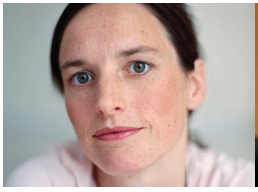
AMERICAN BRAIN TUMOR ASSOCIATION

Stereotatic Radiosurgery



American Brain Tumor Association®

Providing and pursuing answers™

ACKNOWLEDGEMENTS

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 its 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**.

We gratefully acknowledge Helen A. Shih, MD, Chief of CNS Section, Department of Radiation Oncology and Marc R. Bussière, MSc, Director of Stereotactic Physics, Massachusetts General Hospital, in Boston for their review of this publication.

ABTA2015-0620

Stereotactic Radiosurgery

INTRODUCTION

Stereotactic radiosurgery (SRS) is a special form of radiation therapy – it is not a form of open surgery. Unlike open surgery, SRS is relatively painless and non-invasive. Stereotactic radiosurgery allows precisely focused, high-dose radiation beams to be delivered to a small, localized area of the body, mostly in the brain. With high dose radiation given by SRS, the likelihood that the tumor/target will be controlled at the site treated is high, however the overall outcome will depend on many different factors. SRS is most commonly used to treat small brain and spinal tumors (both benign and malignant); blood vessel abnormalities in the brain; certain small tumors in the lungs and liver; and neurologic problems such as movement disorders. In this publication, we address radiosurgery as a treatment for brain tumors.

RADIATION THERAPY

When radiation is used to treat brain tumors, the goal is to kill the tumor cells, or at least slow or stop tumor growth. Conventional external beam radiation therapy—or conventional radiation therapy—is the most common form of radiation therapy. It uses an external radiation source to

deliberately deliver full dose radiation to the tumor and some of the surrounding brain tissue.

The dose to normal tissue is a function of many factors, but all treatment plans strive to minimize dose to normal tissue. With conventional external beam irradiation, treatments are "fractionated," i.e., divided up into more than five treatment sessions, most often more than 10 and as many as 30 or more. It is the most common form of radiation therapy used as initial treatment for "primary" brain tumors (those that start in the brain tissue). The target area for conventional radiation techniques for primary gliomas includes a "margin" (a border of normal brain around the tumor as seen on imaging, most commonly by MRI). The margin allows for the possibility that the tumor may have spread into the surrounding tissue. This intended zone of near full-dose radiation includes the obvious tumor (gross tumor volume, or what radiation oncologists call GTV) that is visible on the CT scan or MRI, plus the region around it that is likely to contain smaller amounts of tumor not visible on a CT scan or MRI (clinical treatment volume or CTV). Since some normal brain tissue is unavoidably included in the higher dose regions, conventional radiation therapy is broken down into small daily doses that allow normal brain tissue to repair itself between the treatments. As a result, reaching the desired dose of radiation takes several weeks of daily treatment, weekends normally excluded.

Some tumors can be permanently eliminated by radiation therapy, while others may be prevented from growing for a long time. The dose of radiation therapy with SRS is higher,

which can sometimes lead to better tumor control or treatment effect. There are situations where a tumor does not shrink in response to radiation therapy, but is still considered "cured" or "controlled." This is a common circumstance for patients with certain benign brain tumors.

RADIOSURGERY

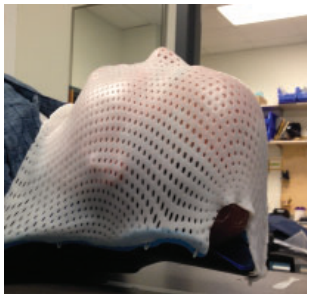
As mentione**d previously, when radiation is used to treat brain tumors, the goal is to kill the tumor cells, or at least slow or stop tumor growth, while limiting adverse effects on normal tissue.**

Since radiation is not completely selective and can affect both normal cells and tumor cells, physicians, with the assistance of medical physicists, work to develop a special type of radiation that focuses the high-dose zone of radiation just on the target area. Radiosurgery is this focused form of radiation.

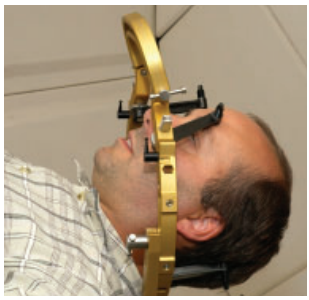
Radiosurgery for brain and spinal column/cord tumors is usually delivered in one to five treatment sessions involving a multidisciplinary team, including: neurosurgeons, radiation oncologists, medical physicists, dosimetrists (specialists who determine exactly how to deliver the prescribed radiation dose), radiation therapy therapists, and nurses.

Radiosurgery focuses radiation beams closer to the tumor than conventional external beam radiation and it is used for treating well-defined targets that do not overlap with the normal brain tissue. Focusing the radiation tightly around the tumor is possible through the use of highly sophisticated computer-assisted radiation delivery equipment. A head frame or face mask used for this treatment allows very precise set-

up, localization, and treatment of the tumor. To summarize, radiosurgery, due to its precision and computer planning, minimizes the amount of radiation delivered to normal brain tissue and focuses radiation in the area that needs to be treated.



