INTRAMEDULLARY NAILING AND THE FEMUR

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ST3

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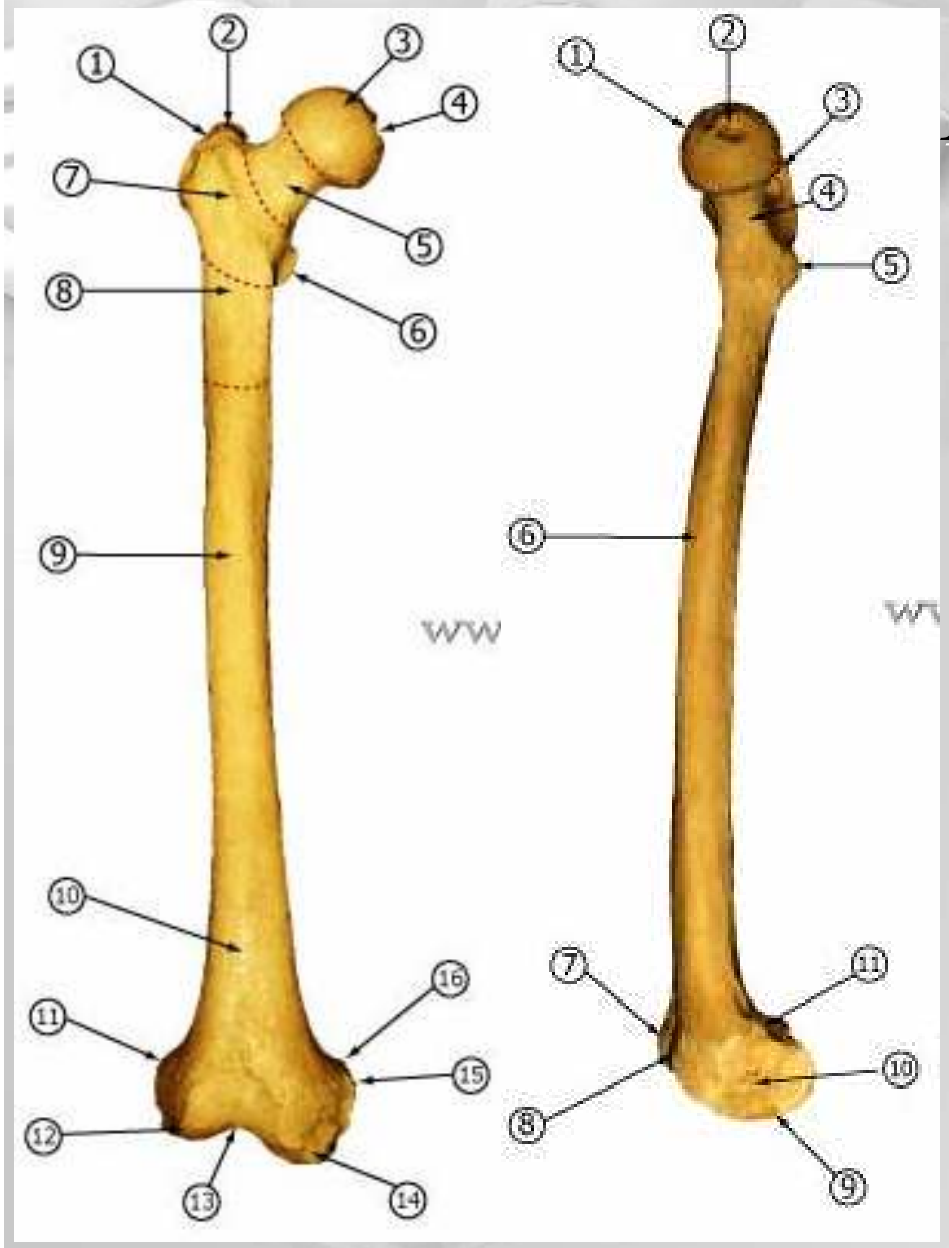
Objectives

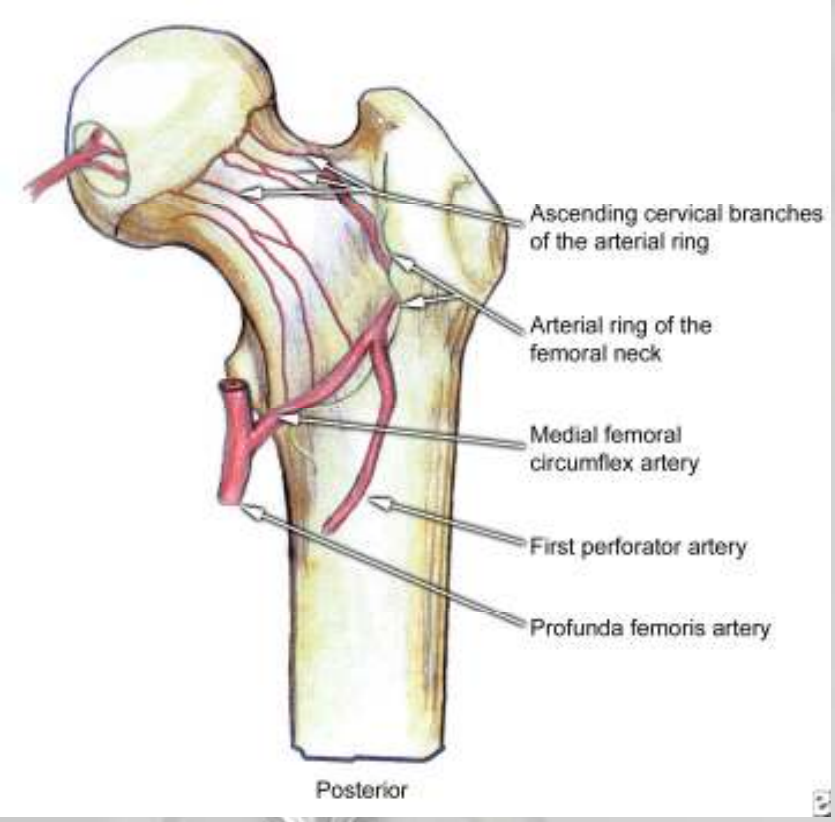
- Femoral Anatomy
- Subtrochanteric Fractures
- Distal Femoral Fractures
- History of Nailing
- Antegrade Nailing
- Retrograde Nailing

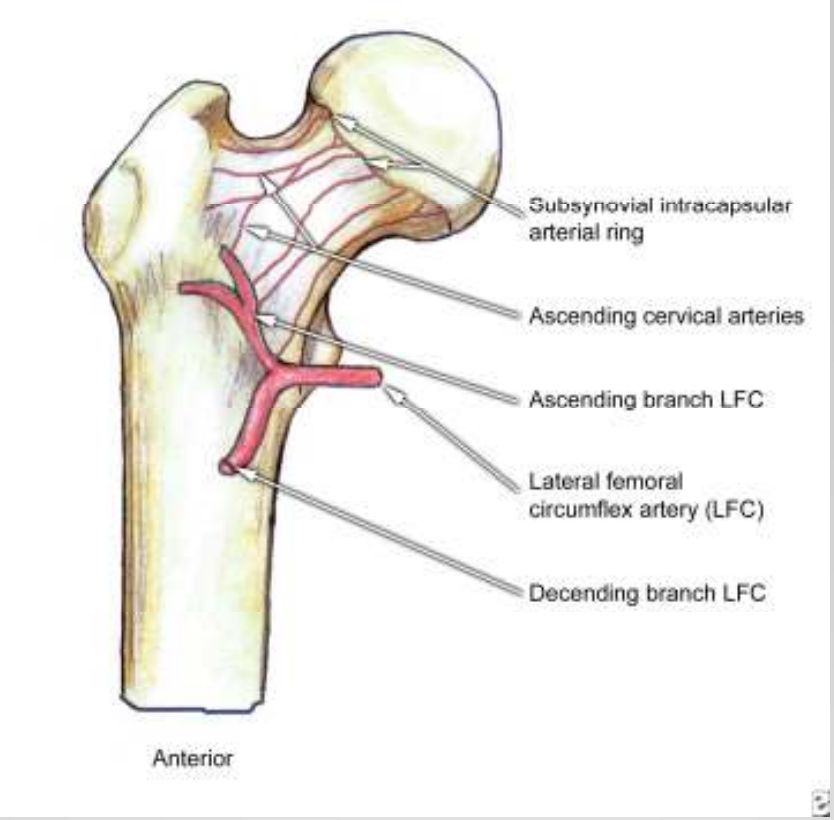


Femoral Anatomy

- Head
- Neck
- Intertrochanteric
- Subtrochanteric (extending 5 cm below lesser trochanter)
- Shaft
- Supracondylar and condylar regions

