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
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
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

Sentinel Injuries

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


Missed opportunities

*Analysis of missed cases of AHT.


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)

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


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

Bruising in infants and children

Most common abusive and accidental injury
Key factors: age, development, location, pattern

- Sugar, et al. (1999)
- 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

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:
   - Cheeks, 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.

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

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

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
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 0.054 mSV
(No pelvis or spine)
*TEN FOLD DECREASE

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

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone Scan</td>
<td>3.2 mSv</td>
</tr>
<tr>
<td>CT Abdomen</td>
<td>2 mSv (up to 4)</td>
</tr>
<tr>
<td>CR HD SS</td>
<td>0.45 mSv</td>
</tr>
<tr>
<td>DR HD SS</td>
<td>0.32 mSv</td>
</tr>
<tr>
<td>DR Limited FU-SS</td>
<td>0.05 – 0.1 mSv</td>
</tr>
<tr>
<td>Chest x-ray</td>
<td>0.01 – 0.15</td>
</tr>
<tr>
<td>Two Plane flight to Paris</td>
<td>0.03 mSv</td>
</tr>
</tbody>
</table>

*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?
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 <7 days 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 ophtho 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, hypophostasias
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

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
How do juries perceive expert witness?
www.courtstatistics.org

5th annual post-conviction conference
www.youtube.com/watch?v=SUv9a9Mn5gI
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
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)
References


References


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
References


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!