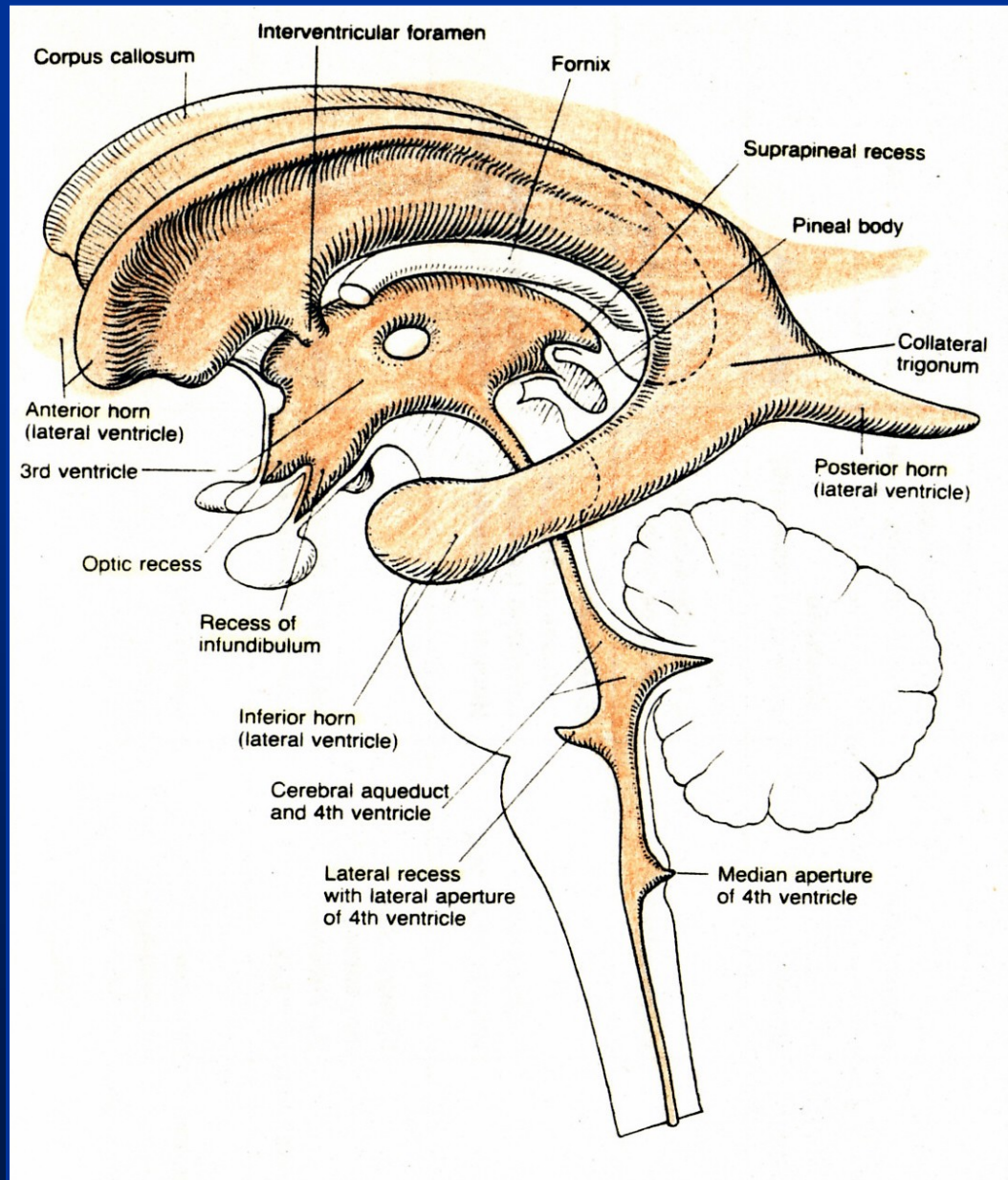


# Hydrocephalus in children

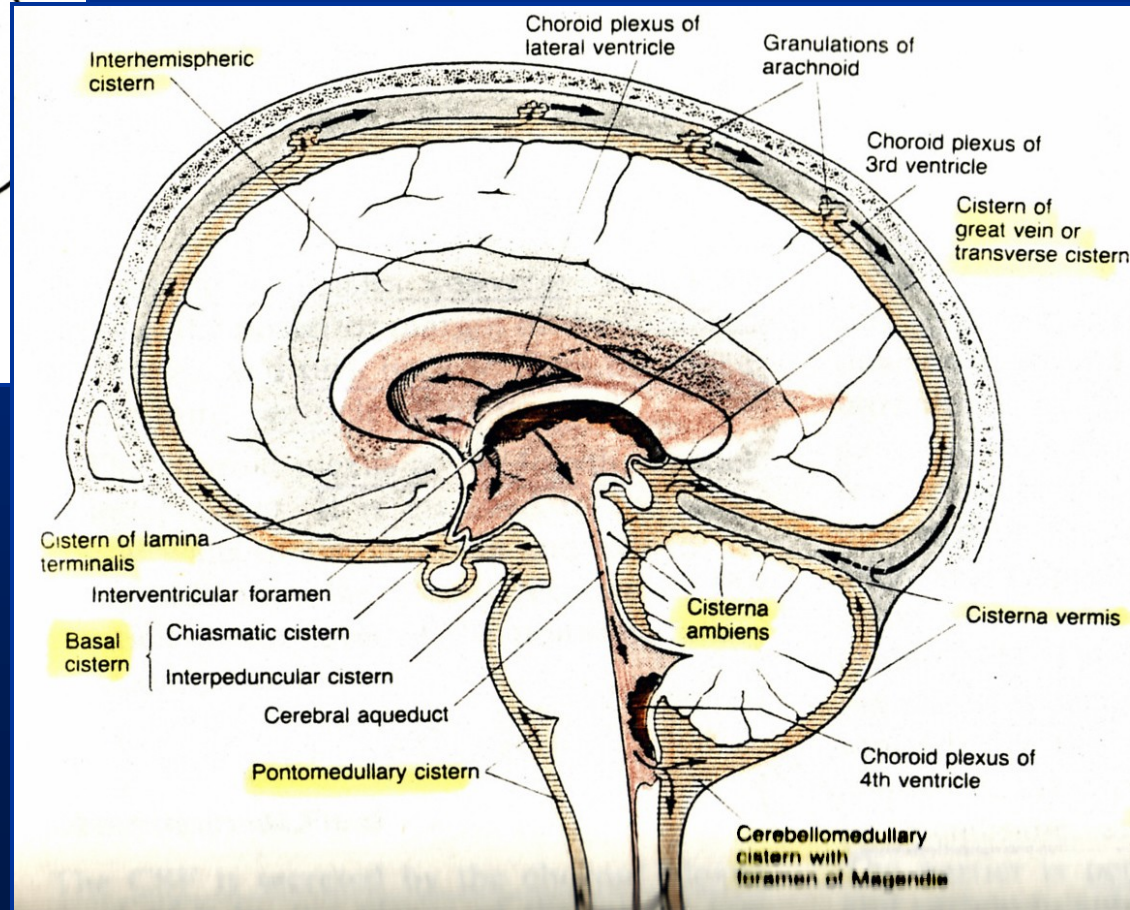
Eva Brichtova, M.D., Ph.D.  
Associate Professor



# Ventricle system



# Ventricle system, cerebral cisterns



# Hydrocephalus taxonomy

- hypersecretion
- hyporesorbtion
- obstructive (non-communicating)
- communicating (non-obstructive)
- congenital
- acquired
  - *posthaemorrhagic*
  - *postinfekctious*
  - *posttraumatic*
- internal
- external
- active
- arrested



# Signs and symptoms

- Makrocephaly, fontanelle bulging, „setting sun sign“, Parinaud sy
- Intracranial hypertension
  - cephalgia - diffuse, worse headache, reverse Tinnel's sign
  - vomiting - explosive, no nausea
  - vertigo
  - seizures
  - unconsciousness
  - respiratory and cardiac arrhythmia

# Hydrocephalus



# Diagnosis of hydrocephalus

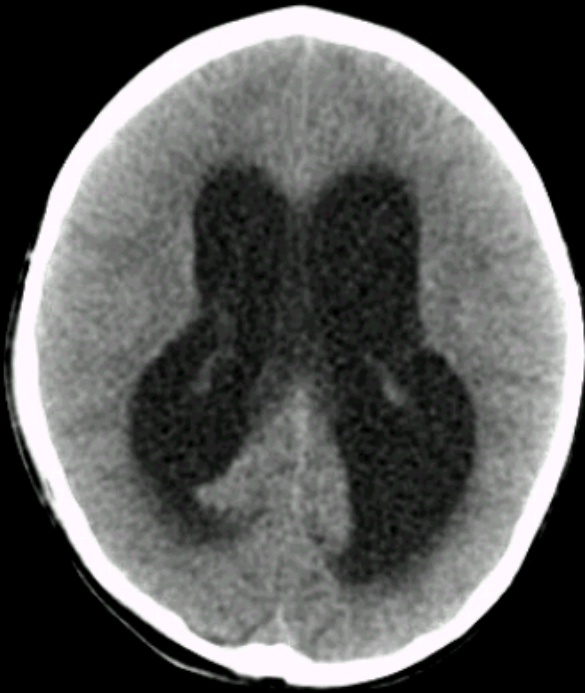
- Neurology examination
- Neuroimaging modalities
  - ultrasound
  - CT
  - MRI
- Ocular fundus

