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Highlights from the Imaging of Child Abuse Conference

CMEP Webinar

3/22/16

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Disclosures

I have no relevant financial relationships to disclose



Objectives

- (1) Provide key messages and themes from conference: including review of current practice and updates to management
- (2) Review literature helpful for evaluating child maltreatment
- (3) Offer suggestions for practice change

Imaging of Child Abuse Conference



- Exam Room, Reading Room, Court room
- Presentations and breakout seminars
- Common Themes, Illustrative cases
- Take home messages and Practice change considerations

Presenters

Dr. Robert Block

Dr. Paul Kleinman, Dr. Jeannette Perez-Rossello

Child Abuse Pediatricians: Sandeep Narang, MD, JD,
Joanne Wood, Marcella Donaruma

Orthopedic Surgeon

Attorneys

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Dr. Block

Imaging changes

Development of Child Abuse Pediatrics

- ABP subspecialty certification
- The Health CARES Initiative
- CHA (NACHRI)
- Helfer Society maturation
- Prevention efforts (i.e. Practicing Safety)

Child Abuse Pediatrics Certification

Produce future CAPs

Training of pediatricians to serve as CAP in children's hospitals

Through research develop a scientific basis for clinical decisions and case management

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Working with other Systems

Documentation

The importance of speaking to investigators

Educating investigators

Release of records

- state reporting trumps HIPAA
- institution policies

Working with other Systems

Effects on children:

1) Adverse Childhood Experiences

2) Stress

- positive stress - brief, mild to mod.
- tolerable stress – more significant stress
- toxic stress – strong, frequent or lifelong

Shonkoff, Jack. The Lifelong Effects of Early Childhood Adversity and Toxic stress. *Pediatrics*. 2012; 129(1)

Sentinel Injuries

“A visible or detectable minor injury in a pre-cruising infant that is poorly explained and therefore concerning for physical abuse”

- Petska, H. Sheets, LK, et al. Sentinel Injuries: Subtle findings in physical abuse. *Ped Clin of No Amer* Oct 2014; 61(5) 923-935

Missed opportunities

*Analysis of missed cases of AHT.

Jenny, et al *JAMA*. 1999;281(7):621-626

Bruises are #1 sentinel injuries

Sentinel Injuries

55 definite abuse cases with prior sentinel injuries

- 23/54 cases (42%) medical provider aware of sentinel injury (per parent)
- 10/23 cases medical providers suspected abuse
- 37/52 (71%) < 3 months old had first sentinel injury
- Median time to sentinel injury to re-presentation:
 - 1 month (range 1 day to 7 months)

Sheets, LK et al. Sentinel injuries in infants evaluated for physical abuse. *Pediatrics*. 2013; 131(4): 701-7. Epub 2013/03/13

Sentinel Injuries

Missed “milder” abuse injuries

- Case series (Oral, 2008)
- Case report (Thackeray, 2007)
- Case report (Petska, 2013)
- Case report (Pierce, 2009)
- Retrospective study (Ravichandiran, 2010)
- Retrospective study (Thorpe, 2014)

Sentinel Injuries

Skeletal Survey (SS):

- 25 – 30% of children <2 y with diagnosis of physical abuse have occult fractures on SS
- 11 – 13% of children < 2 y evaluated for suspected abuse have occult fractures on SS

Belfer, RA et al. Use of the skeletal survey in the evaluation of child maltreatment. Am J Emer Med. 2001; 19 (2):122-124

Day, F, et al. A retrsopsective case series of skeletal surveys in children with suspected non-accidental injury. J Clin Forensic Med. Feb 2006; 13(2): 55-59

Sentinel Injuries

CT/MRI:

- Laskey, 2004: Neuroimaging performed in 38 of 51 (75%) neurologically asymptomatic patients younger <48 months evaluated with a SS for abuse.
 - 11/38 (29%) had occult head injury
- Rubin, 2003: Neuroimaging performed in 51 of 65 (79%) of neurologically asymptomatic high-risk abused infants.
 - 19/51 (38%) had occult head injuries
 - SS alone missed 5/19 (26%) of occult head injuries

Sentinel Injuries

CT/MRI:

- Wilson, 2014: 320 children with isolated extremity fracture and negative SS
 - Head CT performed in 117 (37%)
 - 5/117 (4.3%) had unsuspected traumatic findings of which 3 were forensically significant and none were clinically significant

Wilson, PM, Chua M, et al. Utility of head computed tomography in children with a single extremity fracture. J Pediatrics. 2014: 164(6): 1274-1279

Bruising in infants and children

Most common abusive and accidental injury

Key factors: age, development, location, pattern

- Sugar, et al. (1999)
- Labbe, et al (2001)
- Maguire et al (2005)
- Pierce MC (2016)

