Stereotactic Radiosurgery & Radiotherapy of the Body

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The following is an advanced-level, step-by-step description of stereotactic radiosurgery (SRS) and fractionated stereotactic radiotherapy (FSR) procedures for the body performed in a linear accelerator (LINAC). For basic-level information, see Introduction to Radiation Therapy

Stereotactic Radiosurgery (SRS)

Stereotactic radiosurgery is a form of external beam radiation that delivers a high dose during a single session to shrink or destroy tumors and diseases of the body (Fig. 1). Because a single radiosurgery dose is more damaging than multiple fractionated radiotherapy doses, the target area must be precisely located and completely immobilized with a stereotactic body frame. Any tumor, lesion or malformation to be treated with radiation is called a target. Patients spend one day at the treatment center while the target is located stereotactically, a treatment plan is developed, and radiation is delivered.

Fractionated Stereotactic Radiotherapy (FSR)

Radiosurgery treatments given over multiple visits are called fractionated stereotactic radiotherapy (FSR). Until recently, fractionation was not possible using stereotactic techniques because there was no way to keep the rigid frame in place after the first treatment session. Repositionable body molds and frames, along with x-ray and infrared positioners, ensure treatment accuracy, making multiple radiosurgery sessions possible. FSR offers the precision of stereotaxy for those who have lesions near critical structures, such as the spinal cord, that cannot tolerate high doses. Patients spend the first day at the treatment center while the target is located stereotactically and a treatment plan is developed. They will return daily for several weeks to receive fractions of the complete dose.

Am I a candidate?

You may be a candidate for SRS or FSR if you have a:

- Primary spinal tumor
- Spinal tumor metastasis
- Lung tumor
- Prostate tumor
- Kidney tumor
- Liver tumor

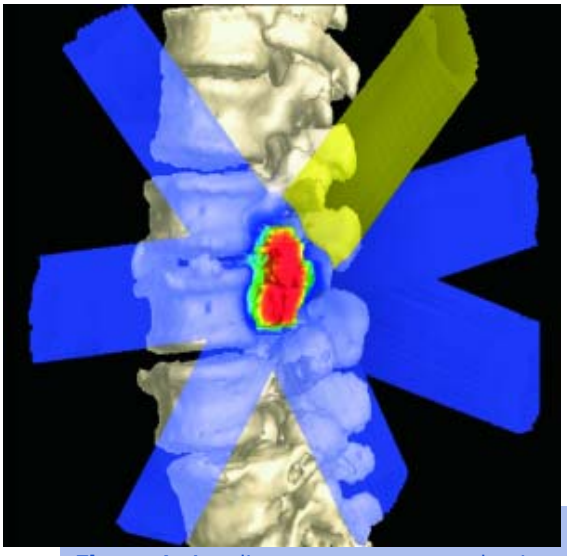

Figure 1. A radiosurgery treatment plan is developed to shape the radiation beam to the exact contour of the tumor located in the bony vertebra of the spine. Precisely shaped beams allow a maximum dose to be delivered to the spinal tumor while minimizing exposure to the spinal cord.

- Gynecological tumor
- Pancreas tumor
- Colon / Rectum tumor

SRS and FSR may be used alone or with other treatments such as surgery, chemotherapy or immunotherapy. Radiosurgery can be used when a tumor or malformation is first diagnosed or has recurred after previous treatment; or it can be used as a supplement, commonly called boost therapy, to other treatments.

Once your condition has been diagnosed, your doctor will discuss all treatment options and may recommend a consultation with a radiation oncologist. The surgeon and radiation oncologist will work together to choose the best type of radiation for your particular tumor or lesion, explain the treatment process and describe some possible side effects. Once you have decided to go ahead with treatment, you will need to sign a consent form. The doctor may also send you for a special MRI scan for use during radiation treatment planning.

What happens before treatment?

Come to the hospital or outpatient center the morning of the procedure and check in with the receptionist when you arrive. Dress comfortably and bring a book or something else to keep you busy during the waiting periods. You may also bring a friend or a relative, who may stay with you during the day.

The nurse or radiation therapist will escort you to a patient holding room, where you will need to change into a gown.

Figure 2. A body frame is a custom-formed vacuum cushion that molds to the exact contours of your body. It attaches to the table and positions you during treatment.

What Happens During Treatment

Step 1. Attach stereotactic frame

For SRS and FSR, you lie in a stereotactic body frame. A bean bag-like cushion is vacuum-molded to your body's exact shape to ensure accurate positioning during treatment. It does not interfere with breathing and is minimally confining. The body cushion and frame do not require any hardware or incisions (Fig. 2).

Step 2. CT or MRI localization

You then undergo an imaging scan using either computerized tomography (CT) or magnetic resonance imaging (MRI) or both. The fiducials on the body frame show up on the scan and help pinpoint the exact three-dimensional coordinates of the target within the body. After the scan you may get up from the body frame.

Patients receiving FSR typically go home after the localization scan. The doctors continue with step 3 (treatment planning), and the patient returns within a week or so to begin treatment. In contrast, SRS patients are taken to a private room and given a light breakfast while they wait for the treatment plan to be determined so that radiation can be delivered on the same day.

