FOCUSING ON TREATMENT

Stereotactic Radiosurgery

American Brain Tumor Association

A Word About ABTA

Founded in 1973, the not-for-profit **American Brain Tumor Association** has a proud history of funding research, providing patient services, and educating people about brain tumors. Our mission is to eliminate brain tumors through research and to meet the needs of brain tumor patients and their families.

We gratefully acknowledge Walter Curran, MD, Professor and Chairman, Department of Radiation Oncology, Thomas Jefferson University Hospital; Clinical Director, Kimmel Cancer Center of Jefferson Medical College; Director, Jefferson Cancer Network; and Group Chairman of the Radiation Therapy Oncology Group (RTOG) for his assistance in writing this publication. We also appreciate the efforts of Shari Rudoler, MD for the original edition.

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What Is Stereotactic Radiosurgery?

Stereotactic radiosurgery is a special form of radiation therapy - it is not surgery. Stereotactic radiosurgery allows precisely focused, high dose X-ray beams to be delivered to a small, localized area of the brain. It is used to treat small brain and spinal cord tumors (both benign and malignant); blood vessel abnormalities in the brain; defined areas of cancer; certain small tumors in the lungs and liver; and neurologic problems such as movement disorders. In this publication, we address radiosurgery only as used for brain tumors.

Despite the use of the word, there is no surgery involved in this form of radiation therapy.

What is Radiation Therapy?

The radiation treatments used for brain tumors are very similar to the radiation you know as a treatment for cancer in other parts of the body. When radiation is used to treat brain tumors, the goal is to slow, or arrest the tumor growth. Radiation either kills tumor cells directly or it interferes with their ability to grow. Radiation is not completely selective, however. It can affect both normal cells and tumor cells. Because of this, scientists worked to develop a special type of radiation that focuses the high-dose zone of radiation just on the target area. This focused form of radiation is called radiosurgery.

Radiosurgery is Different From Conventional Radiation Therapy

Conventional external beam radiation therapy – the most common form of radiation therapy – delivers full dose radiation to the tumor and some of the surrounding brain tissue. For several reasons, the target area for conventional radiation deliberately includes a border (called a "margin") of normal brain around the tumor. These reasons include uneven tumor borders, the risk of invisible spread of the tumor into the surrounding tissue, a larger tumor size, or the presence of multiple tumors. This larger zone of full-dose radiation includes the borders of the tumor where microscopic tumor cells may be located.

Since normal brain tissue is included in the full-dose region, conventional radiation is broken down into small daily doses so the normal brain tissue can tolerate it. As a result, reaching the desired dose of radiation takes several weeks of daily treatment.

Radiosurgery focuses radiation beams more closely to the tumor than conventional external beam radiation. This is possible through the use of highly sophisticated computer-assisted equipment. A head frame or facemask used for this treatment allows very precise set up, localization and treatment of the tumor. Using advanced computer planning, radiosurgery minimizes the amount of radiation received by normal brain tissue and focuses radiation in the area to be treated.

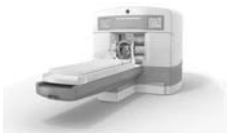
Since conventional radiation therapy covers more normal tissue, it can often be given only once. Radiosurgery, however, may be considered for re-irradiation due to its precision and the possibility of avoiding previously treated areas.

Types of Radiosurgery Equipment

There are three general types of equipment used to deliver radiosurgery: a system with fixed radioactive source, such as the Gamma Knife; linear accelerators; and cyclotrons.

GAMMA KNIFE

The Gamma Knife is a dedicated radiosurgery unit containing two hundred and one cobalt-60 radiation sources which can all be computer-focused onto a single area of the brain.



LINEAR ACCELERATORS

Linear accelerators are the machines used to deliver conventional external beam radiation therapy. A linear accelerator can be modified to deliver a single high-energy computer-shaped beam to the tumor, or the liner accelerator may have been manufactured specifically for use in radiosurgery.

PROTON BEAM RADIOSURGERY

Cyclotrons are nuclear reactors capable of smashing atoms to release proton, neutron and helium ion beams that can be harnessed for radiosurgery purposes. There are only a few of these machines in use.

GAMMA KNIFE

ONCOR LINEAR ACCELERATOR

GANTRY OF PROTON BEAM UNIT AT LOMA LINDA

Names of Radiosurgery Equipment

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. For example, GE, Radionics, Accuray and BrainLab are companies that manufacture linear accelerator-based radiosurgery systems or software. Each manufacturer names their equipment: the X-Knife, Stealth Station, CyberKnife, and Novalis System are some of the brand names of linear-accelerator-based radiosurgery systems or software.

CYBERKNIFE

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

The Gamma Knife is a radiosurgery system with a fixed source of energy. In this system, the radioactive cobalt-60 sources used to produce the radiation beams remain in one place while the patient is moved on a sliding couch toward the source of the radiation.

STAR (Stereotactic Alignment for Radiosurgery), Conforma 3000, and PROBEAT are systems used to deliver proton beam radiosurgery. Proton beams are created by a cyclotron (a nuclear reactor) which smashes atoms, releasing the protons used in this therapy.

