

Frühjahrssymposium der  
Neurologie am Klinikum  
Bremen-Ost

*Dysphagie und Hypersalivation,  
Palliativmedizin, Liquormalresorption*



WANN UND WO

Samstag, 7. Februar 2026

Haus im Park, Klinikum Bremen Ost

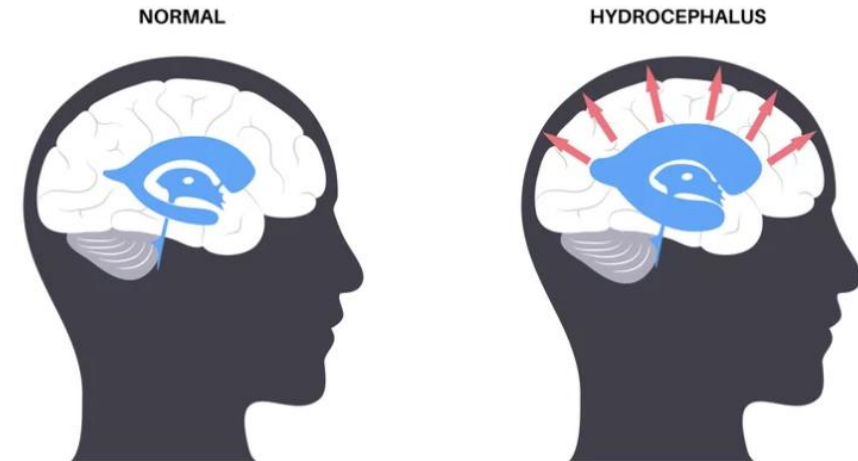
# Ventrikuloperitonealer Shunt - Operation und Nachsorge sowie weitere chirurgische Alternativen

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Klinik für Neurochirurgie  
Klinikum Bremen Mitte

# Keine Interessenkonflikte

# Hydrozephalus (“Wasserkopf”)

- Wasseransammlung im Ventrikelsystem, die zu einer Ausweitung der Hirnsubstanz und ihrer Höhlen führe
- Nicht alle Formen sind gleich:
- Komplexe Physiopathologie
  - Unterschiedliche Ursachen
    - Unzureichende Absorption von Liquor
    - Behinderung des Liquorabflusses
    - Kommunikationsstörung
    - Verstärkte Produktion von Liquor
  - Unterschiedliche Behandlungen

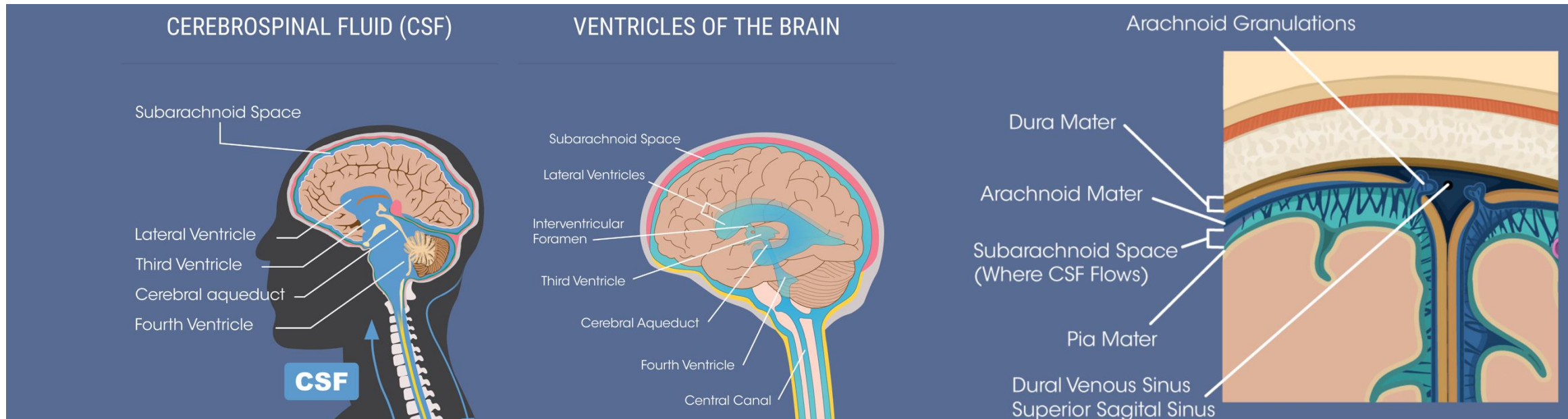


# LIQUOR

Tot. 150 ml: 125 ml subarachnoidal

25 intraventrikulär

400 to 600 ml/Tag



## Malresorptivus

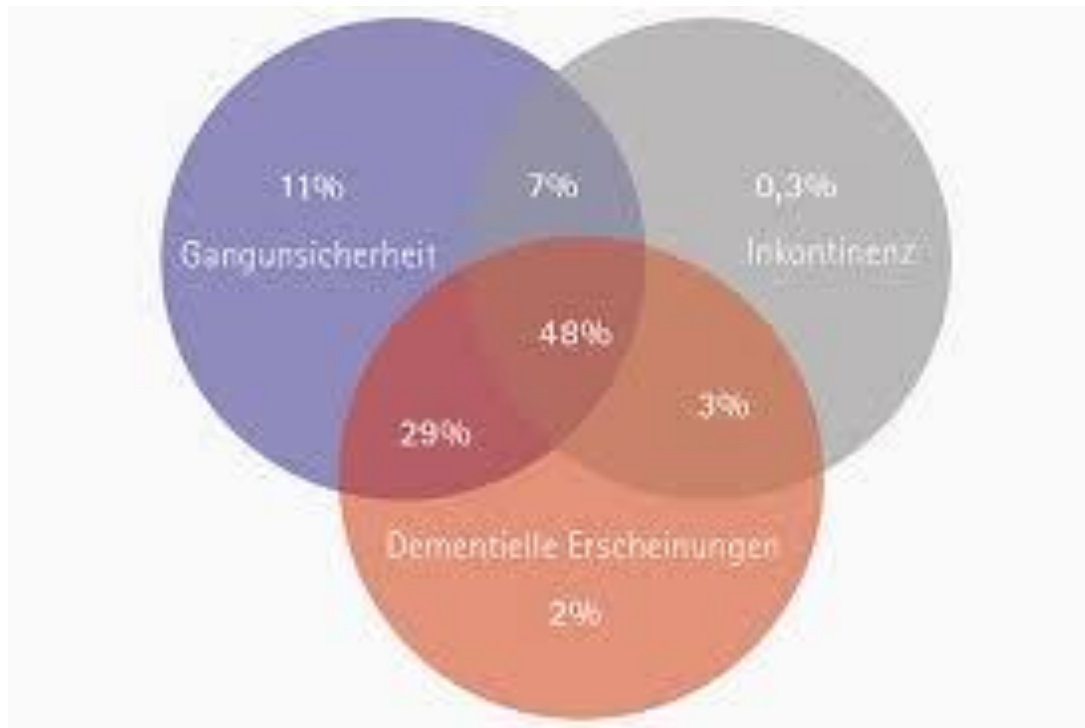
- NPH
- tSAB, aSAB
- Plexus papilloma
- Meningitis, Meningomatosis cerebri
- Pseudotumor cerebri

## Occlusus

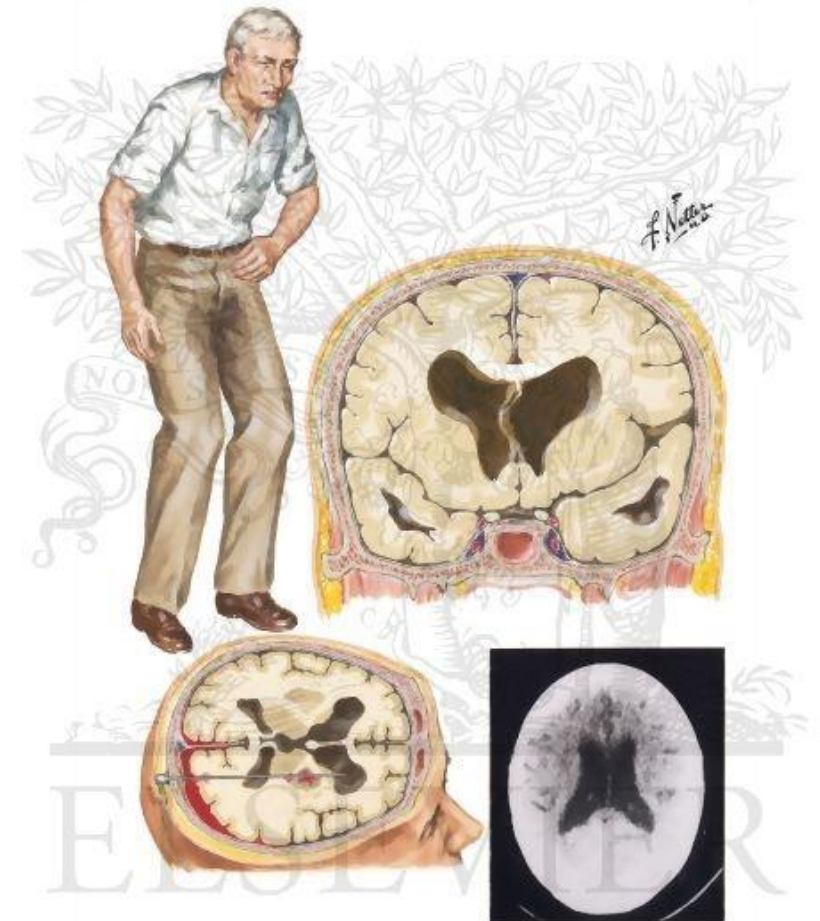
- IVH, SAB
- Tumor des III./IV. Ventrikels, hinterer Schädelgrube (Kolloidzyste, Tectusgliom)
- Aquäduktstenose/LOVA
- Chiari Typ 2

# Normaldruckhydrocephalus

- Hakimische Trias

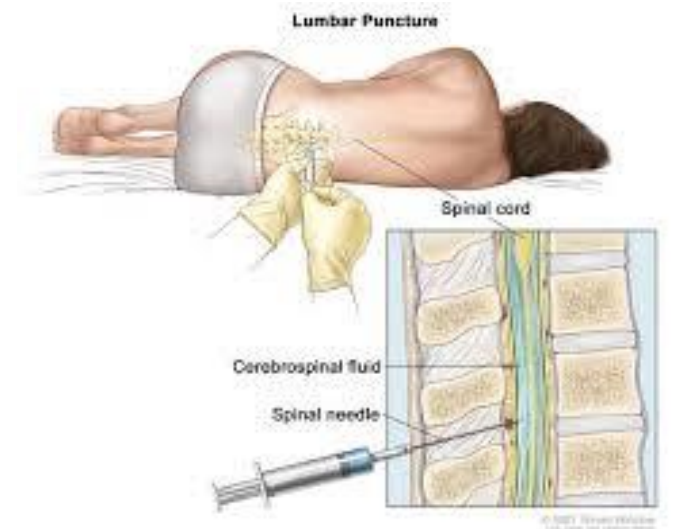
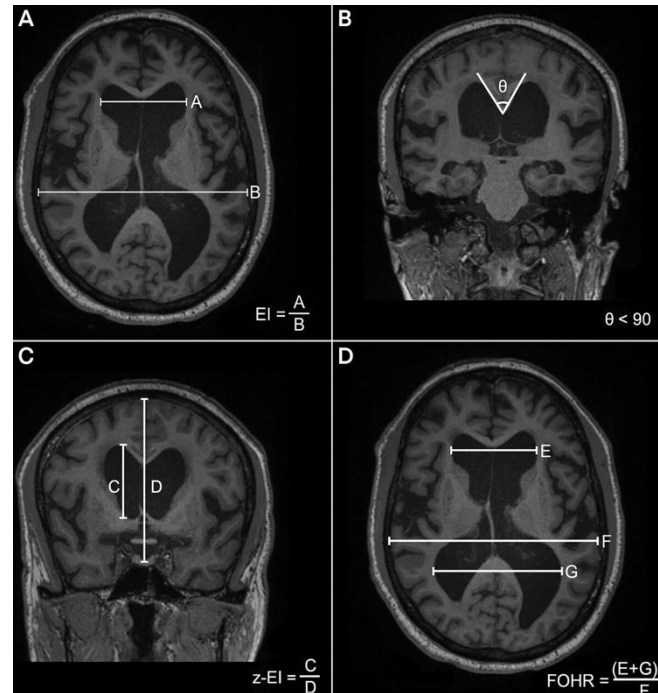


CAVE: Gemische Demenzformen: Parkinson etc.

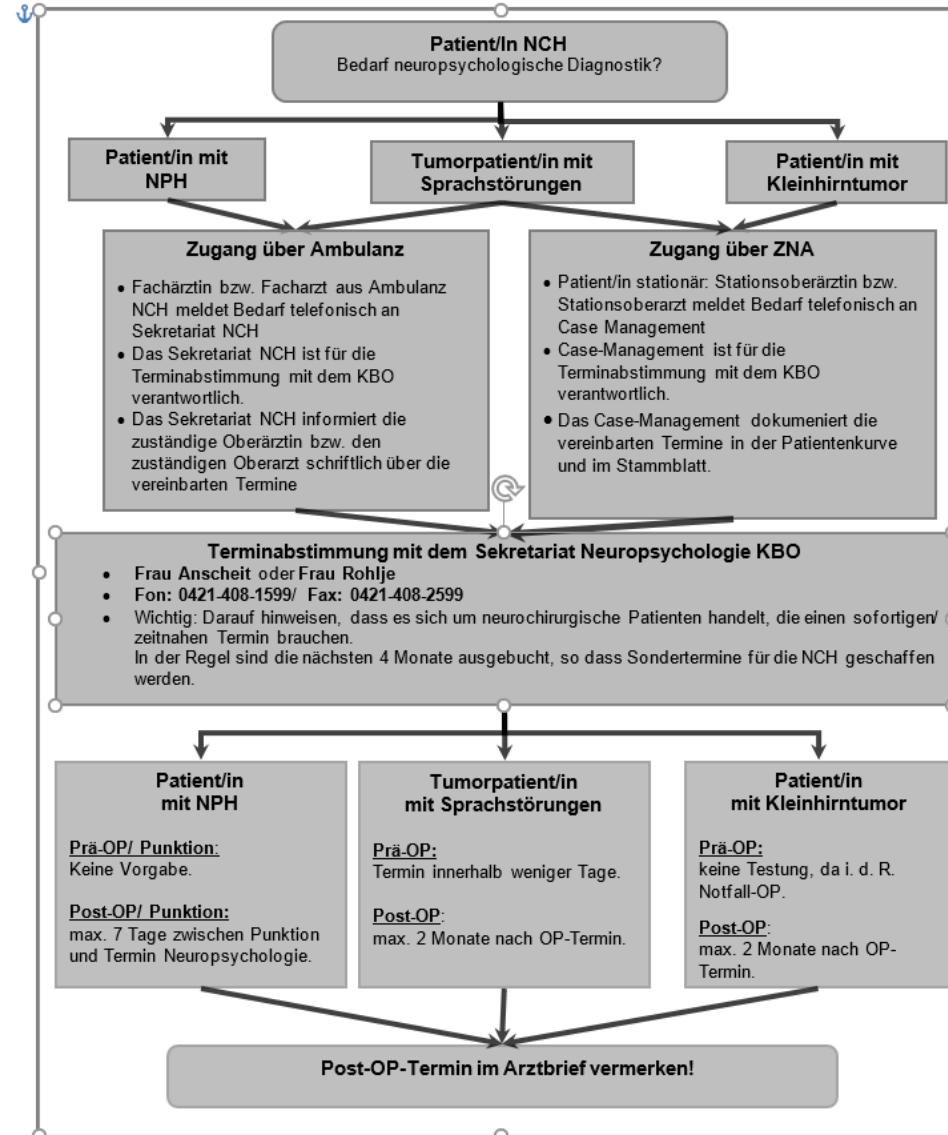


# Diagnose

- Evans' Index  $> 0.30$
- Callosal angle  $\leq 90^\circ$
  
- Liquor Tap Test:
  - MiniMentalTest
  - Gait analysis



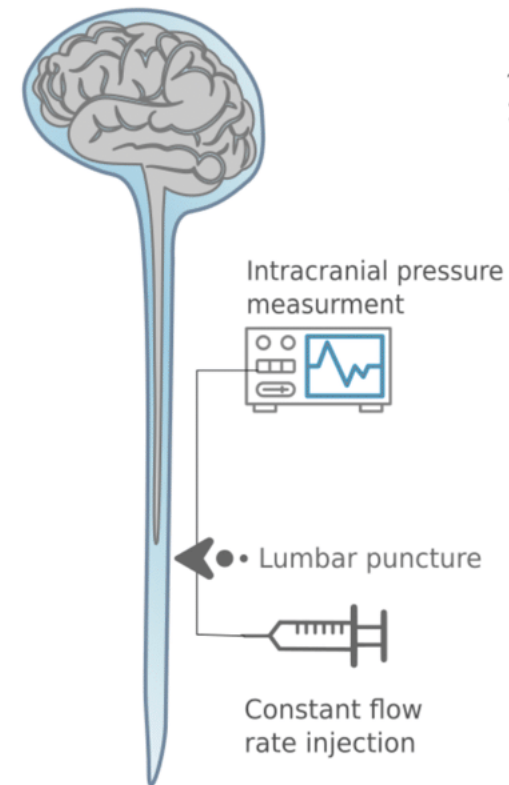
## KLINIKUM BREMEN-MITTE



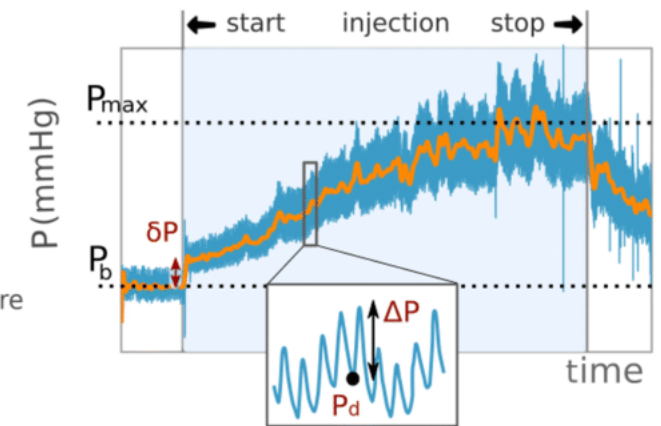
# Infusion test



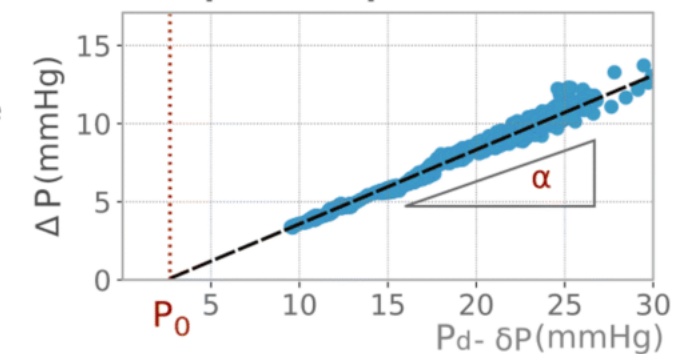
**A Lumbar infusion test**



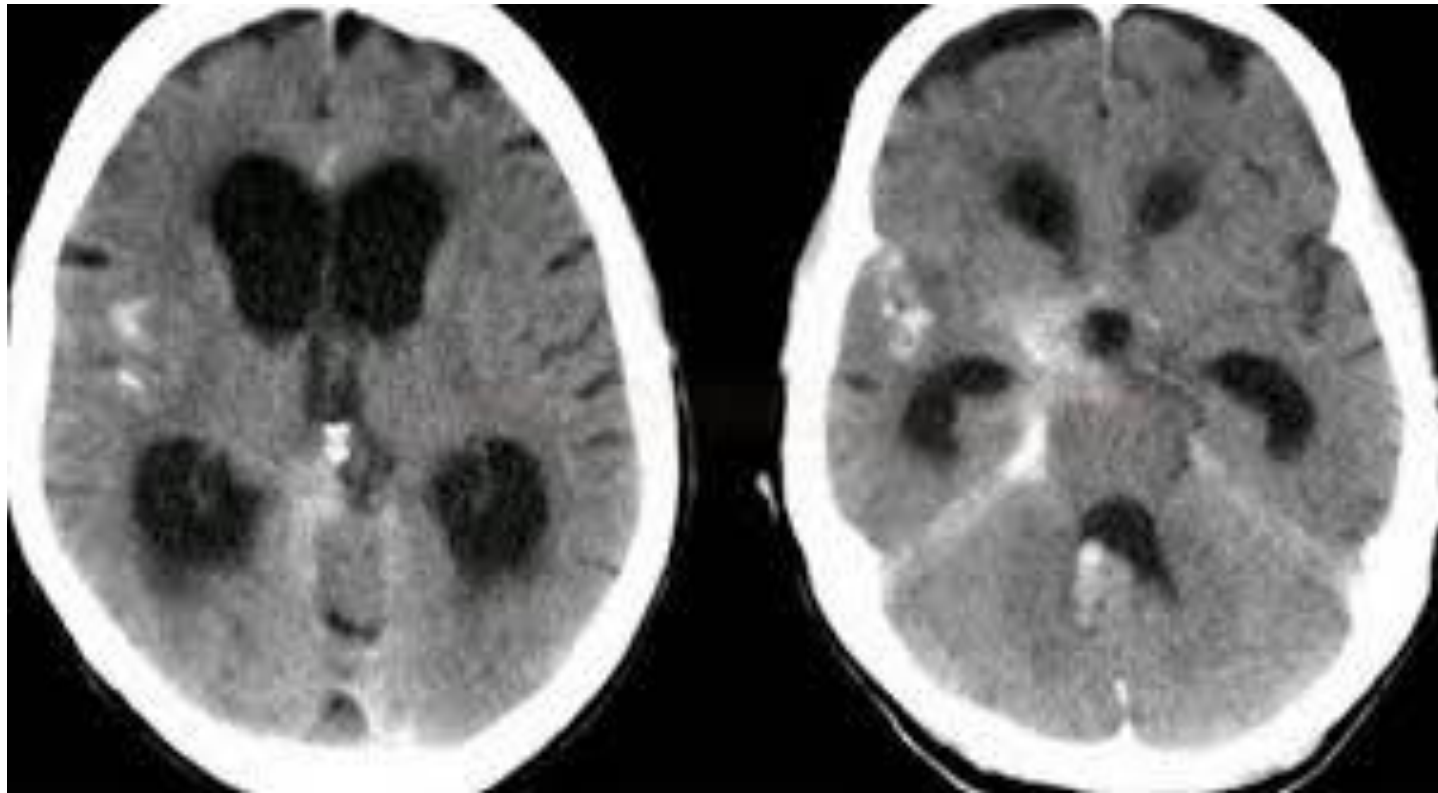
**B Intracranial pressure (ICP)**



**C ICP pulse amplitude**

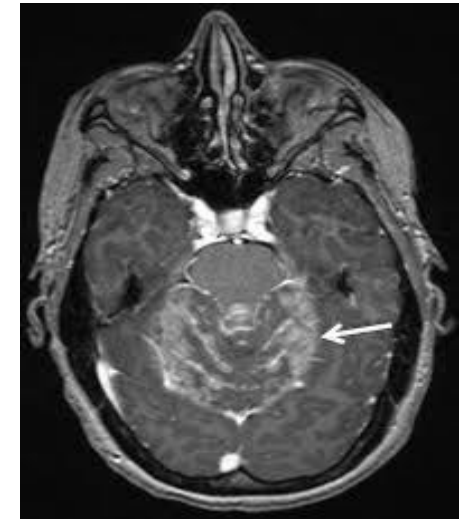


## Subarachnoidalblutung (traumatisch, nicht traumatisch)



# Plexus papilloma, Meningitis, Carcinomatosis cerebri

- Verstärkte Produktion von Liquor
- und/oder insuuffiziente Resorption

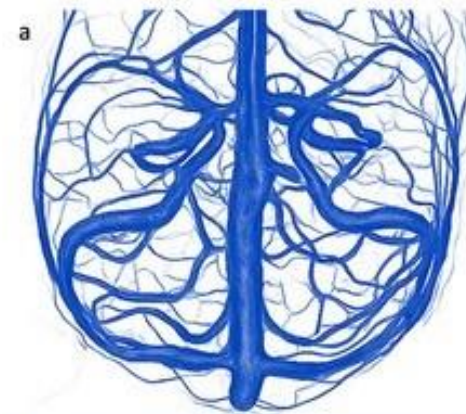


# Pseudotumor cerebri

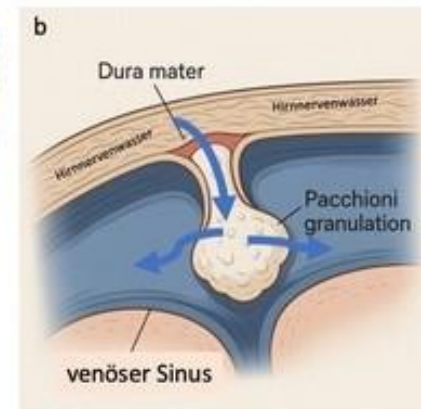
- 1:100.000 Einwohner pro Jahr
- Häufung bei übergewichtigen Frauen 15. -45. Lebensjahr
- Kopschmerzen, Migräne
- Progrediente Sehestörung
- Tinnitus
- Übelkeit



