Orthopedic Hardware and Procedures

John Park

Background

- “Orthopedic Hardware”
  - “Hardware” frowned upon
  - Often used by orthopedists

Fracture Management

External fixation

- Materials
  - Plaster of Paris
  - Fiberglass

External fixation

- Materials
  - Plaster of Paris

External fixation

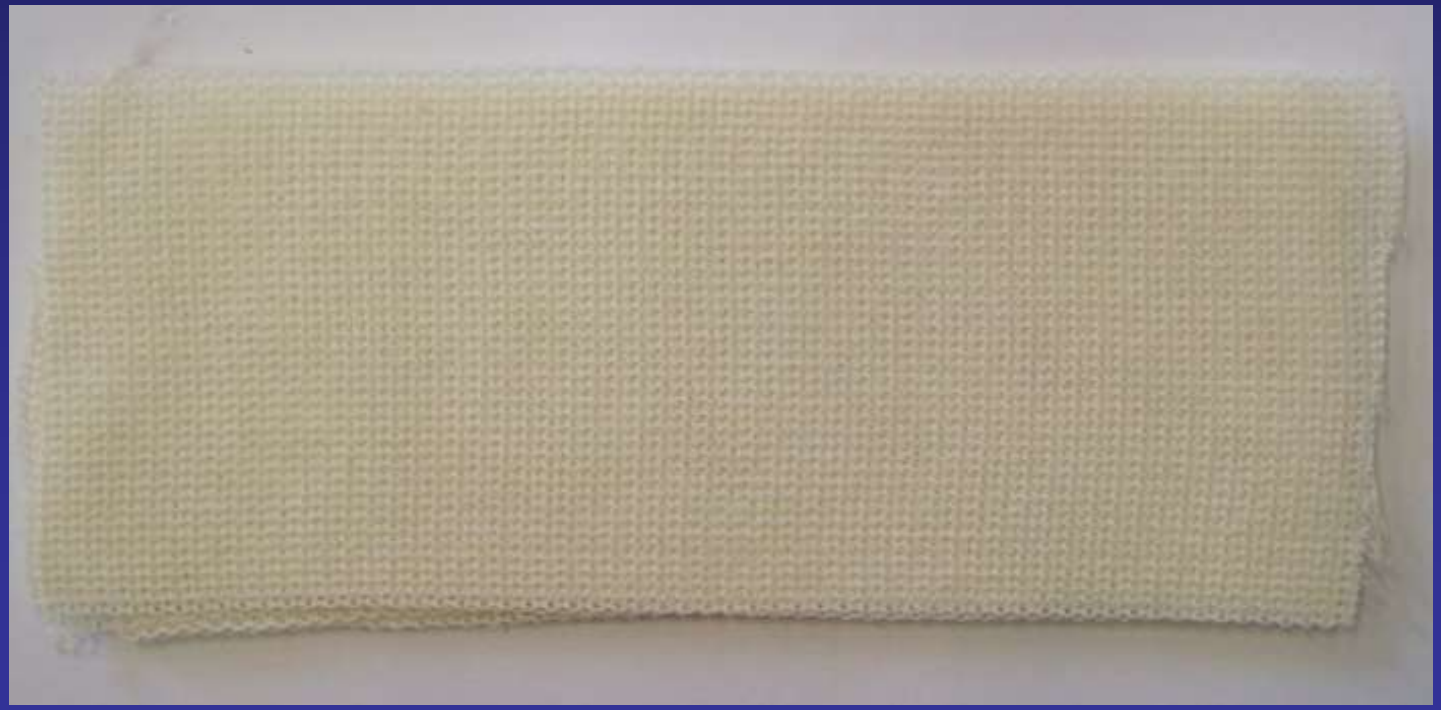
- Materials
  - Plaster of Paris
    - Original casting materials took 2-3 days to harden
    - Improved to 6 hours
    - Around 1800, British diplomat in Turkey observed use of Gypsum
    - First Plaster of Paris bandages introduced in 1850’s
    - Drawbacks: burns, heavy, not waterproof

External fixation

- Plaster

External fixation

- Materials
  - Fiberglass



External fixation

- Materials
  - Fiberglass
    - Fiberglass bandages introduced in early 1970's
    - Benefits: lighter, harder
    - 1990's: waterproof (with special underwrap = $$$)

External fixation

- Fiberglass

Casting vs Splinting

- Splinting
  - Non-circumferential
    - 2 layers of fixation with elastic outer wrap
  - Allows flexibility in fixation to accommodate soft tissue swelling
  - Immobilize joints proximal and distal to fracture
  - Usually 3-14 days before switch to cast

Casting vs Splinting

- Splint

Casting vs Splinting

- Splint

Casting vs Splinting

- Splint

Casting vs Splinting

- U-Splint

Casting vs Splinting

- U-Splint

With posterior slab

Casting vs Splinting

- U-Splint

Casting vs Splinting

- Ulnar gutter Splint

Casting vs Splinting

- Coaptation Splint

Casting vs Splinting

- Coaptation Splint

Casting vs Splinting

- Coaptation Splint

Casting vs Splinting

- Coaptation Splint

Casting vs Splinting

- Finger splints

Casting vs Splinting

- Finger splints

Casting vs Splinting

- Casting
  - Circumferential
  - Immobilize joints proximal and distal to the fracture
  - Usually removed at 4 weeks for radiographs OOP
  - Total length of immobilization usually 6 weeks

Casting vs Splinting

- Cast

Casting vs Splinting

- Short vs Long Arm Casts

Casting vs Splinting

- Long Leg Casts

Casting vs Splinting

- Spica Cast (aka-Hip spica)

Casting vs Splinting

- Thumb spica cast

Casting vs Splinting

- Casting
  - Bivalving
    - Allows immediate application of cast with flexibility to accommodate soft tissue swelling

Casting vs Splinting

- Bivalved cast

Casting vs Splinting

- Bivalved cast

Casting vs Splinting

- Bivalved cast

Casting vs Splinting

- Bivalved cast

Casting vs Splinting

- Bivalved cast

Casting vs Splinting

- Cast Fracture!!

Casting vs Splinting

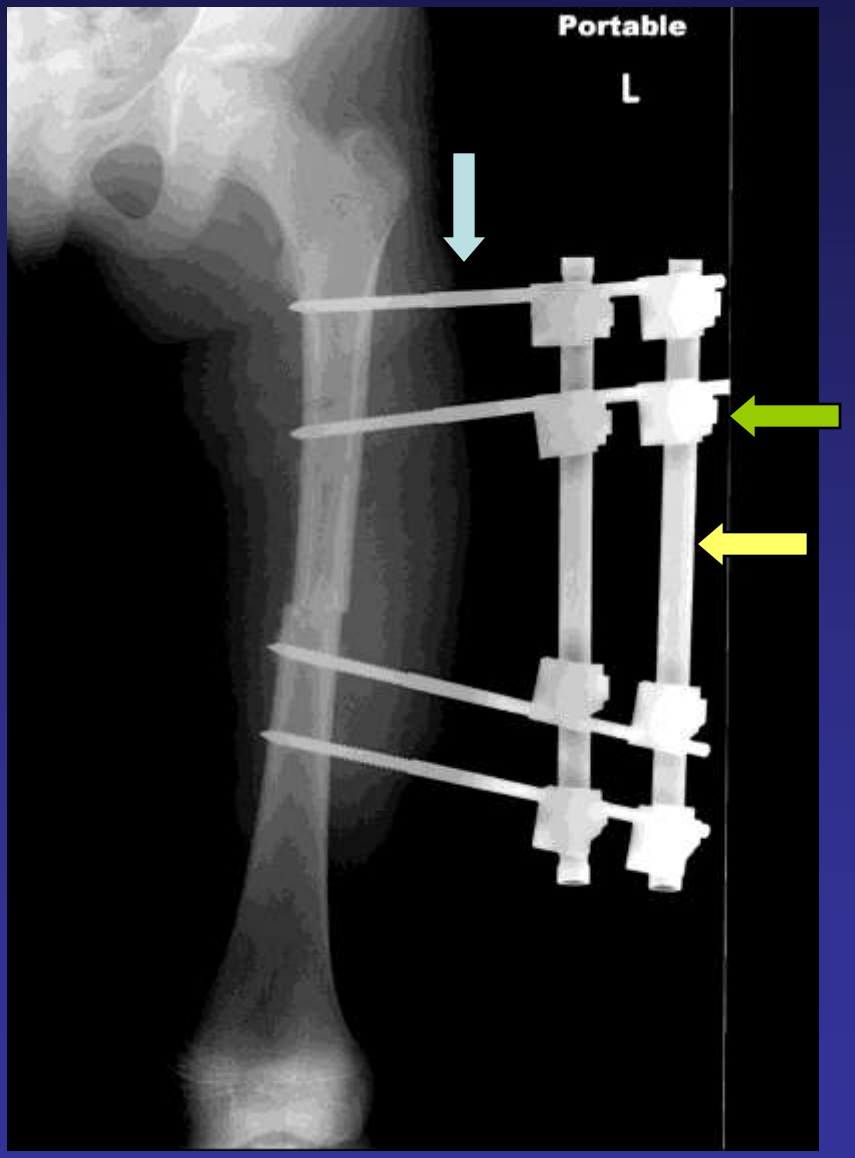
- Cast window
  - Allows ability to monitor skin without loss of fixation

External fixator

- External fixator
  - Minimally invasive
  - Rigid fixation
  - The closer the bars are to the body part, the stronger the construct will be

External fixator

- External fixator
  - Pin
  - Clamp
  - Bar

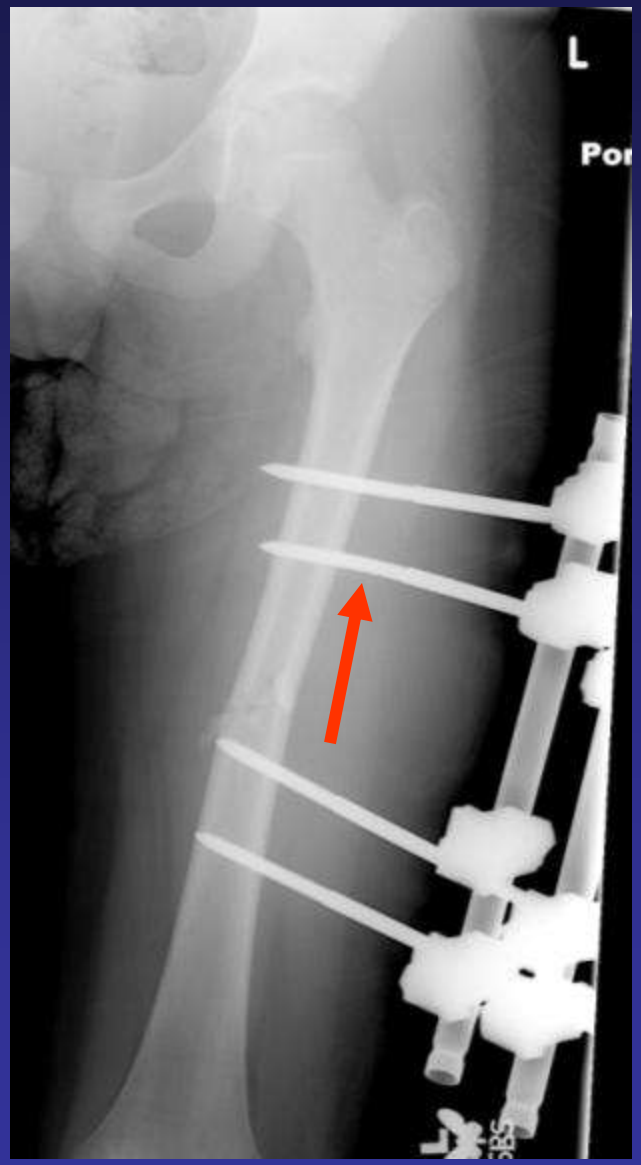


External fixator

- Mexican external fixator

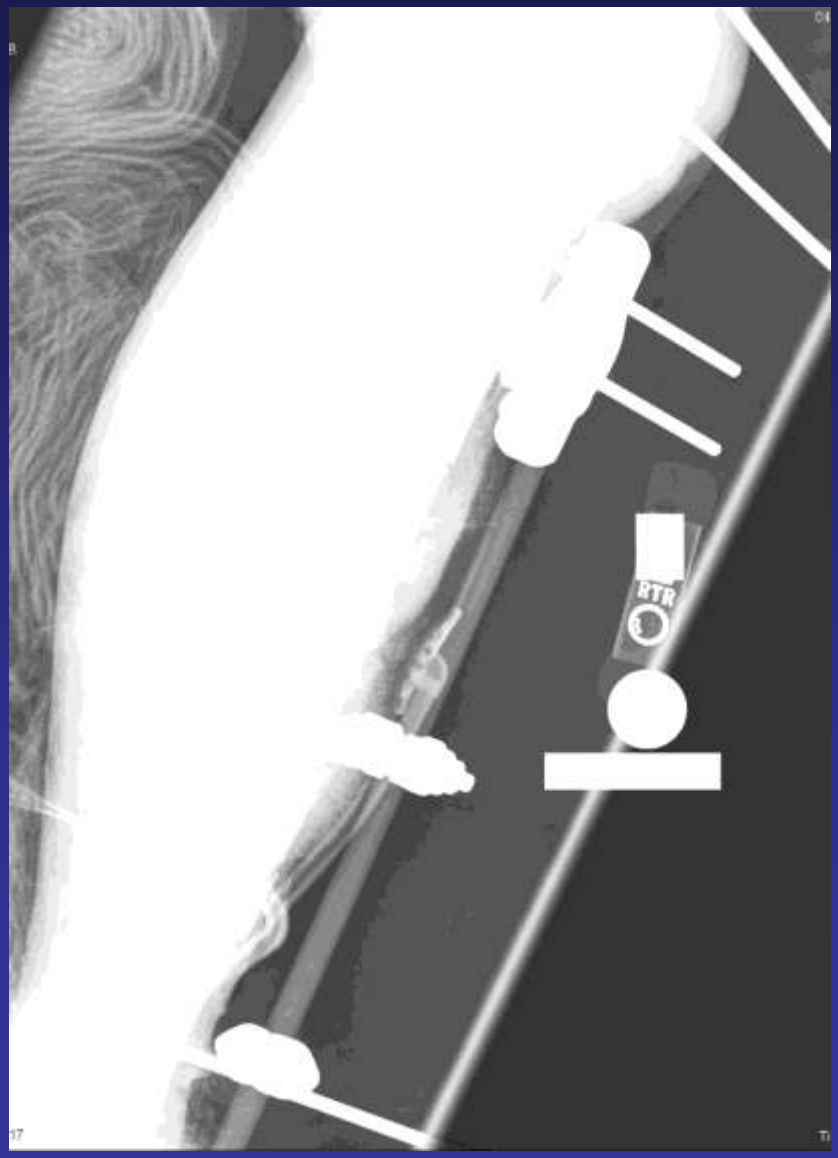
External fixator

- Mexternal fixator



External fixator

- External fixator



Internal fixation

But first…

Nomenclature

- External fixation
  - By definition, minimally invasive
- Internal fixation
  - Can be either minimally or maximally invasive

Nomenclature

- “ORIF”
  - Commonly used to describe the application of any type of internal fixation to fracture
  - This is INCORRECT

Nomenclature

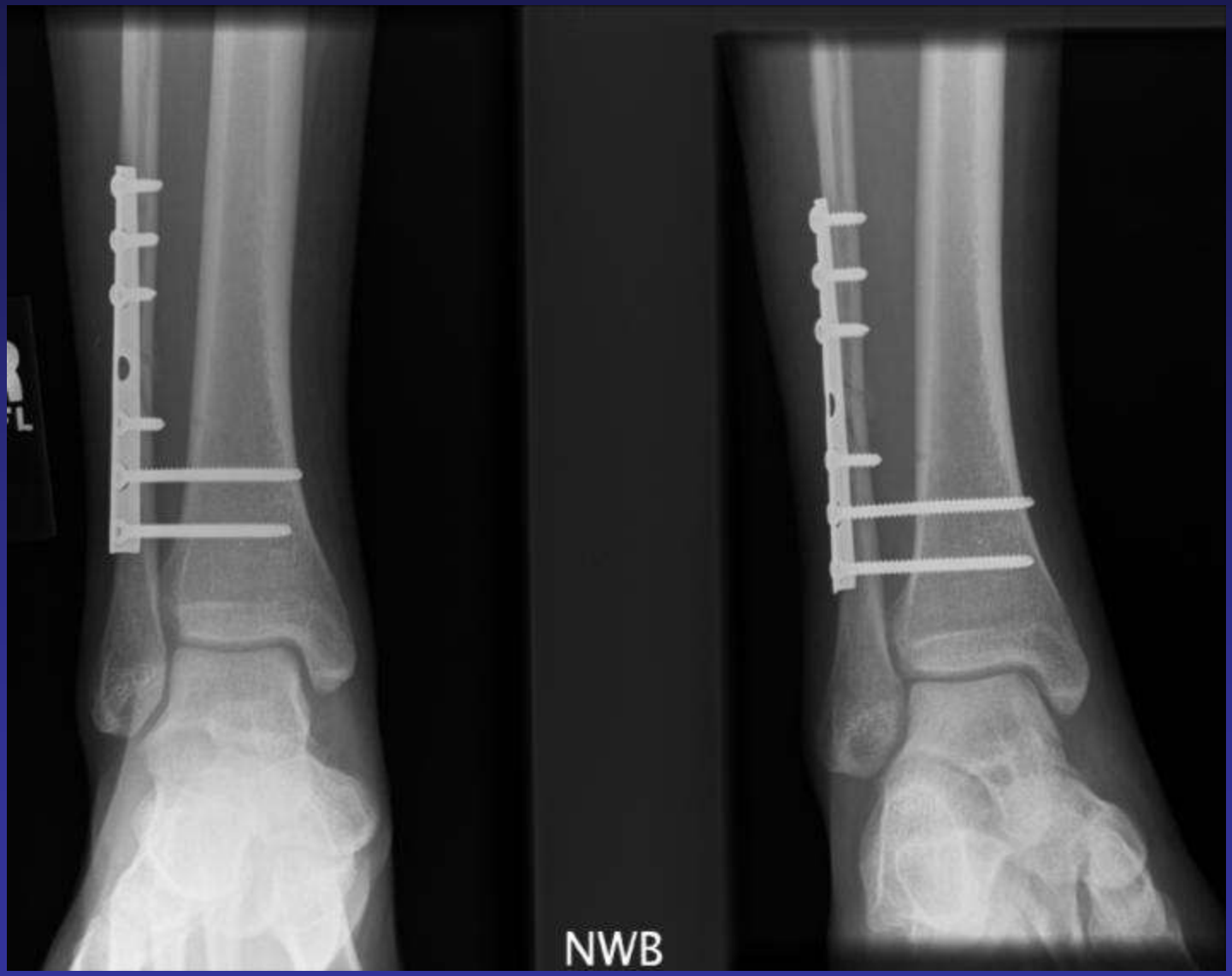
- “ORIF”
  - Describes an open surgical procedure where the fracture site is directly visualized and reduced by the surgeon
  - Internal fixation is then applied across the reduced fracture
  - Thus…OPEN Reduction/Internal Fixation

Nomenclature

- “ORIF”

Nomenclature

- “ORIF”



Nomenclature

- “ORIF”

Nomenclature

- NOT ORIF

Nomenclature

- CRPP
  - Closed Reduction/Percutaneous Pinning
  - Should be used when fracture is not directly visualized but is reduced and fixation applied into the bone

Nomenclature

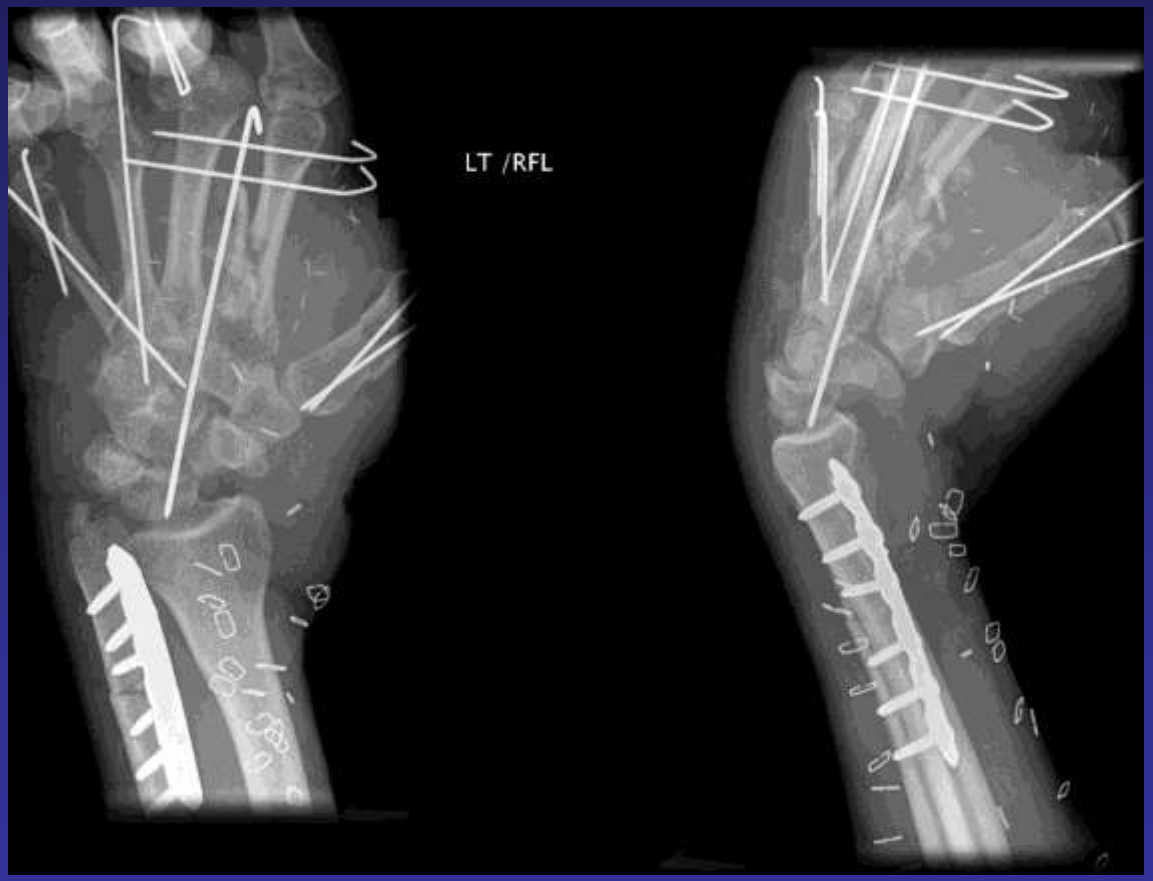
- CRPP

Nomenclature

- CRPP

Nomenclature

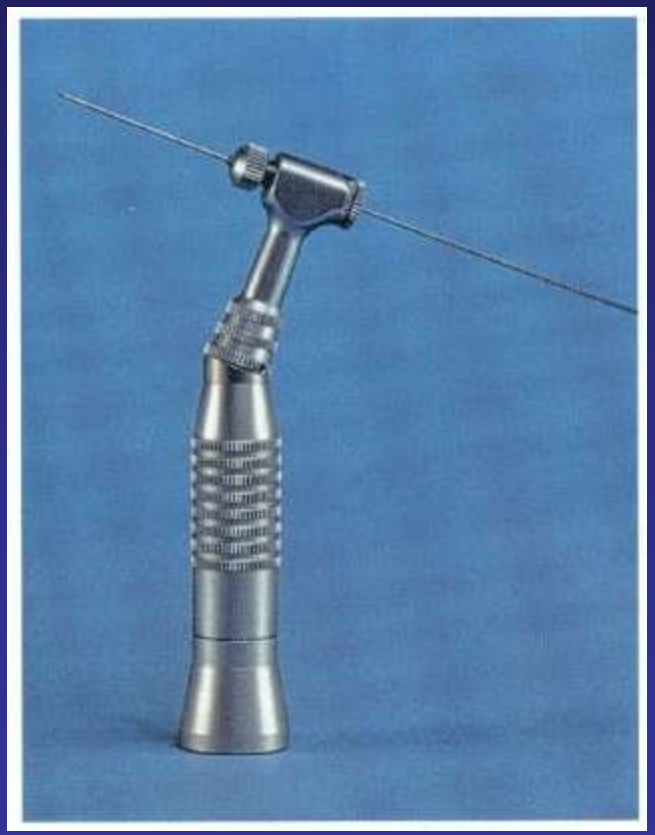
- CRPP



Wires and Pins

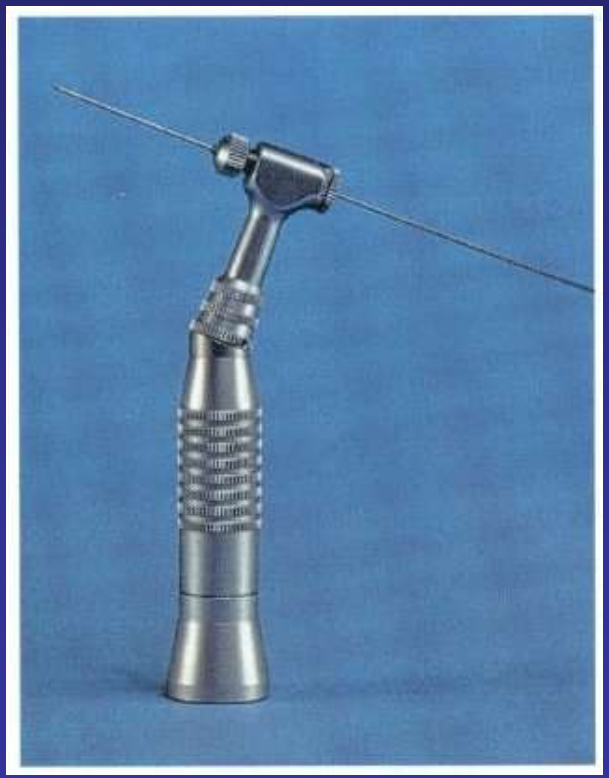
Wires

- Kirschner wire (K-wire)



