Orthopedic Hardware and Procedures

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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

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Casting vs Splinting

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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
  – 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

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

• 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

- 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

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Intramedullary fixation

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Intramedullary fixation

- Femur – rod
Intramedullary fixation

- Femur – rod
Intramedullary fixation

- Femur – rod
Intramedullary fixation

- Femur – rod
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
Arthroplasties

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

• Total arthroplasty
  – Cemented
  – Non-cemented
  – Hybrid
    • Cement on femoral side only
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 arthroplasty 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
- Calcaneal 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
Plates

• Types of plates
  – Dynamic compression plate
    • Low Profile
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
• 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
Anterior Instrumentation

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Anterior Instrumentation

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

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