Dating Abusive Injuries
Barbara Knox, M.D.
University of Wisconsin Child Protection Program

Abusive Head Trauma
“Shaken Baby Syndrome”

- Violent shaking or sudden impact causes excessive brain movement and damage to the cerebral bridging veins

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Subdural Hematoma Imaging

- The subdural space surrounds the brain and is filled with a small amount of cerebro-spinal fluid.

- A subdural hematoma (SDH) is bleeding into this space.
Abusive Head Trauma
“Shaken Baby Syndrome”

- Sagittal venous sinus in dural falx
- Portion of cerebral vein bridging subdural space
- Subarachnoid portion of cerebral vein
- Parafalcine Subdural hematoma

Abusive Head Trauma
“Shaken Baby Syndrome”

- Schema of bridging cerebral vein
- Shearing forces tear bridging cerebral vein
- Hemorrhage into subdural space

Subdural Hematoma Imaging

- SDH results from direct impact or repetitive angular acceleration or deceleration.
Subdural Hematoma Imaging

• CT (Computed tomography) is the initial line of imaging.
• CT is rapid and widely available in the ER setting.

As the subdural space expands it can displace the brain, causing brain injury.
Subdural Hematoma Dating

- Acute (1-3 days) and sub-acute (3-14 days) SDH is high density on CT
- Density decreases as blood cells and hemoglobin breakdown

MRI (Magnetic Resonance Imaging) is often done as a secondary test in non-accidental SDH and brain injury.
- MRI signal intensity of SDH can be used to more accurately date SDH based on the chemical breakdown of hemoglobin.
Early Subacute Subdural Hematoma

Retinal Hemorrhages

• 85% of AHT cases also have retinal hemorrhages present
• Physicians cannot accurately date retinal hemorrhages
Organs most at risk of injury are ones that may be crushed against vertebrae (liver removed). Great vessels, pancreas, duodenum, lacerated liver, ruptured stomach, mesenteric laceration.

External signs may be minimal or absent; patient often lethargic and may vomit.

**Dating the Injury**

- Poor data on this topic
- Bowel wall hematoma injuries have delayed symptoms for hours or days (vomiting/pain as obstruction develops)
- Peritonitis can clinically present within hours of sustaining the injury
- For blunt liver trauma, when ALT>AST, the injury was older than 12 hrs.
- The larger the splenic or liver laceration, the quicker the signs of hypovolemic shock (presentation within minutes to hours)
Medical Evaluation

- The American Academy of Pediatrics recommends screening tests for abdominal injury in all physically abused children to evaluate for occult injuries.
- Screening laboratory studies
  - CBC
  - Liver Function Tests
    - AST >450 and ALT >250 identified in children with liver damage from blunt trauma
<table>
<thead>
<tr>
<th>ABDOMINAL INJURIES</th>
<th>ABUSE</th>
<th>ACCIDENTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE OF PATIENT</td>
<td>&lt; 5 years old</td>
<td>&gt; 5 years old</td>
</tr>
<tr>
<td>HISTORY OF TRAUMA</td>
<td>ABSENT</td>
<td>PRESENT</td>
</tr>
<tr>
<td>ASSOCIATED BRUISES</td>
<td>60%</td>
<td>INFREQUENT</td>
</tr>
<tr>
<td>ASSOCIATED FRACTURES or HEAD TRAUMA</td>
<td>FREQUENT</td>
<td>INFREQUENT</td>
</tr>
<tr>
<td>LIVER LACERATION</td>
<td>LEFT LOBE</td>
<td>RIGHT LOBES</td>
</tr>
<tr>
<td>HOLLOW VISCUS INJURY</td>
<td>65%</td>
<td>8%</td>
</tr>
<tr>
<td>HOLLOW VISCUS TYPE</td>
<td>SMALL BOWEL</td>
<td>COLON</td>
</tr>
<tr>
<td>ISOLATED KIDNEY or SPLENIC INJURY</td>
<td>RARE</td>
<td>FREQUENT</td>
</tr>
<tr>
<td>MORTALITY</td>
<td>20-40%</td>
<td>5%</td>
</tr>
</tbody>
</table>

**Dating Bruises**

*The Dogma*

- Acute bruise with marked swelling (1-3 days)
- Purple (1-5 days)
- Green (5-7 days)
- Yellow (7-10 days)
- Brown (>10 days)