Abbildung 1:



Hirnvenen und venöse Blutleiter

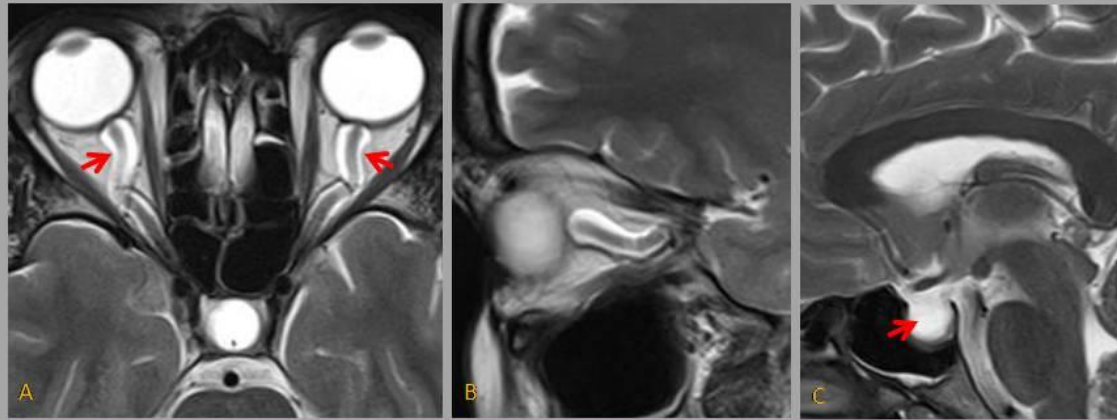


Antomisches Bild: Zusammenspiel venöse Blutleiter und Hirnnervenwasser (erstellt mit KI)



venöse MR-Angiographie bei Patienten mit CIVHS und venöser Sinusstenose bds.

## PSEUDOTUMOR CEREBRI



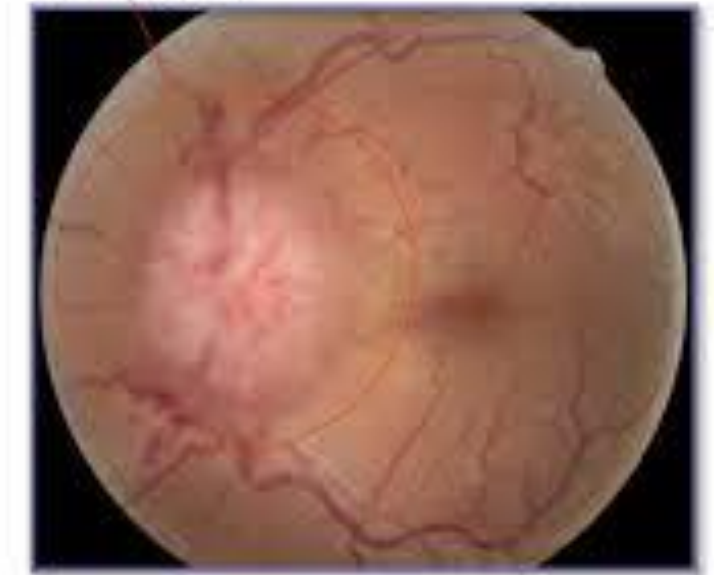
Axial and Sagittal T2 showing bilaterally enlarged subarachnoid ON sheath spaces (A, red arrows), vertical tortuosity of the optic nerve (B) and empty sella (C, red arrow).

### MRI findings:

- Prominent subarachnoid space in the ON sheath.
- Vertical tortuosity.
- Papilledema
  - Flattening of the posterior sclera.
  - Intracocular protusion of the ON.
- Enlarged arachnoidal outpouchings.
  - Empty sella.

## Pseudotumor Cerebri

Optic disc edema



### MRI Findings

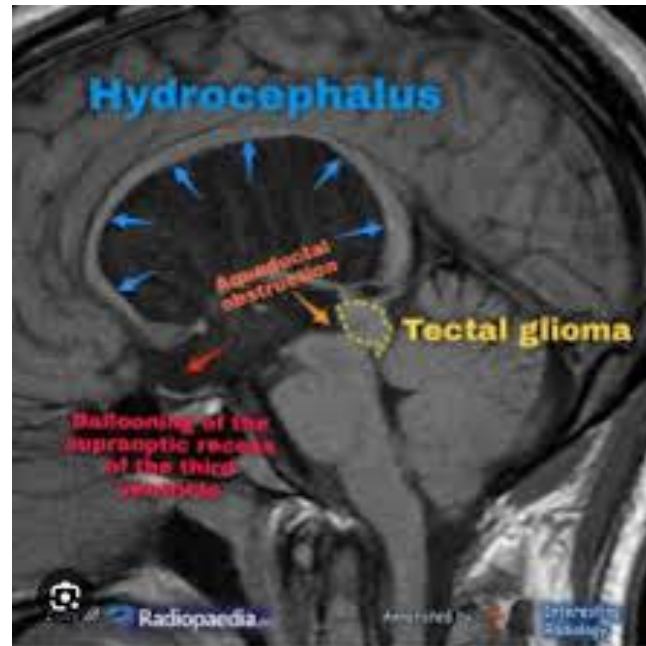
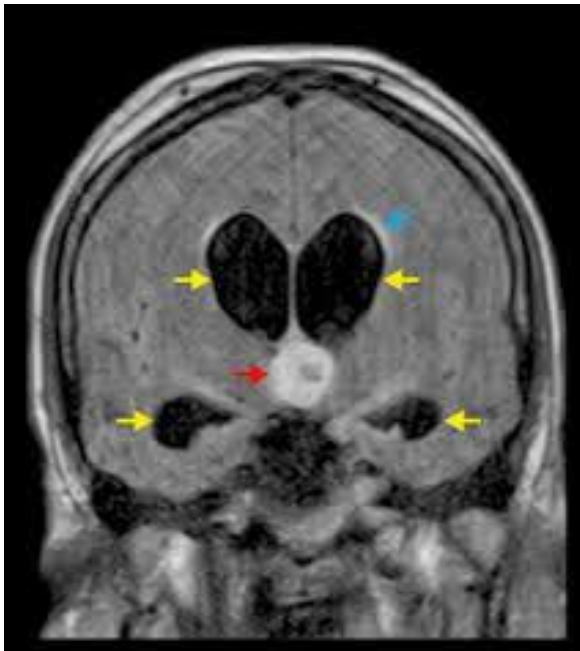
Numerous reported findings.

Two of the most reliable are:

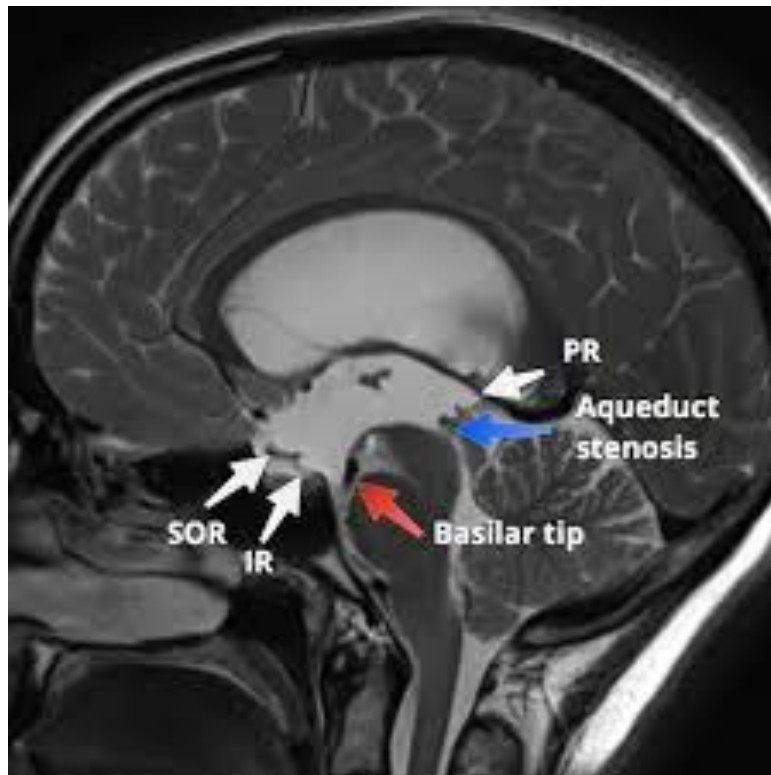
- Flattening of the posterior sclera.
- Partially empty sella turcica.



# Hydrocephalus occlusus



# Aquäduktstenose



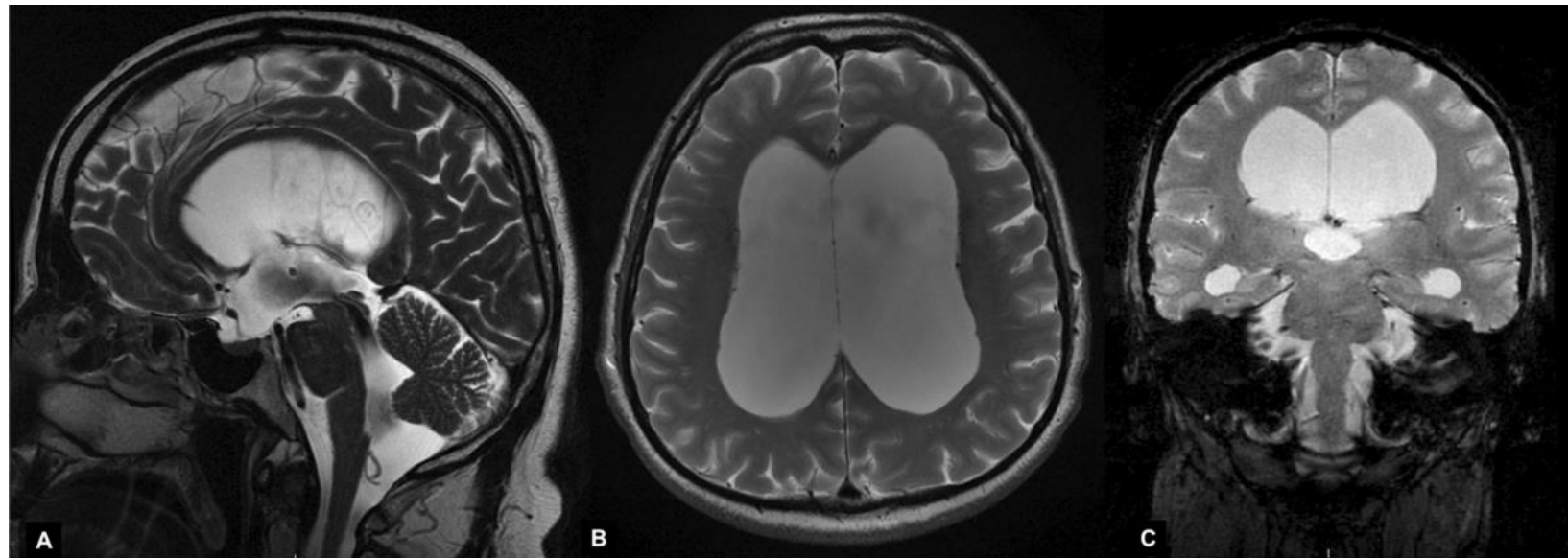
# Chiari Malformation



# Longstanding overt ventriculomegaly in adults (LOVA)

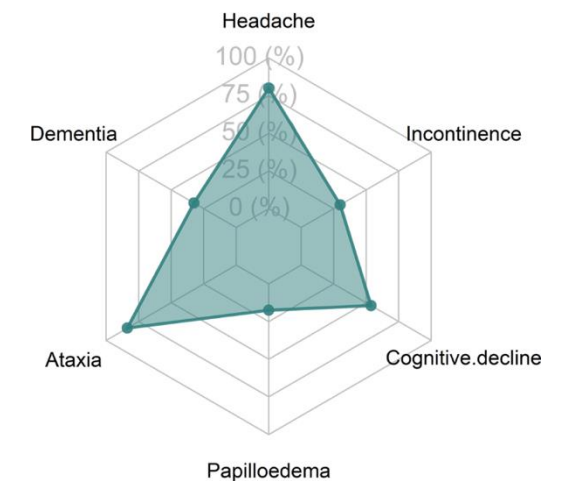
Makrozephalie

chronischen Prozess, der erst im Erwachsenenalter durch eine "Dekompensation" symptomatisch wird



Papilloedema

## LOVA Symptoms



# Behandlungsoptionen

## ***Malresorptivus:***

- temporäre/permanente Liquorableitung (EVD, VP-Shunt, VA-Shunt)
- ETV?
- Sinusstenting
- eShunt®?
- Optikusscheidenfensterung

## ***Occlusus:***

- Tumorresektion, ggf. temporäre/permanente Liquorableitung
- ETV

# TEMPORÄRE LIQUORABLEITUNG

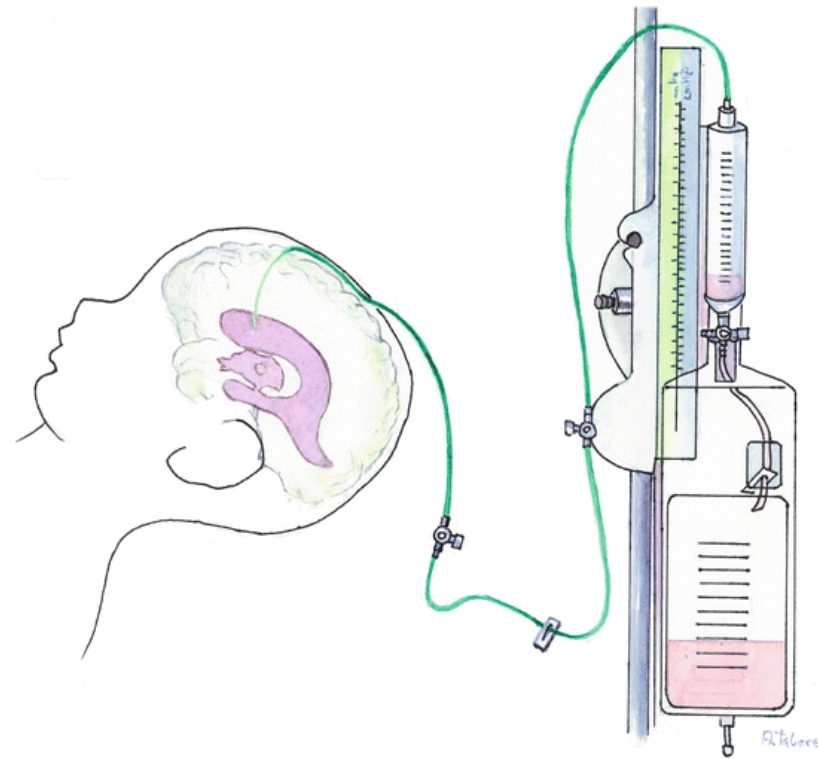
## *Indikationen:*

- akuter Liquoraufstau
- Externe Ableitung eines infizierten Shunts
- ICP Monitoring und Behandlung des Hirndruckes
- Intrathekale Therapie
- Postoperative Liquorfisteln
- Spinale Ischämie (LD)

## *Sorten:*

- EVD
- LD/LP
- Ommaya/Richkamreservoir

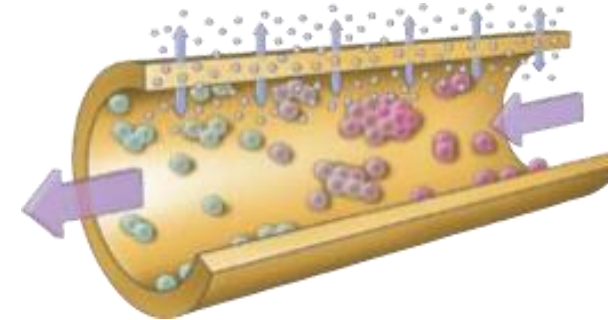
# Externe Ventrikeldrainage (EVD)



Silber oder  
antibiotikageschichtet



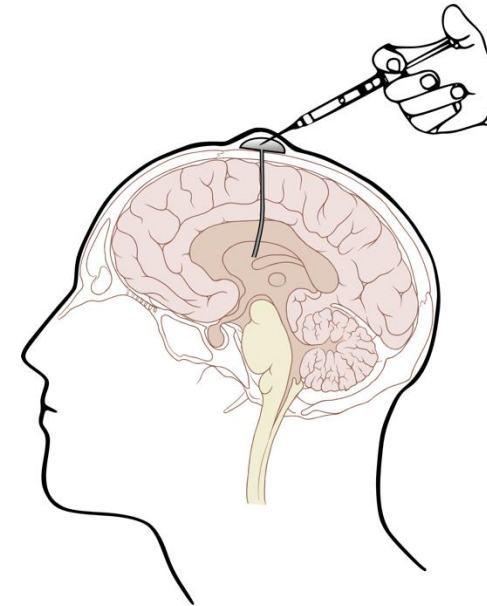
- two slow-release antibiotics (0.15% Clindamycin and 0.054% Rifampicin)<sup>1</sup>



- reducing the potential for gram positive bacterial colonization on the tubing surface up to 28 days<sup>1</sup>

<sup>1</sup> Bayston R et al. Duration of protective activity of cerebrospinal fluid shunt catheters impregnated with antimicrobial agents to prevent bacterial catheter-related infection. *J Neurosurg*, 1997. 87(2): p. 247-51.

# Ommaya/Rickhamreservoir



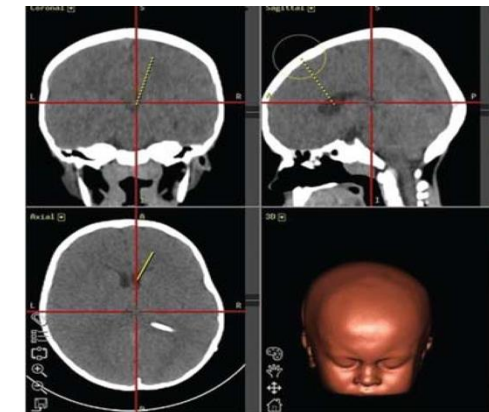
## EVD ANLAGE

### Präop. Gerinnungstatus

- Koagulopathie?
- $\text{INR} \leq 1.6$
- Thrombo's > 100 K
- Möglichst keine Th-Hemmung

### “Bedsite” vs. im OP-Saal

- Keine bipolare Pinzette, Sauger
- Sedierung
- Neuronavigation bei Slitzventrikel etc

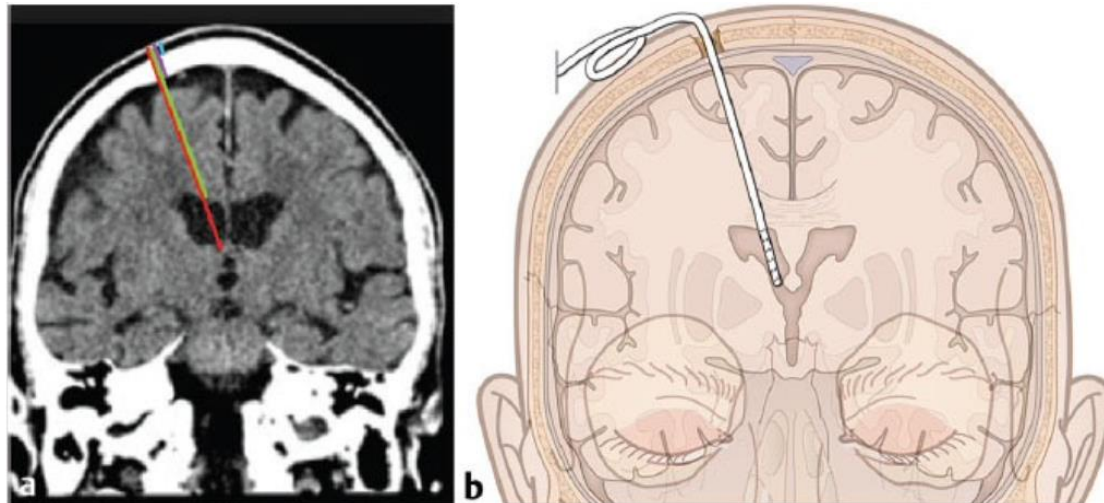




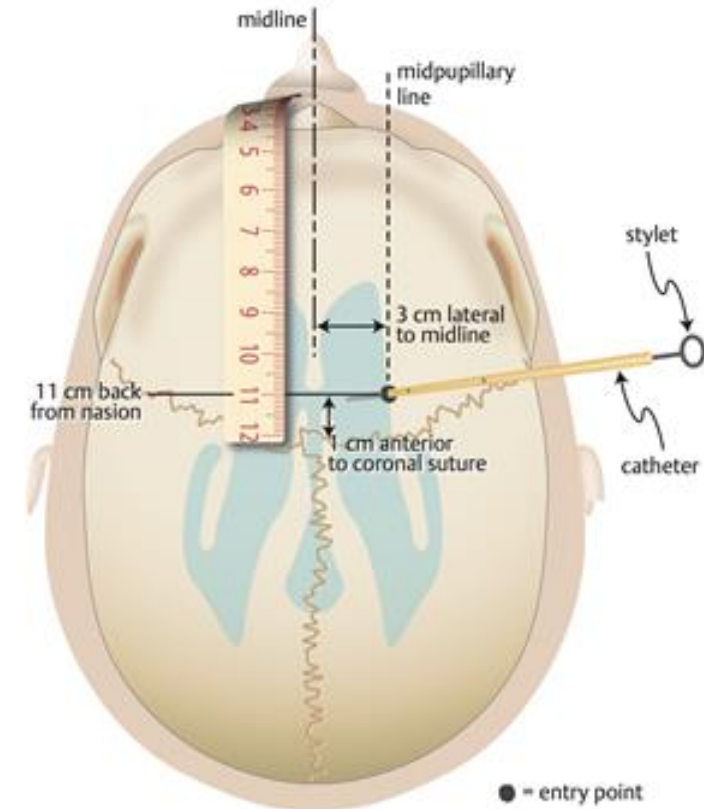
**Fig. 5.3** Cranial access kit. Courtesy: Integra LifeSciences.



