PROCEDURE

Stereotactic radiosurgery - gamma knife

Gamma Knife radiosurgery uses focused radiation beams to treat selected conditions in the brain and head without an incision.

PURPOSE
Treat selected brain conditions with precisely focused radiation

PROCEDURE TYPE
Therapeutic, minimally invasive focused radiation treatment

WHERE IT IS DONE
Outpatient hospital radiosurgery unit

ANAESTHESIA
Local anaesthesia for frame pins; sedation sometimes used

HOW LONG IT TAKES
About 15 minutes to several hours

PREPARATION
Medication review; fasting only if your facility instructs

RECOVERY
Usually same day; no driving after sedation

MAIN RISKS
Brain swelling, radiation injury, neurological changes, treatment failure

RESULTS
Assessed over weeks to years with symptoms and imaging

Overview

Gamma Knife radiosurgery is a form of stereotactic radiosurgery, often shortened to SRS. Despite its name, it does not use a knife and usually does not involve an incision.

The machine directs many small beams of radiation toward one precise area in the brain or head. Each beam has a limited effect on the tissue it passes through. Where the beams meet, they deliver a stronger treatment dose.

A rigid head frame or closely fitted mask keeps your head still. MRI, CT, or blood-vessel imaging is used to identify the treatment area and protect nearby healthy tissue.

Treatment is often completed in one session. Some conditions are treated over several sessions, called fractionated stereotactic radiotherapy.

Why the procedure is performed

Gamma Knife treatment may be offered when a condition can be targeted accurately on brain imaging. Its aim may be to stop growth, shrink abnormal tissue, close abnormal blood vessels, or interrupt pain signals.

It may be used for:

Gamma Knife may reach areas that would be difficult to operate on. It can also be considered when open surgery would carry greater risk or when a small area remains after surgery.

The intended result is not always to remove a lesion. For many tumours, success means stopping further growth. For an AVM, the goal is gradual closure of the abnormal blood vessels.

- Cancer that has spread to the brain
- Selected primary brain tumours
- Non-cancerous tumours, such as meningiomas or vestibular schwannomas
- Arteriovenous malformations, or AVMs, which are abnormal connections between arteries and veins
- Trigeminal neuralgia, a condition causing severe facial pain
- Selected movement disorders or other functional brain conditions

Who should and should not have it

Gamma Knife is most useful for targets that can be clearly seen and treated without exposing too much healthy brain tissue. The number, size, shape, and location of the targets all affect whether it is suitable.

It may be considered if you cannot safely have open surgery, if surgery could damage an important part of the brain, or if you prefer a non-incision treatment after discussing the trade-offs.

It may not be the right choice when a large mass is causing pressure that needs rapid relief. Surgery may then provide faster decompression and may also provide tissue for diagnosis.

Treatment may be avoided or delayed if the diagnosis is uncertain and a biopsy is needed, if the target is too large or poorly defined, or if previous radiation means nearby tissue cannot safely receive more.

Pregnancy requires individual review because radiation exposure should be avoided when possible. Problems that make imaging, lying still, frame placement, or sedation unsafe may also

need to be addressed first.

Gamma Knife does not guarantee that a tumour will shrink, an AVM will close, or pain will stop. Your team should explain the treatment goal and the chance that another treatment may be needed.

How to prepare

Your treating facility's own instructions take priority because preparation differs by equipment, imaging needs, and whether sedation is planned.

Give the team a current list of medicines and supplements. Tell them if you take a blood thinner like warfarin or apixaban , have a bleeding disorder, have kidney problems, could be pregnant, or have allergies to medicines or imaging contrast. Do not stop a prescribed medicine unless your treating team tells you to.

You may be told not to eat or drink for a set period, especially if sedation is planned. If fasting is not required, you may be allowed a light meal.

Ask whether you should wash your hair and avoid hair products on the day. Do not wear jewellery, makeup, or removable metal items if instructed.

Arrange for someone to take you home if you will receive sedation or if the facility requires an escort. Plan to spend longer at the centre than the radiation delivery time because fitting, imaging, and treatment planning can take several hours.

What happens during the procedure

An intravenous line may be placed for medicines or imaging contrast. You may receive a sedative to help you relax, but many people remain awake.

For frame-based treatment, local anaesthetic numbs four small areas of your scalp. A lightweight metal frame is then secured with pins. You may feel pressure during fitting, but the frame should prevent head movement rather than cause ongoing sharp pain.

Some Gamma Knife systems use a fitted mask instead. Mask-based treatment may be given in one or several sessions.

You will have detailed imaging while wearing the frame or mask. A specialist team uses these images to map the target, calculate the radiation dose, and limit exposure to nearby structures. Planning can take longer than the treatment itself.

During treatment, you lie on a couch that moves into the machine. The beams cannot be seen

or felt. You can communicate with the team through an intercom, and they monitor you from outside the room.

Radiation delivery may last from about 15 minutes to several hours. The frame is removed afterward, and small dressings may be placed over the pin sites.