Wires

- Kirschner wire (K-wire)
  - Fracture fixation
  - Intraoperative joysticks for fx reduction
  - Guides for screw placement
  - Traction



Wires

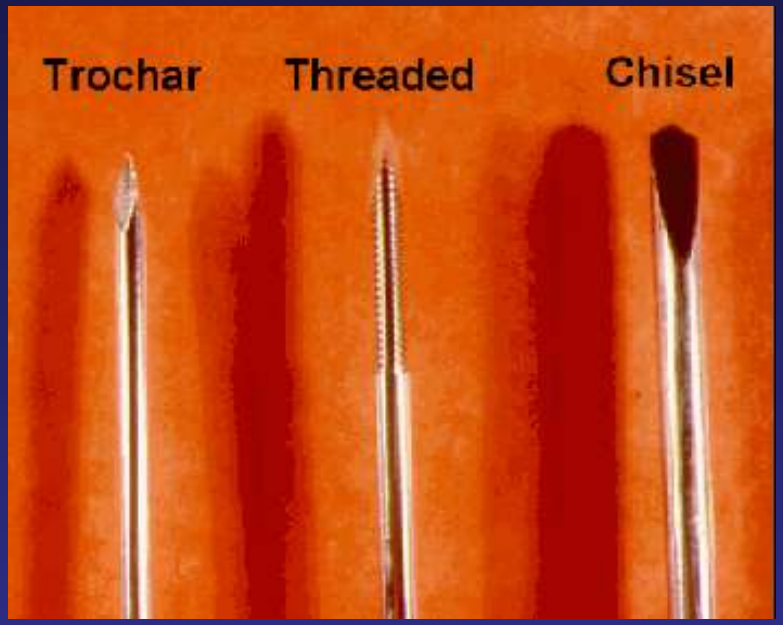
- Kirschner wire (K-wire)

Wires

- Kirschner wire (K-wire)

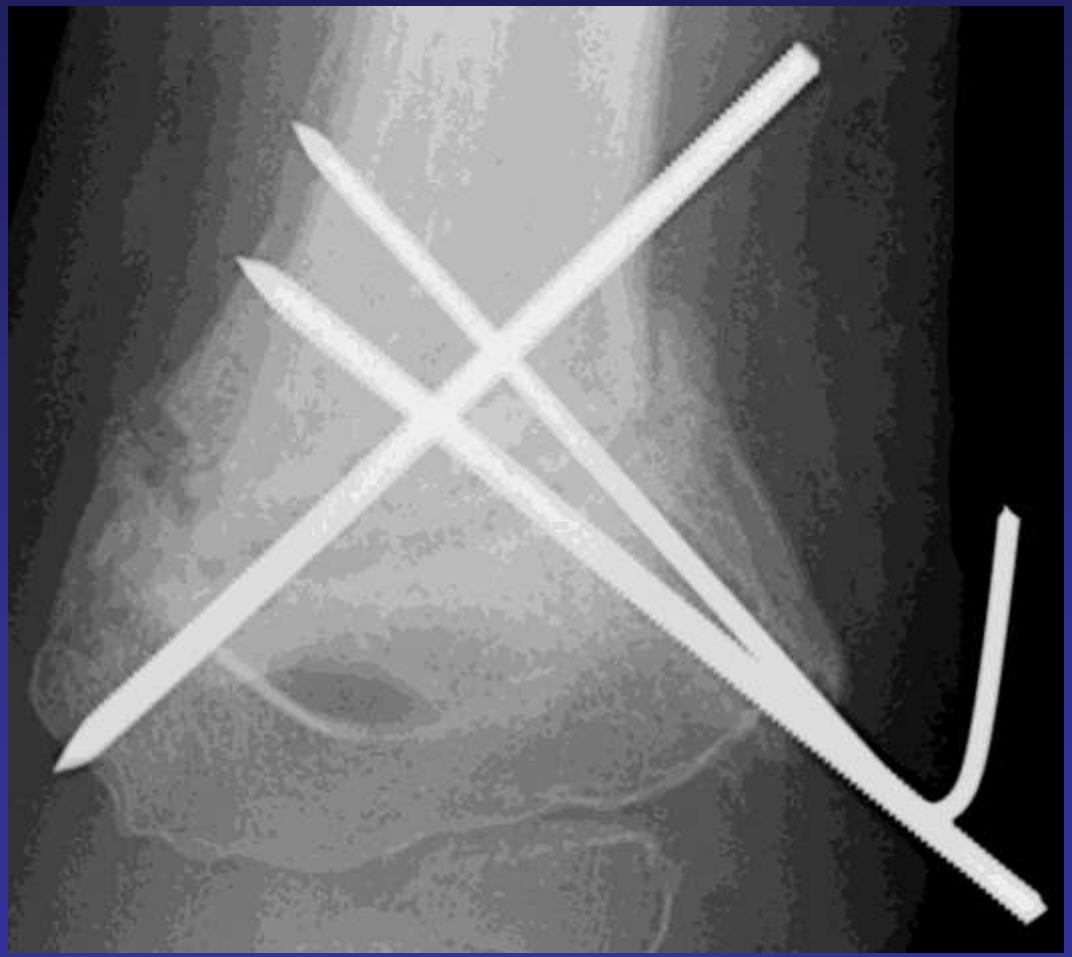
Pin

- Steinmann pin
  - Fracture fixation
  - Guides for screws
  - External fixation
  - Traction



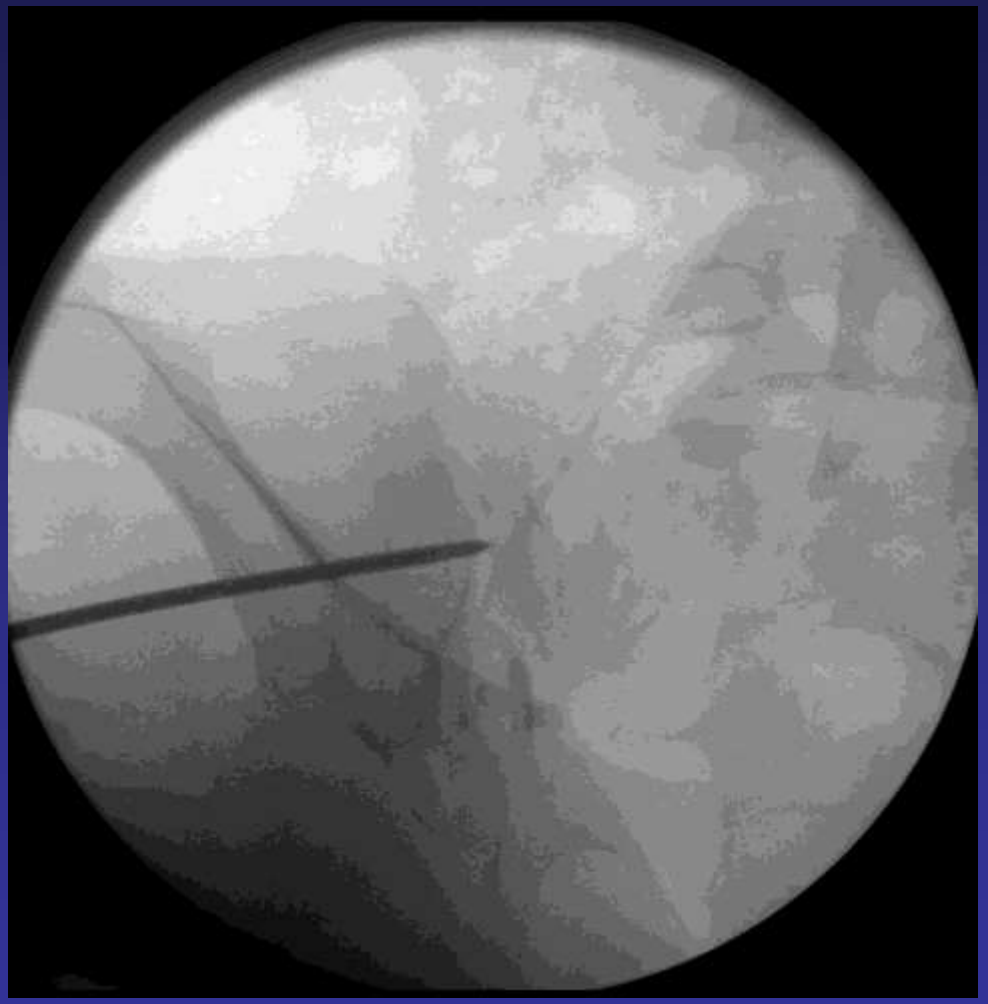
Pin

- Steinmann pin



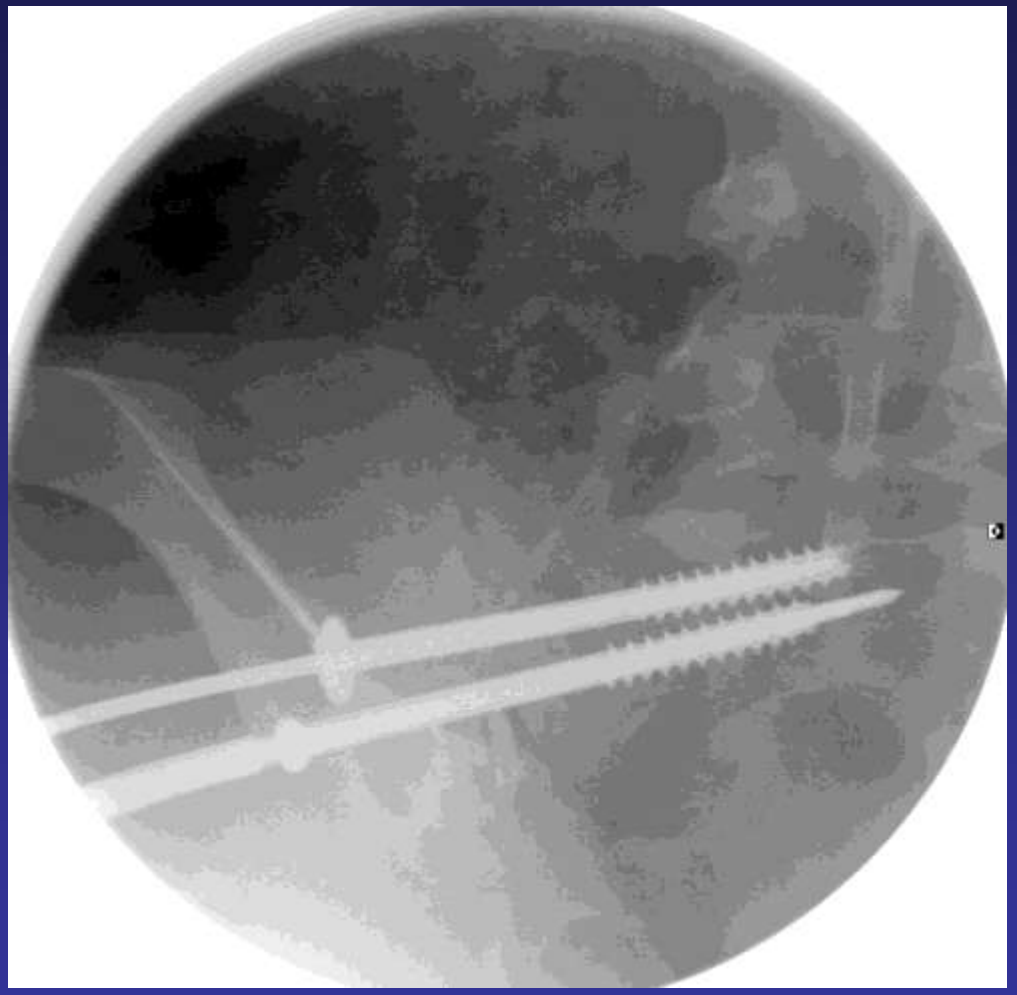
Pin

- Steinmann pin



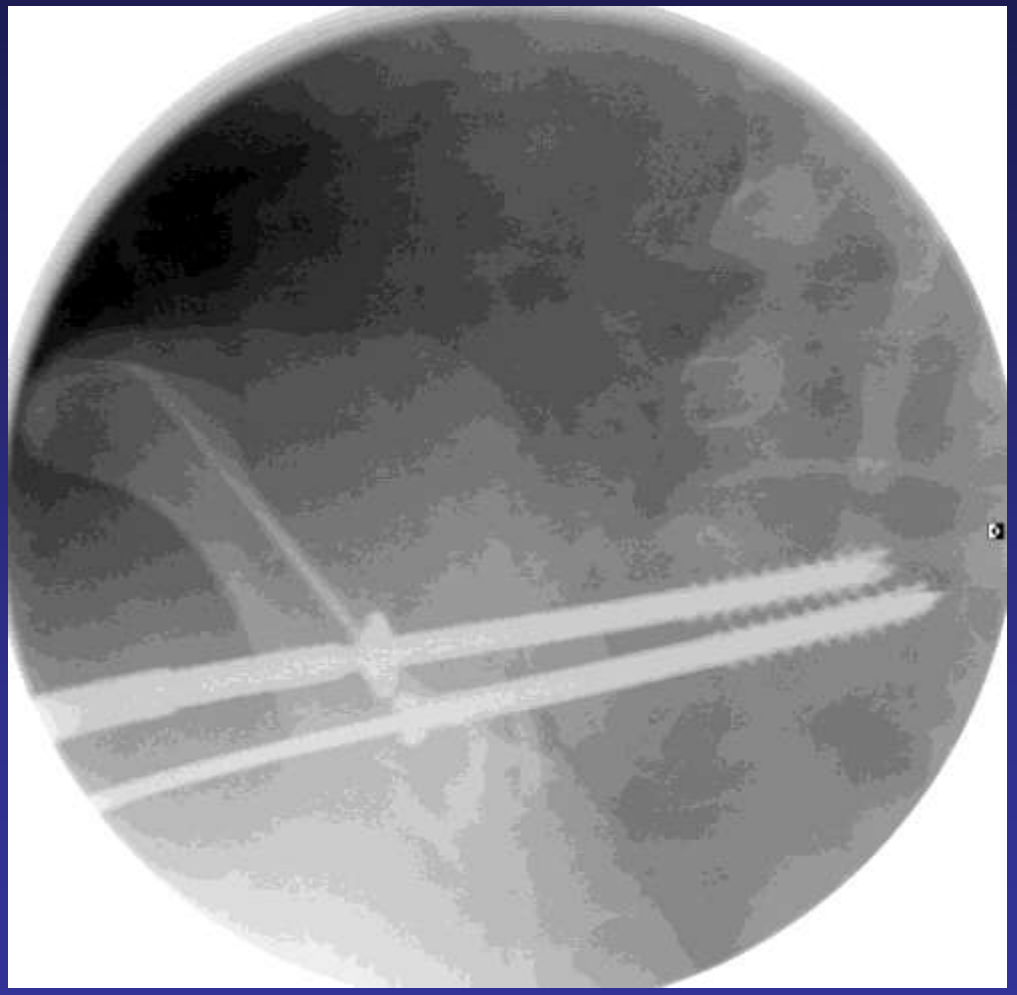
Pin

- Steinmann pin



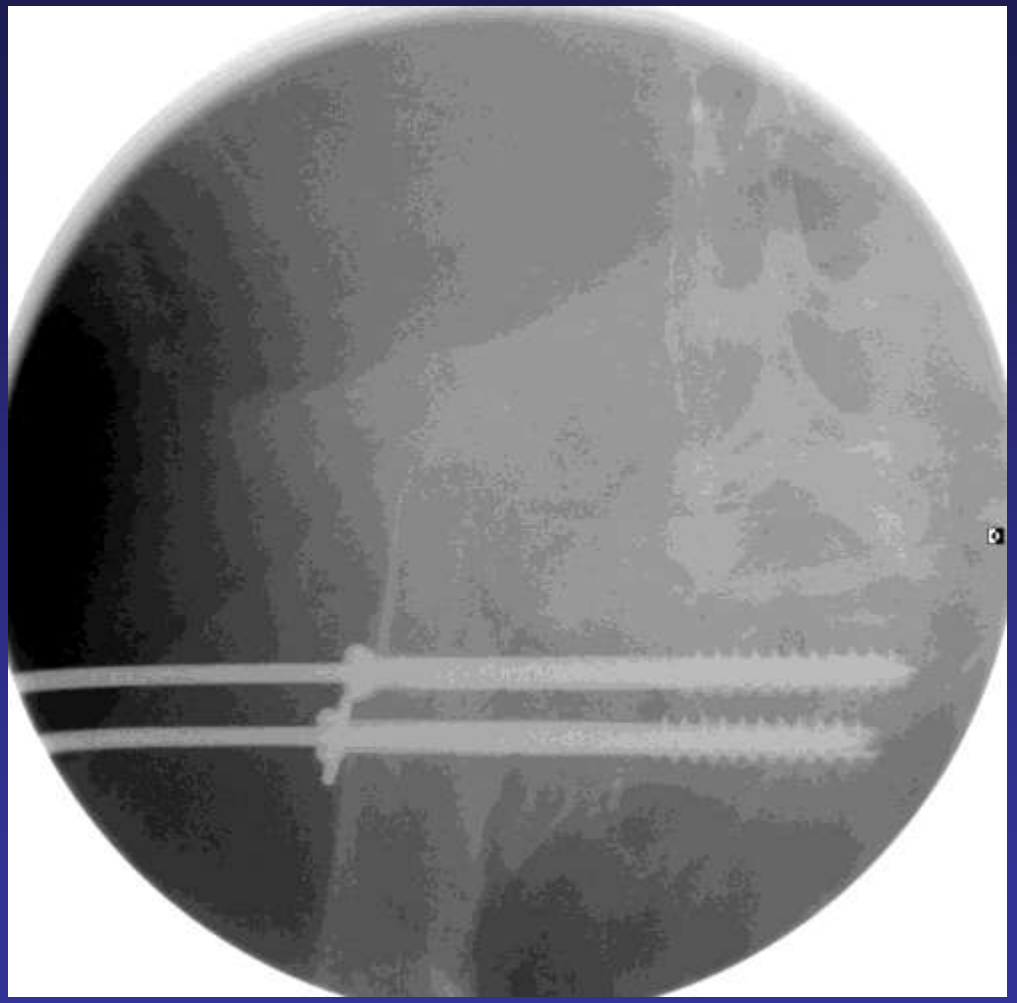
Pin

- Steinmann pin



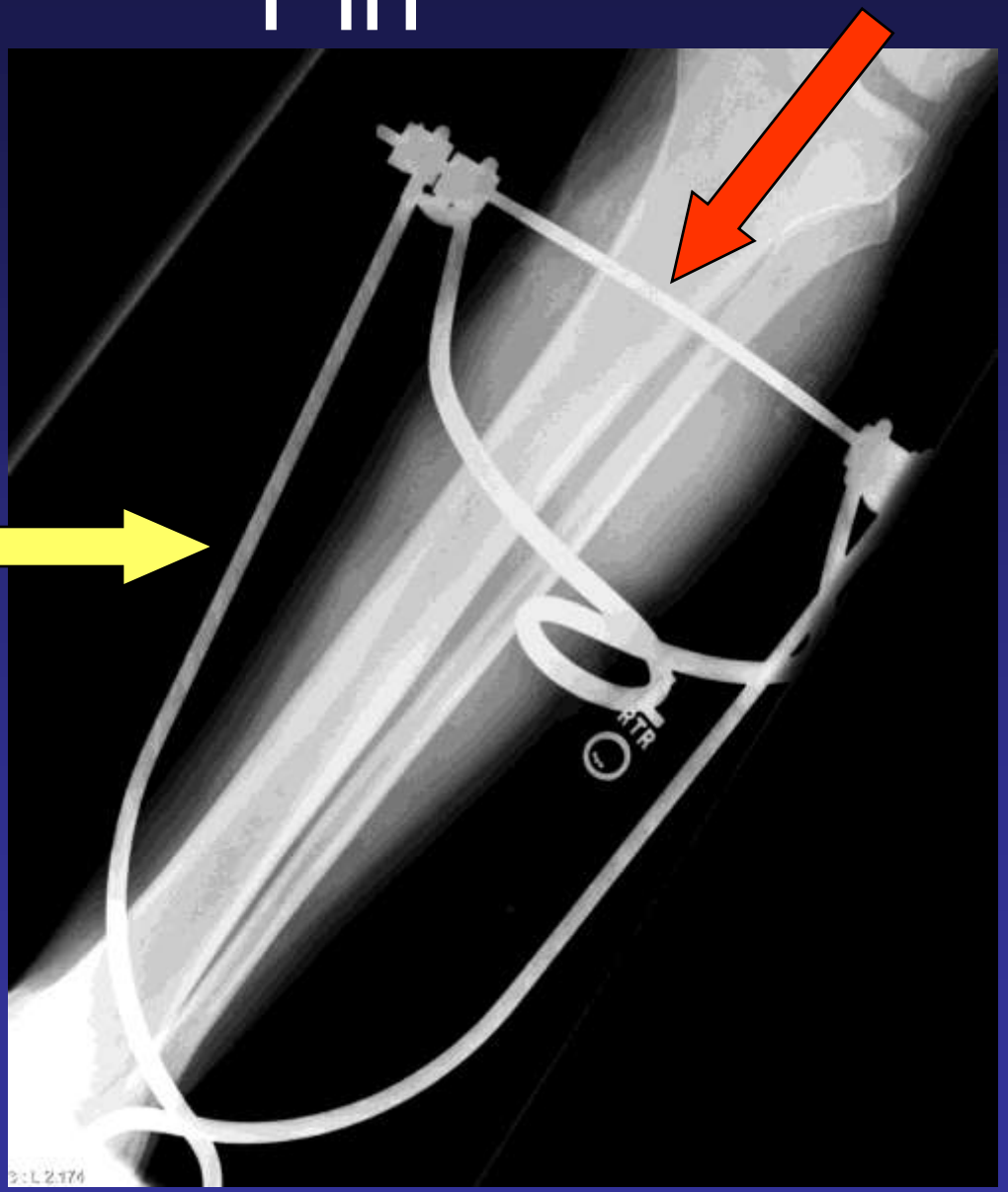
Pin

- Steinmann pin



Pin

- Traction pin
- Traction bow
- 2.5cm posterior and inferior to tibial tubercle



Pin

- Traction with K-wire

Screws

Screws

- Come in various sizes (length, thickness)
- Basic types
  - Cortical
  - Cancellous

