Viewing Time

The program will take up to one hour to complete.

Target Audience

This program is designed for primary care physicians.

Other health care professionals working with patients and their families may also find this program of interest.

Faculty Disclosure

It is the policy of Children's Hospitals and Clinics of Minnesota to ensure balance, independence, objectivity, and scientific rigor in all its educational programs. Our faculty have been asked to disclose to our program audience any real or apparent conflicts of interest related to the content of their presentation. They have also been requested to let you know when any product mentioned in their presentation is not labeled for the use under discussion or is still under investigation.

Faculty Disclosure

Rich Kaplan, MD has disclosed no actual or potential conflict of interest in relation to this educational activity.

During this educational activity **Dr. Kaplan** will not be discussing the use of any commercial or investigational product not approved for any purpose by the FDA.

Abusive Fractures

Rich Kaplan, MD
Staff Physician, Midwest Children's Resource Center, St. Paul, Minnesota; Medical Director, Center for a Safe and Healthy Child, University of Minnesota, Minneapolis, Minnesota

Abusive Fractures

A lecture about different kinds of fractures found in children and what kinds of fractures may be indications of abuse

Program Objectives

Upon completion of this program, participants should be able to:

- Recognize fractures that raise concern for abuse
- Know common causes of "brittle bones"
- Understand the work up for possible abusive fractures

Disclaimer

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Accreditation

Children's Hospitals and Clinics of Minnesota is accredited by the Minnesota Medical Association to provide continuing medical education for physicians. Children's Hospitals and Clinics of Minnesota designates this educational activity for a maximum of 1 AMA PRA Category 1 Credits™ toward the AMA Physician's Recognition Award. Each physician should only claim those credits that he/she actually spent in the activity.

Receiving CME Credit

To receive CME credit you must view the entire program and complete the evaluation form at the end.

Abusive Fractures

Rich Kaplan
Children's Grand Rounds
May, 2009

Myths about fractures

- Spiral fractures are nearly always abusive
  - Fact: Spiral fractures can be accidental if a twisting mechanism is implicated.
- Babies bones break easily
  - Young infants have flexible bones that bend before they break
- There should be bruises over inflicted fractures
  - Bruises over inflicted fractures are rare

Fracture Location According to Association With Bruising

ARCH PEDIATR ADOLESC MED/VOL 162 (NO. 9), SEP 2008 Peters et al

Fracture Site	Total Fractures, No.	No Bruise or Bruise Not Near Fracture, No.	Bruise Near Fracture, No. (%)
Skull	71	35	32 (45.1)
Face	1	0	1 (100)
Rib	317	298	29 (9.1)
Humerus	33	30	3 (9.1)
Radius	29	26	2 (6.9)
Ulna	19	14	1 (5.3)
Femur	66	55	5 (7.6)
Tibia	64	61	2 (3.1)
Fibula	7	6	1 (14.3)
Spine	4	4	0
Pelvis	1	0	1 (100)
Clavicle	7	7	0
Acromion	2	2	0
Metacarpal	3	3	0
Metatarsal	2	2	0

Fracture Specificity

High specificity:

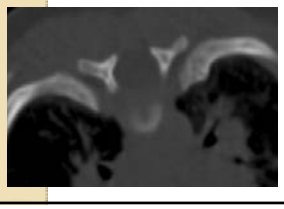
- Rib fractures, especially posterior
- Classic metaphyseal lesions (CMLs)
- Scapular fractures
- Spinous process fractures
- Sternal fractures

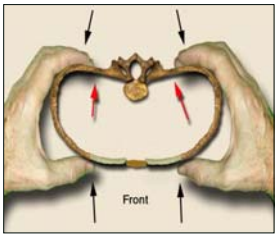
Abusive Rib Fractures

- Relatively common
- 90% seen < 2 yrs of age
- Posterior rib fractures most specific

