AMERICAN BRAIN TUMOR ASSOCIATION

Stereotactic 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 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**.

We gratefully acknowledge Helen A Shih, MD, Radiation Oncology, Massachusetts General Hospital; Ayal A. Aizer, MD, Central Nervous System Radiation Oncology, Dana-Farber Cancer Center; and Barbara Chatzke, patient reviewer; for their review of this edition.

ABTA1223

Stereotactic Radiosurgery

INTRODUCTION

This brochure is about stereotactic radiosurgery (SRS), an advanced method for delivering radiation treatments to patients with different types of tumors, including brain tumors.

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

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

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

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

the amount of radiation to nearby healthy brain tissue and vital organs.[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.[5]

A doctor who specializes in giving radiation therapy is called a radiation oncologist. The ***radiation oncologist*** works with a team of clinicians, including neurosurgeons, neuro-oncologists, medical oncologists, neuroradiologists, medical physicists, dosimetrists, radiation therapists, and nurses.[6]

Radiation therapy uses very focused, high-energy particles (often protons or electrons) or x-rays (photons) to kill the tumor cells seen on an imaging scan.[7] The area being targeted may include a margin—or border—of normal looking brain tissue surrounding the tumor where there may be microscopic tumor cells. Treating the area near the tumor with radiation may help kill cancer that has spread into surrounding tissue. Usually, the margin contains mostly 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 conventional radiation methods. All of these methods deliver a precise amount of radiation to the tumor and limit the amount of radiation to nearby healthy tissue.

ABOUT SRS

SRS is an advanced form of radiation therapy that delivers precisely focused, high-dose radiation beams to treat the tumor.[6,8,9] Despite its name, SRS is not a type of surgery.

SRS uses higher doses of radiation than conventional forms of radiation.[6,10] It uses either photon or proton beams.[7] **These beams are so precise that the radiation is delivered to within one millimeter of the target**.[6] Additionally, these beams are designed to conform to the tumor's shape. These unique features help minimize the negative impact to surrounding healthy tissue and organs beyond the tumor. That, in turn, may result in fewer side effects of the treatment itself.[6,11]

SRS is typically recommended for the treatment of tumors that are:[6,8,12]

- Small with well-defined margins
- Limited in number
- In hard to reach areas using surgery

Small tumors are generally considered to be 3 centimeters (the size of a grape) or less in diameter. Limited in number usually means 1 to 4 tumors.

SRS may be a good option for people who are poor candidates for surgery either due to their age or other health problems.[9]

Brain tumors that may be suitable for SRS include:

- Benign brain tumors such as meningiomas, pituitary adenomas, and vestibular schwannomas/acoustic neuromas[8,12]
- Single and multiple metastatic brain tumors[6,8,12]
- Select primary malignant brain tumors[8,12]
- Some recurrent brain tumors[8,13]

SRS also has been used to treat metastatic spinal tumors.[14,15] Typically, when focused radiation therapy

is applied to areas outside of the brain, the treatment is called ***stereotactic body radiation therapy*** or **SBRT**, although the technique is very similar to SRS.

TYPES OF SRS TECHNOLOGIES

There are different technologies used to deliver SRS. Although the equipment or method varies, the goal is the same.

SRS can be delivered using customized linear accelerators or approaches such as Gamma Knife®, CyberKnife®, or proton-based delivery systems.[6] In general, the specific approach used is not critical; the comfort and expertise of the medical team in administering the technique is more important.

The different SRS approaches are like different brands of cars; each offers subtle differences but when getting from Point A to Point B, it is often more important to have a good driver than to drive a specific brand of car.

WHAT TO EXPECT

The medical team spends a great deal of time and effort to plan treatment with SRS. Keeping patients still, determining exactly where the radiation beams must enter the body to reach the tumor, and choosing the best possible dose of radiation and schedule (if more than one session is needed) are all critical steps in the process.

The different technologies vary slightly in how they deliver SRS, but they all use:[6,12]

- Multiple, high-dose radiation beams/arcs
- Devices and techniques, such as a custom-made mask or a head frame, to position and keep the patient still

CyberKnife® SRS technology. Photo courtesy of Accuray, Inc.

