



มหาวิทยาลัยราชภัฏนครปฐม



Mechanism and Illness of Human Body 2

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increased intracranial pressure : IICP



Anatomy

GCS

IICP

Increased Intracranial Pressure

Ventriculostomy

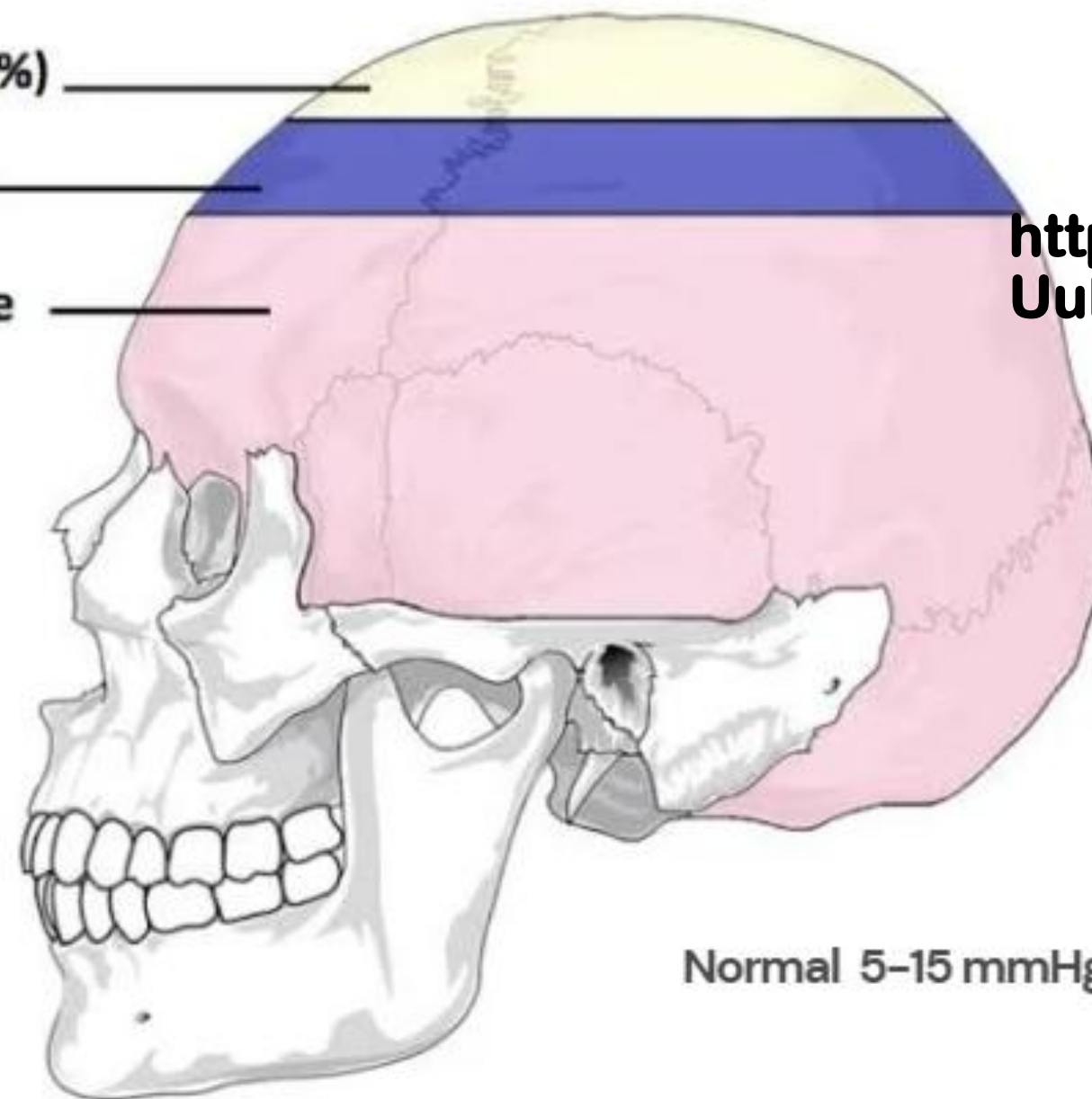
The 3 Components of intracranial

CSF volume = 150ml (10%)

Blood volume = 150ml (10%)

Brain parenchyma volume
= 1400ml (80%)

- ICP > 20–25 mmHg
- For a long time at least 5 min



Normal 5–15 mmHg

<https://images.app.goo.gl/AYd2UuHM6VWBC7qk8>

increased intracranial pressure : IICP



Anatomy

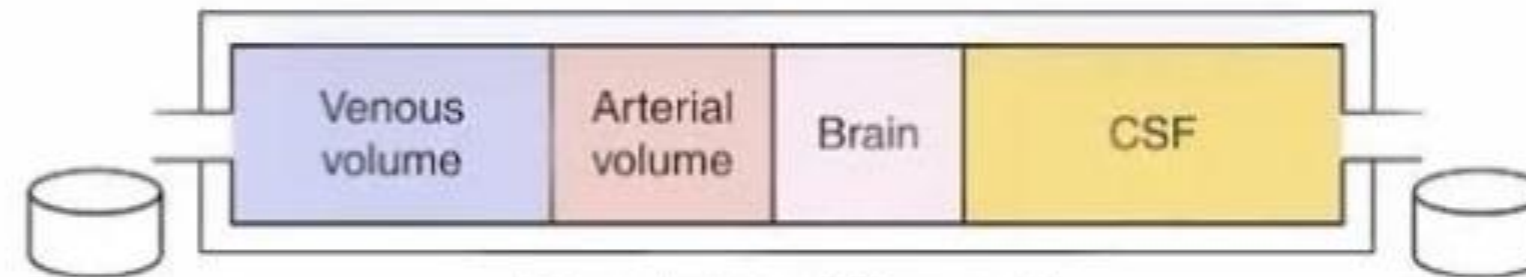
GCS

IICP

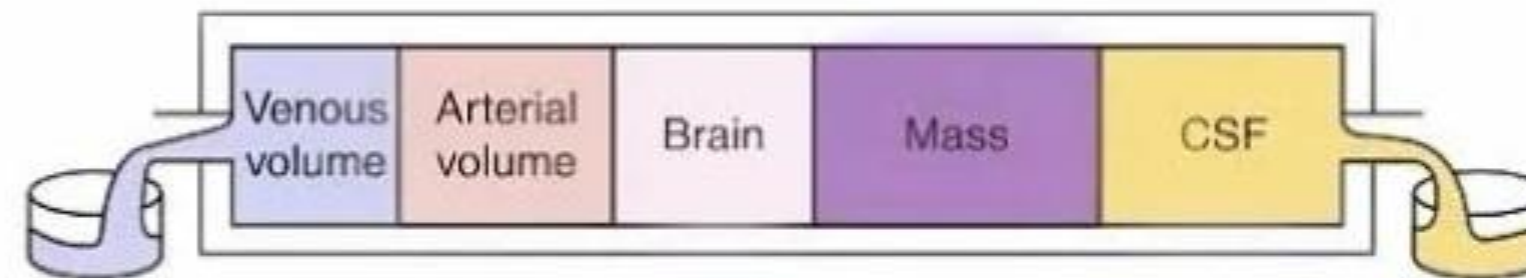
Ventriculostomy

Monro - Kellie

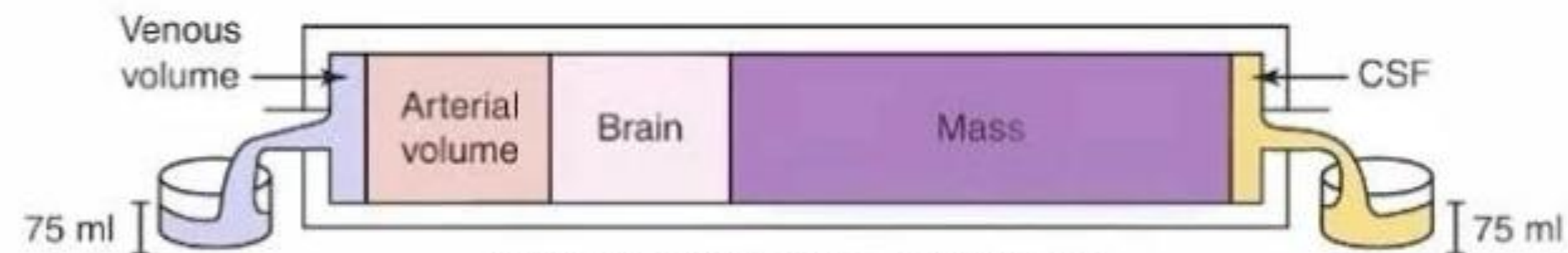
INTRACRANIAL COMPENSATION FOR EXPANDING MASS



Normal state - ICP normal



Compensated state - ICP normal



Uncompensated state - ICP elevated

<https://x.com/jamestooley/status/918794359734177793>

increased intracranial pressure : IICP



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Course of IICP

Increase in Brain volume



Mass, CA, Hematoma (epidural / subdural / subarachnoid hemorrhage) Brain edema, Ischemic stroke, Infection

Increase in Blood



1.vasodilation



Hypercapnia, acidosis, Fever, Infection

2.dural sinus tear

3. high valsalva pressure

Increase in CSF



Hydrocephalus
absorbtion, obstruction, production

increased intracranial pressure : IICP



Anatomy

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Ventriculostomy

Cerebral autoreguration

Cerebral perfusion pressure (CPP)

