Child Abuse Update 2017: Bruising, Burns, Fracture, Head Injuries, and Sexual Abuse

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Ventura County Medical Center
March 2nd, 2017

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Objectives

- Overview of the medical evaluation for both physical and sexual abuse
- Understand terminology used to describe injuries and findings
- Understand the likelihood of positive findings on exam
- Understand the information that helps the medical professional come to a firm conclusion regarding the findings on exam
- Understand the limitations to Medical Exam
- Stress Multi-Disciplinary nature of "diagnosis"

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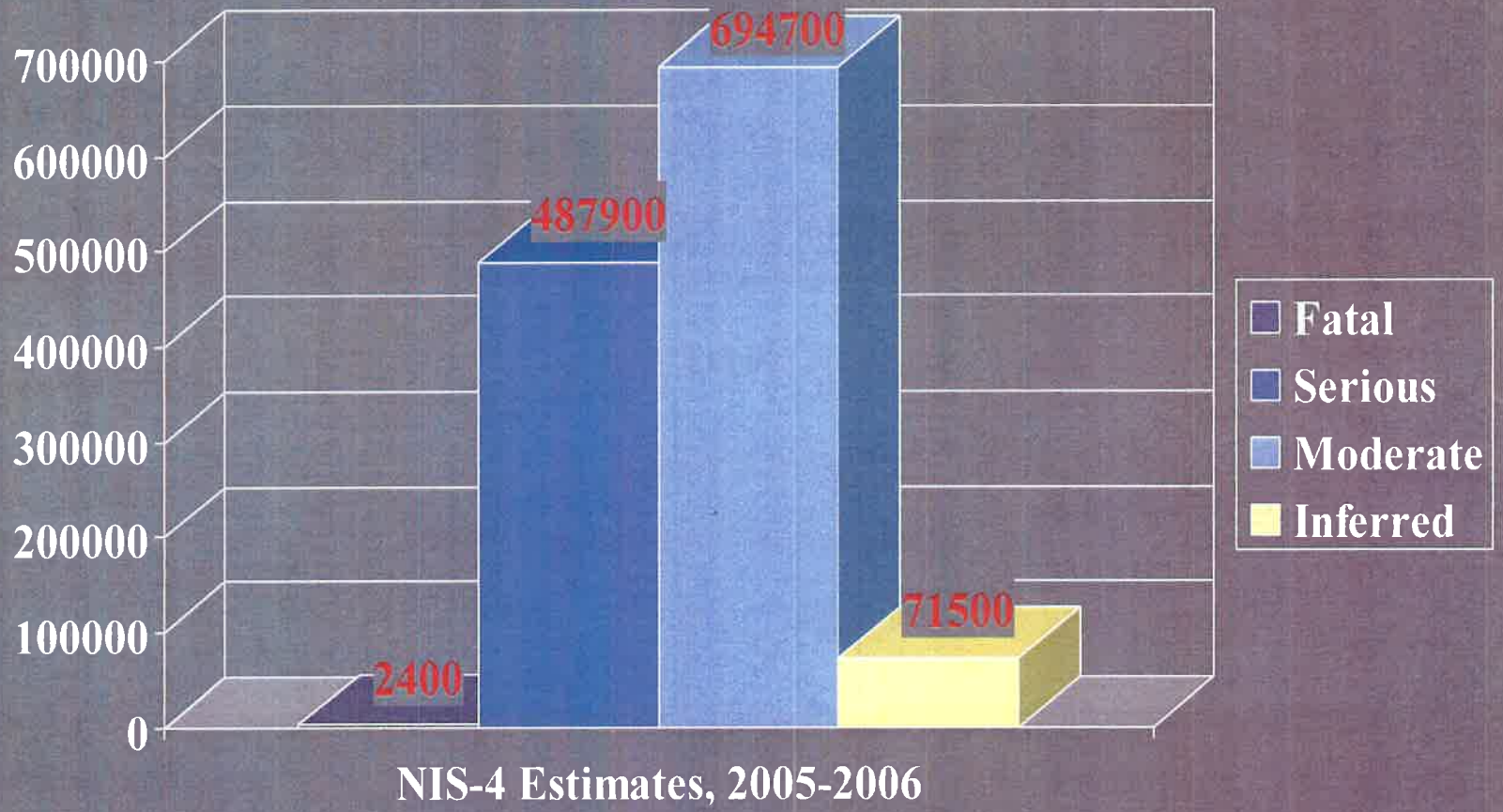
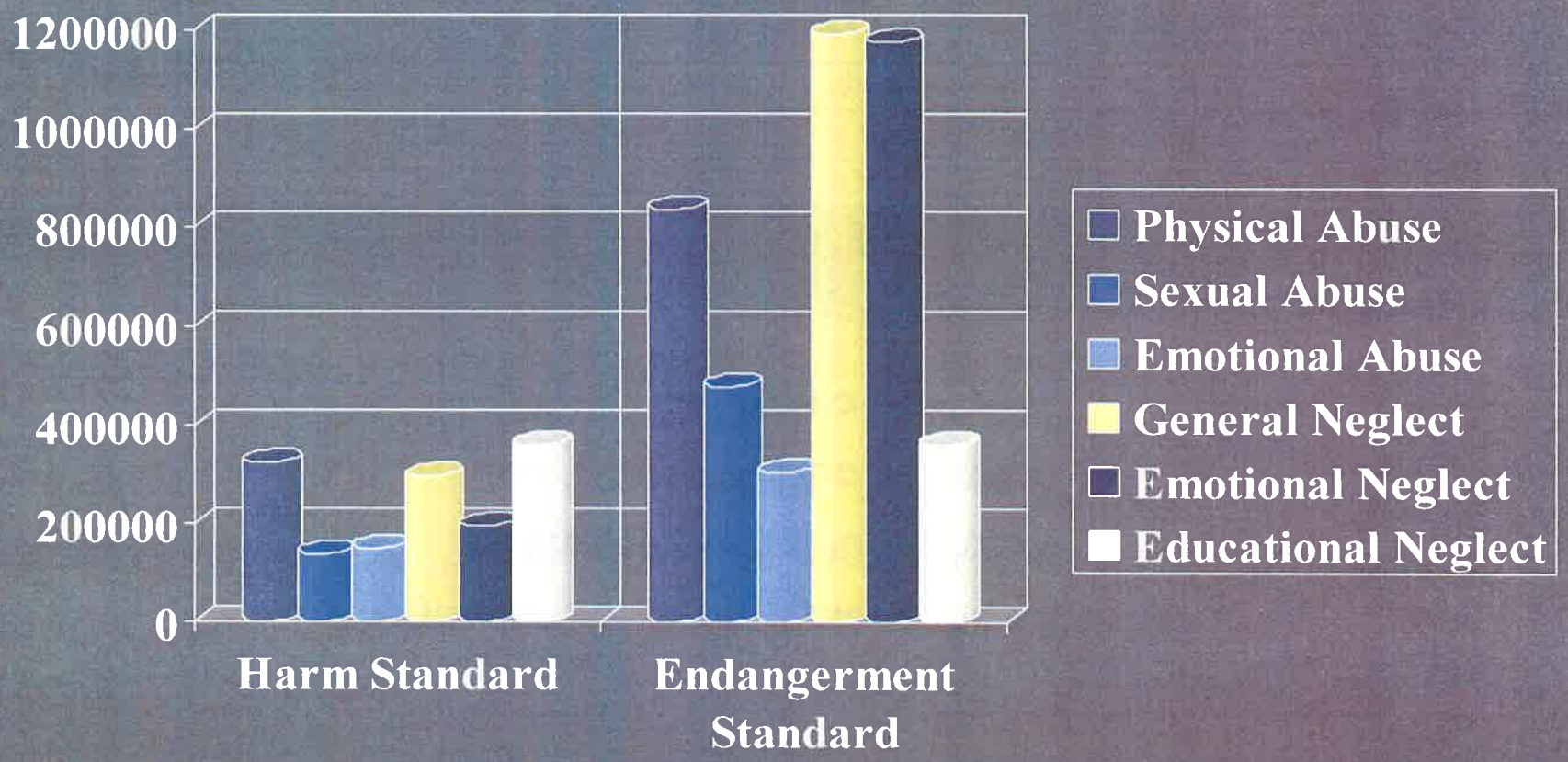
NIS-4 Data (2005-6) on Incidence of Child Abuse, by Severity



NIS-4 Estimates, 2005-2006

*Based on Harm Standard: Total = 1,256,600 or 1.7/100 children

NIS-4 Data (2005-6) on Incidence of Abuse & Neglect by Type



Total: Harm Standard = 1.25M vs Endangerment Standard = 2.9M

California Child Population (0-17) and Children with Child Maltreatment Allegations, Substantiations, and Entries

Incidence per 1,000 Children

Jan 1, 2010 to Dec 31, 2010

California

Age Group	Total Child Population	Children with Allegations	Incidence per 1,000 Children	Children with Substantiations	Incidence per 1,000 Children	% of Allegations	Children with Entries	Incidence per 1,000 Children	% of Substantiations
Under 1	568,709	33,173	58.3	10,930	19.2	32.9	5,478	9.6	50.1
'1-2	1,115,021	54,003	48.4	12,472	11.2	23.1	4,959	4.4	39.8
'3-5	1,638,249	84,047	51.3	16,399	10	19.5	5,475	3.3	33.4
'6-10	2,715,571	131,532	48.4	22,260	8.2	16.9	6,384	2.4	28.7
'11-15	2,747,067	128,580	46.8	20,227	7.4	15.7	6,220	2.3	30.8
16-17	1,204,780	48,301	40.1	6,455	5.4	13.4	2,130	1.8	33
Total	9,989,397	479,636	48	88,743	8.9	18.5	30,646	3.1	34.5

California Allegations: 4.8%

California Substantiations: 18.5%

California Child Population (0-17) and Children with Child Maltreatment Allegations, Substantiations, and Entries

Incidence per 1,000 Children

Jan 1, 2010 to Dec 31, 2010

Ventura

Age Group	Total Child Population	Children with Allegations	Incidence per 1,000 Children	Children with Substantiations	Incidence per 1,000 Children	% of Allegations	Children with Entries	Incidence per 1,000 Children	% of Substantiations
Under 1	12,691	622	49	138	10.9	22.2	87	6.9	63
'1-2	24,828	1,085	43.7	143	5.8	13.2	72	2.9	50.3
'3-5	36,067	1,759	48.8	171	4.7	9.7	71	2	41.5
'6-10	57,606	2,929	50.8	227	3.9	7.8	80	1.4	35.2
'11-15	58,306	2,672	45.8	169	2.9	6.3	63	1.1	37.3
16-17	25,238	1,051	41.6	70	2.8	6.7	41	1.6	58.6
Total	214,736	10,118	47.1	918	4.3	9.1	414	1.9	45.1

Ventura Allegations: 4.7%

Ventura Substantiations: 9.1%

California Substantiations: 18.5%

California Child Welfare Indicators Project (CCWIP)
University of California at Berkeley

California Child Population (0-17) and Children with Child Maltreatment Allegations, Substantiations, and Entries

Incidence per 1,000 Children
Agency Type=Child Welfare
Jan 1, 2015 to Dec 31, 2015
California

Age Group	Total Child Population	Children with Allegations	Incidence per 1,000 Children	Children with Substantiations	Incidence per 1,000 Children	% of Allegations	Children with Entries	Incidence per 1,000 Children	% of Substantiations
Under 1	606,515	34,663	68.4	11,573	22.8	33.4	6,327	12.5	54.7
1-2	1,002,562	51,008	50.9	10,359	10.3	20.3	4,517	4.5	43.6
3-5	1,500,620	83,776	55.8	14,060	9.4	16.8	5,276	3.5	37.5
6-10	2,542,511	151,620	59.6	20,959	8.2	13.8	7,039	2.8	33.6
11-15	2,523,087	132,019	52.3	15,634	6.2	11.8	5,496	2.2	35.2
16-17	1,027,191	48,344	47.1	4,964	4.8	10.3	2,005	2.0	40.4
Total	9,102,486	501,430	55.1	77,548	8.5	15.5	30,660	3.4	39.5

