NOTES
HEAD INJURY

GENERALLY, WHAT IS IT?

PATHOLOGY & CAUSES

- External force to head → brain injury (stretching, compression, impact, rotational) → cellular dysfunction

SIGNS & SYMPTOMS

- Mental-status change
- Consciousness loss
- Headache
- Irritability
- Lethargy
- Vomiting
- Seizure

DIAGNOSIS

DIAGNOSTIC IMAGING

- Concussion
  - Neuro-imaging rules out more extensive injury
- Shaken baby syndrome
  - Fundoscopy (retinal hemorrhage), neuro-imaging reveals characteristic intracranial injury (intracranial hemorrhage, edema)

OTHER DIAGNOSTICS

- Concussion
  - Functional assessment

TREATMENT

SURGERY

- Significant injury
  - Drain ventricle if needed
  - Drain intracranial hemorrhage if required

OTHER INTERVENTIONS

- Mild injury
  - Rest
- Significant injury
  - Monitor intracranial pressure (ICP)

CONCUSSION

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PATHOLOGY & CAUSES

- AKA mild traumatic brain injury
- Direct blow to head, face, neck, other body part transmitting to head → acute, mildly traumatic brain injury → mental status alteration, potential consciousness loss
- Concussion alters cellular functioning
  - Physical trauma → nerve cell membrane disruption → intracellular ion migration (potassium, calcium) to extracellular space → unregulated glutamate release → depolarization
  - Ion shifts at axon level/axonal rupture → disrupted cellular oxidative metabolism → cell death → functional disturbance → temporary (normal function) brain impairment
  - Ion regulation loss → ↑ membrane pump activity (e.g. sodium-potassium ion channels) → ↑ ATP, glucose utilization
  - Paradoxical ↓ cerebral blood flow → cellular energy crisis → susceptible ↑ further injury
  - Excitatory neurotransmitters released (e.g. acetylcholine, glutamate, aspartate) + free-radical generation generation → secondary injury
  - Initial ↑ glucose utilisation → ↓ energy-use metabolic state; neuronal suppression may persist weeks post-injury

CAUSES

- Traumatic head injury (e.g. motor vehicle crash, combat, contact sport)
- Force transmission (head/body injury) → diffuse neuronal-level brain injury → temporary (reversible) brain-function loss → mental status alteration, +/- consciousness loss with little/no resultant imaging change
- Coup-contrecoup injury
  - *Coup injury:* compressive force at impact point → brain injury at contact point
  - *Contrecoup injury:* brain may collide with skull opposite initial impact sight during rebound
- Torque injury
  - Rotational force → different rotational velocity dependent on variable distance from rotation's center, differing grey/white matter density → neuron stretching (more severe injury → shearing)
  - Brain regions most affected: midbrain, diencephalon
  - Injury disrupts normal cellular activity in reticular activating system → consciousness loss

RISK FACTORS

- Biologically-male
- Contact sport, cycling injury, combat-related traumatic brain injury (TBI)
- Hospital-admission history (intoxication-related)
- Low socioeconomic status
- Lower cognitive function

COMPLICATIONS

- Seizure, intracranial hemorrhage, skull fracture, dementia pugilistica, ↑ further concussion risk
- Second-impact syndrome (SIS)
  - Further head injury (post-concussion period) during ↓ blood supply → rapid cerebral edema
- Postconcussive syndrome (PCS)
  - Persistent post-concussive neurocognitive symptoms
- Repeated concussion → ↑ later-life risk of chronic traumatic encephalopathy (tau protein accumulation in neurons → neuronal death → brain atrophy), Parkinson's disease, depression

SIGNS & SYMPTOMS

- Develop after initial injury, may continue developing days afterwards
- Physical
  - Headache; dizziness; vomiting; nausea; concussive convulsion (immediately post-injury); light/sound sensitivity; tinnitus; cranial nerve impairment (extraocular muscle weakness, vertigo, nystagmus); incoordination
- Cognitive
  - Blunted affect, confusion, difficulty focusing attention, consciousness loss, pre-/post-traumatic amnesia, sleeping-pattern change, slow answering questions, memory deficit
- Emotional
  - Irritability, anhedonia, tearfulness, restlessness

DIAGNOSIS

DIAGNOSTIC IMAGING

Contrast-CT scan/MRI

- Concussion → normal findings without other injury
- Contusion, hemorrhage → abnormality

OTHER DIAGNOSTICS

Diagnostic criteria

- *Consciousness loss:* < 30 minutes
- *Memory loss:* < 24 hours
- *Glasgow Coma Scale:* score 13–15 (eye opening, verbal/motor/orientation response)
- More severe symptoms → moderate/severe traumatic brain injury

Neuropsychological testing

- Assess functional impairment (also assesses recovery)
  - Standardized Assessment of Concussion (SAC)
  - Post-Concussion Symptom Scale and Graded Symptom Checklist
  - Sport Concussion Assessment Tool (SCAT5)
  - Westmead post-traumatic amnesia scale