Bruising in infants and children

“TEN 4”

- T** Torso (chest, abdomen, back, buttocks, GU, hip)
- E** Ears
- N** Neck
- 4** Any bruise in infant < 4 months old
Bruising in TEN areas in child < 4 years old

Pierce MC, et al. Bruising characteristics discriminating physical child abuse from accidental trauma. *Pediatrics*; 2010; 125(1):67-74

Radiologic Imaging for Occult Injuries

SKELETAL SURVEY

- ALL children < 2 years old with abusive injury
- ALL children < 2 years old with suspicious injury:

bruises, other skin injuries, or oral injuries in non-ambulatory infants; injuries not consistent with history provided

Christian, C et al. Committee on Child Abuse and Neglect. The evaluation of suspected child physical abuse. *Pediatrics*; 2015;135(5); e1337-54

Radiologic Imaging for Skeletal Survey

Infants/Children with bruising

- I. Skeletal survey is *necessary* in children <24 months old with bruising if any of the following features are present:**
- History of confessed abuse
 - History of bruising occurring during domestic violence
 - Additional injuries on physical exam (e.g., burns, whip marks)
 - Patterned bruising
 - >4 bruises NOT limited to bony prominences
 - Ear, neck, torso, buttocks, genital region, hands, feet if there is no history of trauma
- II. Skeletal survey is also *necessary* in children <12 months old with bruising in the following locations:**
- Checks, eye area, ear, neck
 - Upper arms or legs (not over bony prominences)
 - Hands, feet
 - Torso, buttocks, genital region
 - >1 bruise NOT limited to bony prominences
- III. Skeletal survey is also *necessary* in children <9 months old with bruising in the following locations:**
- >1 bruise in ANY location
- IV. Skeletal survey is also *necessary* in children <6 months old with bruising in the following locations:**
- Bony prominences (head T-shaped area, frontal scalp, extremity bony prominences) EXCEPT if a single bruise and patient presents with history of fall

These guidelines apply to children who do not have a verifiable mechanism of accidental trauma (i.e. MVC or fall in public place), do not have underlying bleeding disorder such as Hemophilia, and who do not have a clear history of birth trauma that accounts for the injury.

Wood, Joanne et al. Development of hospital-based guidelines for skeletal survey in young children with bruises. Pediatrics; 2015; 135(2):e312-20.



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Radiologic Imaging for Occult Injuries

HEAD IMAGING: CT, MRI or both

- ALL infants and children with suspected AHT

- Consider evaluating for occult head injury in neurologically normal patients with suspicious injuries:

Infants with suspicious bruising, High risk infants: age < 6 months, facial injury, rib fractures

Rubin, DM et al. Occult head injury in high-risk abused children. Pediatrics; 2003;111(6):1382-6

Skeletal Survey (SS)

< 2 y	Mandatory SS
2 – 5 y	SS or Bone Scan; select cases
5 y	little value in SS and bone scan; select views

AAP: admit child for safety until adequate studies obtained
ACR-SCR practice parameter guidelines

Initial SS: 21 views

Wood, Joanne, et al. Development of Guidelines for Skeletal Survey in Young Children with Fractures. Pediatrics 2014; 134-45. Epub 6/16/14

Other skeletal imaging

❖ Ultrasound: select cases

❖ MRI: select cases

Other considerations:

- Image twin of abused infant
- Incidence of fracture in neglected or sexually abused child is low; do SS in select cases

Follow up Skeletal Survey (FU-SS)

Follow up: 17 views (with no skull)

No definite guidelines; children < 2 y suspected of abuse

Equivocal or abnormal findings on initial SS

Follow up Skeletal Survey (FU-SS)

Is it useful to obtain FU-SS:

- Harlan 12% (4/34)
- Sonik 16% (1/6)
- Bennett 8.5% (4/47)
- Harper 7% (18/252)

Harlan. Pediatric Rad 2009; 962-968

Sonik. Child Abuse Negl 2010;804-806

Bennett. BMC Research Notes 2011; 4,354

Harper. Pediatrics 2013;131:672-8

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Follow up Skeletal Survey (FU-SS)

Is it useful to obtain FU-SS:

- ✓ Adds info in 14 to 61% cases
- ✓ Identifies new fractures (62 -91% ribs and CMLs)
- ✓ Confirms suspected fx
- ✓ Clarifies findings, normal variants
- ✓ Aids in dating injuries

Follow up Skeletal Survey (FU-SS)

CAN WE DECREASE THE DOSE?

