About Brain and Spinal Cord Tumors in Adults

Get an overview of the functions and parts of the brain and spinal cord, types of brain tumors, and the latest research and key statistics in the US.

Overview and Types

If you have been diagnosed with a brain or spinal cord tumor or are worried about it, you likely have a lot of questions. Learning some basics is a good place to start.

- What Are Adult Brain and Spinal Cord Tumors?
- Types of Brain and Spinal Cord Tumors in Adults

Research and Statistics

See the latest estimates for new cases of brain and spinal cord tumors and deaths in the US and what research is currently being done.

- Key Statistics for Brain and Spinal Cord Tumors
- What's New in Adult Brain and Spinal Cord Tumor Research?

What Are Adult Brain and Spinal Cord Tumors?

- The central nervous system
- Types of cells and body tissues in the brain and spinal cord

Brain and spinal cord tumors are masses of abnormal cells in the brain or spinal cord that have grown out of control.

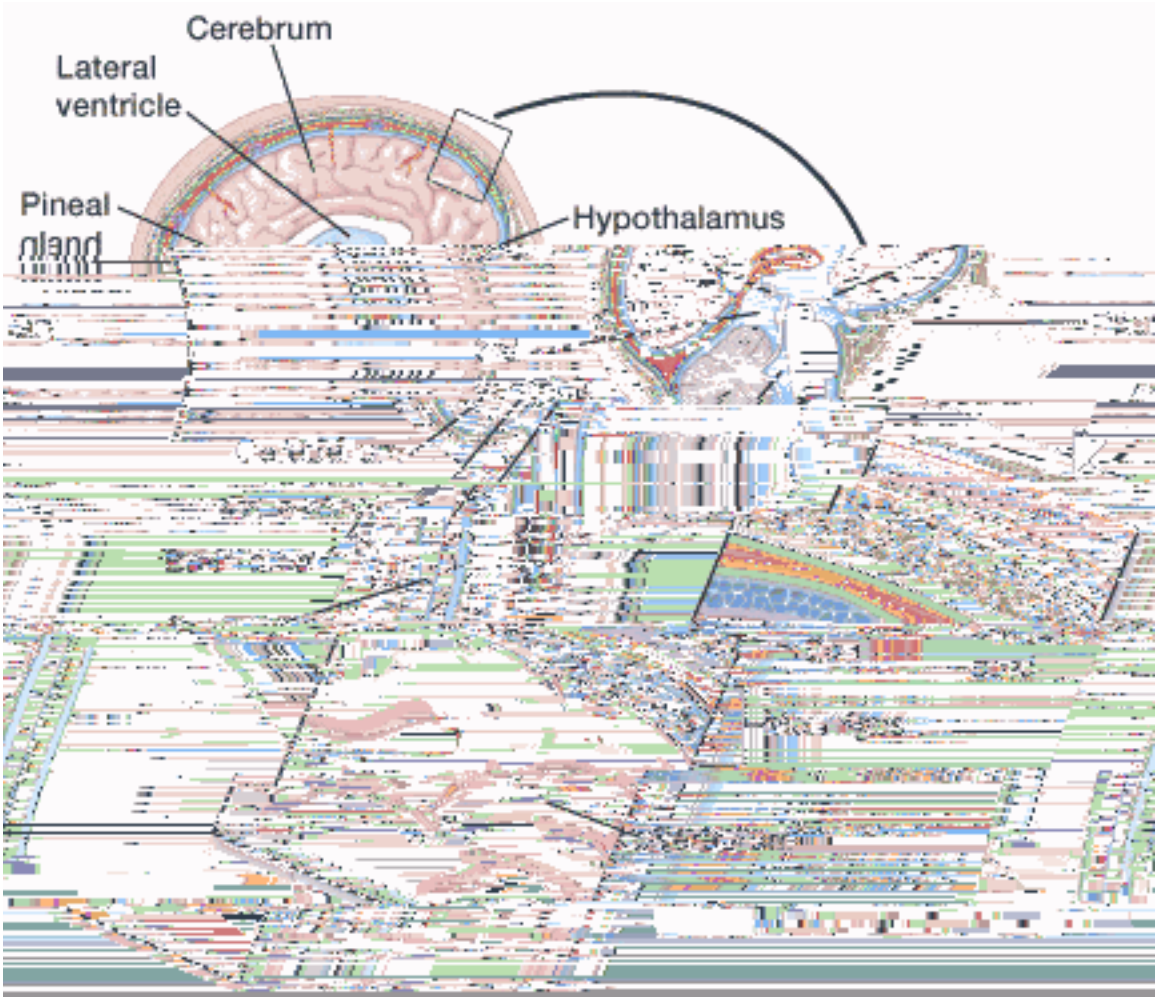
In most other parts of the body, it is very important to distinguish between benign (non-

cranial nerves help carry messages between the brain and the rest of the body. These messages tell our muscles how to move, transmit information gathered by our senses, and help coordinate the functions of our internal organs.