California Allegations: 5.5%

California Substantiations: 15.5%

Ventura

Age Group	Total Population	Children with Allegations	Incidence per 1,000 Children	Children with Substantiations	Incidence per 1,000 Children	% of Allegations	Children with Entries	Incidence per 1,000 Children	% of Substantiations
Under 1	10,545	724	68.7	186	17.6	25.7	126	11.9	67.7
1-2	20,953	1,092	52.1	168	8.0	15.4	79	3.8	47.0
3-5	31,876	1,846	57.9	198	6.2	10.7	69	2.2	34.8
6-10	56,175	3,704	65.9	331	5.9	8.9	108	1.9	32.6
11-15	57,209	3,248	56.8	224	3.9	6.9	93	1.6	41.5
16-17	23,725	1,125	47.4	66	2.9	6.0	34	1.4	50.0
Total	200,483	11,739	58.6	1,175	5.9	10.0	509	2.5	43.3

Ventura Allegations: 5.8%

Ventura Substantiations:10%

California Child Welfare Indicators Project (CCWIP)
University of California at Berkeley

Children with one or more Allegations for Oct 1, 2015 to Sep 30, 2016
California

Sexual Abuse Substantiations:
3362 / 42626= 7.9%

Allegation Type	Disposition Type					Total
	Substantiated	Inconclusive	Unfounded	Assessment Only/Evaluated Out	Not Yet Determined	
	n	n	n	n	n	n
Sexual Abuse	3,362			17,617	2,404	42,626
Physical Abuse						95,693
Severe Neglect					366	8,030
General Neglect					10,079	231,362
Exploitation	104	76	44	84	21	329
Emotional Abuse	3,275	19,418	11,063	9,283	2,229	45,268
Caretaker Absence/Incapacity	2,949	795	1,811	574	165	6,294
At Risk, Sibling Abused	4,381	12,699	34,960	10,558	2,849	65,447
Substantial Risk	.	.	.	.	.	.
Missing	.	.	.	.	.	.
Total	71,557	113,752	172,851	113,816	23,073	495,049

Physical Abuse Substantiations:
5721 / 95693 = 6%

Total Substantiations:
71577 / 495049 = 14.5%

Sexual Abuse Substantiations:
48 / 1244 = 3.8%

Ventura

Allegation Type	Disp…					Total
	Substantiated	Inconclusive	Unfounded	Assessment Only/Evaluated Out	Not … …ined	
	n	n	n	n	n	n
Sexual Abuse	48			667	18	1,244
Physical Abuse					54	2,342
Severe Neglect					2	45
General Neglect					144	6,746
Exploitation	.	.	.	1	.	1
Emotional Abuse	1	102	72	107	2	284
Caretaker Absence/Incapacity	39	8	12	8	.	67
At Risk, Sibling Abused	28	83	654	330	21	1,116
Substantial Risk	.	.	.	.	.	.
Missing	.	.	.	.	.	.
Total	1,208	1,887	5,311	3,198	241	11,845

Physical Abuse Substantiations:
66 / 2342 = 2.8%

Total Substantiations:
1208 / 11845 = 10.2%

"Diagnosing" Abuse

- Diagnosis depends to varying degrees
  - Specificity of history
  - Severity of findings
  - Absence or presence of abnormal labs
  - Observed interactions
- Any given one of these factors may sway medical decision regarding final diagnosis

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Definition: Physical Abuse

"The impairment of physical condition that includes but shall not be limited to any of the following":

- Skin bruising
- Pressure sores
- Bleeding
- Failure to thrive
- Malnutrition
- Dehydration
- Burns
- Fracture of any bone
- Subdural hematoma
- Soft tissue swelling
- Injury to any internal organ
- Any physical condition which imperils health or welfare.

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It's all about the History!!!

- Does injury match history?
- Does injury match child's developmental ability?

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at the risk of sounding redundant…

It's All About The History!!!

Get family to commit to a story early…

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Basic Elements of a History

- History of Present Illness
  - What happened & when, who saw it, when was medical attention sought
- Past Medical History
  - Birth, surgery, immunizations, previous illness
- Developmental History
  - What the child can do, and when gained those skills
- Family History
  - Bleeding, bruising, fractures, early deaths
- Social History
  - Living & work situation, level of education, who cares for child, stressors (money, drug use, violence, arrest)

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Additional Information

- Photos of Scene
  - Walkers, cribs, bouncers, bed, floor surface, implements
  - Heater units, other reported burn implements
- Video (doll) re-enactment of alleged events

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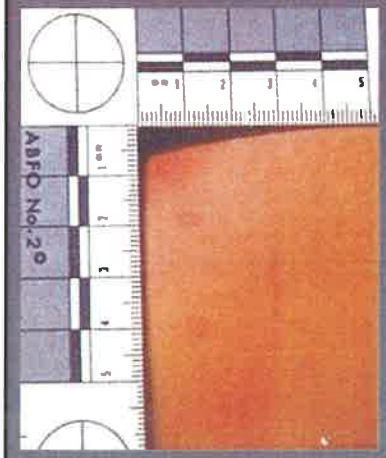
Forensic Photography



- Identify child with "full-face picture"
- If using film, separate roll for each child/victim
- Include anatomic landmark to help identify area
  - Nipple, elbow, knee, chin, etc
- Use measuring bar and color bar to more accurately depict size & color of injuries

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Practitioner's Interpretation

Patient Identification: **Date:**

P. REQUIRED SUMMARY AND INTERPRETATION OF HISTORY, EXAMINATION, AND DIAGNOSTIC STUDIES

Describe:

- ☐ Neglect
- ☐ Physical abuse
- ☐ Evaluation suspicious for physical abuse. Further information needed.
- ☐ Indeterminate cause
- ☐ Evaluation indicates non-abusive cause of medical findings.

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The Bruised Child: Normal or Concerning?

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Definitions

- Abrasion
  - Friction: Results in removal of superficial layers of skin
- Contusion (Hematoma, Bruise):
  - Hemorrhage into the skin after trauma
- Laceration
  - Tears of the skin
- Burns
  - Destruction of skin caused by heat, chemicals, friction

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History and Bruising

- Does injury match history?
- Does injury match child' s developmental ability?

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Dating Bruises

- Can not be done accurately!
  - Depth and extent of bleed varies by location on body and force applied
    - Leads to variable visibility of blood at skin surface
  - Blood breaks down leads to succession of colors (not always predictable)
    - Red, violet, blue, green, yellow, brown

Maguire, *Arch Dis Child*, 2005, 90(2): 187-189

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Developmental Milestones

2 months	Eat, sleep, poop, smile, cry and lay there
4 months	Roll over, social smile
6 months	Sit without support
8 - 9 months	Crawl
9 - 12 months	Cruise (walk while holding on)
> 12 months	Walk

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Normal Bruising

- Rare injuries in infants < 8 month old (1.2%)
  - Mostly on face/head
  - Mostly abrasions
- Most kids > 9 months old had injuries
  - 17% had at least 5 injuries
    - 4% had 10 or more injuries
    - < 1% had >15 injuries
    - 0.2% had >20 injuries
  - Most common shins/knees
    - Can be anywhere
      - <2% had injuries to chest/abdomen/pelvis/buttocks
      - <1% had injuries to chin, ears, neck
  - More common in summer

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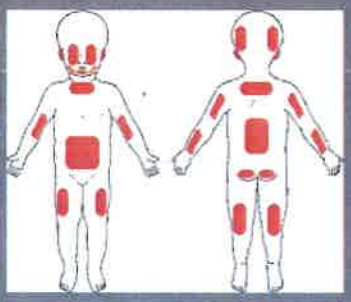
Labbe, J et al. *Pediatrics*, Vol 108(2); Aug 2001

Case #1: Infant with "Bruise"

- 2 month old at doctor's office for well-child check
- Noted to have dark brown/purple mark on left hand
- What do you want to know?
- Concerned?

Suspicious Bruise Areas



Case #1: Bruise?

- On further examination you note his leg to have discoloration as well
- Parents insist "it's been there since birth!"
- What should you do?

Case #3: Medical Cause (ITP)

Bleeding Evaluation

- Coagulation studies
  - PT, PTT, von Willebrand Disease studies, Complete blood count (looking for low platelets or leukemia)
  - Hematology consultation for abnormal results
    - Consider Factor XIII level and platelet function analysis (PFA-100)
    - Factor VIII, IX levels for prolonged PTT
- Screen for other injuries
  - Bruising (particularly abdominal or chest) may be marker of underlying internal injury
  - Injuries to liver, pancreas, lungs, etc

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Case #4: Fall Down Stairs

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Skin Injuries in Children: Summary

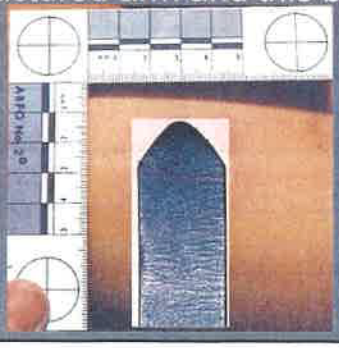
- Concerning findings for abuse
  - Bruises in a child <9 months of age
    - Bruises in child who is not cruising
  - Bruises in uncommon locations
  - > 15 bruises in a child
  - Significant bruising on areas other than legs
    - Particularly neck, back, ears, orbits
  - Significant bruising in cold season

Labbe, J et al. *Pediatrics* 2001; 108(2)
Sugar, *Arch Ped Adol Med* 1999; 153(4): 399-403
Pierce, *Pediatrics* 2010; 125(1): 67-74

