Non-Interpretive Skills

Pediatric Non-Accidental Trauma (NAT)
Before You Begin

This module is intended primarily for **clinical medical students or interns** intending to learn or review non-interpretive radiology skills.

Please note that while not integral, this module series assumes some familiarity with basic imaging techniques and interpretive skills. If you wish to learn or review these concepts, please see our “Interpretive Skills” module series.

If material is repeated from another module, it will be outlined as this text is so that you are aware
Objectives

1) List types of injuries that should raise suspicion for non-accidental trauma.

2) Discuss the reliability of a radiograph to estimate the date of an injury.
Take-Home Message

Always consider abuse in every non-verbal child.
OUTLINE

1) Background

2) Fractures

3) Other Injuries
1) Background

2) Fractures

3) Other Injuries
Victim Demographics
Abuse Statistics in U.S.

Abuse fatalities in 2014:

1,580 deaths / year
4-5 deaths / day
most under 2 years old

All cause fatalities in 2014:

0-1 y: 23,215
1-4 y: 3,830
5-14 y: 5,250
15-24 y: 28,791

http://www.childhelp.org/pages/statistics#gen-stats
NAT Fractures Occur Younger

50% < 1 year old

80% < 3 years old
Victim Risk Factors

Prematurity

Disability/Illness

Isolated
Perpetrator Demographics

60-70% Male

Male: Father
     Boyfriend of mother

Female: Babysitter
        Mother
Perpetrator Risk Factors

- Substance abuse
- Psychiatric illness
- Family stress
- Abused as children
Bruise Patterns and Examples
Bruising Pattern

Accidental

Non-Accidental

Guessing age of bruise is inexact.
Slap Mark
Slap Mark with Ring Mark
Belt Marks

[Images of belt marks on skin]
Bruise Mimic: Melanocytic Nevus

A melanocytic nevus is a common skin finding in children that should not be mistaken for a bruise.
Reporting Requirements

Reporting is required if one "reasonably suspects" abuse.
Who makes the report?

Health Practitioners
Law Enforcement
Teachers
Clergy
...and others
How does the radiologist help?
How does the radiologist help?

1) Find fracture.

2) Estimate age of fracture.

3) Know specificity for abuse.

4) Notify the ordering provider.
What is a “suspicious history”? 

No history

Inconsistent history

Blaming others, including child

Signs of neglect
What are the most common histories?

1) “I just found him this way.”

2) “Just a short fall”
OUTLINE

1) Background

2) Fractures

3) Other Injuries
What is a “complete skeletal survey”?
Complete X-Ray Survey Protocol

1) FRONTAL of every body segment
   and
2) LATERAL for skull and spine
   and
3) OBLIQUES for ribs
Complete X-Ray Survey Protocol

Consider follow-up survey in 1 week if:

1) Normal exam but high suspicion.
   or
2) Indeterminate finding.
What is the difference with a “bone scan”? 
Nuclear Medicine Bone Scan

In this test, a radioactive phosphate analog is injected intravenously and collects anywhere bone is healing. Consider this test only when suspicion for abuse is high despite normal x-ray survey.
Nuclear Medicine Bone Scan

**PRO:**
Higher sensitivity for rib fractures.

**CON:**
Lower sensitivity for classic metaphyseal lesions and skull fractures.
What fractures are specific for abuse?
Fracture Specificity Categories

1) High Specificity

2) Moderate Specificity

3) Low Specificity
Fracture Specificity Categories

1) High Specificity

2) Moderate Specificity

3) Low Specificity
High Specificity Injuries

... are hard to explain by normal injuries (e.g. falling).
High Specificity Fractures

1) Classic Metaphyseal Lesion (CML)
2) Rib (especially posterior)
3) Spinous Process
4) Sternum
5) Scapula
What is a “classic metaphyseal lesion”?
Classic Metaphyseal Lesion
Classic Metaphyseal Lesion

Shearing/twisting injury just proximal to zone of provisional calcification.
Rib Fracture Examples
Rib Fracture

Most specific in infants (< 1 year)
Rib Fracture Mechanism
Rib Fractures at Autopsy
Scapula Fracture Example
Acromion Fracture
Quick Review:

What are the HIGH specificity fractures?
High Specificity Fractures

1) Classic Metaphyseal Lesion (CML)
2) Rib (especially posterior)
3) Spinous Process
4) Sternum
5) Scapula
Fracture Specificity Categories

