

# Abusive Head Trauma and Abdominal Injury

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# Nanny Cam Video



Abusive Head Trauma  
(Shaken Baby Syndrome)

# Case History

- 8 month old male child who was previously healthy, left in the care of babysitter at 8 AM
- Baby fussy all day, but at 11:30 AM eats strained peas with no vomiting
- 3:30 PM found by babysitter to be in distress
- 4 PM presents to ED in a coma with fixed and dilated pupils
- History by babysitter varies

# Physical Examination & Imaging Studies

- Comatose with bulging fontanelle (soft spot)
- Bilateral massive retinal hemorrhages, right vitreous hemorrhage
- No external signs of trauma
- CT: Right SDH with midline shift, cerebral edema
- Skeletal survey: Right occipital skull fracture, healing distal right radius

# Course

- Craniotomy for removal of SDH
- Steadily worsening course in PICU on ventilator
- Babysitter never visits child or inquires about his status in the hospital
- Declared brain dead 4 days after admission and removed from life support

# Commonwealth v Louise Woodward

October 6-30, 1997



# Head Injury Concepts

- Focal vs. Diffuse Injury
- Primary vs. Secondary Injury

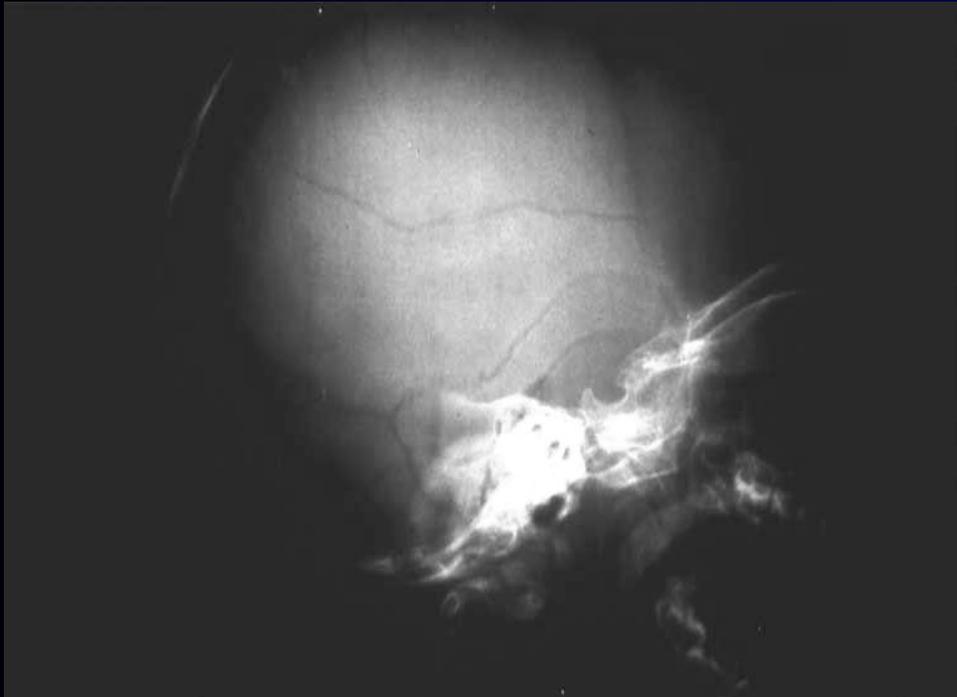
# Focal Injury - Contact Injury

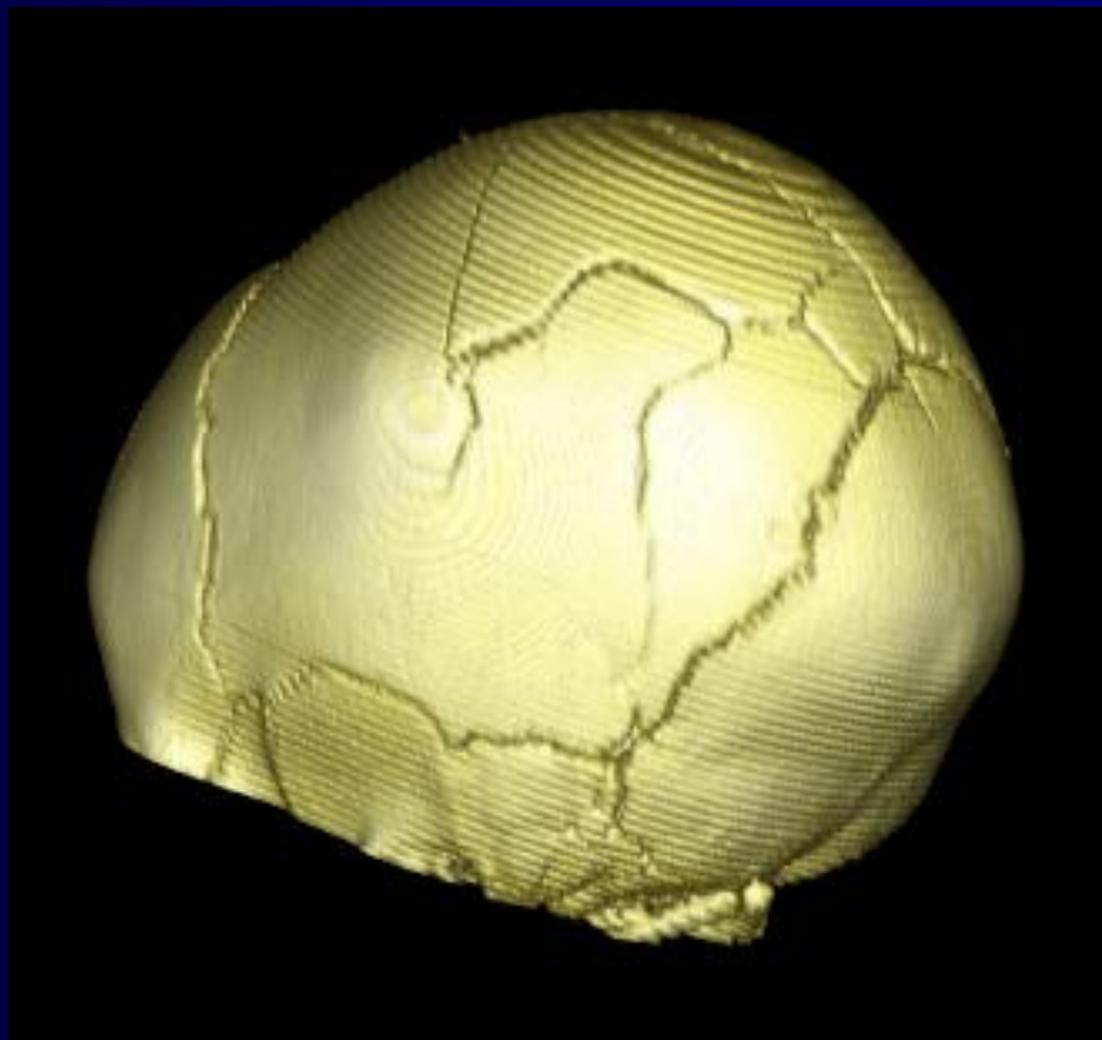
Linear acceleration & forces/ Impact

- Scalp contusions, abrasions, lacerations
- Subgaleal hematoma
- Skull fracture
- Epidural hematoma
- Focal subdural hemorrhage
- Superficial brain contusions and lacerations