70-100 mmHg

Cerebral autoreguration

CPP > 100 mmHg และ < 50 mmHg

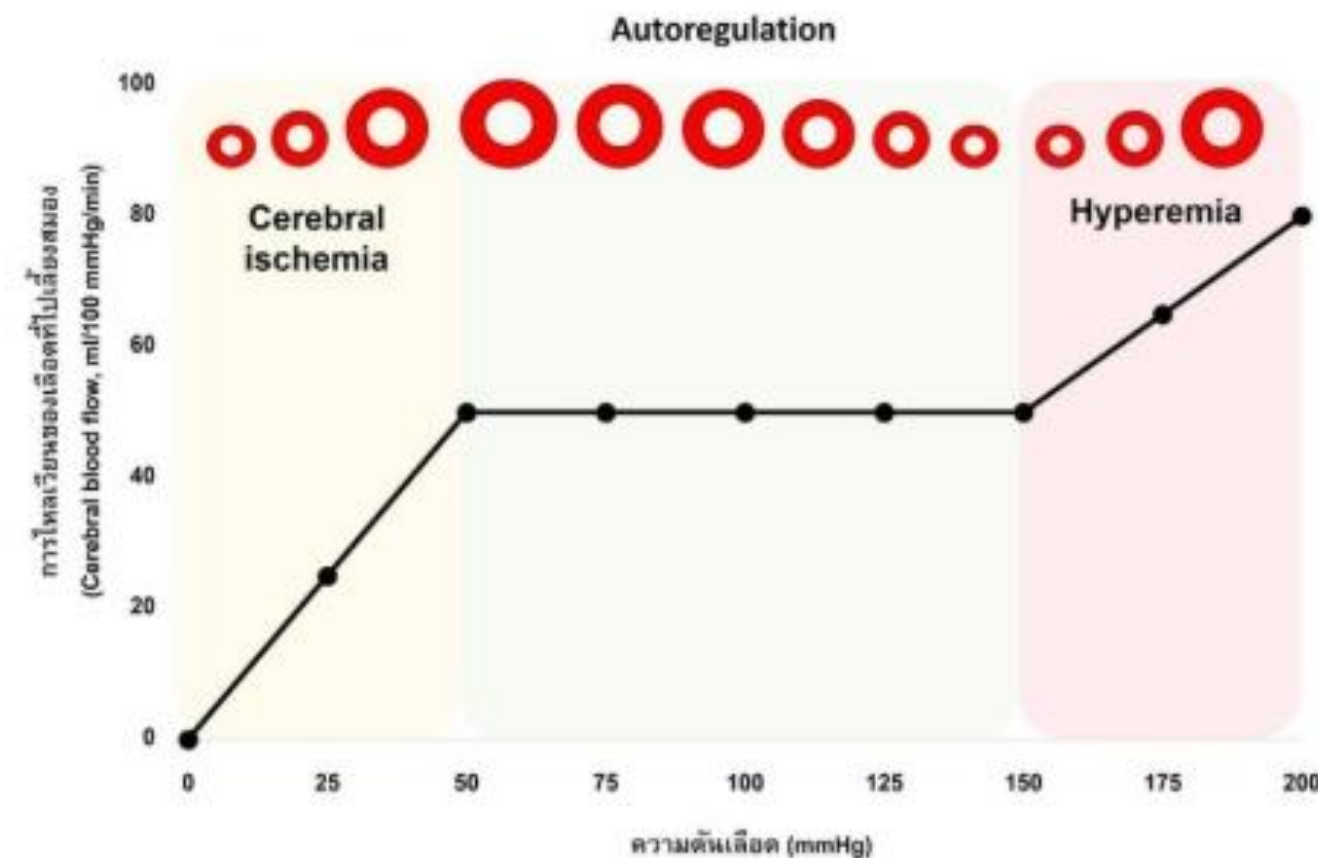
$$CPP = MAP - ICP$$

CPP = Cerebral perfusion pressure

MAP = Mean arterial pressure

$$MAP = \frac{SBP + 2(DBP)}{3}$$

ICP = Intracranial pressure



<https://images.app.goo.gl/KeR9TiLGjD6trhwi9>

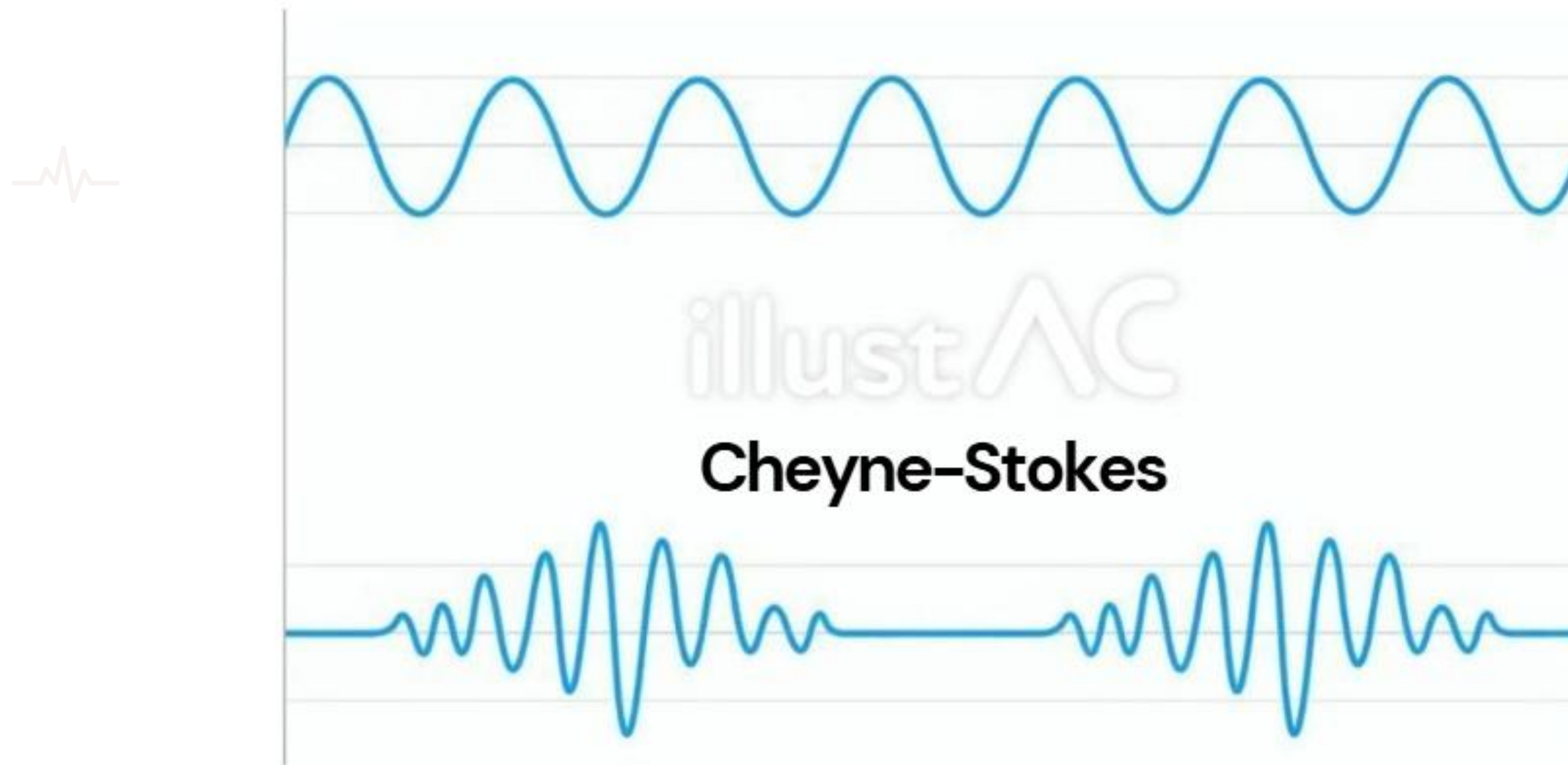
increased intracranial pressure : IICP



Sign & Symptom : IICP			
Anatomy	SIGN	EARLY SIGN	LATE SIGN
GCS	Changes in consciousness	Restless, confused, not knowing the day time place	Coma
IICP	Headache Blurred vision	Headache • vomit, Diplopia • papilledema IICP 2-3 hr.	Severe, excruciating headache
Ventriculostomy	Abnormal pupils	• pupil dilated and not reactive to light of the lesion	pupil dilated and not reactive to light both eye