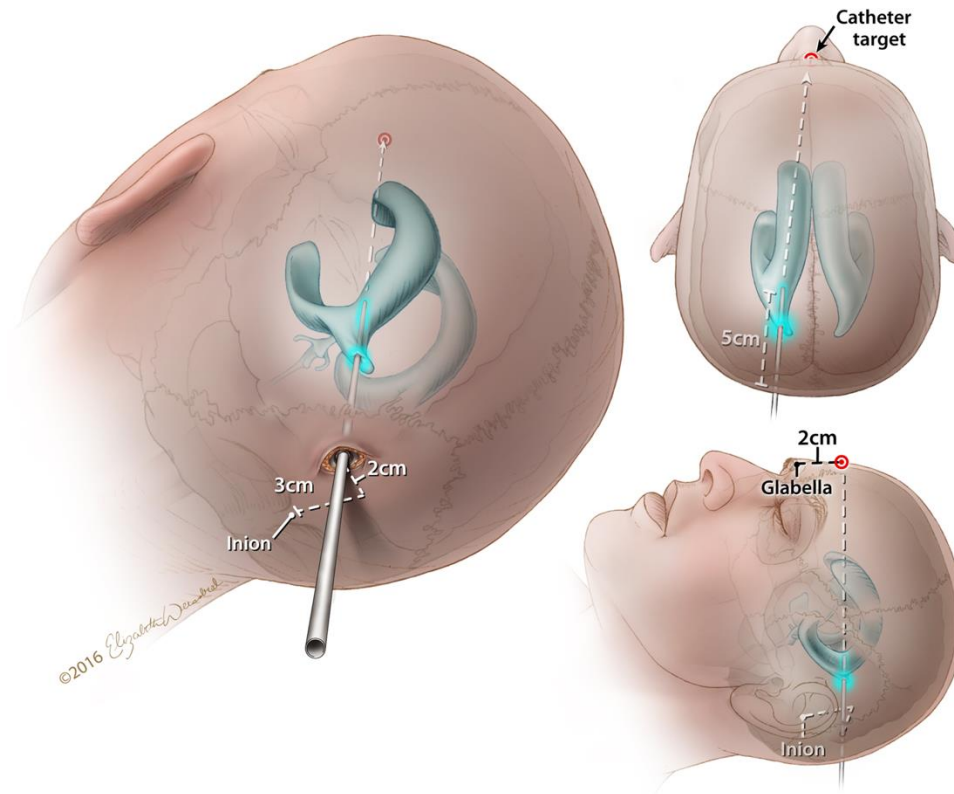
# Kocher Punkt

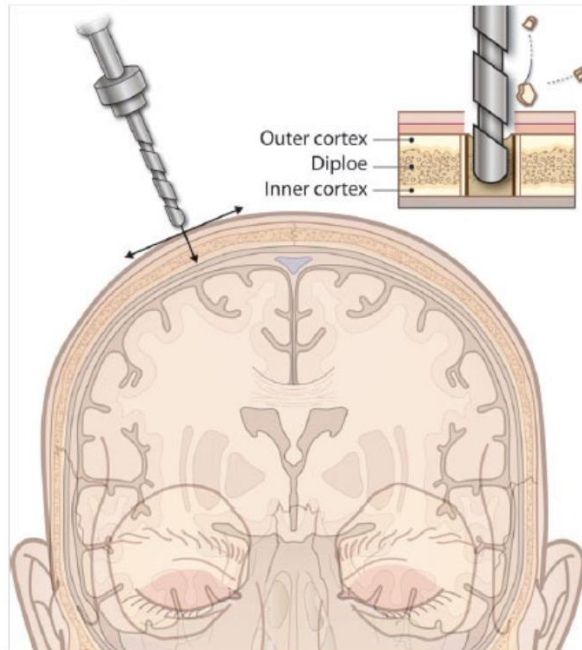


**Fig. 1.6** Coronal measurement of ventricular drain depth. (Reproduced from Operative Procedure. In: Ullman J, Raksin PB. Atlas of Emergency Neurosurgery. 1st Edition. Thieme; 2015.)

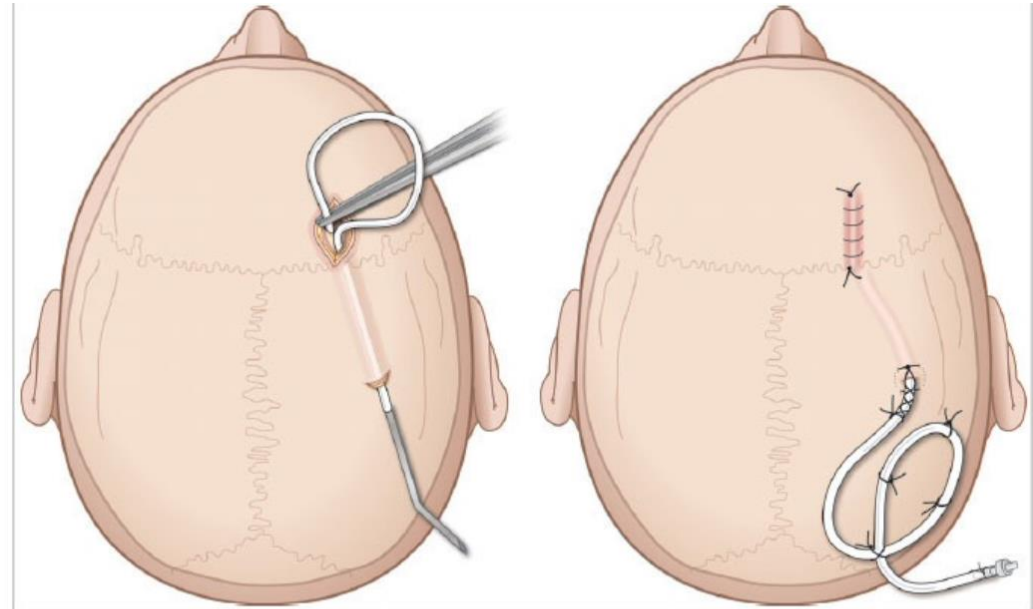


## Dandy's Punkt



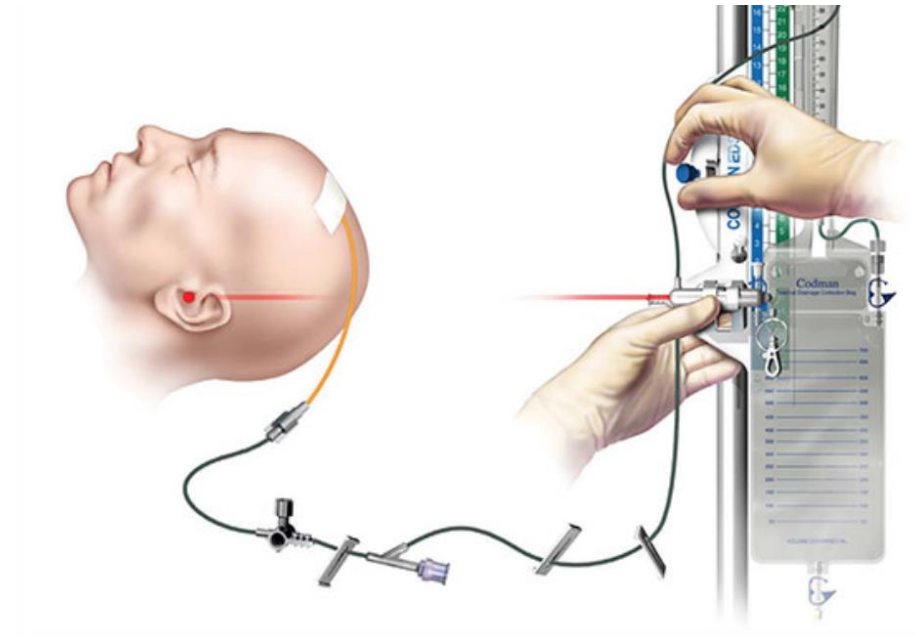
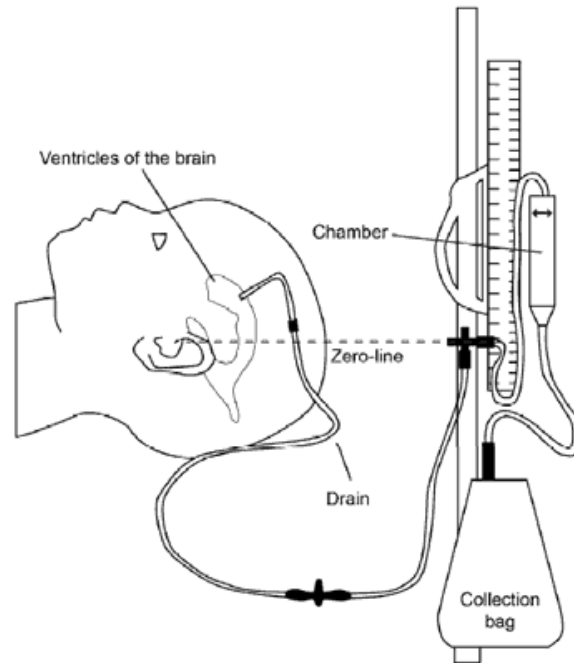


**Fig. 1.12** Burr hole trephination using a twist drill. (Reproduced from Operative Procedure. In: Ullman J, Raksin PB. Atlas of Emergency Neurosurgery. 1st Edition. Thieme; 2015.)



**Fig. 1.13** Tunneling and anchoring of catheter. (Reproduced from Ullman J, Raksin PB. Atlas of Emergency Neurosurgery. 1st Edition. Thieme; 2015.)

# Externes Ablaufsystem



0 cm aus äußerem Gehörgang (Tragus)  
5-10 ml/h Fördermenge i.d.R.

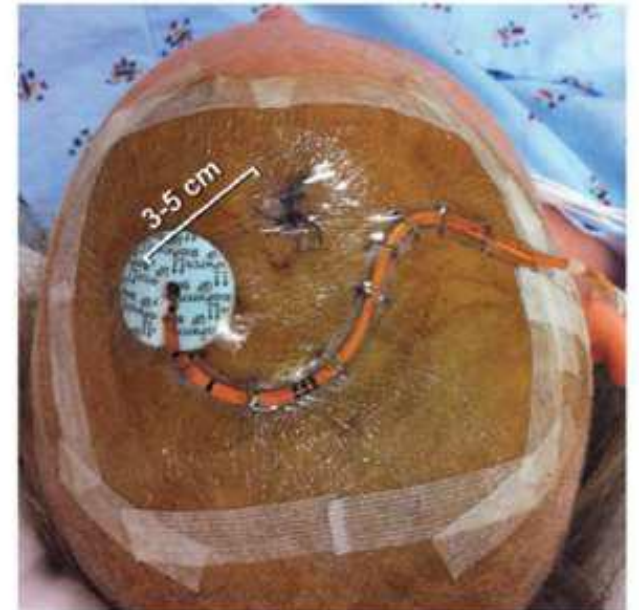
# OP Risiken

1. Infektion
2. Nachblutungen (7%, davon 0.8% klinisch relevant<sup>1</sup>)
3. Fehllage
4. Malfunktion

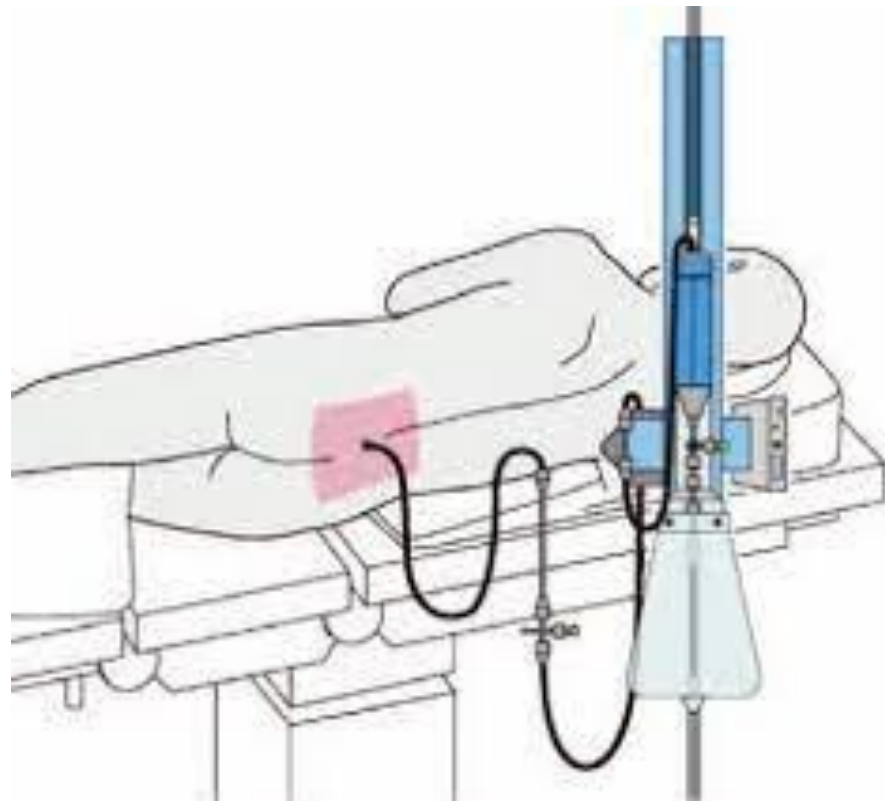
1. Bauer DF et al. Neurosurgery, 2011;69: 255-260)

# Maßnahmenbündel für Asepsis

- Checkliste für die EVD-Anlage
- Asepsis bei der Anlage
- Präoperative antibiotische Prophylaxe
- Großzügiges Haarclipping
- Hautdesinfektionsmittel (Chlorhexidin + alkoholhaltiges)
- Imprägnierter EVD-Katheter (Silber, Antibiotika)
- Tunnelung des EVD-Katheters
- Steriler Verband der Eintrittsstelle



# Lumbaldrainage (LD)



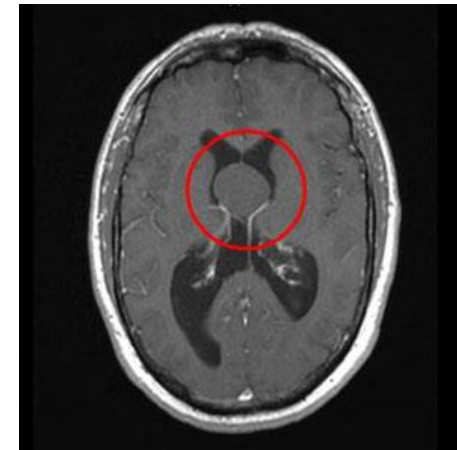
## Kontraindikationen

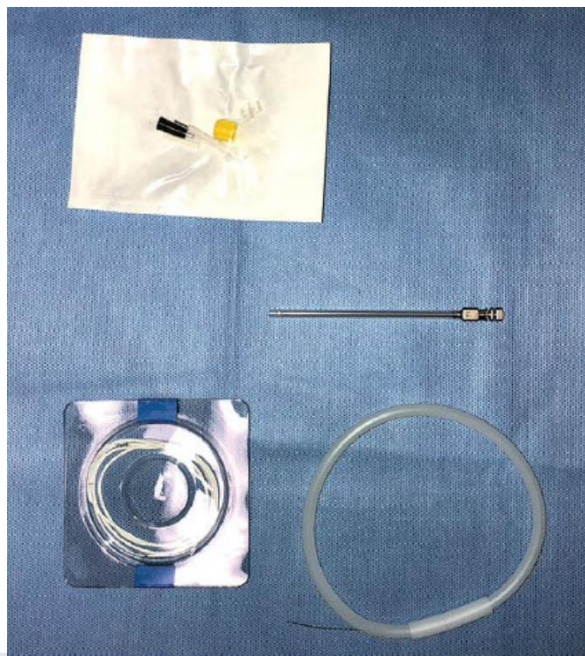
- Intrakranielle RF (HSG)
- Hydrozephalus occlusus
- Tiefstand der Kleinhirntonsillen
- Spinale /epidurale RF
- Gerinnungstörung etc.



## Vorteile zur EVDs

- Einfache Pt. Mobilisierung und Pflege

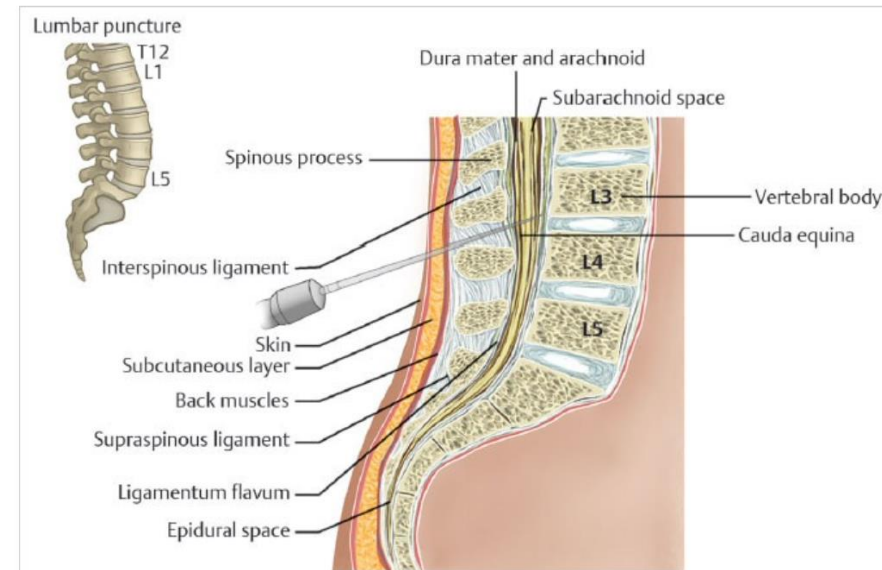
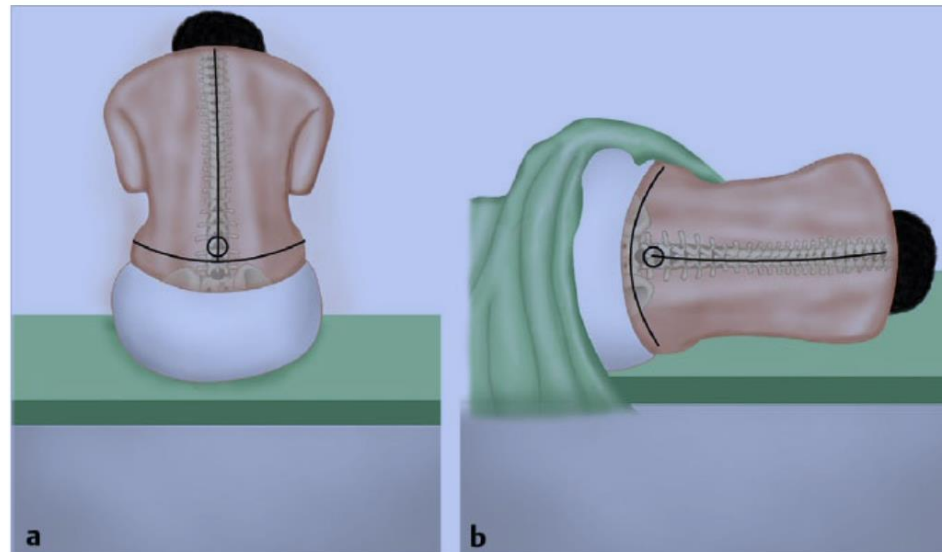




**Fig. 4.1** Lumbar drain (LD) kit: Caps for the catheter once inserted (*top*), 14-gauge Tuohy needle (*middle*), LD catheter (*bottom left*), and LD



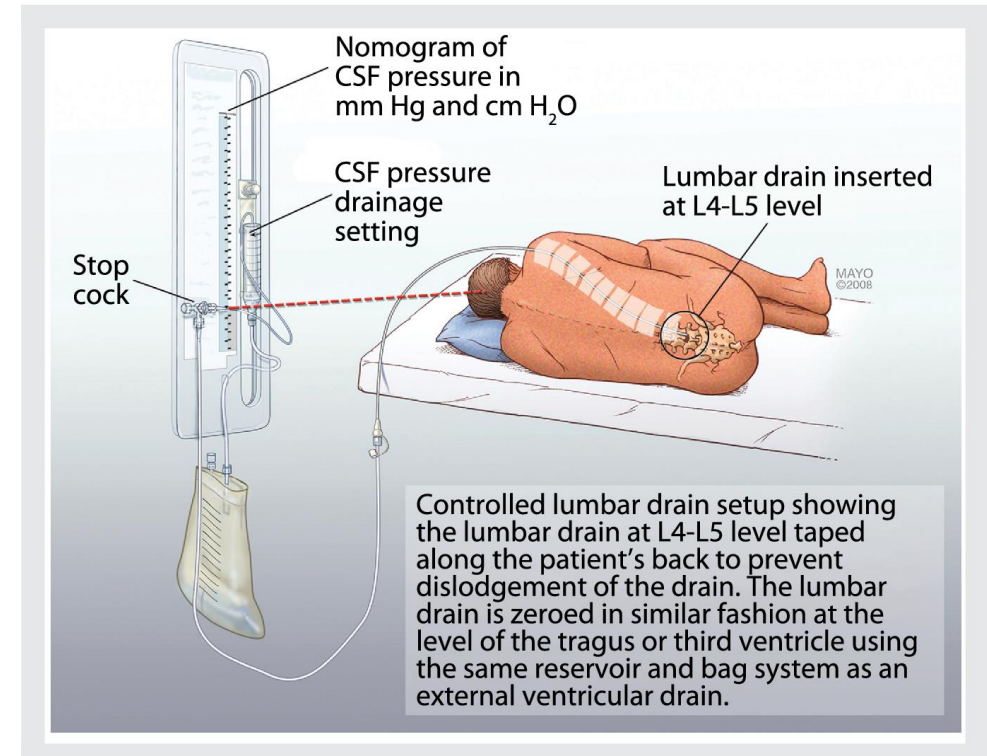
**Fig. 4.4** 14-gauge Tuohy needle and the lumbar drain (LD) catheter with guidewire inserted.



