

WI CAN Education Series

Sticks & Stones and Broken Bones: Pediatric Fractures

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Disclosure Information for: Dr. Van Nguyen Greco

- Learners must attend the entire one-hour session and complete an evaluation to receive contact hours. There will be a code to text confirming attendance. The code and phone number will be displayed at the end of the session.
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Learning Objectives

- Become familiar with bone anatomy
- Become familiar with fracture types and mechanisms
- Be able to identify fractures and factors that are concerning for inflicted trauma in children
- Be aware of medical conditions that contribute to bone fragility

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Overview

- Fractures are common in childhood
 - Boys > girls
 - Peak incidence is in early adolescence
 - Forearm fractures are the most common
- Fractures are the second most common injury seen in abused infants
- Fractures occur due to trauma, bone problems, or both
- Few medical conditions cause solely bone fractures without other signs, symptoms, and abnormal diagnostic testing

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Why Do Bones Break?

- Forces overcome the strength of the bone
- How much force?
 - Varies with chronological and gestational age
 - Varies with type of fracture
 - Varies with bone factors
- Individual factors
 - Genetic and metabolic diseases and disorders
 - Developmental and physical abilities
 - Health status

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Physical Capabilities

- What is the individual child able to do?
- Infants and Toddlers: wide range of when developmental milestones are achieved
- Physically-challenged older children
- Abnormal pain sensation

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Fracture Description

- Name of the injured bone
- Location of the injury on the bone: proximal, midshaft, distal, epiphysis, growth plate, metaphysis
- Orientation of fracture: transverse, oblique, spiral, etc
- Others: open vs closed, angulation/displacement, simple or comminuted
- Timing: acute or healing

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Transverse Fracture

- Fracture line is perpendicular to long axis of bone
- Mechanism: direct force (at fracture site) or tensile force (on both ends) causing bone to bend
- Higher forces compared to other types of fractures

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Oblique Fracture

- Fracture line runs diagonally down the long axis of the bone
- Mechanism: combination: bending, axial loading, complex loading
- Relatively low force

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Spiral Fracture

- Fracture line is diagonal and often in two different oblique directions
- Mechanism: twisting, rotary (torsion) force
- Relatively low force

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Buckle (Torus) Fracture

- Buckling of the cortex
- Usually at distal metaphysis
- Mechanism: axial loading with compression failure
- Ex: fall on outstretched hand

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Greenstick Fracture

- Complete fracture of the tension side and
- Plastic deformation of the compression side
- Resulting in a fracture line that does not extend completely through the width of the bone
- Mostly seen in young children

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Compression Fracture

- Occurs when bones or fragments are driven into one another
- Seen in vertebral bodies
- Mechanism: forceful slamming down
- Relatively high force

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Classic Metaphyseal Lesion (CML)

- Also known as corner fracture, bucket-handle fracture, or chip fracture
- Microfractures through the metaphysis of the bone
- Mechanism: traction and torsion, shearing
- Highly suspicious for abuse in infants <12 months!

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Fracture Location and Abuse Concern

- In the absence of accidental trauma history that can adequately explain the injury
- In children not independently mobile
- In normal, healthy children

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High Specificity

- In non-ambulatory children
 - Trans-physeal distal humerus fracture
 - CMLs
 - Rib fractures
- Without history of major trauma
 - Sternum
 - Scapula
 - Pelvis
- Multiple fractures
 - In different stages of healing
 - Bilateral symmetrical fractures
 - Associated with other injuries (ie. bruises, intracranial or intraabdominal injuries, etc)

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Highly Specific Fractures in Very Young Children

- Rib fractures in children < 3 years old
 - Posterior
- Fractures of the humerus or femur in children < 18 months old

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Moderate Specificity

- Spinal fractures
- Clavicle fractures (especially at either end of the bone)
- Skull fractures
- Fractures of hands or feet
 - Higher specificity in non-mobile infants
- Isolated long bone fractures in ambulatory children without a plausible history

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Common but low specificity

- In ambulatory children
 - Toddler fracture (usually distal tibia)
 - Buckle fractures of distal radius and ulna
 - Supracondylar fracture of the humerus
 - Mid-clavicular fracture
- Non-displaced simple parietal skull fracture with history of fall from height

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Other considerations

- Incidental finding vs reason for seeking medical care
 - Fractures hurt with movement until immobilized or healing
- Significant changes in history
- Reported history does not make sense for mechanism of injury
- Child's physical abilities
- Concerns for neglect:
 - Result of lack of appropriate supervision
 - Unreasonable delay in seeking medical care

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When there is History of a Fall

- Was it witnessed?
- How high was the fall?
- What was the landing surface?
- What was the child's landing position?
- Did someone try to prevent the fall?
- Were there any symptoms and when did they start?