1) High Specificity

2) Moderate Specificity

3) Low Specificity
Moderate Specificity Fractures

1) Multiple fractures
2) Fractures of different ages
3) Vertebral body fractures
4) Digit fractures
5) Complex skull fractures
Multiple Digit Fractures
Vertebral Fractures

- Slamming → Displaced Fx
- Shaking → Compression Fx
Complex, Depressed Skull Fractures

Fracture

Normal Suture
Quick Review:

What are the MODERATE specificity fractures?
Moderate Specificity Fractures

1) Multiple fractures
2) Fractures of different ages
3) Vertebral body fractures
4) Digit fractures
5) Complex skull fractures
Fracture Specificity Categories

1) High Specificity

2) Moderate Specificity

3) Low Specificity
Low Specificity Fractures

1) Periosteal new bone
2) Clavicle fracture
3) Long bone fracture
4) Linear skull fracture
Low Specificity Fractures

Low specificity fractures could be due to accidental or nonaccidental trauma.
Periosteal New Bone
Clavicle fractures can happen by accident during vaginal delivery.
Long Bone Fracture

Non-Ambulatory

Concern for abuse with long bone fracture is higher if child is not yet walking.

Ambulatory

ABUSE

TODDLER'S FX
Linear skull fractures can be accidental (e.g. dropping baby on hard surface) or non-accidental.
Quick Review:

What are the LOW specificity fractures?
Low Specificity Fractures

1) Periosteal new bone
2) Clavicle fracture
3) Long bone fracture
4) Linear skull fracture
Fracture Specificity Categories

1) High Specificity

2) Moderate Specificity

3) Low Specificity
Can the radiologist estimate the age of a fracture?
Fracture Dating

Fracture dating is INEXACT.

Estimates are in weeks to months.
Acute (< 1 week)

No Periosteal Reaction
Subacute (1-7 weeks)

+ Periosteal Reaction
Subacute (2-10 weeks)

- Callus Formation
- or
- Bony Bridging
OUTLINE

1) Background

2) Fractures

3) Other Injuries
Abdominal Injuries
Pancreas Laceration (most common)

Direct blows to the abdomen cause the pancreas to be smashed up against the vertebral bodies. This can be accidental (e.g. handle bar injury) or non-accidental (e.g. punched or kicked).
The grey area within the liver is due to hematoma, which does not enhance with the IV contrast like the rest of the liver parenchyma.
Liver Laceration at Autopsy
Intestinal Hematoma
Intestinal Laceration

Intestinal perforations are surprisingly difficult to detect by imaging, including CT.
Intracranial Injuries
Intracranial Injuries

Retinal Hemorrhage

Subdural Hemorrhage

Diffuse Axonal Injury
Significance of Head Injuries

Leading cause of DEATH.

Infants at greatest risk.
Shaken Baby Syndrome
Fundoscopic Examination

Should be done first in outpatient with suspected abuse.
Retinal Hemorrhage

Normal

Abuse

Occurs in majority of shaken babies.
Subdural Hemorrhage
Subdural Hemorrhage at Autopsy
Subdural Hemorrhage and Edema
Subarachnoid Hemorrhage
OUTLINE

1) Background

2) Fractures

3) Other Injuries
Multiple Choice Questions
Question 1

In non-accidental trauma cases, which organ (besides the spleen) is most at risk?

a) Bladder
b) Kidneys
c) Pancreas
d) Distal Jejunum
Question 1

In non-accidental trauma cases, which organ (besides the spleen) is most at risk?

a) Bladder
b) Kidneys
c) Pancreas
d) Distal Jejunum
Question 2

Which of the following fractures is the MOST SPECIFIC for abuse?

a) Clavicle fracture
b) Humerus metaphysis fracture
c) Skull fracture
d) Tibia diaphysis fracture
Question 2

Which of the following fractures is the MOST SPECIFIC for abuse?

a) Clavicle fracture
b) Humerus metaphysis fracture
c) Skull fracture
d) Tibia diaphysis fracture
Question 3

What should be done first in an outpatient with suspected non-accidental trauma?

a) Head CT
b) Funduscopic examination
c) Head MRI
d) Abdominal Ultrasound
Question 3

What should be done first in an outpatient with suspected non-accidental trauma?

a) Head CT
b) Funduscopic examination
c) Head MRI
d) Abdominal Ultrasound
Take-Home Message

Always consider abuse in every non-verbal child.