Head Injury (PEDIATRIC)

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EPIDEMIOLOGY

20% of all TBIs occur in pediatric age group (birth ÷ 17 yrs).

Children have proportionately **more head injuries** than adults!

- males : females = 2 : 1

INCIDENCE

- peaks:
  1) children < 2 yrs - ***falls*** and ***child abuse***.
  2) children 5-7 yrs (often in early afternoon when school is closing) – ***falls*** and ***transportation-related crashes***.
  3) children ≈ 15 years (mainly in males) - ***sports*** and ***driving***.

MORTALITY

Trauma is leading cause of death in children > 1 year.

- head trauma represents 75-97% of pediatric trauma deaths.
- mortality - 29%.

ETIOLOGY

1. **Motor vehicle accidents** (27-37%):
   children aged 5-9 years – pedestrians
   children aged 9-15 years – bicyclist
   young adults aged 15-19 years – passengers and drivers.
2. **Falls** (24%), esp. children < 4 years.
3. **Child abuse** (24-85% patients are < 2 years, i.e. nonambulatory children).
4. **Recreational activities** (21%) have seasonal distribution (peak during spring-summer).
5. **Assault** (10%)
6. **Firearm** (2%).
7. **Birth trauma** (less common now than in past).

PATHOPHYSIOLOGY

More **diffuse injuries**, less **focal injuries***

*emergency burr holes are generally ineffective; only 20% pediatric severe TBI cases are amenable to neurosurgery

- pediatric head is larger (in proportion to body surface area), stability is dependent on ligamentous (rather than bony) structures, poor control of neck muscles, brain has higher water content* (≈ 88% vs. 77% in adult) - pediatric brain is more prone to *acceleration-deceleration injury* (i.e. *diffuse axonal injury* is more frequent, but *intracranial hematomas* are less frequent).

  *water content is inversely related to myelinization process (unmyelinated brain is more susceptible to shear injuries).
- skull is thin and sutures not fused - brain is susceptible to *deformational forces*.
- skull base is smoother - lower incidence of *contrecoup injuries*.
- infants tolerate *ICP increases* better - because of open sutures.
- children often develop **vasodilation*** in minutes ÷ hours following relatively mild head injury → ICP↑ → rapid neurologic deterioration (mimics enlarging intracranial mass); good prognosis with control of intracranial hypertension.

  *CT cannot differentiate this type of swelling from that caused by diffuse axonal injury

CLINICAL FEATURES

- *infants can lose significant blood amount into cranial cavity* (from *intracranial bleeding* or *skull fracture*); blood can seep through fracture and produce large **galeal** or **subperiosteal hematoma**.
- despite apparently trivial trauma, children may appear pale, lethargic, and have emesis (it is not a sign of ICP↑), headaches, dizziness.
- difficult to obtain accurate neurologic examination.
- early posttraumatic seizures are more common.

DIAGNOSIS

Special indications for **skull X-ray** in pediatric patients → see p. TrH1 >>

TREATMENT

- infants and children often secrete increased amount of ADH after head injury - mild fluid restriction is appropriate (provided there is no hypotension).

HYPOTHERMIA

- *not recommended*: no benefit, plus, may increase the risk of mortality and arrhythmia

Zhang BF "Meta-Analysis of the Efficacy and Safety of Therapeutic Hypothermia in Children with Acute Traumatic Brain Injury" World Neurosurg. 2015 Apr;83(4):567-573
Meta-analysis showed therapeutic hypothermia could increase mortality compared with the normothermia group (RR = 1.84, P = 0.01).
GOS scores did not differ between the hypothermia and normothermia groups.
Hypothermia did not increase the rate of pneumonia (RR = 0.84, 95% CI = 0.63-1.12, P = 0.23) or bleeding (RR = 0.94, 95% CI = 0.39-2.26, P = 0.89), but incidence of arrhythmias was higher (RR = 2.60, 95% CI = 1.06-6.41, P = 0.04).

PROGNOSIS

Much lower morbidity and mortality (than in adults)! – children demand aggressive approach!

- pediatric brain is more "plastic" - if child recovers from coma within 14 days, likelihood of (near-) normal cognitive and neuromotor function is extremely favorable.
- recovery in children takes longer (vs. adults - reach maximum recovery by about 6 months). Prolonged rehabilitation, particularly in cognitive and emotional areas, is often required!

N.B. *infants < 2 yrs* with severe TBI have uniformly poor prognosis:

1) immature autoregulation
2) incompletely myelinated brain (early head injuries impair ability for new learning → mental retardation)
3) open cranial sutures permit greater distortion among meninges, cerebral vessels, and underlying brain.