**Fig. 3.6** The trajectory of the lumbar puncture (LP) needle through the lumbar spinal anatomy and final position of the needle in the lumbar

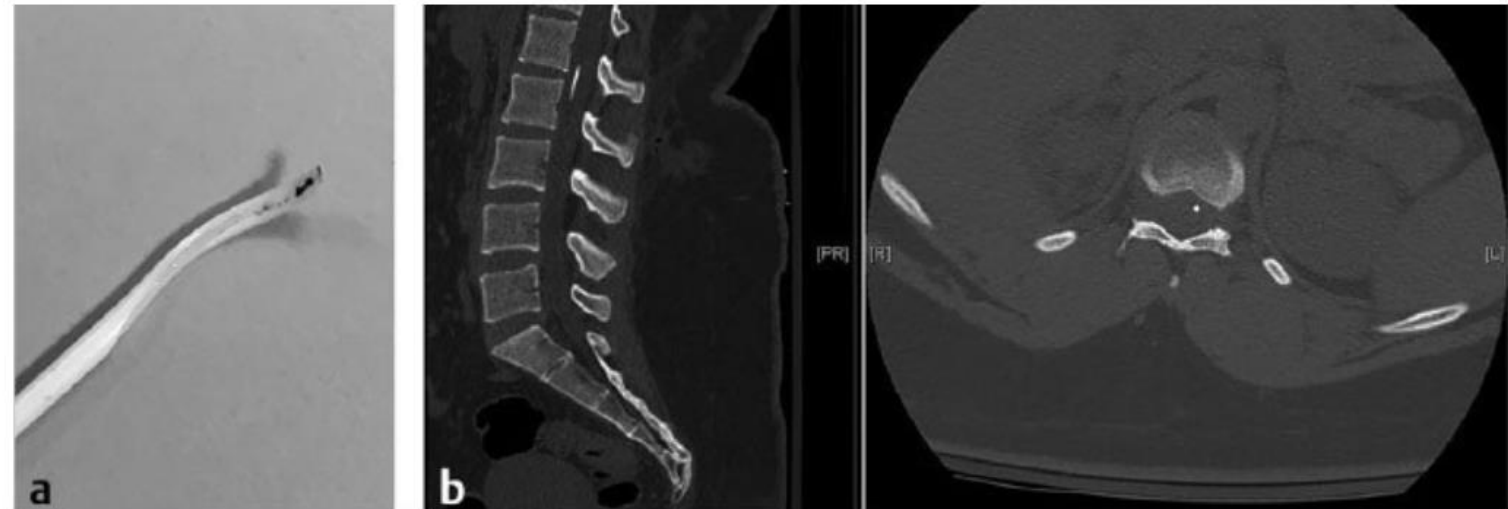


**Fig. 3.7** Intracranial pressure measurement. The three-way stopcock has been assembled and attached to the end of the spinal needle.  
Courtesy: Gaumard Scientific.



# Komplikationen

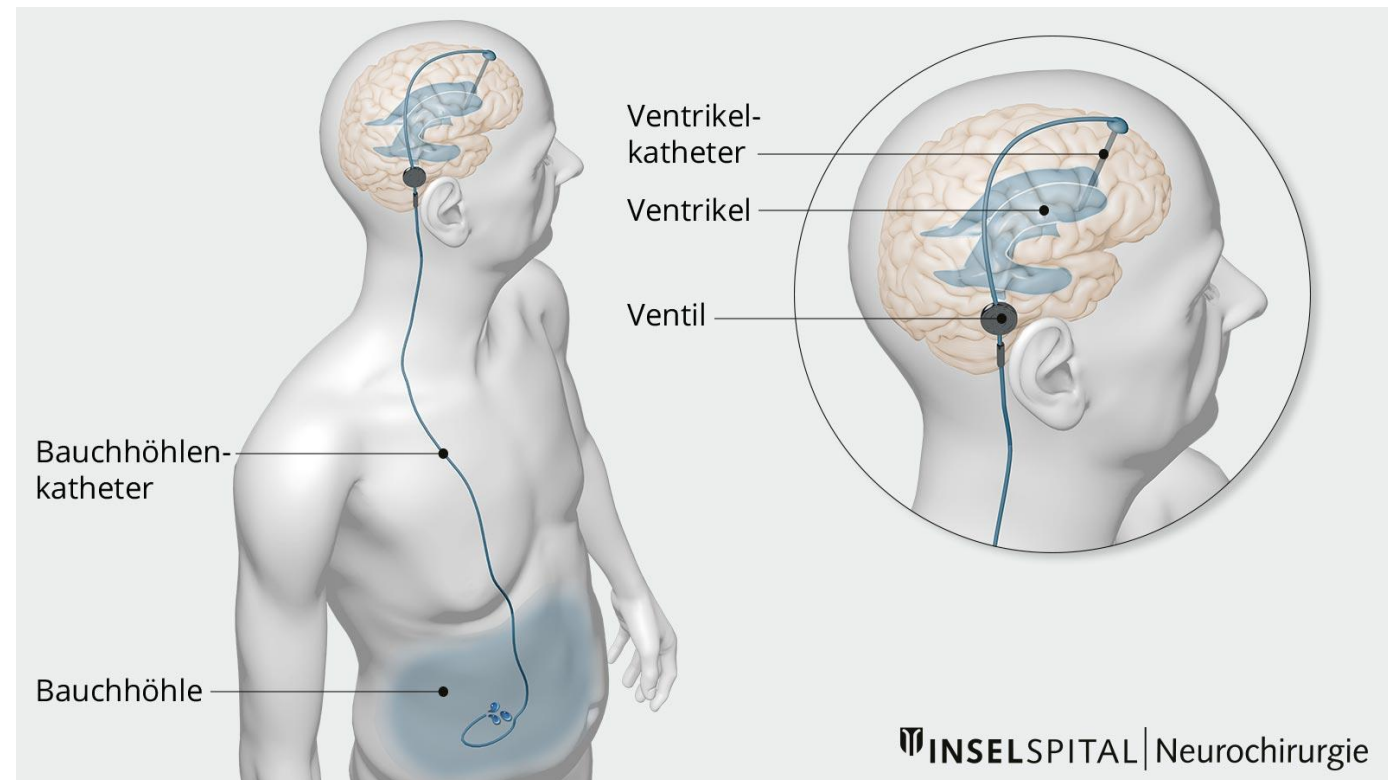
- Kopfschmerzen/SDH
- Donward Herniation
- Infektion (4%)
- Catheter shearing



**Fig. 4.5 (a)** The removed portion of a sheared catheter. The remaining catheter was all intradural in this particular patient and was not removed. **(b)** Computed tomography (CT) scan showing sagittal and axial views of the retained intradural catheter.

# Permanente Liquorableitungen

- Ventrikuloperitonealer Shunt
- Ventrikuloatrialer Shunt
- (Lumboperitonealer Shunt)
- (Ventrikulopleuraler Shunt)



# Indikationen

- Hydrozephalus malresorptivus
- Hydrozephalus occlusus: falls ETV kontraindiziert ist

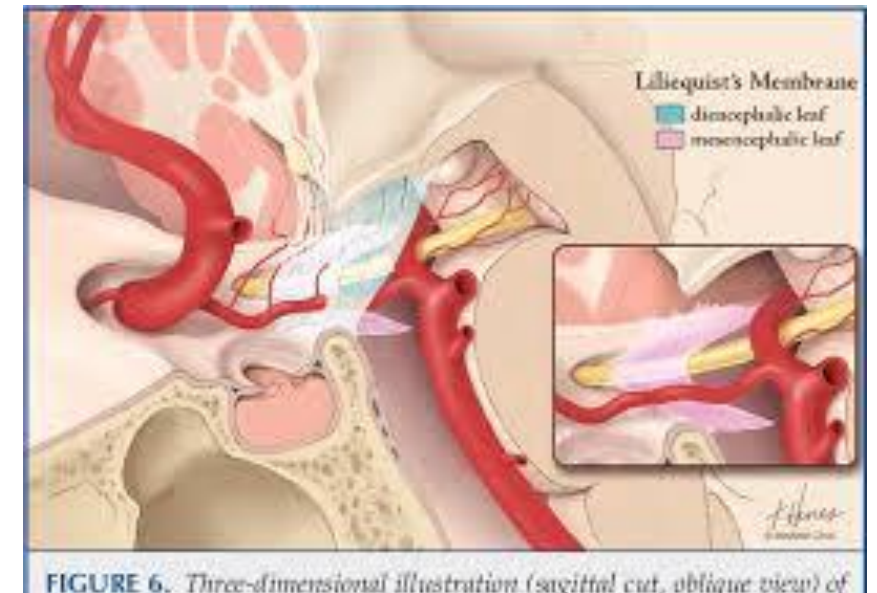


FIGURE 6. Three-dimensional illustration (sagittal cut, oblique view) of

# Kontraindikationen

## VP-Shunt

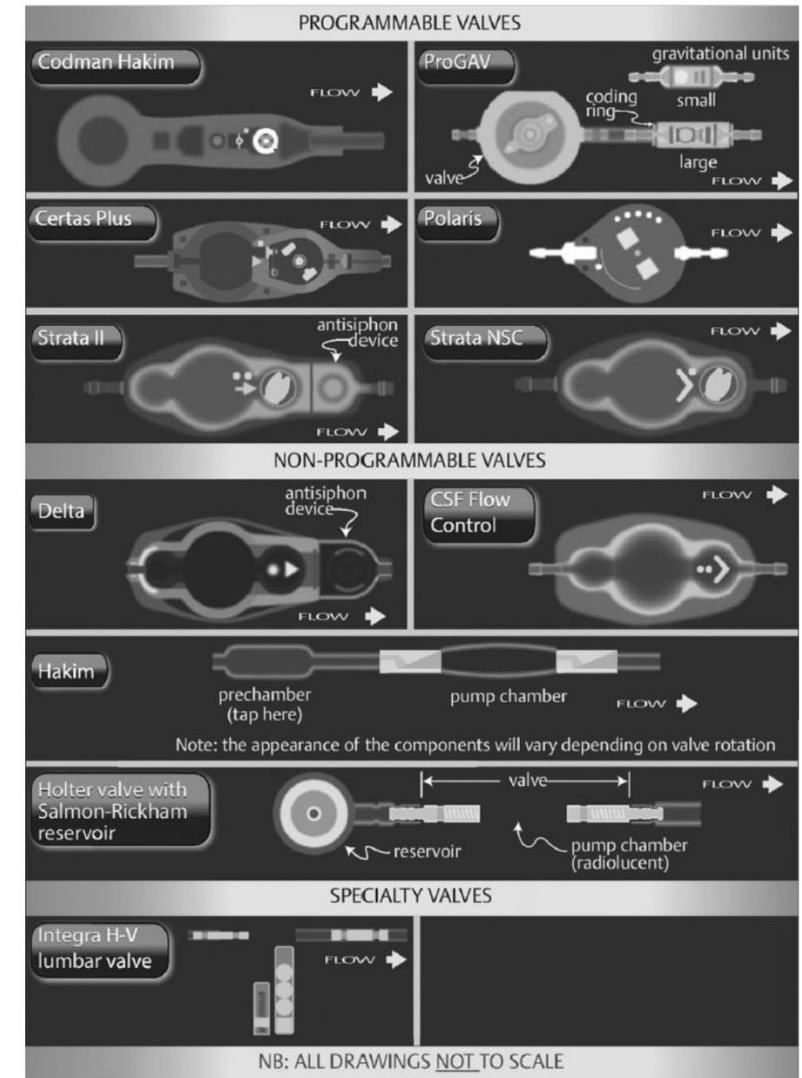
- Meningitis, Liquorinfekt
- Sepsis
- Wundheilungsstörung
- *Peritonitis/Abdomen  
OPs/Adhärenzen/Übergewicht/  
Malresorption*

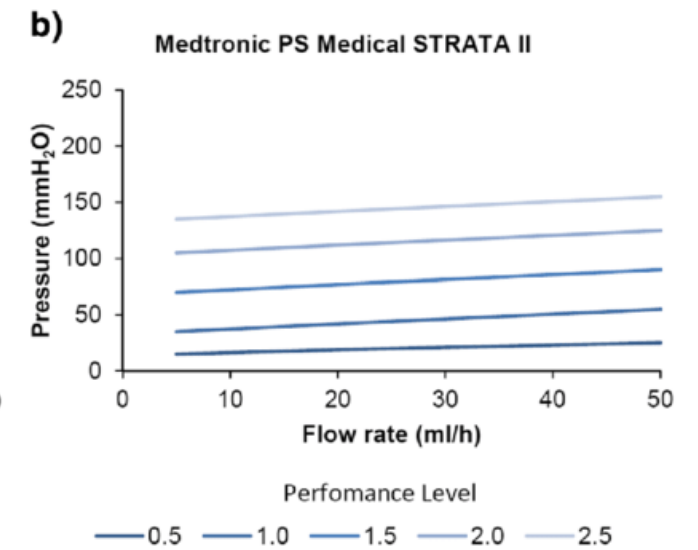
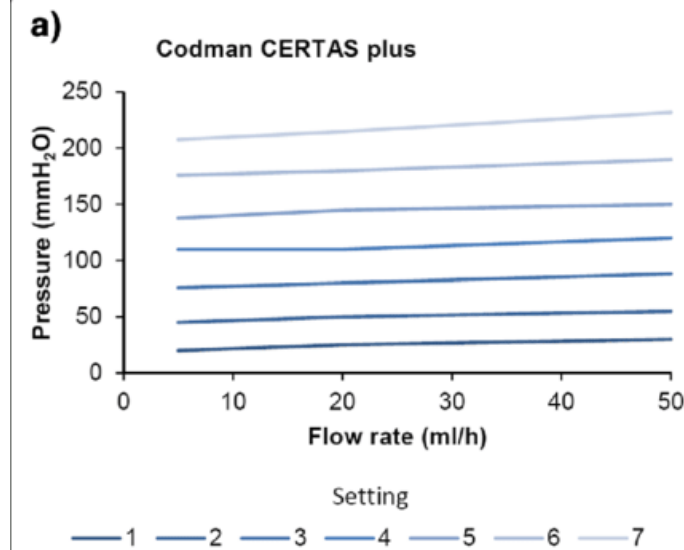
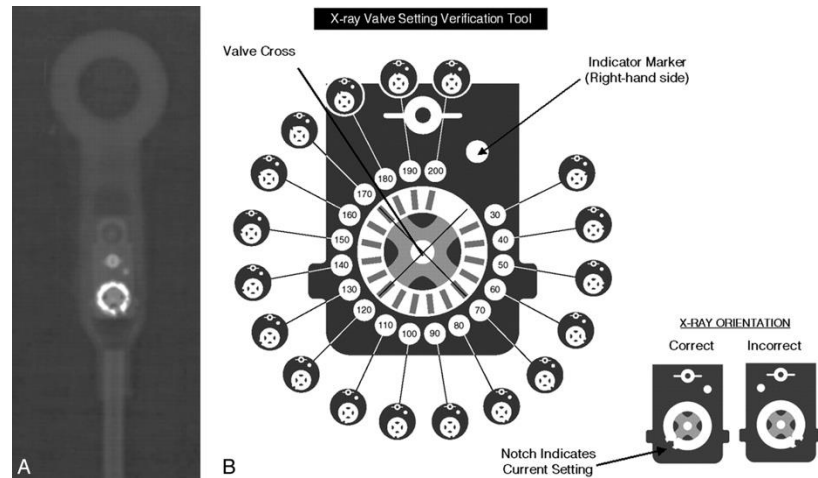
## VA-Shunt

- Meningitis, Liquorinfekt
- Sepsis
- Wundheilungsstörung
- *Chronische Herzinsuffizienz*
- *Pulmonale Hypertonie*
- *Venöse Anomalie/Thrombose*

# Ventile

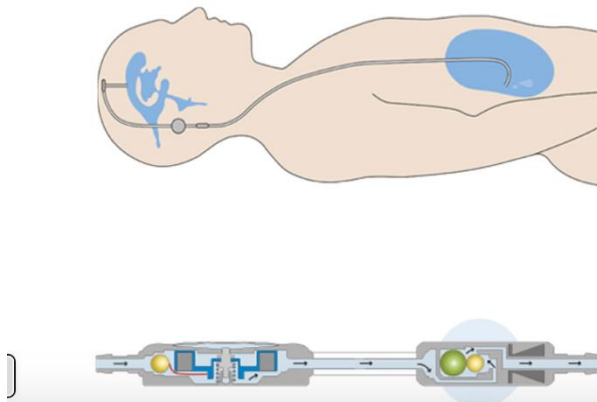
- Fixed pressure (low, medium, high)
- Programmierbare/Umschaltbare:
  - Pressure gradient
  - Flow-regulated
  - Anti-siphoning devices
  - Antibiotic impregnated catheters/valves



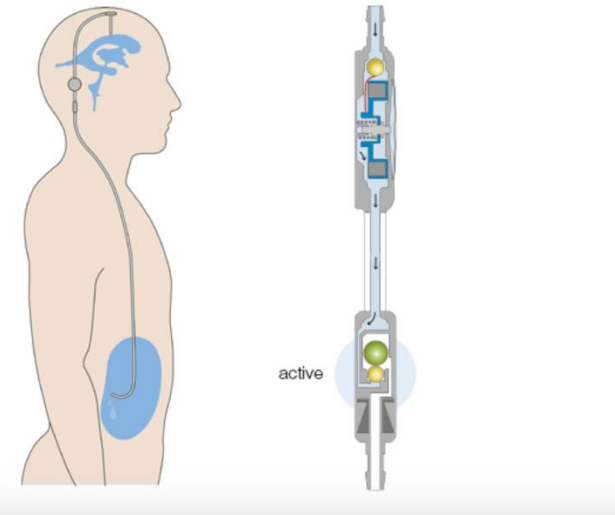
**KLINIKUM BREMEN-MITTE**

**KLINIKUM BREMEN-MITTE**
**HORIZONTAL POSITION**

In the horizontal position, the gravitational unit is completely open and provides no flow resistance. Under these circumstances, the opening pressure of the *proGAV 2.0* is solely controlled by the adjustable unit. The opening pressure setting is determined by the clinical needs of the patient. The range of the adjustable unit is defined from 0 to 20 cmH<sub>2</sub>O. As long as the IVP (intraventricular pressure) is under the defined opening pressure the adjustable unit is closed and the CSF-drainage is prevented. If the patient's IVP increases and rises above the defined opening pressure, the spring pressure of the ball-cone is exceeded and the sealing ball moves away from the cone. Now the *proGAV 2.0* is open and CSF is drained.

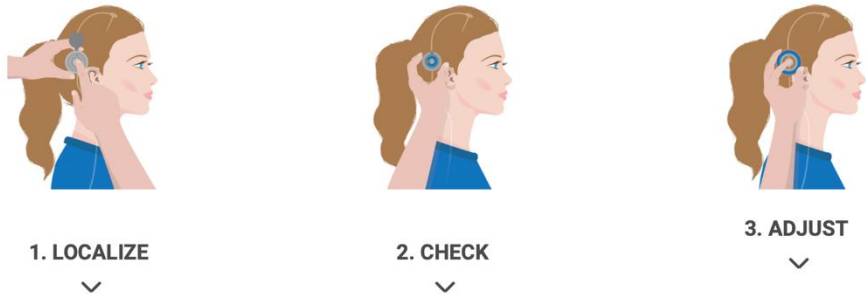

**VERTICAL POSITION**

In the vertical position, the gravitational and the adjustable unit operate collectively. As soon as the patient moves into an upright position, the gravitational unit closes and therefore the total opening pressure of the *proGAV* is significantly increased. The flow of CSF is blocked until the sum of the intraventricular and hydrostatic pressures exceeds the total opening pressure of the *proGAV*. In this case the gravitational unit opens and the drainage of CSF is possible. The opening pressure of the gravitational unit increases steadily as the patient moves to the upright position. This provides effective protection against over-drainage.



proGAV® 2.0  
VALVE ADJUSTMENT

With the innovative *proGAV 2.0 instruments*, measurement and adjustment can be carried out simply and gently with the finger. Thanks to the tactile feedback mechanism of the *proGAV 2.0*, it is readily aparent when the applied pressure is sufficient for an adjustment. Stressful X-ray examinations are not necessary. The unique "Active-Lock" mechanism protects the *proGAV 2.0* from unwanted adjustment due to the influence of external magnetic fields.