(Galbiati & Paola, 2015)

increased intracranial pressure : IICP



<https://images.app.goo.gl/ZrKRmjPyJ16M3DaP7>

increased intracranial pressure : IICP

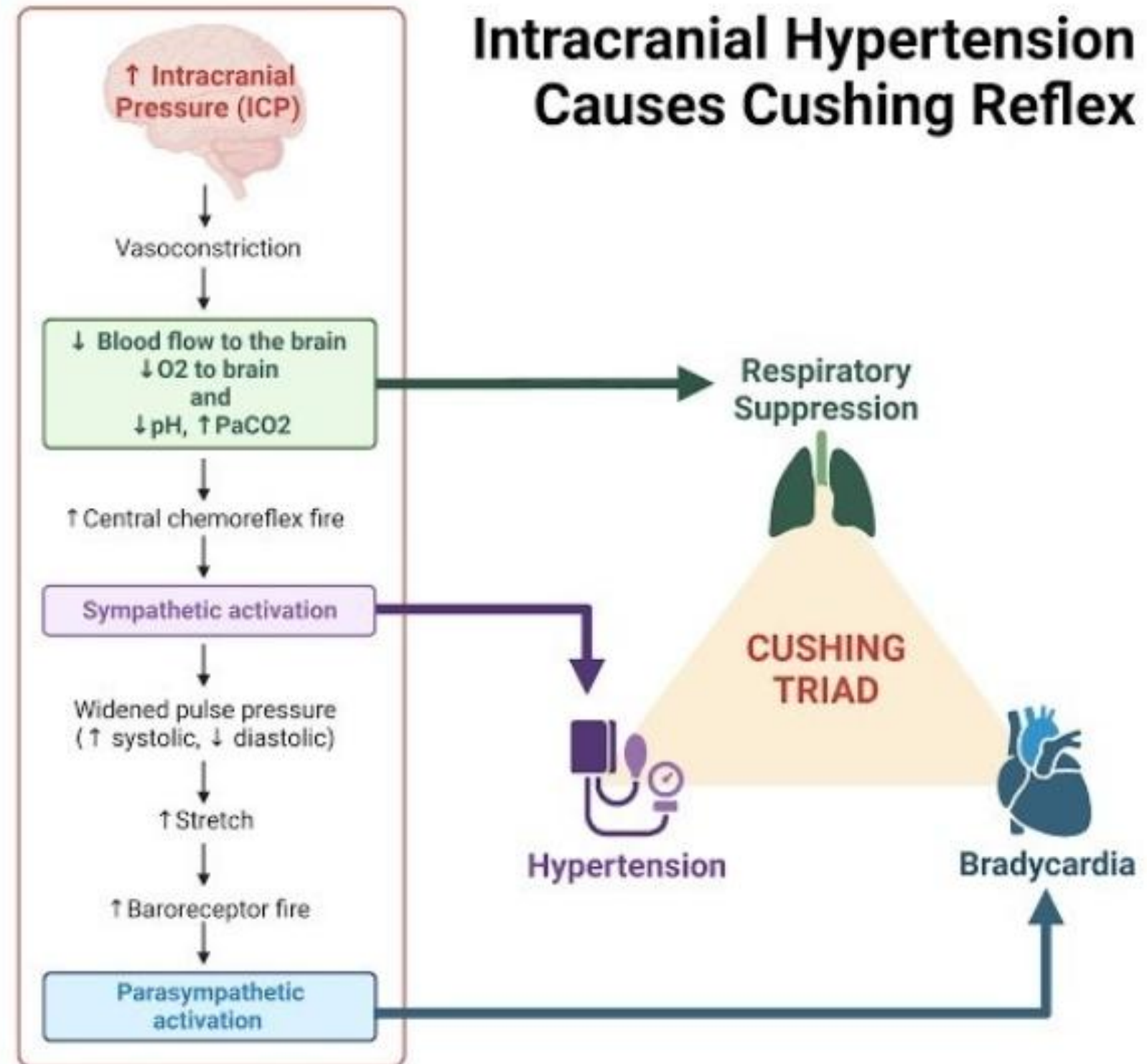


Anatomy

GCS

IICP

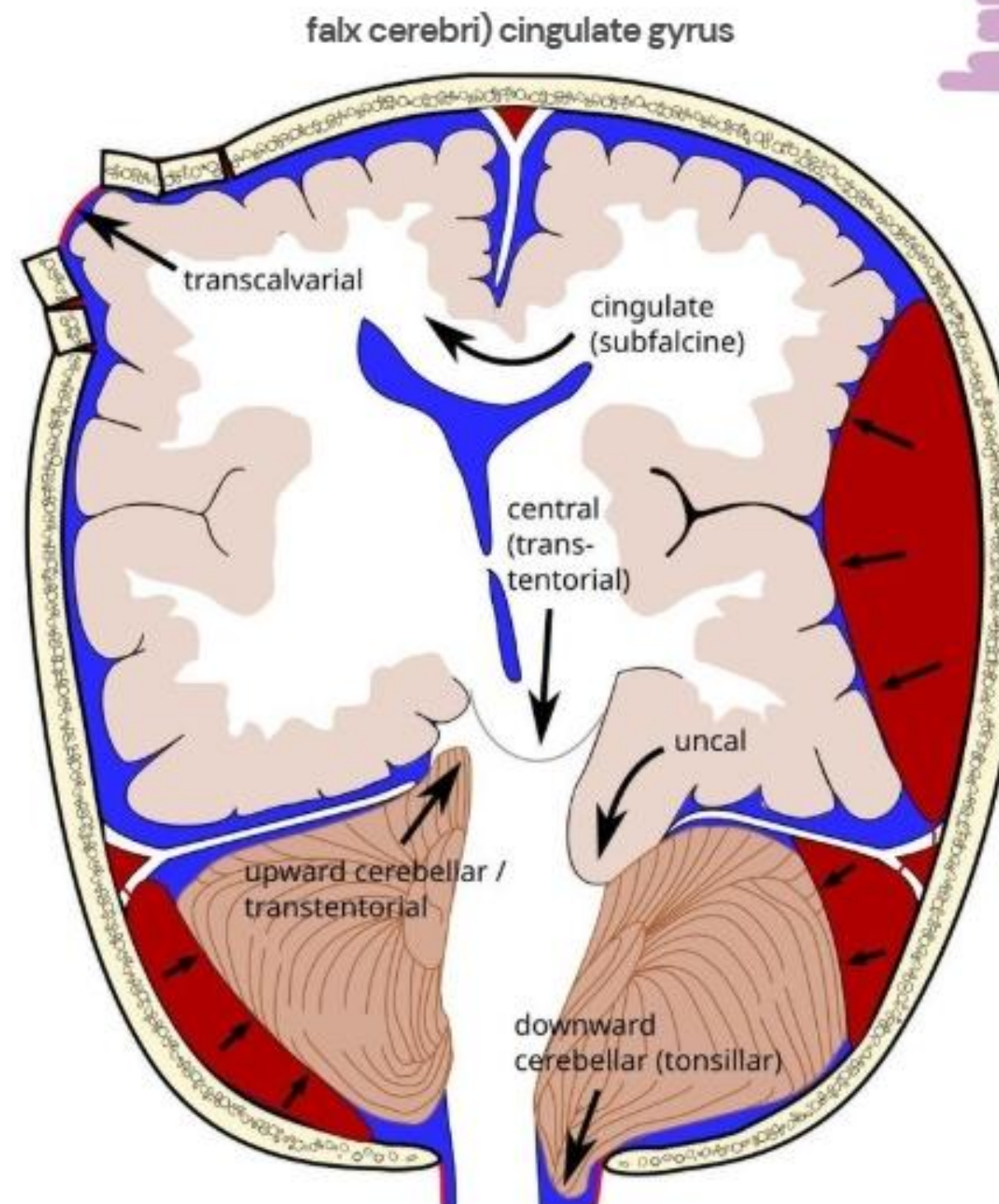
Ventriculostomy



Brain herniation



Anatomy
GCS
IICP
Ventriculostomy



Brain herniation

Supratentorial herniation

1. Uncal (transtentorial)
2. Central
3. Cingulate (subfalcine)
4. Transcalvarial

Infratentorial herniation

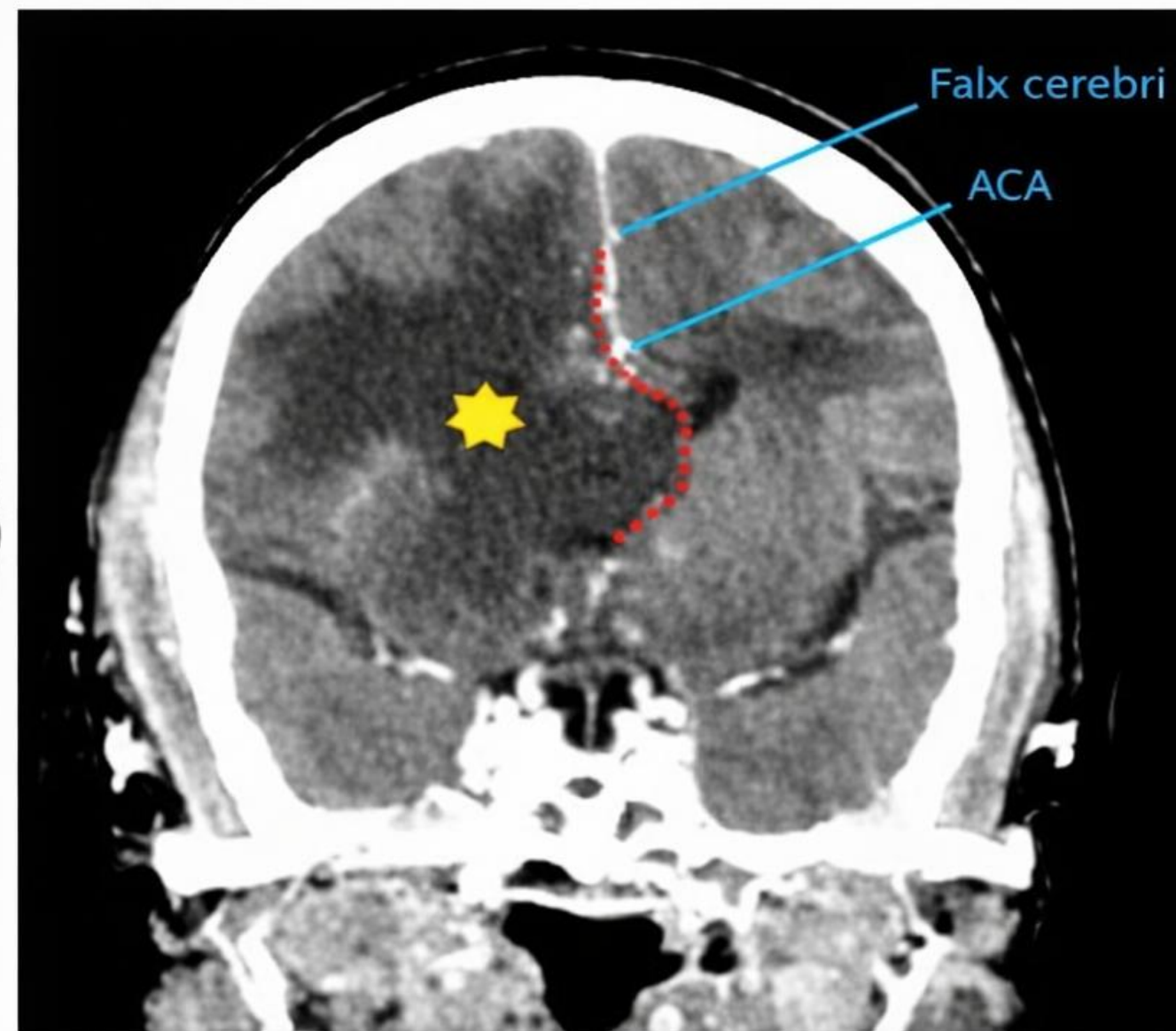
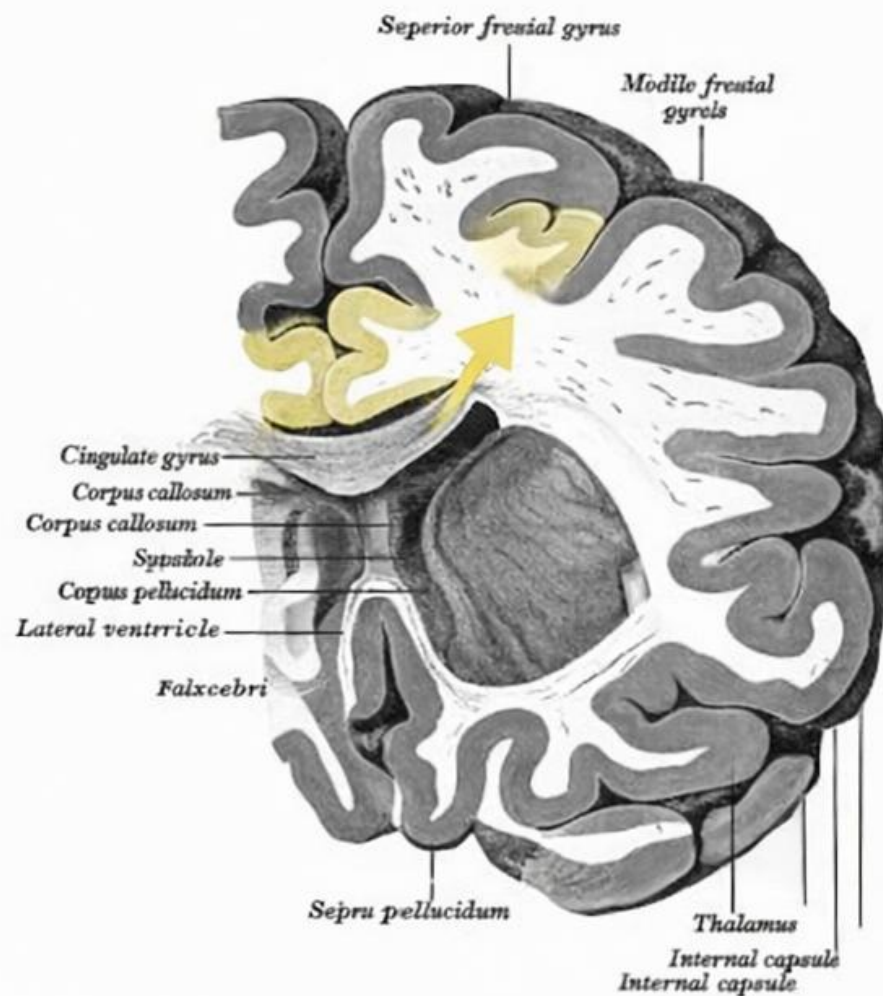
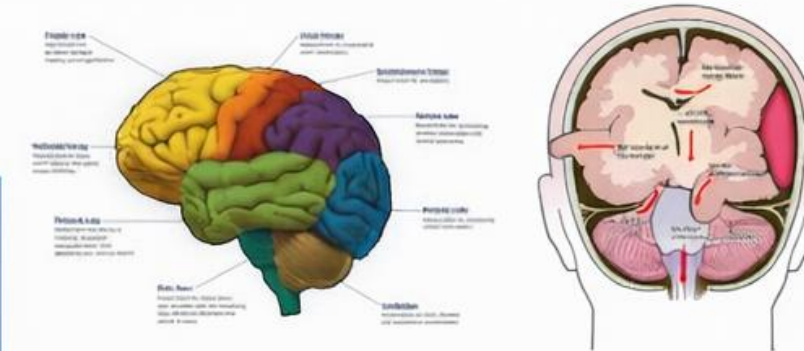
5. Upward (upward cerebellar or upward transtentorial)
6. Tonsillar (downward cerebellar)

