MANAGEMENT OF HYDROCEPHALUS

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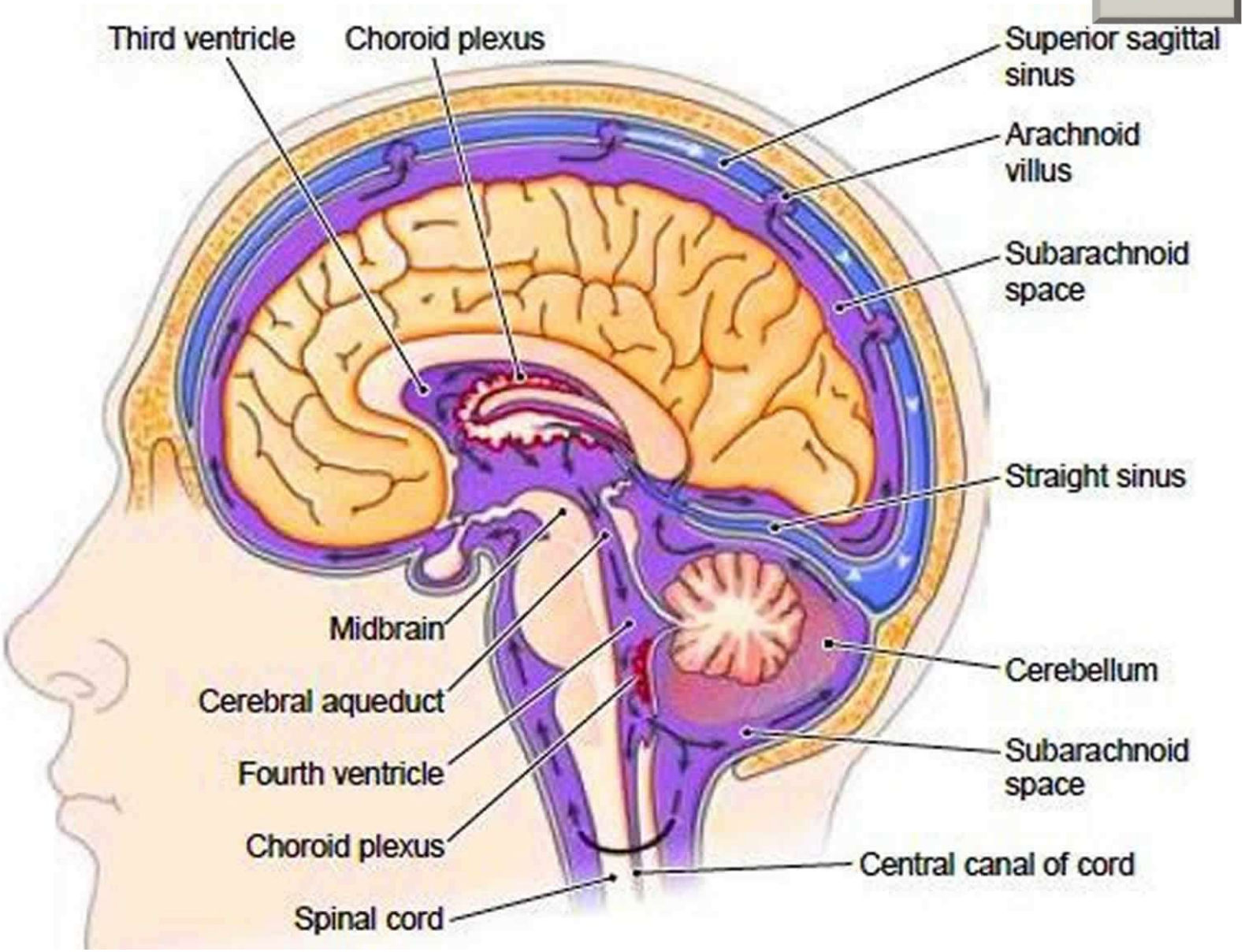
Hydrocephalous

- An excessive accumulation of CSF within the head due to a disturbance of formation, flow or absorption
- If left untreated the patient may develop increased intra-cranial pressure (ICP)
- Result may be brain damage and/or death

CSF Production & Absorption

CSF is production @ 20ml/hr absorbed at the same rate

Total volume 150ml of CSF (25ml in the ventricles)

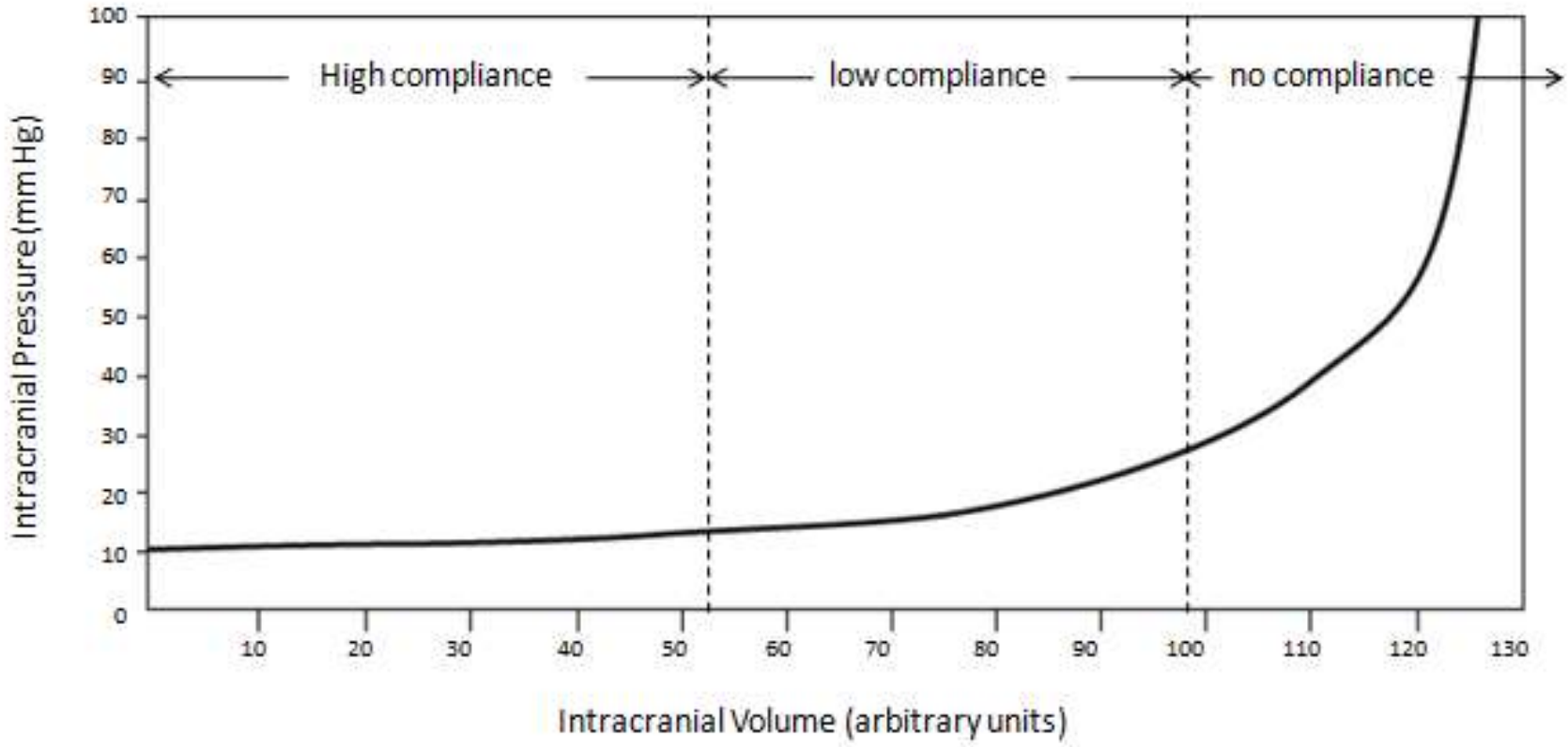


Compliance and the Cranium

- The brain and skull contain three primary components:
  - Brain Tissue
  - Blood
  - Cerebrospinal fluid