Programmable shunt systems  
Programming with ext. magnet

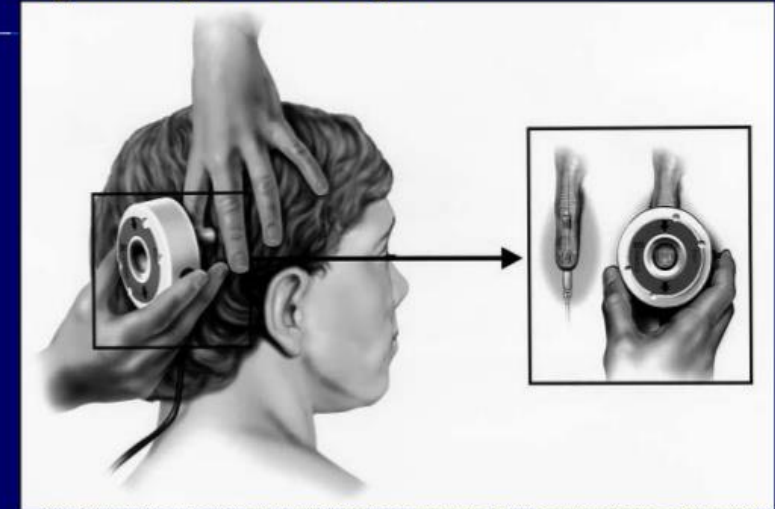
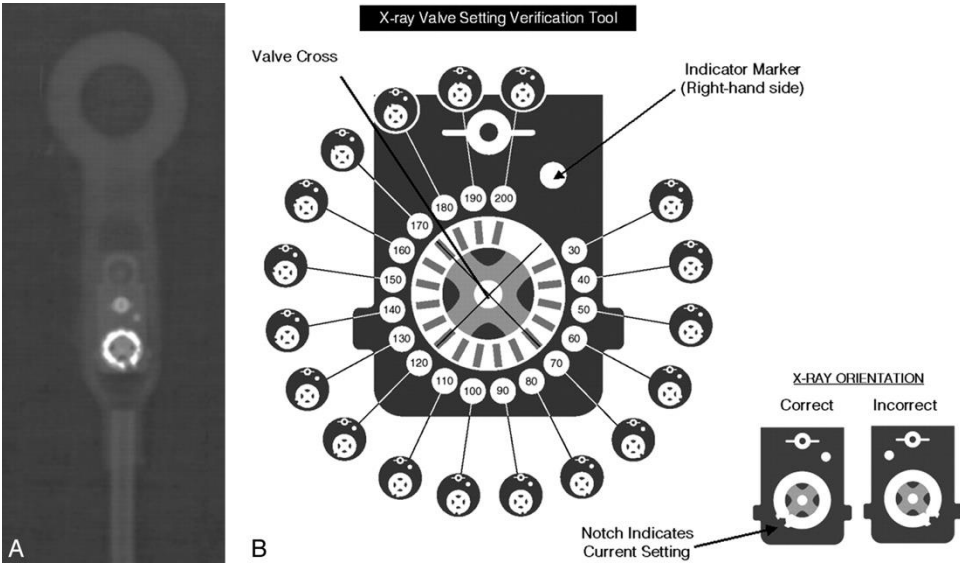


Fig. 4. Adjustment and breakdown of valve with external magnetic field. Illustration courtesy of Goldman, A. & Hirsch, J. Co. Bregman, Ph.D. 2

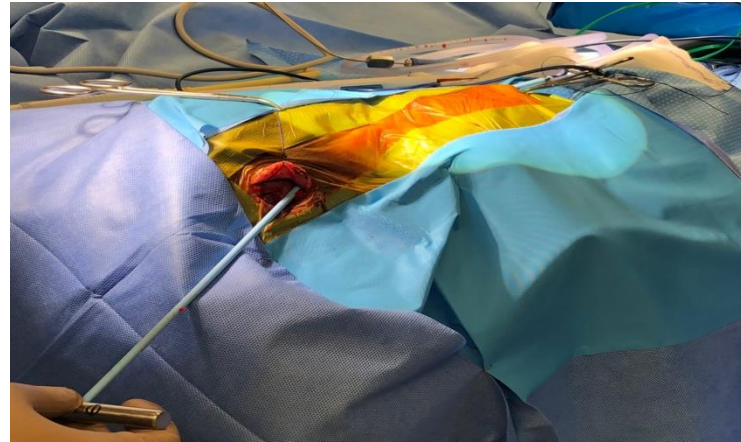


Abdomineller Katheter: Minilaparotomic, Trocar-perkutan,  
laparoskopisch assistiert

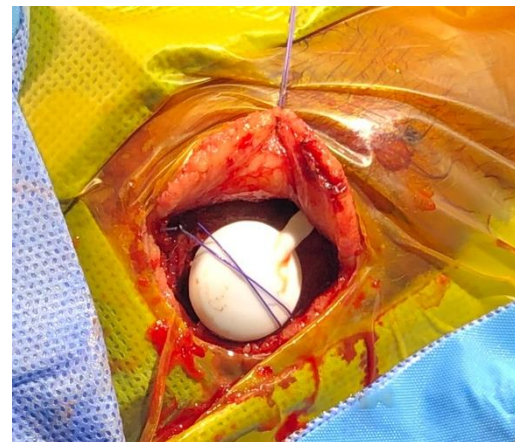


# Subkutane Tunnellierung bis supraklavikulär und retroaurikulär

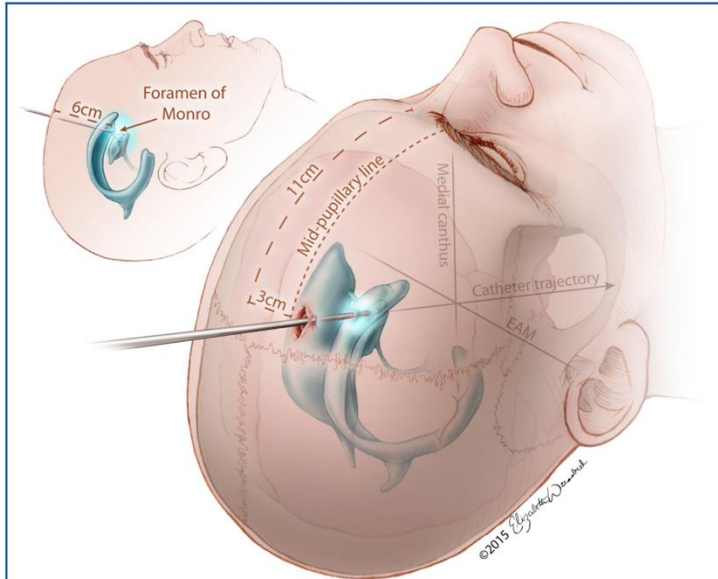
KLINIKUM BREMEN-MITTE



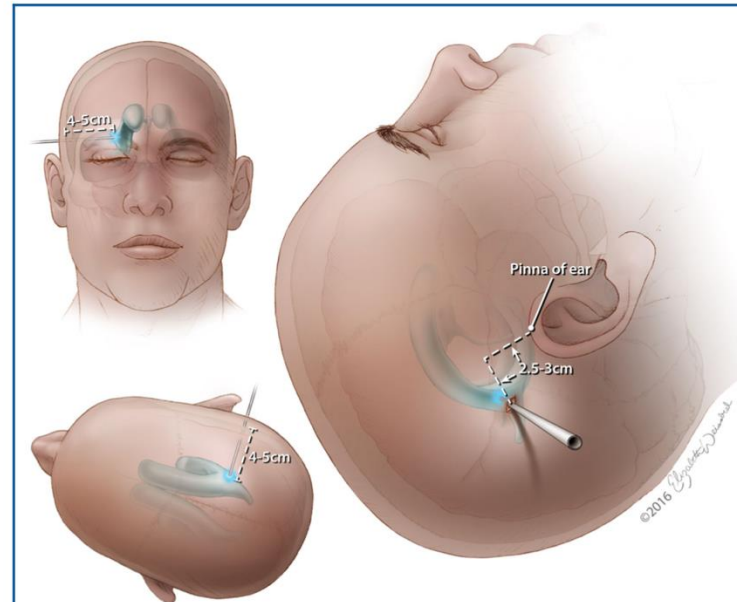
## Retroaurikuläres Ventil



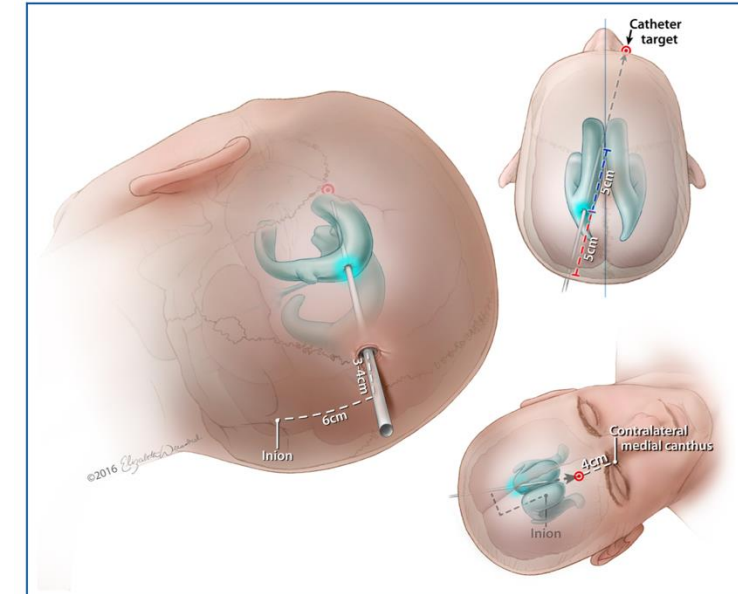
## Ventrikelkatheter



**FIGURE 1.** Ventricular access via Kocher's point. The burr hole should be placed 11 cm superior and posterior to the nasion and 3 cm lateral to the midline. Next, the ventricular catheter should be aimed at an angle that is perpendicular to the intersection of lines drawn from the ipsilateral medial canthus and the ipsilateral external auditory meatus (EAM). The catheter should be passed to a depth of approximately 6 cm or until the frontal horn of the ipsilateral lateral ventricle is reached. ©2015 Elizabeth N. Weissbrod. Used with permission.



**FIGURE 6.** Ventricular access via Keen's point. After a burr hole is placed 2.5 cm superior and posterior to the pinna of the ear, the catheter should be placed perpendicular to the cortex and aimed in a slight cephalic direction. The catheter should be advanced 4 to 5 cm or until the trigone of the ipsilateral lateral ventricle is reached. ©2016 Elizabeth N. Weissbrod. Used with permission.



**FIGURE 7.** Ventricular access via Frazier's point. From a parietal approach, the burr hole should be positioned slightly above and lateral to the lambdoid suture at a location that is 6 cm superior to theinion and 3 to 4 cm lateral to the midline. The catheter is directed to a point that lies 4 cm above the contralateral medial canthus and passed 5 cm or until CSF is encountered. The catheter stylet is then removed, and the catheter is soft-passed an additional 5 cm, placing it within the body of the ipsilateral lateral ventricle. ©2016 Elizabeth N. Weissbrod. Used with permission.

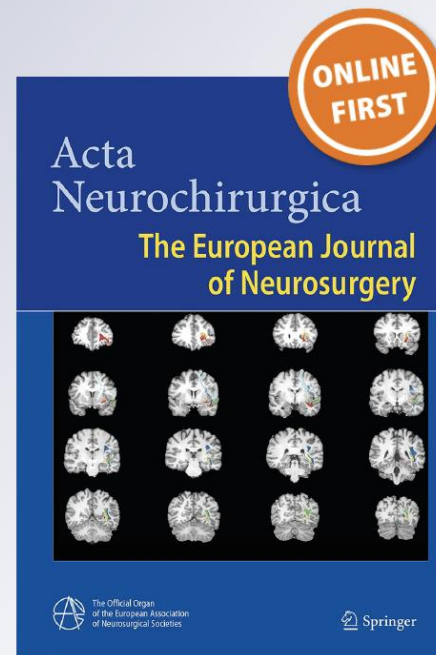
*Minimal exposure maximal precision  
ventriculoperitoneal shunt: how I do it*

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Roser**

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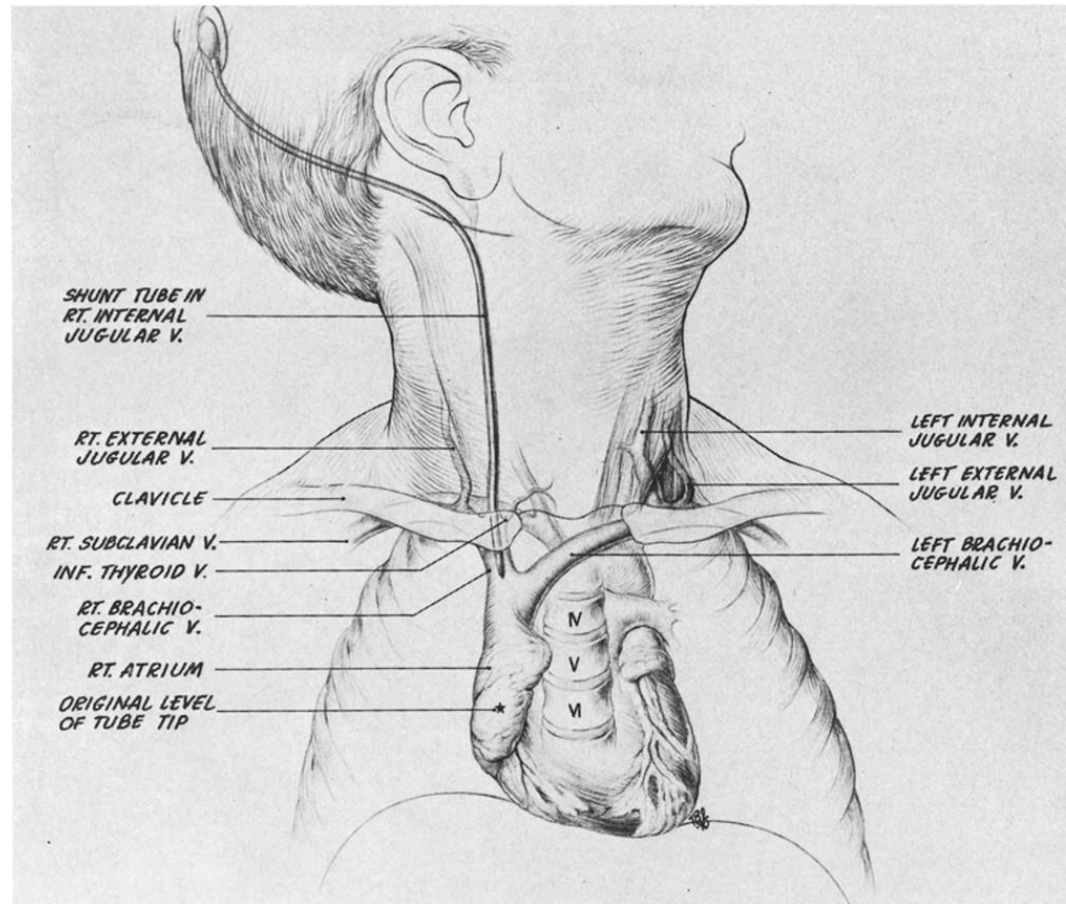
 Springer

