Gamma Knife® stereotactic radiosurgery

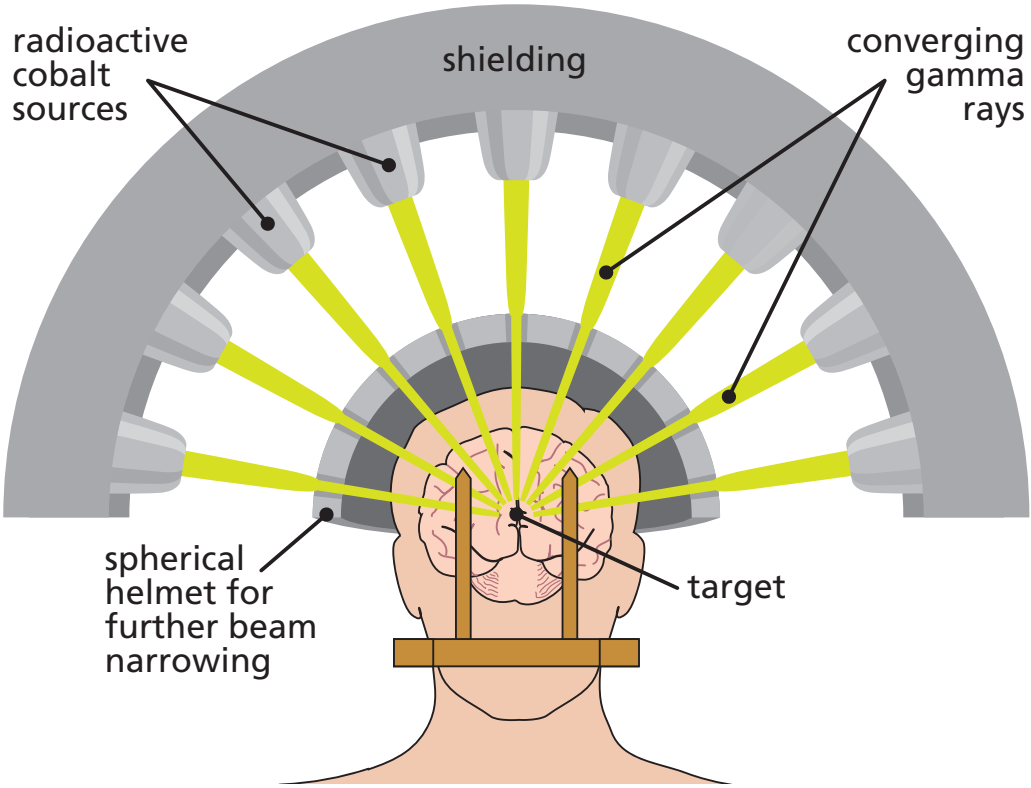
Information for families

Great Ormond Street Hospital for Children NHS Foundation Trust

This information sheet from Great Ormond Street Hospital (GOSH) explains about Gamma Knife® (also known as stereotactic radiosurgery), when it can be used and what to expect when your child comes to GOSH for assessment and treatment.

What is Gamma Knife® stereotactic radiosurgery?

Gamma Knife® stereotactic radiosurgery is not actually a type of surgery at all – instead of opening the skull to remove a tumour or lesion, it is treated through the skin and skull using gamma radiation beams. These beams are focused on the precise area of the tumour or lesion so that surrounding healthy brain tissue is less affected.



How does Gamma Knife® stereotactic radiosurgery work?

Gamma Knife® surgery was popularised in the 1980s in the United States (US) and was brought to the UK shortly afterwards. Two centres are currently commissioned by the NHS to treat children who need Gamma Knife®: GOSH and Sheffield. Gamma Knife® is used for adults more widely throughout the UK.

It uses cobalt as the source of the gamma radiation beams, arranged in a semi-circular container so that all the beams point towards the centre of the semi-circle. The beams can be individually moved by computer so that they meet and focus on the specific area of the brain where the tumour or lesion is located. These beams can travel through the skin, skull and brain tissue without causing damage so there is no need for traditional open surgery.

Although gamma radiation is radioactive, the risk of long-lasting toxic effects on your child is very low. This is because each beam individually is very weak. A special process called 'collimation' focuses many weak beams onto the lesion, giving a high dose to the planned target with minimal effect on surrounding healthy brain structures.

How do you know if it is suitable for my child?