SPECIAL SITUATIONS

"SHAKEN BABY" SYNDROME

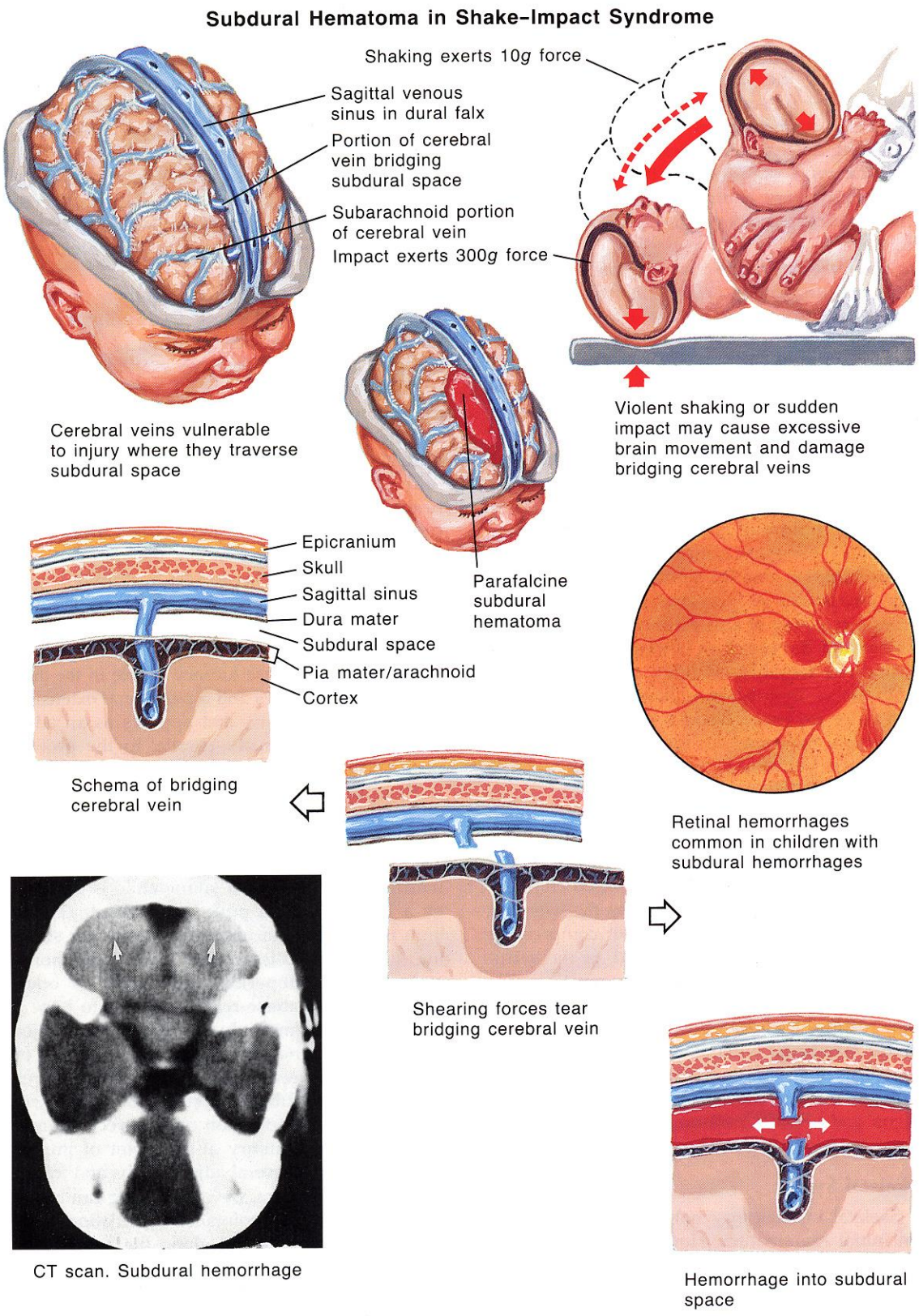
- infant is held by shoulders (or grasped around chest by 2 hands) and violently shaken → typical acceleration-deceleration injury:

Neurologic damage + minimal external signs of trauma + no explanatory severe trauma!

1. **SAH**
2. **Subdural hematomas**, esp. posterior interhemispheric & tentorial (repeated abuse → hematomas of different ages – seen as heterogeneous subdural accumulations).
3. **Cerebral contusions** and **shearing injures** (diffuse cerebral swelling with absent differentiation between white and grey matter - may be refractory to medical management; after 2–3 weeks significant atrophy, multicystic encephalomalacia develops → severe mental / motor disability → severe microcephaly).
4. **Retinal hemorrhages** (bilateral) in absence of coagulopathy - most specific sign of shaken baby syndrome!!!; intraretinal, preretinal, or vitreal; funduscopy should be performed quickly in any child with suspected child abuse before retinal hemorrhages disappear (flame-shaped hemorrhage disappears within few days; round intraretinal hemorrhage may last 2 weeks); retinal hemorrhages also may occur from childbirth and persist for up to 4 wk!

