Proton Therapy [1]

Proton therapy (also called proton beam therapy) is a type of radiation treatment that uses protons rather than x-rays to treat cancer. A proton is a positively charged particle that is part of an atom, the basic unit of all chemical elements, such as hydrogen or oxygen. At high energy, protons can destroy cancer cells.

Proton therapy was first used for cancer treatments in the United States in 1974 at a physics research laboratory. In 1990, the first U.S. hospital-based proton facility began treating patients. Since then, tens of thousands of people in the United States have received proton therapy. The number of U.S. centers that offer this specialized treatment is growing but is still small.

How proton therapy differs from other radiation treatments

Like standard x-ray radiation, proton therapy is a type of external-beam radiation therapy. It painlessly delivers radiation through the skin from a machine outside the body. Protons, however, can target the tumor with lower radiation doses to surrounding normal tissues--€”approximately 60% lower, depending on the location of the tumor.

Traditional radiation treatment can damage the tissue around the tumor. However, with proton therapy, the protons' energy hits the tumor site, delivering a smaller dose to surrounding healthy tissue. With standard treatment, doctors may need to reduce the radiation dose to limit side effects, resulting from damage to healthy tissue. With treatment using protons, on the other hand, doctors can select an appropriate dose, knowing that there will likely be fewer early and late side effects of radiation on the healthy tissue.

How proton therapy works

A machine called a synchrotron or cyclotron accelerates (speeds up) the protons. The speed of the protons is a sign of their high energy. The protons travel to a specific depth in the body based on their energy. After the protons reach the desired distance, they deposit the specified radiation dose around the tumor, leaving minimal radiation doses behind. In contrast, x-rays continue to deposit radiation doses in healthy tissues beyond the tumor as they exit the patient's body, potentially causing side effects.

Before treatment, the health care team plans the proton treatment by locating the tumor using computed tomography [2] (CT) or magnetic resonance imaging [3] (MRI) tests and marks the

tumor's location on the patient's body. This technique is similar to the process for planning radiation therapy with x-rays. The patient will often be fitted with a device that restricts the patient's movement to keep the tumor from moving out of the proton beam. The type of device depends on where the tumor is located. For example, a patient may wear a custom-made mask for a tumor in the eye, brain, or head.

Treatment is then delivered in a treatment room where the protons leave the machine and magnets direct them to the tumor. During the treatment, the patient must remain still to avoid moving the tumor out of the focused proton beam.

Patients often receive proton therapy in an outpatient setting, meaning that it does not require hospital admission. The number of treatment sessions depends on the type and stage of the cancer. Sometimes, doctors deliver proton therapy in one to five proton beam treatments, generally using larger daily radiation doses. This is typically referred to as stereotactic body radiotherapy. If the proton therapy is given at the same time as surgery, it is called radiosurgery.

Cancers treated with proton therapy

Proton therapy goes to a specific area of the patient's body, so this therapy can best shrink tumors that have not spread to other parts of the body. It is especially useful for treating a tumor next to critically important tissues (such as the optic nerves that travel between the eye and brain) that need protection from radiation damage. Doctors may use proton therapy alone, or they may combine it with standard radiation therapy, surgery, and/or chemotherapy.

Proton therapy is particularly useful for treating cancer in children because it lessens the chance of harming healthy, developing tissue. Children may receive proton therapy for rare cancers of the central nervous system (brain and spinal cord) and the eye, such as retinoblastoma and orbital rhabdomyosarcoma.

In addition, proton therapy may be used to treat these cancers:

- Central nervous system cancers (including chordoma, chondrosarcoma, and malignant meningioma)
- Eye cancer (including uveal melanoma or choroidal melanoma)
- Head and neck cancers (including nasal cavity and paranasal sinus cancer and some nasopharyngeal cancers)
- Lung cancer
- Liver cancer
- Prostate cancer
- Spinal and pelvic sarcomas (cancers that occur in the soft-tissue and bone)

Some noncancerous tumors of the brain may also benefit from proton therapy.

Advantages and disadvantages

Compared with standard radiation treatment, proton therapy has several benefits. It reduces the risk of radiation damage to healthy tissues; may allow a higher radiation dose to be directed at some types of tumors, which may keep the tumor from growing or spreading; and may result in

fewer and less severe side effects (such as low blood counts, fatigue, and nausea) during and after treatment.

However, there are some drawbacks:

Limited availability. This treatment requires highly specialized, expensive equipment. As a result, proton therapy is available at just a few medical centers in the United States. Find a list of medical centers that currently offer proton therapy [4].

Higher expense. Proton therapy costs more than conventional radiation therapy, and insurance providers have varying rules about which diagnoses are covered and how much patients need to pay. Talk with your insurance provider to learn more.

Research and future applications

Researchers are studying proton therapy for cancers in other parts of the body, including those listed below:

- Breast cancer
- Esophageal cancer
- Pancreatic cancer
- Rectal and anal cancer
- Sarcoma

Some scientists are trying to find out if proton therapy can be more effective by combining it with other treatments, such as chemotherapy and targeted therapy (treatment that targets the cancer's specific genes or proteins or the tissue environment that contributes to cancer growth and development). Currently, there is no evidence that proton therapy cures more people or is more effective at prolonging a person's life than other standard forms of therapy.

In addition, more research is needed to see if proton therapy has fewer long-term side effects than x-rays.

More Information

Understanding Radiation Therapy [5]

Radiation Therapyâ€"What to Expect [6]

Additional Resources

RadiologyInfo: Proton Therapy [7]

Links:
[1] http://www.cancer.net/navigating-cancer-care/how-cancer-treated/radiation-therapy/proton-therapy
[2] http://www.cancer.net/node/24486
[3] http://www.cancer.net/node/24578
[4] http://www.proton-therapy.org/map.htm
[5] http://www.cancer.net/node/24728

[6] http://www.cancer.net/node/24661
[7] http://www.radiologyinfo.org/en/info.cfm?pg=protonthera&bhcp=1