Vascular Supply - Head

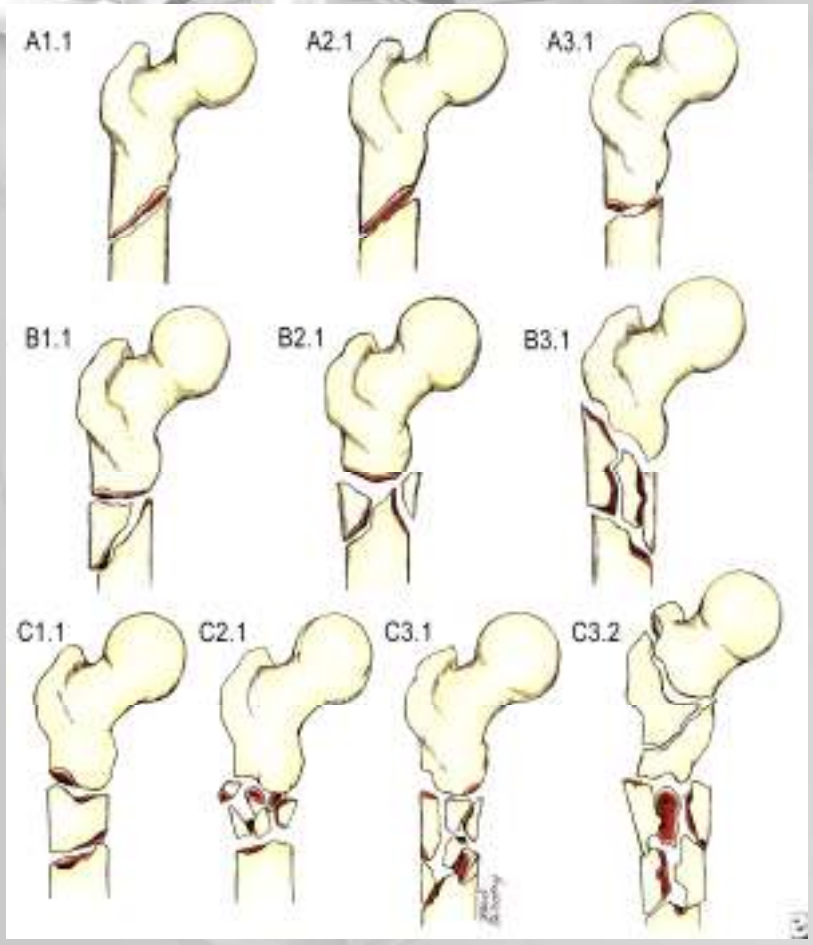




Subtrochanteric Fractures

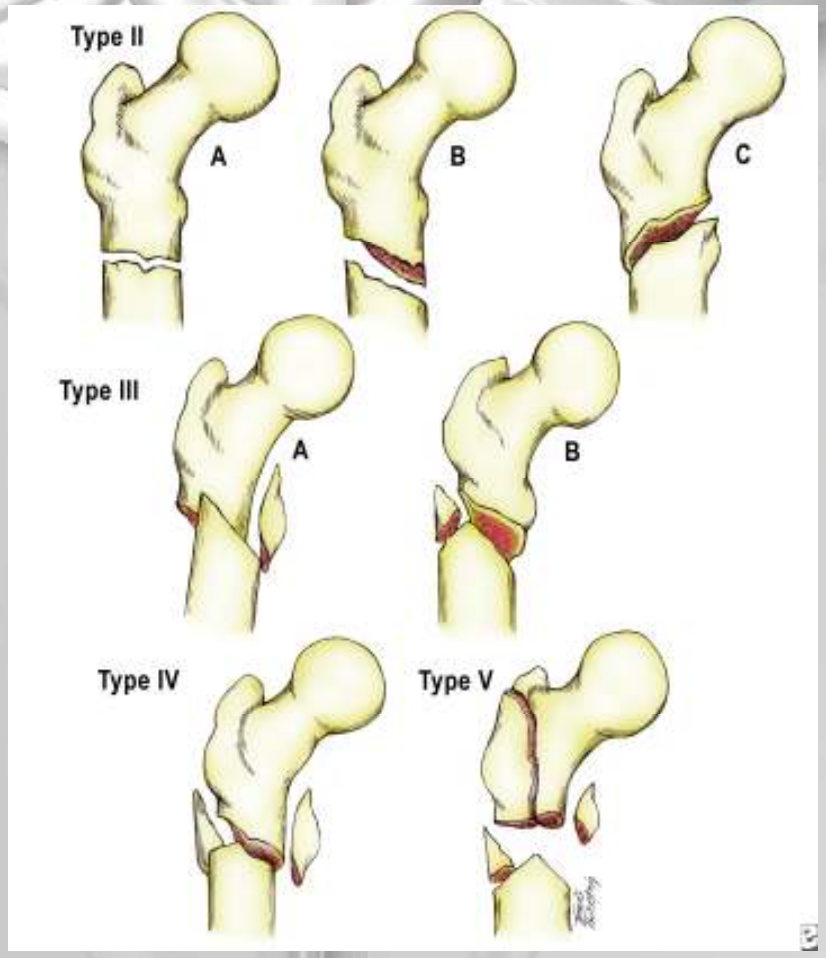
- Between lesser troc and 5cm distal
- 10-30% of all hip fractures
- High (<25yr) or low energy (>65yr)
- Pathological (35%)
- High biomechanical stress
  - Medial – compressive
  - Lateral – tensile
- Mainly cortical bone therefore decreased vascularity / healing

Classification - OTA



- Femur, diaphyseal (32)
  Type A: two part
  A1: spiral
  A2: oblique
  A3: transverse
- Type B: butterfly fragment
  B1: spiral wedge
  B2: bending wedge
  B3: comminuted wedge
- Type C: complex/comminuted
  C1: spiral
  C2: segmental
  C3: irregular

