FRACTURES AND CHILD ABUSE

William S Wood, MD
Orthopedic Trauma Director
Phoenix Children's Hospital
Assistant Clinical Professor
University of Arizona – Phoenix School of Medicine

PHOENIX CHILDREN'S HOSPITAL

- Nothing to declare

INCIDENCE

- Over 1 million abused children in US each year
- Child abuse 2nd most common cause of death behind accidents
- If unreported, 10% chance death, 50% repeat abuse

INCIDENCE

- Highest risk factors for child abuse:
  - Parental job loss
  - Disability in children
  - Non-biological child
  - Parental loss

INCIDENCE

- 1/3 of children with physical abuse are found to have fractures
- Fractures are 2nd most common manifestation in child abuse
- Majority under age of 2
- 4 out of 10,000 children under 18 months have fractures due to abuse

Pandya et al 2011

ASSOCIATED FINDINGS

- Multiple fractures
- Fractures in different stages of healing
- Younger than 3 years of age
  - Even more so in child not yet walking
- Absence of trauma

ASSOCIATED FINDINGS

- Delay in presentation
- Inconsistency in story
- Lower SES
- Unplanned pregnancy
- Non-ambulatory child

IMAGING

- Adequate views of suspicious area
- <5 years old:
  - Skeletal survey
- >5 years old:
  - Bone scan

FRACTURE PATTERNS

- Force patterns
  - Most injuries due to child abuse occur by indirect forces
  - develops as child is grabbed by an extremity
    - shaken, twisted or pulled

FRACTURE PATTERNS

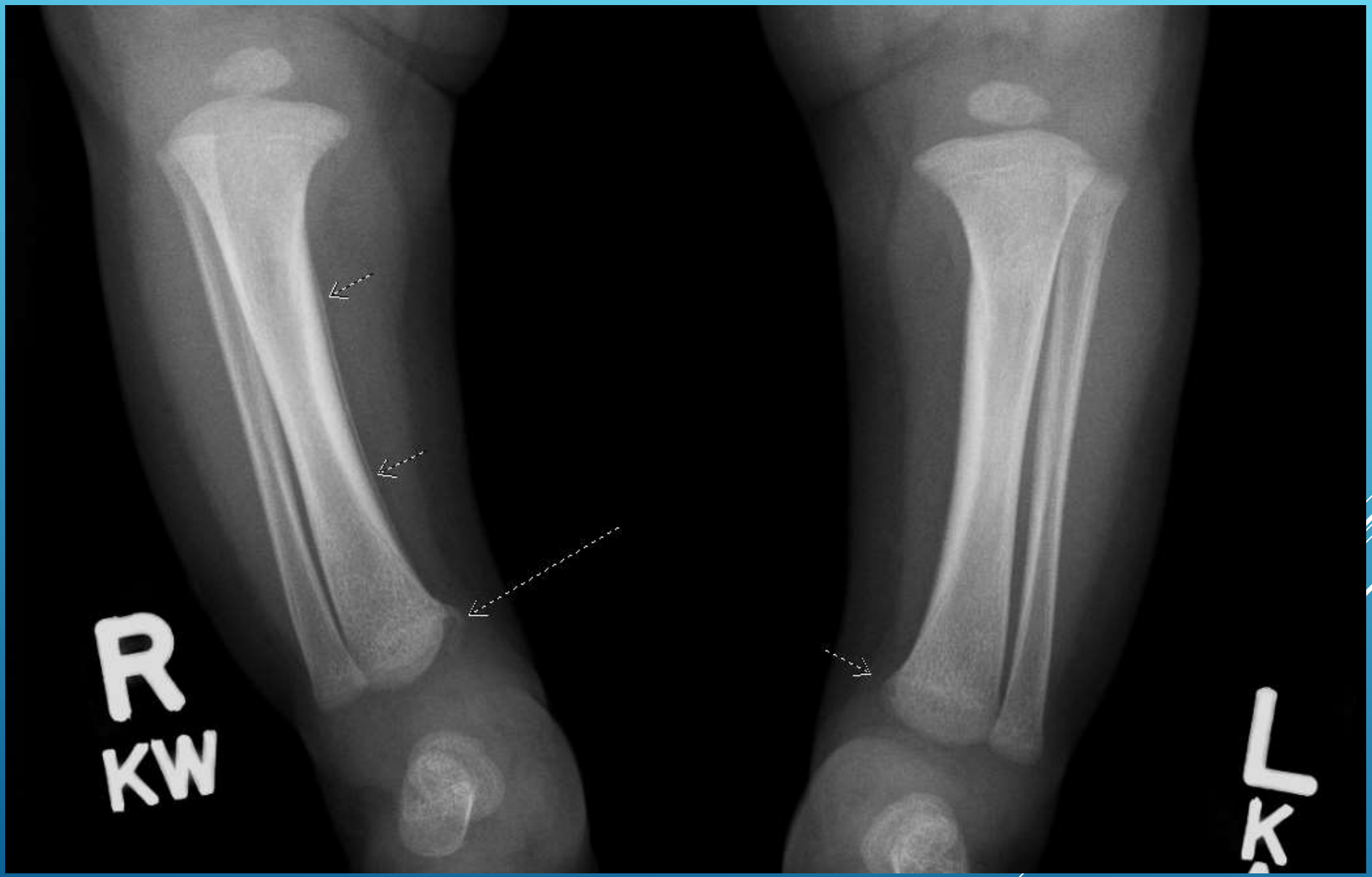
- Classically:
  - Spiral fractures
  - Transverse fractures
- **Metaphyseal fractures**
  - Corner/bucket handle fracture pattern

