Bone Anatomy and Healing

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for
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Objectives

• Outling the anatomy of bone
• Outline the natural fracture healing process
• Explain direct and indirect bone healing
• Describe factors which influence fracture healing
ORTHOPAEDISTS
WHAT IS OUR JOB?

THE BONE IS FRACTURED
WE FIX IT!!

ORTHOPAEDISTS = CARPENTER???
For a fracture to heal...

mechanics

biology
What is Fracture?

- Force/injury to bone
- Break of bony continuity
- Loss of structure
- Soft tissue damage
- Damaged to blood supply
Fracture is a combination of BONE + SOFT TISSUE injury
Anatomy of the bone

- Epiphysis
- Metaphysis
- Diaphysis
- Spongy bone
- Periosteum
- Marrow cavity
- Blood vessel
- Articular surfaces
Blood Supply: Cortical Diaphysis

- **Endosteal vessels**
  - Nutrient medullary artery
  - inner 2/3 of cortex

- **Periosteal vessels**
  - outer 1/3 of cortex
  - From fascial/muscles attachments
Fractures

- Disruption of blood supply
- Soft tissue damage with loss of periosteal vessels

Damage to blood supply

Bone necrosis at ends of fragments
BONE HEALING
Stages of Indirect Bone Healing

(1) Phase of inflammation and tissue response ~ 7 days

- Hematoma & granulation tissue formation
- Typical inflammatory response
- Can endure significant strain & motion

Effect from surgical treatment

- Destruction of cell & granulation by surgical exposure
- Closed techniques
- Minimally invasive techniques
(2) Phase of intramembranous and endochondral ossification (soft callus stage)

1~3 weeks

- Forming woven bone cuffs (intramembr oss) away from fx. gap
- Enchondral oss at fx site
- Vessel-ingrowth of vessels
(3) **Phase of consolidation (hard callus stage)**

- Woven bone = hard callus
- Cartilage

- Conversion into calcified tissue
- Hard callus moving toward the fracture gap

1~4 months
**Phase of remodelling**

- Conversion of the woven bone into lamellar bone through surface erosion / osteonal remodeling
- Until complete restoration of original morphology of the bone, recanalization

**Stages of Indirect Bone Healing**
17 years old male
B-boy accident
Deformity Lt arm
After closed reduction and casting F/U at 1wks

Hematoma at fx site
Bone Healing

Indirect ("Secondary")
- Formation of callus
- Relative stability
- Interfragmentary motion

Then surgical treatment came along
Bone Healing

**Indirect (“Secondary”)**
- Formation of callus
- Relative stability
- Interfragmentary motion

**Direct (“Primary”)**
- No callus
- Absolute stability
- No motion between fragments
Direct Bone Healing

Primary Healing

Contact healing

Gap healing
Direct Bone Healing

- **Absolute stability**
  - interfragmentary compression
  - Direct contact of bones & no motion
  - Lag screws and neutralization plating
  - Compression plating
Indirect Bone Healing

- Relatively stable fixation
  - Casting
  - External fixation
  - Intramedullary nailing
  - Bridging plate

Not 100% anatomical reduction!
FACTORS AFFECTING BONE HEALING
For a fracture to heal:

- **Biology***
  - Damaged to soft tissues & blood supply
    - Initial injury
    - Surgical treatment

- **Mechanics**
  - Appropriate stability for the desired healing
Mechanism: What is the difference?

Old lady fell from standing  
Young male motor accident

Higher energy trauma!
• More severe fracture!
• More severe soft tissue injury!
• More damage to blood supply!
Blood supply of bone is effected by

- Initial injury
  - Amount of force, fx pattern, degree of soft tissue injury
- Initial management
  - Splinting, patient resuscitation
- Surgical technique
  - Exposure, reduction
- Type of implants
The Downside of Fracture Fixation

- Surgical exposure damages blood supply
- Drilling, reaming and clamping damage the bone and its surrounding tissues
- Disruption of the healing environment
- Risk of infection
Plating: Simple Fractures

Open reduction NOT open up the Bone!!!

Soft tissue is necessary for BONE HEALING!
Respect the Soft Tissue

- Minimize soft tissue trauma
- Preserve blood supply
- Submuscular plating
- Indirect reduction techniques
- Small foot print tools

Biologic plating!!!
Surgical technique: More Biologic
Appropriate implant selection
Good surgical technique

Minimizes disturbances to healing process
Conclusions

- Bone will heal under the right environment.
- The healing process varies with the mechanical environment.
- Biology
  - Systemic: patient factor
  - Local: injury, treatment
- Every implant has an impact on the healing process.
For a fracture to heal...

**mechanics**  
**biology**

Surgeon’s Role: provide the best environment for bone healing

Thank You!