Screws

- Cortical

Screws

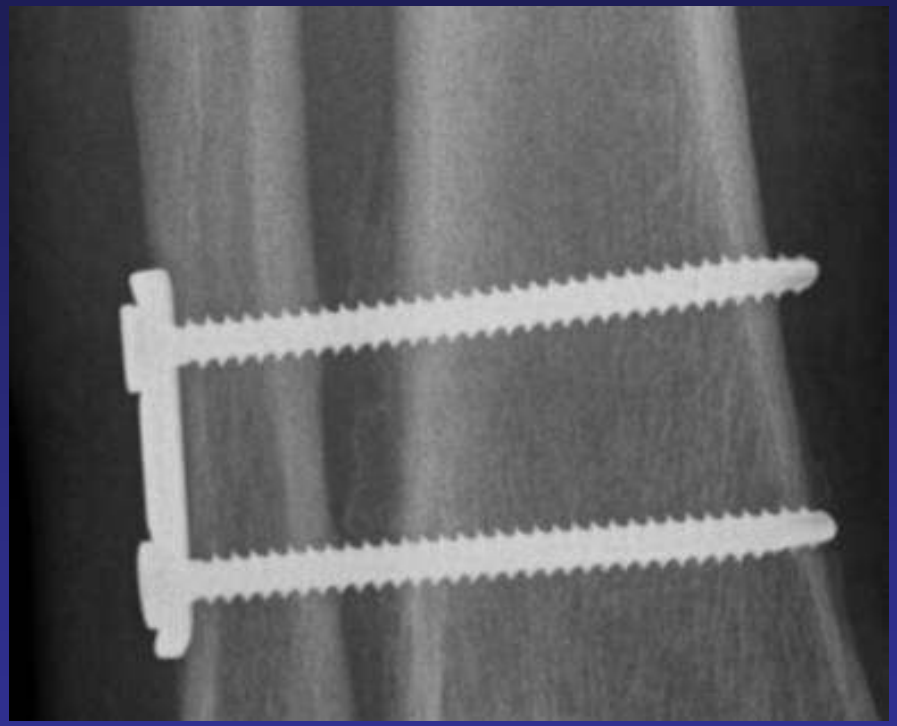
- Cancellous

Screws

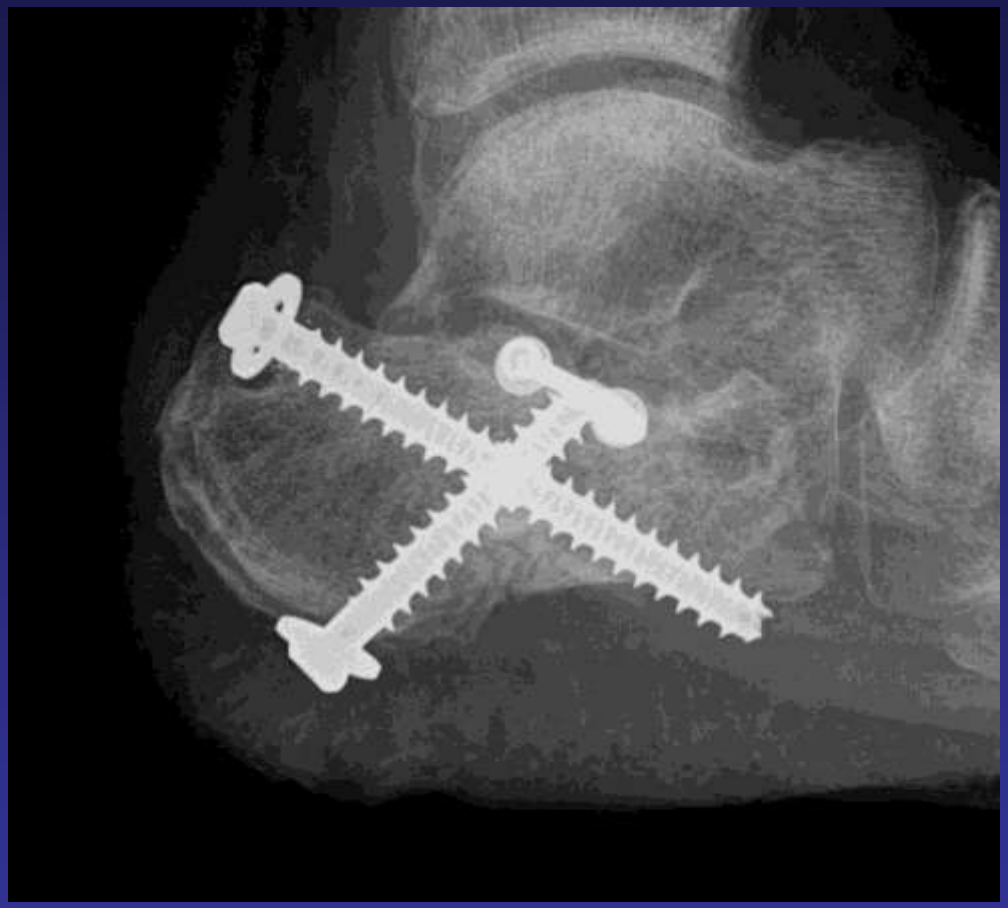
Cortical Screw

Cancellous Screw

Screws

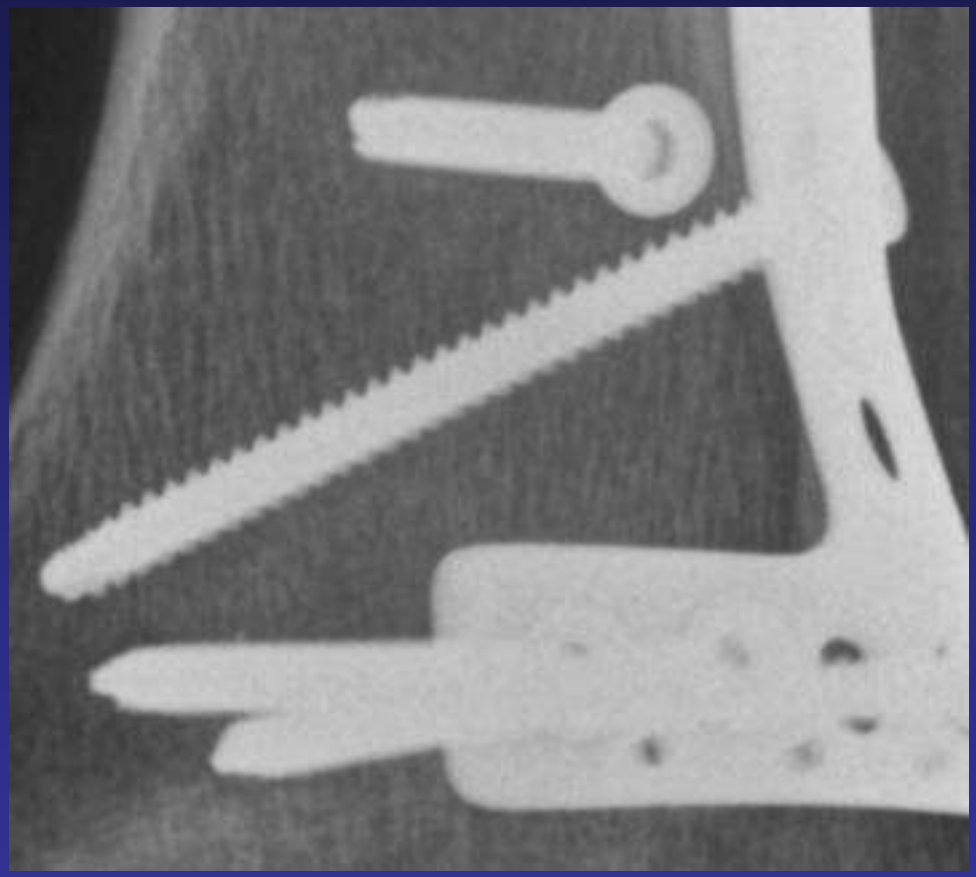


Cortical Screw

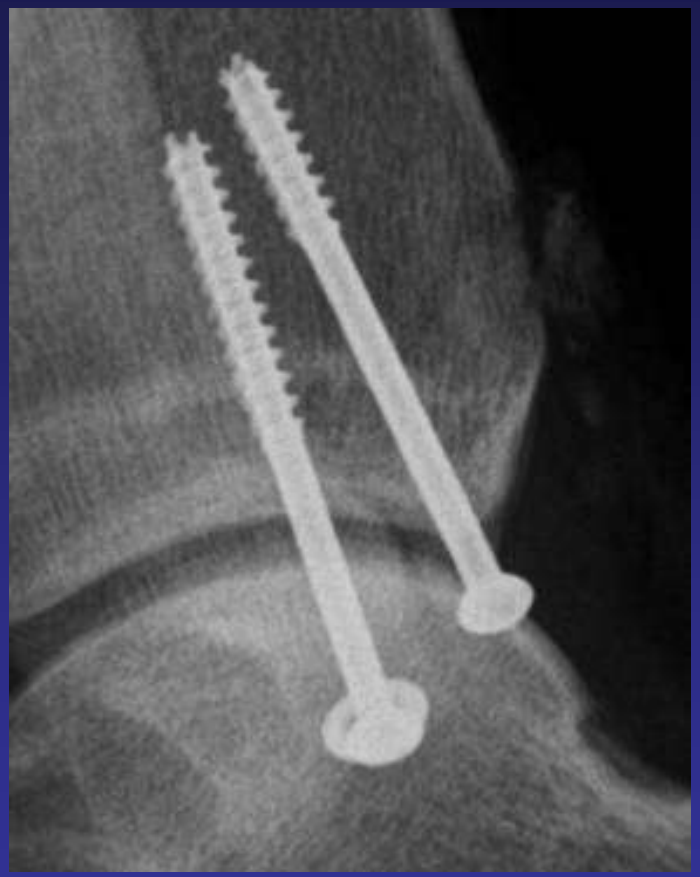


Cancellous Screw

Screws



Cortical Screw



Cancellous Screw

Screws

Cortical Screw

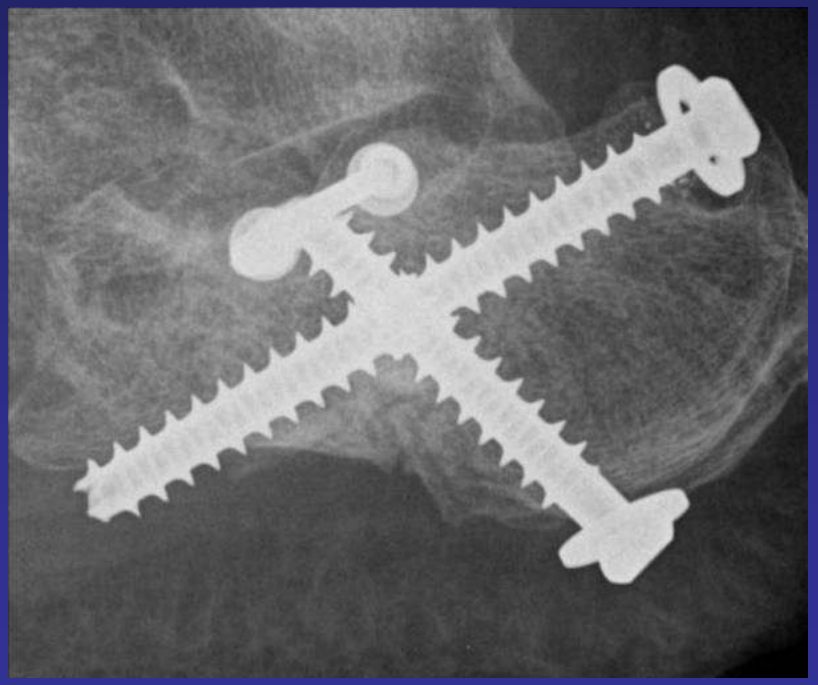
Cancellous Screw

Screws

- Types of cancellous screws
  - Fully-threaded
  - Partially-threaded (Lag)

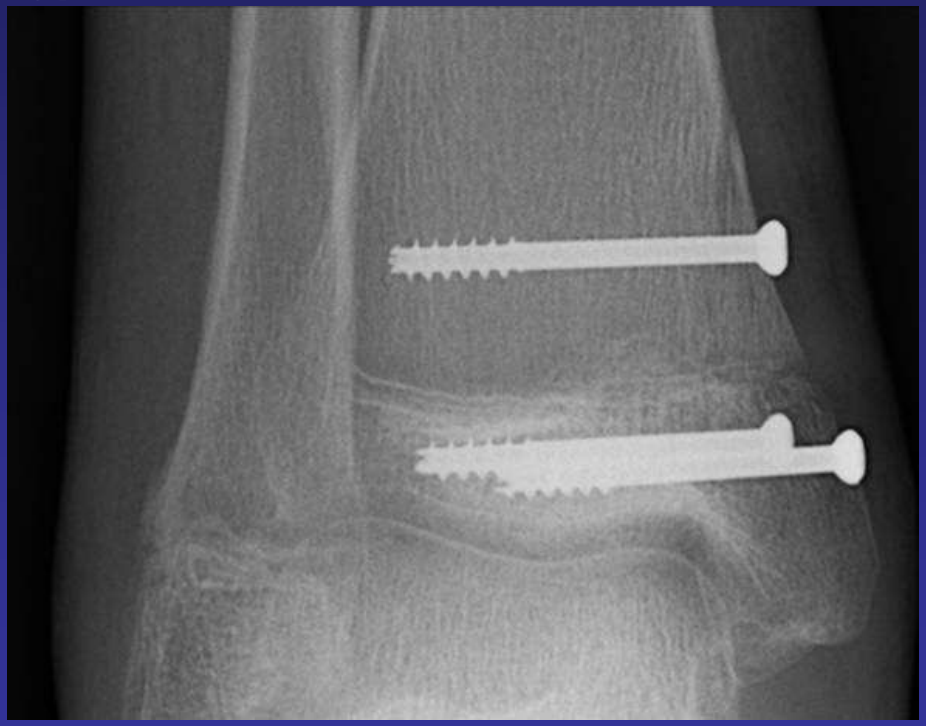
Screws

- Cancellous
  - Fully-threaded



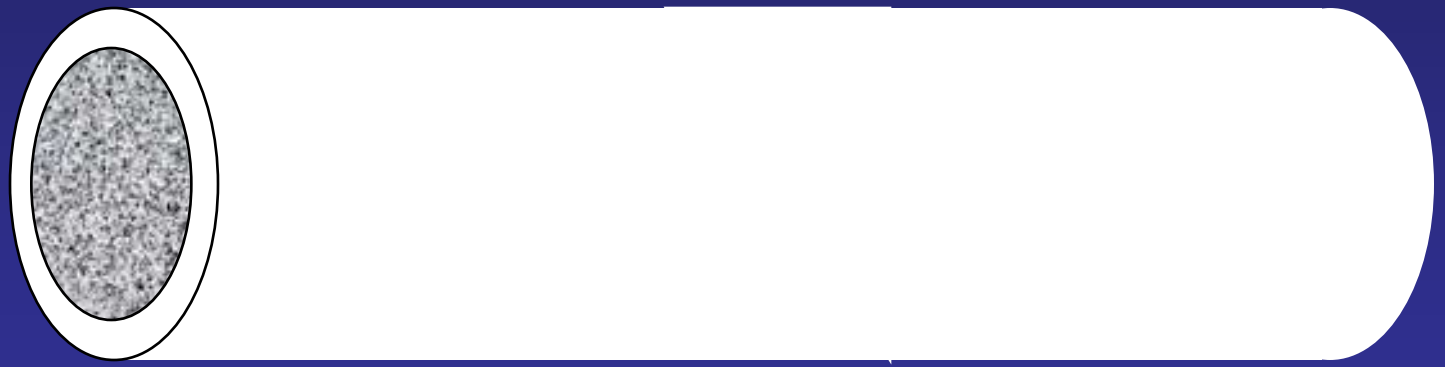
Screws

- Cancellous
  - Partially-threaded (Lag)