- A change in any one of these components results in adjustment to the other two which is called **compliance**

Compliance Dynamics



$$\text{Compliance} = \frac{\Delta P}{\Delta V}$$

Compliance and Hydrocephalus

- As discussed, the skull is a fixed vault with limited volume to hold brain tissue, blood, and CSF

- If too much CSF exists, the blood and brain tissue are compressed or squeezed out resulting in a possible neurological deficit

CLASSIFICATION OF HYDROCEPHALUS

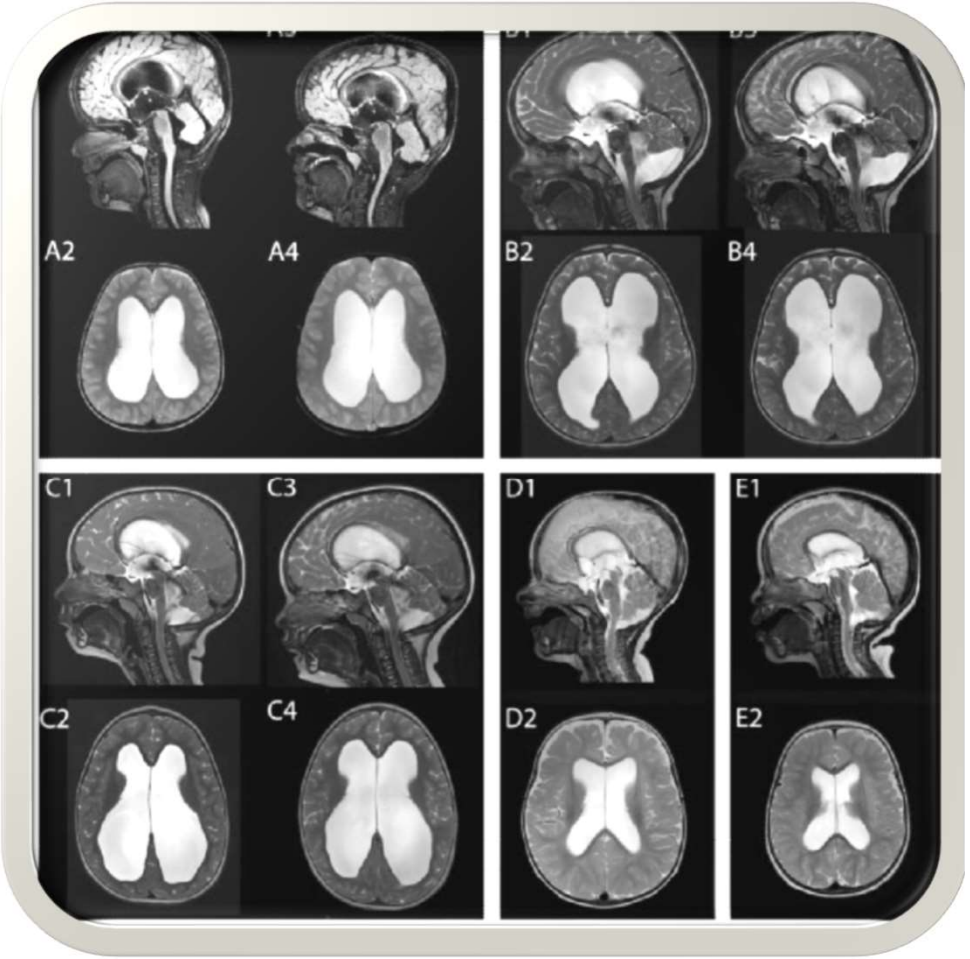
NON COMMUNICATING HYDROCEPHALUS	COMMUNICATING HYDROCEPHALUS
I. CONGENITAL LESIONS **A. AQUEDECTAL OBSTRUCTION (STENOSIS)** 1. GLIOSIS 2. FORKING 3. TRUE NARROWING 4. SEPTUM **B. ATRESIA OF THE FORAMINA OF LUSCHKA AND MEGENDIE (DANDY-WALKER CYST)** **C. MASSES** 1. BENIGN INTRACRANIAL CYST 2. VASCULAR MALFORMATION 3. TUMOURS **II. ACQUIRED LESIONS** **A. AQUEDECTAL STENOSIS(GLIOSIS)** **B. VENTRICULAR INFLAMATIONS AND SCARS.** **C. MASSES** 1. TUMOURS 2. NON-NEOPLASTIC MASSES	**I. CONGENITAL LESIONS** **A. ARNOLD-CHIARI MALFORMATION** **B. ENCEPHALOCELE** **C. LEPTOMENINGEAL INFLAMATION** **D. LISSENCEPHALY** **E. CONGENITAL ABSENCE OF ARACHNOIDAL GRANULATIONS** **II. ACQUIRED LESIONS** **A. LEPTOMENINGEAL INFLAMATION** 1. INFECTIONS 2. HEMORRHAGE 3. PARTICULATE MATTER **B. MASSES** 1. TUMOURS 2. NON-NEOPLASTIC MASSES **C. PLATYBASIA** **III. OVERSCREATION OF CSF (CHORIOD PLEXUS PAPILLIOMA)**

2 Forms of Hydrocephalus

- *Communicating*
  - Full communication of CSF between ventricles and the subarachnoid space
- *Non Communicating*
  - CSF cannot flow out of the ventricles due to blockage or malformation

