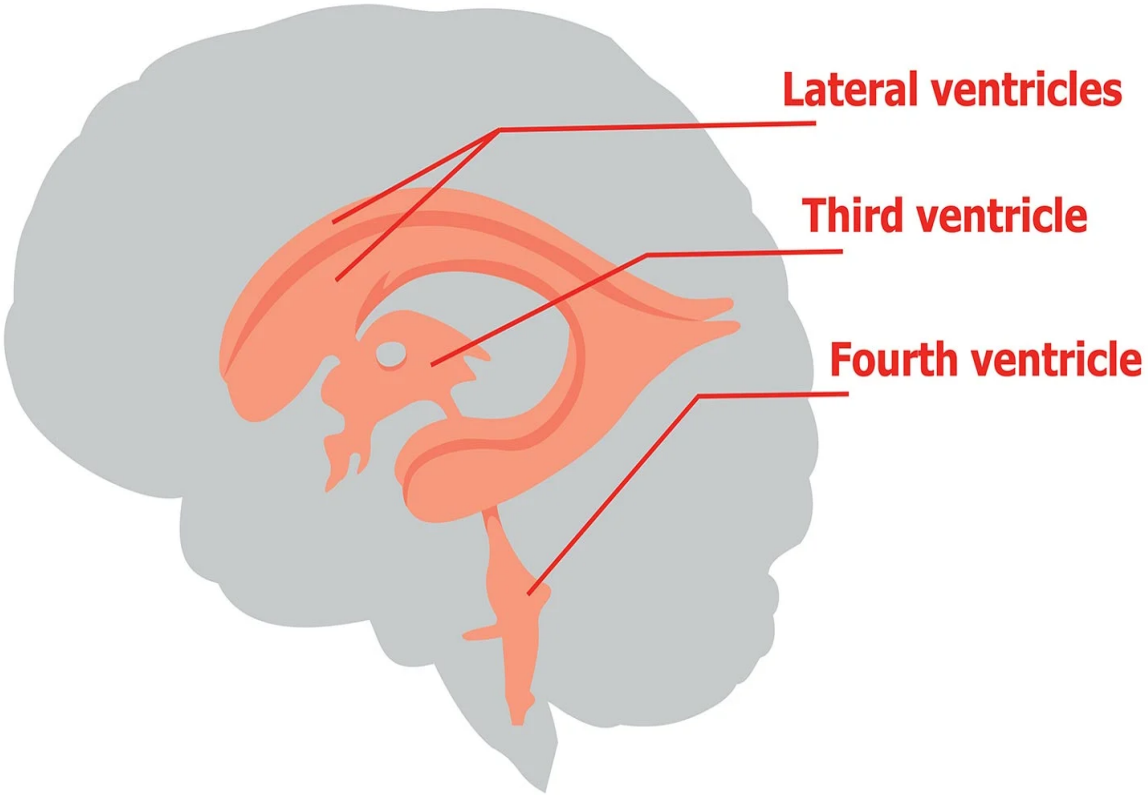
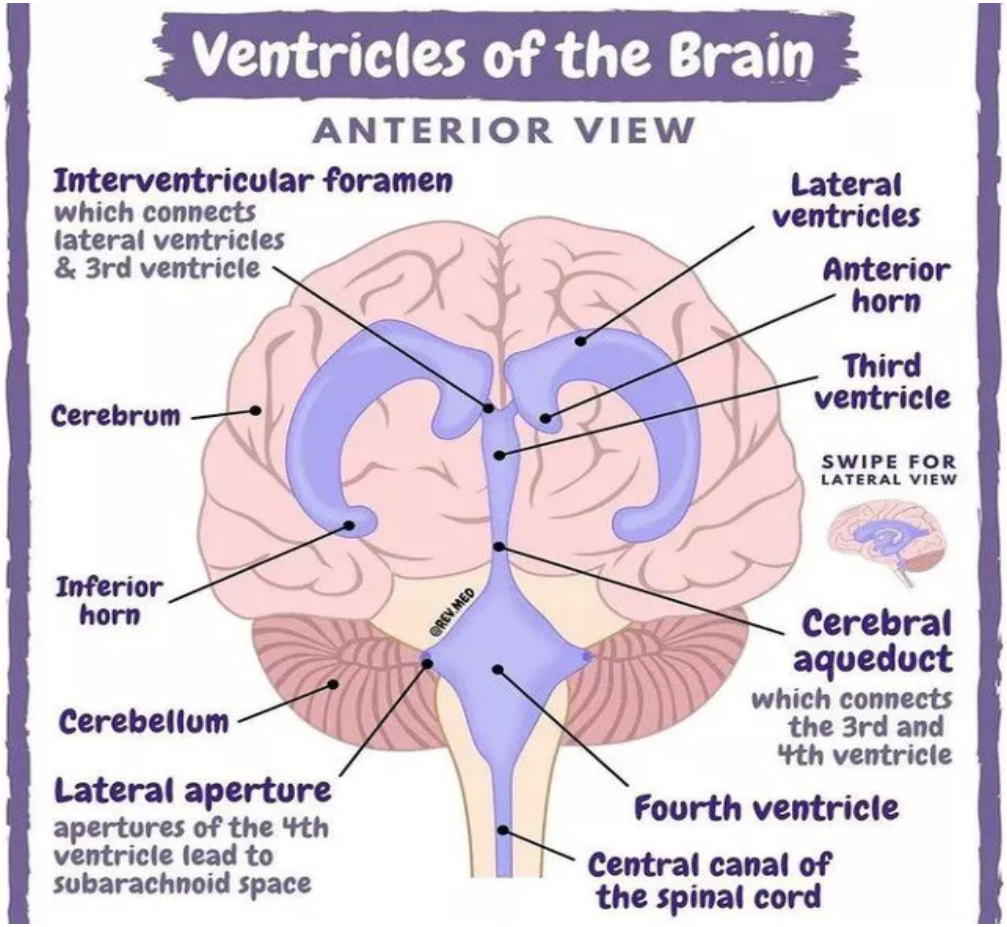
HYDROCEPHALUS

Done by : Shahed Al-khresheh

Bushra Alkawamlah

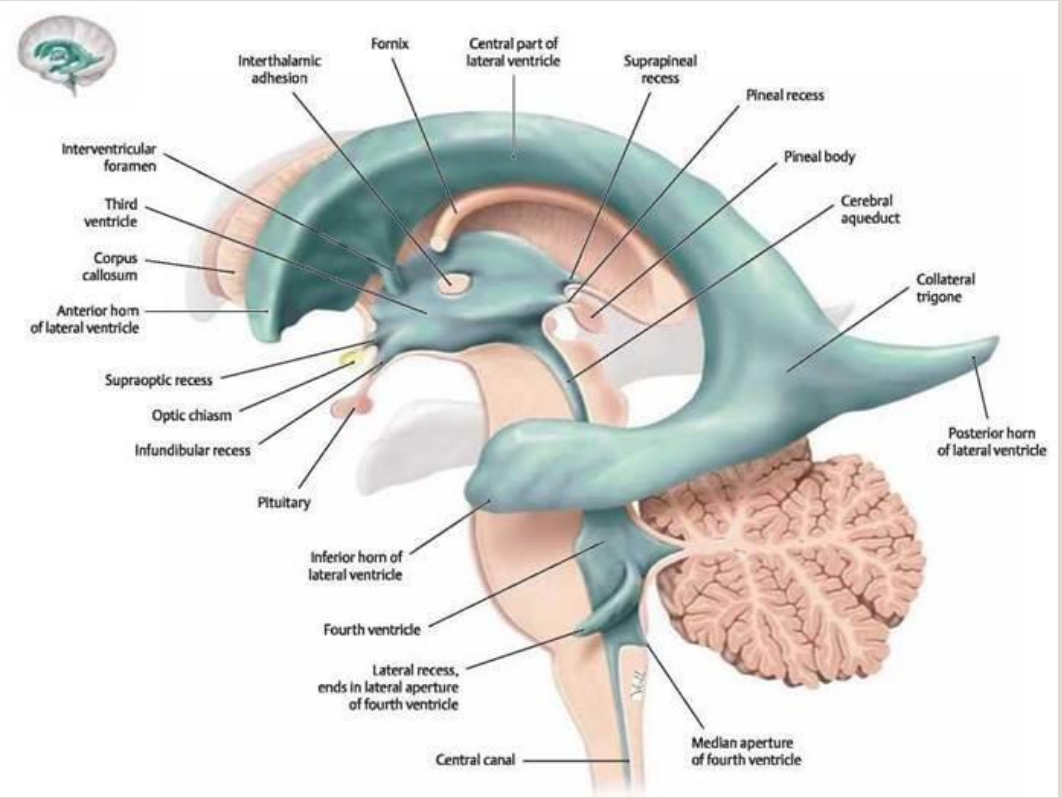

Lateral ventricles
Third ventricle
Fourth ventricle


Ventricles of the Brain
ANTERIOR VIEW
Interventricular foramen
which connects lateral ventricles & 3rd ventricle
Lateral ventricles
Anterior horn
Third ventricle
Cerebrum
SWIPE FOR LATERAL VIEW
Inferior horn
@REV.MED
Cerebral aqueduct
which connects the 3rd and 4th ventricle
Cerebellum
Lateral aperture
apertures of the 4th ventricle lead to subarachnoid space
Fourth ventricle
Central canal of the spinal cord

INTRODUCTION

Hydrocephalus : is an abnormal enlargement of the ventricles due to an excessive accumulation of CSF resulting from a disturbance of its flow, absorption or, uncommonly, secretion

VENTRICULAR SYSTEM OF THE BRAIN

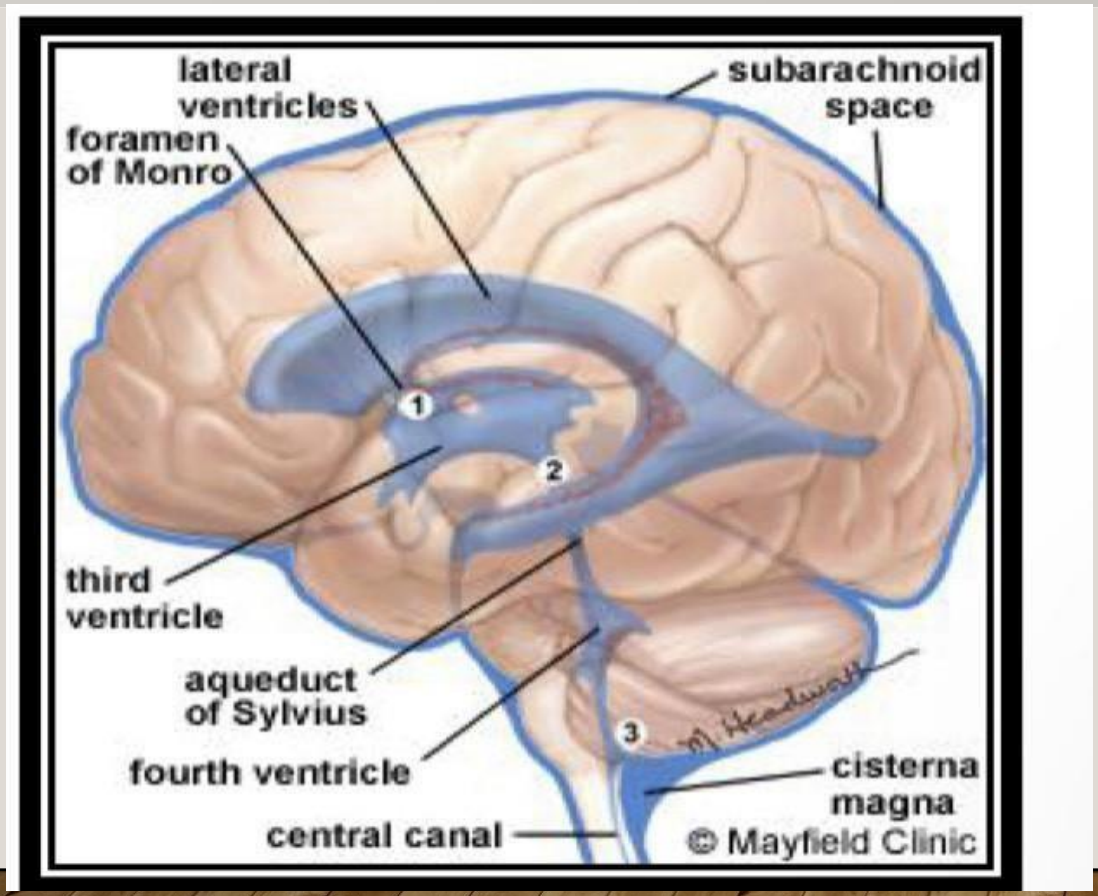


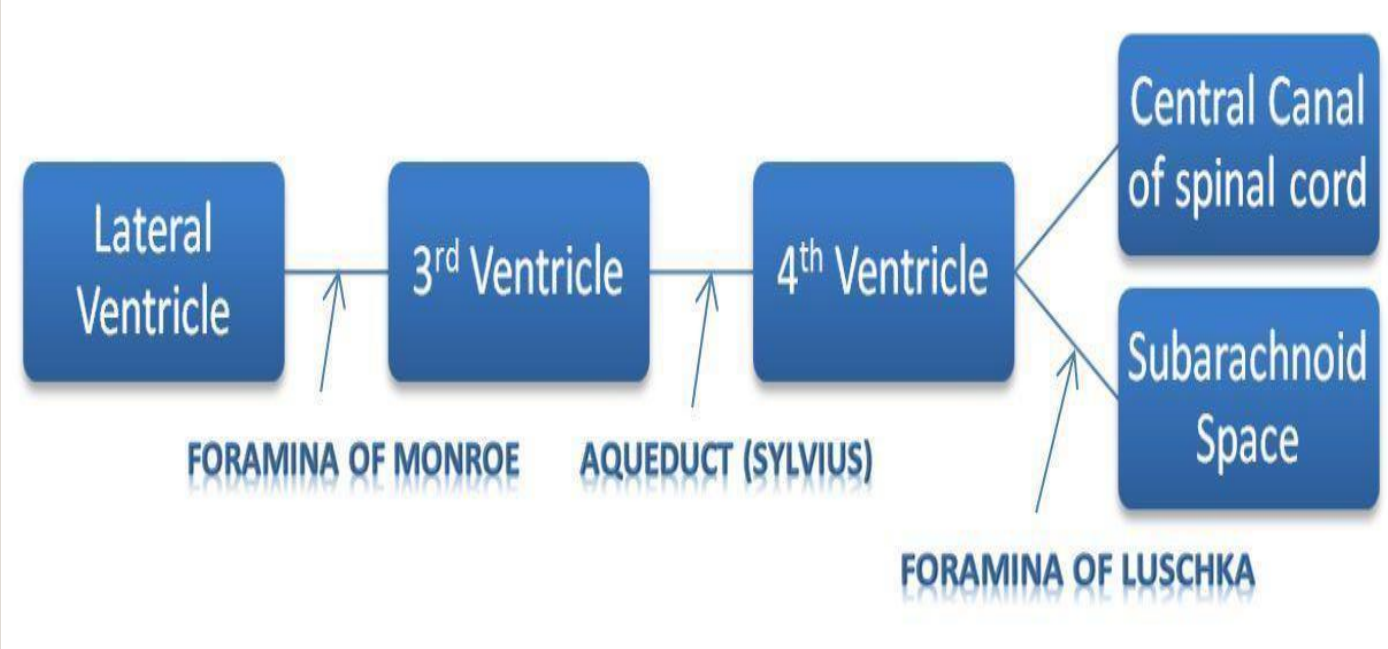
- The brain ventricles : are four cavities located within the brain that contain cerebral spinal fluid (CSF).
- Two lateral ventricles , the third ventricle and the fourth ventricle
- It protects the brain by allowing it to "float" in a fluid bath and provides a shock absorber against head trauma. The CSF itself also helps to provide nutrients to the brain and to keep the brain in chemical balance.