- 3-dimensional imaging scans or other approaches to pinpoint tumor location to deliver the radiation therapy as accurately as possible
- A pre-treatment planning session, known as a simulation, to customize the radiation therapy for the specific patient[7,9]

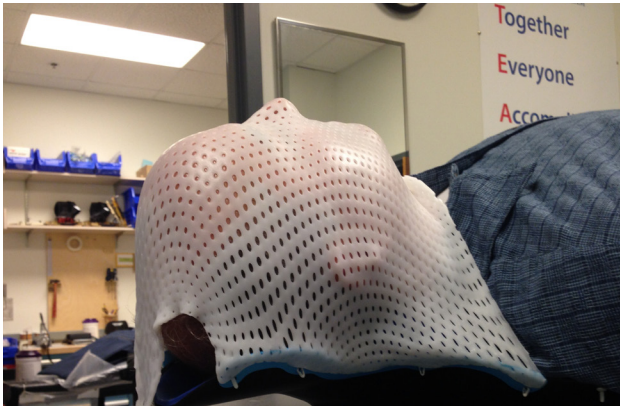
Prior to the treatment, the patient will be given instructions for how to prepare. **Typically, SRS is given as an outpatient procedure.**[6,9] Although not typically needed, the patient may be given oral or intravenous medication to help relax during the treatment.

Because SRS involves higher doses of radiation than conventional forms of radiation therapy, it requires that the patient be very still during the treatment.[10] Many types of head frames have been adapted for the different SRS systems to hold the patient's head still during radiation planning and treatment.

Historically, patients have been fitted with a light-weight ***head frame*** that is attached to the skull with screws, known as ***pins***, during a procedure that requires local anesthesia.[6]

SRS invasive head frame.

However, SRS technologies have largely moved to a frameless approach that uses a **custom-made mask** instead. Some newer SRS technologies also can adjust for patient movement during the session.[12]



SRS custom-made face mask.

With the head frame or custom-made mask firmly in place, the patient will have **magnetic resonance imaging (MRI)** and/or computed tomography (CT) scans.[6,16] The medical team will use these imaging scans and special computer software to develop a personalized treatment plan, tailoring the radiation dose, and mapping the exact area to be treated.

If having SRS using focused gamma beams, the simulation most commonly occurs the same day

of treatment. After the simulation, developing an individualized treatment plan can take an hour or two during which time the patient can relax.[6] If having SRS using a linear accelerator or proton therapy, the simulation often occurs one day or a few days before the scheduled SRS treatment session.[7]

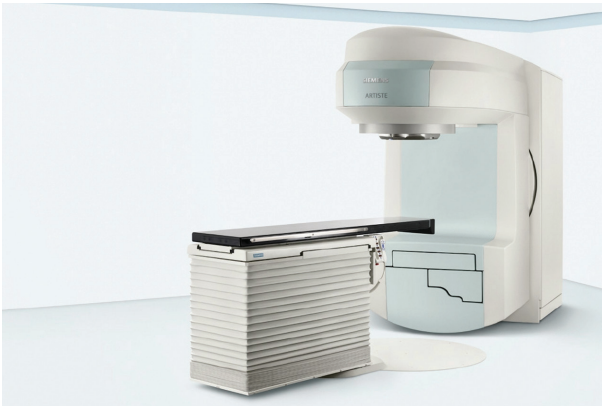
The SRS treatment will take place in a special treatment room.[16] If having SRS using focused gamma beams, the patient is positioned on a bed that slides into the machine.

Gamma Knife® used to deliver SRS therapy.

If having SRS using a linear accelerator or proton therapy, the patient is placed on a treatment table. Newer technology uses a linear accelerator mounted on a robotic arm that is guided by imaging scans.[6] Once the patient is properly positioned, the medical team leaves the room to start the SRS treatment.

Typically, an SRS session lasts anywhere from 20 minutes to two hours, from beginning to end.[6,7,9] The patient is exposed to radiation for only a short period of time. Most of the time is spent adjusting the patient's position and equipment settings.

In general, the area treated will include the tumor and possibly a small margin of mostly normal tissue surrounding it. Multiple narrow beams/arcs are



Linear accelerator used to deliver SRS therapy. Photo courtesy of Siemens Medical Systems, Inc.

programmed to come from different directions to deliver a specific dose of radiation to the tumor where all the beams intersect. The full dose of radiation is limited to the point at which the beams/arcs converge on the target, while non-target areas receive much smaller doses of radiation.[13,17]

The procedure itself is painless.[6] Some patients may see flashes of light when the machine is on, even with their eyes closed. Others may note an odd smell.