# Cerebral ultrasound examination

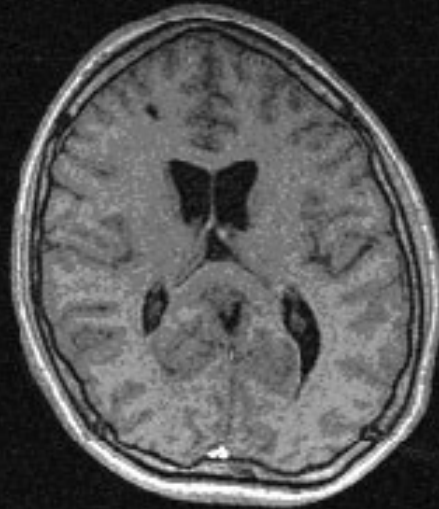




# Cerebral CT



# Cerebral MRI



PF



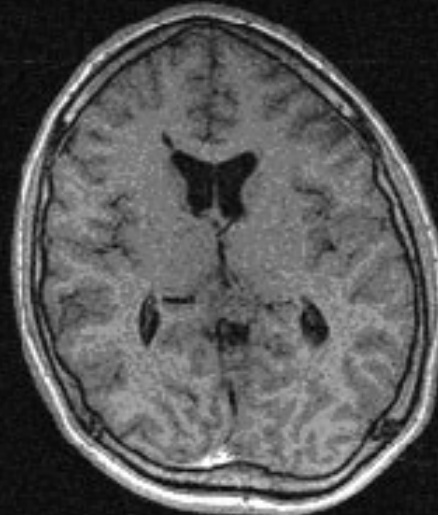
PF

AH

AH



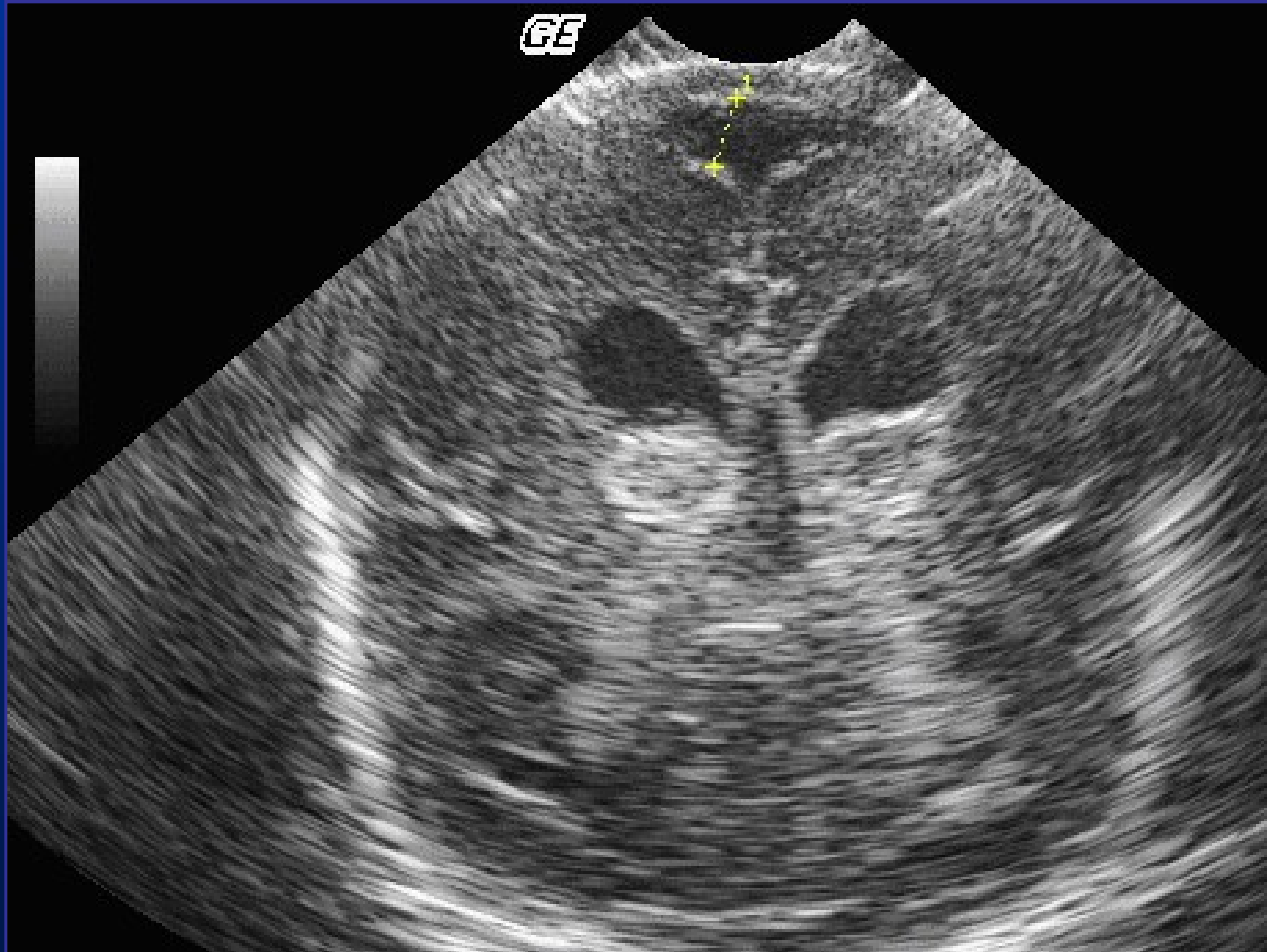
PF



PF

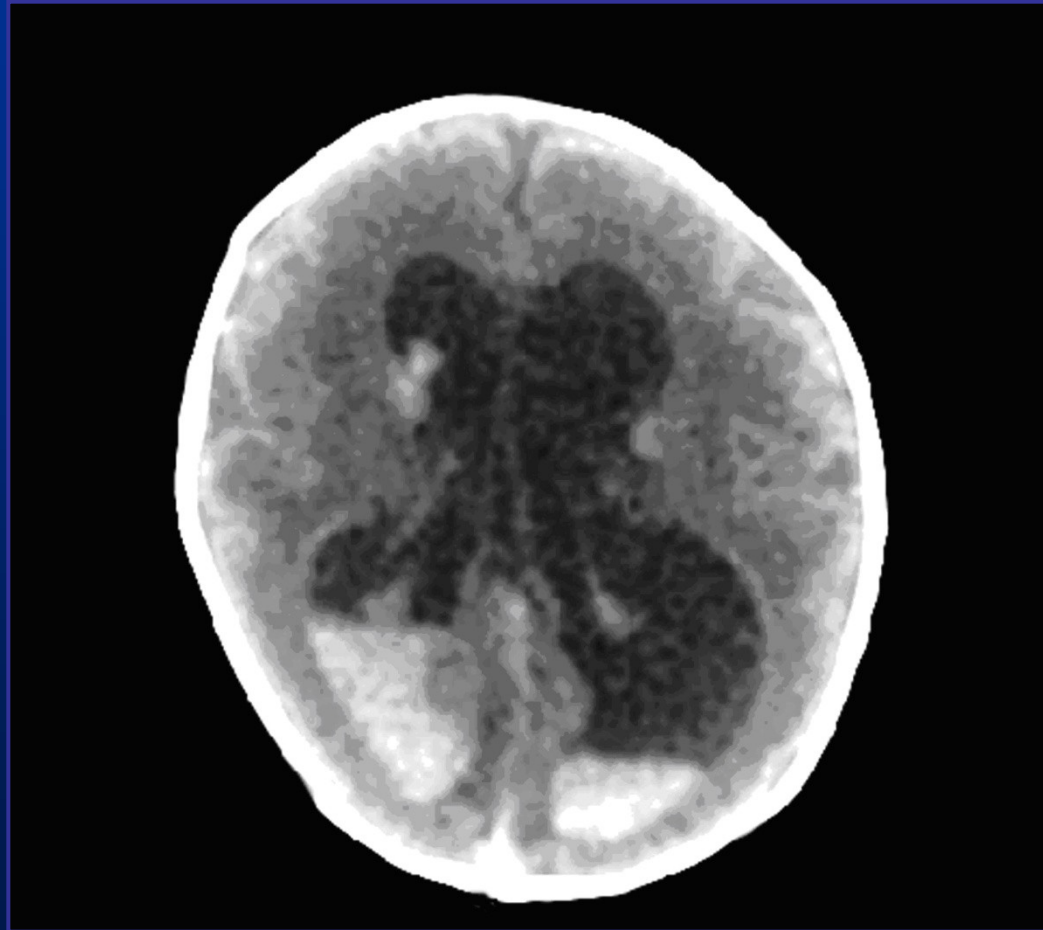
# Posthaemorrhagic hydrocephalus

ultrasound imaging



# Posthaemorrhagic hydrocephalus

CT imaging





# Hydrocephalus treatment

- Medical
- Surgery

# Hydrocephalus treatment temporary

- Medicamentose (diuretics)
- Spinal tap
- Ventricular puncture
- Ventricular drainage
- Lumbar drainage

# Posthaemorrhagic hydrocephalus

temporary treatment



# Surgical treatment of hydrocephalus

Drainage – shunting – VA, VP,

(Nulsen, Spitz, Holter, Pudenz)

Neuroendoscopy techniques



# Surgical treatment of hydrocephalus

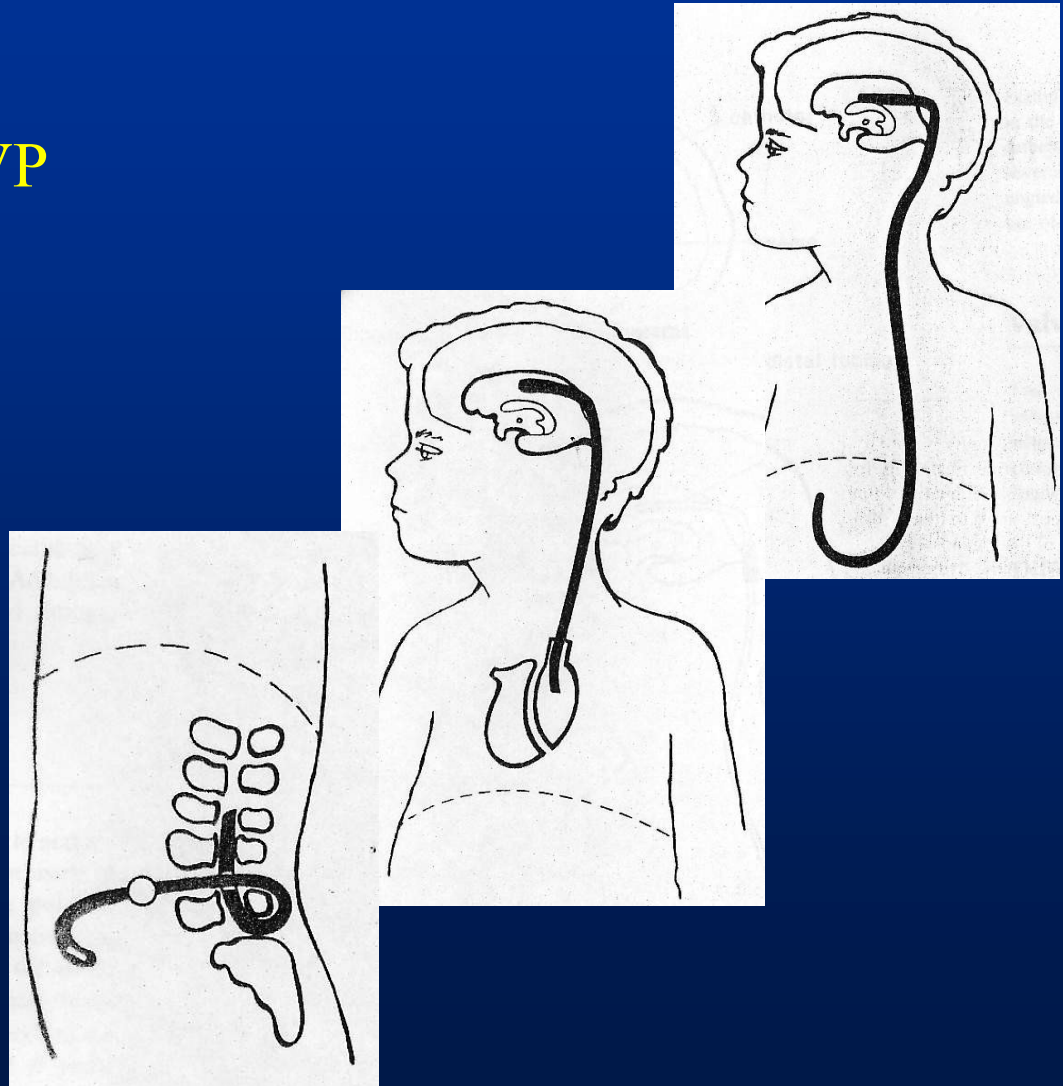
- A) Eliminating of obstruction cause (e.g. tumor extirpation)
- B) Arteficial CSF communication (neuroendoskopy,  
Stookey – Scarff)
- C) CSF drainage

# Drainage

- Most common surgery performed
- Communication between the ventricles and CSF resorption space

