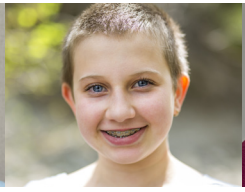
AMERICAN BRAIN TUMOR ASSOCIATION

Proton Therapy


American Brain Tumor Association®

Providing and pursuing answers®

ABOUT THE AMERICAN BRAIN TUMOR ASSOCIATION

Founded in 1973, the American Brain Tumor Association (ABTA) was the first national nonprofit organization dedicated solely to brain tumor research. The ABTA has since expanded our mission and now provides comprehensive resources to support the complex needs of brain tumor patients and caregivers, across all ages and tumor types, as well as the critical funding of research in the pursuit of breakthroughs in brain tumor diagnoses, treatments and care.

To learn more, visit abta.org.

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Proton Therapy

INTRODUCTION

This brochure is about **proton therapy, an advanced method for delivering radiation treatments** to patients with different types of cancers, including brain tumors.

About 70% of brain tumors are not cancerous, but they are still a serious medical condition and often require treatment.[1,2] The remaining 30% of brain tumors are cancerous (malignant). Cancerous brain tumors generally grow faster and behave more aggressively than so-called benign tumors. They commonly invade other areas of the brain and spinal cord and can be deadly. **Brain tumor treatments include surgery, radiation, and chemotherapy.**

Radiation therapy may be used alone, or in combination with other treatments, to:[3,4,5]

- Help prevent the tumor from returning after surgery or chemotherapy
- Relieve symptoms caused by a tumor
- Treat tumors that cannot be removed with surgery

The goal of radiation therapy is to destroy tumor cells and slow or stop the tumor from growing, while

limiting the amount of radiation to nearby healthy brain tissue.[4] This is especially important for young children, as their developing brains and bodies are very sensitive to the potential long-term effects of radiation.

A doctor who specializes in giving radiation therapy is called a *radiation oncologist*.[6] The radiation oncologist works with a team of doctors, medical physicists, technical experts, radiation therapists, and nurses.

Radiation therapy uses very focused, high-energy particles and waves (protons, electrons or photons) to kill the tumor cells and a margin – or border – of normal brain tissue surrounding the tumor.[6] Treating the area near the tumor may help kill cancer that has spread into surrounding tissue. Often, the margin contains some healthy tissue and possibly vital structures, such as the brain stem and spinal cord, which, if damaged, may result in long-term side effects.

The most common type of radiation used to treat brain tumors is known as *external beam radiation therapy*, or EBRT.[4,7] There are different EBRT methods, but all of them involve using a machine to deliver the radiation through the skin directly to the tumor. One type of EBRT is proton therapy.

The gantry rotates and directs the protons to the patient's tumor.
Photo courtesy of MD Anderson Proton Therapy Center

WHAT IS PROTON THERAPY?

Proton therapy uses positively charged particles, known as protons, to send a high level of energy directly to the tumor site using a machine called a *synchrotron* or *cyclotron*.[5] The energy fuels the protons to travel to the desired depth in the body. But unlike photon beams, the proton beams do not travel through the entire body. Once they reach the tumor, the proton beams deliver the targeted radiation dose to the tumor and then they stop moving through the tissue.[8,9]

This unique feature helps to reduce the harm caused to surrounding healthy tissues and organs beyond the tumor. That, in turn, may result in fewer side effects, such as cognitive changes (a decline in mental sharpness, thought processes, and memory).

Proton therapy is typically recommended for the treatment of tumors that are smaller with well-defined margins and those that are located near vital organs and heathy brain tissue.[3,5] It is usually not recommended for tumors that have spread to other areas of the body.

Brain tumors that may be suitable for proton therapy include:

- Arteriovenous malformations[10,11]
- Atypical teratoid/rhabdoid tumor[12]
- Certain low- and high-grade gliomas[13,14,15]
- Chondrosarcomas[5,16,17]
- Chordomas[5,17]
- Ependymomas[14,18]
- Germ cell tumors[19,20]
- Juvenile pilocytic astrocytomas[21,22]
- Meningiomas[5,23]
- Medulloblastomas[14,24]
- Pituitary adenomas[25,26]
- Some brain tumors previously treated with radiation therapy[27,28]
- Vestibular schwannomas/Acoustic neuromas[29,30]

