The Treatment of Hydrocephalus

Hydrocephalus is usually treated by diverting the cerebro spinal fluid (CSF) to a place in the body where it can be absorbed.

**Endoscopic Third Ventriculostomy**

An endoscopic third ventriculostomy (ETV) is a surgical procedure in which an opening is created in the floor of the third ventricle using an endoscope. The ETV diverts CSF from the third ventricle to the subarachnoid space, where it can be absorbed in the usual way. Very occasionally, an ETV is combined with removal of some choroid plexus (tissue which produces CSF) in order to reduce the amount of CSF produced.

**Shunts**

A shunt is the most commonly used way of controlling the high pressure inside the head caused by hydrocephalus. It diverts CSF from the ventricles or other CSF-filled spaces to be absorbed in another area of the body. All shunts are thin tubes which drain CSF from a space where it is collecting, to be absorbed in another part of the body. Nearly all ventricular shunts have a valve in the ‘neck’ area of the tubing, which opens when the pressure in the head reaches a certain level. These can be fixed pressure, adjustable pressure (programmable), or dual-pressure (gravitational). Gravitational shunts can also be programmable.

The shunt itself is made from silicon, a strong, long-lasting and inert substance that very few people are allergic to. Some shunts can help reduce infection after surgery such as Bactiseal, or silver-impregnated shunts.
Common sites for shunts

**Ventriculo-Peritoneal (VP)**

Ventricular peritoneal shunts have the proximal (head end) catheter placed in the ventricles (usually lateral ventricle) and the other (distal) end in the space surrounding the intestines. This space has a fluid similar to CSF, so the CSF mixes with this fluid and is absorbed. If the shunt is infected, the membrane covering the intestines, (the omentum) can block the distal end of the shunt. Occasionally, the fluid is not properly absorbed, and collects in the abdomen. This is often fixed by changing the position of the distal shunt to another area of the abdomen.

VP shunts can become infected following bladder surgery, so your urology team would need to be aware of this possibility, and be vigilant after your operation. VP shunts do not need to be changed (revised) routinely in children because of growth. They are changed only if and when they stop working effectively, for example if they block or begin to over drain. VP shunts won’t be suitable if you need peritoneal dialysis.

**Ventriculo-Atrial (VA)**

Ventricular atrial shunts drain from the ventricles into the heart. This is less commonly used than VP shunts. If placed in babies or children, the shunt often has to be changed (revised) when the child grows, to ensure the distal end remains in the heart. Unlike VP shunts, they don’t block if the shunt is infected, but bacteria flows into the bloodstream. This can lead to symptoms such as feeling generally unwell, low grade fever, night sweats, blood in the urine or a persistent cough.

If you have a VA shunt and experience these symptoms, shunt infection can be ruled out through a blood test. Contact Shine’s Health Team for details.

**Lumbar Peritoneal (LP)**

Lumbar Peritoneal shunts drain from the CSF space around the lumbar spine to the abdomen. This type of shunt is used for draining CSF where there is no blockage through the ventricles, but not enough CSF is being absorbed, such as in communicating hydrocephalus, and IIH. They can be combined with gravitational valves to reduce over drainage. Sometimes LP shunts become dislodged from the spine, and sometimes, because the shunt is placed below the brain, it can create a downward pressure on the base of the brain, leading to a condition called Chiari Malformation. More information on Chiari I can be found at: [www.annconroytrust.org](http://www.annconroytrust.org)
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Ventriculo-Pleural (VPL)

This shunt drains from the ventricles to a thin, fluid-filled layer between the coverings of the lungs. The CSF mixes with this fluid and is absorbed into the bloodstream. It would only be placed here if other sites weren’t suitable. If fluid is not absorbed effectively, it can collect and prevent the lung from expanding.

If you have a VPL shunt and are getting short of breath, especially when you exercise, tell your Neurosurgeon as the shunt may have to be moved to a different site.

External shunts

These shunts have the proximal end in the space between the brain and the skull (subarachnoid space), and the distal end is usually placed in the peritoneum. These are used when fluid is collecting around the outside of the brain, but is not trapped within the ventricles.

Ventriculo-Subgaleal

This shunt is often used for new or premature babies, who are too small for a shunt, or who may not need a permanent shunt. One end is placed in the ventricle, the other into a ‘pocket’ the surgeon forms between the skin on the baby’s scalp and the underlying tissue. Because the scalp has many small blood vessels, the fluid is easily absorbed directly into the bloodstream.

Types of shunts

Programmable

Some shunts have valves that can be adjusted to open at varying pressures, by using a special device placed on the skin. This way, the neurosurgeon can alter the way the shunt works without having to replace it. This is particularly helpful in children, as the drainage pattern changes as the child grows, and also for people with NPH. Currently the most commonly used programmable shunts are adjusted with a magnetic device. This can mean that occasionally some types can be accidentally reset by magnetic fields coming close to the valve area, or by powerful magnets such as those in MRI scanners. Some types of programmable valves, such as ProGAV, need physical pressure to be applied to ‘unlock’ the mechanism before the magnet resets it, so it can’t be changed unintentionally by magnetic fields of 3 Tesla or less.
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Others, such as Codman Certas, can only be changed by magnetic fields in a certain direction, meaning MRI should not change the setting.