CEREBROSPINAL FLUID

- The CSF: is clear ,colorless fluid formed mainly by the choroid plexus , within the lateral ventricles, third and fourth ventricles of the brain .
- One third of CSF is from brain ECF
- Normal values of CSF dynamics :
  - Volume : 140 ml (120-150)
  - Formation : 0.4 ml/ min (0.3-0.6)
  - Turnover : 4 hrs (4-6 hrs)
  - ICP: <15 mmHg in adults (recommended intervention when it exceeds 22)

NORMAL CSF CIRCULATION





CONT..

- CSF CIRCULATION

▪The CSF flows from the lateral ventricles through the foramen of Monroe into the 3rd ventricle, via the aqueduct of Sylvius into the 4th

•ventricle and then through the foramina of Magendie and Luschka into the subarachnoid space and basal cisterns.

▪The CSF circulates throughout the spinal subarachnoid space and the basal cisterns up through the tentorial hiatus.

▪It flows over the cerebral hemispheres and is largely absorbed by the arachnoid villi of the dural sinuses.

CLASSIFICATION OF HYDROCEPHALUS

- Obstructive hydrocephalus **(**non-communicating**)** : when there is an obstruction to the flow of CSF through the ventricular system.

•Communicating hydrocephalus **:** when there is no obstruction to the flow of CSF within the ventricular system but the hydrocephalus is due either to obstruction to CSF flow outside the ventricular system or to failure of absorption of CSF by the arachnoid villi.

- some books classified it according to etiology

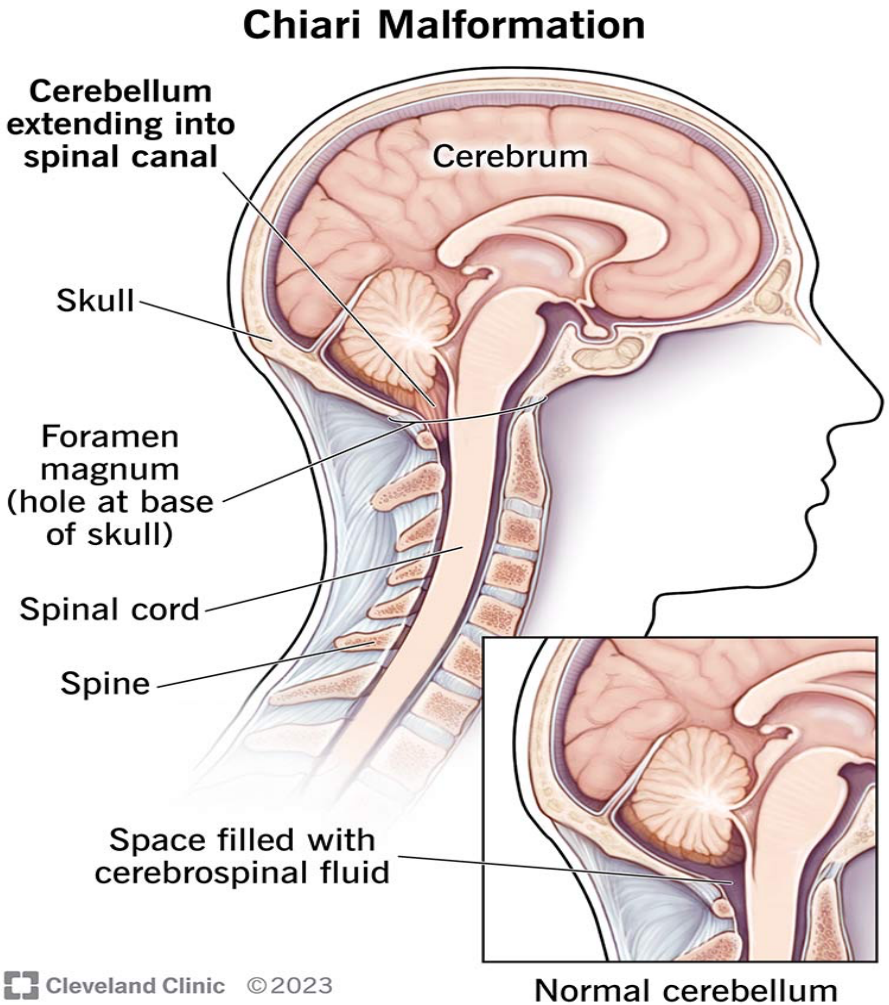
ETIOLOGY OF OBSTRUCTIVE HYDROCEPHALUS

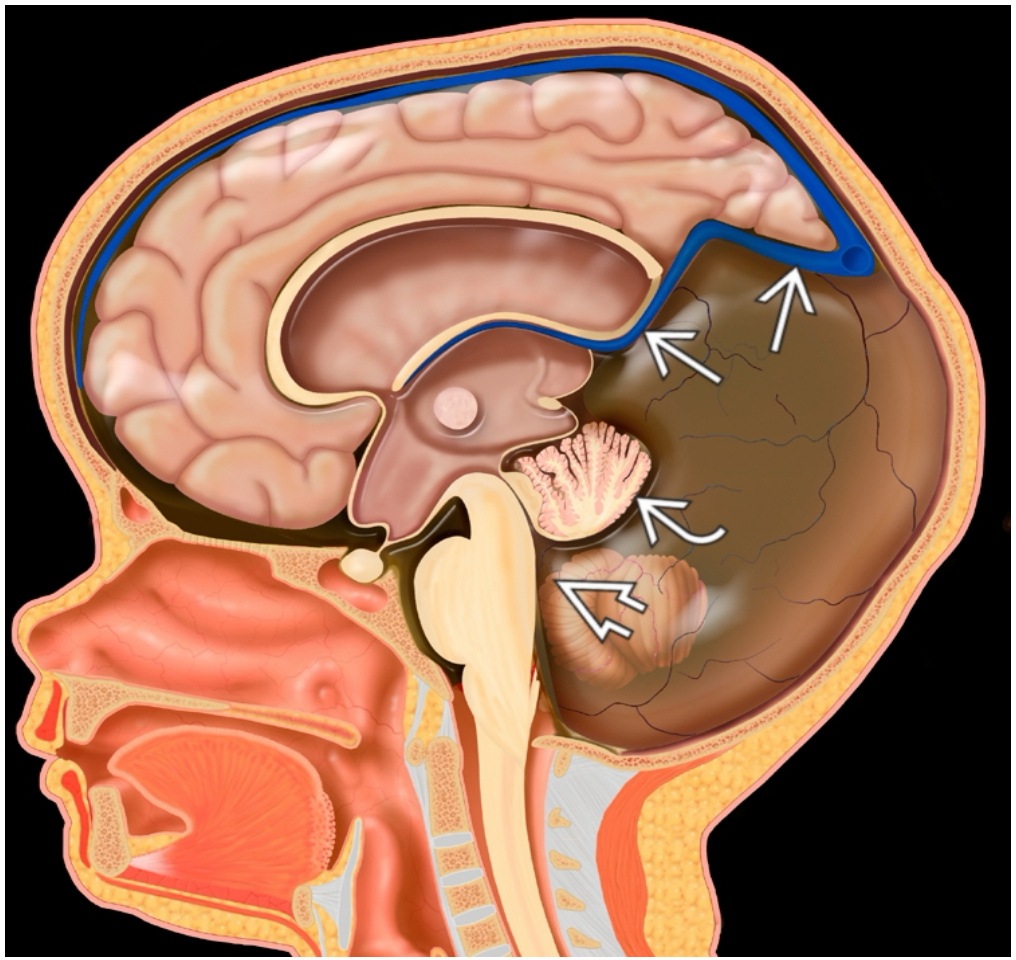
Congenital :

1. Aqueductal stenosis
2. Chiari malformation
3. Dandy -walker malformation
4. Intrauterine infection
5. Colloid cyst obstructing the interventricular foramen

Acquired :

1. brain tumor obstructing the flow of CSF
2. (especially medulloblastomas, pinealoma, ependymomas, and astrocytoma)


Chiari Malformation
Cerebellum extending into spinal canal
Cerebrum
Skull
Foramen magnum (hole at base of skull)
Spinal cord
Spine
Space filled with cerebrospinal fluid
Normal cerebellum
Cleveland Clinic ©2023



ETIOLOGY OF COMMUNICATING HYDROCEPHALUS

1) DECREASE ABSORPTION : (DAMAGE TO ARACHNOID VILLI)

INFECTIOUS DISEASE OF THE CENTRAL NERVOUS SYSTEM POST-MENINGITIS AND CYSTICERCOSIS (TAENIA SOLIUM)

POST HEMORRHAGIC (POST SUBARACHNOID HEMORRHAGE OR POST- INTRAVENTRICULAR HEMORRHAGE)

2) INCREASE PRODUCTION :

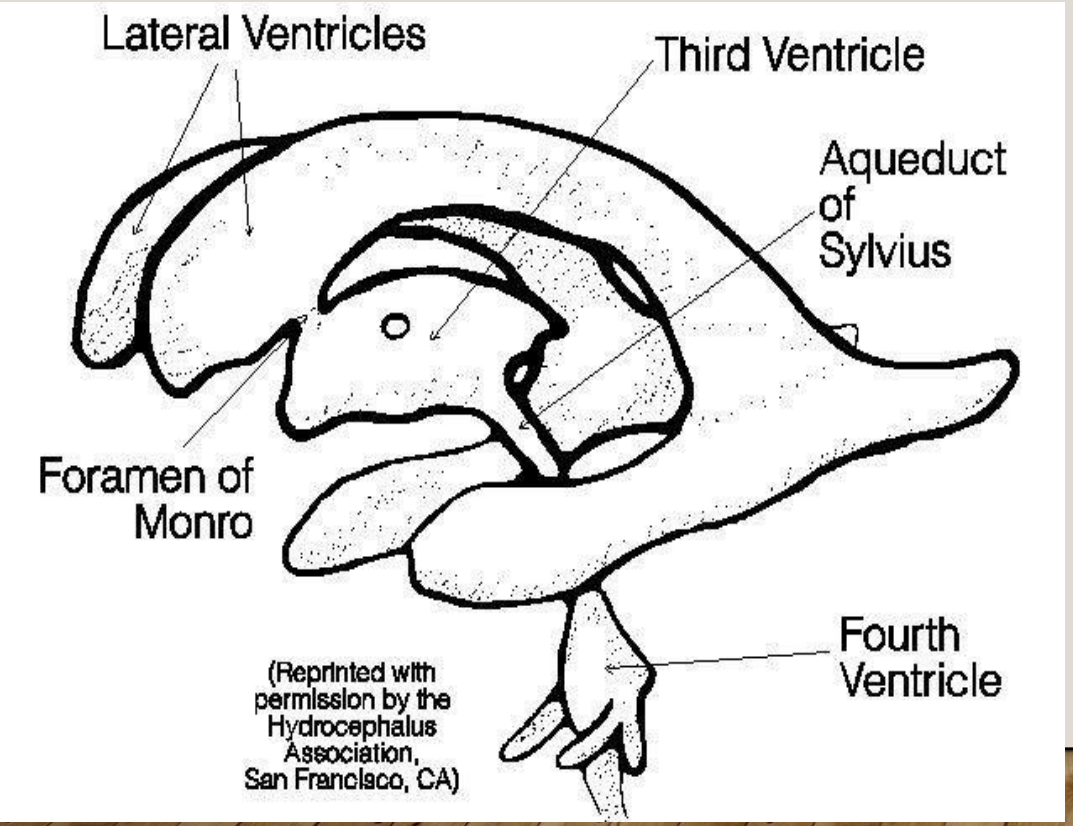
CHOROID PLEXUS PAPILLOMA OR CARCINOMA OR EVEN INFLAMMATION OF CHOROID PLEXUS

SYLVIUS *AQUEDUCTAL STENOSIS*

- **The most common congenital cause is stenosis of the aqueduct of Sylvius.**
- **This is a major cause of hydrocephalus in children with spina bifida and myelomeningocele .**

SYLVIUS *AQUEDUCTAL STENOSIS*

- The normal aqueduct measures about 1 mm in diameter, and is about 11 mm in length.



Is the most common cause of congenital hydrocephalus (43%).

- Aqueduct develops about the 6th week of gestation.
- Obstruction between 3rd and 4th ventricles
- M:F = 2:1 .
- Other congenital anomalies (16%): thumb deformities.
- Prognosis: 11% to 30% mortal

ETIOLOGY OF AQUEDUCTAL STENOSIS

- **Intrinsic Pathology of the Aqueduct (in infancy) inherited :**

▪Gliosis of the Aqueduct (peri-aqueductal gliosis): Usually of infectious origin showing a marked gliofibrillary response. The lumen is clear of ependyma. (proliferation of astrocyte)

▪Stenosis of the Aqueduct (true stenosis): Narrowed aqueduct without evidence of gliosis (aqueduct histologically normal). This may have hereditary basis.

▪Forking of the Aqueduct: Multiple channels (often narrowed) with normal epithelial lining that do not meet, separated by normal nervous tissue unable to handle CSF volume. Most often seen with spina bifida.

