Language of Fractures

Looking at Bones in General

There are 206 bones!
- They're all different!
- They have different functions.
- Exposed to different mechanical forces.
- They each respond differently to stress/trauma.

Why are Fractures Hard?

Example: Proximal Femur Fractures

- Femoral neck fx
  - Intertrochanteric fx
  - Subtrochanteric fx
  - Displaced fx

Example: Metatarsals

5th MT:
- Fractures
  - Very Common
  - Base 5th MT
  - 1) Avulsion fx
  - 99% Heal
  - 2) Jones fx
  - 50% non-union

Even where fractures occur within a bone affects the treatment, prognosis
Language of Fractures

Looking at Bones in General

**Bone Model**

- **White Line = Cortical Bone**
- **Gray Fill = Trabecular Bone (Cancellous)**

Looking at Bones in General

**Simple vs Comminuted**

- **Simple Fx:**
  - 2 fragments
  - Proximal fragment
  - [L] proximus: "nearest"
  - Near body attachment
  - Distal fragment
  - [L] distare: "distant"
  - away from attachment

- **Comminuted:**
  - >2 fragments
  - Segmental fragment

Looking at Bones in General

**Radiographic Views**

- **AP (Anterior → Posterior)**
- **PA (Posterior → Anterior)**
- **LATERAL**
- **MEDIAL**

**Terminology**

- **Patient sides**
  - Medial: Towards the middle
  - Lateral: Towards the side
  - Anterior: Front (Volar)
  - Posterior: Back (Dorsal)

Looking at Bones in General

**Simple vs Comminuted**

- **Butterfly**
- **Segmental fragment**
- **Distal fragment**
- **Proximal fragment**

Looking at Bones in General

**Fracture Orientation**

- **Transverse**
  - Horizontal

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Language of Fractures

Looking at Bones in General

**Fracture Orientation**

**Intro**

**Patterns**

- Transverse
  - Horizontal
  - Avulsion
  - End of bone

- Longitudinal
  - Vertical
  - Compression

**Displaced**

- Angulated

**Bone Ends**

- Immature

**S-H**

- Plastic
- Torus
- Occult
- Stress
- Don’t Miss

**Oblique**

- Diagonal
- Most common

**Weber A**

**Spiral Fracture**

- Twisting injury
- Resembles:
  - Oblique fracture
  - Butterfly frag.
- Need multiple views to see the spiral

**F, J 33yoM**

“There is an oblique fracture of the distal tibia, with lateral displacement of the distal fracture fragment ½-shaft width.”

**Displacement**

**RULE:**

We describe displacement of *distal fragment* relative to *proximal fragment*.

Toddlers Fx

- Distal Tibia
- < 5 years old

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Displacement

RULE:
We describe displacement of distal fragment relative to proximal fragment

“There is a transverse fracture of the distal tibia, with lateral displacement of the distal fracture fragment by 1-shaft width.”

Displacement: Check all Views

Open (Compound) Fracture

Fractured end of the bone is poking through the skin.
- Common with Tibia Fxs
- Very little skin covers tibia
- Sterile bone is exposed to the non-sterile air...
- Bone is now infected
  - “Osteomyelitis”
- Requires:
  - Surgical washout
  - IV antibiotics (6 weeks)

Displacement... exceptions

Clavicle

- Proximal fragment relative to distal
- Neck muscles pull the proximal fragment up

“Superior displacement proximal clavicle fragment >2-shaft widths, with a segmental fragment”

Required internal fixation
Displacement... exceptions

Spine – Spondylolisthesis
- Displacement of the upper vertebral body relative to lower vertebral body
  - “Anterior slippage of L5 on S1”
  - “Spondylolisthesis of L5 on S1”
  - “Anterolisthesis of L5 on S1”

Impaction
- Fragments are driven into each other.
  - Foreshortened
  - “Telescoped in”

Override
- Similar to impaction
  - Foreshortened
  - Fragments overlap

Distance
- Fragments pulled apart
  - Doesn’t usually occur as the result of direct trauma
    - Trauma tends impact/override
    - Patella fractures tend to distract
  - Distraction can occur when reducing fractures under traction
Language of Fractures

Intro
Patterns
Orientation
Displaced
Angulated
Bone Ends
Immature
S-H
Plastic
Torus
Occult
Stress
Don't Miss

Welcome to the Language of Fractures. This presentation focuses on recognizing patterns, orientations, and other features of fractures.