The brain is protected by the skull. Likewise, the spinal cord is protected by the bones (vertebrae) of the spinal column.

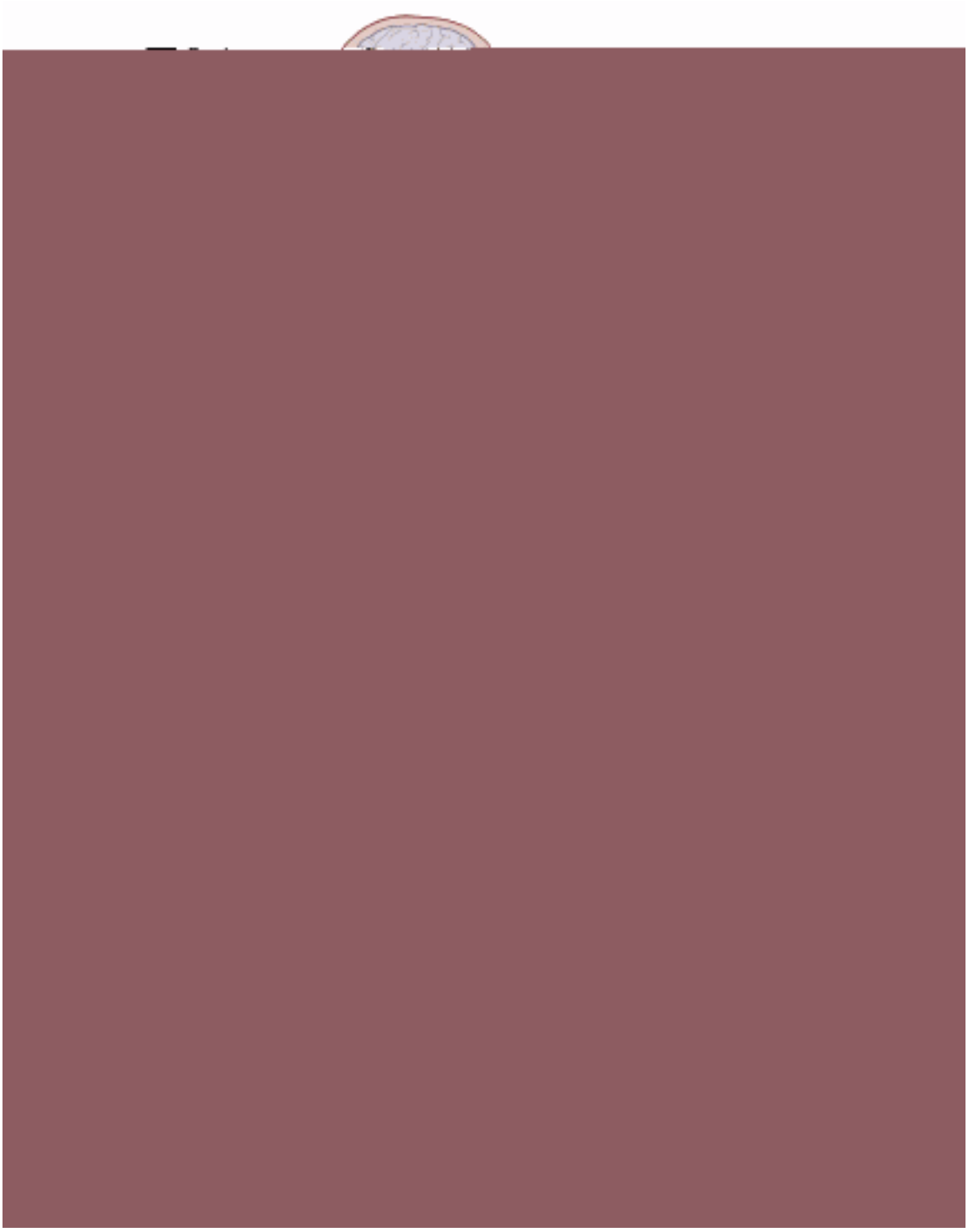
The brain and spinal cord are surrounded and cushioned by a special liquid, called **cerebrospinal fluid** (CSF). Cerebrospinal fluid is made by the choroid plexus, which is found in spaces within the brain called **ventricles**. The ventricles and the spaces around the brain and spinal cord are filled with CSF.