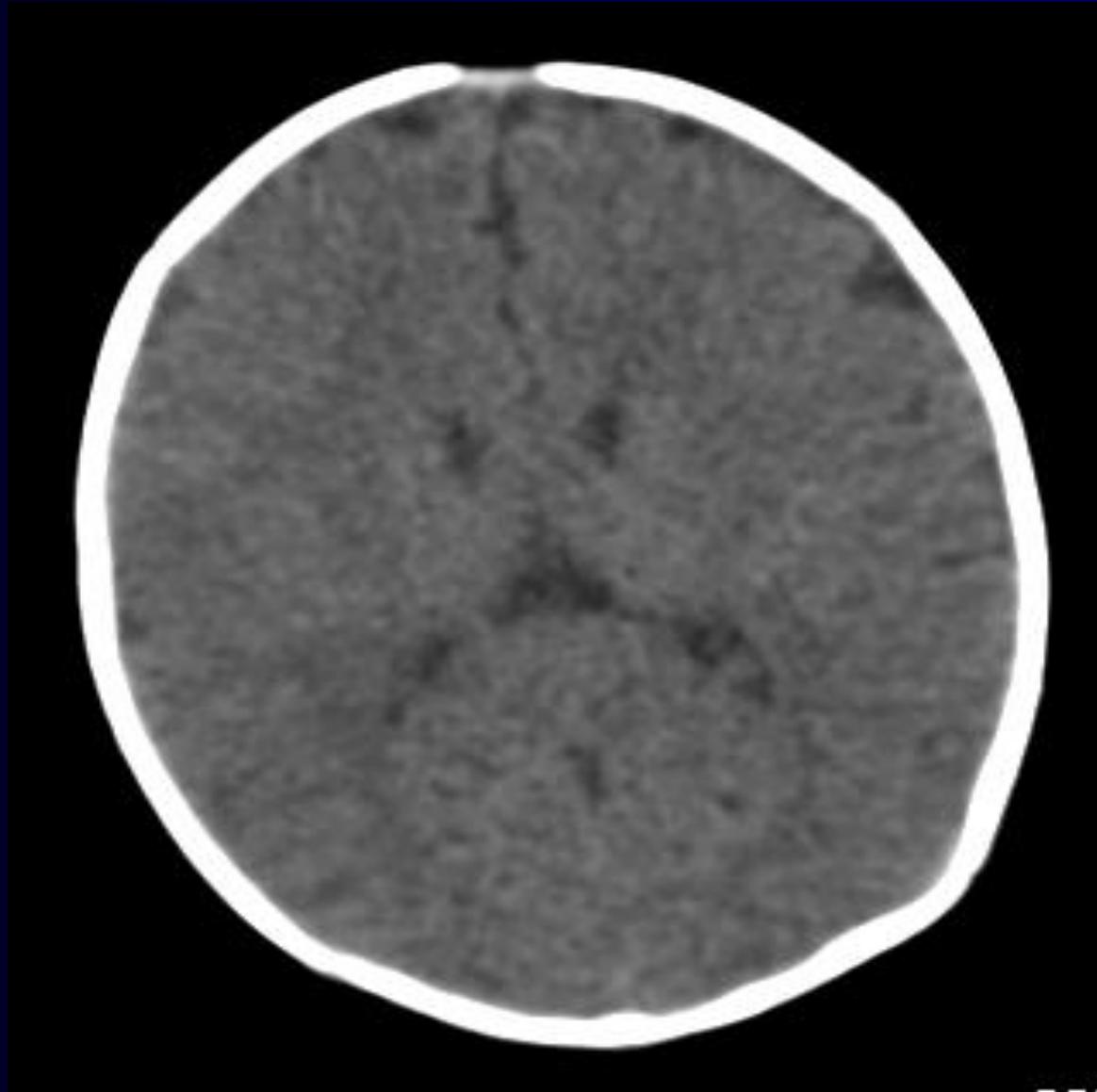


# Skull Fracture

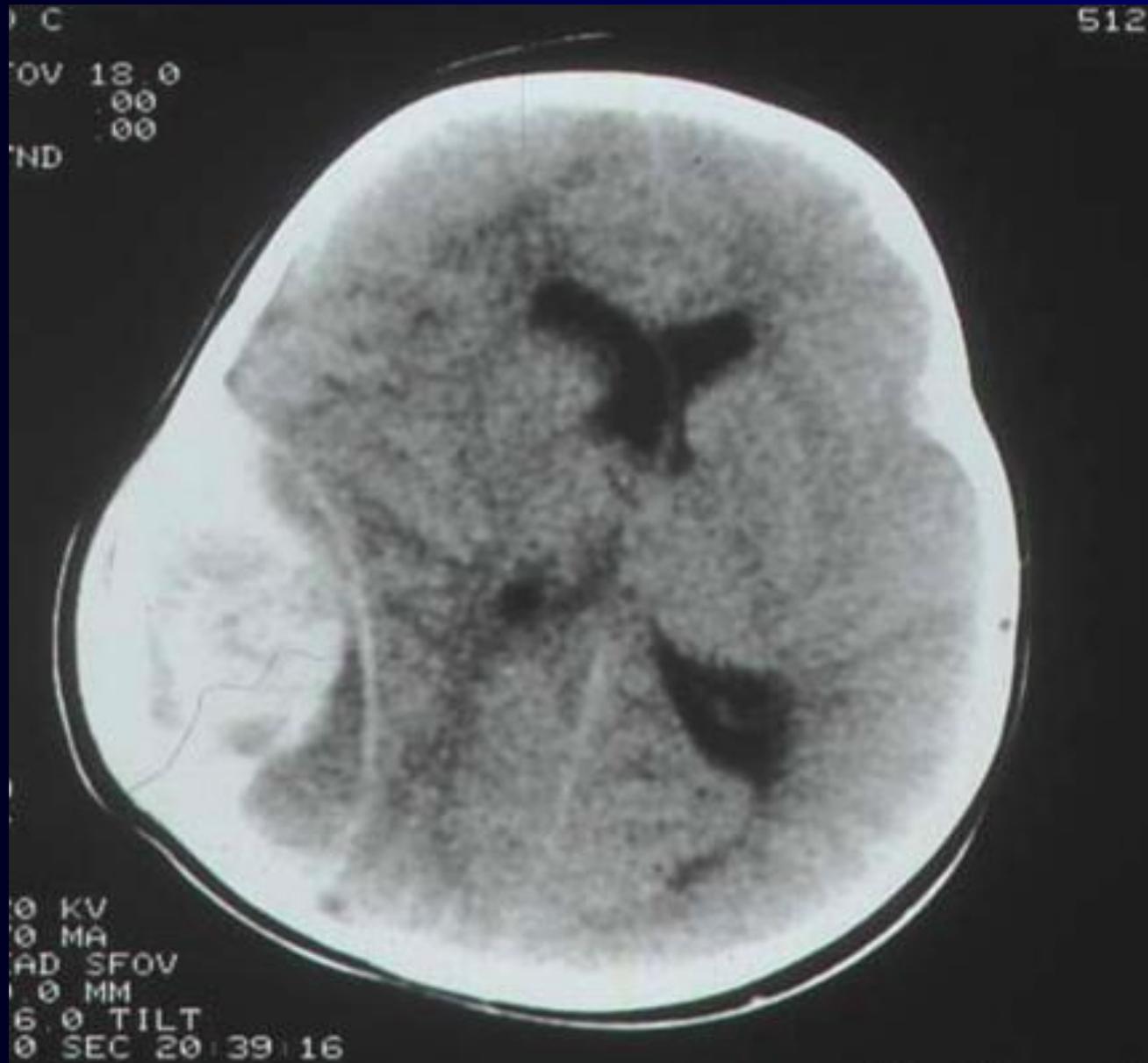




# Normal CT



# Epidural Hematoma



Shaking and the sudden deceleration of the head at the time of impact cause several things to happen:

- Bridging veins from the brain to the dura tear open and bleed, creating the subdural hematoma
- Brain strikes the inner surface of the skull, causing direct trauma to the brain substance
- Axons are sheared off
- Lack of oxygen further damages brain substance
- Damaged nerve cells release chemicals-further oxygen deprivation and damage to adjacent nerve cells

Scene Trigger: IDENTER! Frame  
1 82/85/21 15:25/21 +888745

8 PLAY 38:8 588 1/1588  
ID Status Play Rec Shutter

**INJURY**



STUNNED  
APPEARANCE



DECREASED  
LEVEL OF  
CONSCIOUSNESS



ALTERED  
BREATHING



VOMITING



CONVULSIONS



**DEATH**



COMA

# Forces Required

- No good experimental model exists
- *High degree of force*
  - analogous injuries are seen with...
- “...so violent that individuals observing [the shaking] would recognize it as dangerous...”

# Forces Required

- "...and likely to kill the child."  
-AAP 2001

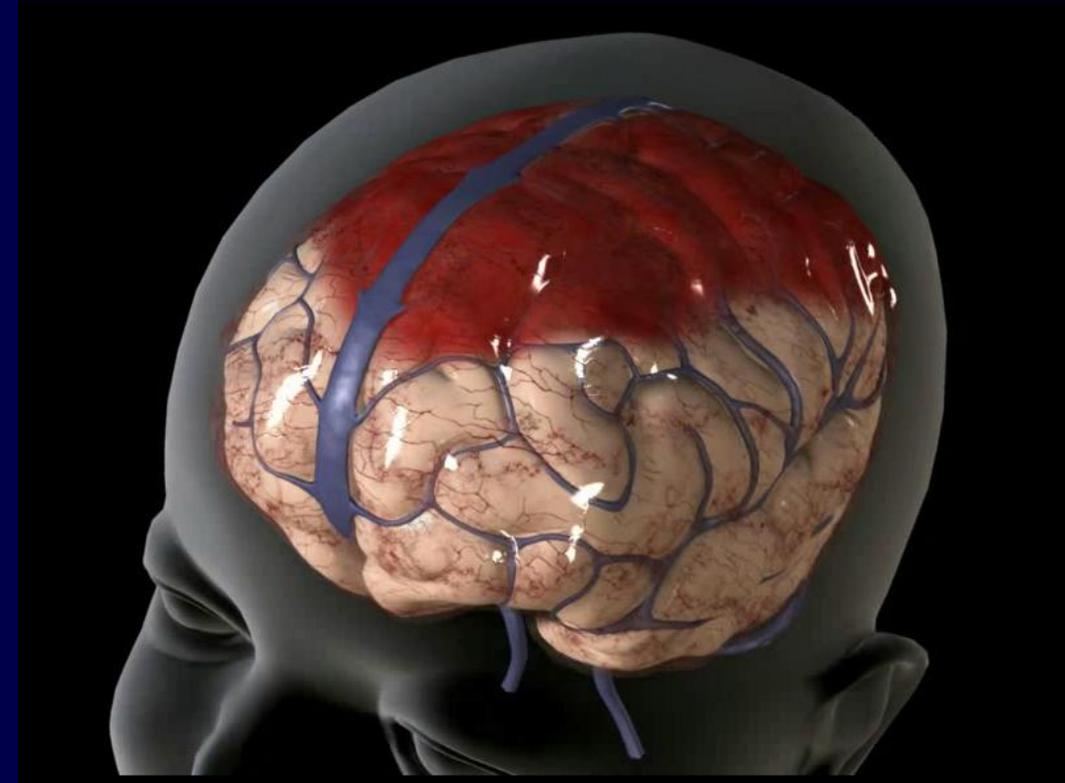
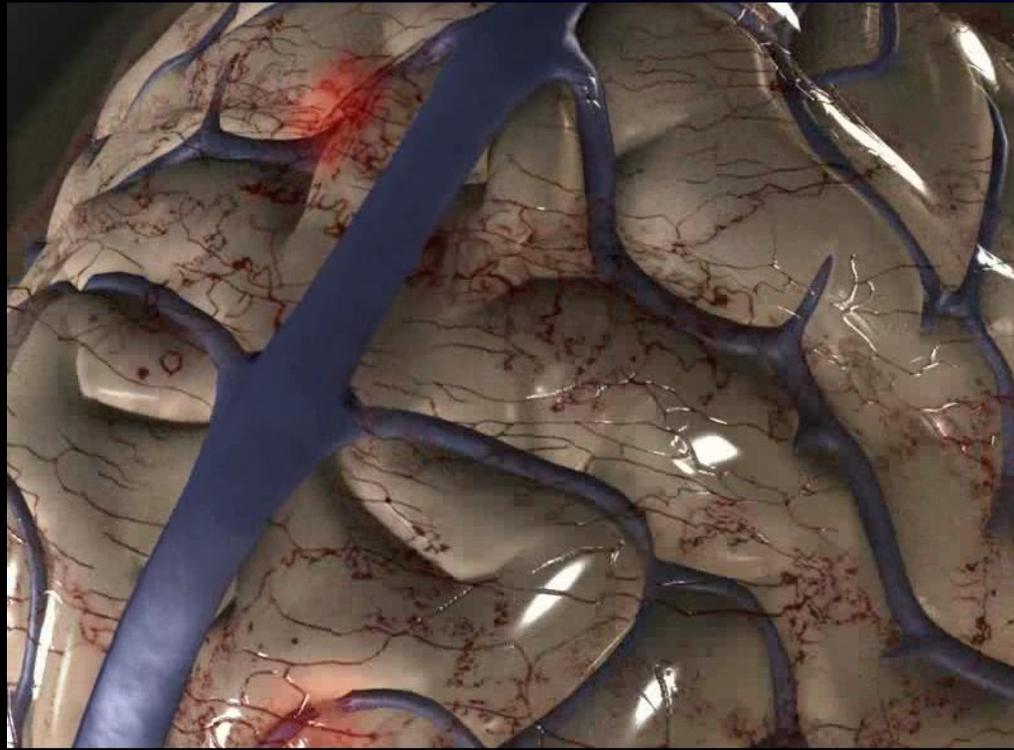


