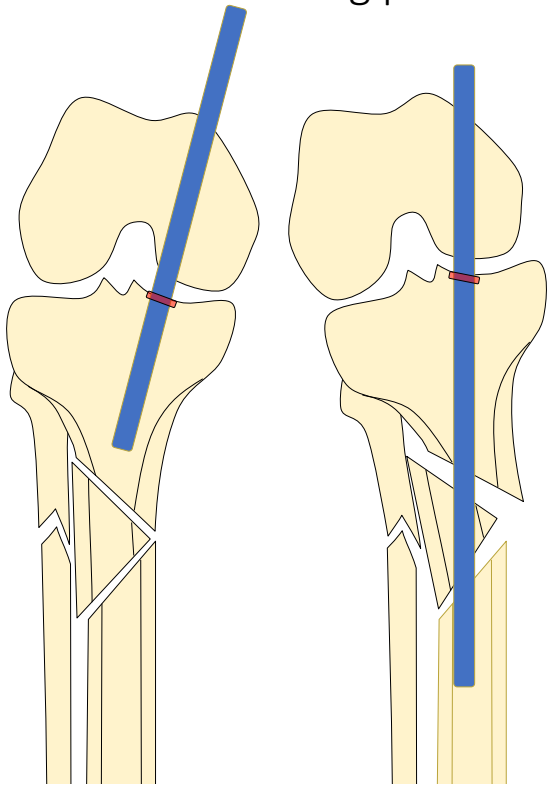


FIG. 1

Photograph of the upper end of the tibia, showing the extra-synovial area of bone. The perforation was produced by passing a straight drill upwards along the medullary cavity. Note that it encroaches only on the margin of the lateral articular facet. The black spots indicate suitable points of entry for a medullary nail.



Too medial: higher risk for deformity compared to more lateral startimg point

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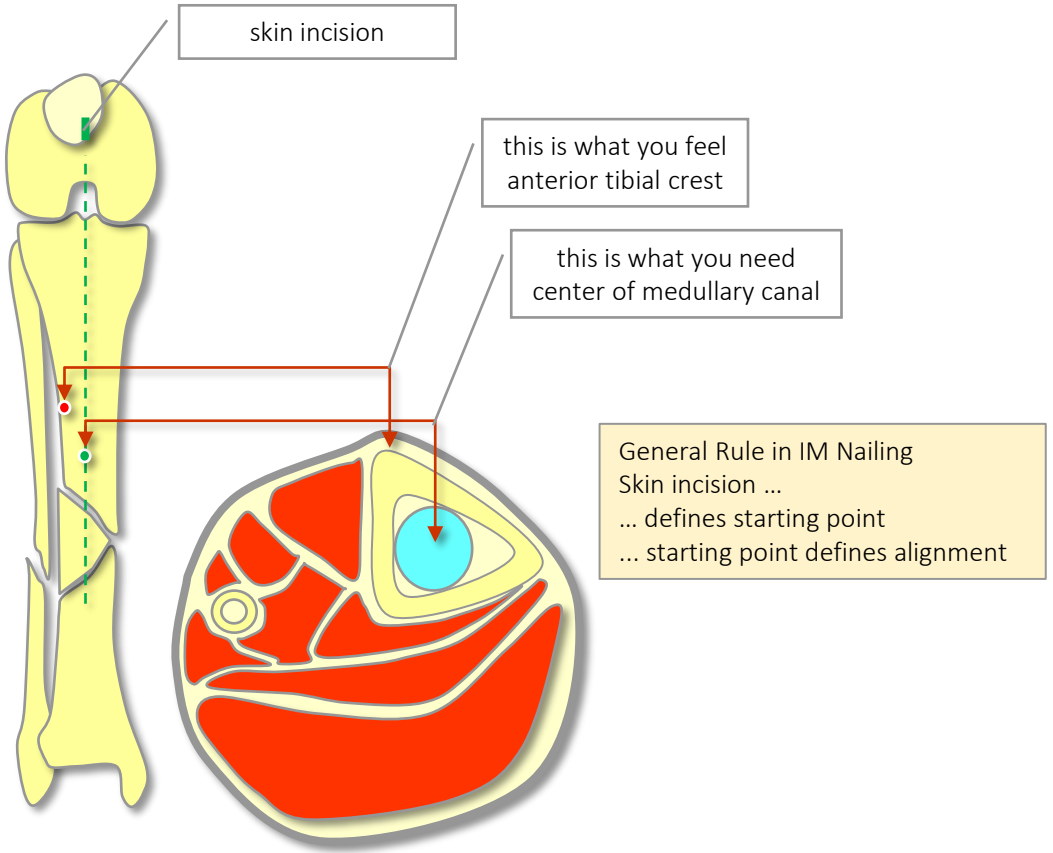
#5 Understand Excentricity of Shaft Cross Section

frame assisted
tibia nailing
no fracture table

skin incision
& starting point
in line with
medullary cavity



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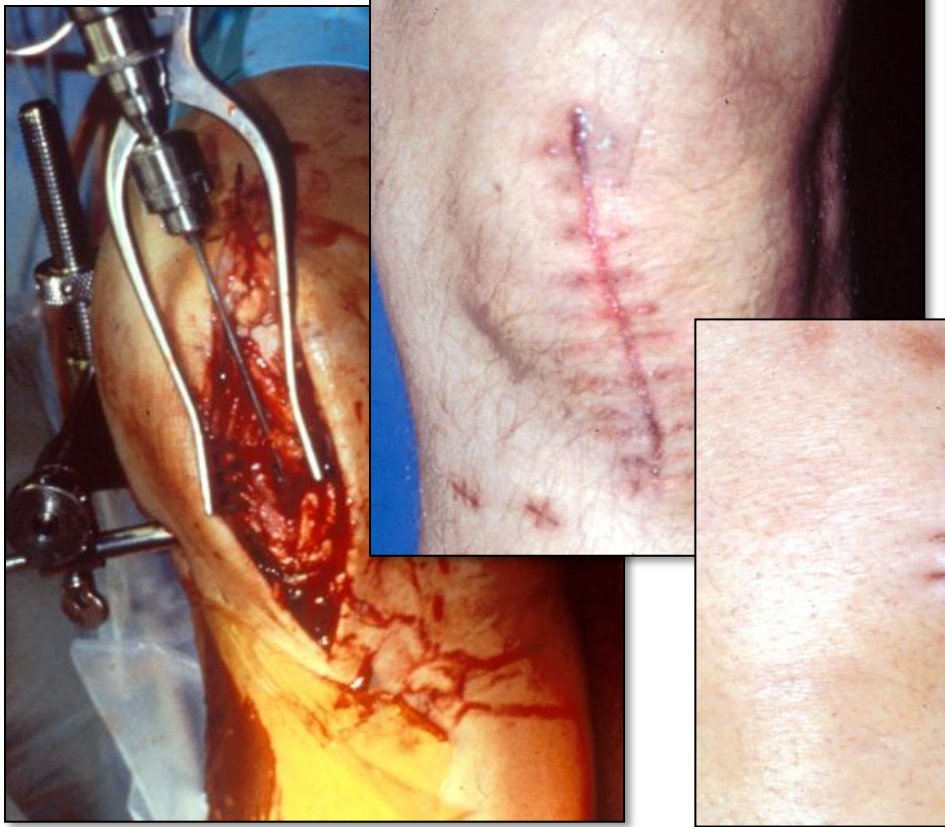
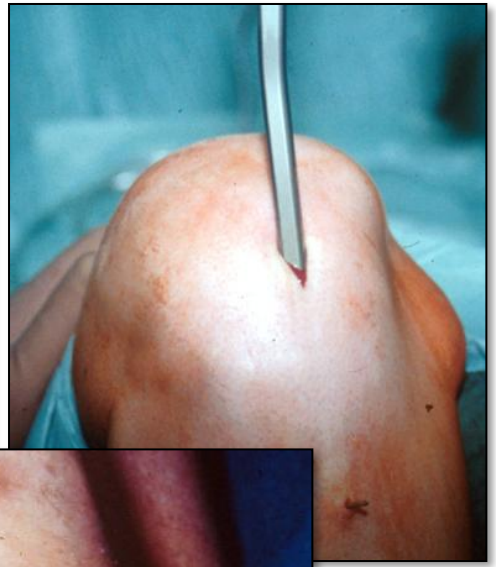
Approach





ability for painfree kneeling depends from

- incision length (p=0.007, f=5.139)
- position of nailtip (p=0.013, f=4.463)

n=131, FU 12-38 months / Anova (1), Kruskal Wallis, Schandelmaier 1999

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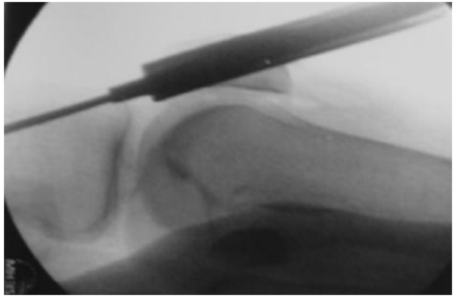
Approach

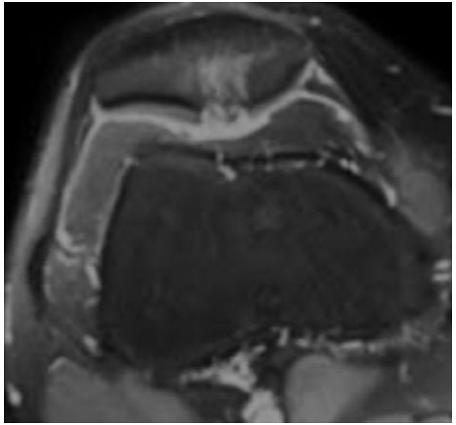
options ...

- suprapatellar
- parapatellar
- trans Ligamentous
  ....
- more data needed ...

?

- Tornetta P III, Collins E (1996) Semiextended position of intramedullary nailing of the proximal tibia. CliCORR
- Ryan SP, Steen B, Tornetta P III et al (2014) Semiex- tended nailing of metaphyseal tibia fractures: alig- nement and incidence of postoperative knee pain. JOT
- Jones M, et al (2014) Radiologic outcome and patient-reported function after intramedullary nailing: a comparison of the retropatellar and infrapatellar approach. JOT





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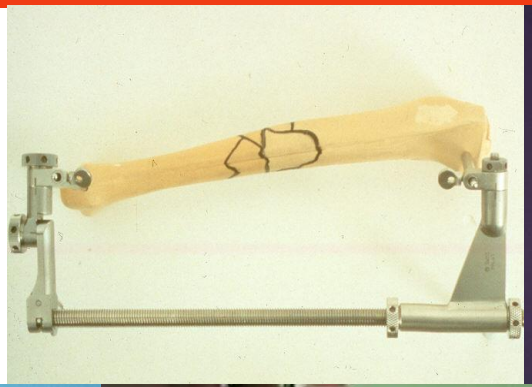
Instruments

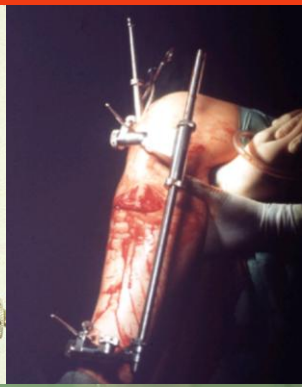
Distractor / temp exfix

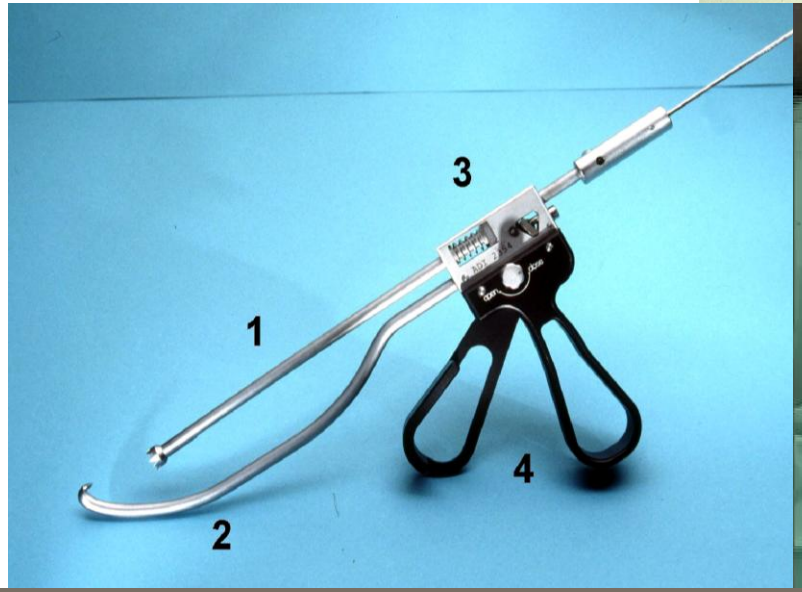
Co-linear bone clamp

Schanz-Screws

T-handle







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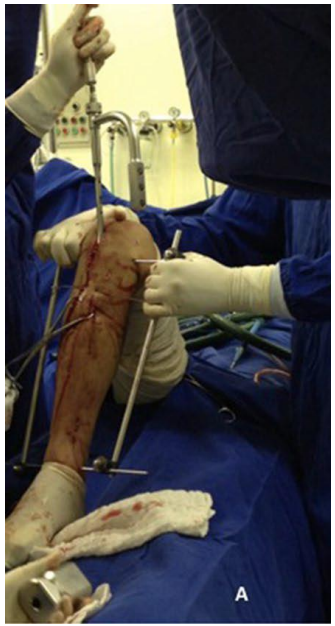
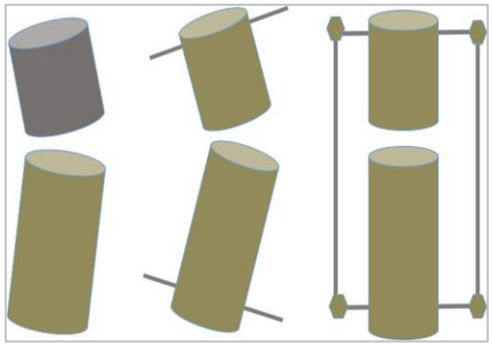
Instruments

Ex-Fix Frame





"Clothesline technique" for proximal tibial shaft fracture fixation using conventional intramedullary nail: William Dias Belangero et. al. European Journal of Orthopaedic Surgery & Traumatology (2018)

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Additional assist/permanent implants

plate assisted nailing

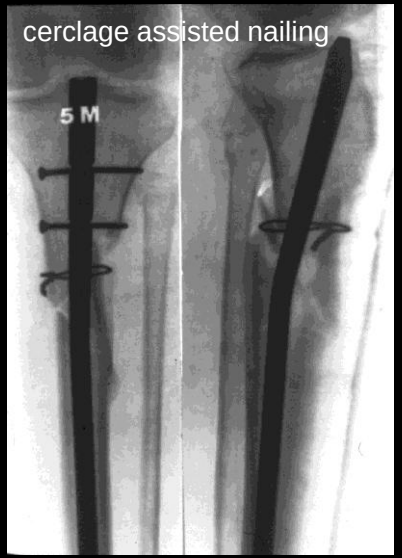
sharing of tasks

plate:
translation
rotation

nail:
length
bending

Nork SE, Barei DP, Schildhauer TA, Agel J, Holt SK, Schrick JL, Sangeorzan BJ (2006) Intramedullary nailing of proximal quarter tibial fractures. J Orthop Trauma 20(8):523–528

cerclage assisted nailing



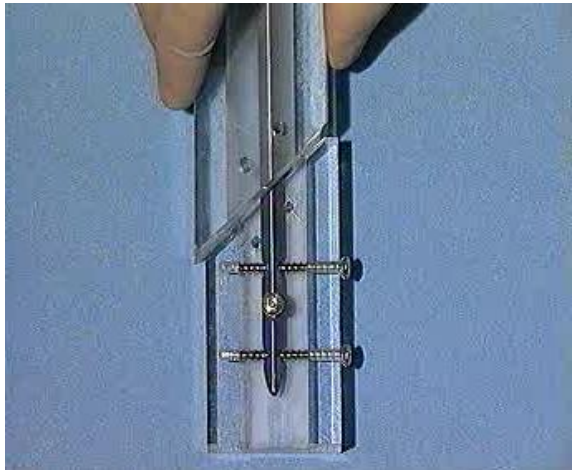
fixator assisted nailing

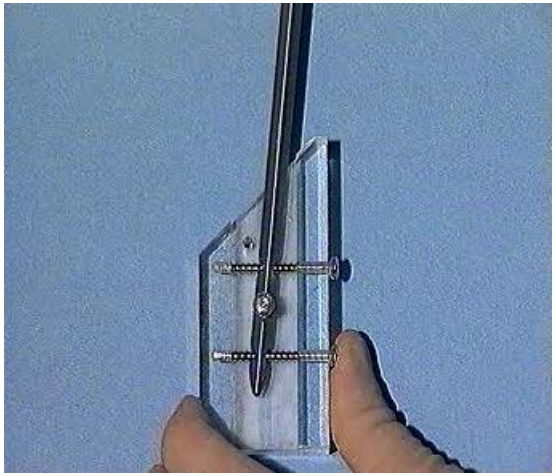
3 Problems in metaphyseal tibia fx‘s with im nailing

