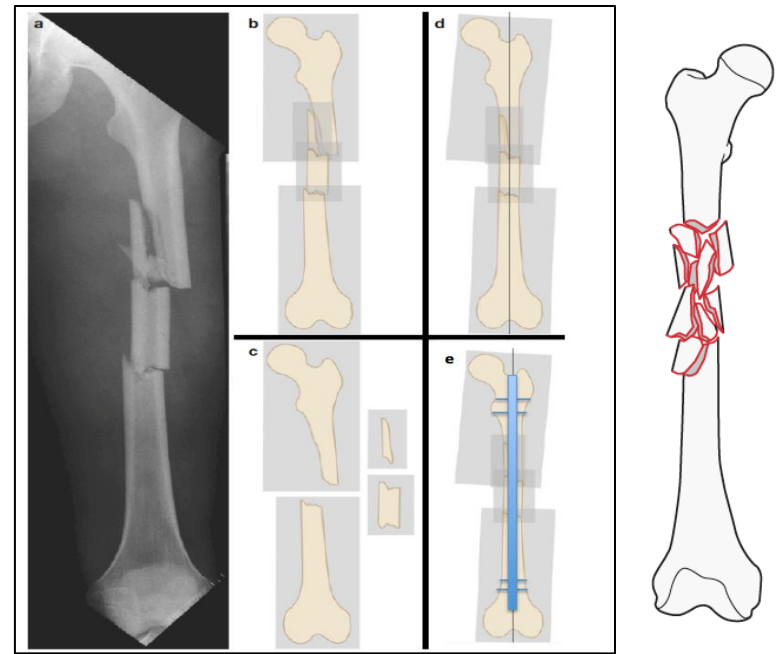


Segmental Femur Fractures Management Challenges



32C2 32C3
intact segment multifragmentary

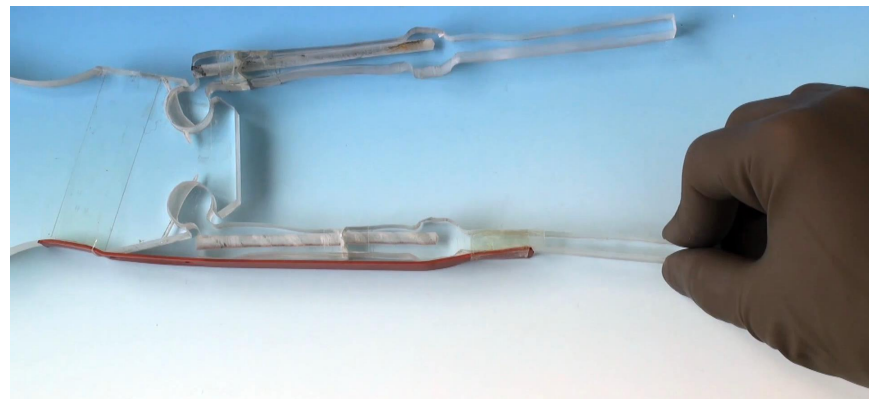
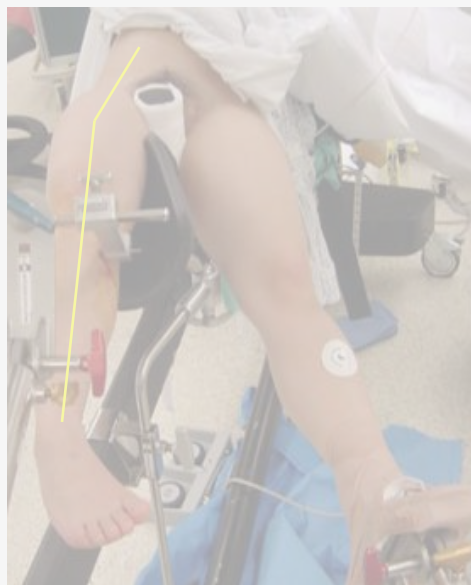
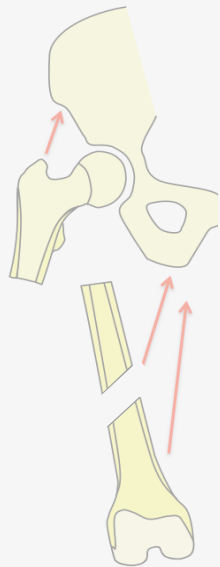
*Qualifications:

i Proximal diaphyseal-metaphyseal

j **Pure diaphyseal**

k Distal diaphyseal-metaphyseal

Management Challenge #1 Fx table vs simple radiolucent table



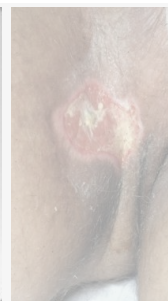
consider the role of IT band in im nailing

conflict

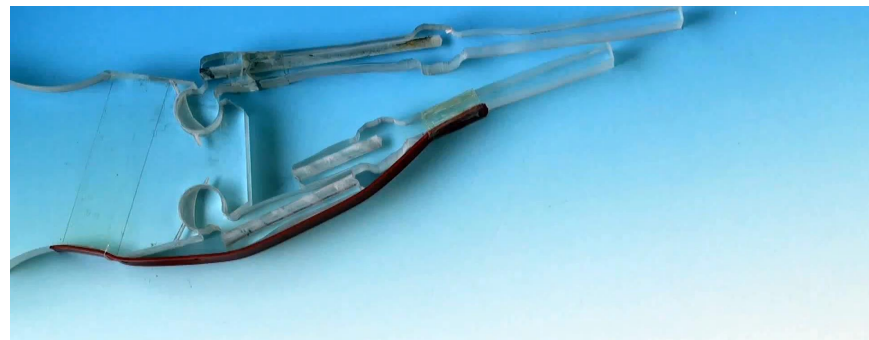
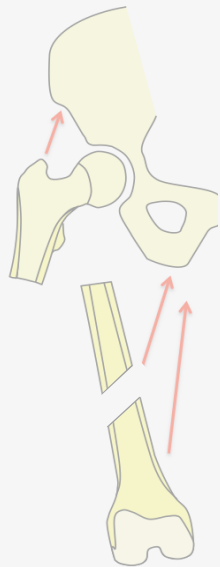
- easy access to starting point in **ad**-duction, but ilio-tibial tract tightens
- ilio-tibial tract soft in **ab**-duction, but access difficult

Problems fx table

- Access to proximal femur easy in ad-duction
- ad-duction tightens ilio-tibial tract
- tightened ilio-tibial tract shortens fx
- shortened fx makes reduction difficult
- shortened fx requires higher reduction forces
- shortened fx leads to more reduction time



Management Challenge #1 Fx table vs simple radiolucent table



Problems fx table

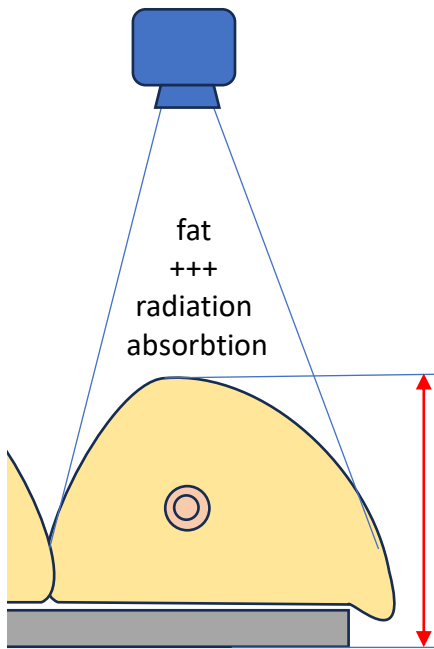
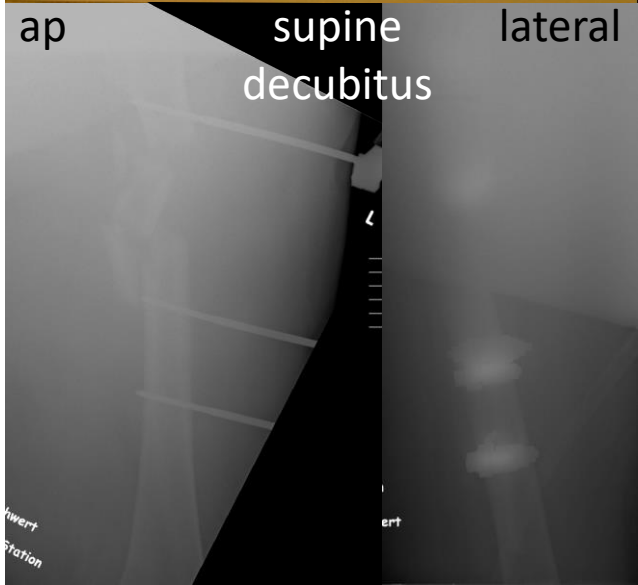
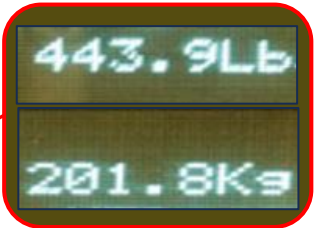
- Access to proximal femur easy in ad-duction
- ad-duction tightens ilio-tibial tract
- tightened ilio-tibial tract shortens fx
- shortened fx makes reduction difficult
- shortened fx requires higher reduction forces
- shortened fx leads to more reduction time

consider the role of IT band in im nailing

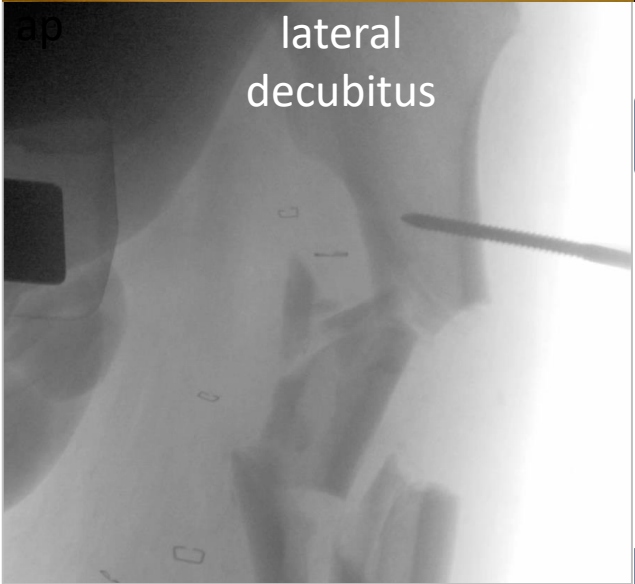
solve the conflict by splitting the process in 2 steps

1. starting point, nail insertion in **ad**-duction, then
2. proximal fragment neutral & distal fragment in **ab**-duction (relaxes iliotibial tract) & eases reduction

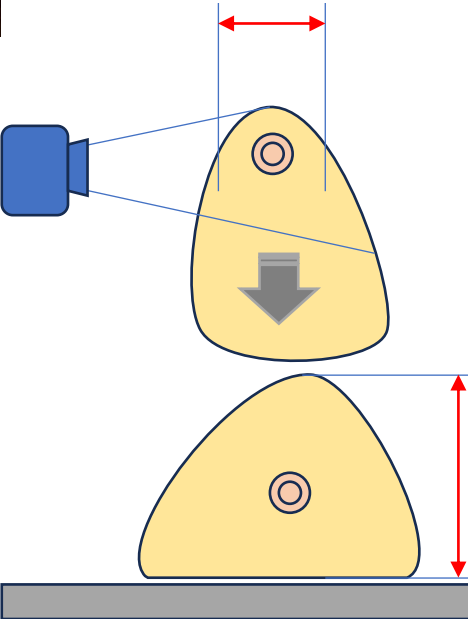
Management Challenge #2 Nailing Supine vs lateral decubitus



Management Challenge #2 Nailing Supine vs lateral decubitus

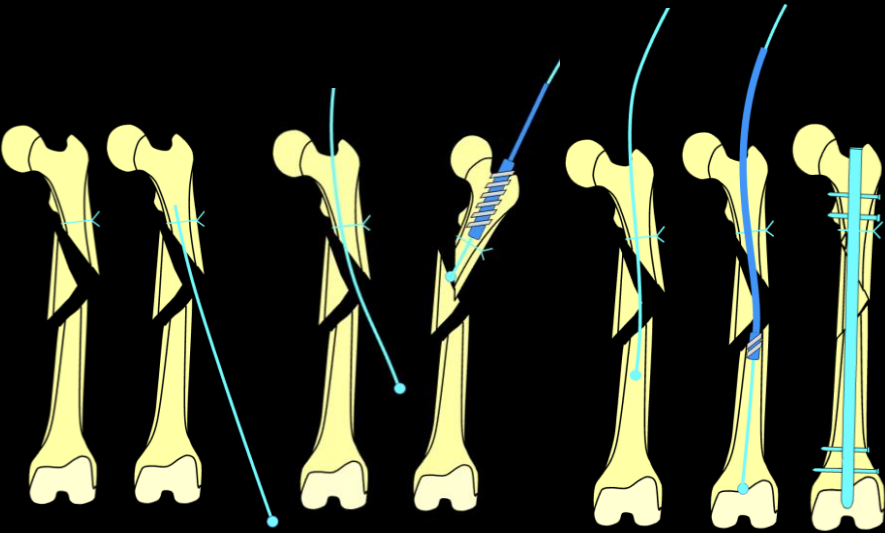


lateral decubitus &
ap projection ...
soft tissues flow away
(gravity)
less volume to penetrate



Management Challenge #3 Starting point in obese patients

retrograde starting point

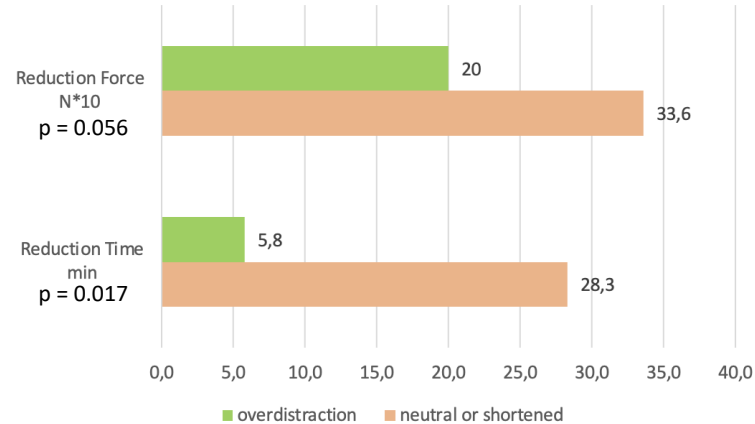


Management Challenge #4 Post Damage Control Shortening

Overdistraction of the Fracture Eases Reduction in Delayed Femoral Nailing

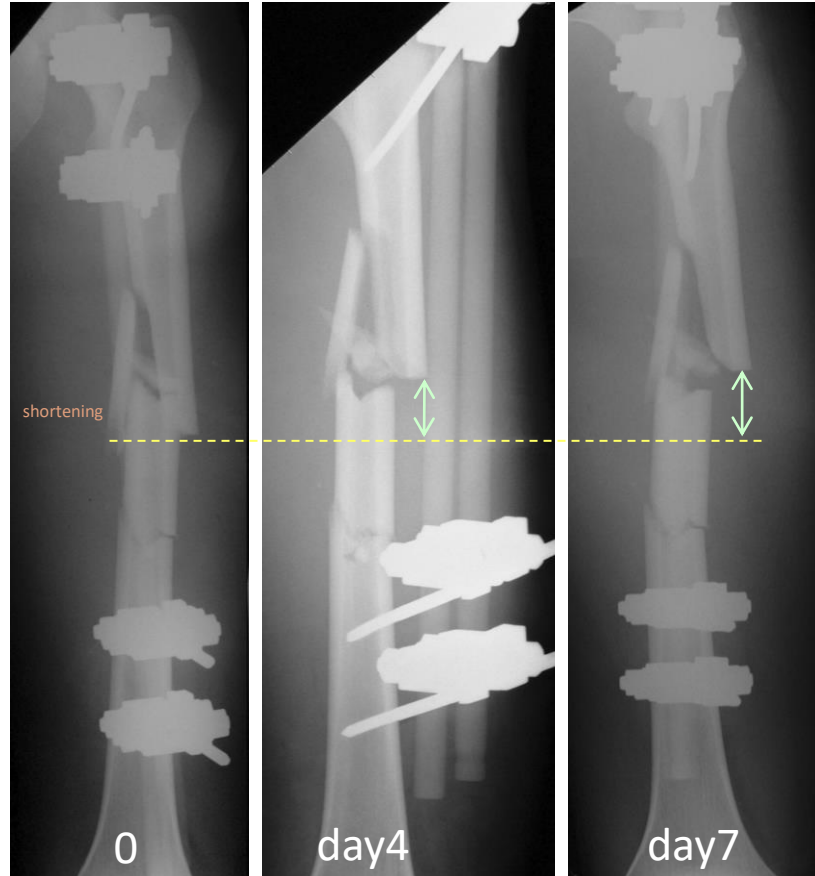
Results of Intraoperative Force Measurements

Gosling T, Hufner T, Westphal R, Faulstich J, Hankemeier S, Wahl F, Krettek, C



Conclusion

- Fracture shortening leads to higher forces & prolonged reduction time
- Overdistraction should be performed as soon as possible under careful soft-tissue monitoring



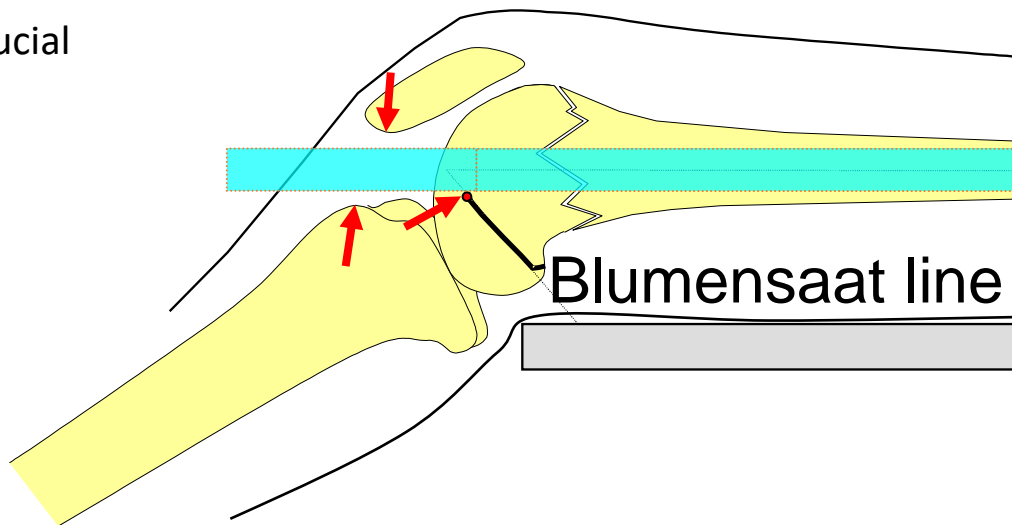
Management Challenge #5 Retrograde nail – starting point

Retrograde nailing has advantages

- Easier in large patients to find starting point
- Better for combined fracture patterns (ipsilateral femoral neck, tibia, acetabulum)

Retrograde nailing has its problems

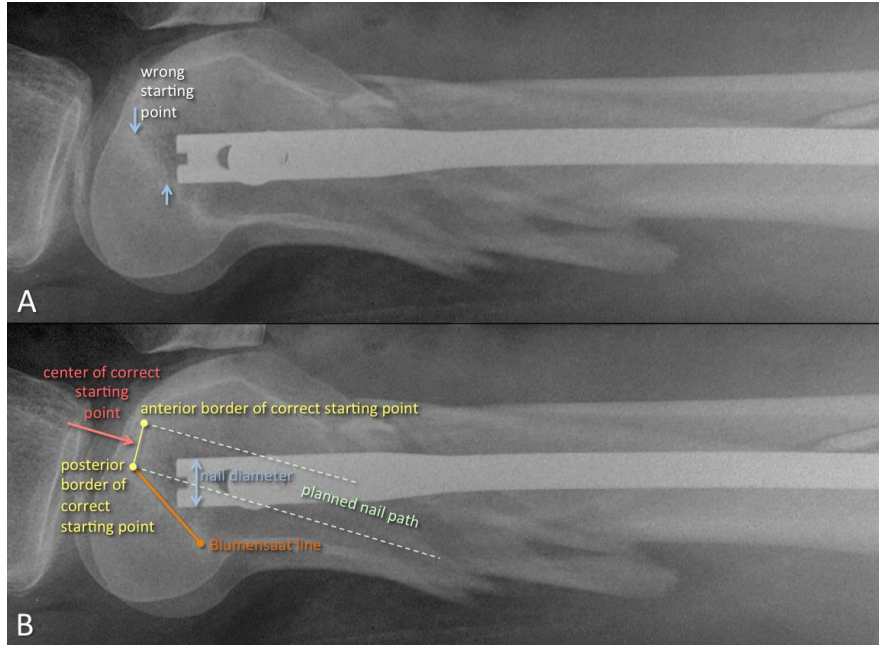
- Union rates are slightly lower, more dynamizing with small diameter nails
- starting point is crucial



Management Challenge #5 Retrograde nail – starting point

too posterior

- PCL origin compromised
- recurvatum deformity, hyperextension
- pseudo-laxity: straight knee – lig loose



Management Challenge #6 Deformity

Torsion

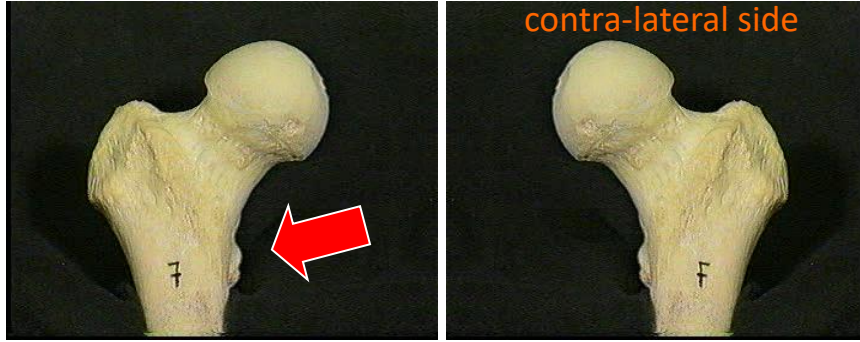
2. Sit-Test

1. Lift-off Test

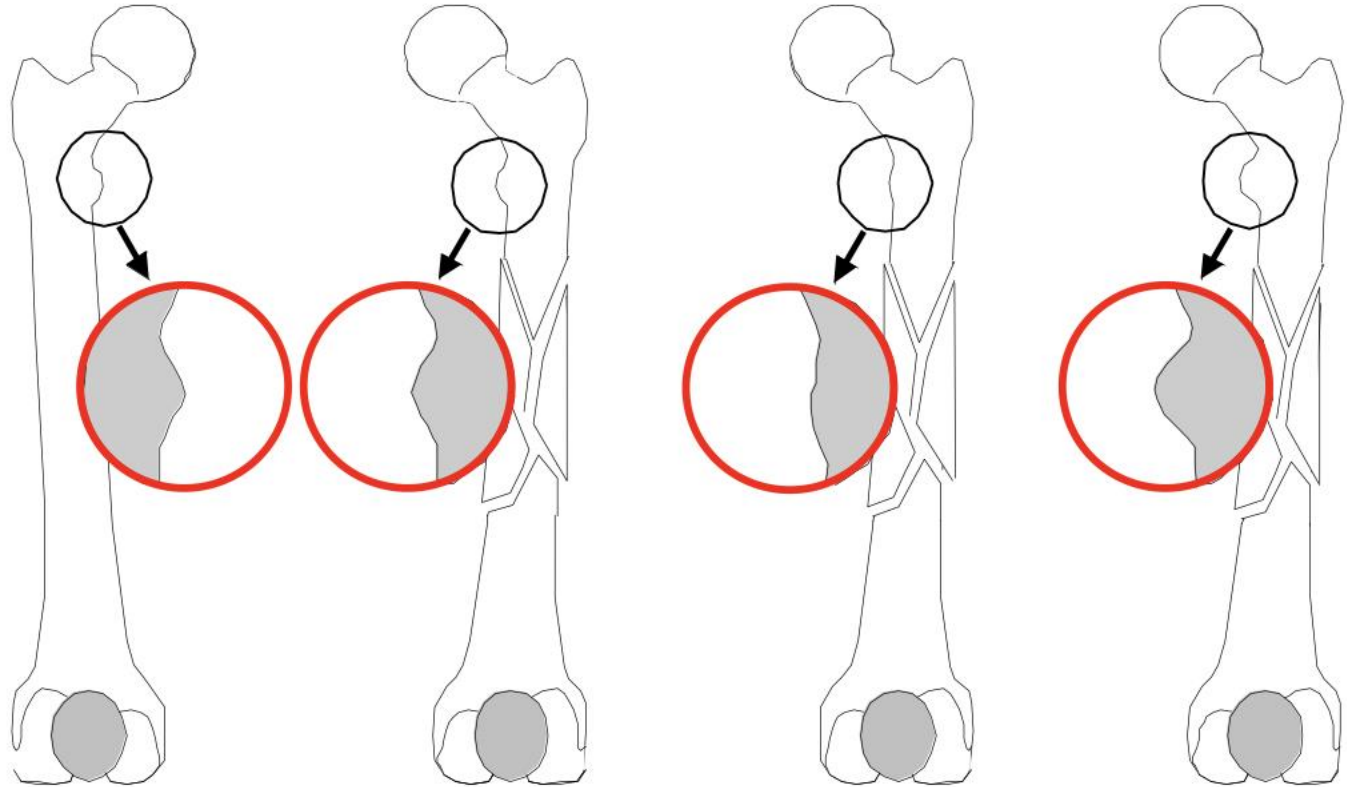


Krettek, C. and T. Gösling (2015). Femoral Nailing. In; Intramedullary Nailing - A comprehensive Guide. Springer.