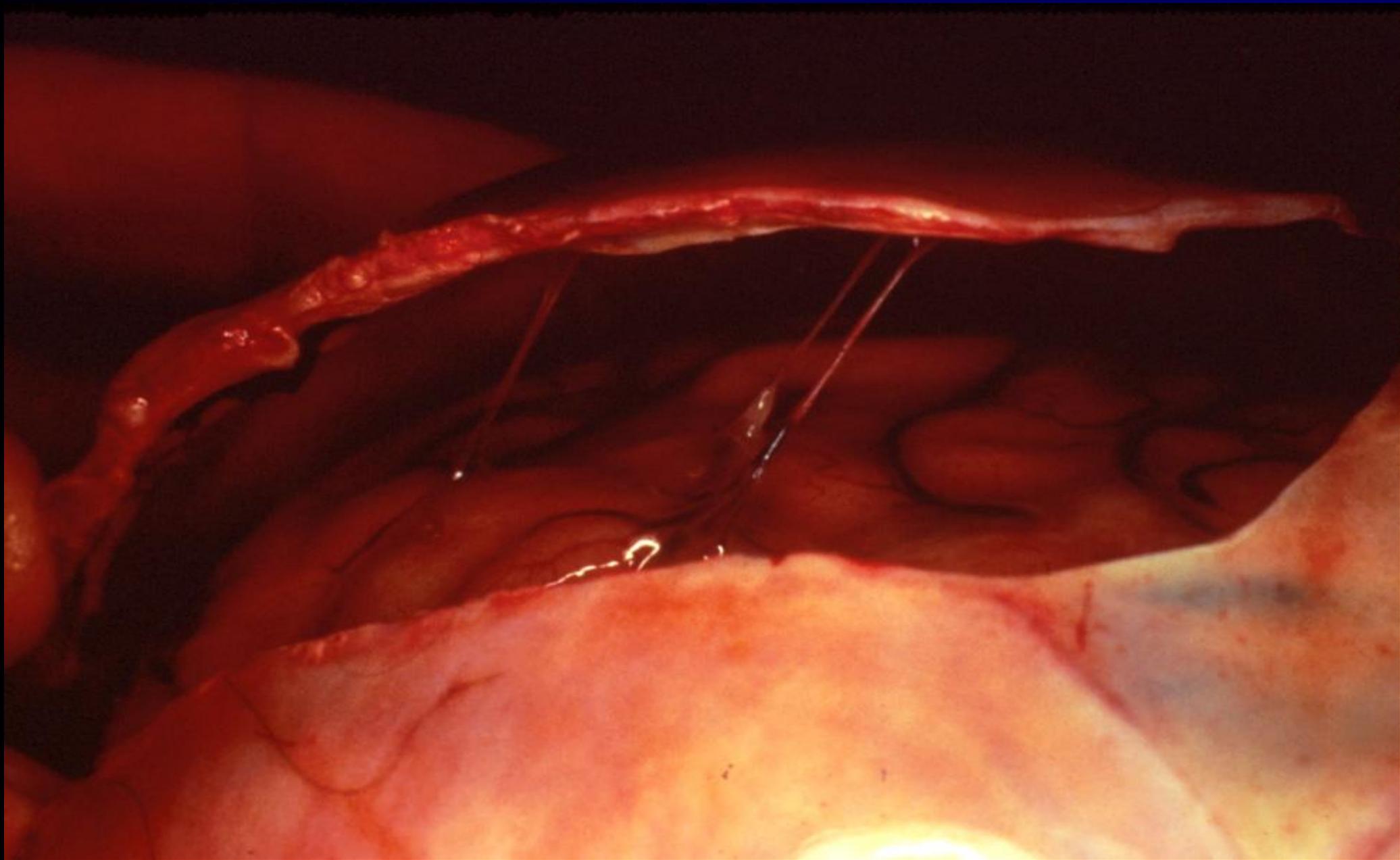
# Diffuse Brain Injury

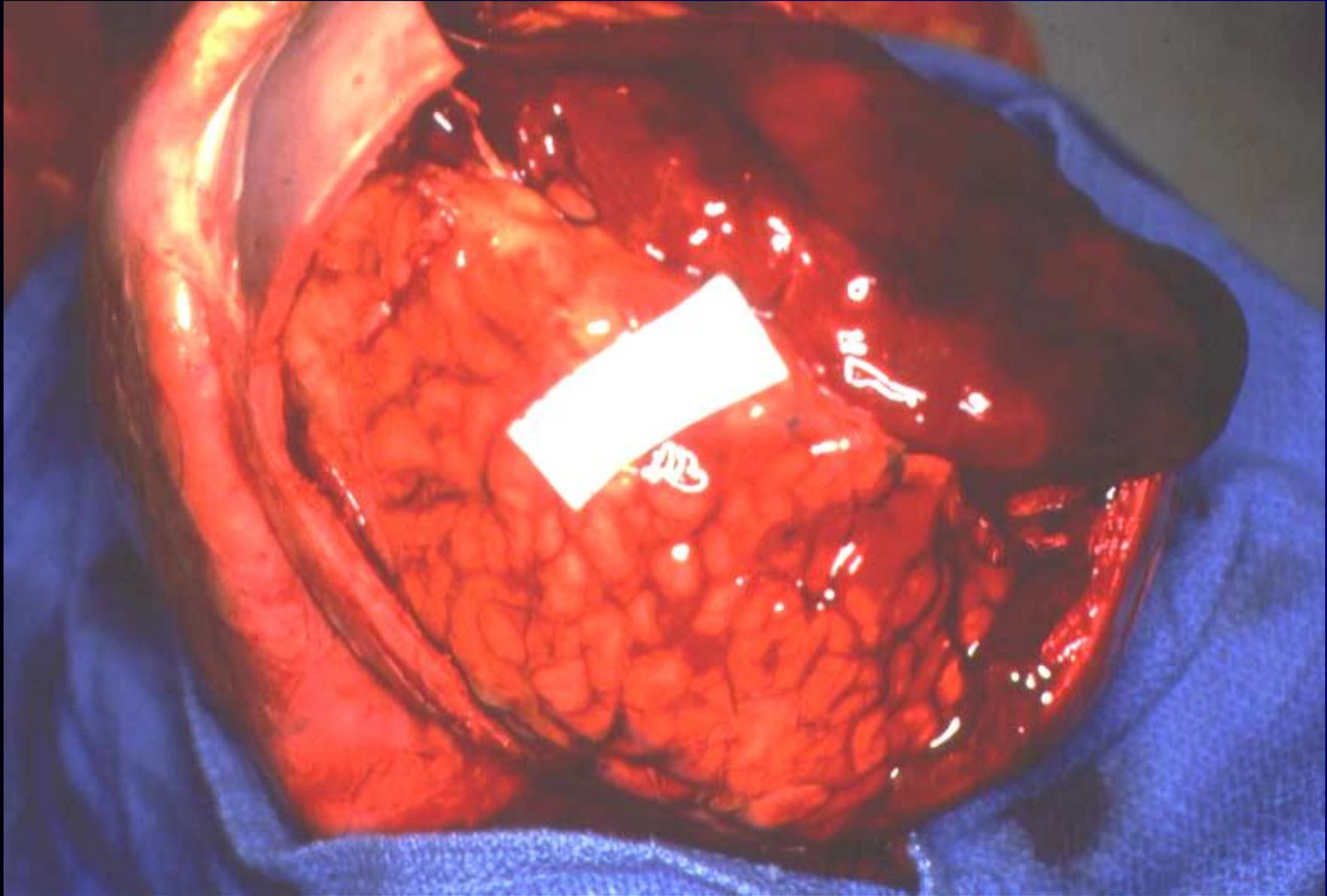
Rotational acceleration and forces with or without impact

- Concussion
- Diffuse axonal injury
- Deep brain hematoma
- Deep brain contusion
- Gliding contusion
- Diffuse subdural hemorrhage
- Subarachnoid hemorrhage