▪Septum or Membrane Formation: A thin membrane of neuroglia may occlude the aqueduct. There may be a primary developmental defect or it may follow granular ependymitis from intrauterine infections. This is the rarest of the types of narrowing.

Extrinsic Pathology of the Aqueduct (in adult) acquired :

▪ Infectious: Abscesses.

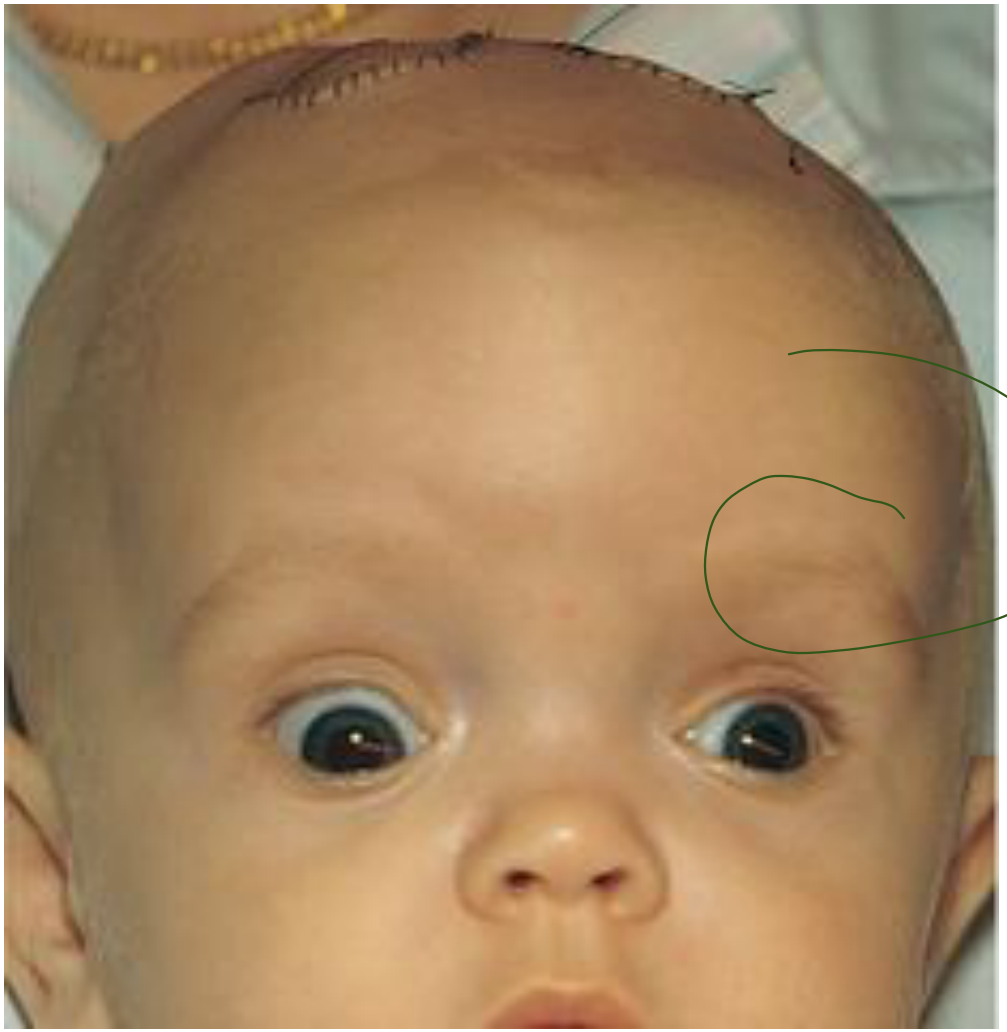
▪Neoplastic: Pineal tumors, brainstem gliomas, medulloblastoma, ependymoma.

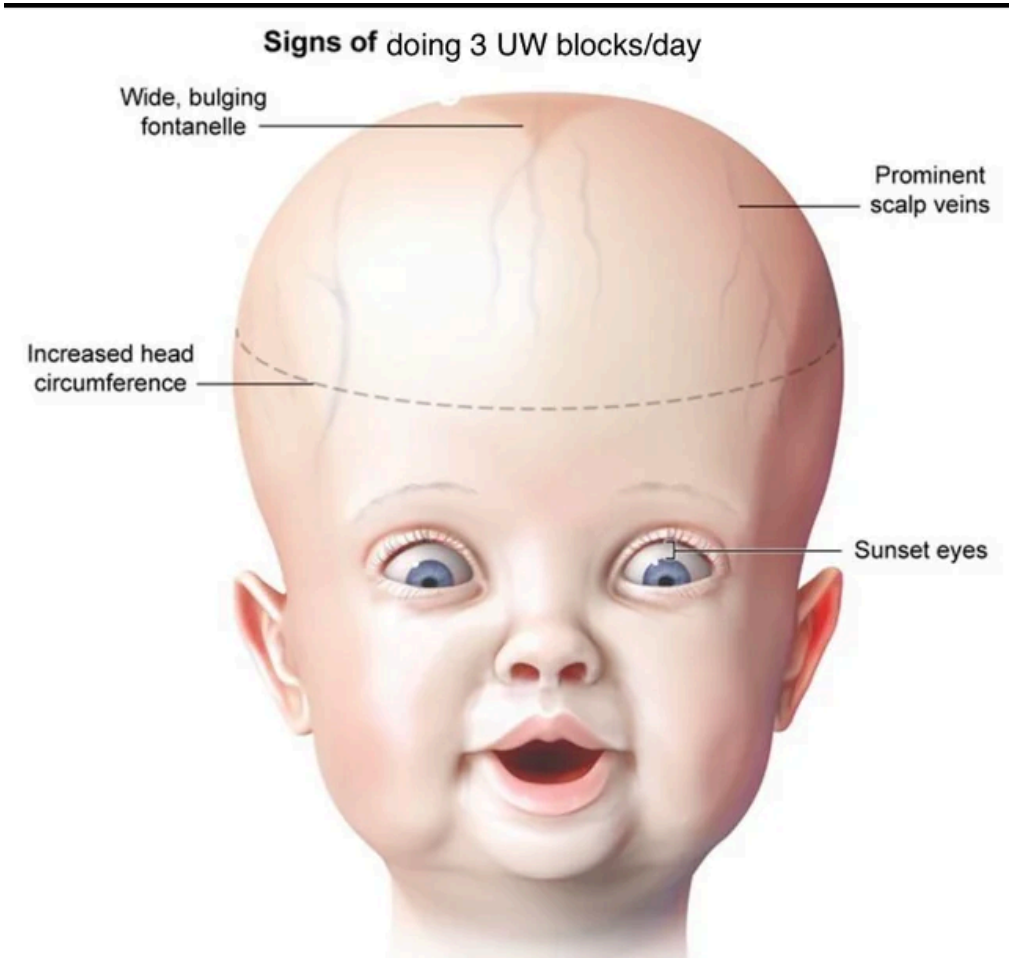
▪ Vascular: AVM, aneurysm.

▪ Developmental: Arachnoid cysts.

CLINICAL FEATURES OF AQUEDUCTAL STENOSIS

- Obstructive hydrocephalus: presents with macrocephaly and/or intracranial hypertension.
- Parinaud's syndrome: Inability to elevate eyes.
- Collier's sign: Retraction of the eyelids.

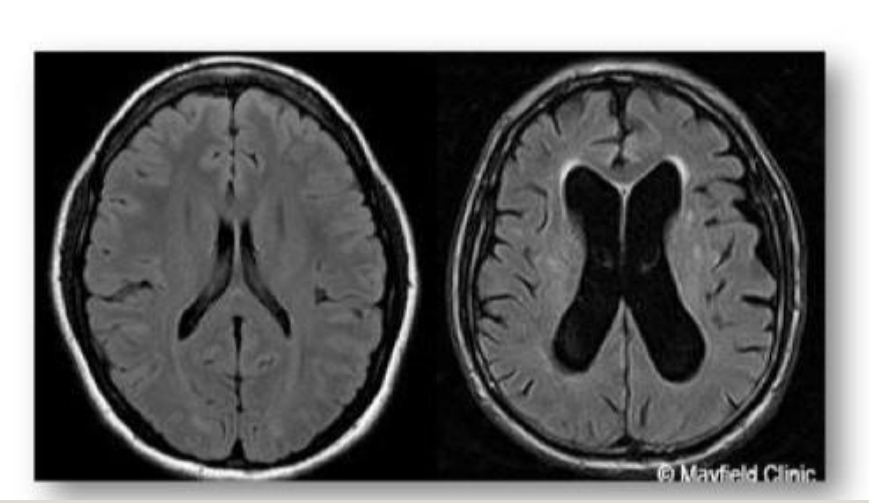



Signs of doing 3 UW blocks/day
Wide, bulging fontanelle
Prominent scalp veins
Increased head circumference
Sunset eyes

IMAGING OF AQUEDUCTAL STENOSIS

- Ultrasonography : can detect Aqueductal stenosis in utero.

- CT and MRI : MRI is essential if third ventriculostomy is to be considered.



MRI IN AQUEDUCATAL STENOSIS

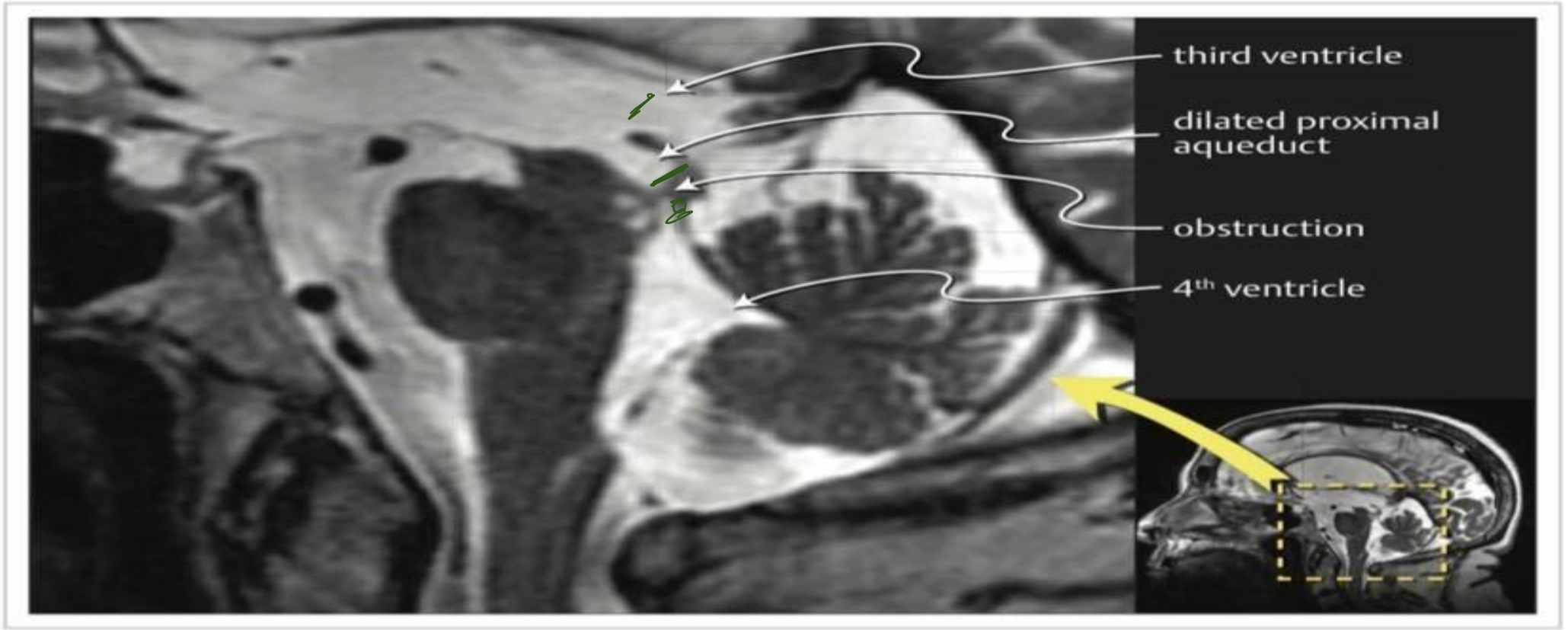


Fig. 15.4 Aqueductal stenosis in an adult.
Sagittal T2 MRI showing a web-like obstruction of the Sylvian aqueduct in a patient with dilated third and lateral ventricles with normal-sized 4th ventricle. The aqueduct proximal to the obstruction is also dilated, but the aqueduct connecting to the 4th ventricle (distal to the obstruction) is not dilated.
Inset depicts the location in the sagittal T2 brain MRI from where the detail is obtained.

