



---

## Pathology

---

### Sheet

*Lec No:* 2

*Subject:* Disturbed fluid balance & increased ICP

*Done By:* Shahd Rihan

*Corrected By:* Omar saffar

*Doctor:* Heyam Awad

00/00/2017

# سُبْحَانَكَ اللَّهُمَّ رَبِّ الْعَالَمِينَ

Before we start :

1. You can watch (كيف تسيطر على عقلك و تبرمجه للنجاح) video  
<https://www.youtube.com/watch?v=QsMkoPCXCvo>
2. This sheet was written according to sec.2 record
3. Please refer to slide
4. Be aware while reading this sheet & if you find any mistake please correct it 😊

## ❖ Topics :

1. Introduction
2. Increased ICP "*intracranial pressure*"
3. Global causes of increased ICP
  - Brain edema
  - Hydrocephalus
4. Herniation
5. Hypoxia & Ischemia
6. Brain death

## Introduction

Brain is enclosed within the skull:

- Advantage → protect the brain
- Disadvantage → brain can't expand!! → so expansion of the tissues & fluid inside the brain can cause huge problem to the patient

What's present inside the skull ??

- 80% brain tissue (including fluid; around 75% )
- 10% CSF
- 10% blood

All these components:

1. Occupies certain volume , if it increases → little expansion can happen → signs & symptoms occurs to the patient ( it can be very dangerous & cause death )
2. Apply certain pressure ( normal pressure = 10 – 15 mmHg , maximum value = 25 mmHg )

NOTE: maximum value mean you don't need to reach it & if you reach it, the patient still has normal function of the brain ( NO signs & symptoms )

- If you exceed this maximum limit then the result is increased ICP ( intracranial pressure )



## Increased ICP

Increased ICP → means that the pressure inside the cranium has increased to a value more than 25 mmHg

### ❖ Causes :

- ✓ Increased the volume inside the cranium ( hemorrhage , tumor , edema , ...etc )
- ✓ If any component inside the cranium increases & its volume increase :
  - Brain tissue might increase by tumor
  - Edema in the brain ( as the brain contain 75% fluid )
  - Hemorrhage ( increased blood )
  - Increase CSF

❖ Signs & symptoms :

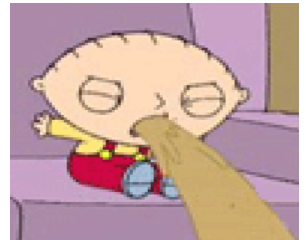
The pressure builds step by step so there are certain stages when ICP increases

**Stage 1** : ICP = 26 – 28

- Signs & symptoms = headache & vomiting → this is very important clinically as if patient come to you with **sudden headache & vomiting ( especially projectile vomiting )** then you should do something for him- take it seriously - & NOT to let him go home ( because if the patient leaves without doing anything to him, it might progress to stage 2 then stage 3 & you might kill the patient ☹ )

NOTE : Projectile vomiting :

vomiting with the material ejected with great force , (very dangerous).



**Stage 2** :

- Certain loss of function, dizziness, little confusion.

**Stage 3** ( last stage ) : Herniation

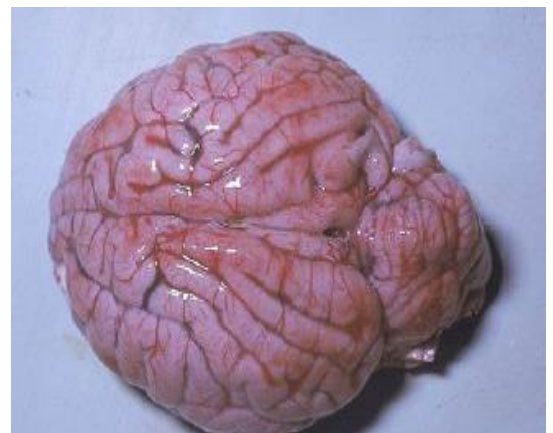
Now we will talk about the causes:

- ✂ Localized causes like tumor, infarction.
- ✂ Global causes that affect the brain generally

**Global causes of increased ICP**

We will talk about the **global** causes:

1. Brain edema - most important one -
2. Hydrocephalus



## Brain edema

Edema = Increase interstitial fluid

This fluid come either from blood vessels or from cells ( neural or glial cells )

### ❖ Types:

2 types: Vasogenic & Cytotoxic

Injury to blood vessels → fluid go out to interstitium → **Vasogenic edema**

- Vasogenic edema = edema due to increased pressure inside the vessels or injury to the vessels
- NOTE : occasionally injury to the vessel cause hemorrhage more than edema

More permeable membrane of the neural or glial cell due to inflammation or toxins → fluid go out to the interstitium → **Cytotoxic edema**

- Usually the 2 types of brain edema are co-exist ( like when there is inflammation ( the permeability of blood vessels increase & at the same time its toxic to the cells))

### ❖ Morphology :

If patient with brain edema die & you look to his brain then you will see :

- **Softness of brain tissue** ( Edema mean there is fluid so the brain ⇨ **Soft** )
- **Increased brain weight** ( normally it is 2% of body weight , about 1.2 – 1.4 Kg)
- **Flat gyri and narrow sulci** ( as there is less demarcation due to accumulation of fluid )

Note :

Male or female  
Brain weight: M > F  
Brain size: F > M



## Hydrocephalus

Hydro means “Water”, so Hydrocephalus means → “ Increased CSF within the brain ”

- CSF = fluid that come from the ventricle especially from modified ependymal cells called **choroid plexus**
- Function of CSF : Lubrication , exchange of material , buffer & a lot of functions in brain & spinal cord
- So CSF produce from choroid plexus then go through certain canal then go to sub-arachnoid space to undergo reabsorption ⇨ so there are production & re-absorption & they are balanced

### ❖ Causes that increase CSF :

If the production increased or the reabsorption decreased then there is net increase in the CSF

The **commoner** is decreased absorption as the causes of increased production usually the tumors which is rarely happen as well as we need functional tumor here which is also rare!!

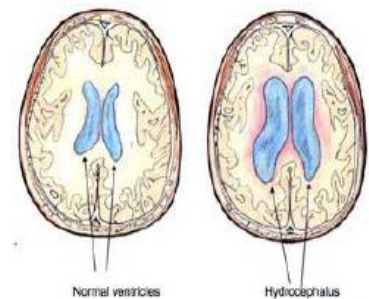
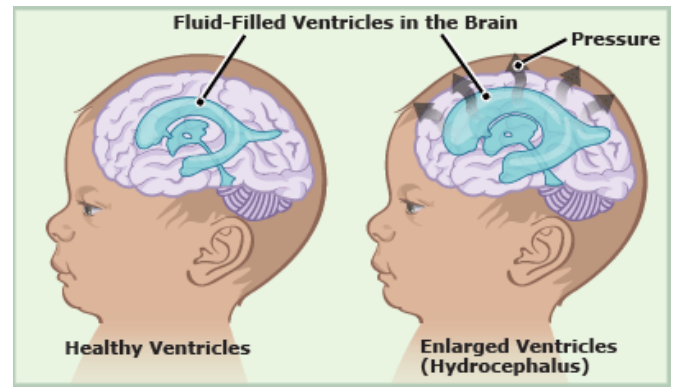
Decreased absorption can happen due to obstruction in the ventricular system

*“Increased CSF means Hydrocephalus”*

↑CSF lead to ↑ICP

Hydrocephalus might be:

- **Localized** : called non-communicating hydrocephalus \ if only one area is compromised
- **Generalized** : called communicating hydrocephalus





- CSF accumulate in sub-arachnoid & ventricles BUT more in ventricles ( as seen in MRI ) even if the absorption occur in sub-arachnoid ! ( that's because the site of CSF production is the ventricles )

### ❖ Hydrocephalus in baby vs. hydrocephalus in adult:

- In **baby** : the skull have sutures "*fontanelles*" that close at the 6<sup>th</sup> month\* so in baby this sutures still open → there is chance for expansion to happen → increase head circumference → less likely for the pressure to increase



- In **adult** : sutures are closed → no chance to expand → NO increase in head circumference → increase ICP & herniation

*\*Actually fontanelles don't close "ossify" at the 6<sup>th</sup> month, to be more accurate; the anterior **fontanelle** close over by 9 to 18 months. The sphenoidal and posterior **fontanelles** close during the first few months of life*

-Extra note

NOW as we said the end result of increased ICP is herniation in stage 3

## Herniation

Hernia means the thing that go out of his site that held it, or "*a condition in which part of an organ is displaced and protrudes through the wall of the cavity containing it*"

Brain is held by skull & surrounded by dura that also held it in its place.