You may have also heard the term "stereotactic radiotherapy." Stereotactic radiosurgery is given in a single session. If given in multiple sessions, the treatment may be called stereotactic radiotherapy or fractionated stereotactic radiotherapy.

"Frameless radiosurgery" refers to radiosurgery that does not use a metal frame to immobilize the head during treatment. Rather, markers able to be viewed on a scan are placed on the scalp, or a face mask is used to help hold the head steady. The treatment equipment is then aligned with the markers or with the face mask.

The Goals of Radiosurgery

In general, the purpose of any form of radiation therapy is to shrink and destroy tumor cells. Some tumors can be cured by radiation therapy, while others may be controlled. There are situations where a tumor does not shrink in response to radiosurgery but is still cured. This is a common circumstance for patients with certain benign brain tumors.

Because radiosurgery is a highly-focused treatment, this form of radiation therapy is useful in situations where the tumor is small and contained in a localized area. Although the definition of "small" may vary slightly from institution to institution, "small" tumors are generally considered to be those 3 cm (about 1¼ inches) or less in diameter.

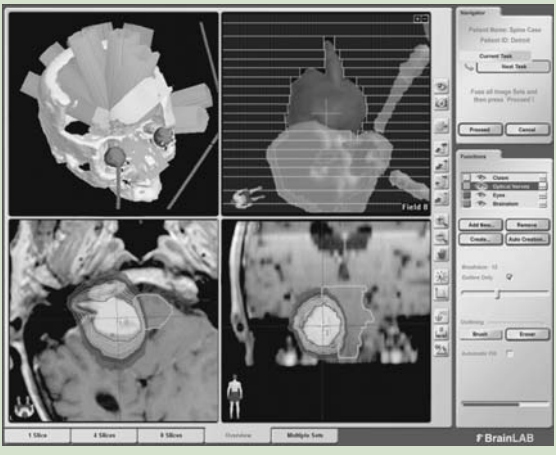
Radiosurgery can be used for tumors in the brain or in the spinal cord. It may be used to treat multiple tumors if the tumors are small and there are a limited number. Sometimes, radiosurgery is used to treat tumors that cannot be removed, or those that can be only partially removed. Also, radiosurgery may be used as a local "boost" at the end of conventional external beam radiation therapy.

NOVALIS SHAPED BEAM SURGERY SYSTEM

How is Radiosurgery Given?

There are several techniques used to deliver radiosurgery. In the paragraphs that follow, we describe a typical day of treatment using the more common types of radiosurgery equipment. Although the equipment or method you see 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, radiation physicist, neurologist, anesthesiologist, specially trained nurses, technologists and the unit support staff. Members of the team first review your medical records to decide if radiosurgery would be of benefit to you. If it is determined that radiosurgery is an option and you consent to treatment, the next steps will be obtaining the records and 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 determine the plan for treating your tumor. The radiosurgery team calibrates the equipment to match your



RADIOSURGERY PLANNING IMAGES

personalized treatment plan, including the area to be treated and the dose of radiation to be given. In general, the area radiated includes the abnormal area with a tiny 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 (which control seizures). 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 will 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 drive you home.

When you arrive at the radiosurgery unit for your treatment, you may have an IV (intravenous) line started to help prevent dehydration. If you have questions, remember to ask them before any relaxing medication is given to you. This will allow you to better understand the answers.

Most forms of radiosurgery require placement of a lightweight headframe, also called a "halo." The headframe 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. The headframe is attached the day of your treatment. Your doctor will first inject a local anesthetic into your scalp at the places where the pins will be placed. This anesthetic is a "freezing" medication similar to that used by your dentist. Once the scalp is

numbed, screws or pins are positioned. Those pins will hold the headframe in place during the treatment planning and actual treatment. Placing the pins and positioning your headframe can take several hours, depending on the technique used. If your treatment will be given in more than one session, computerized markers may be used to exactly match the previous pin locations. Or, the headframe may be attached to your head with a mouthpiece that is custom made for you, and allows exact reproduction of the position of the frame during each session.

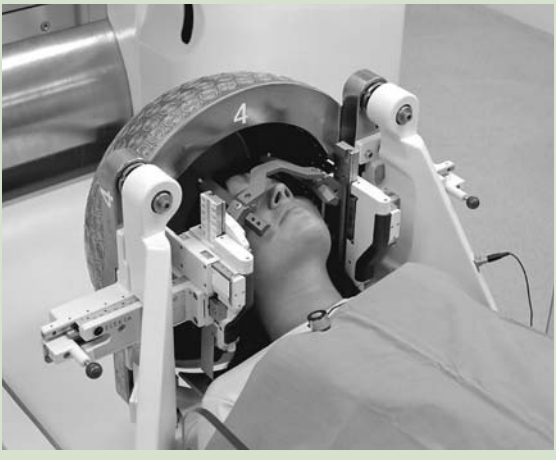
Those being treated with proton beam radiosurgery may be fitted with a molded plastic face mask, which serves the same purpose as a headframe. If your radiosurgery is to be done with a "frameless" system, you may also be fitted for a face mask. Low-dose x-ray images will be taken to continually track your position during treatment.