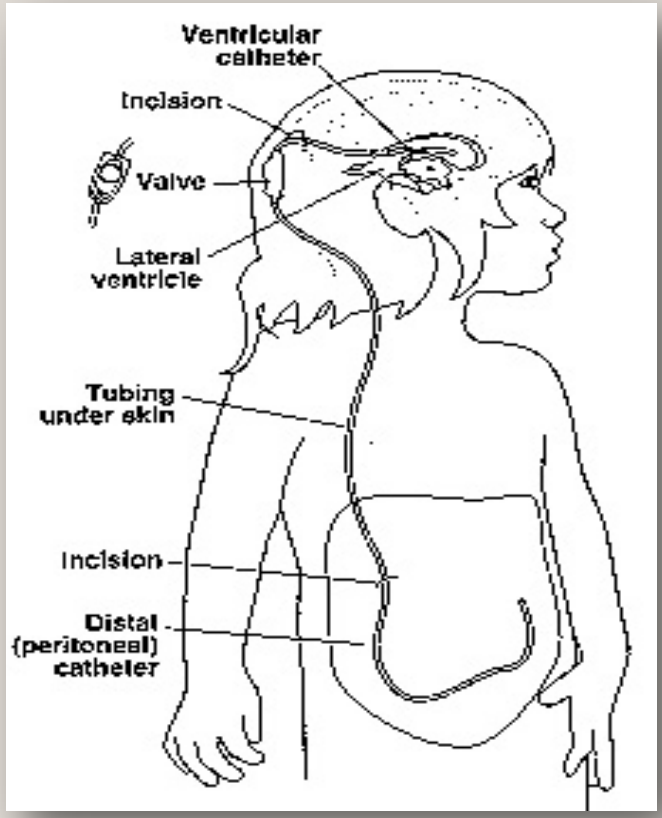
TREATMENT OF AQUEDUCTAL STENOSIS

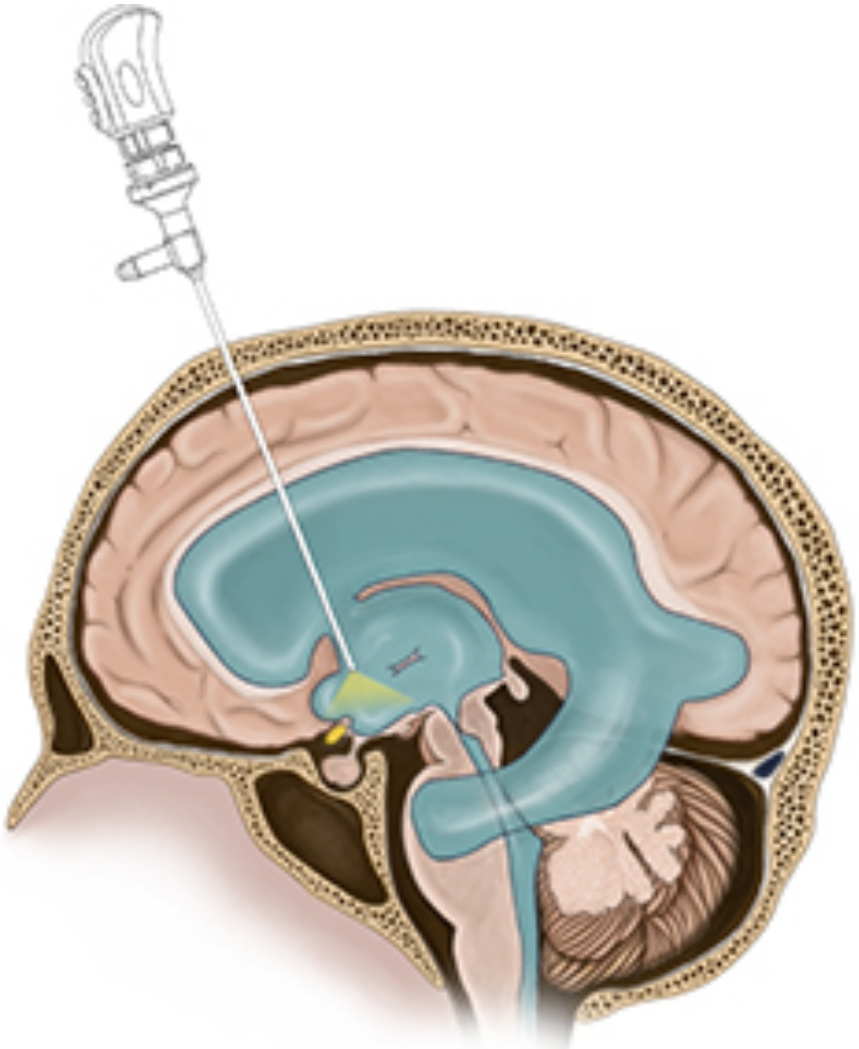
I. Remove underlying cause: of obstruction if possible.

II. Third ventriculostomy: as initial treatment of choice.

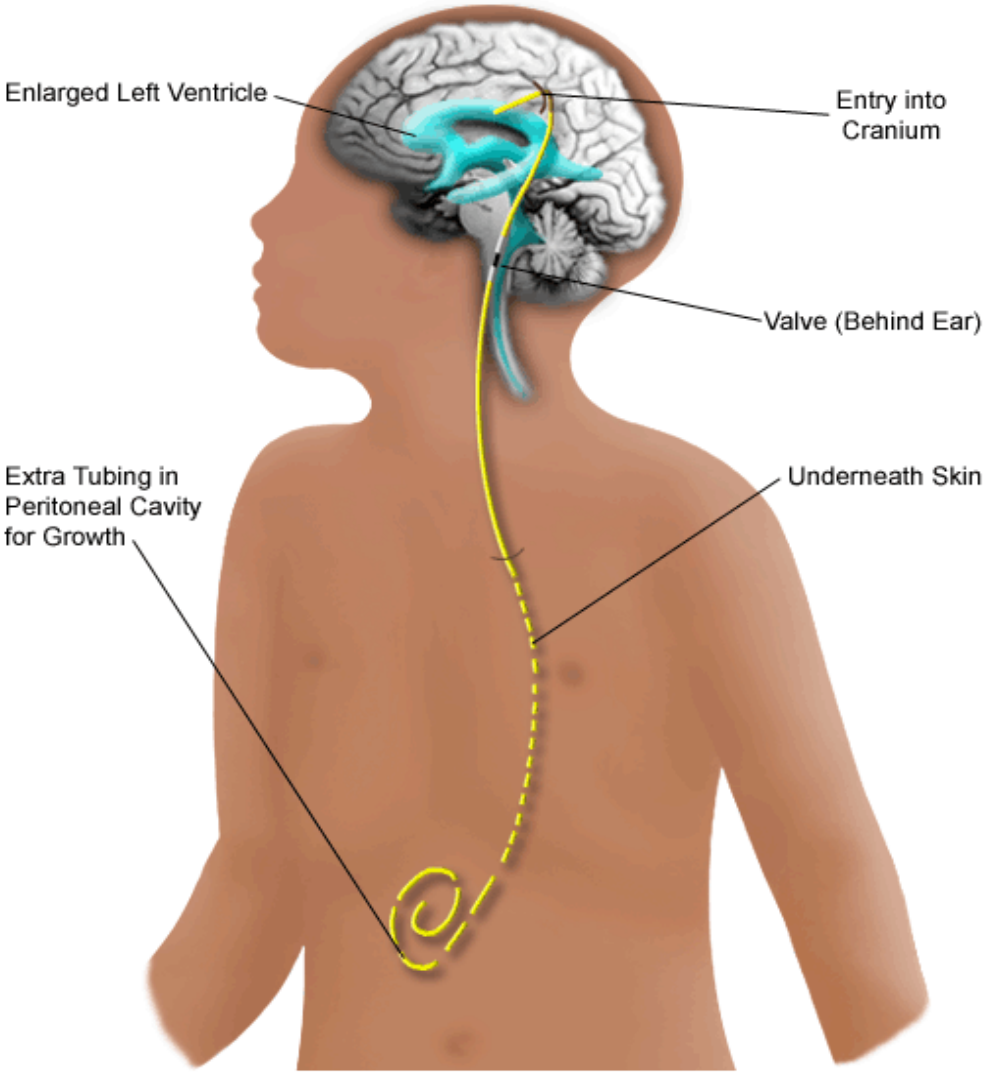
III. VP shunt: if technical reasons do not allow third ventriculostomy or if the child fails after ventriculostomy.

IV. Aqueductal stent: can be placed if technically feasible. Usually rarely done due to risk of upper brain stem injury.





Ventriculoperitoneal Shunt Placement

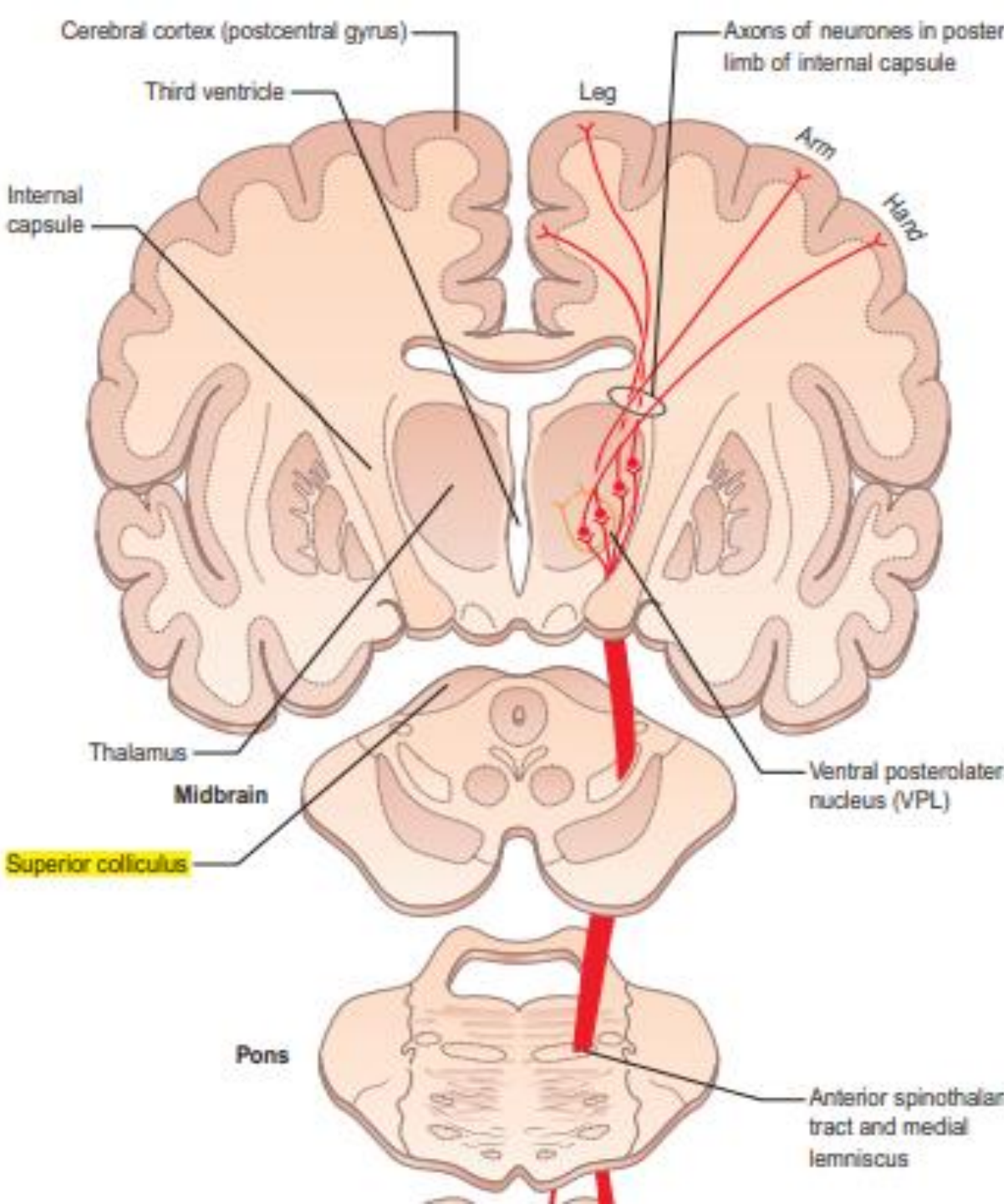


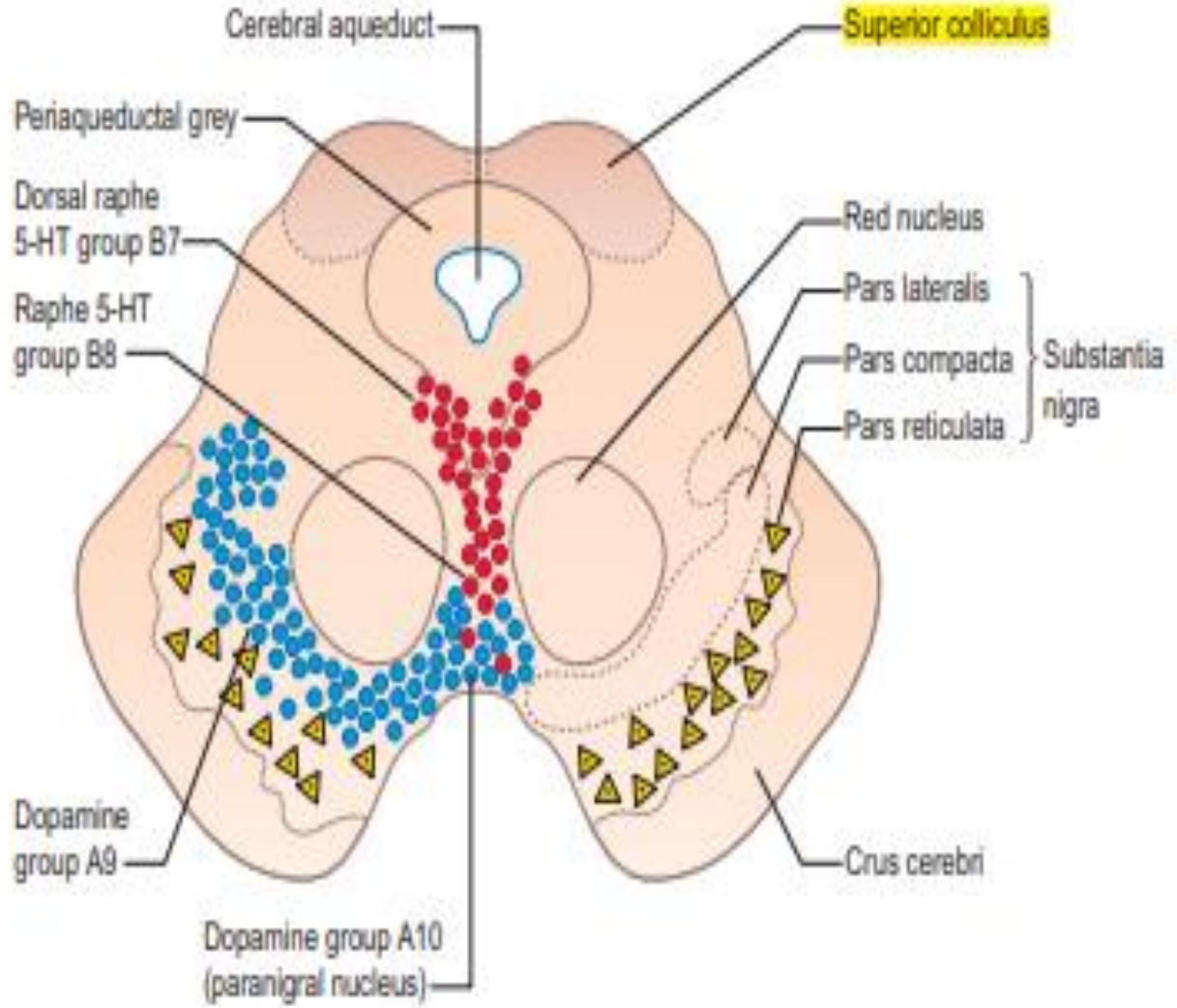
Presenting features Hydrocephalus in infants

- failure to thrive.
- increased skull circumference (compared with normal growth curves).
- tense anterior fontanelle.
- ‘cracked pot’ sound on skull percussion. (hyper-resonance)
- transillumination of cranial cavity with strong light.
- severe, impaired conscious level and Vomiting .
- ‘setting sun’ appearance due to lid retraction and impaired upward gaze from 3rd ventricular pressure on the midbrain tectum.
- thin scalp with dilated veins.