Torsion: Lesser trochanter shape sign



Torsion: Lesser trochanter shape sign



Validity confirmed

Kim JJ, Kim E, Kim KY (2001)
Predicting the rotationally neutral state of the femur by comparing the shape of the contralateral lesser trochanter. Orthopedics 24: 1069

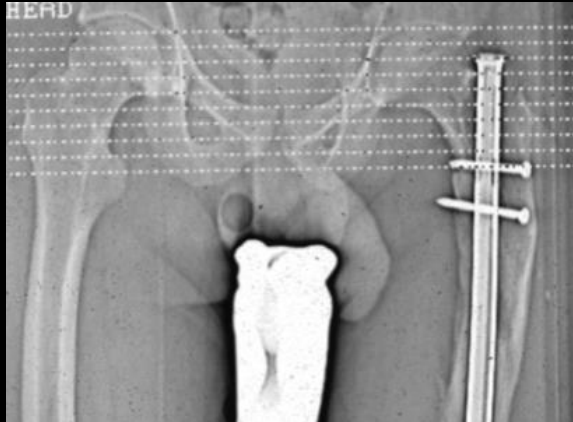
external torsion deformity

internal torsion deformity

Torsional Deformity Examples



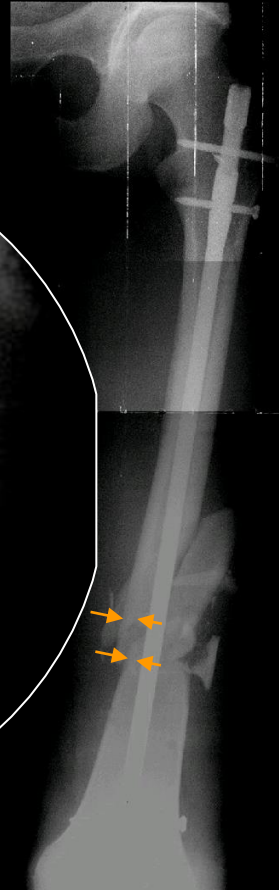
internal torsion deformity



external torsion deformity

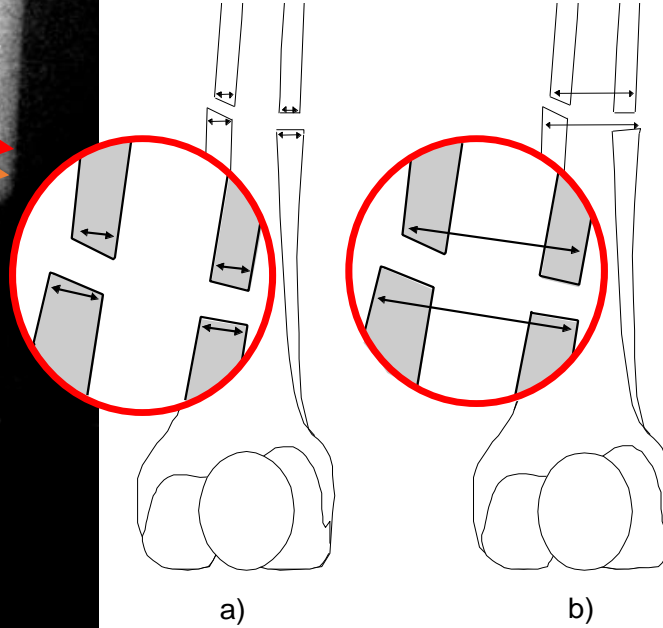
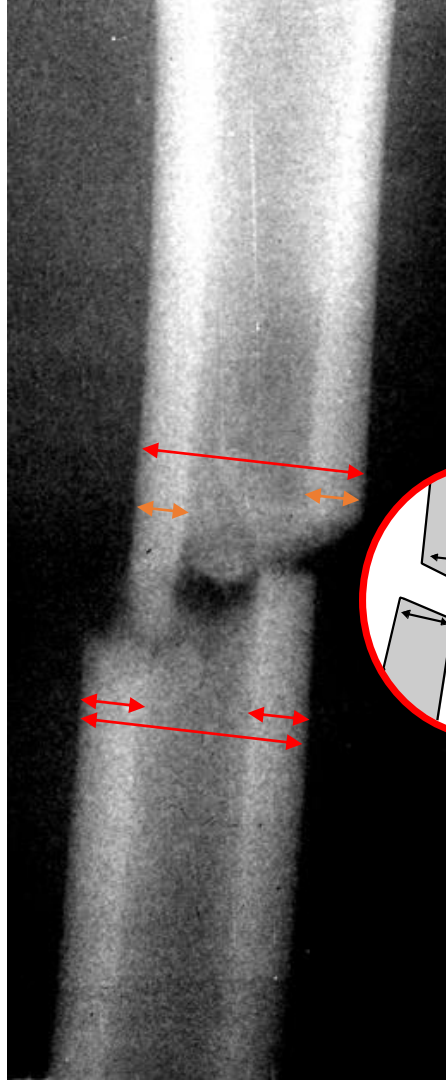


cortical thickness sign

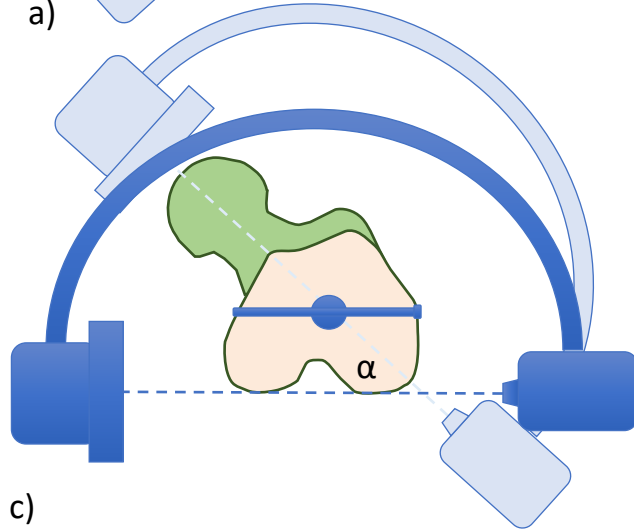
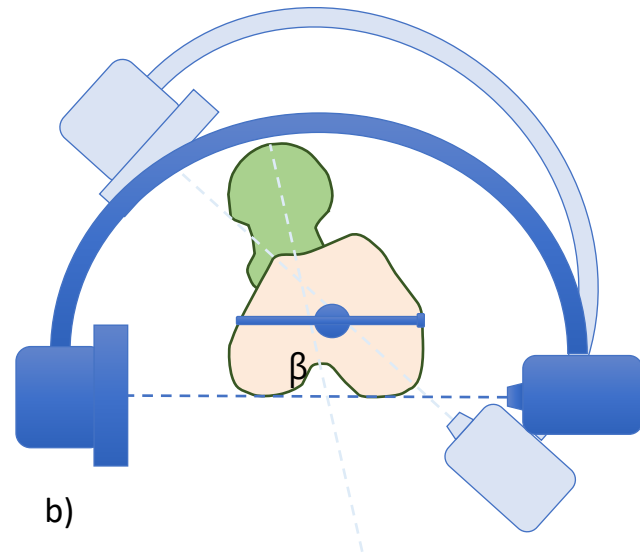
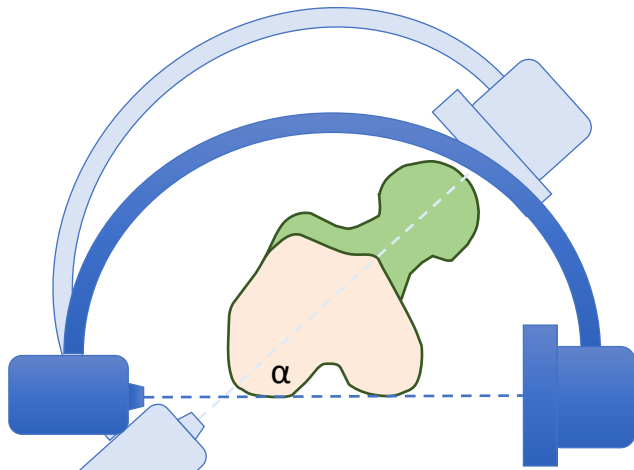


internal torsion deformity

Torsion: Cortical step sign & Diameter difference sign

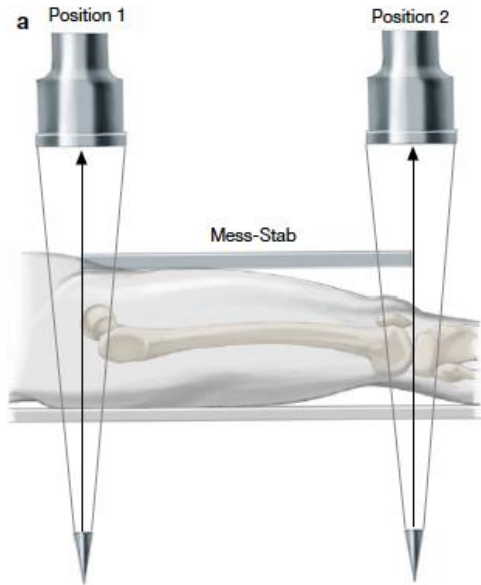


Torsion

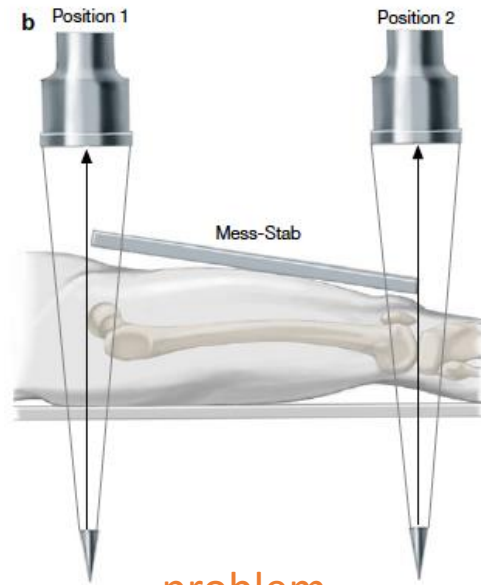


Tornetta P, 3rd, Ritz G, Kantor A. Femoral torsion after interlocked nailing of unstable femoral fractures. The Journal of trauma. 1995 Feb;38(2):213-9. PubMed PMID: 7869438.

Length



correct



problem
meter stick oblique

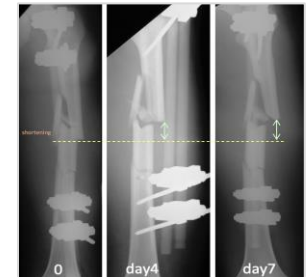
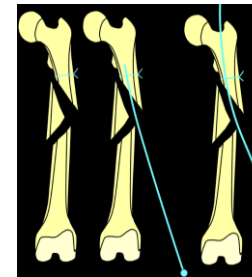
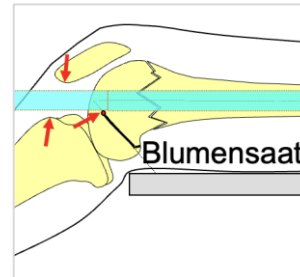
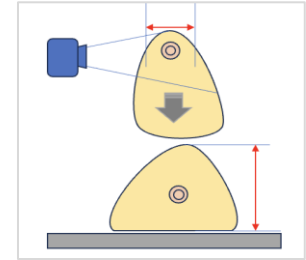
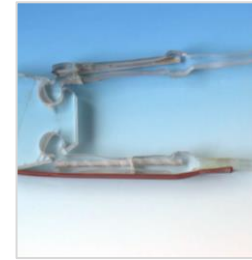
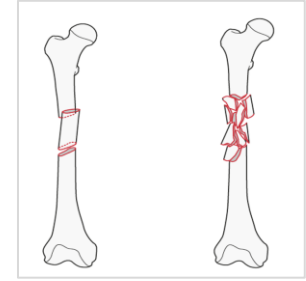


problem
meter stick not centered

Segmental Femur Fractures Management Challenges

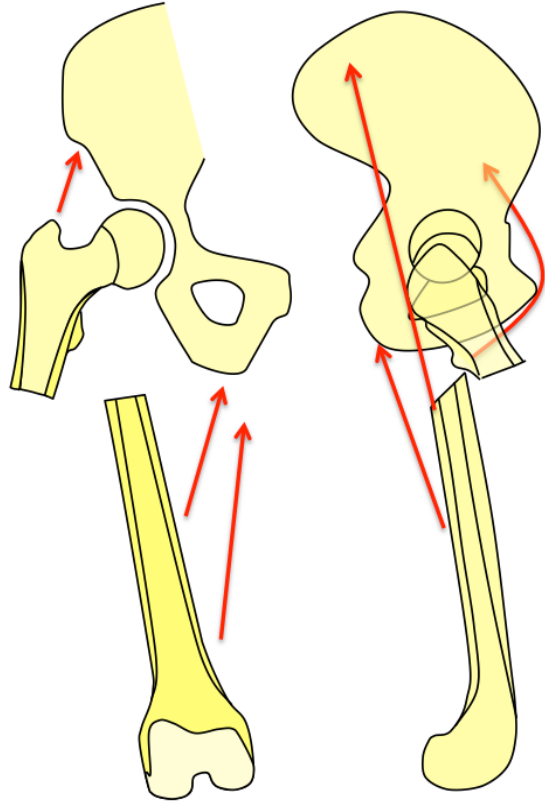
Summary

- 1) OR Table Fx table vs simple radiolucent table
role of IT band for reduction
- 2) Positioning Supine vs lateral decubitus
- 3) Insertion site antegrade-retrograde
- 4) Retrograde nail starting point alignment
- 5) Deformity Techniques to avoid deformity
lesser troch shape sign – sit test – lift off test



Management Challenge #8 Retrograde nail

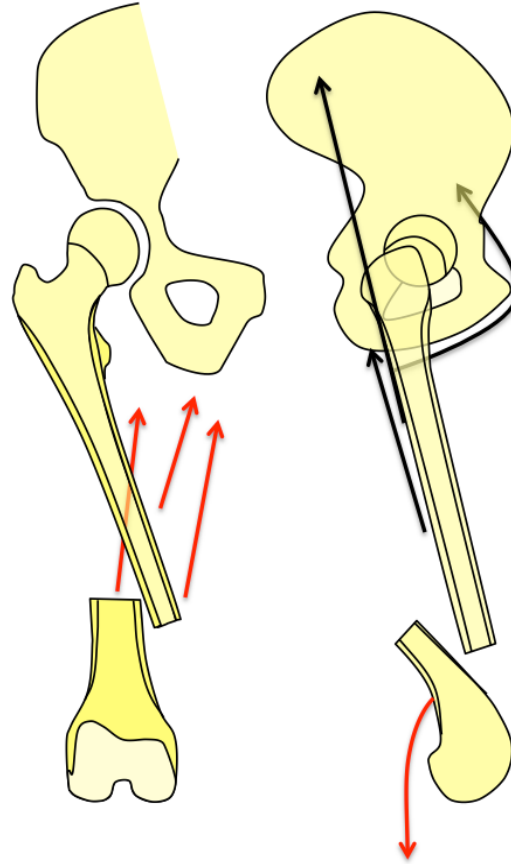
Proximal fractures



A

B

Distal fractures



C

D

Management Challenge #1 Decision making DCO or ETC?

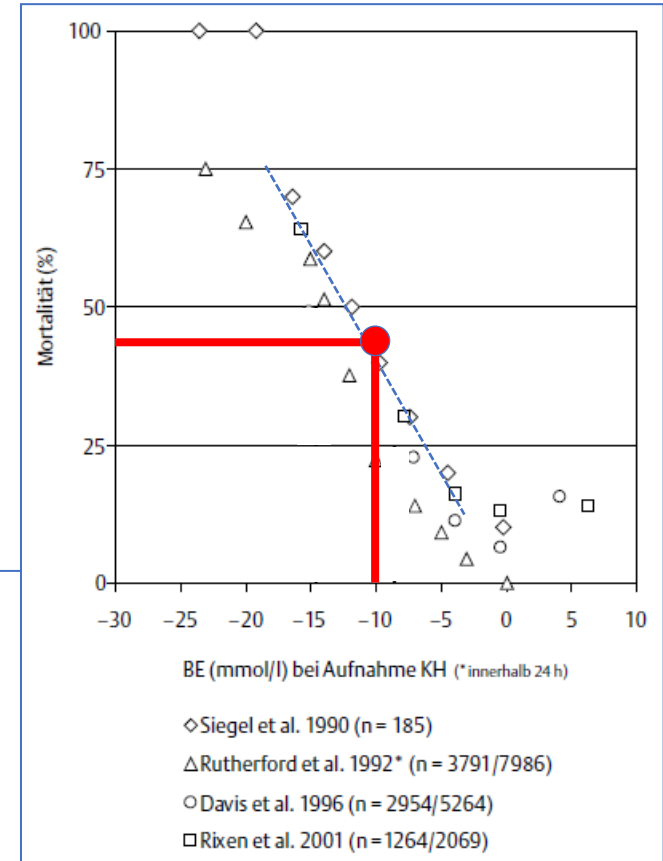
- isolated injury or polytrauma?
- TBI? chest injury?
- Patient status:
acidosis – coagulation status – temp
lactate?

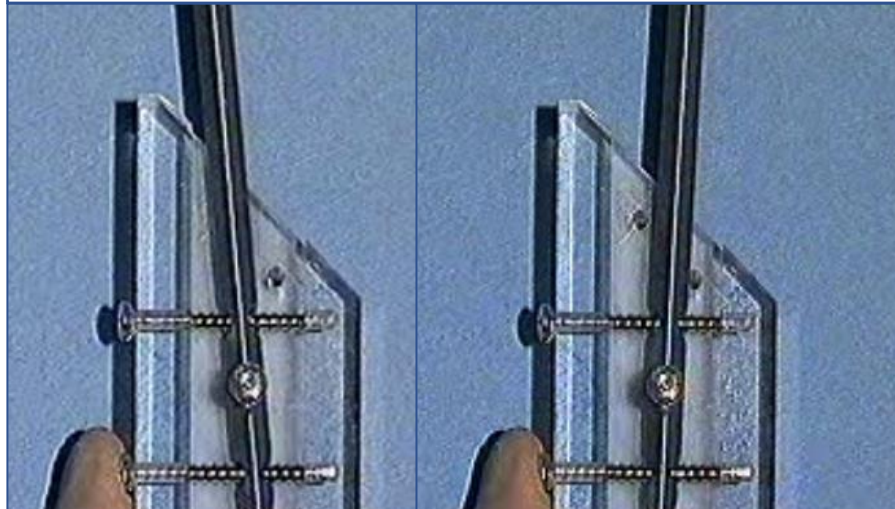
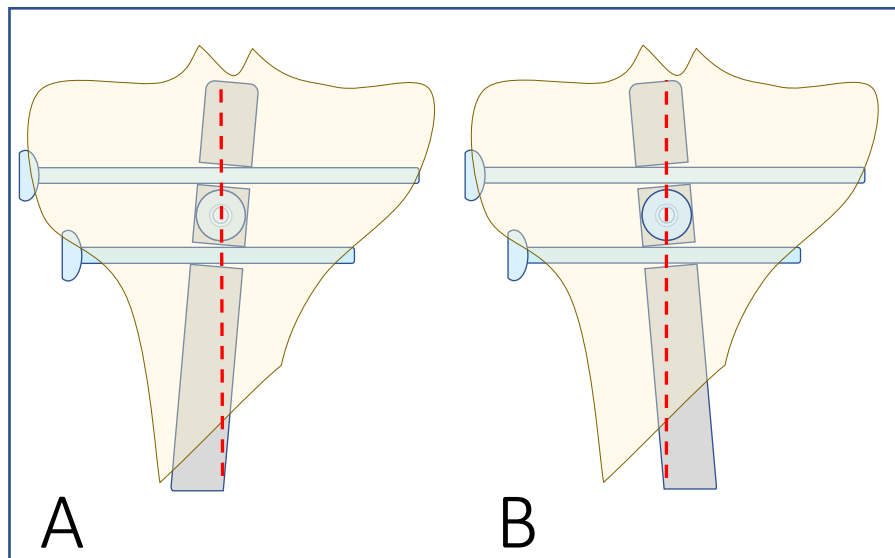
High correlation between BE and lactate
(Pearson -0.81) Caputo, Am J Emerg Med. 2015

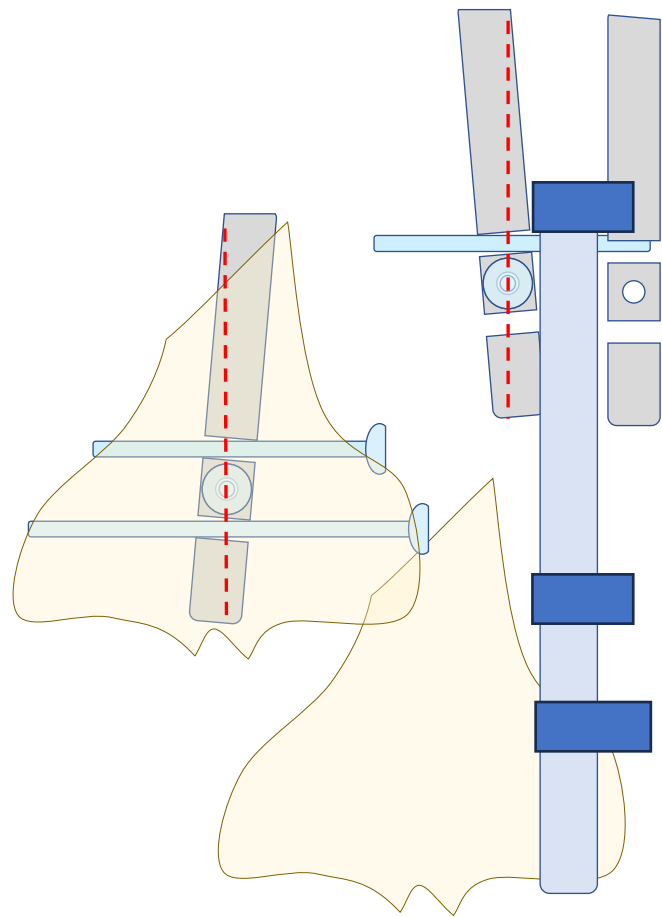
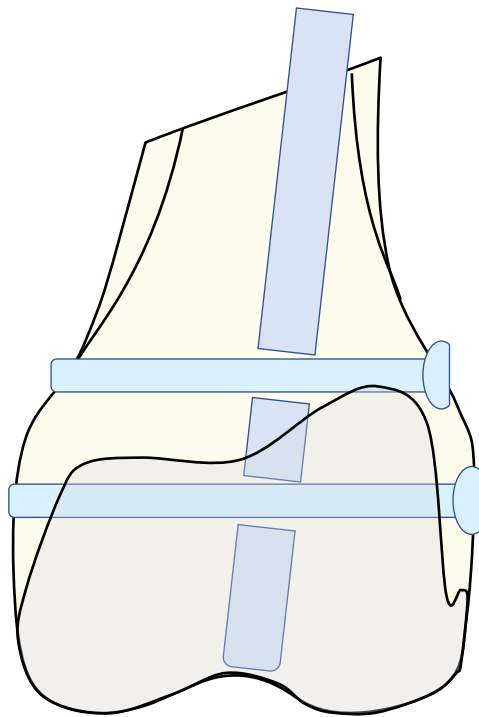
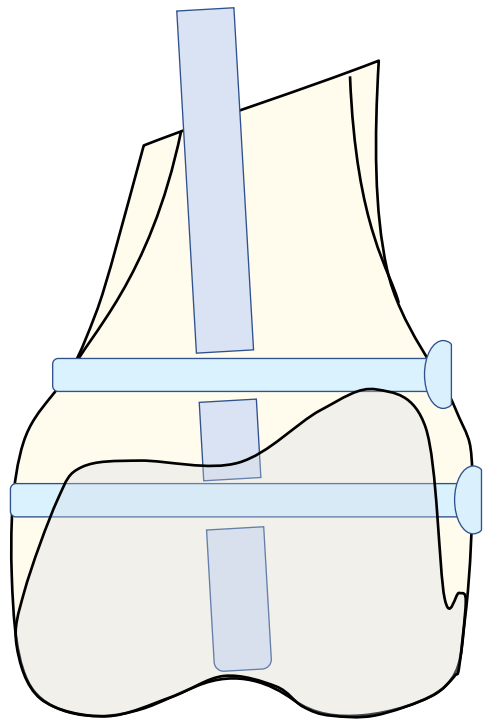
Mortality significantly increased if **> 2 mmol/L**