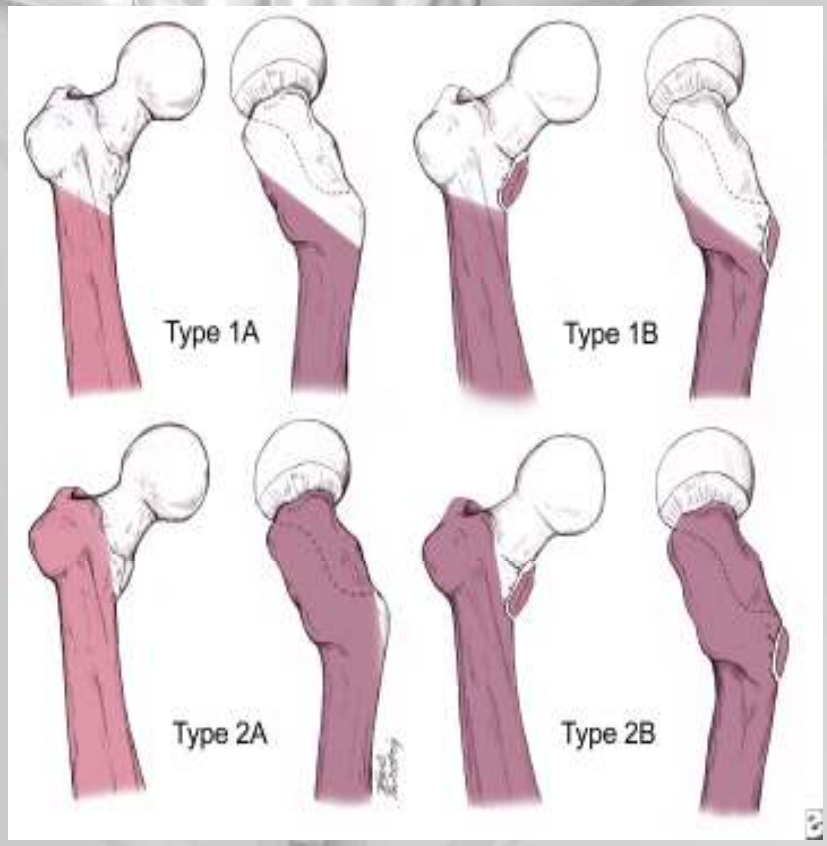
Classification - Seinsheimer's



- Type 1
  - Undisplaced <2mm
- Type 2
  - Two part / lesser troc
- Type 3
  - Three part / lesser troc
- Type 4
  - Comminuted
- Type 5
  - Comminuted / Greater troc

Seinsheimer F III. Subtrochanteric fractures of the femur. J Bone Joint Surg 1978;60A:300–306.

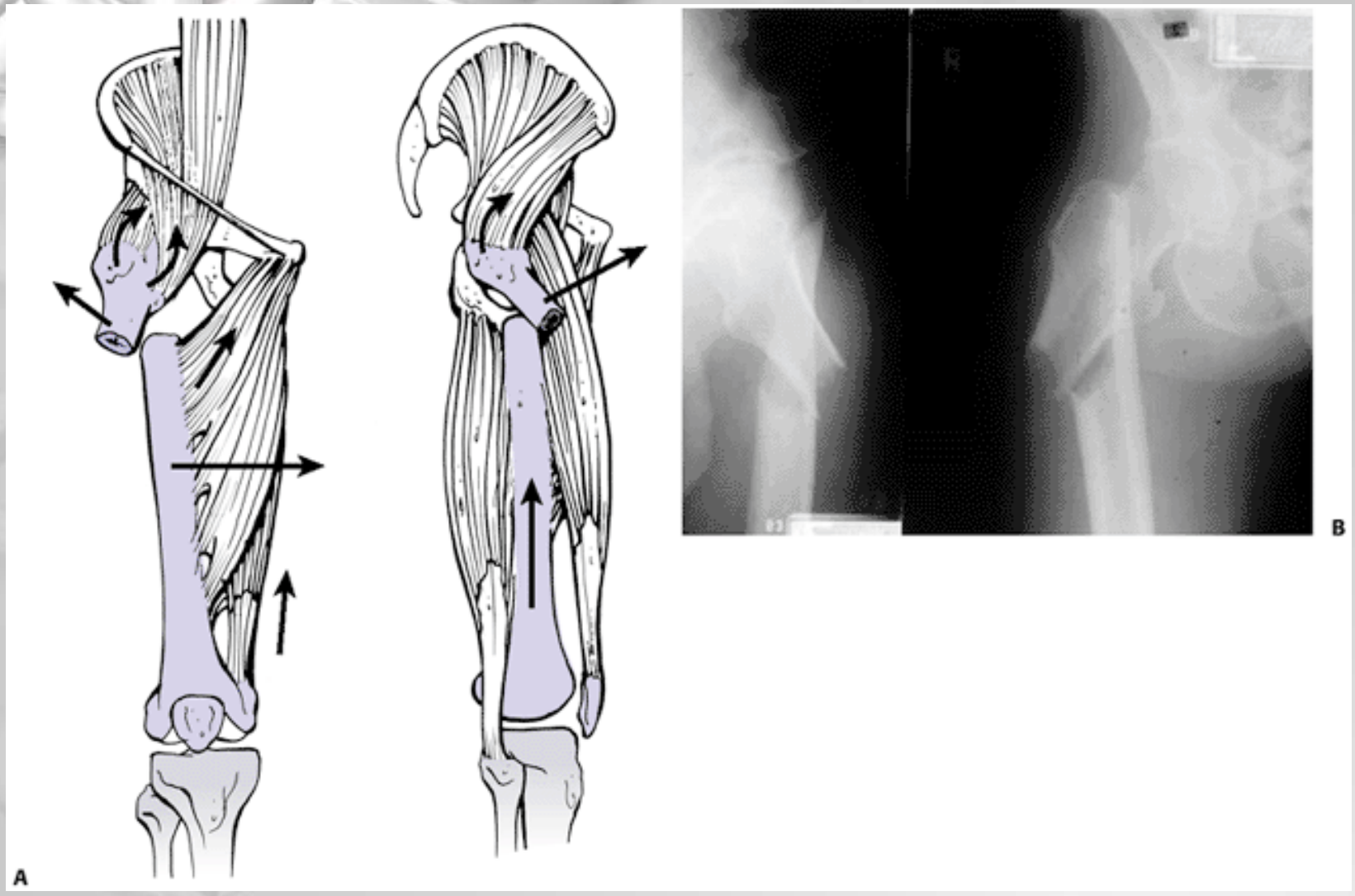
Classification – Russel Taylor

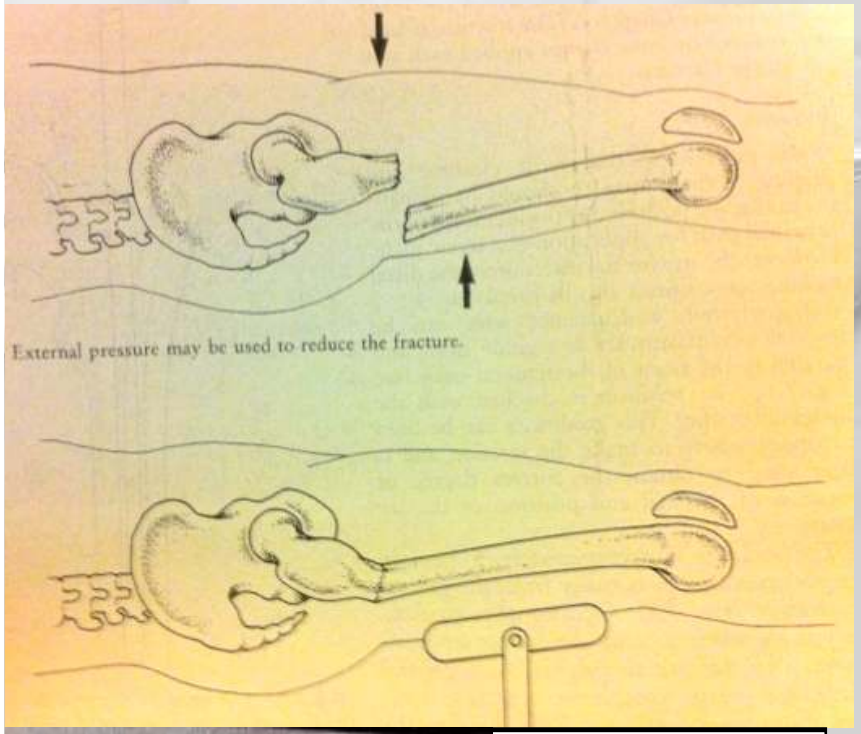


Russell-Taylor classification of subtrochanteric fractures. Skeletal Trauma 1998;2:1891–1897.