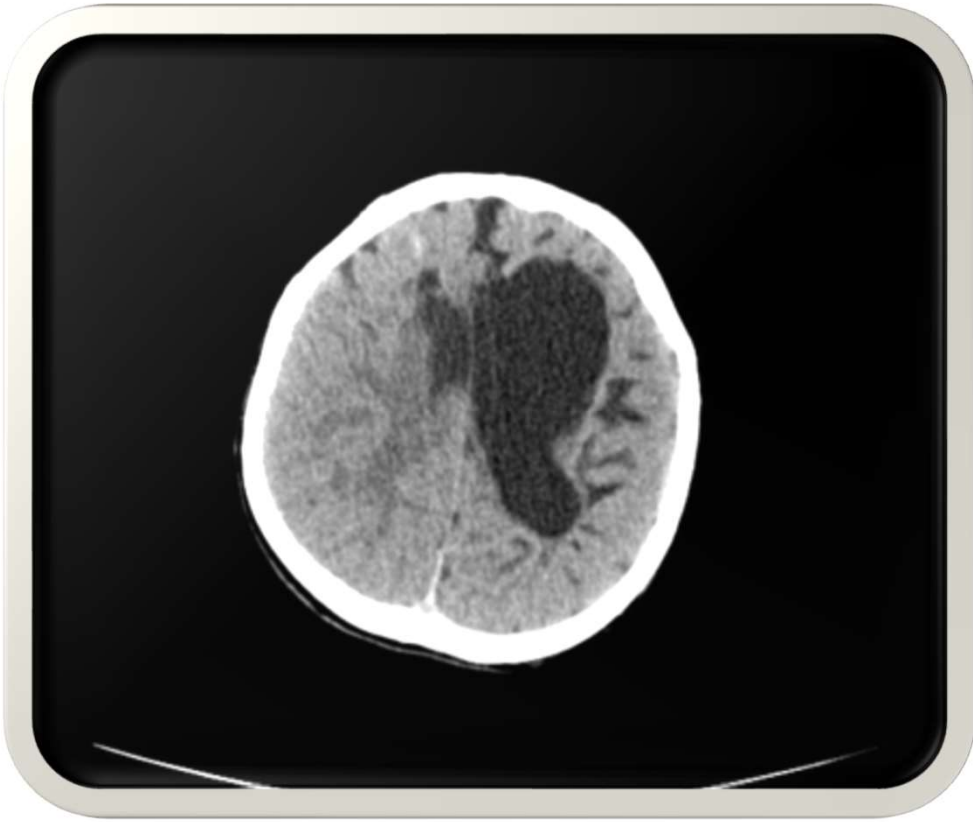
Arrested hydrocephalus

- CSF pressure normal
- Pressure gradient between ventricles and parenchyma has been dissipated
- Ventricular size remains stable or decrease
- No New neurological deficits
- Advancing psychomotor development with age.



Hydrocephalus ex vacuo

- cerebral atrophy and dilatation of sulci
- Intracranial pressure is normal
- Absence of periventricular edema



Normal pressure hydrocephalus

- Hydrocephalus with normal CSF opening pressure on lumber puncture and absence of papilledema
- Intermittent rise of CSF pressure causing ventricular dilatation.

- *Gait problems*
- *Urinary incontinence*
- *Memory problems*

Management

Medical

Surgical

Endoscopic

Shunts

Temporary

- ✓ EVD
- ✓ Ommaya
- ✓ spinal taps

Medical treatment

Acetazolamide

- 8-30 mg/kg/d, up to 100 mg/kg used
- CA inhibitor,
- *Safety in Children not established, ? teratogenic*

Furosemide

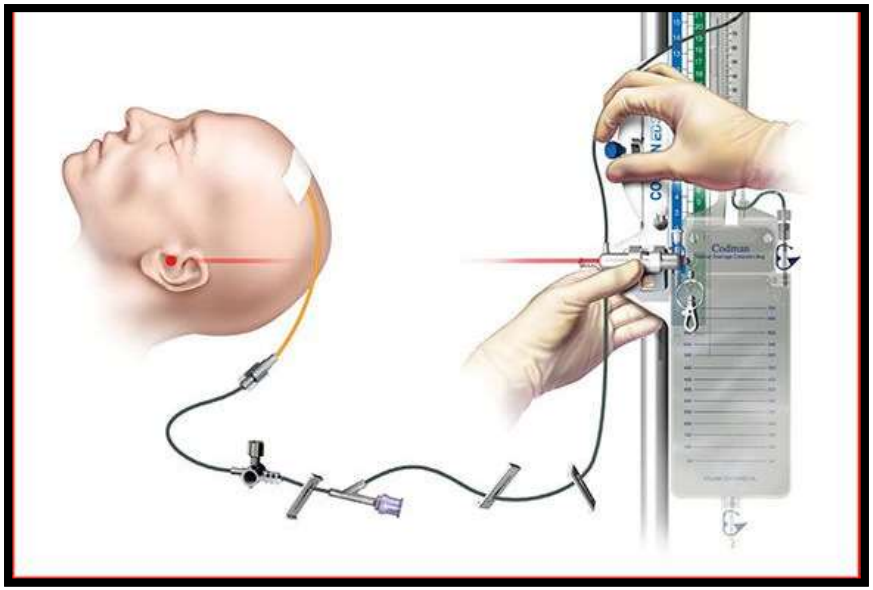
- 1mg/kg/d
- Loop diuretic,
- high concentration inhibit carbonic anhydrase

Spinal Taps

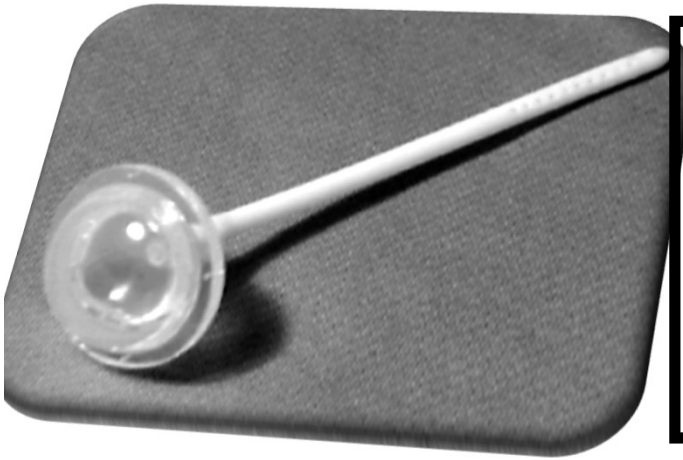
- HCP after intraventricular hemorrhage
- transient serial taps may temporize until reabsorption resumes but LP can only be performed for communicating HCP.
- If reabsorption does not resumes when protein is <100mg/dl then it is unlikely to start as before.

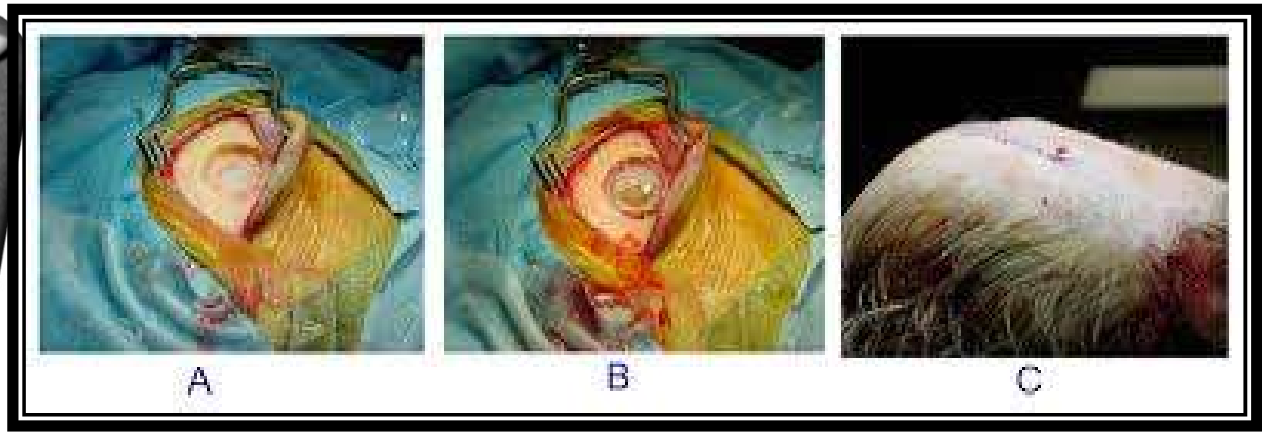
TEMPORARY CSF DRAINAGE

EVD



OMMAYA RESERVIOR



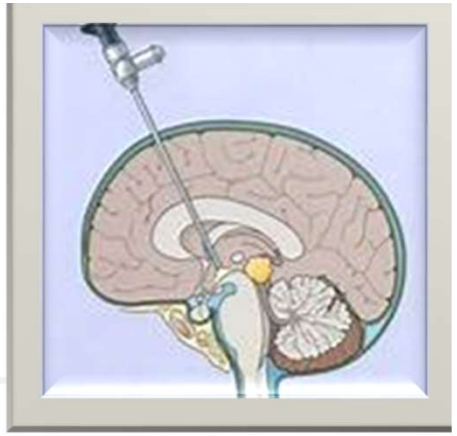


Surgical treatment

- Goal- “Optimum neurologic function and good cosmetic result” not “normal sized ventricles.
- Options-