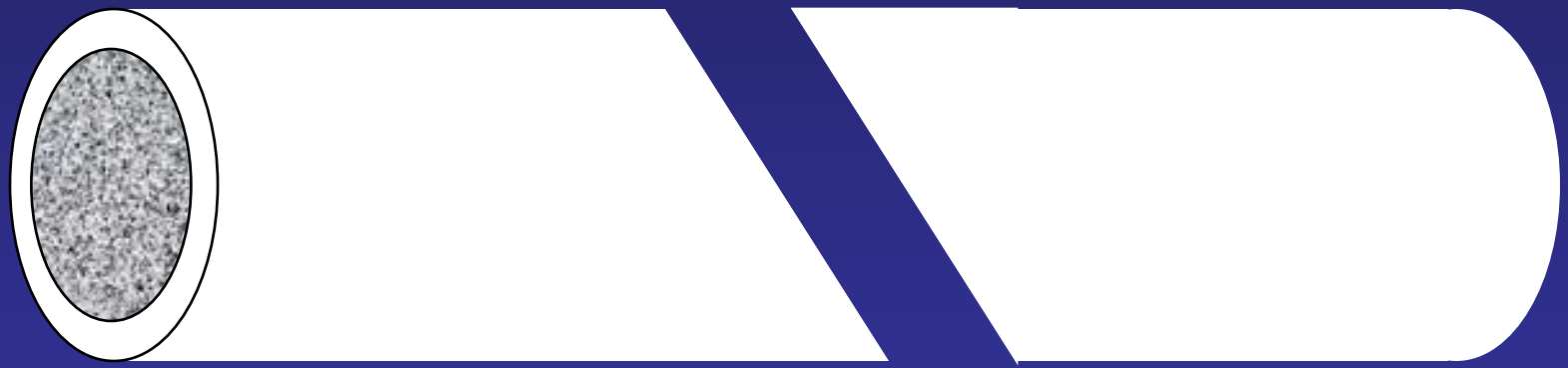
Screws

- Cancellous
  - Principle of lagging



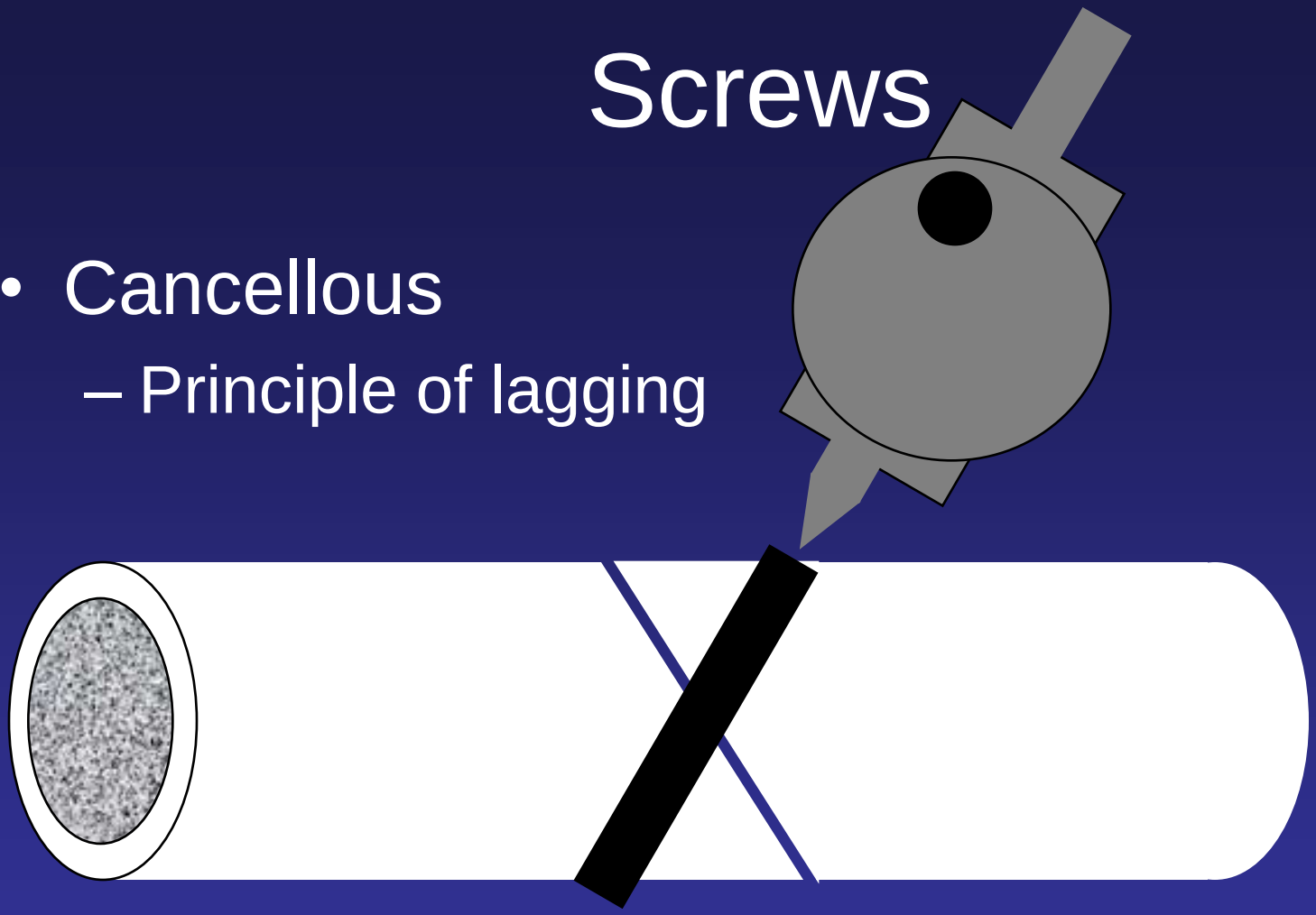
Screws

- Cancellous
  - Principle of lagging



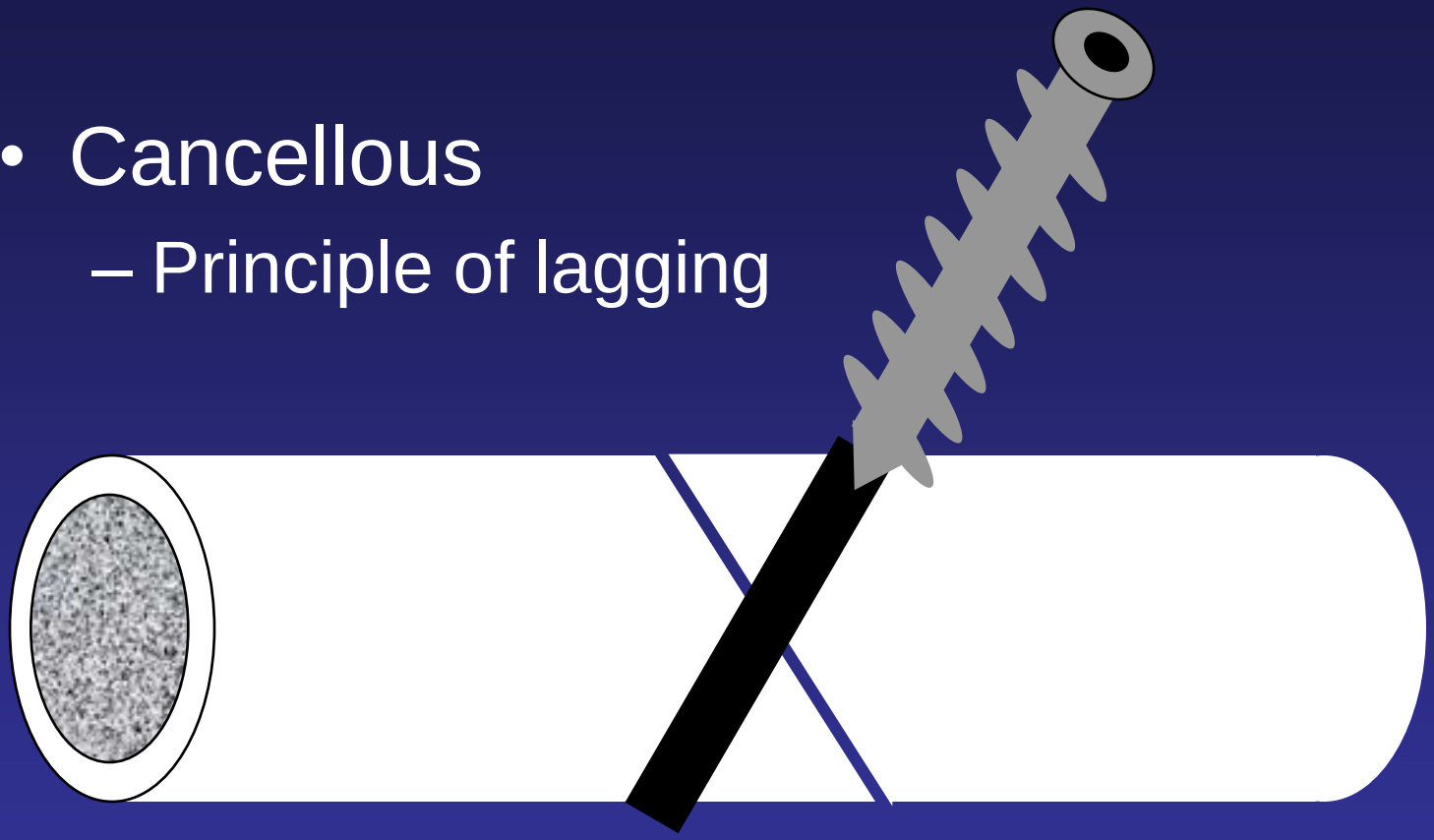
Screws

- Cancellous
  - Principle of lagging



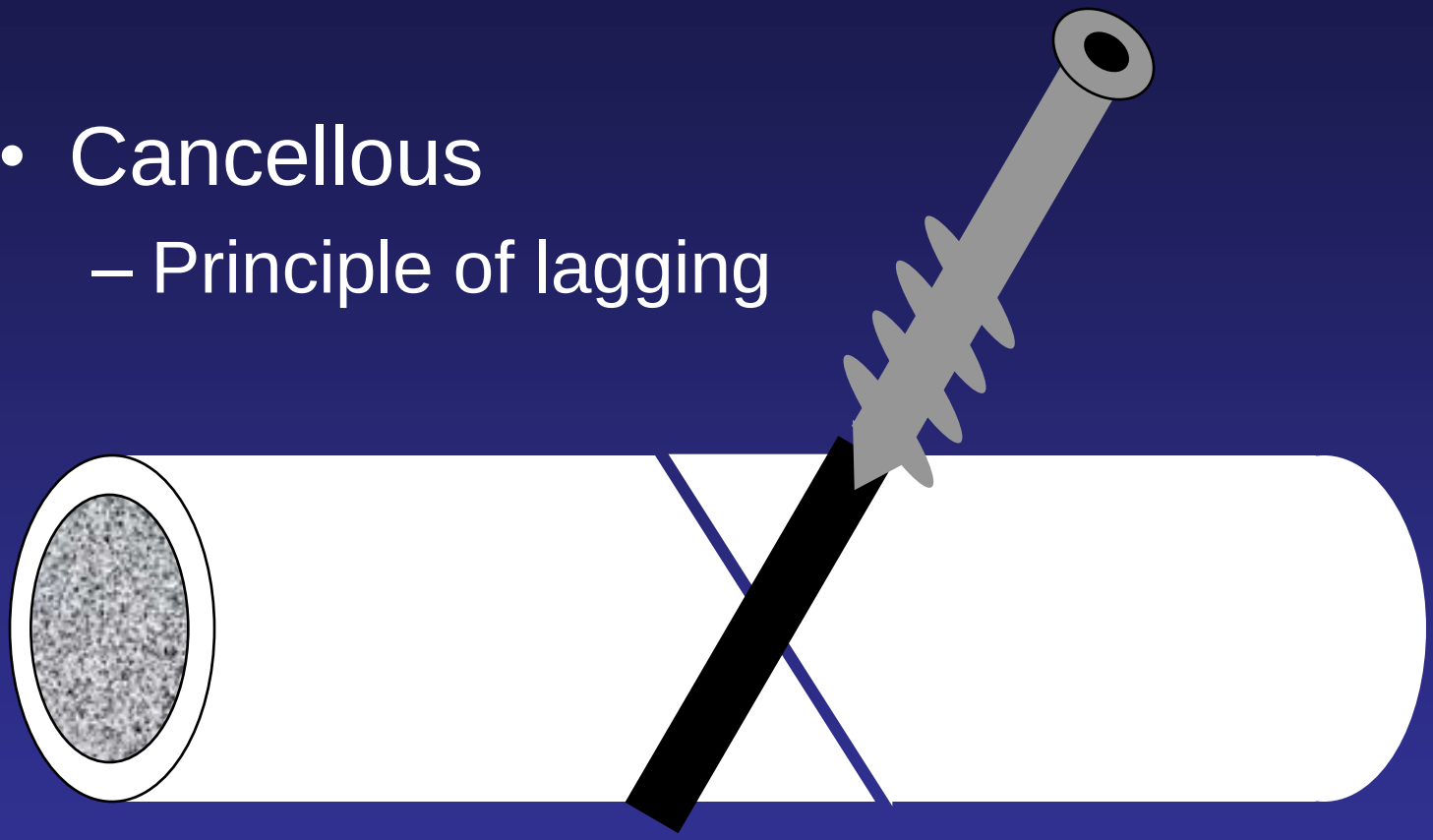
Screws

- Cancellous
  - Principle of lagging



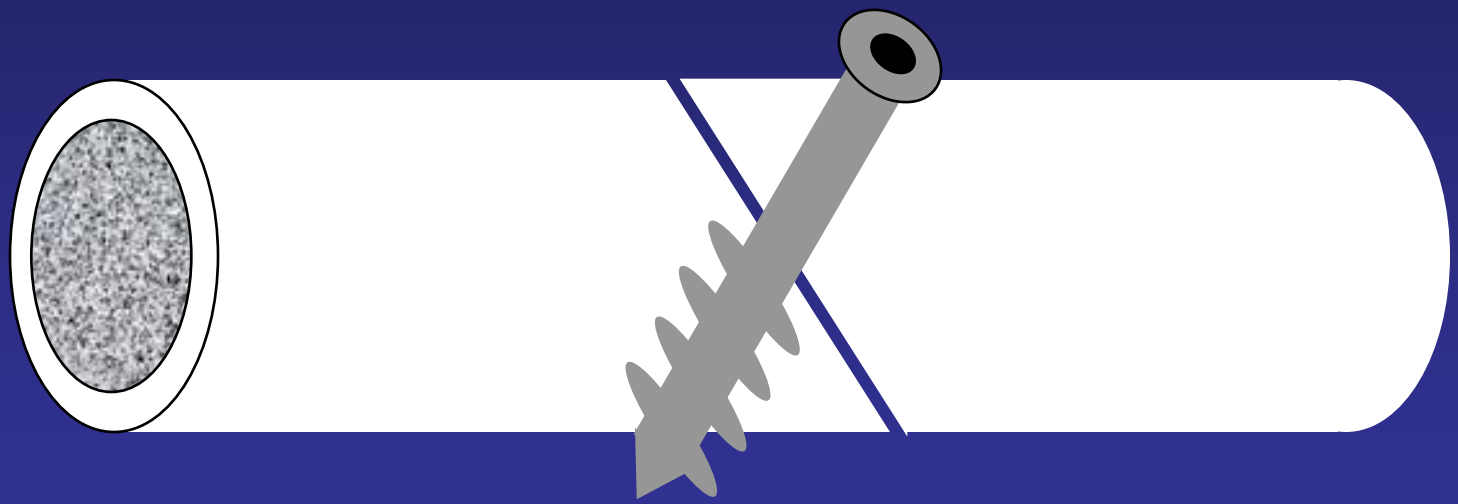
Screws

- Cancellous
  - Principle of lagging



Screws

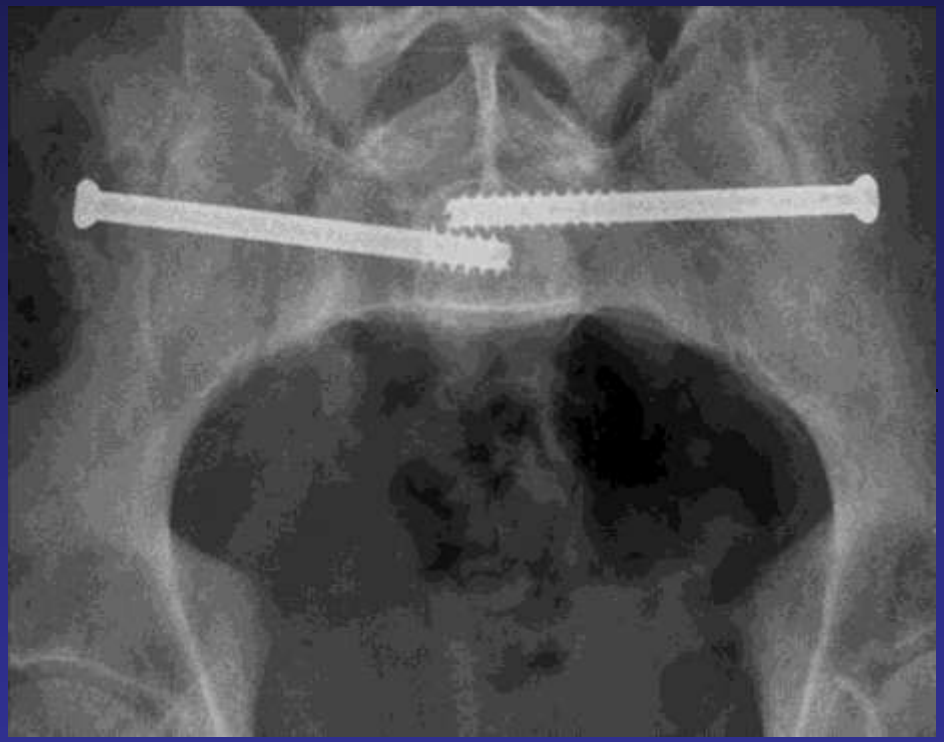
- Cancellous
  - Principle of lagging



Screws

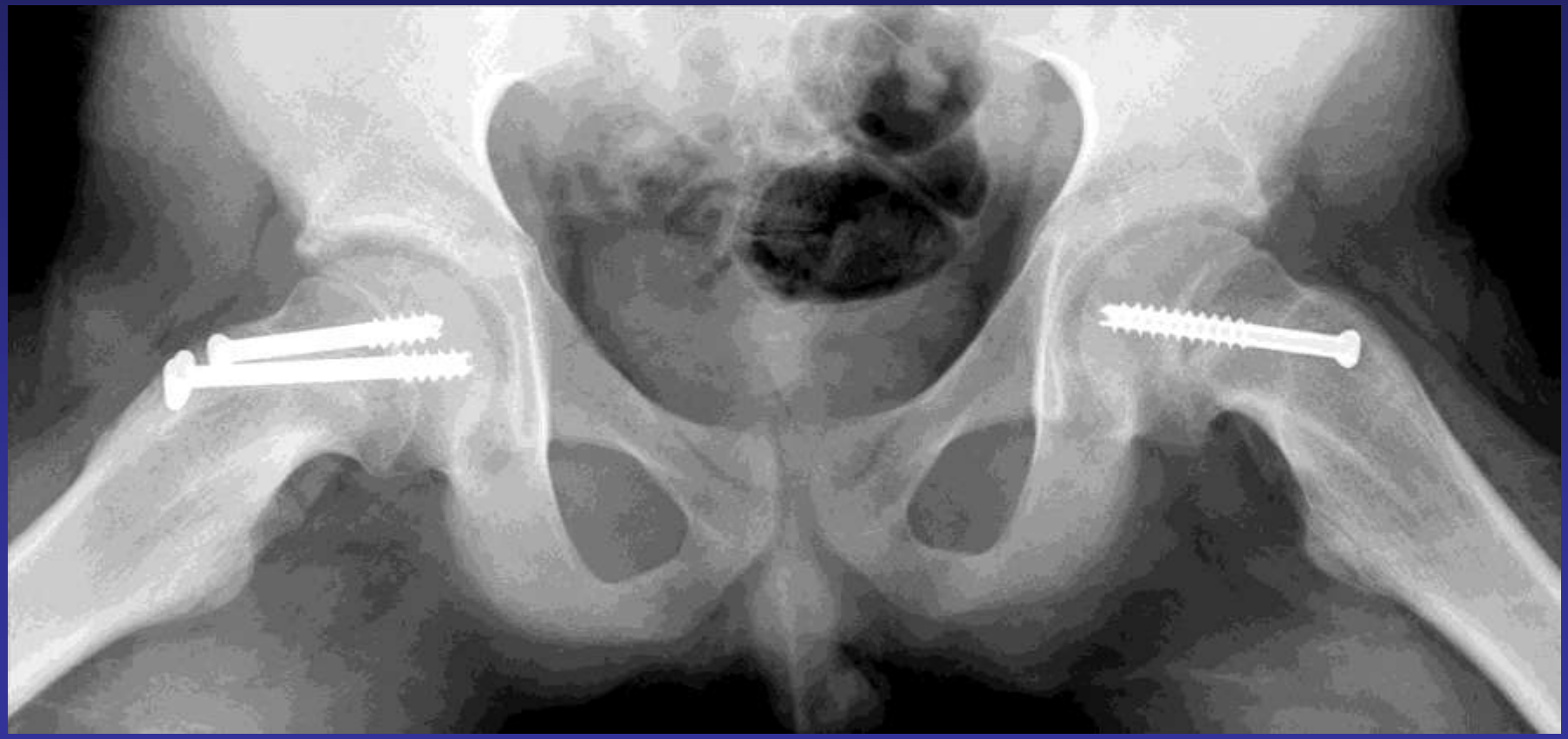
Screws

Screws



Screws

- Bad Lag Screws

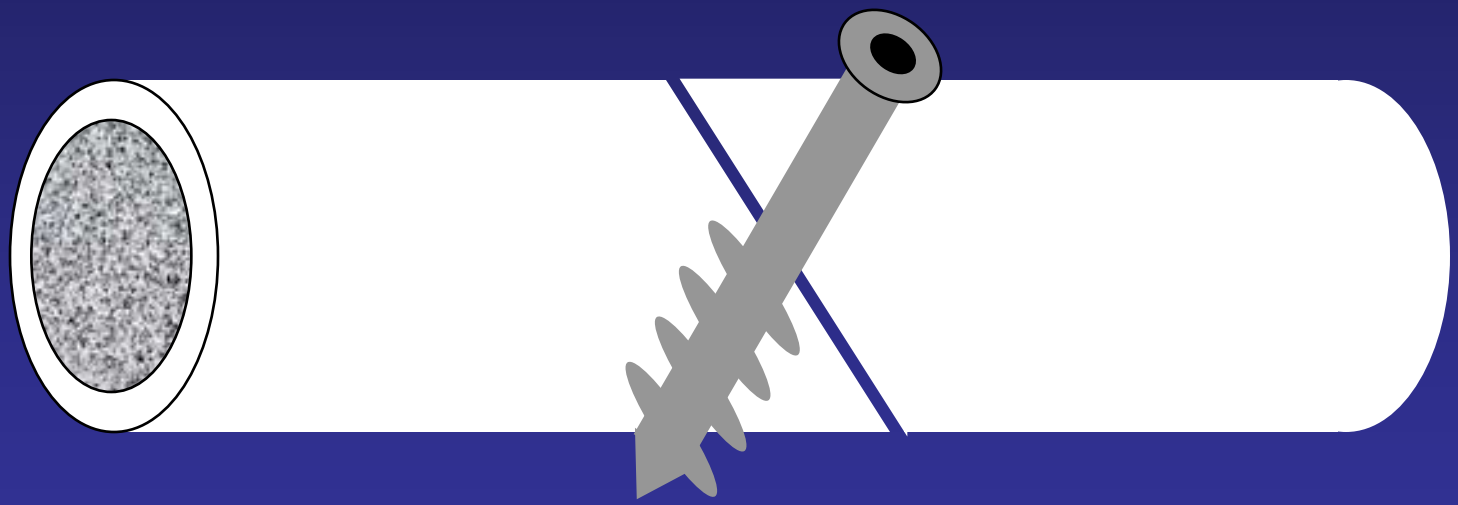


Screws

- Specific screw uses
  - Interfragmentary
  - Plate fixation
  - Syndesmotic
  - Locking
  - Derotation

Screws

- Specific screw uses
  - Interfragmentary



Screws

- Specific screw uses
  - Interfragmentary

Screws

- Specific screw uses
  - Interfragmentary

Screws

- Specific screw uses
  - Interfragmentary

Screws

- Specific screw uses
  - Plate fixation

Screws

- Specific screw uses
  - Syndesmotic

Screws

- Specific screw uses
  - Syndesmotic

Screws

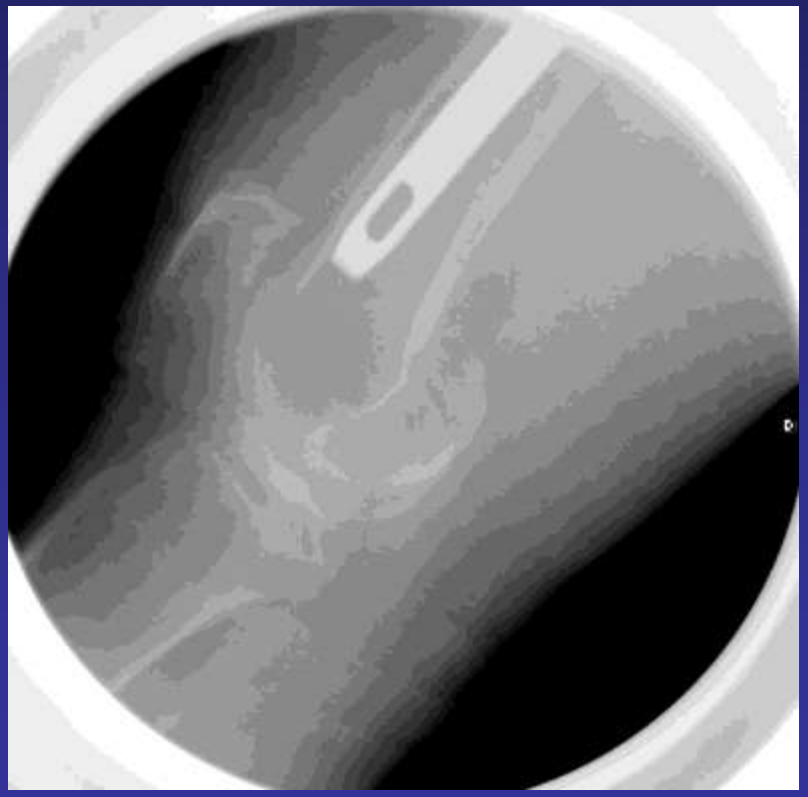
- Specific screw uses
  - Syndesmotic

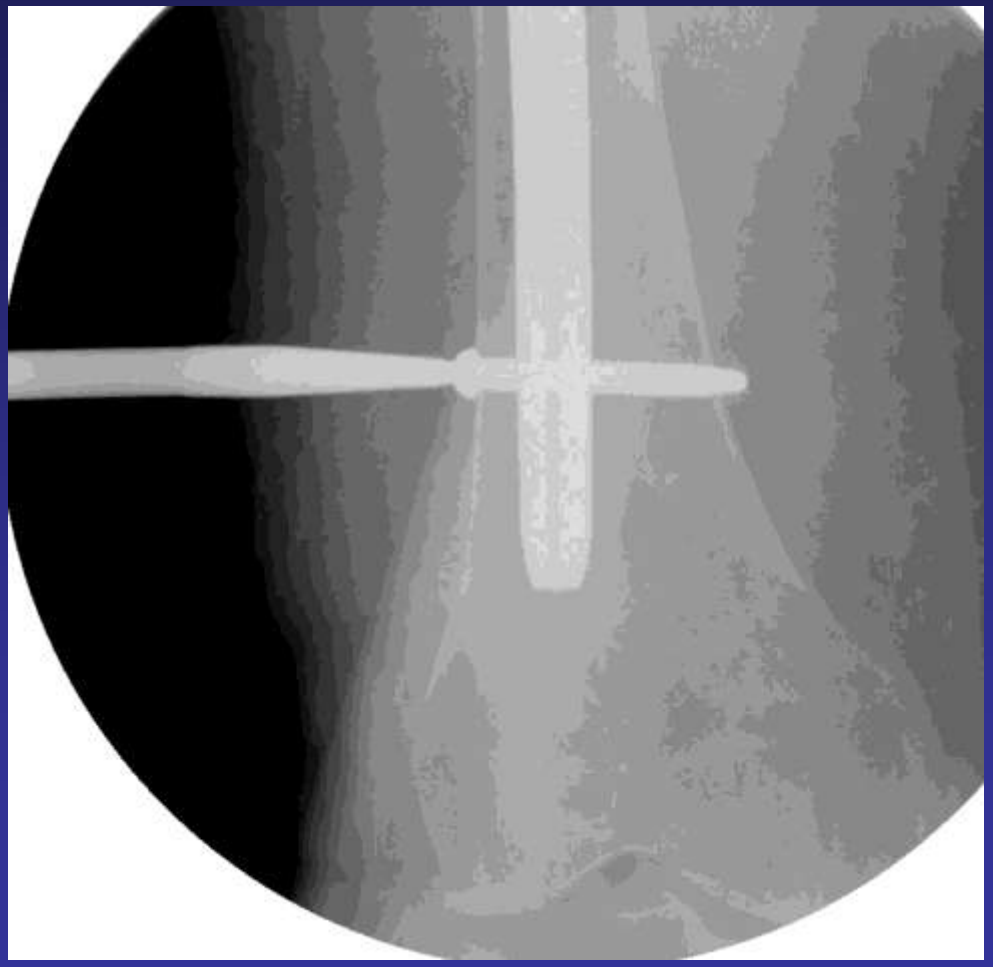
Screws

- Specific screw uses
  - Locking

Screws

- Specific screw uses
  - Locking





Screws

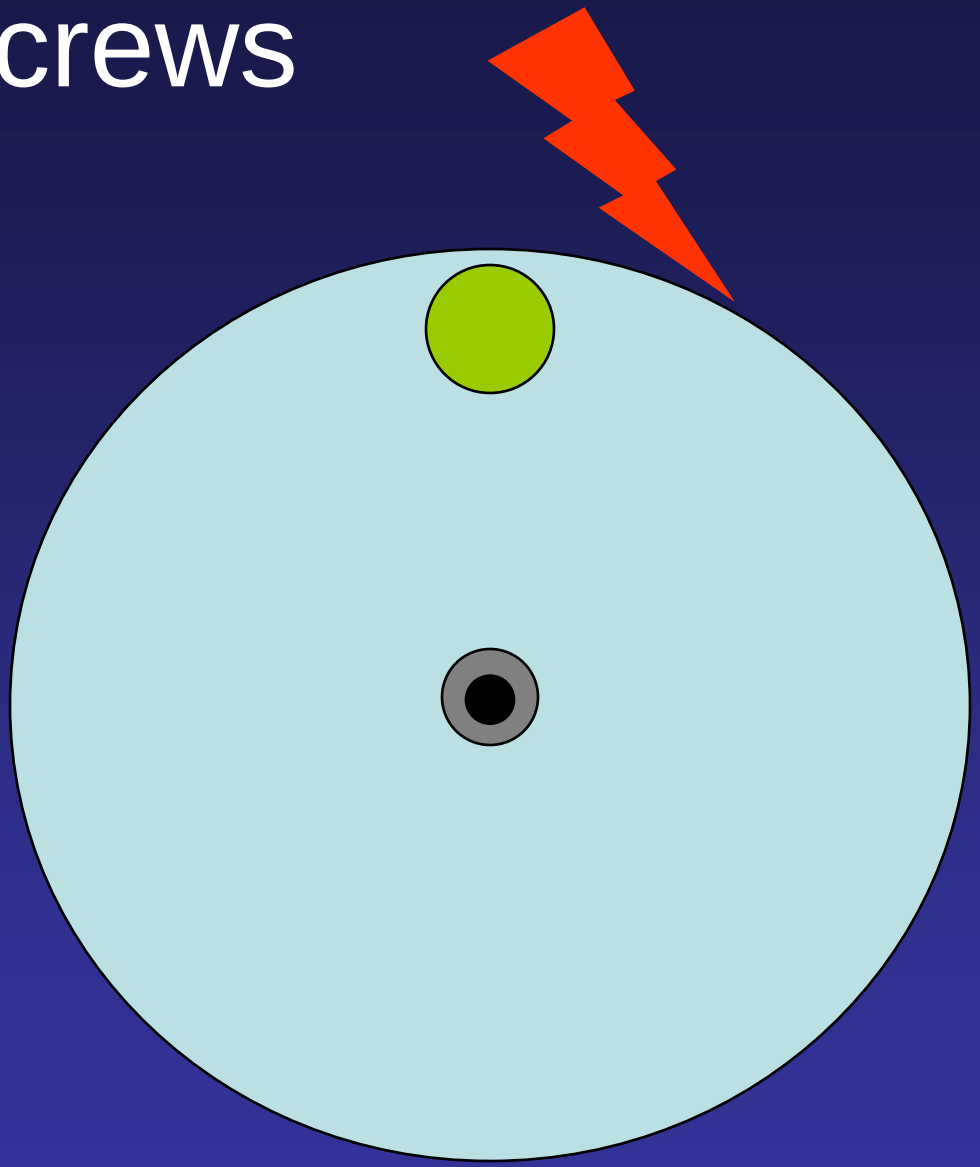
- Specific screw uses
  - Locking

Screws

- Specific screw uses
  - Dynamization
    - Removal of distal locking screw(s) to allow compression at fracture site with weight-bearing