Options:

- 1) Take less images
- 2) Use better camera

Follow up Skeletal Survey (FU-SS)

LIMITED 17 views

New info in 37%

- AP bilateral oblique chest
- AP humeri
- AP forearms
- AP femurs
- AP tib/fib
- AP feet

Harlan. Follow up SS for NAT: Can a more limited survey be performed.
Ped Rad 2009; 39: 962-968

No pelvis or lateral spine; 15 views total

Harper. Pediatrics 203; 131: 672-8

Multi-center Limited FU-SS Study

Traditional FU-SS of 19 images	0.579 mSv
Limited view FU-SS of 15 images (No pelvis or spine)	0.054 m SV
*TEN FOLD DECREASE	

Hansen, et al. Pediatrics 2014; 134: 242-248

Ahmed, et al. Pediatrics 2010; 126: e853

Follow up SS (FU-SS)

Use better camera: Conventional Radiography (CR)

Vs.

Digital Radiography (DR)

DR:

Provides better image quality than CR at equivalent doses

Converts x-rays into electrical charges by a direct readout

Changes the dose implication

Bone Scan

- Consider when there are equivocal findings OR with negative SS with high suspicion for abuse
- Consider in patients going into Spica cast overnight
- Pt needs to be sedated
- Technectium vs F 18 PET
 - * F 18 PET better resolution, quick scanning time, multiple planes

Radiation dosing

Bone Scan	3.2 mSv
CT Abdomen	2 mSv (up to 4)
CR HD SS	0.45 mSV
DR HD SS	0.32 mSv
DR Limited FU-SS	0.05 – 0.1 mSv
Chest x-ray	0.01 – 0.15
Two Plane flight to Paris	0.03 mSv

*National Council on Radiation Protection and Measurement and unpublished data

Nomenclature of Dating Subdurals

CONSISTENCY OF RADIOLOGY REPORTING

WHAT IS THE
RADIOLOGIST'S FAVORITE
PLANT?

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THE HEDGE



Hedge: limit or qualify (something) by conditions or exceptions.

Nomenclature for dating of subdurals

Radiologists should provide description and not necessarily timing

Based on description and clinical picture, medical providers should be the ones making assessment for timing

Descriptive Terms: CT – density (iso-, hyper-, hypo-)
MRI – intensity

Hyperattenuating <7days after trauma and absent >11 days
(aka hyperdense)

Enhancement of SD membranes (may represent older injury; 5 to 8 days old)

Abusive Head Trauma (AHT) Imaging

CT initially; MRI 3 to 7 days later

Consider serial imaging

Bridging veins

- injury and disruption, SDH,

Parenchymal injury

- contusions, laceration, hypoxic-ischemic injury

Retinal injury

- MRI SWI best sequence; absent or delayed ophthalmology exam

Mimics of intracranial bleed

- 1) Pseudo SAH – secondary to diffuse edema or HIE
- 2) Pseudo SAH or SDH – secondary to IV contrast
- 3) Dense dural sinuses due to hemoconcentration
- 4) Thrombosis of dural sinuses
- 5) Partially encapsulated cephalhematoma – post birth/trauma, sub-periosteal blood

Fractures

Accidental

OI

Osteopenia of prematurity

Rickets (Vit D deficiency)

Disuse osteopenia

Osteomyelitis

Systemic disease: chronic renal or liver disease, leukemia, hypophostasia

Rare: scurvy, copper deficiency, Menkes, congenital syphilis

Osteopenia of prematurity

<28 weeks gestation; <1500 g at birth

Decreased bone mineralization at birth

Fx usually in first year of life

After 1st year of life normalizes

Disuse Osteopenia

Patients with inability to ambulate OR limited ability to ambulate

Fractures can occur even with normal handling

Elemental Formula Rickets

Hypophosphatemia, low Vit D, increased Alkaline phosphatase

- develop hypocalcemia

Neocate and Neocate Jr.

X-rays often show overt rachitic disease

Tx: phosphate supplements

*Carpenter et al; case in progress

Fractures concerning for Abuse

ALL CASES: Serum calcium, alkaline phosphatase, phosphorous

Consider in all cases AND obtain if demineralization:

PTH, 25-hydroxy Vit D, Urine calcium excretion
(random urine Ca/Cr)

Risk factors present OR x-ray findings:

Serum copper, ceruloplasmin, Vit C

OI: genetic analysis of COL1A1/1A2 and AR forms OR skin biopsy;

Genetics consult

Flaherty, E, et al. Evaluating children with fractures for child physical abuse. Pediatrics
2014;133(2): e477-489

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Chest/Abdominal and Spine Injuries

Need to have high index of suspicion

CT Abdomen: IV contrast routine; oral contrast debatable

Focused Assessment with Sonography for Trauma (FAST)