PENCIL BEAM PROTON THERAPY

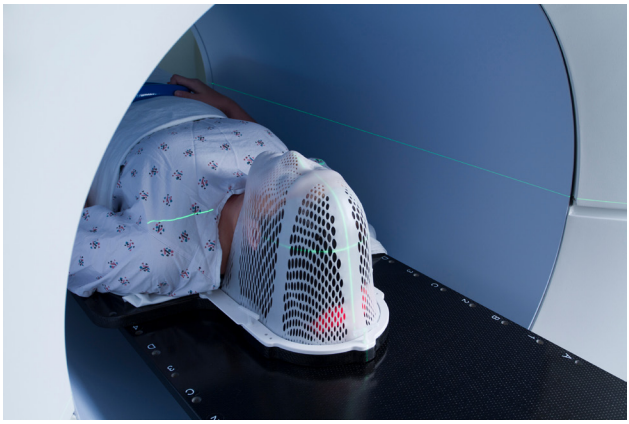
A more advanced type of proton therapy, known as *pencil beam proton therapy*, delivers a single, narrower proton beam that is only a few millimeters wide. Using proton beam therapy on a tumor has been described as painting on a canvas, only using the tip of the brush instead of broad strokes. This treatment approach reduces the risk for side effects even more so than proton beam therapy. Pencil beam proton therapy has been shown to effectively treat brain tumors in both adults and children.[31,32,33]

WHAT TO EXPECT

The healthcare team spends a great deal of time and effort to plan treatment with proton beam therapy. Keeping patients still, determining exactly where the proton beams must enter the body to reach the tumor, and choosing the best possible dose of radiation and schedule are all critical steps in the process.

People usually receive proton therapy in an outpatient setting, not a hospital. During a pre-treatment session known as a **simulation**, patients are guided into the position they will need to stay in for the sessions.[4,6] Next, patients will have a **computed tomography (CT) or magnetic resonance imaging (MRI)** scan.[5,34] The imaging scan will help clinicians tailor the radiation dose and number and shape of radiation beams as well as map out the exact area to be treated.

Patients having proton therapy for a brain tumor will need to be fitted with a **custom-made mask.**[5,34] This mask will keep patients still and help to precisely direct the proton beam during the actual procedure. The location where the proton beam will enter the skin is marked.



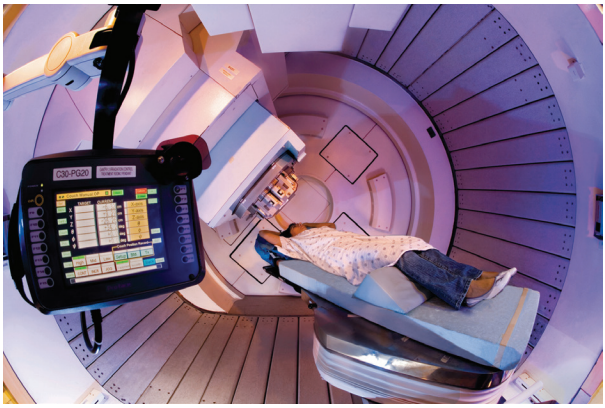
Patient receiving targeted radiation therapy while wearing a customized mask for head stabilization during treatment.

Before every treatment, the medical team will do either a CT or MRI scan, which helps ensure that patients are in the same exact position each time. That way, the proton beams will hit the tumor and not nearby tissue.

During the proton therapy session, patients are placed on a **treatment table** in a special treatment room.[5,6,16] Some treatment rooms have a gantry, which is a donut-shaped, rotating steel machine that is about 35 feet in diameter, three stories tall, and weighs up to 200 tons. Most of this massive machinery is built behind walls and is not visible to the patient in the treatment room. Once the patient is in the proper position, the medical team leaves the room to start the procedure. The gantry rotates around the table, directing the protons to the patient's tumor through a nozzle on the cyclotron/synchrotron. The proton beam travels through the gantry, guided by magnets, toward the tumor.

Typically, proton therapy treatments last 15 to 30 minutes, from beginning to end.[5] **The procedure itself takes only a few minutes and is painless.**[8,16]

The number of treatment sessions needed depends on the type and grade of the tumor.[5] To minimize side effects, treatments are typically given five days a week for five to



The gantry with a patient during the procedure.
Photo courtesy of MD Anderson Proton Therapy Center

seven weeks.[3,7] This allows enough radiation into the body to kill the cancer while giving healthy cells time to heal.

Following proton therapy, patients should be able to return to their normal activities. Patients will likely see their doctor every three to six months for a follow-up exam.[3]

BENEFITS OF PROTON THERAPY

The greatest benefit proton therapy offers is that it reduces the amount of radiation to healthy tissues as well as vital organs and structures near the brain tumor.[5,9,35] As much as 60% less radiation is delivered to healthy tissues around the tumor using proton therapy compared with other forms of EBRT.[5,36] Sparing healthy tissues and organs may reduce the side effects that patients experience.