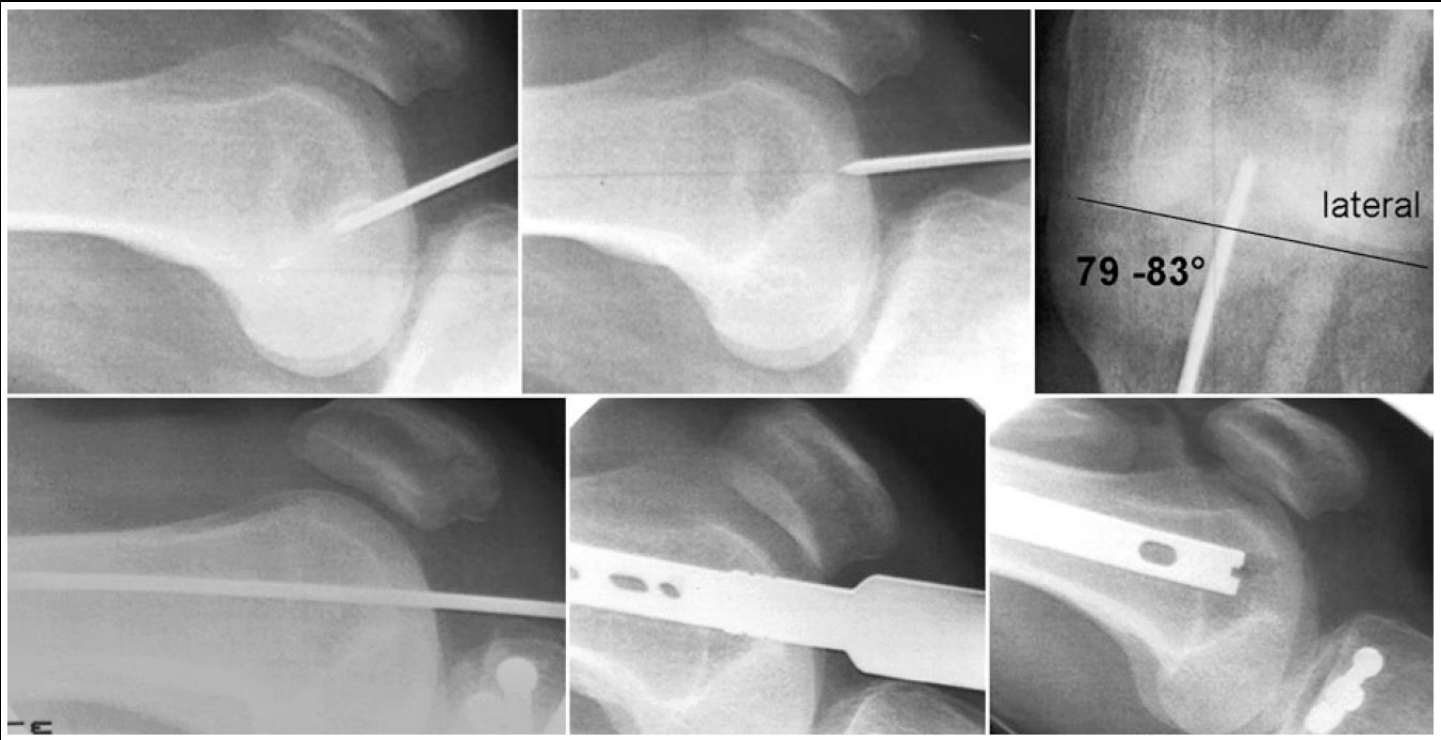
Lactate of **> 4 mmol/L** **mortality > 40 %**

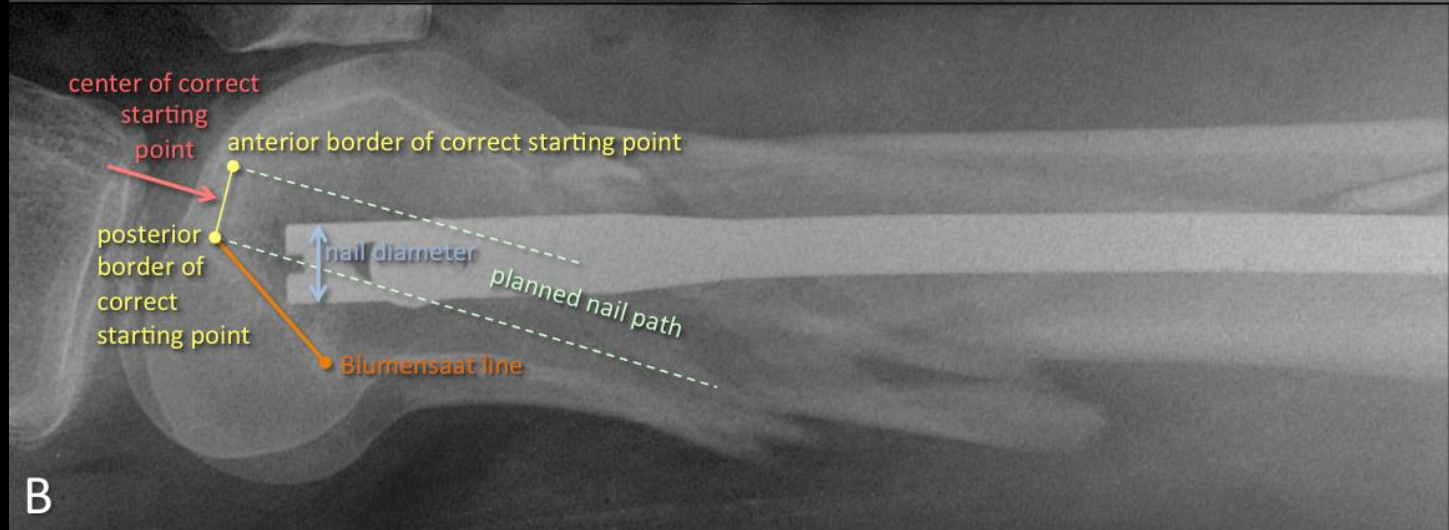
Callaway, J Trauma 2009













a)



I

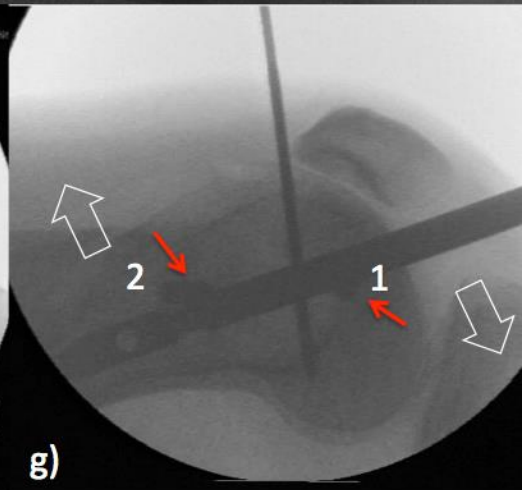
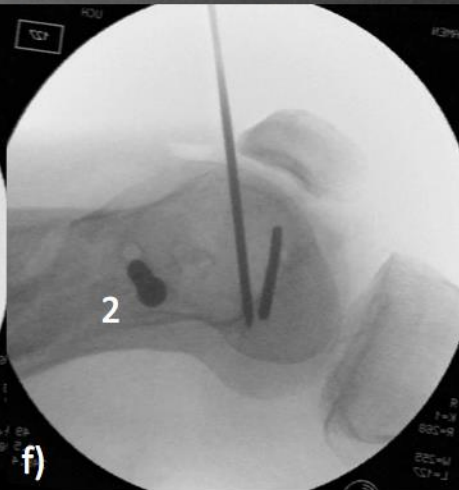
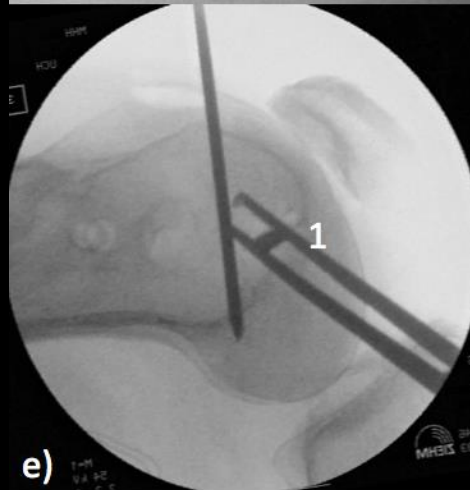
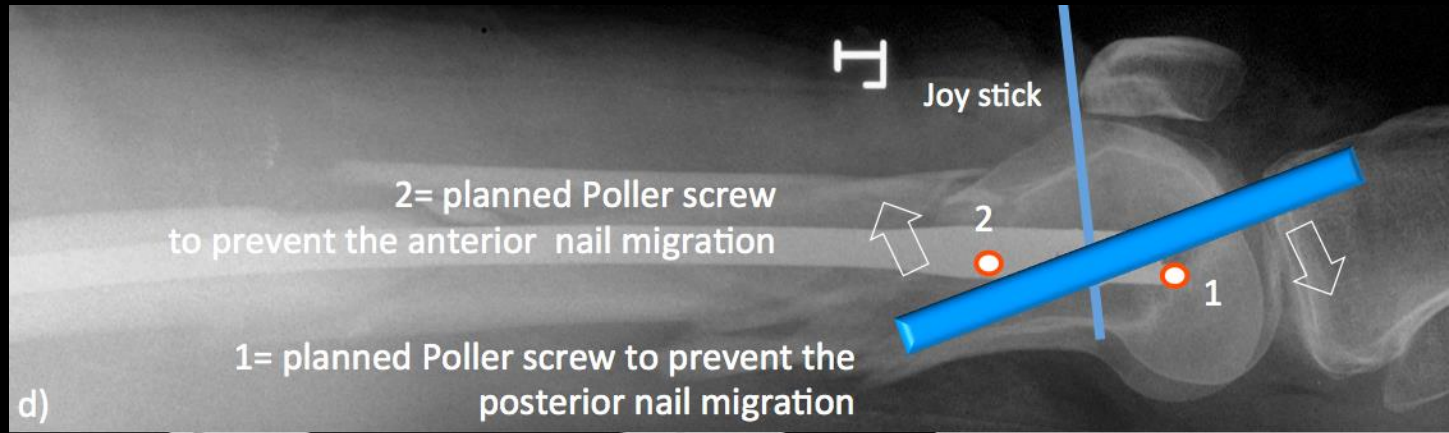


b)



25°

I





h)



i)





Where to place Poller screws ?
How many ?

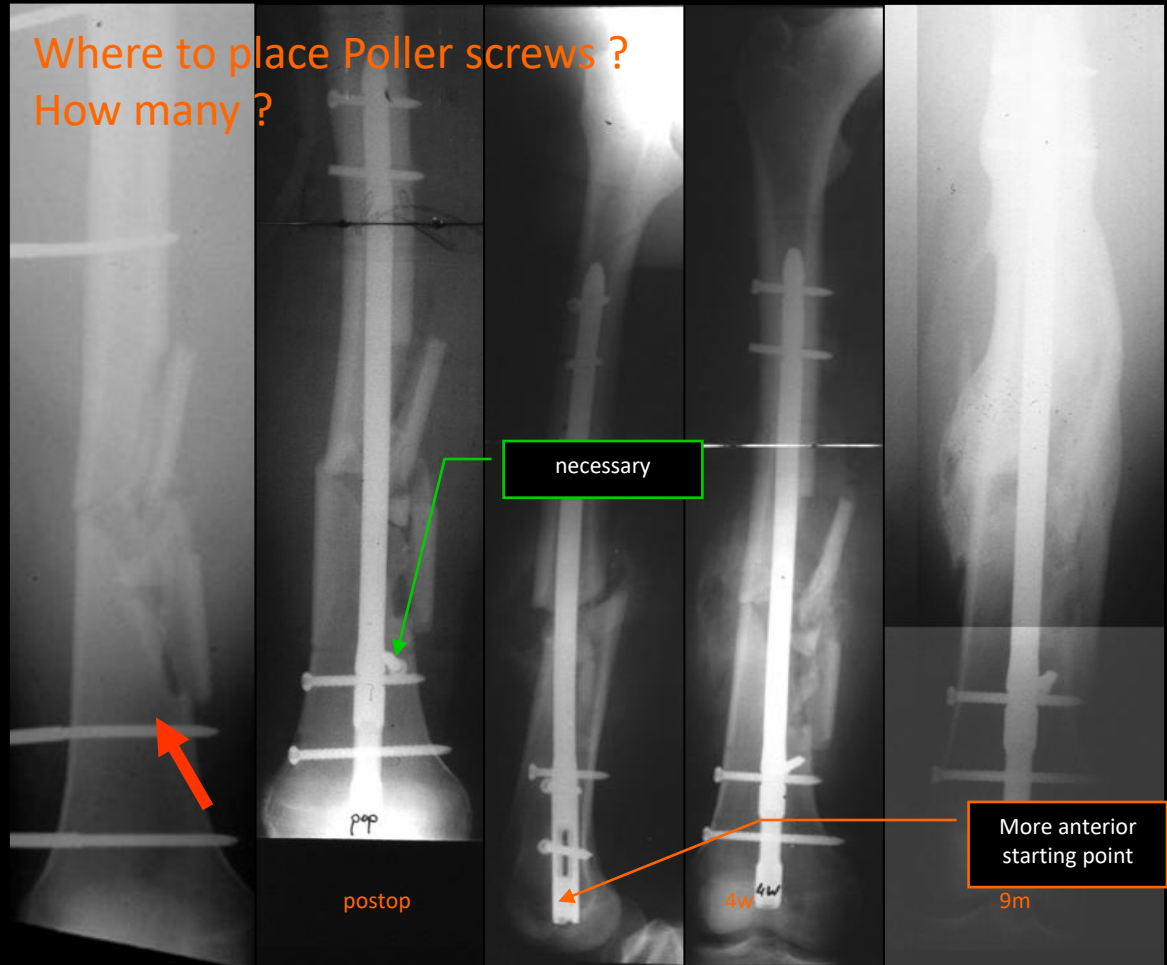
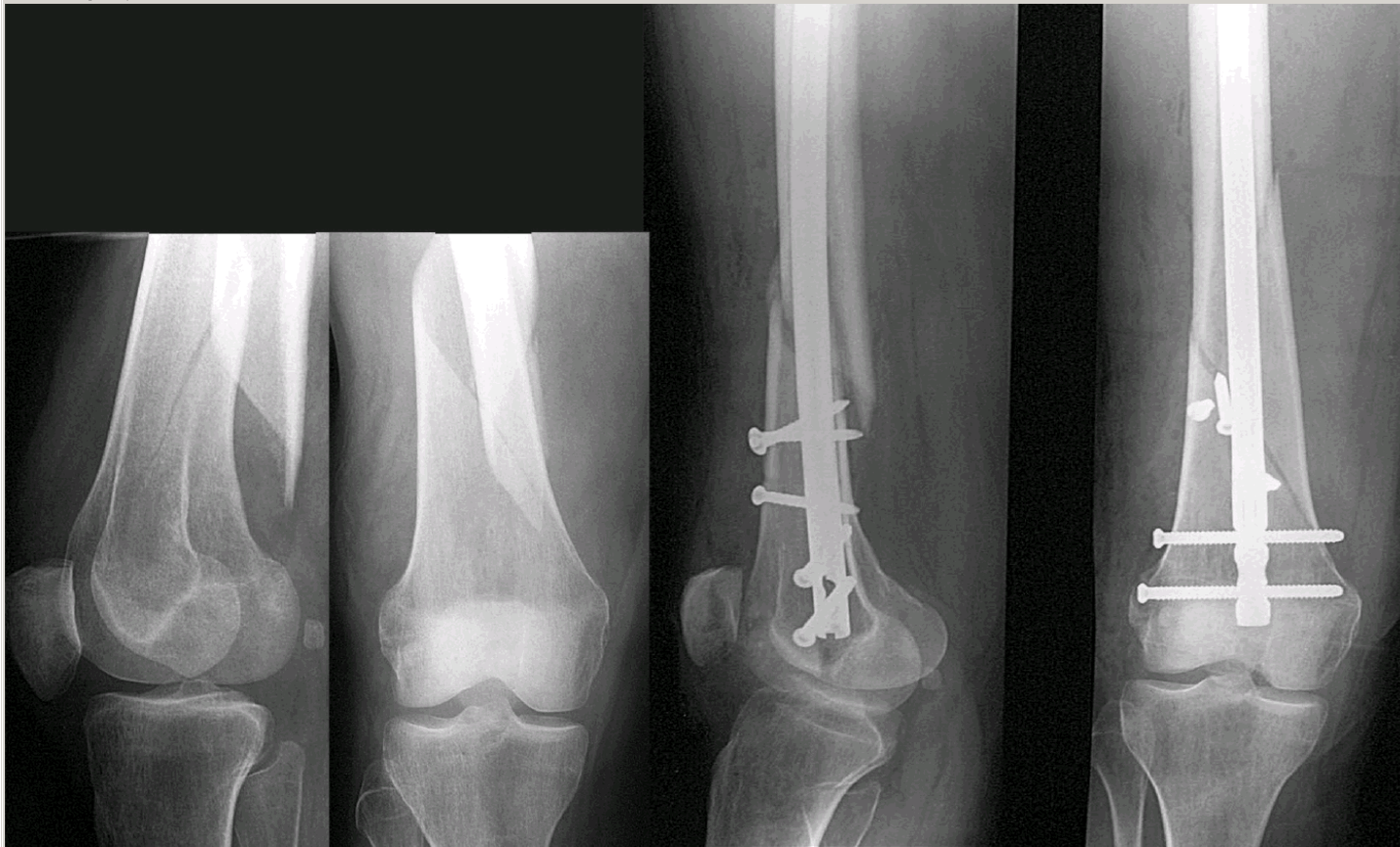
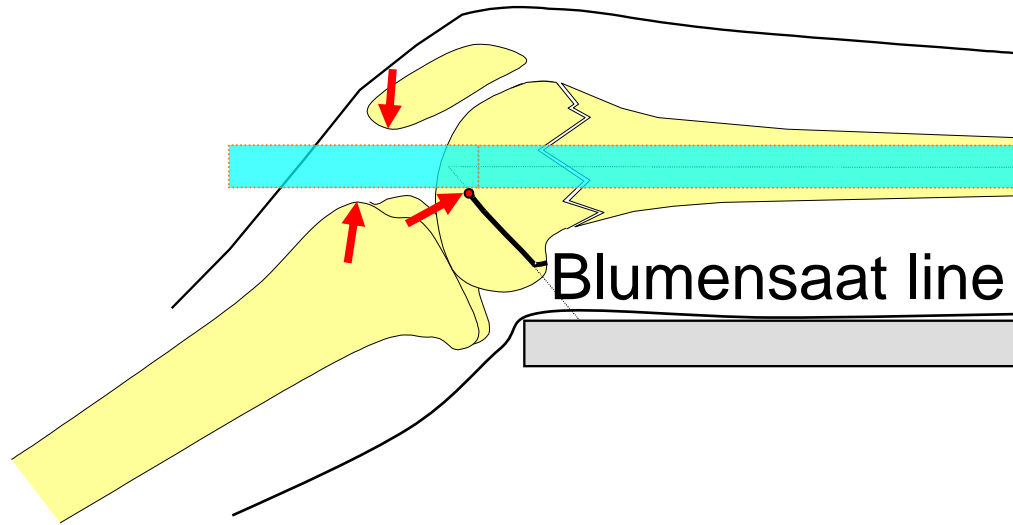


Fig 51-48.jpg

File Edit Image Help



Management Challenge #9 ...



Management Challenge #10 ...

