Surgical treatment of hydrocephalus

Hydrocephalus (HC) is a term for abnormal accumulation of **cerebrospinal fluid** (CSF) in the ventricles of the brain . As a result, the surrounding brain tissue can be *oppressed*.

A more detailed classification, causes and symptomatology of HC can be found on the **hydrocephalus** page.

HC can be treated **surgically** in three basic ways:

1. **drainage**,
2. **by removing the obstruction** (in the case of obstructive HC, most often it is a tumor),
3. **endoskopically** [1].

This page presents the **basic types of drainage** and the endoscopic method in the form of ventriculostomy of the III. chamber. The solution of **obstructive HC** (removal of specific obstruction) is described individually in individual chapters of **neurosurgery**.

Diagnostics

- **CT** – *the first choice*, depending on the type of HC, pathologies can be visualized *(ventricular dilatation, origin of obstruction, etc.)*
- **MRI** – compared to CT, T2 MRI has the advantage in particular, on which CSF can be visualized (*fluid-sensitive* T2)
- **ultrasound** – especially in *infants and younger pediatric patients*;
- **LIT (lumbar infusion test)** – detection of CSF resorption disorders, performed mainly in patients with *normotensive hydrocephalus* (NHP);
- **LD** (lumbar drainage) – serves to determine the *patient's response* to drainage and to evaluate subsequent treatment procedures (mainly before the definitive application of a VP shunt in NHP patients) [2][3].

Classification of drainage treatment

Surgical treatment of HC drainage directly depends on the given type of hydrocephalus:

1. in the case of **acute HC, temporary drainage** is indicated
2. in the case of **chronic HC,** the goal of treatment is **long-term drainage**

Table summarizing the individual types of drainage in terms of duration of drainage treatment:

Type of treatment	Temporary	Long term
Type of drainage	external ventricular drainage	ventriculoperitoneal drainage
	external lumbar drainage	ventriculoatrial drainage
	ventriculosubgaleal drainage	lumboperitoneal drainage

Treatment of acute hydrocephalus

In the case of **acute HC** , depending on the patient's individual predispositions, **temporary drainage** may be indicated. It is most often *ventricular or lumbar drainage*, or *ventriculosubgaleal drainage.*

External ventricular drainage

External ventricular drainage (EVD – *external ventricular drain*) is used mainly in the case of **acute obstructive HC** , in which there is a clear limitation of the flow of CSF in the CSF channels[4]. From the lateral ventricle of the non-dominant hemisphere, the CSF is drained into the reservoir.

Indication

Indications for the *application of EVD* (it does not always have to be only acute HC) are:

1. **reduction of intracranial pressure** (eg, acute hydrocephalus, craniotrauma)
2. **drainage of inflammatory CSF** (CNS infection – the reason is the prevention of post-inflammatory obstructive HC, or the emergence of acute obstruction of the outlet tracts);
3. **drainage of bloody CSF** (most often after bleeding or surgery (post-hemorrhagic HC), again we want to prevent the risk of obstructive HC or acute obstruction of the drainage channels);
4. **diversion of the natural flow of CSF** (most often in the healing of wounds in the region of the posterior

fossa) . [5]

EVD can also be used perioperatively. It is thus indicated in the case of the need to achieve decompression in brain operations (especially in surgical resections of lesions in the posterior fossa area).

External lumbar drainage

In addition to diagnostic use, external lumbar drainage (LD – *lumbar drain*) is also used in the treatment of **acute communicating HC**. The cerebrospinal fluid is drained from the lumbar section of the spine and, as in the case of EVD, is *drained into a reservoir*. It is applied between L3–L5. [6][7]

Indication

The indications are very similar compared to EVD, the decision to choose the type of drainage is directly proportional to the individual symptoms and comorbidities of individual patients:

1. **reduction of intracranial pressure**;
2. **drainage of inflammatory CSF**;
3. **drainage of bloody CSF**;
4. **diverting the natural flow of CSF** [8]


External ventricular drainage

LD, like EVD, can also be used perioperatively to achieve decompression in brain operations (most often in resections of lesions in the posterior fossa, brainstem). In certain cases, it is applied for liquefaction , which can arise as a postoperative complication in case of incomplete closure of the dura, etc., and if a total revision of the wound is not necessary.

Ventriculosubgaleal drainage

This type of drainage is similar to external ventricular drainage, as in this case too the CSF is drained from the **lateral ventricle of the non-dominant hemisphere**. This time, however, the cerebrospinal fluid is not drained into a reservoir, but into a *pocket created in the subgaleal space of the head* . There, the resorption of cerebrospinal fluid occurs, or it can be punctured .[9]

Complications

The most common complications of drainage treatment include:

- **bleeding** [10],
- **infection**,
- **mechanical complications of drainage**,
- **system overdrainage**,
- **surgical complications** – drainage malposition, epidural hematoma, etc. [11][12]

Treatment of chronic hydrocephalus

Even in the case of treatment of chronic hydrocephalus, surgery is indicated based on the individual presentation of the patients. It is not a rule that every chronic hydrocephalus must be treated surgically. Treatment of **chronic HC is long-term**.