Presenting features Hydrocephalus in Adult

- **Acute** onset and deterioration
- **Gradual** onset and slowly progressive deterioration.





Dopaminergic neurones

Serotoninergic neurones

GABAergic neurones

A. Acute-onset adult hydrocephalus

This type of presentation occurs particularly in patients with tumours causing obstructive hydrocephalus, although it may occur with any of the causes of hydrocephalus and an acute rapid neurological deterioration may occur in patients who have had long-standing chronic hydrocephalus.

The major presenting features are due to the signs and symptoms of raised intracranial pressure(ICP) :

- headache
- vomiting
- papilledema
- deterioration of consciousness .
- Upgaze will often be impaired due to pressure of the dilated 3rd ventricle on the superior colliculus of the tectum.

B. Gradual onset adult hydrocephalus

this type of onset occurs less frequently than the previous type. The symptoms of raised intracranial pressure are only very gradually progressive and late diagnosis is common.

Early features in the adolescent involve deteriorating school performance as a result of headaches, failing mental function, memory loss and behavioral disturbances.

Endocrine abnormalities such as infantilism and precocious puberty can occur in association with chronic hydrocephalus in older children and adolescents due to disturbance of the hypothalamus and possible compression of the pituitary gland.

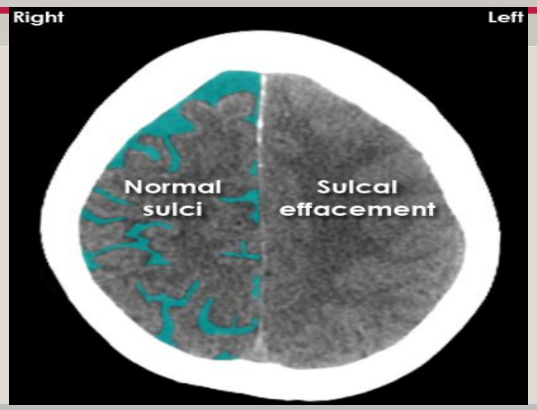
If the condition is unrecognized progressive visual failure will occur, secondary to papilloedema and optic atrophy. acute decompensation may occur and the patient may suddenly develop a rapid deterioration of conscious state.

RADIOLOGICAL INVESTIGATION:

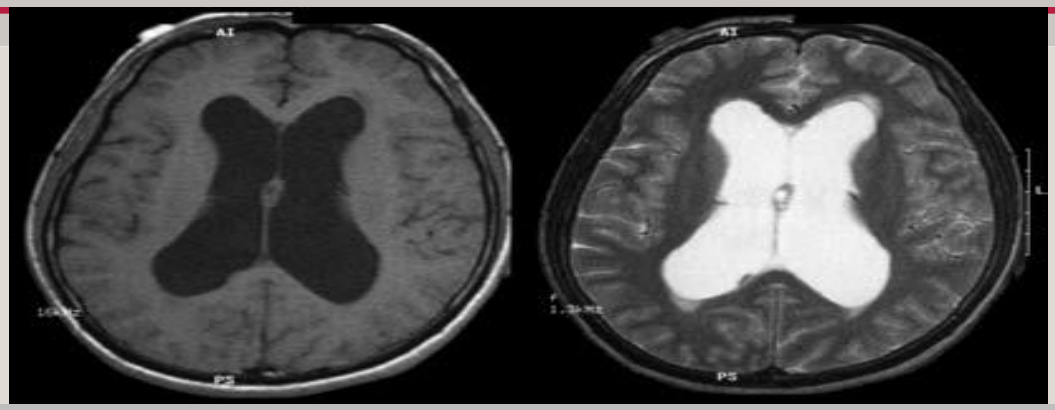
CT

MRI

A)



B)



- The most important investigation is either a CT scan or MRI of the brain which will show which ventricles are dilated.
- If the lateral ventricles and 3rd ventricle are all very dilated, and the 4th ventricle is small, it is likely that the obstruction is at the level of the aqueduct of Sylvius.
- In a communicating hydrocephalus all the ventricles are dilated.

❖**Signs on Radiology:**

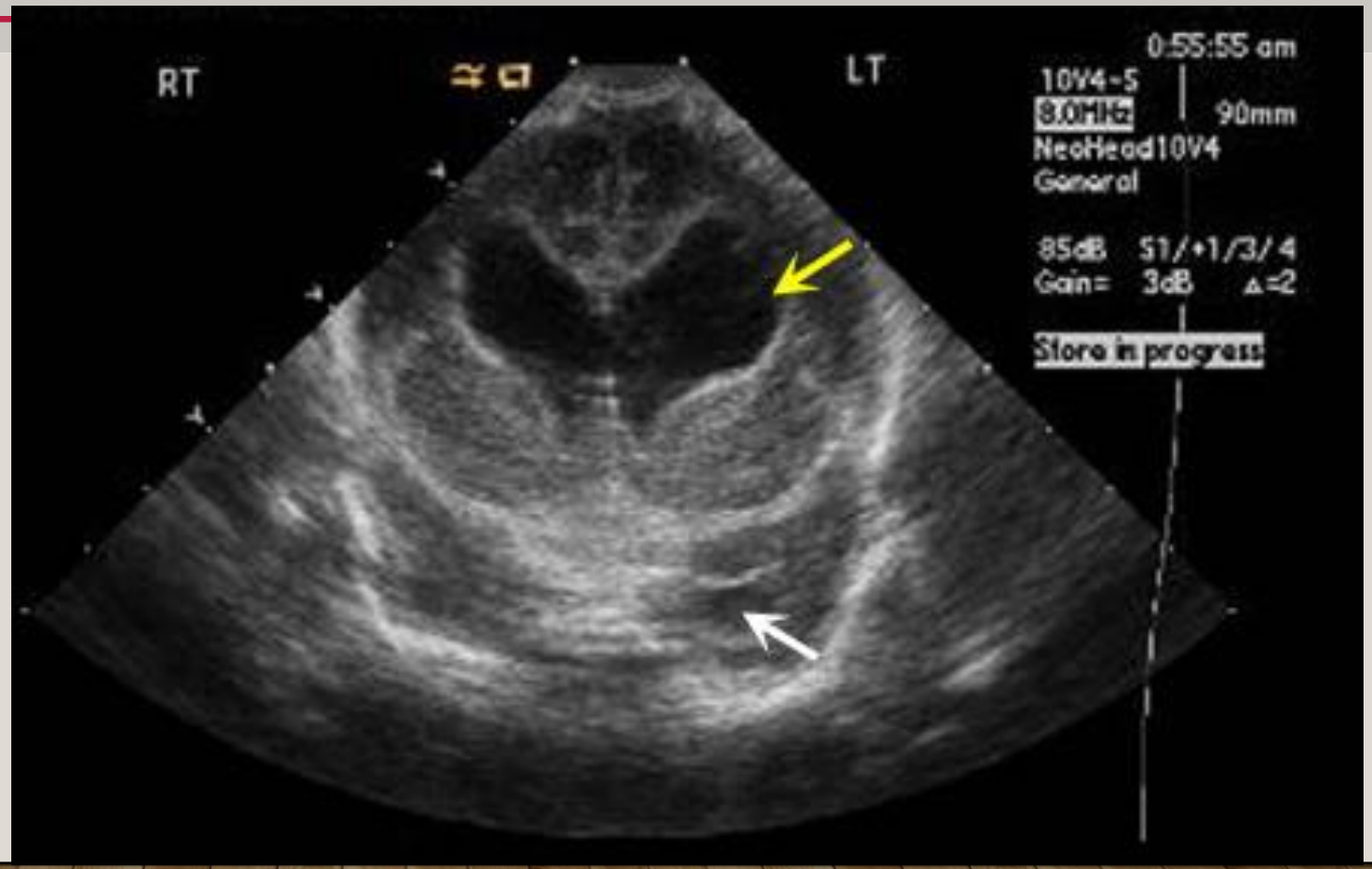
A. Effacement of gyri and sulci

B. Ventriculomegaly

Ultrasonography

***Ultrasonography through the* open anterior fontanelle is useful in assessing ventricular size in infants and may obviate the need for repeated CT scans.**

Infant with hydrocephalus with dilatation of frontal horns of both lateral ventricles (yellow arrow) and temporal horn (white arrow).



Treatment

Management of hydrocephalus will depend on the underlying cause, options include :

1. **Removing a causative mass lesion.**
2. **Ventricular shunting.**
3. **Third ventriculostomy.**

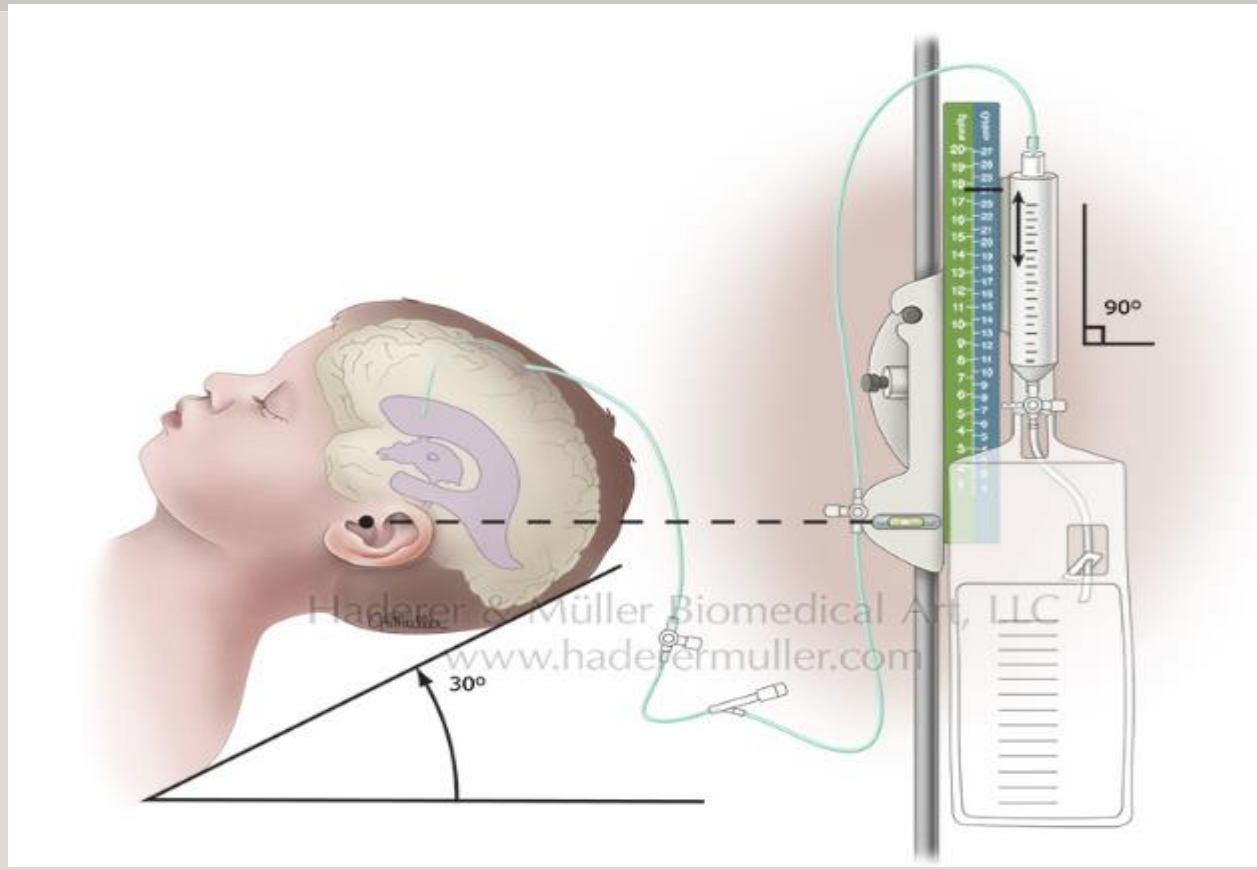
MEDICAL MANAGEMENT

This can be tried in mild cases of hydrocephalus.

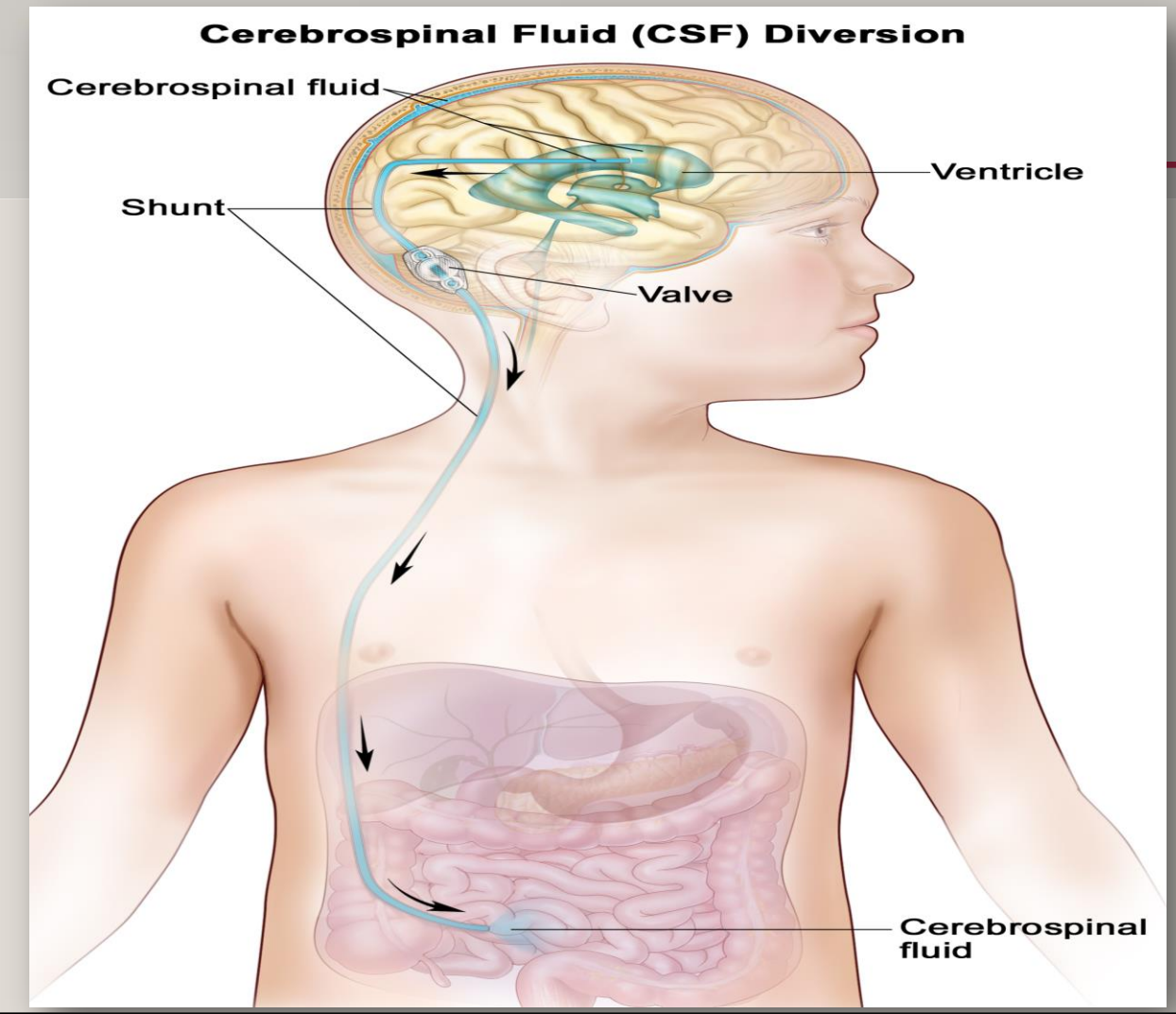
- **Acetozolamide**: dose of 50mg/kg/day dimnishes CSF production.
- **Oral glycerol** has also been used for the similar purpose.