Skeletal Injuries

- Rib Fractures
  - (posterior) don't occur from CPR
  - *rare* from birth





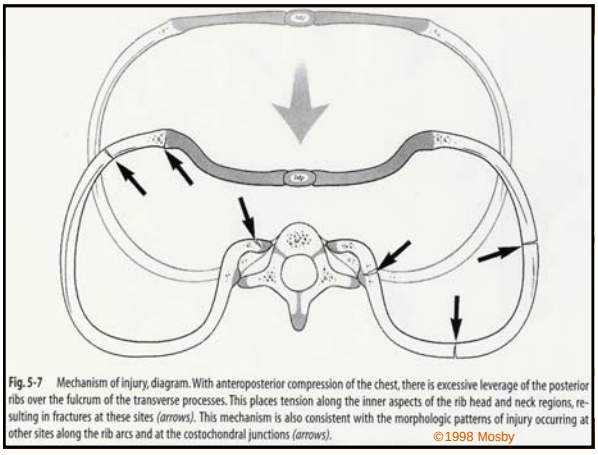
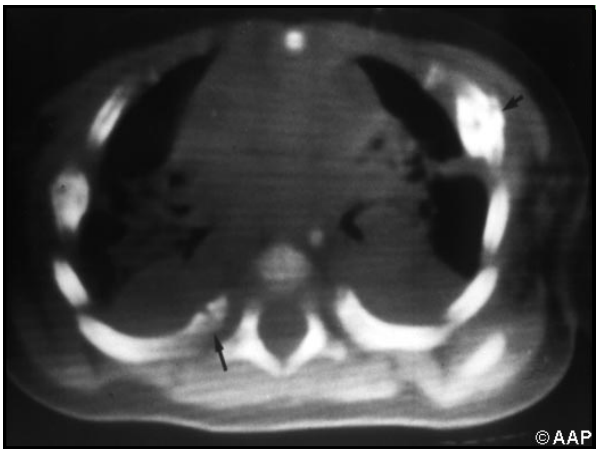
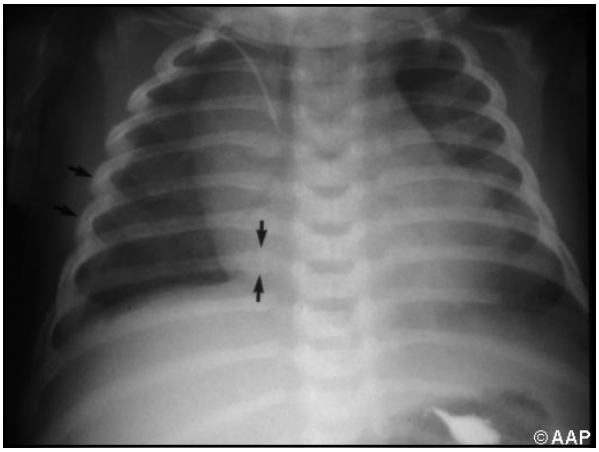
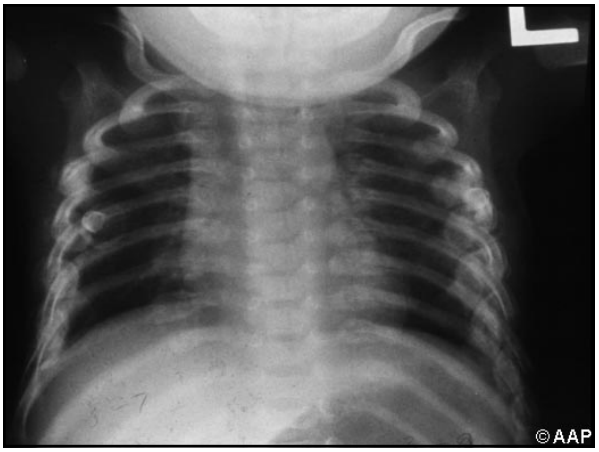


Fig. 5-7 Mechanism of injury, diagram. With anteroposterior compression of the chest, there is excessive leverage of the posterior ribs over the fulcrum of the transverse processes. This places tension along the inner aspects of the rib head and neck regions, resulting in fractures at these sites *(arrows)*. This mechanism is also consistent with the morphologic patterns of injury occurring at other sites along the rib arcs and at the costochondral junctions *(arrows)*.