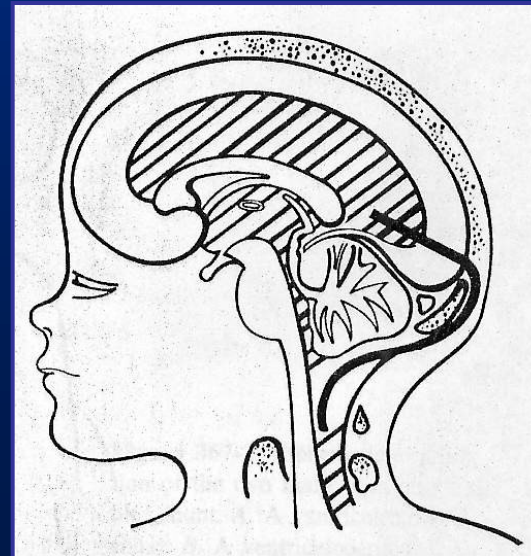
# Drainage modifications

- ventriculo – peritoneal VP
- ventriculo – atrial VA
- lumbo - peritoneal



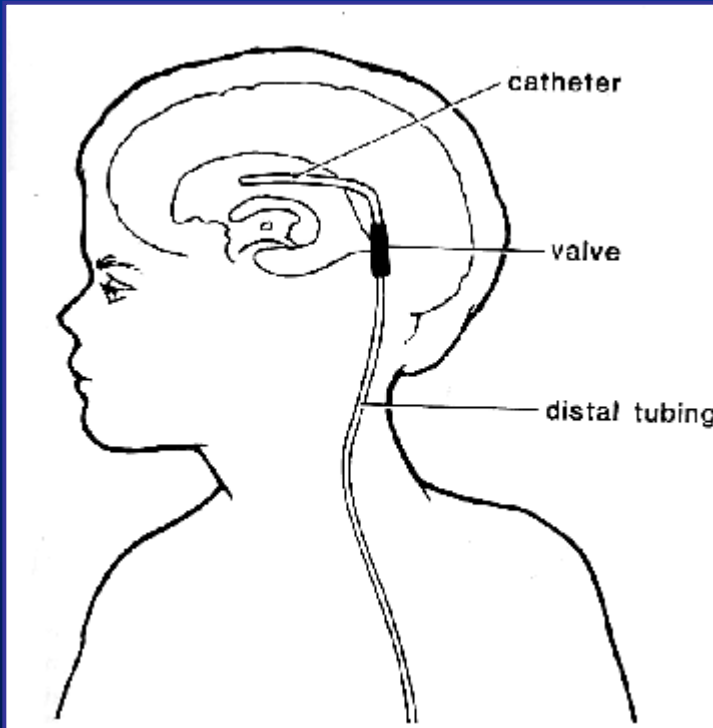
# Drainage modifications

- ventriculo - subgaleal
- ventriculo - pleural
- Torkildsen





# V-P drainage



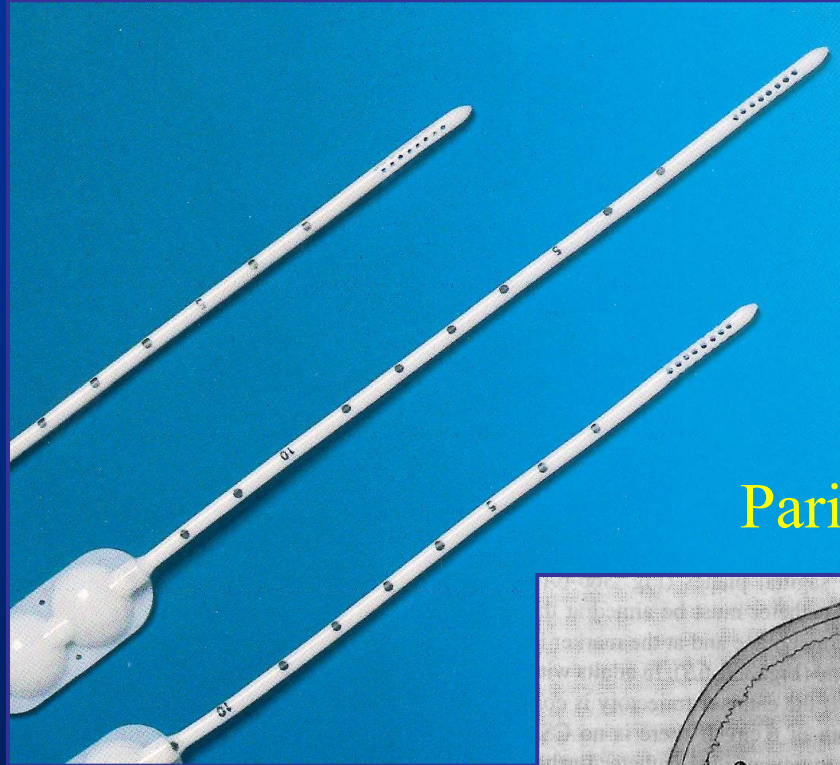
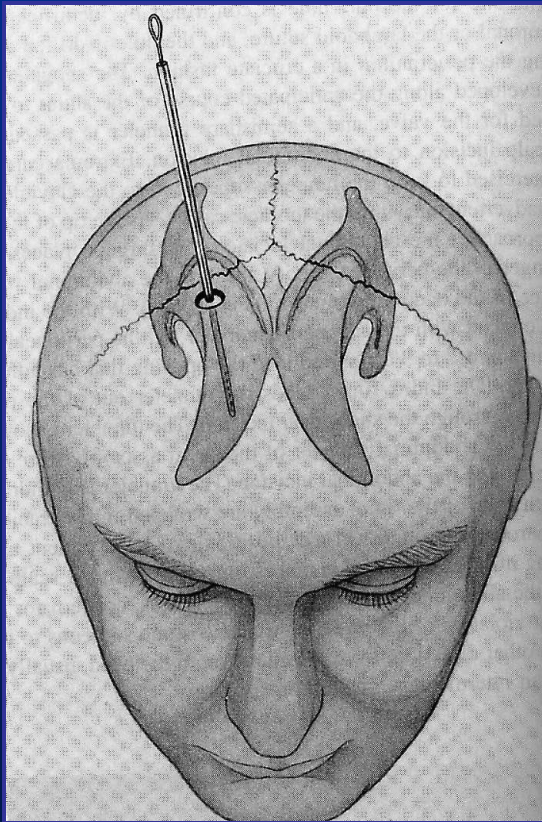
ventricular catheter

valve

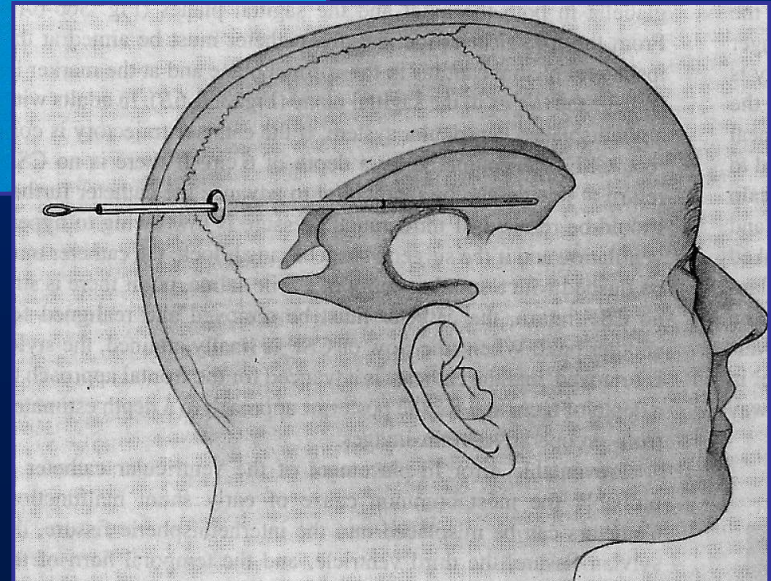
peritoneal catheter

# Insertion of ventricular catheter

Dorso-frontal



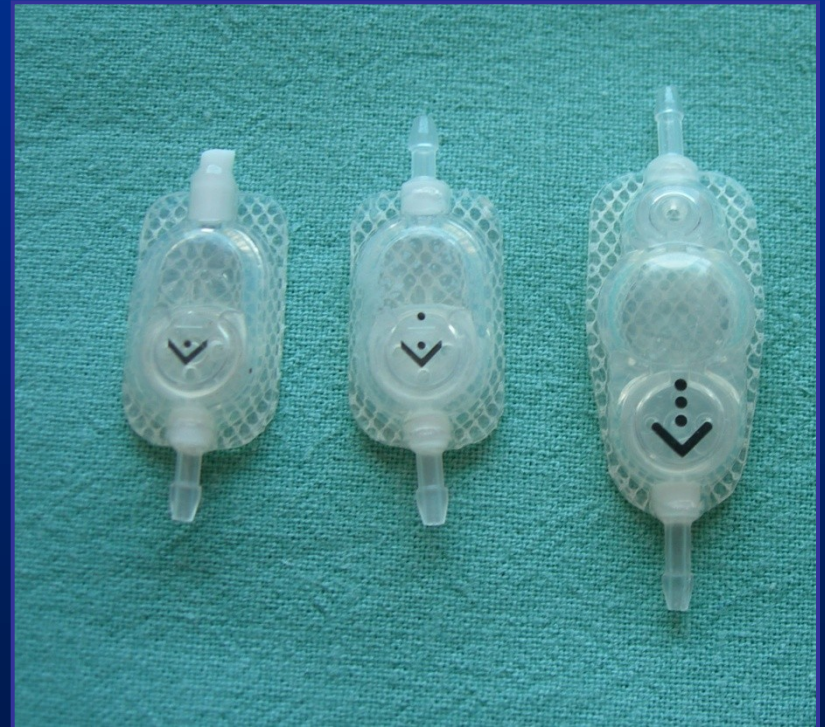
Parieto-occipital



# Valves – non programmable

Valve opening pressure:

low pressure	50 mm H <sub>2</sub> O
middle pressure	100 mm H <sub>2</sub> O
high pressure	150 mm H <sub>2</sub> O