Slap Marks

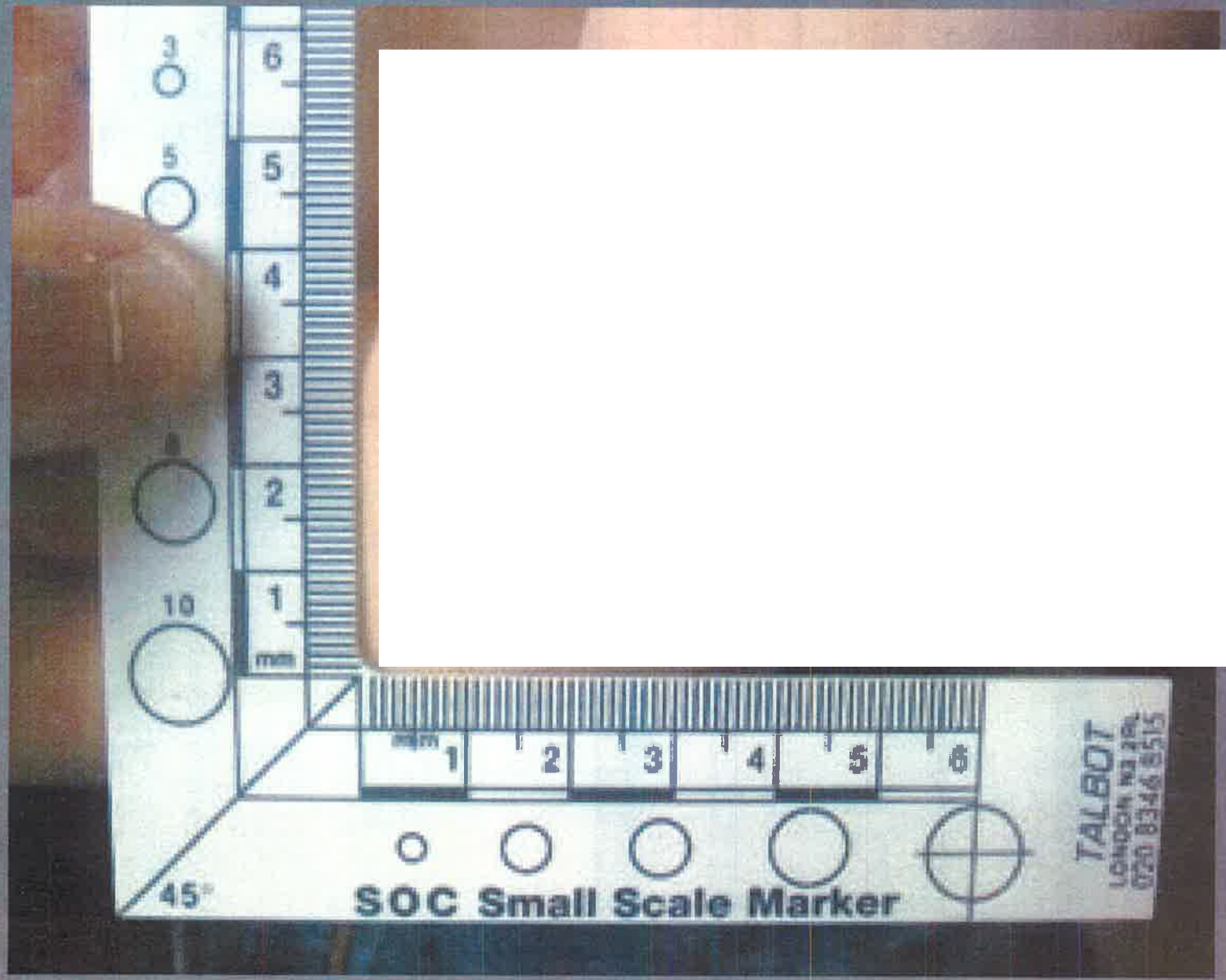
Suspicious Bruising: Pinch to ear

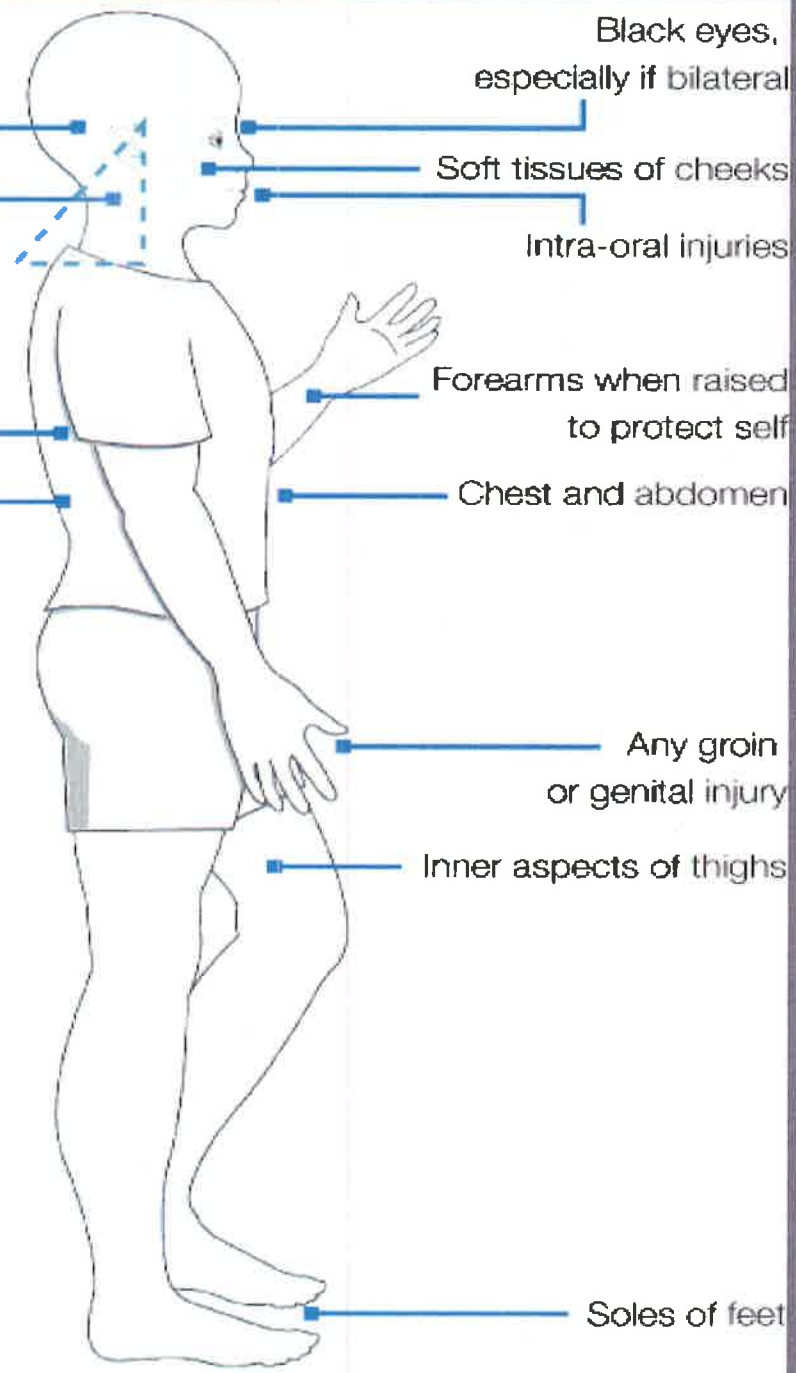
Case #6: 2 year old with fractured arm and this bruise



Abuse or accident?

Bites





REMEMBER

Concerns are raised by:

- injuries to both sides of the body
- injuries to soft tissue
- injuries with particular patterns
- any injury that doesn't fit the explanation
- delays in presentation
- untreated injuries

Burns:
Inflicted or Accident?

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Burns

- Thermal injuries can be caused by accident, abuse, or neglect
- Pattern of injury is important
  - Burns secondary to falling or splashing of hot liquid should have a **non-specific pattern**
  - Inflicted injuries typically involve many different planes
  - Thermal injuries with a stocking glove distribution represent immersion injuries
- *Is the injury consistent with the history?*

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Burn Injuries

- Extent of the burn depends on:
  - Water temperature
    - 117° F is the threshold for scald injuries
  - Duration of exposure
    - 3rd degree burns occur on adult skin after:
      - 1 minute in 127° F water
      - 30 seconds in 130° F water
      - 2 seconds in 150° F water
  - Presence or absence of clothing and material
    - Fleece may cause water to remain in contact with skin longer, increasing intensity of burn
  - Area of body exposed
    - Soles and palms tend to have thicker skin than other parts of the body

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Inflicted Burn Injury

- Burns make up 10% of all child abuse cases
- 10% of Burn Unit admits are abusive
- Most inflicted burns in children < 10 years old
  - Majority < 2 years old
- Burns often used as punishment
  - During toilet training
  - Playing near stove
- Characteristics of inflicted burns
  - Buttocks, palms, soles, mixed areas of burned and unburned skin
  - Clean line of demarcation
- Changing / inconsistent history
- History not compatible with developmental skill of child

Inflicted or Accident?

First Degree Burn: Superficial layers of the skin only, no blistering…Sunburn

Instructions for Evidence Worksheet for Immersion Burns

Section A

The location should include the address and room in which the burn occurred.

Section B

Two investigators are required to gather the information on the worksheet. You will need an immersion thermometer, a 35mm camera, a measuring device, and a watch with a second hand.

Photograph the scene with a 35mm camera. Use a ruler, yardstick, or tape measure in all photographs.

Sketch the scene including all objects in the area. Be sure to include the distance from the basin or tub in relation to nearby objects and the dimensions of furniture, fixtures, etc.

Section C

One investigator holds the thermometer so that the water from the faucet is hitting at the immersion line on the thermometer. That person notes the starting temperature, which is recorded by the other investigator, who is also holding the watch. The first investigator calls out the time and the second investigator calls out the temperature in response, recording it at 5-second intervals (or when the temperature remains constant for 15 seconds). **Note:** The person holding the thermometer should not be wearing glasses since the steam will fog them up.

When recording the hot and cold water temperature together, turn the faucets on full and record when the temperature remains constant for 15 seconds.

Section D

After the tub or basin is filled, you can hold a low-key interview with the caretaker and/or witnesses while checking the temperature at 5-minute intervals.

Section E

Have the suspect show you how he or she ran the water when the burn occurred. If the suspect wants to run the water deeper than 5 inches, allow this and note it on the worksheet.

EVIDENCE WORKSHEET FOR IMMERSION BURNS

A

Case No.

Present Date:

Suspect's Name:

Victim's Name:

Incident Location (within dwelling):

Address:

City/State/Zip:

B

Bathtub Measurements (measurements should be made in inches)

Width:	Inside Depth:
Top Length:	Bottom Length:

Construction (porcelain, fiberglass, plastic, etc.)

C

Running Water Temperatures (in Fahrenheit)

HOT		COLD	
Seconds	**Degrees**	**Seconds**	**Degrees**
0	_____	_____	_____
5	_____	Running Water Temperature	
10	_____	(Full Hot and Cold)	
20	_____	Seconds ____	Peak Temp. ____
_____	_____		

D

Full Tub; Standing Hot Water, 5 Inches Deep
(temperature measured in middle of tub at water mid-depth)

FILL TIME			
Inches	**Minutes/Seconds**	**Minutes**	**Degrees**
1	_____	0	_____
2	_____	5	_____
3	_____	10	_____
4	_____	15	_____
5	_____	20	_____
		25	_____
		30	_____

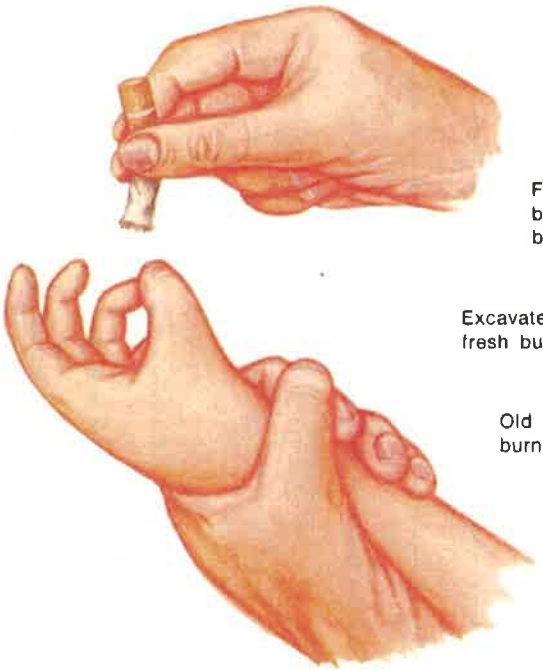
E

_____ ran a tub of water on my request.
Results: Depth 5 inches. One minute after water off: Temperature _____ degrees Fahrenheit.