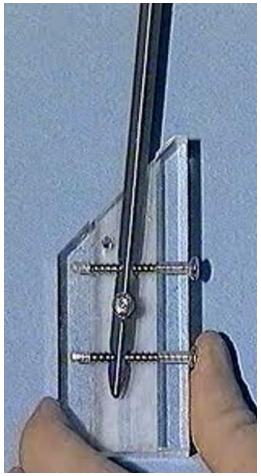
1. diameter discrepancy
   nail - medullary cavity

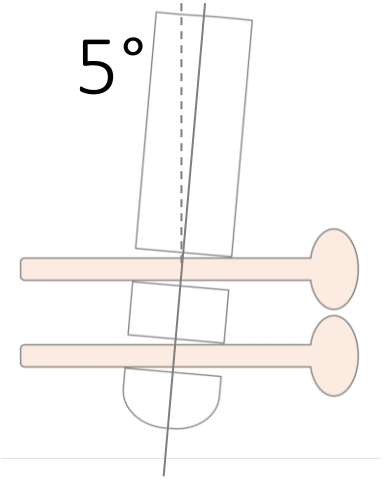
2. nail translation
   along interlocking screws

3. Toggeling
   due to manufacturing tolerances









plexi-glass model, 8 mm UTN, 3 distal interlocking screws

Krettek et al (1999) JBJS-B
Krettek et al (1999) J Orthop Trauma

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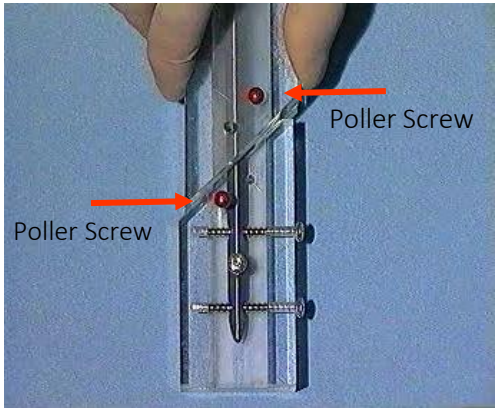
Biomechanics: axial load

Poller screws …
reduce diameter discrepancy
prevent translation along the screw
increase contact area
transform shear into compression



Krettek et al (1999) JBJS-B
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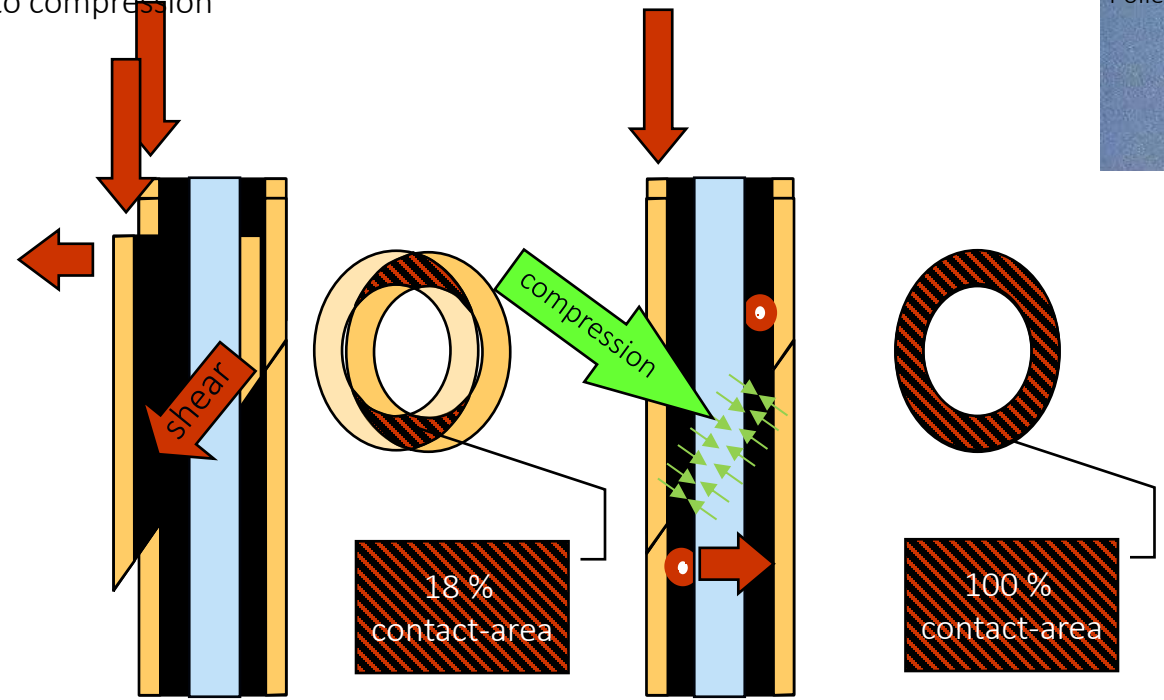

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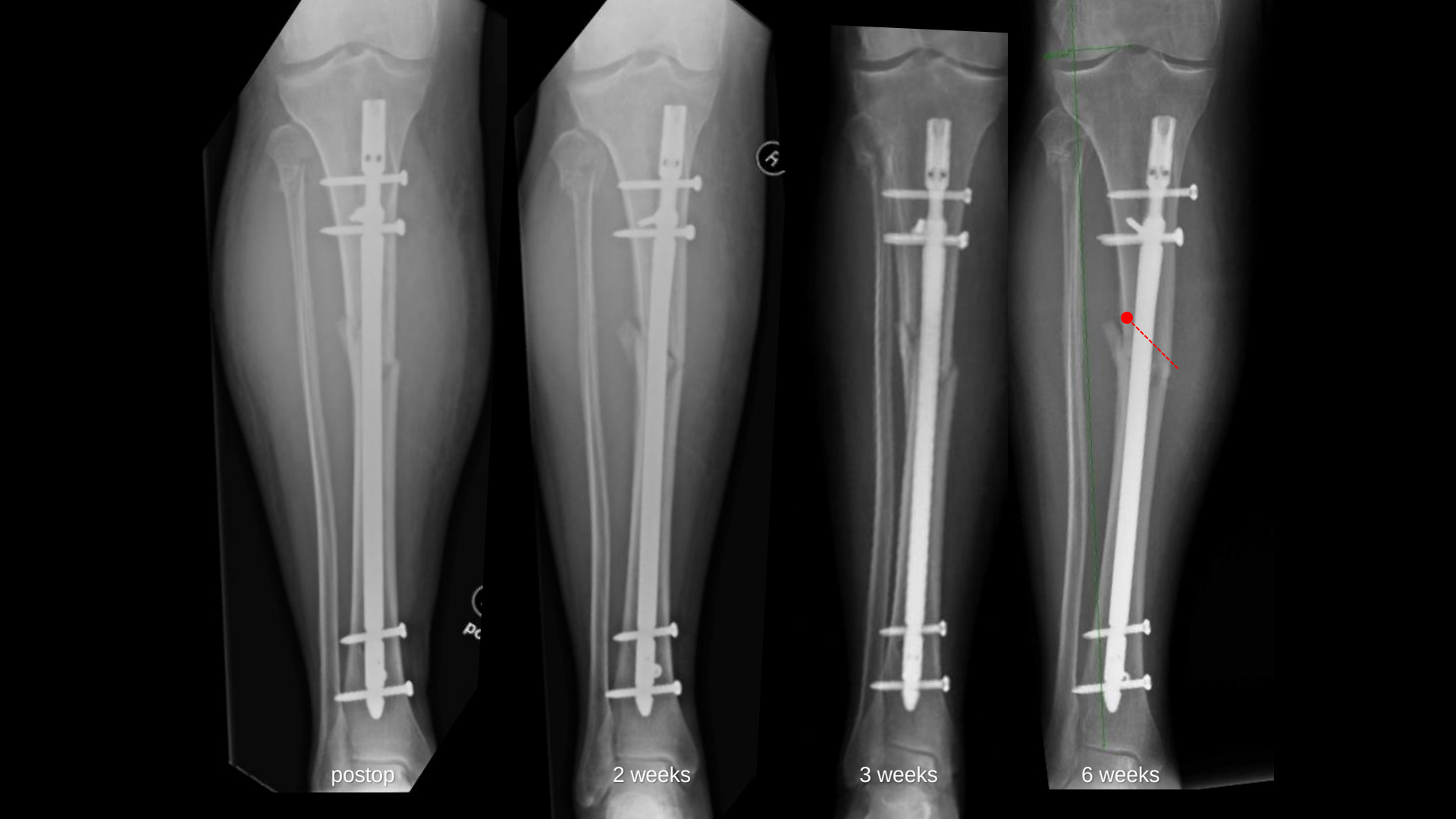
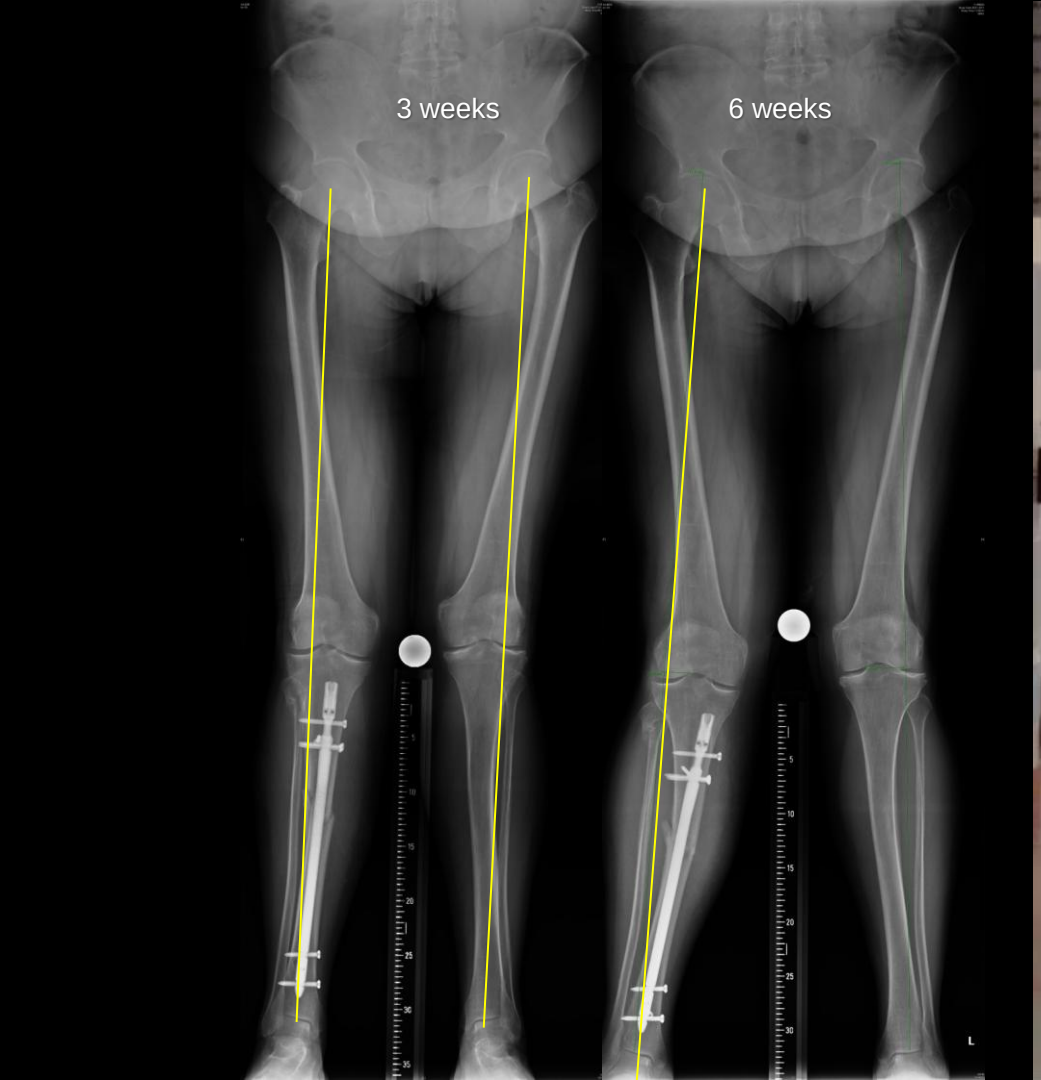
61y
postop
14.12.10
postop
2 weeks