- Type 1 (intact piriform fossa)
  - 1A – fx below lesser troc
  - 1B – involves lesser troc
- Type 2 (piriform fossa involved)
  - 2A – stable medial buttress
  - 2B – medial buttress lost

Deforming forces



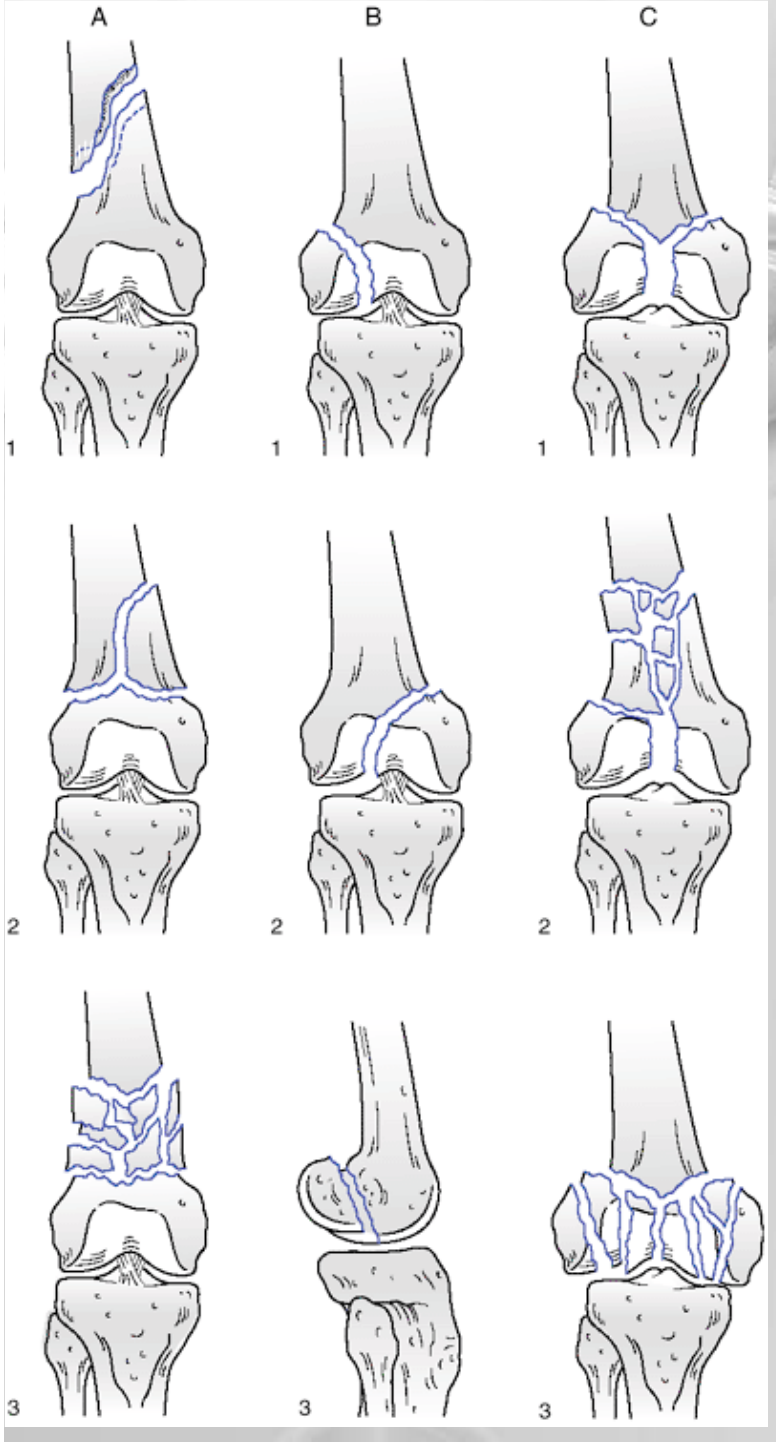


Fracture Reduction

- Reduction levers
- Posterior “sink”
  - Obese patients
  - Bar / Crutch
- Percutaneous half pins
- Open Reduction
- Reduction Rod / nail in proximal segment

Distal Femoral Fracture

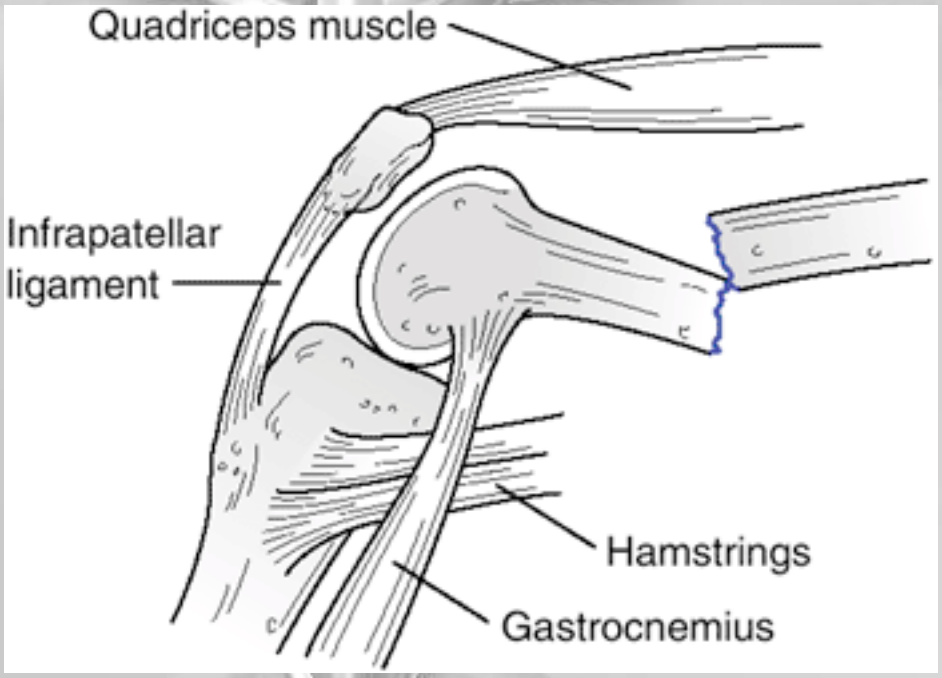
- Distal 15cm
- 7 % of all femoral fractures (31% if exclude NOFs)
- Bimodal distribution
  - High / low energy
- Axial loading with rotation / valgus/ varus force



AO classification

- A: Extra-articular (Transverse)
  - Retrograde nail / MIPPO
- B: Unicondylar fracture
  - deforming forces: gastrocnemius
  - B III (Coronal or Hoffa fracture), only soft tissue attachment is posterior capsule, behaves like a large loose fragment.
  - Closed reduction / percutaneous screws
- C: Bicondylar Fracture
  - Unrestricted pull of the quadriceps and gastrocnemius
  - MIPO

Deforming Forces



- Depends on configuration
- Gastrocnemius
  - Posterior angulation and rotation
- Quadriceps / Hamstrings
  - Shortening and anterior displacement shaft

Reduction

- Closed

  - Percutaneous 2 x 6.5mm cancellous screws
  - Towels under distal femur - knee flexion & relax gastrocnemius
  - External fixator / distractor - restore alignment / length
  - Schanz screws – joysticks
  - Valgulisation – eases ilio tib tract
  - Percutaneous Clamp

