NOTES
INCREASED INTRACRANIAL PRESSURE

GENERALLY, WHAT IS IT?

PATHOLOGY & CAUSES

- Abnormal ↑ intracranial pressure
  - *Normal:* 10–15mmHg (adults); 5–20mmHg (infants)

Monro-Kellie hypothesis

- Fixed cranial volume in skull
- Three main components
  - Cerebrospinal fluid (CSF), blood, brain tissue

Intracranial compliance (ICC)

- Changes in intracranial content volume and changes in intracranial pressure (ICP)
- Slight ↑ volume → compensatory mechanisms → slight ↑ ICP
  - CSF displacement into thecal sac
  - Venoconstriction/extracranial drainage → ↓ cerebral venous blood volume
- Drastic volume increase → ↓ ICC → ↑ ICP

↑ ICP

- → compression of blood vessels → ↓ brain perfusion → brain ischemia → edema → ↑↑ ICP
  - Cerebral perfusion pressure (CPP) = mean arterial pressure (MAP)–ICP
  - ↓ CPP → ↑ systemic blood pressure/vasodilation → ↑ cerebral blood volume → ↑ ICP → ↓ ↓ CPP

Nerve compression

- → impaired brain function

CAUSES

- Cerebral edema (e.g. acute hypoxic ischemic encephalopathy, trauma)
- Intracranial space occupying lesion (e.g. tumor, aneurysm, hemorrhage, etc.)
- ↑ CSF production
- Obstructive hydrocephalus
- ↓ CSF absorption
- Venous outflow obstruction
- Idiopathic intracranial hypertension

SIGNS & SYMPTOMS

- Deteriorating level of consciousness (early sign)
- Headache
- Nausea
- Vomiting
- Ocular palsies
- Mydriasis (dilated pupils)
- Papilledema
- Dyspnea
- Back pain
- Decorticate/decerebrate posturing

DIAGNOSIS

DIAGNOSTIC IMAGING

CT scan

- Mass lesions, midline shift, basilar cisterns effacement

OTHER DIAGNOSTICS

- ICP monitoring
  - Intraventricular catheter (gold standard)
  - Intraparenchymal fiberoptic catheter

TREATMENT

MEDICATIONS

- Sedation (propofol), osmotic diuretics, prophylactic anticonvulsants

SURGERY

- Surgical removal of space-occupying lesion
- Decompressive craniectomy
- Extraventricular drain (EVD)

OTHER INTERVENTIONS

- Target → ICP < 20mmHg, MAP > 90mmHg, CPP > 65mmHg
- Elevate head (30°) → maximize venous outflow
- Airway, breathing, and circulation (ABCs), maintain adequate oxygenation
- *Treat shock (if applicable):* hypertonic saline (HTS) (e.g 7.5%) to treat edema; HTS maintains high serum osmolality → reduces cerebral edema (> 280 mOsm/L); ↑ serum osmolarity prevents intravascular fluid leakage to brain tissue; ↑ serum osmolarity draws excess water from brain tissue → ↓ ICP
- Hyperventilation

BRAIN HERNIATION

osms.it/brain-herniation

PATHOLOGY & CAUSES

- Brain tissue displacement: through skull opening or dural fold
- Damages associated with herniated section

TYPES

Supratentorial herniation

- Cingulate/subfalcine
  - Gyrus forced under falx cerebri → cerebral artery compression → cerebral ischemia then edema → ↑ ICP
- Uncal/transtentorial
  - Cranial nerve (CN) compression in nerves III, IV, posterior cerebral artery → ipsilateral visual cortex ischemia → homonymous hemianopsia
- Central
  - Temporal lobes squeezed through notch in tentorium cerebelli → basilar artery stretched → tearing, bleeding (Duret hemorrhage)
- Transcalvarial
  - Brain herniates through fracture/surgical site (craniectomy) → decortication of herniated gyrus

Infratentorial herniation

- Tonsillar
  - Cerebellar tonsils herniate in foramen magnum → brainstem, spinal cord compression

CAUSES

- ↑ ICP

SIGNS & SYMPTOMS

- Decorticate/decerebrate posturing
- Seizures
- ↓ level of consciousness, coma
- Glasgow Coma Scale (GCS) 3–5
- Mydriasis (dilated pupils)
- Irregular/slow pulse
- Respiratory/cardiac arrest
- Loss of brainstem reflexes (blinking, gagging, pupillary reflex)

DIAGNOSIS

DIAGNOSTIC IMAGING

Head CT scan/MRI

- Depending on the cause, results show mass lesions (e.g. tumor, aneurysm, infarction, hemorrhage etc.) and subsequent displacement of the brain away from the mass, depending on localization

TREATMENT

MEDICATIONS

- Osmotic diuretics
- Paracetamol (manage fever)
- Sedation/paralytic agents
- ↓ metabolism → ↓ O_2 consumption + ↓ CO_2 production → no systemic vasodilation → ↓ cerebral blood volume → ↓ ICP
- Prophylactic anticonvulsants

SURGERY

- Decompressive craniectomy

OTHER INTERVENTIONS

- HTS boluses → support circulation
  - HTS → ↑ serum osmolarity → draw excess water from brain tissue → ↓ ICP
- Hyperventilation
  - Helps avoid ↑ $PaCO_2$ or hypoxemia → systemic vasodilation → ↑ ↑ cerebral blood volume → ↑ ICP