postop
14.12.10
15 days
postop
29.12.10

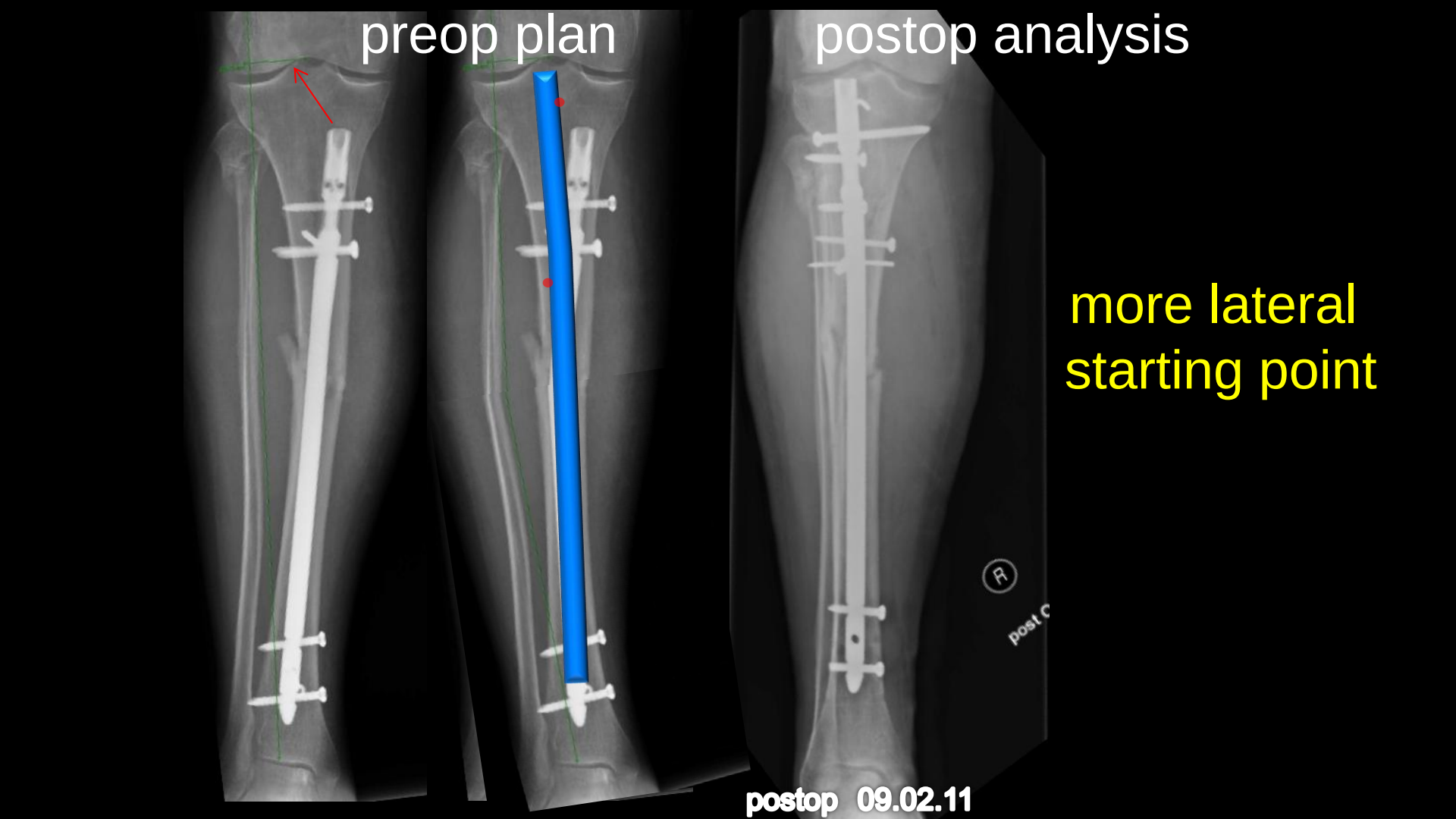

postop
2 weeks
3 weeks
6 weeks

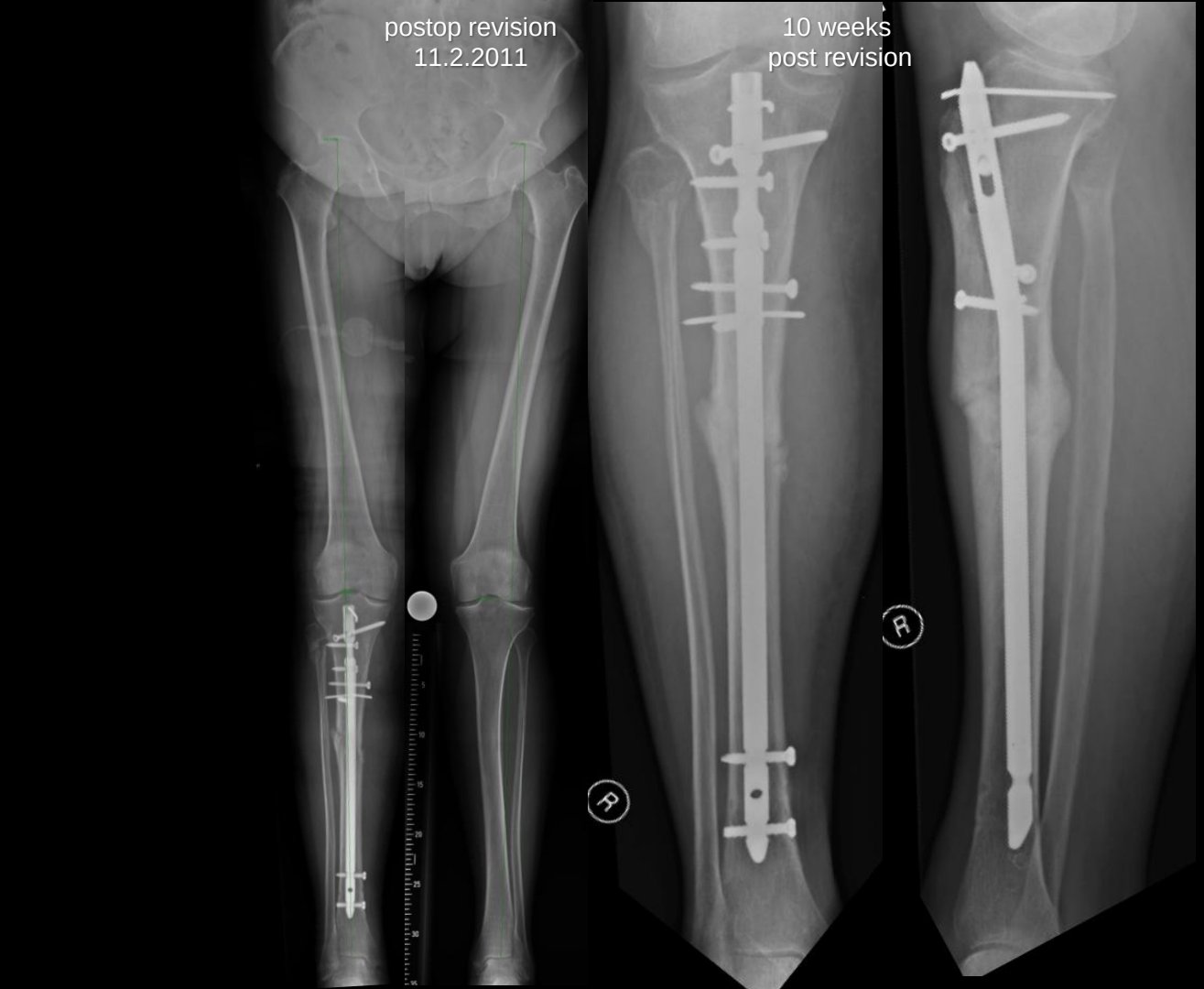

3 weeks
6 weeks

preop plan

postop analysis

more proximal
starting point


preop plan
postop analysis
more lateral
starting point
postop 09.02.11


postop revision
11.2.2011
10 weeks
post revision

Intramedullary nail versus minimally invasive plate osteosynthesis for displaced extraarticular proximal tibia fractures: a prospective comparative cohort study

Teimouri et al, Eur J Orthop Surg Traumatol 2023

MIPO (n = 29) versus IMN (n = 30)
IMN more knee pain, shorter union time and better functional scores compared to MIPO

Extra-articular proximal tibia fracture fixation with locked plating (LP) versus intramedullary nailing (IMN) A meta-analysis

Monahan et al Injury 2024

7 studies, prox 1/3, n=319 LP and 300 IMN, 1y FU

IMN significantly shorter time to union (p = 0.049)
lower risk for superficial infection (p = 0.028)

LP significantly lower risk for malunion (p = 0.017)
postoperative compartment syndrome (p = 0.018)

Summary Nail vs Plate in 1/3 Proximal Tibia Fx

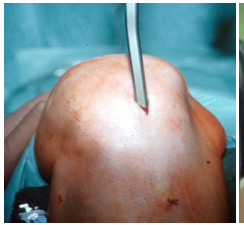
- The more proximal,
  the more plating & vice versa

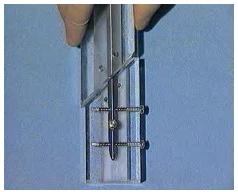
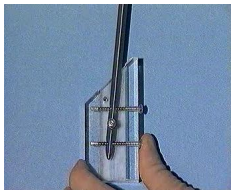
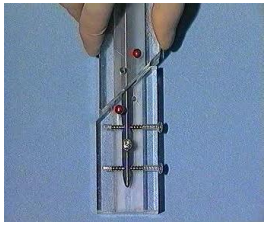
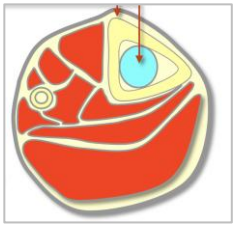
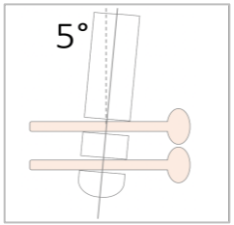
- Nail:
  -Starting point is crucial
  -Understand Patho-Mechanics
  & deformity rules: deforms
  to the higher fracture line
  - Additional assist tools/implants
  Plate, Exfix, Poller screws, other

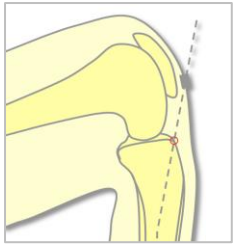
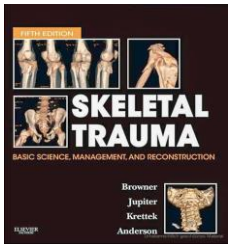
- PLATE:
  locked plate, MIPPO technique

- Results: comparable

- mostly valgus deformity
- excentric shape ... start lateral
- excentric muscle vector
- lateral/proximal fx obliquity
- excentricity of tibial shaft
- excentricity of tibial crest

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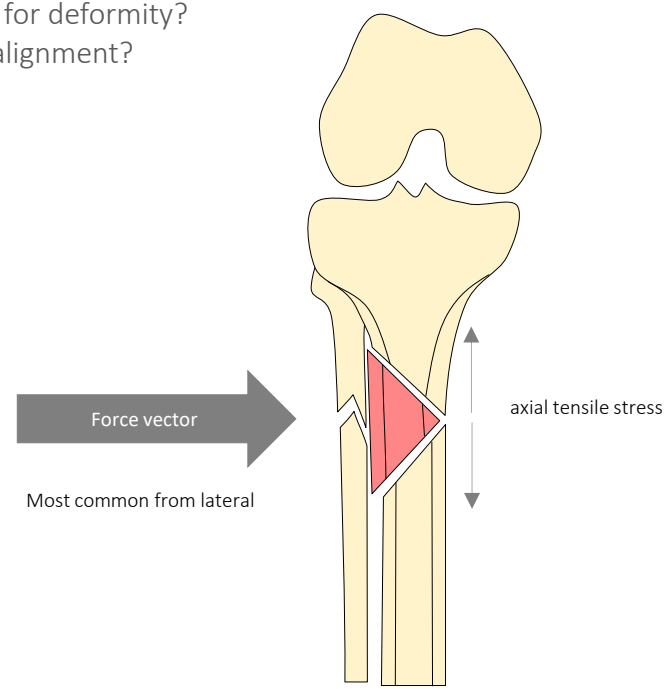
Objectives

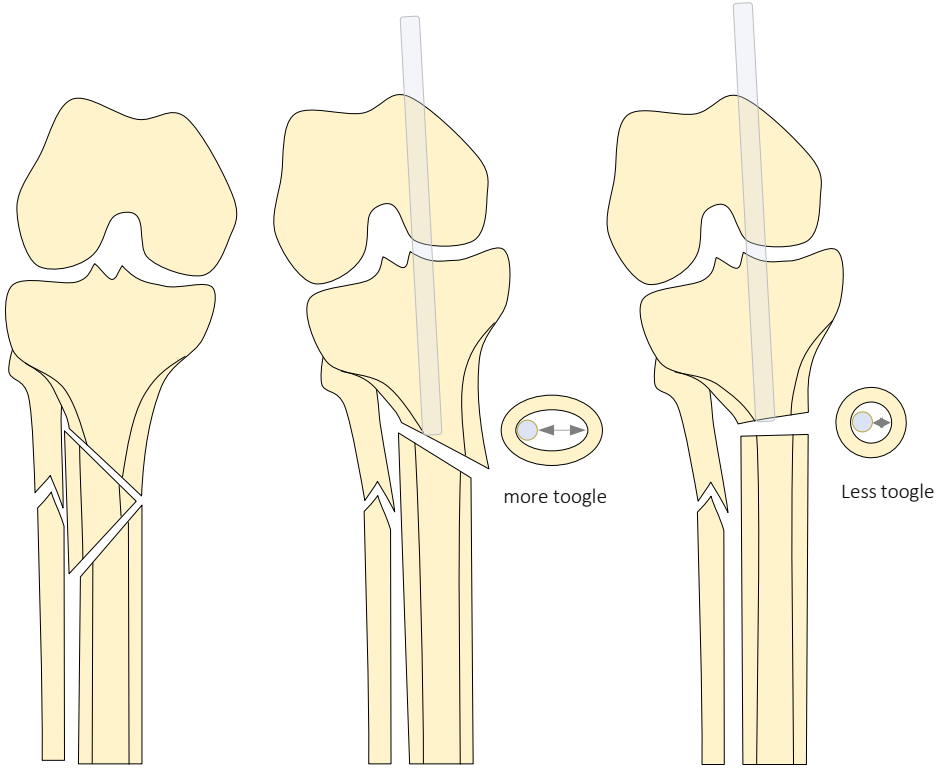
- Understand problems related to nailing of proximal tibia fxs
- discuss the specific anatomy
- realize the dislocating risk factors
- Learn about various options how to ensure reduction

#1 Understand the Fracture Mechanics & fx Pattern

- Why is understanding of fracture mechanics important?
- Fracture orientation proximal fragment?
  Lateral up – transverse – medial up?
- Implications for deformity?
- Risk for malalignment?



Oblique & wedge fx: higher risk for deformity compared to transverse fx



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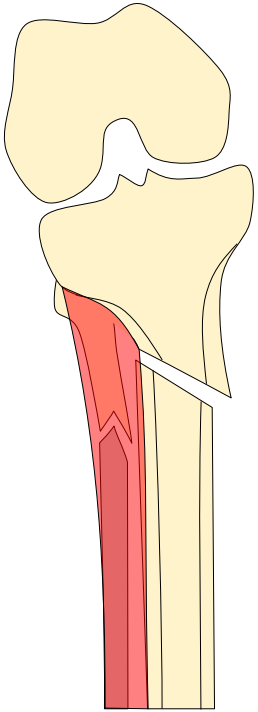
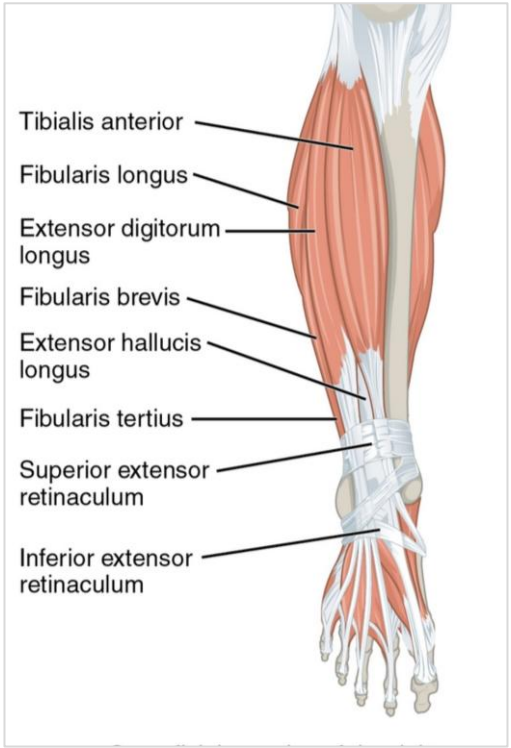
#2 Understand Excentric Muscle Distribution

all muscle on the lateral side / posterior
valgus / antecurvation deformity





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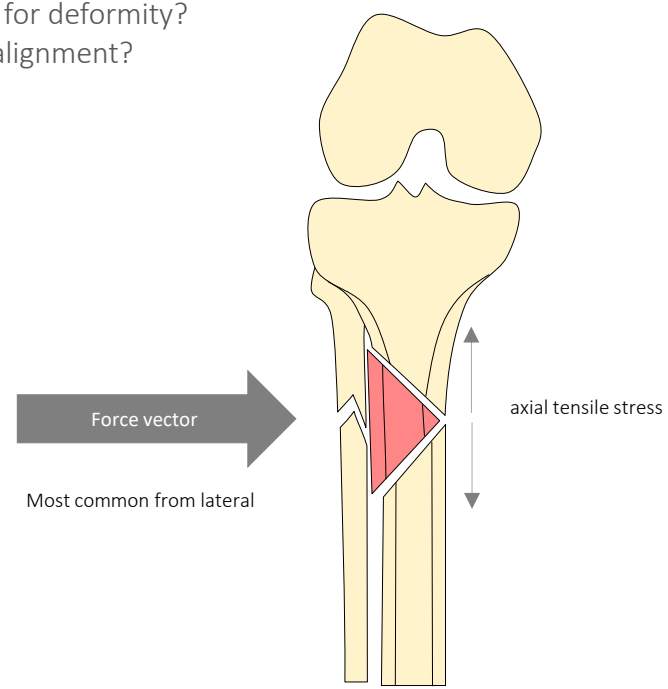