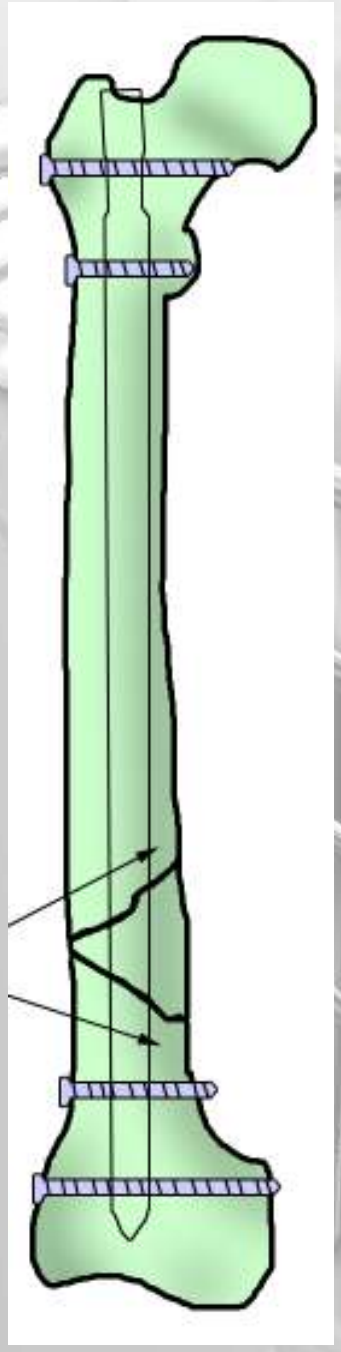
- Open

Ipsilateral Neck and Shaft Fractures

- 1-6 % shaft fracture have assoc neck fracture (Whittle, Russell, Taylor)
- Iatrogeninc (Yang JBJS 80B 1998)
  - 152 nails – 8 NOFs – 2 iatrogenic
- Other assoc injuries
  - Patella fracture
  - Acetabular fracture
  - Pelvic fracture

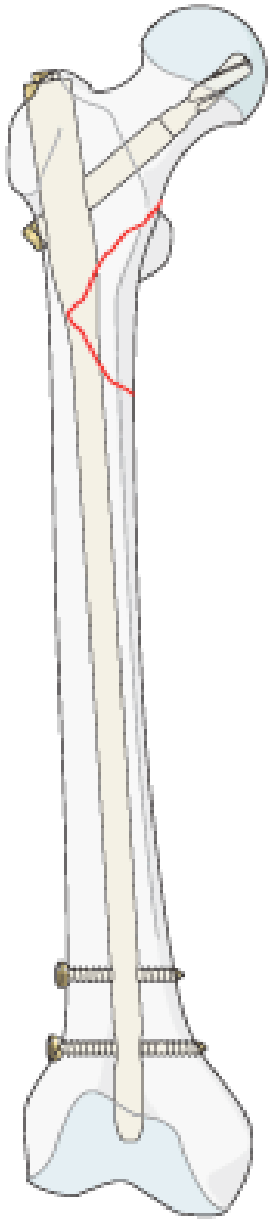
History of IM Nailing

- 16th Century – Wooden sticks
- 19th Century – Ivory nail
- 1890 – Locking Ivory nails
- 1917 – Autogenous bone
  - Span of Cortex passed down canal
- WW1 – Hey Groves, Metallic Rods
- 1931 – Smith Peterson, steel rods
- 1940 – Gerhard Küntscher
  - V- shaped stainless steel nail



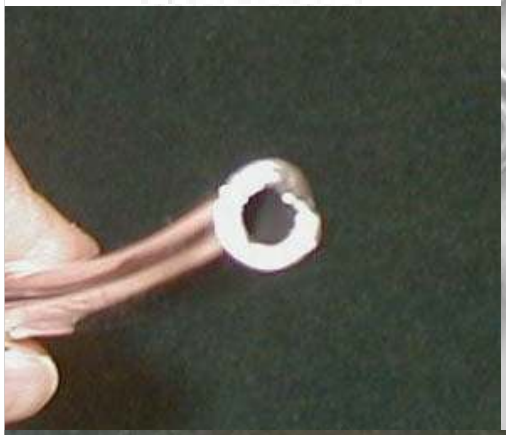
Generations of Nails

- First generation
  - Piriform fossa entry
  - Proximal and distal locking screws
  - Span femur
- Second generation
  - Fixation into the femoral head
  - Entry site at or just anterior to piriform fossa
  - Distal locking screws
  - Span femur



Generations of Nail

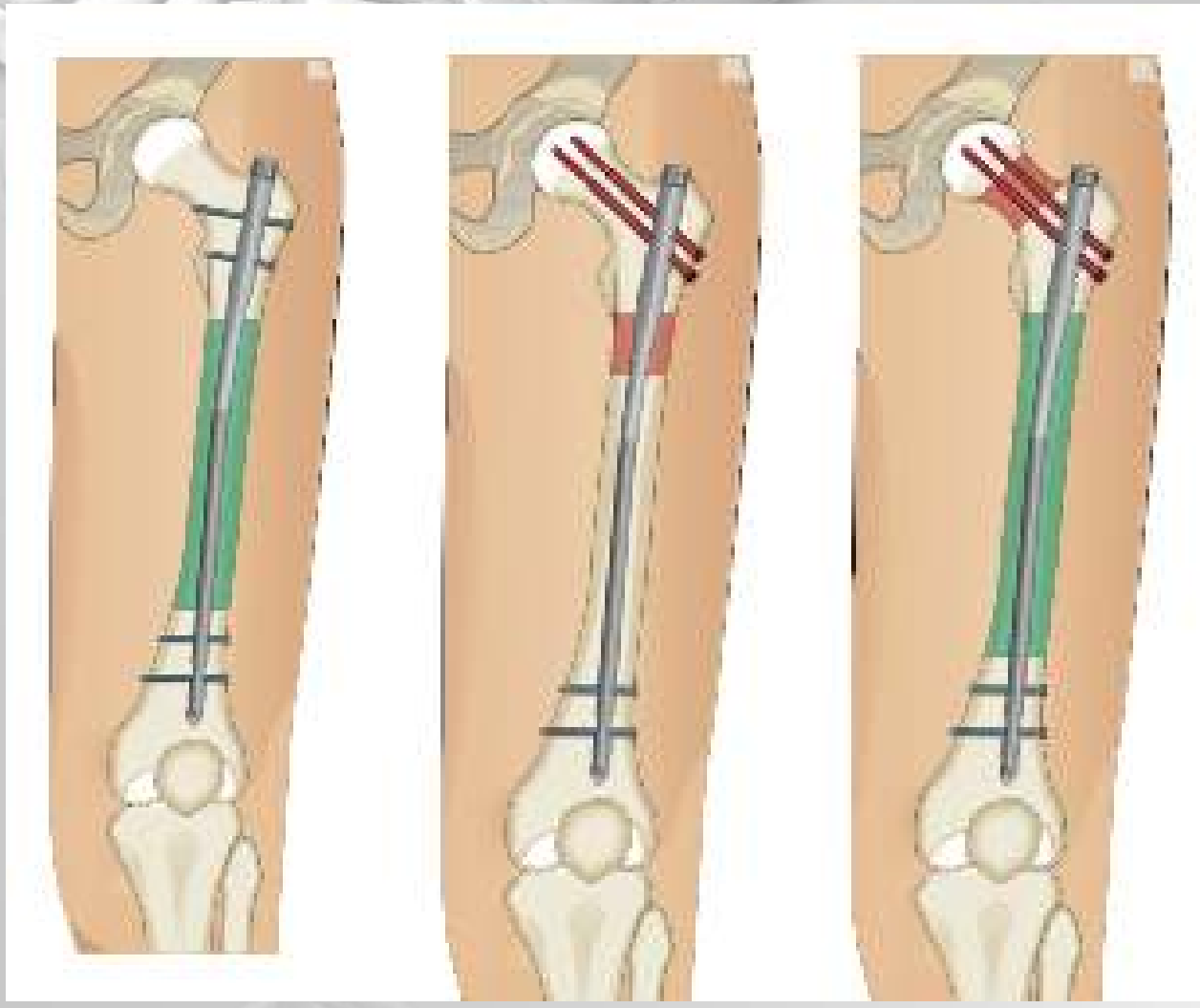
- Third generation
  - Greater trochanter entry
  - Fixation into the femoral head
  - Distal locking screws
  - Span femur
- Latest Development - Lateral entry