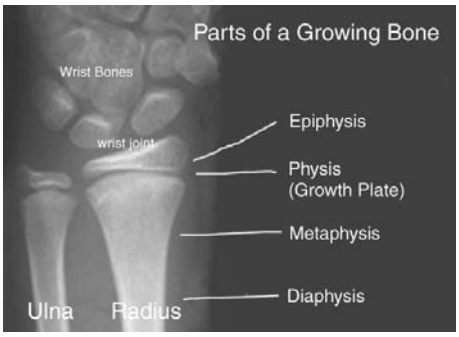
Rib Fracture Causes

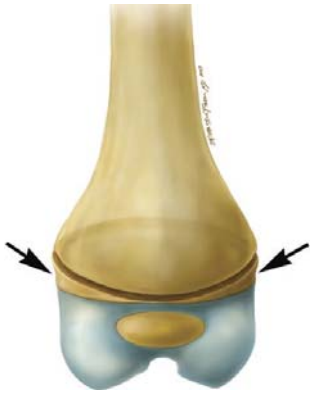
- Uncommon with birth trauma
- Not cardiopulmonary resuscitation, especially posterior rib fractures
- Compressive forces, not direct blows
- Seldom see overlying bruises
- After fractures, infant is usually asymptomatic

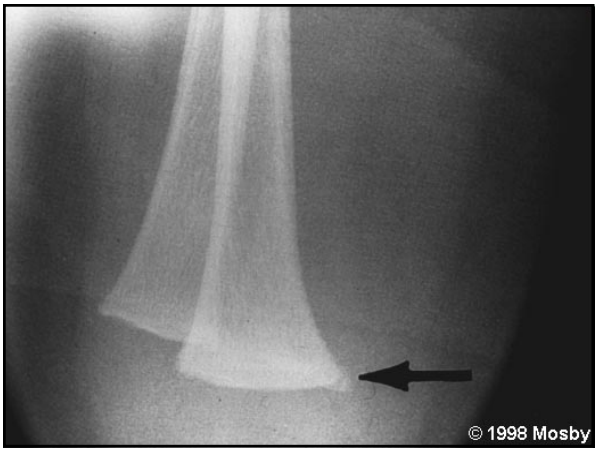
Classic Metaphyseal Lesions

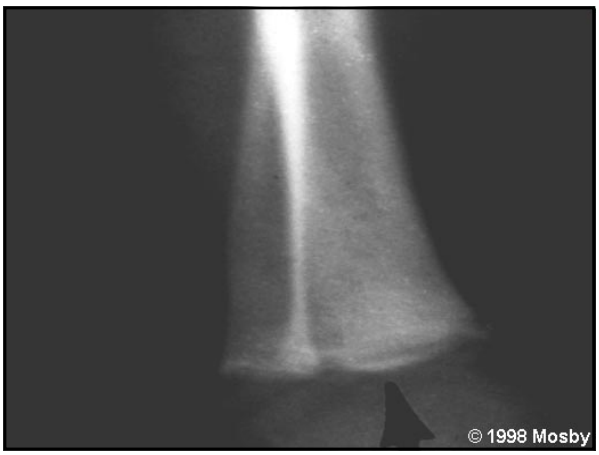
- Long bone fractures
- Weakest part of growing bone
  - Chondro-ostoid junction (primary spongiosa of metaphysis)
  - Near subperiosteal bone collar

Classic Metaphyseal Lesion









CML

- Requires shearing forces **not** produced in accidental trauma
- Possibly produced during shaking where limbs flail about
- Also consider twisting and jerking

Accidental causes of metaphyseal fractures

A. Botash, MD

Moderate specificity

- Multiple fractures, especially bilateral
- Fractures at different ages
- Epiphyseal separations
- Vertebral body fractures/subluxations
- Digit fractures
- Complex skull fractures

Vertebral body compression fracture in a 3-month-old boy

Lonergan, G. J. et al. Radiographics 2003;23:811-845

RadioGraphics

Metacarpal fractures

Common but low specificity:

