PROCEDURE

# Stereotactic radiosurgery - cyberknife

CyberKnife delivers highly focused radiation to a tumour or abnormal tissue without an incision.

**PURPOSE**
Destroy or control precisely targeted abnormal tissue

**PROCEDURE TYPE**
Therapeutic, non-invasive robotic radiation treatment

**WHERE IT IS DONE**
Outpatient specialist radiotherapy centre

**ANAESTHESIA**
None for most treatments

**HOW LONG IT TAKES**
30 to 120 minutes per session

**PREPARATION**
Planning scans; fasting or medication changes only if instructed

**RECOVERY**
Same day; no driving after sedation

**MAIN RISKS**
Fatigue, swelling, radiation injury, nearby organ damage

**RESULTS**
Assessed over weeks to months with follow-up imaging

## Overview

CyberKnife is a brand of stereotactic radiation treatment. Despite the word "surgery," it does not usually involve an incision or surgical instruments.

The system uses a compact radiation machine attached to a robotic arm. It sends many small radiation beams toward a carefully mapped target. Each beam has a limited effect on the tissue it passes through, but the beams meet at the target to deliver a strong treatment dose.

X-ray imaging checks your position during treatment. The system can adjust for small movements and, for some body tumours, movement caused by breathing.

Treatment to the brain or spine may be called stereotactic radiosurgery, or SRS. Similar treatment elsewhere in the body is often called stereotactic body radiotherapy, or SBRT.

Treatment may be given in one session or divided into several sessions, called fractions.

## Why the procedure is performed

CyberKnife may be used to destroy abnormal cells, slow their growth or stop a treated area from getting larger. In some cases, the aim is long-term control. In others, it is used to relieve or prevent symptoms.

It may be considered for:

Whether it is suitable depends on the target's size, number, shape and location. Your general health, previous treatments and the condition being treated also matter.

- Brain metastases, which are cancers that have spread to the brain
- Some primary brain tumours
- Certain non-cancerous brain tumours, such as meningiomas
- Arteriovenous malformations, or abnormal tangles of blood vessels
- Trigeminal neuralgia, a condition causing severe facial nerve pain
- Selected tumours in the lung, liver, pancreas, prostate, kidney or spine
- A small number of cancer deposits elsewhere in the body
- Tumours that remain or return after other treatment

## Who should and should not have it

CyberKnife can be useful when a target is small and clearly visible on imaging. It may be offered when open surgery would be difficult, when you are not well enough for an operation, or when focused radiation offers a reasonable chance of controlling the treated area.

It is not automatically the best option for every tumour. Treatment may be avoided or delayed when:

Some implanted medical devices, including pacemakers, need special assessment and monitoring. They do not always prevent treatment.

If you need a marker implanted to track the target, your team will also consider whether that separate procedure is safe for you.

- The target is too large or too close to a sensitive structure

- Disease is too widespread for focused treatment to be useful
- Swelling is already causing pressure that needs urgent surgery
- The area has received radiation before and another dose would be unsafe
- You cannot remain in the required position, even with support or sedation
- Imaging cannot define or track the target accurately
- Pregnancy could expose a developing baby to radiation
- An infection or another medical problem needs treatment first

## How to prepare

Your treating facility's own instructions take priority because preparation differs by treatment site and equipment.

Before treatment, you will usually have a planning appointment. This may include a CT scan, MRI scan or both. Contrast dye may be used to make certain tissues easier to see.

A custom mask may be made for treatment involving the head or neck. It fits closely over your face and attaches to the treatment table. It should not stop you from breathing. For body treatment, a shaped cushion or cradle may help you remain in the same position.

Some tumours require small metal markers, called fiducials, to be placed in or near the target beforehand. Their placement is a separate procedure and may involve a needle, endoscope or minor operation.

Tell the treatment team about:

Do not stop blood thinners or other prescribed medicines unless your team gives specific instructions. Fasting is not normally needed for the radiation itself, but it may be required if you will receive sedation, contrast or a separate procedure.

- Pregnancy or the possibility of pregnancy
- Pacemakers, pumps or other implanted devices
- Allergies, especially to contrast dye
- Claustrophobia or difficulty lying still
- All medicines and supplements you take

## What happens during the procedure

You will change clothing if needed and remove items that could affect imaging. The radiographers will help you lie in the planned position. Your mask or body support will be fitted, and the team will check your alignment.

The staff then leave the room, but they can see and hear you throughout treatment. You can speak to them through an intercom.

The robotic arm moves around you without touching you. It delivers radiation from many angles while imaging systems check the target's position. You may hear the machine moving or clicking, but you will not see or feel the radiation.

You must remain as still as you reasonably can. If you are uncomfortable or need help, tell the team. Treatment can usually be paused.

A session commonly lasts between 30 minutes and two hours. You may need one session or several sessions given over a number of days.

## Recovery and what to expect afterward

Pain: The radiation itself does not cause immediate pain. You may have stiffness or soreness from lying still. A close-fitting mask can leave temporary pressure marks. If fiducial markers were inserted, that area may be tender.