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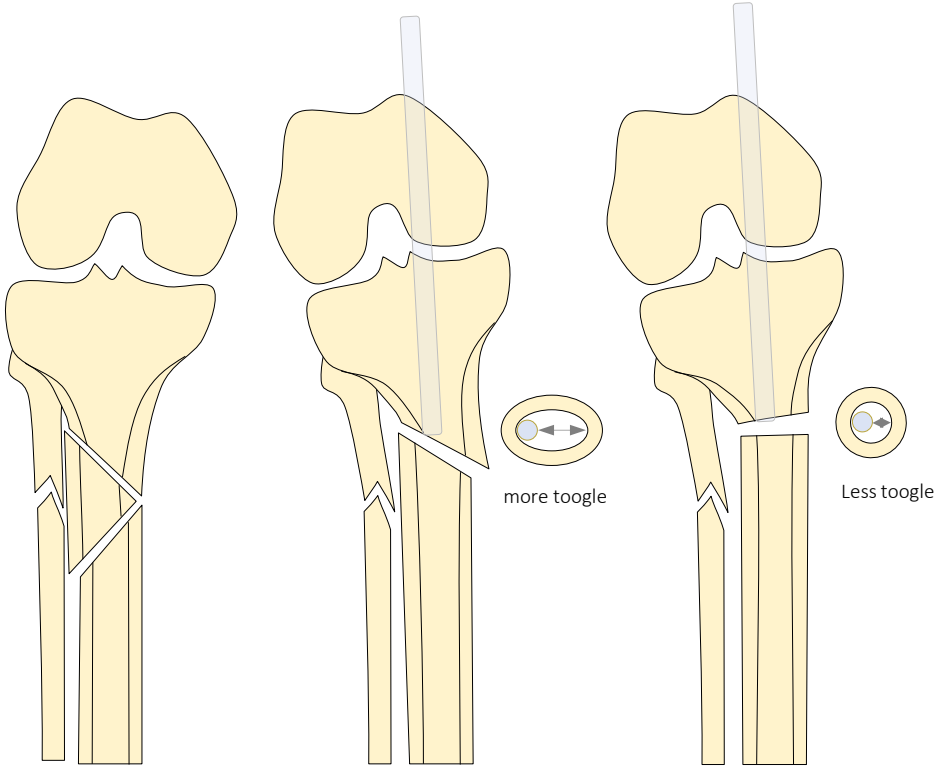

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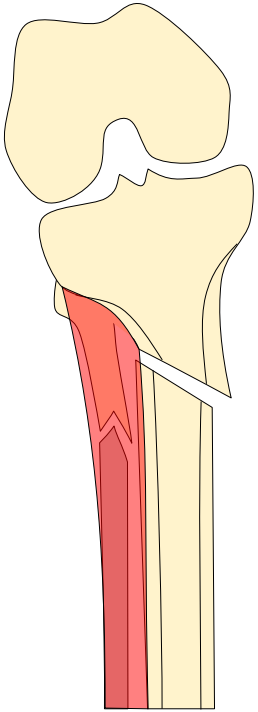

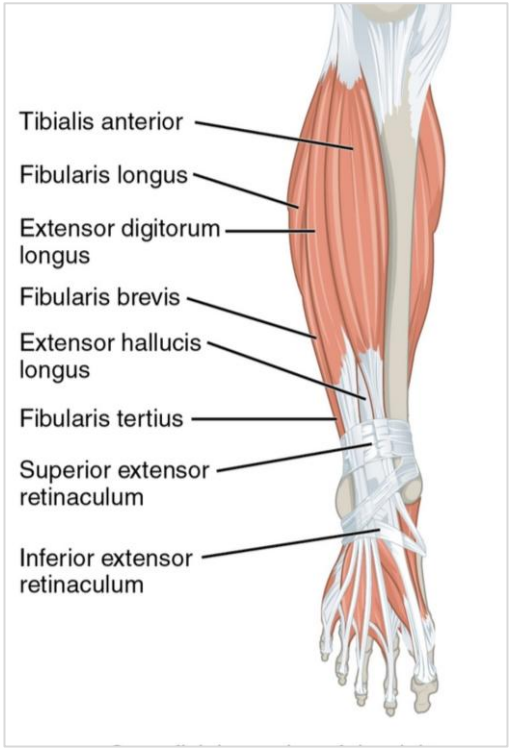

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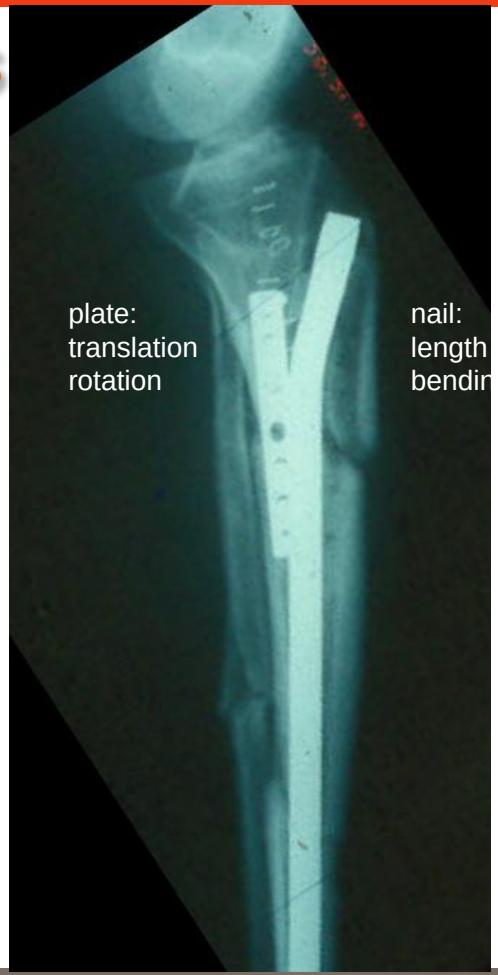
Additional implants

nail + Plate



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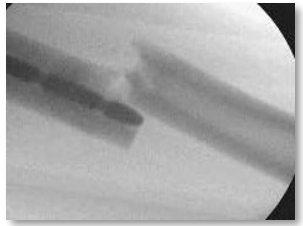
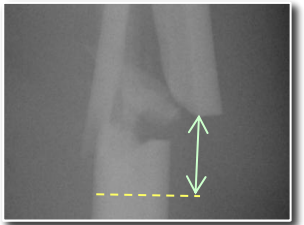
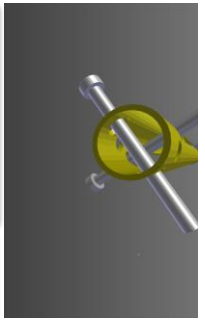
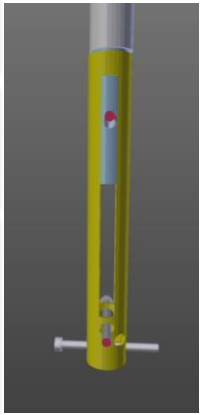
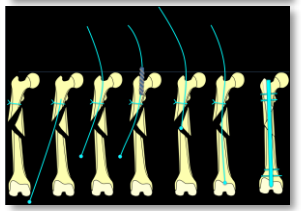
Summary

1. Overdistraction eases intramedullary nailing
2. Patho-mechanics of IT band and it‘s role for reduction
3. Double joy stick + C-arm for ‚3D‘- navigation
4. Through fx retro-grade guide wire placement in obese subtroch fx
5. Implant rotation for small alignment corrections
6. Use of Poller screws for wrong starting point
7. Use of Poller screws for correction of malalignment
8. transosseous cerclage wires
9. role of iPhone in torsional correction
10. Motorized nails for defects /malalignment

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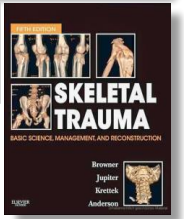


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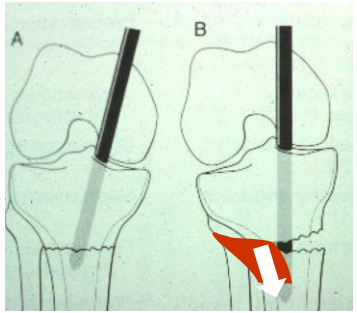
risk factors for valgus

1. excentric bone

2. all muscles lateral



3. bending wedge
   lack of (lateral)
   support
   (most common)

Study:
retrogradely reamed
tibiae

exit point analysis
relativ to
tibial tubercle

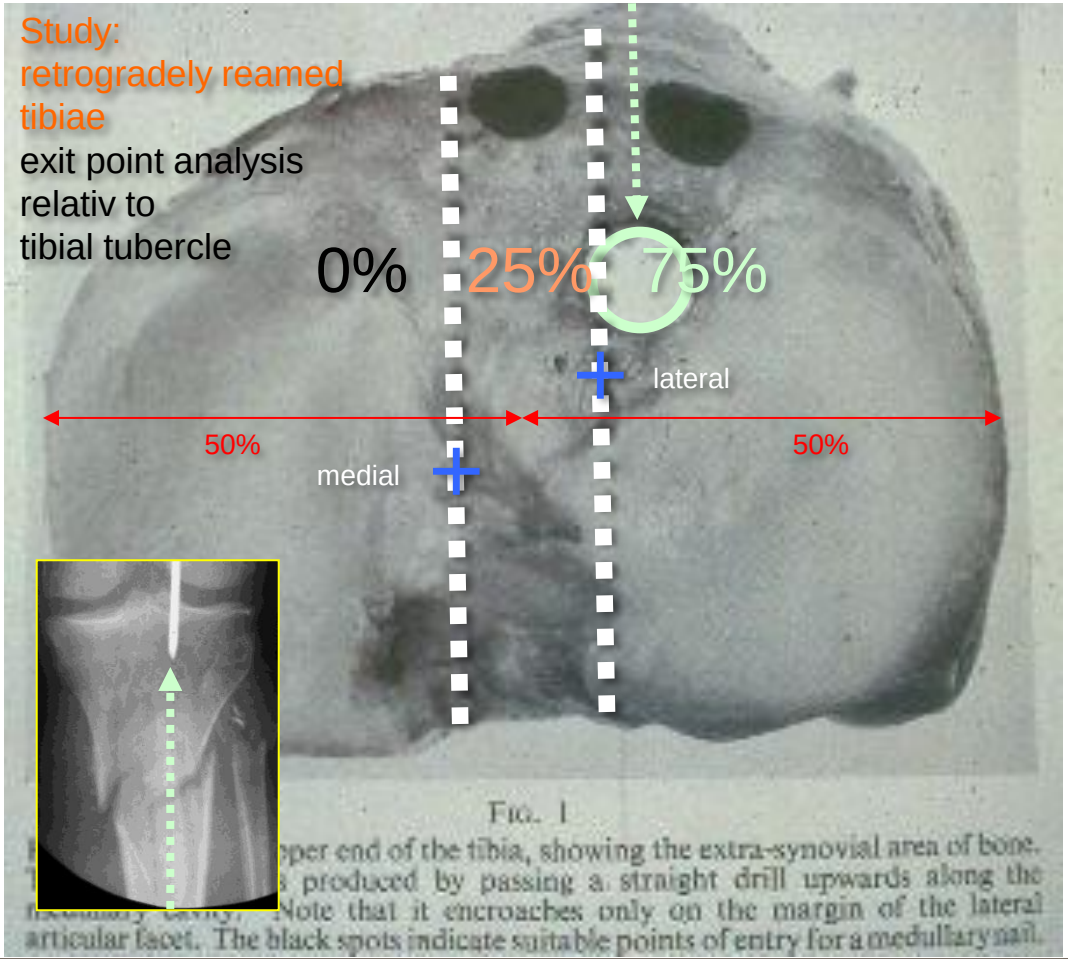


FIG. 1

...per end of the tibia, showing the extra-synovial area of bone. ... produced by passing a straight drill upwards along the ... Note that it encroaches only on the margin of the lateral articular facet. The black spots indicate suitable points of entry for a medullary nail.

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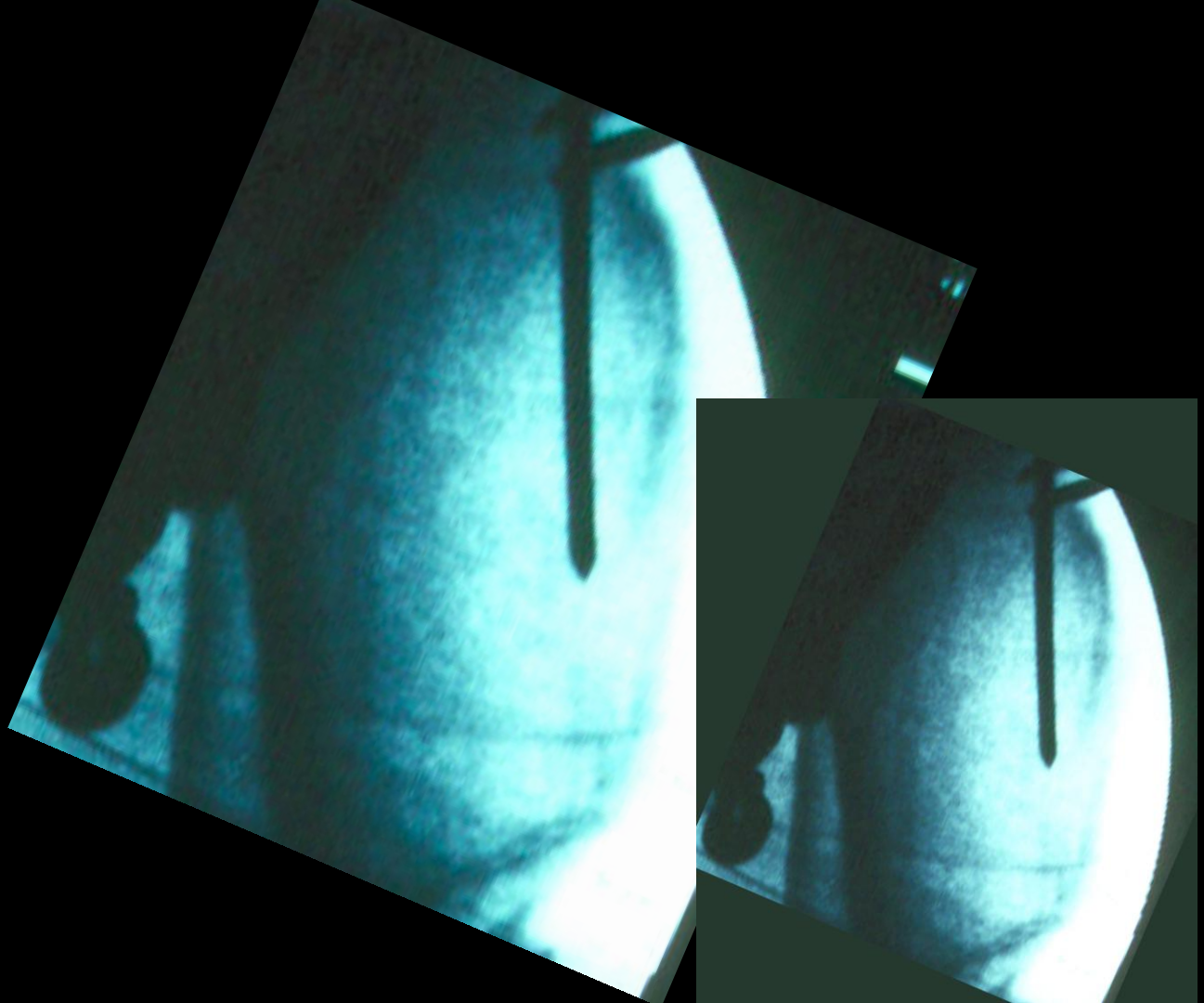
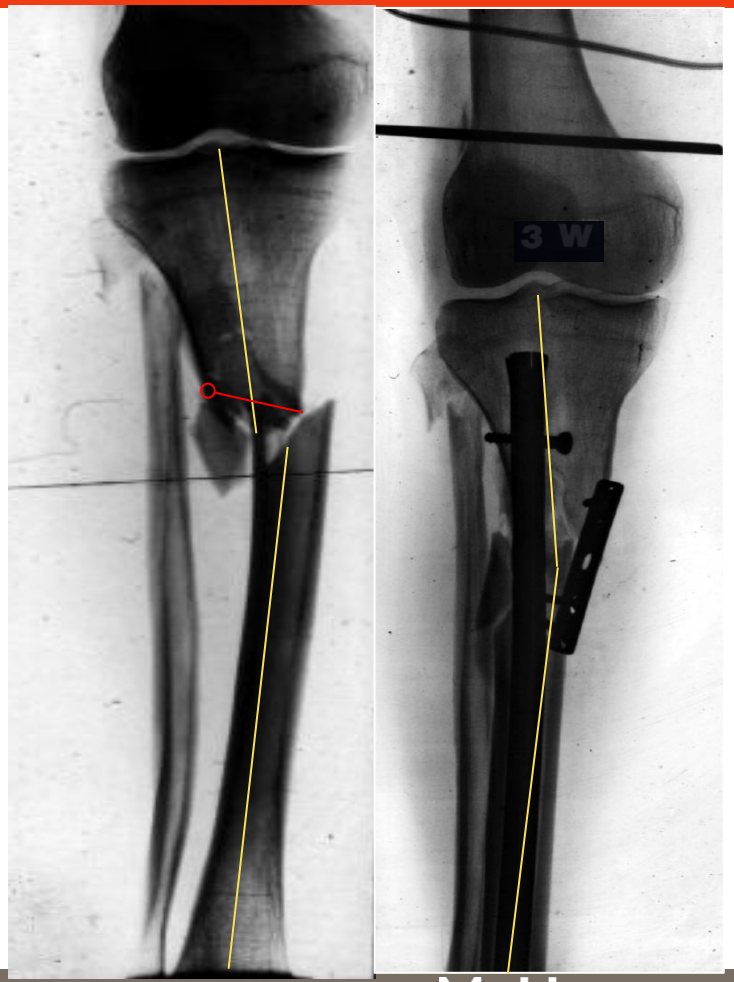


Proximal tibia fx
Which deformity can you expect?