If the brain go out from any weakness area then this is herniation

### ❖ Weakness area & Types of herniation :

Foramen magnum → **Tonsillar** herniation

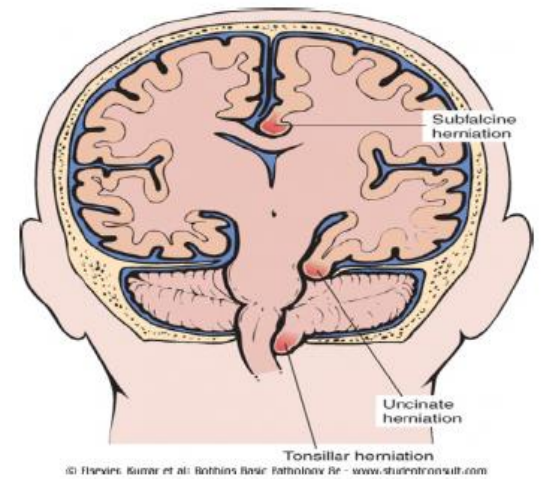
Under falx cerebri there is weak area that can undergo herniation → **Sub-falcine** herniation

Under tentorium also there is weak area → **sub-tentorial** herniation

There are 2 dural reflections:

- Falx cerebri
- Tentorium cerebelli

- ❖ So there are 3 types of herniation, BUT the **most dangerous** one is **tonsillar herniation** because the brain stem "*medulla oblongata especially*" is compressed so respiration & cardiac centers could be affected so the patient might die.



- ❖ **Sub-falcine area** lies near to the **Ant. cerebral artery** so when there is sub-falcine herniation ⇒ Ant. cerebral artery can be compressed ⇒ Ischemia in the area that is supplied by this artery.
- ❖ **Sub-tentorial area** lies near to the **Post. Cerebral artery** so : sub-tentorial herniation → compresses the artery → Ischemia in area that supplied by it .

In sub-tentorial area there is also an important structure which is the **3<sup>rd</sup> cranial nerve** that responsible for the movement of the eyes & it might be compressed in sub-tentorial herniation

**Treatment of herniation:** decrease ICP ( open in the cranium to remove fluid )





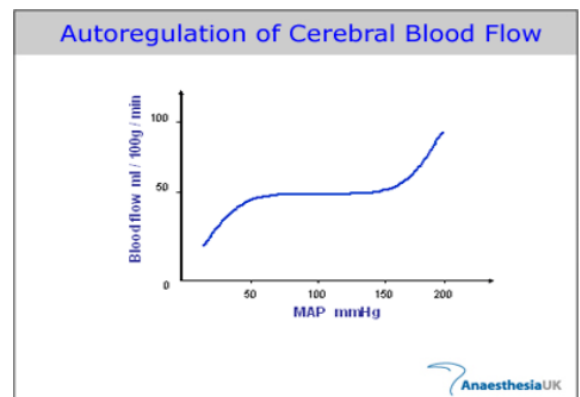
Now , one of the important cause that can result in brain edema as one of its complications is Hypoxia & Ischemia

## Hypoxia & Ischemia

We will talk about **global** hypoxia, NOT focal hypoxia

Focal ischemia lead to infarctions which is part of stroke – will discuss in the next lecture ☺

- Global hypoxia affecting all the brain
- The cause might be hypoxic or ischemic → so the problem might be in blood supply **or** hypoxia without a problem in blood supply
- Normally when blood pressure increases then the flow to organs will increase ( i.e more fluid ) so the blood vessels in that area try to decrease the amount of fluid that come to it by vasoconstriction WHILE when the pressure decrease then less fluid so vasodilation – BUT this mechanism not present in the brain
- The brain independently keeps taking it's enough blood supply irrespective to the systemic BP & this is called **Autoregulation** that happen between 50 to 150 mmHg ( there is variation in these numbers so you should memorize the numbers that you will take in physiology )