1. Eliminating the cause of obstruction.
2. Endoscopic methods.
3. Shunting.

ETV

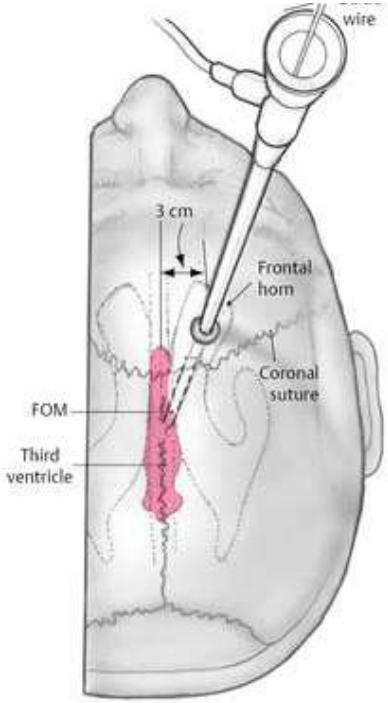


- MAKING A HOLE IN FLOOR OF 3RD VENTRICLE TO BYPASS THE OBSTRUCTION OF CSF FLOW

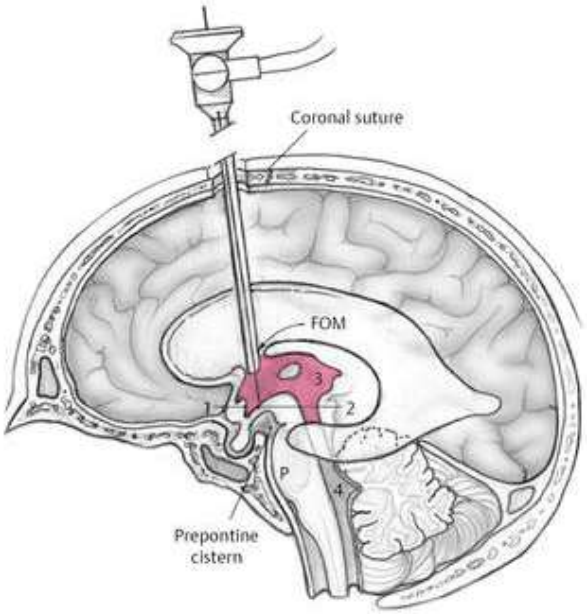
Endoscopic - 3rd Ventriculostomy

1. **Obstructive HCP.**
2. **Shunt infection.**
3. **Patients with subdural hematomas .**