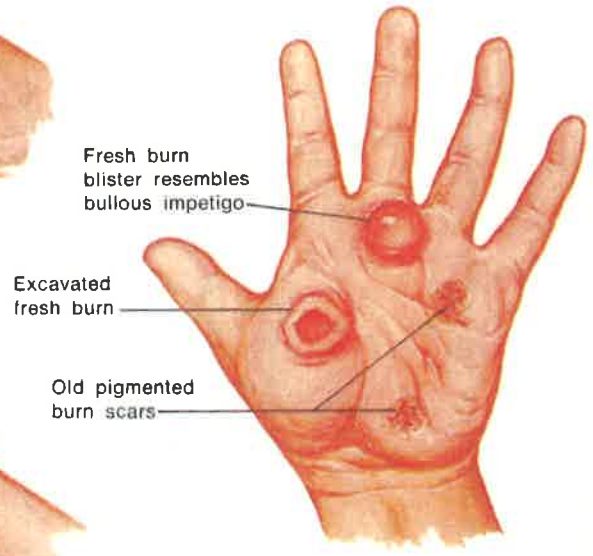
Investigator #1 _____ ID# _____ Division _____

Investigator #2 _____ ID# _____ Division _____

Source: Phylip J. Peltier, Criminal Investigator, Oroville, California



Cigarette burns are usually inflicted on palms, soles, and buttocks



Burns in various stages of healing indicate repeated abuse

JOHN A. CRAIG, M.D.
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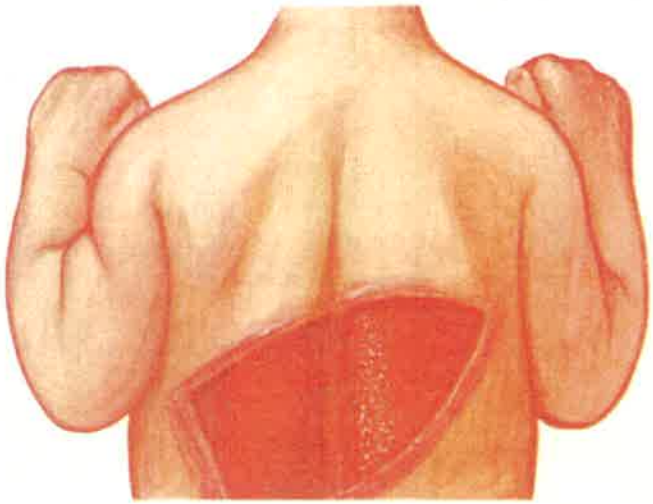

Abuse must be suspected if burn is in configuration of common household utensil or appliance, especially if burn is located where injury could not be accidental

Fractures in Children

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Orientation/extension of fracture line

Transverse
A fracture that is perpendicular to the shaft of the bone

Comminuted
A fracture in which there is more than two fracture fragments

Oblique
An angulated fracture line

Segmental
A type of comminuted fracture in which a completely separate segment of bone is bordered by fracture lines

Spiral
A multiplanar and complex fracture line

Intra-articular
The fracture line crosses the articular cartilage and enters the joint

Torus
An incomplete buckle fracture of one cortex, often seen in children

Greenstick
An incomplete fracture with angular deformity, seen in children

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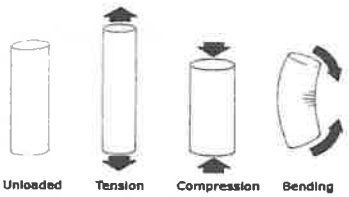

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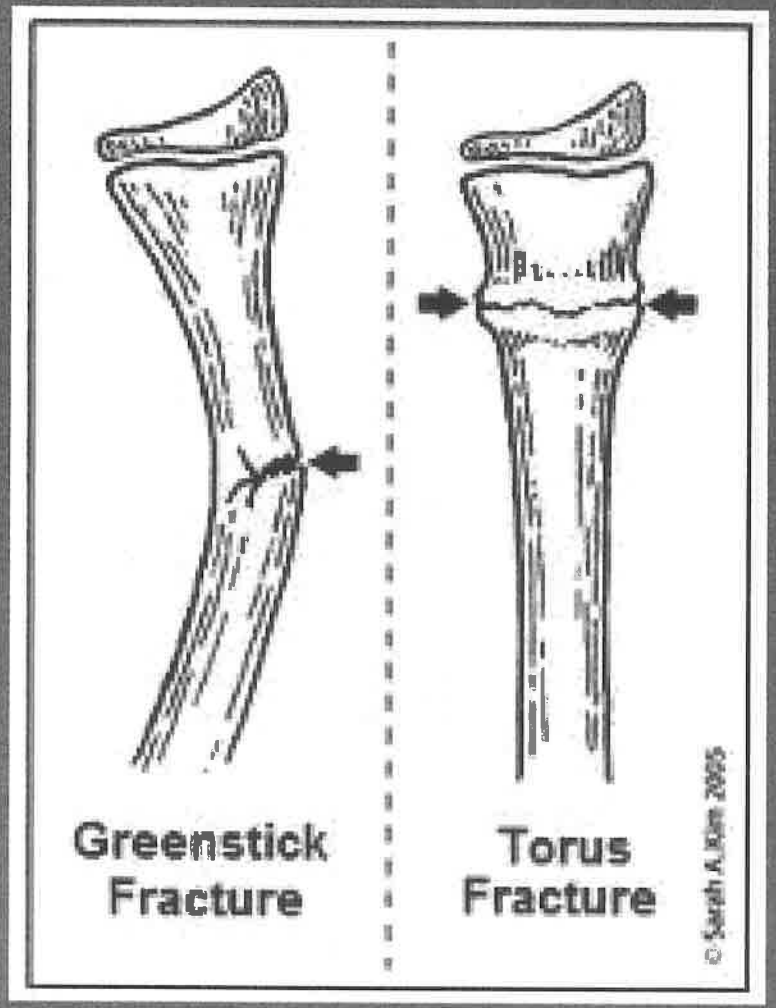
Torus and Greenstick Fractures



Timetable of radiographic change in children's fractures [1, 2]

Category	Early	Peak	Late
Resolution of soft tissue injury	2-5 d	4-10 d	10-21 d
Periosteal new bone formation	4-10 d	10-14 d	14-21 d
Loss of fracture line definition	10-14 d	14-21 d	
Soft callus	10-14 d	14-21 d	
Hard callus	14-21 d	21-42 d	42-90 d
Remodeling	3 mo	1 yr	> 2 years

1. *Diagnostic Imaging of Child Abuse, Williams & Wilkins, Baltimore, 1987, 112
2. O'Connor and Cohen, 1998

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Fracture With High Specificity for Abuse

- Classic Metaphyseal Lesions
- Posterior rib fractures
- Infants with unexplained fractures
- Scapular, spinous process or sternal fractures

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Skeletal Survey: 20 separate X-rays!

- Appendicular Skeleton
  - Humeri (AP)
  - Forearms (AP)
  - Hands (PA)
  - Femurs (AP)
  - Lower legs (AP)
  - Feet (PA or AP)
- Axial Skeleton
  - Chest (AP & lateral)
    - Obliques recommended
  - Pelvis (with lumbar spine) (AP)
  - Lumbosacral Spine (AP)
  - Cervical spine (AP + lateral)
  - Skull (Frontal + lateral)

American College of Radiology Practice Guideline, 2006 81

Case #2

- 4 month old rolls off changing table
- Parents note swelling to head
- Immediately to ED
  - Well-appearing
  - No vomiting, seizing
  - No bruises on exam
- X-ray of skull
  - Linear parietal fracture
- Abuse?

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Common Accidental Fractures from Falls

- Infants
  - Linear skull fracture
    - Generally parietal
    - Occasionally:
      - Crosses suture line
      - Small subdural hematoma
    - Infant otherwise well
      - Rare epidural hematoma
  - Clavicle fracture
    - Birth trauma
- Toddler / Preschool
  - Tibia
  - Fibula
  - Femur
  - Radius
  - Ulna
  - Hands
  - Feet
  - Clavicle

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Case #3

- 2 year old "practicing ballet"
- Complains of pain after jumping around living room

- Abuse?

Toddler's Fracture

- Spiral fracture of tibia (shin bone)
- Toddler / Preschooler
- Mechanism
  - Jump & plant
  - Run & twist
- Immediate symptoms
  - Pain, limp, refusal to walk

Case #4

- 4 month old brought in with fever & fussiness
  - Temp 101.2
  - No other symptoms
- Exam:
  - Acting normal, slightly fussy
  - Swollen left ankle
  - Tender at left knee
- How many fractures do you see?
- Accident or abuse?
- What else needs to be done for this child?

Classic Metaphyseal Lesion (CML)

- A series of micro-fractures across the metaphysis
  - parallel to the growth plate
  - perpendicular to the long axis
- Caused by
  - Acceleration / deceleration forces on arms & legs during violent shaking events
  - Forceful twisting or jerking of an arm or leg
- Falls and blunt trauma do not cause horizontal motion across the metaphysis

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Metaphyseal Fractures

- Kleinman et al coined the term '*classic metaphyseal lesion*' (or CML) to describe the injury
- Specific for abuse
  - If present, highly suggestive of abuse
- Not as sensitive: 39-50%
  - If not present, does not rule out abuse
- Seen almost exclusively in children < 2 years old
- Most often occur in the...
  - Distal femur
  - Proximal tibia
  - Distal tibia
  - Proximal humerus

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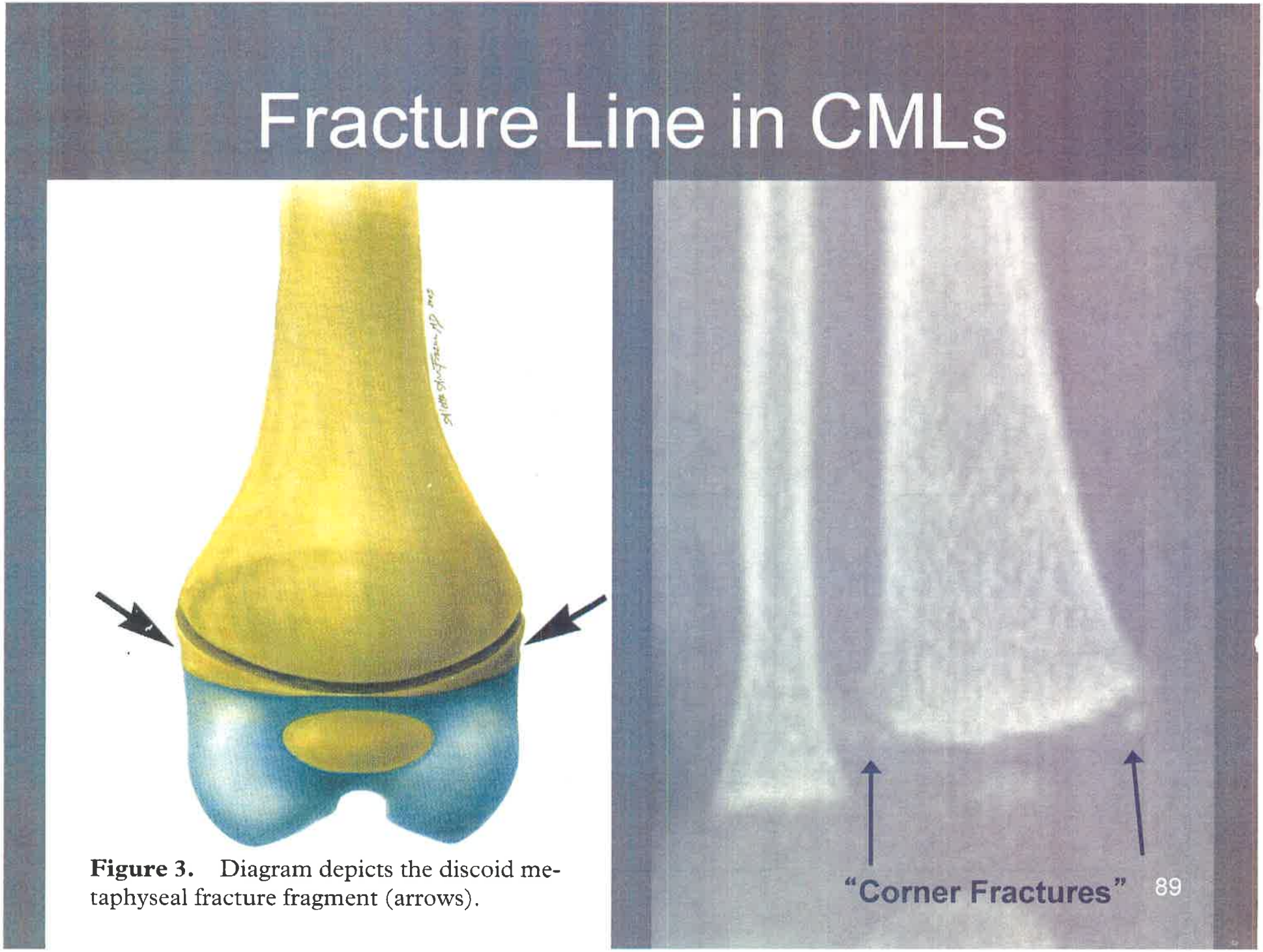
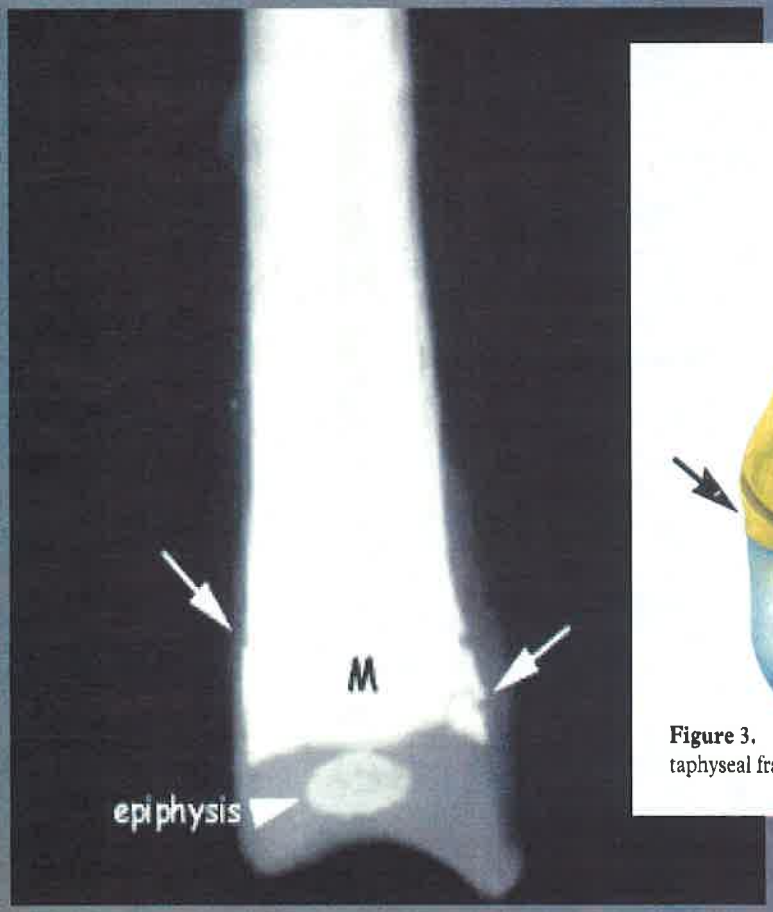


