Meningioma tumor

Overview
A meningioma is a type of tumor that grows from the protective membranes, called meninges, which surround the brain and spinal cord. Most meningiomas are benign (not cancer) and slow growing; however, some can be malignant. Symptoms typically appear gradually and vary depending on the location and brain area affected. Because of their slow-growth, not all meningiomas need to be treated immediately. Treatment options focus on removing the tumor and relieving the compression on the brain.

What is a meningioma?
Three layers of membranes, called meninges, lying just under the skull, protect the brain and spinal cord. From the outermost layer inward they are: the dura, arachnoid, and pia. A meningioma grows from the arachnoid cells that form the middle layer, and are firmly attached to the dura (Fig. 1). Some meningiomas contain cysts or calcified mineral deposits, and others contain hundreds of tiny blood vessels. Because meningiomas tend to grow inward, they commonly cause pressure on the brain or spinal cord. They can also grow outward, causing the skull to thicken (hyperostosis).

Meningiomas are classified by their cell type and grade by viewing the cells taken during a biopsy under a microscope. Treatment varies depending on the grade of the meningioma.

- **Grade I, benign** meningiomas are the slowest growing. If the tumor is not causing symptoms, it may be best to observe its growth over time with periodic MRI scans. If there is a chance the tumor will grow enough in your lifetime to cause symptoms, then surgical removal may be recommended. Patients who undergo complete removal of a grade I meningioma usually do not require additional treatment. In contrast, incomplete removal may need radiation after surgery.

- **Grade II, atypical** meningiomas are slightly more aggressive in growth than grade I and have a slightly higher risk of recurrence. Surgery is the first line treatment. Some grade II meningiomas require radiation after surgery.

- **Grade III, malignant** meningiomas are the most aggressive and are called anaplastic. Malignant meningiomas account for less than 1% of all meningiomas. Surgery is the first line treatment for grade III, followed by radiation. If the tumor recurs, chemotherapy is used.

What are the symptoms?
Meningiomas grow slowly; it may take years before they cause symptoms. Some people with meningiomas have no symptoms. The tumor may be found incidentally on a diagnostic scan performed for another reason. Symptoms of a meningioma vary by the location and size of the tumor. They often first appear as headaches and seizures caused by increased pressure of the growing tumor. Weakness in the arms or legs, or loss of sensation, may occur with spinal cord meningiomas.

Meningiomas are named according to their location (Fig. 1) and cause various symptoms:
- **Convexity meningiomas**: grow on the surface of the brain. They may not produce symptoms until they reach a large size. Symptoms include seizures, neurological deficits, or headaches.

- **Falx and parasagittal meningiomas**: grow from the dura fold that runs between the left and right sides of the brain. The falx contains two large blood vessels (sinuses). Because of the danger of injuring the sinuses, removing a tumor in this region can be difficult. Symptoms may include personality changes, headache, vision problems, and arm or leg weakness.

- **Olfactory groove meningiomas**: grow along the nerves that run between the brain and the nose and often cause a loss of smell. They can compress the frontal lobes, causing personality changes that may be mistaken for depression. They can also compress the optic nerves, causing visual problems or even blindness.

- **Tuberculum sella meningiomas**: grow near the pituitary gland and optic chiasm. They cause visual field problems and can extend into the optic canal.

- **Sphenoid meningiomas**: grow along the sphenoid ridge behind the eyes. These tumors can cause visual problems, loss of sensation in the face, or facial numbness. They often encase major blood vessels (e.g., cavernous sinus, or carotid arteries) as well as the cranial nerves, making them difficult to completely remove.

- **Posterior fossa meningiomas**: grow along the underside of the brain near the brainstem and cerebellum. These tumors can compress the cranial nerves, causing facial symptoms or loss of hearing. Petroclival tumors can compress the trigeminal nerve, resulting in facial pain or spasms of the facial muscles.

- **Foramen magnum meningiomas**: grow where the spinal cord connects to the brain and can cause headaches, and signs of brainstem compression, such as difficulty walking.

- **Intraventricular meningiomas**: grow inside the fluid-filled ventricles of the brain. They block the flow of cerebrospinal fluid, causing hydrocephalus, headaches and dizziness.