Gamma Knife® stereotactic radiosurgery can be used for:

- **Tumours** – cancerous or non-cancerous (benign) – located in the brain tissue
- **Blood vessel lesions** in the brain, such as arteriovenous malformations (AVM) or cavernomas
- **Some forms of epilepsy** where the seizures start in a specific area of brain tissue

Gamma Knife® stereotactic radiosurgery tends to be suggested if a tumour or lesion is located within the brain near an area of brain tissue responsible for important functions, such as speech or movement. It may also be preferable to traditional open brain surgery if the tumour or lesion is deep inside the brain where reaching it could involve large risks. It may also be suitable for children who are too sick for open surgery to be safe.

What happens before the procedure?

Preparing for the procedure

There are various stages during your child's Gamma Knife® stereotactic radiosurgery treatment – briefly, these are:

- **Fitting the headframe** – Your child will need to wear a headframe for the procedure, which is attached through the skin to the outer layer of skull using fine pins. This is attached after your child is under general anaesthetic so they do not feel any pain.
- **Complex imaging** – This is carried out while your child has the headframe in place and is used to precisely target the area of tissue to be treated. This usually involves a MRI scan, plus an angiogram for vascular lesions such as AVMs.
- **Planning** – The team will use the results of the imaging to programme the gamma beams and work out what dose of radiation is needed.

The surgeon will explain each of these stages to you before you decide whether or not to give permission for your child to have the procedure.

Pre-admission clinic

Preparing for a planned operation, test or procedure before coming in to hospital avoids delays and reduces the risk of cancellation. The results of any tests and investigations are available in plenty of time and can also be re-checked if they are not within the normal range. Your child may need various blood tests before the operation – this depends on your child's medical condition and the nature of the procedure that is planned.

The doctors and/or nurses will meet you and your child to take down their medical history and any other information needed before your child is admitted to hospital. The nurses will explain about any care your child will need before and after the procedure. If your child has any medical problems, particularly allergies, please tell the doctors about these. Please also bring in any medicines your child is currently taking.

You will be seen by one of the team carrying out your child's procedure and be asked to give permission by signing a consent form. If you give your consent at the pre-admission appointment, you will need to confirm that you still agree to the procedure on the day of admission. Radiographers will go through a checklist to ensure the MRI scan will be safe.

One of the team will explain about the types of anaesthesia that are used at the hospital, and also about options for pain relief after the operation, test or procedure. An anaesthetist may come to see your child in the pre-admission clinic if there any questions or concerns about anaesthesia. Most Gamma Knife® procedures in children are carried out under general anaesthetic, but local anaesthetic may be considered for older children following appropriate discussion.

The night before the procedure

You will be asked to give your child a bath or shower and hairwash before surgery. It is important that your child does not eat or drink anything for a few hours before the operation. This is called 'fasting' or 'nil by mouth'. Fasting reduces the risk of stomach contents entering the lungs during and after the procedure.

The pre-admission team will tell you the time after which your child should be 'nil by mouth' – in other words, have nothing to eat or drink before the anaesthetic. In broad terms, this is six hours for food (including milk), four hours for breast feeding and two hours for clear fluids before the procedure.

It is equally important to keep giving your child food and drink until those times to ensure they remain well-hydrated and get adequate nutrition. This may involve waking your child in the night to give them a drink which we recommend.

On the day of the procedure

Please come to Woodpecker at the time stated in your admission letter. One of the nurses will check that your child is well enough for the procedure, complete some paperwork with you and take some baseline observations.

As Gamma Knife® Stereotactic Radiosurgery involves the use of radiation, we are obliged to ask any girls over the age of 12 whether there is any chance they might be pregnant. This is to protect babies in the womb from receiving unnecessary radiation.

If you did not give your consent for the operation at the pre-admission appointment, a member of the surgical team will visit you to explain about the procedure and ask you to sign a consent form. All children are seen by the anaesthetist on the day of the procedure.

What does the procedure involve?

Fitting the headframe

The headframe is used as part of the planning and delivery of the Gamma Knife® stereotactic radiosurgery. It is attached by pins through the skin and outer layer of skull so it does not move during the procedure. We will not need to clip any of your child's hair to fit the frame. As the procedure is performed under general anaesthesia, your child will not feel anything or be aware of what is happening.