Parts of the brain and spinal cord



The main areas of the brain include the cerebrum, cerebellum, and brain stem. Each part has a special function.

Cerebrum: The cerebrum is the large, outer part of the brain. It is divided into left and right hemispheres (halves) and controls reasoning, thought, emotion, and language. It is also responsible for planned (voluntary) muscle movements (throwing a ball, walking, chewing, etc.) and for taking in and interpreting sensory information such as vision, hearing, smell, touch, and pain.



Pituitary gland and hypothalamus: The pituitary is a small gland at the base of the brain. It is connected to a part of the brain called the **hypothalamus**. They work together to make hormones that help regulate the activity of several other glands in the body. For example:

damaged by tumors that start nearby.

Glial cells: Glial cells are the supporting cells of the brain. Most brain and spinal cord tumors develop from glial cells. These tumors are sometimes referred to as **gliomas**.

There are 3 main types of glial cells:

- **Astrocytes** help support and nourish neurons. When the brain is injured, astrocytes form scar tissue that helps repair the damage. The main tumors starting in these cells are called **astrocytomas** or **glioblastomas**.
- **Oligodendrocytes** make myelin, a fatty substance that surrounds and insulates the nerve cell axons of the brain and spinal cord. This helps neurons send electric signals through the axons. Tumors starting in these cells are called **oligodendrogliomas**.
- **Ependymal cells** line the ventricles (fluid-filled areas) within the brain and form part of the pathway through which CSF flows. Tumors starting in these cells are called **ependymomas**.

(A fourth type of cell, called **microglia**, are the infection-fighting cells of the central nervous system. They are part of the immune system and are not truly glial cells.)

Neuroectodermal cells: These are very early forms of nervous system cells that are probably involved in brain cell development. They are found throughout the brain, although they are not often seen in the adult central nervous system. The most common tumors that come from these cells develop in the cerebellum and are called **medulloblastomas**.

Meninges: These are layers of tissue that line and protect the brain and spinal cord. CSF travels through spaces formed by the meninges. The most common tumors that start in these tissues are called **meningiomas**.

Hyperlinks

References

Dorsey JF, Salinas RD, Dang M, et al. Chapter 63: Cancer of the central nervous system. In: Niederhuber JE, Armitage JO, Doroshow JH, Kastan MB, Tepper JE, eds. *Abeloff's Clinical Oncology*. 6th ed. Philadelphia, Pa: Elsevier; 2020.

National Cancer Institute Physician Data Query (PDQ). Adult Central Nervous System Tumors Treatment. 2020. Accessed at www.cancer.gov/types/brain/hp/adult-brain-treatment-pdq on February 4, 2020.

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Types of Brain and Spinal Cord Tumors in Adults

There are two main types of brain and spinal cord tumors:

- Tumors that start in the brain or spinal cord are called **primary brain (or spinal cord) tumors**.
- Tumors that start in another part of the body and then spread to the brain or spinal cord are called **metastatic or secondary brain (or spinal cord) tumors**.

In adults, metastatic tumors to the brain are actually more common than primary brain tumors, and they are treated differently. **This information is about primary brain tumors.**

Unlike cancers that start in other parts of the body, tumors that start in the brain or spinal cord rarely spread to distant organs. Even so, brain or spinal cord tumors are rarely considered benign (non-cancerous). They can still cause damage by growing and spreading into nearby areas, where they can destroy normal brain tissue. And unless they are completely removed or destroyed, most brain or spinal cord tumors will continue to grow and eventually be life-threatening.

How brain and spinal cord tumors are classified

Several factors are important when doctors are trying to figure out how best to treat a brain or spinal cord tumor and what the prognosis (outlook) is likely to be:

The type of tumor (based on the type of cell it starts in): Tumors can form in almost any type of tissue or cell in the brain or spinal cord. Some tumors have a mix of cell types. Different types of tumors tend to start in certain parts of the brain or spinal cord, and tend to grow in certain ways. (The most common types of brain and spinal cord tumors in adults are described below.)

The grade of the tumor: Some types of brain and spinal cord tumors are more likely to grow into nearby brain or spinal cord tissue (and to grow quickly) than are others. Brain and spinal cord tumors are typically divided into 4 grades (using Roman numerals I to IV), based largely on how the tumor cells look under a microscope:

Gliomas are not a specific type of brain tumor. Glioma is a general term for tumors that start in glial cells. A number of tumors can be considered gliomas, including:

- **Astrocytomas** (which include **glioblastomas**)
- **Oligodendrogliomas**
- **Ependymomas**

About 3 out of 10 of all brain tumors are gliomas. Most fast-growing brain tumors are gliomas.