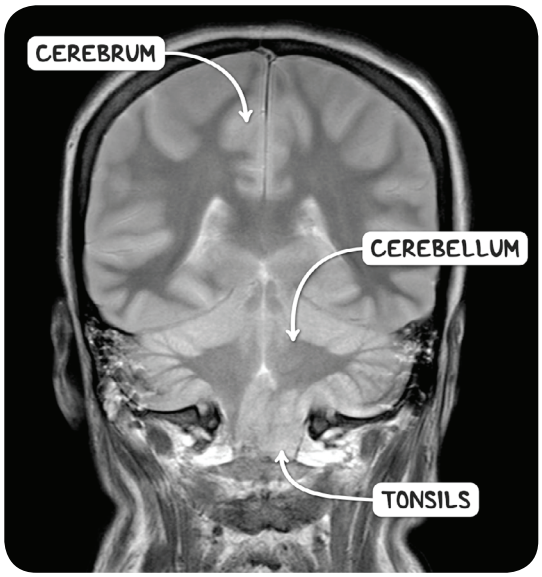

Figure 81.1 An MRI scan of the head in the coronal plane demonstrating herniation of the cerebellar tonsils secondary to hypoxic brain injury.

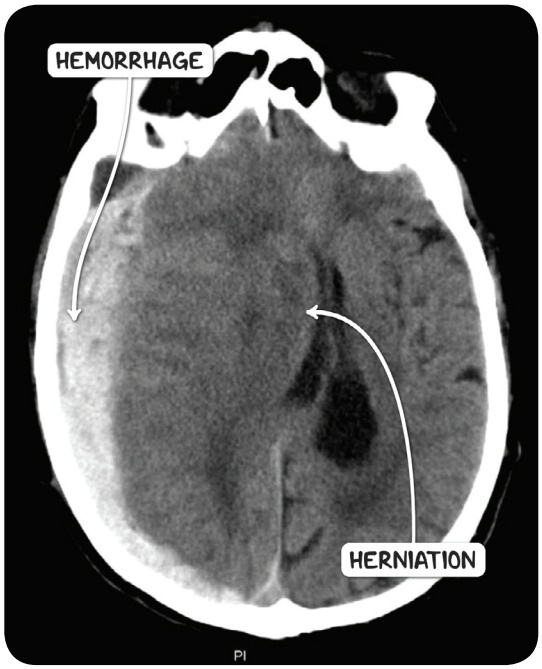

Figure 81.2 A CT scan of the head in the axial plane demonstrating a right sided acute subdural hemorrhage. The pressure effect has pushed the medial aspect of the right cerebral hemisphere underneath the falx cerebri, known as sub-falcine herniation.

IDIOPATHIC INTRACRANIAL HYPERTENSION (IIH)

osms.it/idiopathic-intracranial-hypertension

PATHOLOGY & CAUSES

- AKA pseudotumor cerebri
- Chronic ↑ ICP, no obvious cause

CAUSES

- ↑ ICP → CN II compression → visual impairment

RISK FACTORS

- Overweight, biologically female, fertile individuals

SIGNS & SYMPTOMS

- Papilledema
- Visual field loss
- CN palsies, typically CN VI (long intracranial course)
- Headache
- Pulsatile tinnitus
- Photopsia (seeing flashes of light)
- Diplopia (double vision)
- Temporary visual disturbance
- Retrobulbar pain
- Back pain

DIAGNOSIS

OTHER DIAGNOSTICS

- Headache & papilledema with
  - *No secondary cause of ↑ ICP:* normal neuroimaging (MRI, contrast CT scan), normal CSF composition
  - *No malignant hypertension:* mimics IIH
  - *Lumbar puncture:* ↑ opening pressure

TREATMENT

- *Goal:* treat symptoms/preserve vision

MEDICATIONS

- Carbonic anhydrase inhibitor (acetazolamide) → ↓ CSF production
  - *Contraindication:* pregnancy
- Loop diuretics (furosemide) → ↓ papilledema and ↓ mean CSF pressure
  - *Contraindication:* pregnancy

SURGERY

- Optic nerve sheath fenestration (ONSF)

OTHER INTERVENTIONS

- Weight loss

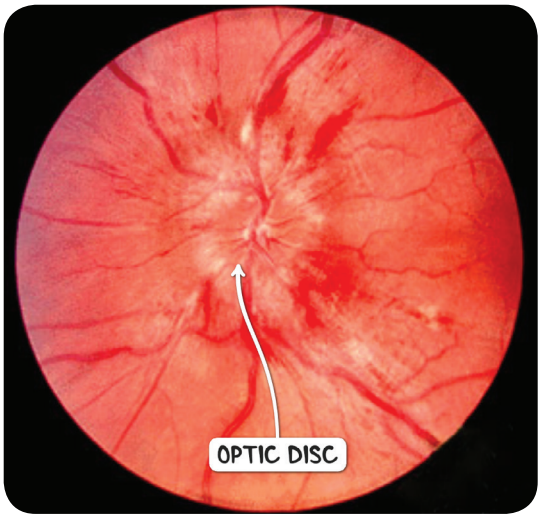

Figure 81.3 A retinal photograph demonstrating an expanded optic disc caused by intracranial hypertension.