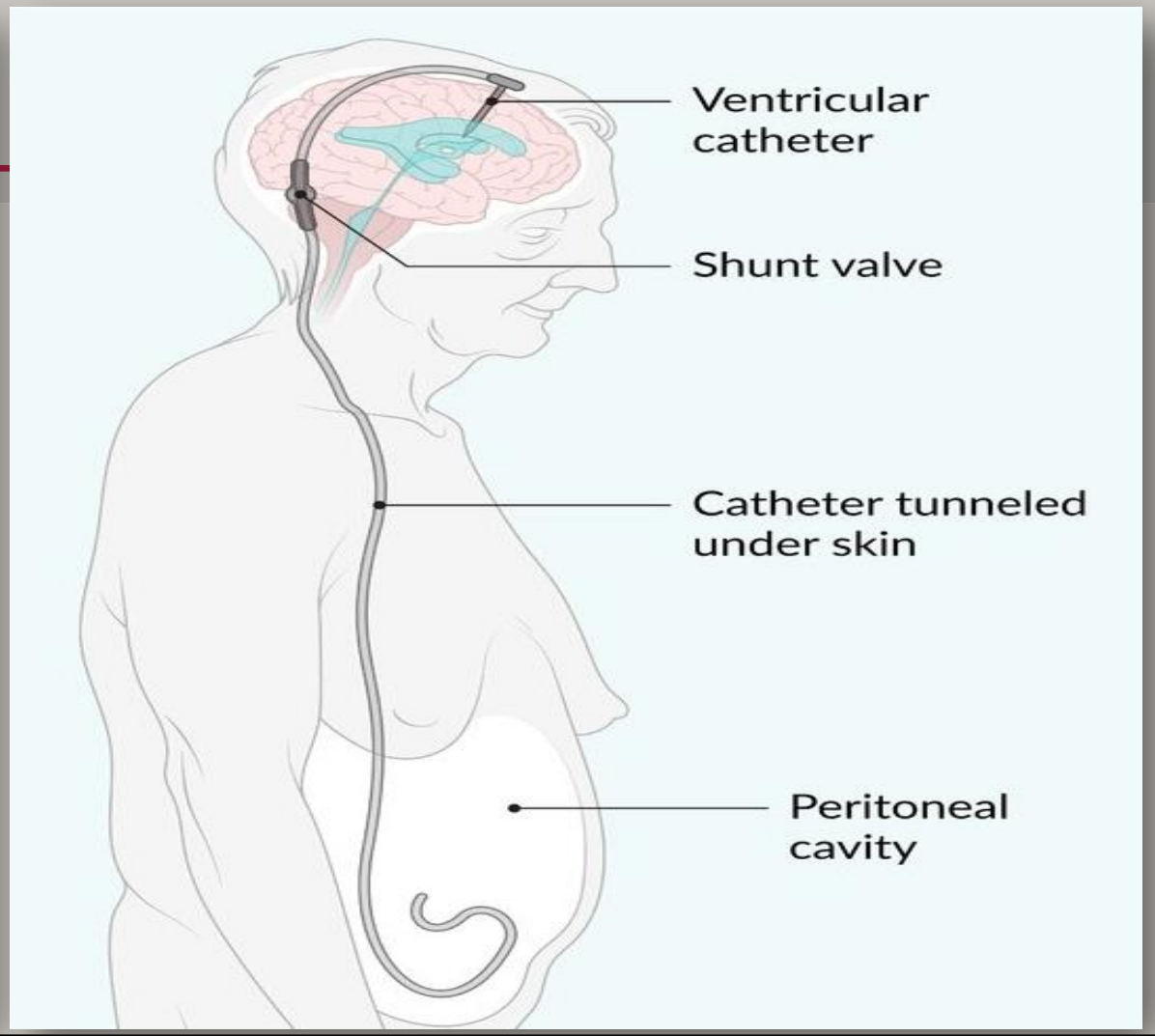
1. Removing a causative mass lesion

In some circumstances it may be appropriate to treat the hydrocephalus by tumor removal and decompression of the CSF pathways, perhaps with the insertion of an external ventricular drain (EVD) to cover the early postoperative period.



2. ventriculoperitoneal shunt





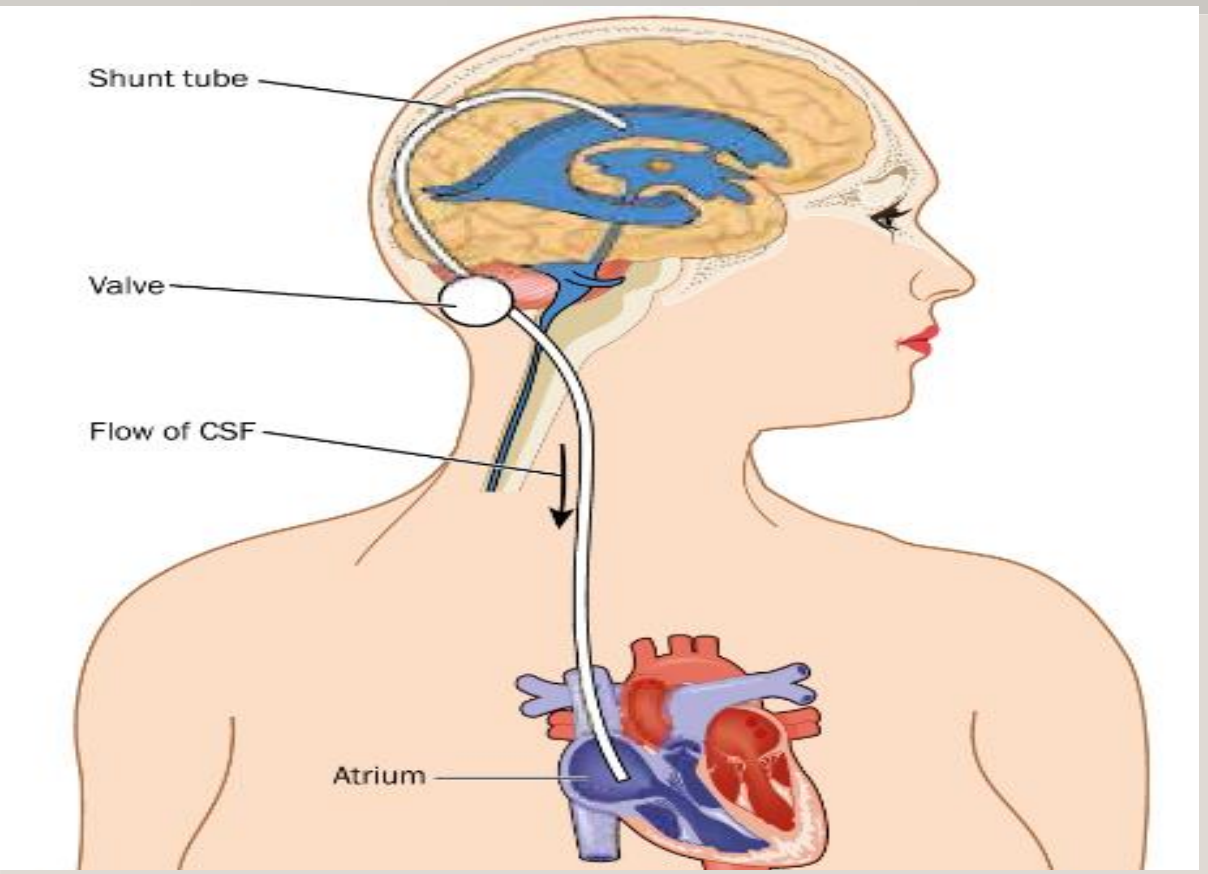
2. ventriculoperitoneal shunt

- involves the insertion of a catheter into the lateral ventricle. The catheter is then connected to a shunt valve under the scalp and finally to a distal catheter, which is tunneled subcutaneously down to the abdomen and inserted into the peritoneal cavity.

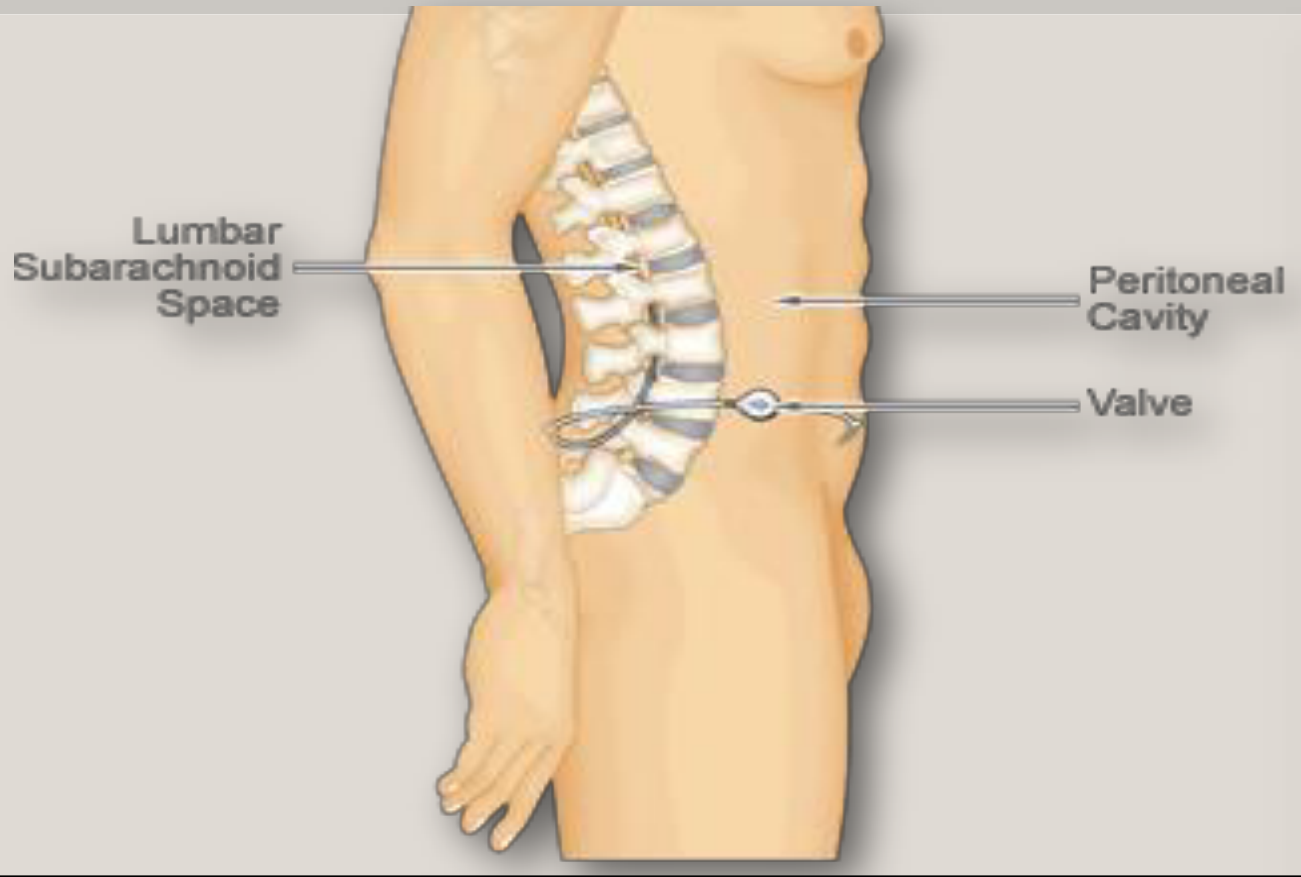
- If the CSF pressure exceeds the shunt valve pressure, then CSF will flow out of the distal catheter and be absorbed by the peritoneal lining.

3. Other options:

A. ventriculo-atrial shunt



B. lumboperitoneal shunt



Lumbo-peritoneal shunt

Other options for distal catheter placement include:

A. (ventriculo-atrial shunt): from the right atrium via the deep facial and jugular vein , it's necessary when there has been marked intraperitoneal sepsis or multiple abdominal operations.
B. (lumboperitoneal shunt) : *The lumboperitoneal shunt involves drainage of the CSF from the lumbar theca rather than the ventricle. (pseudotumor cerebri)*

➢LP shunts reduce the spinal CSF volume, while VP shunts keep the cranial and spinal CSF volume in the physiological range.