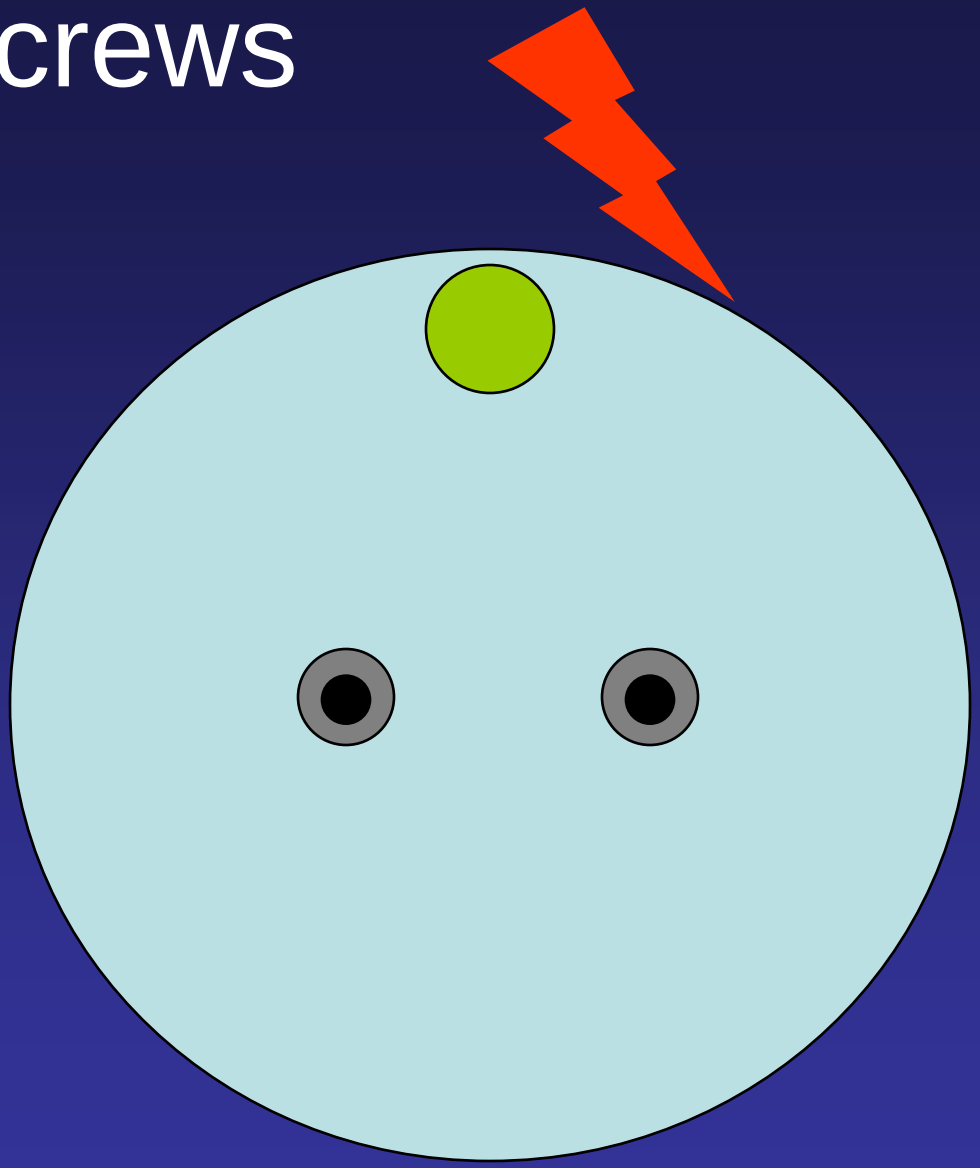
Screws

- Specific screw uses
  - Derotation



Screws

- Specific screw uses
  - Derotation



Screws

- Specific screw uses
  - Derotation

Screws

- Specific screw uses
  - Derotation

Screws

- Special screws
  - Headless
  - Interference
  - Dynamic Hip Screw (DHS)

Screws

- Headless-compression with single screw
  - Herbert
  - Acutrak –variable pitch

Screws

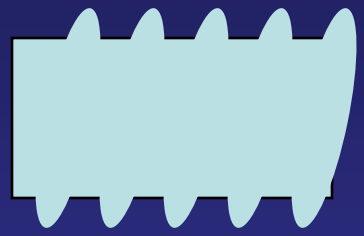
- Headless
  - Herbert

Screws

- Interference

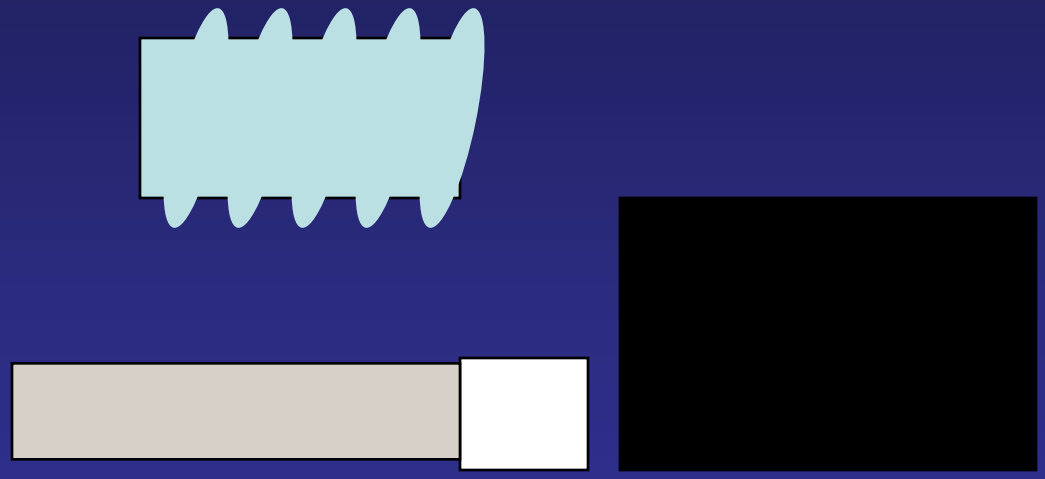
Screws

- Interference



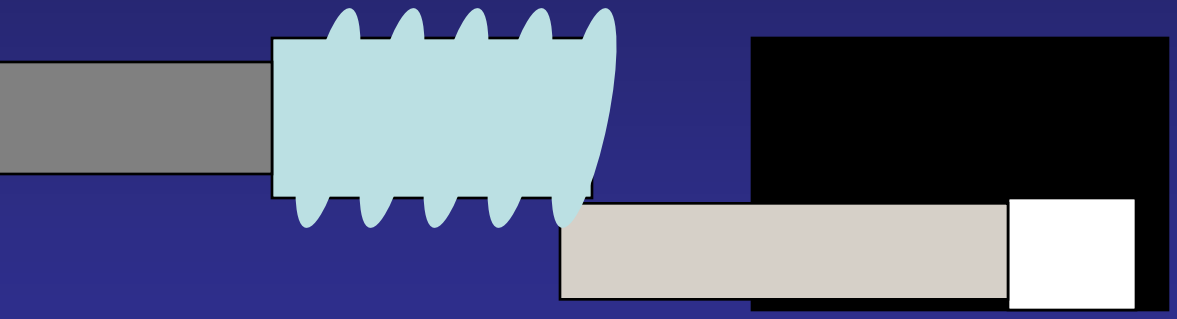
Screws

- Interference



Screws

- Interference



Screws

- Interference

Screws

- Dynamic Hip Screw
  - Large lag screw attached to side plate
  - Allows dynamic compression of fx with weight-bearing

Internal Fixation Devices

Intramedullary fixation

- Femur – rod
- Tibia – nail
- Humerus – nail
- Flexible – nail

Intramedullary fixation

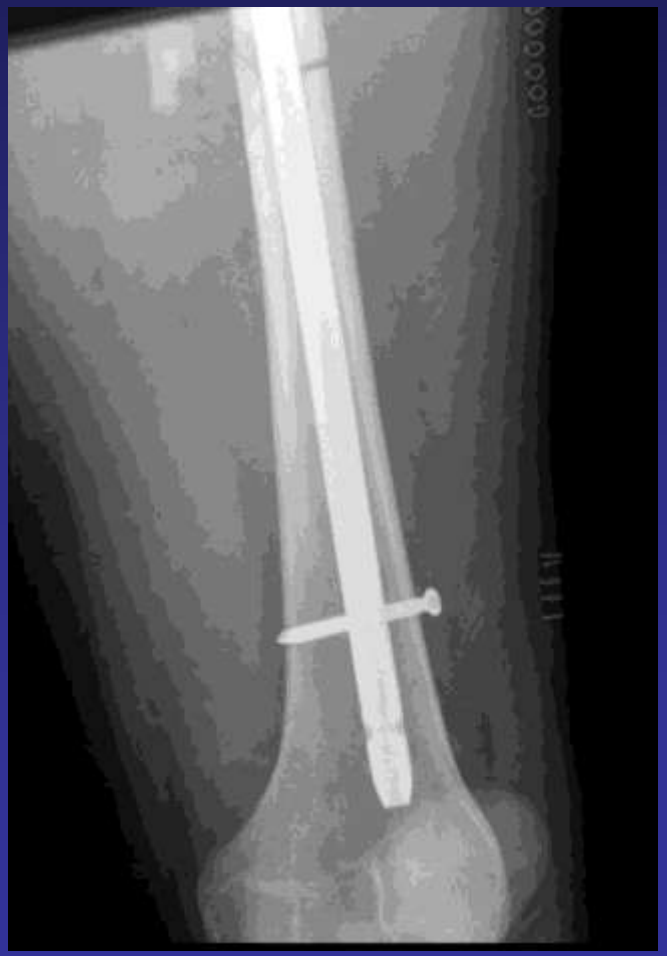
- Principles
  - Maintains alignment of fracture fragments
  - Does not strip periosteum
  - Minimally invasive
    - Bone entry site
    - Small stab incisions for locking screws
  - Can allow for dynamic compression (dynamization)

Intramedullary fixation

- Approaches
  - Anterograde
    - Femur
    - Tibia
    - Humerus
    - Radius
    - Ulna
  - Retrograde
    - Femur only