Figure 3. Diagram depicts the discoid metaphyseal fracture fragment (arrows).

Radiographic Appearance



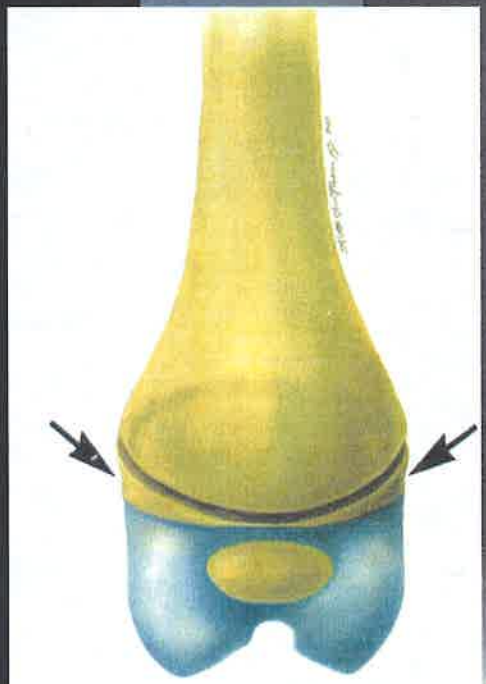
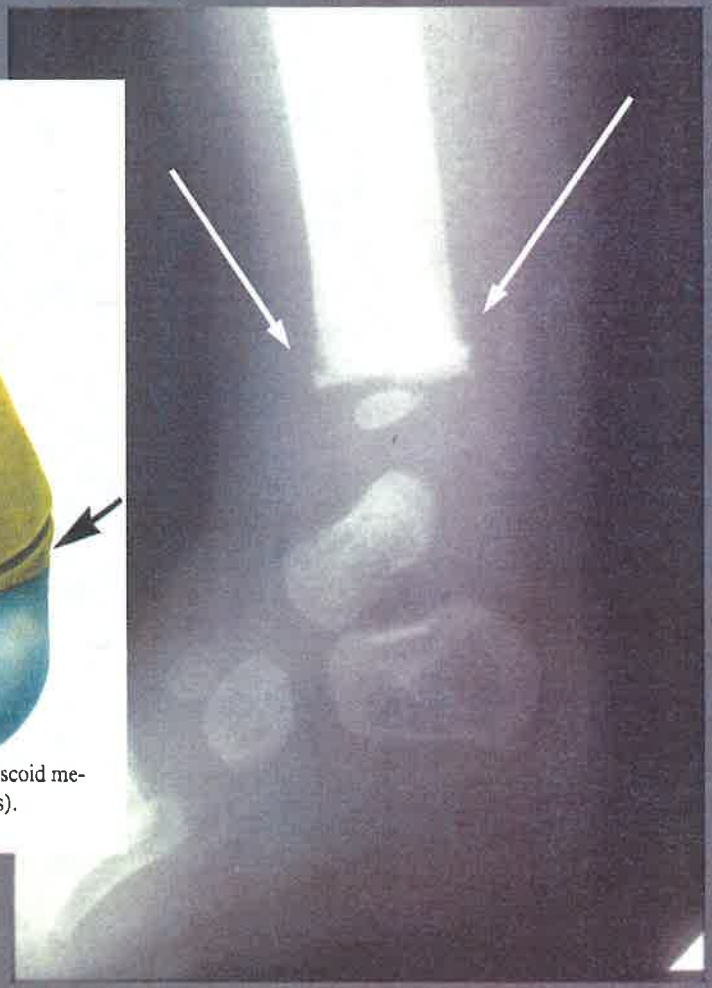


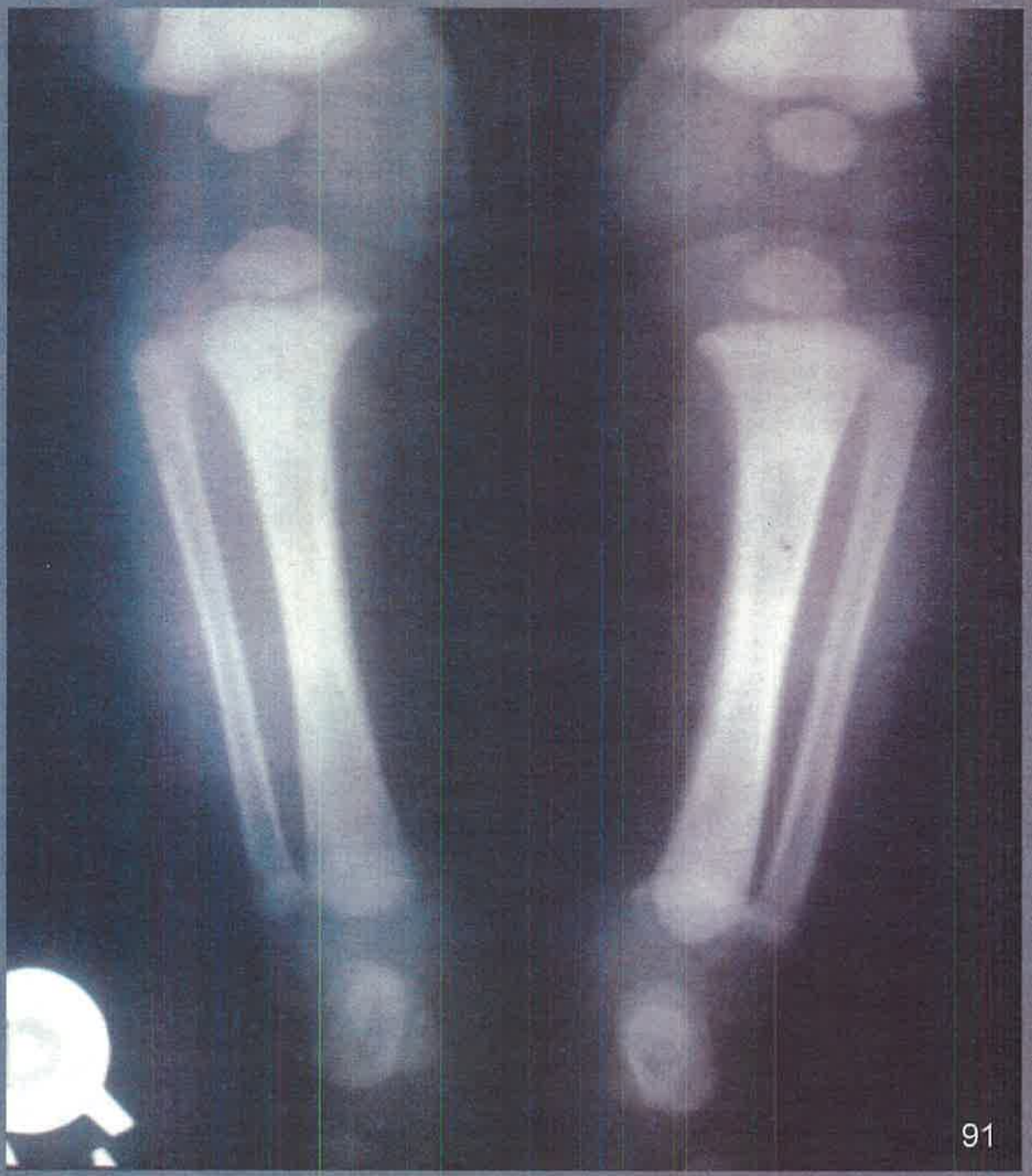
Figure 3. Diagram depicts the discoid metaphyseal fracture fragment (arrows).



The center region is thin and as a result may be radiographically occult

Bucket Handle Fracture

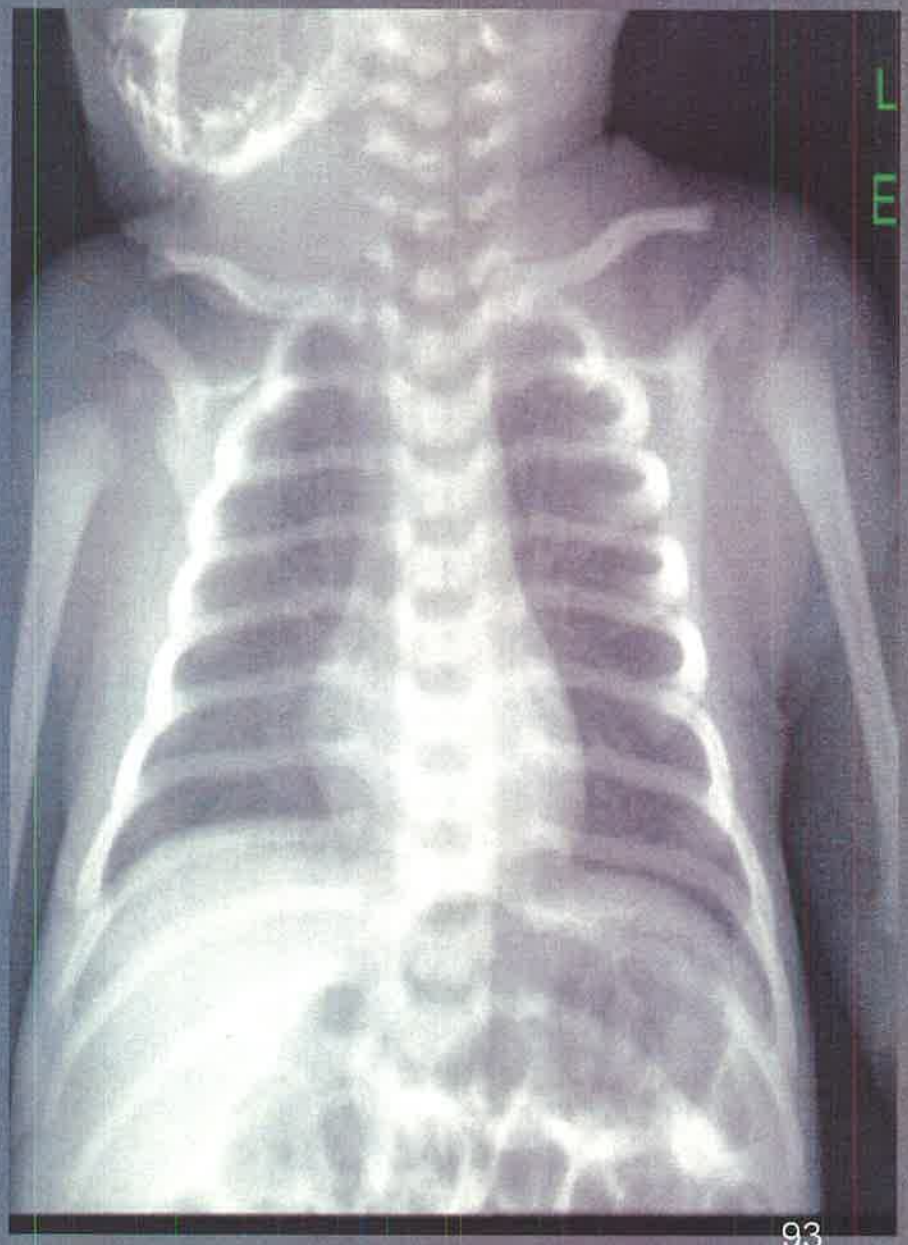
Can you see them?



