PROCEDURE

Proton therapy

Proton therapy uses targeted radiation to treat cancer while reducing exposure to nearby healthy tissue.

PURPOSE
Treat cancer while limiting radiation to nearby healthy tissue

PROCEDURE TYPE
Therapeutic - non-invasive external-beam radiation

WHERE IT IS DONE
Outpatient proton therapy centre treatment room

ANAESTHESIA
None for most sessions; sometimes needed to remain still

HOW LONG IT TAKES
15 to 45 minutes per treatment session

PREPARATION
Planning scans, positioning supports, medication and pregnancy review

RECOVERY
Same day; driving usually allowed without sedating medicine

MAIN RISKS
Fatigue, skin changes, site-specific injury, later second cancer

RESULTS
Tumour response assessed over weeks to months with follow-up imaging

Overview

Proton therapy is a type of radiation treatment. It uses beams of protons, which are positively charged particles, to damage cancer cells and stop them from growing.

Standard radiation therapy usually uses high-energy X-rays, also called photons. X-rays release radiation as they enter and leave the body. Protons can be planned to release most of their energy inside the tumour and then stop. This may reduce the radiation reaching healthy tissue beyond the tumour.

This physical advantage does not mean proton therapy is always more effective than standard radiation. For many cancers, both treatments provide similar tumour control. The possible benefit of protons is often a lower dose to nearby organs.

Treatment is painless while the beam is on. You are not radioactive afterward, so it is safe to be around other people.

Why the procedure is performed

Proton therapy may be used to cure a cancer, control its growth, reduce the chance of it returning, or ease symptoms from an advanced cancer. It may be used alone or with surgery, chemotherapy, immunotherapy, or other treatments.

It is most often considered when a tumour is close to an organ that is sensitive to radiation. Examples include the brain, spinal cord, eyes, heart, lungs, or important structures in the head and neck.

It may also be considered for:

The decision is based on the type, size, and location of the cancer, whether it has spread, previous treatment, and a comparison of proton and photon radiation plans.

- Children and young people, whose developing tissues are sensitive to radiation
- Tumours at the base of the skull or along the spine
- Selected brain, eye, head and neck, chest, abdominal, pelvic, or prostate cancers
- An area that has already received radiation

Who should and should not have it

You may be offered proton therapy when your radiation team expects it to protect healthy tissue better than other treatments without reducing the dose to the cancer.

It is not automatically the best choice because it is newer or more technically complex. It may not offer a meaningful advantage if standard radiation can treat the tumour safely. Proton therapy also requires specialist equipment and may involve travel or a long stay near a treatment centre.

Treatment may be avoided, changed, or delayed if:

Pregnancy does not always rule out radiation, but it requires an individual risk assessment. Previous radiation also does not automatically rule out proton therapy. Your team must review the earlier dose and the health of nearby tissues.

- Safe positioning is not possible, even with support or anaesthesia

- Tumour movement or changes in body shape make the proton dose unreliable
- Another treatment is more likely to control the cancer
- The delay needed to arrange proton therapy could affect the outcome
- You are pregnant and radiation could expose the pregnancy

How to prepare

Your treating facility's own instructions take priority because equipment and treatment plans differ between centres.

Before treatment, you will have a planning appointment called a simulation. This usually includes a CT scan in the exact position used for treatment. MRI or PET images may also be combined with the CT images to show the tumour more clearly.

A custom mask, cradle, cushion, or body mould may be made to help you remain in the same position. Small skin marks or permanent pinpoint tattoos may be used for alignment.

Tell the team about:

Fasting is usually unnecessary for proton therapy itself. You may need to stop eating and drinking if you will receive sedation or general anaesthesia. Do not stop prescribed medicines, including blood thinners like warfarin or apixaban , unless your treating team gives you specific instructions.

- All medicines, supplements, allergies, and implanted medical devices
- Previous radiation treatment
- Any chance that you could be pregnant
- Claustrophobia, pain, or difficulty lying still

What happens during the procedure

At each appointment, radiation therapists position you on the treatment table using your mask, mould, or other supports. Imaging is taken to confirm that your body and the treatment area are aligned correctly.

The therapists then leave the room, but they can see, hear, and speak with you throughout treatment. The machine may rotate around you or move into position. It does not touch you.

The proton beam is shaped and directed according to your individual plan. Some systems use

pencil-beam scanning, which moves a narrow beam across the tumour layer by layer.

You will not see or feel the radiation. You may hear the equipment moving. Most of the appointment is spent checking your position; the beam may be on for only a few minutes.

Proton therapy is often divided into separate treatments called fractions. Some plans use a few larger fractions, while others use many smaller fractions over several weeks.

