Imaging of Abusive Head Trauma

V. Michelle Silvera MD
Boston Children’s Hospital
No disclosures
Overview

• Imaging findings in AHT

• Dating of injury based on imaging

• Approaches to increase detection of abnormalities and specificity
  – Post process your CTs: reformats and 3D models
  – Ct positive: follow with MRI
  – Image serially
Diffuse axonal injury in AHT is:

A) a common finding and the cause of the diffuse cerebral swelling
B) a common finding and involves the gray-white matter junction
C) a common finding and involves the corpus callosum and midbrain
D) a rare finding and if present most commonly involves the cervicomedullary junction
E) a rare finding and if present most commonly involves the white matter and basal ganglia
Abusive Head Trauma in Infants

- Shaken Baby Syndrome
- Whiplash Shaken Baby Syndrome
- Shaken Impact Syndrome
- Shaken-slam Syndrome
- Battered Child Syndrome
- Non-accidental Trauma
- Non-accidental Injury
- Intentional Injury
- Trauma-X
- Non-accidental Head Injury
- Inflicted Head Injury
- Abusive Head Injury
- Abusive Head Trauma
Abusive Head Trauma

Triad:
- subdural hematoma
- retinal hemorrhage
- encephalopathy (brain swelling/anoxic brain injury)

• Little or no external evidence for injury
Mechanism of Inflicted Head Injury

- Direct impact injury to head
- Asphyxiation, strangulation
- Shaking an infant held by the arms or trunk ending with or without impact
Abusive Head Trauma

Mostly children under the age of 2
  – majority of cases in the first year of life
  – peak incidence 6 months

Prospective study of children admitted for head injury <2 years
  – 24% from inflicted trauma, 32% suspicious*

Duhaime AC et al. Head injury in very young children,: mechanisms, injury type and opthalmologic findings in 100 hospitalized patients younger than 2 years of age. Pediatrics 90:179-185.
Abusive Head Trauma

• History:
  – vague, changing, clinical findings incompatible with history or developmentally incompatible

• Symptoms:
  – lethargy, decreased consciousness, irritability, vomiting, respiratory difficulties, apnea, seizures
Abusive Head Trauma

Clinical:
– retinal hemorrhage
– fractures
– bruising (patterned)
– burns
Abusive Head Trauma

Sequelae:
- developmental delay
  learning disabilities
  behavioral issues

- mental retardation
  cerebral palsy,
  blindness, death
Mandatory Reporters of Child Abuse

- Teachers and other school personnel
- Child care providers
- Social Workers
- Physicians and other health-care workers
- Mental health professionals
- Law enforcement officers
- Medical examiners and coroners
- Clergy (some states)
Imaging of AHT

No single radiologic finding is pathognomonic or specific for abusive head injury

Pattern recognition, patterns differ with age

- Imaging pattern < 1 year of age
  - multifocal, extensive, thin subdural hematomas
  - hypoxic ischemic injury
  - retinal hemorrhages
  - skull fracture, scalp edema
AHT: Skull Fractures

comminuted
occipital
diastatic
Fracture vs. Sutures

13 month old girl r/o occipital bone fracture
body bruises, inconsistent hx, multiple skeletal fxs various ages, in foster care
Fracture vs. Suture

Normal Anatomy
Occipital Bone Fractures
13 month old girl r/o occipital bone fracture
body bruises, inconsistent hx, multiple skeletal fxs various ages, in foster care

3D Surface Shaded Display
Fracture vs. Normal Variant

7 month old with growing head circumference
Further evaluation with plain films

AP plain film

Lateral plain film
3D Surface Shaded Display
AHT: In-Plane Fractures
12 month old s/p fall from high chair
Coronal Reformat

Sagittal Reformat
3 D Model
AHT: In-Plane Fractures
12 month old s/p fall from high chair
Subdural Hematomas

3 month old with bradycardia and respiratory depression
In dad’s care, left unattended on floor, later found unresponsive, limp, apneic
multiple body bruises, SS: multiple old fractures
Subdural Hematomas

2 y.o. in mom’s boyfriend’s care, crawling, suddenly collapsed.
SS: multiple fractures varying ages
F/u: seizures, hemiparesis. Foster care
AHT : Parenchymal Injury

- Parenchymal hemorrhage
- White matter contusional clefts
- Diffuse axonal injury
- Hypoxic ischemic changes:
  - diffuse or patchy hypodensity
  - loss of gray-white matter differentiation
  - sparing of basal ganglia and posterior fossa structures
AHT: Hypoxic Ischemic Injury