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Healing of Fractures

- Bones show signs of healing on radiographic imaging
 - Usually visible by 10-14 days
 - EXCEPT the skull and often CMLs
- Rate: newborns > infants > young children > older children > adults
- Repeated injury may delay healing

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Medical Evaluation of Fractures

- Detailed history of injury incident (from caregiver and child if verbal)
- Child's and family's medical history
- Physical examination of the entire body
- Skeletal survey in children <2y/o or non-verbal, non-ambulatory older child
- Lab tests if concerns for metabolic bone diseases
 - Serum calcium, phosphorus, alkaline phosphatase
 - Serum 25-OH vitamin D, intact parathyroid hormone (iPTH)
 - Genetics consultation for OI testing
 - Other specific tests for rare conditions if appropriate

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Differential Diagnosis of Fractures

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| • Trauma – accidental | • Mimics of fractures |
| • Trauma – inflicted | -Physiologic periosteal new bone |
| • Trauma – birth | -Normal variant |
| • Extreme prematurity / severe illness | -Congenital syphilis |
| • Rickets | -Scurvy |
| • Osteogenesis imperfecta | -Caffey's disease |
| • Menke's kinky hair disease | -Leukemia |
| • Other metabolic problems | -Medication side-effects |
| • Drug-induced | |

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Birth Trauma

- Fairly rare
- Often related to difficult delivery (breech position, assisted with forceps or vacuum) and/or large size of infant
- May have associated intracranial or retinal hemorrhages
- Usually singular or very few in number
- Most common: clavicle, rib, skull
- Less common: humerus and limbs
- Simple fractures, including CML, may be missed initially
- Infant may or may not have symptoms (which may be nonspecific)
- All (except skull) should show signs of healing on X-ray by 10-14 days

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Fractures due to Prematurity

- Fractures are more likely to occur in infants born <33 weeks of gestation, severely ill, or requiring intravenous feeding
- Fractures would more likely occur during hospitalization or within weeks of birth
- They should not be attributed to prematurity if they occur months later

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Fractures and Prematurity

- The last 3 months of pregnancy are crucial for normal bone development (increased transfer of calcium and phosphorus from mother, increased fetal movement)
- Preterm infants are born with decreased mineralization, putting them at risk for fractures
- Osteopenia of prematurity has multiple contributing factors
- Intravenous feeding (TPN) often cannot provide adequate calcium and phosphorus to support rapid bone growth
- Medications may decrease absorption of the necessary minerals
- Lack of movement due to medical sedation or severity of illness

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Metabolic Conditions Associated with Fractures

- All have associated signs and symptoms
 - Involvement of multiple body systems, not just a single bone
- Abnormal lab tests generally make the diagnosis
- Do NOT resolve without specific treatment

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Rickets

- Vitamin D deficiency is common but rickets is rare!
- Occurs from inadequate vitamin D intake or absorption
- The result of failure of mineralization of growing bone and cartilage; abnormal organization of the cartilaginous growth plate and impairment of cartilage mineralization
- Diagnosis is made by the presence of clinical features **AND** radiologic and laboratory features
- Fractures are rare and usually only with severe radiographic abnormality
- Healing only occurs with treatment

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Osteogenesis imperfecta

- A genetic disorder affecting type I collagen (present in bone, sclera, meninges, tendon, dermis, fascia)
- Many cases are dominantly inherited but majority are spontaneous mutations
- 10-15% of cases are recessive (both parents carry the mutation but do not have the disease)
- Incidence in U.S. is about 1:10,000-20,000 live births
- Seen equally in males & females
- Fractures may be similar to those associated with abuse
- Fractures can occur with normal handling or minimal trauma
- These children may be less susceptible to pain (resulting in delay in medical care)
- Easy bruising may occur
- While fractures do decrease in adolescence, they do NOT completely stop
- OI is NOT known to cause other organ injury
- **The diagnosis of OI does not preclude abuse**

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Osteogenesis imperfecta

- **Type I** presents universally with blue sclerae; commonly short stature, fractures, bone deformity, early hearing loss, teeth problems or family history of same
- **Types II and III** are severe and usually fatal at birth or in early infancy
- **Type IV** may or may not have any typical features
- **Types V-VIII** are extremely rare, with specific radiographic findings
- Diagnosis is based on careful review of family history, X-rays, and characteristic features on physical exam
- Confirmation of clinical suspicion is done with biochemical (measurement of amount and structure of the collagen in skin cells) and molecular genetic testing (screening the actual genes for problems)
- Each testing method identifies almost 90% of subjects known to have OI (from P.H. Byers)

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Summary

- While childhood fractures are not uncommon, fractures in young children are more commonly associated with non-accidental trauma
- No fracture is pathognomonic, but certain fractures are more concerning for NAT
- Detailed history and physical examination is KEY in determining NAT vs accidental trauma
- Metabolic causes are NOT common and rarely result in solely fractures without other discernable signs and symptoms

9/8/2008

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