Imaging scans

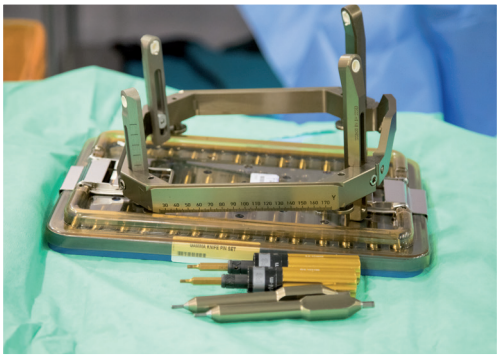
Once the headframe is in place, your child will have more imaging scans so that the location of the tumour or lesion is plotted in relation to the measurements on the headframe. This will usually be a MRI scan but an angiogram may be needed to look at blood vessel lesions in the brain.

Planning the treatment

Straight after the imaging scans, the team will review the results and use them to plan the precise area for treatment and the most suitable dose of gamma beams for your child. Your child will remain under general anaesthetic until the plan is finalised.

Having treatment

When the team have finished their planning, your child will then be transferred onto the Gamma Knife® machine. The headframe will lock into position with a click so that your child's head remains still during the procedure.

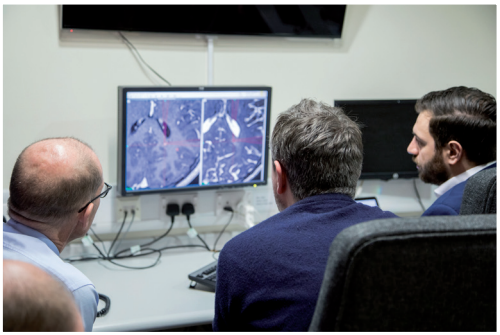


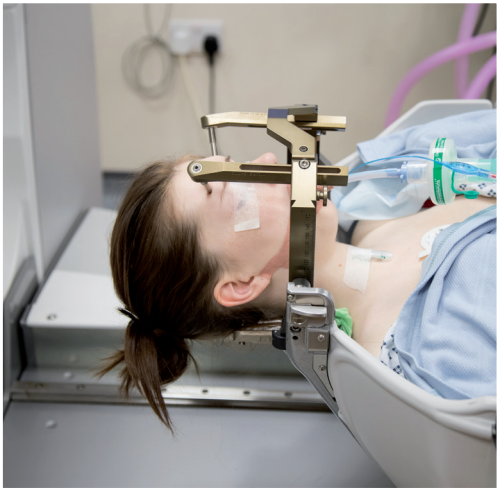
The radiographer and anaesthetists will then leave your child and go into the next room, where they will be able to see your child on closed-circuit television and monitor them throughout using a connected medical monitor. They will move the bed into the Gamma Knife® machine and the procedure will start.

Unlike an MRI scan, the Gamma Knife® machine does not make any noise. The machine itself does not move and nothing will touch your child during the procedure. The length of the treatment itself varies based on the size and shape of the lesion and cannot be accurately predicted before planning. Most treatments take at least 30 minutes and may be much longer (around two to three hours) for complex lesions. The majority of lesions can be treated in a single session, but large lesions may require 'staged' treatment. In these cases, your child will be discharged and re-admitted (usually a few weeks or months later) for the second stage.

Removing the headframe

Your child will only need the headframe during the treatment session so it will be removed as soon as treatment is finished while they are still under general anaesthesia. The pins will be removed gently and the forehead pin sites are covered with small dressings that look like small sticking plasters. Afterwards, your child will go back to the ward to recover and will be discharged from hospital the following morning.





Are there any risks?

The risks associated with Gamma Knife® stereotactic radiosurgery will vary depending on the location of the tumour or lesion and its size.

Gamma Knife® stereotactic radiosurgery does not break the skin or need access through the skull so there is no risk of bleeding as with traditional open surgery. There is a small chance that the pin sites could become infected but normal daily hygiene is usually enough to prevent this – we may give you some antibiotic ointment just in case.

Although Gamma Knife® stereotactic radiosurgery targets a very precise area of brain tissue, surrounding cells can be affected too, which may lead to swelling of the brain afterwards. This is not usually severe enough to need treatment other than a few doses of corticosteroid medicines, given either intravenously or by mouth.

Nearby structures such as nerves can also be affected for a short while, leading to numbness or ear problems. The brain tissue can also react to the procedure causing seizures – this is not a sign of epilepsy. Your child may feel tired and a bit sick after the procedure too – this is also a normal reaction.