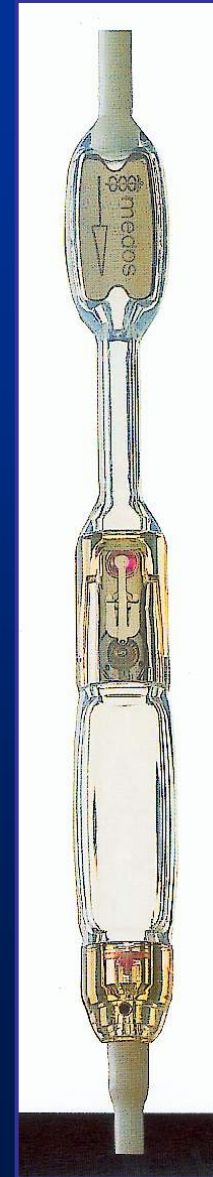




# Programmable valves



system Codman





# Programmable valves

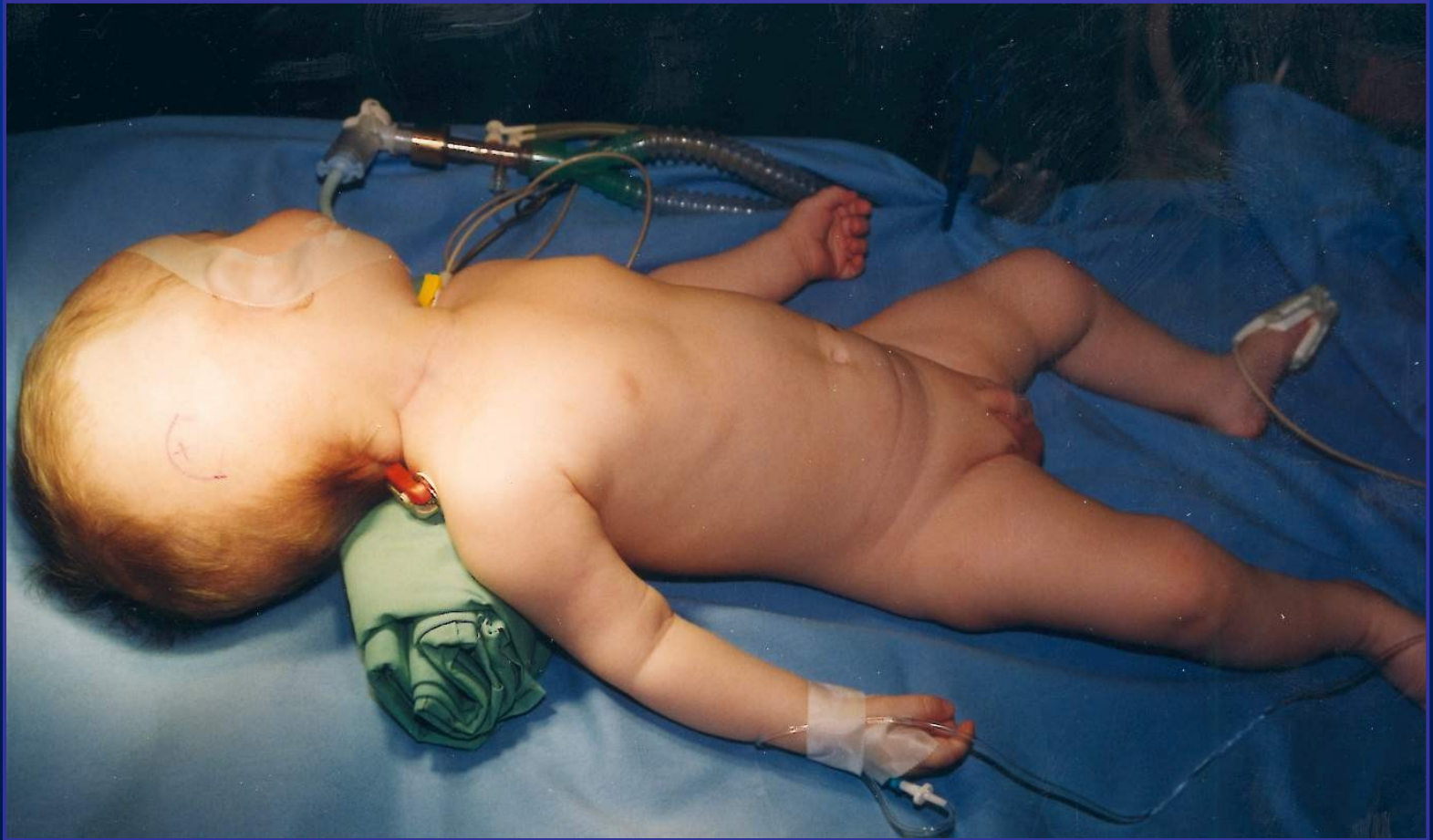
system Strata Medtronic



# Surgery - drainage

## VP shunt

patient positioning





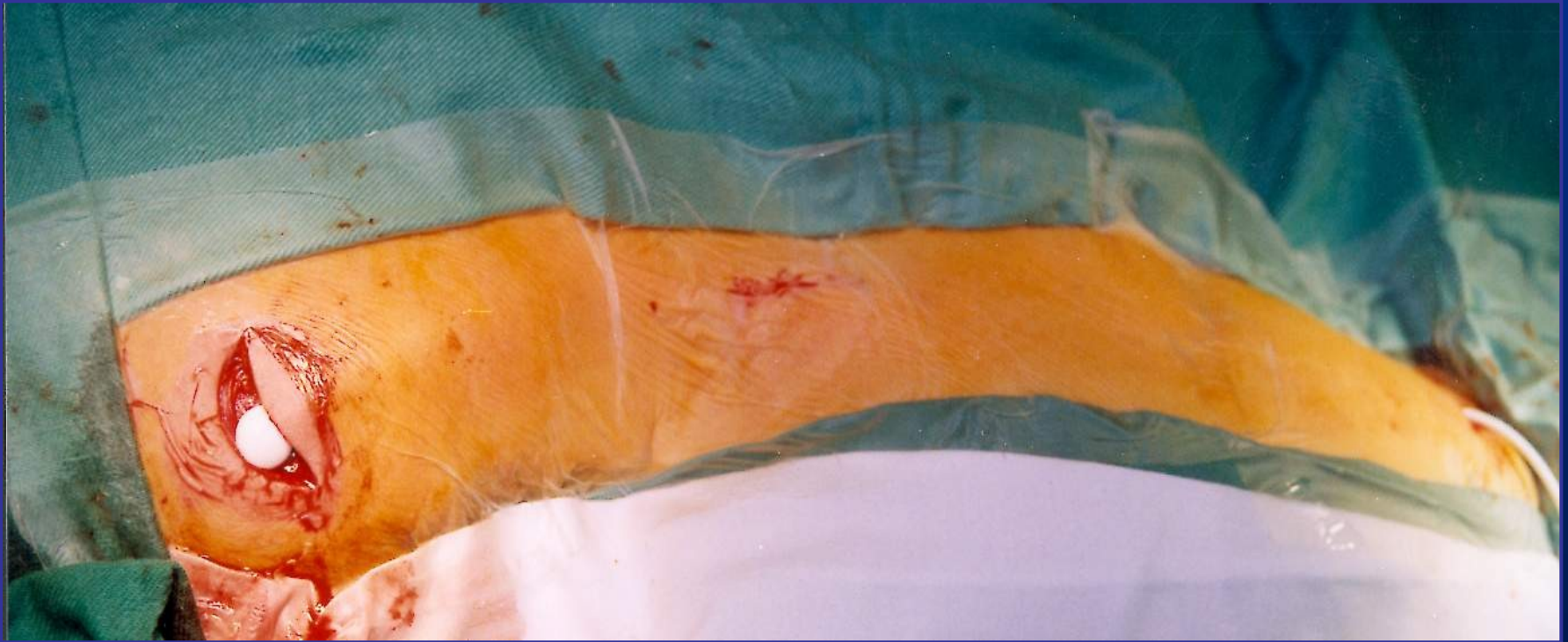
## Surgery - drainage - VP shunt



## Surgery - drainage - VP shunt

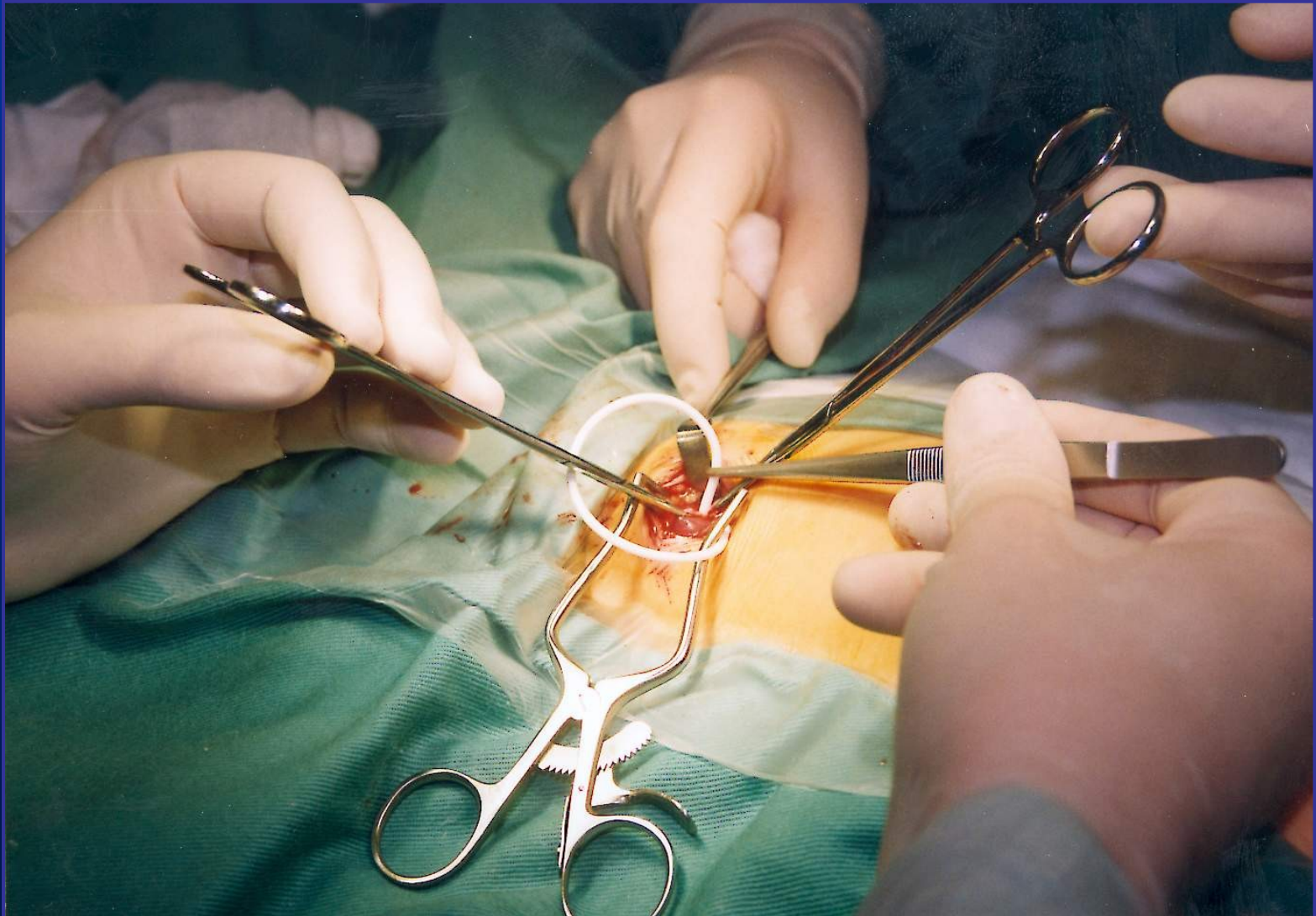


## Surgery - drainage - VP shunt





## Surgery - drainage - VP shunt



## Surgery - drainage - VP shunt



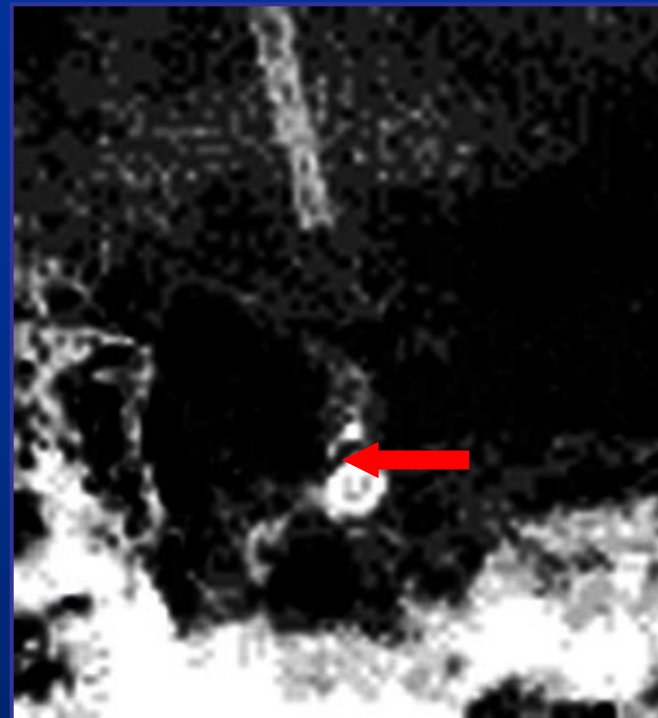
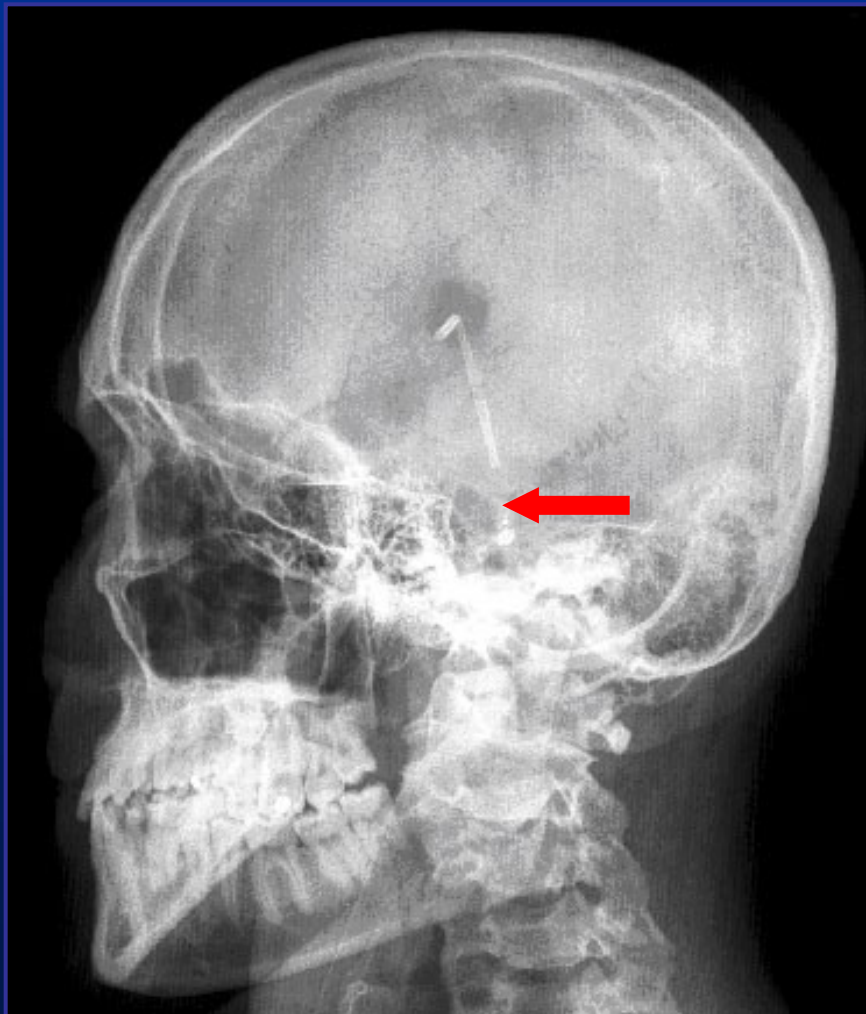
# Shunt malfunction