Biomechanics

- Nail features
  - Wall thickness increases torsional stiffness
  - Open slot decreases rigidity
  - Nail diameter – bending stiffness
  - Material – titanium 1.6x stronger than steel
  - Cross sectional shape
  - Use of interlocking screws resists axial loading
  - Radius of curvature of nail (120cm vs 150-300cm)

Antegrade Nailing

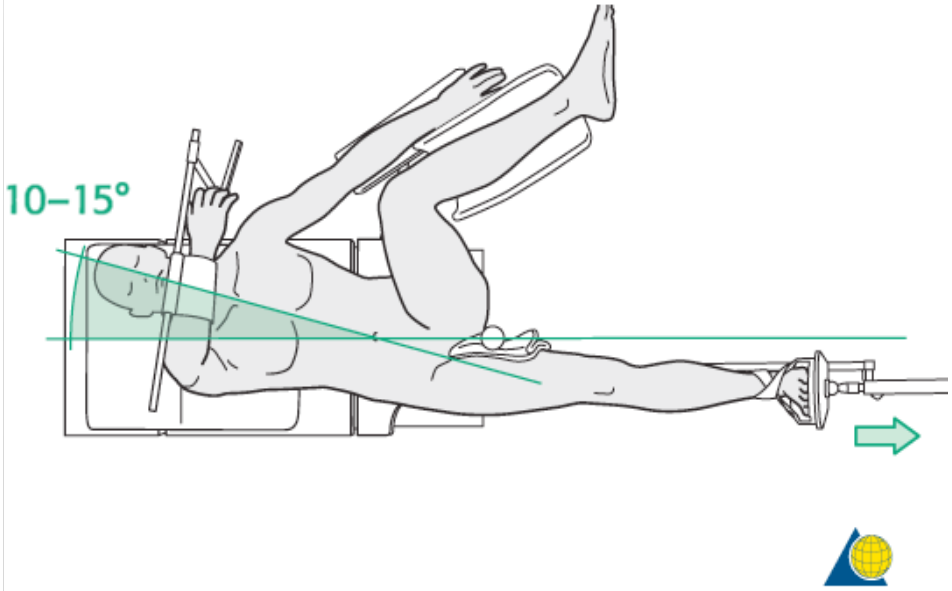


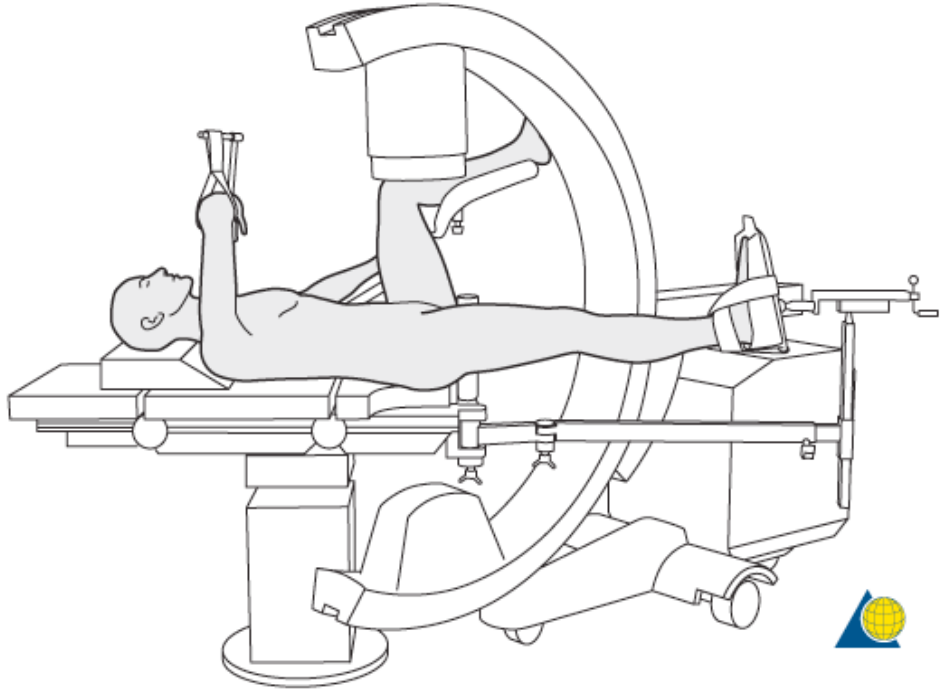
- Indications

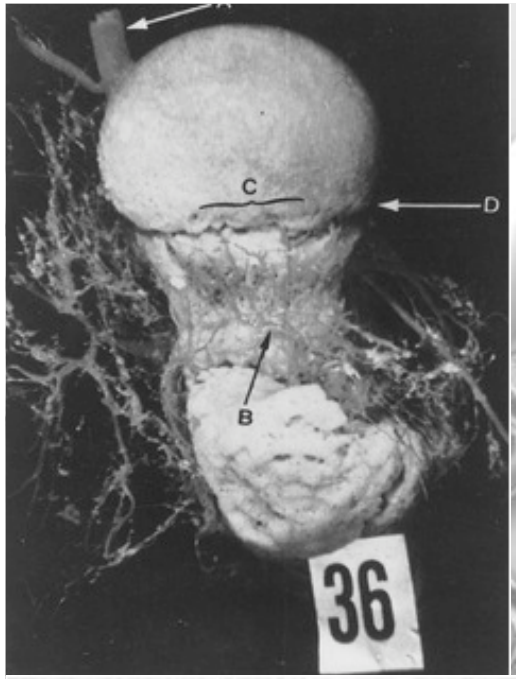
Antegrade nailing

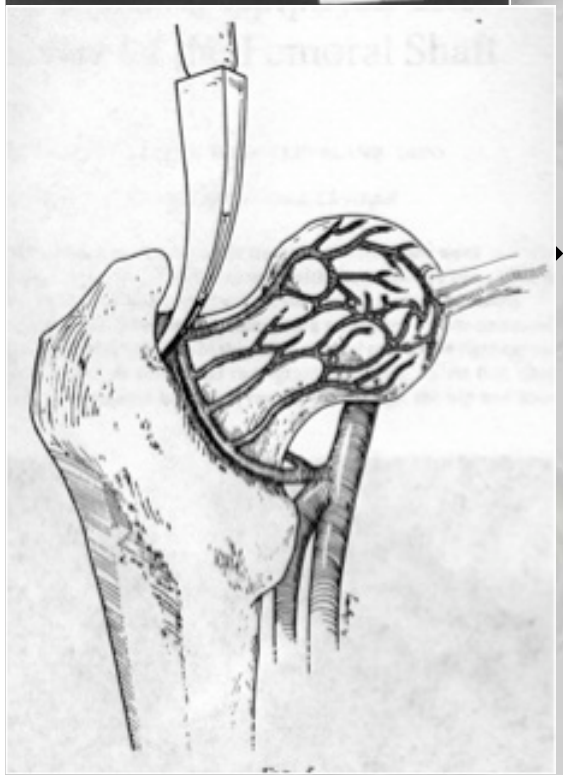
- Contraindications
  - Isolated femoral neck fracture
  - Periprosthetic fractures
  - Occluded intramedullary canal
  - Polytrauma patients in unstable condition
    - Ex Fix
    - Convert to nail <2 weeks