Bucket Handle Fracture

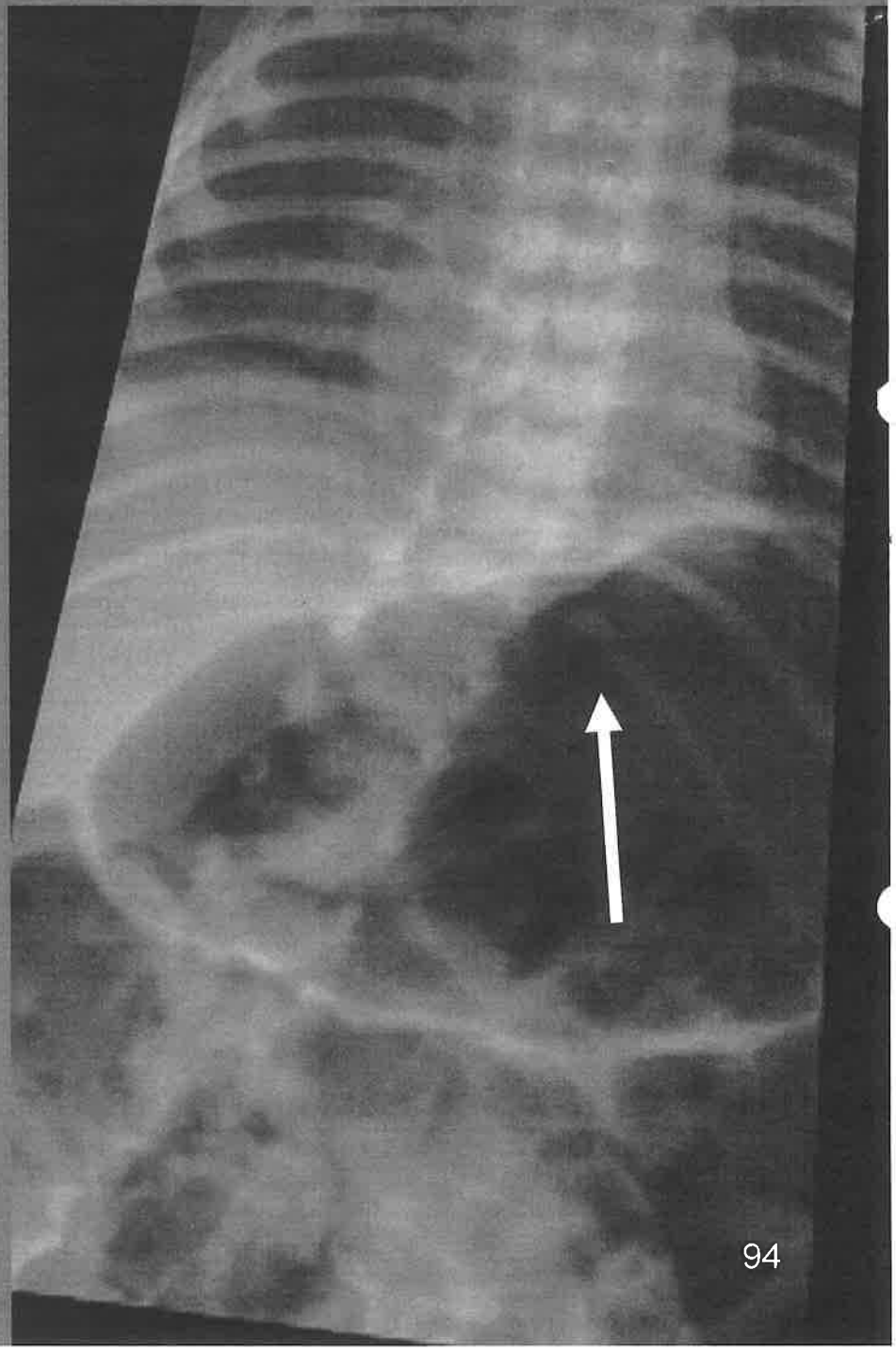
Case #5

- 1 month old brought to ED by parents
  - Fussy
  - Not eating well overnight
  - Temp 101 in ED
- While holding for spinal tap, bruising and crepitus (swelling/crunching) noted on back
- X-ray as shown
- What else do you want?



Case #5

- Can you spot the fracture?



Rib fractures

- Strongly correlated with abuse in infants
- Mechanism that generates the fractures is relatively specific
- Fracture of the first rib is virtually diagnostic of child abuse because of the force required
- A tight hold around an infant's chest may result in fractures of the
  - anterior
  - lateral
  - or posterior aspects of the rib

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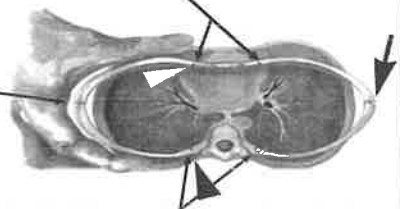
Rib fractures

At the costochondral junction, the anterior ribs are bent inward resulting in a fracture

Laterally, the inner cortex is buckled & compressed, while the outer cortex is distracted



The posterior rib is levered over the transverse process resulting in a fracture of the inner cortex, often not complete through bone

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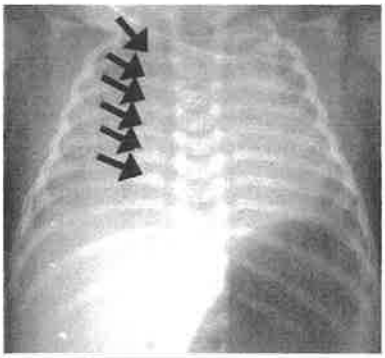
Radiologic appearance

...rib fractures with callus formation

Radiologic appearance



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Case #6: Hand Pain

- 3 year old child
- Fell off counter in kitchen trying to reach cookie jar yesterday
- Bruise and healing laceration on hand
- Accident or abuse?

Osteogenesis Imperfecta (OI)

- Diagnosis
  - Clinical suspicion must be high
    - Multiple / repeated fractures
    - Rarified bones consistent with undermineralization
    - Family history of OI
    - Lack of other abuse findings
  - Genetic testing by blood sample
    - 90% accuracy
  - Collagen testing possible as well
  - Refer to geneticist if suspicious or likely defense in court

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Other fractures

Without a good accidental explanation...

- ...spiral long bone fractures in the non-walking infant, due to the forces needed to create such fractures, are quite suggestive of child abuse.
- ...sternal and scapular fractures are highly suggestive of abuse
- ...spinal fractures in the infant is suggestive of child abuse.

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References

- Bulloch et al. , Cause and Clinical Characteristics of Rib Fractures in Infants, Pediatrics 105(4) April 2000.
- Diagnostic Imaging and Child Abuse: Technologies, Practices, and Guidelines; Medical Technology and Practice Patters Institute, Washington, DC.
- Kleinman, Paul K., Diagnostic Imaging of Child Abuse, Williams & Wilkins, Baltimore, 1987; 112.
- Lonergan et al., "Child Abuse: Radiologic-Pathologic Correlation", from the archives of Armed Forces Institute of Pathology; Radiographics, July-August 2003; 23(4) 811-845.

- Pictures and radiographs from:
  - Lonergan et al. (above)
  - http://rad.usuhs.mil/rad/home/peds/abuse.html
  - http://www.srs.org.sg/2002/ASM/11th_ASM/ASM/2_Feb_Saturday/Refresher_Course_1/Peter_Strouse/strouse.html
  - http://www.aafp.org/afp/20000515/3057.html

Head Trauma: Abuse or Accident

- 4 month old fell to floor from grandma's arms
  - Scalp swelling / bleeding under skin
  - Parietal bone fracture
  - No brain injury
  - Acting normally

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Deaths from Falls in Children: How Far is Fatal?

Distance	Number	Deaths#
10' - 45'	118	1
4' - 10'	65	0
< 4'	100	7*

*5/7 had signs of abuse (e.g. extensive retinal hemorrhages, fractures)
All deaths were from traumatic brain injury

Chadwick, et al: *Journal of Trauma*, 1991 (San Diego)

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Head Trauma: Abuse or Accident?

- Mom slipped on ice while carrying baby
- Baby fell onto road
  - Scalp swelling / bleeding under skin
  - Parietal bone fracture
  - No brain injury
  - Acting normally
- Dad and family friends witnessed fall

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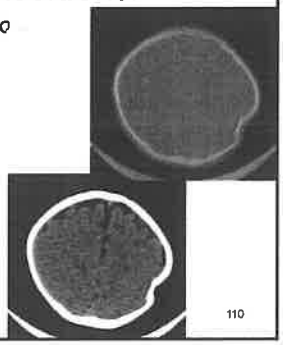
Injuries from witnessed & corroborated free falls

	With independent witness	Without independent witness
# falls	106	53
Distance	<2 feet – 70 feet	< 5 feet
Injuries	3 depressed skull fractures (small)	
Deaths	1 (from 70 foot fall)	2

Williams. *J Trauma*, 1991

Head Trauma: Abuse or Accident?

- Fell from dad's shoulders to floor
  - Depressed skull fracture
  - Scalp swelling / bleeding under skin
  - No brain injury
  - Acting normally
  - No eye bleeding: Retinal Hemorrhages (RH)



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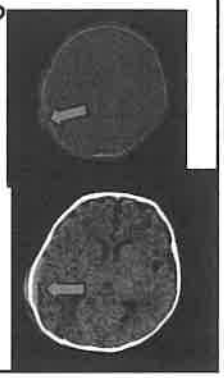
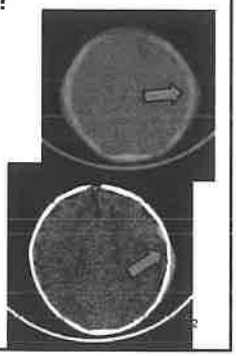
Head Trauma: Abuse or Accident?

- 4 month old dropped from mom's arms during domestic dispute
  - Scalp swelling
  - Parietal skull fracture
  - Small epidural hematoma
  - 6 Small, central retinal hemorrhages
  - Acting normally



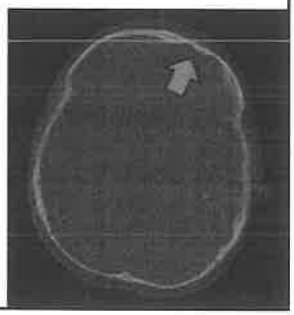
Head Trauma: Abuse or Accident?

- Pulled off of bed by sibling to floor
  - Scalp swelling
  - Parietal skull fracture
  - Small epidural hematoma
  - 3 small, central retinal hemorrhages
  - Acting normally



Head Trauma: Abuse or Accident?

- 9 month old fell from crib onto floor
  - Frontal bone fracture
  - No intracranial injury
  - No eye bleeding
  - Acting normally



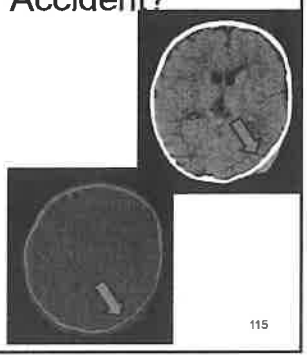
Falling out of bed: A relatively benign occurrence

- 207 children < 6 y/o
  - fell 25" - 54" from hospital beds
  - 1 skull fracture
  - 1 clavicle fracture
  - 0 intracranial injuries

Lyons, Oates. *Pediatrics*, 1993

Head Trauma: Abuse or Accident?