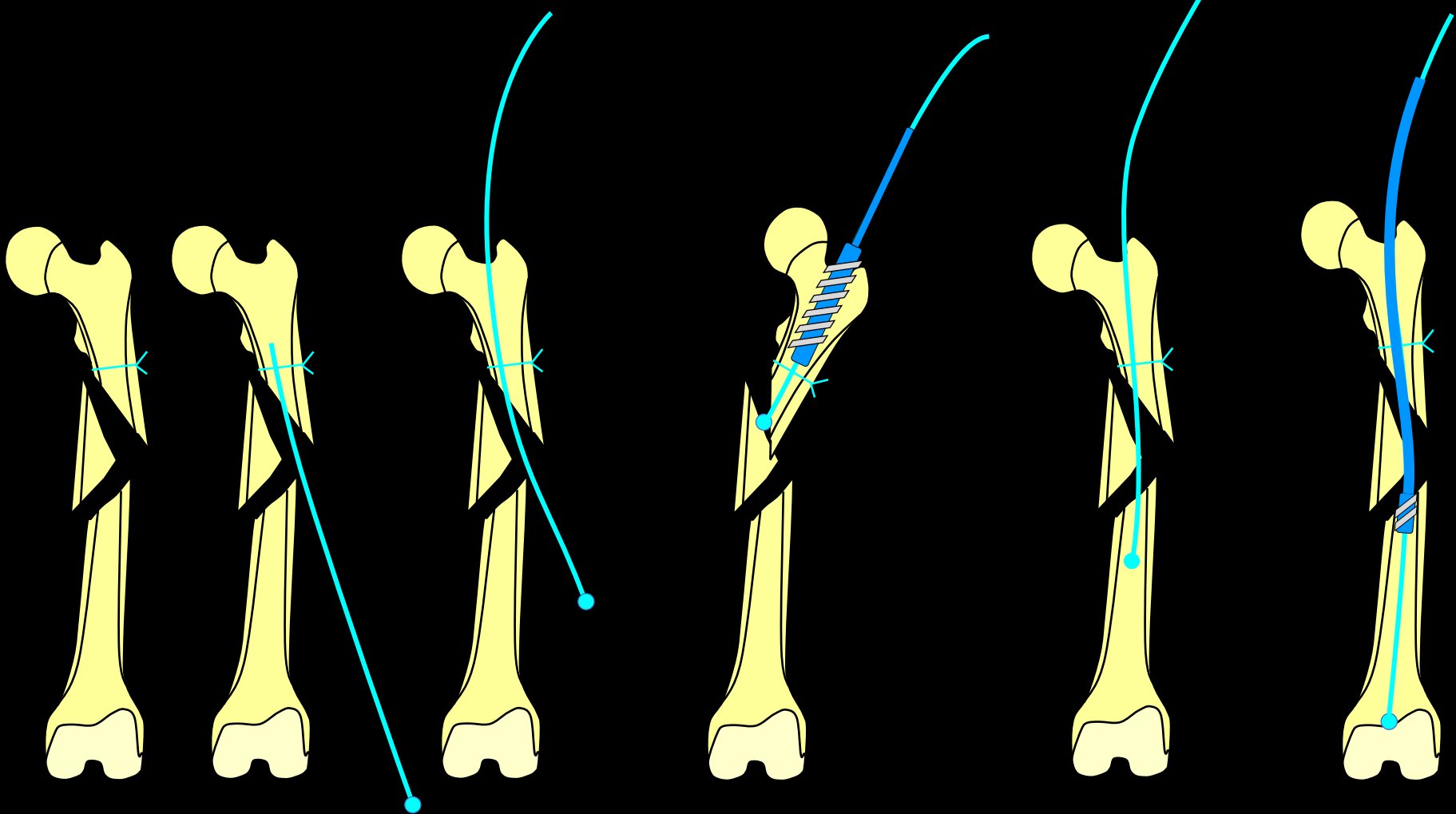
nail

plate

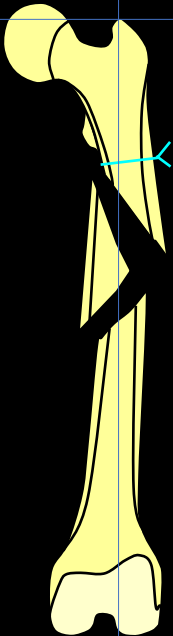
exfix

Summary Management Challenge in Segmental Femur Fractures

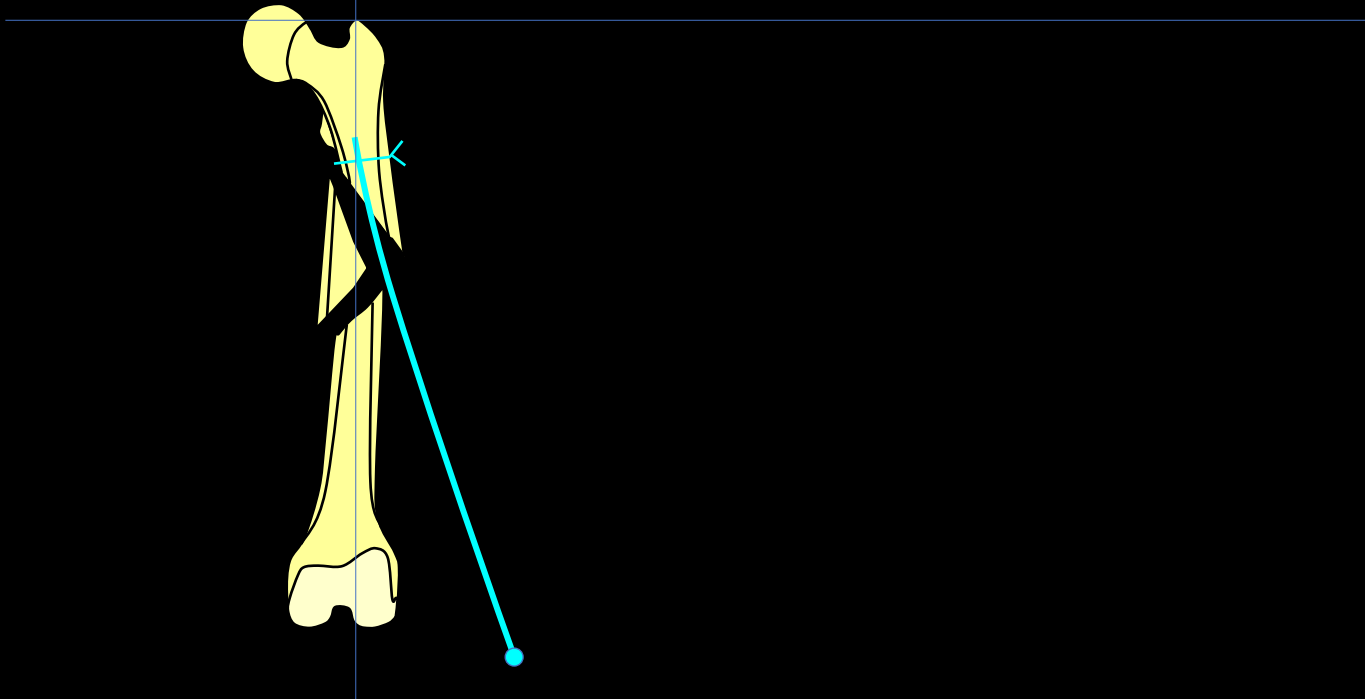
- 1) Decision making DCO or ETC? isolated injury, polytrauma, head injury, chest injury
- 2) Implant choice nail – plate – exfix
- 3) OR Table Fx table vs simple radiolucent table
- 4) Positioning Supine vs lateral decubitus
- 5) Insertion site antegrade-retrograde
- 6) Canal preparation reamed vs unreamed?
- 7) Reaming technique – avoid rotation of the mid segment (AO32C2)
- 8) Alignment
- 9) Open fx – vascular injuries – infection
small open wound challenge ...
- 10) Bone defects



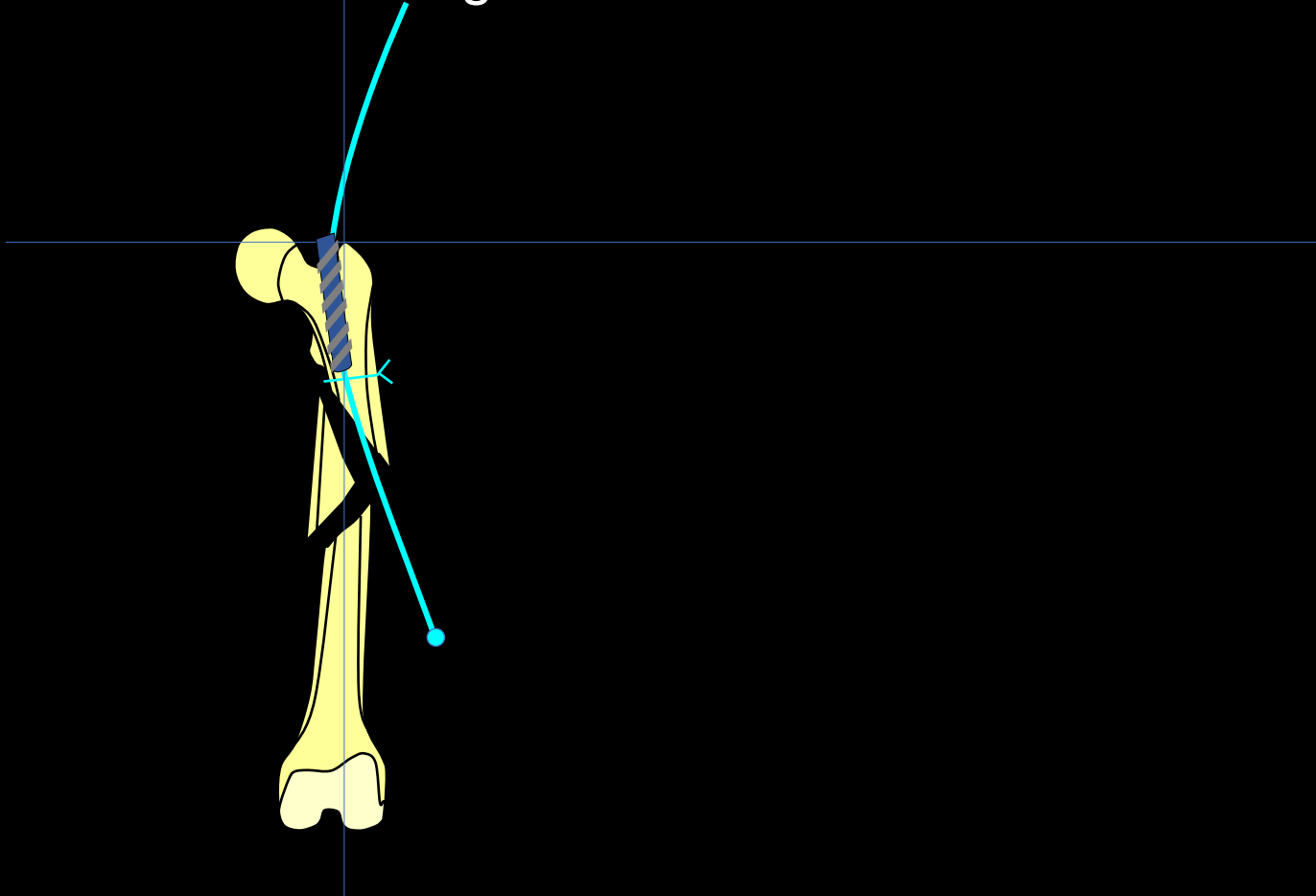
Technique #4 retrograde guide wiring + antegrade nailing



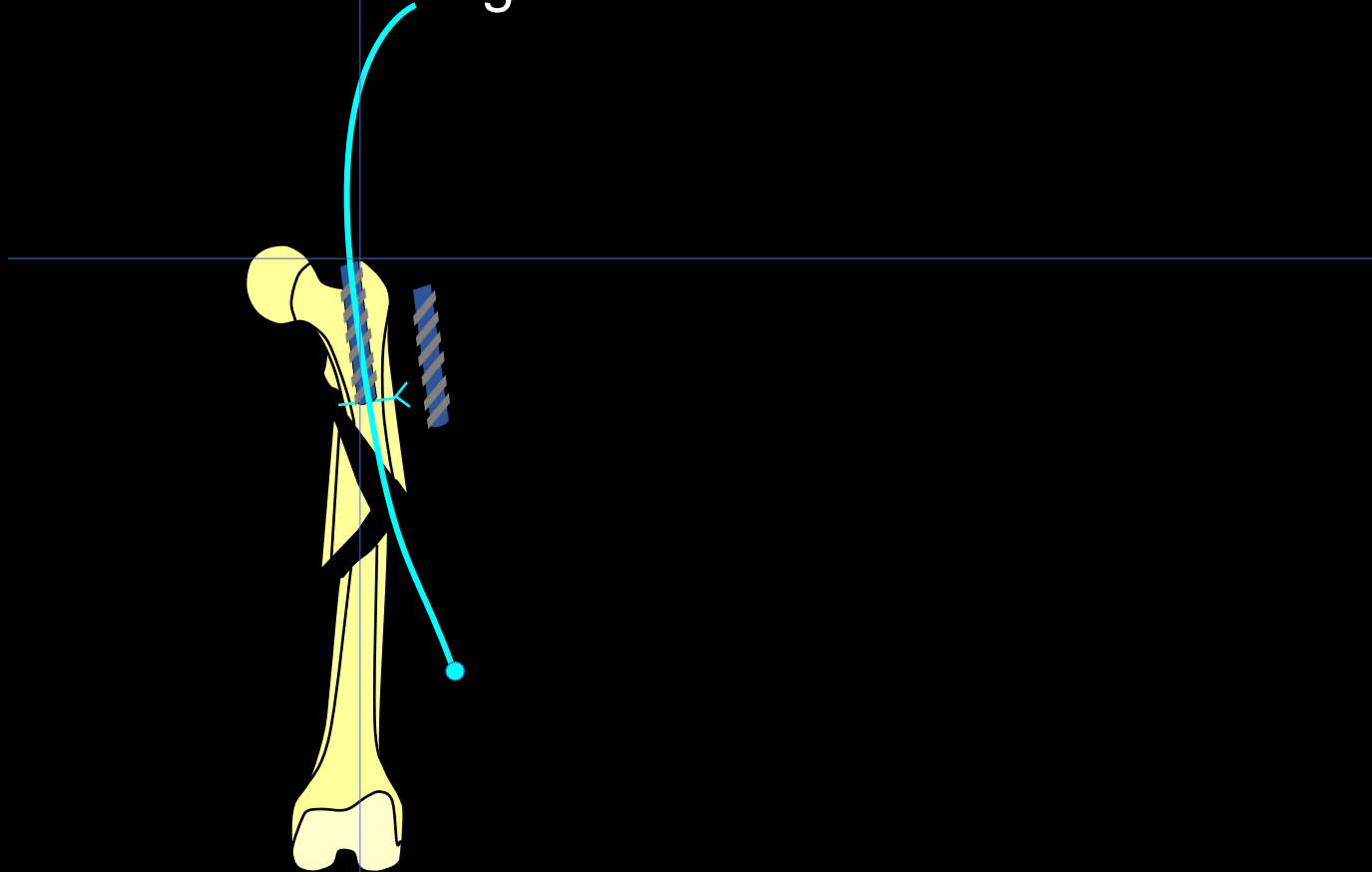
Technique #4 retrograde guide wiring + antegrade nailing



Technique #4 retrograde guide wiring + antegrade nailing



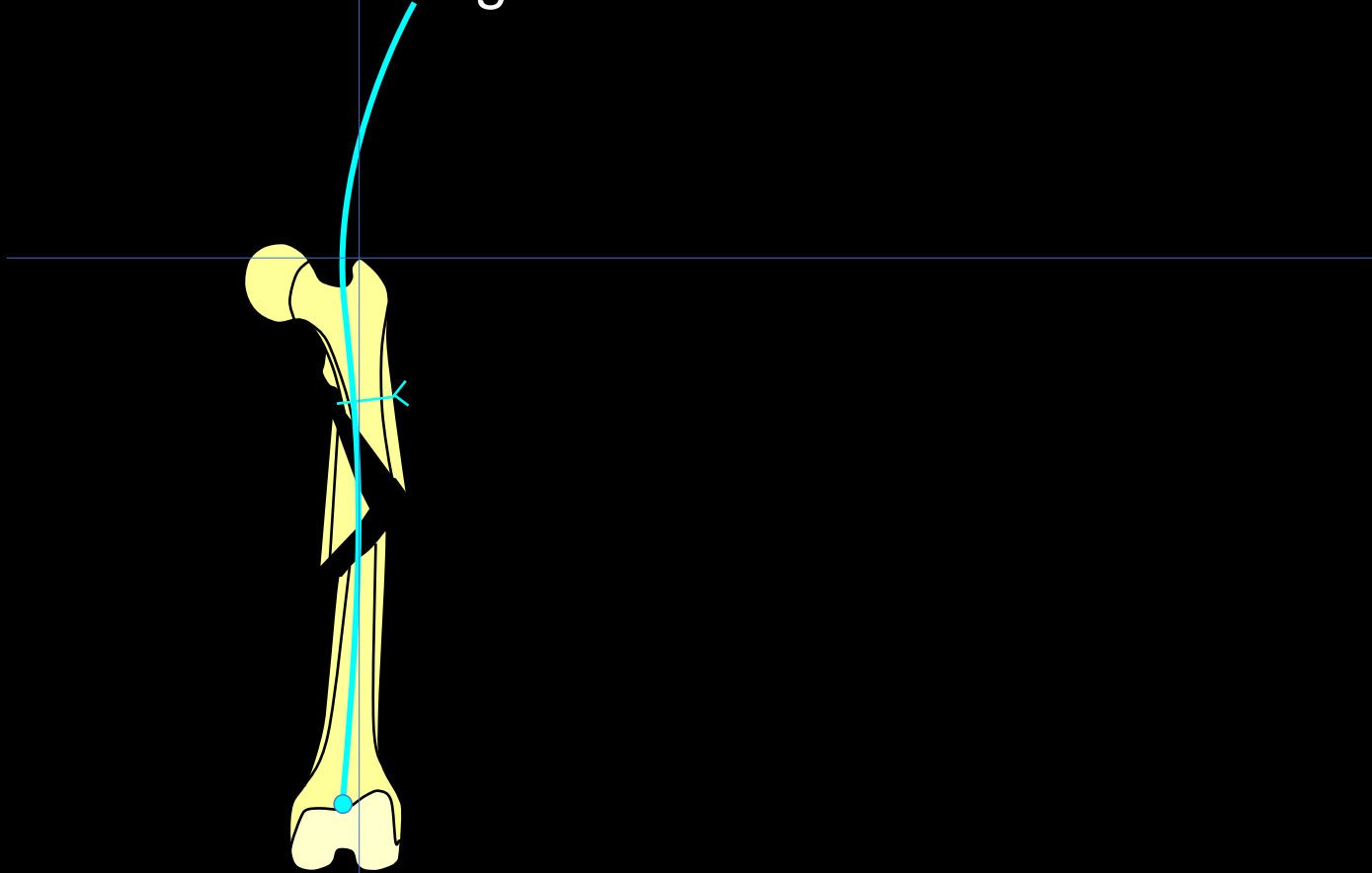
Technique #4 retrograde guide wiring + antegrade nailing



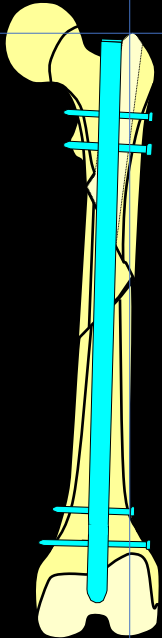
Technique #4 retrograde guide wiring + antegrade nailing

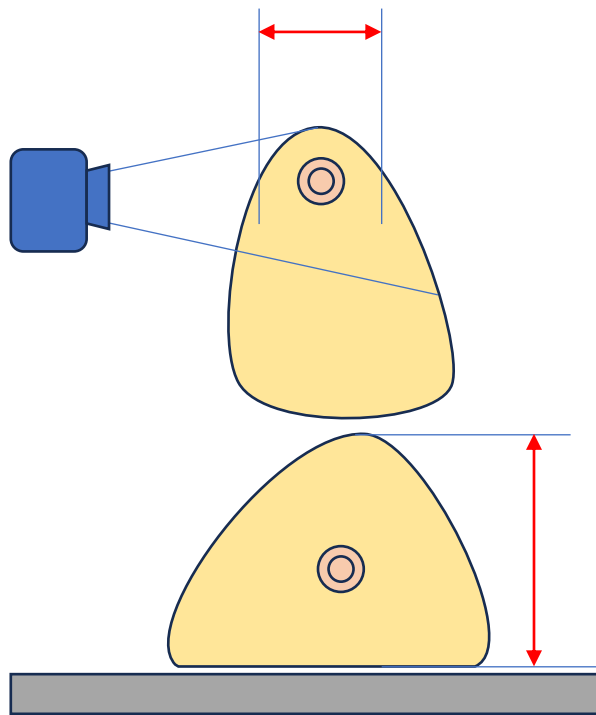
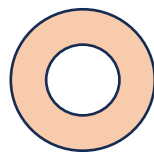
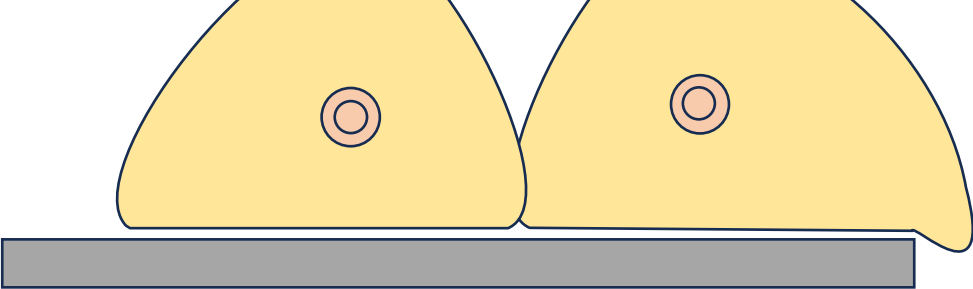


Technique #4 retrograde guide wiring + antegrade nailing



Technique #4 retrograde guide wiring + antegrade nailing

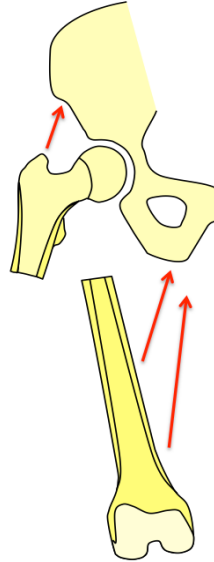




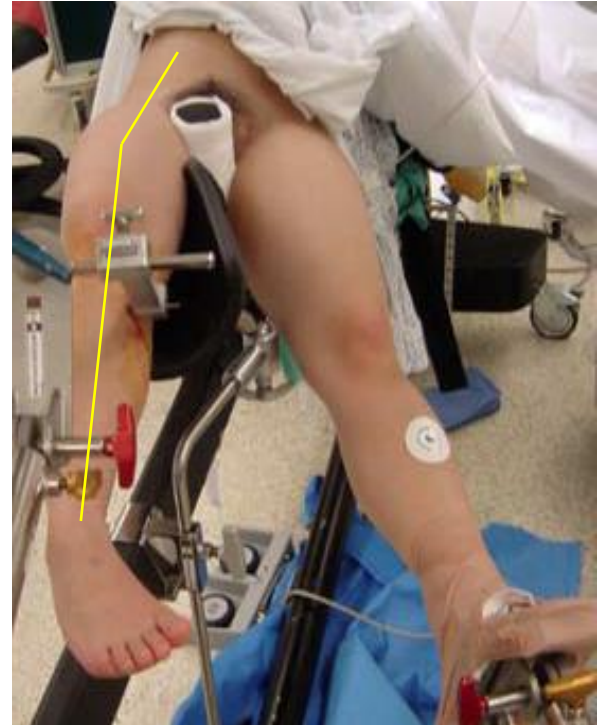
Role of IT band in femoral nailing

Problem chain

Access to proximal femur easy in ad-duction
ad-duction tightens ilio-tibial tract
tightened ilio-tibial tract shortens fx
shortened fx makes reduction difficult
shortened fx requires higher reduction
forces
shortened fx leads to more reduction time



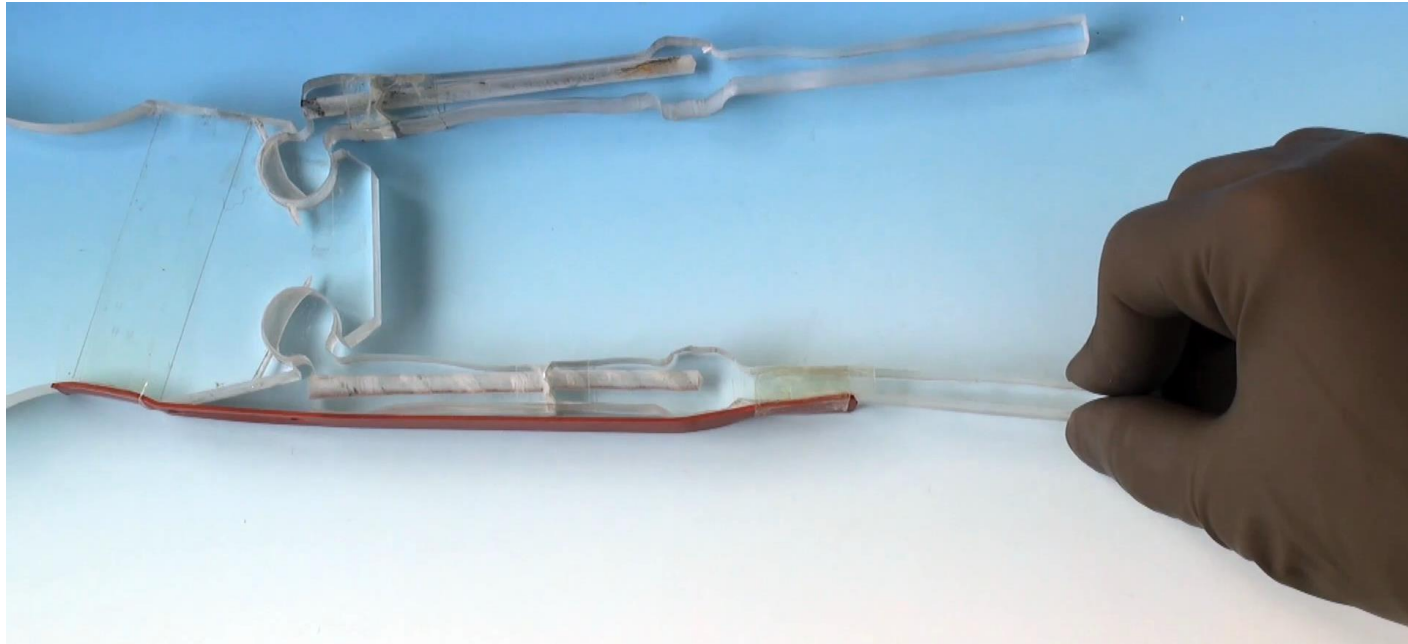
... brute or smart force ?