As the gamma beams pass through the skin there is a small chance that this patch of skin may lose hair but this usually affects only a very small area and is temporary. If the target area is close to the skull surface, there is a higher risk of temporary hair loss.

Sometimes the treatment is not successful and may need to be repeated. The chance of success varies dependent on the type, size and location of the lesion and will be discussed with you by the team prior to treatment. Long-term side effects are rare but possible and again depend on the individual case. Even though Gamma Knife® uses radiation there is no evidence that it causes tumours later on in life.

Are there any alternatives to the procedure?

The team will discuss which alternatives are suitable for your child and whether they are available at GOSH or elsewhere in the UK. Not every alternative will be suitable or available.

One alternative to Gamma Knife® stereotactic radiosurgery is CyberKnife® radiosurgery. This uses x-rays instead of gamma beams, which are delivered by a robotic machine that moves around the head to deliver the beams. Another is proton beam therapy. This uses a beam of particles to affect the tumour or lesion rather than radioactivity. Both of these are available in the UK and your team will refer you to another hospital if they think that CyberKnife® or proton beam therapy will be a better option for your child.

In many circumstances, traditional open surgery may be suggested for removing a tumour or lesion but this is dependent on where in the brain it is located. The surgeon will have to cut through the skin and skull to access the brain tissue, which carries a risk of bleeding and infection. Surgery may be combined with radiotherapy and chemotherapy before and after surgery to shrink the tumour further.

What happens after the procedure?

Once your child has started to recover from the anaesthetic, they will be brought back to Koala Ward to continue recovering. At the end of the day, the doctors will visit you to talk about the procedure. Your child will need to stay on Koala Ward overnight just to check that they are not feeling sick or do not have a headache – if these symptoms develop, the nurses will give medicines to improve them. Your child will be able to go home later that day or the following morning.

Going home

For the first few days after treatment, your child may have a mild headache – this is not a worrying sign, more a sign that the treatment is working. The pin sites may feel a bit sore for a day of two but regular pain relief such as paracetamol or ibuprofen should help. Most children are well enough to return to nursery or school two or three days after coming home.

You should check the pin sites every day for signs of oozing which may suggest that your child has an infection. The day after going home your child can have a hair wash and shower or bath but should not scrub the pin sites until they have healed completely.

You should call the ward if your child:

- Develops a headache that does not get better with pain relief
- Bleeding or oozing from the pin sites
- Develops weakness or vision problems that are worse than before treatment
- Has a seizure if they have not previously had one

If you are concerned about your child, you should take them to your nearest Accident and Emergency (A&E) department.

Follow up appointments

We will arrange a follow up appointment around eight weeks after the procedure. This is a clinical check-up to make sure your child has recovered fully from the treatment. Scans will be arranged – the timing of which will depend on the type of lesion which has been treated.

What is the outlook for children who have had Gamma Knife® stereotactic radiosurgery?

Research carried out at other centres shows that Gamma Knife® stereotactic radiosurgery is safe and effective for many types of tumours and lesions in children.

The aim of Gamma Knife® stereotactic radiosurgery is to target treatment only at the abnormal brain tissue rather than affecting larger amount of surrounding tissue. This reduces the risk of side effects from traditional open surgery, such as learning difficulties, vision problems and damage to the brain. The gamma beams stop the cells or vessels within this abnormal tissue growing so that they start to shrink, which in turn reduces the symptoms that the tumour or lesion is causing.

Children who have had Gamma Knife® stereotactic radiosurgery will need similar follow up to those who have had traditional open surgery, having regular appointments and imaging scan throughout childhood and adolescence. If the tumour or lesion comes back, Gamma Knife® stereotactic radiosurgery can be repeated safely.

Further information and support

Contact our Neurologist Clinical Nurse Specialists on 020 7405 9200 extension 0569

There are lots of support organisations for anyone affected by brain tumours and diseases, the main ones in the UK are:

- **The Brain and Spine Foundation**
  – call their helpline on 0808 808 1000 or visit their website at www.brainandspine.org.uk
- **Macmillan Cancer Support**
  – call their helpline on 0808 808 0000 or visit their website at www.macmillan.org.uk
- **The Brain Tumour Charity**
  – call their information line on 0808 800 0004 or visit their website at www.thebraintumourcharity.org

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