03.03.2026



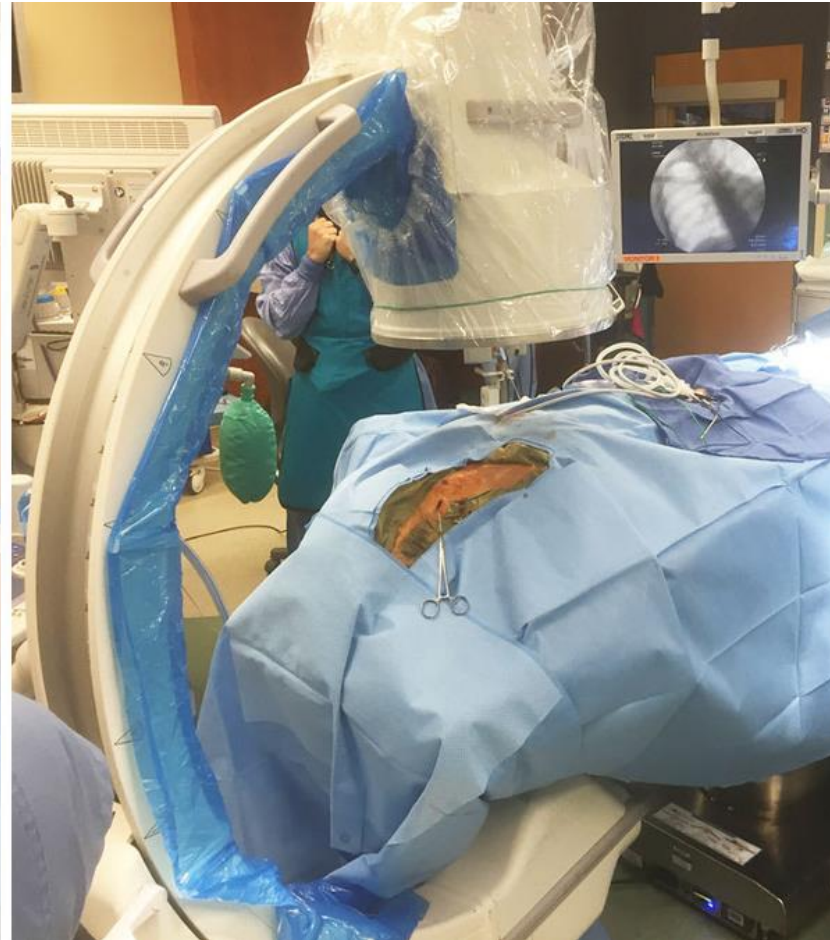


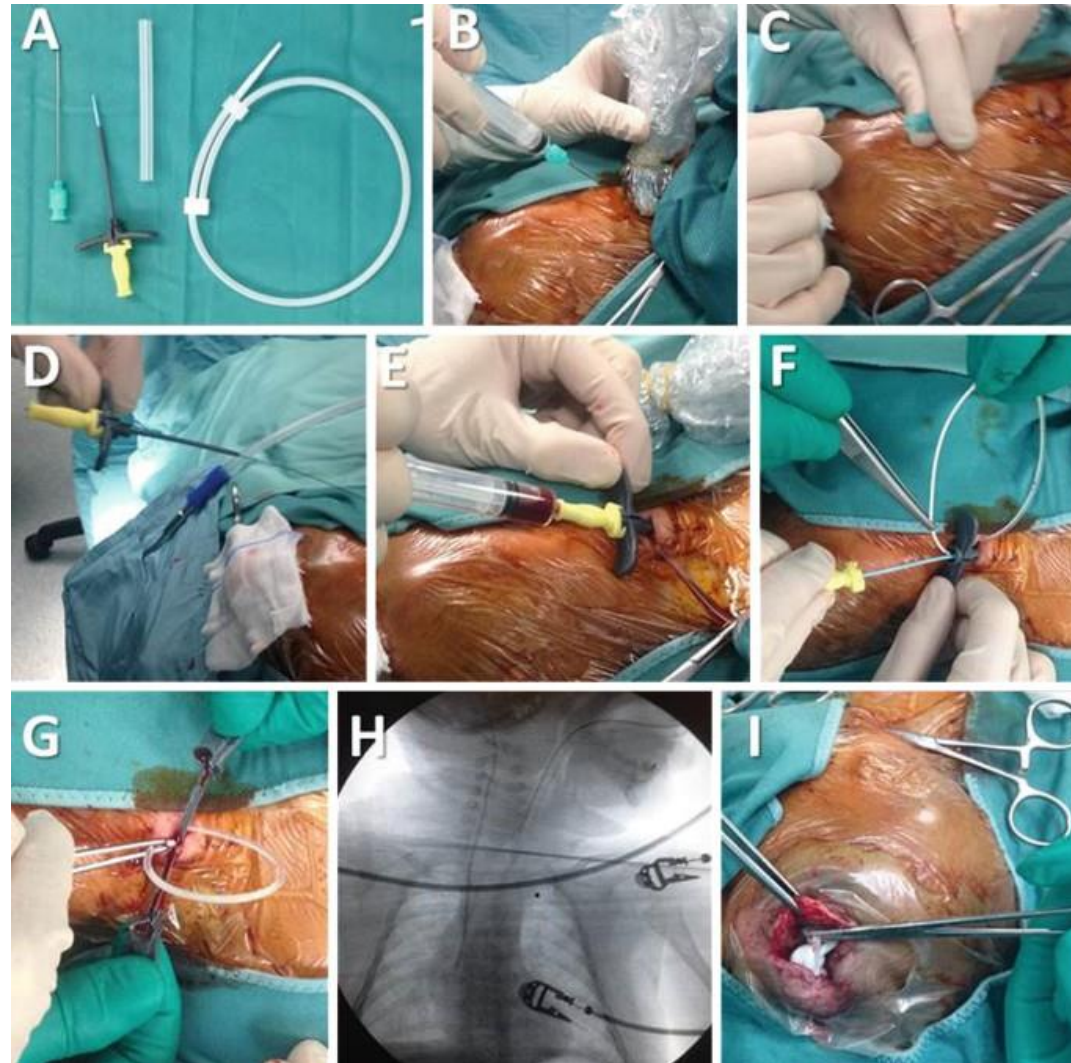
# VA Shunt



KLINIKUM BREMEN-MITTE

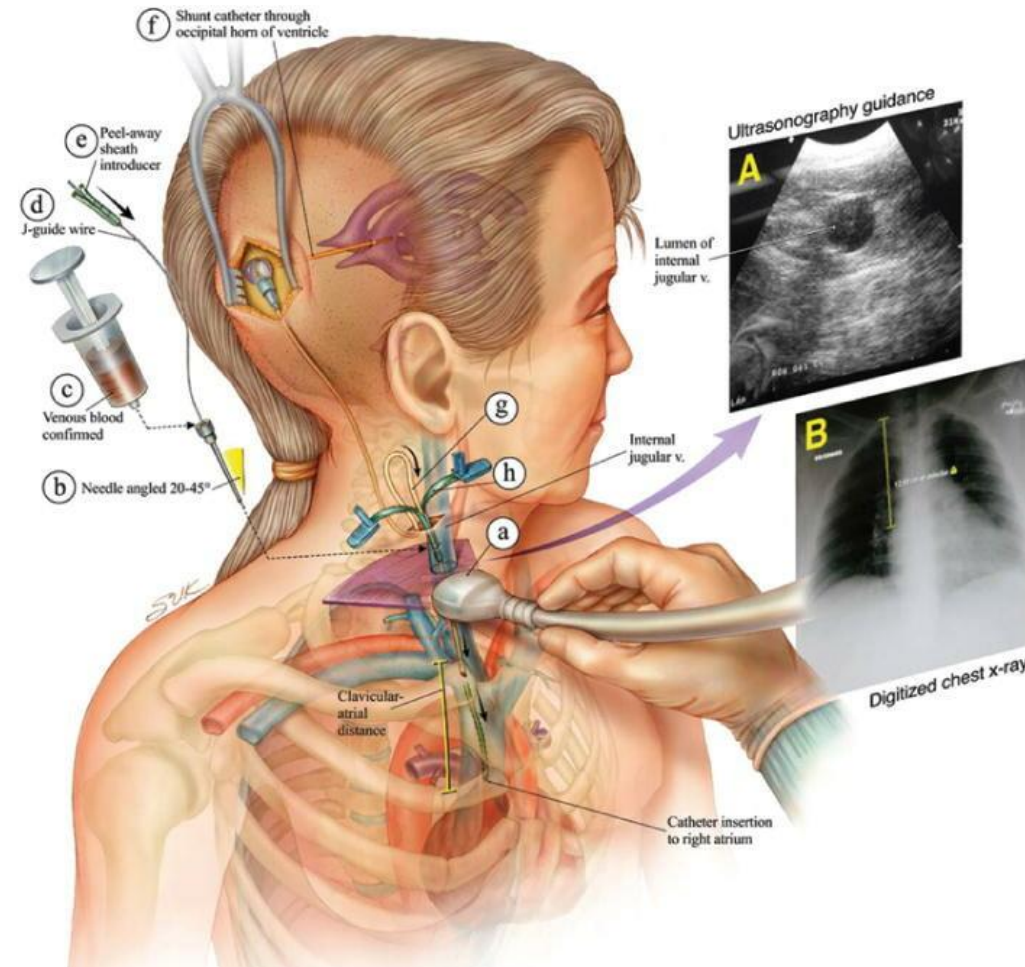
Open





## Kontrolle des atrialen Katheters im Vorhoff

- Chest X-ray
- iodinate contrast
- EKG electrode



## Postoperative Kontrollen/Nachsorge

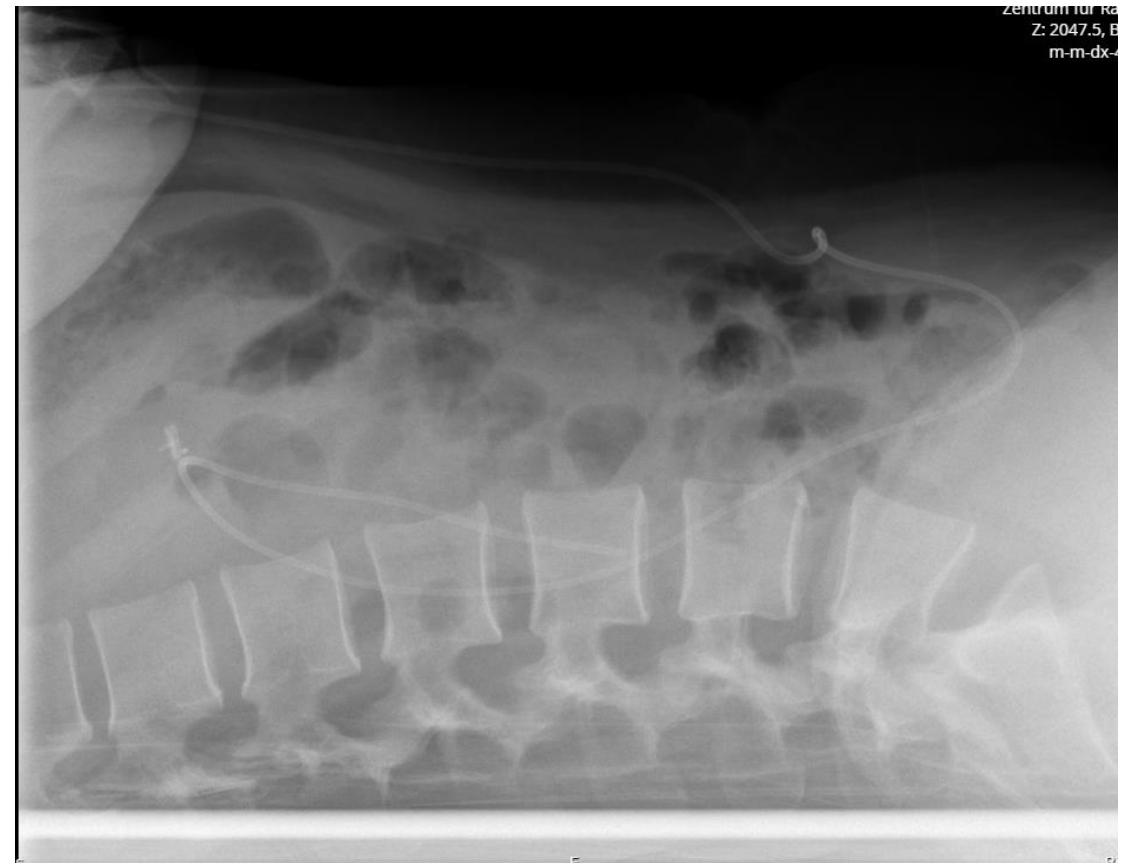
- CCT
- Röntgen Shuntsverlauf



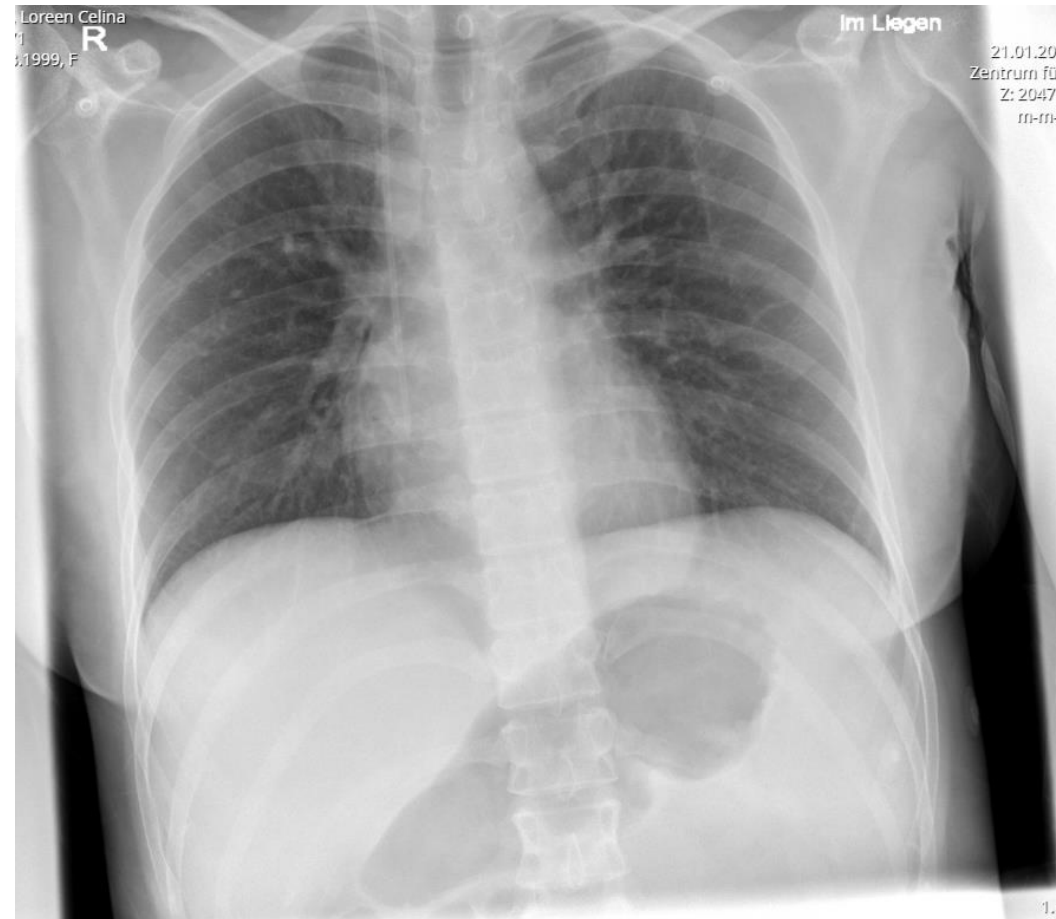
## KLINIKUM BREMEN-MITTE



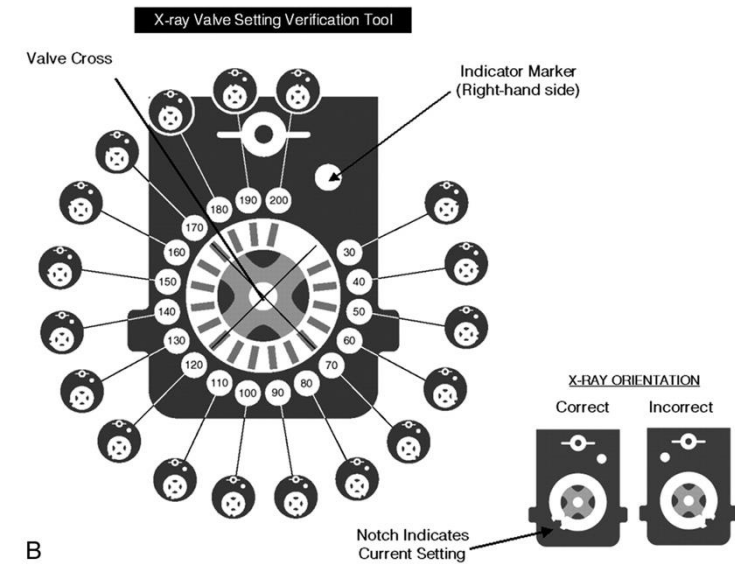
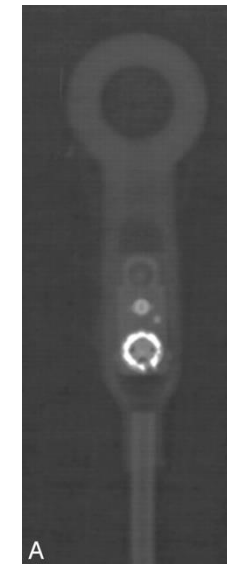
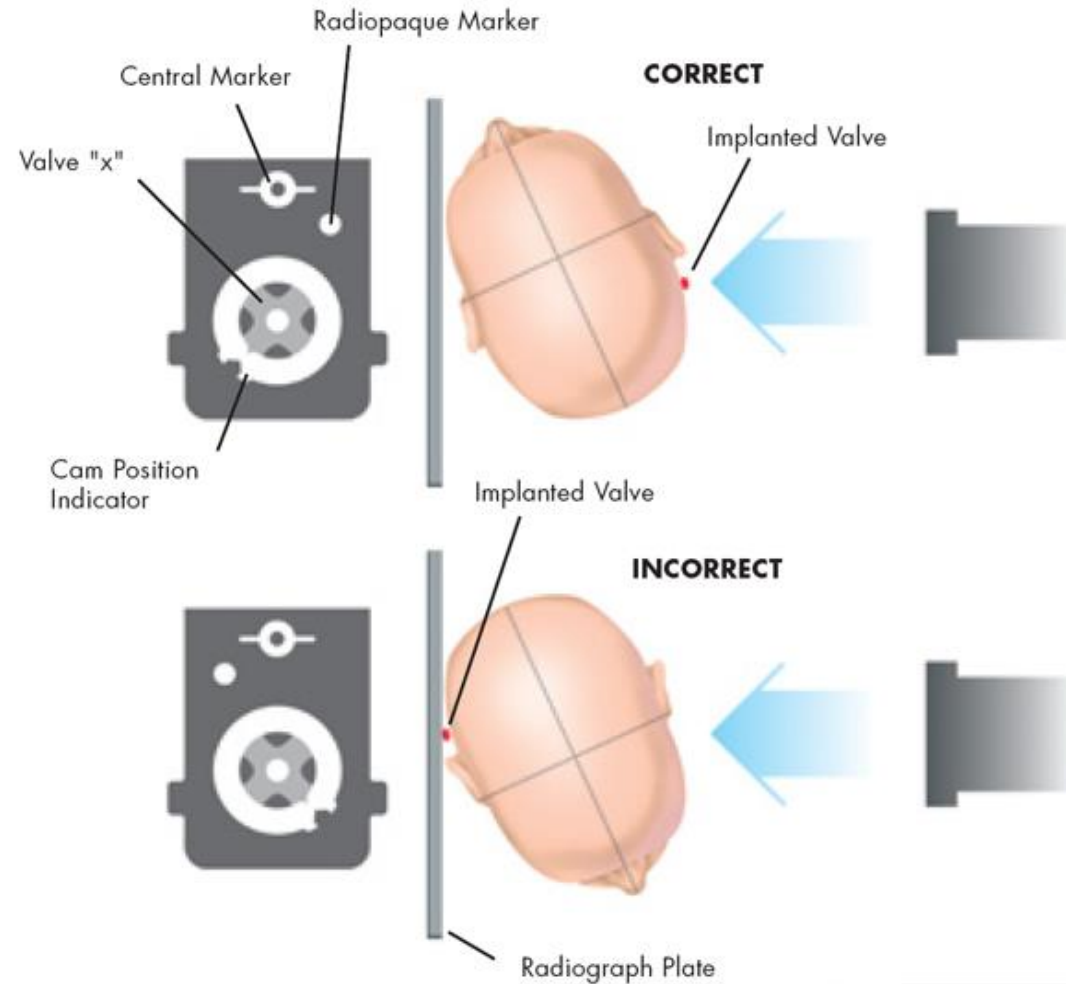
## Abdomen in 2 Ebene



# VA Shunt



# Röntgen Ventilaufnahme

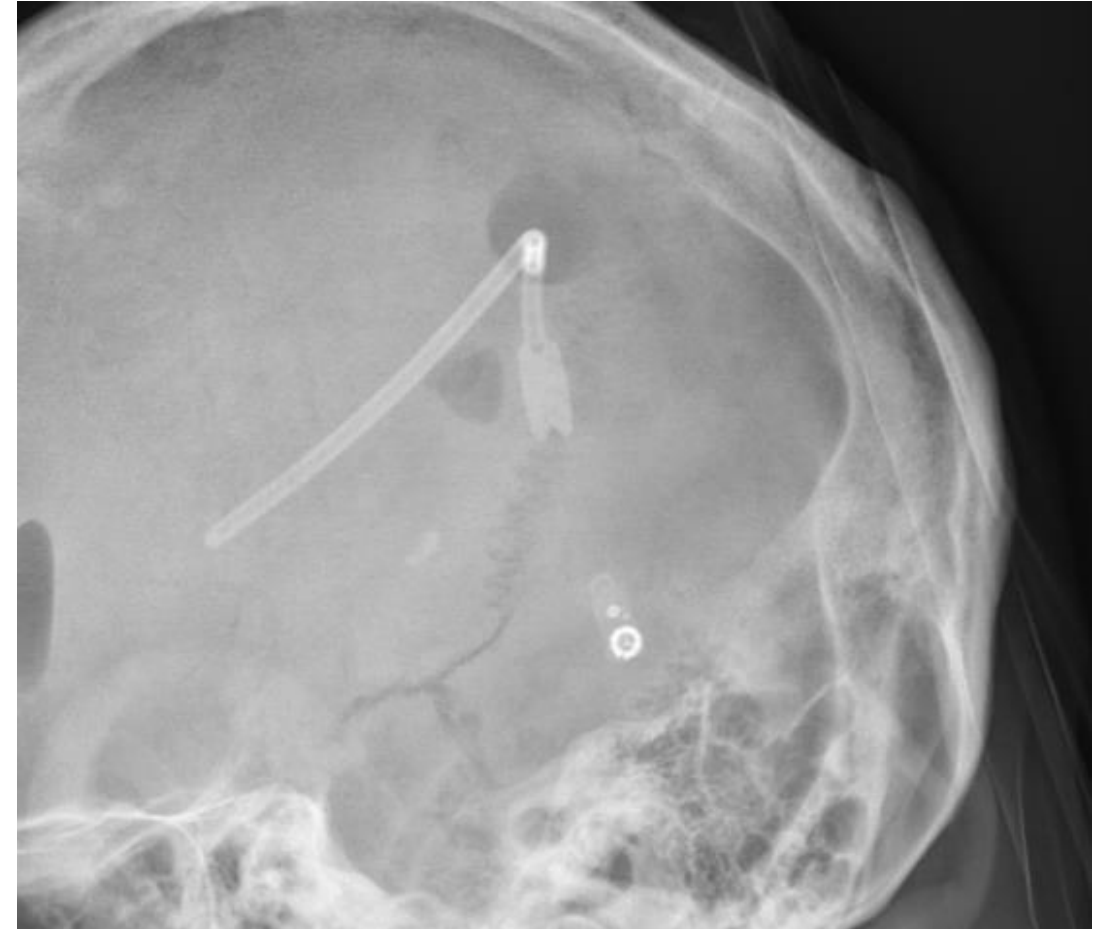


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**Falsch**



**Richtig**



# Komplikationen

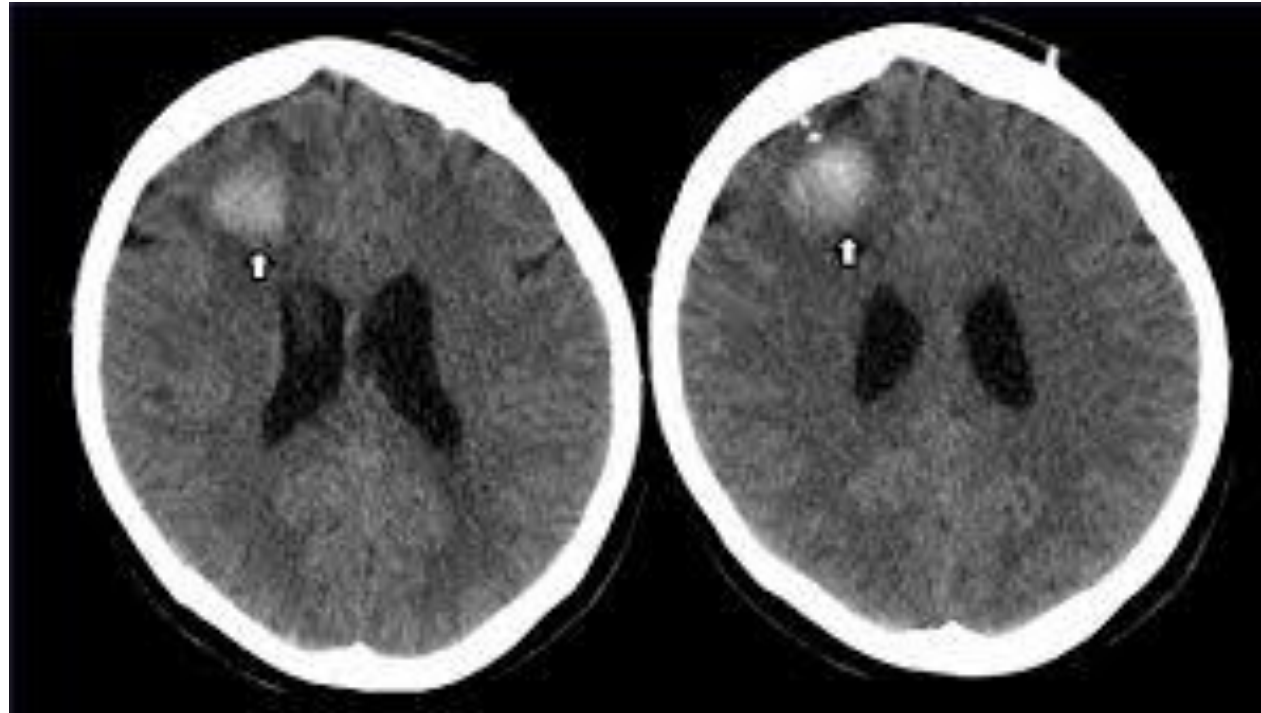
- Shuntinfektion
- Shuntmalfunktion
- Nachblutungen
- Verletzungen der Organen am Hals/Thorax/Abdomen
- Thromboembolie (VA-Shunt)
- Fehllage
- Shuntmigration
- Insuffiziente Länge (Kinder)
- Verkalkungen/Porosität (Kinder)
- Unter-/Überdrainage

# Komplikationen

- Shuntinfection (3-20%<sup>1-3</sup>): coagulase-negative staphylococci, *S. aureus*, gram-negative bacteria<sup>4-5</sup>
- Shunt malfunction/obstruction (90-day shunt failure rate 10.7%, with half of the failures within the first 5 postop days)<sup>6</sup>.

1. Dallacasa P et al. Cerebrospinal fluid shunt infections in infants. *Childs Nerv Syst.* 1995;11:643–648.
2. Odio C et al. CSF shunt infections in pediatrics. A seven-year experience. *Am J Dis Child.* 1984;138:1103–1108.
3. Kulkarni AV et al. Cerebrospinal fluid shunt infection: a prospective study of risk factors. *J Neurosurg.* 2001;94:195–201.
4. Wang KC et al. Cerebrospinal fluid shunt infection in children: efficiency of management protocol, rate of persistent shunt colonization, and significance of 'off-antibiotics' trial. *Childs Nerv Syst.* 1999;15:38–43.
5. Stamos JK et al. Ventriculoperitoneal shunt infections with gram-negative bacteria. *Neurosurgery.* 1993;33:858–862.
6. Venable GT et al. What is the risk of a shunt malfunction after elective intradural surgery? *J Neurosurg Pediatr.* 2015 Dec;16(6):642-7.

# Nachblutungen

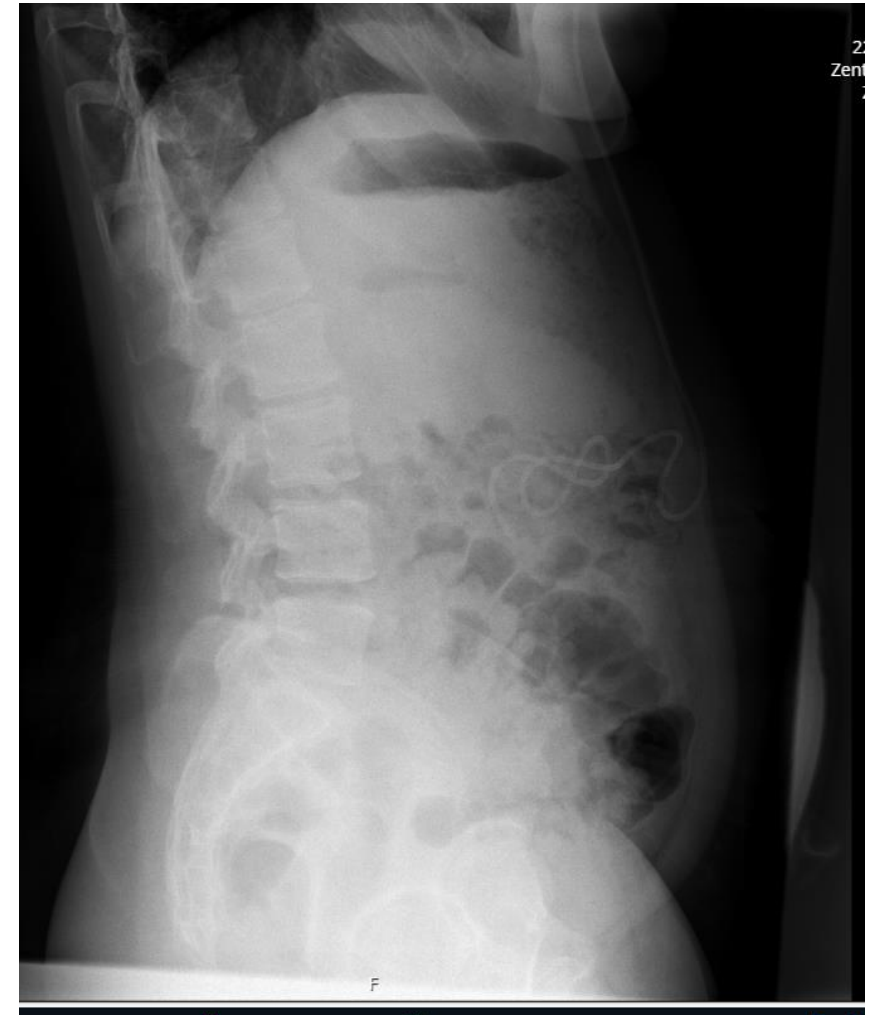


# Fehllage



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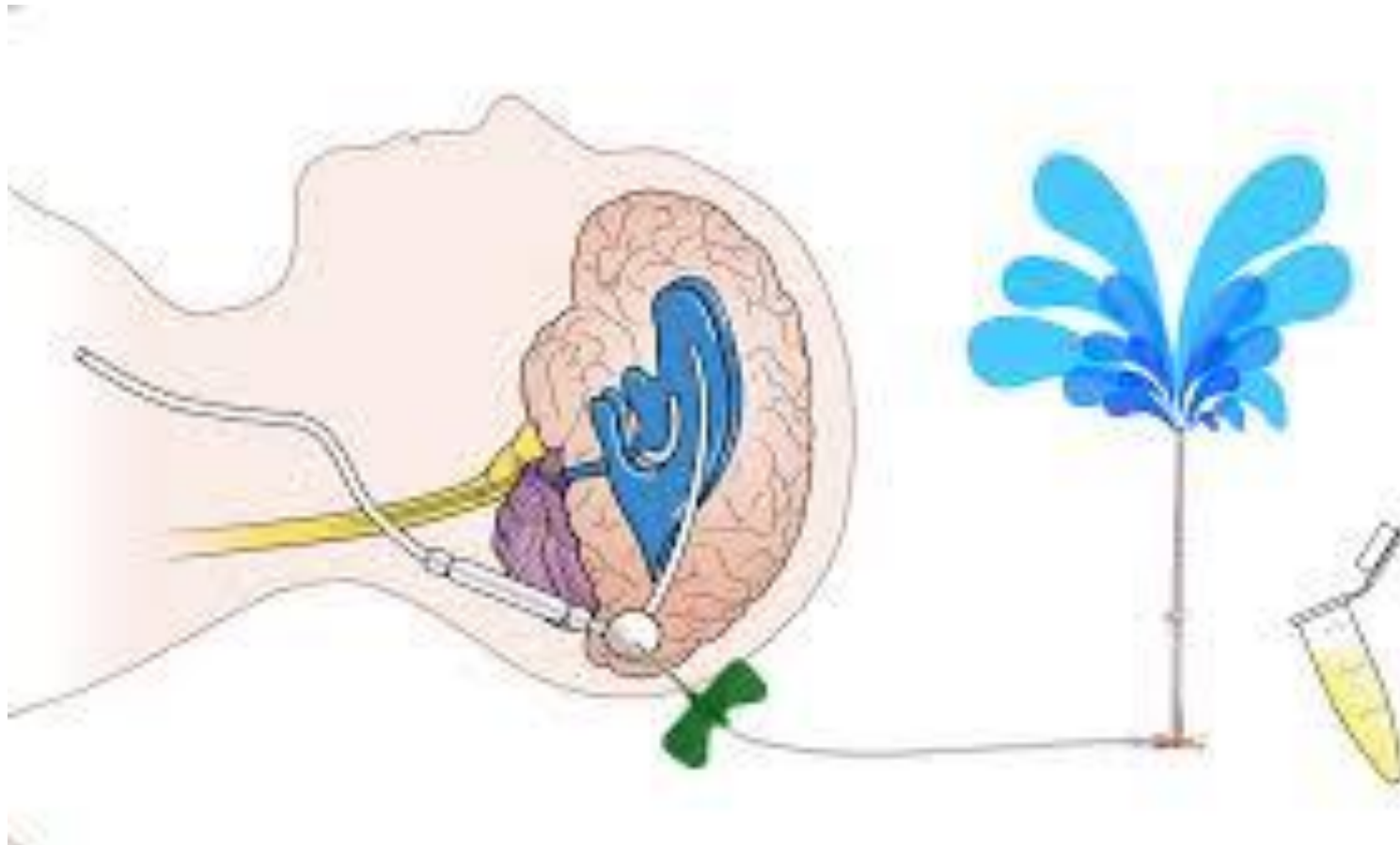