Role of IT band in femoral nailing

conflict

easy access to starting point in **ad-duction**, but ilio-tibial tract tightens
ilio-tibial tract soft in **ab-duction**, but access difficult



Technique #2 Role of IT band in femoral nailing

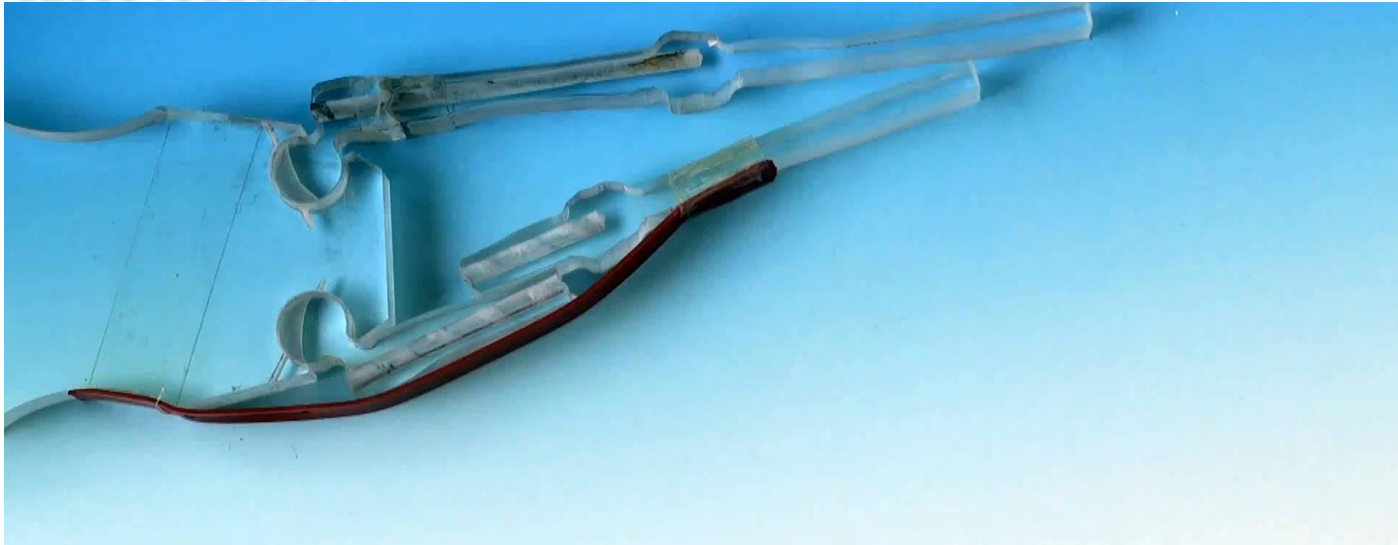
Solution split the steps

starting point, nail insertion in **ad-duction**

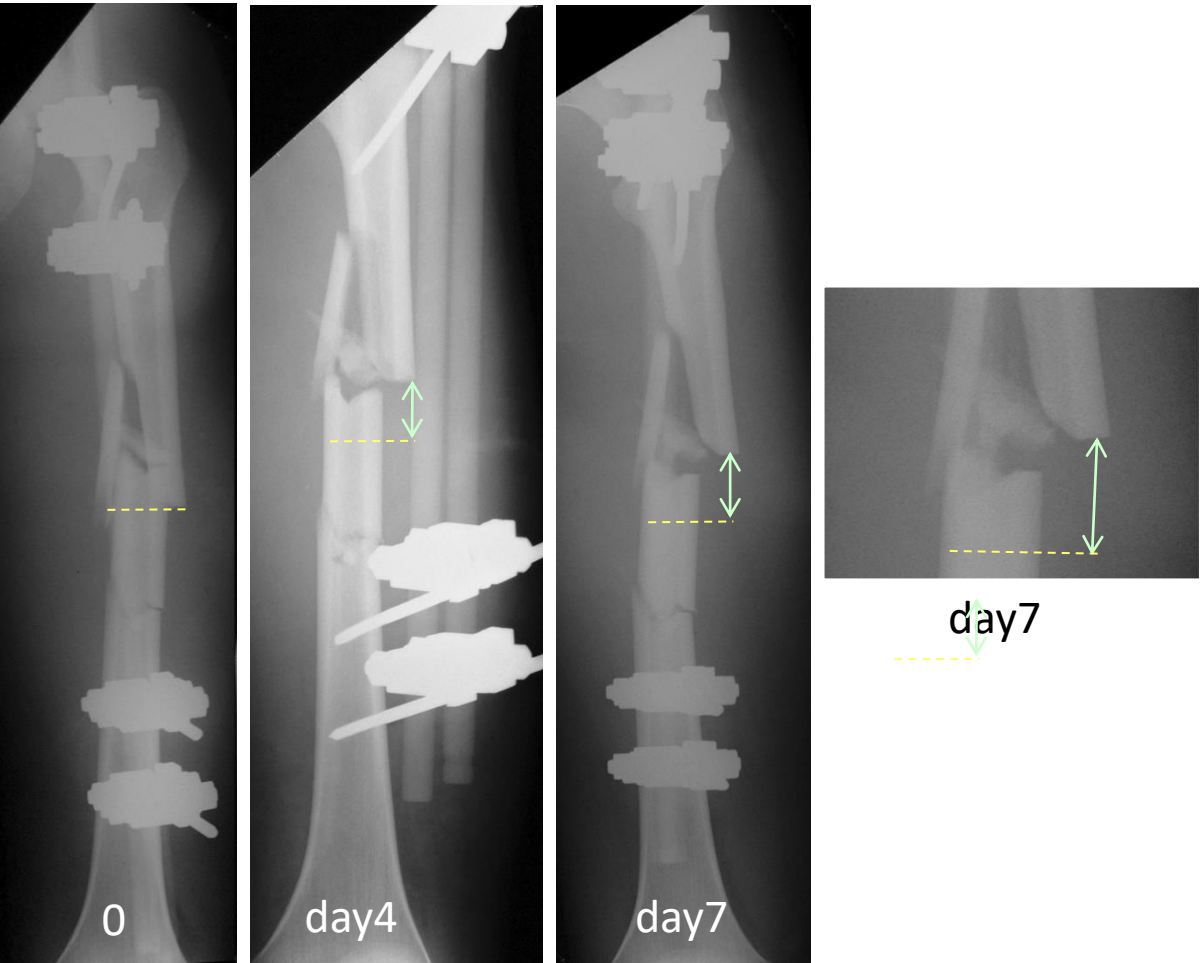
then proximal fragment **neutral**

distal fragment in **ab-duction** (relaxes iliotibial tract)

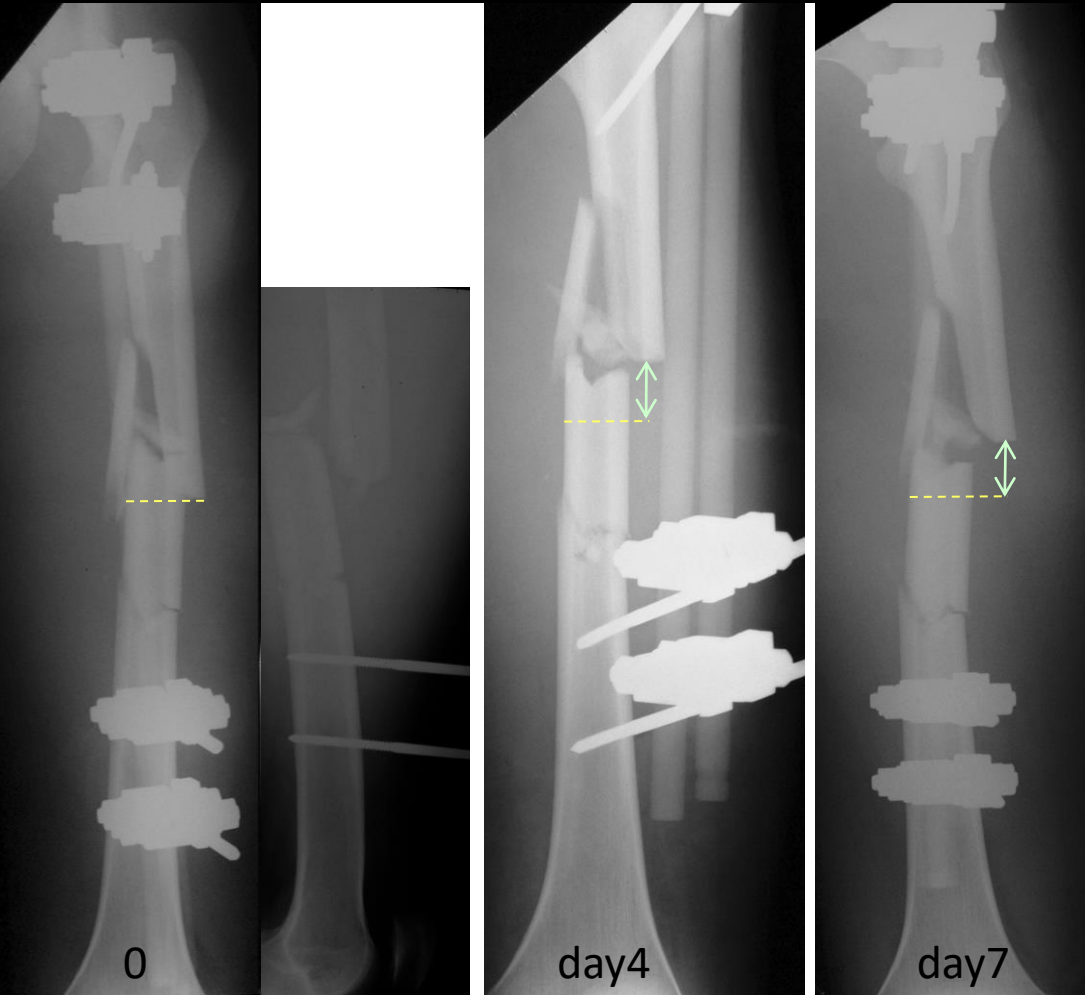
eases **reduction**



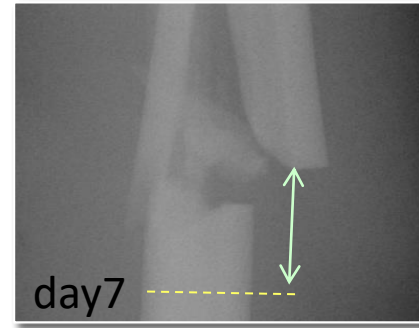
Management Challenge #5 post DCO shortening



Technique #5 Overdistraction of the Fracture Eases Reduction in Delayed Femoral Nailing



Staged distraction
without radiographic control
clinical parameters only



Technique #5 Overdistraktion of the Fracture Eases Reduction in Delayed Femoral Nailing

Overdistraktion of the Fracture Eases Reduction in Delayed Femoral Nailing

Results of Intraoperative Force Measurements

Gosling T, Hufner T, Westphal R, Faulstich J, Hankemeier S, Wahl F, Krettek, C

Question: does ExFix + overdistraktion reduce reduction forces & shorten reduction time in IM nailing ?

Methods: experimental study, 7 pts / 8 femur fxs.

Measured amount of shortening/distraktion, distraktion forces (load cell), time for reduction

Results:

Group A

ExFix neutral or shortening

maximal force was 336 N (± 51.9 N)

reduction time 28.3 min (± 21.8 min)

Group B

over- distraktion

200 N (± 43.1 N)

5.8 min (± 4.0 min)

p = 0.017

p = 0.056

Conclusion: Fracture shortening leads to higher restraining forces & prolonged reduction time Overdistraktion should be performed as soon as possible under careful soft-tissue monitoring

Femur Fractures

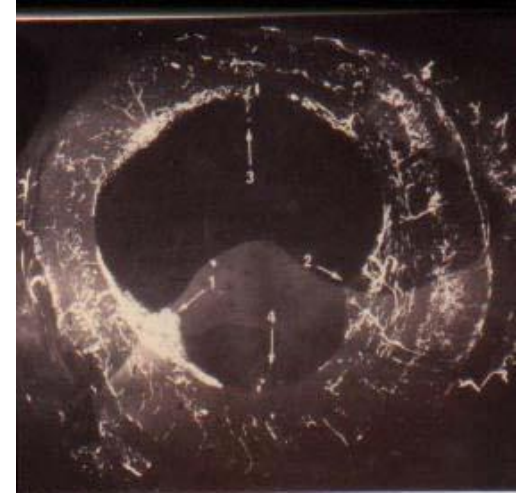
- Common injury due to major violent trauma
- 1 femur fracture/ 10,000 people
- More common in people < 25 yo or >65 yo
- Femur fracture leads to reduced activity for 107 days, the average length of hospital stay is 25 days
- Motor vehicle, motorcycle, auto-pedestrian, aircraft, and gunshot wound accidents are most frequent causes

Anatomy

- Long tubular bone, anterior bow, flair at femoral condyles
- Blood supply
 - Metaphyseal vessels
 - Single nutrient artery in diaphysis enters through the linea aspera
 - Nutrient artery communicates with medullary arteries in intramedullary canal
 - Medullary arteries supply 2/3 of endosteal blood supply

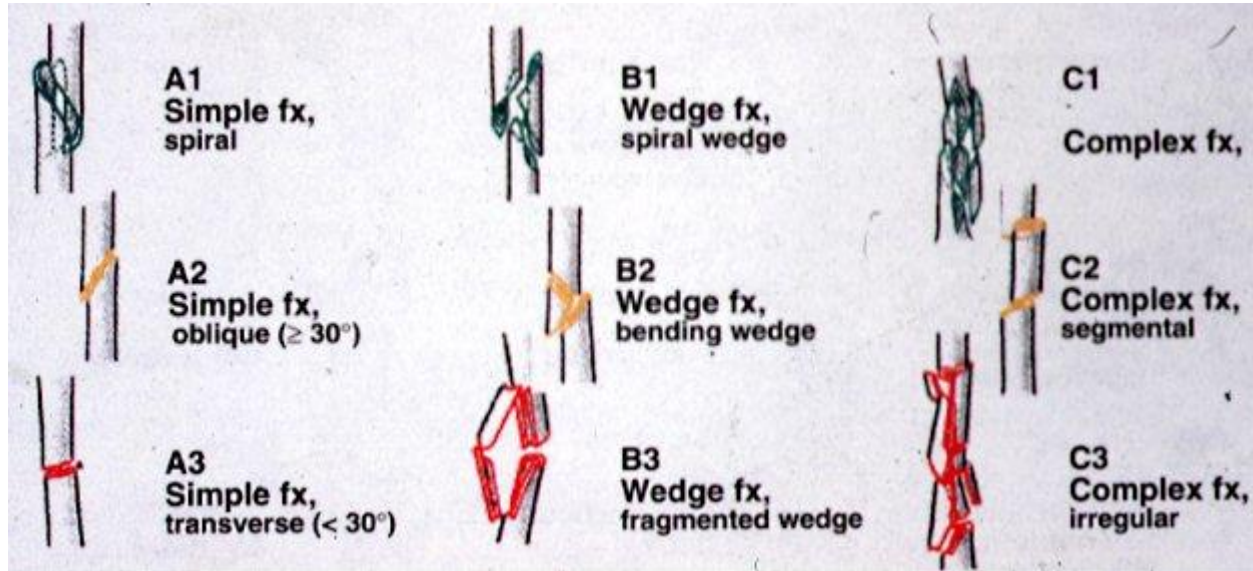
Blood Supply

- Reaming destroys intramedullary endosteal blood supply
- Periosteal blood flow increases
- Medullary blood supply is re-established over 8-12 weeks if spaces left in canal by implant
- Unreamed intramedullary nailing decreases blood flow less; restoration of endosteal blood flow earlier but equal to reamed canal at 12 weeks



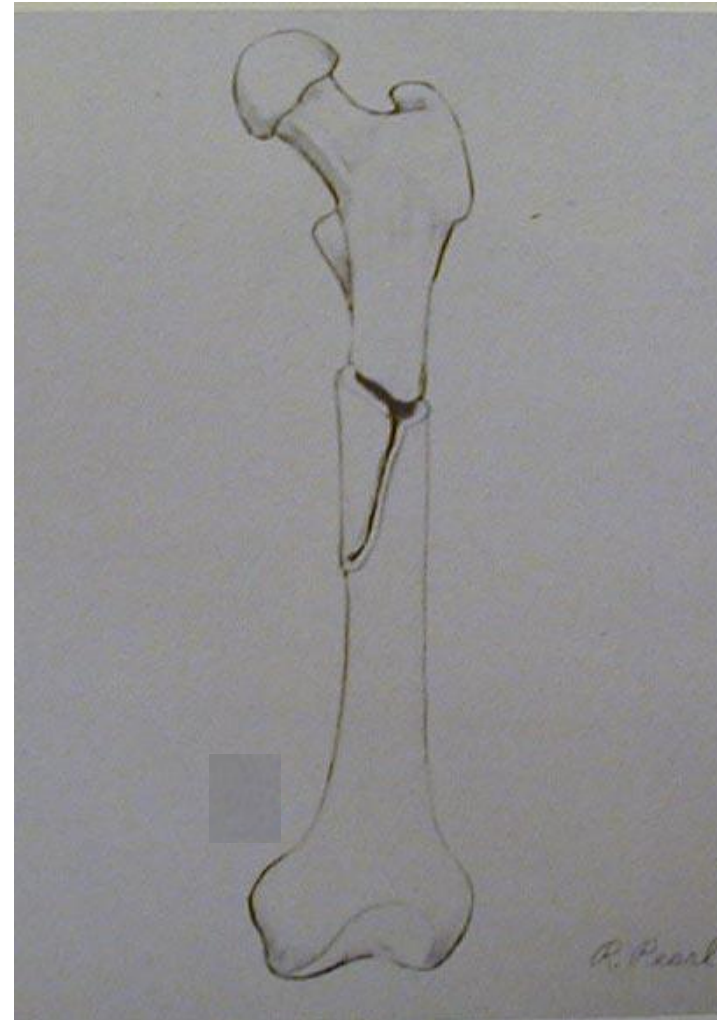
Femur Fracture Classification

AO/OTA Femur Diaphysis - Bone segment 32



Femur Fracture Classification

- Type 0 - No comminution
- Type 1 - Insignificant butterfly fragment with transverse or short oblique fracture
- Type 2 - Large butterfly of less than 50% of the bony width, > 50% of cortex intact
- Type 3 - Larger butterfly leaving less than 50% of the cortex in contact
- Type 4 - Segmental comminution
 - Winkquist and Hansen 66A, 1984



Femur Fracture Management

- Piriformis fossa intact, lesser trochanter intact
- Can you nail this ?
- Should you nail this ?



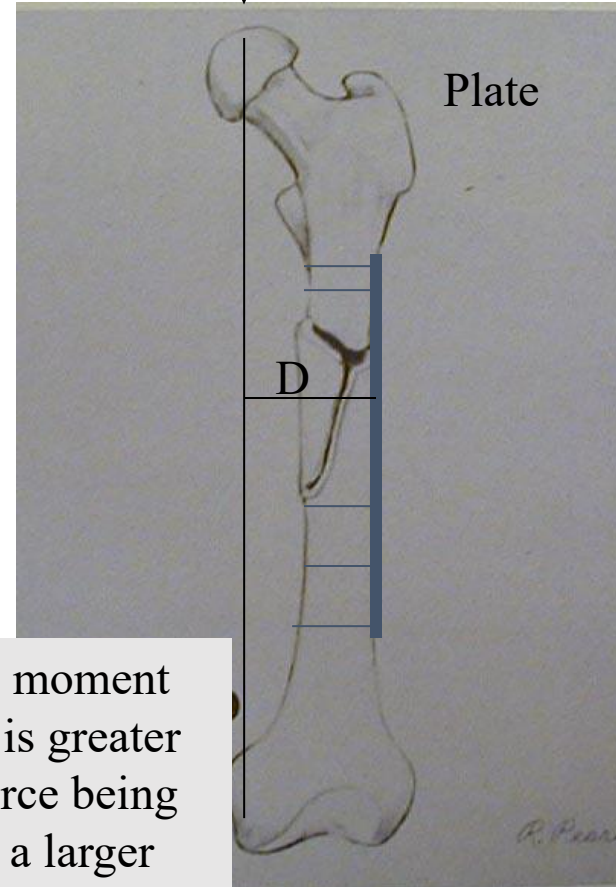
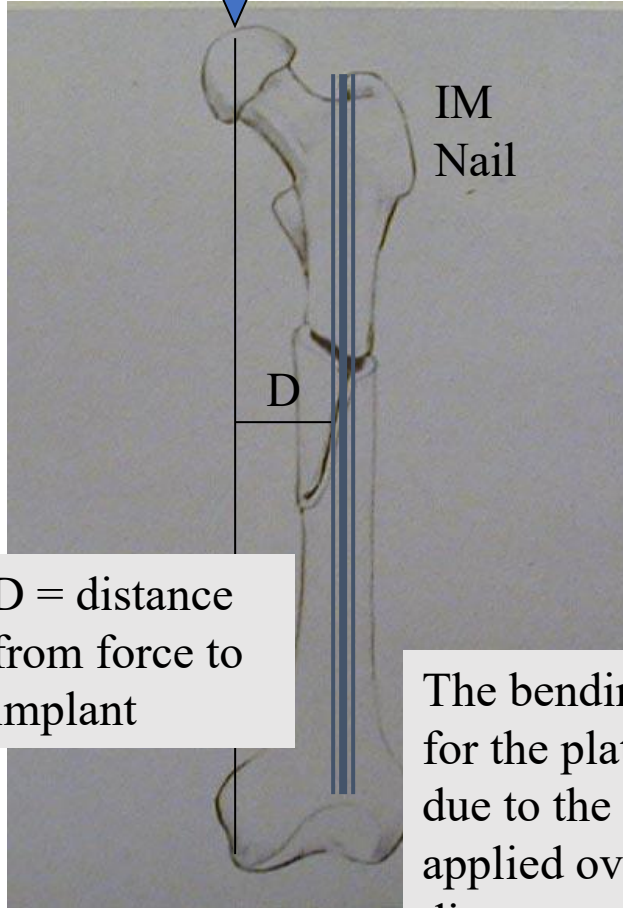
Femur Fracture Management

- Initial traction with portable traction splint or transosseous pin and balanced suspension
- Evaluation of knee to determine pin placement
- Timing of surgery is dependent on:
 - Resuscitation of patient
 - Other injuries - abdomen, chest, brain
 - Isolated femur fracture

F = Force

$$\text{Bending moment} = F \times D$$

F = Force



The bending moment for the plate is greater due to the force being applied over a larger distance

Femur Fracture Management

- Diaphyseal fractures are managed by intramedullary nailing through an antegrade or retrograde insertion site
- Proximal or distal 1/3 fractures **MAY** be managed best with a plate or an intramedullary nail depending on the location and morphology of the fracture

Hare traction splint for initial
reduction of femur fractures prior
to OR or skeletal traction



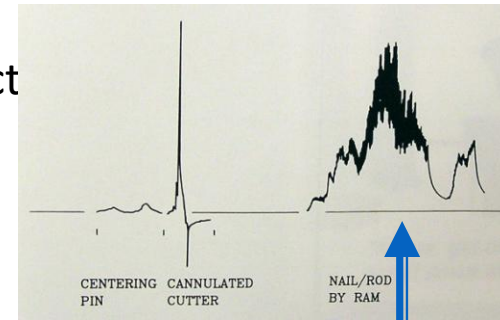
Femoral IM Nailing To Ream ?