- **Intraorbital meningiomas**: grow around the eye sockets of the skull and can cause pressure in the eyes to build up, giving a bulging appearance. They can also cause loss of vision.

- **Spinal meningiomas**: grow mainly in the thoracic spine. They can cause back pain (typically at night) or loss of sensation and paralysis of the legs from compression of the spinal nerves.

**What are the causes?**

Scientists are not certain what causes meningioma tumors. Most agree that a damaged chromosome is the most common abnormality in meningiomas, but the cause of this abnormality is unknown. People with the genetic disorder neurofibromatosis type 2 (NF2) are more likely to develop meningiomas. Studies show that patients who received radiation treatment to the head for other conditions are at higher risk for developing meningiomas later in life.

**Who is affected?**

Meningiomas represent about 36% of all primary brain tumors and 12% of all spinal cord tumors. They can occur in children, but most often occur in adults between the ages of 40 and 60 years. Most are benign (not cancer); less than 10% are malignant. While malignant meningiomas occur in both women and men, benign meningiomas are three times more common in women.

**How is a diagnosis made?**

The doctor will ask about your personal and family medical history and perform a physical exam. In addition to checking your general health, the doctor performs a neurological exam to check mental status and memory, cranial nerve function (sight, hearing, smell, tongue, and facial movement), muscle strength, coordination, reflexes, and response to pain. The doctor may order diagnostic imaging such as computerized tomography (CT) or magnetic resonance imaging (MRI) scans to help determine the size, location, and type of any tumor (Fig. 2). In some cases, angiograms of the blood vessels are necessary.

![Figure 2. MRI scan of a sphenoid meningioma. The tumor has filled the area where the temporal lobe normally lies. The illustration shows that as the tumor grows, it compresses and displaces normal brain tissue and can encase the arteries and nerves, causing vision problems.]

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What treatments are available?
There are a variety of treatment options for meningiomas. The treatment that is right for you will depend on your age, general health status, and the location, size, and grade of the meningioma. Each treatment has benefits, risks, and side effects that should be discussed and understood.

Observation (“watch and wait”)
Because meningiomas grow slowly, patients with no or few symptoms may be monitored instead of undergoing surgical removal of the tumor. The doctor will monitor the growth of the tumor with periodic MRI scans. Patients should immediately report any change in their symptoms.

Surgery
Surgical removal is the most common treatment for meningiomas that cause symptoms. A surgeon performs a craniotomy to open the skull and remove the tumor (Fig. 3). A biopsy of tissue is examined by a pathologist to determine the tumor grade. Although total removal can provide a cure for meningiomas, it is not always possible. The tumor location determines how much can be safely removed. If the tumor cannot be completely removed, radiation can treat the remainder of the tumor.

Technologies have improved the surgeon’s ability to precisely locate the tumor, define the tumor’s borders, avoid injury to vital brain areas, and confirm the amount of tumor removal while in the operating room. These include:

- **Image-guided surgery** (IGS) is a technology that helps the surgeon pinpoint the exact location of a tumor – similar to a GPS for the brain. Before surgery, a special MRI scan is performed, with fiducial markers placed on the skin around the patient’s head. During surgery, the fiducial markers correlate the “real patient” lying on the table to a 3D computer model of the patient created from his or her MRI or CT scans. Using a hand-held probe, the surgeon can track the probe’s position in real time on the computer model of the patient’s anatomy. IGS allows very precise planning of the approach by pinpointing the tumor location and guiding the skin and bone openings.

- **Brain mapping functional MRI** (fMRI) creates a series of images of the brain in action. The images capture blood oxygen levels in parts of the brain that are responsible for movement, perception, language and thinking (Fig. 4). By identifying and “mapping” these eloquent areas, surgeons can remove tumors to the greatest extent possible without harming areas that are critical to the patient’s quality of life.