- Neurological examination
- Fundus oculi
- Percutaneous valve test
- Valve pressure resetting  
(programmable valves only)



# X-rays

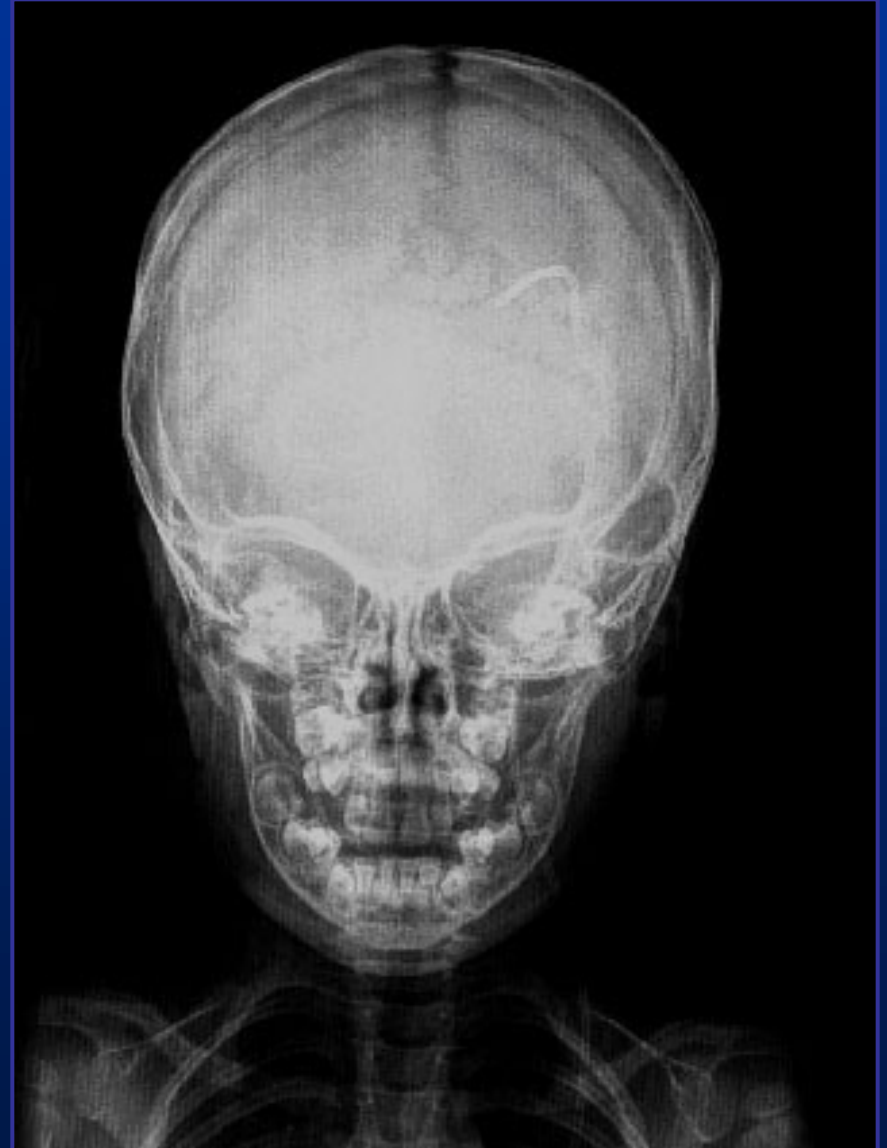
(systém Codman valve markers)



# Laboratory examinations:

- FW, blood count, inflammation markers, serum osmolarity
- CSF examination – valve puncture  
(bacteriology, biochemistry, cytology)

# X-rays:



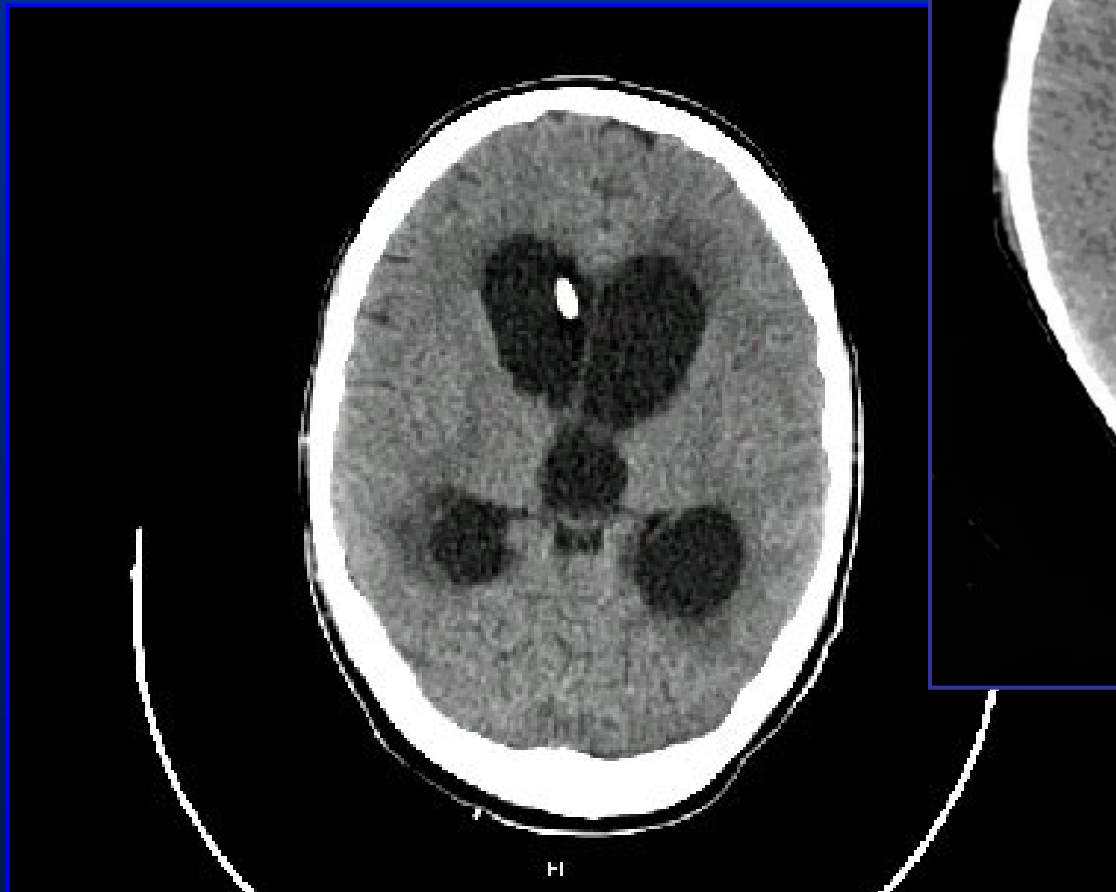
# X-rays:



# Ultrasound:



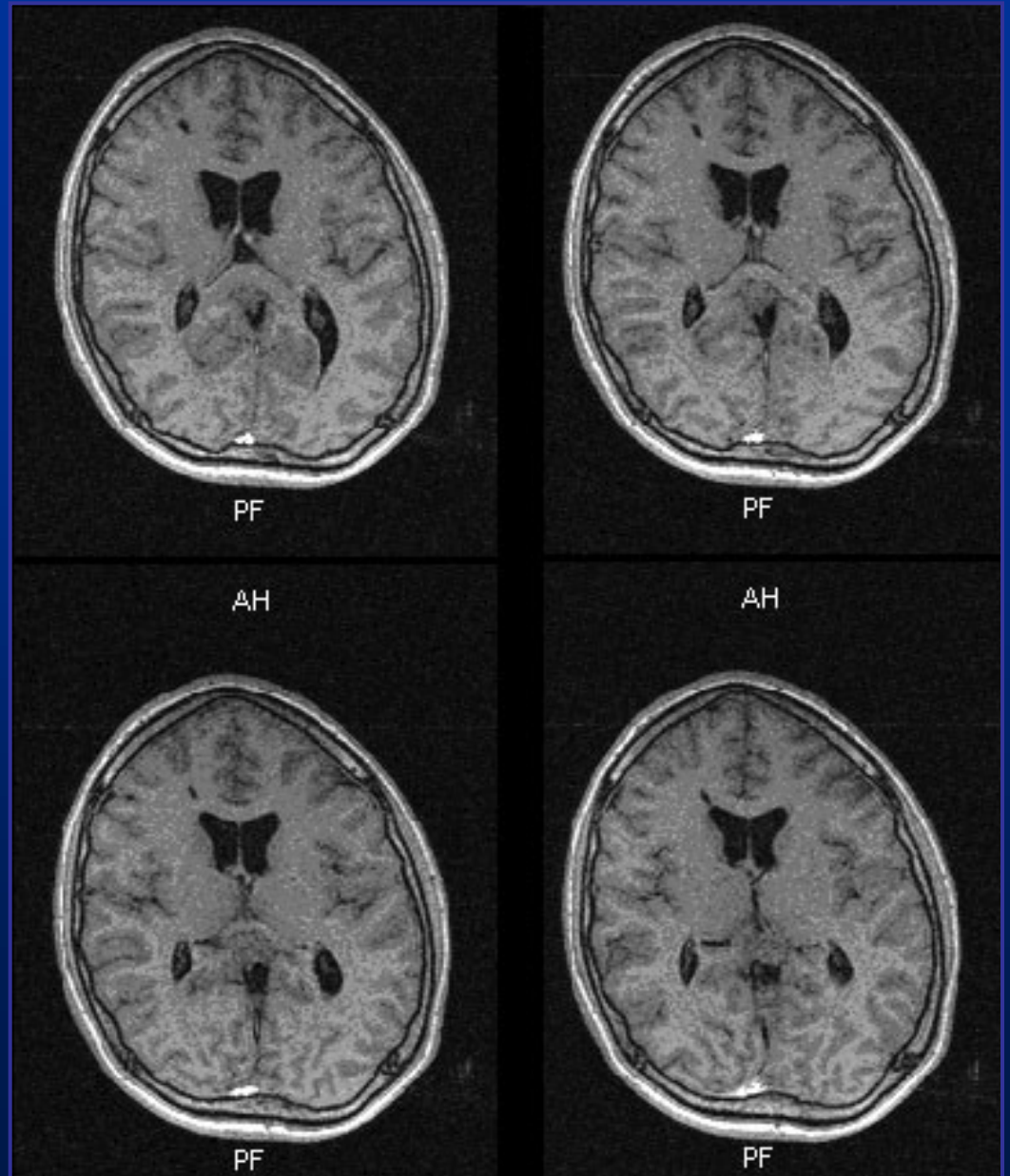
CT





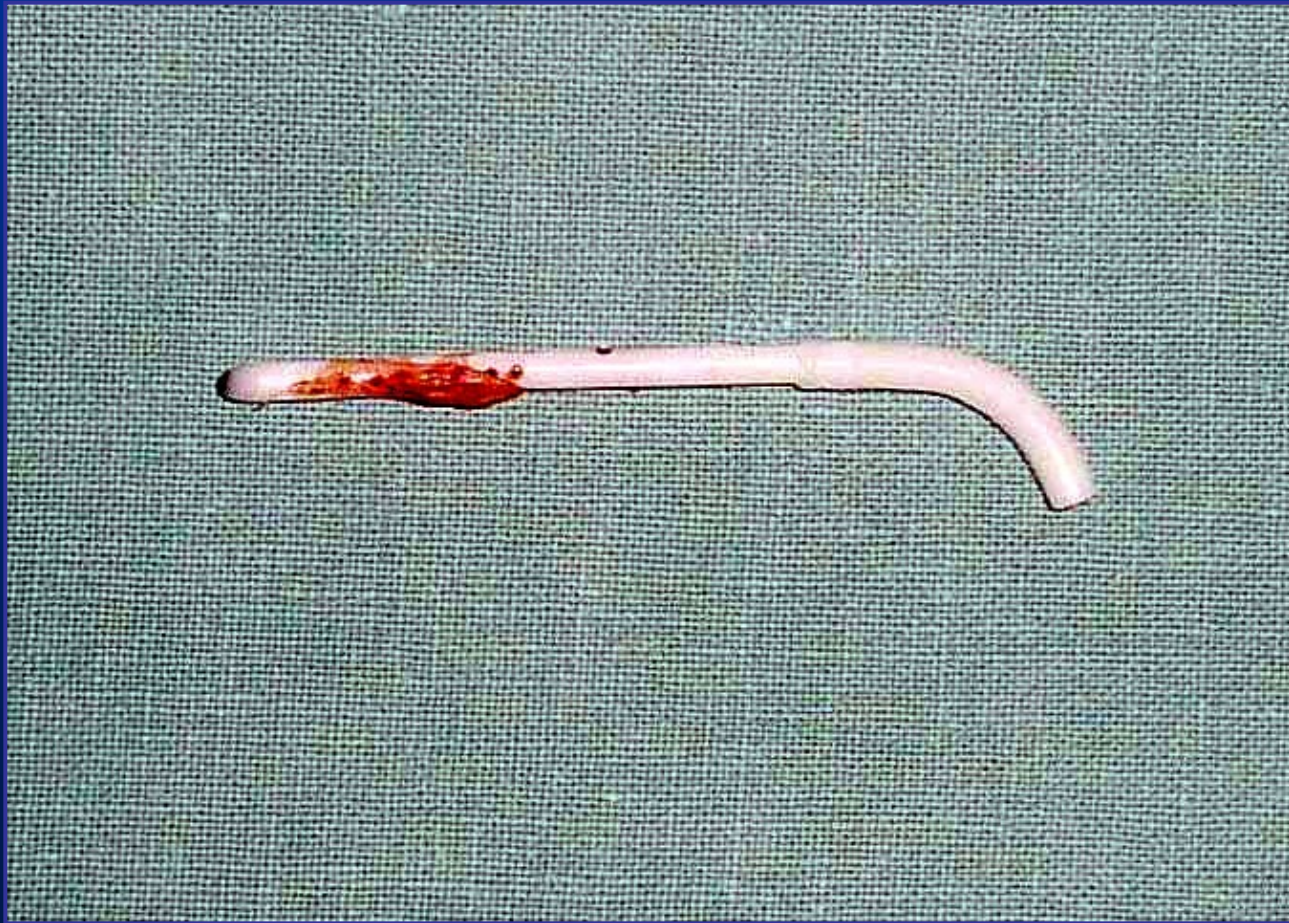
# MRI

(cave programmable valves)



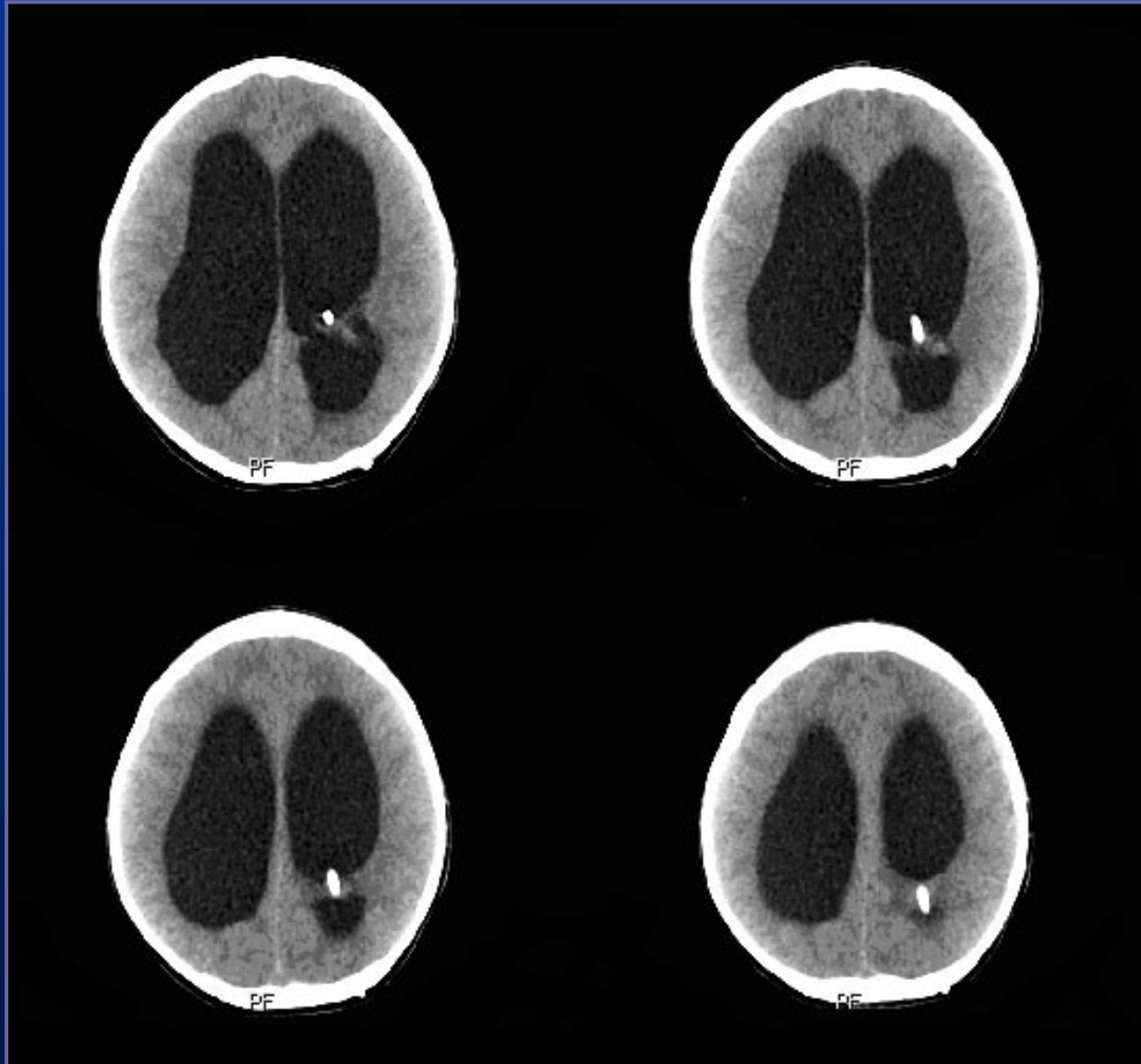
# Central (ventricular) catheter malfunction

- blood clot obturation



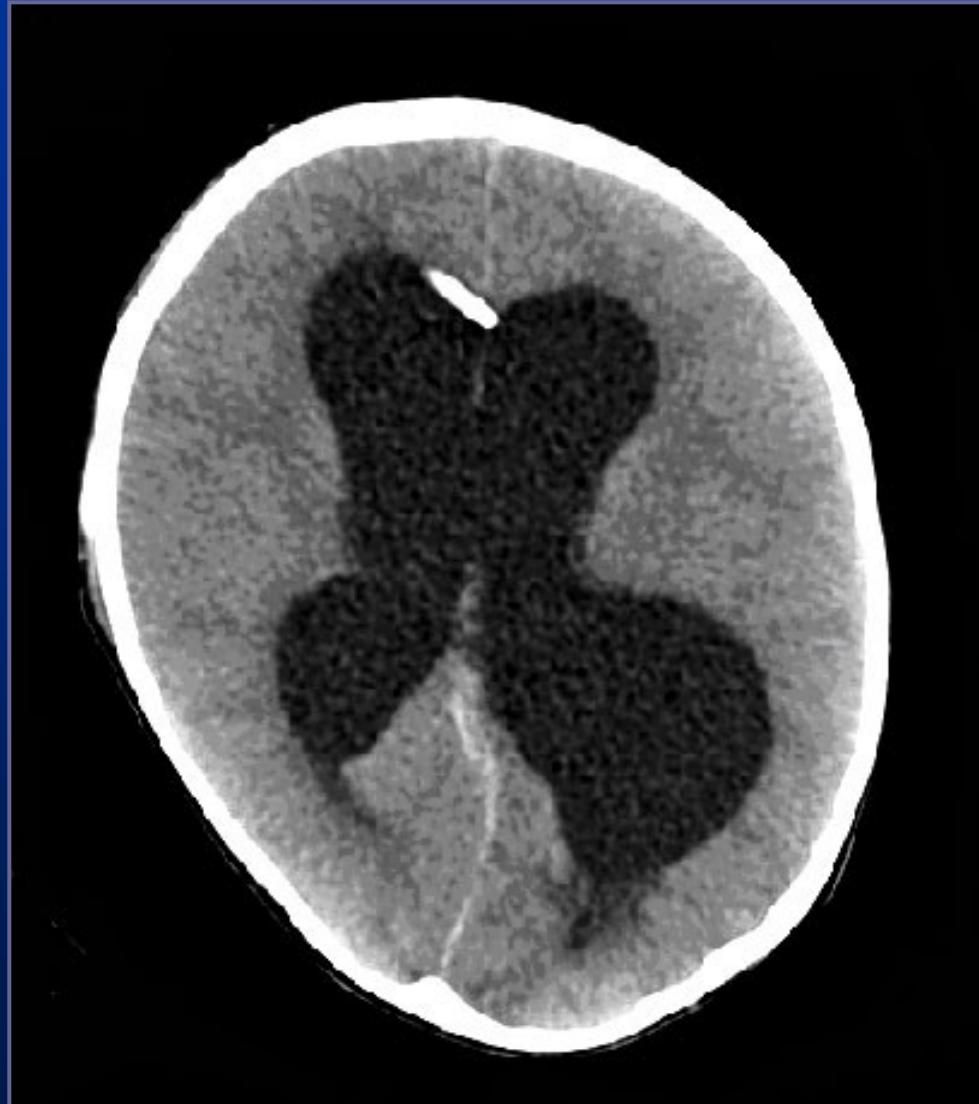
# Central (ventricular) catheter malfunction

## chorioideal plexus adhesions





# Central (ventricular) catheter malfunction malposition



# Central (ventricular) catheter malfunction

Surgical treatment – catheter repositioning or replacement



## Valve malfunction:

- blood clot obturation
- elevated CSF viscosity  
(inflammatory process)
- slit ventricle syndrom