- Subperiosteal new bone formation
- Clavicle fractures
- Long bone shaft fractures
- Linear skull fractures

Clinical and radiologic features of osteogenesis imperfecta

Type I

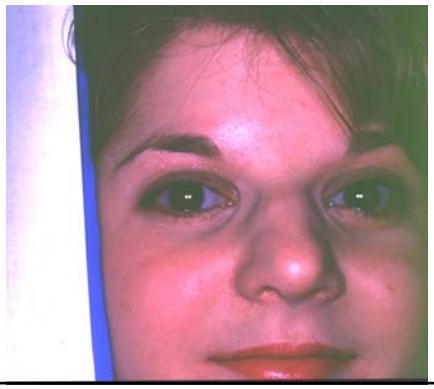
Mild Phenotype
- Hearing loss in about 50% (late onset)
- Mild but significant osteoporosis
- Wormian bones (significant number)
- Normal or close to normal stature
- Primarily autosomal dominant (FH)

Group 1A (Most)
- Blue sclera / Normal teeth

Group 1B
- Dentinogenesis Imperfecta (DI)

Blue Sclerae

Blue Sclerae



Blue Sclerae

Irregular, isolated bones (esp Lambdoid suture and posterior fontanelle)

Type II

- Always lethal in the prenatal period

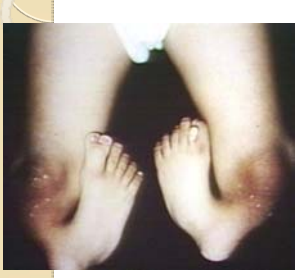
Type III

- Moderately severe phenotype early
- Short stature at birth with bowed legs
- Blue grey sclera at birth converting to normal white later
- Dentinogenesis Imperfecta is common
- Many fractures early & throughout life
- **Progressive deformation of spine and extremities**

Type III (continued)

- Severe osteoporosis (even early on)
- Wormian bones and skull deformation with poor ossification
- Slightly short, thin, deformed (angulated) long bones with thin cortices
- "Popcorn" metaphyseal calcifications
- Codfish vertebrae (severe osteoporosis)
- Exuberant callus formation, common

OI Type III



Radiographs in OI

Type IV

- Similar to type I
- Significant short stature early (even in the newborn)
- Distinctive craniofacial configuration (triangular facies, bitemporal bulging)
- Fracture onset often prenatal
- Normal sclera
- Hearing loss not common
- Primarily autosomal dominant

Group IVA

- Normal teeth

Group IVB

- Dentinogenesis Imperfecta

Diagnosis of OI

- Clinical Diagnosis:
  - Characteristic Physical Features
  - Characteristic Fractures
- Radiological Diagnosis:
  - Osteoporosis
  - Wormian bones
- Laboratory Diagnosis:
- DNA Identification many mutations now identified
- When unclear fibroblast culture to identify type 2 collagen may help

Other Reasons for "Brittle Bones"

- Prematurity, especially with maternal steroid use
- Nutritional deficiencies
  - Rickets
  - Scurvy
- Metabolic Bone Diseases
  - Osteopetrosis
  - Boney dysplasias

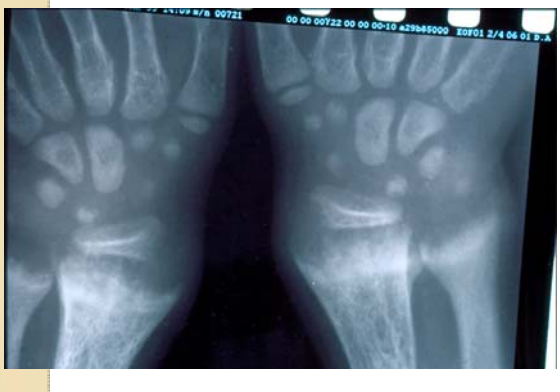
Osteopenia of Prematurity

- Virtually universal in babies < 32 weeks gestation
- Can peak when corrected age is near term
- NICU review:
  - Nutrition
  - Therapies/ROM
  - Films -- especially chest
- Plane films not sensitive for demineralization <40%