### 1. Diastasis: Joint Widening
- **Scaphoid-Lunate Joint**
  - Space between scaphoid & lunate should not be wider than the spaces between carpal bones.
  - Not always due to trauma.
  - Scapholunate diastasis + Chondrocalcinosis = CPPD aka “Pseudo-Gout”

- **Pubic Symphysis**
  - Diastasis: Joint Widening
  - S,G 59yoM
  - Superior Pubic Ramus
  - Inferior Pubic Ramus
  - Pubic Body

### 2. Angulation
- **Valgus vs Varus**
- Need to specify what is angulated relative to what.
  - Lateral angulation of the distal fracture fragment
  - Vertex medial angulation
  - Valgus angulation

- **Valgus**
  - Vertex deviated MEDIAL
  - Knee deviated medially (knock-kneed)
  - Angle femoral neck/shaft (normally 120°) is deviated medially
  - Coxa Valga
  - Vertex deviated towards GENITALS
Language of Fractures

Hallux Valgus

“Bunion”
- 1st MTP (Metatarsal-Phalangeal joint)
- "Hallux"
- Joint deviates medially
- "Valgus"
- Very common in women
- Due to tight pointy shoes

Extra vs Intra-Articular Fractures

Intra-articular fractures
- Involve articular cartilage
- Extend into joints
- Risk of developing 2° OA
- Reduction must be anatomic

Extra-articular fractures
- Don’t involve joints
- Reduction can be relatively anatomic
- Bones will remodel
- Particularly with weight-bearing

Parts of the Immature Bone

Epiphysis
- End of the bone
- Ununited Growth Plate
- Port that forms ankle

Metaphysis
- End of the shaft

Diaphysis
- Bone shaft

Salter-Harris Fractures

All involve the Physes
- If fracture doesn’t involve the physes
- not Salter-Harris
- If the patient is skeletally mature (physes fused)
- not Salter-Harris
- Physes fractures risk of premature growth plate fusion
- Could lead to a leg length discrepancy
Salter-Harris Fractures

**Types I – V**

As the # goes up, fractures get worse

Salter-Harris: Type I

- **Physiology Only**
- Can be quite subtle
- Especially when non-displaced
- Comparison with normal contralateral side helps

Salter-Harris: Type II

- **Physiology + Metaphysics**
- Doesn’t extend into joint
- Most common type of S-H

Salter-Harris: Type III

- **Physiology + Epiphysis**
- Extends into joint
- Potentially more serious
Salter-Harris: Type III

Physis + Epiphysis
- Extends into joint
- Potentially more serious
- >2mm articular step-off → surgery
- CT very helpful assess alignment

Salter-Harris: Type IV

+ Epiphysis + Metaphysis
- Distal Tibia = "Triplane Fracture"
- Usually evaluated with CT

Salter-Harris: Type V

Crush Injury
- Rare
- High rate of premature fusion

Bowing (Plastic) Fractures

Adult bones are brittle
- Tend to break
Child bones are soft
- They can bend
  - Bending ("plastic") deformation
  - Typically will remodel with time
Looking at Bones in General

**Greenstick Fracture**
- Adult bones are brittle
  - Tend to break like a dry stick
- Child bones are soft
  - Can break like a green stick
  - Only through one cortex
  - Incomplete Fx

**Torus (Buckle) Fracture**
- Plastic-type fracture
  - Commonly in radius of children who fall on hand
  - Metaphysis-Diaphysis Junction
  - Dorsal cortical buckling

**Radiographically Occult Fractures**
- Not detected on radiographs
  - Places with many overlapping structures
    - Cervical Spine
    - CT is good for these fractures
  - Fractures too non-displaced to see
    - Femoral neck, scaphoid
    - CT is not good for these fractures
  - Non-displaced on radiographs is non-displaced on CT
  - MR is good for these fractures