FRACTURE PATTERNS

- Corner/bucket handle fracture
  - occur when an indirect force is applied to the periosteal attachment to the surface of the metaphysis
  - periosteum serves as the anchor for the epiphyseal cartilage to the metaphysis
  - Failure of the bone in this area results in a corner fracture

FRACTURE PATTERNS

- Corner/bucket handle fracture
  - Typically from a whiplash type injury
    - Violently shaking an infant
  - Causes a torsional injury in the weak zone of provisional calcification towards the cortex and undercuts a fragment of bone which appears as a “corner” fracture


R
KW
L

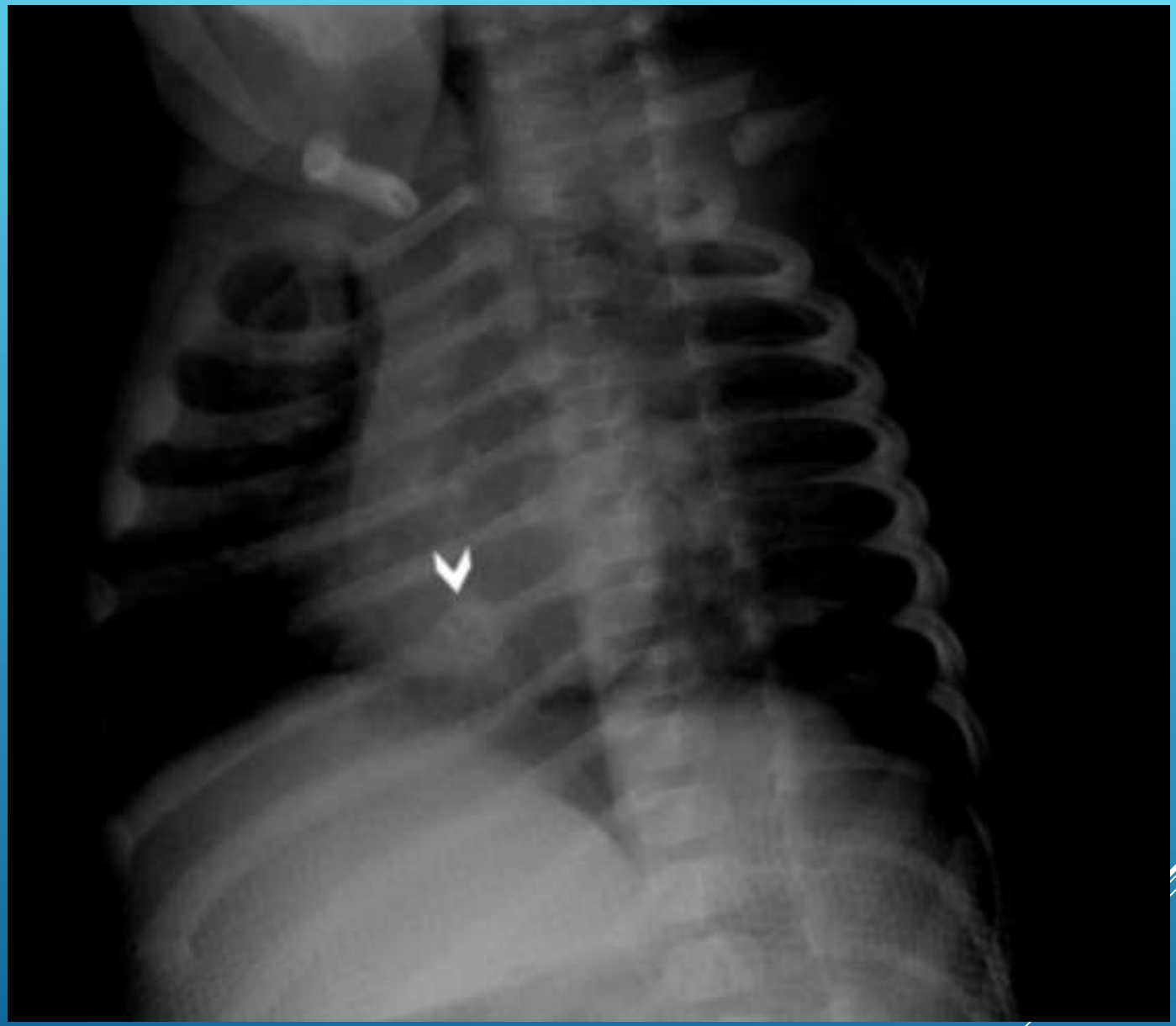

L
DMV

FRACTURE PATTERNS

- Corner/bucket handle fracture
  - Loses specificity in children older than walking age
    - Younger children cannot exert torsional force needed by themselves
    - Corner fractures do NOT occur from falls (off changing table, etc)

RIB FRACTURES

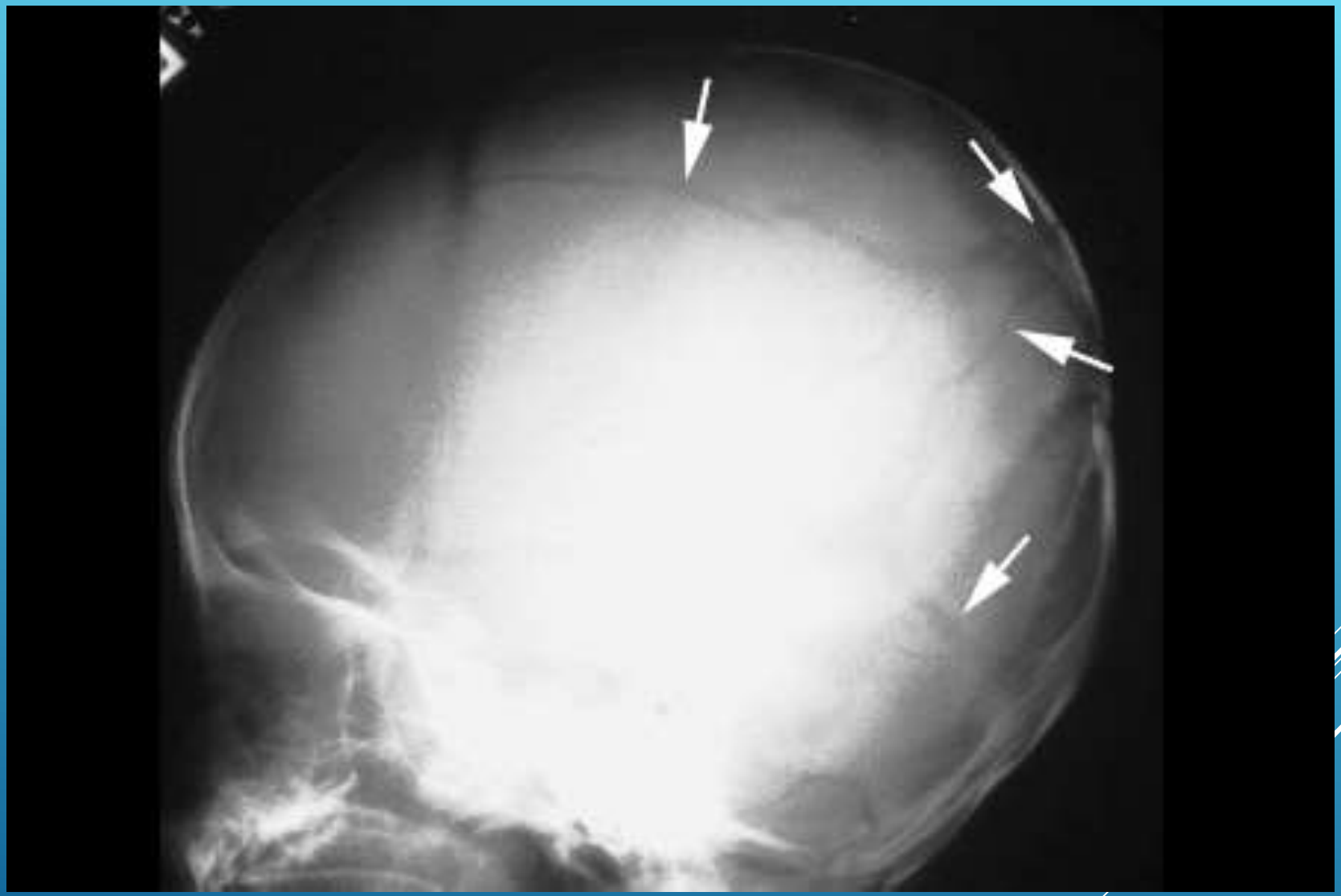
- Kemp et al 2008: meta-analysis
- 7 studies, excluded fx from MVA/violent trauma/surgical
- Children <15 years old
- Probability of abuse, given a rib fracture: 71%
- Abuse fx more common ant/post
- Non-abuse fx more common lateral