Deformity rule:
deforms to side of higher fx line
or wedge

example 1:
bending wedge lateral
- valgus deformity
- most common
- mostly impact from lateral (car bumper)

example 2
- no bending wedge deforms to the side higher fx line



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Fibula is important
Sequence matters …

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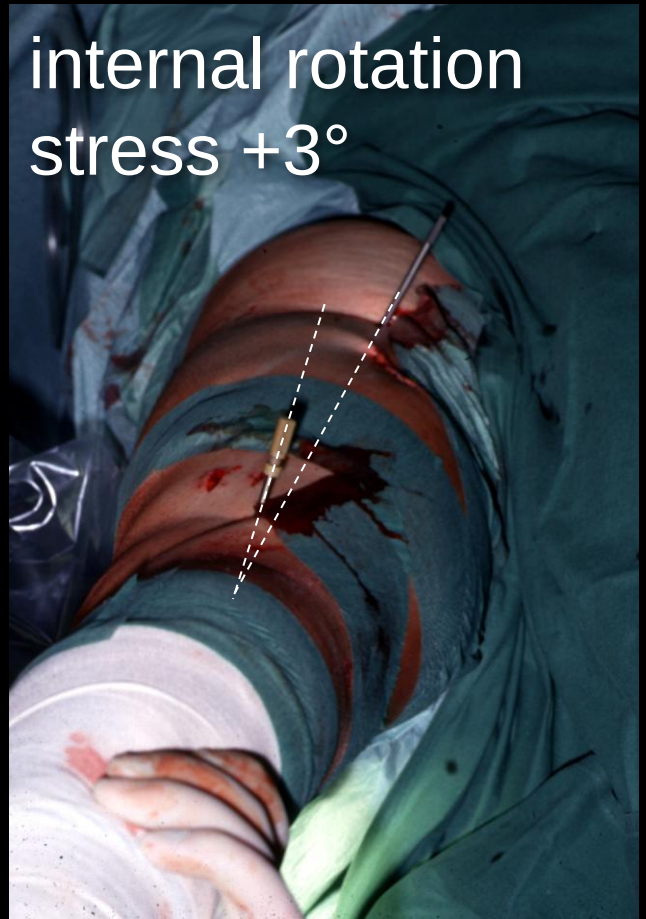
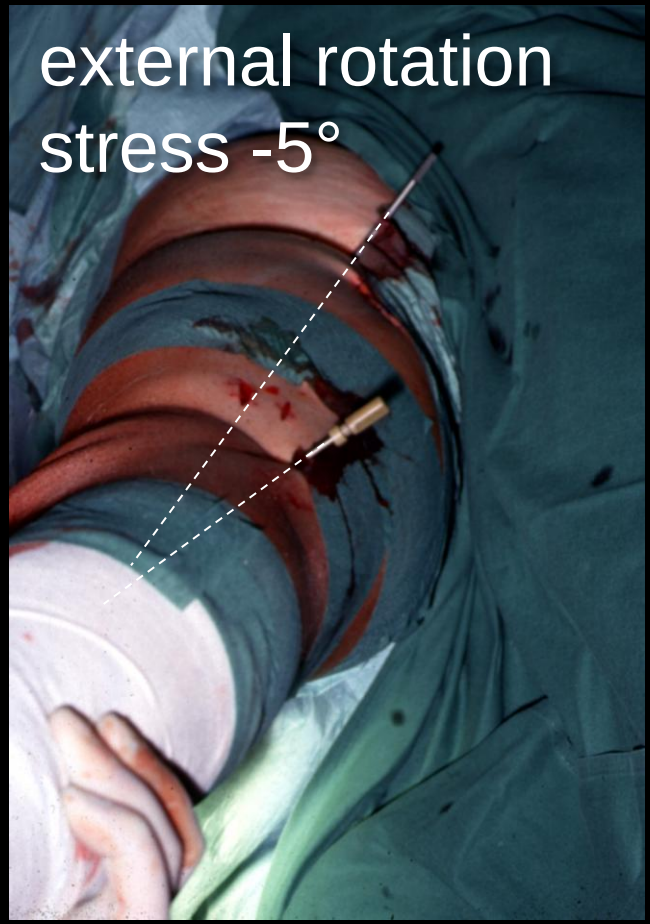
Toggeling problems also in femoral nailing





Case #2

Distal femoral Fracture

Doren F. 36y

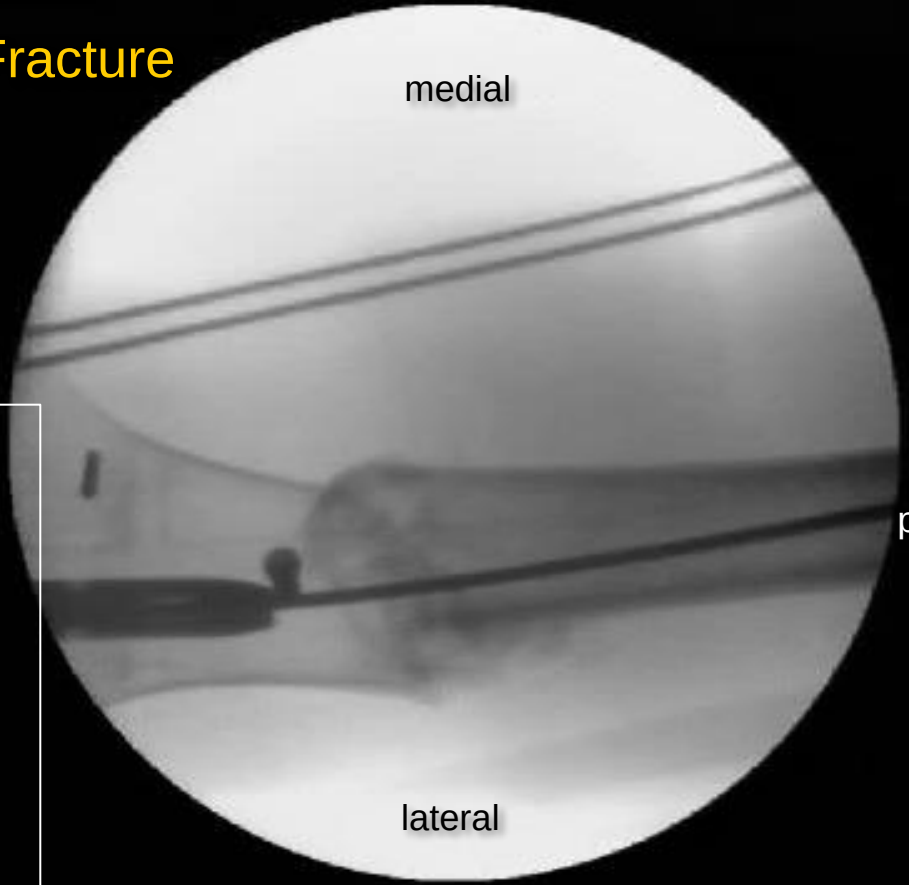
after 1 y medial knee pain

nail drifted too far medial = varus

Case #2

Distal femoral Fracture

Doren F. 36y



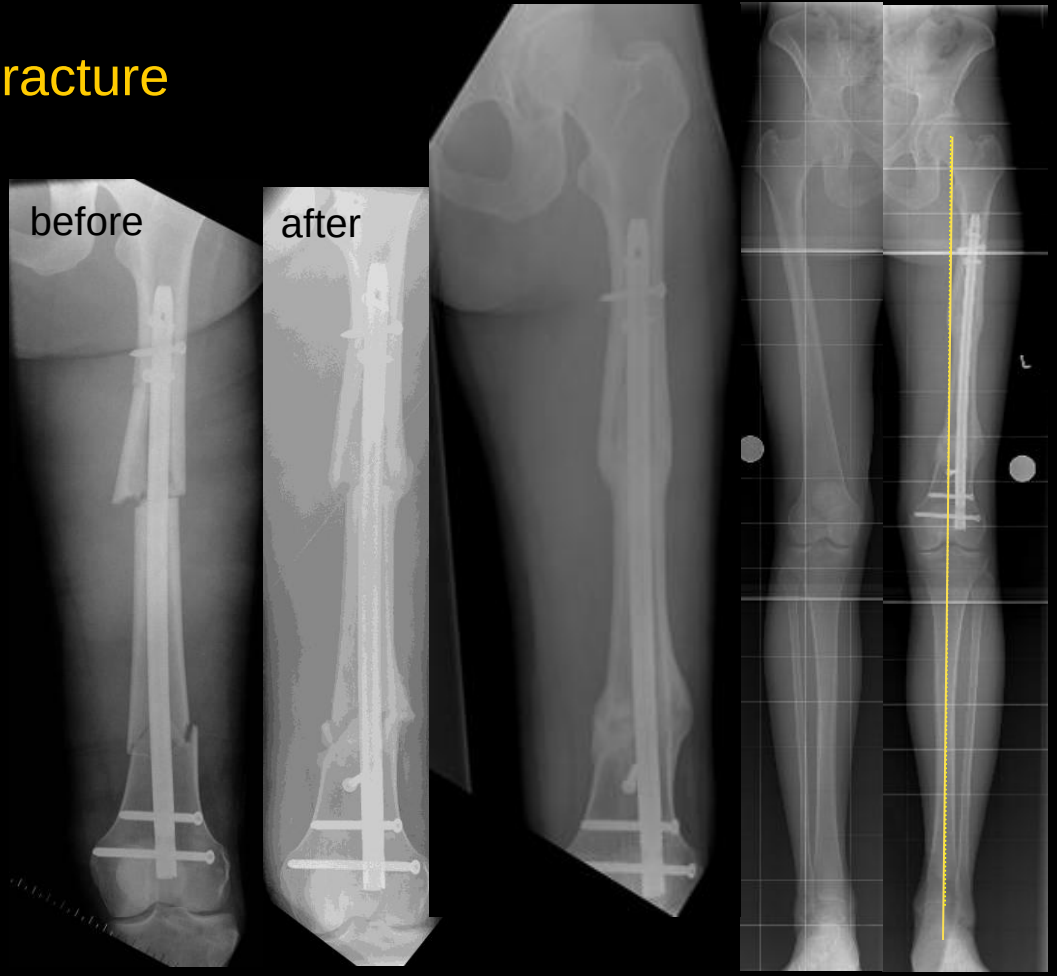
nail drifted too far medial = varus

prevent medial metaphysis force nail to be lateral

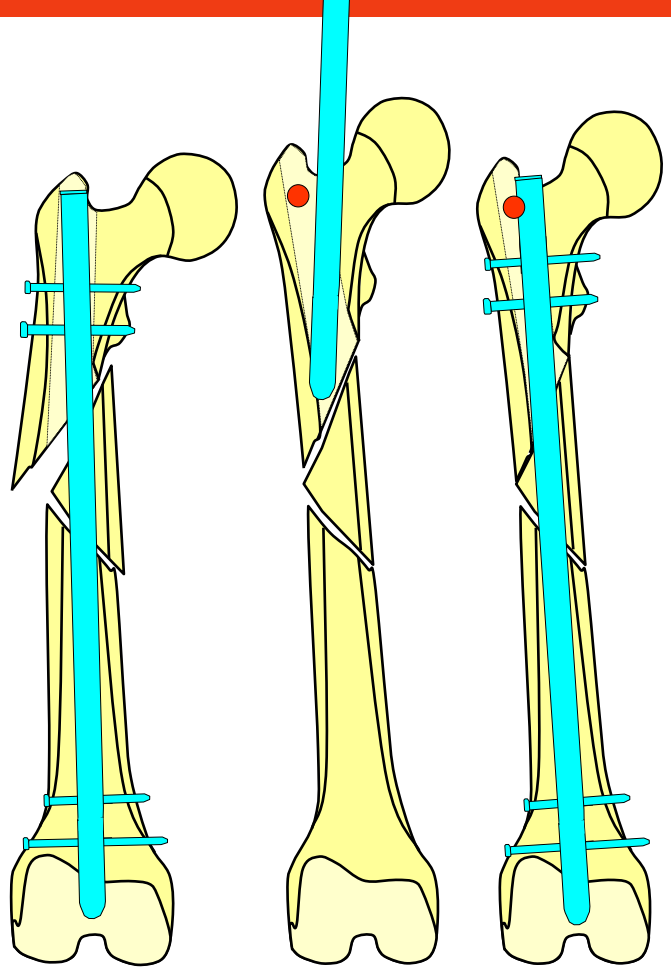
Case #2

Distal femoral Fracture

Doren F. 36y



wrong starting point too lateral



reasons

- positioning
- draping
- approach
- obesity
- asymmetric bone quality
  lateral soft
  medial hard

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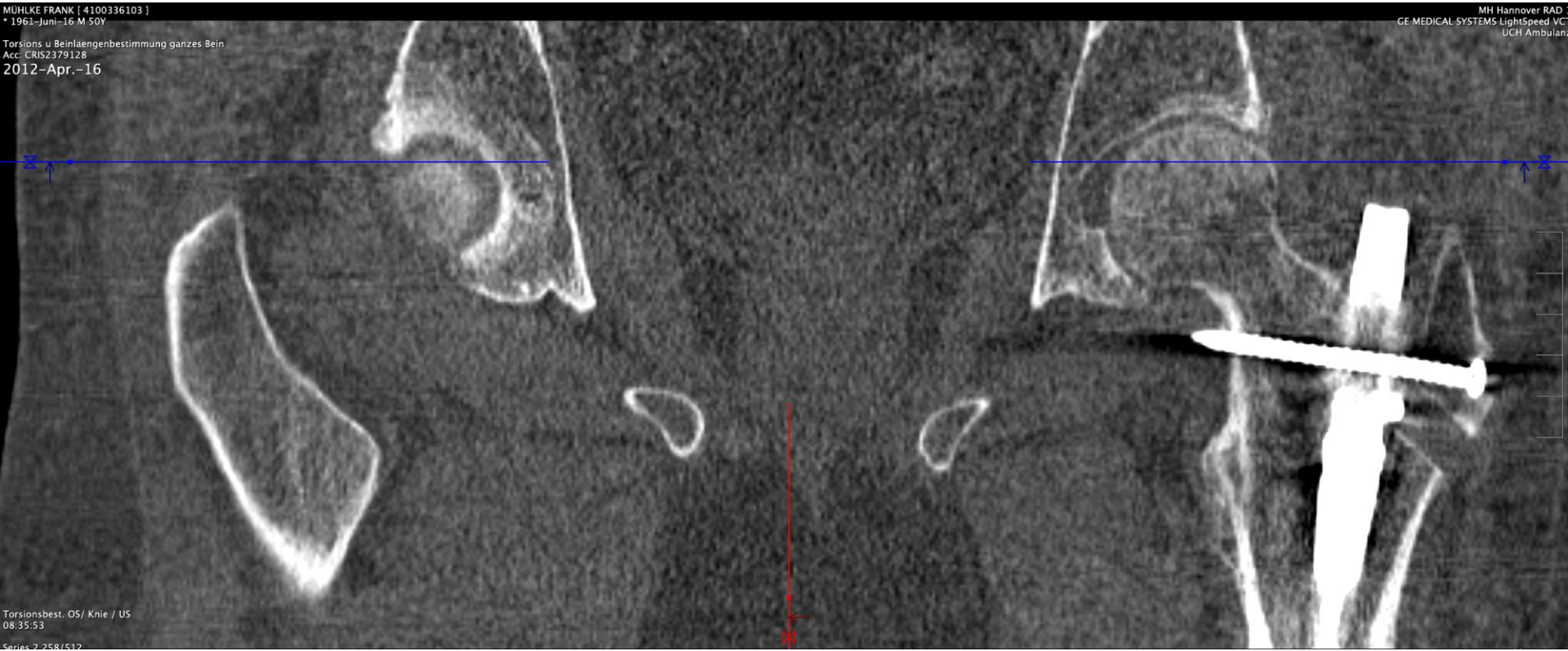