5 week old with respiratory distress, lethargy and seizures
SS: skull and rib fractures, liver laceration, duodenal hematoma
AHT: Hypoxic Ischemic Injury

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Follow up CT <24 hrs later
AHT: Hypoxic Ischemic Injury

5 week old with respiratory distress, lethargy and seizures
SS: skull and rib fractures, liver laceration, duodenal hematoma

MRI < 24 hrs later
AHT: Hypoxic Ischemic Injury

5 week old with respiratory distress, lethargy and seizures
SS: skull and rib fractures, liver laceration, duodenal hematoma

8 months later
father in jail, care facility, severe sz d.o., G-tube, stander, supportive chair
AHT: Hypoxic Ischemic Injury

16 mos old in care of babysitter, 2-3 ft off couch, tongue laceration, bruising chest, duodenal hematomas, baby died
AHT: Hypoxic Ischemic Injury

16 mos old in care of babysitter, 2-3 ft off couch, tongue laceration, bruising chest, duodenal hematomas, baby died
7 hrs after insult
Small SDH with excessive midline shift
AHT: Unilateral HIE

2 year old girl cared for by mother’s boyfriend found unresponsive by brother
retinal hemorrhages, facial bruising
AHT: Unilateral HIE

2 year old girl cared for by mother’s boyfriend found unresponsive by brother
retinal hemorrhages, facial bruising

10 days later
AHT: Unilateral HIE

2 year old girl cared for by mother’s boyfriend found unresponsive by brother retinal hemorrhages, facial bruising

6 months later

child lives with father, seizures, dense hemiparesis, wheelchair, communication board
Patterns of HIE in AHT

All cases of AHT
White Matter Contusional Tears

Credit F. Lonergan MD. et al.
White Matter Contusional Tears

Axial T2

Axial FLAIR

1 month old with AHT
White Matter Contusional Tears
AHT: Contusional Tear
1 month old with confessed shaking and impact
SS: multiple fractures

Cor T2

Cor T2
AHT: Contusional White Matter Tear

Sagittal

Coronal
Contusional White Matter Tear

5 week infant with vomiting, increased lethargy, possible seizure. SHDs, skull fx. SS: mult fx. No RH
AHT : Parenchymal Contusions

3 month old with bradycardia and respiratory depression
In dad’s care, left unattended on floor, later found unresponsive, limp, apneic
multiple body bruises, SS: multiple old fractures

Day of Admission
AHT: Parenchymal Contusions

Day of Admission

1 Day later
Retinal Hemorrhages

16 mos baby girl in care of babysitter, s/p fall off couch
tongue laceration, bruising chest, pancreatic contusion, duodenal hematoma, pt died
Dating of Subdural Hematomas
AHT: Timing of SDHs

Quick dynamic changes in size and density in the first few days:

- ongoing bleeding and clotting
- acute on chronic sdh
- layering of blood products
- redistribution of blood products
- arachnoid tears

All Subdural collections referred to as “Subdural Hematomas” = hematoxygromas, hygromas, subdural collections
AHT: Layering Subdural Hematomas

Axial T1

Axial T2
AHT: Layering Subdural Hematomas

Axial T1

Axial T2
AHT: Low Density SDH

1 month old with AHT

Day 3 after injury
AHT: Low Density SDHs
1 month old with AHT

Day 1
Day 3
Day 10

Same patient
SDH: Changes in Density
AHT in 3 month old

Day 1

Day 3
Subdurals of Different Ages?

Axial T1

Axial T2
Heterogeneous SDH: Acute on Chronic?
both AHT cases

reported as: "heterogeneous sdh"

xanthochromic fluid and membranes

reported as "acute on chronic"

Acute on Chronic SDH

acute blood all one age, no membranes

Acute SDH
Enhancing Membranes: Acute on chronic?

3 month old with AHT

8 days post trauma
SDHs: Enhancing Membranes

3 month old with AHT

3 days post trauma

8 days post trauma
Dating of subdural collections

Dating a SDH is challenging

Terminology:

- “acute”, “chronic”, “acute on chronic”
- hygroma, effusion, hematohygroma
- hyperdense, isodense, hypodense, uniform, mixed density
Spinal Subdural Hematoma

5 wk old male, respiratory distress and lethargy, szs skull fracture, liver laceration, healing rib fx
Summary

- Pattern recognition
- CT reformats and 3D models in evaluation of skull fractures
- Care in dating SDHs
- MRI and serial imaging improves confidence and specificity