**Stress Fractures**
- Result of chronic repetitive micro-fractures
  - Will progress if repetitive stress continues

**Fatigue Fractures**
- Occur in Spine; Sacrum

**Insufficiency Fractures**
- Occur in Femoral Neck

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Looking at Bones in General

2nd MT Fatigue Fractures

Small Periosteal Reaction

G J 19yoF

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3 weeks later

K D 40yoF

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H S 50yoF

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Slide 63 of 76

K D 58yoF

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Jump to next slide

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H C 22yoF

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Jump to next slide

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D G 18yoM

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Common site for Fatigue Fractures in athletes

Radiographically may see:

Nothing

most usual finding

Periosteal Reaction

Common site for Fatigue Fractures in athletes

Radiographically may see:

Nothing

most usual finding

Periosteal Reaction

Trabecular Sclerosis

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Language of Fractures

Looking at Bones in General

**Tibial Fatigue Fractures**
- Common site for Fatigue Fractures in athletes
- Radiographically may see:
  - Nothing
  - Most usual finding
  - Periosteal Reaction
  - Trabecular Sclerosis
  - Cortical Lucency

**Fatigue Fracture: Management**
- Diagnosis primarily by History/Exam
  - Patient tells of new or repetitive activities
  - Pain worse with activity; relieved with rest
  - Focally tender
- Get Radiographs
  - May confirm diagnosis (periosteal reaction)
  - Make sure not already a complete fracture
- Treat (even if radiographs are negative)
  - Stop/change activity; hard soled shoe

**MRI for Stress Fractures**
- MR is Sensitive & Specific for fracture
  - Sees marrow edema, periosteal reactions
  - (Bone scans: sensitive but not specific)
- When should you consider MR?
  - Fatigue fractures in patients reluctant to stop
  - College athletes
  - Ironmen: Marathoners
  - Patients not responding to conservative treatment
  - Insufficiency fractures in osteoporotic pts
- Insufficiency fractures in osteoporotic pts
  - Spine/sacral fractures may require prolonged rest
  - Hip fractures require surgery

**MR staging Tibia Fatigue Fractures**
- 1) Periosteal reaction only
  - “Shin Splints”
- 2) Marrow edema: Most sensitive sequence
  - T2 with fat suppression (or IR, STIR)
- 3) Marrow edema: Most specific sequence
  - T1
- 4) Line through Cortex

**2 Fractures Not to Miss**
- 1) Femoral Neck Fracture
  - Common in osteoporotic patients
  - Need to detect non-displaced
    - Can treat with percutaneous pinning
    - If fracture becomes displaced...
    - Need to treat with hip replacement
  - But non-displaced fractures are hard to see on radiographs
    - Particularly in osteoporosis
  - MRI does not miss fractures!
    - Get MR if radiographs are negative & you are concerned for occult hip Fx
- 2) Scaphoid Fracture
  - High rate of non-union, avascular necrosis
  - Non-displaced fractures require splint/cast
  - Displaced fractures require surgical screw
  - But non-displaced fractures are hard to see
  - Diagnosis is made primarily by exam
  - Snuffbox Tenderness = Presumed Scaphoid Fx
  - Treat with splint/cast for 2 weeks
  - Even if radiographs are read as negative
  - Reexamine after 2 weeks
  - Repeat radiographs if still has snuffbox tenderness
  - MRI does not miss fractures!
    - Used for persistent pain; UW athletes

**2 Fractures Not to Miss**

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**Language of Fractures**

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**Don’t Miss**

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**Old Radiology Saying…**

“The hardest fracture to find… is the second fracture”

“Satisfaction of the Search”

- You feel good when you find one fracture… so you stop looking for other fractures
- This is why it is important to understand
  - Mechanisms of injury
  - Patterns of fractures
- This is why it’s important to have a Radiologist formally interpret all studies!

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**Schreibman’s Sayings…**

“Trauma is not evenly distributed within the population”

- Patients who come in with new fractures have had fractures in the past
  - People who drive recklessly… do so repeatedly
  - People who get into fights… do so repeatedly
  - Students who get drunk on Friday night and punch walls… do so repeatedly
- It can be hard to tell old from new fractures
- This is why it’s important to have a Radiologist formally interpret all studies!
- Sometimes we suggest additional studies

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**Any Questions?**

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**Don’t Miss Scaphoid Fractures!**

S,T 78yof

Narrowed Thumb MCP

Widened Distal Radial Ulna Joint

Scapholunate Diastasis

Scaphoid Waist Fracture

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