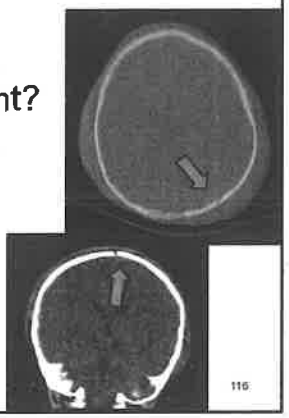
- 10 month old fell in bouncy seat from counter onto kitchen floor
  - Scalp swelling
  - Parietal skull fracture
  - No intracranial injury
  - No eye bleeding
  - Acting normally



115

Head Trauma: Abuse or Accident?

- 12 month old fell down 3 steps to brick patio
  - Scalp swelling
  - Parietal skull fracture
  - Tiny convexity subdural bleed (SDH)
  - No eye bleeding
  - Acting normally



116

Head Trauma: Abuse or Accident?

- Fall down 7 carpeted steps
  - Scalp swelling
  - Parietal skull fracture
  - Tiny epidural hematoma (EDH)
  - No eye bleeding
  - Acting normally

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Severe intracranial injury based on trauma / fall mechanism

Falls out of bed	<1%
Falls from bunk beds	1.5%
Falls in baby walkers / down stairs	1%
	8%
Falls down stairs	0-4%
Falls from shopping carts	<1%

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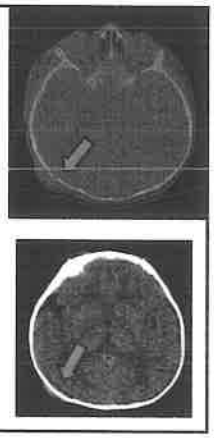
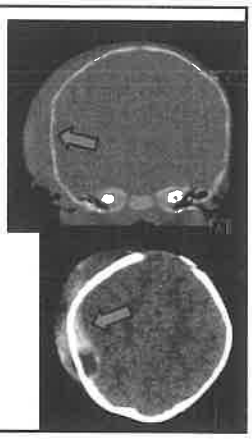
Head Trauma: Abuse or Accident?

- Restrained passenger in T-bone car accident
  - Scalp swelling
  - Parietal skull fracture
  - No intracranial injury
  - 10 Small retinal hemorrhages, centrally located
  - Neurologically normal



Head Trauma: Abuse or Accident?

- 9 month old fell from car onto concrete sidewalk
  - Significant scalp swelling
  - Parietal skull fracture
  - Moderate-sized epidural hematoma
  - Neurologically normal
  - No eye bleeding (retinal hemorrhages)



Head Trauma: Abuse or Accident?

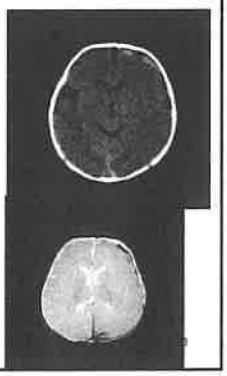
- 7 month old pulled self over crib rails, fell onto tiled floor
  - Comatose, bleeding, low blood pressure
  - Scalp swelling
  - Parietal skull fracture
  - "Mixed density" subdural bleed
  - Brain bruise / swelling
  - No eye bleeding
  - skeletal survey normal

Head Trauma: Abuse or Accident?

- 7 month old pulled self over crib rails, fell onto tiled floor
  - Upper cervical pre-vertebral edema
  - Vertebral body edema T5-T9

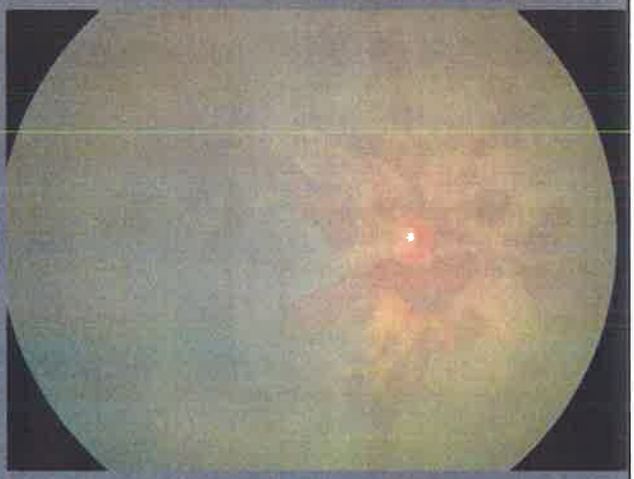
Head Trauma: Abuse or Accident?

- 3 month old began screaming spontaneously
  - -- stiffened, extended arms and hands, had disordered breathing
- Comatose, not breathing, low heart rate on admission
- On ventilator to assist breathing



Head Trauma: Abuse or Accident?

- Required urgent decompressive neurosurgery
  - Removed piece of skull
- 16 healing rib fractures
- Extensive eye bleeding
  - multiple layers
  - extending toward the periphery



Cascade of Events in Shaking

- Variable motion of brain tissue
  - due to different relative densities of grey and white matter, and CSF
- Axons damaged during event
- Decreased oxygen to brain (Hypoxia) during and after shaking
  - Child not breathing during event
  - Damage to cervical spinal cord and brainstem
- Neuronal death / rupture releases excitatory amines
- Brain swelling (Cerebral edema = "Big Black Brain")
  - Leads to further hypoxia, elevated intracranial pressure
- Death (often declared brain dead) or recovery
  - Survivors often have severe sequelae

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Exceptions

- Epidural hemorrhage (EDH)
- Hemorrhage with pre-existing intracranial abnormality
  - increased extra-axial spaces
  - prior intracranial bleed
  - cerebral atrophy
- Bleeding disorder
- Ruptured AVM or other vascular malformation

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Retinal Hemorrhages

- Present in 80% + of abusive head trauma (AHT) cases
- Not diagnostic of abusive head trauma
  - VERY suggestive of AHT when
    - Multiple
    - Distributed throughout retina
    - Involve multiple layers of retina
- In AHT there is rarely swelling of the optic disc (papilledema)

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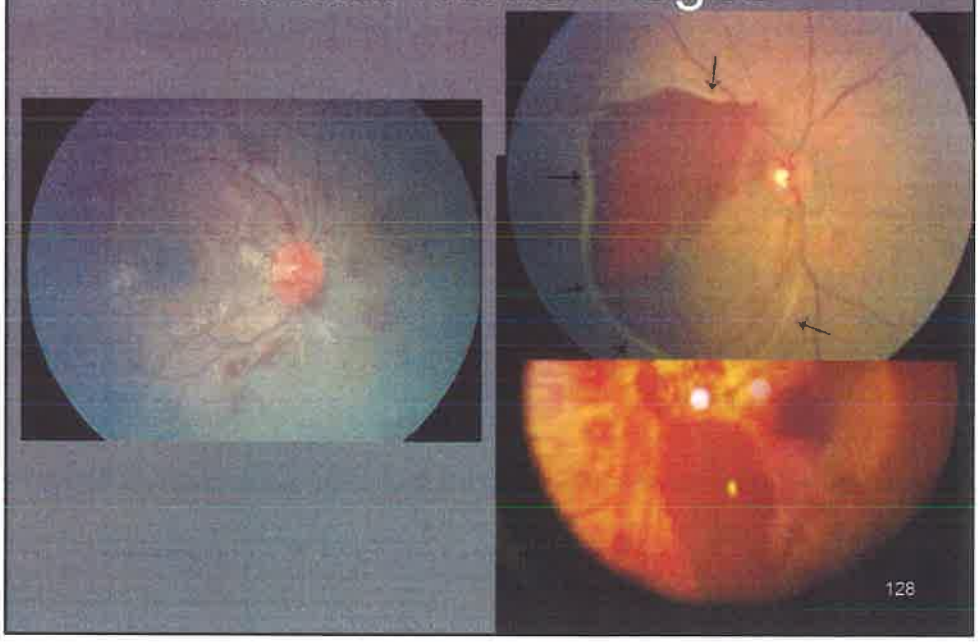
Retinal Hemorrhages



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Retinal Hemorrhages: Non-AHT Causes

- Severe trauma
  - Found in MVA/severe accident (0-10%)at much lower incidence than AHT (53-80%)
- Birth trauma (34-39%), resolve by 4-9 days
- Limited incidence in:
  - CPR (0-2.3%)
  - Convulsions (0.7%)
  - Forceful vomiting (~0%)
  - Severe persistent coughing (~0%)
- Non-AHT retinal hemorrhages
  - Few, often unilateral, distributed in posterior pole

Togioka et al. *J Emerg Med* 2009;37(1):982906

Sexual Abuse

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Incidence of Sexual Abuse

- 80-90% of victims are female
  - 75-85% abused by male assailant known to the child
    - Most likely a family member: father, stepfather, uncle, cousin, mother's boyfriend
    - Repetitive abusive episodes common
    - More likely to acquire STI with repetitive abusive episodes
  - Victims of unknown assailants tend to be older than children abused by someone they know
    - Usually single episode of abuse when unknown assailant
    - Often have more significant physical & genital trauma
- Type of abuse varies by gender
  - Males: 50% of abused males report anal penetration
  - Females: 50% report vaginal and 33% report anal penetration

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Incidence of Child Sexual Abuse By 18 Years of Age

Author	Year	Female	Male
Russell	1984	38%	NA
Wyatt	1985	45%	NA
Finkelhor	1990	27%	16%
Elliott	1995	42%	12%
Felitti	1998	25%	16%

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Sexual Abuse Examination

- 2 categories of patients:
  - Pre-pubertal
  - Post-pubertal
  - Anatomy significantly different due to hormonal differences
- Sub-category
  - Acute: within 3-5 days
  - Non-acute: >5-7 days

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Reasons for Emergency examination include but are not limited to :

- The child complains of pain
- There are signs or complaints of bleeding or injury
- The alleged assault occurred within the previous 72 hours (or other state mandated time interval) and the transfer of biological material may have occurred and will be collected for later forensic analysis.
- Medical intervention is needed emergently to assure the health and safety of the child

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Sexual Abuse Exam: Consent

- < 12 years old
  - Acute exam can be done without parental consent if concern for:
    - Loss of evidence (parents not immediately available)
    - Parent as perpetrator
  - Non-acute exam requires:
    - Parental consent or
    - Court order
- > 12 years old
  - Patient required to consent for exam
  - Can NOT perform exam if patient refuses
  - Neither law enforcement nor parents can override patient's refusal

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Examination Techniques

- A speculum examination of the vagina is not indicated during the sexual abuse examination of the pre-pubertal child.

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Acute vs Non-Acute

Acute: Use CalEMA 930/923

- Within 3-5 days of event
- History guides evidence collection
- Acute injuries
  - 20-30% pre-pubertal
  - 60-80% post-pubertal
- Assess need for acute medical treatment
  - STD/Pregnancy prophylaxis
  - Treatment of acute injuries
    - Bleeding, tears, etc

Non-Acute: Use CalEMA 925

- > 5-7 days from event
- Generally no evidence collection
- Old Injuries
  - 5% pre-pubertal
  - 10+% post-pubertal
- Assess chronic (ongoing) symptoms
- STD screening & treatment

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Absence of Injuries: Does NOT Preclude Abuse

- **Acute Exam**: Victims with physical exam findings
  - Pre-pubertal: 20-30%
  - Post-pubertal: 60-70%

Anogenital injuries found in only 23% of 273 children on **acute exam**

Anus	27%
Posterior fourchette	19%
Hymen	16%
Labia minora	16%
Perineum	9%

Christian, et al. *Pediatrics* 2000;106:100-4

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What is Normal?