*not appropriate screening in hemodynamically stable children with suspected blunt abdominal trauma

Spinal injuries: CT, bone scan or MRI

Court Room

During investigation: educate law enforcement and attorneys

- ATTENDINGs should provide MEDICAL OPINION
- Residents and other medical staff can provide facts
NOT opinion

Court Room

How do juries perceive expert witness?

www.courtstatistics.org

5th annual post-conviction conference

www.youtube.com/watch?v=SUv9a9Mn5gl

Court Room Testimony

- Use Plain English
- Highlight your experience
- Explain diagnostic process
- State incidence of abuse
- Be thoroughly prepared
- Listen to each question carefully before answering; be brief

Court Room Testimony

- Avoid misleading statements

- If asked Yes/No can answer :
 - can say you can't answer Y/N OR
 - state you are here to explain the basis for your conclusion OR
 - Yes, but....

- Be respectful, don't exaggerate or speculate

- Consider demonstrative aids

- Turn to judge or jury when answering

Imaging Gently

www.imagegently.org



The Alliance for Radiation Safety in
Pediatric Imaging

100 mSv → increase cancer risk by 1%
? One time dose OR cumulative

Chest x-ray: 0.01 – 0.15 mSv

CT Head 1- 2 mSv

Benefit vs Risk ratio

Other Matters to consider

- Parents refusal of SS
- How much work-up with ALTEs? (2nd ALTE consider work-up)
- Routine MRA and MRV (document normal SSS)
- Rapid MRI (should not be used for NAT)
- Alternative theories and controversies for intracranial and skeletal findings

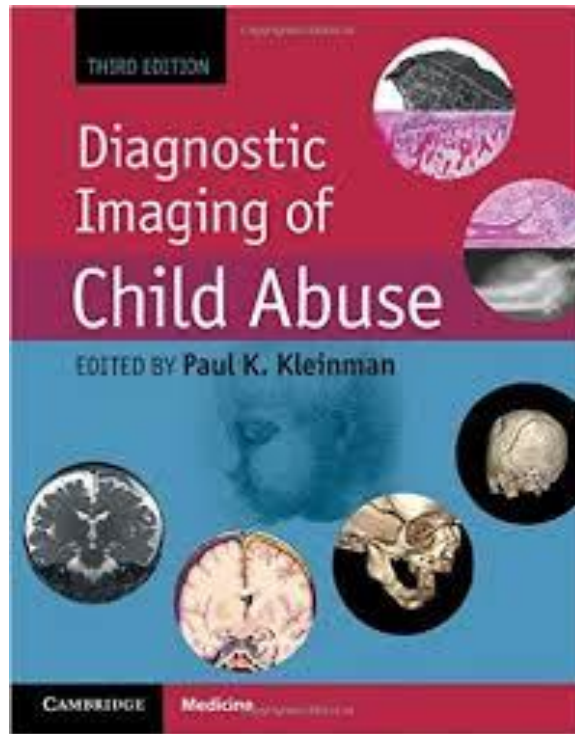
Practice changes

- Educate medical providers on Sentinel injuries and child abuse
- Consider developing local clinical guidelines for identification and evaluation of children with potential sentinel injuries
- Have low threshold for considering abuse and obtaining SS
- On follow up SS – eliminate skull, lateral spine and possibly pelvis

Practice changes

- Meet with your Pediatric radiologist and Neuro-radiologist to discuss use of terms vs timing AND follow up SS
- If obtaining MRI Brain and MRI c-spine, consider MRI whole spine
- Consider standard practice of 3D images on CT Head of all children with suspected abuse under 2 years (or under 1 year)
- Avoid Rapid MRI vs CT for skull fractures
 - Rapid MRI missed 40% of skull fractures

Resources



- 3rd edition, Dr. Kleinman
- Full color
- Expanded and revised chapters
- New images
- New material on extremities, thoracic, spinal and intracranial injuries
- New chapters on calcium and phosphorous metabolism

Interesting Reads

“The Unbearable Asymmetry of BS” by Brian Earp

www.quillette.com

NY Times Retro reports

“Is SBS the Satanic Panic” by Amy Nicholson (LA weekly; online 4/9/15)

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Kleinman et al. Absence of Rickets in infants with fatal AHT and CML. *Radiology* June 2015.

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Trout, et al. Abdominal and Pelvic CT in cases of suspected abuse: can clinical and laboratory findings guide its use. Ped Radiol; January 2011; 41(1); pp 92-98

Coley, Brian et al. Journal of Acute Care and Trauma Surg; 2009

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Moreno, J, JD. What do Pediatric Healthcare Experts Really Need to Know About Daubert and the Rules of Evidence, 43 Ped Rad; 2013;135

That's all Folks!

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