Rickets

Rickets

- Clearly a real issue
- Take a detailed family and dietary history
- Do not expect pathologic fractures without radiologic changes
- Ionized calcium, vitamin D and phosphorus levels should be measured when questions arise

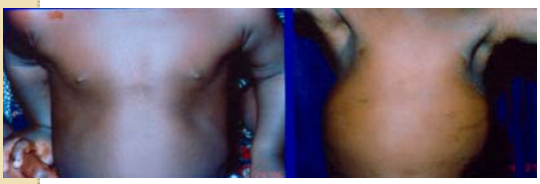


Leg Deformities

Enlarged Wrists & Ankles

Rib Beading

Rib Cage Deformities



Dental Enamel Hypoplasia

Child Treated With Oral Calcium

August 1996

January 2000

Scurvy

- Almost never an issue with routinely fed children
- Take a careful dietary history
- Fractures would be unusual without cutaneous or systemic symtoms

Other Causes

- Osteopetrosis
- Metaphyseal dysplasia

Temporary Brittle Bone Disease

- Paterson: 39 patients reported with fractures in infancy
- Controversy arises because:
  - Fractures are classic child abuse fractures
  - No identified etiology
  - Paterson's theory of a temporary enzyme deficiency has no basis in science

"Temporary Brittle Bone Disease"

- Other theories suggest a lack of prenatal movement leads to brittle bones
- Disease coincidentally improves after foster placement
- The disease is not diagnosed outside of court

Dating Fractures

General Considerations

- Healing varies by age, location and severity
- Some fx's like CML's and skull fx's are not amenable to radiologic dating
- Delay in treatment (immobilization) will lead to a delay in healing
- Dating estimates should be expressed in conservative ranges

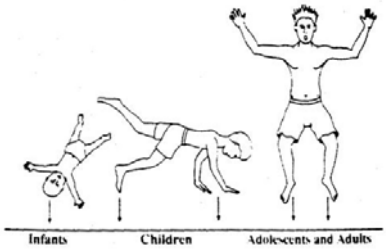
Radiologic Dating

- Resolution of soft tissue changes:4-10 days
- SPNBF: 7-14 days
- Loss of fracture line: 10-20 days
- Soft callus:14-21 days
- Hard callus: 21-42 days
- Remodeling: 1 year

Evaluating Fractures

- A detailed history including witnesses
- A clear developmental history
- Past medical history/ family history
- Scene evaluation : pictures and measurements
- Skeletal Survey (when indicated)
- CT vs Bone Scan

Drawing of Fall Mechanics

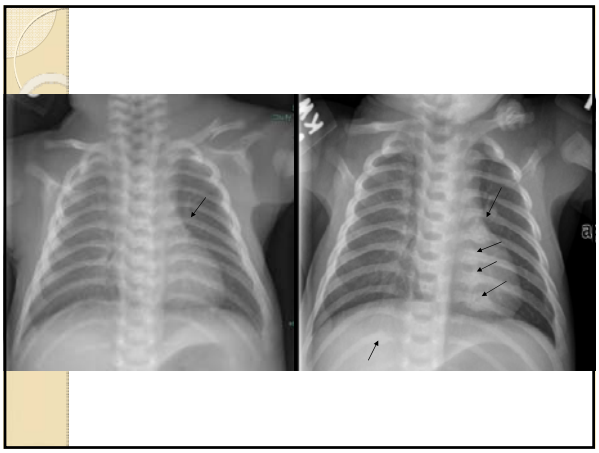


Sawyer Jr, Flynn Jm, Dormans JP, Caaloan J, Drummond DS. Fracture patterns in children and young adults who fall from significant heights. *J Pediatric Ortho*. 2000; 197-202

A Botash, MD

Follow-up Skeletal Surveys

- Follow-up skeletal survey in 10-14 days to look for additional sites of injury that may not be seen on initial study
  - Skull films are not repeated
  - Nuclear Bone scan can also be considered but has some limitations.



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