Hypothesis:

Femoral reaming increases fatty emboli to the lungs and potentially
increases pulmonary complications

Femur Fracture Reaming

- Reaming advantages:
 - Nail will not get incarcerated
 - Higher union rates
 - More durable fracture/nail construct
 - Earlier weight bearing



- Unreamed nails - still generate fat embolism with opening of piriformis fossa and probably higher pressure with unreamed nail insertion

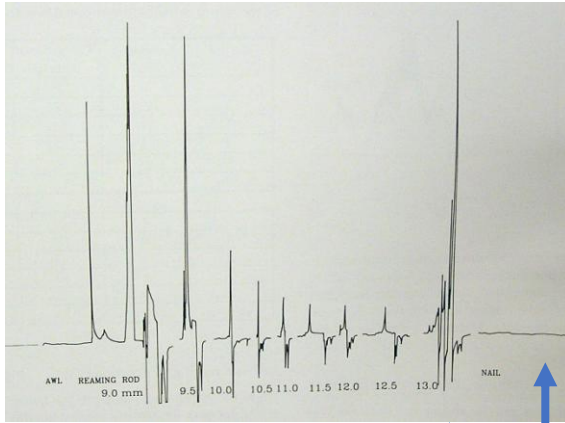
Femur Fracture Reaming

- Reaming of the femoral shaft fracture
 - Multiple studies demonstrate that the thoracic injury is the major determinant of pulmonary complications, **NOT** the use of a reamed IM nail
 - Charash J Trauma 1994
 - Van Os J Trauma 1994
 - Ziran J Trauma 1997
 - Bone Clin Orthop 1998
 - Bosse JBJS 79A 1997

Femur Fracture Reaming

- Reaming of the femoral shaft fracture
 - Only Pape (J Trauma 1993) has shown a deleterious pulmonary effect to immediate reamed intramedullary nailing in acute femur fracture patients with pulmonary trauma
 - In both a retrospective analysis and multiple animal studies (Pape , J Trauma 1992)
 - However, other animal studies refute these results
 - Wolinsky, J Orthop Tr 1998
 - Duwelius, JBJS 79A 1997

Femur Fracture Reaming Pressures



awl

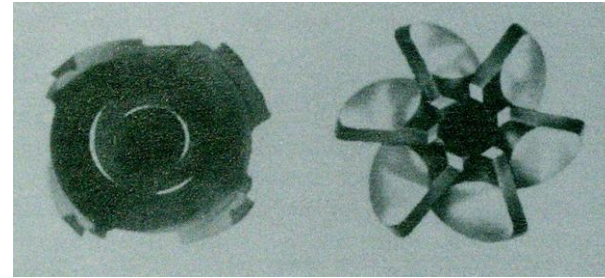
9.5mm first

reamer

9mm reaming guide pin

NO increase pressure with nail insertion

13mm reamer with larger shaft



No difference in pressures
generated by head design

- Muller, Injury 1993

Injury + Patient

POLYTRAUMA

- Early stabilization beneficial
 - Seibel Ann Surg 1985
 - Bone, JBJS 1989
 - Goris , J Trauma 1982
 - Johnson, J Trauma 1985
 - Behrman, J Trauma 1990
 - Bone, J Trauma 1994

Johnson KJ, et al :Incidence of ARDS in patients with multiple musculoskeletal injuries: effect of early operative stabilization of fractures. J Trauma 1985

- 1. Incidence of ARDS increased with increased ISS and delay in fracture stabilization**
- 2. The more severe the injury, the more significant fracture stabilization was in preventing ARDS**
- 3. Pts with ISS > 40 had an increased mortality assoc with a delay in fracture stabilization**

Damage Control Orthopaedics



Select group of critically injured or “borderline” patients may not tolerate extensive procedures or blood loss

External Fixator for Femoral Shaft Fracture

Exchange Nailing in the femur is safe and yields high union and low infection rates

Nowotarski JBJS 2000



Injury + Patient

Practice management guidelines

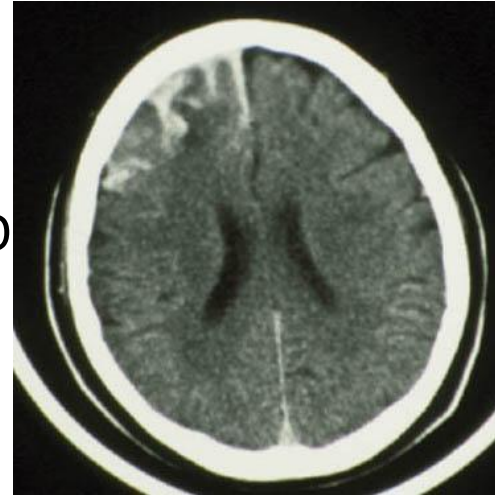
Recommendations-Polytrauma

- Level II-no improvement in survival
 - some patients fewer complications
 - no detrimental effect of early fixation
 - early fixation preferable

Dunham J Trauma 2001

Head Injury + Femur Fx

- Early fixation of long bone fractures does NOT promote secondary brain injury which may increase mortality, BUT hypoxia, hypotension, and increased ICP DO



Poole J Trauma 1992

Schmeling CORR 1995

McKee J Trauma 1997

Velmahos Am J Surg 1998

Scalea J Trauma 1999

Chest Injury + Femur Fx

CHEST INJURY



**Thoracic trauma ITSELF
is the major determinant of
morbidity and mortality,
NOT IM NAILING**

Bone CORR 1995

Bosse JBJS 1997

Timing of femur fracture fixation: effect on outcome in patients with thoracic and head injuries Brundage SI, J Trauma 2002

Data showed that early femur fracture fixation (< 24 hours) is associated with an improved outcome, even in patients with coexistent head and/or chest trauma. Fixation of femur fractures at 2 to 5 days was associated with a significant increase in pulmonary complications, particularly with concomitant head or chest trauma, and length of stay. Chest and head trauma are not contraindications to early fixation with reamed intramedullary nailing.

Femur Fractures Reduces Mortality

- 3069 patients, ISS \geq 15
- serious abdominal injury (AIS >3) had most benefit from resuscitation
- delay > 12 hours DECREASED mortality by 50% in multisystem trauma patients

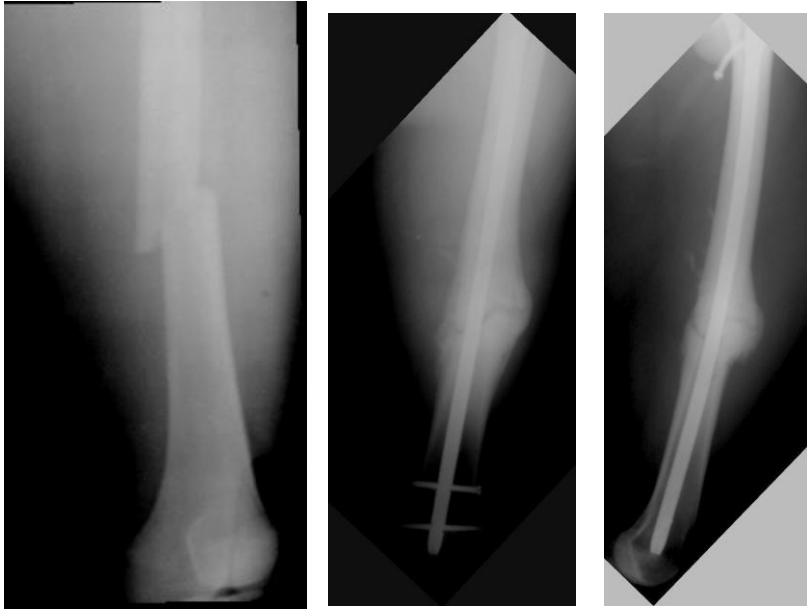
• Morshed, JBJS 2009

Comparison of Reamed vs Unreamed IM Nails

224 patients multiply injured patients

Risk of nonunion was 5x greater in unreamed group

80% of nonunions could have been prevented by reaming



NO increase in
ARDS with
reaming !!

Conclusion:
REAM

Powell and COA,
JOT 2006

Femoral Nailing

Course # 101

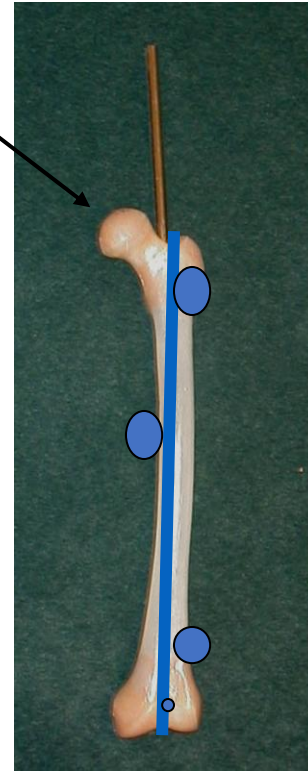
1. Femoral Nail Design
2. Ream vs Unreamed
3. Nails available, treatment options

Technik der Marknagelung, 1945



Straight
nail with 3
point
fixation

First IM nailing
but not locking



Klemm K, Schellman WD:
Verriegelung des marnagels, 1972

Locking IM nails in the 1980's

Kempf I, Grosse A: Closed
Interlocking Intramedullary Nailing.
Its Application to Comminuted
fractures of the femur, 1985

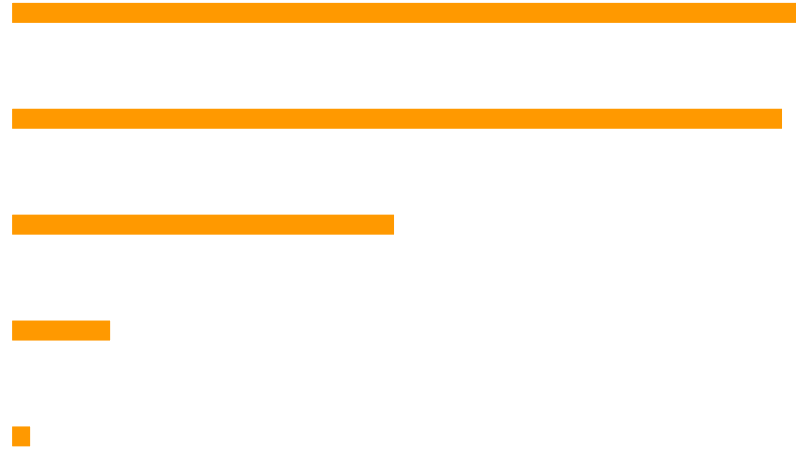


IM Nail Variables

- Stainless steel vs Titanium
- Wall Thickness
- Cannulation
- Slotted vs Non-slotted
- Radius of Curvature
- ? To Ream

Stiffness

Modulus of Elasticity



X 10⁸ PSI

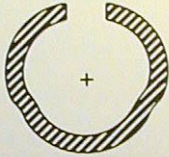
Metallurgy less important than other
parameters for stiffness of IM Nail

Wall Thickness



Large determinant of stiffness

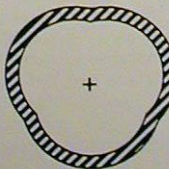
Slotted vs Non-slotted



Anterior slot - improved flexibility

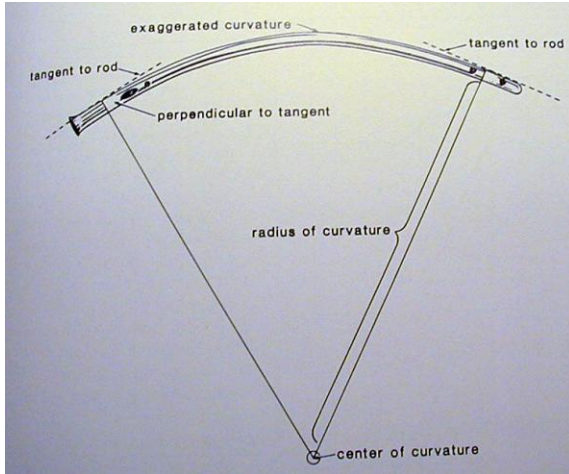


Posterior slot - increased bending strength



Non-slotted - increased torsional stiffness,
increased strength in smaller sizes, ?
comminution

Radius of Curvature of femur averages 120 cm

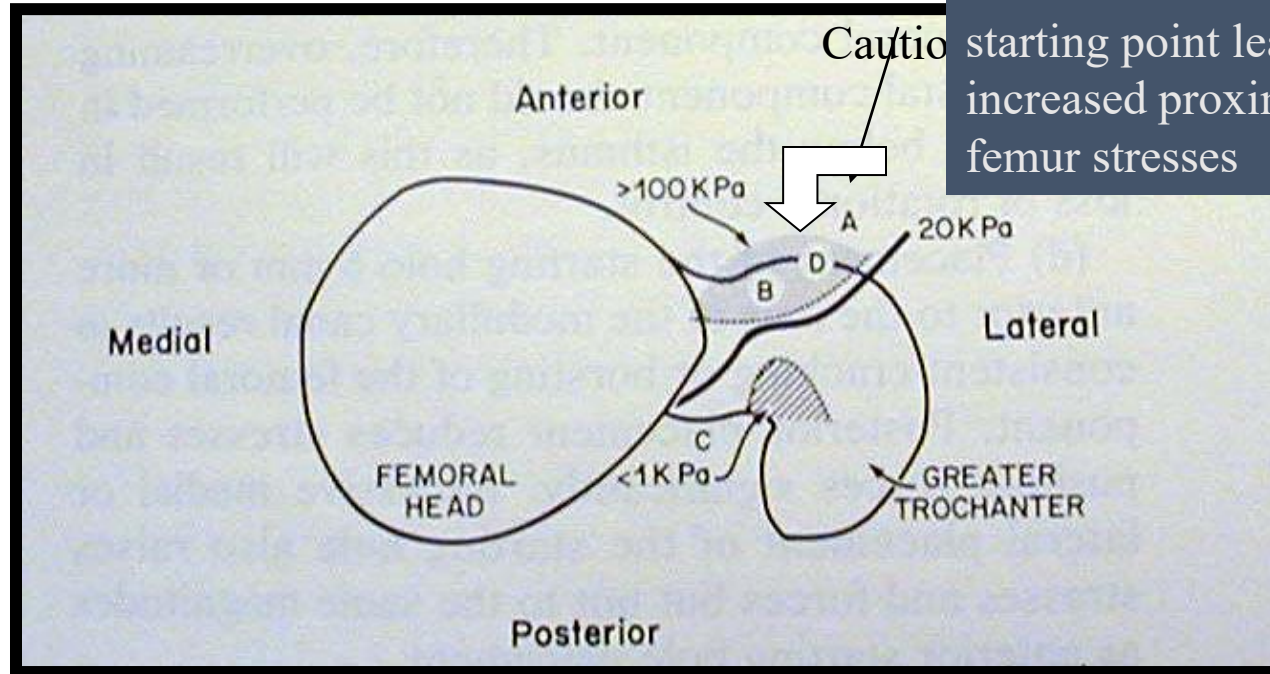


- Current femoral nails radius of curvature ranges from 150-300 cm
- IM nails are straighter (larger radius) than the femoral canal

Femur Fracture Management

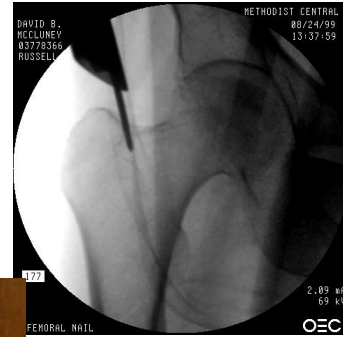
- Antegrade nailing is still the gold standard
 - Highest union rates with reamed nails
 - Extraarticular starting point
 - Refined technique
- Antegrade nailing problems:
 - Varus alignment of proximal fractures
 - Trendelenburg gait
 - Can be difficult with obese or multiply injured patients

Antegrade Femoral Nailing: piriformis fossa starting point

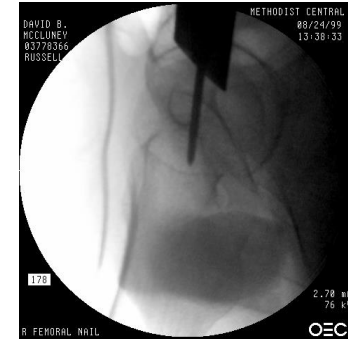


Caution !! Anterior starting point leads to increased proximal femur stresses

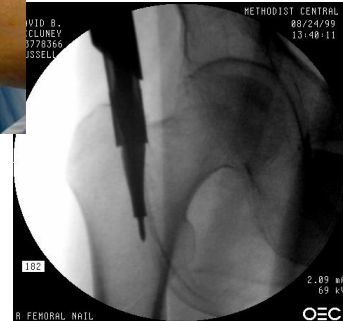
Minimally Invasive Nail Insertion Technique (MINIT)



1



2



3

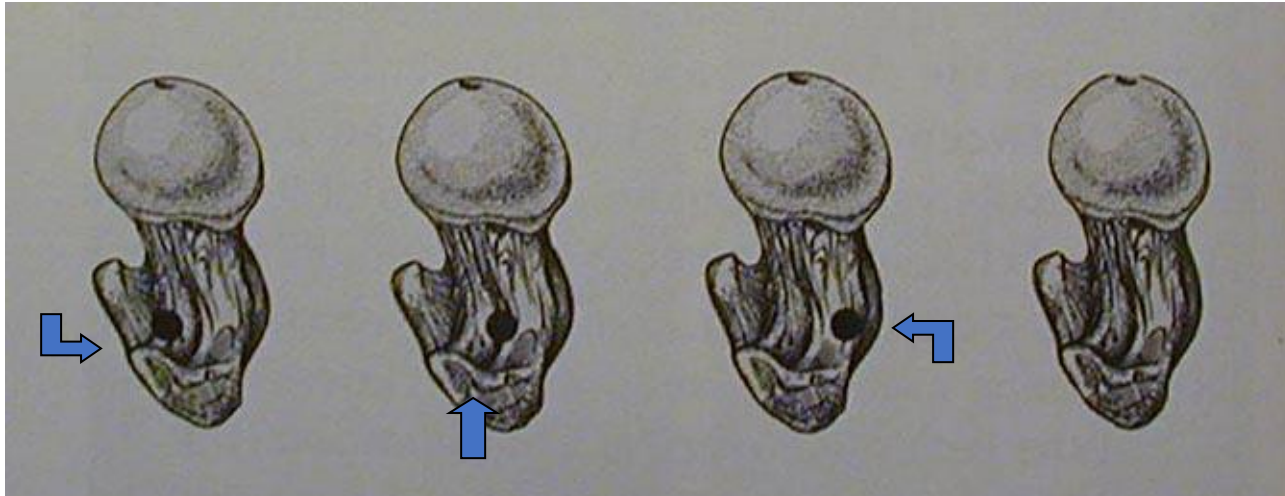


4

Courtesy T.A. Russell, M.D.

Antegrade Femoral Nailing

starting point

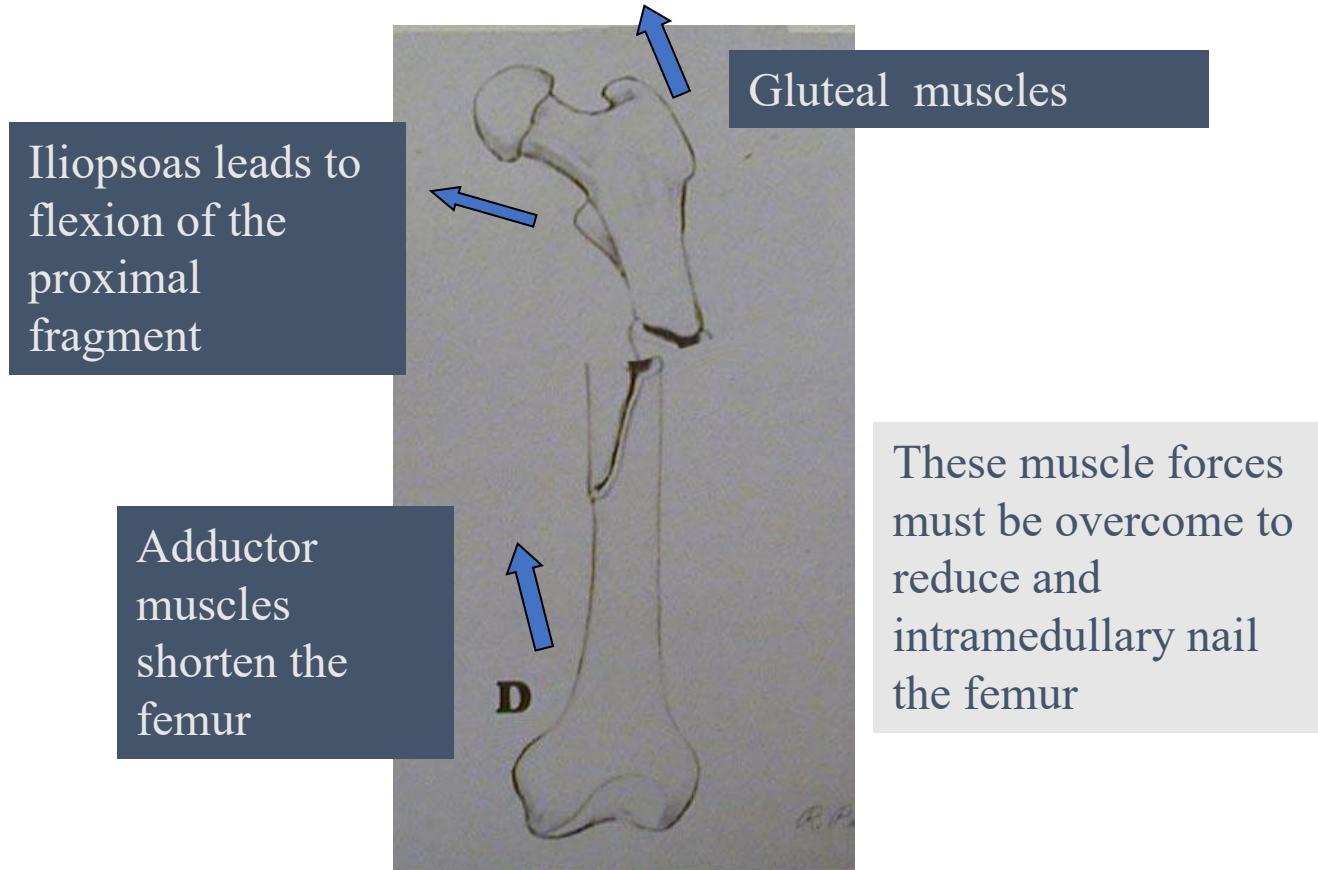


Posterior -
loss of
proximal
fixation

Piriformis
fossa- proper
starting point

Anterior - generates
huge forces, can lead
to bursting of
proximal femur

Femur Fractures



Static Locking of All Femoral IM Nails !!!

- Brumback- 1988
 - 98% union with Statically Locked Rod



Immediate Weight Bearing

- Mythical 70 Kg Man
 - Axial Load to Failure 300%
 - 75% Stiffness in Bending
 - 50% Stiffness in torsion
 - Withstand 500,000 cycle at loads of 3X body
 - 28 Winquist type 4 fractures
 - 27 Healed primarily
 - No Locking Bolt or Rod Fatigue
 - Brumback JBJS 1999



Antegrade Nailing

Fracture Table or Not ?