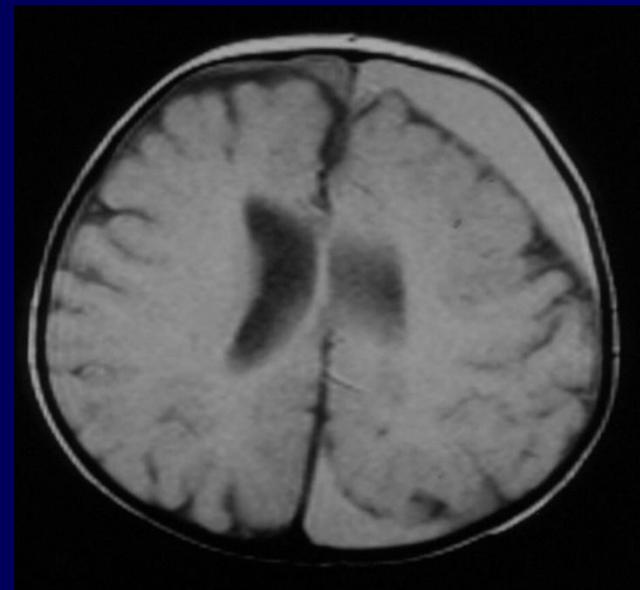
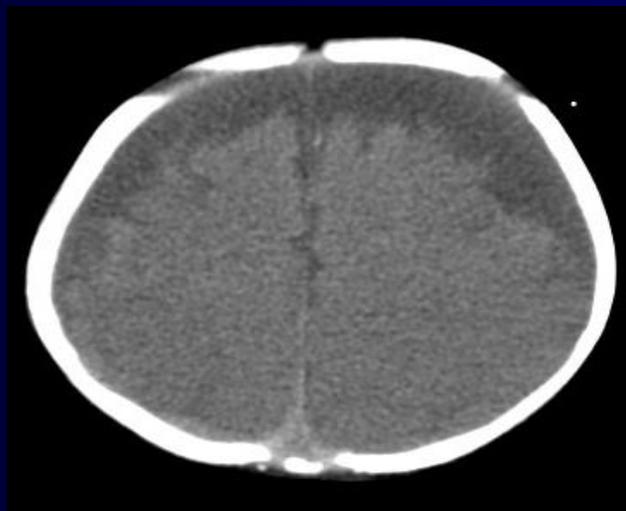
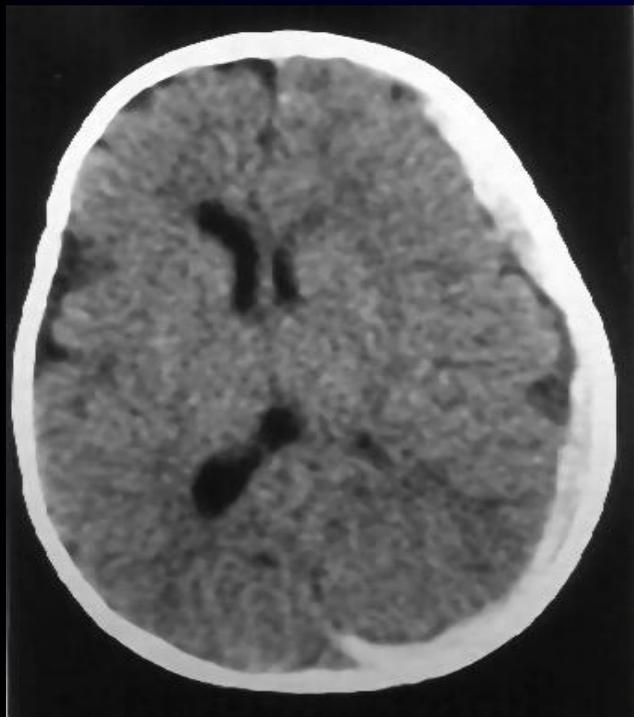
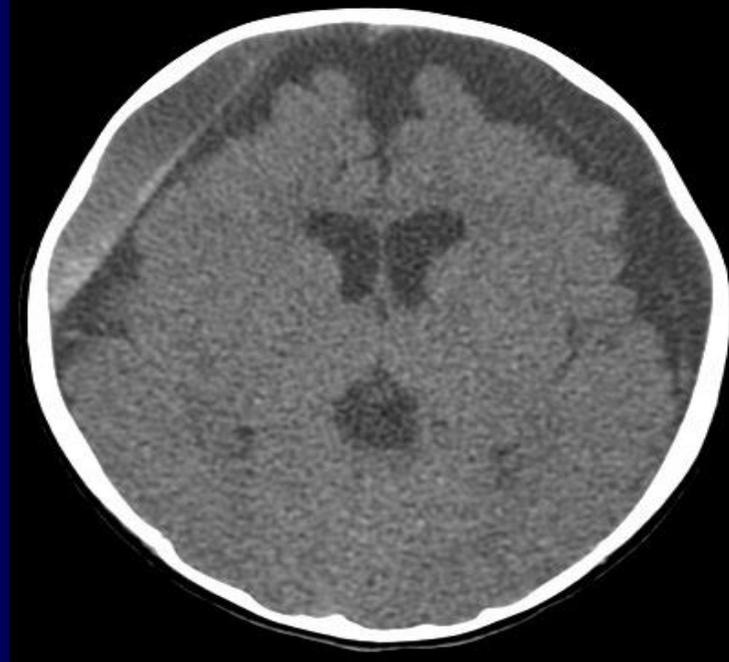
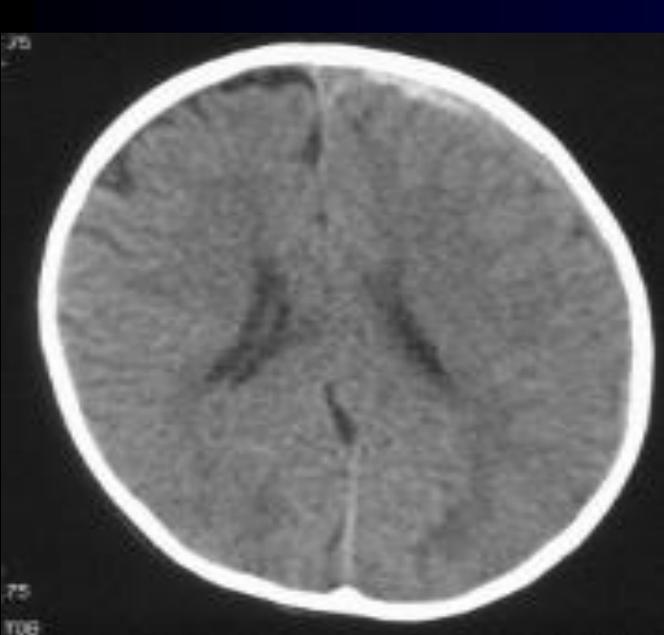
# Subdural Hematoma







Subdural Hematoma



# Diffuse Axonal Injury

- Can be traumatic or ischemic injury
- Brain moves within skull, hemispheres can move independently of each other, gyri can move independently of each other
- Axons stretch and die
- Seen as cerebral edema, petechial hemorrhage, parenchymal tears