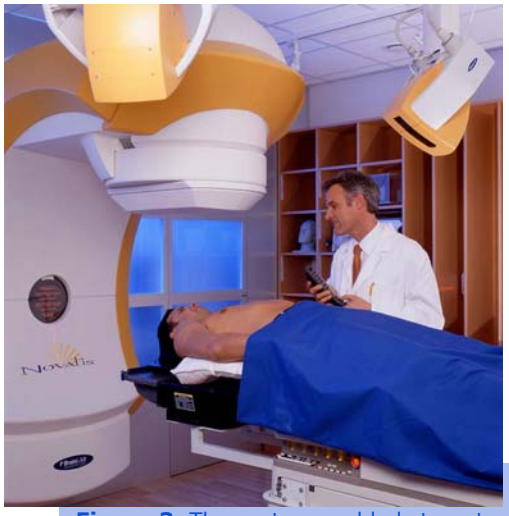

Figure 3. The custom-molded stereotactic body frame is secured to the table, precisely positioning the target in the treatment field. X-ray positioners, which are mounted on the ceiling, take stereoscopic x-rays of your anatomy and compares them to the position in the treatment planning software.

Step 3. Treatment planning

Information about the target's location, volume and proximity to critical structures is gathered by the CT scan and transferred into the treatment planning computer system. In some cases MRI images also are sent electronically to the system. The software uses the CT or MRI images to form a 3D view of your anatomy and the target. Using the software, the team (radiation oncologist, surgeon and physicist) determine the radiation prescription:

- appropriate radiation dose
- number and angle of treatment arcs
- size and shape of the beams to exactly match your tumor or target

It is crucial that the dose be applied only to the affected area. By using numerous beams, the radiation dose of normal tissue is minimized. All beams meet at a single point, where the target is located. At the center the single beams add up to a very high dose of radiation.

Figure 3. The therapist uses infrared body markers, which are detected by the infrared cameras, to compare your body position to the computerized treatment plan and verify correct positioning.

Step 4. Position the patient

Once the LINAC is calibrated and prepared for your specific treatment plan, you lie in the stereotactic body frame. The stereotactic body frame is secured to the treatment table. Alignment lasers and localizing x-rays help the radiation therapist position you correctly (Fig. 3). Infrared markers are placed on your skin near the target area. These markers are detected by infrared cameras and compared to the body position in the treatment planning computer (Fig. 4). Stereoscopic x-rays are taken and compared to the treatment plan. Any misalignments are detected and corrected by a computer-controlled motorized tabletop.

Step 5. Treatment

Once exact positioning is confirmed, the therapist leaves the room and operates the LINAC machine from the control room. The treatment team can watch you through video monitors and speak to you over an intercom. The LINAC and treatment table periodically move to deliver radiation beams from one or more directions.

The LINAC machine is large and makes noises as it moves around your body. Its size and motion may be intimidating at first; it may pass close to your body, but will not touch you. Treatment may take 30-60 minutes or longer, depending on the number of targets.

What happens after treatment?

Step 6. Remove stereotactic frame

After treatment the radiation therapist releases the stereotactic body frame from the table. You may then change back into your clothes, gather your belongings and go home.

If you received FSR, the custom body mold is stored at the center for your next treatment session. You will return each day at your scheduled time to repeat steps 4 through 6 until all fractions of the complete dose are delivered.

What are the results?

Following SRS or FSR treatment, CT, MRI, or angiography scans will be taken periodically to look for signs of response. Several months may pass before the effects of treatment are visible.

What are the risks?

Side effects vary depending on the tumor type, total radiation dose, size of the fractions, length of therapy, and amount of healthy tissue in the target area. Some side effects are temporary and some are permanent. Generally, patients may experience fatigue, skin irritation around the target area, and hair loss (see Introduction to Radiation Therapy).

On rare occasions, the radiation dose can cause a build up of dead tumor tissue, called radiation necrosis, several weeks to months after treatment. Dead or necrotic tissue can become toxic to surrounding normal tissue and swelling may occur. Treatment for radiation necrosis may include steroid medication, hyperbaric oxygen treatments, or surgical removal.

Sources & links

If you have more questions, please contact Precision Radiotherapy at 513-475-7777. Additional information is available on the web at www.PrecisionRadiotherapy.com.

Links

National Cancer Institute
www.cancer.gov
International Radiosurgery Association
www.irsa.org
American Brain Tumor Association
www.abta.org

www.radiologyinfo.org

www.oncologychannel.com

Glossary

benign: not cancerous.
chemotherapy: treatment with toxic chemicals (e.g., anticancer drugs).
fractionated: delivering the radiation dose over multiple sessions.
lesion: a general term that refers to any change in tissue, such as tumor, blood, malformation, infection or scar tissue.
linear accelerator: a machine that creates a high-energy radiation beam, using electricity to form a stream of fast-moving subatomic particles; also called a LINAC.
malignant: cancerous.
metastatic: cancerous tumor that has spread from its original source.
stereotactic: a precise method for locating structures within the body by the use of 3-dimensional coordinates.
target: area where the radiation beams are aimed; usually a tumor, malformation or other abnormality of the body.