So from 50 – 150 mmHg there is autoregulation so the tone of blood vessels remains constant & the amount of blood that comes to the brain remain constant

The problems begin when :

- The systolic pressure > 150 mmHg → in this cause rupture can occur due to increase fluid
- The systolic pressure < 50 mmHg → hypoxia & ischemic damage to the brain

## ❖ Types of hypoxia:

2 types of hypoxia : ischemic & functional

- **Functional hypoxia :**

Functional → means low  $O_2$  ( either low amount or decrease utilization of it ) although there is normal blood flow

Causes of functional hypoxia :

Anemia ( all types ) , poisoning ( CO or Cyanide ) , high altitude

In CO poisoning >> the CO has higher affinity to Hb than  $O_2$

In CN- poisoning >> the cell can't take the  $O_2$  ( the problem in utilization of  $O_2$  )

- **Ischemic hypoxia :**

Blood flow decreases severely ( i.e systolic pressure  $< 50$  ) → so the  $O_2$  decrease ( global hypoxia ) → symptoms similar to functional hypoxia symptoms

Systolic BP become  $< 50$  in :

- ↳ Cardiac arrest
- ↳ Shock
- ↳ Severe hypotension

Global hypoxia or ischemia to the brain lead to changes in the brain ( swelling ) as in any reversible injury the first manifestation is swelling

If it's **mild** >> little confusion in the patient

If it **increases** >> death to the neurons

If it's **severely increased** >> brain death

So sever hypotension , if it's sustained without treatment , it will lead to brain death

Functional hypoxia



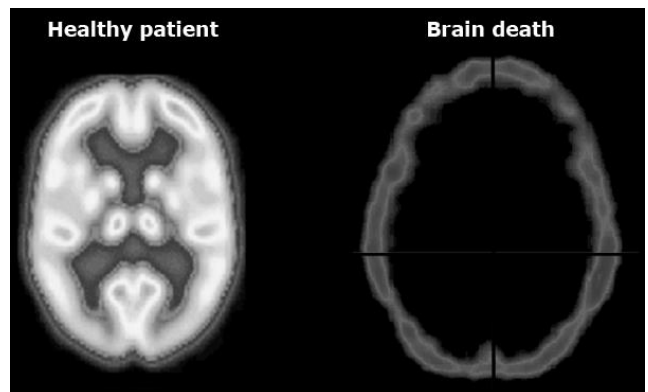
NOT all cells in CNS affected by hypoxia & ischemia in the same degree !! :

- Neurons affected more than glial cells
- Certain neurons affected more than other neurons : Most susceptible neurons: **pyramidal cells** of hippocampus and neocortex + **Purkinje cells** of the cerebellum

NOTE : Hippocampus is part of limbic system that has an association with emotion → So ischemia affect emotion firstly .

## Brain death

- Sometimes you hear that patient has brain death or brain stem death & the patient on ventilator so the heart & respiration works, whenever you remove the ventilator then the patient will die !!
- Patient with brain stem death means that he is dead !! , but his family still believe that he is alive .
- So one important clinical decision you need to take , is to decide whether to keep the ventilator or to remove it !!



### First thing:

- you need to be sure that the patient actually has brain death – NOT false diagnosis !

**Guidelines to diagnose with brain death: - NOT included in the exam -**

- 1. Structural problem in the brain**
- 2. Exclude all the reversible causes of coma like hypothermia**
- 3. 2 Doctors ( one consultant & the other worked for 5 years at least in medical treatment ) to do several tests in 2 separate occasions to see if there is reflexes or not**

**>> if there is NO reflexes & the other 2 points exist then → brain stem death**

**Second :**

- Go to the family explain the state , consult regard to the removal of ventilator & ask them about organ transplantation !

Its more benefit to take the organ for transplantation before the removal of ventilator ( more success rate )

---



*Le Fin.*

"Between what is said and not meant, and what is meant but not said, most of love is lost." – Khalil Gibran

Sorry for any mistake

Done by: Shahd Rihan

Revised by: *Omar Saffar*