- Lots of studies to document normal pre-pubertal anatomy
- Exam of non-abused pre-pubertal children
  - McCann, *Pediatrics* 1990 Sep;86(3):428-39
  - Myrhe, *Acta Paediatr*. 2003 Dec;92(12):1453-62.
  - Berenson *Am J Obstet Gynecol.* 2000 Apr;182(4):820-31
  - Garnder *J Pediatr.* 1992 Feb;120(2 Pt 1):251-7.
  - Myrhe, *Acta Paediatrica* 2001;90(11):1321-28

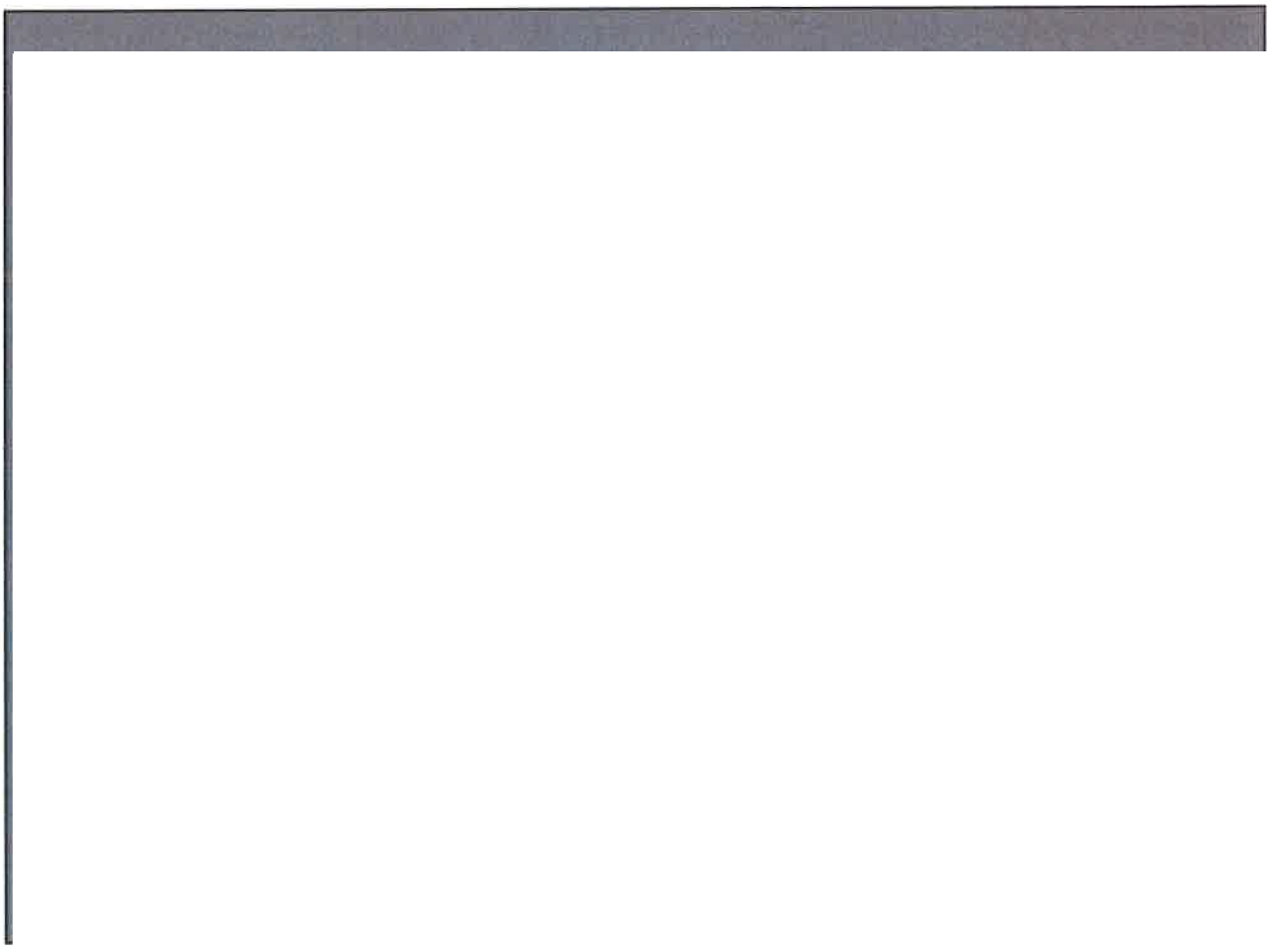
s

Vagina)

ette

The Exam

- *The likelihood of positive physical findings in a documented, non-acute, case of child sexual abuse--with penetration--**is less than 5%***!



Anogenital Trauma Heals Remarkably Well

- 94 children with various injuries
  - 81 girls, 13 boys
- 37 **hymenal** injuries
  - 17 transections: 15 persisted, 2 healed completely after surgical repair
  - 20 non-transections all healed completely
- 47 **posterior fourchette** injuries
  - 22 healed completely
  - Others healed as vascular changes (16), scarring (6), labial fusion (2)
- 17 cases of **labial trauma**
  - All healed without residua
- 39 cases **perihymenal** injury
  - 2 healed with vascular changes
  - 37 injuries left no residua

Heger et al, *Pediatrics* 2003;112:829-837

Healing of Non-Hymenal Injuries

- 239 girls
  - 113 pre-pubertal, 127 post-pubertal
- Abrasions
  - healed by 3rd day
- Edema
  - resolved by 5th day
- Bruising
  - resolved in 2-18 days
- Lacerations
  - Superficial healed in 2 days
  - Deep took up to 20 days to heal
- Healing
  - New blood vessels formed only in pre-pubertal girls
  - Scarring only occurred after deep lacerations

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McCann et al, *Pediatrics* 2007;120;1000-1011

Genital Anatomy in Pregnant Adolescents: "Normal" Does Not Mean "Nothing Happened"

- Retrospective case review
  - 36 adolescents pregnant at time of or recently before sexual abuse examination
    - Age range 12.3-17.8 years
    - 1 adolescent pregnant with 2nd child
    - 1 adolescent had miscarriage and D&C prior to exam
    - 1 adolescent had abortion prior to exam
  - Review of colposcopic slides
    - Reviewers blinded to medical history other than pregnancy status

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Kellogg, N. et al. *Pediatrics*, Jan. 2004; 113(1):e67-e69

Interpretation of Images by Reviewers

- Nonspecific
  - Included variations of normal anatomy and hymenal configurations, notches through <50% of hymenal rim, apparently enlarged openings
- Suggestive evidence
  - Deep notches in posterior hymen, scars
- Definitive evidence
  - Cleft extending to base of hymen
- Inconclusive=lack of consensus

Kellogg, N. et al. *Pediatrics*, Jan. 2004; 113(1):e67-e69

Results

*82% of exams were normal/nonspecific
*11% of findings were suggestive
*7% of findings were definitive for penetrating trauma

(*When inconclusive category eliminated)

- Average time between last sexual contact and exam was 3.1 mo. for normal group and 1 mo. for definitive group.
- 56% pregnancies were result of sexual abuse
- 56% of adolescents had bleeding with first coitus

Kellogg, N. et al. *Pediatrics*, Jan. 2004, 113(1):e67-e69
149

Study Conclusions

- Despite definitive evidence of sexual contact (pregnancy), only 2 of 36 adolescents had findings diagnostic of penetrating trauma.
- Reasons for lack of genital findings
  - Penetration does not result in visible tissue damage
  - Acute injuries occur but heal completely
- Investigation/prosecution of sexual abuse cases must focus on history.

Kellogg, N. et al. *Pediatrics*, Jan. 2004; 113(1):e67-e69
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Conditions Mistaken for Abuse

- Lichen sclerosis
- Urethral prolapse
- Vulvar ulcers
  - EBV, Bechet's, Crohn's, influenza
- Perineal groove
- Rectal prolapse
  - Possibly from Shigella
- Dilation of anal sphincter (both internal and external)
  - <2 cm diameter
- Deep folds in peri-anal skin
  - Mistaken for injury
- Peri-anal or vulvuar inflammation/redness
  - Group A strep

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Acute Injuries *Indicative* of Abuse

- Extensive bruising on the hymen
- Laceration (tear, partial or complete) of the hymen
- Peri-anal lacerations extending deep to the external anal sphincter

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Old Injuries *Indicative* of Abuse

- Indicative of blunt force penetrating trauma
  - Hymenal transection (complete)
  - Missing segment of hymen tissue
- Residual injuries concerning for abuse
  - Peri-anal scars
    - If not due to another condition
  - Scars of posterior fourchette, fossa
    - Excluding linea vestibularis and labial adhesions

ASPAC: Adams: Approach to Interpretation, 2009
153

Sexually Transmitted Infections

- Following infections are indicative of contact with infected mucosal surfaces or secretions
  - Trichomonas in child >1 year old
  - Gonorrhea if not neonatal transmission
  - Chlamydia in child > 3 years old
  - Syphilis (not congenital)
  - HIV
    - If not neonatal, blood transfusion, or needle-stick associated transmission

154
Hammerschlag, CID, 2011;53 (Suppl 3): S103-109

Sexually transmitted infections: Herpes simplex

Herpes Simplex Virus (HSV), Type 1 or 2
- Either virus type (1 or 2) can infect oral or genital mucosa
- ~50% population has titers (evidence prior infection) to HSV1
  - Only ~1-2% children evaluated for sexual abuse have titers to HSV2
  - Most labs do a HSV 1/2 antibody screen, not specific titers, and lab tests frequently give inconsistent results on type-specific antibodies: Not reliable
- Genital HSV is rare in children < 11 years old
  - Full evaluation including STI screening
- **In and of itself, genital HSV in pre-pubertal children not diagnostic of sexual abuse, but should precipitate exam and investigation**

155
Hammerschlag; CID; 2011:53 (Suppl 3): S103-109

Sexually transmitted infections: Human papillomavirus (warts)

- Association between genital warts and sexual abuse is complicated by many factors
  - Long latency before lesions become clinically apparent
    - Vertical transmission at birth
    - Horizontal transmission after birth
  - Diagnostic criteria not standardized
    - Clinical diagnosis vs lab defined (detection of HPV DNA)
    - HPV DNA identified in genital and rectal swabs of15% of girls thought to be abused, and 2.1% non-abused children

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Hammerschlag; *CID*; 2011:53 (Suppl 3): S103-109

Acute Sexual Abuse Exam: Evidence Retrieval

- Swabs of mouth, vagina, anus, penis and/or scrotum
- Swab any other area indicated as potential for DNA by history
  - Bite marks
  - Areas licked
  - Areas of ejaculation
- Swabs for semen
  - Much more likely to find in > 10 year old, un-bathed, within 24 hours of assault
    - Still only 9-20% detection rate

Arborgast KB, et al. *Arch Pediatr Adolesc Med.* 2005;159:342-6

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Acute Sexual Abuse Exam: Evidence Retrieval

- Vaginal wet mount
  - Use microscope
  - Looking for sperm (motile or non-motile)
- Toxicology
  - Blood alcohol level
  - Urine drug screen
- Foreign material
  - Scrapings from under fingernails
  - Soil or debris
  - Pubic hair combings
  - Foreign bodies
  - Matted hair cuttings
- Reference samples
  - DNA from the patient
  - Often obtained from mouth

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Forensic Evidence Retrieval

- Clothing!!!
  - The longer time interval between assault and exam, less likely finding forensic evidence on the *body*
  - Emphasizes need to identify and collect clothing
  - In pre-pubertal patients, rarely find semen, except on clothing

Pediatrics 2000;106:100-4, *Child Abuse Negl.* 2006 Apr;30(4):367-80, *Arch Pediatr Adolesc Med.* 2006 Jun;160(6):585-8

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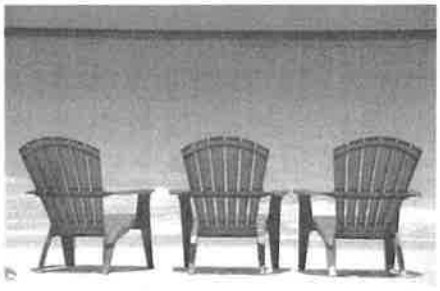
Questions?



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