Supine - better for multiply injured patients, tough starting point

Lateral - easier piriformis fossa starting point, difficult set up, ? rotation

Without a fracture table, length, distal lock first and slap nail



Femur Fracture Management

- Retrograde nailing has advantages
 - Easier in large patients to find starting point
 - Better for combined fracture patterns (ipsilateral femoral neck, tibia, acetabulum)
 - Union approaching antegrade nails when reamed
- Retrograde nailing has its problems:
 - Union rates are slightly lower, more dynamizing with small diameter nails
 - Intra-articular starting point

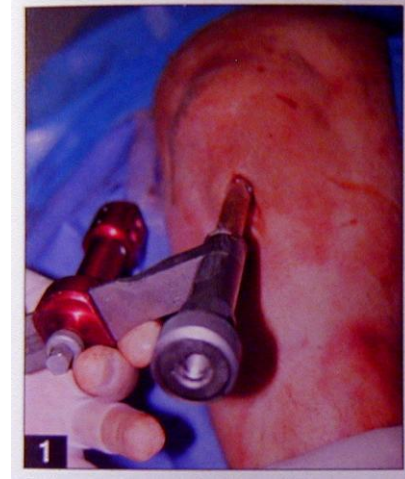
Femur Fracture Technique

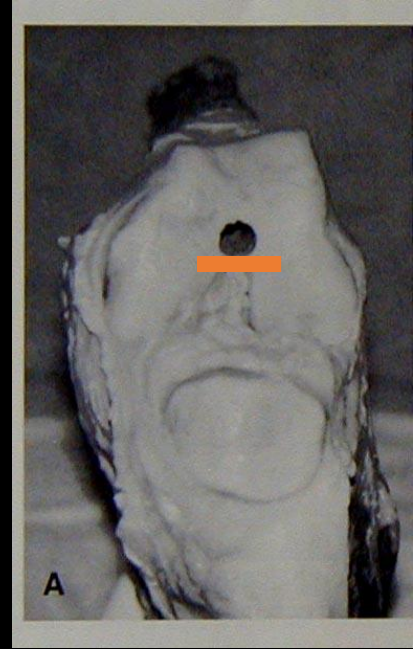
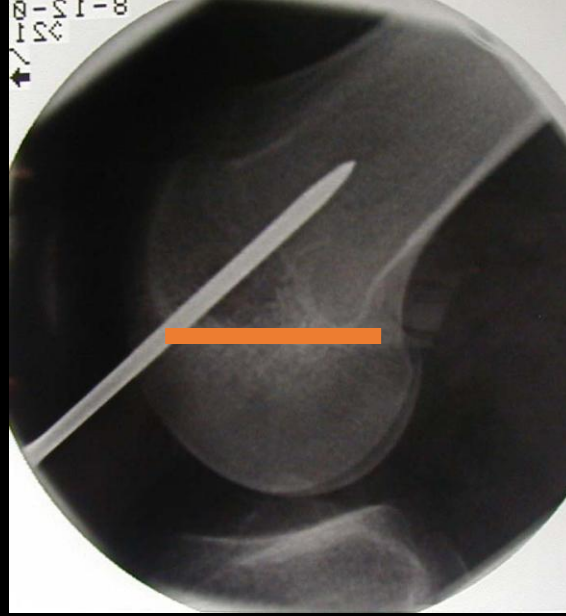
- Retrograde Intramedullary Nailing
 - Supine - flex the knee 50° to allow access to Blumensaat's line



Percutaneous with
fluoro OR

Limited open
technique

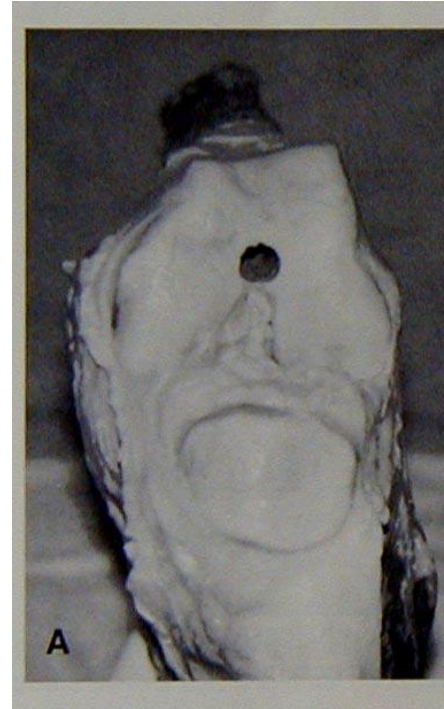
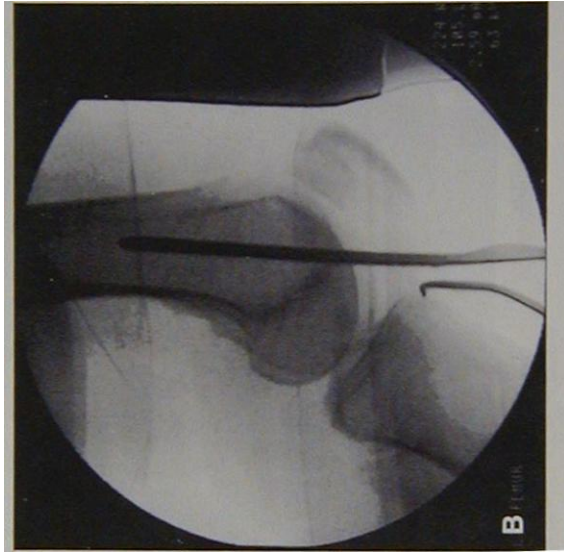




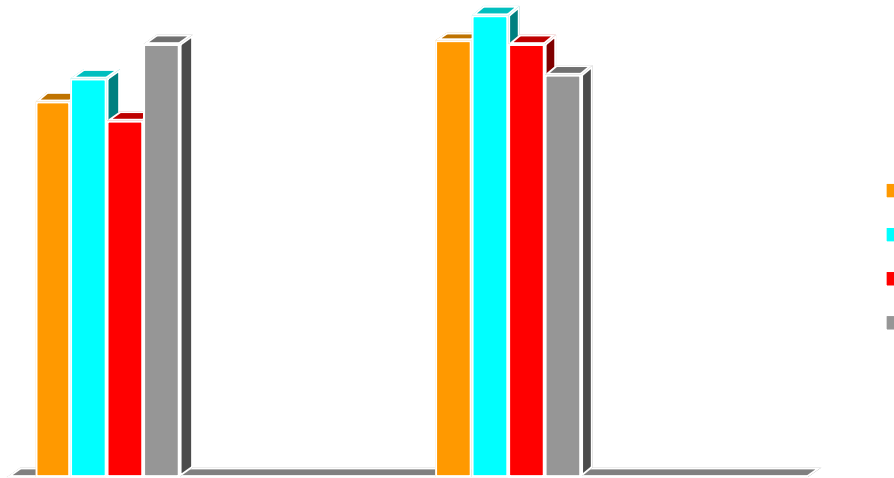
Center guide pin on AP and Lateral
Especially important for distal 1/3 fractures
Above Blumensaat's Line

Retrograde Femoral Nailing

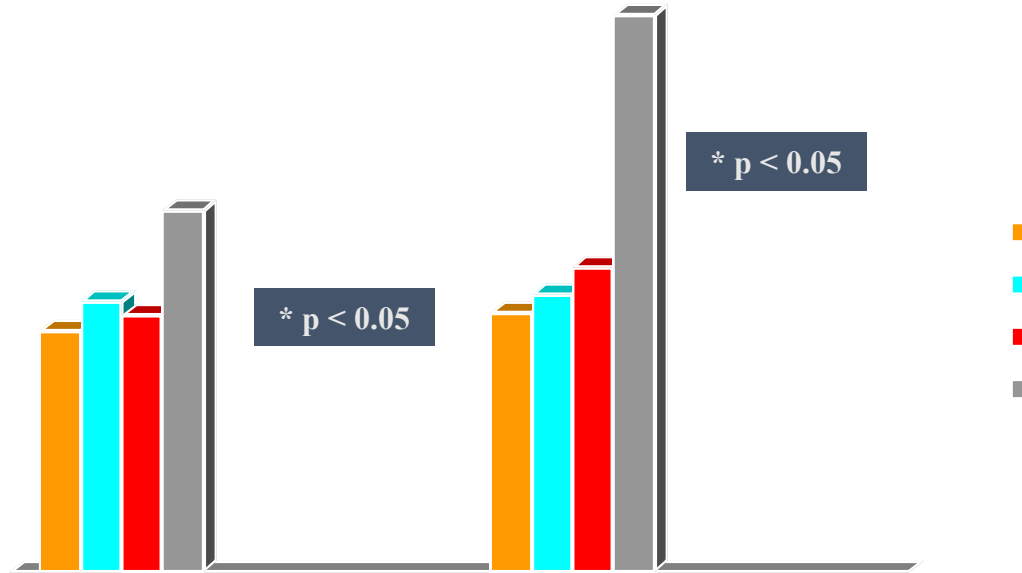
Starting Point



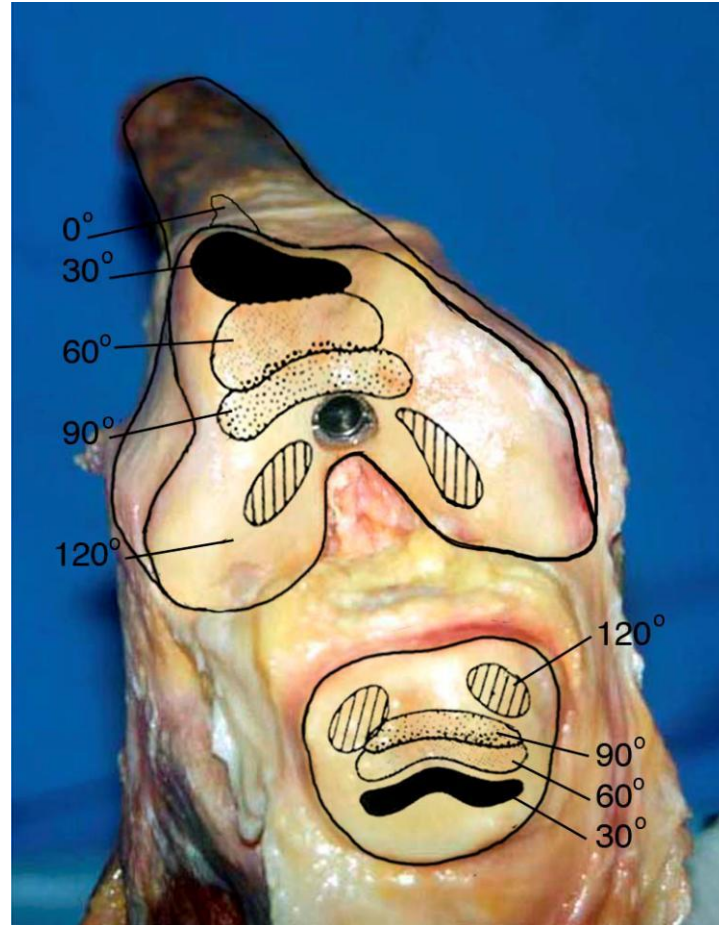
Mean Contact Area



Maximum Pressure



Only with the nail 1 mm prominent were the patellofemoral pressures increased



Retrograde Femoral Nailing

- A cadaveric study using Fuji film demonstrated **NO** deleterious effects on the patello-femoral joint with a properly inserted retrograde IM nail
- The orthopaedic literature does **NOT** support decreased knee motion or increase knee pain with a retrograde nail

1



2



Bilateral femur fractures nailed
retrograde

Less comminuted fracture nailed
first to assess length for segmental
fracture

- 42 yo male C2 femur, Gr 2 open ipsilateral tibia fx



- Immediate post-op with treatment through a limited 4cm knee incision



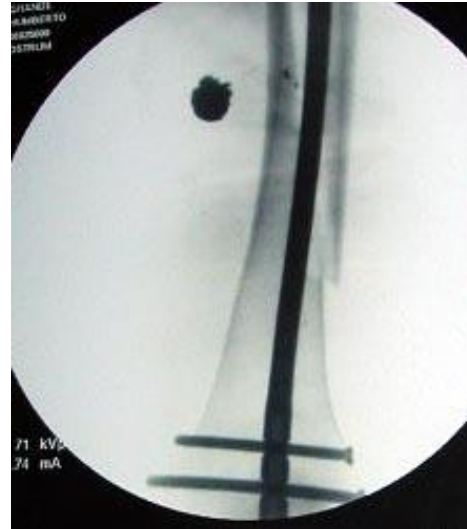
Femur Fracture Management

- Retrograde Nailing
 - Union rates lower with unreamed nails
 - Higher dynamization with non canal sized nails
 - Better union rates equal to antegrade with reamed canal sized nails
 - Moed JBJS 1995, J Orthop Trauma 1998
 - Ostrum J Orthop Trauma 1998, 2000
 - Advantages for ipsilateral acetabulum or femoral neck and shaft fracture, floating knees, obese patients, supracondylar fractures including those around total knee replacements

Retrograde Nailing is Beneficial for Floating Knee Injuries



Shortening after Retrograde Nail Insertion



Backslap after distal locking



Retrograde Nail: Long or Short ?

- 9 human matched cadaver femurs, gap model
- 36 cm vs 20 cm
- Coronal and sagittal testing
- 75 Newtons applied in 3 point bending
- Locked with 1 or 2 proximal screws

Retrograde Nail: Long or Short ?

	<u>20cm</u>	<u>36cm</u>
2 prox,sagittal	7.2*	1.8*
2 prox,coronal	6.3	4.3
1 prox,sagittal	7.6*	2.2*
1 prox,coronal	13.6*	4.4*

Longer nails provide improved stability !!!

* statistically significant at $p < 0.05$

Femur Fracture Technique

- Antegrade Intramedullary Nailing
 - Supine - better for multiply injured patients
 - Lateral - easier piriformis fossa starting point, difficult set up, rotation concerns
 - Without a fracture table
- Retrograde Intramedullary Nailing
 - Supine - flex the knee 50° to allow access to Blumensaat's line

Antegrade v Retrograde Comparisons

Equal union rates

Tornetta, JBJS (B), 2000

Ricci, JOT, 2001

Ostrum, JOT, 2000

- **ANTEGRADE**

- More hip and proximal thigh pain
- Greater incidence of Trendelenburg gait

- **RETROGRADE**

- More symptomatic distal hardware
- Higher dynamization rates with small diameter nails

Obesity

Antegrade v Retrograde

	Obese BMI >30	Non-Obese BMI <30	
Ante OR Time	94	Retrograde nailing is easier in obese patients !!	
Retro OR Time	67		
Ante Fluoro	247	135	P<.03
Retro Fluoro	76	63	nss

Comparison of Knee function after Antegrade and Retrograde IM Nailing with Isokinetic Evaluation

No differences in :

- knee range of motion
- Lysholm Scores
- isokinetic knee evaluation
- time to union
- secondary surgeries (including hardware removal)

- Daglar, JOT 2009

Antegrade Femoral Nailing: Piriformis vs Trochanteric

- Reduction and starting point are still the keys !!
- Problems arise with subtrochanteric fractures
- Inappropriate starting point leads to malreduction

Piriformis Nail: Poor Technique



Piriformis Nail:

Poor T



Illustration 80.
Place of the incision in re-
lation to the tip of the
trochanter.

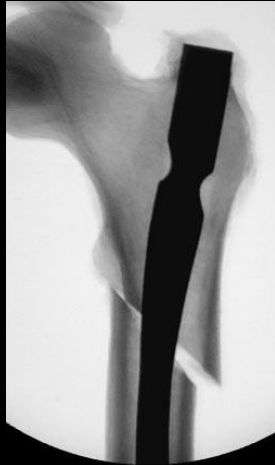




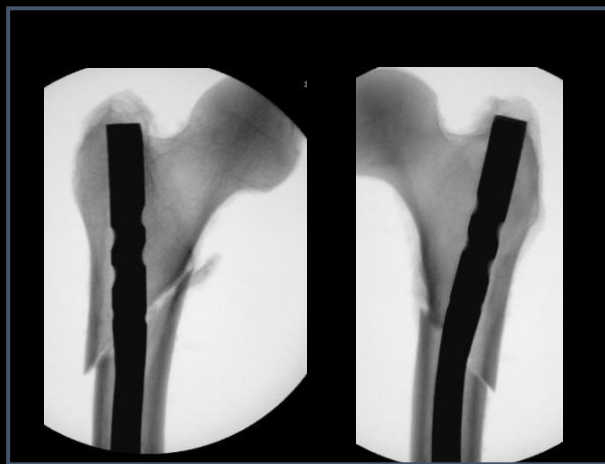
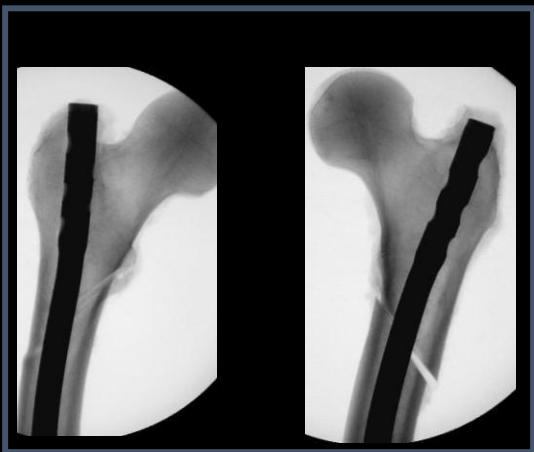
**Tip of
Trochanter**



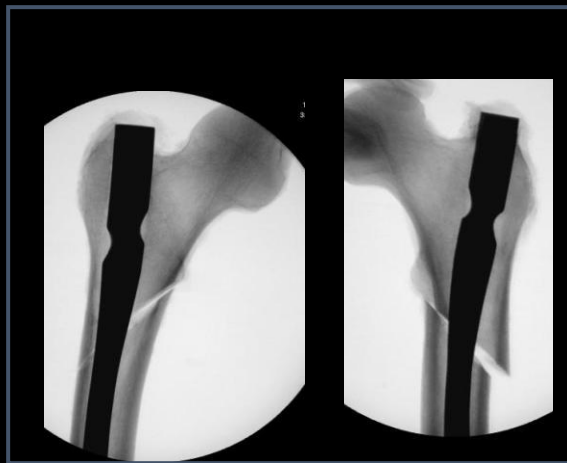
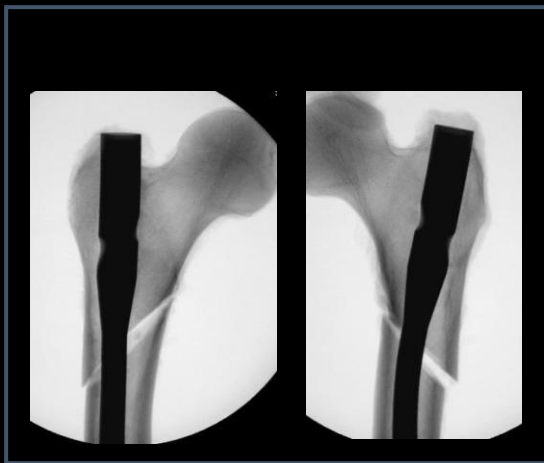
2-3 mm
medial to tip



2-3 mm
lateral to tip



Femur # 9

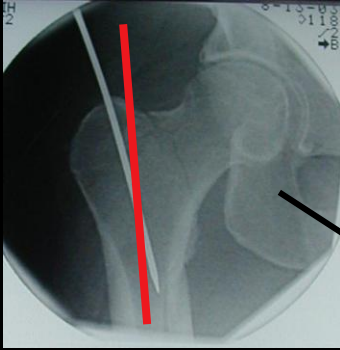


Recommendations

The tip of the trochanter or slightly medial is the entry site of choice for antegrade trochanteric nailing of subtrochanteric fractures

The lateral starting point, even 2-3 mms from the tip of the trochanter, is to be avoided

Ostrum R, JOT 2005

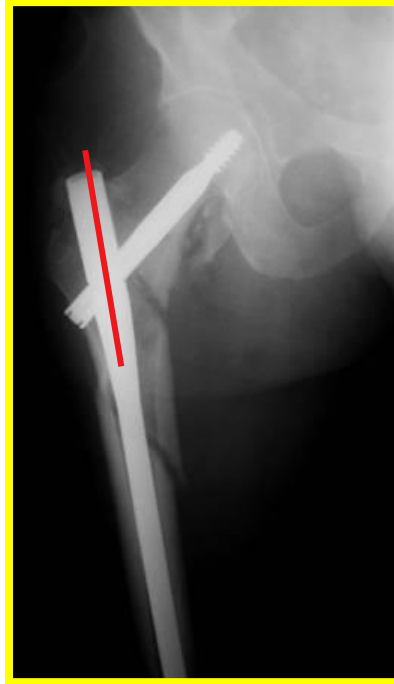


Lateral to tip of GT is OK
for shaft fractures

Medial to the tip of the
GT for subtrochanteric
fractures

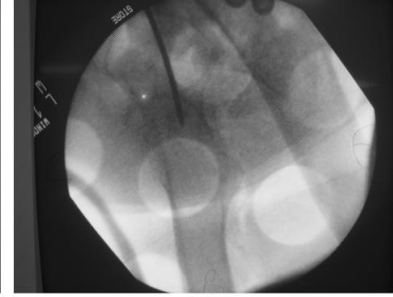


Reduction with **medial** tip starting point



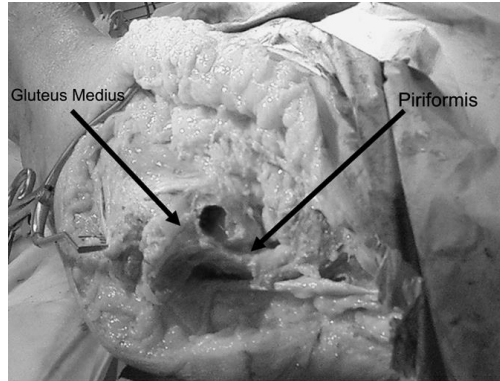


AP

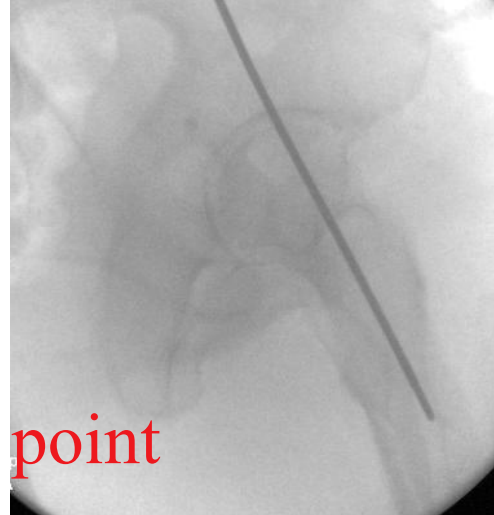
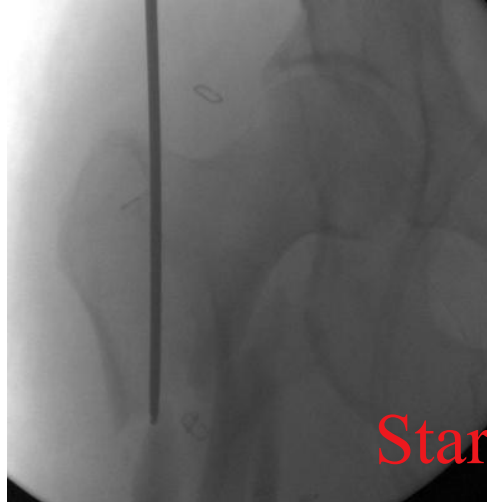


Lateral

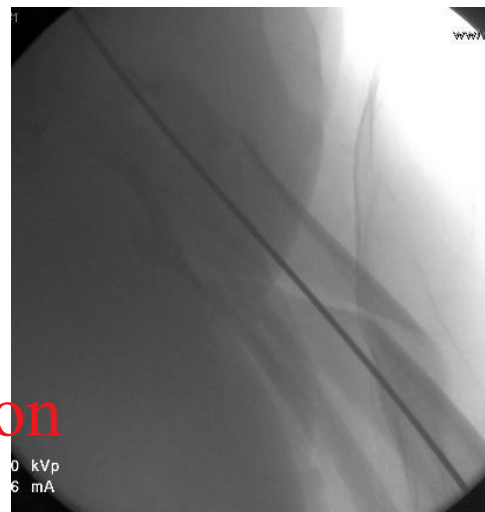
Medial Trochanteric Portal



Perez E, Russell TA. JOT 2007



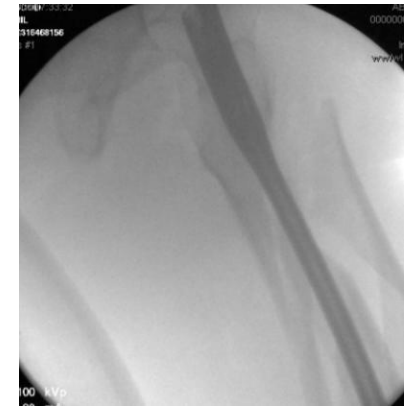
Starting point

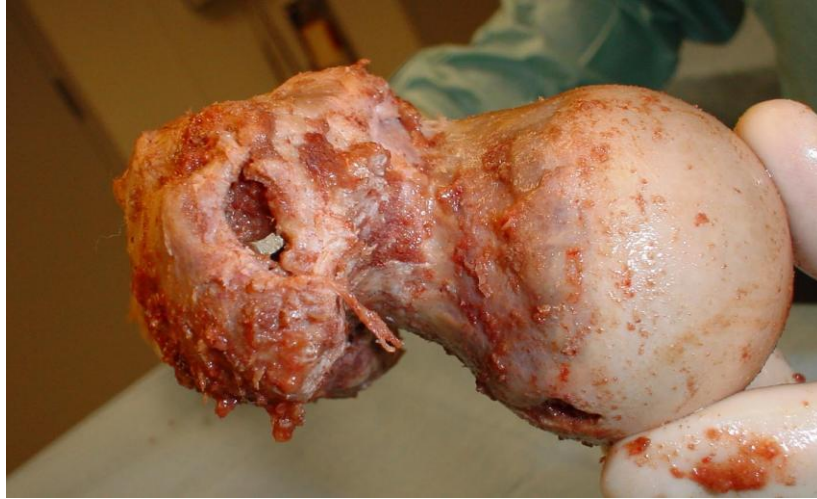


Reduction



- Assessing rotation in the lateral position
- Without changing rotation of the C-arm
- A true AP of the hip and knee





- 17 mm entry hole in trochanter
- 15-50% disruption of gluteus medius tendon
- ? Functional sequelae

- McConnell T, Clin Orthop 2003

A prospective, randomized comparison of trochanteric vs piriformis fossa entry portal for high energy proximal femur fractures

- NO difference in : Hip Scores, RTW, Ambulation, Hip/Knee ROM
- Varus ≥ 5 degrees
 - Recon = 2
 - Gamma = 4
- BMI significantly linked to duration of OR and length of incision, NOT EBL