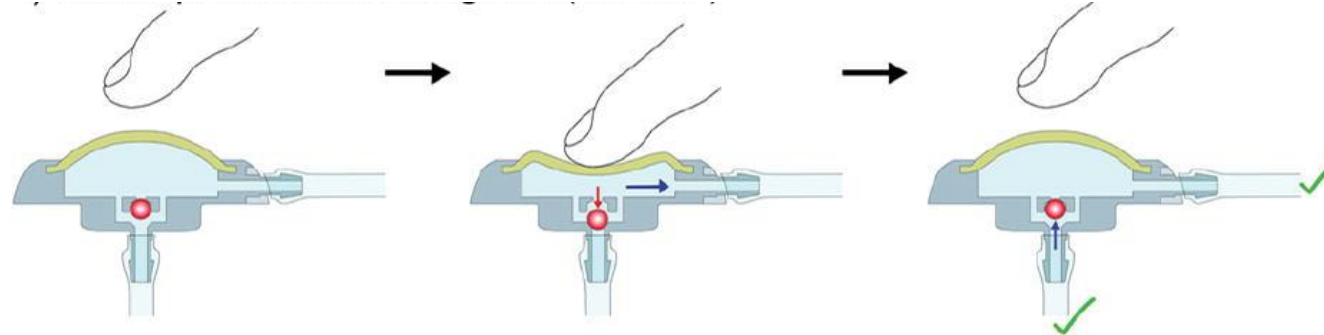
**Why we need 2 views**



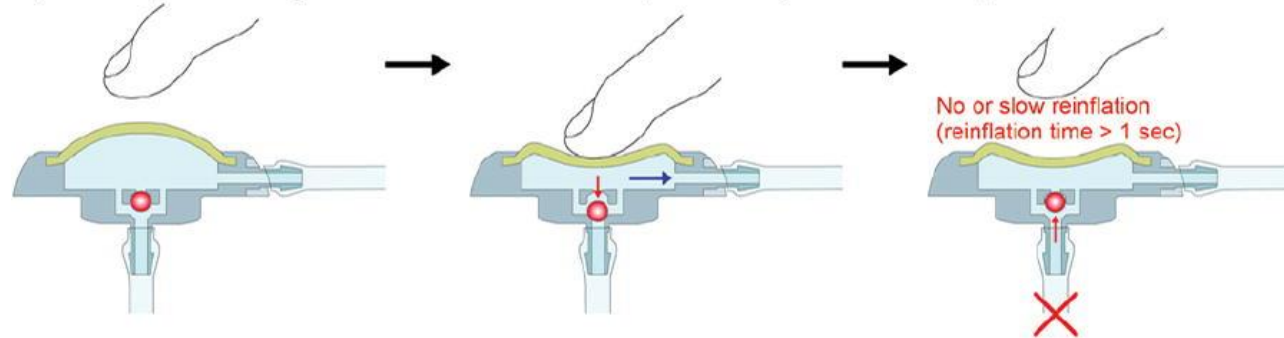
**In radiology**

# Problem solving



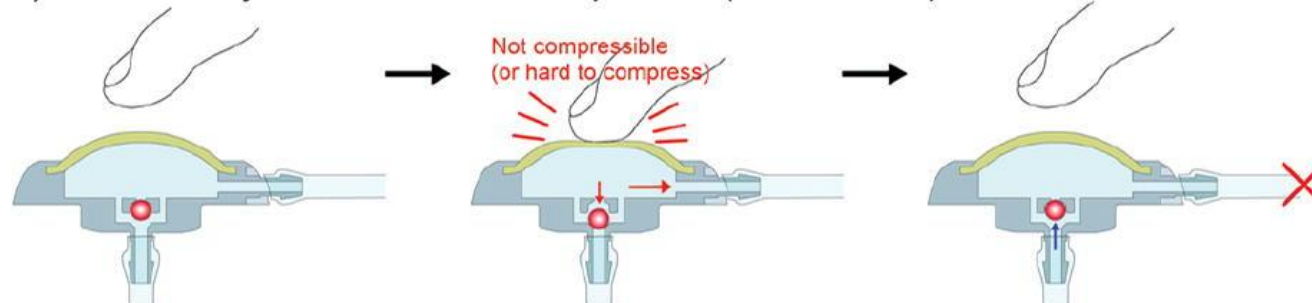


2) Shunt proximally occluded: test result positive ("not-normal")



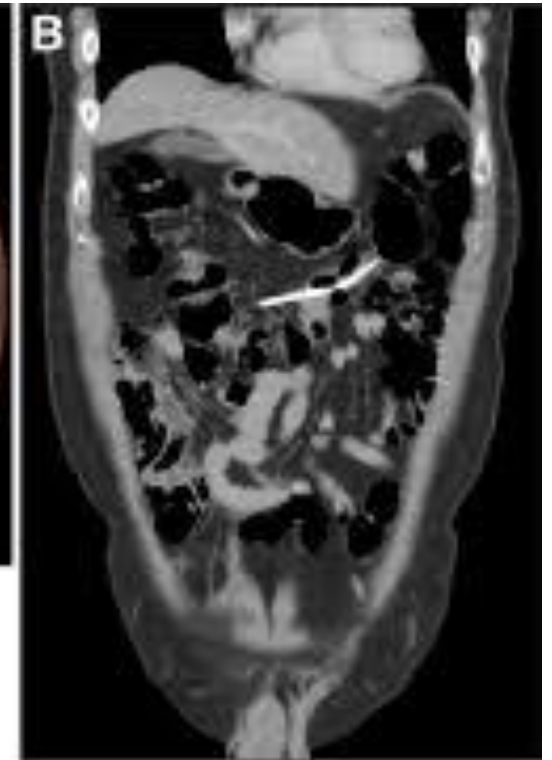
No or slow reflation  
(reflation time > 1 sec)

3) Shunt distally occluded: test result positive ("not-normal")

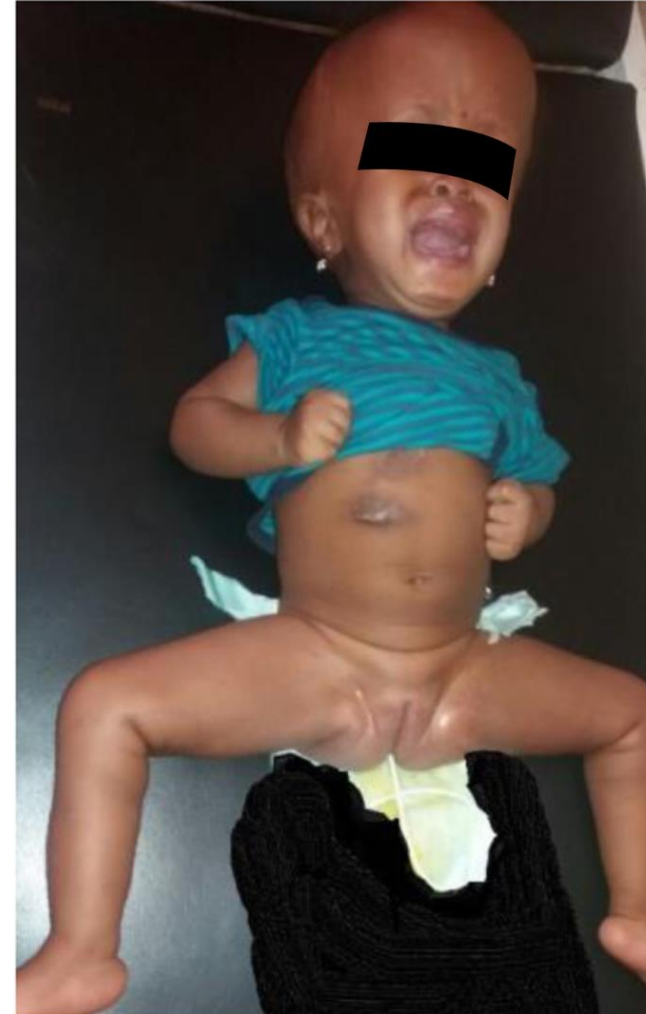


Not compressible  
(or hard to compress)

## Exposure/Migration



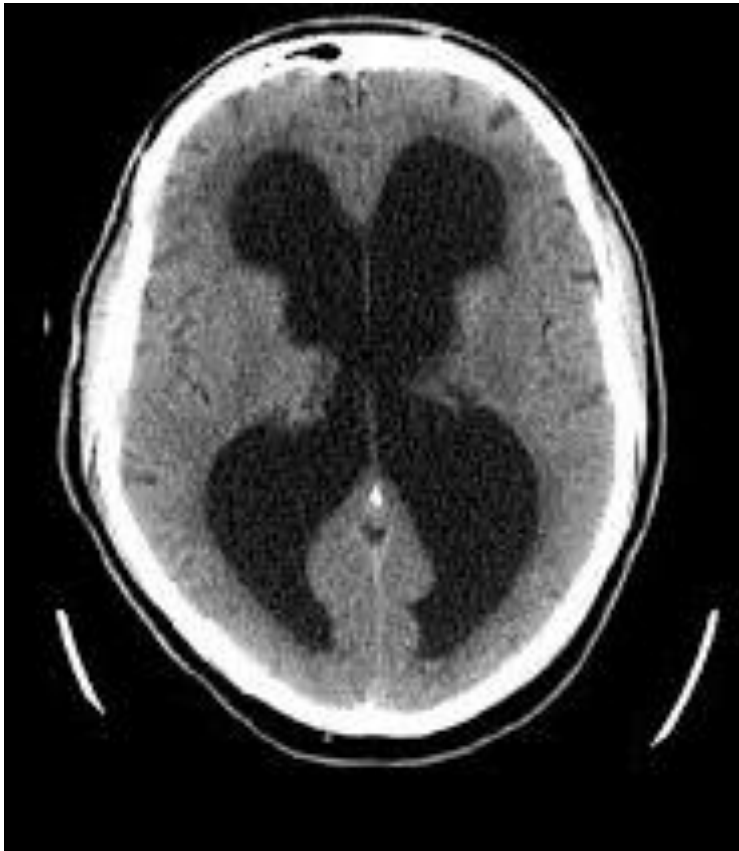
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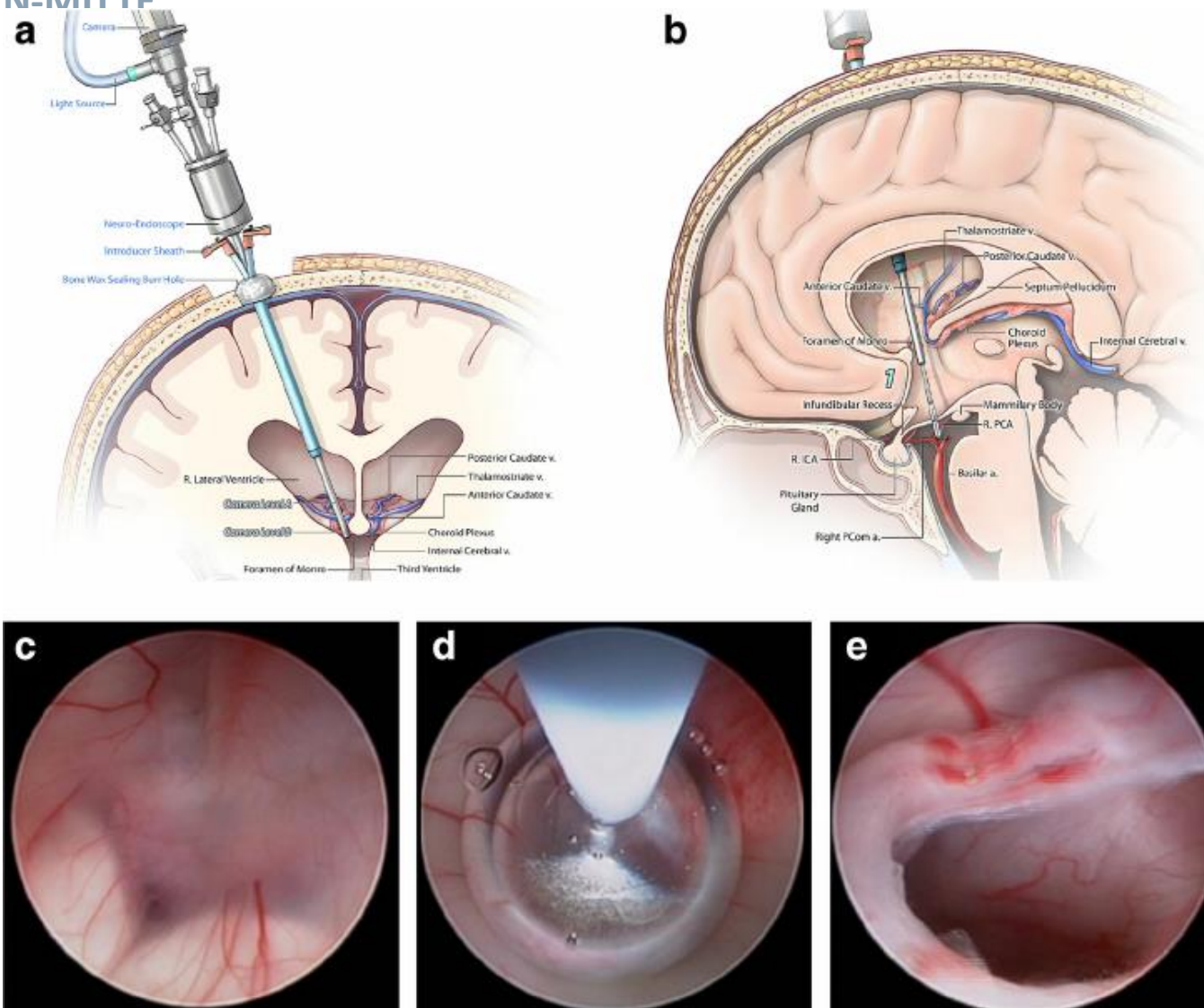


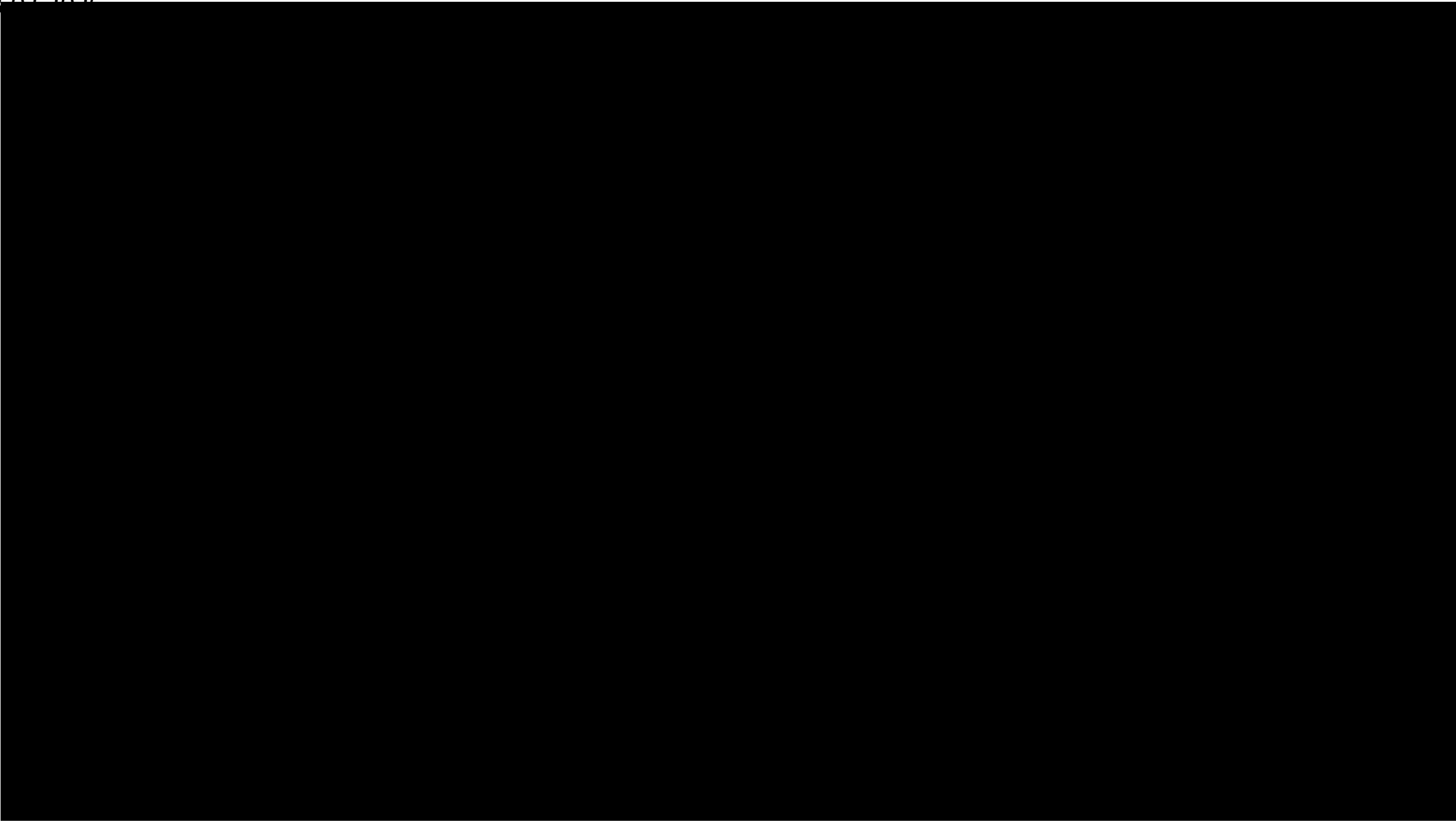
# Unter-/Überdrainage



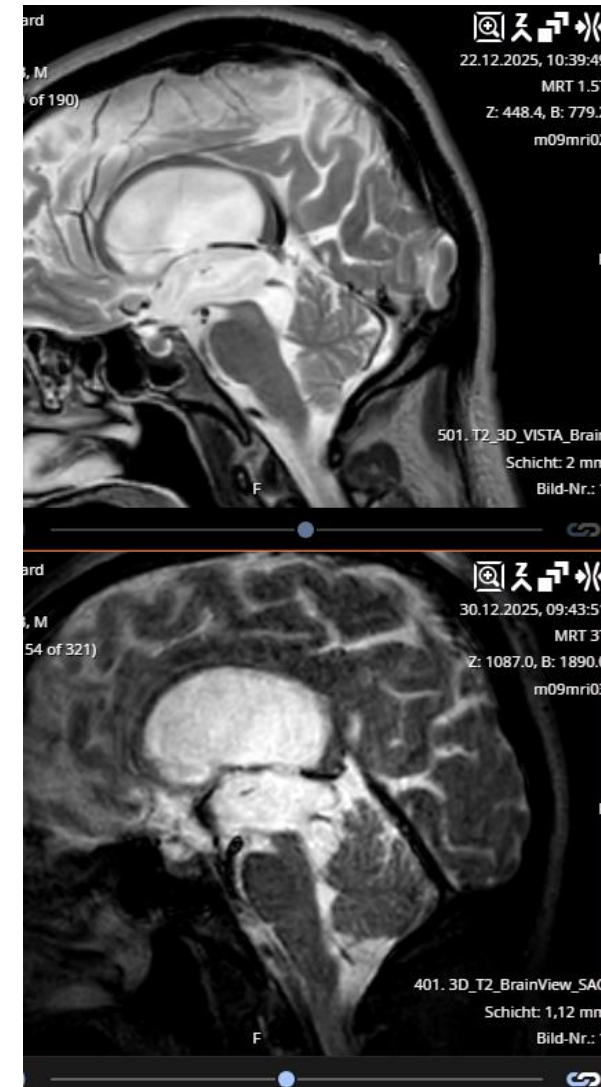
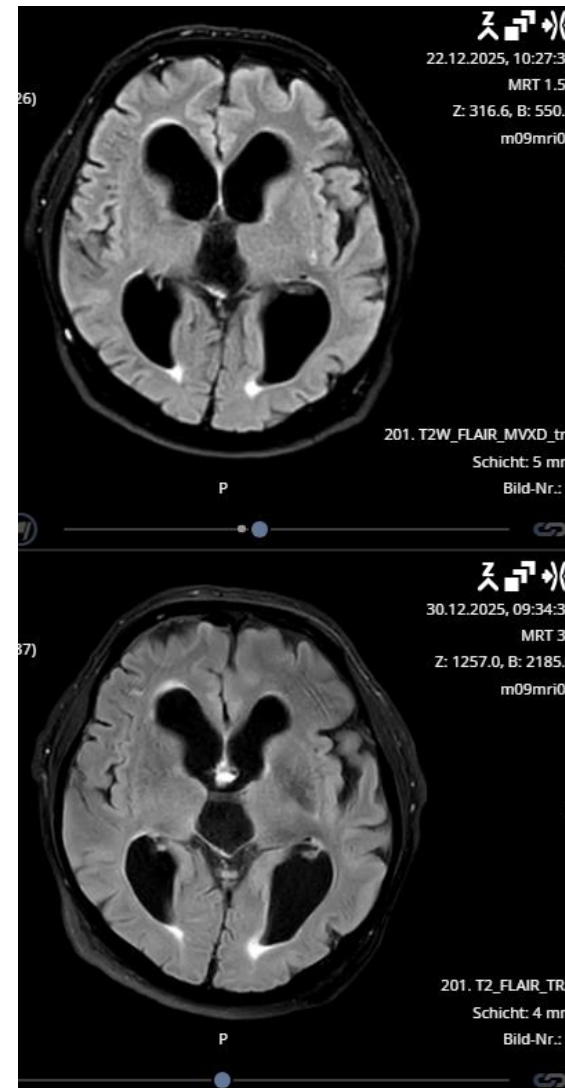
# Endoskopische Drittventrikulozysternostomie (ETV)

- Hydrozephalus occlusus
- LOVA
- Endoskopische Tumorresektion/PE
- Hydrozephalus malresportivus/NPH?