Patient Set up



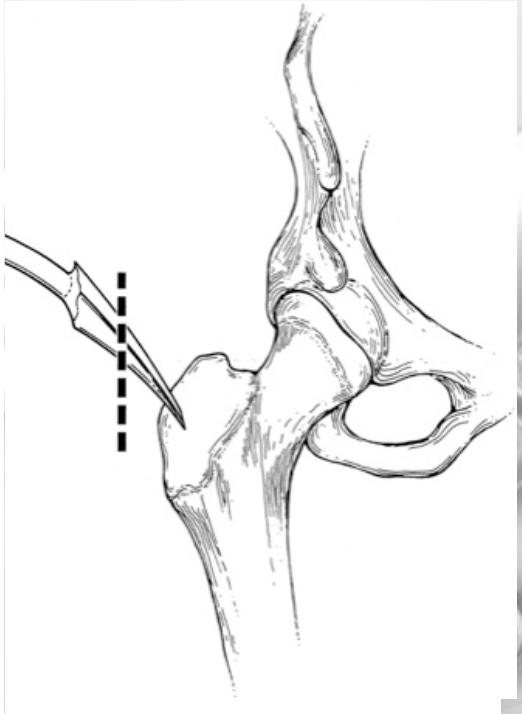


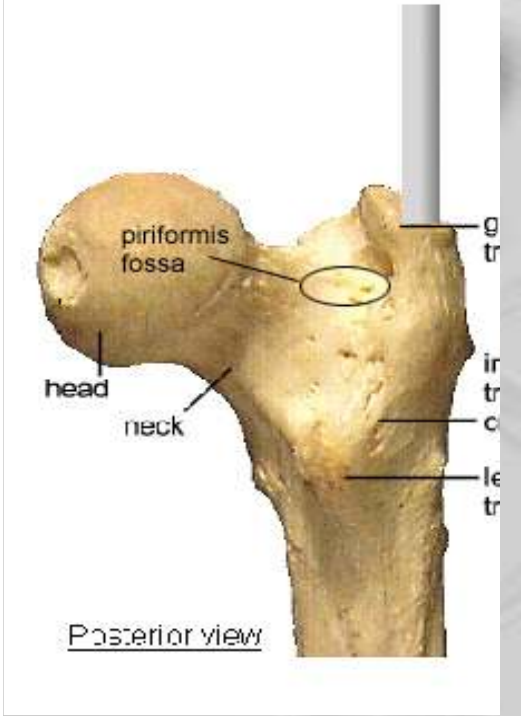




Piriform Entry

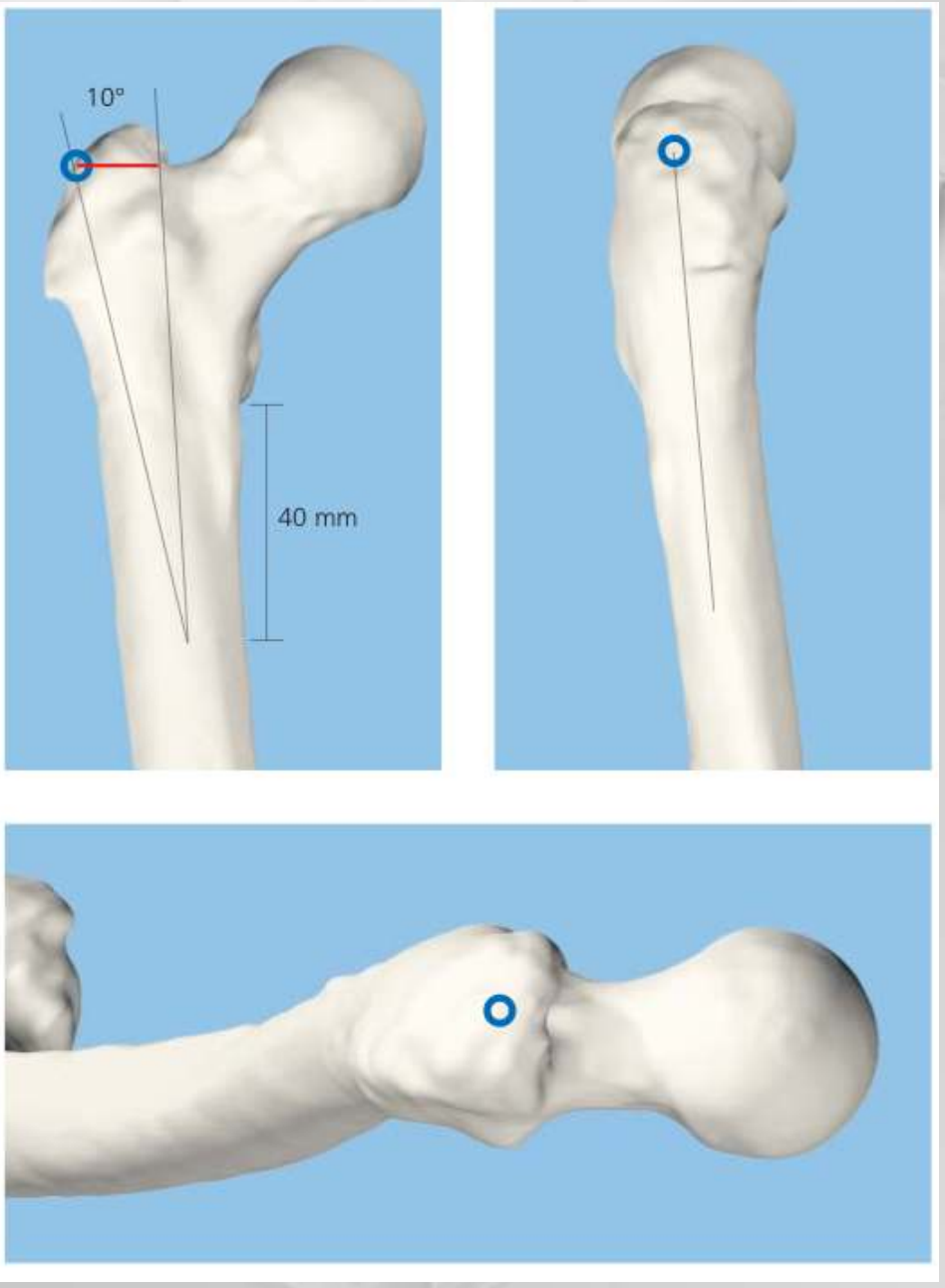
- In line with intramedullary canal
- Entry point cruical
  - Anterior – deformation of nail and proximal fragment comminution
- Dora et al (J Ortho Tr 2001)
  - Cadaveric study – 16
  - Branches of MFCA damaged in all cases





Trochanteric Entry

- Easy to identify starting point
  - Slightly medial to tip of greater troc as drift laterally when reaming
- Avoids damage to MCFA
- Use guidewire vs. awl to start
- Ricci et al (OTA 2004)
  - Piriformis vs. trochanter entry
  - Similar union / complications/ functional results
  - Operative time longer - Piriformis



Lateral Entry

- Consider in children
- Benefits
  - Easy access
  - No splitting glut med
- Risks
  - Iatrogenic proximal femur fracture – stiff reamers / anterior starting point
  - Varus / Valgus deformity (5º)

AVN following nailing

- >1 year after nailing
- Adolescents due to damage to MCFA
- 3-4% Incidence
- POSNA 2000
  - 1600 femurs nailed -> 0.8% AVN
- Keeler (J Paed Ortho 2009)
  - 80 femurs, adolescents, lateral entry
  - No incidence of AVN

To Ream or Not to Ream

Advantages

- Larger implant = more rigid
- Increased rate of union
- Increased periosteal blood flow
- Osteoconductive elements
- Decreased hardware failure