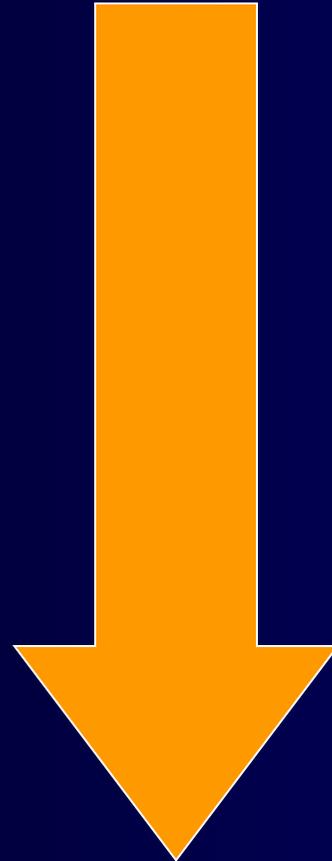
# Spectrum of Axonal Injury

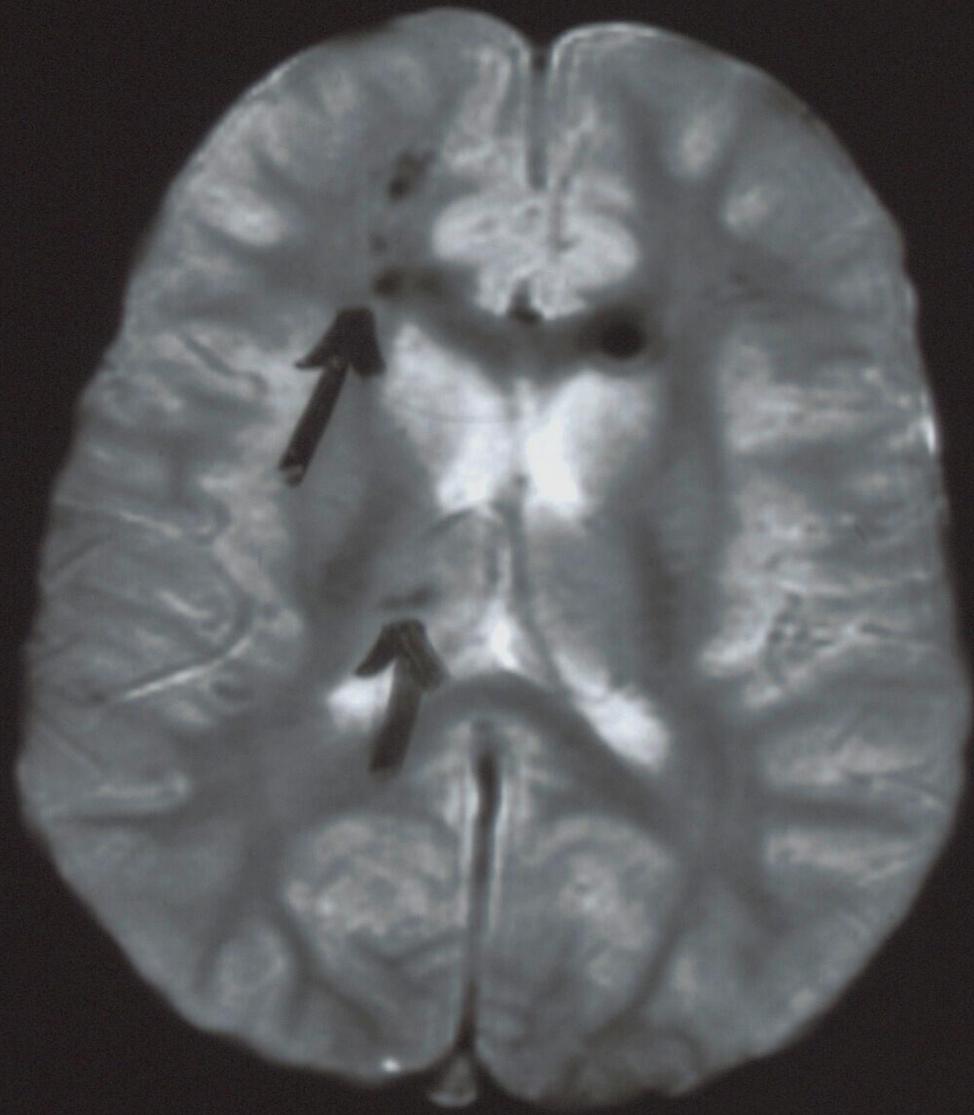
Mild, Reversible

Concussive  
symptoms

Severe,  
Irreversible

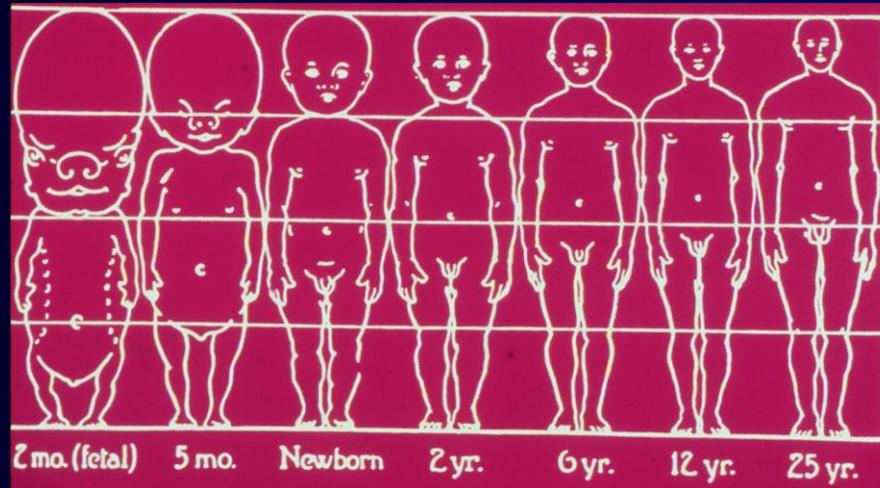
Diffuse axonal injury  
dispersed throughout  
brain and at deepest  
levels





# Pathophysiology

- Vulnerability of infant anatomy
  - large head, brain, subarachnoid spaces; weak neck muscles
  - thin, pliable skull with flat base



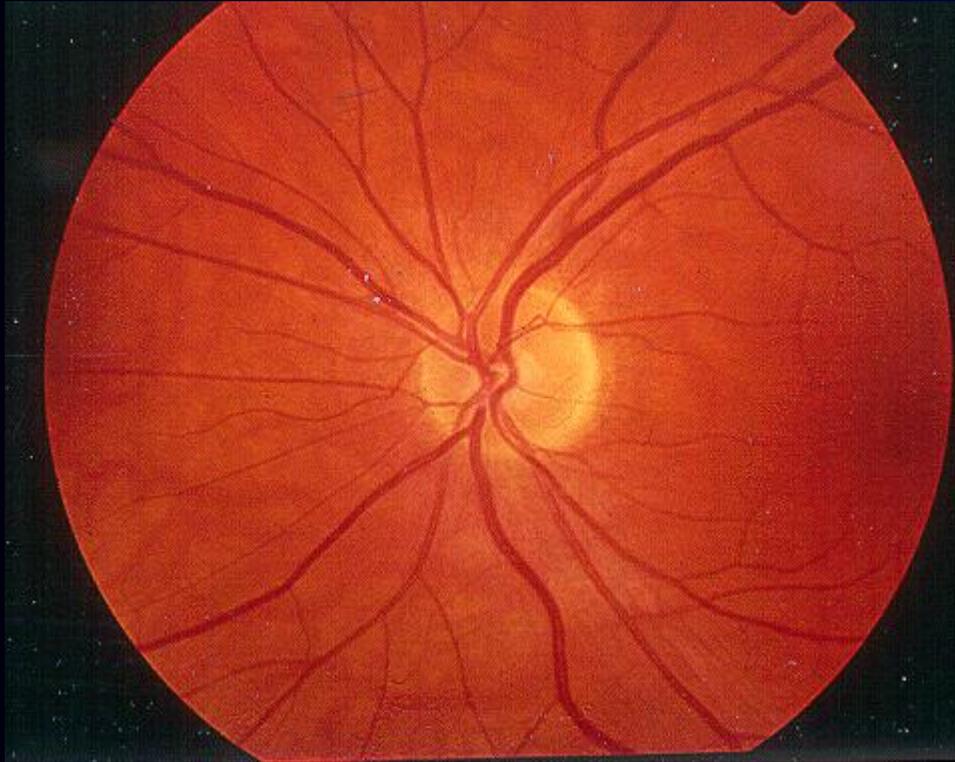
# Primary Brain Injury

- Cortical Injury – contusions, lacerations
- Axonal injury
- Hemorrhage

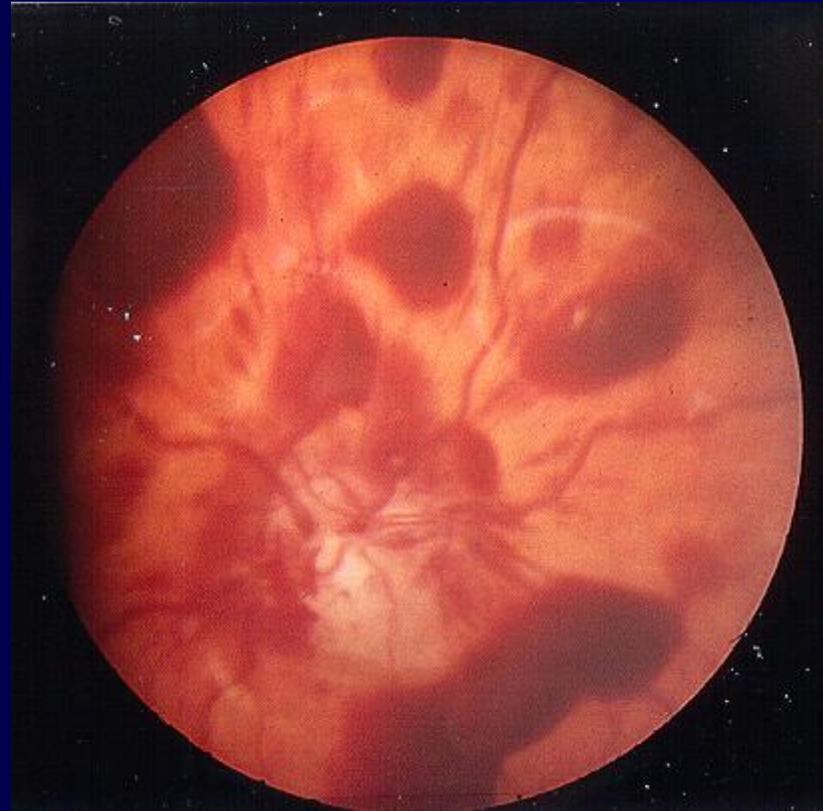
# Secondary Brain Injury

- Hypoxic-Ischemic Encephalopathy
  - Metabolic alterations in ion homeostasis and membrane function
  - Pathologic changes in microvasculature
- Cerebral Edema
  - Leads to increased intracranial pressure, ischemia, herniation
- Altered Neurochemistry
  - Increased release of excitatory amino acids  edema