COMPLICATIONS OF THE SHUNT

1) Infection:

- **Infection is the second most common cause of shunt malfunction ,with an approximately 8–15% among patients who undergo VPS placement.**
- **It's usually caused by skin commensals, such as *Staphylococcus epidermidis*. *Neonates are susceptible to Escherichia coli and hemolytic streptococcal infections*.**
- **Most infections become apparent clinically by 6 weeks and over 90% are apparent within 6 months.**

❑ ***Risk factors for infection include :***

- ***very young children.***
- ***open myelomeningocele.***
- ***longer operative time .***
- ***excessive staff movement into and out of theatre.***

https://youtu.be/Yb9dSjDykpI?si=OhLNtZUEHMG8dCjK

- **Treatment :**

- **Removal of the shunt, external CSF drainage and treat the infection prior to re-insertion of the shunt at a different site.**

- **The introduction of antibiotic-impregnated catheters has resulted in a reduction in shunt infection rates.**

COMPLICATIONS OF THE SHUNT

2) Shunt blockage :

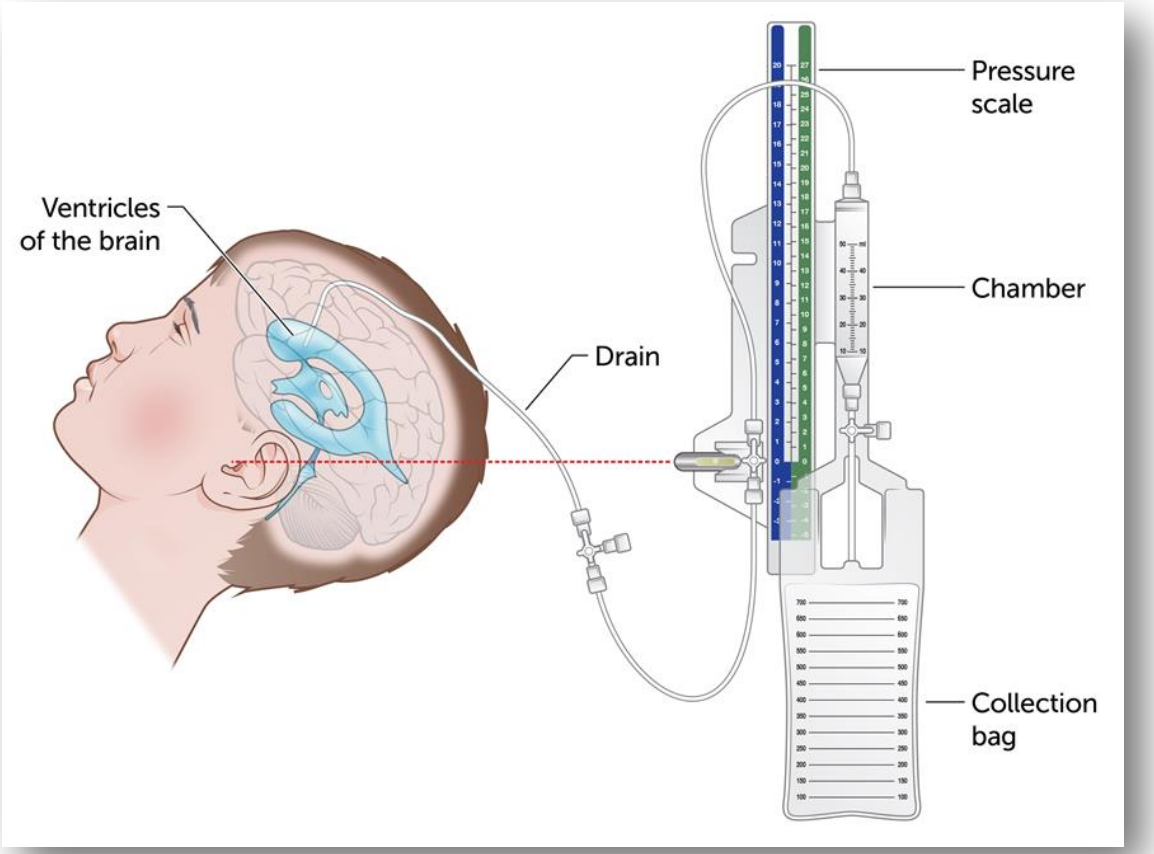
- **Shunt catheter obstruction is by far the most common cause shunt malfunction.**
- **Shunt blockage may affect the ventricular catheter, shunt ,valve or distal catheter.**
- **More than one-half of cases of shunt blockage are subsequently shown to be infected.**
- **Causes of blockage : choroid plexus adhesion, blood, cellular debris or misplacement of the distal catheter in the pre-peritoneal space.**

3) Intracranial hemorrhage :

- **Shunt systems may over drain leading to subdural hemorrhage .**
- Other complications are common to intracranial surgery and include **seizures (5%), CSF leak, stroke and (< 1%) intracerebral hemorrhage**.

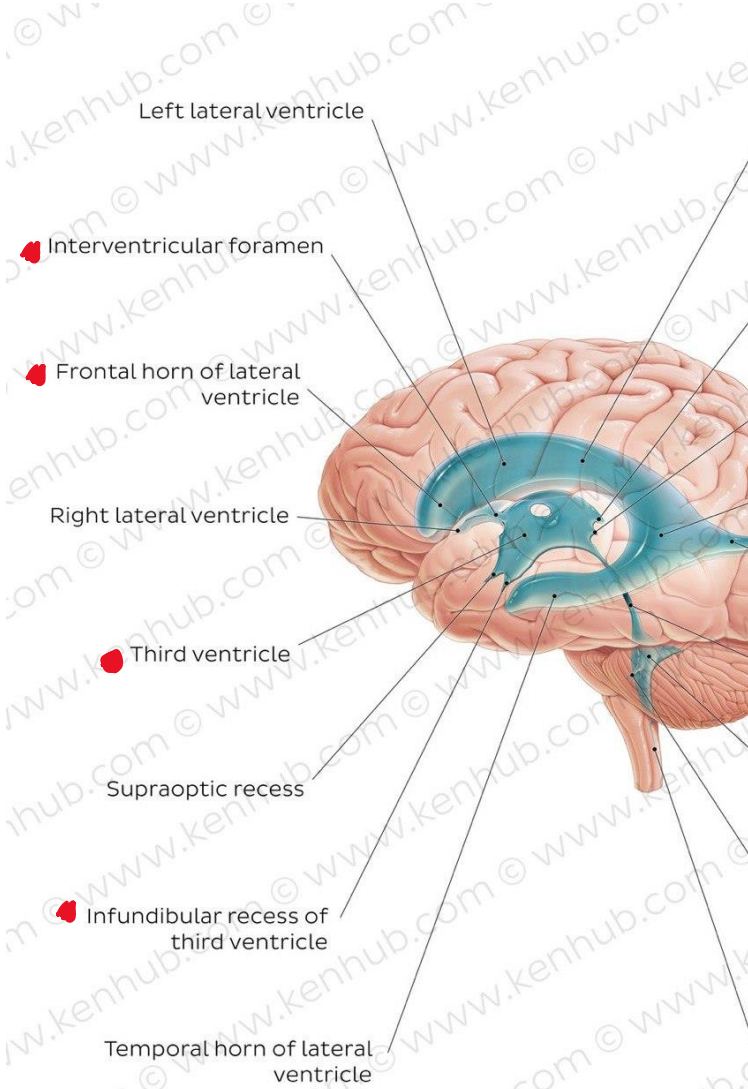
EXTERNAL DRAINS

- External drains can be placed within the ventricle (EVD) or the lumbar thecal sac (lumbar drain).
- These are useful for temporary CSF drainage and can be used to administer intrathecal antibiotics to treat CSF infection., take sample and decrease ICP.



ENDOSCOPIC THIRD VENTRICULOSTOMY

- **Involves the insertion of a neuro-endoscope into the *frontal horn of the lateral ventricle* and then into *the third ventricle* through the foramen of Munro. A stoma can be created in the floor of the third ventricle in between the mamillary bodies and infundibular (pituitary) recess.**
- **CSF can then communicate freely between the ventricular system and interpeduncular subarachnoid space.**
- **The technique is particularly useful when there is obstruction of the CSF pathways below the third ventricle such as with aqueduct stenosis or posterior fossa mass lesions.**



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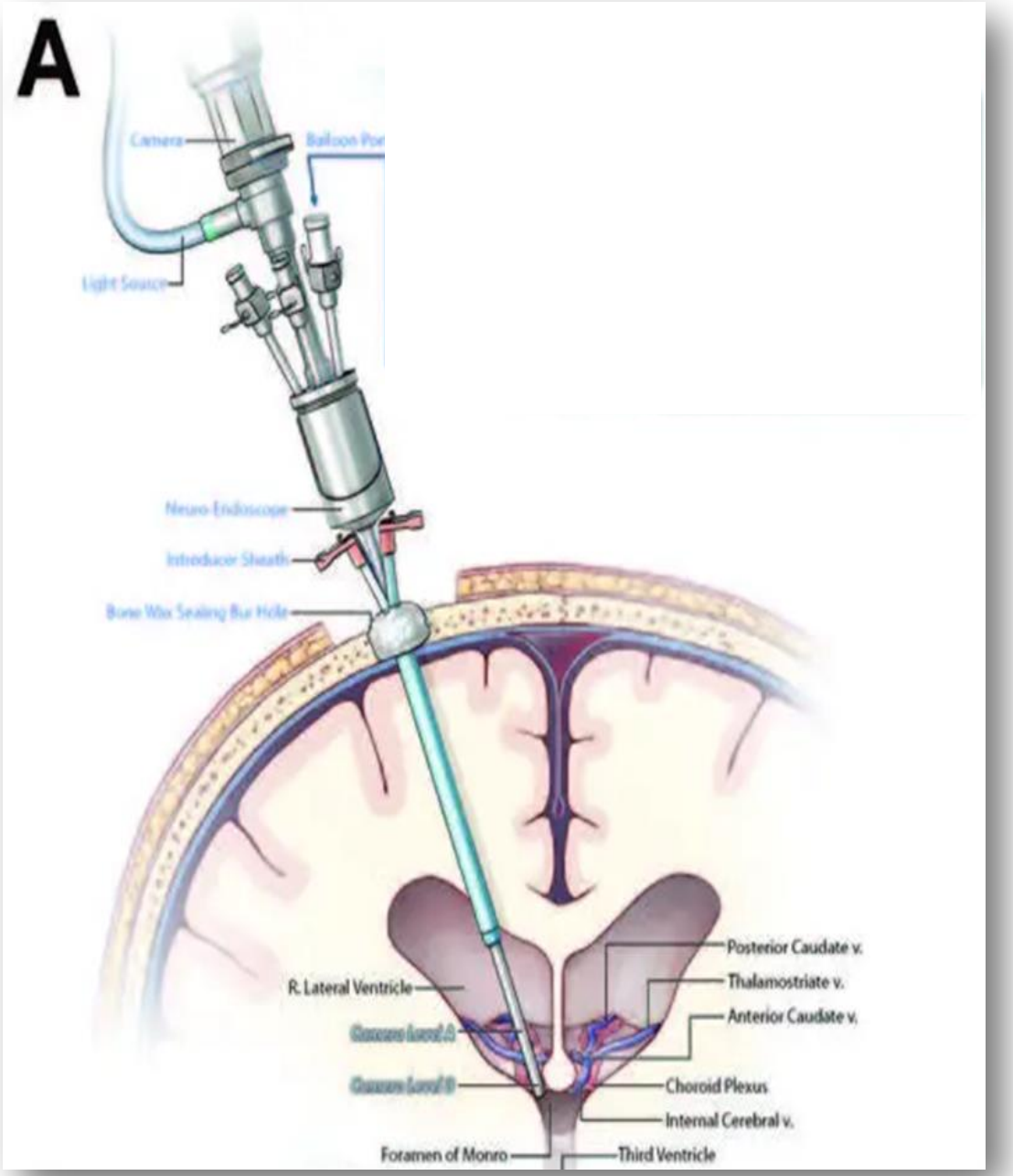
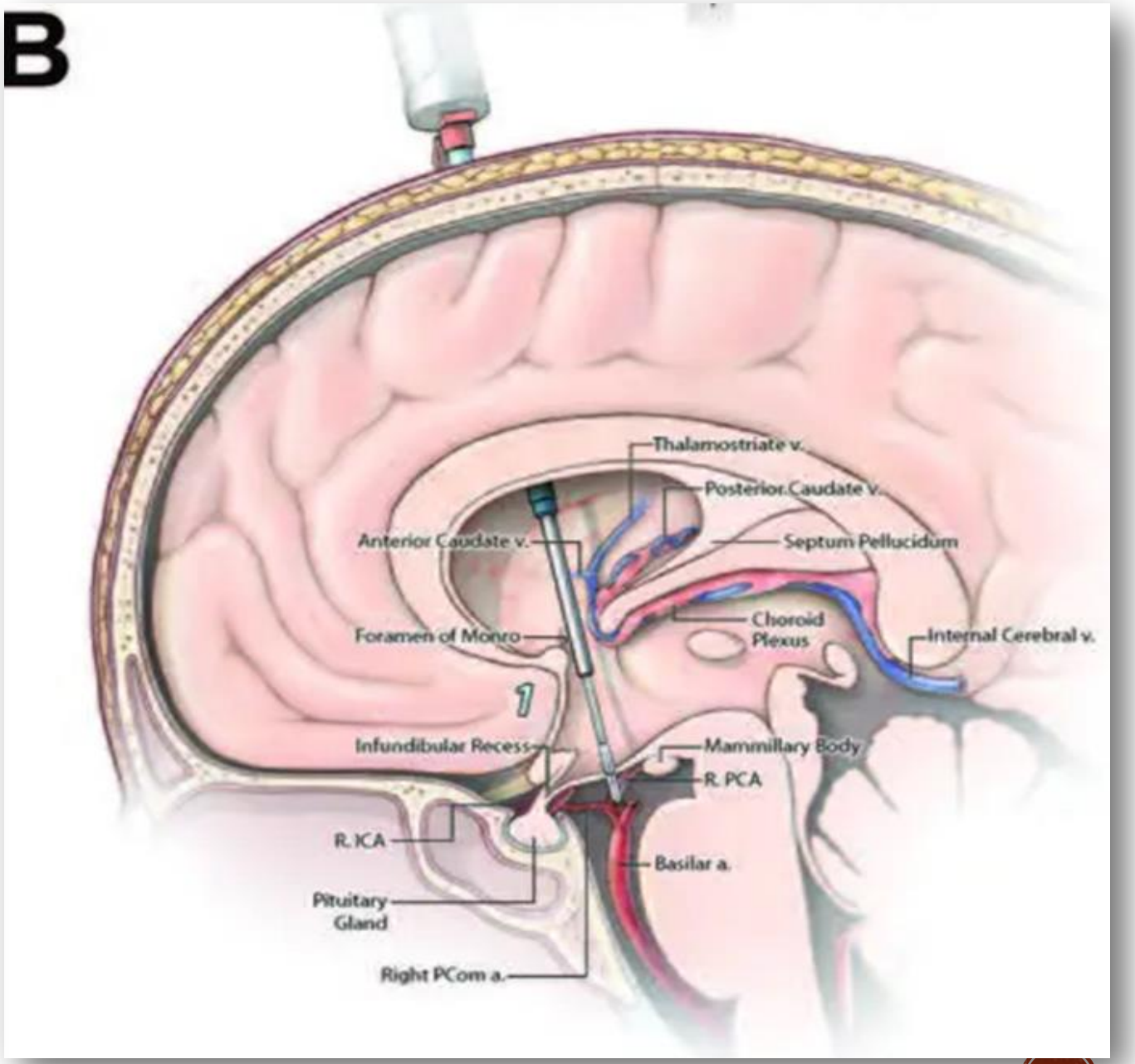
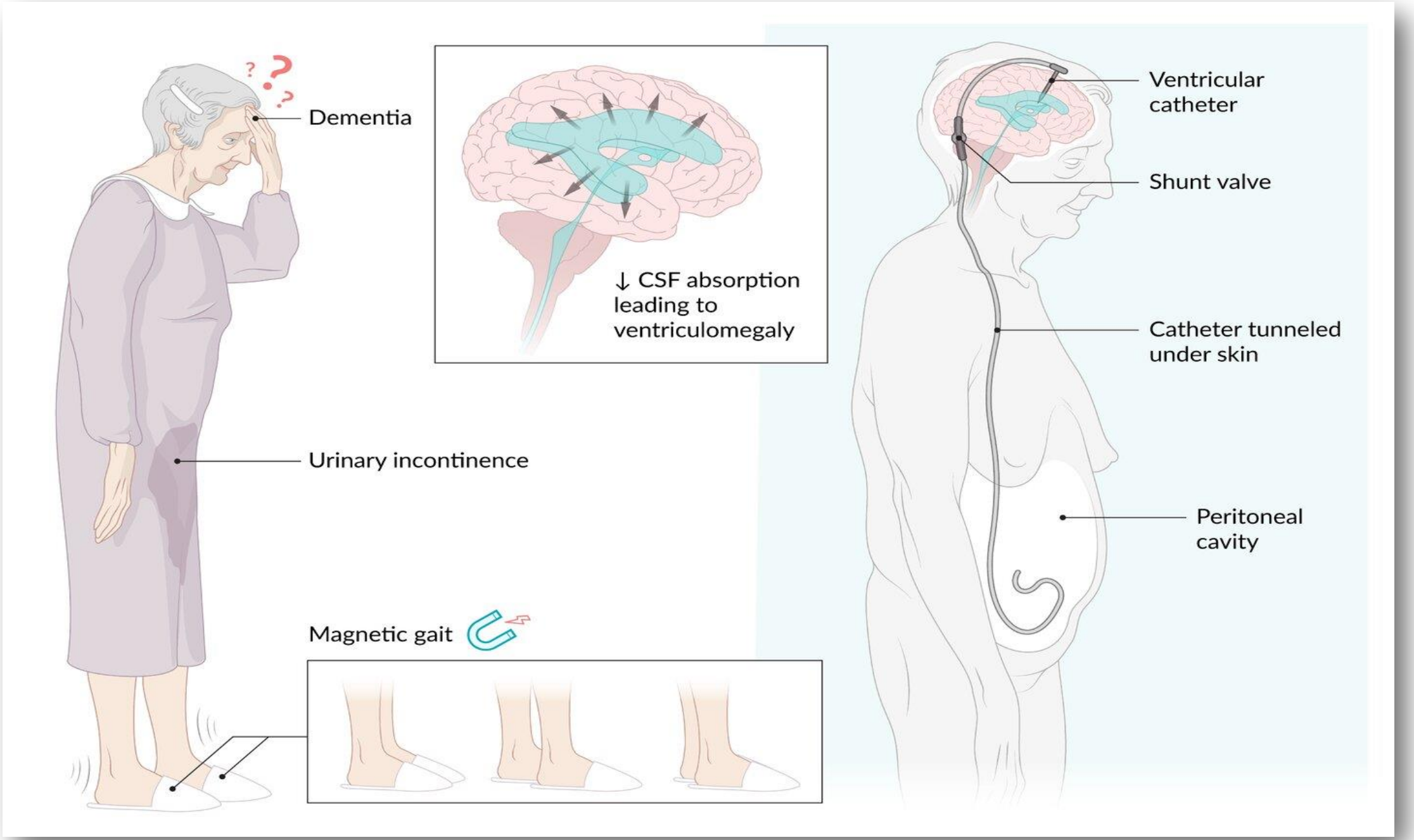