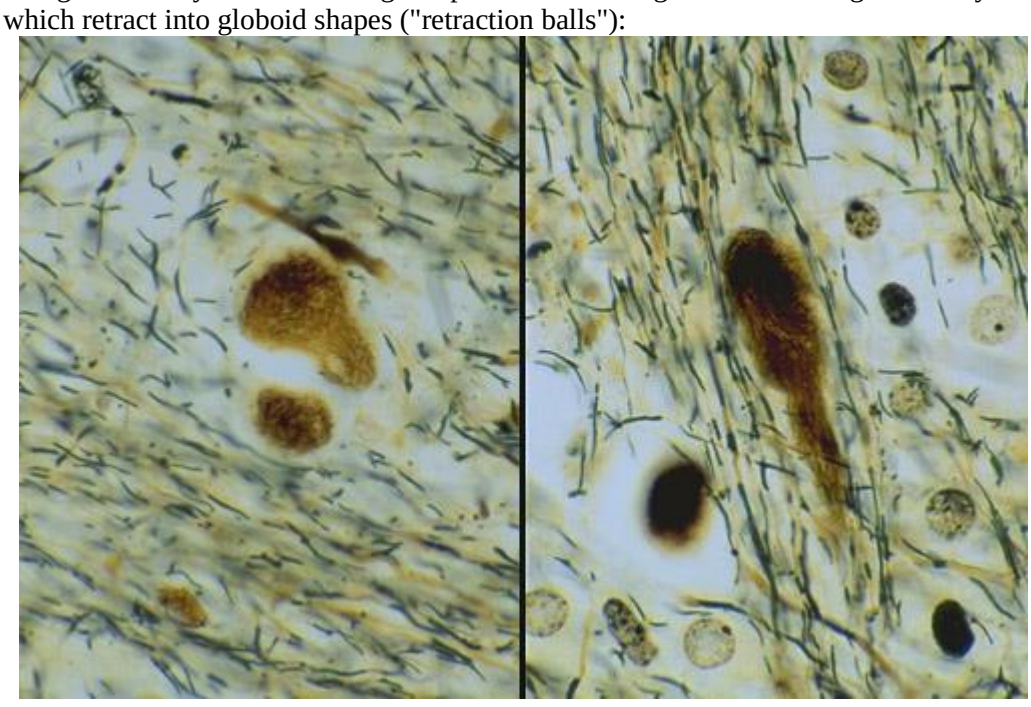
– *falls from < 3 feet* are insufficient to explain such injuries!
– ***skull fractures*** cannot occur with shaking!
– recent studies have shown that *simple act of shaking is insufficient to cause subdural hematoma* (these children probably sustain deceleration injury when they are slammed onto surface, even padded surface - **SHAKING-IMPACT SYNDROME**).
– skeletal fractures (metaphyseal, posterior rib) occur while child is shaken violently in to-and-fro fashion.

- presents as infant (usually < 1 yr old) with seizures, lethargy, apneic spell or becoming suddenly 'unconscious'.
- history is often confusing and inconsistent; often frequent visits to doctors because of irritability, feeding problems, vomiting or symptoms of encephalopathy.
- careful systemic survey for evidence of other injuries (e.g. skin bruising); injuries caused by choking, squeezing, and throwing are often associated.
- perform **X-ray**: see p. Ped3 >>
  skull - look for unexplained skull fractures: multiple (involving > 1 bone), bilateral, non-parietal, old (esp. leptomeningeal cysts).
  N.B. ***accidental falls*** cause single, narrow, linear fractures, most commonly in parietal bone!
  for children < 2 years, **skeletal survey** is recommended (look for old fractures); **isotopic bone scans** may be useful.
- victim child is often brought to medical attention in delayed fashion → ≈ 25% mortality!
- refer to proper child welfare agency.