Radiosurgery face mask

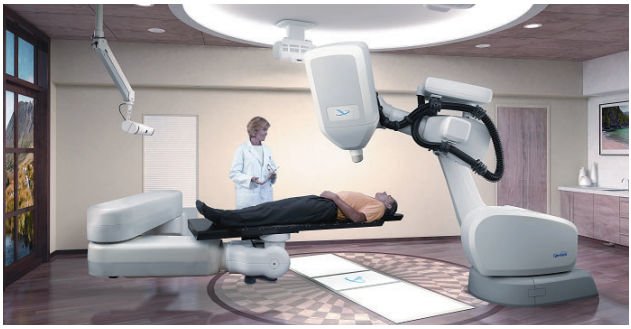


Radiosurgery invasive headframe

Radiosurgery non-invasive headframe

Because radiosurgery is a highly focused treatment, this form of therapy is useful for situations which the main concern is treating the contrast-enhancing tumor that can be easily seen on a CT scan or MRI, and where there is little or no reason to think that there are lots of unseen tumor cells in the surrounding area. (A common situation of this kind occurs when a cancer from another part of the body spreads, or "metastasizes," to the brain. This situation is called a brain metastasis, or secondary tumor of the brain.)

It is also useful in situations where the tumor is small and contained in a localized area.



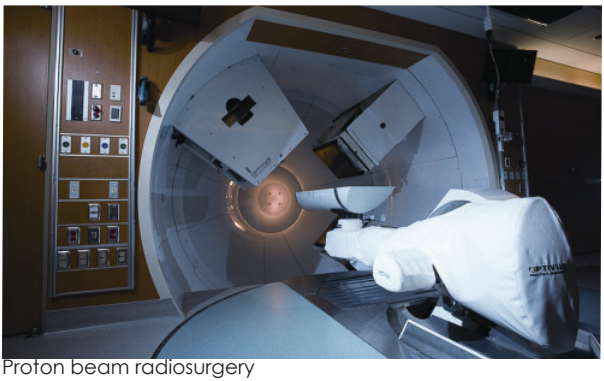
CyberKnife
Courtesy of Accuray, Incorporated

Novalis System
Courtesy of BrainLab

Although the definition of "small" may vary slightly from institution to institution, "small" tumors are generally considered to be those 3 cm (slightly over an inch) or less in diameter.

Cobalt-60 radiosurgery
Courtesy of Elekta Instruments

Radiosurgery may be used to treat multiple tumors, if they are small and limited in number. Sometimes, radiosurgery is used to treat tumors that cannot be removed, or those that can be only partially removed.



Proton beam radiosurgery
Courtesy of the James M. Slater Proton Treatment Center at Loma Linda University Center

In addition, radiosurgery may be used to give additional dose to a more focused area at the end of conventional radiation therapy.

RADIOSURGERY TECHNOLOGIES

Stereotactic radiosurgery uses these technologies:

- The Gamma Knife®, which uses highly focused gamma rays aimed at the target region
- Linear accelerator (LINAC) and Cyber Knife® unit, which focus high-energy x-rays, also known as photons, to the target region
- Proton accelerator, which aims protons (ionized hydrogen) at the target region

Several companies manufacture radiosurgery equipment and the software for these computer-based systems. Each company gives their radiosurgery system a brand name, much in the same way an automobile manufacturer names their cars.

Each system has some inherent differences in the way the planning is done or the radiation is delivered, each with its own advantages and limitations. At this time, there is no definitive evidence that one system is better than another.

RADIOSURGERY TECHNIQUES

There are several techniques used to deliver radiosurgery. In the paragraphs that follow, we describe a typical treatment course using the more common types of radiosurgery equipment. Although the equipment or method you encounter may vary, the goal of the treatment is the same.

Your first contact with the radiosurgery unit will likely be with one of the members of the radiosurgery team. Radiosurgery requires a team of specialists. That team may include a neurosurgeon, radiation oncologist, radiologist, medical physicist, neurologist, anesthesiologist, specially trained nurses, radiation therapists, and the unit support staff.

Members of the team will first review your medical records to decide if radiosurgery would be of benefit to you. Please notify the team if you have any implanted cardiac devices. If it is determined that radiosurgery is an option and you consent to treatment, the next steps will be obtaining the records and imaging studies (scans) needed to plan your personalized treatment.

Your recent MRI scans, a current scan or additional images, biopsy or surgical reports, pathology reports, and specially designed planning software are used to precisely plan for treating your tumor. You may be given intravenous medications to help you relax during the treatment. The radiosurgery team calibrates the equipment to match your personalized treatment plan, including the area to be treated and the dose of radiation to be given. In general, the area irradiated includes the abnormal area with a minimal margin of surrounding normal tissue. The dose of radiation is centered over the entire volume of the target area. The radiation dose decreases rapidly as the distance away from the target area increases.