A
Camera
Light Source
Neuro-Endoscope
Introducer Sheath
Bone Wax Sealing Bur Hole
R. Lateral Ventricle
Posterior Caudate v.
Thalamostriate v.
Anterior Caudate v.
Choroid Plexus
Internal Cerebral v.
Foramen of Monro
Third Ventricle


B
Thalamostriate v.
Posterior Caudate v.
Anterior Caudate v.
Septum Pellucidum
Choroid Plexus
Foramen of Monro
Internal Cerebral v.
1
Infundibular Recess
Mammillary Body
R. PCA
R. ICA
Basilar a.
Pituitary Gland
Right PCom a.

- **It has an advantage over shunting in that no tubing is left in the patient and therefore infection rates are lower.**
- **Rare, but serious, complications include basilar artery rupture or memory impairment from injury to the fornix.**
- **ETVs may block off, however, with about one-half of these patients ending up with a shunt.**
- **The procedure is less useful for communicating types of hydrocephalus or in infants of less than 6 months of age but has a success rate of over 70% for accepted indications.**

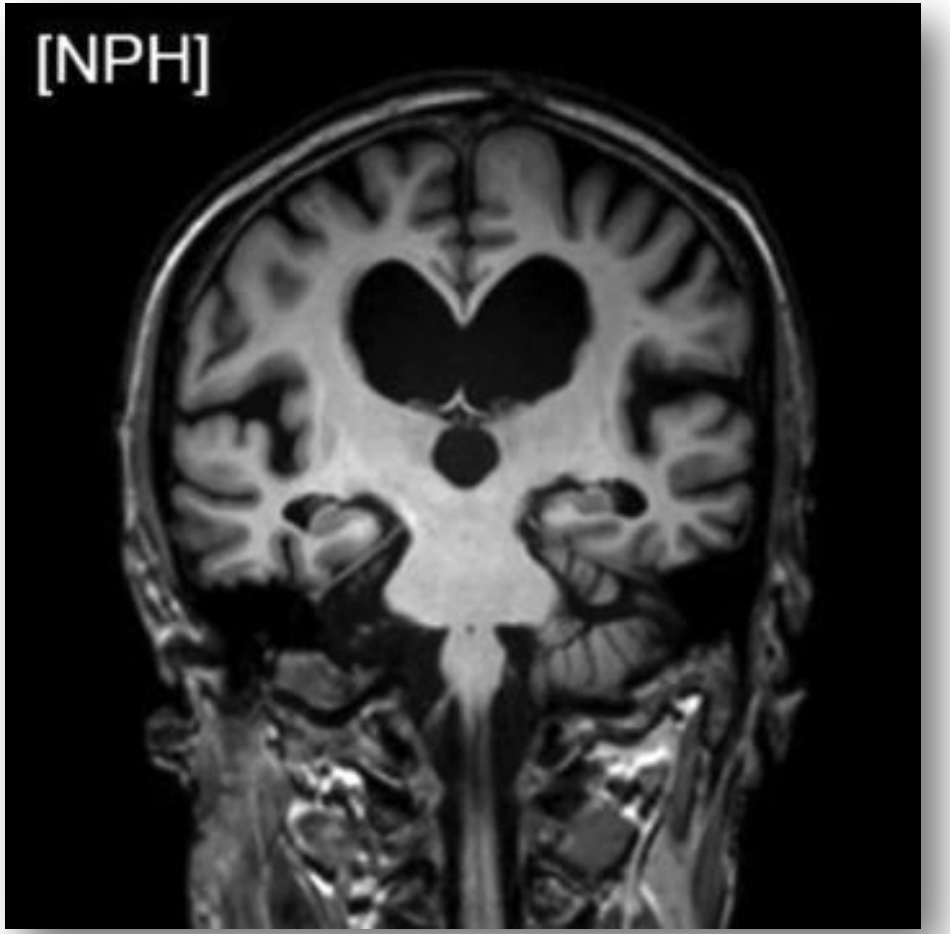
NORMAL-PRESSURE HYDROCEPHALUS

- **Normal-pressure hydrocephalus a form of chronic communicating hydrocephalus that primarily affects elderly individuals (> 60 years) and is characterized by a distinct clinical triad (urinary incontinence, dementia, apraxic "magnetic" gait) , where the radiological studies showed hydrocephalus, but the lumbar CSF pressure was normal.**
- **Etiology: in a large percentage the communicating hydrocephalus may have resulted from obliteration of the subarachnoid pathways in the basal cisterns following an episode of meningitis or subarachnoid hemorrhage, from either rupture of an aneurysm, arteriovenous malformation or following trauma.**
- **Although lumbar puncture pressure is within the normal range, continuous monitoring of the intracranial pressure in these patients will frequently reveal abnormal wave formation, especially at night.**


Dementia
↓ CSF absorption leading to ventriculomegaly
Ventricular catheter
Shunt valve
Catheter tunneled under skin
Peritoneal cavity
Urinary incontinence
Magnetic gait

INVESTIGATION

- **The CT scan or MRI will show dilated ventricles without significant cortical atrophy.**
- **The difficulty arises that normal-pressure hydrocephalus may occur in patients with a scan appearance of cortical atrophy, but in these patients the degree of ventricular dilation should be more than would be expected just to compensate for the degree of atrophic change.**



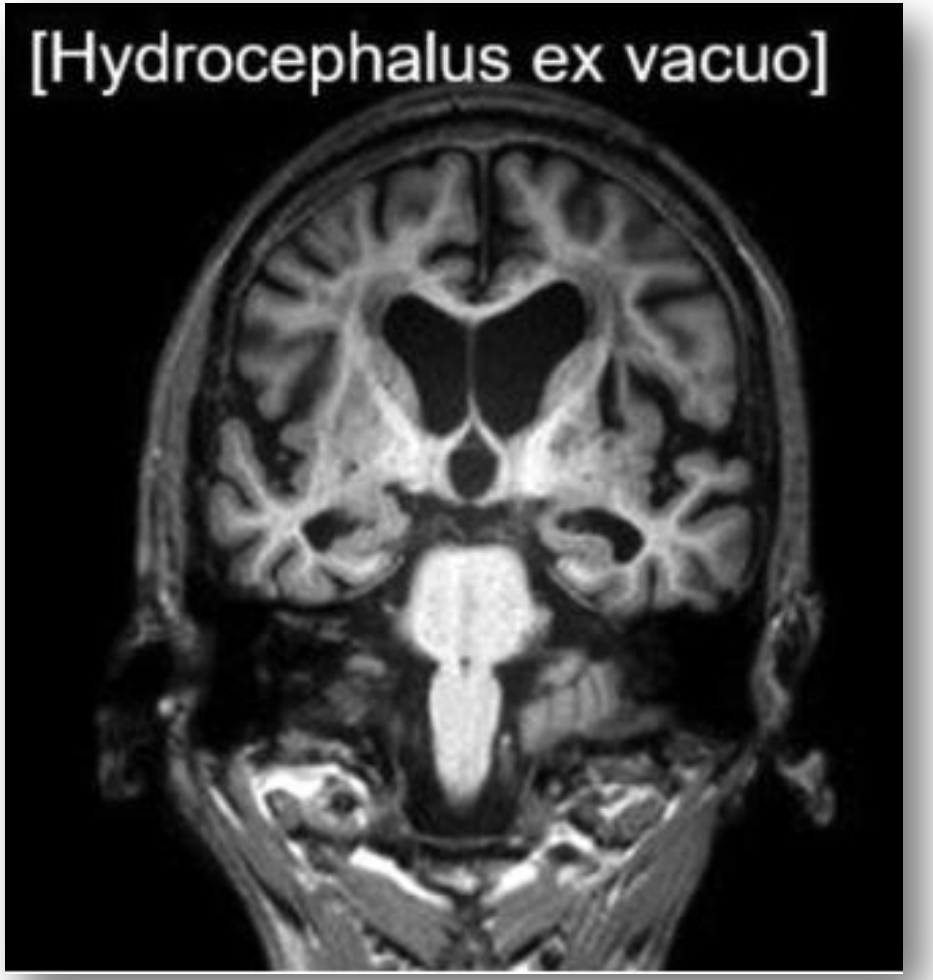
TREATMENT

- **The following criteria can be used to assess the patients with the greatest chance of improvement following a shunt:**
  - ❑ **A clinical presentation of the classic triad, particularly if the features of gait disturbance predominate.**
  - ❑ **The CT scan or MRI showing marked hydrocephalus with minimal cortical atrophy.**
  - ❑ **A clearly defined cause for the hydrocephalus, such as a past episode of subarachnoid hemorrhage, trauma or meningitis.**
  - ❑ **Abnormal pressure waves on continuous intracranial pressure monitoring.**

- **Naturally, a patient who has all these positive criteria deserves a shunt and should make a good recovery following the operation.**

HYDROCEPHALUS EX-VACUO

- **A compensatory enlargement of the cerebrospinal fluid (CSF) spaces caused by degenerative encephalic volume loss.**
- **Etiology : cerebral atrophy, stroke, traumatic brain injury, Alzheimer disease, Huntington disease, AIDS**
- **The ventricles and subarachnoid space appear enlarged secondary to loss of brain tissue (an actual shrinkage of brain substance).**
- **Although there is more CSF than usual, intracranial pressure and flow of cerebrospinal fluid are normal.**
- **imaging: Enlarged CSF spaces, especially (lateral ventricles) and Cortical atrophy may be prominent.**



EXTERNAL HYDROCEPHALUS

- **A condition that occurs in infancy and early Childhood.**
- **characterized by : enlarged subarachnoid space in the frontal areas and interhemispheric fissure (due to lack of absorption from villi) with raised intracranial pressure without significantly enlarged ventricles.**
- **It is attributed to an absorption deficiency and typically resolves within a year.**

Benign External Hydrocephalus

THANK YOU


FIERCE HOPE
LOUD AWARENESS
SUPERNATURAL STRENGTH
RAD BRAIN