

# Stereotactic Radiosurgery (SRS)



FOCUSING ON TREATMENT



American Brain Tumor Association

## A Word About ABTA

Founded in 1973, the American Brain Tumor Association was the first national nonprofit organization dedicated solely to brain tumors. Since then, ABTA has been a consistent leader in funding brain tumor research, and providing patient/family information and support.

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## What Is Stereotactic Radiosurgery (SRS)?

Stereotactic radiosurgery (SRS) 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 tumors); 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 as treatment for brain tumors.

## What is Radiation Therapy?

Radiation treatment for brain tumors is similar to that used for cancer in other parts of the body. When radiation is used to treat brain tumors, the goal is to kill the tumor cells, or at least slow tumor growth. 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 – deliberately delivers full dose radiation to the tumor and some of

the surrounding brain tissue. 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 usually includes a “margin” (a border of normal brain tissue around the tumor). The margin allows for the possibility that the tumor may have spread into surrounding tissue. This intended zone of full dose radiation includes the obvious tumor that is visible on a 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. Since some normal brain tissue is unavoidably included in the full dose region, *conventional radiation therapy* is broken down into small daily doses that are easier for the normal brain tissue to tolerate. As a result, reaching the desired dose of radiation takes several weeks of daily treatment.

*Radiosurgery* focuses radiation beams closer to the tumor than conventional external beam radiation. Radiosurgery is useful for situations where the main concern is treating 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. Focusing the radiation tightly around the tumor is possible through the use of highly sophisticated computer-assisted equipment. A head

frame or face mask 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 radioactive cobalt-60 system; linear accelerators; and cyclotrons.

*Cobalt-60 Radiosurgery*



Gamma Knife is a brand name that describes a dedicated radiosurgery unit which contains two hundred and one radioactive cobalt-60 radiation sources. These radiation sources are all computer-focused onto a single area or tumor within the brain.

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 linear accelerator may have been manufactured specifically for use in 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.

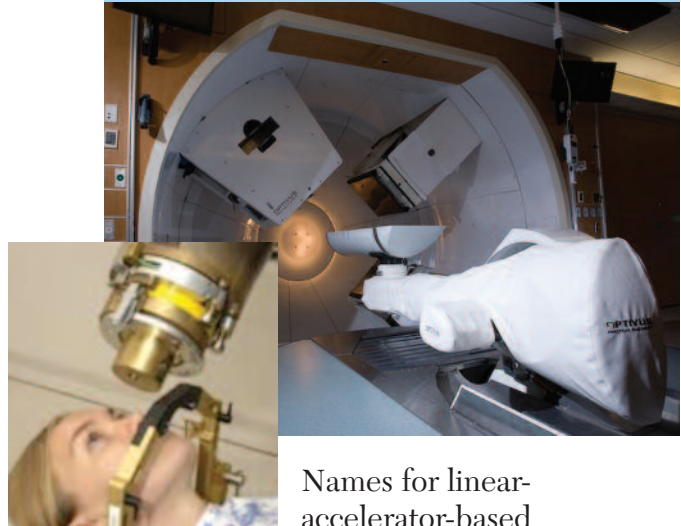
*ONCOR Linear Accelerator*



### 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.

*Proton Beam Radiosurgery*



Names for linear-accelerator-based

radiosurgery systems and software include: the X-Knife, Stealth Station, CyberKnife, and Novalis System. The Gamma Knife is a Cobalt-60 system. STAR (**S**tereotactic **A**lignment for **R**adiosurgery), 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.

*Despite the use of the word, there are no “knives” and no surgery involved in this form of radiation therapy.*

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.

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 permanently eliminated by radiation therapy, while others may at least be prevented from growing for a long time. There are situations where a tumor does not shrink in response to radiosurgery but is still considered “cured” or “controlled.” 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 1 ¼ inches) or less in diameter. Radiosurgery can be used for tumors in the brain or in or near 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.

### 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 is used to determine a precise plan for treating your tumor. 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 radiated 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 (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.

### Meet Your SRS Team

Your SRS care team may include:

- a neurosurgeon
- a radiation oncologist
- a radiologist
- a radiation physicist
- a neurologist
- an anesthesiologist
- specially trained nurses
- technologists
- your hospital or medical center's support staff

*Novalis System*



When you arrive at the radiosurgery unit for your treatment, you may have an IV (intravenous) line started to provide easy access for providing steroids or relaxing medications if you need them. 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.

Some forms of radiosurgery require placement of a lightweight head frame, also called a “halo.” The head 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. The head frame 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 head frame in place during the treatment planning and actual treatment. Placing the pins and positioning your head frame 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 head frame 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.

Many radiosurgery systems do not require a rigid head frame but, instead, use a molded plastic face mask, which serves the same purpose. If your radiosurgery is to be done with this type of “frameless” system, low-dose x-ray images will be taken to verify that you are in the proper position during treatment.

Once the head frame or face mask 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 facemask*



radiosurgery team. Your physician may give you a mild sedative to help you relax during the planning time and subsequent treatment.

For Gamma Knife treatment, you will be placed on a couch, and then a large, oversized helmet will be attached over your head frame. 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 doughnut-hole shaped piece of equipment called a “gantry” through which the radiation beams are delivered.

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. In some cases the radiation dose 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.

The actual treatment time for any of these techniques generally ranges from 15 minutes to about two hours. 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 a few months after the treatment to evaluate

its success, however, it may take a year (sometimes longer) to truly evaluate the full effect of the treatment.

## Side-Effects of Treatment

When your treatment plan is initially created, your radiosurgery team can talk with you about potential side effects. 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. 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 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 the radiation effect on the target region. Radionecrosis is sometimes accompanied by swelling of 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 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*, and *Conventional Radiation Therapy*. 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. We can also help you network with other patients or family members through our *Connections* pen pal program, and our *Connections* online community at: <https://connections.abta.org>. To access these free services, please visit our web site at [www.abta.org](http://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.

### Photo Credits

We thank the following people who graciously provided photos to enhance this publication.

PAGE	PHOTO CREDIT
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Adolescent and Young Adult Resources  
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Resources for Talking with Children When  
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When Your Child Returns to School

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Headlines  
ABTA Brain Tumor E-News

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Listing of Brain Tumor Support Groups  
Listing of Bereavement (Grief) Support Groups  
Organizing and Facilitating Support Groups  
Pen Pal Programs

- Connections (for patients and family members)
- Bridges (for those who have lost someone to a brain tumor)

Reaching Out for Support  
Resources for Online Support  
TLC (Tips for Living and Coping) e-bulletin

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