

Raised intracranial pressure

Pathophysiology

Normal intracranial pressure

Normal ICP varies from 5 to 15 mmHg in the adult at rest. ICP varies with venous pressure and is thus affected by factors such as gravitational drainage and manoeuvres that raise intrathoracic pressure (coughing, Valsalva, positive pressure ventilation) or lower it (normal inspiration). Normal values in small children and infants are lower than for adults.

Aetiology of raised intracranial pressure

The principle causes of raised ICP are:

1. Mass lesions,
 2. Hydrocephalus and
 3. Cerebral oedema.
- The skull is a rigid container that encloses the brain, cerebrospinal fluid (CSF) and arterial/venous blood.
 - The addition of a new mass lesion such as a growing tumour or haematoma can initially be compensated for by the egress of CSF and venous blood from the skull.
 - During this compensation phase, there is only a small increase in ICP.
 - When compensation is maximal, there is then a rapid rise in ICP for relatively small increases in volume.
 - This increased pressure causes compression and herniation of the brain.

Cerebral oedema

Cerebral oedema may be:

1. Cytotoxic or
 2. Vasogenic.
- **Cytotoxic oedema** refers to cerebral swelling as a result of cellular engorgement and can occur in both neurones and glia in response to insults such as ischaemia.
 - **Vasogenic oedema** results from an accumulation of extracellular cerebral fluid, usually as a result of breakdown of the blood–brain barrier and leakage of fluid through ‘leaky’ capillaries. Vasogenic oedema is commonly seen with tumours such as metastases, malignant gliomas and meningiomas. Hydrocephalus is discussed later.

Raised intracranial pressure and cerebrovascular physiology

- The brain does not store much energy and is unable to utilize anaerobic metabolism.
- The brain is therefore critically dependent on a constant flow of oxygen and glucose via the cerebral arterial vasculature.
- In the absence of arterial blood flow, brain tissue will be viable for only a few minutes.

- In normal circumstances, cerebral blood flow is maintained at a constant rate despite fluctuations in mean arterial pressure (MAP) of between 50 and 150 mmHg via mechanisms termed cerebral autoregulation.
- These mechanisms include neural regulation via aortic and carotid baroreceptors, and local factors such as arteriolar responsiveness to oxygen and carbon dioxide.
- In the injured brain, cerebral autoregulation may be impaired either locally or globally.
- Cerebral blood flow is then dependent on MAP with a fall in MAP leaving the brain susceptible to ischaemia, and a rise in MAP resulting in hyperaemia, increased cerebral blood volume and thus raised ICP.
- Cerebral perfusion can be estimated by the following formula: cerebral perfusion pressure (CPP) = MAP – ICP.
- Studies of patients in traumatic coma have shown that poor prognostic factors include an ICP of >20–25 mmHg or a CPP of < 60 mmHg.

Clinical features

- Symptoms of raised ICP in a patient include headaches that tend to be worse in the early morning or on lying down and may improve with ambulation.
- Associated symptoms include nausea, vomiting or visual disturbance, particularly double vision or blurred vision.
- The headache may be exacerbated by coughing, straining or bending.
- In addition there may be symptoms relevant to the location of the pathology, for example, cognitive and personality change, unsteadiness of gait and incontinence of urine in frontal lobe pathology or right-sided weakness and garbled speech.
- In infants, raised ICP causes a bulging fontanelle, progressive macrocephaly with sutural diastasis, and dilatation of scalp veins rather than papilloedema.

Treatment

Appropriate treatment of raised ICP depends on identifying the cause.

Medical

- Mannitol is an osmotic diuretic that can be used in emergency settings to reduce ICP: the dose is 0.5–1.0 g kg⁻¹.
- Vasogenic oedema is often treated with the administration of high-dose steroids in the form of dexamethasone, for example 8 mg twice daily. Steroids reduce the permeability of the blood–brain barrier and are useful in reducing cerebral swelling prior to definitive treatment of the underlying cause of the vasogenic oedema.
- A carbonic anhydrase inhibitor such as acetazolamide can play a role in control of raised ICP in idiopathic intracranial hypertension and acts by reducing CSF production.

Raised intracranial pressure

Surgical

A variety of mass lesions can cause raised ICP and are amenable to surgical treatment via craniotomy:

1. In trauma, acute extradural and subdural haematomas, intracerebral contusions and chronic subdural haematomas;
2. In cerebrovascular pathology, superficial lobar haematomas, haematomas associated with ruptured aneurysms;
3. In neuro-oncology, a variety of primary and secondary tumours.
4. Occasionally, surgical control of ICP will involve decompressive craniectomy.

Signs of raised intracranial pressure

- ✓ Papilloedema
- ✓ Sixth nerve palsy
- ✓ Impaired up gaze
- ✓ Focal neurological deficits
- ✓ Impaired conscious level

In infants:

- ✓ Progressive macrocephaly
- ✓ Bulging anterior fontanelle
- ✓ Dilated scalp veins
- ✓ Sun-setting eyes

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

مَا كَانَ مُحَمَّدٌ أَبَا أَحَدٍ مِنْ رِجَالِكُمْ وَلَكِنْ رَسُولَ اللَّهِ وَخَاتَمَ النَّبِيِّينَ ۗ وَكَانَ اللَّهُ بِكُلِّ شَيْءٍ عَلِيمًا

صدق الله العظيم



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

ووهبنا له إسحاق ويعقوب كلا هدينا ونوحا هدينا من قبل ومن ذريته داود وسليمان وأيوب ويوسف
وموسى وهارون وكذلك نجزي المحسنين (٨٤) وذكريا ويحيى وعيسى وإلياس كل من الصالحين
(٨٥) وإسماعيل واليسع ويونس ولوطا وكلا فضلنا على العالمين (٨٦)

صدق الله العظيم

فتأمل.....

Muqdad fuad