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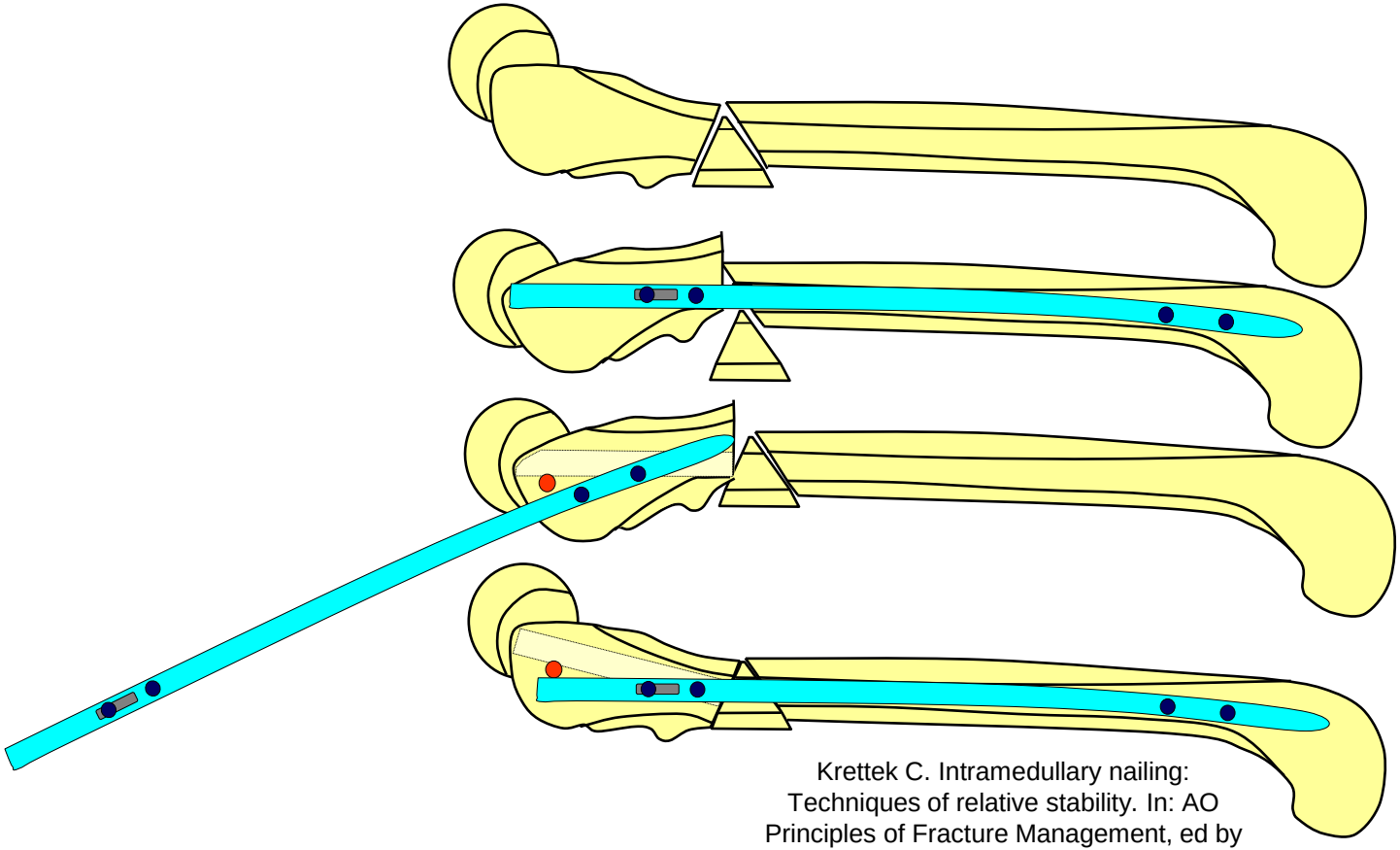
wrong starting point too anterior

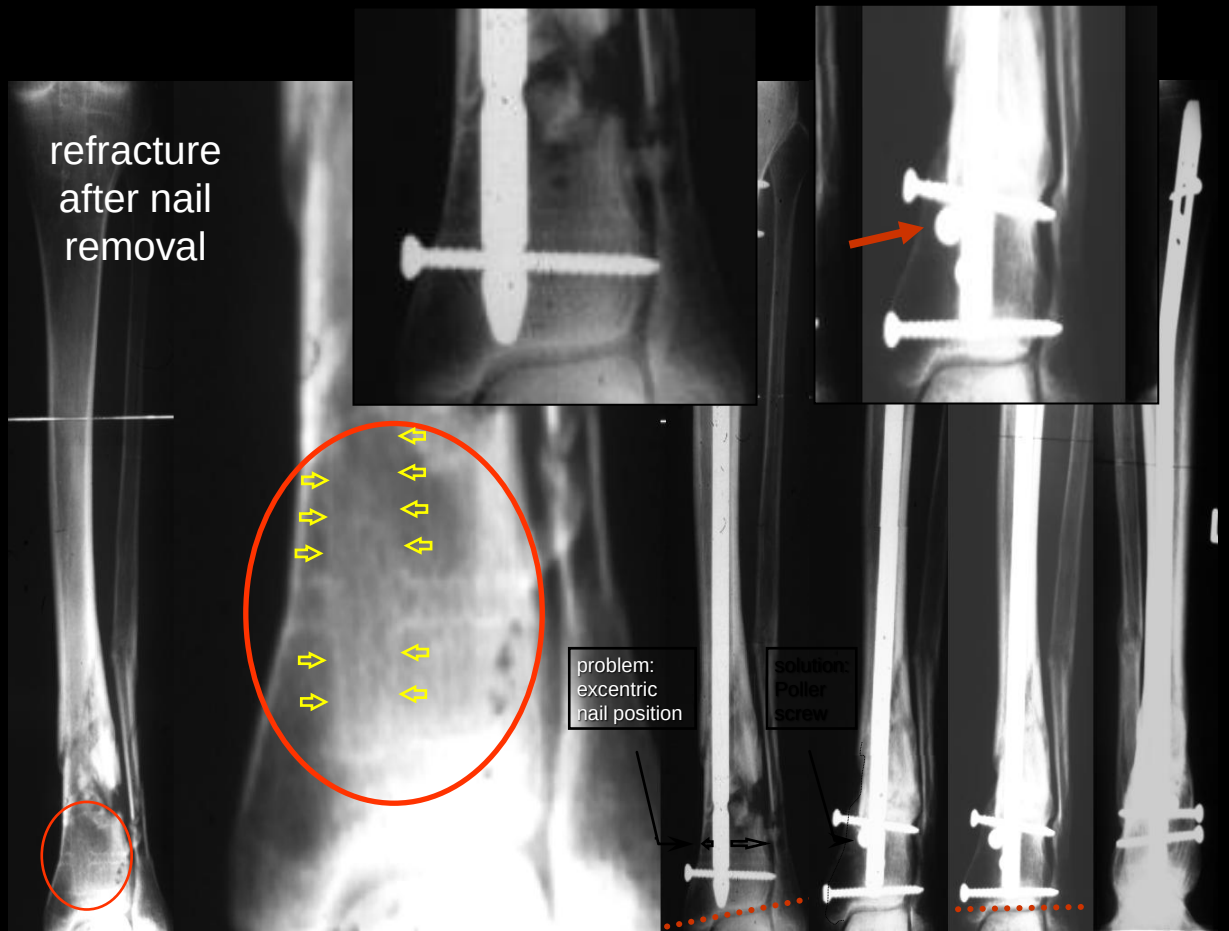
reasons

- positioning
- draping
- approach
- obesity
- asymmetric bone quality
  lateral soft
  medial hard



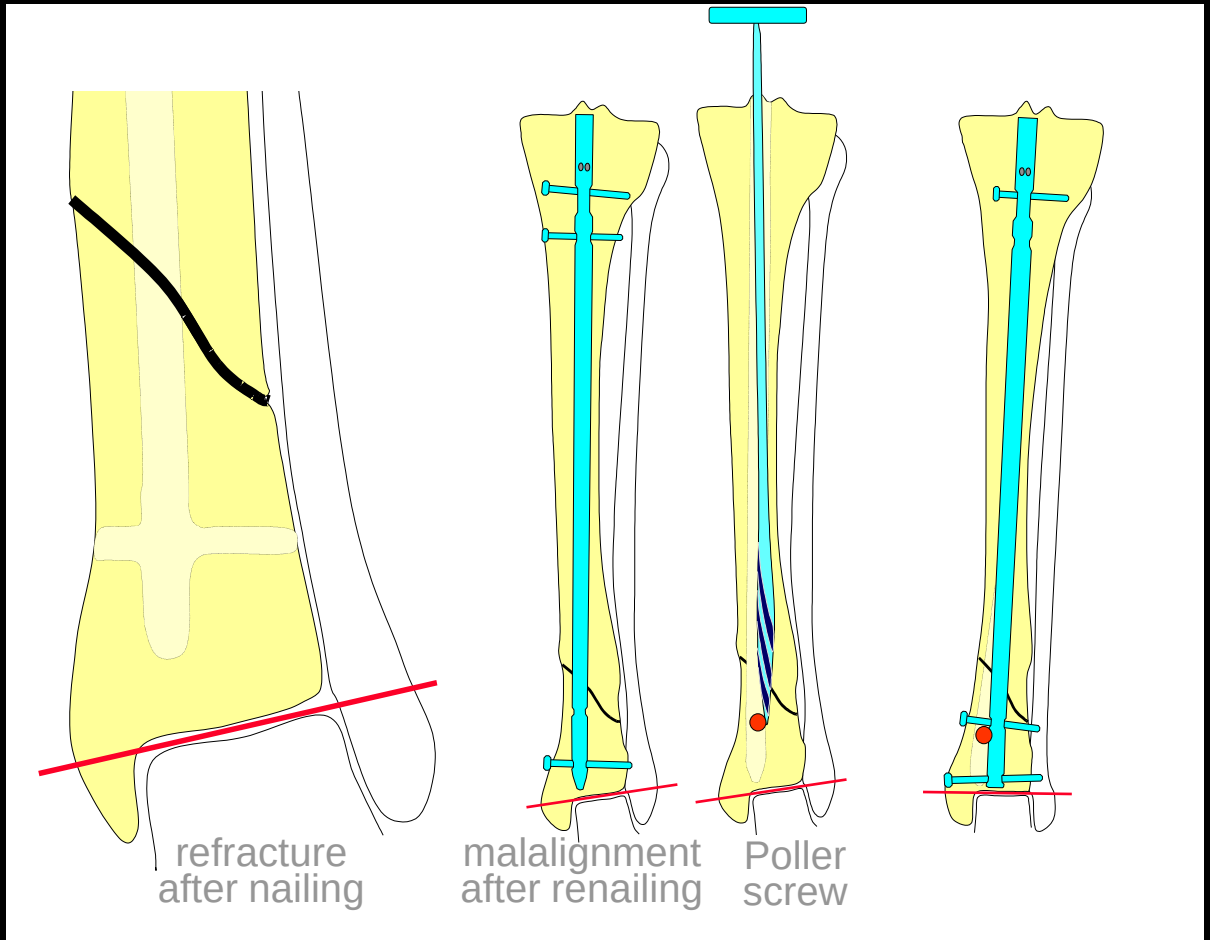
Krettek C. Intramedullary nailing: Techniques of relative stability. In: AO Principles of Fracture Management, ed by TP Rüedi et al 2001.

Problem: refracture, sclerotic nail path



Poller screws as manipulation tool

- Positioning
  - Freehand
  - Floating Knee
  - Bilateral Fx
- Implant Selection
  - Magnification
- Reduction
  - Distractor
- Starting Point
  - Anatomy
  - Floating Knee



Poller screw blocks wrong entry point

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  - Distractor
- Starting Point
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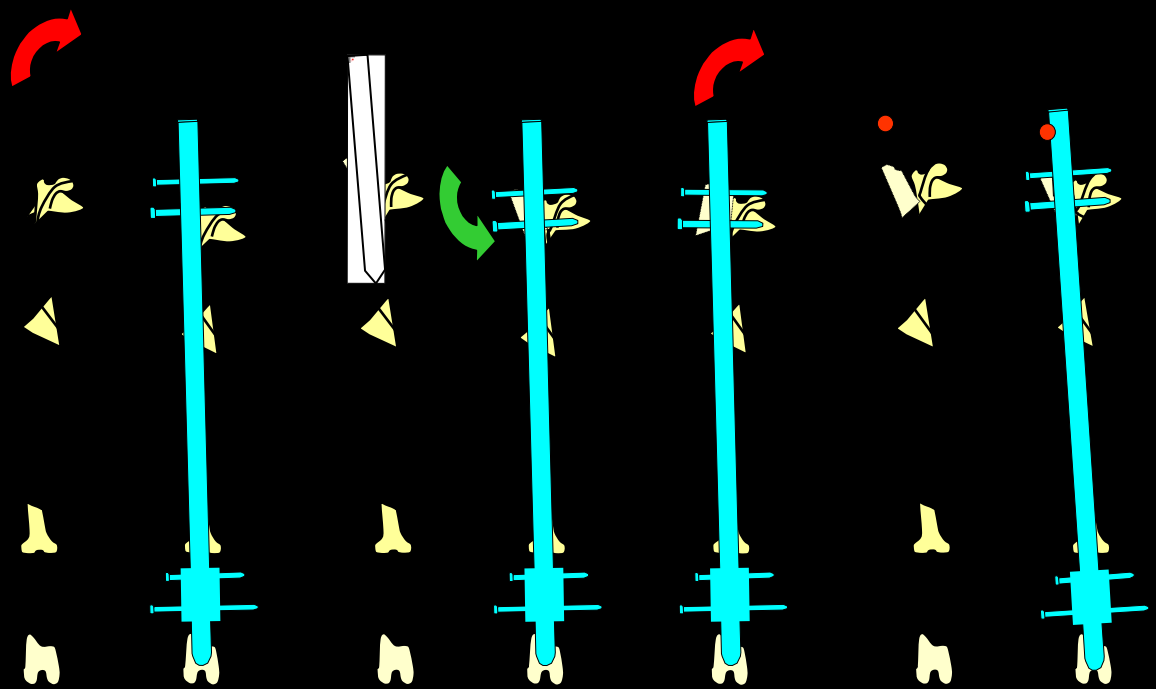

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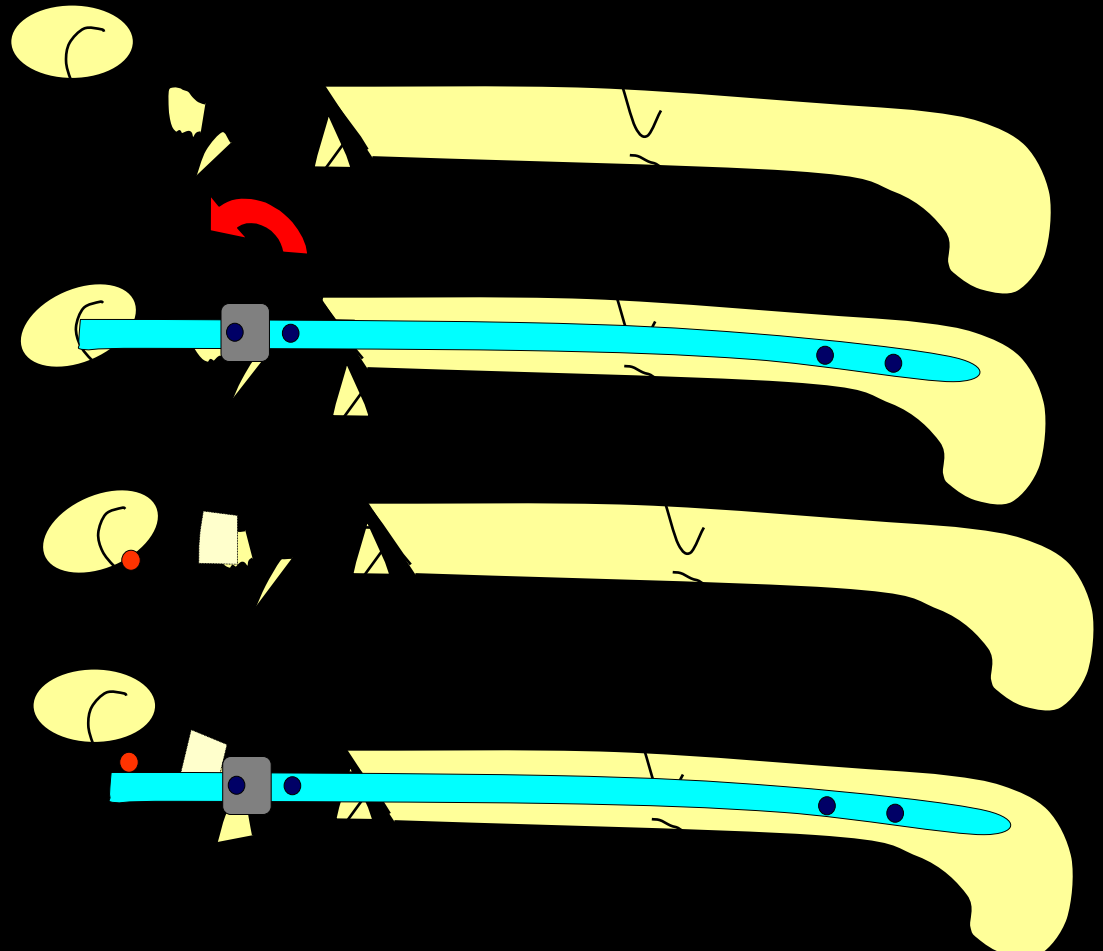