Before the treatment, your team may prescribe medications such as steroids (which prevent brain swelling) or anti-seizure drugs. The staff at the radiosurgery unit will also provide you with specific instructions to follow in preparation for your treatment. Be sure to tell them—in advance—about all of the medications you are using, including prescription drugs, over-the-counter medications, vitamins, dietary supplements, or herbal preparations. They will tell you which drugs to continue, and which to stop prior to treatment. You may also receive information about your diet the day prior to the treatment, any special shampoo instructions for the evening before, the time and location of your appointment, and transportation guidelines. Plan to bring someone with you to escort you home.

Some forms of radiosurgery require attaching a lightweight, yet rigid, head frame to the head. The screws that attach to the skull are called pins. In such cases the majority of the work is done on the day of treatment. The frame has two functions. It helps your doctor define the exact location of the tumor, and it will keep your head immobilized so that there is no movement during treatment. You may have an IV (intravenous line) of relaxing medications with this type of treatment.


Headframe

Many radiosurgery systems do not require a rigid head frame. "Frameless" radiosurgery does not use an invasive (does not attach to the skull or pierce the skin) frame

to immobilize the head during treatment. In such cases it is common that some of the preliminary work leading to the treatment is done on a different day. The frameless systems allow the immobilization to be removed and replaced on at a later time with reproducible accuracy such that the patient may go home while the necessary planning is being done. This method may use a face mask or dental impression system to immobilize the head and uses image-based techniques (x-rays or CT) to localize the target. In some cases markers may be used for imaged based localization.

Once the rigid head frame or alternative immobilization device is in position, MRI and/or CT scans will be taken. You will then be able to rest while the treatment plan is calculated by the radiosurgery team (or go home if using a frameless system). Your physician may give you a mild sedative to help you relax during this planning time and the subsequent treatment.

Generally, your therapy will take place in a treatment room and will last anywhere from 30 minutes to two hours, taking into account adjustments for positioning and equipment settings. During the session, you will lie on your back with the immobilization device holding your head in place. You will not feel the radiation because it is a relatively painless and non-invasive procedure. Nothing additional to the immobilization device will touch your head. The time that you are exposed to radiation will only be a few minutes and the majority of the time is spent ensuring that the setup is correct.

After you receive your treatment, the head frame is removed. Generally, you return home the same day. Occasionally, a patient might be kept overnight for observation. The radiosurgery team will provide you

with instructions for caring for yourself in the next few days, and for your follow-up visit with your own physician. Most people feel able to resume their usual activities within a day or two.

If you are to receive multiple treatments, these will be done on an "outpatient" basis. You will be given a schedule of appointments, and your head frame or mask will be repositioned each time you receive treatment.

After you complete your treatments, you should feel free to contact the radiosurgery team with any questions or concerns. Unless your team instructs you differently, the doctor coordinating your usual brain tumor care is the doctor with whom you make your follow-up appointments. A scan will be done in a few months to evaluate the initial effect of the treatment, but it may take a year (sometimes longer) to truly evaluate the full effect of the treatment.

SIDE EFFECTS

When your treatment plan is initially created, your radiosurgery team can talk with you about potential side effects. Some people have few to no side effects from this type of radiation therapy. Once they have rested following the treatment and have resumed their regular activities, tenderness at the pin sites may be their only side effect. Your doctor can suggest pain medications if needed, or perhaps a topical gel to numb the pin site until it heals. Other people have reactions that vary from early side effects to delayed reactions.

Early symptoms are often due to brain edema (swelling) cause by the radiation. These symptoms can include nausea, vomiting, dizziness or headaches. Your doctor can

prescribe steroids, anti-nausea drugs or pain relievers to control these symptoms, which are usually temporary. Typically, as the swelling diminishes, so do the symptoms.

Two to three weeks after treatment, you may experience hair loss in the area irradiated, but this does not occur in everyone. Hair loss depends on the dose of radiation received by portions of the scalp and the ability of the radiated hair follicles to heal. Re-growth usually begins in three to four months, and can be a slightly different color or texture than before. Your scalp may also become temporarily irritated. Since some lotions cause further irritation, do not treat this yourself. Call your radiosurgery team for advice.

Some patients may experience delayed reactions weeks or months after their treatment. These reactions can include "necrosis," or cell death in the high radiation dose region due to the radiation effect on the target region. Radionecrosis is sometimes accompanied by swelling of the brain tissue in reaction to the presence of the dead tumor tissue. The symptoms may mimic the symptoms of tumor regrowth or stroke. Treatment of delayed reactions will be based on the type of side effect. Other effects depend on the location of the tumor.

All treatments, even those claiming to be "natural therapies," have the potential for serious or life-threatening effects. When your doctor discusses the possible side effects of the treatment planned for you, ask him/her to help you weigh the benefits of the treatment against the risks.

AMERICAN BRAIN TUMOR ASSOCIATION INFORMATION, RESOURCES AND SUPPORT

BROCHURES

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: A 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 abtacares@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: abtacares@abta.org
Website: abta.org

AMERICAN BRAIN TUMOR ASSOCIATION

8550 W. Bryn Mawr Avenue, Suite 550
Chicago, IL 60631

For more information contact:

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

American Brain Tumor Association®

Providing and pursuing answers™