Contraindication- Communicating HCP

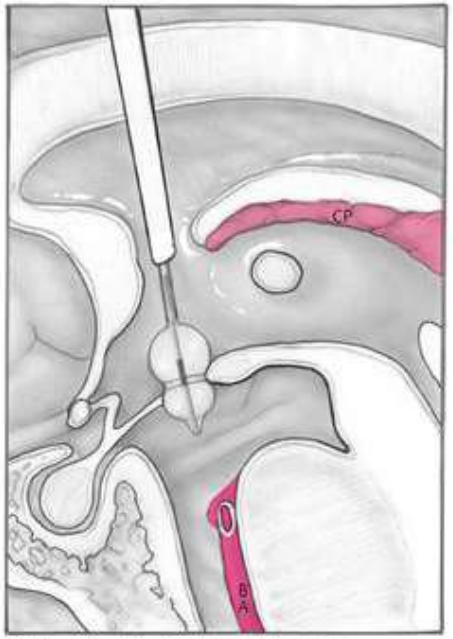


A



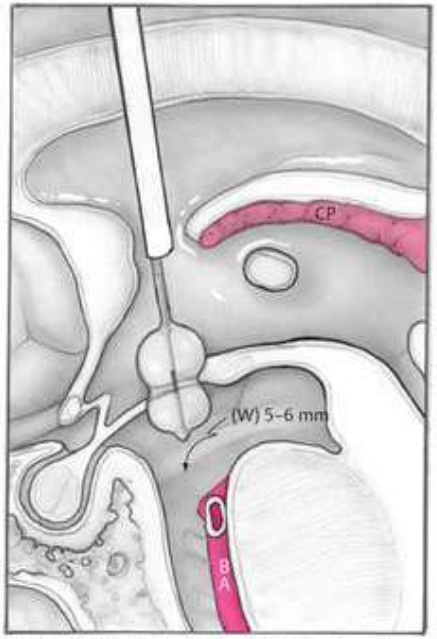
B

(W) "Waist" area diameter 5–6 mm



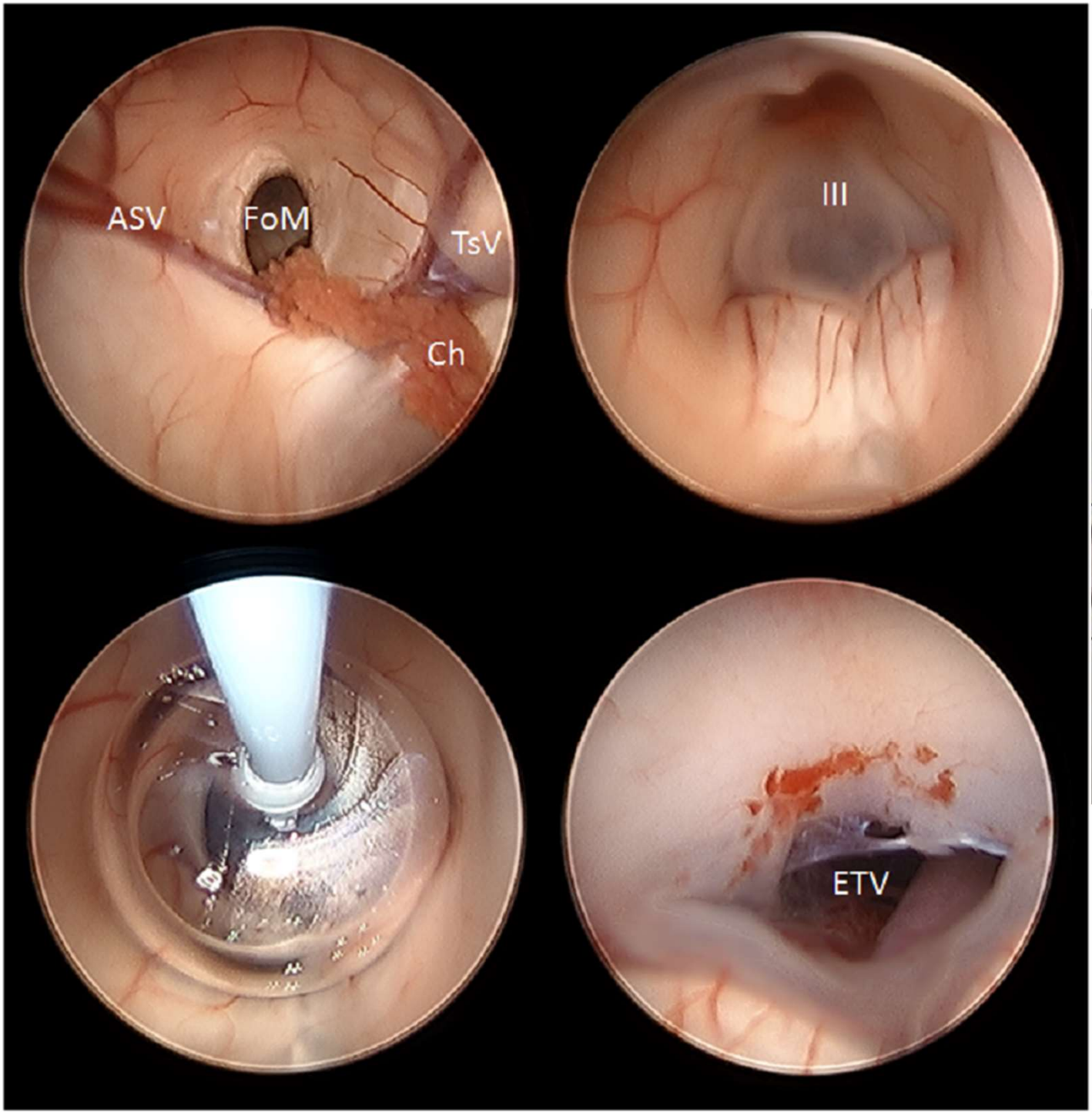
C

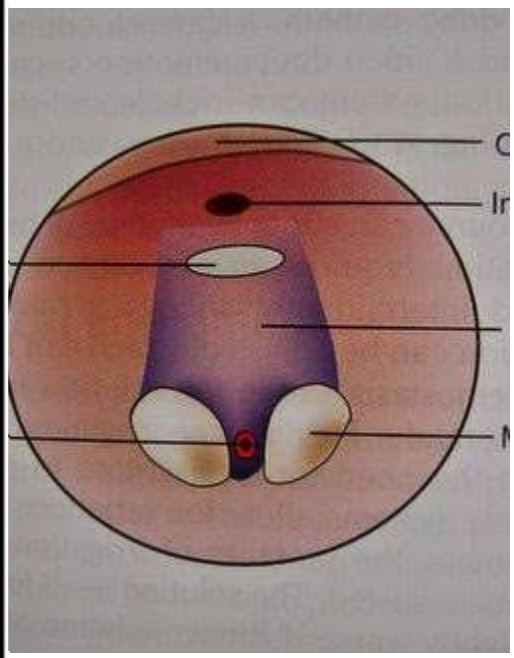
Distal section of double balloon inflates hold catheter in place for the dilation



D

Entire double balloon inflates dilating fenestrated membrane with outer diameter of balloon waist

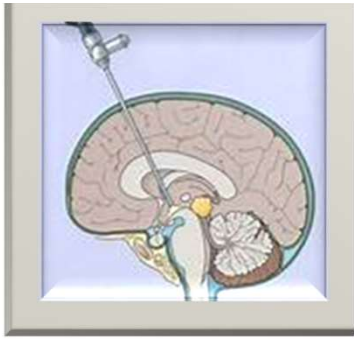

ASV
FoM
TsV
Ch
III
ETV



ETV SUCCESS RATE

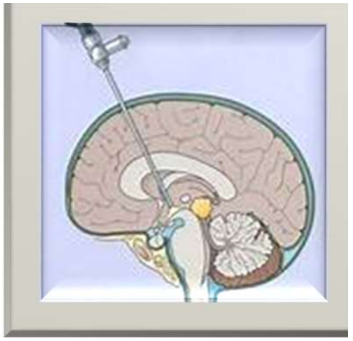
- **overall=56% (range is 60 to 94% for nontumoral AS).**
- Success rate is lower in infants as they may have under developed sub arachnoid space.
- Lower success rate – if preexisting pathology present like- tumor, previous shunt, previous SAH, WBRT, adhesions.

ETV COMPLICATIONS



1. Hypothalamic injury.
2. Transient 3rd and 6th nerve palsies.
3. Uncontrollable bleeding.
4. Cardiac arrest.
5. Traumatic basilar artery aneurysm.
6. Meningitis

Endoscopic choroid plexus coagulation

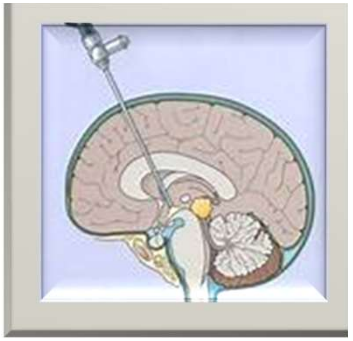


Indications-

I. Communicating slowly progressing HCP in infants- 64% cured.
II. Choroid plexus papilloma/hyperplasia.
III. Necrotizing enterocolitis.
IV. Intractable shunt failure.

Contraindication- Obstructive HCP.

Endoscopic fenestration



- Septostomy – for U/L HCP
- Multiloculated HCP.
- Aqueductoplasty or aqueductal stenting.
- Cysts with secondary HCP- Arachnoid cyst, Cysticercal cysts (3/4 ventricle)
- Colloid cyst of third ventricle.
- Pineal region tumors- ETV + Biopsy