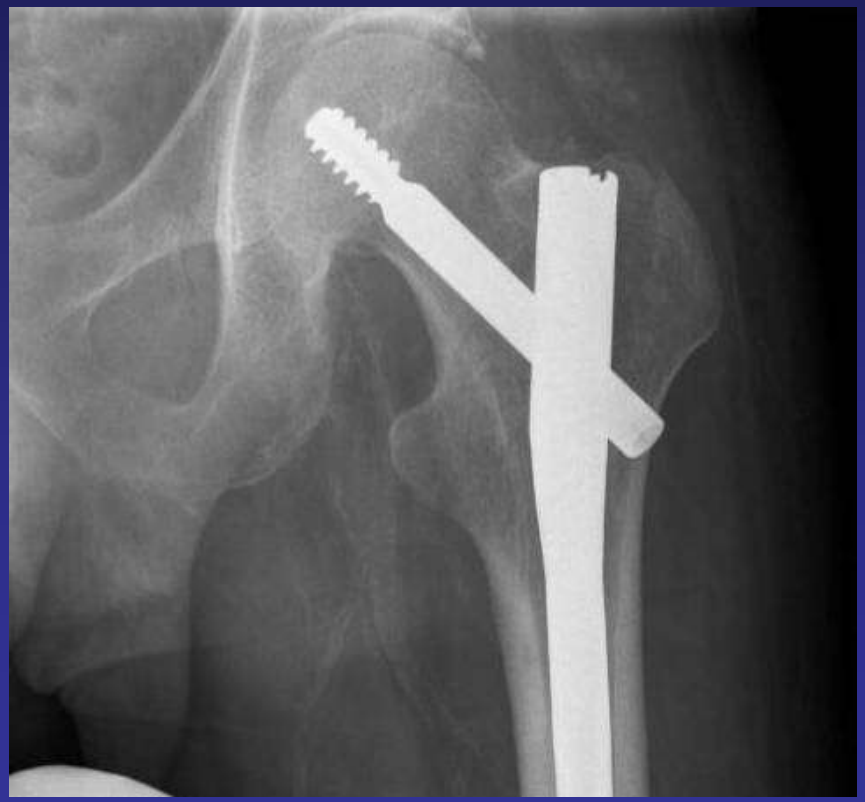
Intramedullary fixation

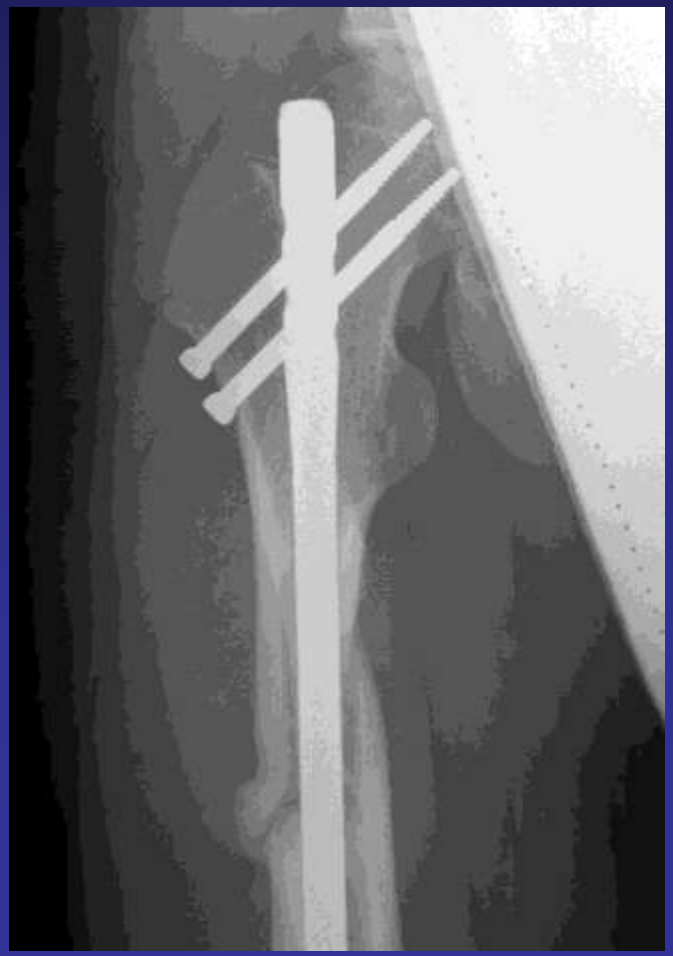
- Femur – rod



Intramedullary fixation

- Femur – rod



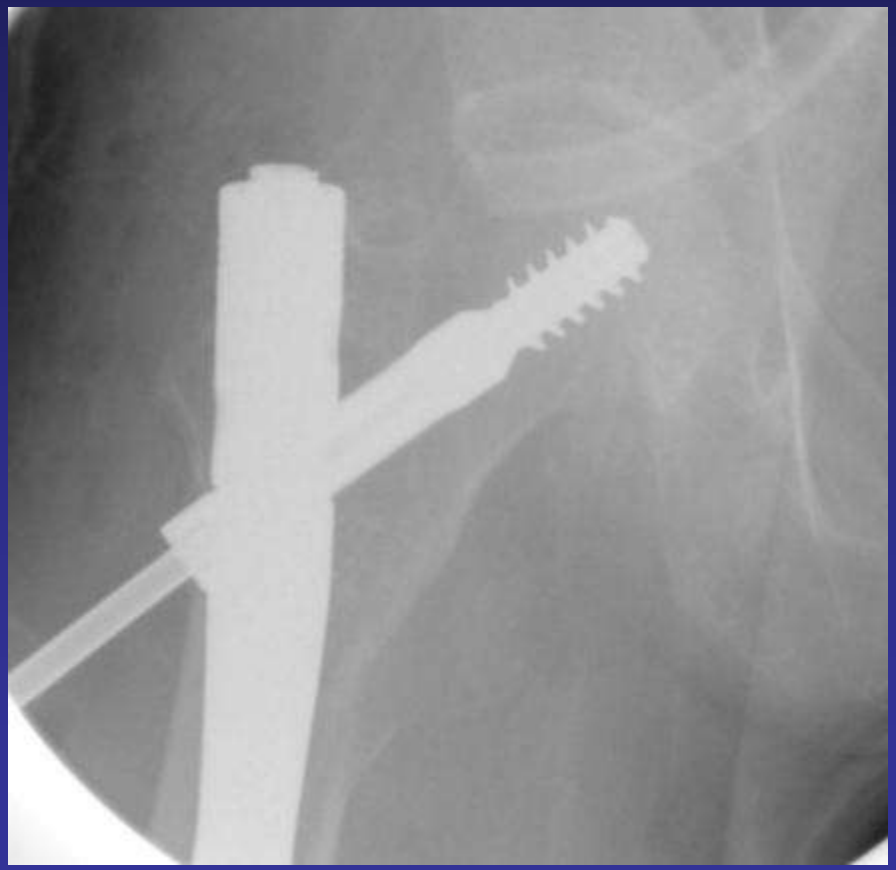


Intramedullary fixation

- Femur – rod

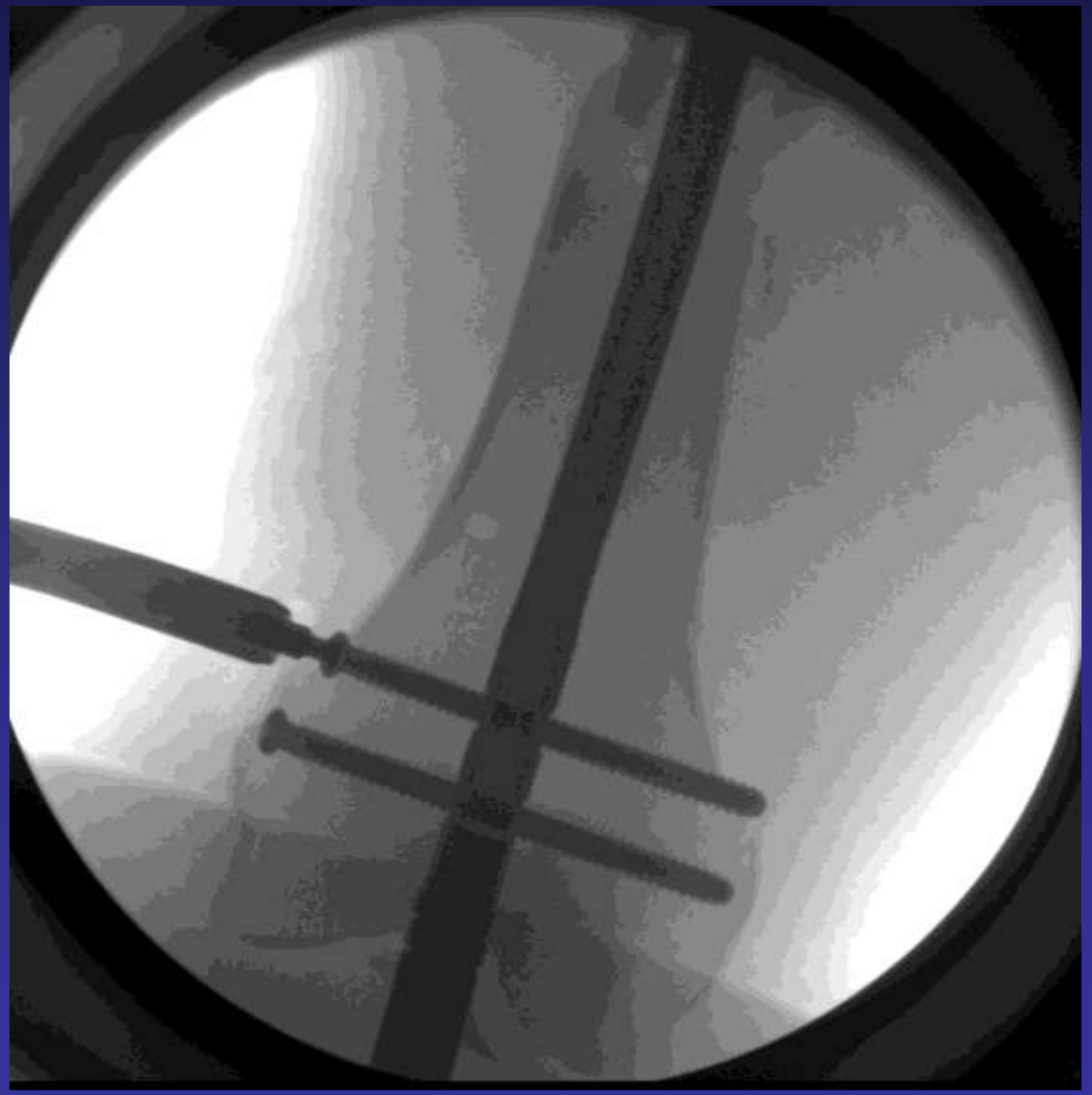
Intramedullary fixation

- Femur – rod



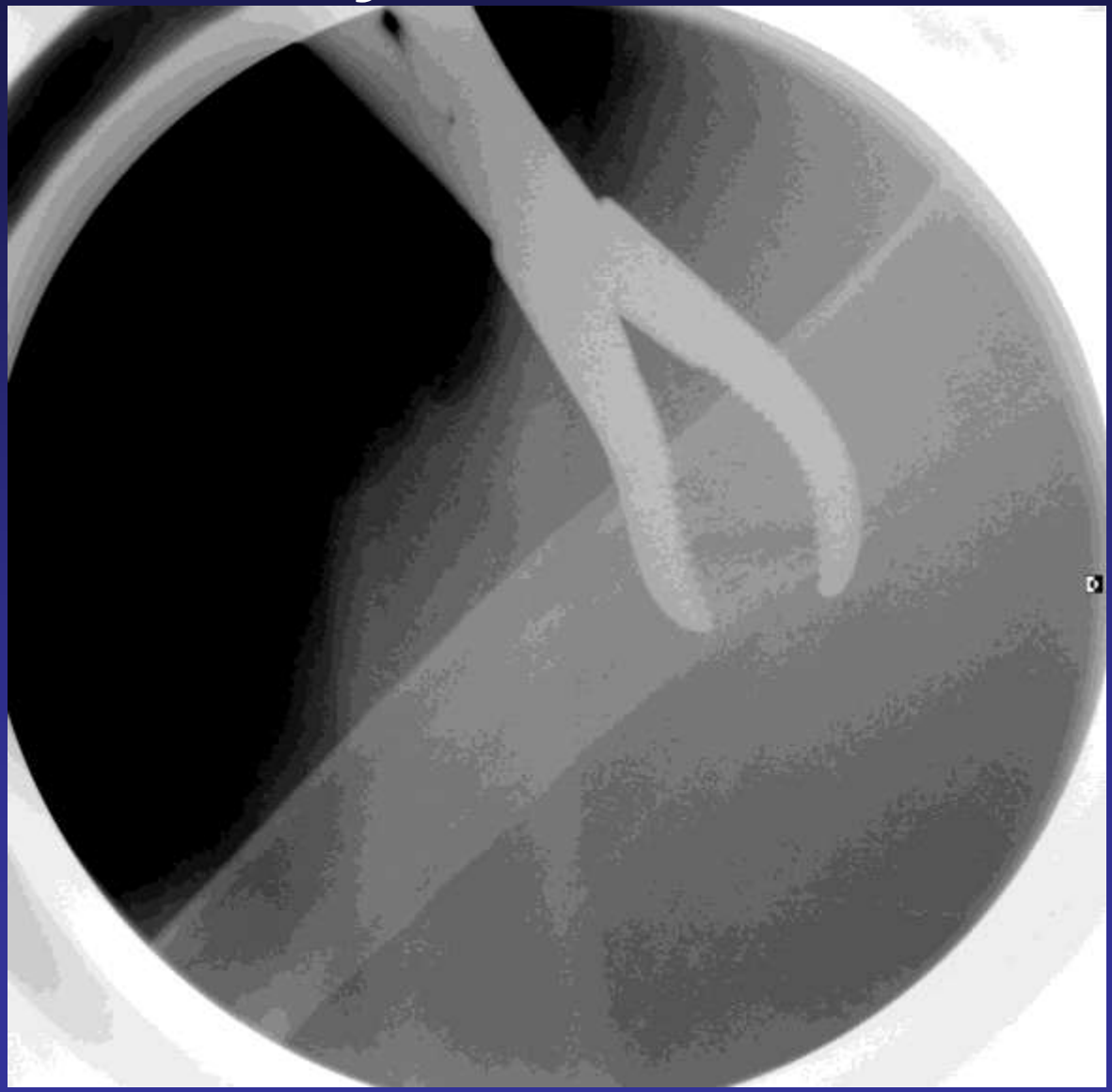
Intramedullary fixation

- Femur – rod
  - retrograde



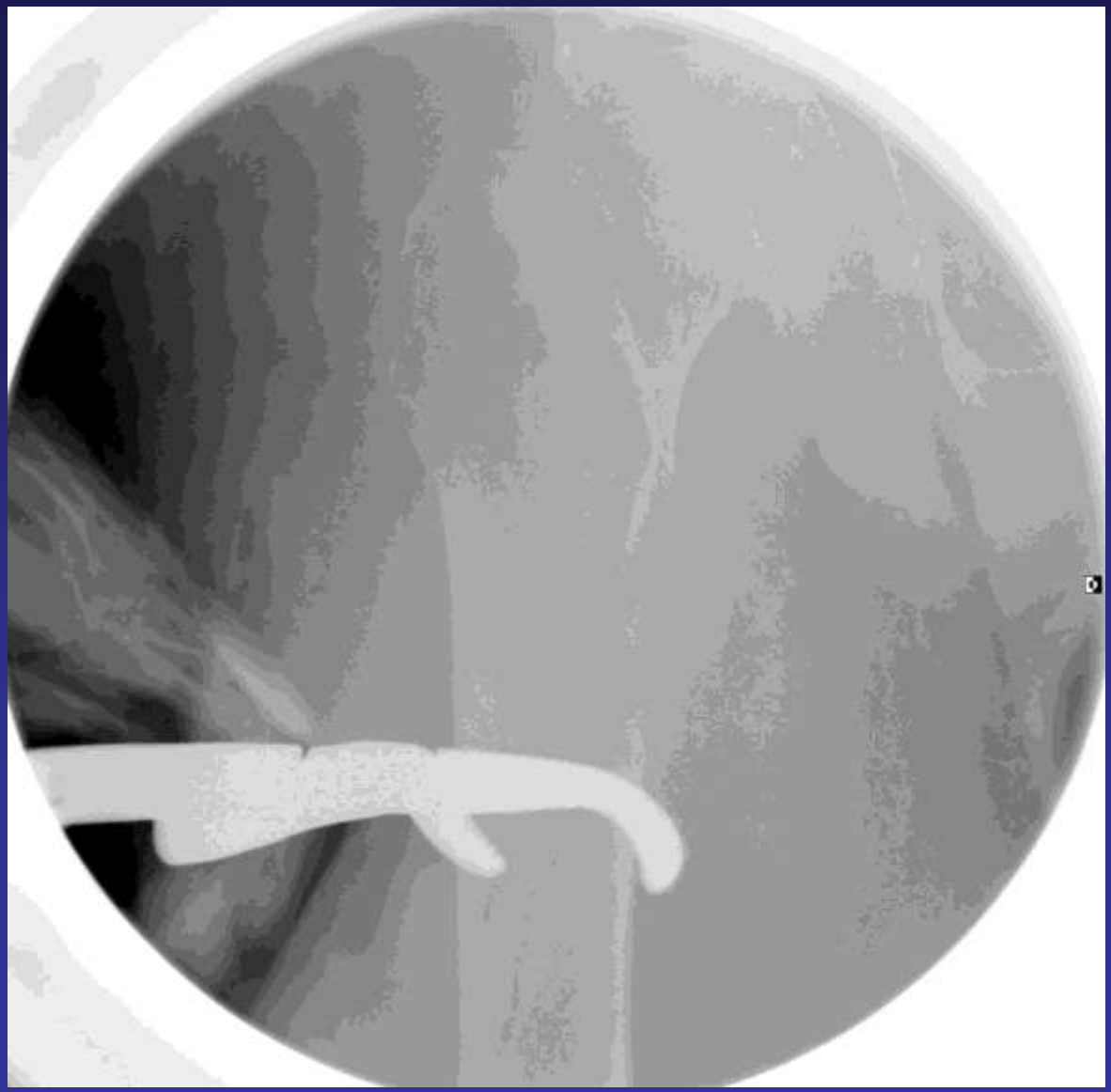
Intramedullary fixation

- Femur – rod



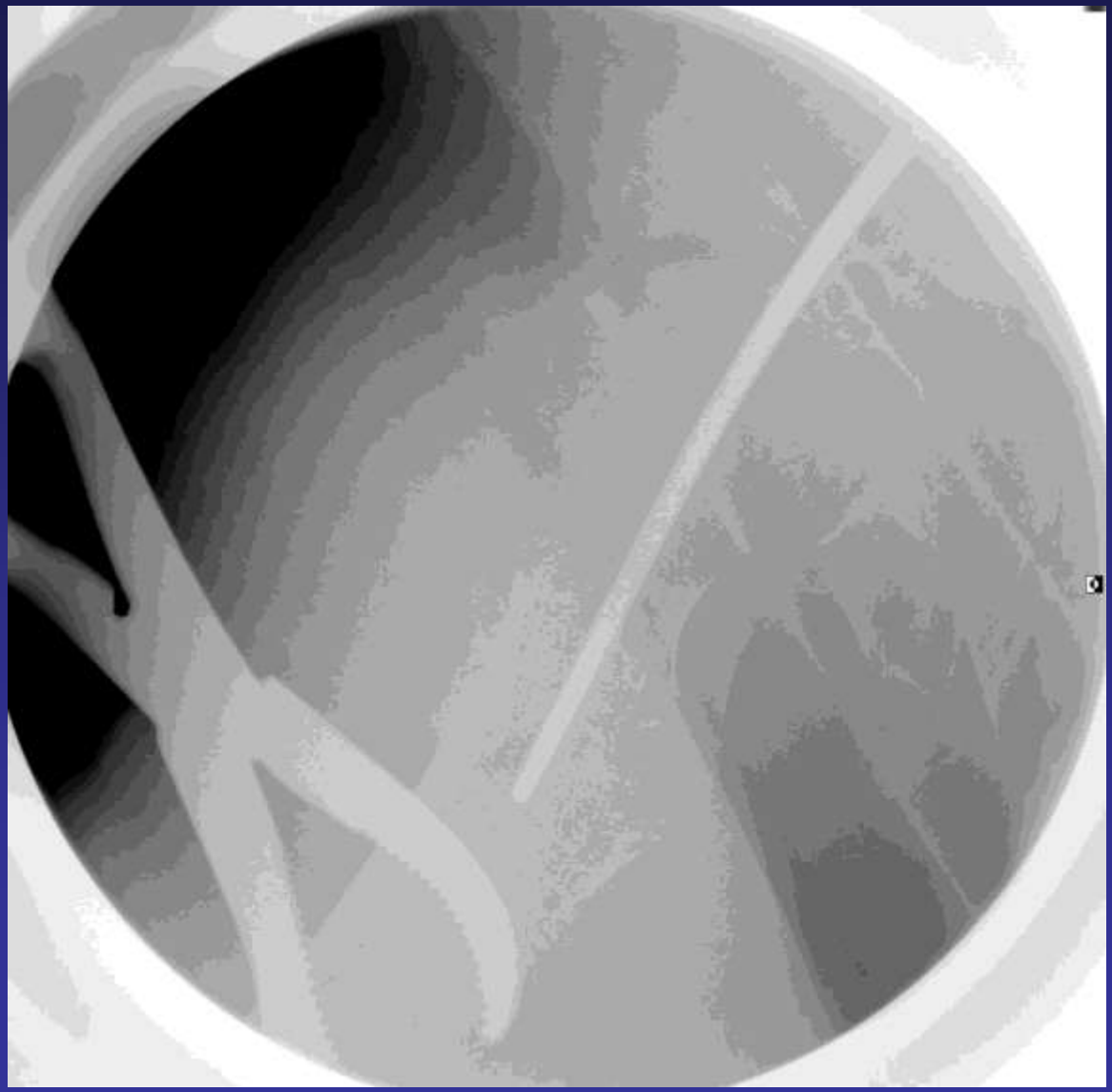
Intramedullary fixation

- Femur – rod



Intramedullary fixation

- Femur – rod

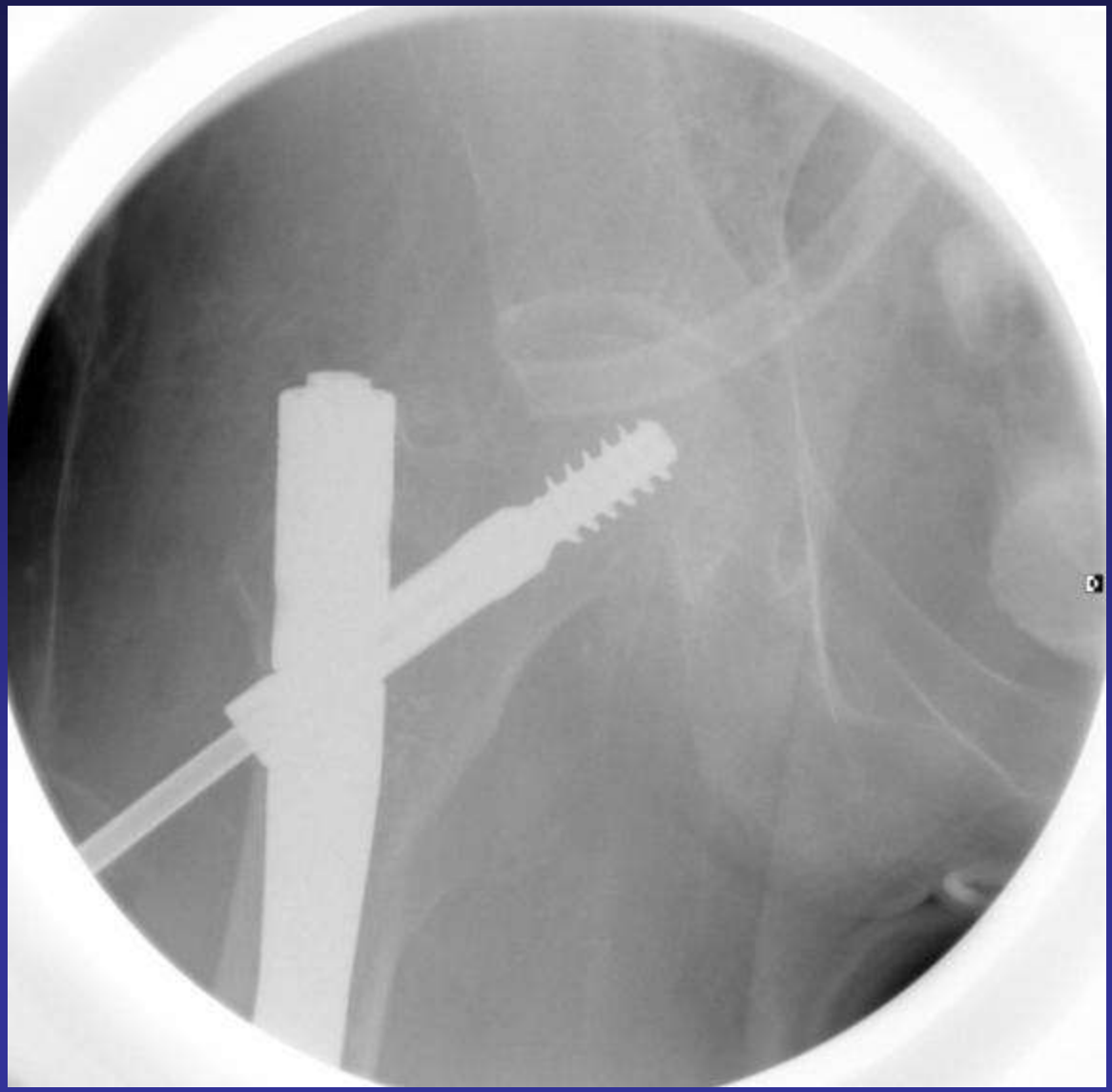


Intramedullary fixation

- Femur – rod

Intramedullary fixation

- Femur – rod



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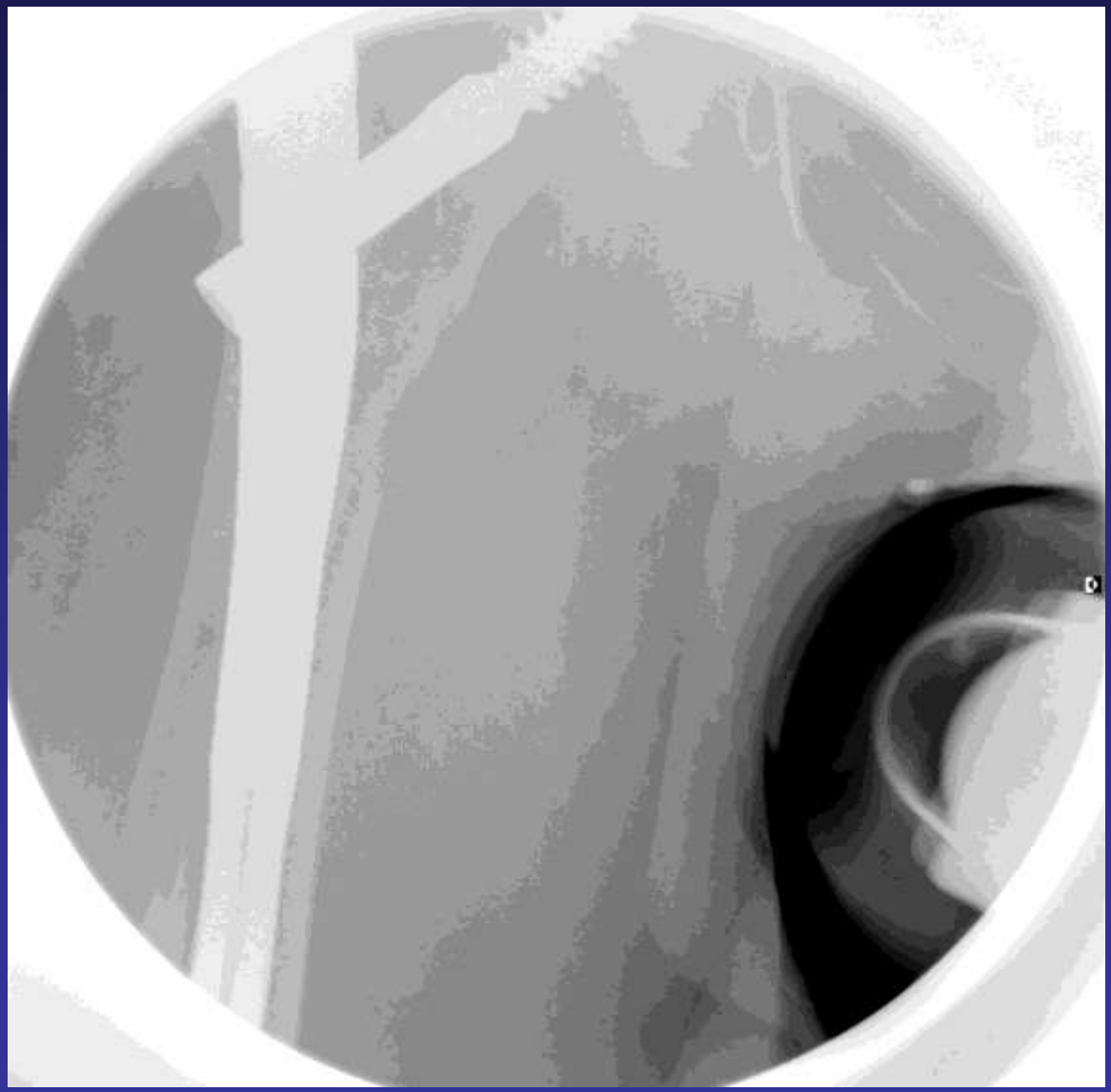

Intramedullary fixation

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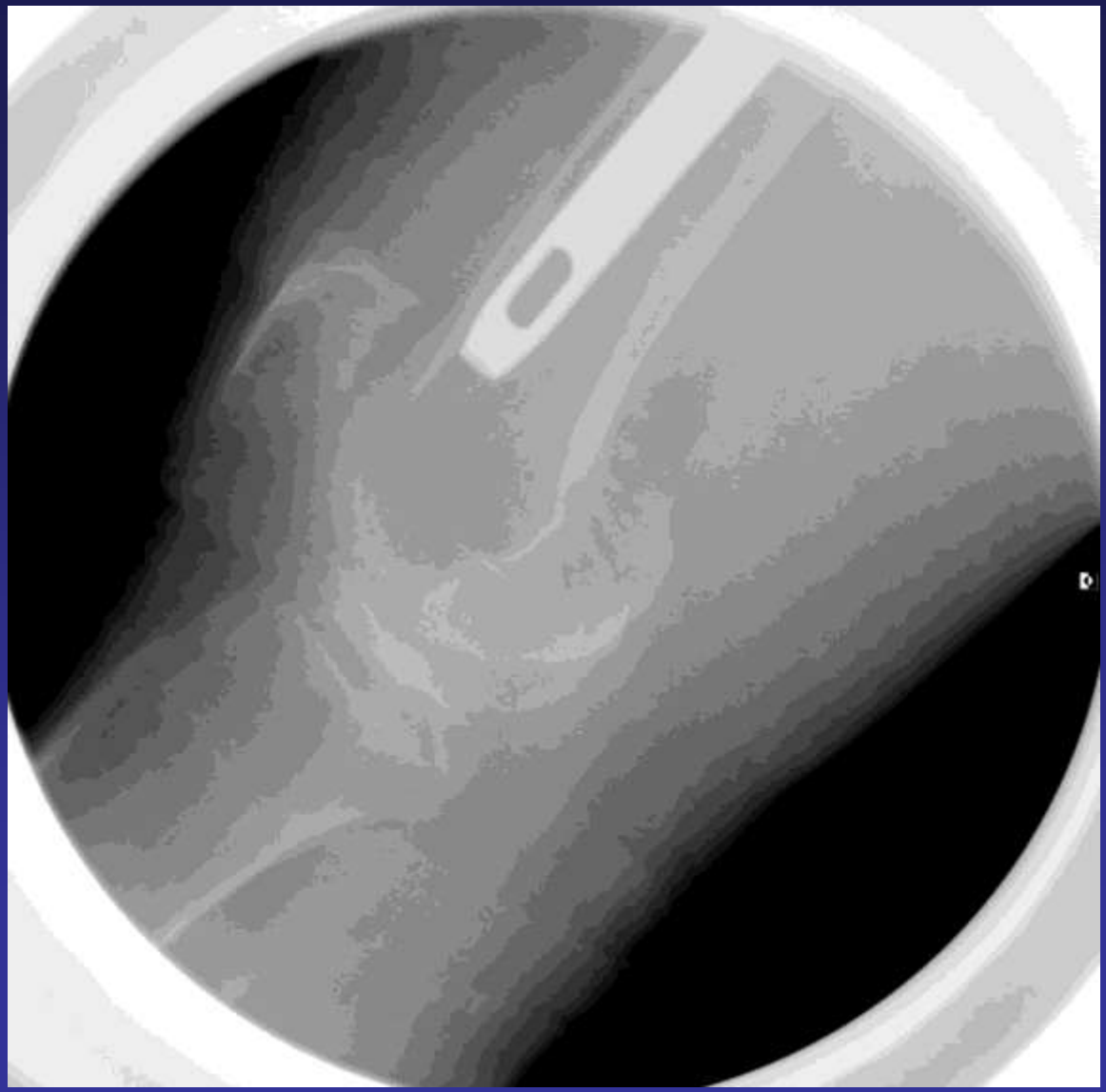


Intramedullary fixation

- Femur – rod
  - Fractured locking screw

Intramedullary fixation

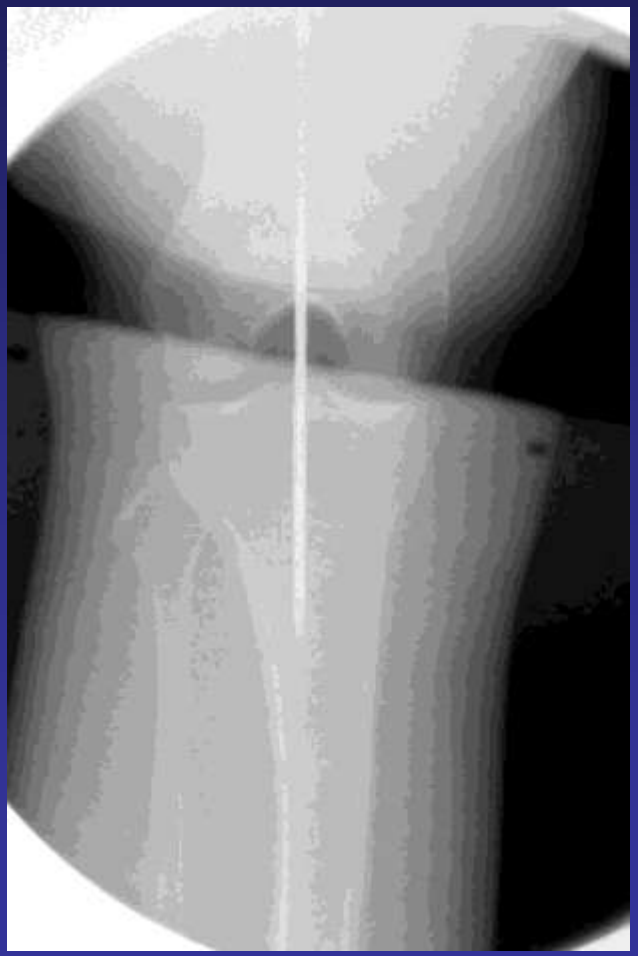
- Tibia - nail

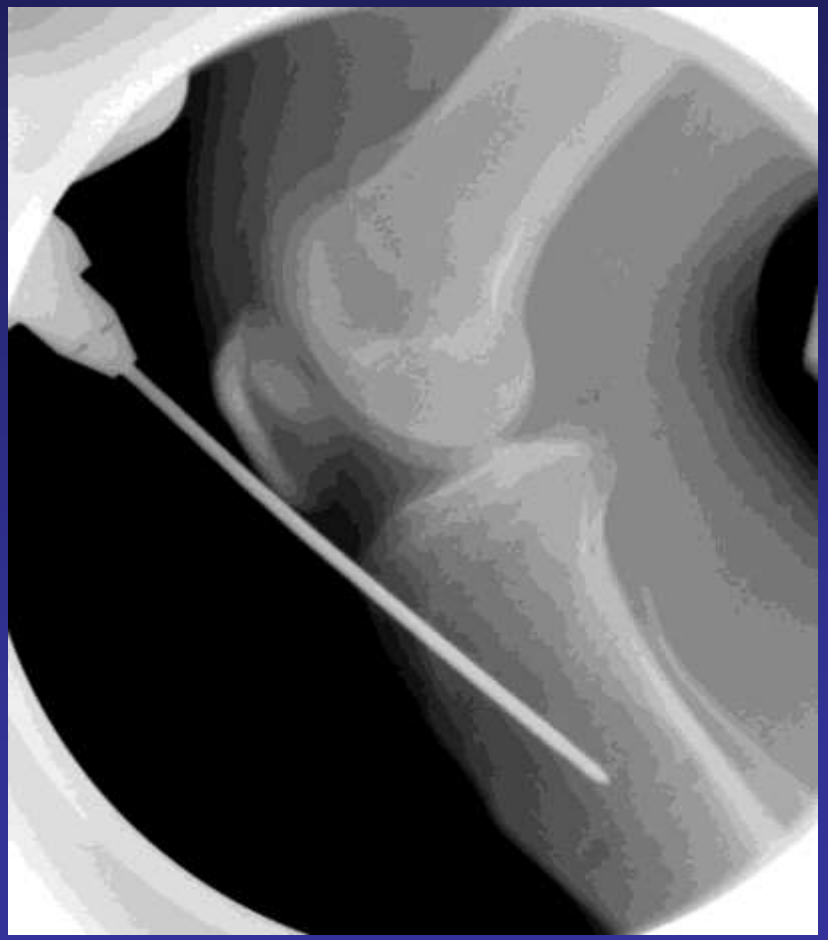
Intramedullary fixation

- Tibia - nail

Intramedullary fixation

- Tibia - nail





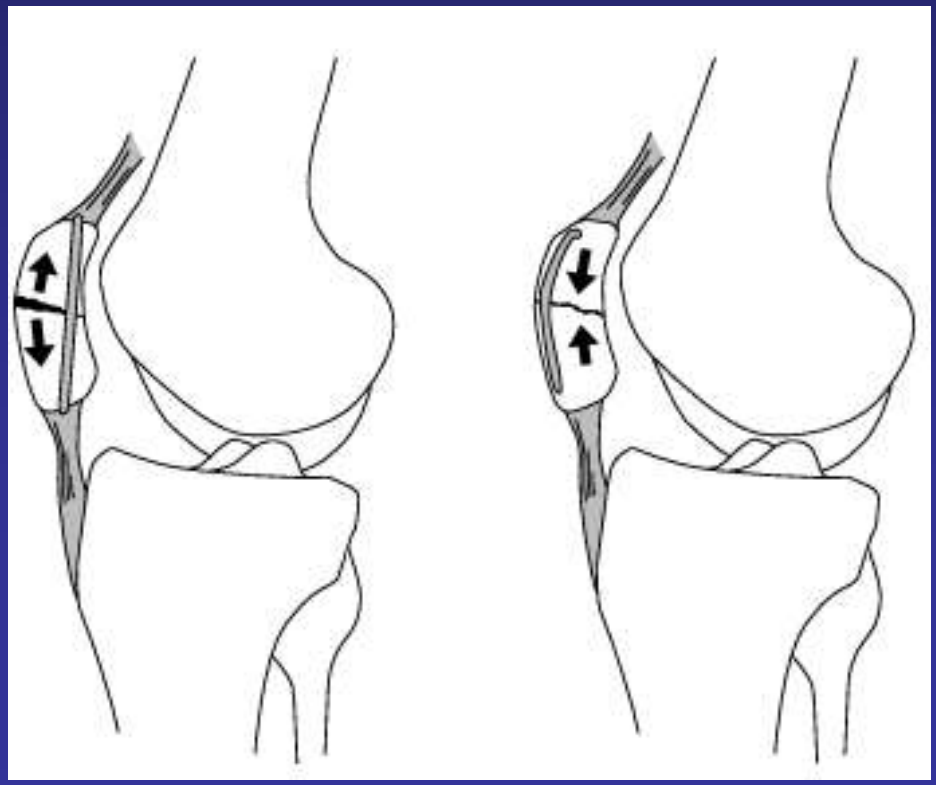
Intramedullary fixation

- Tibia - nail

Special Fixation

Special Fixation

- Tension band wiring
  - Wiring pattern converts tensile force of pull of muscle/ligament into a compressive force across fracture