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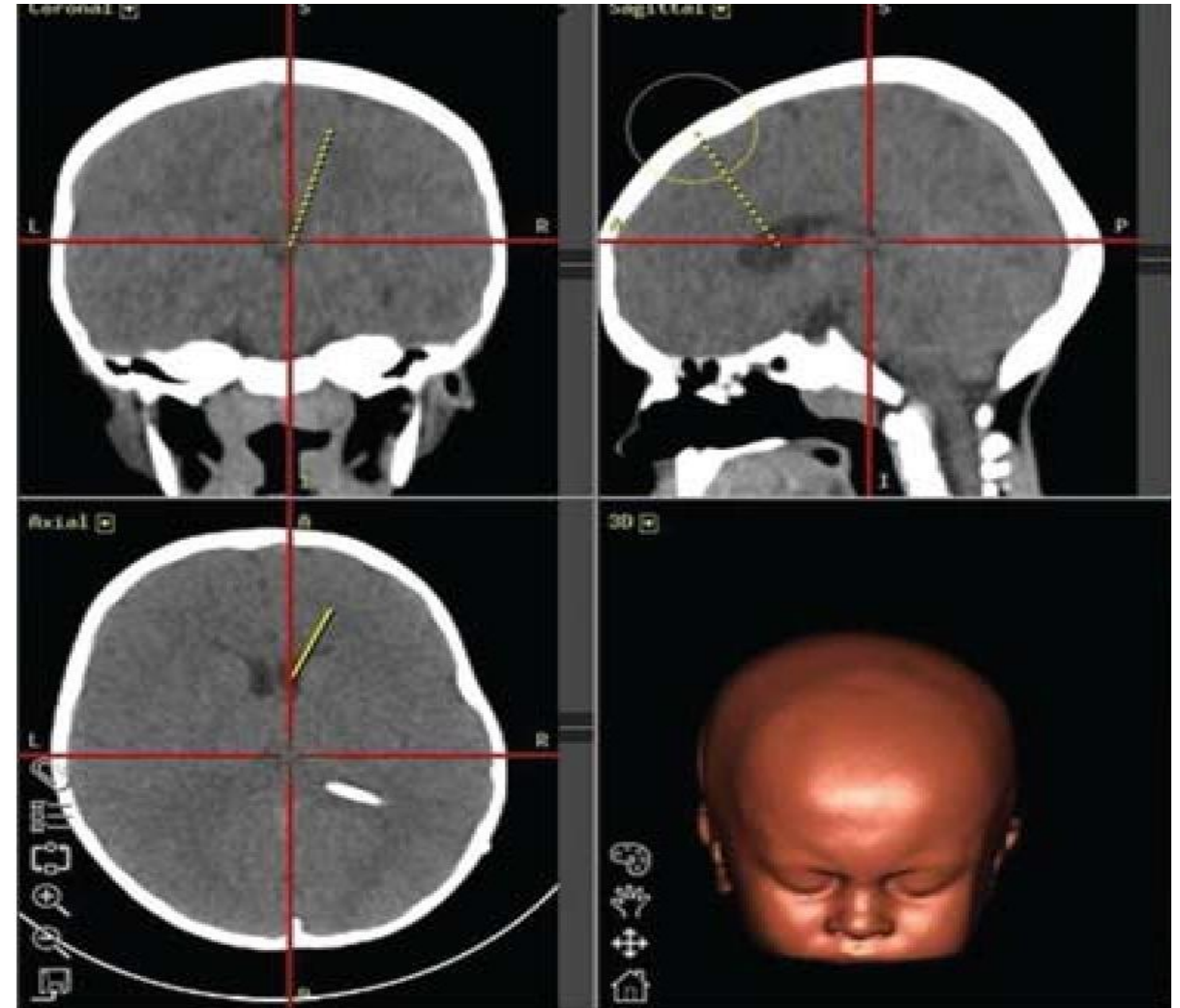
# Pseudotumor cerebri

## Therapieoptionen:

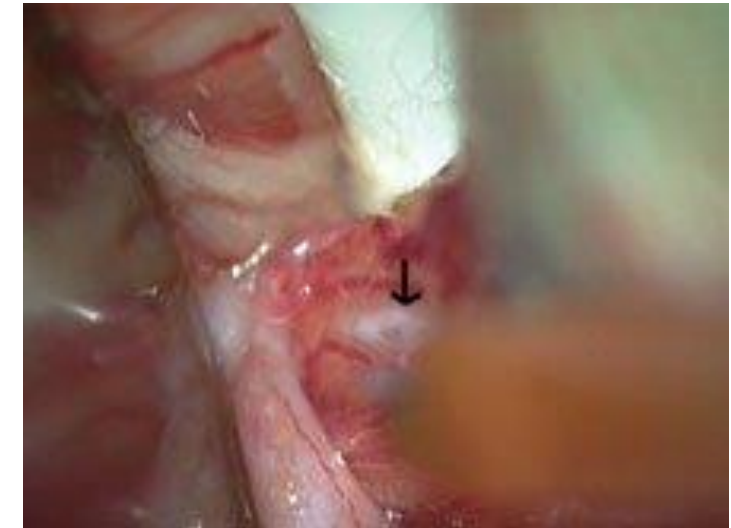
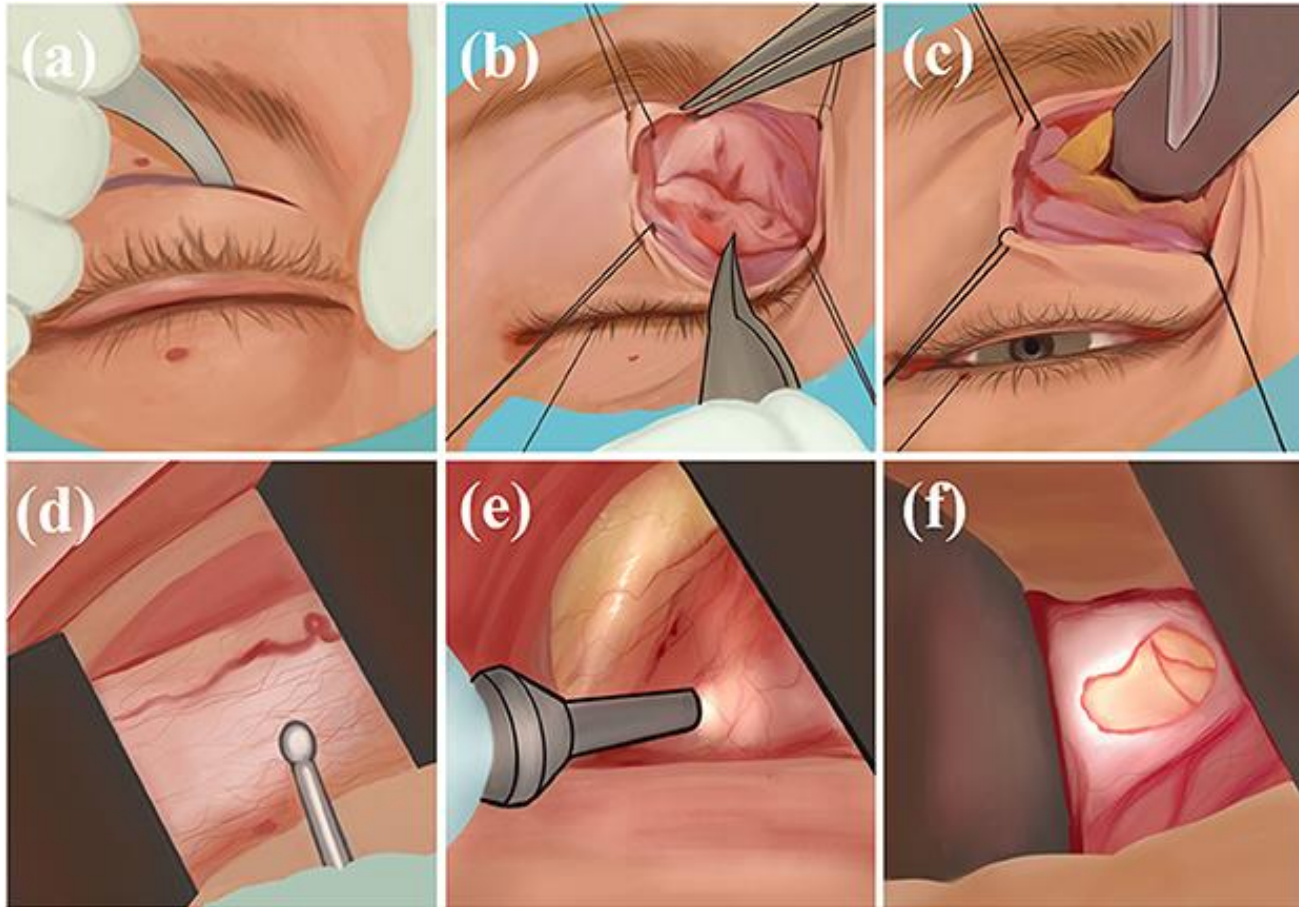
- Acetazolamid
- Gewichtabnahme
- VP-Shunt
- Sinus stenting
- Optikusscheidenfensterung

# Slitzventrikel

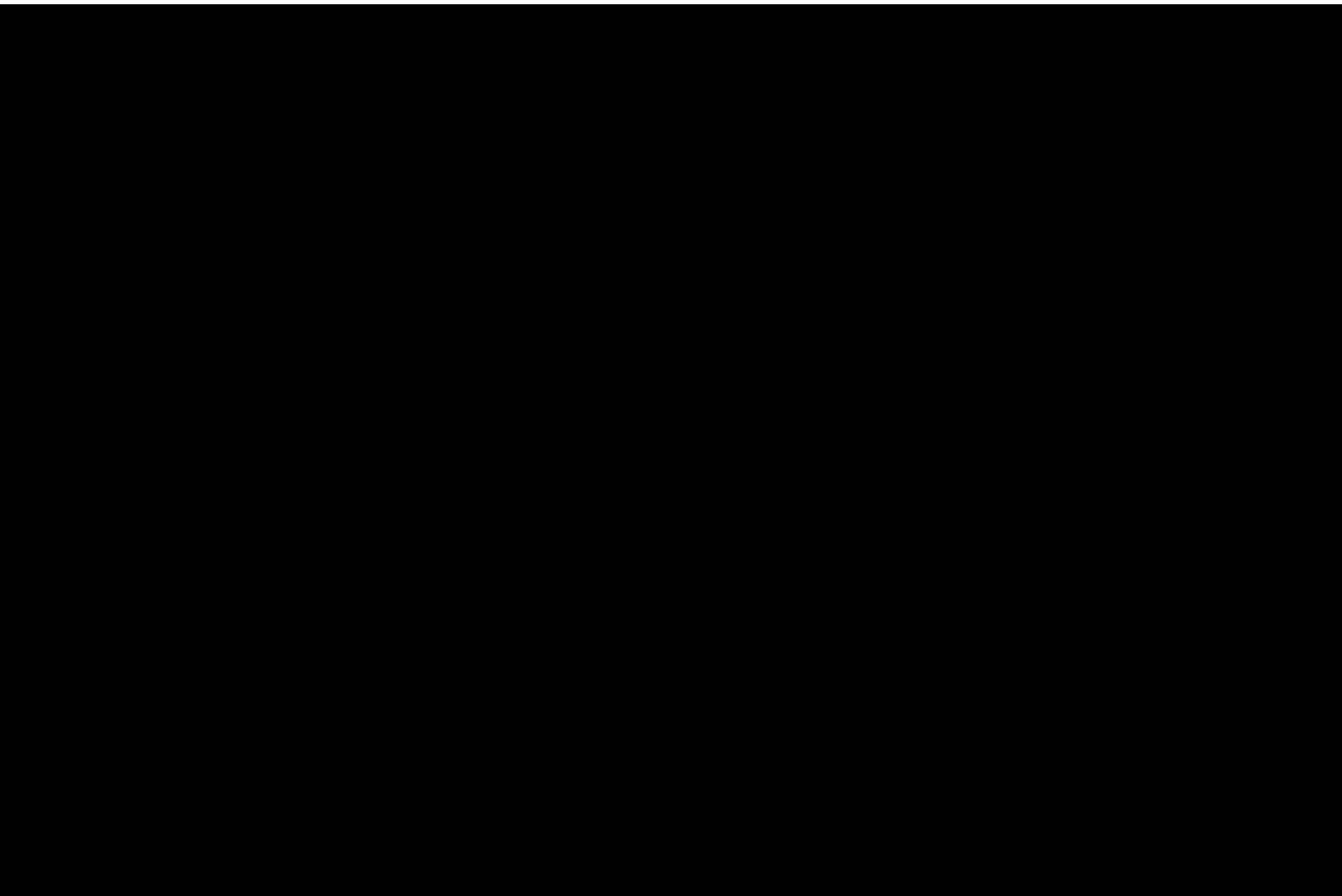
- Neuronavigation
- Über/Unterdrainage/Malfunktion



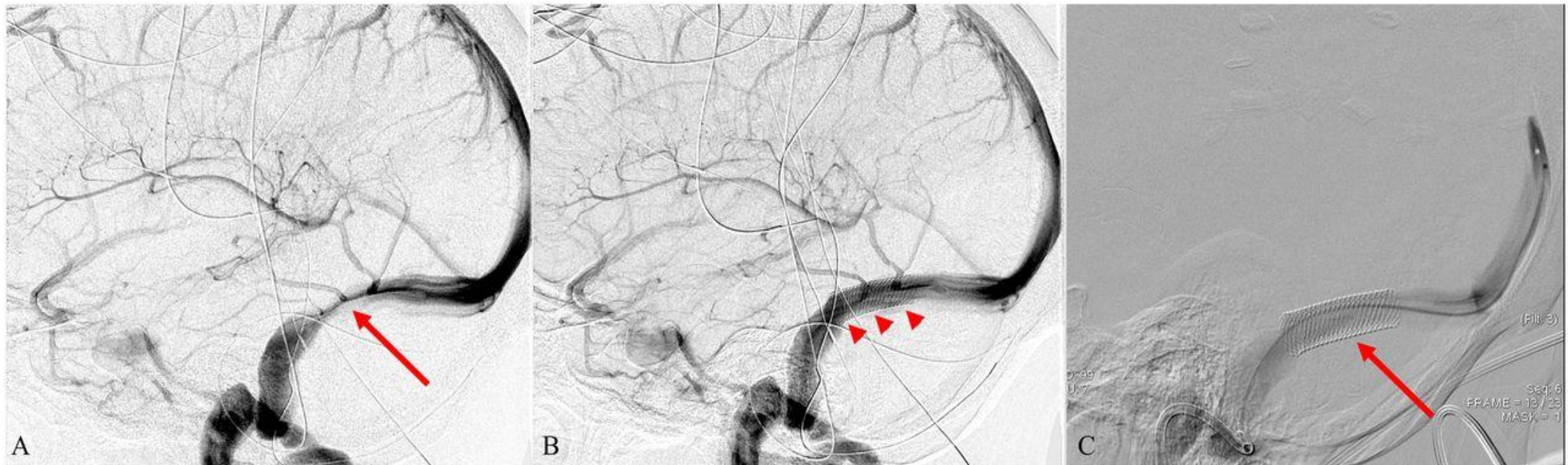
# Optikusscheidenfensterung



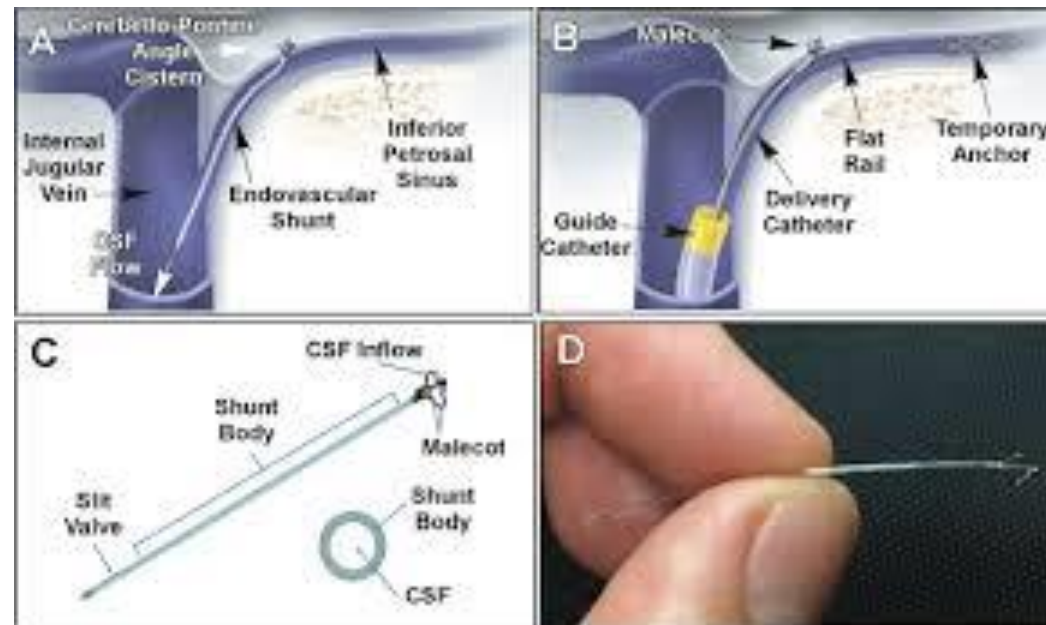
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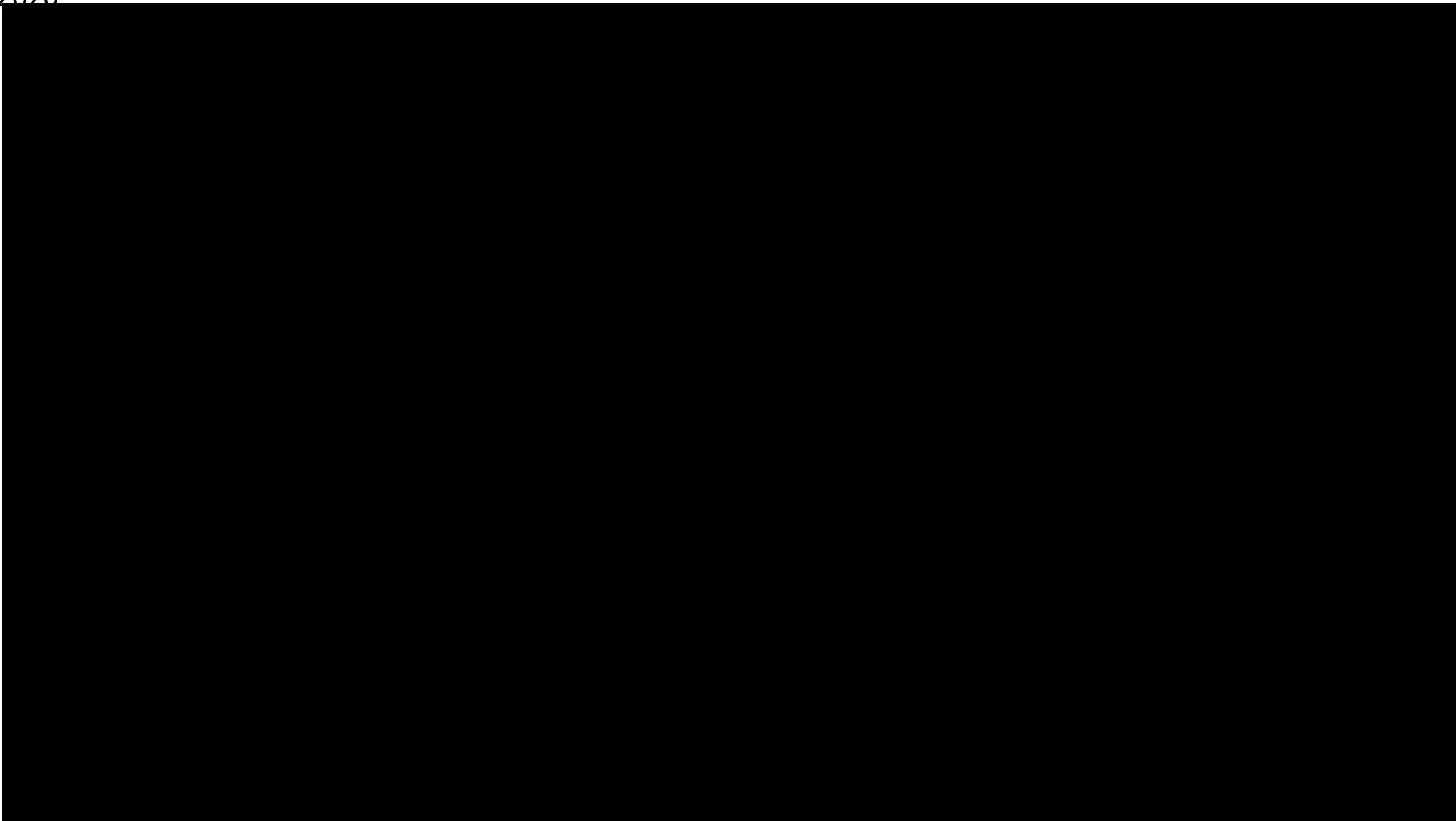


# Sinus stenting



## eShunt®





## STRIDE Study

- **Objective:** Compare the eShunt System to the standard-of-care ventriculoperitoneal (VP) shunt to assess its ability to improve NPH symptoms (e.g., walking, cognitive issues).
- **Target Population:** Patients 60 years of age or older experiencing at least two common NPH symptoms.
- **Study Status:** As of early 2025, the trial is recruiting, with the first patient randomized in the pivotal study.

- **Initial Results:** Early studies reported 97% of treated patients experienced improvement in NPH symptoms, with no device-related serious adverse events, including 95.3% of subjects meeting efficacy endpoints in a 90-day follow-up.
- **Regulatory Status:** The eShunt System is an investigational device, limited by U.S. law to investigational use only and not for sale

# Zusammenfassung

- Nicht alle Formen Hydrozephalus sind gleich
- Unterschiedliche Behandlungsoptionen
- Ursache orientiert
- Behandlung der Komplikationen

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# Diskussion

