Intramedullary Nailing: History & Rationale
Overview

1. What is IM Nailing?
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What is IM Nailing?

- Method of internal fixation in which a metal rod is implanted within the intramedullary canal
- Functions as an internal splint
- Load sharing device = faster return to normal weight bearing
- Minimizes soft tissue damage
- Designed to address long bone fractures
- Locking screw = length/rotation
- Considered the standard of care
History

• Bernardino de Sahagun, a 16th century anthropologist who traveled to Mexico with Hernando Cortes, recorded the first account of the use of an intramedullary device. De Sahagun witnessed Aztec physicians placing wooden sticks into the medullary canals of patients with long bone nonunions.

• During the mid 1800s through the first decade of the 1900s, most of the work in intramedullary nailing of nonunions appear to revolve around the use of ivory pegs.
History

- 1897: Nicolaysen outlines principles of IM nailing (Norway)
- 1913: Schöne reports nailing forearm fractures with 3 & 4mm silver rods (Germany)
- 1917 Hoglund (US) reported the use of bone as an Intermedullary implant
- 1918 E. W. Hey Groves reports IM nailing of femoral neck/shaft fractures (England)
History

- 1940: Küntscher pioneers modern IM nailing during World War II
- 1941-1948: Lörenz Böhler performs closed nailings in 58 of 61 femur fractures
- 1945: First American nailing performed by MacAusland w/a nail made of Tantalum
- 1945: Drs. Street, Hansen, & Brewer design a diamond-shaped Stainless Steel nail in Memphis
- 1952: Küntscher pioneers IM reaming
Design Rationale

- Gerhard Küntscher
- 1939: first nailing in a human was for a subtrochanteric femur fracture
- Original nails had a “V” shape
- Post WWII changed to a Cloverleaf cross-section = interference fit
- Nail flexibility during insertion
  - Increased rotational stability
- Unlocked
- Greater Trochanteric entry
Design Rationale

• Dr. Küntscher worried about AVN of the femoral head with a Piriformis Fossa entry site

• Küntscher Nail:
  • Longitudinally slotted
  • Cloverleaf cross-section
    – “Transverse Elastic Jamming”
    – Maximal bending stiffness
  • Excellent stability
  • 1mm thick wall section
  • Non-locked = poor rotational control relative to modern nails
Design Rationale

Küntscher’s Principles of Fracture Fixation:
1. Closed procedure
2. Stable fracture fixation
3. No external fixation
4. Early weight-bearing

AO Principles of Fracture Management:
1. Fracture reduction
2. Stable internal fixation
3. Preservation of blood supply
4. Early, active mobilization
Design Evolution

• 1960’s: Küntscher proposes the theory of locked nails
  • “Detensor Nail”

• 1972: Developed by Klemm & Schellmann
  • “Interlocking Nail”

• 1970’s: Popularized by Drs. Arsène Grosse & Ivan Kempf
  • Changed proximal screw angle from 60° to 45°
  • Moved screw holes distally
**Design Evolution**

- **Nail Design:**
  - Improved mechanical stability
  - Prevented shortening/rotation
  - Increased indications via screw angles & distal locking holes
  - More complex, distal, proximal fractures
- **Modified Küntscher Nail:**
  - Longitudinal slot
  - Cloverleaf design
  - 1.5mm wall thickness
- **Greater Trochanteric entry site**
Early Complications

- Iatrogenic fracture proximally during nail insertion
- Inadequate fixation of fractures (non locked):
  - Proximal nail migration
  - Malrotation of fragments
  - Axial shortening
- End results of complications:
  - Delayed union
  - Malunion
  - Shortening
  - Premature implant removal
Closed-section IM Nails

• 1984: Smith & Nephew introduces the Russell-Taylor IM Nail system:
  • Improved rotational stability
  • Increased implant stiffness
  • 98% success rate

• Nail Design:
  • Closed-section nail
  • Distal locking
  • Piriformis Fossa entry site
  • Stainless steel

• Reamed or Unreamed
Greater Trochanteric Entry Site

• “No new ideas in orthopaedics”
• Advocated by Küntscher in order to avoid AVN
• Advantages:
  • Reduced blood loss
  • More percutaneous
  • Ease of implant insertion
  • Modern implants better approximate anatomy of the proximal femur
• Avoids further displacement of femoral neck, head, & trochanter in proximal femur fractures
Unreamed & Reamed IM Nails

• Unreamed Nails:
  • Popularized by the AO
  • Solid design = no guide wire
  • Nail used as reduction device

• Reamed Nails:
  • Gradual change from Stainless Steel to Titanium alloy
  • Increased flexibility & elimination of Nickel sensitivity
  • Smaller diameter nails
  • Enables sounding for canal diameter and proper implant fit
Modern IM Nails

• Greater Trochanter most popular insertion site for new nails
• Cannulated
• Titanium alloy
• Multiple locking options
• Advanced instrumentation
• “First Generation Nail”
  • Interlocking option
• “Second Generation Nail”
  • Reconstruction option
• “Third Generation Nail”
  • TriGen
Modern IM Nails

- Proximal Herzog Curve:
  - Curvature of medullary canal
  - Proximal portion similar to funnel shape.
Indications for IM Nails

- Fractures between proximal middle and distal thirds of shaft
- Ipsilateral neck / shaft
- Intertrochanteric & subtrochanteric
- Non-unions
- Mal-unions
- Bone lengthening / shortening
- Pathological fractures
- Fusions:
  - Knee & ankle
New School

TAN, FAN, Knee, Distal Tibia, Hindfoot Fusion, Humeral Nails
Benefits

• Percutaneous procedure:
  • Reduced blood loss
  • Vascular preservation
  • Closed dynamic osteosynthesis = improved healing conditions

• Mechanical efficiency vs. plate:
  • Load sharing device
  • Early weight bearing

• Reaming:
  • Autograft theory
  • Increases implant contact area = increases indications
The Future.....

- Biomaterials
- Decreased instrumentation
- Simplified Inventory
- Sureshot....
Thank you!
We are smith&nephew