- **Keyhole & endoscopic surgery** are minimally invasive techniques that enable surgeons to remove tumors at the skull base through small keyhole openings, such as through the nose, eyelid or eyebrow. Tumors that formerly required a large craniotomy and brain retraction can be accessed with endoscopes through natural pathways such as the nose and sinuses.
• **Intraoperative MRI** is a specially designed operating room in which the patient can undergo an MRI scan before, during, and after surgery while still under anesthesia. This enables the surgeon to have real-time images of the patient’s brain and to know exactly how much tumor has been removed prior to ending the procedure. This technology improves the potential for total tumor removal and reduces the need for a second operation.

**Radiation**

Indications for radiation include: (1) incomplete tumor removal, (2) inoperable tumors, (3) malignant meningioma, and (4) patient choice. In these cases, radiation may be used to damage the DNA inside the cells, making them unable to divide and reproduce. The goal of radiation treatment is to maximize the dose to abnormal tumor cells and minimize exposure to normal healthy cells (Fig 5). The benefits of radiation are not immediate but occur over time. Gradually, the tumor will stop growing, shrink, and in some cases completely disappear. Benign tumors, whose cells divide slowly, may take several months to a year to show an effect.

There are two techniques for delivering radiation: a single high dose (stereotactic radiosurgery) or multiple low doses (fractionated radiotherapy).

• **Stereotactic radiosurgery** delivers a high dose of radiation during a single session. Although it is called surgery, no incision is made. Because a single radiosurgery dose is more damaging than multiple fractionated doses, the target area must be precisely located and completely immobilized with a stereotactic head frame or facemask. Patients spend most of the day at the center while the tumor is precisely located, a treatment plan is developed, and a radiation dose is delivered.

• **Fractionated radiotherapy** delivers a low dose of radiation daily over 5 to 6 weeks. A facemask is used to precisely localize the tumor and accurately reposition the patient for each treatment session. Delivering a fraction of the total radiation dose allows normal cells time to repair themselves between treatments. It also reduces side effects. Fractions are usually given five days a week with a rest over the weekend.

**Clinical trials**

Clinical trials are research studies in which new treatments – drugs, diagnostics, procedures, vaccines, and other therapies – are tested in people to see if they are safe and effective. Research is always being conducted to improve the standard of medical care and to explore new drug and surgical treatments. Information about current clinical trials, including eligibility, protocol, and locations, are found on the web. Studies can be sponsored by the National Institutes of Health (www.clinicaltrials.gov) as well as private industry and pharmaceutical companies (www.centerwatch.com).

**Recovery**

The location of the tumor is the most important factor in determining the outcome. Convexity, parasagittal, and sphenoid wing meningiomas usually are completely removable and surgery can yield excellent results. Optic, cavernous sinus, and skull base meningiomas have a higher rate of complication and are more difficult to completely remove. The patient’s age and overall health prior to surgery may also affect the results. Meningiomas may recur after surgery or radiation. Regular follow-up MRI or CT scans (1 to 2 years) are an important part of long-term care for anyone diagnosed with a meningioma.

**Sources & links**

If you have more questions, please contact the Mayfield Brain & Spine at 800-325-7787 or 513-221-1100. For information about the University of Cincinnati Neuroscience Institute’s Brain Tumor Center, call 866-941-8264.
Support
Support groups provide an opportunity for patients and their families to share experiences, receive support, and learn about advances in treatments and medications.

Links
American Brain Tumor Association
www.ABTA.org  800-886-2282

National Brain Tumor Society
www.braintumor.org  800-934-2873

Glossary
anaplastic: when cells divide rapidly and bear little or no resemblance to normal cells in appearance or function.
benign: does not invade nearby tissues or spread; not cancerous.
bio[p]sy: a sample of tissue cells for examination under a microscope to determine the existence or cause of a disease.
edema: tissue swelling caused by the accumulation of fluid.
hyperostosis: an excessive growth of bone.
meninges: three membranes (pia mater, arachnoid mater, and dura mater) that surround the brain and spinal cord.
hemangiopericytoma: a very uncommon type of meningioma, highly vascular and usually fast growing.
mass effect: damage to the brain caused by the bulk of a tumor, blockage of fluid, and/or excess accumulation of fluid within the skull.
malignant: having the properties of invasive growth and ability to spread to other areas; cancerous.
meningioma: a tumor that grows from the meninges, the membrane that surrounds the brain and spinal cord.