

## Brain Tumors

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*This information is reviewed by a physician with expertise in the area presented and is further reviewed by committees from the American College of Radiology (ACR) and the Radiological Society of North America (RSNA), comprising physicians with expertise in several radiologic areas.*

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### Brain Tumors Overview

A brain tumor is a group of abnormal cells that grows in or around the brain. Tumors can directly destroy healthy brain cells. They can also indirectly damage healthy cells by crowding other parts of the brain and causing inflammation, brain swelling and pressure within the skull.

Brain tumors are either malignant or benign. A malignant tumor, also called brain cancer, grows rapidly and often invades or crowds healthy areas of the brain. Benign brain tumors do not contain cancer cells. They look normal under a microscope and are usually slow growing.

Brain tumors fall into two different categories: primary or metastatic. Primary brain tumors begin within the brain. A metastatic tumor is formed when cancer cells located elsewhere in the body break away and travel to the brain. For this reason, metastatic brain tumors are almost always malignant, while primary brain tumors may be benign or malignant.

Brain tumors are classified based on where the tumor is located, the type of tissue involved, whether the tumor is benign or malignant, and other factors. If a tumor is determined malignant, the tumor cells are examined under a microscope to determine how malignant they are. Based on this analysis, tumors are rated, or graded, by their level of malignancy from least to most malignant.

Factors that determine the tumor grade include how fast the cells are growing, how much blood is supplying the cells, the presence of dead cells in the middle of the tumor (necrosis), if the cells are confined to a specific area, and how similar the cancerous cells are to normal cells.

The cause of primary brain tumors is unknown. Environmental and genetic factors may cause some brain tumors. Prior exposure to therapeutic irradiation as a child seems to be a causative agent in very few patients.

Symptoms of a brain tumor include headaches, nausea, vomiting, seizures, behavior changes, memory loss, and vision or hearing problems.

### What are my treatment options?

A variety of therapies are used to treat brain tumors. The type of treatment recommended depends on the size and type of the tumor, its growth rate, and the general health of the patient.

Treatment options include surgery, radiation therapy, chemotherapy, targeted biological agents, or a combination of these. Surgical resection (if safe) is generally the first treatment recommendation to rapidly reduce pressure in the brain. This Web site focuses on radiation therapy for brain tumors.

In the past two decades, researchers have developed new techniques of delivering radiation that target the brain tumor while protecting nearby healthy tissues. These treatments include brachytherapy, intensity-modulated radiation therapy (IMRT) and radiosurgery.

Radiation therapy may be advised for tumors that are sensitive to this treatment. Conventional radiation therapy uses external beams of x-rays, gamma rays, or protons aimed at the tumor to kill cancer cells and shrink brain tumors.

The therapy is usually given over a period of several weeks. Whole brain radiation therapy is an option in the case of multiple tumors.

New types of radiation therapy include:

- Intensity-modulated radiation therapy (IMRT): an advanced mode of high-precision radiotherapy that utilizes computer-controlled x-ray accelerators to deliver precise radiation doses to a malignant tumor or specific areas within the tumor. The radiation dose is designed to conform to the three-dimensional (3-D) shape of the tumor by modulating—or controlling—the intensity of the radiation beam to focus a higher radiation dose to the tumor while minimizing radiation exposure to healthy cells.
- Stereotactic radiosurgery is a highly precise form of radiation therapy that directs narrow beams of radiation to the tumor from different angles. For this procedure, the patient wears a rigid head frame. Computed tomography (CT) or magnetic resonance imaging (MRI) help the doctor identify the tumor's exact location and a computer helps the doctor regulate the dose of radiation. Stereotactic radiotherapy is similar physically to radiosurgery but involves multiple treatments and usually involves wearing a reusable cast for the head positioning or another type of tracking system for positioning. This modality would be recommended for tumors within or close to critical structures in the brain that can not tolerate a large single dose of radiation.
- Hyperfractionation involves smaller doses of radiation two to three times a day, as opposed to a larger amount once a day.
- Three-dimensional conformal radiation therapy (3D-CRT): a conventional form of radiation treatment delivery that uses a specific arrangement of x-ray beams of designed to conform to the shape of the tumor to maximize tumor dose and minimize normal surrounding tissue dose. This form of treatment is tailored to the patient's specific anatomy and tumor location. CT and/or MRI scan is often required for treatment planning.
- Brachytherapy: the temporary placement of radioactive materials within the body, usually employed to give an extra dose—or boost—of radiation to the area of the excision site.

Surgery, also called surgical resection, is often indicated for primary brain tumors. A surgeon removes some or the entire tumor without causing severe damage to surrounding tissues. Surgery may also be used to reduce pressure within the skull (called intracranial pressure) and to relieve symptoms (called palliative treatment) in cases when the tumor cannot be removed.

Chemotherapy, or anticancer medications, may be recommended. Chemotherapy along with radiation, or concurrent chemo radiation therapy, has become the standard of care for primary malignant brain tumors.