Brain herniation



1. Cingulate Herniation (Subfalcine herniation)

- Cingulate gyrus shifts under the **Falx cerebri** to the opposite side
- Signs of increased pressure & position-related symptoms along with symptoms from distortion of distant brain areas



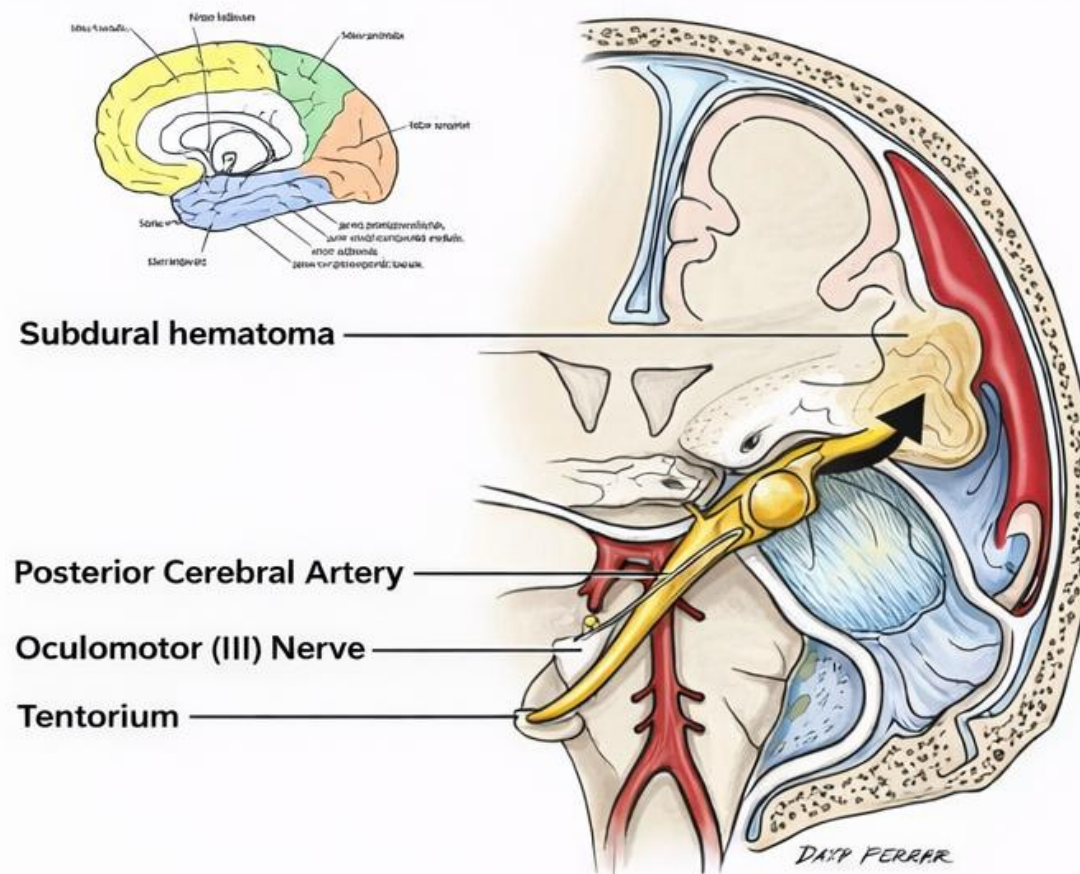
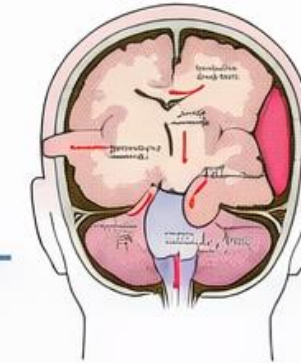
Brain herniation



Brain Herniation

2. Lateral trans-tentorial herniation (Uncal herniation)

- **Uncus** shifts medially over the **Midbrain**, compressing the Midbrain and Posterior Cistern
- Symptoms: Altered consciousness and CN 3 dysfunction causing **dilated** or “**blown**” pupil on the side of herniation, along with **ptosis** and lack of light reflex