Eating: Most people can eat and drink normally afterward. Follow different instructions if your treatment involved sedation or an area that affects swallowing or digestion.

Activity: Many people return to light activity the same day. Fatigue can develop over the following days. Your team may limit certain activities because of the treated condition, not because the radiation remains in your body.

Driving: Do not drive if you received a sedative. You may also have driving restrictions because of seizures, neurological symptoms or the location of a brain lesion. Follow the advice given by your team and local licensing rules.

Work: Some people return to work the next day. Others need time off because of tiredness, headache, nausea or the effects of treatment near a sensitive organ. Recovery may take longer when CyberKnife is combined with surgery, chemotherapy or other treatment.

You are not radioactive after CyberKnife treatment. It is safe to be around other people, including children and pregnant people.

## Risks and possible complications

Side effects depend mainly on the area treated, the radiation dose and nearby healthy tissue.

Short-term effects may include tiredness, headache, nausea, mild skin irritation or temporary swelling around the target. Steroid medicine is sometimes prescribed to control swelling, particularly after brain treatment.

Site-specific effects can include coughing after lung treatment, bowel or bladder changes after pelvic treatment, or swallowing discomfort after treatment near the throat or chest.

Delayed radiation injury can develop months or years later. Possible effects include:

The treatment team should explain the risks that apply to your target and how they compare with the expected benefit.

- Damage to nearby nerves, brain tissue or other organs
- Radiation necrosis, meaning injured tissue at the treated site
- Bone weakening or fracture after treatment near a bone
- Bleeding or swelling around the treated area
- A small long-term risk of a new cancer caused by radiation

## Results and follow up

CyberKnife does not usually produce an immediate visible result. Cancer cells may stop dividing or die gradually. Non-cancerous tumours may shrink slowly or simply stop growing. Treated blood vessel abnormalities can take longer to close.

You will usually have follow-up imaging, such as CT or MRI scans, over the following weeks and months. These scans look for changes in the target and nearby tissue.

Early swelling can sometimes make an area appear larger even when treatment is working. For this reason, one scan may not provide a final answer.

Keep routine follow-up appointments even if you feel well. Your team will review symptoms, scan findings and whether you need further treatment.

## Alternatives

The alternatives depend on what is being treated and the goal of care.

Open surgery can remove tissue immediately and provide a sample for laboratory testing. It is more invasive, requires anaesthesia and usually has a longer recovery.

Conventional radiotherapy treats a larger area using smaller doses over more sessions. It may be better for widespread or less clearly defined disease, but it exposes more nearby tissue to low-dose radiation.

Another stereotactic radiation system , such as Gamma Knife or a standard linear accelerator, may offer similar focused treatment. The best system is usually the one that can safely deliver the required plan; CyberKnife is not proven to be best for every condition.

Thermal ablation , such as radiofrequency, microwave or cryoablation, destroys tissue using heat or cold. It requires a probe to be inserted and is suitable only for certain locations.

Medicines , including chemotherapy, targeted therapy or immunotherapy, can treat disease throughout the body. They may not control a single target as directly and can cause whole-body side effects.

Active monitoring avoids immediate treatment and its side effects. It may be reasonable for a slow-growing or symptom-free abnormality, but there is a risk that it will grow or become harder to treat.

Supportive or palliative care focuses on comfort and quality of life rather than controlling the target. It may be chosen alone or alongside other treatment.

## When to call your healthcare team

Contact your treatment team promptly for worsening headache, repeated vomiting, increasing confusion, new balance problems, fever, severe uncontrolled pain or redness and drainage from a fiducial insertion site.

Seek emergency help for:

Mild tiredness, temporary soreness or a mild headache can usually be discussed during routine follow-up. Contact the team sooner if these symptoms are persistent, worsening or difficult to manage.

- A new seizure or a seizure lasting longer than instructed
- Sudden weakness, facial drooping or difficulty speaking
- Loss of consciousness or severe confusion
- New severe breathing difficulty
- Sudden loss of bladder or bowel control with leg weakness

## Common questions

Will I be asleep?

Most people are awake. The treatment is painless, and general anaesthesia is not normally needed. Sedation may be considered if you cannot tolerate the mask or remain still.

Can I drive home?

You may be able to drive if you received no sedation and have no condition-related restriction. Do not drive after sedation. Check the plan with your treatment team before the appointment.

How painful is it?

You cannot feel the radiation. The main discomfort is usually from remaining still or wearing a close-fitting mask. Tell the radiographers if you need the session paused.

When will I know whether it worked?

The treatment team knows when the planned radiation has been delivered, but its effect takes time. Follow-up scans over weeks or months show whether the target is stable, shrinking or changing.

How many treatments will I need?

Some targets are treated once. Others need several sessions to protect nearby healthy tissue. Your plan is based on the target's size, location and radiation tolerance.

Will I be radioactive afterward?

No. CyberKnife uses external radiation and leaves no radioactive material in your body.

## Sources

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