SHUNTS

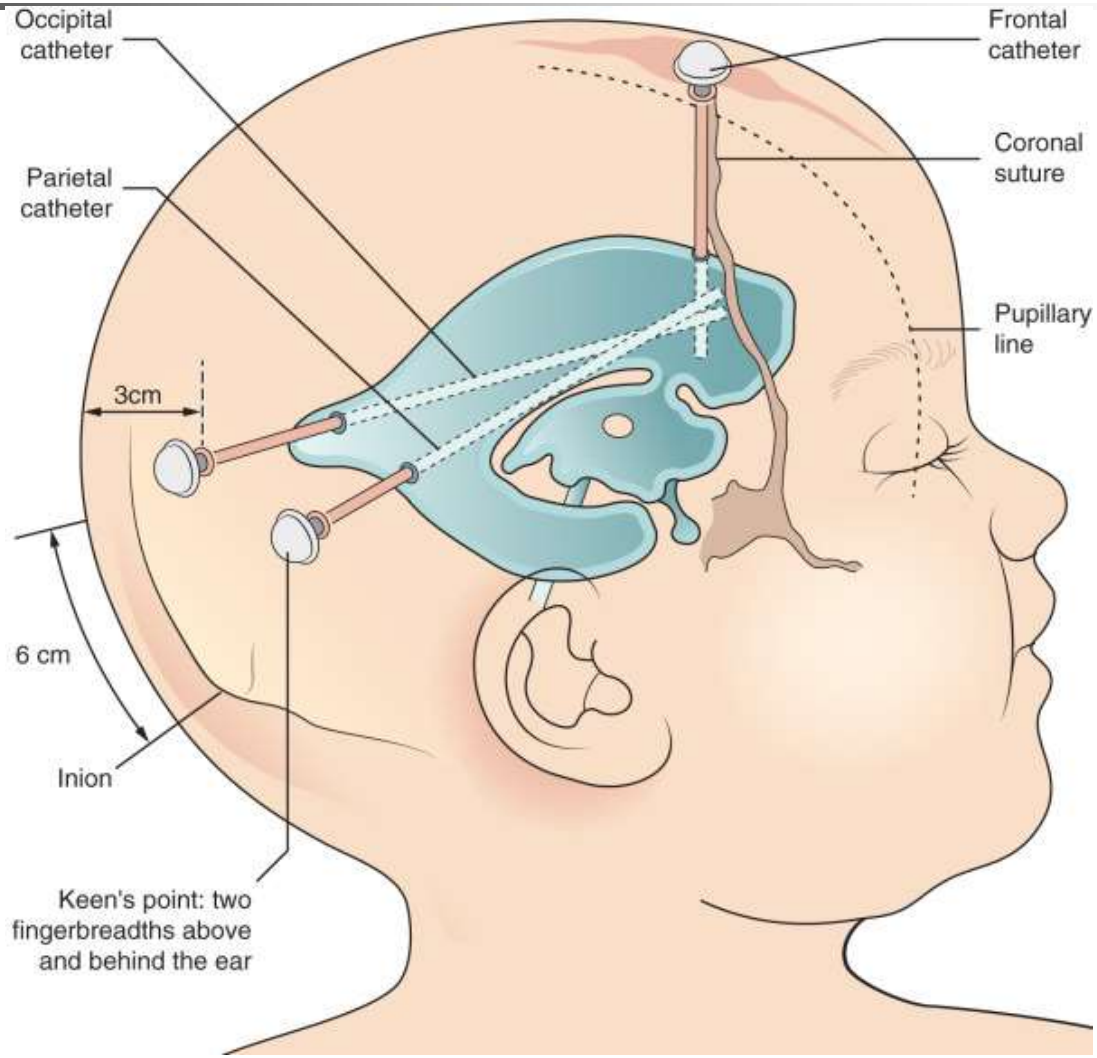
Types

- VP shunt
- VA shunt
- Torkildsen shunt- ventricles to cisternal space.
- Miscellaneous– Ventriculopleural, gall-bladder, ureter or bladder.
- LP shunt
- Cyst or subdural shunt

Surgical Procedure

- The surgical procedure to place a shunt is relatively short and uncomplicated:
  - Incision in the peritoneal cavity
  - Incision in the scalp
  - Small burr hole on the skull (6-9mm)
  - Tunneling under the skin
  - Insertion of the ventricular catheter
  - Connecting with valve
  - Closure