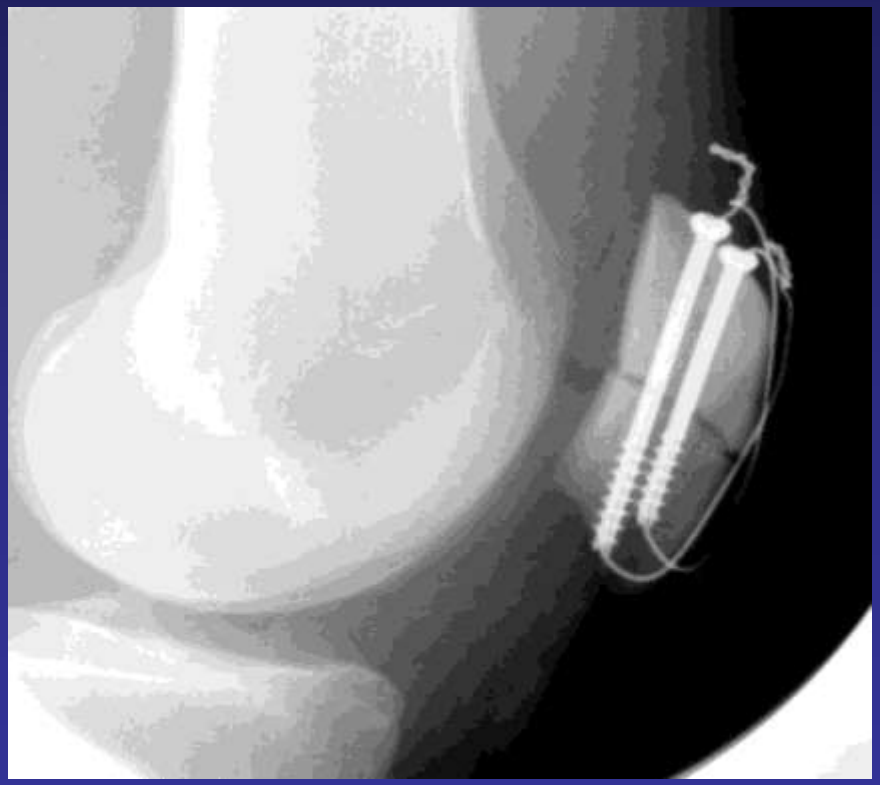


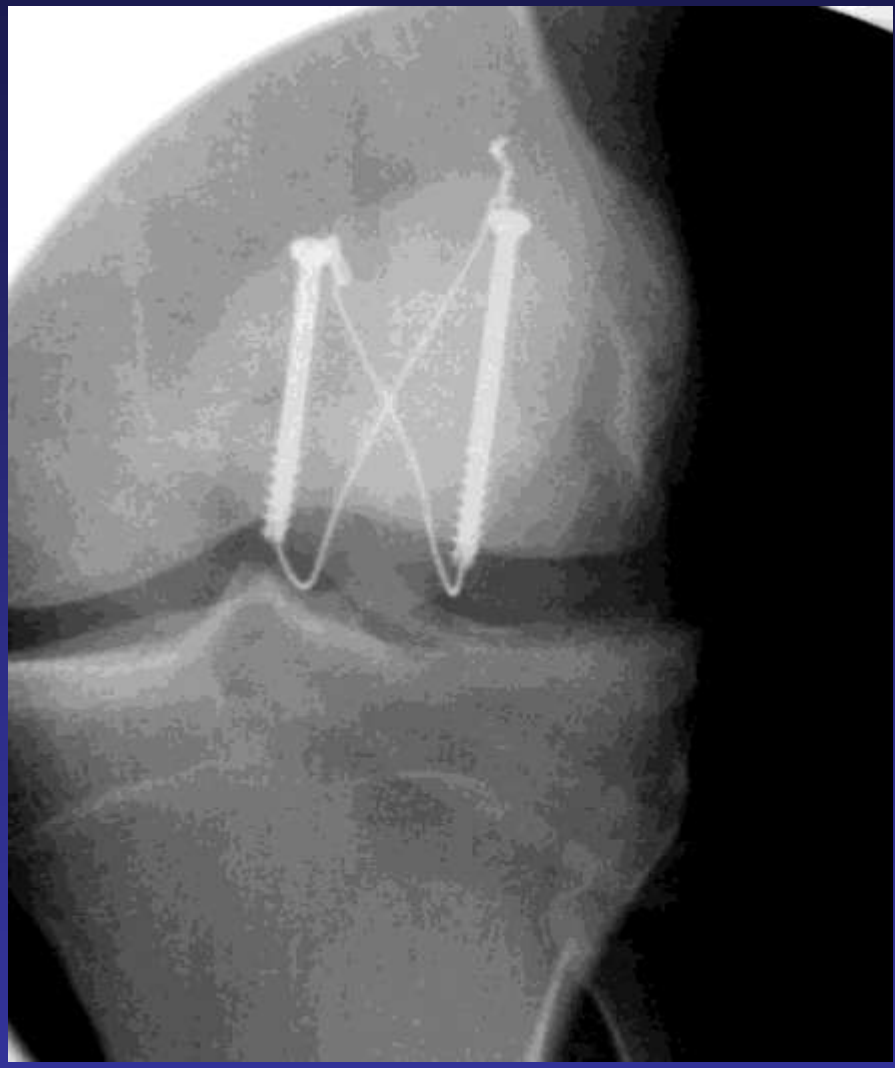
Special Fixation

- Tension band wiring

Special Fixation

- Tension band wiring





Special Fixation

- Tension band wiring

Special Fixation

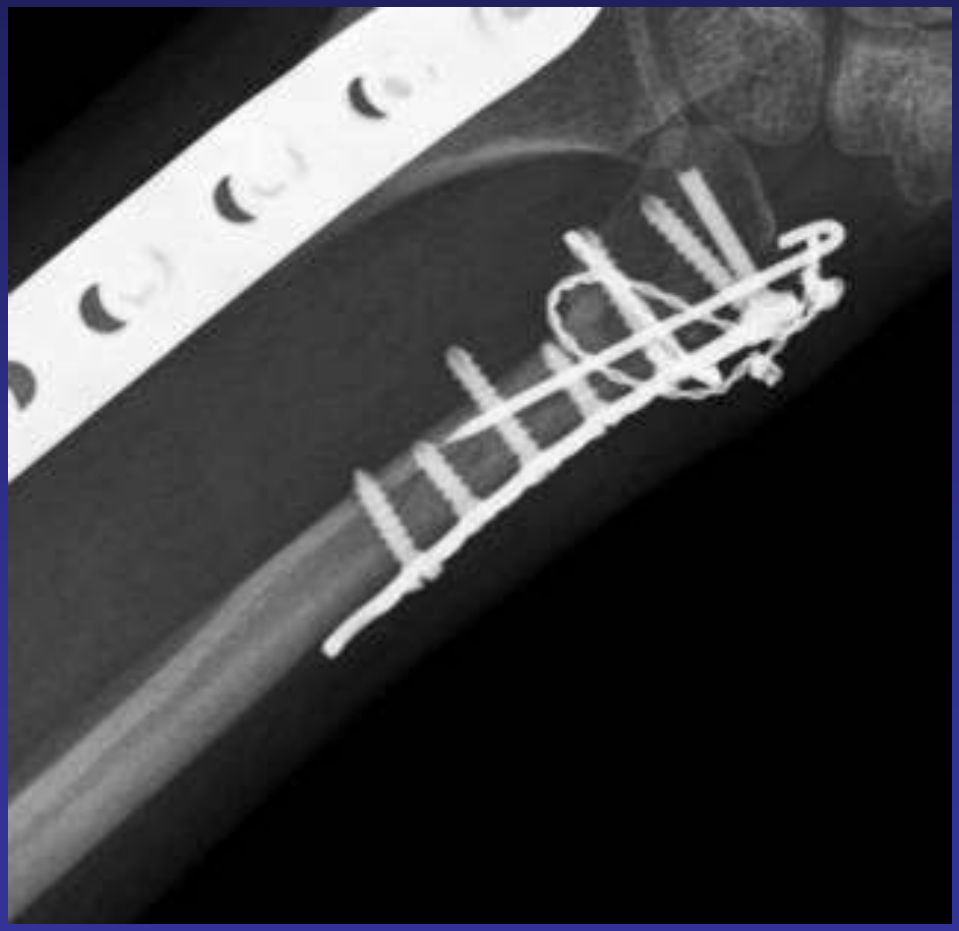
- Tension band wiring

Special Fixation

- Cerclage wiring
  - Looped wire provides stabilization in conjunction with more rigid fixation
  - Used for fracture management and in spinal instrumentation

Special Fixation

- Cerclage wiring



Arthroplasties

Arthroplasties

- Joint replacement
- Total arthroplasty
  - Replaces both sides of articulation
- Hemiarthroplasty
  - Resurfacing – replaces only 1 surface
  - Unipolar – replaces only 1 side of articulation
  - Bipolar – replaces both surfaces but only 1 side of articulation

Arthroplasties

- Total arthroplasty

Arthroplasties

- Total arthroplasty
  - Cemented
  - Non-cemented
  - Hybrid
    - Cement on femoral side only

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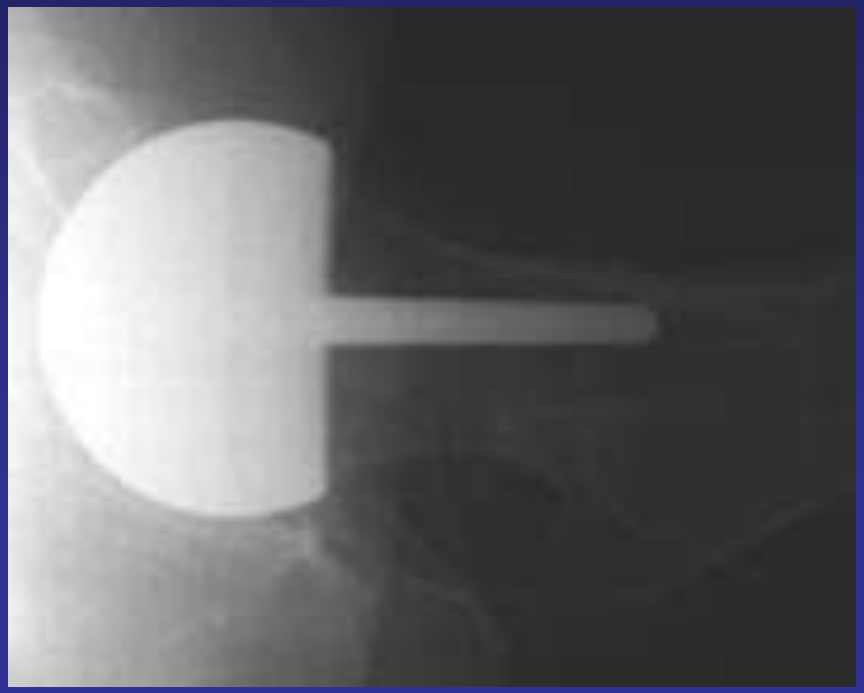
Arthroplasties

- Hemiarthroplasty
  - Resurfacing



Arthroplasties

- Hemiarthroplasty
  - Unipolar
    - Prosthetic head articulates directly with acetabulum

Arthroplasties

- Hemiarthroplasty
  - Bipolar

Arthroplasties

- Hemiarthroplasty
  - Bipolar
    - Small femoral head articulates with metal cup (lined with polyethylene) which fits into native acetabulum

Arthroplasties

- Knee arthroplasty
  - TKA (cemented, non-constrained)

Arthroplasties

- Knee arthroplasty
  - TKA (cemented, constrained)

Arthroplasties

- Knee arthroplasty
  - Unicondylar knee replacement
    - Younger patients, usually medial, done to buy time

Arthroplasties

- Revision arthroplasty
  - Primary arthoplasty removed due to infection or failure
  - Tip-off = long stem

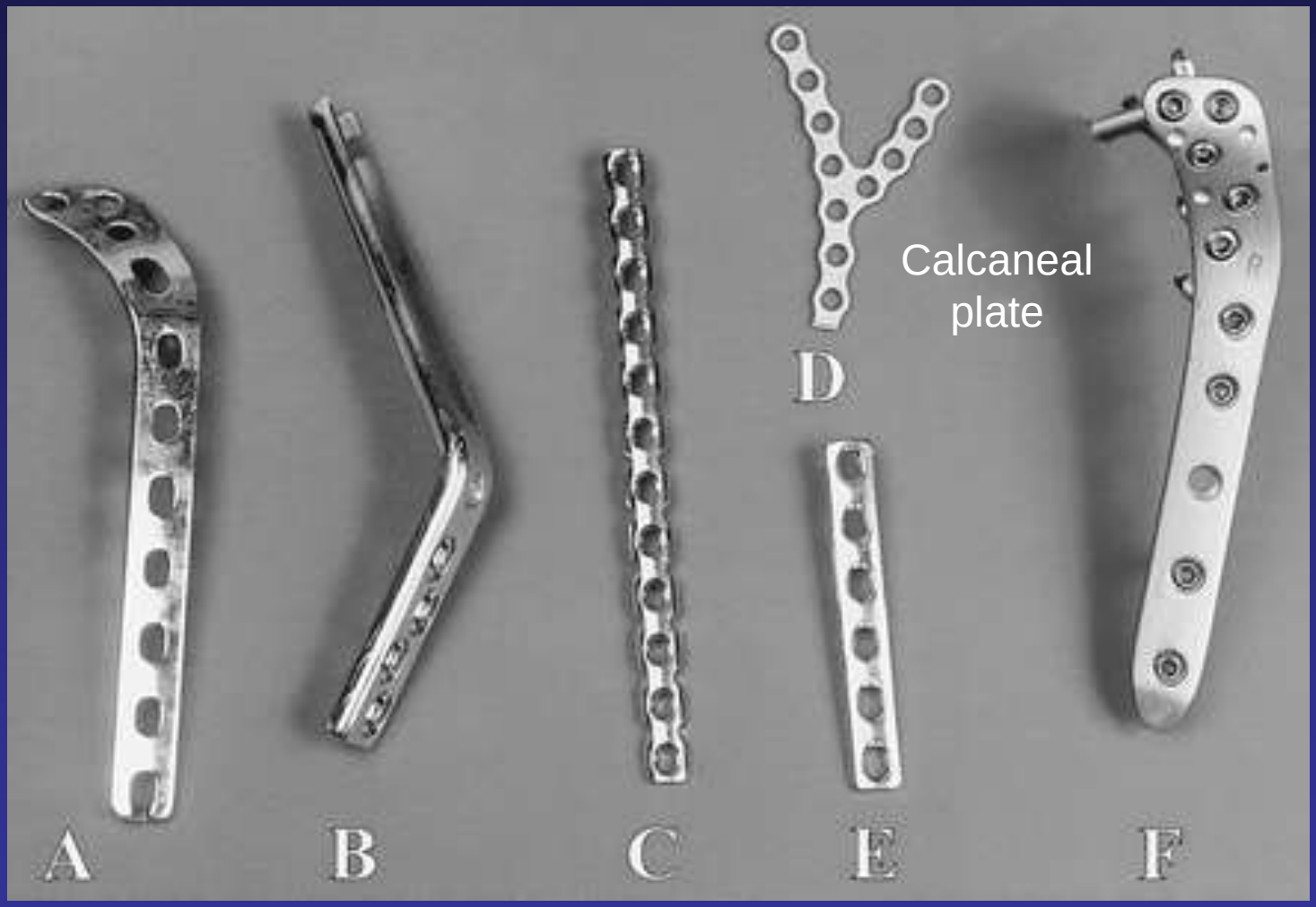
Arthroplasties

- Revision arthroplasty

Arthroplasties

- Revision arthroplasty

Plates



Tibial condylar plate

Blade plate

Reconstruction plate

Dynamic compression plate (DCP)

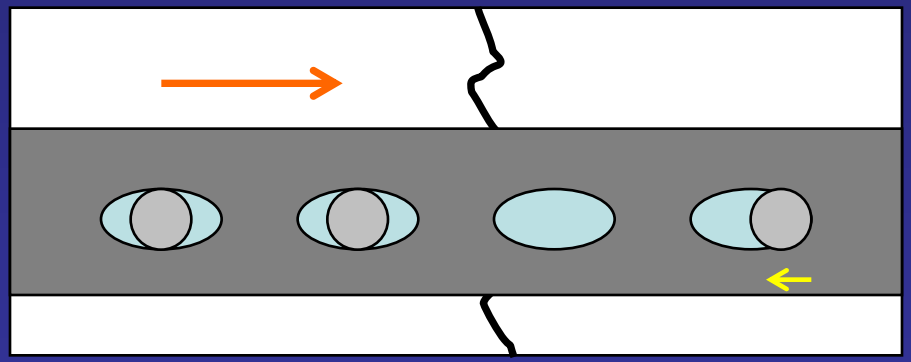
LISS plate

Plates

- Multiple functions
  - Compression
    - Rigid fixation
    - Apply compression across fracture
  - Neutralization
    - Hold fragments in place
    - Used in conjunction with lag screws
  - Buttress
    - Fracture reduced, but used to “lock-in” frags
    - Used in tibial plateau

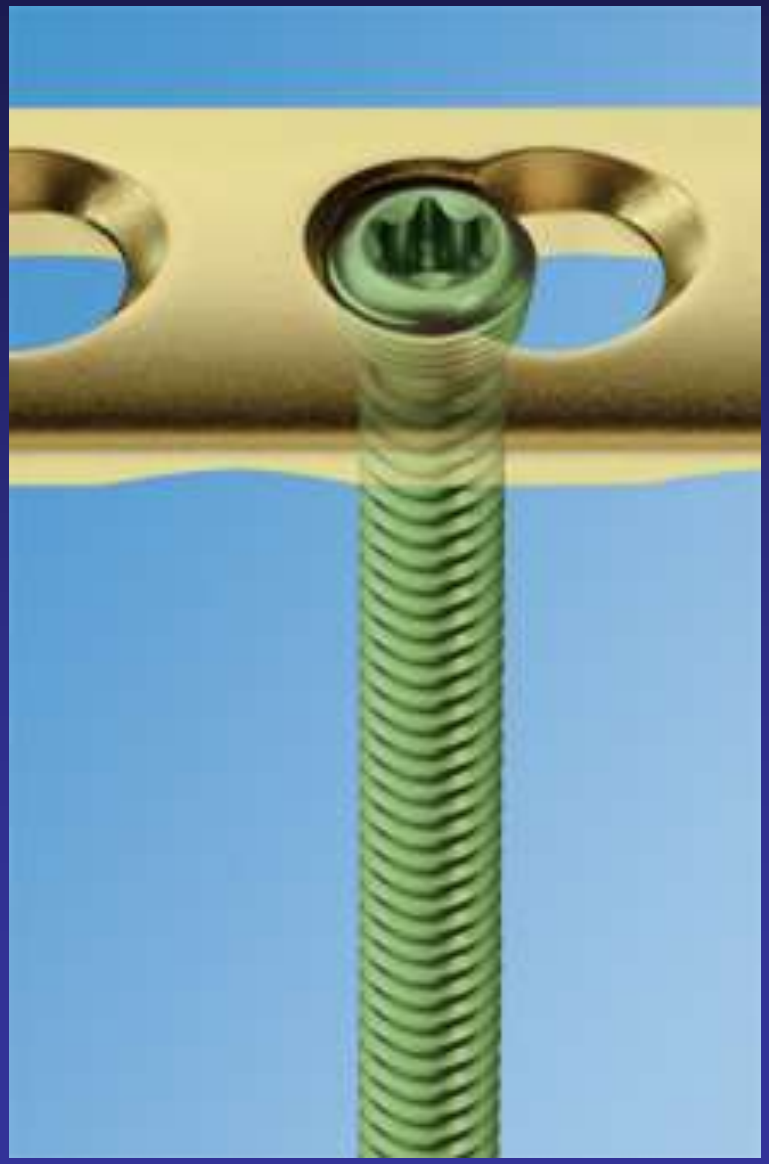
Plates

- Types of plates
  - Dynamic compression plate
    - Allows compression across fracture
    - Can be any of the 3 types



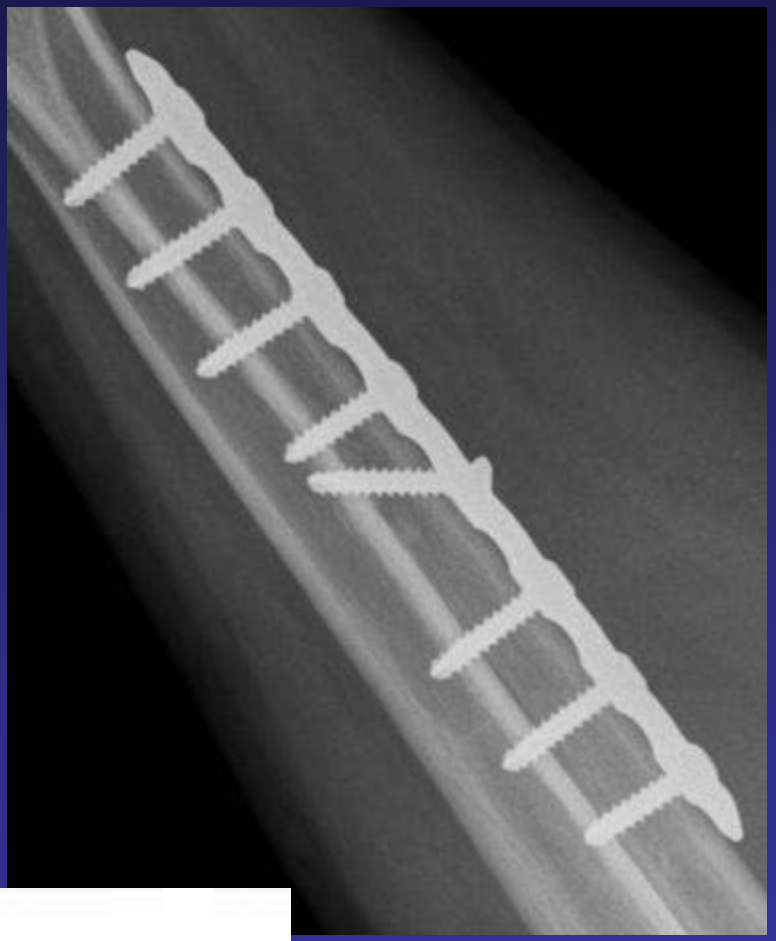
Plates

- Types of plates
  - Dynamic compression plate
    - Locking Compression plate



Plates

- Types of plates
  - Dynamic compression plate
    - Low Profile
      - Reduced contact with periosteum may increase blood flow to fracture