SKULL FRACTURES

- Probability of abuse, given a skull fracture: 30%
- Most commonly linear and parietal, no diff between abuse/non
- Multiple & bilateral fx more common in abuse

Kemp et al 2008



UPPER EXTREMITY FRACTURES

- Almost all children with an abuse fx are less than 3 years old
- Humeral shaft fx: highly associated with abuse
- Supracondylar fx of humerus: No
- Proximal humerus fracture: No
- Forearm: No

- Transphyseal separation of the distal humerus
- <1-2 yrs old
- Commonly misdiagnosed
  - Elbow dislocation
- Strongly associated with child abuse

LOWER EXTREMITY FRACTURES

- Femur fxs
  - Non-ambulatory patients
  - No difference in type of fx
    - i.e. spiral, transverse, oblique, between abused and non-abused fx groups
- Tib/fib fxs
  - <12 months old: highly associated with abuse

MOST COMMON FRACTURE PATTERNS: REVISISTED

- King, et al, J Pediatr Orthop, 1988
  - Retrospective study, 500 fxs of confirmed abuse
  - Most common:
    - Transverse fx pattern (not spiral fx)
    - Humerus (then femur, tibia)
    - Middle third of diaphysis (not corner fx)
    - One fracture at one site only (not multiple fxs/diff stages of healing)

ASSOCIATED INJURIES

- Soft tissue injury
  - #1 presenting sign of abuse
  - McMahon, JBJS, 1995
    - Retrospective review
  - 92% of abuse cases had assoc soft tissue injury
  - Ecchymosis most common

EXCEPTIONS OF ABUSE FRACTURES

- Femur spiral fractures
- Tibia "toddler's" fracture
- Proximal tibia "trampoline" fracture
- Osteogenesis Imperfecta
- Rickets
- Birth injury
- Other
  - Genetic mutations, chromosomal disorders, mineral deficiency, immunodeficiency

EXCEPTIONS OF ABUSE FRACTURES

- Femur spiral fractures
  - Common in ambulatory toddlers
  - Typically from low energy injury
  - "He was running across room and just twisted leg and fell"

EXCEPTIONS OF ABUSE FRACTURES

- Tibia "toddler's" fracture
  - Spiral fracture of distal third of tibial shaft
  - Low energy twist and fall injury
  - Going down slide with parent


R
SKI

EXCEPTIONS OF ABUSE FRACTURES

- "Trampoline" fracture
  - Proximal tibia transverse or short oblique fracture
  - Almost always from absorbing energy from trampoline bounce