Children with other programmable shunts should be supervised when playing with magnetic toys etc. or around children using Vagal Nerve Stimulators (VNS) to control seizures.

**Gravitational**

Shunts drain at different rates depending on whether we are standing or lying, owing to the effects of gravity. Shunts tend to drain more when we are upright, owing to a ‘syphon’ effect, and the greater the height between the head and the bottom end of the shunt, the more drainage tends to occur. This only happens with shunts, not ETVs, and to counteract this effect, some shunts (such as GAV, and PaediGAV) operate with two settings, one for standing, and another for lying down, to help reduce over drainage.

**Antimicrobial**

**Bactiseal shunts**

Bactiseal shunts are impregnated with two antibiotics to kill bacteria that are introduced at the time of the shunt surgery. The antibiotics are embedded throughout the shunt’s material, rather than being coated onto the inside of the shunt. This means the antibiotics aren’t washed off the shunt by the flow of the CSF, so continues to kill bacteria for several weeks after the shunt is inserted.

**Silver shunts**

Silver has long been considered to have antimicrobial properties, and Silverline shunts have silver included in its material. There is a clinical trial underway at the moment, BASICS, comparing the rate of shunt infections using Bactiseal, Silverline and plain shunts.


**Shunt Accessories**

**Antisiphon devices**

Some shunts have devices included or added, to reduce or prevent over drainage owing to gravity when standing up (siphoning).
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Ommaya reservoirs

Although not strictly a shunt, they are often used alongside shunts or ETVs. They are formed of silicon, with one end in the ventricle. The other is a closed end placed just under the surface of the scalp. No CSF flows through the device, but it provides direct access to the ventricle, and can be useful for measuring intracranial pressure, or for doctors to draw off CSF in the case of suspected shunt or ETV blockage, to relieve the pressure.

Shunt complications

Shunt Infections

Occasionally, bacteria from the skin can infect the shunt, at the time of surgery. Bacteria live within layers of the skin, no matter how clean it is or how thoroughly the skin is prepared for surgery. The bacteria are harmless when on unbroken skin but can cause infections in other parts of the body. The bacteria are released into the surgical cut onto the underlying tissue. Signs of shunt blockage develop very quickly for infected VP shunts, but infected VA shunts do not block, and may not result in any symptoms for several years after insertion. It is not possible for a shunt to become infected through day-to-day illnesses, such as colds, flu or dental problems. You will not need antibiotic cover for dental work. However, VP shunts can become infected following abdominal infections, like a burst appendix, or bladder or bowel surgery; do ensure your surgeons know you have a VP shunt if these situations arise.

If it is suspected that your VP shunt is infected, it will usually block, and you will need to seek medical attention straight away. The shunt will be removed and sent for testing, and an External Ventricular Drain (EVD) system will be inserted. This will allow the infected CSF to be drained into a bag outside the body, whilst antibiotics are used to clear the infection. It is important that blood or protein present in the CSF are allowed to clear before the new shunt is fitted, as these can block the new valve.

Shunt blockages

Shunts can block for a number of reasons.

Proximal

The tiny drainage holes in the proximal catheter may become clogged with healthy brain cells as the catheter is passed through the brain on its way to the ventricle.
This may be a repeated problem for some people, leading to a shunt’s blocking within a few days of being inserted, even with no infection present.

Some people are more prone to this, and at the moment we don’t know why that is.

The drainage holes can become blocked with choroid plexus, a tissue in the ventricles that produces CSF.

The shunt can move slightly so the tip is no longer in the ventricle but in the brain tissue itself.

The valve can become blocked with protein or blood from haemorrhage, although this is rare.

**Distal**

The bottom end of a VP shunt can become blocked by the tissue covering the bowel, especially if there is a lot of scar tissue (adhesions) in the abdominal cavity, or infections or blood in the abdomen.

**Shunt revisions**

If it is necessary to change part or all of your shunt, your neurosurgeon will aim to achieve this with the smallest risk of complications possible. Shunts may, over time, become attached to surrounding tissues, and it can be difficult to remove without causing complications. However, if the shunt is infected, it will usually be necessary to remove the whole shunt so that the infection can be treated effectively.

If the shunt needs changing for another reason, it may be possible to leave a non-functioning shunt in place and just add another shunt system, in another part of the head. If the proximal catheter is blocked but the distal catheter is working, it may be possible to just change the blocked component. Shunts which are under-or-over draining may be ‘tied off’ when another shunt is inserted, to stop them working.