Disadvantages

- Elevated intramedullary pressure
- Elevated pulmonary artery pressure
- Fat embolism
- Disrupts Endosteal blood supply

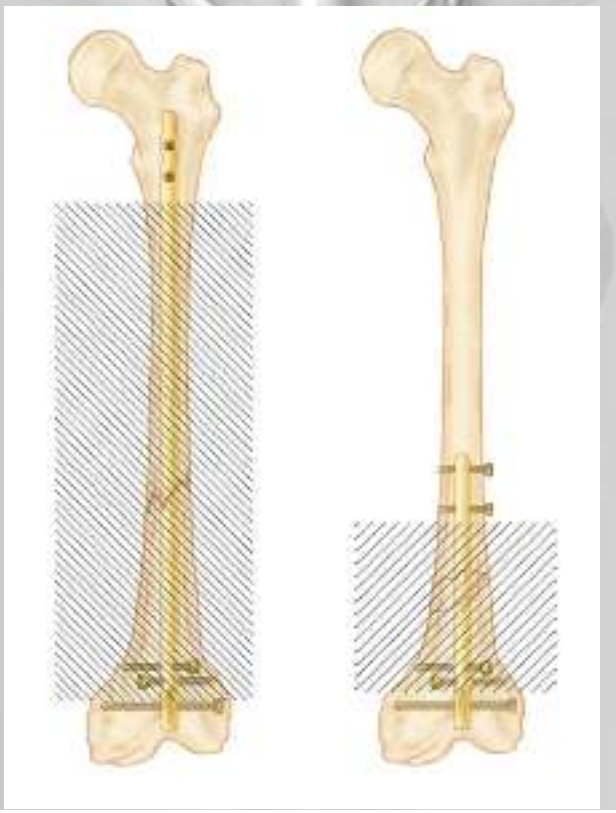
- Giannoudis (Injury 1997)
  - Ream (20.5 wks) / Unream (26.9 wks)
- Tornetta &Tiburzi (J Orth Tr 2000)
  - Ream (80days) / Unream (109 days)
- Canadian Study Group (JBJS Am 2003)
  - Non Union rate - Ream (1.7%)
    - Unreamed (7.5%)
- Bhandari (J Orth Tr 2000)
  - Decreased rate of non union and implant failure with reaming

Retrograde Nail

- Küntscher (Proc R Soc Med 1970)
- Short supracondylar nails placed through intercondylar distal femoral starting portal- 1991
- Use expanded to treat intercondylar fractures / periprosthetic fractures

Retrograde Nailing - Indications

- For use when surgical time and repositioning cannot be tolerated.
- Ease in identifying starting



- Morbid obesity
- Distal metaphyseal fractures
- Peri prosthetic
- Non / Mal Union
- Pathological fracture
- Ipsilateral femoral neck fracture
- Ipsilateral patella fracture
- Ipsilateral tibia fracture

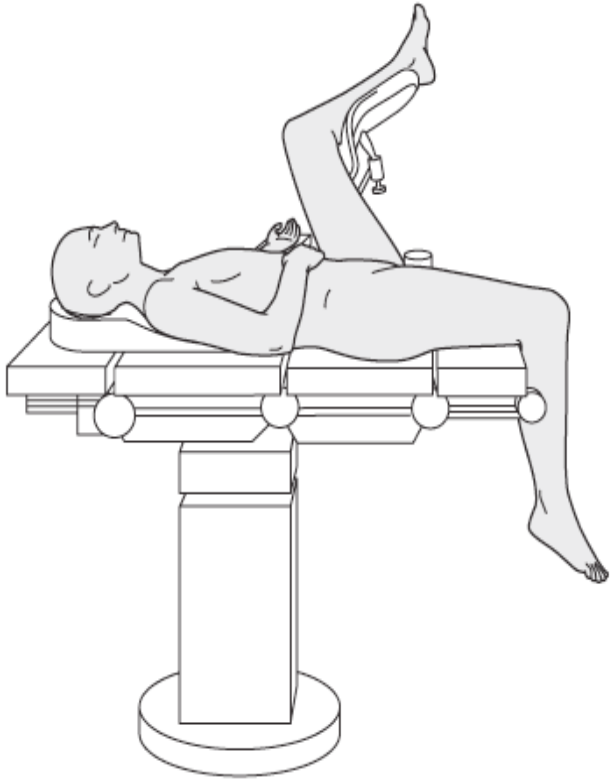
Entry Point

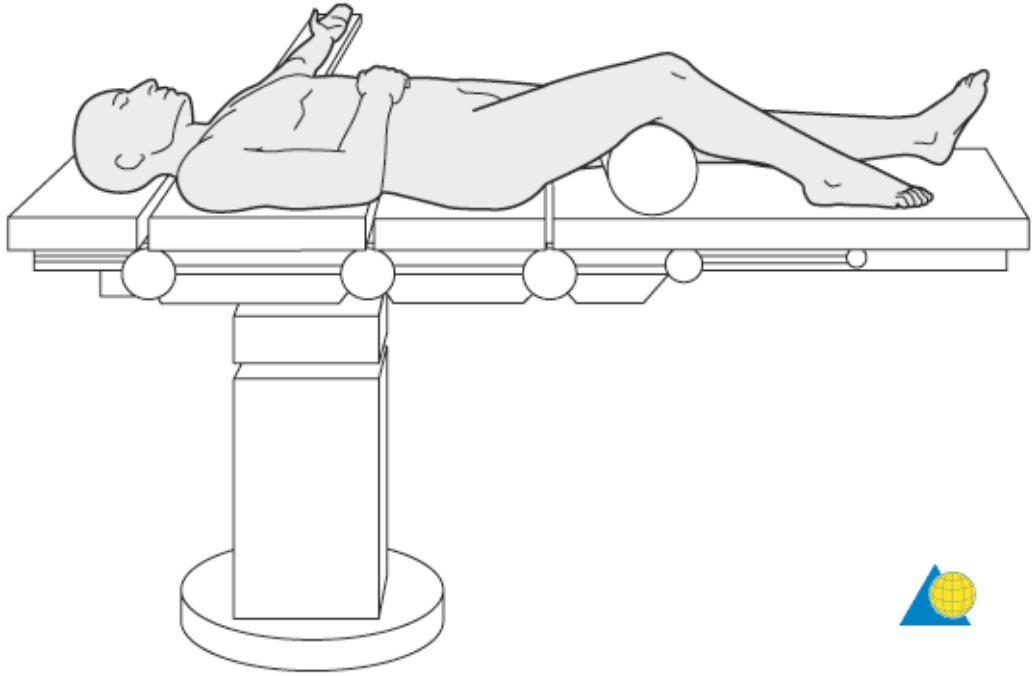
AP – in line with shaft Lateral – apex of Blumensaat's line

Retrograde Nailing - Contraindications

- Subtrochanteric fracture
- Limited knee motion (if starting point inaccessible)
- Patellar baja
- Open fractures

Patient Set up





Techniques

- Nail recessed beneath the cartilage surface distally
- Above lesser troc proximally
- Morgan (J Ortho Tr 1999)
  - 1mm prominence increases patello-femoral contact pressure
- Distal locking – jig
- Proximal locking – Ant to Post locking
  - Safe zone – level of lesser troc

Complications

- Proximal locking – profunda femoris damage
- Heterotopic ossification in intra-articular and periarticular locations
- Synovial metallosis
- Decreased blood flow to the distal femur and the cruciate ligaments

Conclusion

- Choice of nail depends on fracture configuration and pt related factors
- Consider muscle forces to aid reduction
- Associated injuries
- AVN risk – esp before physeal closure
- KNOW YOUR IMPLANT !