As the proton beams race toward the tumor site, they release a much smaller amount of energy on surrounding healthy tissues and organs than conventional forms of radiation. Other kinds of radiation therapy, such as photon beams, spread radiation as they exit the body whereas once the proton beams stop, there

is virtually no radiation released on the tissue beyond the targeted tumor.[5,35]

Other benefits of proton therapy include:

- Resulting in fewer secondary cancers compared with other forms of EBRT[37,38,39]
- Delivering a higher radiation dose to the tumor than is possible with conventional forms of radiation therapy[5,16]
- Reaching tumors located near critical organs and brain tissue[3,5,16]

Clinical trials are under way to compare proton beam therapy with conventional forms of radiation therapy for treating cancers, including brain tumors.[5] Many of these studies are funded by the National Cancer Institute and the Patient-Centered Outcomes Research Institute.[40]

Proton Therapy for Children. Children, especially younger ones, have the most to gain from proton therapy because their growth and development can be negatively affected by radiation exposure.[35,36] Treatment with proton therapy for brain tumors in children is associated with favorable cognitive outcomes, including those related to intelligence, processing speed, and functioning (ability to perform normal daily activities).[41,42]

Some studies have shown proton therapy results in better cognitive outcomes than conventional forms of radiation for children treated for brain and other central nervous system tumors.[43,44] Researchers suggest that this could lead to a better quality of life and functioning in adult survivors of pediatric brain tumors.[41] Children often tolerate proton therapy well, but younger children may need to be sedated if they cannot remain still during the procedure.

Disadvantage of Proton Therapy. A major drawback to proton therapy is that it requires highly specialized and expensive equipment[5] costing upwards of $200,000,000. Proton therapy is available in only a few medical centers in the United States. However, the number of proton therapy

treatment centers is growing. In 2006, there were five such centers in the U.S. By 2020, that number had risen to 35.[45] Proton therapy costs more than conventional radiation therapy and insurance providers vary on which cancers they cover and how much the patient must pay.[5] Smaller, single room facilities, which are less expensive and require less space, are becoming more common and should make proton therapy available in more areas and more affordable in the future.

SIDE EFFECTS

As with all radiation therapy, there is the potential for patients undergoing proton therapy to experience side effects from the treatment. Different people experience different side effects. If side effects do occur, they tend to start after a few treatments and usually stop shortly after the final treatment.4

Common side effects from proton therapy include fatigue (extreme tiredness even after sleeping), mild skin reactions (redness, irritation, swelling, dryness, or blistering), hair loss near the treated area, upset stomach (nausea, vomiting, diarrhea, and loss of appetite), and headache.[5,16]

Some long-term side effects may occur months or years after treatment is finished. These may include secondary cancers, infertility (inability to become pregnant or father a child),[4] and radiation necrosis (death of healthy tissue due to the treatment) at or near the treatment site.[34]

Follow-up studies have shown that both adults and children treated with proton therapy for brain tumors did not have a significant decline in cognitive skills and functioning, even years after treatment.[15,46,47,48]

Side effects depend on:[3-5]

- Tumor type, size, and location
- Part of the body being treated
- Types of healthy tissue near the tumor
- Treatment dose
- Patient's overall health

Relieving symptoms of side effects, whether they are caused by the tumor itself or treatments, is an important part of the care plan for all patients with brain tumors.

AMERICAN BRAIN TUMOR ASSOCIATION INFORMATION, RESOURCES AND SUPPORT

Educational brochures are available on our website or can be requested in hard copy format for free by calling the ABTA. Most brochures are available in Spanish, with exceptions marked with an asterisk.

GENERAL INFORMATION

About Brain Tumors: A Primer for Patients and Caregivers
Brain Tumor Dictionary*
Brain Tumors Handbook for the Newly Diagnosed*
Caregiver Handbook*

TUMOR TYPES

Ependymoma
Glioblastoma and Anaplastic Astrocytoma
Medulloblastoma
Meningioma
Metastatic Brain Tumors
Oligodendroglioma and Oligoastrocytoma
Pituitary Tumors

TREATMENT

Chemotherapy
Clinical Trials
Conventional Radiation Therapy
Proton Therapy
Stereotactic Radiosurgery*
Steroids
Surgery

AMERICAN BRAIN TUMOR ASSOCIATION INFORMATION, RESOURCES AND SUPPORT

INFORMATION

ABTA WEBSITE | ABTA.ORG

Offers more than 200 pages of information, programs, support services and resources, including: brain tumor treatment center and support group locators, caregiver resources, research updates and tumor type and treatment information across all ages and tumor types.

EDUCATION & SUPPORT

- **ABTA Educational Meetings & Webinars**
  In-person and virtual educational meetings led by nationally-recognized medical professionals.

- **ABTA Peer-to-Peer Mentor Program**
  Connect with a trained patient or caregiver mentor to help navigate a brain tumor diagnosis.

- **ABTA Connections Community**
  An online support and discussion community of more than 25,000 members.

- **ABTA CareLine**
  For personalized information and resources, call 800-886-ABTA (2282) or email info@abta.org to connect with a CareLine staff member.

GET INVOLVED

- Join an ABTA fundraising event.
- Donate by visiting abta.org/donate.

CONTACT THE ABTA

CareLine: 800-886-ABTA (2282)
Email: info@abta.org
Website: abta.org

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