SRS is commonly given in one dose, but in some cases, it may require up to five doses.[6,9,12] This is especially true for larger tumors (more than 3 centimeters in diameter) or tumors in especially sensitive areas.[13] When SRS is given in more than one session, it is referred to as ***fractionated SRS***.[6,7] To minimize side effects from the radiation therapy, the additional treatments are typically given over a one- or two-week timeframe.[8] This allows enough radiation into the body to kill the cancer while giving healthy cells time to heal.[9] Additional SRS sessions will mimic the first one.

Once the SRS session is complete, the head frame or custom-made mask will be removed. The healthcare team will provide follow-up care instructions for the

next few days. **Following SRS, most patients should be able to return to their normal activities within a couple of days.**[6] Before driving, operating heavy machinery, flying, or engaging in strenuous physical activity, patients should ask their doctor if it is okay to perform such activities.

During a follow-up visit scheduled a few months after the SRS session(s), the doctor will conduct an imaging scan to evaluate the initial effect of the SRS treatment.

BENEFITS OF SRS

The primary benefit of SRS is that it delivers very high doses of radiation with great accuracy, minimizing the amount of radiation to nearby healthy tissue and structures.[6,12] Sparing healthy tissue and organs helps reduce the side effects that patients experience from radiation therapy. **This benefit is particularly important for young children**, whose growth and development can be negatively affected by radiation therapy.[5]

In general, benign tumors typically stabilize or shrink slightly over a period of several years following SRS treatment.[6] Benign tumors rarely disappear, but they are made inactive by the radiation and lose their ability to grow. This is considered a good response to the radiation therapy.

Metastatic tumors may shrink quickly, even within a couple of months and often will disappear entirely. Like benign tumors, some metastatic tumors may not shrink completely but will stop growing and remain stable. This is also considered a good result. Certain tumors, such as acoustic neuromas, appear to enlarge temporarily due to the SRS treatment but then regress over time. This is known as ***pseudoprogression*** and is a normal temporary inflammatory reaction that occurs in the first one to two years after treatment.

SRS is becoming the preferred form of radiation therapy for some patients with a limited number of metastatic brain tumors because it is associated with good local control, which refers to stopping the cancer from growing beyond the original tumor site; a smaller chance of cognitive decline (in skills such as thinking, learning, concentrating, problem-solving, and decision-making); and better quality of life compared with conventional forms of radiation therapy.[13,18,19]

For patients who have a single or limited number of metastatic brain tumors that are small, studies support using SRS alone to initially manage the tumors.[13] Patients with these types of tumors have had local control rates of 70% or greater at one year following treatment, according to controlled trials.

Recently, national cancer experts who form treatment guidelines began recommending consideration of SRS following surgery for patients who function well, are able to perform normal daily activities, and have low tumor volume, which refers to the amount of cancer present.[20]

SRS is increasingly being used to treat recurrent or new tumors that arise after initial therapy for patients who are functioning well and have largely stable disease.[13] Patients with previously untreated tumors are expected to have similar local control rates to those seen with initial therapy.

For metastatic spinal tumors, SRS has been shown to offer good local control when used as either the main treatment option or following surgery.[14,15]

While SRS is effective at getting rid of existing tumors, it does not prevent new tumors from developing.[11]

SIDE EFFECTS

As with all radiation therapy, there is the potential for patients undergoing SRS 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 within a few weeks after the final treatment.[4,6] Side effects depend on the tumor type being treated, dose of radiation given, and number of treatments needed.[3,7] When SRS is combined with chemotherapy, patients may have more severe side effects.[21]

Common side effects from SRS include fatigue, mild skin reactions, hair loss near the treated area, nausea and vomiting, new or worsening headache, dizziness, and edema.[3,8,13] Much rarer risks include seizures or bleeding. Relieving 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.

Fatigue

Often described as feeling extremely tired, run down, or lacking energy,[22,23,24] fatigue may start a few weeks into treatment.[25] It typically goes away gradually after treatment has ended, but normal energy levels may take several months to return. Tips to manage fatigue include:[22,23,24]

- Plan daily activities. Eliminate unnecessary tasks. Patients can do necessary tasks during the time of day they feel their best.
- Take time to rest. Enjoy relaxing activities, such as listening to music, doing a hobby, or meditating. Naps can help conserve energy for when it's needed most, just limit them so it's not hard to fall asleep at night.

- Engage in some physical activity. Light exercise (as approved by the doctor) can improve energy levels and quality of life.
- Eat and drink well. Healthy meals and snacks offer needed nutrients and energy.
- Ask family members and friends to help with routine tasks such as making a meal, grocery shopping, or running an errand. People want to help; they just don't know what they can do.
- Patients can speak with their employer about changing work schedules (modified hours or remote work) until their energy levels increase.