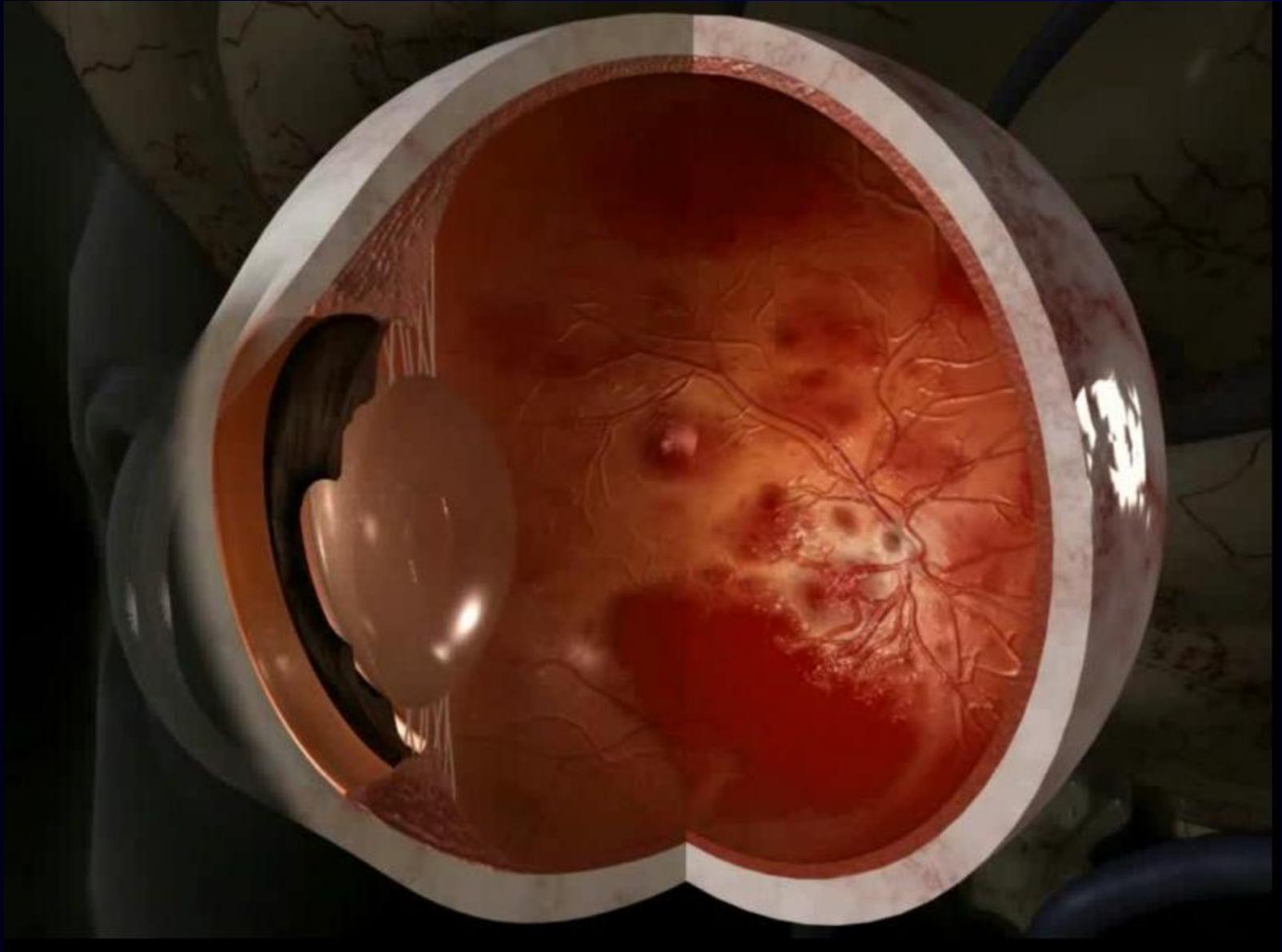
# Retinal Hemorrhages



Normal eye



Retinal hemorrhages



# Retinal Hemorrhages

Severe anterior retinal hemorrhages:

- Are not caused by CPR
- Are not associated with minor injuries

Minor posterior retinal hemorrhages

- Can be seen with birth
- Are seen in a wide variety of illnesses such as meningitis, severe hypertension, sepsis

# Retinal Hemorrhages

- Vitreous traction theory
  - shaking produces traction on the tightly adherent vitreous causing retinal injury

# Retinal Hemorrhages with Accidental Injury

- Johnson 1993 *Neurosurg*: 2/200, both MVA
- Elder 1991 *J Ped Child Health*: 0/25
- Gilliland 1994 *Foren Sci Int*: 2/169, both MVA
- Buys 1992 *Ophthal*: 3/79, all CA
- Duhaime 1992 *Peds*: 10/100, 9 CA, 1 MVA
- Conclusion: RH occur rarely with severe accidental trauma and not at all with trivial trauma

# Site and Extent of RH of AHT

- Posterior pole of retina most common
- Typically in all layers-- but may be just one
- The more extensive RH, the more likely AHT
- But it cannot be said that less extensive RH is less likely to be AHT

# Characterizing Retinal Hemorrhages

- No longer just that they are present
- Location and distribution are becoming increasingly important
- Description of lesions critical
- Dating of hemorrhage is not supported by literature

# Victims of AHT

- Age range 2 weeks to several years
- Average age 6.6 months, median age 5 months
- Slight predominance of male victims
- Death rates equal for males and females

# Diagnostic Criteria

- Radiologic evidence of intracranial injury: bleeding, cerebral edema, ischemia, contusions, skull fractures
- Retinal hemorrhages- bilateral or unilateral
- 50% show associated injuries such as rib or limb fractures, and bruises

# Differential Diagnosis of AHT

- Accidents- falls, other household injury
- Bleeding disorders- factor deficiencies, liver dz., Vit K deficiency
- Metabolic disease- GA1
- Infection- meningitis, encephalitis, sepsis
- Birth trauma
- Intracranial pathology-SA cysts, sinus thrombosis, ruptured AVM, IC tumors

Table 3-4. Falls in Childhood

AUTHOR	CASES	MECHANISM OF INJURY	INJURIES	DEATHS
<b>Short Falls</b>				
Helfer, <i>Pediatrics</i> . 1977;60:533-535.	246	Falls from beds	3 linear skull fractures	No deaths
Nimityongskul, <i>J Pediatr Orthop</i> . 1987;7:184-186.	76	Falls from bed/cribs	97% minor injuries, 1 linear skull fracture	No deaths
Joffe, <i>Pediatrics</i> . 1988;82:457-461.	363	Stairway falls	92% minor injuries, 6% distal fractures, 1 concussion	No deaths
Lyons, <i>Pediatrics</i> . 1993;92:125-127.	207	Witnessed falls from cribs/beds	29 minor injuries, 1 linear skull fracture	No deaths
Chiaviello, <i>Pediatrics</i> . 1994;94:679-681.	69	Stairway falls	78% minor injuries, 11 concussions, 5 skull fractures, 1 SDH who fell with adult	No deaths
Chiaviello, <i>Pediatrics</i> . 1994;93:974-976.	65	Baby walker injuries, 71% stairway falls, 3% falls off porch	Skull fracture, concussion, IC hemorrhage, burns	1, in fall down stairs in walker
<b>Long Falls</b>				
Barlow, <i>J Pediatr Surg</i> . 1983;18:509-511.	70	Falls >1 story (means 2 stories)	10 multiple injuries, 45 single major injuries, 15 minor soft tissue injuries	No deaths
Williams, <i>J Trauma</i> . 1991;31:1350-1352.	106	Witnessed falls 4-70 feet	77 minor injuries, 14 severe injuries (5-40 ft), no lethal injuries <10 feet	1 death at 70 ft
Musemeche, <i>J Trauma</i> . 1991;31:1347-1349.	61	Multiple story falls	39 multiple injuries, 16 single major injuries, 6 minor soft tissue injuries	14 deaths overall, no deaths 3 stories or less, 50% mortality between 5 and 6 floors, >85% mortality over 6 floors
Chadwick, <i>J Trauma</i> . 1991;31:1353-1355.	317	Caregiver-reported deaths from falls 1-45 feet	7 deaths—7/7 SDH, 5/7 retinal hemorrhages, 5/7 other injuries	7 deaths < 4 ft (all histories thought to be false), 0 deaths 4-10 ft, 1 death in 118 falls >10 ft

# Childhood Falls

Starling SP. Head injury in child abuse. In: Giardino ER and Alexander R, eds. *Child Maltreatment: A clinical guide and reference*. GW Medical, 2005

# AHT

Should Be Included in the Differential Dx of:

- - infant vomiting of unknown etiology
- - “flu-like” illnesses in infants
- - fussy infants of unknown etiology
- - atypical “colic”
- - sudden unexplained seizures in a previously healthy infant
- - depressed mental status in infants and small children

# Missed Abusive Head Trauma

Jenny 1999 JAMA

- 173 AHT patients; criteria: seen by MD with SBS symptoms; not diagnosed; later presented for medical care
- 31% unrecognized; most often missed were white children with 2 parents in the home, and milder symptoms
- most often diagnosed with AGE, accidental HI, and rule out sepsis

# Timing of Injury

- Willman 1997 *Child Abuse & Neglect*
  - 94/95 accidental head injury victims had immediate onset of symptoms
- Gennarelli- 1970s and 1980s
  - subhuman primate and human studies
- Starling 1995 *Pediatrics*
  - 36/37 (97%) of confessed perpetrators of AHT are with pts when they become ill
- General time frames
  - radiologic & clinical dating of physical injuries

# Shaking vs Impact

- Duhaime *J Neurosurg* 1987
  - using accelerometers on infant models suggests shaking alone cannot produce sufficient force to cause brain injury
  - found evidence of impact by PE in only 1/2 of fatal cases (n=13), but all had evidence on autopsy
- This theory is disputed by Hadley 1989, Alexander 1990, Pounder 1997- all report shaking cases with no evidence of impact

# Current Defense Theories

- Shaking does not cause injury
- Minor trauma/short fall causes injury; minor unrecognized injury leads to subsequent re-bleed
- Vaccines cause injury
- Undiagnosed illness/birth trauma/metabolic disease in child

# Relationship of Perpetrators to Victims

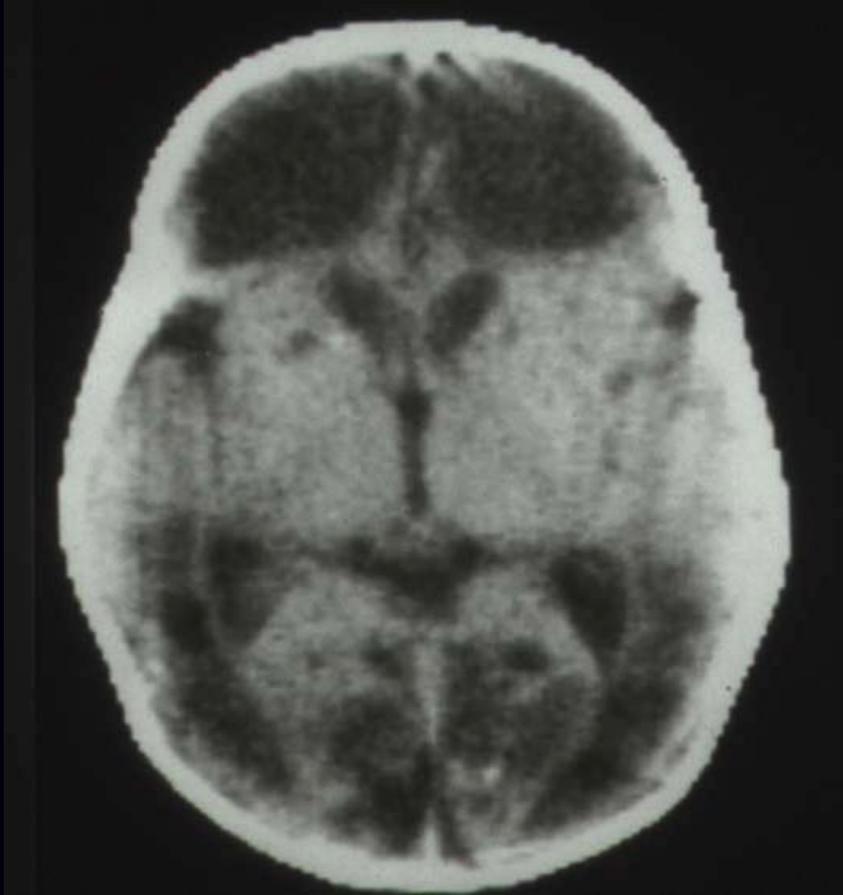
<i>Relationship</i>	<i>Number</i>	<i>Percent</i>
Father	47	37
Boyfriend	26	20.5
Female Babysitter	22	17.3
Mother	16	12.6
Male Babysitter	5	3.9
Step-father	4	3.1
Other	7	5.5
Total	127	100

