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TUBES/SHUNTS

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Implantation of a glaucoma drainage device (**GDD** - also known as a **tube** or **aqueous shunt**) works by diverting aqueous from the front of the eye via a tube to a drainage plate stitched onto the white of the eye, much further back than where a trabeculectomy trap door is stitched.

It is felt that less scarring occurs further back in the eye, so tubes may give better long-term success in eyes where trabeculectomies have already failed.

Tubes are a useful option when a trabeculectomy with mitomycin has failed and needling to resurrect the trabeculectomy has been unsuccessful. Tubes are usually considered as the first choice surgical procedures in eyes in which there are is a high risk of trabeculectomy failure or at increased risk of hypotony (low pressure complications) with trabeculectomy surgery. In these eyes tube surgery may be highly successful and safer than trabeculectomy surgery.

In whom should tube surgery be considered?

Examples where tubes may be considered as first choice procedures include:

- Corneal graft eyes
- Eyes which have undergone multiple retinal surgeries
- Aphakic eyes (no lens)
- Very large myopic eyes (which have an increased risk of hypotony)
- Certain types of inflammatory eye (uveitic) conditions
- Neovascular glaucoma
- Eyes with complex previous ocular surgery or secondary glaucomas

How Successful Is Tube Surgery?

Tube surgery has been reported to have similar long-term outcomes to trabeculectomy but generally speaking, one may expect to be still on a pressure-lowering drop (or two) to achieve a low target pressure. The larger the surface area of the drainage plate, the lower the long-term IOP-lowering.

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What Types of Tube Are Available?

Two different tube devices are in common usage in the UK:

Ahmed

The **Ahmed** GDD contains a form of valve, which acts as a 'flow restrictor' with the intention of preventing the pressure from going too low.

The advantage of the Ahmed is that one can achieve low target pressures quickly, so it is useful in conditions like neovascular glaucoma where the IOP can be very high and 'instant' IOP relief is important.

The disadvantage is that as the Ahmed has a small surface area drainage plate, the long-term target pressure may not be adequate without the use of additional IOP-lowering drops. This factor, however, may be useful in children and in people with uveitis where hypotony can be a major problem.

Baerveldt

The other type of tube in common usage is the **Baerveldt**, which is the preferred device at Moorfields. This differs from the Ahmed in that it does not have its own flow restrictor or valve and the plate has a larger surface area (there are 250 and 350 mm2 variants) meaning that lower target IOPs can be achieved.

The lack of a flow restrictor means that there is a risk of very low pressure in the early post-operative period. In order to prevent this, a number of surgical tweaks are required to create a flow restrictor.

A supramid, which is a kind of suture material, is inserted into the tube lumen to reduce the amount of flow within the tube. A ligating suture can additionally be place on the outside of the tube to further reduce the amount of flow.

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How Is The Surgery Performed?

The procedure may be undertaken as a local anaesthetic procedure, with or without the addition of intravenous sedation, or as a general anaesthetic. If a local anaesthetic is used, the surgery can be performed as a day case procedure. The surgery takes longer than cataract or trabeculectomy surgery so most patients either require local anaesthetic with sedation or general anaesthesia.

The first part of the surgery involves opening up the conjunctival membrane lining the outside of the eye. The area of the white of the eye (sclera) where the tube plate will be sutured can be treated with mitomycin C, although there is less evidence that this reduces the risk of failure due to scarring as compared to its usage with trabeculectomies.

The plate of the tube is sutured onto the white of the eye at about 10-12 mm behind the limbus, which is the junction between the cornea and the white of the eye. The most popular location for the tube is in the upper, outer quadrant of the eye but other quadrants may also be used. The Baerveldt has large 'wings' that need to be slipped under two of the muscles controlling eye movement. This usually does not cause any problems but occasionally this may lead to double vision (diplopia). The Ahmed is small enough to fit between the muscles without needing to go under them.

Once the plate is secured, the tube portion is cut to the appropriate length and an opening is made for the tube to enter the eye. The most common entry site is through the sclera into the anterior chamber but it is also possible to place the tube behind the iris (if the patient has undergone cataract surgery) or, more rarely, into the vitreous cavity.

For the Baerveldt, an assessment is made of the degree of aqueous flow at the plate. Various manipulations such as adjustment of the length of supramid suture within the lumen of the tube and addition of a tight ligation suture on the outside of the tube may be used to reduce the amount of flow. These manipulations will reduce the risk of very low pressure (hypotony) in the early post-operative period.