Ventriculostomy of the III. chamber

It is a neuroendoscopic creation of an opening in the base of **III. ventricle** , is a solution to **obstructive HC** (some authors mention the possibility of applying ventriculostomy of the III. ventricle also in other types of hydrocephalus, but this is not usual). [13]

Technique

A cerebrotomy is performed near the *coronal suture* , the endoscope is introduced through the lateral ventricle into the III. chambers. As a result of HC, the *foramen intraventriculare widens* , so it is possible to revise the base III. ventricles and perforation of the arachnoid membrane. *Monopolar electrocoagulation* is used for perforation.[14]

The subsequent dilation of the opening is important, so that it does not close due to *tissue regeneration*. We achieve the possibility of CSF circulation through III. chamber into the interpeduncular cisterns at the base, through the hole in the base of III. ventricles it is possible to see *a. basilaris*. [15]

Principle

The principle is to re-enable the circulation of CSF , which was limited as a result of the obstruction.

Indication

Ventriculostomy is primarily III. chambers applied for a specific obstructive HC, which arose as a secondary consequence of, for example:

- stenosis of *aquaeductus Sylvii*,
- Dandy-Walker malformation,
- *intraventricular hematoma*,
- *tumor* in the posterior fossa
- *craniosynostosis* [16][17][18]

Benefits

For example:

- *effective causal treatment*
- unlike a shunt, the patient is not at risk of *valve dysfunction*

Cons

Disadvantages of the III. ventriculostomy can be divided into **two basic points**:

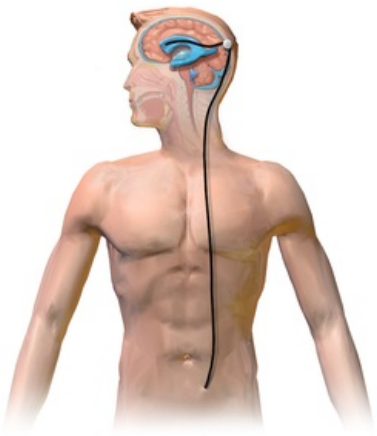
- **high risk of complications** (both morbidity and mortality)
- **invasive procedure**

Shunt

Long-term drainage, the principle of which is the **implantation of two catheters together with a valve** that **regulates the circulation of CSF**. Excessive CSF in the *cerebral ventricles* , or in the *lumbar part* of the spine, it is diverted by means of a shunt to **another part of the body**, where the CSF is allowed to be absorbed.

Valve Requirements

The valve must *respond to opening pressure* and must be one-way. The flow of CSF is regulated according to the setting of the opening pressure of the valve, which has different values. According to the values of the opening pressure, we divide the valves into *high-pressure, medium-pressure and low-pressure*. [19]



Ventriculoperitoneal shunt

Ventriculoperitoneal shunt (VP shunt)

CSF is drained into the peritoneal cavity via a catheter leading from the *lateral chamber* further under the skin.

It is the **most frequently applied shunt** [20][21].

Ventriculoatrial shunt (VA shunt)

CSF is drained from the lateral ventricles by the venous system into the ***atrium dextrum***.

It is *not as common* as a VP shunt, it depends on the individual disposition of the patient and his comorbidities – it is often indicated for a VA shunt due to contraindications or a previous unsuccessful application of a VP shunt.

Lumboperitoneal shunt (LP shunt)

CSF is drained from the **dural sac** (subarachnoid space) in the area of the lumbar spine into the **peritoneal cavity**. The catheter is inserted *below the level of the L2 vertebra*.

In addition to the mentioned three types of shunts, there are others, e.g. v*entriculopleural shunts (VPL shunt)* etc. [22]

Ventriculocisternal shunt (Torkildsen shunt)

Using an implanted catheter, CSF is drained from the lateral ventricle into the **cerebellomedullary cistern** [23][24].

Complications

As in the case of the treatment of acute HC, drainage treatment in the similar application of shunts is accompanied by a spectrum of possible complications:

- **infection** – (up to 15%) most often *Staphylococcus epidermidis,* ventriculitis, meningitis;
- **shunt failure** – obstruction, kinking of the catheter (most often in the neck area), etc.

- **distal complications**– peritoneal pseudocysts, pleural effusion (primarily in ventriculopleural shunts) [25][26][27]

CT - Ventriculoperitoneal shunt

Links

Related articles

- Hydrocephalus
- Malformations of the CNS
- Normotensive hydrocephalus
- Drainage

External links

- Lumbar drainage - video and article (https://www.neurosurgicalatlas.com/volumes/principles-of-cranial-surgery/lumbar-drain)
- Ventriculostomy of the III. chamber - video with commentary (https://www.youtube.com/watch?v=3LWBNkcOnzk)
- VP shunt (https://radiopaedia.org/articles/ventriculoperitoneal-shunt?lang=us)

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