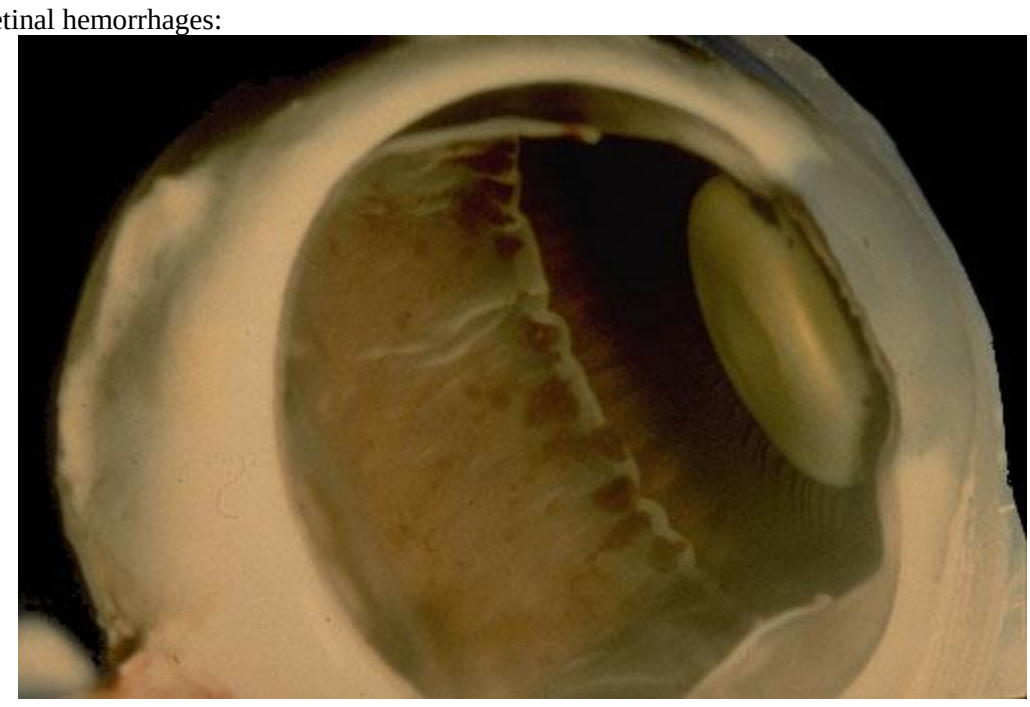


Source of picture: Frank H. Netter "Clinical Symposia"; Ciba Pharmaceutical Company; Saunders >>

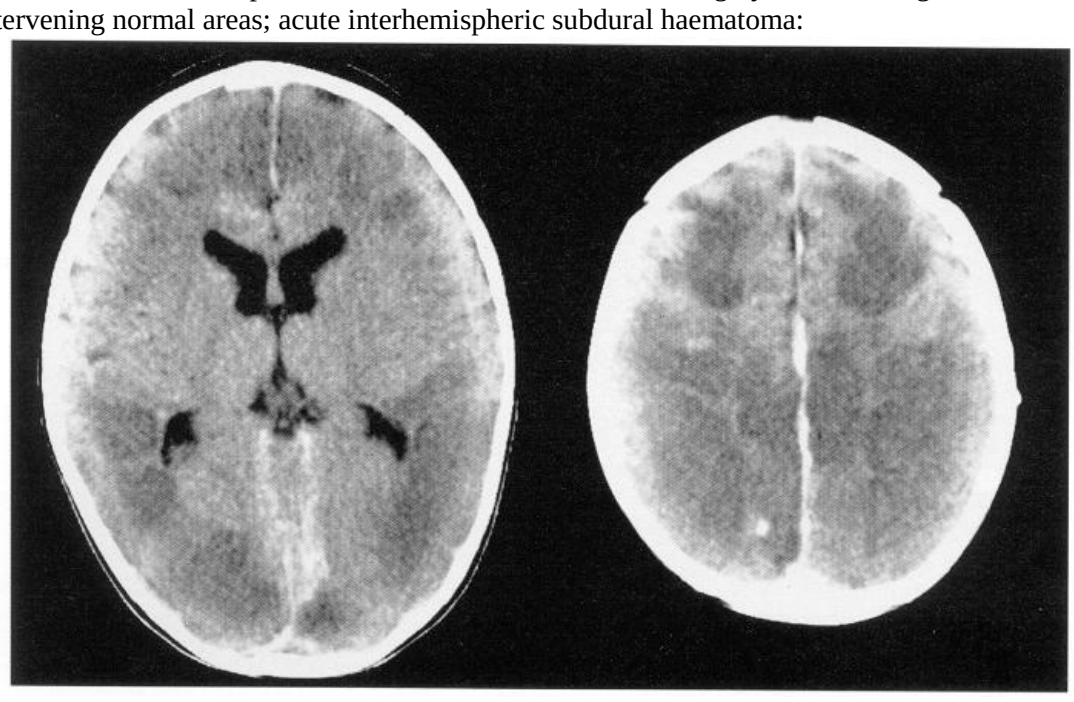
Forces generated by violent shaking can produce stretching of axons; strong force may shear off axons, ends of which retract into globoid shapes ("retraction balls"):



Retinal hemorrhages:



Axial noncontrast CT - poor differentiation between white and grey matter in large areas of brain with intervening normal areas; acute interhemispheric subdural haematoma:



Axial noncontrast CT - large amount of acute subdural hemorrhage, both between hemispheres and over convexities; diminished density and loss of gray-white differentiation in left hemisphere is because of

associated hypoxic-ischemic injury:

BIBLIOGRAPHY for ch. "Head Trauma" → follow this LINK >>