TREATMENT

MEDICATIONS

- Analgesia
  - Paracetamol, NSAIDS
  - Avoid narcotics (prevent further consciousness-clouding)

OTHER INTERVENTIONS

- Physical, cognitive rest (1–2 days) → gradual full-function return
  - Delay return to contact sport until complete symptom resolution
- 24 hour observation period for neurological deterioration (diagnostic findings → outpatient/in-hospital)
- Functional single concussion recovery (usually 48–72 hours), headaches (over 2–4 weeks)

SHAKEN BABY SYNDROME

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PATHOLOGY & CAUSES

- AKA abusive head trauma/shaking-impact syndrome
- Child head injury caused by another person
- Traumatic shaking → child's head flung violently back/forth (may strike surrounding surfaces/objects) → acceleration–deceleration, rotational force → bridging vessels tear (subdural hematoma), diffuse axonal injury, oxygen deprivation, brain swelling, ↑ ICP
- Infant anatomy → ↑ neurological-injury risk from shaking
  - Large head:body ratio, weak cervical paraspinal muscles → acceleration-deceleration force movement
  - Thin, pliable infant skull → ↑ force transfer across subarachnoid space
  - Relatively flat skull base → ↑ brain movement with deceleration force
  - Soft infant brain (↑ water content compared to adult), incompletely-myelinated infant neurons → ↓ blood flow autoregulation

RISK FACTORS

- Age (often first year of life), abusive caregiver; caregivers hold unrealistic expectations of child; emotional stress; aggression; biological sex (male > female); perinatal illness (e.g. premature birth, difficult labor, hospitalization, congenital conditions); incessant crying
- Family/individual factors
  - Family dysfunction history (abuse, neglect; domestic violence; drug/alcohol abuse)
  - Young/single parent, parental depression, low socioeconomic status (financial stress), limited education, biologically-male > -female (stepfather/maternal boyfriend)

COMPLICATIONS

- Retinal hemorrhage (diffuse, multilayered); subdural hemorrhage; diffuse brain injury; global hypoxia, ischemia; increased intracranial pressure, herniation; skull fracture; spinal cord/paraspinal injury; hemorrhagic shock open fontanelle, (cranial sutures allow large blood accumulation)

SIGNS & SYMPTOMS

- Trauma signs may be invisible
- Retinal hemorrhage; long bone, rib fracture; soft-tissue scalp swelling; bruising; irritability; poor feeding; lethargy, coma; vomiting; seizure; bulging fontanel (↑ ICP)
- Late, severe neurologic deterioration signs
  - Bradycardia, pupillary change

DIAGNOSIS

DIAGNOSTIC IMAGING

Brain CT scan/MRI

- Intracranial hemorrhage
  - Hematoma; subarachnoid, subdural (most common), epidural hemorrhage; intraparenchymal bleeding
- Cerebral contusion/edema
- Uncal, subfalcine, transtentorial herniation
- Hypoxia/ischemia
  - Loss of grey-white distinctions
- Skull fracture
- Appendicular, axial skeleton survey
  - Detects additional injuries

Fundoscopy

- Retinal hemorrhage (before intracranial pathology evident)

X-ray

- Limb X-ray → metaphyseal fractures
- Chest X-ray → rib fractures

OTHER DIAGNOSTICS

- Diagnostic triad
  - Subdural, subarachnoid hemorrhage
  - Metaphyseal fractures (extremities flail uncontrollably during shaking)
  - Retinal hemorrhage

TREATMENT

SURGERY

- Monitor ICP → cerebral ventricle drainage may be required
- Intracranial hematoma → drain blood collection (when indicated)

OTHER INTERVENTIONS

- Many countries have mandatory suspected child abuse reporting laws → report incident

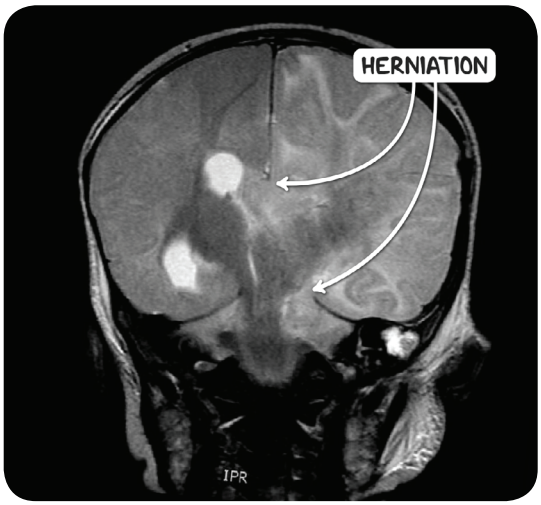

Figure 78.1 An MRI scan in the coronal plane of an three month old female with head injury secondary to abuse. There is intraparenchymal hemorrhage as well as sub-falcine and transtentorial herniation of the brain.