Recovery and what to expect afterward

Pain: You may have a mild headache or tenderness where the frame pins were placed. Follow the facility's advice about pain relief and pin-site care. Tell the team if pain is severe or worsening.

Eating: Most people can eat and drink after treatment. Nausea can occur, particularly after a long session or sedation, so starting with light food may be more comfortable.

Activity: Plan a quiet day after leaving the centre. Follow any limits given for exercise, hair washing, or caring for the pin sites. Fatigue may last for several days.

Driving: Do not drive after sedation. Some centres advise everyone to avoid driving on the treatment day, so arrange transport and follow your discharge instructions.

Work: Many people return to desk-based work within a day or a few days. You may need longer if you have fatigue, neurological symptoms, or a physically demanding job.

Risks and possible complications

Short-term effects can include headache, nausea, fatigue, scalp tenderness, minor pin-site bleeding, or temporary swelling around the treated area. Localised hair loss can occur where radiation reaches the scalp.

Brain swelling may cause or worsen headaches, weakness, balance problems, speech changes, seizures, or other symptoms related to the treated location. Medicines such as corticosteroids like prednisone or hydrocortisone may be prescribed when swelling is expected or develops.

Delayed radiation injury can damage tissue near the target. This is sometimes called radiation necrosis. It may appear months or years later and can resemble tumour growth on a scan. Further imaging, medicine, or occasionally surgery may be needed.

Other risks depend on the exact area treated. These can include hearing changes, facial numbness, hormone problems, vision changes, or other nerve effects.

The target may continue to grow, fail to close, or return after an initial response. Additional radiosurgery, conventional radiation, surgery, or another treatment may then be considered.

For an AVM, the risk of bleeding does not disappear immediately. It remains until imaging confirms that the abnormal vessels have closed.

Results and follow up

The treatment plan is known on the day, but the biological effect develops gradually. Gamma Knife does not produce a pathology result because no tissue is removed.

Cancerous tumours may respond over weeks or months. Non-cancerous tumours may shrink slowly or simply stop growing. An AVM can take several years to close. Facial pain may improve within days or weeks, although relief can take longer and pain may return.

Follow-up usually includes a review of your symptoms and repeat MRI or other imaging. The timing is based on the condition treated, its location, and your earlier results.

Keep routine appointments even if you feel well. Imaging may identify treatment effects or renewed growth before they cause noticeable symptoms.

Alternatives

Open surgery may remove a mass quickly, relieve pressure, and provide tissue for diagnosis. It involves an incision, anaesthesia, and usually a longer recovery, and some locations are difficult to reach safely.

Conventional radiotherapy treats the area in smaller doses over more sessions. It may be better for larger or less sharply defined areas, but it exposes more surrounding tissue to radiation and requires repeated visits.

Other stereotactic systems, including linear accelerator or robotic systems, can deliver similar focused radiation. They may use a mask rather than a fixed frame and may offer treatment over several sessions.

Observation with regular scans avoids immediate treatment. It may be reasonable for a small, slow-growing, or symptom-free finding, but the condition could grow or become harder to treat.

Medicines can control symptoms such as facial pain, seizures, or swelling but may not treat the underlying target. Chemotherapy, targeted therapy, or immunotherapy may be options for certain cancers.

For an AVM, alternatives include surgery or embolisation, in which a specialist blocks abnormal blood vessels from inside the circulation. These may work more quickly but have different

risks, and embolisation may not close the entire AVM.

When to call your healthcare team

Seek emergency help for a seizure, sudden severe headache, fainting, new one-sided weakness, facial drooping, difficulty speaking, sudden loss of vision, or trouble breathing.

Contact your healthcare team urgently for worsening headaches, repeated vomiting, new confusion, increasing drowsiness, new balance problems, or a change in your usual neurological symptoms.

Call the treatment centre about persistent bleeding, spreading redness, swelling, pus, or fever after frame placement.

Mild fatigue, a manageable headache, and tenderness at pin sites can often be discussed during routine follow-up. Contact the team sooner if these effects are getting worse rather than improving.

Common questions

Will I be asleep?

Usually not. Most people are awake, with local anaesthetic used for frame placement. A sedative may help you relax. General anaesthesia is sometimes used when a person cannot remain still.

Can I drive home?

Do not drive if you received sedation. Some facilities do not allow anyone to drive on the treatment day, so plan for someone else to take you home.

How painful is it?

The radiation itself cannot be felt. Frame placement can cause pressure and brief discomfort despite local anaesthetic. A mild headache or sore pin sites may occur afterward.

When will I know if it worked?

There is usually no immediate result. Your team assesses your symptoms and follow-up scans over weeks, months, or sometimes years.

Will I be radioactive afterward?

No. Gamma Knife radiation does not remain in your body, so you are not radioactive after treatment.

Will my hair fall out?

Most people do not lose all their hair. Small temporary patches of hair loss can occur where radiation reaches the scalp.

Sources

- Mayo Clinic. "Gamma Knife surgery." Patient information covering preparation, treatment, risks, and recovery.
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- Johns Hopkins Medicine. "Gamma Knife Radiosurgery." Patient information on treatment planning, delivery, risks, and follow-up.