- Starling SP and Holden JR, *Southern Medical Journal*. 2000
- Starling SP, et al. *Pediatrics*. 1995

# Short-term Outcomes

- Starling 1995 *Pediatrics*
  - 23% die, 55% impaired, 22% good outcome
- Ewing-Cobbs 1998 *Pediatrics*
  - mental deficiencies in 45% of all AHT and only 5% of non-inflicted injury
- Duhaime 1996 *Ped Neurosurg*
  - <1/3 good outcomes, poorest prognosis is ↓ consciousness and bilateral hypodense CTs

# Encephalomalacia



# Long-Term Outcome

<b>Author</b>	<b>Number of patients in series</b>	<b>Age at injury</b>	<b>Age at follow-up</b>	<b>Outcomes</b>
Fischer, 1994	10	Mean 4.1 m	Mean 10.1 yrs (range 8-15 yrs)	7 with impairments, 5/10 hemi- or quadriplegic. 6/10 special education or MR
Bonnier, 1995	12	Mean 5.5 months	7 yrs 2 months (range 4-14 yrs)	6 severely impaired from diagnosis, all with MR and multiple disabilities; 6 with "sign-free interval" at 2 months; 5/6 disabled at 5 years; 1 normal at 5 years

Duhaime, 1996	14	Mean 6.4 m	9.0 yrs (range 5.5-15.5 yrs)	1 died at age 8; 2 normal with regular school; 3 good outcome, but tutors; 2 moderate, with language and motor delay; 6 severe, with 4/6 blind, 5/6 hemiparetic or wheelchair-bound
Haviland, 1997	15	Median 3 m	3 m to 3 yrs	2 died; 7/13 totally dependent; 5/13 moderate handicap (hemiparesis, blindness, DD, seizures); 1 normal at 3 months
Ewing-Cobbs, 1998	20	Mean 10.6 m	1.3 months after injury	3 severe disability (total dependence or severe motor or cognitive disability); 13 moderate (hemiparesis, rehab); 4 good recovery

Gilles, 1998	11	Mean 12 m	17 m after injury (range 5-31 m)	all DD; 10 severe visual impairment; 9 hemi- or quadriparesis; 8 microcephaly
Lowen, 2000	75	Mean 4.7 m	Mean 64.7 months	72% in PT, 66% Special Ed, 59.8% visual impairment, 46.1% not walking, 43.5% seizure disorders, 42.4% sleeping difficulties

# Family's Time Costs

- Managing child's interaction with professionals
- Waiting in professional's offices
- Managing child's finances
- Seeking information about community resources and coordinating community services
- Managing family emotions and psychological responses
- Adapting home, work, and recreational lifestyle patterns

# Family's Time Costs

- Personal care
- Providing medical care
- Monitoring medical and assistive equipment
- Additional shopping or errands
- Additional household chores
- Escorting child to get health care
- Escorting to other childhood activities

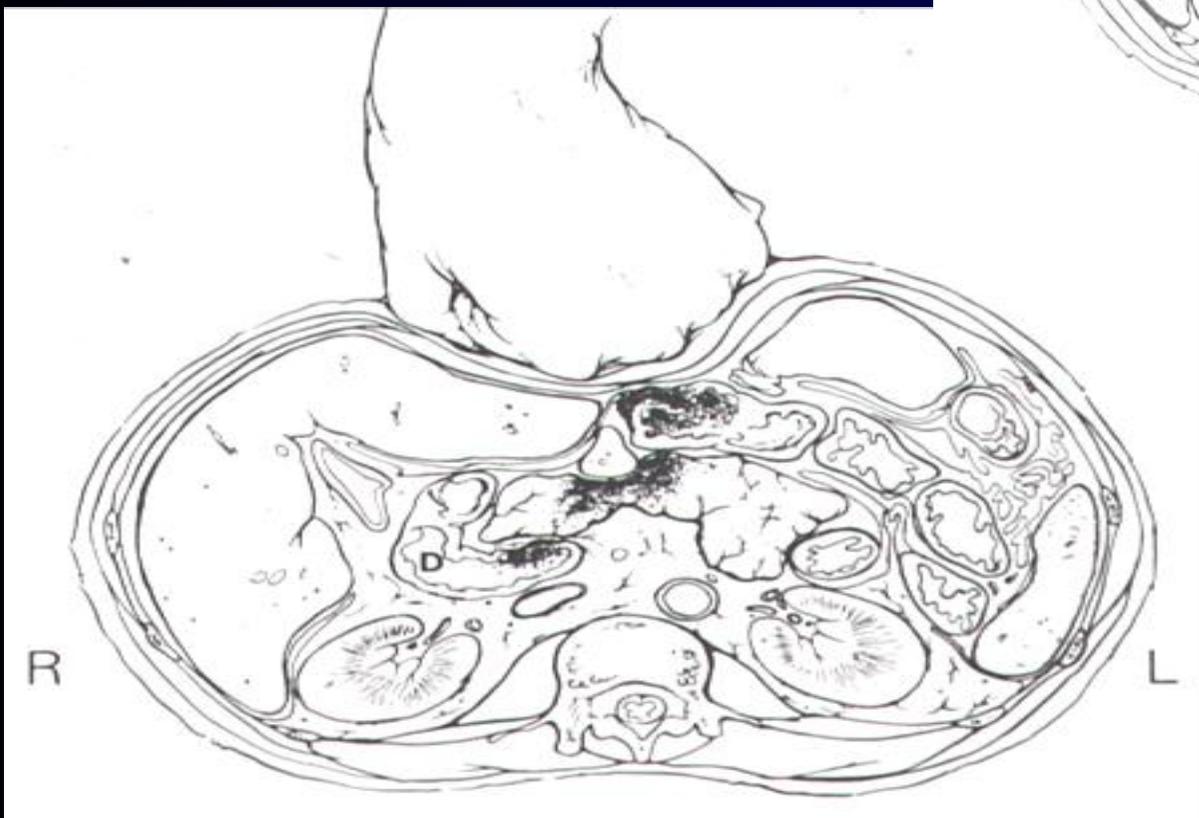
# Family's Out-of-Pocket Costs

- Transportation
- Additional child care, including respite
- Pharmaceuticals not covered by Medicaid or insurance
- Additional rehabilitation
- Additional special education
- Architectural modifications of the home
- Assistive devices
- Day treatment programs

# Unresolved Issues

- How hard must a child be shaken to produce signs and symptoms?
- How many repetitions of shakes are required?
- How little shaking causes learning impairment and behavior problems?
- Is impact really required?

# Inflicted Thoracoabdominal Trauma



# Case

- 18 month old presents to ED with complaint of vomiting & decreased appetite.
- Working diagnosis gastroenteritis
- Oral rehydration instituted & tolerated
- Patient almost ready for discharge
- ED resident does one final examination prior to discharge.

# Case Continued

- On examination, ED resident noticed bruising concerning for physical abuse
- DFCS was contacted secondary to bruising
- Next morning, no vomiting & improved hydration....but 18 month old wouldn't move around the crib.
- Screening liver enzymes obtained

# Case

- AST/ALT each >3000
- Abdominal CT obtained
- Liver laceration identified on CT
- Patient transferred to PICU for further management.
- **TAKE HOME:** A thorough physical examination is important, and signs and symptoms of abuse can be subtle and mimic normal pediatric medical problems.

# Blunt abdominal trauma causes injury by:

Direct blow- disrupts integrity of solid organs

Impingement- hollow organs forced against spine

<b>SOLID</b>	<b>HOLLOW</b>
liver spleen pancreas kidneys	stomach, duodenum, jejunum, small intestine, large intestine, bladder, ureters

\*Large and small blood vessels and nerves supply all of the organs & these are subject to injury as well

# Abdominal Injuries in Child Abuse

- Often delay in presentation
- Presenting complaints: abdominal pain, poor appetite, lethargy, vomiting, shock
- Tenderness, guarding, distention
- May have normal exam

# History:

## Inflicted Abdominal Trauma

- Who, what, when, where
- Description of child's behavior/activities over time is critical
- Onset of symptoms (when last 'normal'?)
- Ask specifics about food intake (what, how much, appetite, vomiting, etc)
- Who has seen child over past few days (can describe child's behavior)?

# Inflicted Abdominal Trauma

- Details of trauma event
  - Forces involved
  - Surface area of contact
  - Witnesses present
  - Child's reaction

# Key Questions to Ask Yourself

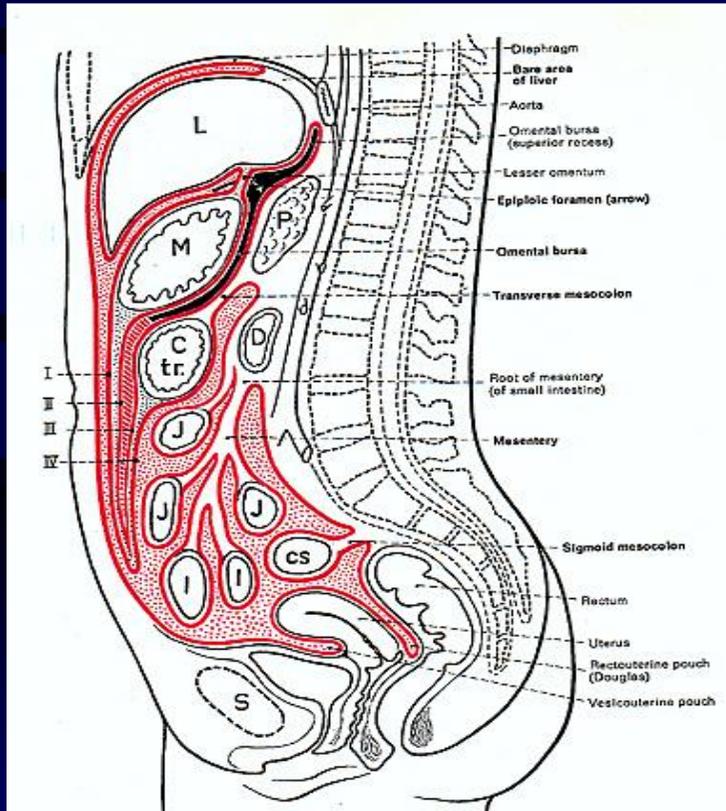
- Is level of child's development consistent with story?
- Does the story change over time, and/or between caregivers?
- Is the history vague, speculative and/or inconsistent?