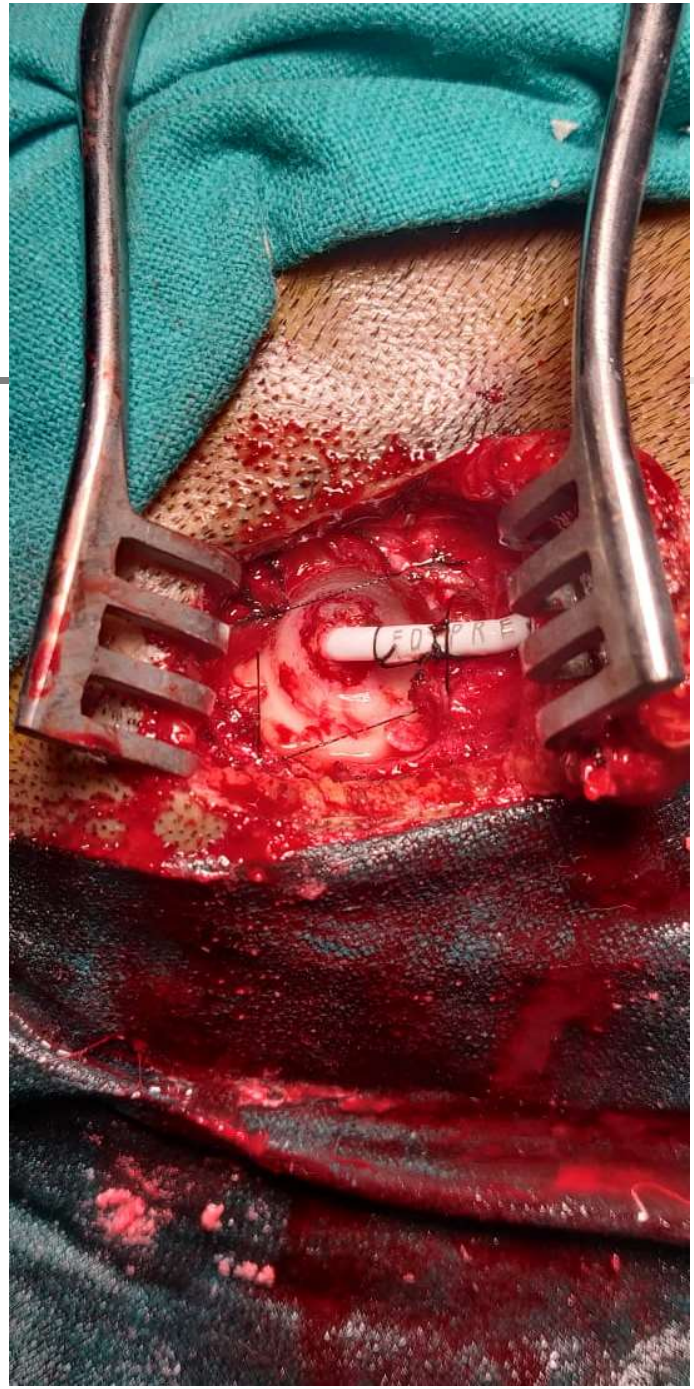
Entry points

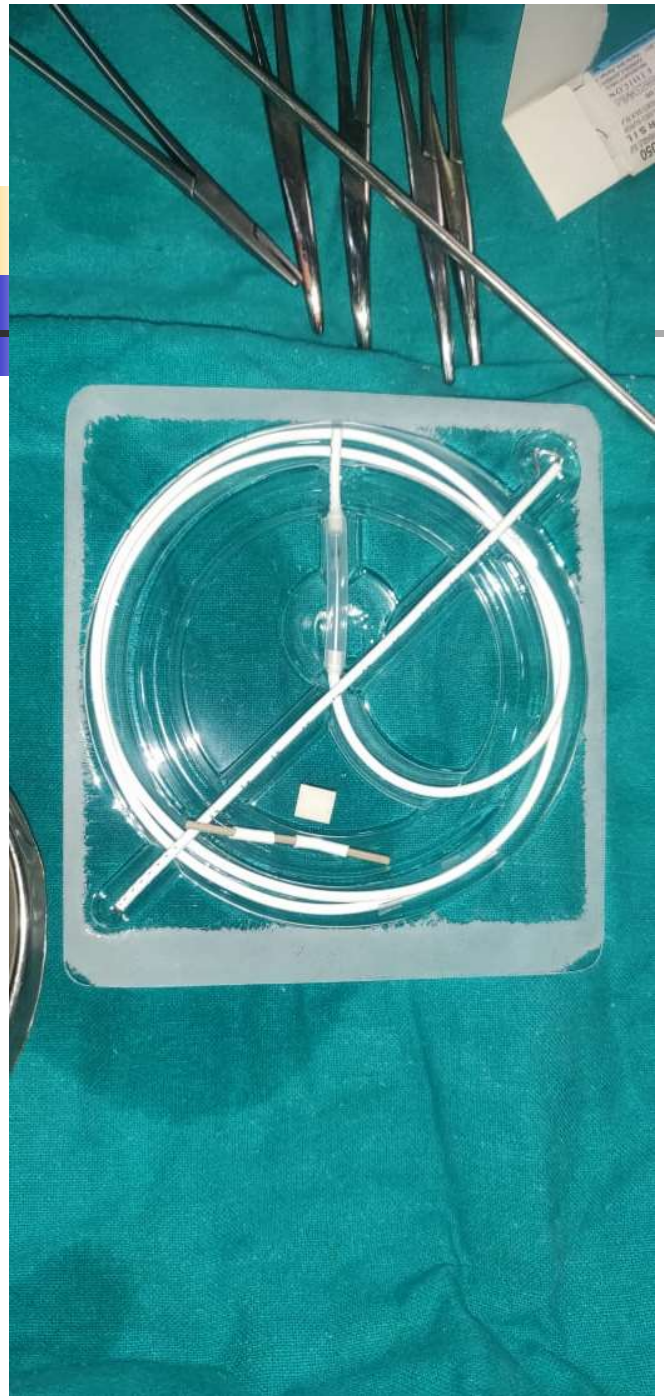


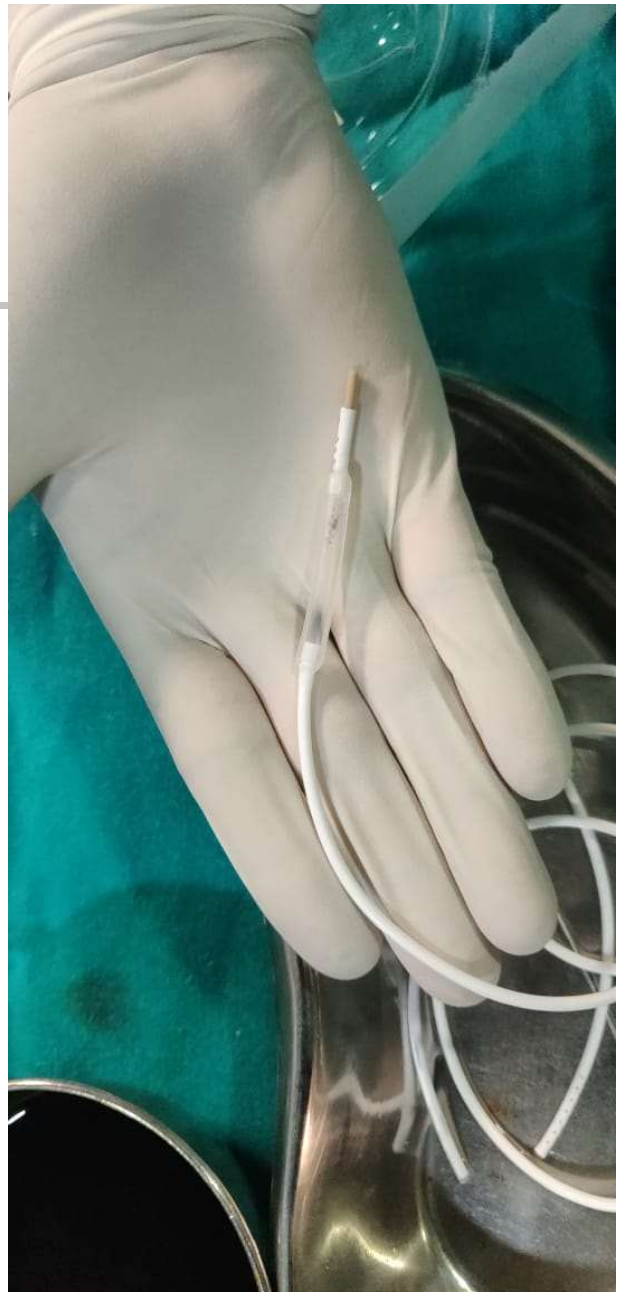
Peritoneum

Burr hole

tunnelling







complications of various shunts

- Those that may occur with any shunt-

1. Obstruction –M.C. , proximal catheter>valve/distal catheter(12-34%)
2. Disconnection
3. Infection (1.5 to 38%)
4. Hardware erosion through skin.
5. Seizures-5.5% in I yr., 1.1 %/yr. after 3 Yr.(Higher in frontal catheter.)
6. Conduit for extra neural mets.
7. Silicone allergy.

VP shunt complications

- **Inguinal hernia**– if inserted when processus vaginalis is patent.
- Requires long catheter to compensate for child growth.
- Peritoneal end obstruction-more with distal slit valves, by peritoneal pseudocyst, Peritoneal adhesions may decrease absorptive surface, catheter malpositioning.

VP shunt complications

- Peritonitis
- Hydrocele
- CSF ascites
- Tip migration –Into scrotum, viscus perforation, through diaphragm.
- Intestinal obstruction.
- Over shunting.

Indian Scenario

"The inexpensive Chhabra shunt in comparison to Codman shunt had no statistically significant diff in outcome" (J Neurosurgery{peds 4}102:358-362,2005)

- **Shunt malfunction rates are higher specially in cases of post meningitis hydrocephalus.**
- **a patient must be carefully evaluated as a potential candidate for ETV**

Advances in management of hydrocephalus

Advances in valve mechanism

- Valve Mechanism allows you to change operating pressure non invasively

- Codman Valve
  - Codman Programmable Valve
  - 18 pressure settings


Codman CERTAS® Plus
Programmable Valve
Codman® HAKIM®
Programmable Valve

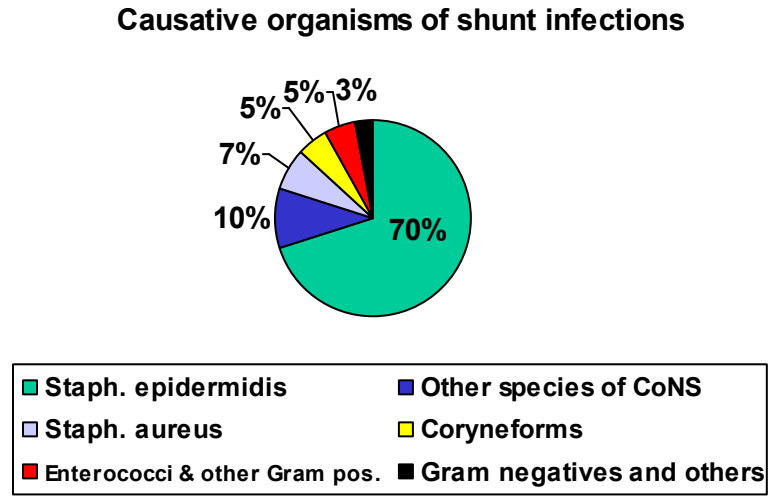
Antibiotic impregnated shunts

Account for approx. 77% of shunt infections.

»**Bacteria In Shunting**

›Most common bacteria in shunt infections?