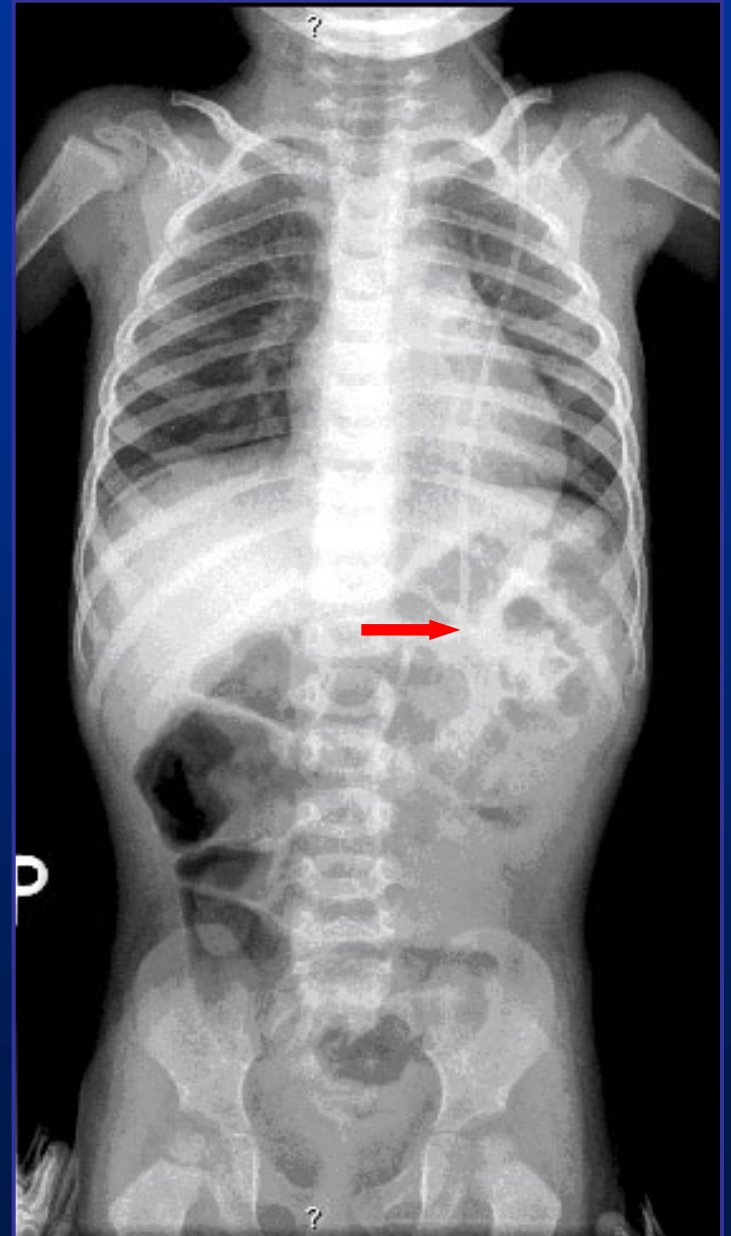
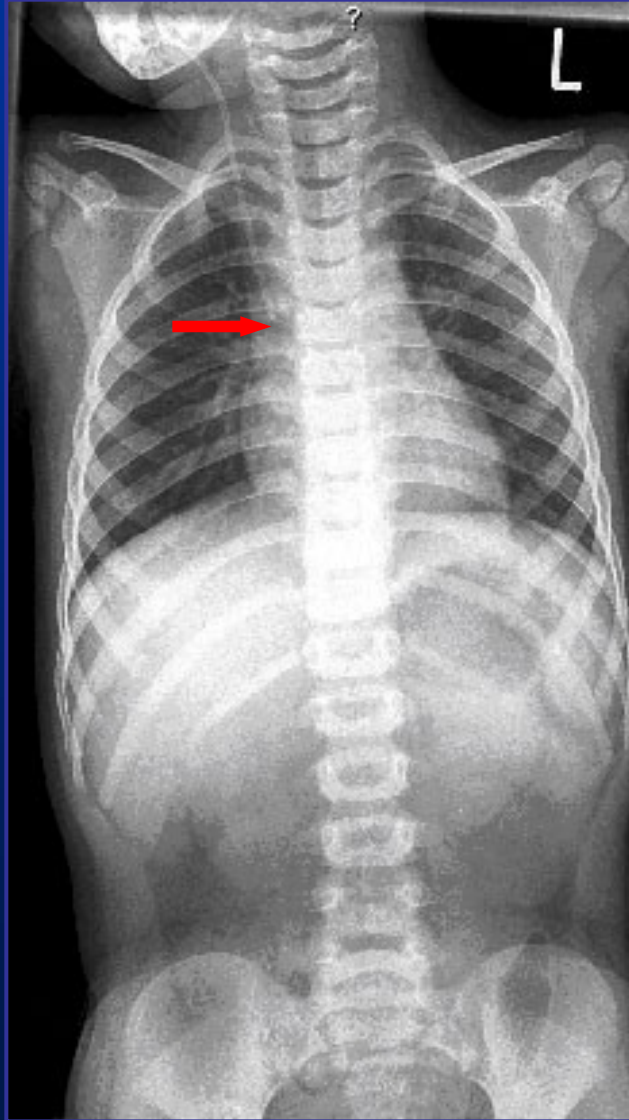




# Distal catheter malfunction:

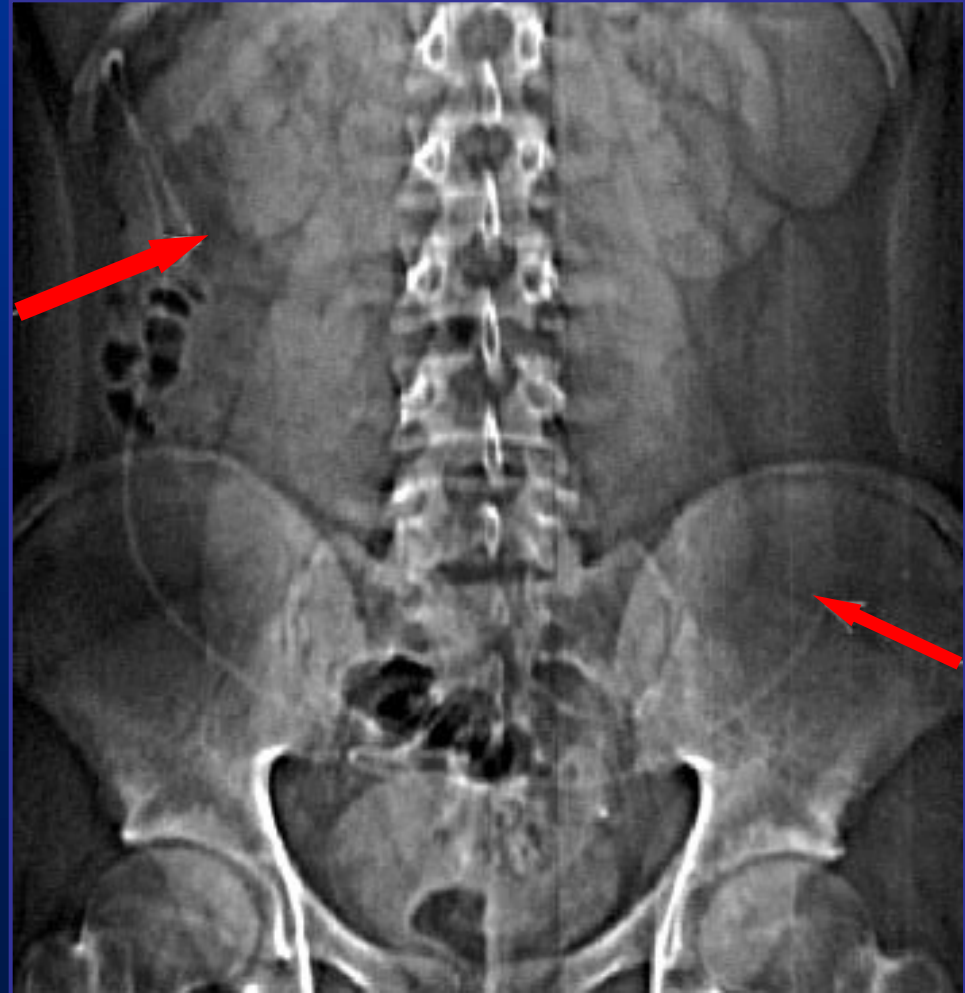
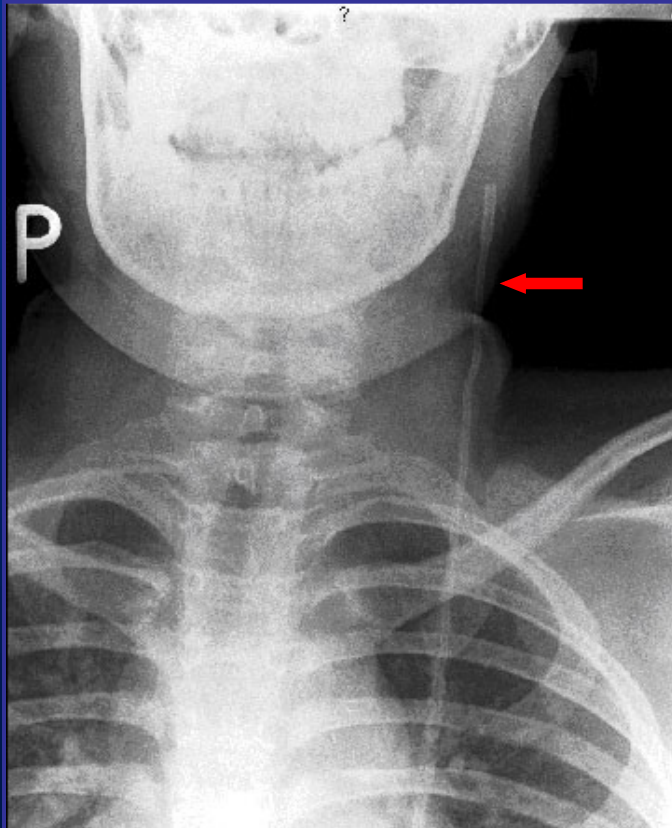
- Unsufficient catheter lenght due to pts growth (X – rays)
- Distal catheter malfunction causes:
  - continuity cut-off
  - peritoneal adhesion
  - peritoneal pseudocyst - septic
    - aseptic
  - peritonitis due APE
  - hyporesorbtion – ascites
  - catheter intolerance, catheter expulsion
  - displacement to subcutaneous tissue
  - intestine perforation
  - hernia inguinalis, umbilicalis
- Atrial catheter malfunction causes:
  - catheter thrombus (heart ultrasound)

# Unsufficient catheter lenght due to pts growth



# Continuity cut-off:

- diconnection
- disruption



## Treatment – immediate surgery

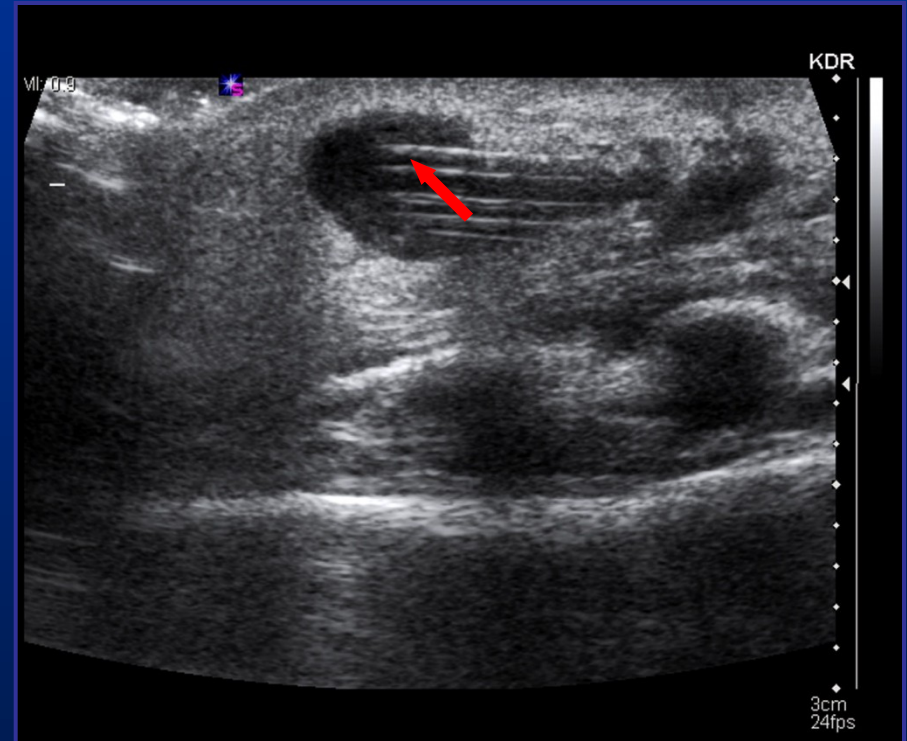
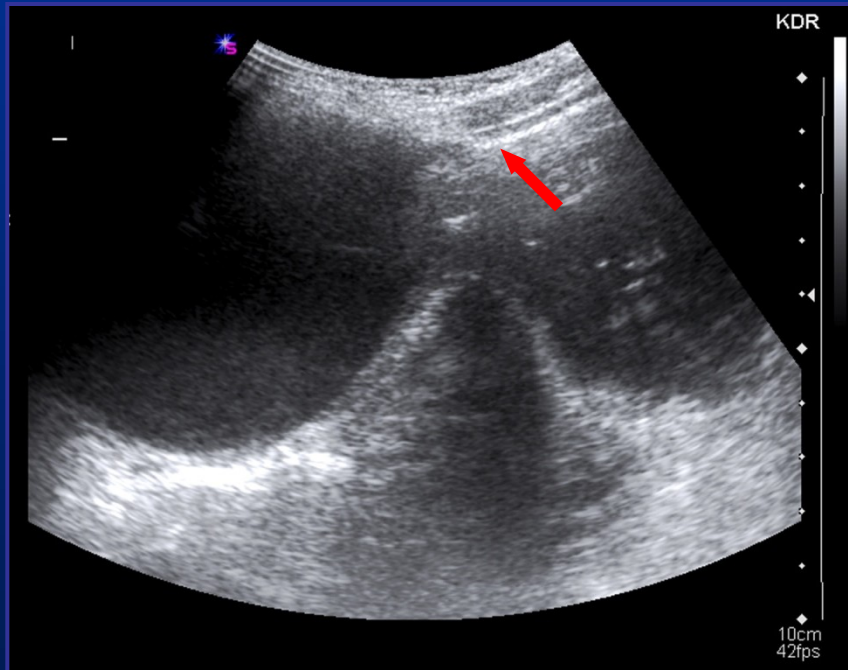
- re-connection if possible
- catheter replacement (removing the displaced one)