Astrocytomas

Astrocytomas are tumors that start in glial cells called **astrocytes**. About 2 out of 10 brain tumors are astrocytomas.

Most astrocytomas can spread widely throughout the brain and blend with the normal brain tissue, which can make them very hard to remove with surgery[1]. Sometimes they spread along the cerebrospinal fluid (CSF) pathways. It is very rare for them to spread outside of the brain or spinal cord.

As with other types of brain tumors, astrocytomas are often grouped by grade.

Low-grade (grade I or II) astrocytomas tend to grow slowly. These include:

- **Non-infiltrating (grade I) astrocytomas**, which do not usually grow into nearby tissues and tend to have a good prognosis. Examples include pilocytic astrocytomas and subependymal giant cell astrocytomas (SEGAs). These are more common in children than in adults.
- **Grade II astrocytomas**, such as diffuse astrocytomas and pleomorphic xanthoastrocytomas (PXAs). These tumors tend to be slow growing, but they can grow into nearby areas, which can make them harder to remove with surgery. These tumors can become more aggressive and faster growing over time.

High-grade (grade III or IV) astrocytomas tend to grow quickly and spread into the surrounding normal brain tissue. These include:

- **Anaplastic (grade III) astrocytomas**
- **Glioblastomas (GBMs) or grade IV astrocytomas** are the fastest growing. These tumors make up more than half of all gliomas and are the most common malignant

brain tumors in adults.

Oligodendrogliomas

These tumors start in brain glial cells called **oligodendrocytes**. These are grade II tumors that tend to grow slowly, but most of them can grow into (infiltrate) nearby brain tissue and can't be removed completely by surgery. Oligodendrogliomas sometimes spread along the CSF pathways but rarely spread outside the brain or spinal cord. As with astrocytomas, they can become more aggressive over time. Very aggressive (grade III) forms of these tumors are known as **anaplastic oligodendrogliomas**. Only about 1% to 2% of brain tumors are oligodendrogliomas.

Ependymomas

These tumors start in ependymal cells, and typically grow in the ventricles or spinal cord in adults. They can range from fairly low-grade (grade II) tumors to higher grade (grade III) tumors, which are called **anaplastic ependymomas**. Only about 2% of brain tumors are ependymomas.

Ependymomas are more likely to spread along the cerebrospinal fluid (CSF) pathways than other gliomas but do not spread outside the brain or spinal cord. These tumors may block the flow of CSF from the ventricles, causing the ventricles to become very large – a condition called **hydrocephalus**.

Some (but not all) ependymomas can be removed completely and cured by surgery. But because they can spread along ependymal surfaces and CSF pathways, treating them can sometimes be difficult. Spinal cord ependymomas have the greatest chance of being cured with surgery, but treatment can cause side effects related to nerve damage.

Meningiomas

Meningiomas begin in the meninges, the layers of tissue that surround the outer part of the brain and spinal cord. Meningiomas account for about 1 out of 3 primary brain and spinal cord tumors. They are the most common primary brain tumors in adults (although strictly speaking, they are not actually brain tumors).

Meningiomas are often assigned a grade, based on how the cells look under the microscope.

- **Grade I (benign) meningiomas** have cells that look the most like normal cells. These are the most common type of meningioma. Most of these tumors can be cured by surgery[3], but some grow very close to vital structures in the brain or cranial nerves and cannot be cured by surgery alone.
- **Grade II (atypical or invasive) meningiomas** usually have cells that look slightly more abnormal. They can grow directly into nearby brain tissue and bone and are more likely to come back (recur) after surgery.
- **Grade III (anaplastic or malignant) meningiomas** have cells that look the most abnormal. These are the least common type of meningiomas. They tend to grow quickly, can grow into nearby brain tissue and bone, and are the most likely to come back after treatment. Some may even spread to other parts of the body.

Medulloblastomas

Medulloblastomas develop from neuroectodermal cells (early forms of nerve cells) in the cerebellum. They are fast-growing (grade IV) tumors and often spread throughout the CSF pathways, but they can be treated by surgery[4], radiation therapy[5], and chemotherapy[6].

Medulloblastomas occur much more often in children than in adults. They are part of a class of tumors called **embryonal tumors** that can also start in other parts of the central nervous system. For more information on these tumors, see Brain and Spinal Cord Tumors in Children[7].

Gangliogliomas

Gangliogliomas contain both neurons and glial cells. These tumors are very uncommon
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Schwannomas are almost always benign (grade I) tumors. They can arise from any cranial nerve. When they form on the cranial nerve responsible for hearing and balance near the cerebellum, they are called **vestibular schwannomas**or **acoustic neuromas**. They can also start on spinal nerves after the point where they have left the spinal cord. When this happens, they can press on the spinal cord, causing weakness, sensory loss, and bowel and bladder problems.