Close-up:
R Eye



Close-up:
L Eye



Note: Similar lighting was used for both of these close-up images

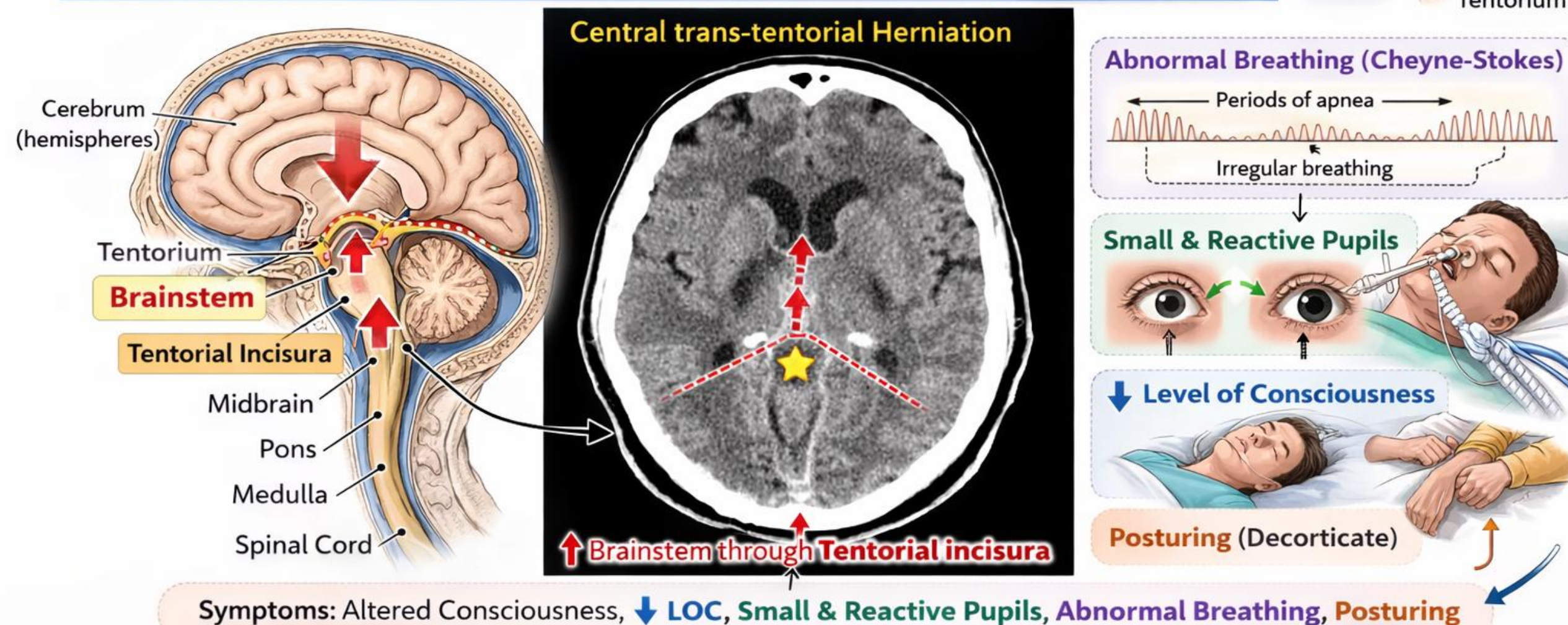
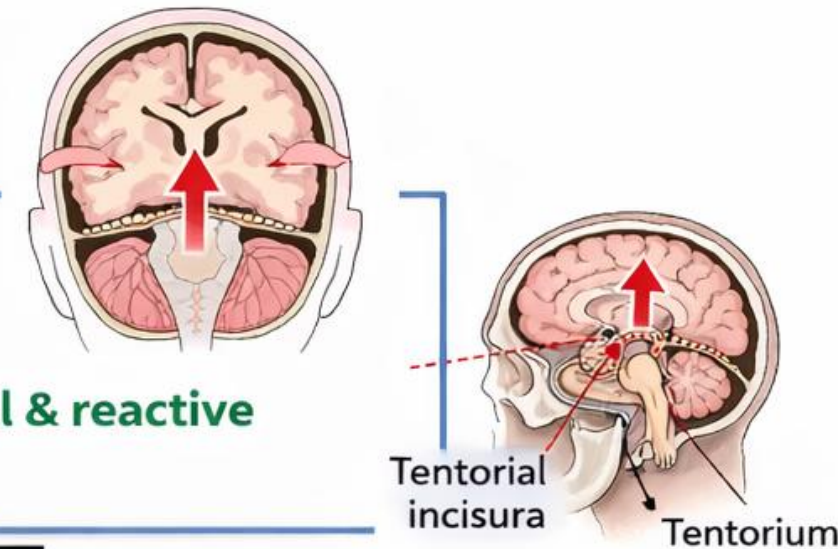
Brain herniation



Brain Herniation

3. Central trans-tentorial herniation

- **Brainstem** herniates **upward** through the **Tentorial incisura** (between tentorium)
- Symptoms : Altered consciousness, **↓ level of consciousness**, **small & reactive pupils**, **abnormal breathing (Cheyne-Stokes)**, and **posturing**



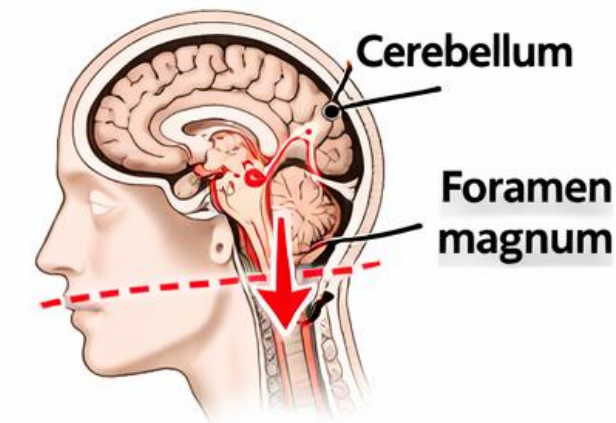
Brain herniation



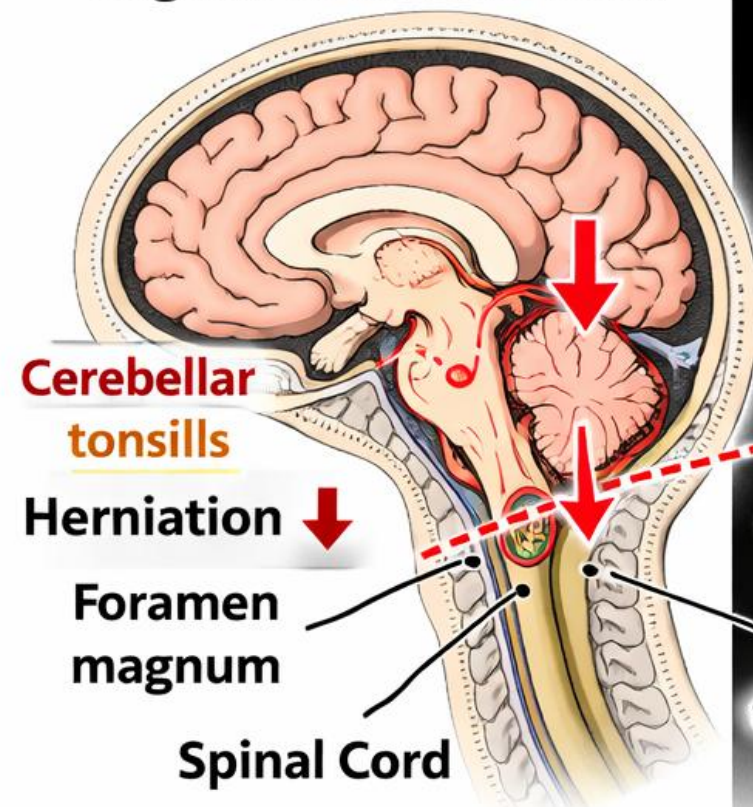
Brain Herniation

↓ 4. Tonsillar Herniation

- **Inferior herniation** of **Cerebellar tonsils** through the **Foramen magnum**
- Symptoms : **Neck stiffness**, ↓ **Consciousness**, **Abnormal respiratory effort**, Heart & breathing arrest

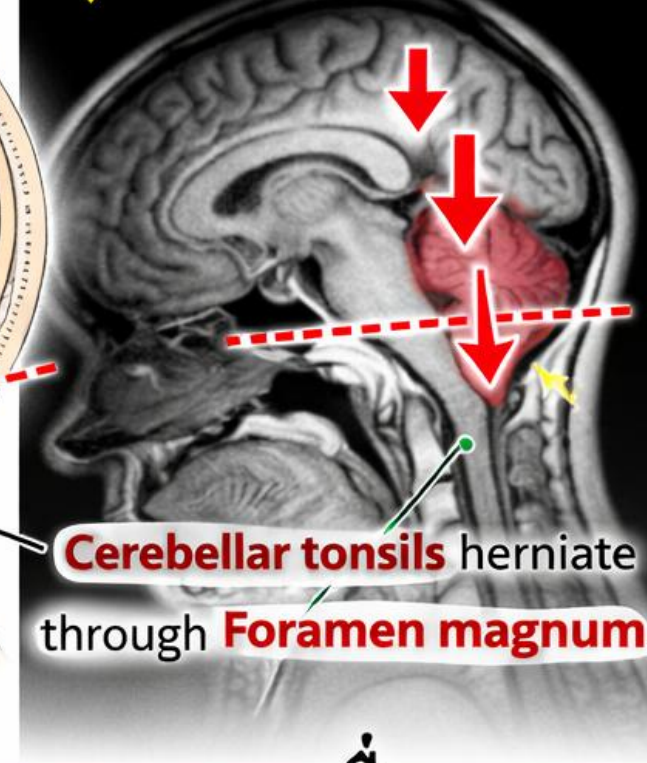


Sagittal Brain (Side view)