# Peritoneal catheter – distal end - pseudocyst

Ultrasound:



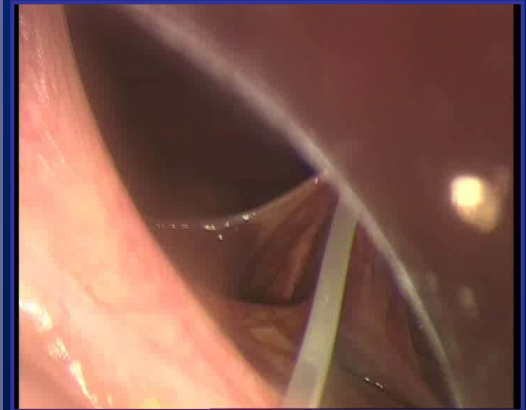
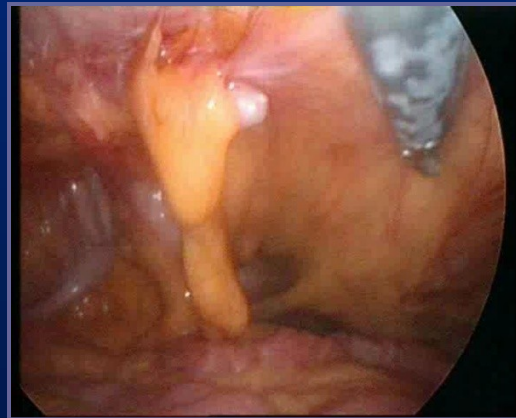
Septic: elevated CRP, FW, leukocytosis

# Peritoneal adhesions

Localized – laparoscopy, catheter deliberation, replacement

Diffuse – temporary external drainage

Intraluminal – catheter replacement





# Laparoskopy 3D, system Viking



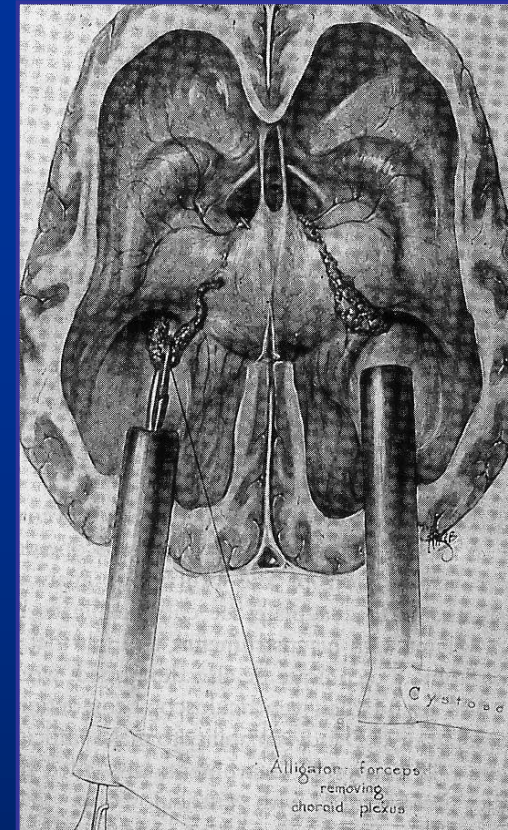
# Infectious complication:

- drainage extraction
- temporary external drainage
- antibiotics





# Neuroendoscopy



1923 Mixter

- first 3rd ventriculostomy

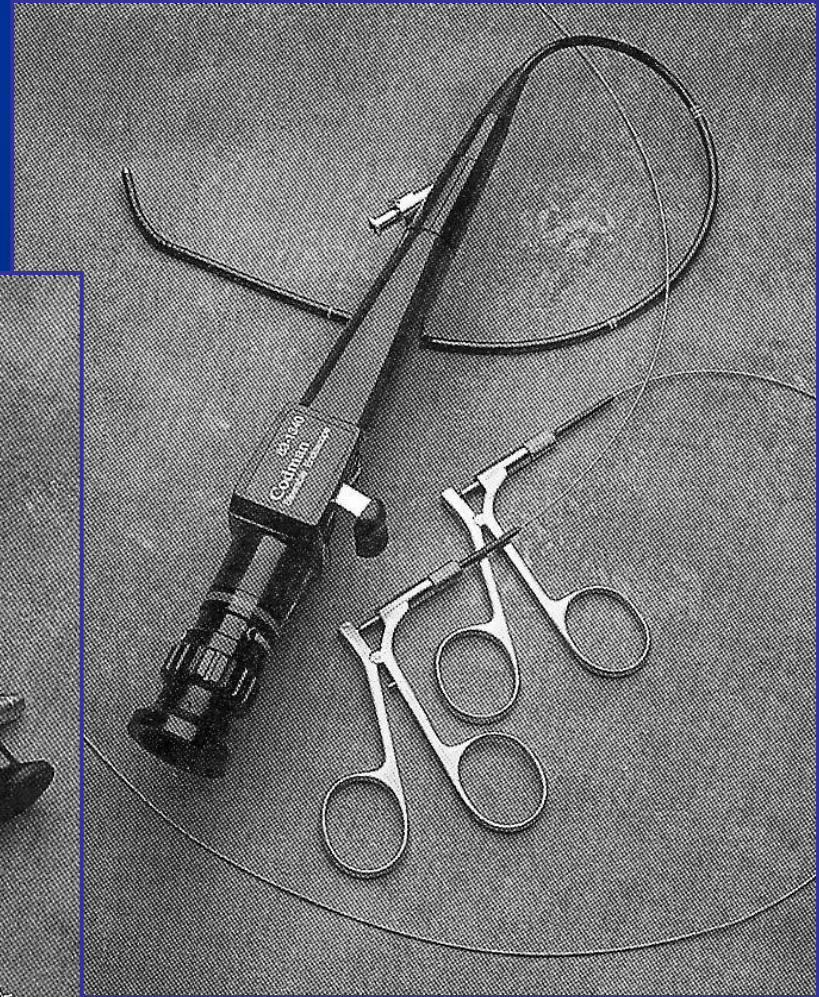
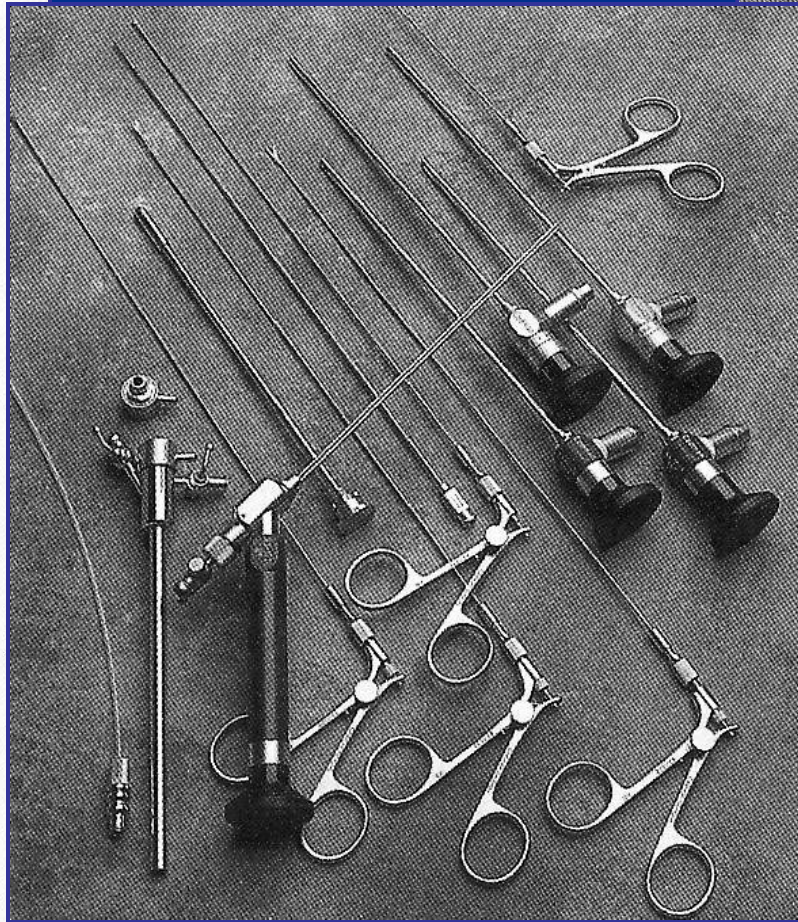
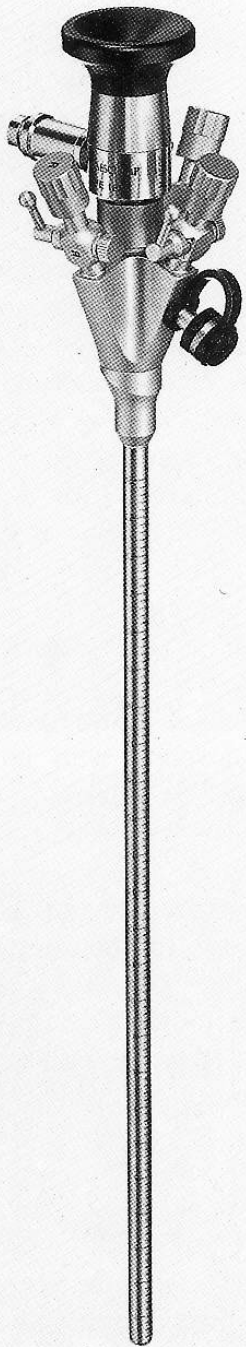
80s

- neuroendoscopy techniques

(flexible endoscopy, assisted endoscopy)



# Neuroendoskopy





# Neuroendoskopy:

- Exstirpatio and biopsy of intra or periventricular expansions
- Cyst marsurpialisation
- Aqueductoplasty
- Third ventriculostomy

# Indications for Neuroendoscopy:

- Obstructive hydrocephalus
- Ventricular catheter implantation or replacement
- Ventricular (paraventricular) tumors
- Arachnoideal cyst
- Subdural space revision

# Neuroendoscopy – complications:

- haemorrhagy
- hyperthermia (aseptic)
- pneumocephalus
- periventricular tissue damage
- CSF fistula
- infection
- SD haematoma