Recovery and what to expect afterward

Pain: The treatment itself should not hurt. Soreness can develop later in the treated area, depending on which tissues receive radiation.

Eating: Most people can eat normally after a session. Treatment involving the mouth, throat, chest, abdomen, or pelvis may cause swallowing problems, nausea, bowel changes, or reduced appetite. A dietitian can help if eating becomes difficult.

Activity: You can usually return to normal activity after each treatment. Fatigue may build during the course, so you may need more rest or lighter exercise.

Driving: You can usually drive after treatment if you did not receive sedating medicine and feel well enough. If you had sedation or general anaesthesia, follow the centre's driving restrictions and arrange for someone to take you home.

Work: Some people continue working throughout treatment. Others reduce their hours or take leave because of fatigue, travel, or side effects. Effects may continue for several weeks after the final session before improving.

Risks and possible complications

Proton therapy can affect healthy cells within or close to the treatment area. Side effects depend mainly on the body part treated, the total radiation dose, other treatments, and your general health.

Common short-term effects include fatigue, temporary hair loss in the treated area, and skin that becomes dry, itchy, tender, or darker. Treatment near specific organs can cause other effects, such as mouth soreness, swallowing difficulty, nausea, diarrhoea, bladder irritation, headache, or cough.

Some effects appear months or years later. These can include scarring, stiffness, hormone changes, reduced organ function, bone injury, fertility problems, or changes in memory and concentration. Radiation can also slightly increase the long-term risk of a new cancer. The

exact risks are specific to the treatment area and dose.

Proton plans are sensitive to changes in anatomy. Weight loss, tumour shrinkage, swelling, or movement from breathing or digestion can change where the beam releases its energy. Repeat scans and a revised plan may be needed.

Results and follow up

Proton therapy does not usually produce an immediate result. Cancer cells may continue to die for weeks or months after treatment. Symptoms treated for comfort may improve sooner, but the timing is different for each person.

Your team will arrange follow-up visits and, when appropriate, blood tests or imaging. Scans are often delayed until treatment-related swelling has had time to settle. Early imaging can sometimes look abnormal even when treatment is working.

At follow-up, your team will assess the cancer, check for side effects, and help manage recovery. Ask for a treatment summary showing the area and radiation dose, especially if you may receive future treatment elsewhere.

Alternatives

Alternatives depend on the cancer and the goal of treatment.

Photon radiation therapy is much more widely available and controls many cancers as effectively as proton therapy. It may expose more healthy tissue to low or moderate radiation, although modern techniques can be highly precise.

Surgery can remove a tumour and provide tissue for testing. It is invasive, requires recovery, and may not be safe when a tumour is close to vital structures.

Brachytherapy places a radiation source inside or next to the tumour. It can limit radiation to surrounding tissue but is suitable only for certain cancers and may require an invasive procedure or anaesthesia.

Medicines such as chemotherapy, targeted therapy, hormone therapy, or immunotherapy can treat cancer cells throughout the body. They have different side effects and may not replace treatment directed at one tumour.

Active surveillance may be reasonable for some slow-growing cancers. It avoids immediate treatment effects but requires regular testing and accepts the possibility that treatment may be needed later.

Supportive or palliative care focuses on comfort and quality of life. It can be given with cancer treatment or used when further tumour-directed treatment is unlikely to help.

When to call your healthcare team

Report side effects that are worsening, interfering with eating or drinking, or not controlled by the medicines and skin care recommended by your team. Mild fatigue and skin changes can usually be discussed during routine treatment reviews.

Contact your healthcare team promptly for persistent vomiting, inability to drink, worsening pain, new difficulty swallowing, significant skin breakdown, or symptoms specific to the treated area.

Seek urgent medical help for severe breathing difficulty, a new seizure, sudden weakness, confusion, uncontrolled bleeding, or another rapidly developing serious symptom. Use local emergency services rather than waiting for a routine radiation appointment.

Common questions

Will I be asleep?

Most adults are awake. Young children and people who cannot remain still may need sedation or general anaesthesia.

Can I drive myself home?

Usually, yes. Do not drive if you received sedation, took medicine that affects alertness, or feel too unwell to drive safely.

How painful is proton therapy?

You should not feel the beam. Side effects may later cause tenderness, inflammation, or discomfort in the treated area.

When will I know if it worked?

Your team will assess this over weeks or months using symptoms, examinations, blood tests, and imaging. There is usually no immediate result after the final session.

How many treatments will I need?

The number is based on the cancer, treatment goal, total dose, and dose given at each session. Your radiation oncologist will explain your schedule before treatment starts.

Will I be radioactive afterward?

No. External-beam proton therapy does not leave radiation in your body.

Sources

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