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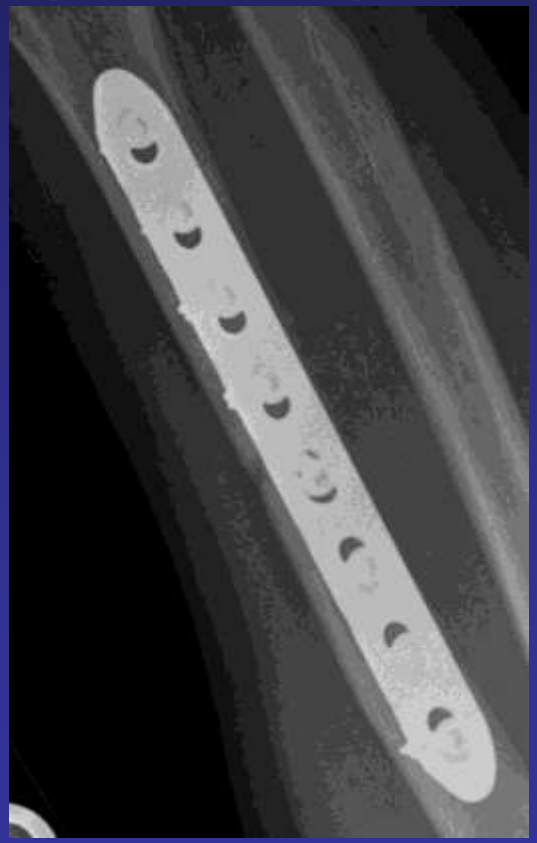
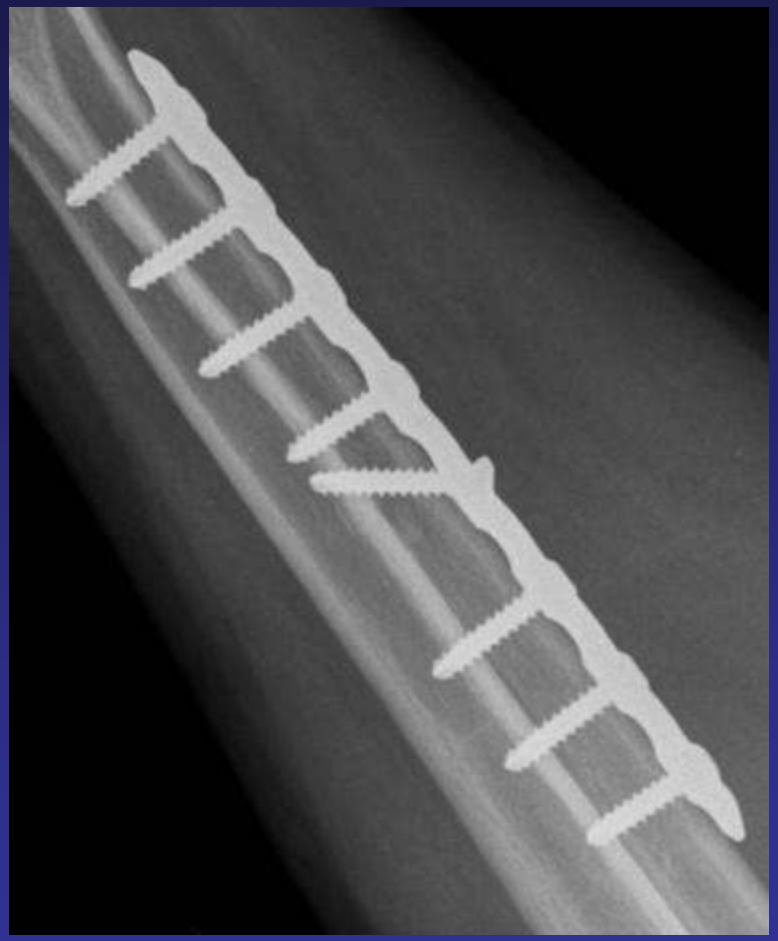




Plates

- Types of plates
  - Tubular plates
    - Aka “1/3 tubular”
    - Looks like DCP
    - Areas of limited ST
      - Dist fib, ulna

Plates

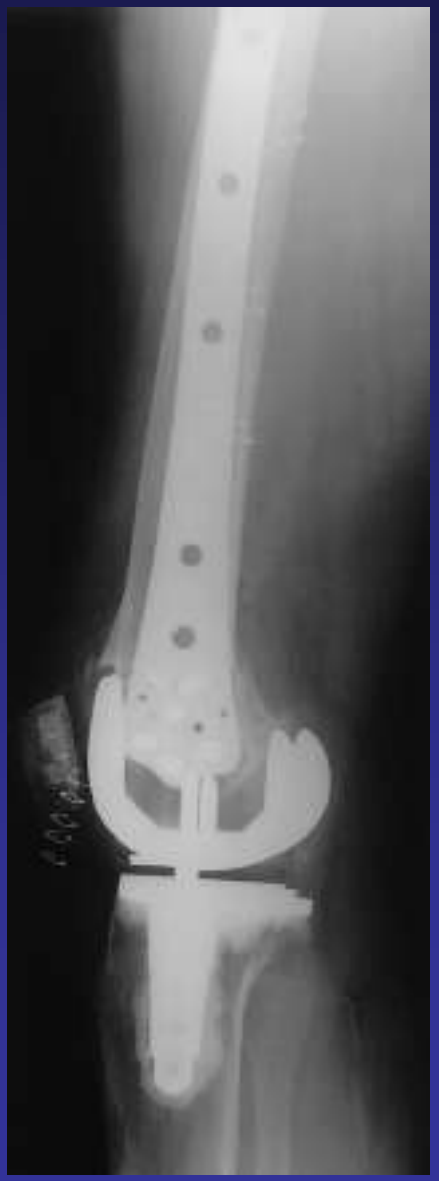
- Types of plates
  - Blade plate
    - Blade attached to side plate
    - Blade through large frags

Plates

- Types of plates
  - Reconstruction plate
    - Aka “Recon” plate
    - Very malleable, cut to length

Plates

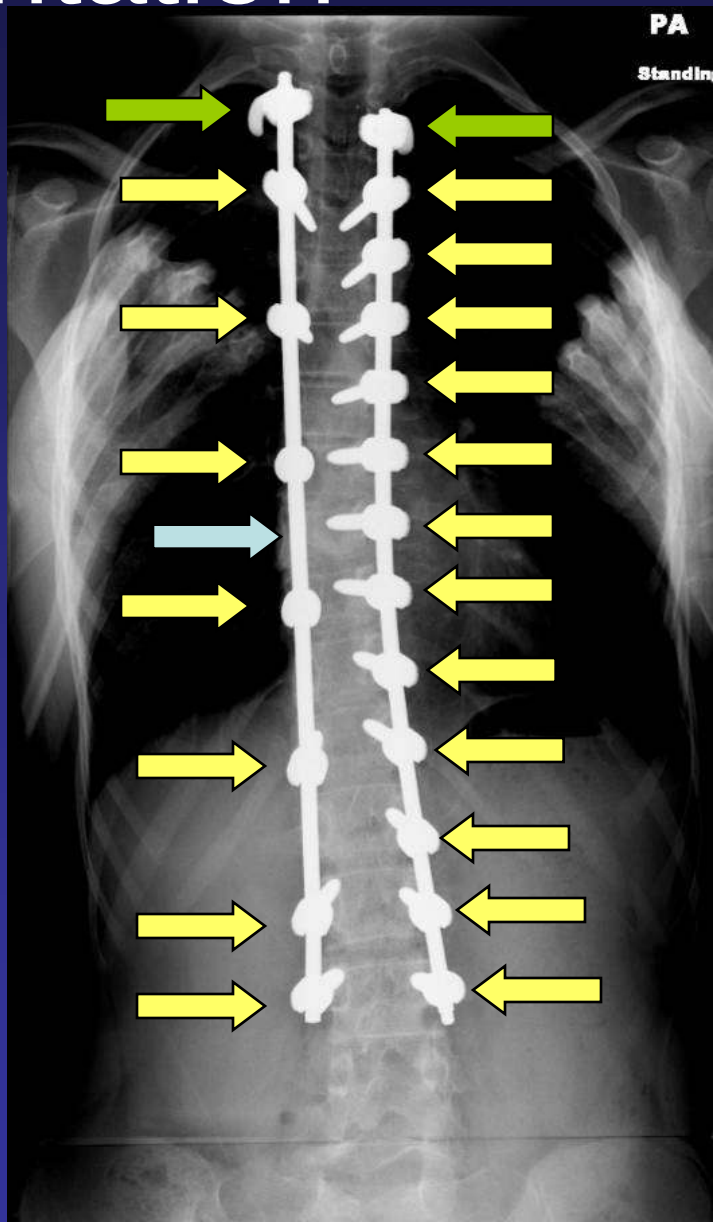
- LISS plate
  - Less Invasive Stabilization System
  - Contoured to specific bone
  - Reduced ST injury
  - Distal femur, prox tib



Spinal Fixation

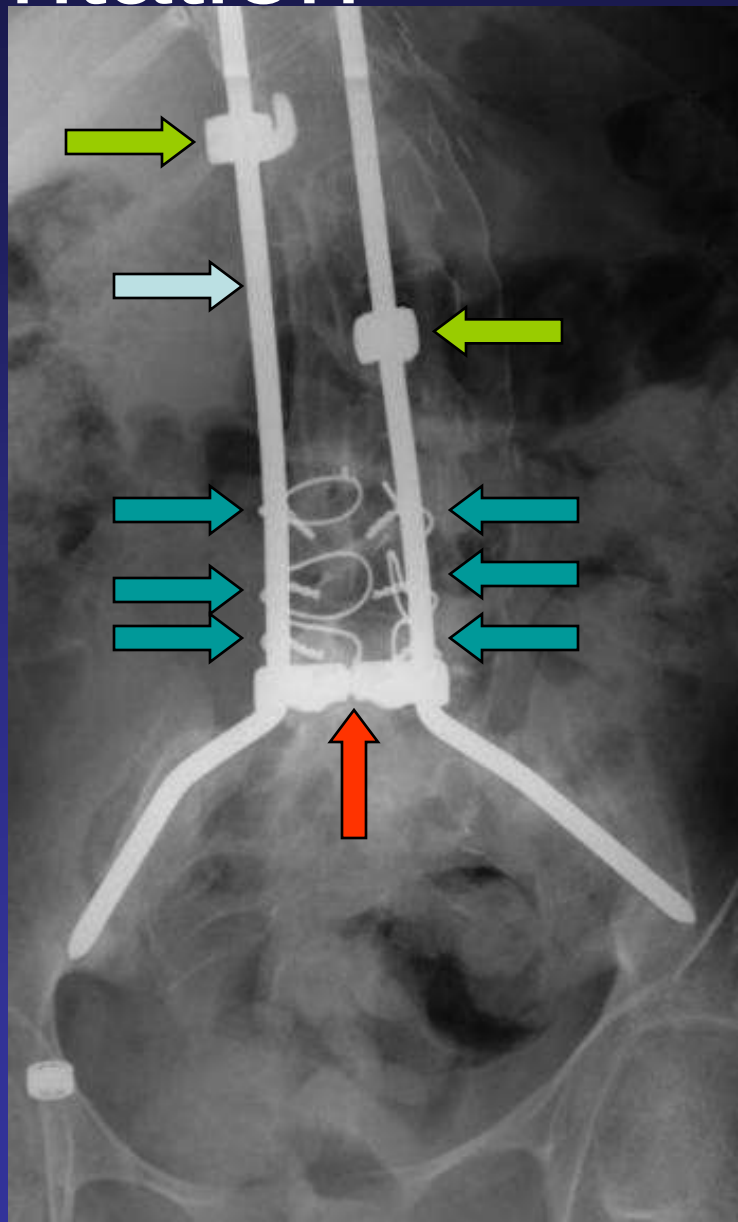
Spinal Instrumentation

- Rod
- Laminar hooks
- Pedicle screw



Spinal Instrumentation

- Rod
- Laminar hooks
- Pedicle screw
- Cerclage wire
  - laminar or spinous process
- Cross-link



Spinal Instrumentation

- 5 basic types
  - Distraction/Compression
  - Segmental instrumentation
  - Derotation or coupled systems
  - Pedicle screw (Translational) systems
  - Anterior instrumentation

Distraction/Compression

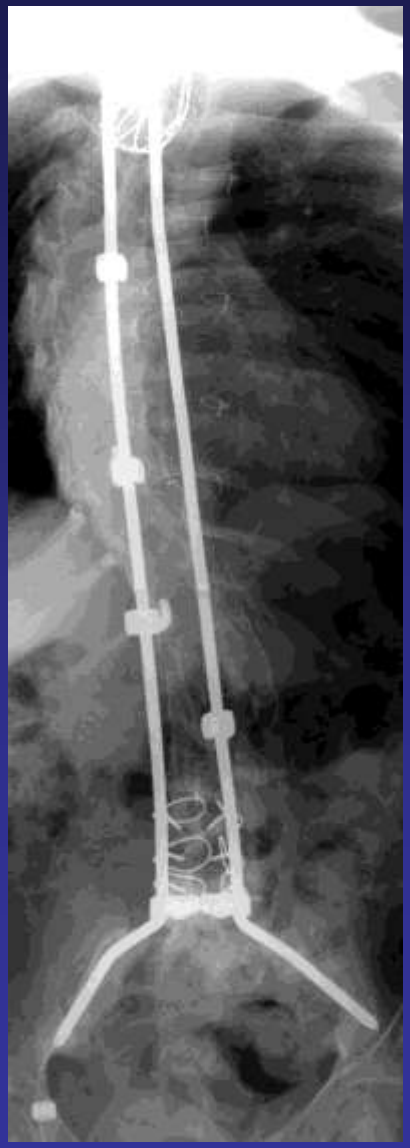
- Harrington rods
  - 1950's
  - Allows distraction of concave margin of curvature
  - Ratcheted rod with opposed laminar hooks

Segmental

- Luque rods
  - Smooth rod with multiple wires which pull spine to rod
  - Distributes force over many segments

  (Galveston technique)

  (Luque rectangle)



Coupled systems

- Cotrel-Dubousset
  - Aka “CD rod”
  - Hooks on rods
  - Allows compression and distraction on same rod

Pedicle screw

- Pedicle screws
  - 50-75% into body
  - Does not rely on intact posterior elements (ideal after posterior decompression)

Posterior instrumentation

- In practice, use combinations that work best for each curve

Anterior Instrumentation

- Allows very strong lateral forces
  - Actually lateral fixation
  - Bad results when anterior
  - Same principles
    - Screw purchase slightly weaker because body is mostly cancellous bone

Anterior Instrumentation

- Interbody devices
  - Interbody cage
  - Main function is to restore disc height
  - PLIF
    - Posterior Lumbar Interbody Fusion

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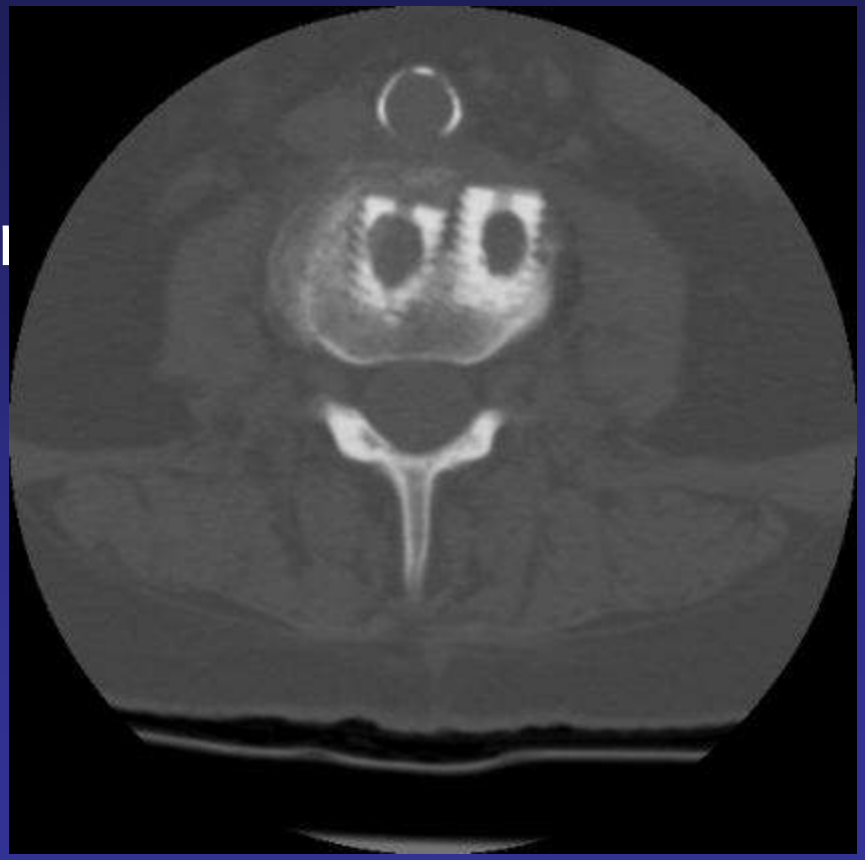

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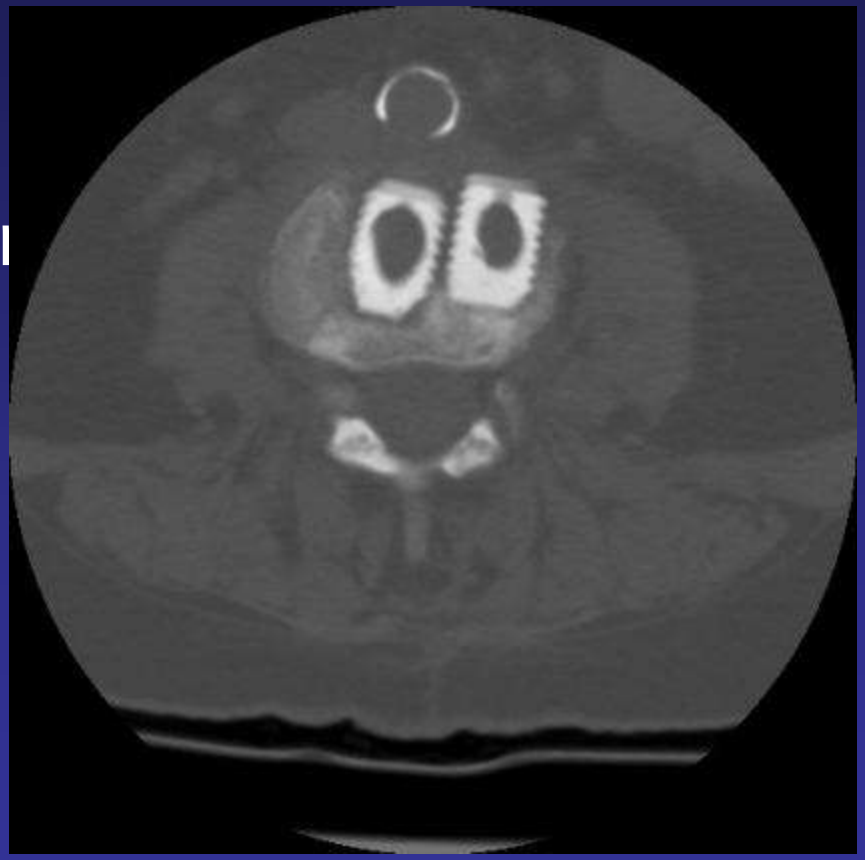

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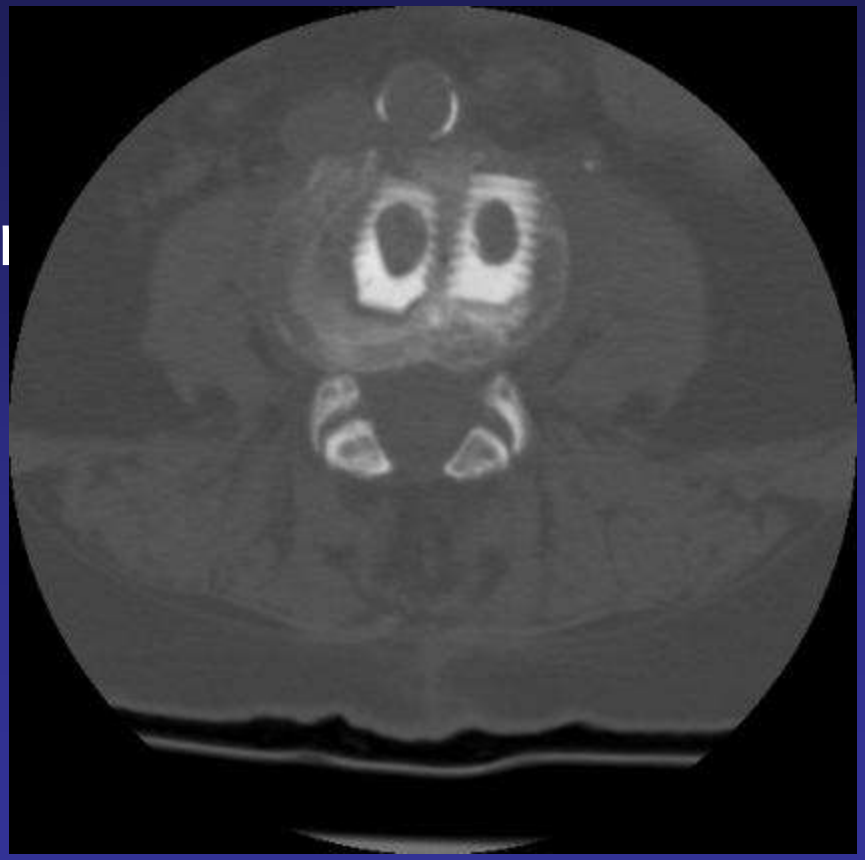

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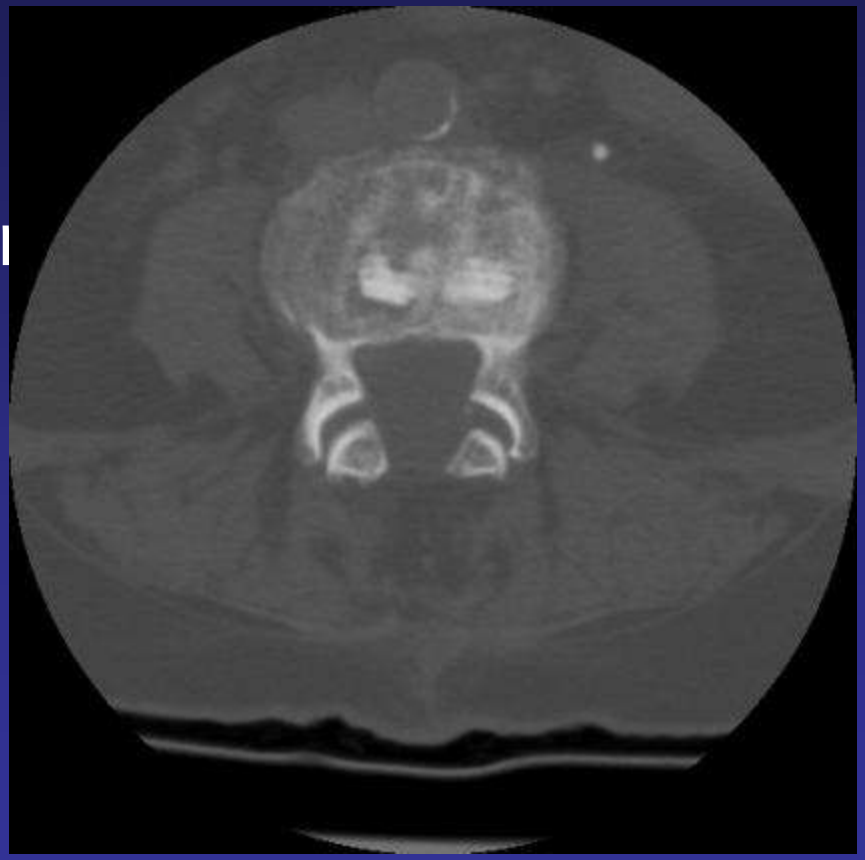

Take Home Points

- Non-circumferential = Splint
- Circumferential with split = Bivalved
- Thin wire that’s bent = K-wire
- Thicker pin not bent = Steinmann pin
- Screw with naked shank = Lag screw
- Screw across fx = Interfragmentary screw

Take Home Points

- If open surgery = ORIF
- If K-wires only = CRPP
- Femur = rod
- Tibia = nail
- Plate = plate
- Tension bands and syndesmotic screws are allowed to break

Take Home Points

- 1 side of joint = hemiarthroplasty
- Both sides = total (beware the bipolar!)
- Rods, hooks, pedicle screws, cross links

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