MRI (Sagittal)

↓ Tonsillar Herniation

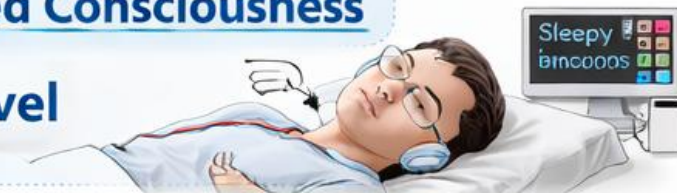


Neck Stiffness (Rigidity)



Altered Consciousness

↓ Level



Abnormal Respiratory Effort

Apnea, Irregular breathing → **Arrest**

Oopisthotonic Position (Decerebrate posturing)



↑ ICP → Brainstem & Cerebellar tonsils pushed downward → **Death**

Brain herniation



Brain Herniation

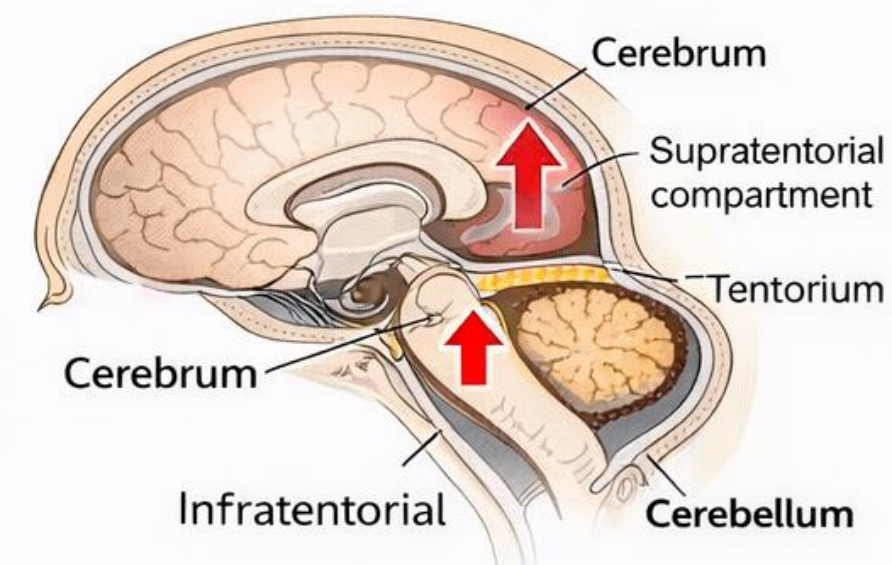
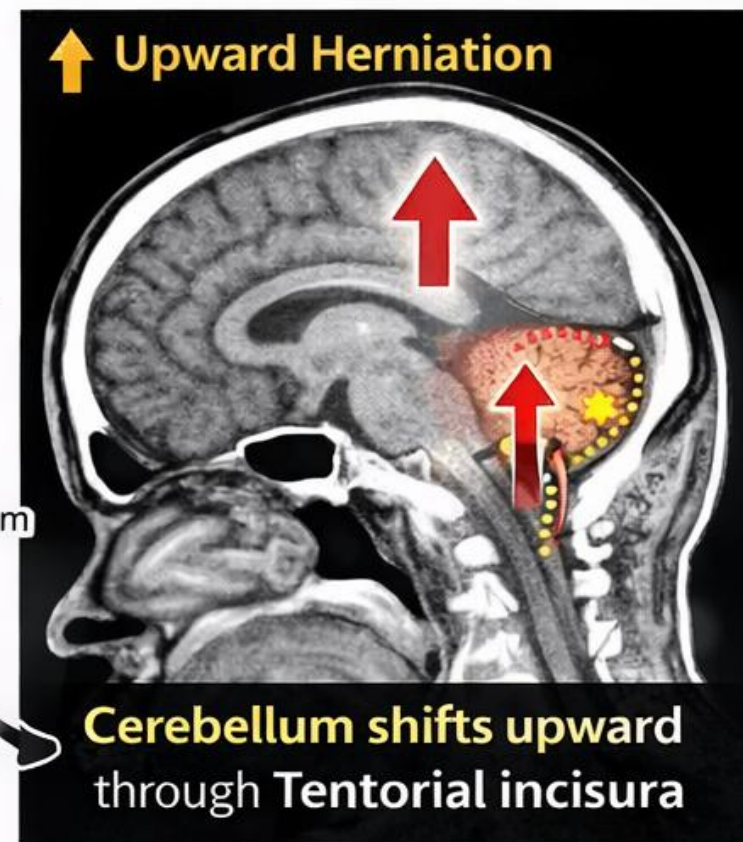
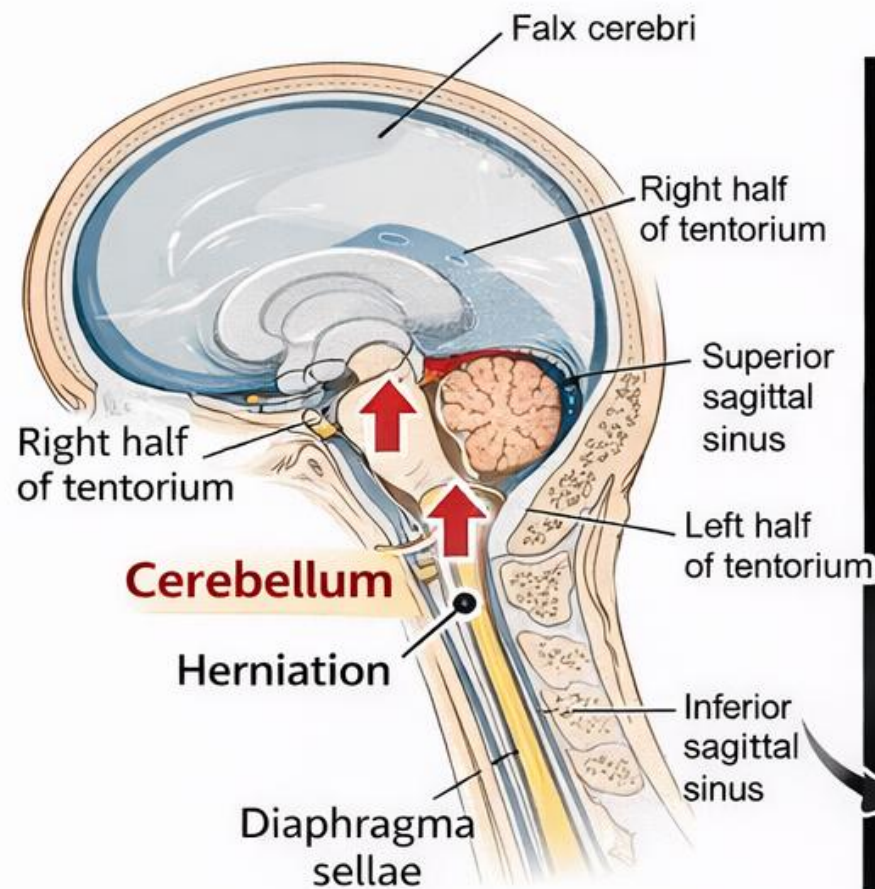
5. Upward trans-tentorial herniation

- Cerebellum shifts **upward** from the infratentorial compartment into the supratentorial compartment, often due to increased CSF.
- Cerebellum herniates **upward** through the Tentorial incisura
- **Symptoms** : Altered eye movements and **Parinaud syndrome**



Parinaud Syndrome

Altered eye movements and
Parinaud syndrome



↑ ICP → Brainstem & **Cerebellar tonsils** pushed **downward** → **Death**

Altered level of consciousness (ALOC)



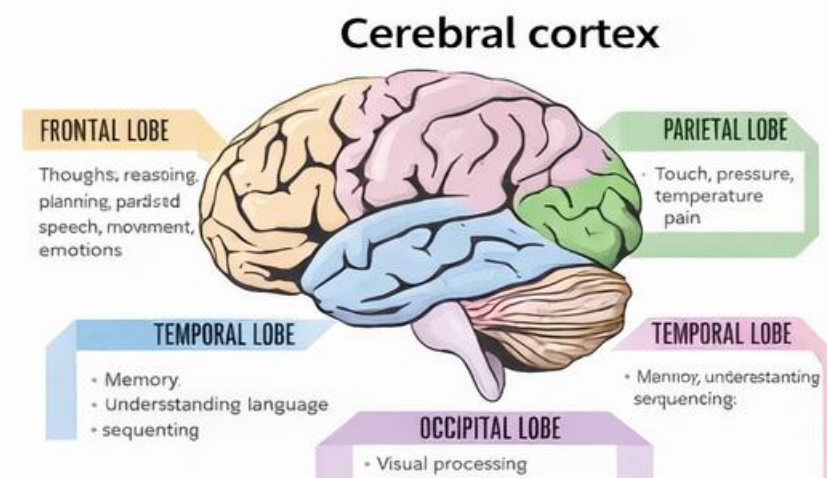
Consciousness: Awareness of oneself and the environment