A piece of cadaveric donor tissue (usually sclera, but also cornea or pericardium) is usually stiched onto the patient's sclera over the tube entry site in order to prevent erosion. There are more details about donor patches in the section below about 'erosion'. The conjunctiva is then stitched back into its original place. It is becoming increasingly popular to use a form of biological fibrin glue to attach the donor patch and the conjunctiva at the end of the procedure, rather than using sutures. This may lead to increased comfort in the early post-operative period. The main reason for doing this is to increase the speed of the surgery as well as the speed of recovery. This glue is not suitable for eyes which have undergone many surgeries which may have caused extensive scarring of the conjunctiva.

What Does Post-Operative Care Involve?

Post-operative care of tubes is perhaps a little simpler than for trabeculectomy with little post-operative manipulation required, particularly for the Ahmed.

For the Baerveldt, the ligating suture (if present) can be lasered at the slit lamp to gently increase flow and improve IOP control. Over time, a 'capsule' develops around the drainage plate. This capsule acts as a natural resistor to flow, so once it has formed it will reduce the chances of getting very low pressures. Usually it takes about 12 weeks for the capsule to form. After this stage, it becomes safe to remove the supramid (which can be done at the slit lamp, or as an additional procedure in the operating theatre). This is intended to achieve the optimal IOP control but it may be that additional IOP-lowering medications are required to achieve a lower target IOP.

Patients will have to take a reducing course of topical steroid and a short course of topical antibiotic. For the Baerveldt, the IOP may be quite high whilst the supramid is in place. Often patients will need to take multiple IOP-lowering drops until the supramid has been removed. Invariably though, the IOP control is better on drops than prior to the surgery.

How Will My Eye Look When I Have A Tube?

In nearly all cases, the plate, the tube and the donor patch should be covered over by the upper lid. If this is the case, most people won't be able to tell that you have had a surgical procedure to the eye. Occasionally the upper lid may droop slightly or look swollen but this normally gets better.

It will be possible to see the donor patch (which may look 'whiter' than the rest of the eye if sclera or pericardium was used) if you hold up your upper lid and look down.

The tube itself will not be visible inside the eye, except using a slit lamp.

What Are The Possible Complications?

Failure

As with the trabeculectomy, tubes may fail because of scarring in the tissues. This may occur in about 20 - 30% of cases after 5 years. In these cases, it may be necessary to add IOP-lowering drops. Unfortunately, unlike trabeculectomy, needling to break down the scar tissue to improve IOP-control is less likely to give long-term success. In situations where IOP cannot be controlled with drops, it may be necessary to consider performing a cyclodiode treatment or indeed inserting a second tube in a different quadrant. It is relatively rare to need to resort to additional surgery or cyclodiode treatment.

Vision Loss

Sight threatening risks from infection or suprachoroidal haemorrhage are very rare and occur in about 1 in 1000 cases, as per trabeculectomy.

Low IOP/Hypotony

Complications of hypotony should be relatively rare with the Baerveldt with the use of a supramid and ligating sutures. It is, however, possible to get hypotony when a ligating suture is lasered or when the supramid is removed. Early hypotony is relatively common using the Ahmed, if the 'valve' happens to open at a lower IOP than intended. In most cases, the hypotony will resolve without serious complications. If the hypotony is causing visual problems, it may be necessary to inject gel inside the eye or to return to the operating theatre to reinsert a supramid or to add a ligating suture.

Erosion

There is about a 5% risk of tubes eroding onto the surface of the eye – this makes the tube an infection hazard and therefore requires urgent surgical revision.

In order to reduce the risk of erosion at the time of original surgery, a patch of donor material (usually human sclera but also cornea or bovine pericardium) is sutured over the area where the tube enters the eye. All donor material has been screened for blood borne infection so there is no risk of diseases such as HIV or hepatitis when using these patches. At the time of writing there is no known method for testing for prion disease such as variant CJD. The risk of transferring such a disease on a donor patch is vanishingly rare and we use these patches in children.

In practical terms, though, once you have had a donor patch implanted you cannot donate blood as the donor service likewise cannot test for prion disease.

If tube erosion occurs, the tube usually requires repatching with donor material, and perhaps the tube may need to be moved to a different position on the eye.

Diplopia – Double Vision

Another potential complication from using the Baerveldt is that it can cause diplopia (double vision).

This is because the wings of the drainage plate are inserted under the muscles that control eye movement.

Double vision is uncommon following Baerveldt implantation and it usually resolves over time. If it is troublesome, the double vision can be resolved using special prisms in the glasses, or in some cases using botox therapy.

Corneal Failure

Tube surgery is associated with an increased risk of corneal failure and these eyes may require corneal grafts. This is theoretically less likely to happen with tubes sited well away from the cornea and that are of shorter length within the eye. It does, however, remain a long-term concern and so occasionally tubes will need to be resited to positions within the eye where they are less likely to cause corneal failure.