**Dating Bruises**

*The Literature*

- "Estimation of the Age of Bruising" *Archives of Diseases of Children, 1996*
- "Dating of Bruises in Children: An Assessment of Physician Accuracy" *Pediatrics, 2003*
- Direct exam by physicians
- Poor accuracy with dating
- Poor interrater reliability
Bruises should resolve or deeply fade by 10 days

Dating Abusive Bites
• There is no available literature documenting physician or dentist ability to accurately date onset of a bite injury to a child
• Forensic odontologists can identify perpetrator(s) via photodocumentation/impression
• Swabs to State Crime Lab

Dating Abusive Burns
• Abusive burns typically occur in children younger than age 6 and have the greatest percentage of hospitalizations for treatment
Dating Abusive Burns

- No studies documenting physician accuracy for dating burns of abuse
- Physicians experienced in burns and wound healing should be able to make statements about injury timing

Cases where burn injury exists of varying ages, medical providers should be able to confidently say that one injury is older than another based upon differences noted in wound healing between the lesions.

Documenting that one burn injury is older than another would eliminate a caregivers claim that the injury was secondary to accidental mechanisms occurring during a single event.

Time-Temperature Scales

Exposure Time to Cause 2nd Degree Burns

<table>
<thead>
<tr>
<th>Temp. (F)</th>
<th>Adult Skin</th>
<th>Child Skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>127</td>
<td>60 seconds</td>
<td>60 seconds</td>
</tr>
<tr>
<td>130</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>140</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>150</td>
<td>2</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>158</td>
<td>1</td>
<td>&lt; 1</td>
</tr>
</tbody>
</table>

Child left in comfortable water. Parent returns to find hot running, child burned.

To add 3" (11 gal) @ 5.5 gal/min flow = 2 minutes
Burn Time @ 125°F = 2 minutes
Total Burn Time = 4 minutes

Friction/Pressure Burns

• Innocent pressure injuries may be confused with dry contact burns
• Constricting bands from tight clothing causes a cutaneous pressure injury resembling a ligature mark
• A non-circumferential injury can be produced if pressure form the constricting garment is augmented in certain anatomic locations

Fractures

• The most common abuse-related injury (excluding soft tissue injury)
• Documented in 11-55% of physically abused children
• In one large series of abuse related fractures:
  76%: Long bones
  8%: Skull
  8%: Rib cage

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

Skull Fractures-Cannot Date Injury

Dating Fractures: General Considerations

- 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

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.
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

<table>
<thead>
<tr>
<th>Fracture Site</th>
<th>No. Fractures, N=91</th>
<th>No. Fractures Associated With Bruising, N=91</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skull</td>
<td>71</td>
<td>35 (45.1)</td>
</tr>
<tr>
<td>Face</td>
<td>1</td>
<td>0 (100)</td>
</tr>
<tr>
<td>Rib</td>
<td>317</td>
<td>20 (6.2)</td>
</tr>
<tr>
<td>Humeral</td>
<td>33</td>
<td>3 (9.1)</td>
</tr>
<tr>
<td>Radius</td>
<td>29</td>
<td>2 (6.9)</td>
</tr>
<tr>
<td>Ulna</td>
<td>19</td>
<td>1 (5.3)</td>
</tr>
<tr>
<td>Femur</td>
<td>66</td>
<td>5 (7.6)</td>
</tr>
<tr>
<td>Tibia</td>
<td>64</td>
<td>3 (4.7)</td>
</tr>
<tr>
<td>Fibula</td>
<td>7</td>
<td>1 (14.3)</td>
</tr>
<tr>
<td>Spine</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Pelvis</td>
<td>1</td>
<td>0 (100)</td>
</tr>
<tr>
<td>Clavicle</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Acromion</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Metacarpal</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Metatarsal</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

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.

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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
Skeletal Survey vs. Bone Scan
Which Imaging is Appropriate?

- Skeletal scintigraphy in young children requires radiologic personnel with strong training and experience.
- Bone scans are more sensitive than skeletal surveys in detecting abnormalities, but this difference decreases with age.
  - Better at identifying rib fractures and acute subperiosteal hemorrhaging.
- Radiography provides a higher level of specificity.
- Certain lesions such as the CML are better visualized via skeletal survey.