1. Content of consciousness or awareness

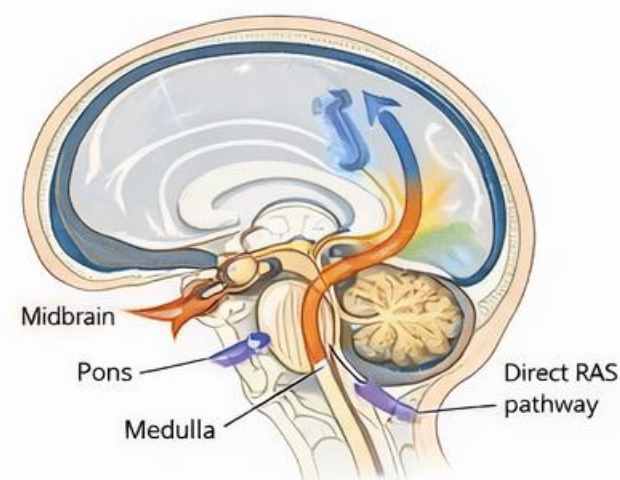
- The aspect of consciousness that reflects **mental content** such as:
 - Thoughts of past and future events, names, images, language, object recognition, problem-solving, planning, enjoyment, etc.
- Primarily related to the **Cerebral cortex**

2. Level of consciousness or wakefulness

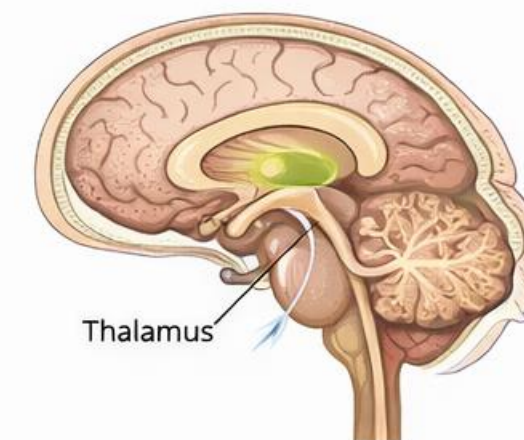
- The aspect of consciousness that reflects arousal to various stimuli such as: light, sound, smell, touch, etc.
- Primarily related to the **Reticular Activating System** (Direct/Collateral pathway) and **Thalamus**



Cerebral cortex



Reticular Activating System (RAS)



Thalamus

Altered level of consciousness (ALOC)



Impaired Consciousness

Causes

1. Primary brain mechanisms: RAS, 3rd ventricle, Pons, or large cerebral hemispheres

- Direct damage: stroke or bleeding within the affected areas
- Infections: Brain abscess, meningitis, encephalitis
- Conditions: brain tumors, hydrocephalus
- Seizure disorders: epilepsy



Stroke



Bleed



Infection

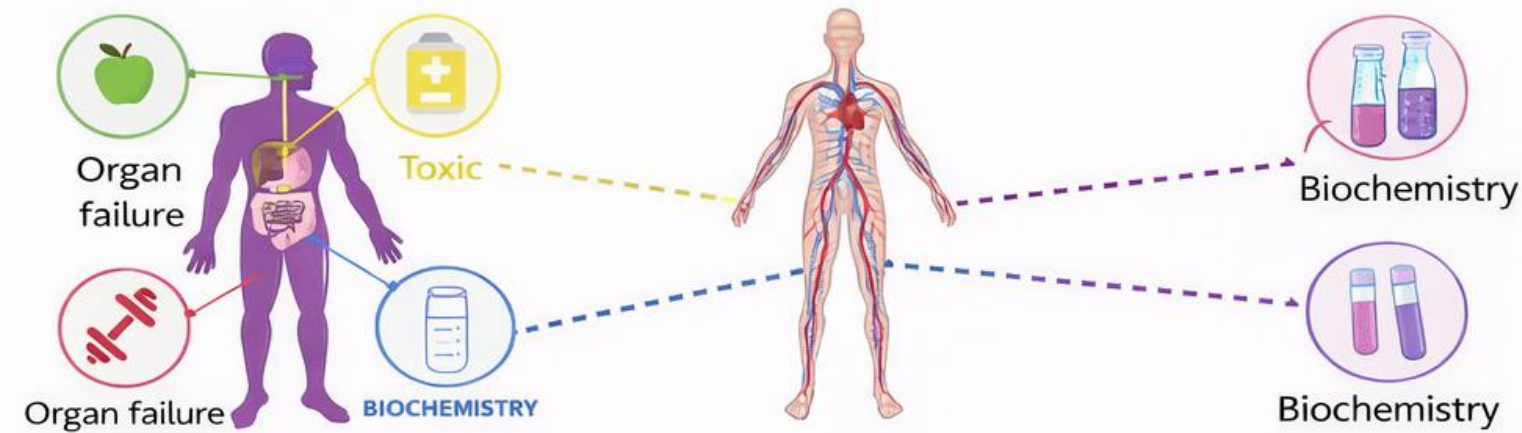


Seizure



2. Secondary system dysfunction:

- **Structural:** metabolic or toxic disorders that indirectly impact the brain due to systemic dysfunction such as infection, respiratory failure or organ failure
- **Metabolic:** irregularities in glucose, electrolytes, blood pressure from cardiac dysfunction, dehydration, acute changes in blood levels of oxygen, carbon dioxide, etc.



Altered level of consciousness (ALOC)



1. Conscious Level ☆

- 
- A small, light-colored ECG (heart rate) line graphic is positioned to the left of the list of consciousness levels.
1. **Alert** Awake, aware of time, place, and person
 2. **Confusion** Disoriented, confused
 3. **Disorientation** Loss of normal awareness
 4. **Drowsiness** Sleepy, easily arousable
 5. **Stupor** Unresponsive, needs strong stimulus
 6. **Semi-Coma** Unresponsive except to deep pain
 7. **Coma** Completely unresponsive
 8. **Coma** Completely unresponsive

Altered level of consciousness (ALOC)

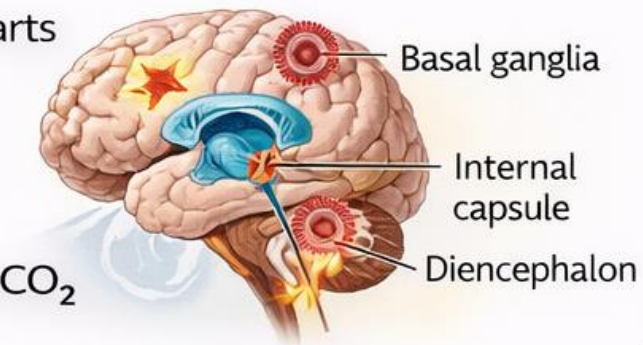


Impaired Consciousness

2. Respiratory Abnormalities

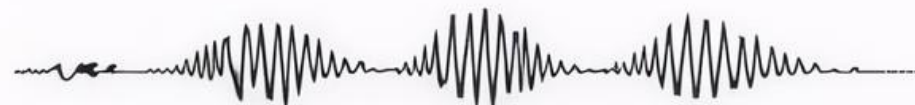
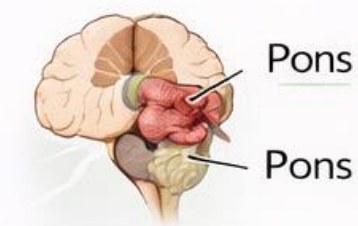
1. Cheyne-Stokes Respiration (CSR)

- Cyclic, waxing and waning breathing pattern
- Starts with deepening, then becomes shallower with apnea pauses and then restarts a new cycle
- Caused by damage to the areas involved in consciousness regulation such as the Basal ganglia, Internal capsule or Diencephalon
- Involves metabolic dysregulation and chemoreceptor sensitivity to levels like elevated PaCO_2 and low pH



2. Central Neurogenic Hyperventilation (CNH)

- Sustained, very rapid and deep respiration
- Severely disrupts the acid-base balance leading to respiratory alkalosis
- Caused by damage to the upper brainstem, especially the Pons, due to severe central nervous system injury



Altered level of consciousness (ALOC)

Glasgow coma scale					
EYE OPENING		VERBAL RESPONSE		MOTOR RESPONSE	
					
Spontaneous	4	Oriented	5	Obey commands	6
To sound	3	Confused	4	Localizing	5
To pressure	2	Words	3	Normal flexion	4
None	1	Sounds	2	Abnormal flexion	3
		None	1	Extension	2
GLASGOW COMA SCALE SCORE					
Mild 13-15		Moderate 9-12		Severe 3-8	

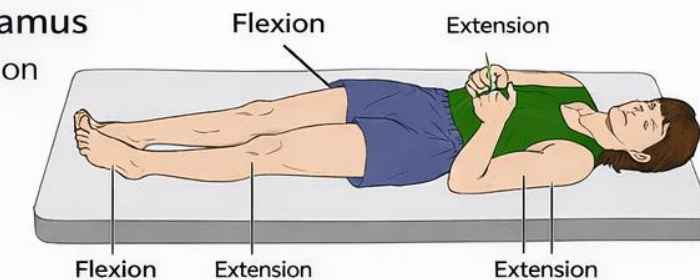
<https://share.google/kuPtruqr7JRmYrbFs>