Mild Skin Reactions

These may include redness, irritation, swelling, dryness, blistering, or a sunburn look.[26,27,28] Skin reactions may start a few weeks after the first treatment and usually stop a few weeks after treatment has ended. While skin reactions are often mild, some may be more severe. Tips to manage mild skin reactions include:

- Moisturize dry, itchy skin often to reduce itching and soften the skin. Ask the healthcare team for product recommendations. Antihistamines may be prescribed to relieve itching.
- Shower and bath with warm – not hot – water. The latter can dry skin even more. Apply moisturizer shortly after the shower/bath while the skin is still damp.
- Practice good sun protection. Use a broad-spectrum sunscreen with a 15+ SPF (sun protection factor), wear a hat and protective clothing, and avoid the sun during peak hours.

- Keep the skin clear and dry to reduce the chance of infection. Open sores may be a sign of infection that may need treatment with oral antibiotics.
- Use mild soaps. Avoid products that contain alcohol or fragrances as they can dry or irritate the skin.
- Ask the healthcare team about corticosteroid skin creams, which may help prevent skin changes.

Hair Loss

Hair loss, also known as alopecia, may be temporary or permanent, depending on the dose of radiation therapy.[29,30,31] When hair does grow back, it usually takes several months after treatment has ended. It may be thinner or a different color or texture. Tips to manage hair loss include:

- Treat hair gently. Use a hairbrush with soft bristles or a wide-tooth comb. Wash less often and with a mild, fragrance-free shampoo. Avoid using hair dryers, irons, or gels and clips that can hurt the scalp.
- Choose a new hairstyle. Some patients opt for a short hairdo or even shave their head, making it easier to deal with when the hair starts falling out. Shorter hairstyles may make thin hair appear fuller.
- Avoid using chemical products to curl, straighten, or color the hair that can further damage it.
- Use sun protection. Wear a broad-spectrum sunscreen with a 15+ SPF, and a hat or scarf when outdoors.
- Sleep on a satin pillowcase to decrease friction.

Nausea and Vomiting

Nausea is a sick or queasy feeling whereas vomiting is throwing up, often after feeling nauseas. One or both can occur before treatment, within 24 hours after treatment, or a few days after treatment has ended.[32] Tips to manage nausea and vomiting include:[32,33,34]

- Ask the healthcare team about antiemetics. These medicines may help prevent or reduce nausea and vomiting. There are different kinds of antiemetics, so one may work better than another.
- Drink plenty of water and fluids. Sip on water, fruit juices, ginger ale, flat soda, tea, and/or sports drinks throughout the day to help prevent dehydration.
- Avoid certain foods. These include fatty, fried, greasy, spicy, or sweet foods as well as citrus fruits, juices, and tomatoes. If the smell of food is nauseating, try eating cold food.
- Modify foods on treatment day. Some patients report that eating a small snack before having SRS reduces nausea, while others avoid food and drink right before or after treatment. After treatment, wait at least one hour before eating or drinking.
- Engage in complementary medicine practices. These include acupuncture, guided imagery, meditation, and/or hypnosis.

Edema

Also known as swelling in the brain, edema commonly occurs several months following treatment and decreases over time.[35,36] Edema may cause seizures,[37]

so patients should tell their healthcare team if they experience either symptom. Patients should be monitored for edema throughout the course of their SRS. Tips to manage edema include:

- Ask the healthcare team about medications to help reduce edema. The doctor may prescribe a short course of steroids to take during and possibly after treatment has ended.[13,21,38]

- If prescribed steroids, follow the doctor's instructions for taking them. Never abruptly stop steroid medications as they need to be slowly reduced, allowing the body time to begin making its own natural steroids again.

- Report stomach irritation, nervousness or difficulty sleeping, yeast infection in the mouth, and/or weakness in the legs as these may be side effects of steroids and can be treated with other medicines.

Radiation necrosis (death of healthy tissue caused by radiation therapy) is the most common delayed complication, but only occurs in a small percentage of patients.[13] It can happen anytime from six months to several years following treatment. Treatment options for radiation necrosis include corticosteroids and bevacizumab[13,39] as well as surgery and a minimally invasive procedure called ***laser interstitial thermal therapy.***[40,41]

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 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 Patient & Caregiver Mentor Support 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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