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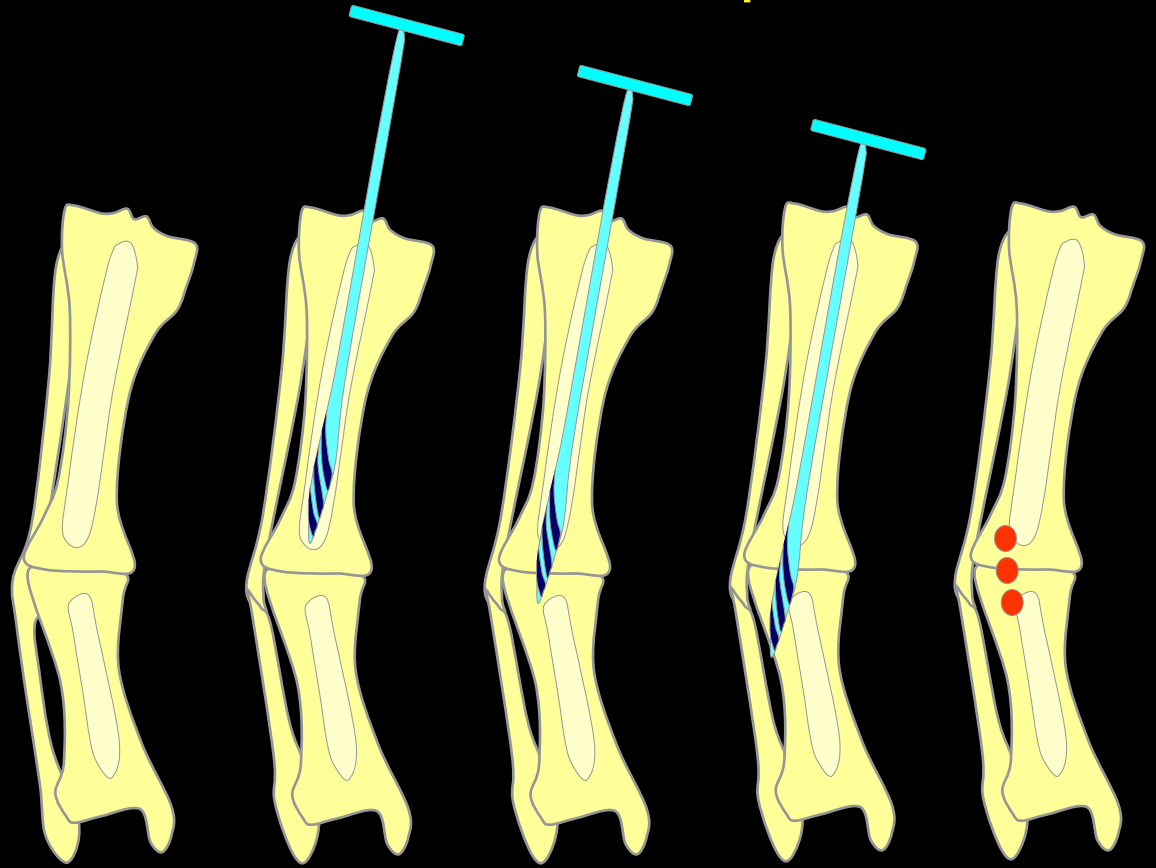

Poller screws as manipulation tool

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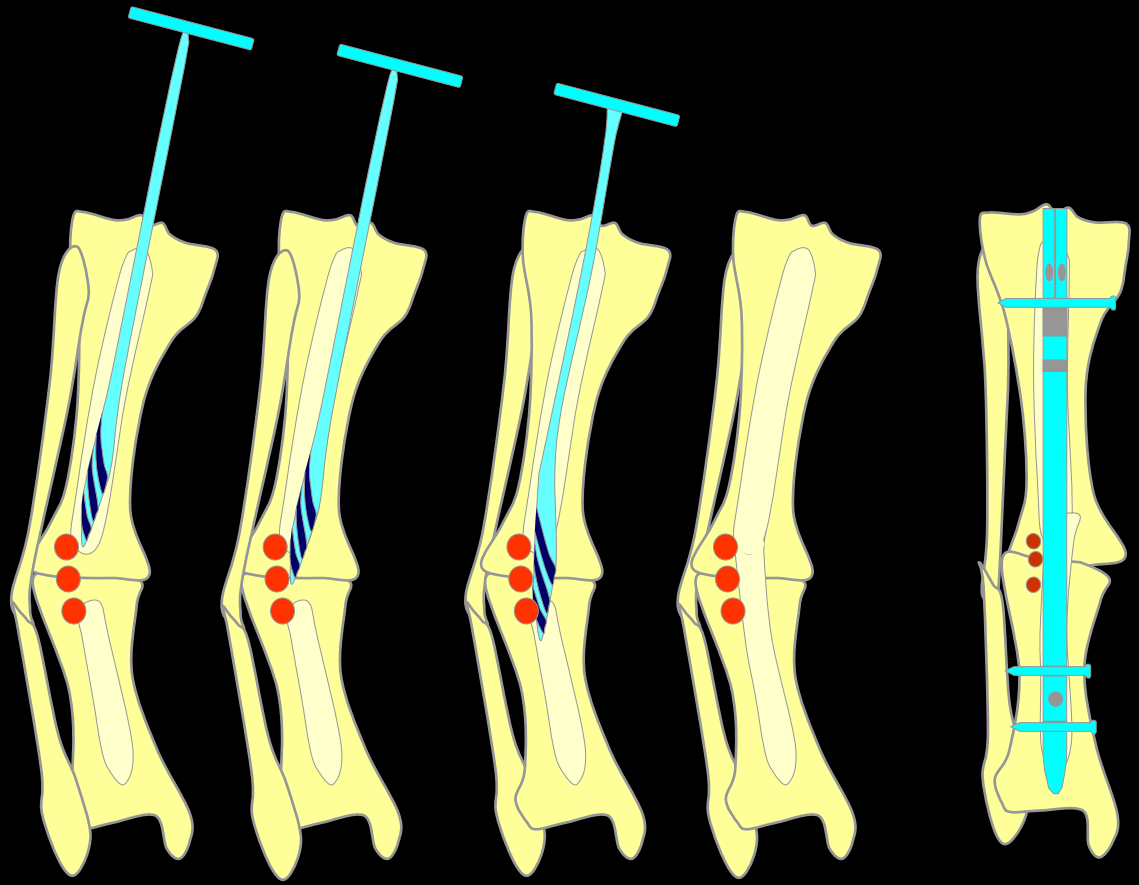

Fibula is important
Sequence matters …

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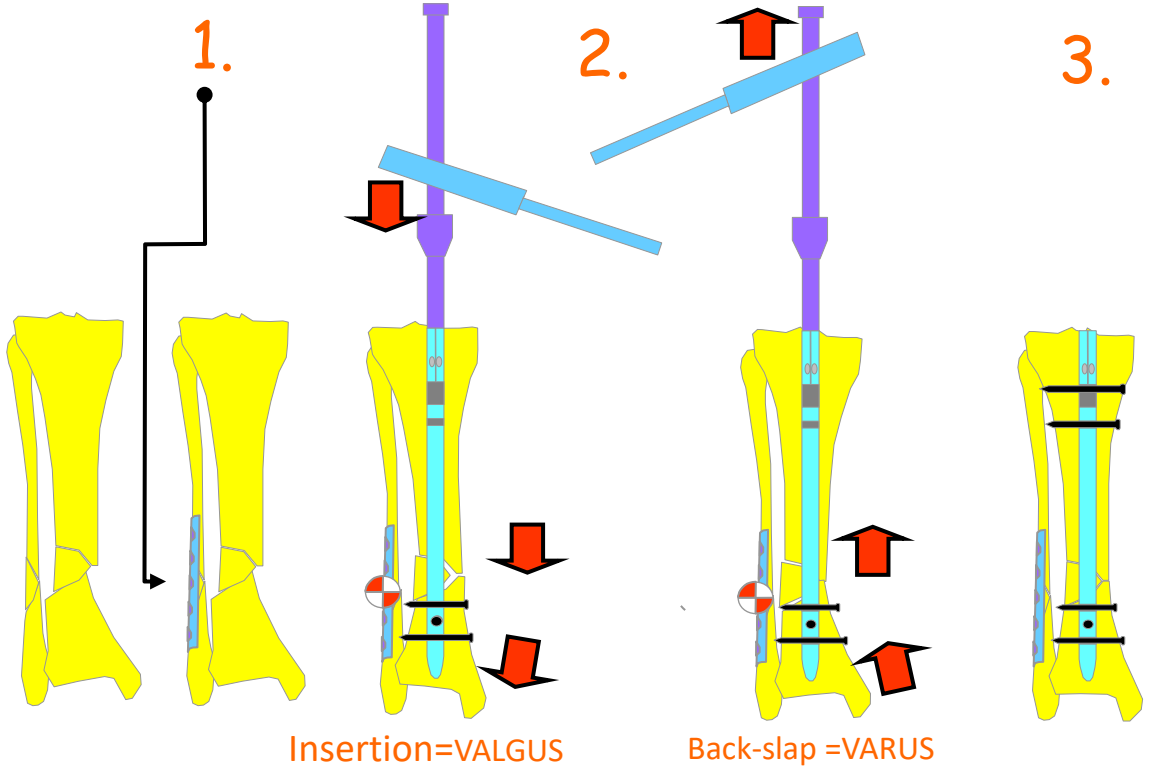
Sequence matters …
The Role of the Fibula in Distal Tib-Fib Fx



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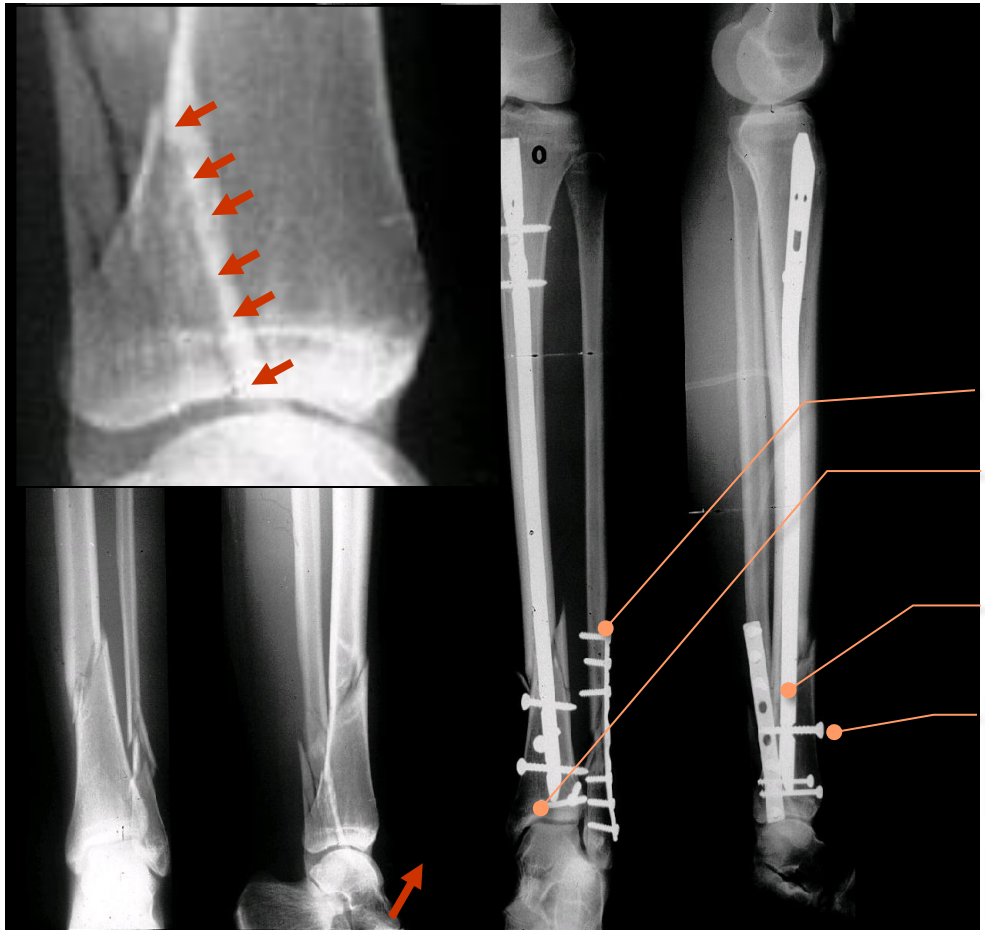
Role of the Fibula in Distal Tib-Fib Fx

Sequence of Steps



1. fibula
2. Joint reco lag screws
3. Handream metaphysis
4. Insert nail distal locking 1st
5. alignment fine tuning

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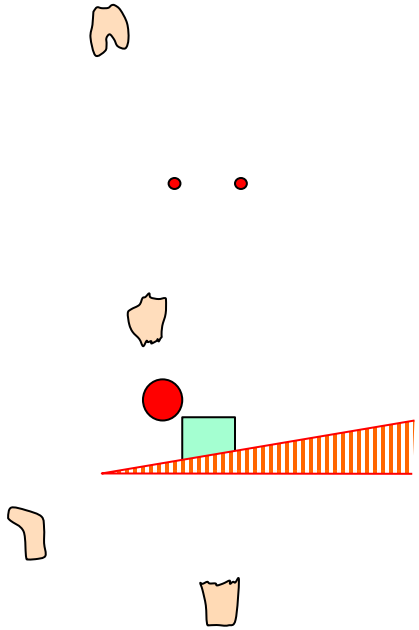
Technique #5 use nail bend to correct frontal plane malalignment



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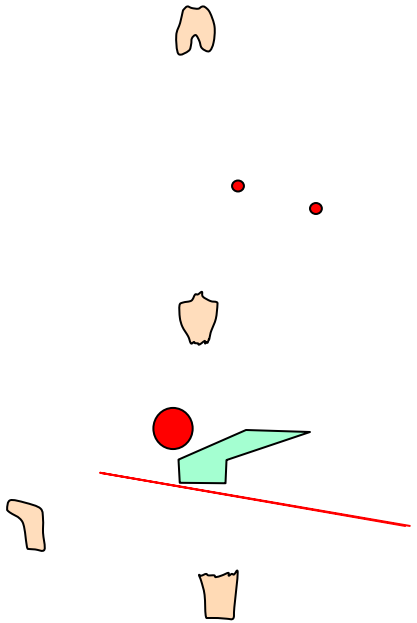