# Distinguishing Between Accidental and Inflicted Injuries

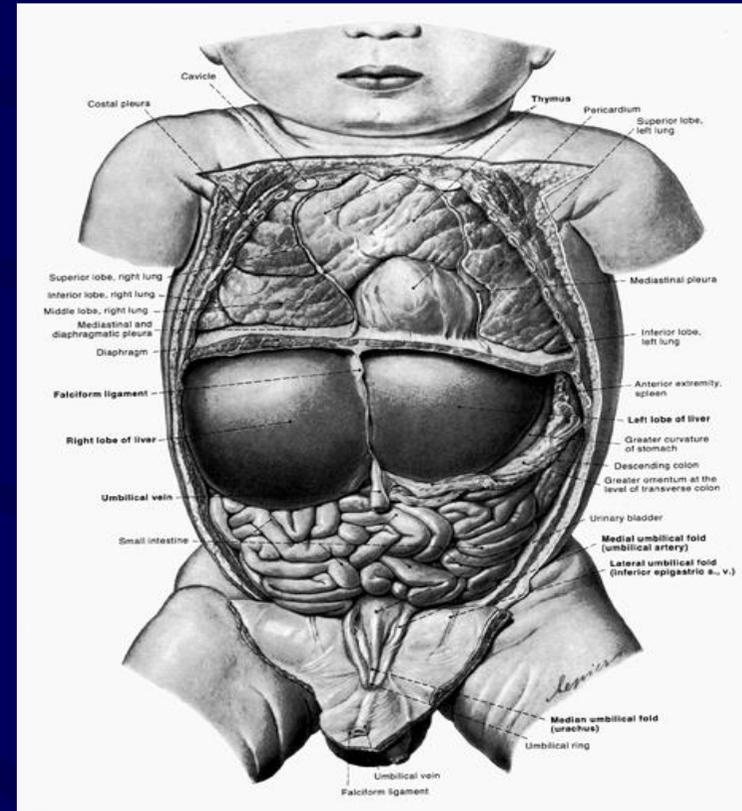
	<u>Accidental</u>	<u>Inflicted</u>
Median Age	7 yrs. 8 mo.	2 yrs. 6 mo.
History	MVA	Discrepant history
Medical Care	Prompt	Delayed
Organ Involved	Solid	Hollow
Mortality Rate	21%	53%

*Ledbetter et al-156 children <13 yrs with abdominal injuries*

# Why kids are vulnerable



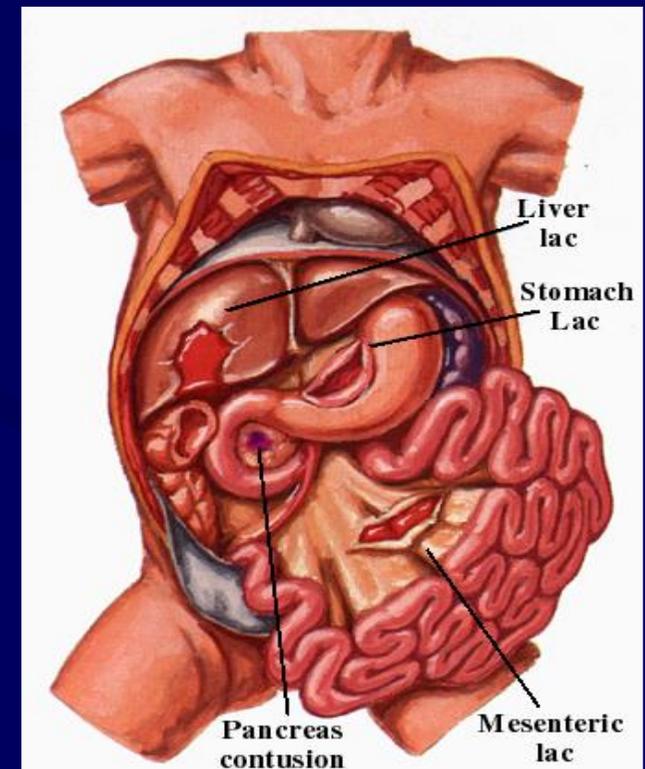
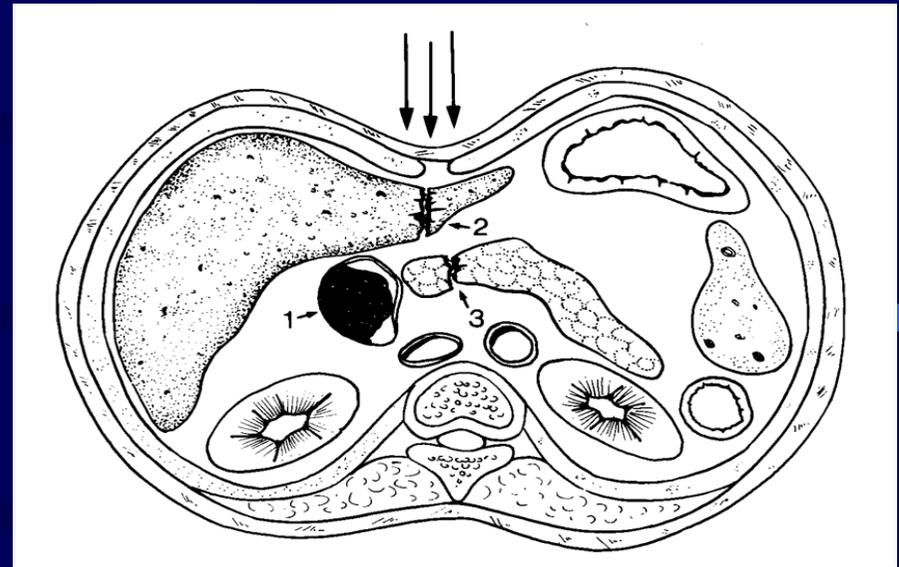
Narrow A-P Diameter



Flared ribs; protuberant organs

# Mechanisms of Injury

- Crushing
- Acc/Dec of mobile structures
- Differential movement within and between structures
- Blow-out



# Abdominal Trauma

- Direct abdominal blows can cause internal injury without external bruising
- Screen suspected trauma with **transaminases, amylase, lipase**
- Consider plain films to rule out free air
- Consider CT/MRI



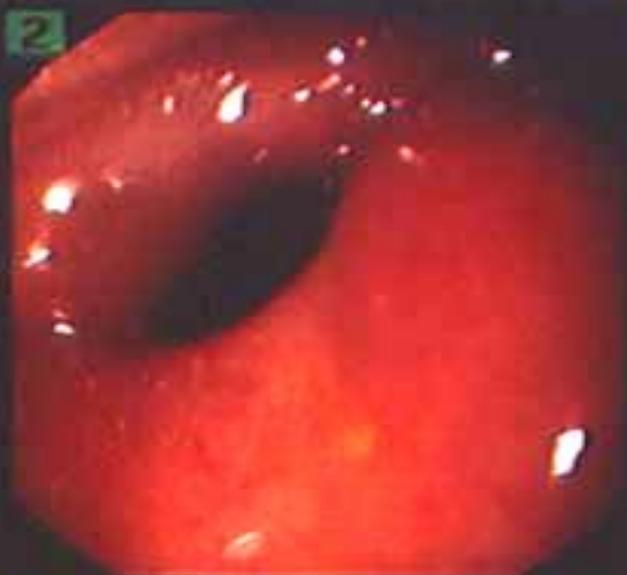
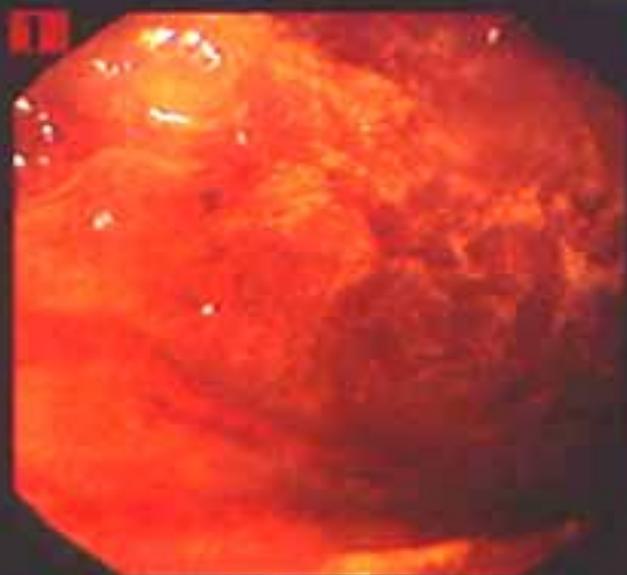




06



# The Children's Hospital



[REDACTED]

449864

Sept 7, 1994



-  Gastritis
-  Gastritis
-  Normal Duodenal Mucosa
-  3RD PORTION OF DUODENUM 86

Endoscopist: Michael R. Narkiewicz MD  
Referring Physician:

# Conclusions

- Abdominal trauma can be subtle and good exam and a detailed history are vital to making the diagnosis.
- Consider screening for abdominal trauma in all suspected abuse cases
- CT/MRI for positive screens and all abdominal bruising

# Questions

- [Tamika.bryant@choa.org](mailto:Tamika.bryant@choa.org)