Impaired Consciousness

Abnormal Reflex Motor Response

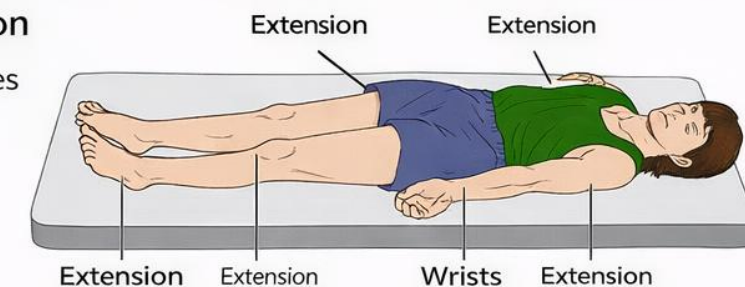
1 Decorticate posturing

- Results from damage to the **internal capsule** or **thalamus** separating the brain's hemispheres from the diencephalon
- Impairs the **pyramidal** system



2 Decerebrate posturing

- Caused by damage to the **midbrain** or **diencephalon**
- Midbrain is a connector between the brain's hemispheres separating the forebrain from the cerebellum



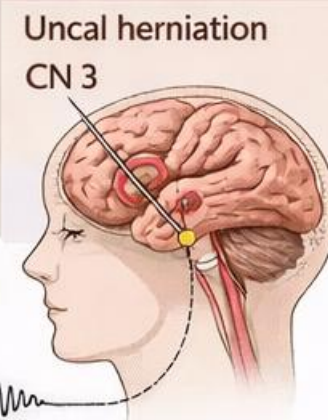
Altered level of consciousness (ALOC)



Impaired Consciousness Abnormal Pupillary Reactions

1 Dilated and nonreactive pupil (Uncal herniation)

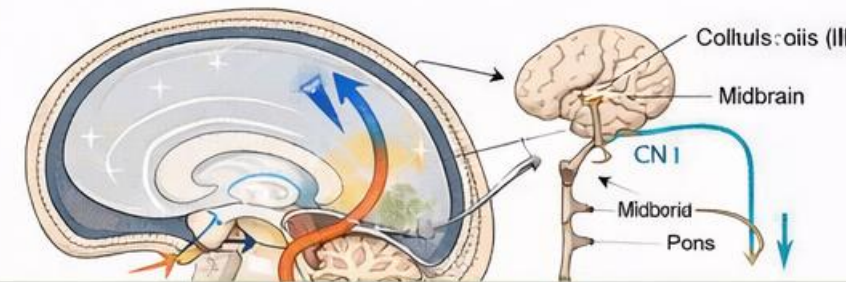
- Pupil unilaterally dilated and fixed
- Compression of **oculomotor nerve (CN 3)** from uncal herniation
- Results in **parasympathetic** innervation loss to the eye
- Spelled under **thoracic** relation without causes



2 Hippus (Midbrain damage)

- Pupils dilate and constrict randomly without light stimulation
- Damage to the upper **midbrain** tectum impair light reflex afferents

- Severe midbrain damage
- Cardiopulmonary arrest (hypoxia)
- Anticholinergic poisoning



3 Pinpoint pupils (Pontine damage)

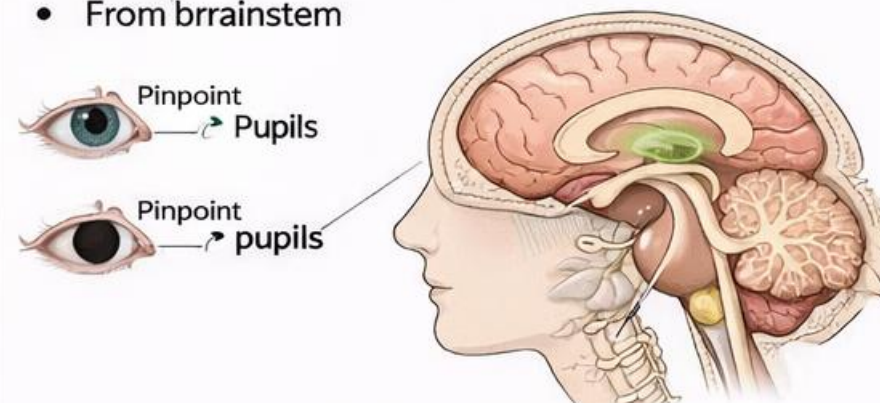
- Pupils bilaterally **pinpoint** and nonreactive
- Damage to the **Pons** disrupts sympathetic output, **fight or flight** control signal
- Opioid use or hemorrhage



Hippus

4 Small, nonreactive pupils (Diencephalon damage)

- Bilaterally **small** (1.5 mm, and nonreactive)
- Causes, **opioid** use or **hemorrhage** of spinal cord lesion
- From **brainstem**



Diencephalon damage

Altered level of consciousness (ALOC)

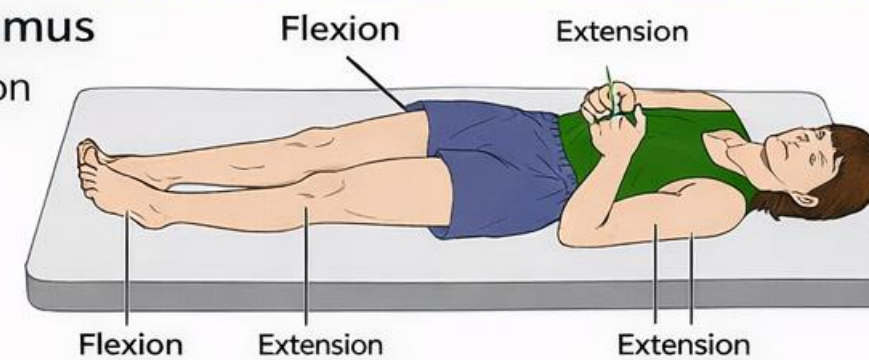


Impaired Consciousness

Abnormal Reflex Motor Response

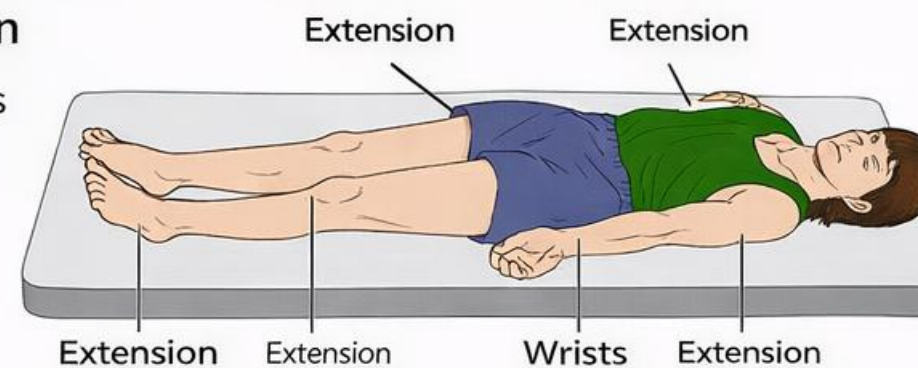
1 Decorticate posturing

- Results from damage to the **internal capsule or thalamus** separating the brain's hemispheres from the diencephalon
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- Caused by damage to the **midbrain or diencephalon**
- Midbrain is a connector between the brain's hemispheres separating the forebrain from the cerebellum



Altered level of consciousness (ALOC)



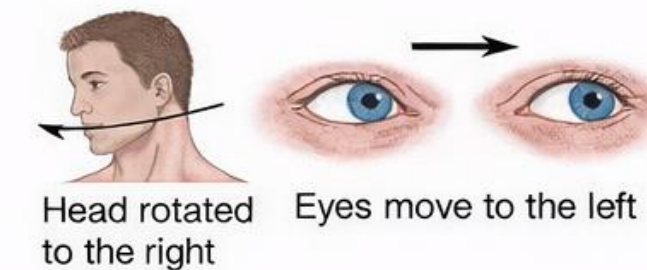
Impaired Consciousness

Abnormal Reflexes

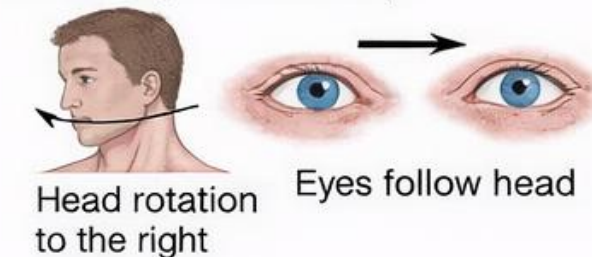
1 Oculocephalic reflex (Doll's eye reflex)

- Positively supports brainstem dysfunction
- Turn the head quickly to the side
- Check if the eyes turn in the **opposite direction** of head rotation
- Absent or abnormal response indicates severe brainstem damage, higher risk of brain death

Normal (reflex present)



Abnormal (reflex absent)

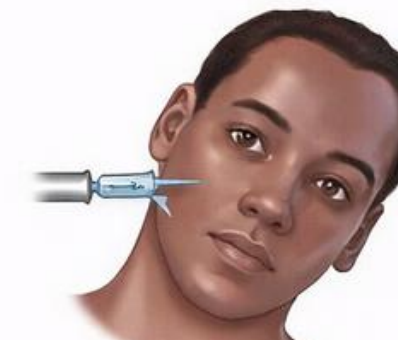


2 Oculovestibular reflex (Caloric test)

- More precise than oculocephalic reflex
- Cold (30°C or ice water) or warm (42°C ~~ees~~ ice water) is instilled into one ear → > <
- The head is elevated 30–100 degrees, opposite ear is up
- Normal response: **eyes move** toward irrigated ear, followed by nystagmus toward the opposite ear
- **Abnormal response:** absent or abnormal eye movement is consistent with severe brainstem damage, brain death

A. Normal caloric

B. Abnormal caloric



A. Normal caloric

B. Abnormal caloric



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