INCREASED INTRACRANIAL PRESSURE

Sheba Medical Center, Acute Medicine Department
Irene Frantzis P-Year student SGUL 2013

Normal Values

- Normal intracranial volume: 1700 ml
- Volume of brain: 1200-1400 mL
- CSF: 70-160 mL

- Normal ICP:
  - Adults:<10-15 mmHg
  - Children: <3-7 mmHg

Definition

- Persistant elevation of > 20mmHg for more than 10 minutes = elevated ICP

- If pressure is > 30 mmHg, there is a poor prognosis

Causes

- Mass lesions
  - Tumor, Hematoma, Abscess
- CSF disturbance
  - Hydrocephalus
- Obstruction of venous sinuses
  - Depressed fractures, cerebral venous thrombosis
- Diffuse brain edema/swelling
  - Encephalitis, Meningitis, Reye's Syndrome, Subarachnoid hemorrhage, Lead encephalopathy, water intoxication, near-drowning
- Idiopathic

Cerebral Edema

- Vasogenic cerebral edema- most common form
- Cytotoxic cerebral edema- secondary to cellular injury
  - Ex. Ischemia, metabolic poisons
- Hydrocephalic edema

Signs and Symptoms

- Headache:
  - worse in the morning/ when arising
  - “Band-like”, “pressure”
  - Exacerbated by sneezing, coughing, exertion
- Vomiting
  - Projectile
  - Often in the morning
- Papilloedema
  - Indicates chronic elevated ICP
- Decreased consciousness
- Cognitive change

Signs and Symptoms

- Cognitive Change
  - Most likely due to caudal displacement of diencephalon and midbrain
- Light- near pupillary dissociation
- Cushing's Triad (usually late signs)
  - Systolic hypertension
  - Bradycardia
  - Respiratory depression

Diagnosis

- Clinical signs + Radiology+ Laboratory results

- Radiology-
  - CT is quick and easy
  - Good for detecting edema, tumor, compressed cisternae, midline shift
- Lab: Look for hyponatremia, check Arterial Blood Gases for increase pCO2

Radiology

45 year old pt with acute intracranial hemorrhage, cerebral edema and midline shift

http://www.webmm.ahrq.gov/case.aspx?caseID=174

Monitoring ICP

- Can use techniques such as
  - Intraventricular fluid filled catheter transducer system (but needs ventriculostomy)
  - Catheter tip transducer systems
  - Can use lateral ventricles (usually)
  - In infants- transduction device over anterior fontanelle
- Indications to monitor ICP are usually in trauma situations
  - Patients with severe head injury
  - Abnormal CT scan

Treatment

- Depends on cause
- General:
  - Elevate head 30-45 degrees-> helps to lower JVP (normally the principle determinant of ICP), also lower venous outflow
  - Keep $pCO_2 < 32$ mmHg, but > 25 mmHg
  - Restrict fluids
  - Furosemide 1mg/kg single dose

Treatment cont'd

- Mannitol: 1g/kg- effect lasts for 3-6 hrs
  - 0.25 g/kg every 4-6 hrs
  - Adverse effects: CHF, hypokalemia, hyperosmolarity, sudden rebound ICP
- Dexamethasone
  - 10-20 mg initially, then 4mg every 6 hrs
  - For edema
- Analgesia and Sedation
  - IV propofol, etomidate, midazolam for sedation
  - Morphine, alfentanil for analgesia

Treatment

- Decompressive craniectomy
  - Beneficial in trauma, cerebral infarction, intracerebral, subarachnoid hemorrhage, Reye's syndrome
  - Decreased mortality, but may increase morbidity
- CSF drainage
  - Ventriculostomy- risk of infection, hemorrhage
- Avoid pyrexia
  - Can increase ICP
- Seizures should be managed aggressively
  - Can precipitate rapid deterioration

Treatment cont'd

- Neuromuscular blockade
  - When analgesia and sedation do not reduce muscle activity which raises ICP
- Hypothermia
  - Second-tier treatment
  - Investigated in head injury as means of controlling ICP
- Barbiturate coma
  - Not common practice
  - Depresses cerebral metabolic activity→ lower cerebral blood flow→ lower ICP

Effects of Space- Occupying Lesions

- Increase volume in intracranial space→ minimal inc in pressure due to compliance → when CSF is displaced, blood is displaced and compliance is lost→ increase ICP

Effects of SOL

- Cerebellar Tonsil herniation
  - Through foramen magnum
  - Compress medullary respiratory centers
  - Leads to death
- Lateral displacement of brain
  - Change in consciousness