The use of these drugs or chemicals to slow down or kill rapidly dividing cells can be used before, during, or after surgery to help destroy tumor cells and to prevent them from returning. Chemotherapy drugs may be taken by pill or by injection and are often used in combination. Various drugs which are believed to make radiation therapy more effective, called radiosensitizers, may also be prescribed.

## What happens during radiation therapy?

For conventional radiation therapy, your initial visit with the radiation oncologist is called a consultation. During this visit, the physician will review the history of your illness and perform a physical examination. Consultations with other members of your treatment team may also take place at this time.

After you and your radiation oncologist, a physician specializing in radiation therapy has decided on a course of treatment, you will begin the first phase—treatment planning. During this planning phase of your treatment, your radiation oncologist along with the help of radiation therapist, dosimetrist and physicist will simulate your radiation therapy treatment using either conventional radiographs (x-rays) or a computed tomography (CT) scan. In some cases, an MRI scan may be required. These radiographic studies are used to plan the type and direction of radiation beams used to treat the cancer.

You will be asked to lie without moving on the treatment table during simulation, although no radiation therapy will be given at that point. Typically, treatment begins one to two days after your treatment planning session.

During your actual radiation therapy treatment, you will be asked to lie on the treatment table without moving. A radiation therapist will administer the treatment prescribed by the radiation oncologist. The treatment will last only a few minutes, and you will not feel anything. If you undergo stereotactic radiosurgery, you will wear a rigid head frame. In this procedure, a computed tomography (CT) scan or magnetic resonance imaging (MRI) will be used to help the doctor identify the tumor's exact location and a computer will regulate the dose of radiation as needed.

Treatment planning sessions and your first radiation therapy treatments may take an hour or two. Thereafter, treatments will usually last a few minutes and you will be in and out of the radiation department in 30 to 45 minutes for each session. Typically, treatments are given once or twice a day, five days a week for five to seven weeks.

## What are possible side effects of radiation therapy?

The side effects of radiation therapy to the brain may not occur until two weeks after the start of your therapy. Many people experience hair loss but the amount varies from person to person. Hair usually grows back once therapy is finished.

The second most frequently reported side effect is a skin irritation. The skin around your ears and scalp may become dry, itchy, red or tender. It is important not to attempt to treat this side effect on your own, but rather to seek medical treatment as soon as it occurs. Fatigue is another possible side effect of radiation therapy. The best way to fight fatigue is to make sure to get adequate rest, eat a healthy diet, and rely on friends and family for support. Your normal energy levels should return about six weeks after you finish your therapy.

Edema, or swelling of the brain, is also prevalent among individuals undergoing radiation therapy to the brain. If you experience a headache or a feeling of pressure, report your symptoms to your oncologist. You may be prescribed medications to help reduce brain swelling, seizures or to control pain. When chemotherapy and radiation therapy are given at the same time, patients may experience more severe side effects. Your doctor can suggest ways to ease these uncomfortable symptoms.

Other possible side effects include:

- hearing problems
- nausea
- vomiting
- loss of appetite
- memory or speech problems
- headaches

## What are some of the possible risks or complications?

Radiation is a powerful weapon against cancer cells, but sometimes it kills healthy brain tissue as well—a severe side effect called radiation necrosis. Necrosis (a late effect of high doses of radiation) can cause headaches, seizures, or even death in a small number of cases. This can occur six months to a few years after treatment. However, the risk of necrosis has declined in recent years with the advent of the newer, targeted radiation therapies described above and the emergence of powerful imaging, brain mapping, and information technologies.

Other complications include:

- memory loss
- return of tumor growth

In children, radiation may damage the pituitary gland and other parts of the brain. This could cause learning problems or slow growth and development. Additionally, radiation during childhood increases the risk of developing tumors later in life. Researchers are studying chemotherapy as an alternative to radiation therapy in children with brain tumors.

## What kind of treatment follow-up should I expect?

Regular follow-up treatment is extremely important after treatment for a brain tumor. Besides regular physical and neurological exams, you may need periodic magnetic resonance (MRI), MR spectroscopy, perfusion or diffusion MRI, computed tomography (CT) or positron emission tomography (PET) scans, blood tests or an endoscopy procedure. Your physician may also recommend home care, occupational or vocational therapy, pain management, physical therapy and participation in support groups.

This follow-up care will help your physician to:

- spot any sign that the tumor is returning.
- monitor the health of your brain.
- identify and treat the side effects of chemotherapy or radiation therapy.
- detect the presence of other types of cancer at the earliest possible stage.

## Are there any new developments in treating my disease?

Over the past decade, improvements in fractionated and stereotactic radiotherapy are bringing new hope to patients with brain tumors, both in terms of survival and quality of life. A number of experimental drugs and therapies are also showing promise in clinical trials, including:

- Gene therapy involves the transfer of genetic material into a tumor cell, aiming to either destroy the cell or stop its growth.
- Angiogenesis inhibitors are drugs that interfere with the growth of blood vessels in the tumor, thus "starving" the tumor of the nutrients and oxygen it needs to grow. Treatment with these drugs is also called angiostatic therapy.
- New classes of biological agents and enhanced drug delivery methods are being evaluated in clinical trials.

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