PREPARING A FACEMASK

FACEMASK IN PLACE

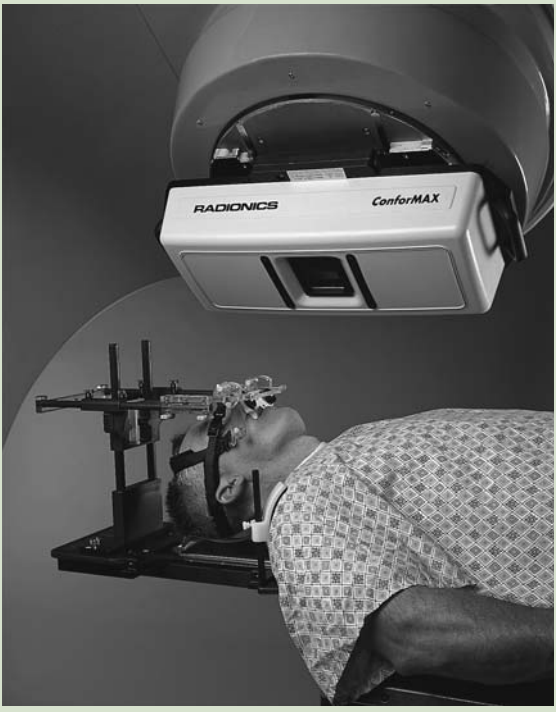
Once the headframe or facemask is in position, MRI and/or CT scans will be done with the headframe on. You will then be able to rest while the treatment plan is calculated by the radiosurgery team. Your physician may give you a mild sedative to help you relax during this planning time and the subsequent treatment.

For Gamma Knife treatment, you will be placed on a couch, and then a large, oversized helmet will be attached over your headframe. Open holes in the helmet allow computer-programmed beams to match the shape of your tumor. The entire couch (with you securely on it) is then slid into a dough-nut hole shaped piece of equipment called a "gantry" through which the radiation beams are delivered.



GAMMA KNIFE HELMET

If you are treated with a linear accelerator, you will be positioned on a sliding bed around which the linear accelerator circles. There are two common techniques by which linear accelerators deliver radiosurgery. One is by directing many arcs of photon beams at the target area. The pattern of the arc is computer-matched to the shape of your tumor. The second technique is to deliver the radiosurgery by a series of shaped "fixed" fields and not arcs. In some cases the radiation dose



INTEGRA RADIONICS CONFORMAX HEADFRAME

pattern is shaped by varying the intensity of radiation through these fields. This technique of varying the intensity is known as "intensity modulated radiation therapy" or IMRT.

For proton beam-based radiosurgery, you will usually be positioned on a table with your head in a fitted face-mask or a frame. As the nuclear reactor smashes atoms, the released protons are directed toward the tumor through beam-shaping blocks. The beams are computer-programmed to match the shape of your tumor.

DELIVERING PROTON RADIOSURGERY

The actual treatment time for any of these techniques generally ranges from 15 minutes to about two hours. After you receive your treatment, the headframe is removed. Generally, you return home the same day or you may 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 followup 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 headframe 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 followup 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 of Treatment

When your treatment planning is first done, your radiosurgery team can talk with you about the potential effects of the treatment specifically planned for you. Some people have few or 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 help numb the pin site until it heals. Other people have reactions which vary from early side effects to delayed reactions.

Early symptoms are often due to brain edema (swelling) caused 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. Once the swelling resolves, these symptoms usually resolve.

Two to three weeks after treatment, you may experience hair loss in the area radiated, 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. Regrowth usually begins in 3-4 months, and may 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 treatment. These reactions can include necrosis or cell death in the high radiation dose region due to swelling in reaction to the radiation effect on the target region. These symptoms are mainly due to swelling or death of brain tissue in the treated area. They may mimic the symptoms of tumor regrowth or stroke. Treatment will be based on the type of side effect that occurred. 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 her/him to help you weigh the benefits of the treatment against the risks.

To Learn More

This pamphlet is part of our Focusing on Treatment series of publications. Other publications in this series include *Steroids, Surgery, Conventional Radiation Therapy* and

Chemotherapy. In addition, we offer publications and resources that explain the different types of brain tumors, treatment options, support resources, and the latest news in brain tumor research. To access these free services, please visit our web site at *www.abta.org,* or call us at 800-886-2282.

It is our hope that the information in this pamphlet helps you communicate better with the people who are treating you. Our purpose is not to provide answers; rather, we encourage you to ask questions.

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Talking to Your Child Packet
When Your Child Returns to School

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  Bridges (program for those who have lost someone to a brain tumor)
Resources for Online Support
TLC (Tips for Living and Coping) e-bulletin

Single copies of our publications are available free of charge.

American Brain Tumor Association

2720 River Road, Des Plaines, Illinois 60018

800.886.2282 TEL info@abta.org EMAIL
847.827.9918 FAX www.abta.org WEB

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info@abta.org EMAIL
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