EXCEPTIONS OF ABUSE FRACTURES

- Osteogenesis Imperfecta
  - inherited connective tissue disorder
  - abnormalities in type 1 collagen
  - may have multiple fractures
  - radiographic evidence of old healing fractures on presentation
  - large phenotypic variance in presentation
    - from perinatal death to normal life-span

EXCEPTIONS OF ABUSE FRACTURES

- Osteogenesis Imperfecta
  - Look for:
    - Blue Sclera
    - Family history

EXCEPTIONS OF ABUSE FRACTURES

- Osteogenesis Imperfecta
- 4 types
  - type 1-blue sclera, positive family history
  - type 2-lethal
  - type 3-severe, progressive, fx at birth
  - type 4-"silent," mild bone disease, clear sclera, commonly mistaken for child abuse

EXCEPTIONS OF ABUSE FRACTURES

- Osteogenesis Imperfecta
- skin fibroblast culture for dx
  - can reveal abnormal collagen in 85% of OI patients

OI OR CHILD ABUSE

- Dent, et al, J Pediatr Orthop 1991
  - 200 fxs of OI compared with age matched controls with abuse fxs
  - Spiral and transverse fx patterns common in both
  - Metaphyseal fx patterns about 15% in both groups
  - Conclusion: cannot use specific fx pattern to distinguish OI fx from child abuse fx

EXCEPTIONS OF ABUSE FRACTURES

- Rickets
  - Vitamin D deficiency
  - Metabolic bone disease
  - Failure to mineralize new bone
  - Look for:
    - Physeal fraying
    - Physeal cupping
    - Bilateral symmetry

EXCEPTIONS OF ABUSE FRACTURES

- Birth injury
  - Difficult extraction or birth position
  - Robust callus by 1-2 weeks of life
  - Completely remodeled in 2-3 months

TAKE HOME POINTS

Jayakumer et al 2010 , JBJS

Systematic review of the literature concerning fractures of abuse

Specifically pathognomonic:
Bucket-handle/corner metaphyseal fractures in non-ambulatory child
Posterior rib fractures in any child
Humeral shaft fractures in child <3
Skull fracture in child <18m
“elbow dislocation” in child <1

Box 2: Features associated with possible child abuse

Physical abuse should be considered in the differential diagnosis when an infant (under 18 months) presents with a fracture in the absence of an overt history of important trauma or a known medical condition that predisposes to bone fragility. The following indicators can be used to inform decisions about the likelihood of child abuse:

- Multiple fractures are more common after physical abuse than after non-abusive traumatic injury
- A child with rib fractures has a 7 in 10 chance of having been abused
- A child with a femoral fracture has a 1 in 3-4 chance of having been abused
- Femoral fractures resulting from abuse are more commonly seen in children who are not yet walking
- A child aged under 3 with a humeral fracture has a 1 in 2 chance of having been abused
- Mid-shaft fractures of the humerus are more common in abuse than in non-abuse, whereas supracondylar fractures are more likely to have non-abusive causes
- An infant or toddler with a skull fracture has a 1 in 3 chance of having been abused
- Parietal and linear skull fractures are the most common type of skull fracture seen in abuse and non-abuse
- No clear difference exists in the distribution of complex skull fractures between the two groups

Table I. Specificity of fracture types for paediatric non-accidental injury

Fractures with high specificity
Metaphyseal fractures
Rib fractures
Scapular fractures
Outer-end clavicle fractures
Fractures of different ages
Vertebral fractures or subluxation
Digital injuries in non-mobile children
Bilateral fractures
Complex skull fractures
Frequent fractures but with low specificity
Mid-clavicular fractures
Simple linear skull fractures
Single long-bone fractures

ABUSE

- Fx is 2ND presenting symptom
- Abuse is 2nd leading cause of child death
- Risks:
  - Disability
  - Premature
  - Loss of parent
  - Loss of parent job

ABUSE

- If you see ___, think abuse
  - Posterior rib fxs
  - Corner fxs
  - Distal humerus transphyseal separation
    - i.e. an "elbow dislocation" in nonossified elbow
  - Long bone fx but not ambulatory
  - Multiple fx/bruises

ABUSE

- If think abuse,
  - CPS
  - Skeletal survey
- Most common presentation:
  - A "routine" fx! (single bone, long bone, transverse)