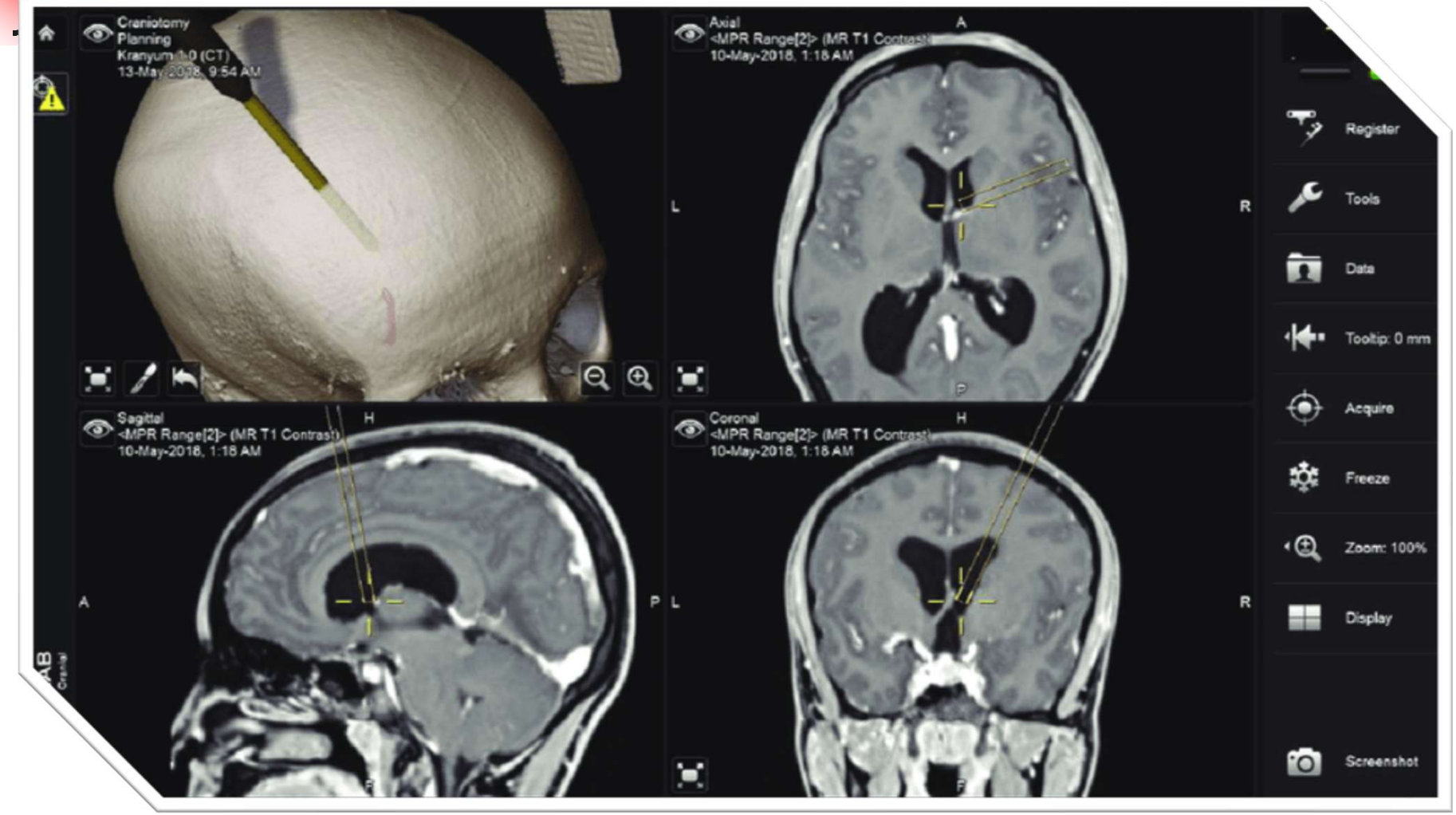
‹*S. epidemidis*
‹*S. aureus*
‹*Coryneforms*
‹*Streptococci*
‹*Enterococci*



Antibiotic impregnated shunt

- *Ventricular and Distal Silicone Catheters*
- *Impregnated with Two Antibiotics*
  - *Rifampicin & Clindamycin*
- *And they are ORANGE!!!*

Neuronavigation



What's New: Shunt Insertion

- *Neuronavigation for shunt placement*

J Neurosurg. 2010 Dec;113(6):1273-8. Epub 2010 Apr 16.

Effect of electromagnetic-navigated shunt placement on failure rates: a prospective multicenter study.

Hayhurst C, Beems T, Jenkinson MD, Byrne P, Clark S, Kandasamy J, Goodden J, Nandoe Tewarie RD, Mallucci CL

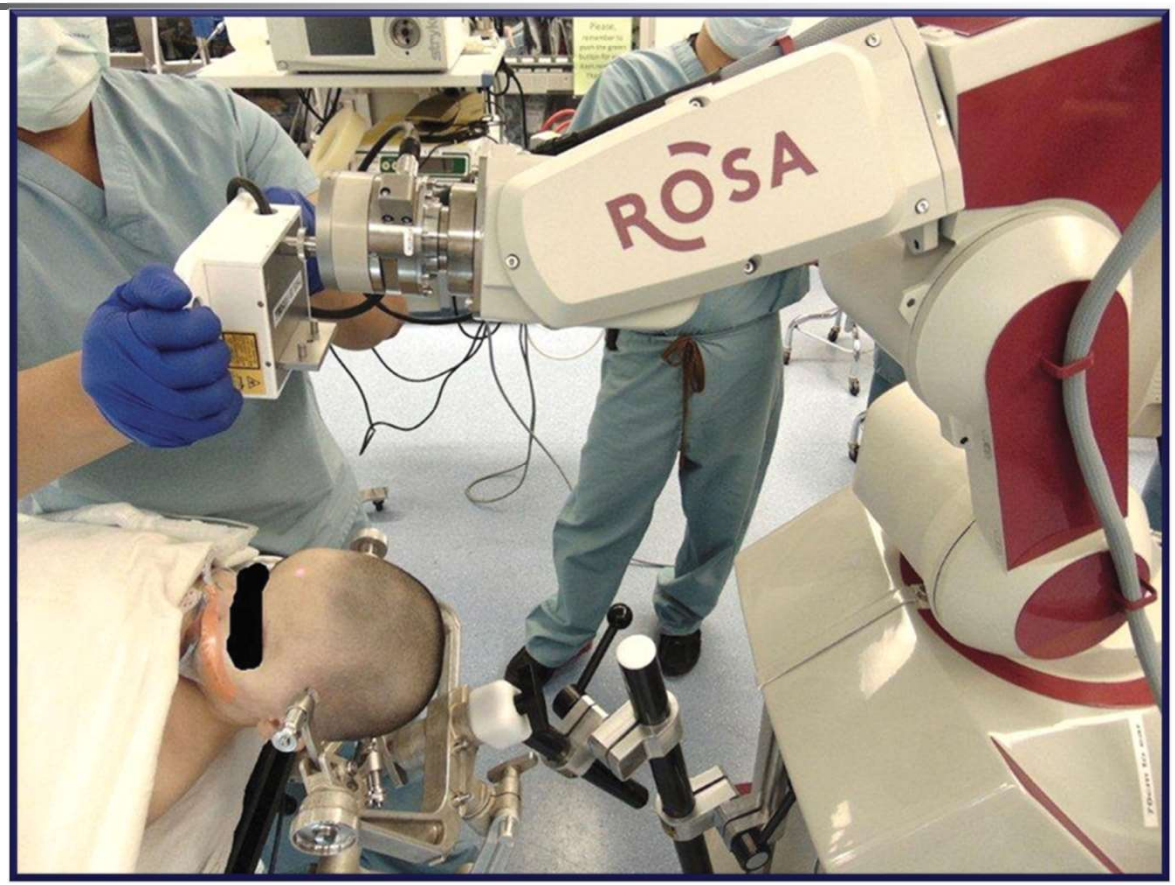
postoperative CT in both groups using a 3-point scale developed for this study: (1) optimal position free-floating in CSF; (2) touching choroid or ventricular wall; or (3) intraparenchymal.

75 patients were included in the study, 41 with standard shunts and 34 with Emnavigated shunts.

Seventy-four percent of navigated shunts were Grade 1

compared with 37% of the standard shunts (p=0.001, chi-square test). There were no Grade 3 placements in the navigated group, but 8 in the standard group, and 75% of these failed. **Early shunt failure** occurred in 9 patients in the standard group and in 2 in the navigated group, reducing the early revision rate from 22 to 5.9% (p=0.048, Fisher exact test)

Robot assisted ETV



Thank you for your attention !!!