Brain Herniation

Uncal .1

Central .2

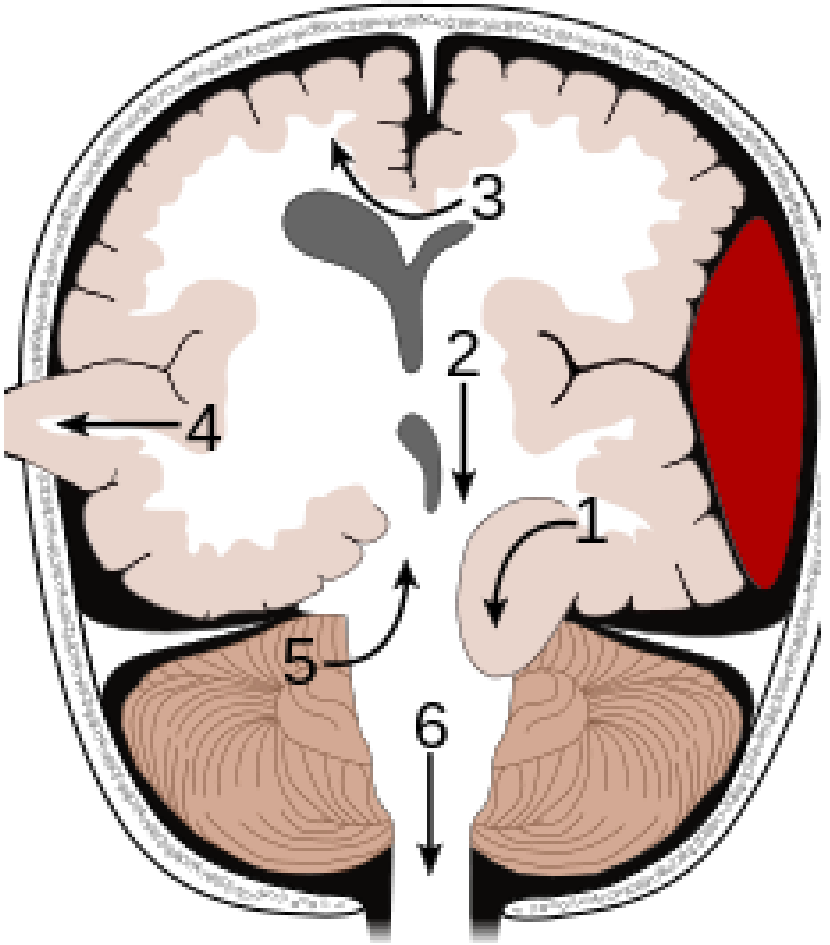
Cingulate .3

Transcalvarial .4

Upward cerebellar .5

Tonsilar .6

Image taken from wikipedia



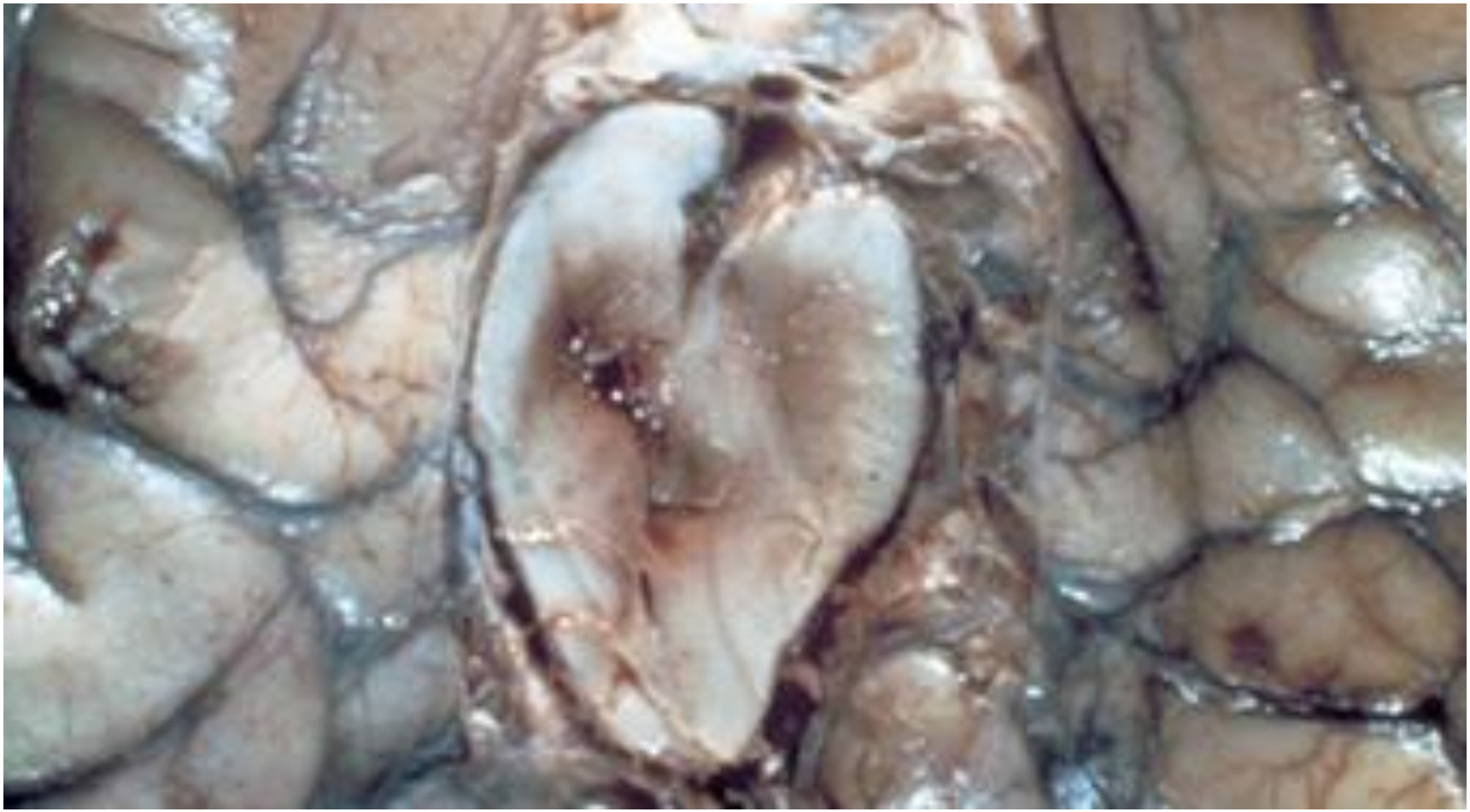
Effects of SOL

- Uncal herniation (usually ipsilateral)
  - May push midbrain on controlateral tentorium→ compression of cerebral peduncle→ ipsilateral hemiparesis
  - Compress CN III: ipsilateral pupil dilatation
  - Compress midbrain cerebral peduncle: hemiparesis hemiplegia
  - Compress posterior cerebral artery:may hemorrhage to occipital lobe→ homonymous hemianopsia
  - Brainstem compression→ respiratory, postural oculomotor change

Effects of SOL- increased ICP

- Central Herniation (Rostrocaudal deterioration)
  - Change in consciousness
  - Respiratory changes
    - Diencephalon→ Cheyne- Stokes respiration (hyperventilation and apnea)
    - Midbrain→ central neurogenic hyperventilation
    - Pons→ Apneustic respiration (prolonged inspiratory phase, apnea)