Femur Fracture

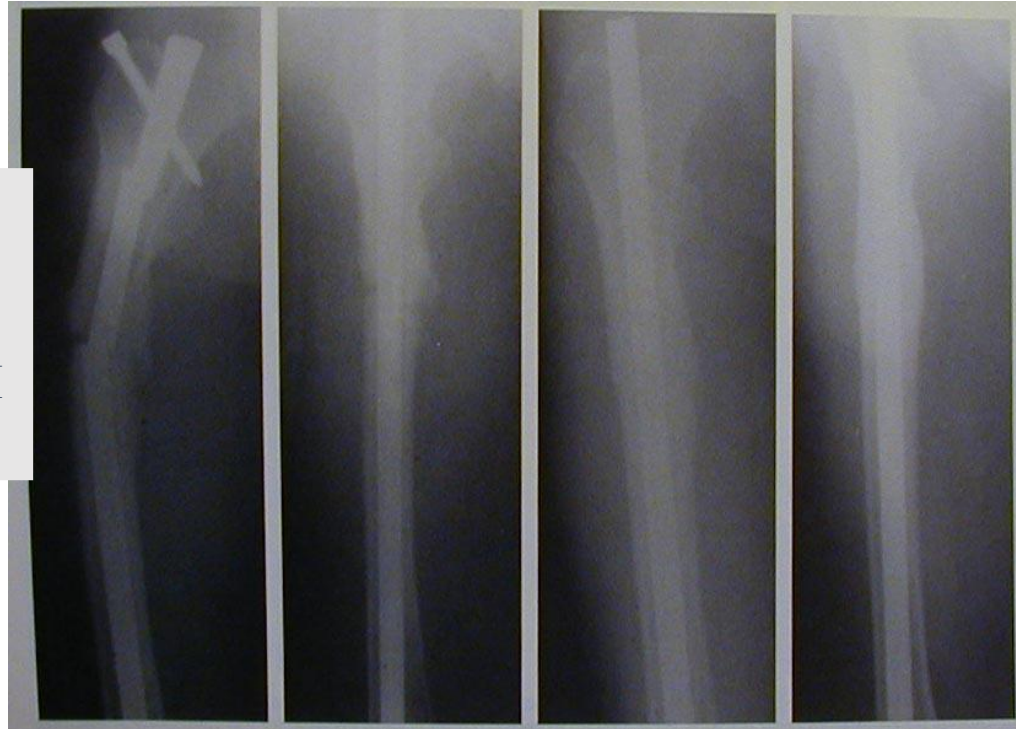
Complications

- Hardware failure
- Nonunion - less than 1-2%
- Malunion - shortening, malrotation, angulation
- Infection
- Neurologic, vascular injury
- Heterotopic ossification

Femur Fracture

Nonunion

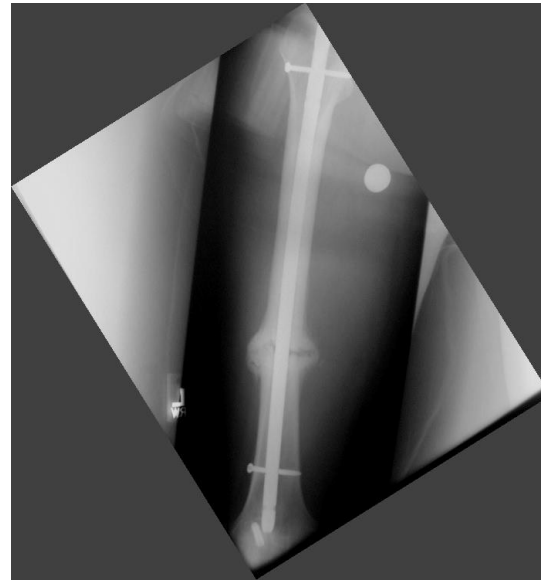
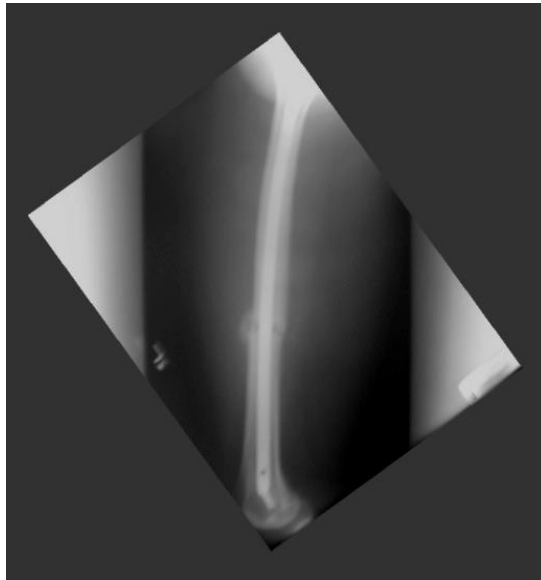
Femoral
nonunion
with
broken IM
Nail



on after
change,
amed
1 nail

Hypertrophic Nonunion

- Problem with smaller diameter nails
- Don't Dynamize → EXCHANGE !!
- Has a blood supply, WANTS MORE STABILITY



Plating of femoral nonunions after IM Nail

- 23 pts, nonunion of femur after IM nail
- nail removal, PLATING, soft tissue preservation
- 21/23 healed, avg 12 weeks
- avg OR time 164 minutes (120-240)
- avg EBL = 340 ml (200-700)

• Bellabarba, JOT 2001

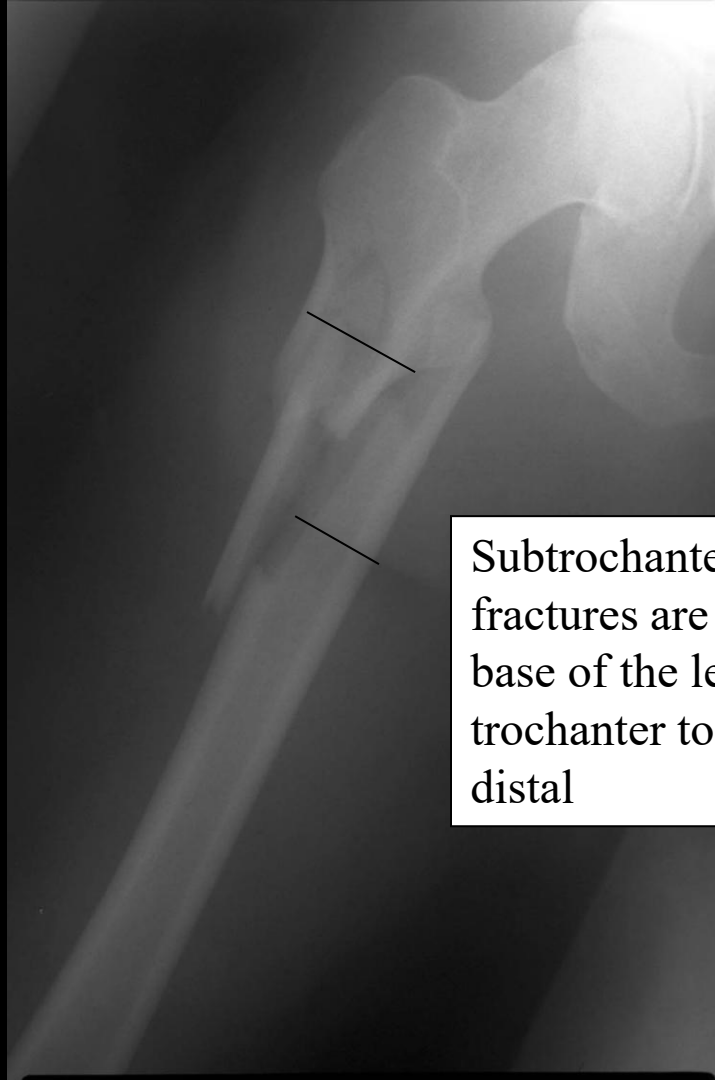
Exchange Nailing of femoral Nonunions

- 42 pts, closed exchange nailing
- 7 positive cultures
- 36 (86%) healed, avg 4 mos after OR
- Lack of immediate weight bearing, open fractures assoc with nonunion after 1st OR
- Atrophic/oligotrophic nonunions, and infection were associated with treatment failure after exchange nail
- A second nail larger by 2 mm or more than the original nail was associated with a higher success rate
 - Shroeder, JOT 2009

Femur Fracture

Subtrochanteric Fracture Management

- Possible to perform intramedullary nail if the piriformis fossa is intact
- Choice of nail type depends on if the lesser trochanter is intact
- Varus seen with proximal femur intramedullary nailing
- Plating is also an option with/without an intact starting point



Subtrochanteric fractures are from the base of the lesser trochanter to 5 cm distal

Low Subtroch Fx's



Most low subtrochanteric fractures with an intact piriformis fossa can be treated with a 1st gen IM Nail



When piriformis fossa is not involved and the lesser trochanter is fractured, a 2nd generation nail may be used

Nail

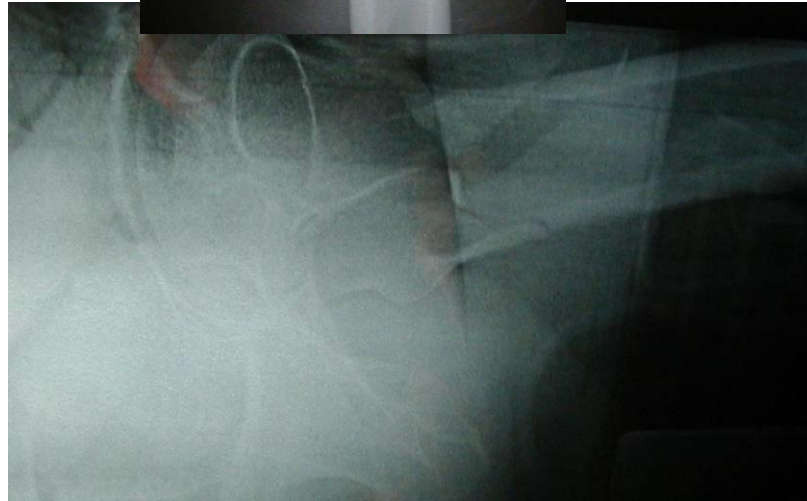


or...

Plate



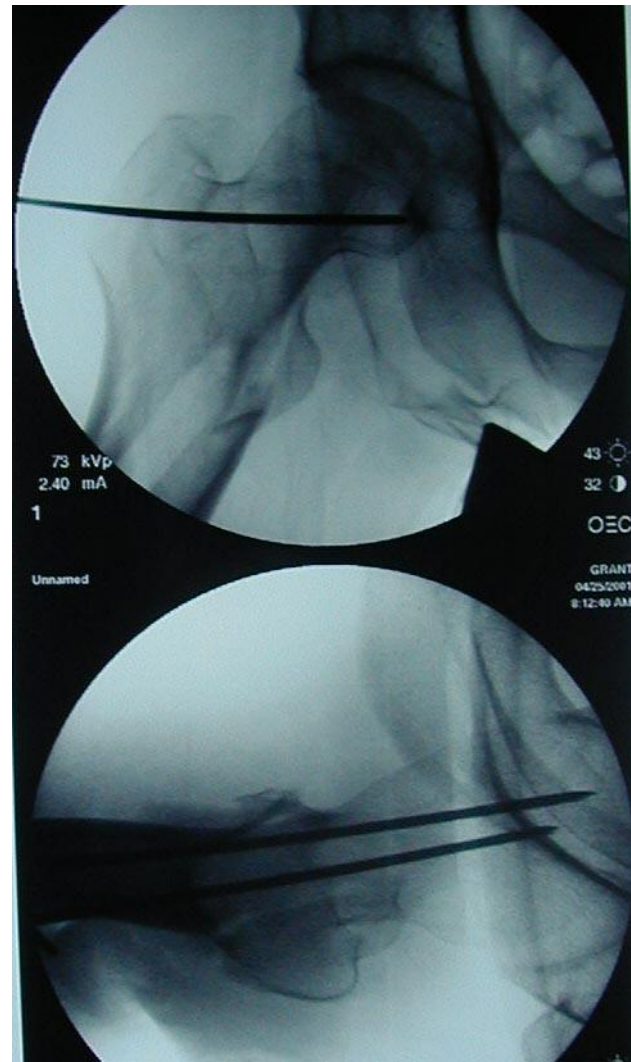
Indirect Reduction: Technique



Indirect Reduction

Step 1- Approximate closed
reduction with fracture table in
BOTH planes

Step 2 - Percutaneous insertion
of guide pins

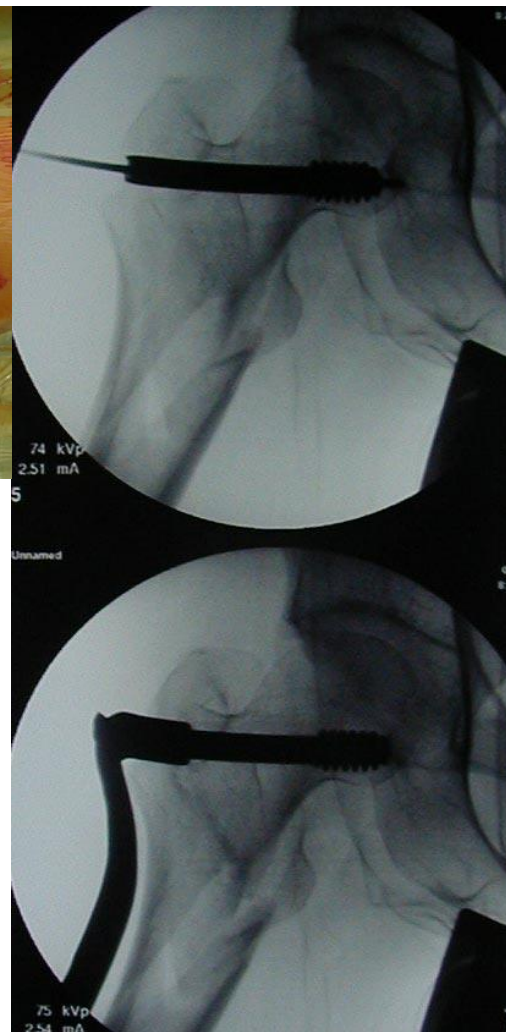


Knee



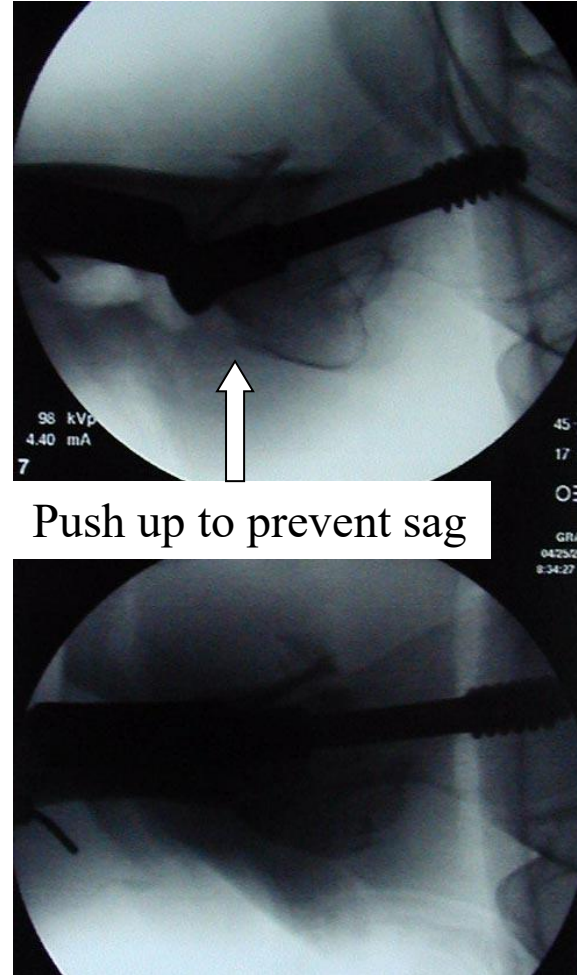
Head →

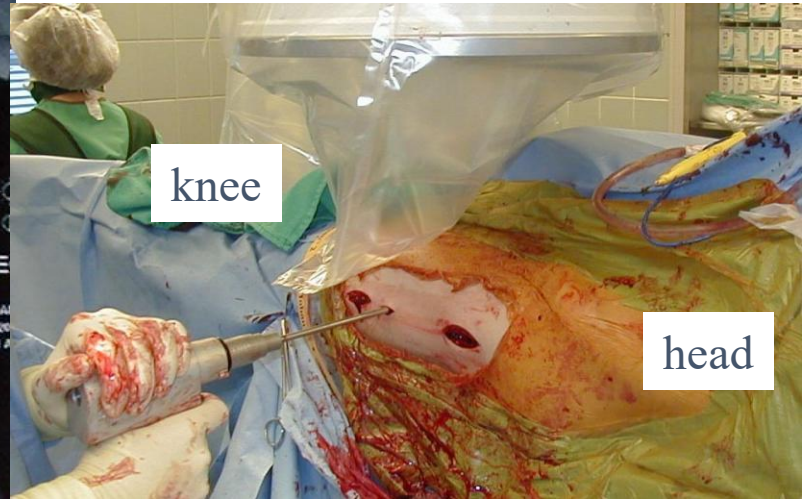
Step 3 - Placement of
lag screw and
percutaneous plate
placement



Indirect Reduction

Step 4 - Final reduction with
percutaneous screw
placement





Screw Placement



Indirect Reduction



Ipsilateral Femoral Neck & Shaft Fractures

- Optimum fixation of the femoral neck should be the goal
- Varus malunion of the femoral neck is not uncommon, osteotomies can lead to poor results
- Vertical femoral neck fracture seen in 26-59% of cases (Pauwel's angle $> 70^\circ$)
- Rate of avascular necrosis is low, 3%, even when missed

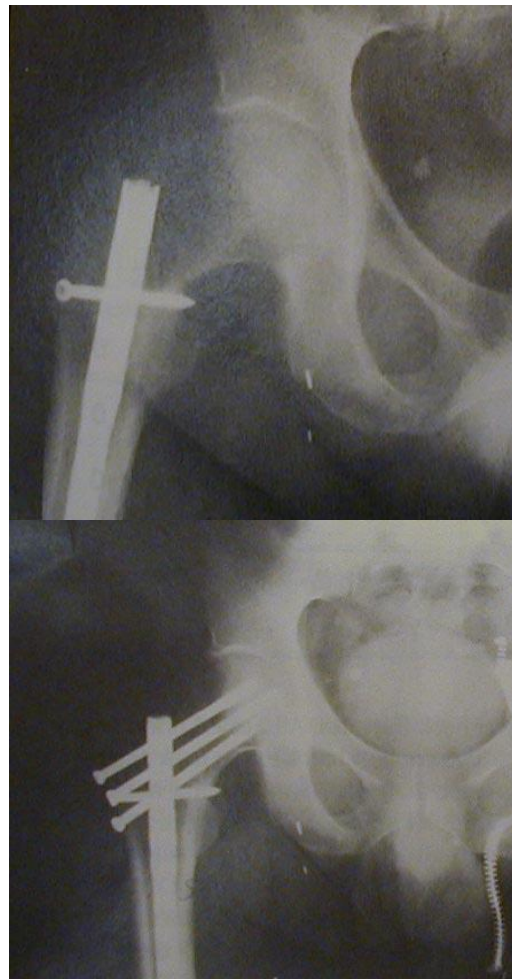
Ipsilateral Femoral Neck & Shaft Fractures

- Type 1 - nondisplaced femoral neck/hip fractures
- When found prior to nailing can be treated with screws or a sliding hip screw then retrograde or antegrade nail



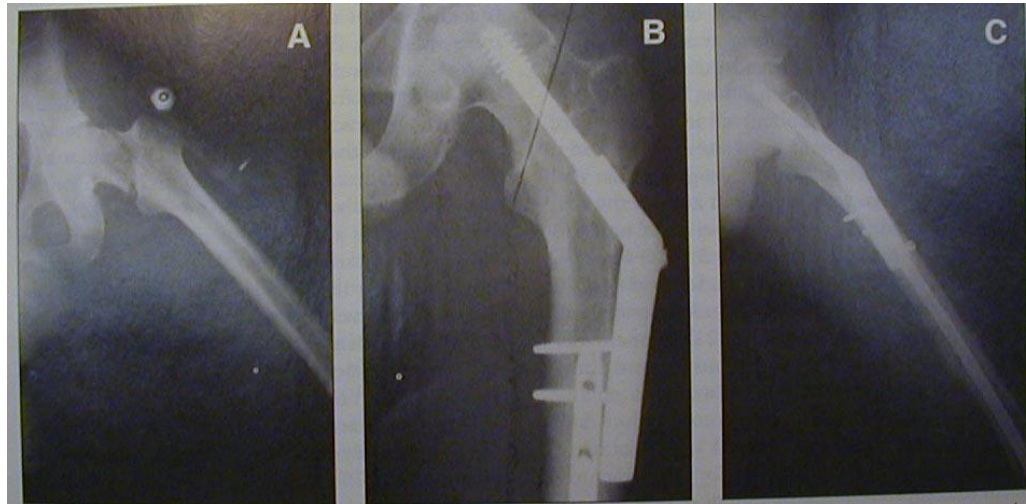
Ipsilateral Femoral Neck & Shaft Fractures

- Type 2 - missed femoral neck fracture
- Insertion of screws around the nail
- Low AVN rate even when missed
- Vertical fractures not iatrogenic



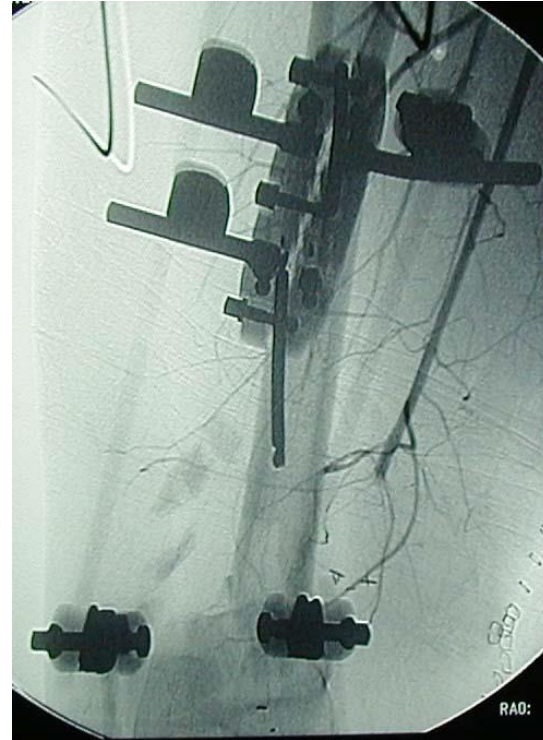
Ipsilateral Femoral Neck & Shaft Fractures

- Type 3 - displaced femoral neck fractures
- Treat with implant appropriate for neck fracture **FIRST**
- Treat femoral shaft fracture with retrograde nail



Femoral Shaft Fracture with Vascular Injury

- Quick external fixation with restoration of length
- Fasciotomies



Femoral Shaft Fracture with Vascular Injury

- Exchange femoral nail either in same setting or in a few days
- When found early plating or rodding of femur is rarely possible first
- Do **NOT** perform IM nailing after arterial repair without initial length restoration

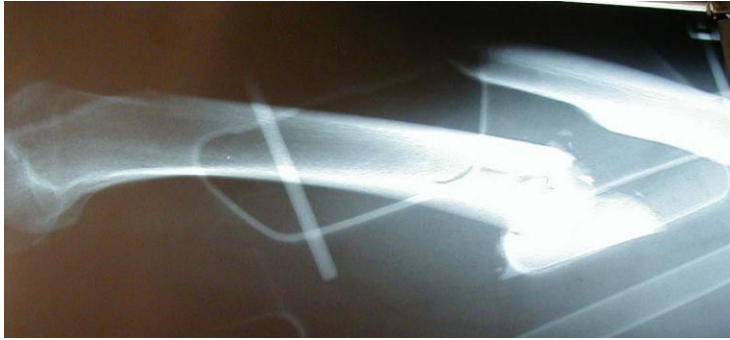
Open Femur Fracture

Antegrade IM Nail is Safe

- Reamed , Antegrade Intramedullary Nailing has been shown to be effective
- A high union rate, low complications
- Perhaps stage Grade 3B fractures after debridement and skeletal traction
 - Brumback, JBJS 71A, 1989
 - Lhowe, Hansen JBJS 70A, 198

Open Femur Fracture

Antegrade IM Nail is Safe



IM Nailing of the Femoral Shaft

- Choice *TO* nail depends on fracture configuration, especially at proximal and distal ends
- Choice *OF* nail depends on fracture location, associated musculoskeletal injuries, obesity
- *Think* before IM Nailing of femur

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