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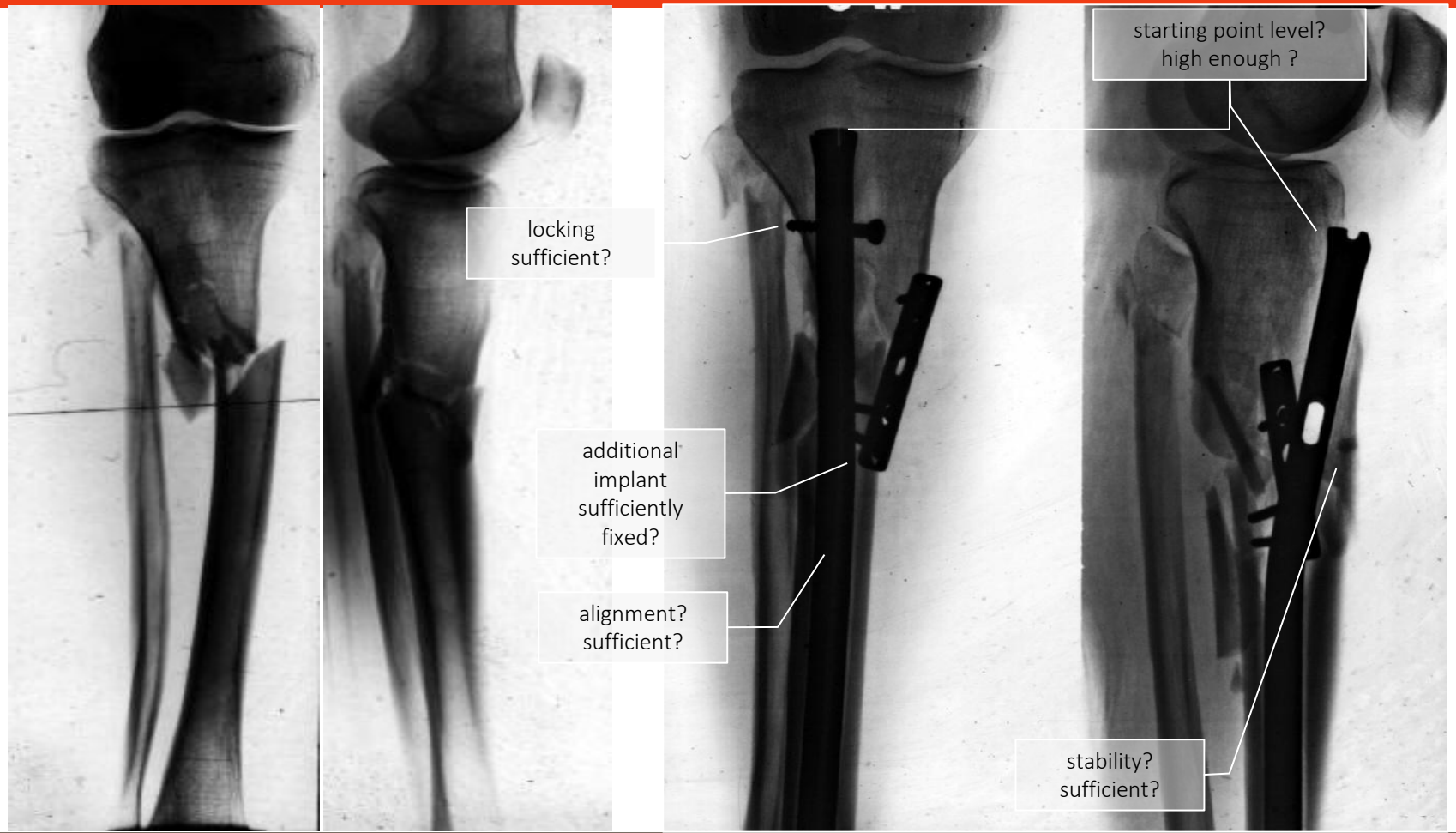

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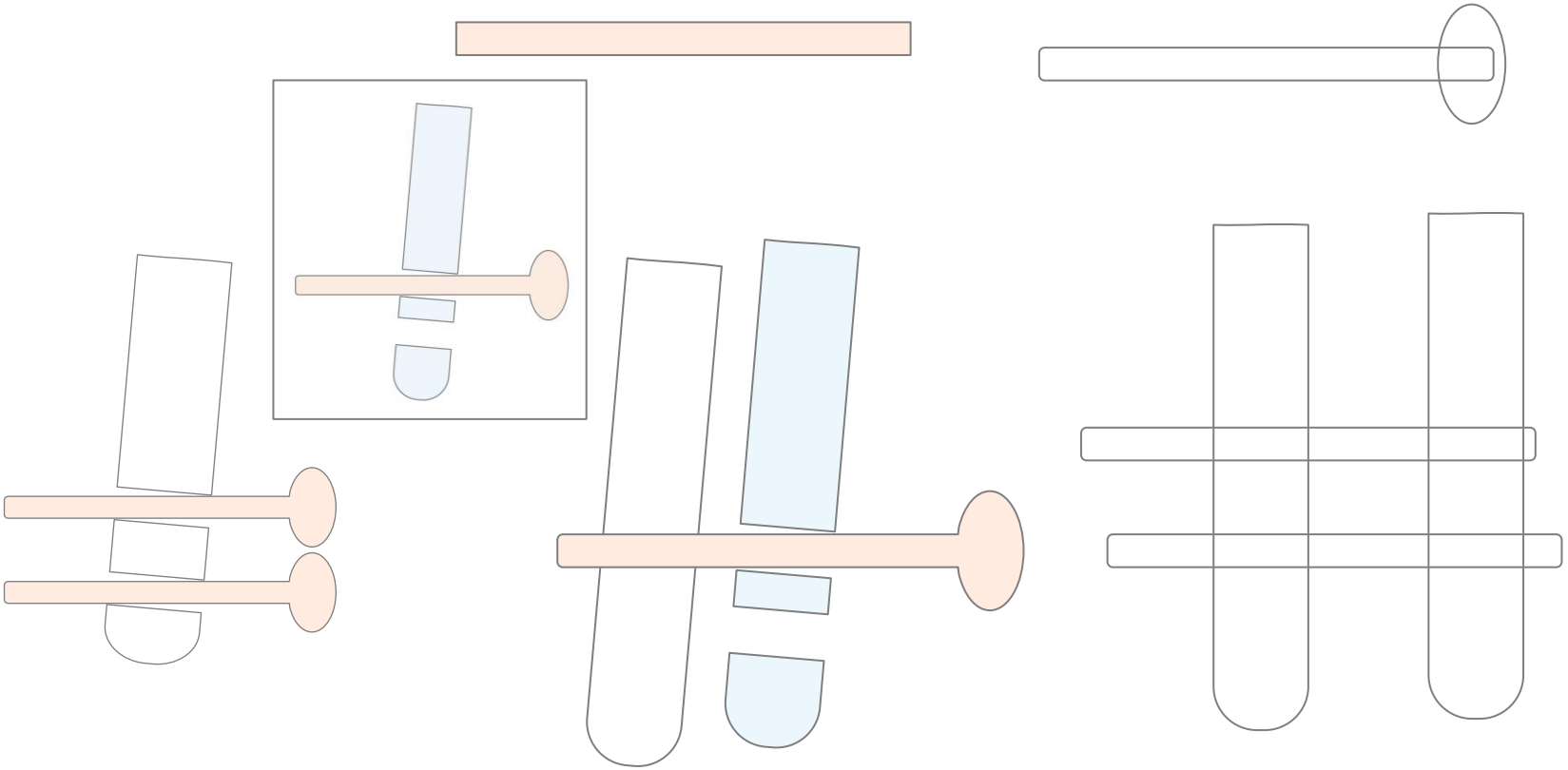

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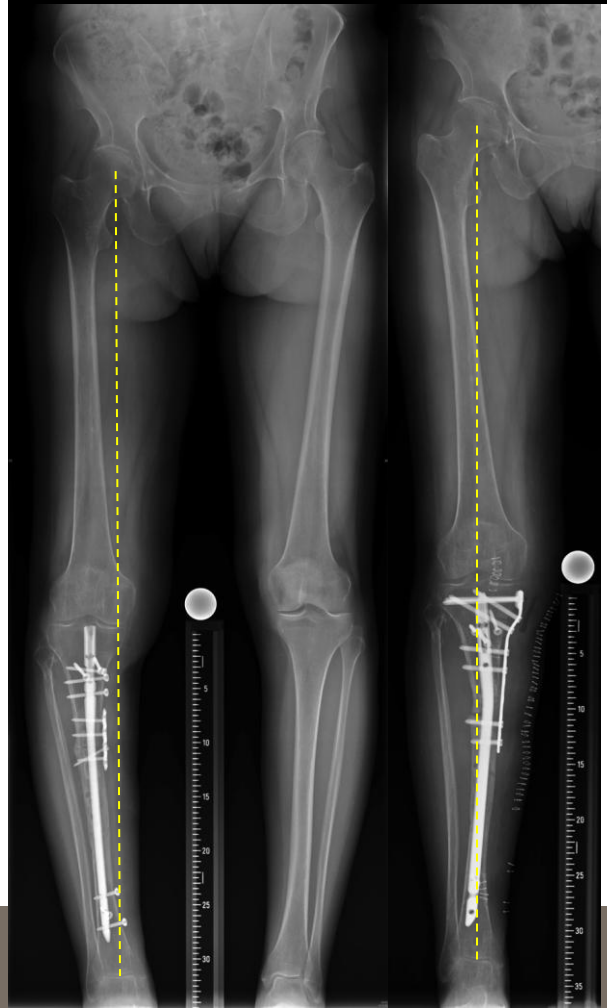

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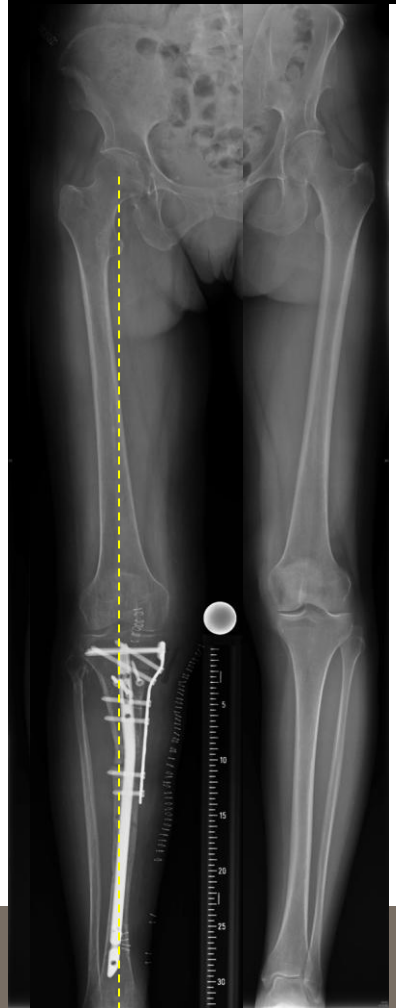

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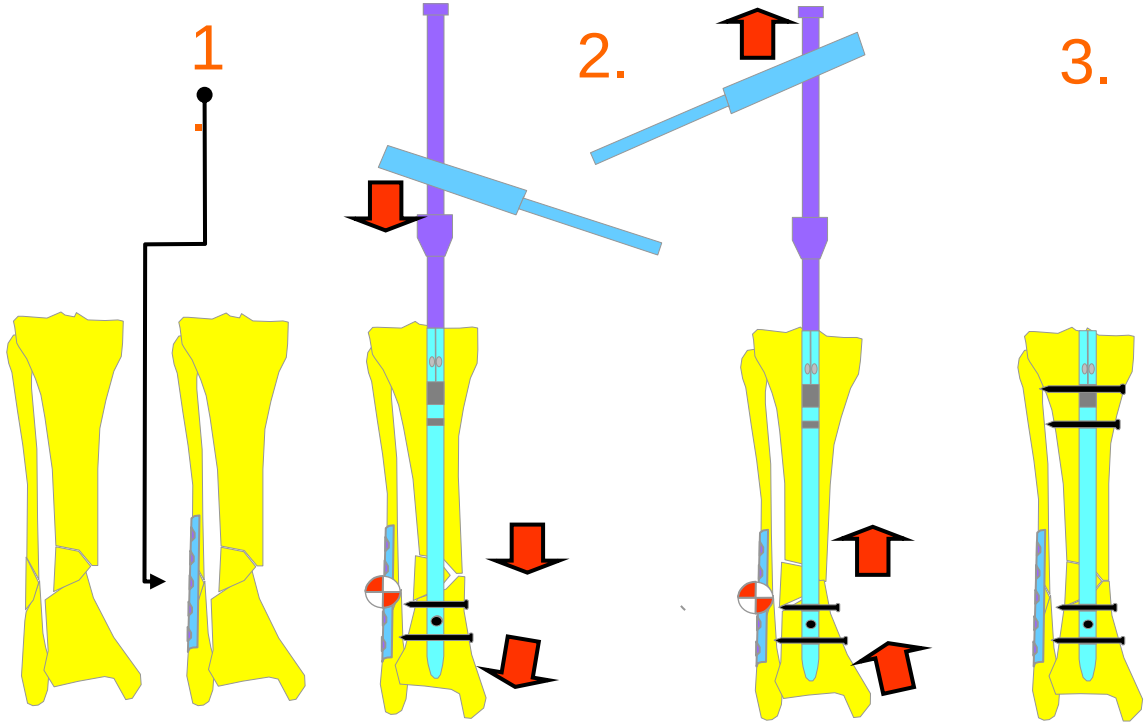

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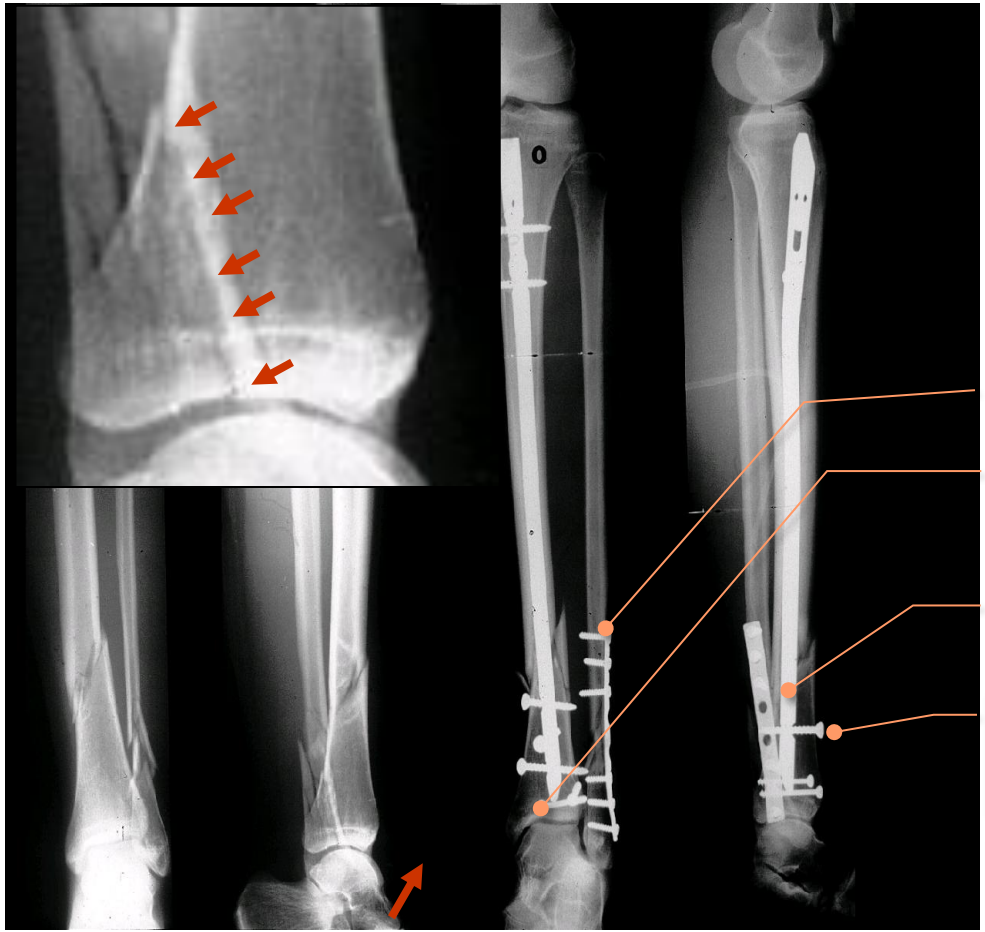
Role of the Fibula in Distal Tib-Fib Fx

Sequence of Steps



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#6 Understand General Rule in IM Nailing

Skin incision …
… defines starting point
… starting point defines alignment

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