    - Medulla→ ataxic respiration (irregular, chaotic, apnea)

Uncal Herniation

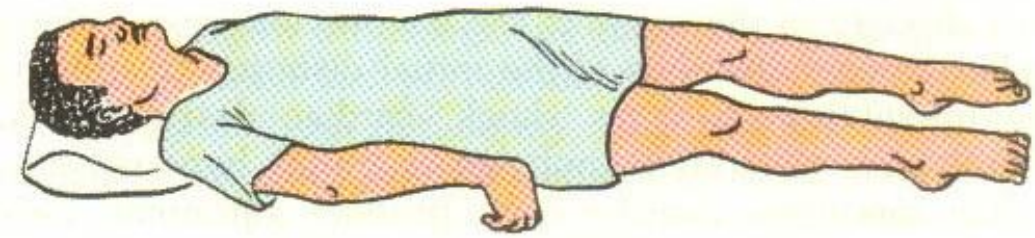


Effects of SOL- increased ICP

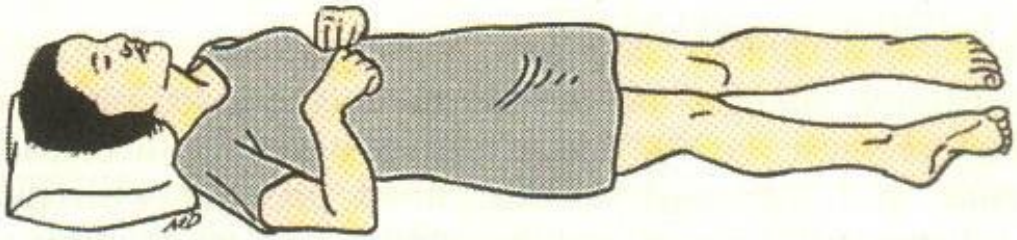
- Central herniation
  - Pupillary changes
    - Small, reactive: compressed diencephalon→ dec sympathetic
    - Dilated, fixed: compressed CN III
    - Midposition, fixed: compress both CN III, midbrain
  - Changes in postural reflexes
    - Decorticate rigidity: Flexed arms, extended legs
    - Decerebrate rigidity: arms and legs extended

Posture Change

http://hansmednotes.blogspot.co.il/2012/03/decerebrate-vs-decorticate-rigidity.html



A. Extension posturing (decerebrate rigidity)



B. Abnormal flexion (decorticate rigidity)

References

- Dunn LT, “Raised Intracranial Pressure” J Neurol Neurosurg Psychiatry 2002; 73:123-127
- Irwin R.S., Rippe JM. Manual of Intensive Care Medicine, 4th ed. Lippincott william and Wilkins.2006. p.756-759