Craniopharyngiomas

These slow-growing (grade I) tumors start above the pituitary gland but below the brain itself. They may press on the pituitary gland and the hypothalamus, causing hormone problems. Because they start very close to the optic nerves, they can also cause vision problems. Their tendency to stick to these important structures can make them hard to remove completely without damaging vision or hormone balance. Craniopharyngiomas are more common in children, but they are sometimes seen in adults.

Other tumors that can start in or near the brain

Chordomas

These rare tumors start in the bone at the base of the skull or at the lower end of the spine. Chordomas don't start in the central nervous system, but they can injure the nearby brain or spinal cord by pressing on it.

These tumors are treated with surgery[10] if possible, often followed by radiation therapy[11], but they tend to come back in the same area after treatment, causing more damage. They usually do not spread to other organs. For more information on chordomas, see Bone Cancer[12].

Non-Hodgkin lymphomas

Lymphomas are cancers that start in white blood cells called **lymphocytes** (one of the main cell types of the immune system). Most lymphomas start in other parts of the body, but some start in the CNS, and are called **primary CNS lymphomas**.

These lymphomas are more common in people with immune system problems, such as those infected with HIV[13], the virus that causes AIDS. Because of new treatments for AIDS, primary CNS lymphomas have become less common in recent years. They account for about 2% of primary brain tumors.

These lymphomas often grow quickly and can be hard to treat. Recent advances in chemotherapy, however, have improved the outlook for people with these cancers. For more information on primary CNS lymphomas (including treatment), see Non-Hodgkin Lymphoma[14].

Pituitary tumors

Tumors that start in the pituitary gland are almost always benign (non-cancerous). But they can still cause problems if they grow large enough to press on nearby structures or if they make too much of any kind of hormone. For more information, see Pituitary Tumors[15].

Hyperlinks

1. www.cancer.org/cancer/types/brain-spinal-cord-tumors-adults/treating/surgery.html
2. www.cancer.org/cancer/types/brain-spinal-cord-tumors-adults/causes-risks-prevention/risk-factors.html
3. www.cancer.org/cancer/types/brain-spinal-cord-tumors-adults/treating/surgery.html
4. www.cancer.org/cancer/types/brain-spinal-cord-tumors-adults/treating/surgery.html

Dorsey JF, Salinas RD, Dang M, et al. Chapter 63: Cancer of the central nervous system. In: Niederhuber JE, Armitage JO, Doroshow JH, Kastan MB, Tepper JE, eds. *Abeloff's Clinical Oncology*. 6th ed. Philadelphia, Pa: Elsevier; 2020.

Key Statistics for Brain and Spinal Cord Tumors

benign (non-cancer) tumors were also included.
- About 18,760 people (10,690 males and 8,070 females) will die from brain and spinal cord tumors.

Risk of developing a brain or spinal cord tumor

Overall, the chance that a person will develop a malignant tumor of the brain or spinal cord in their lifetime is less than 1%. The risk of developing any type of brain or spinal cord tumor is slightly higher among women than among men, although the risk of developing a malignant tumor is slightly higher for men than for women. This is largely because certain types of tumors are more common in one sex or the other (for example, meningiomas are more common in women).

Survival rates for brain and spinal cord tumors

Survival rates for brain and spinal cord tumors vary widely, depending on the type of tumor (and other factors[1]). Rates for some of the more common types of brain and spinal cord tumors are discussed in Survival Rates for Selected Adult Brain and Spinal Cord Tumors[2].

Visit the American Cancer Society's Cancer Statistics Center[3] for more key statistics.

Hyperlinks

1. www.cancer.org/cancer/types/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/staging.html
2. www.cancer.org/cancer/types/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/survival-rates.html
3. cancerstatisticscenter.cancer.org/

References

American Cancer Society. *Cancer Facts & Figures 2024*. Atlanta: American Cancer Society; 2024.

Howlader N, Noone AM, Krapcho M, et al (eds). SEER Cancer Statistics Review, 1975-

2014, National Cancer Institute. Bethesda, MD, https://seer.cancer.gov/csr/1975_2014/, based on November 2016 SEER data submission, posted to the SEER web site, April 2017.

Ostrom QT, Gittleman H, Xu J, et al. CBTRUS statistical report: Primary brain and other central nervous system tumors diagnosed in the United States in 2009-2013. *Neuro Oncol*. 2016;18 Suppl 5:v1v75.

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What's New in Adult Brain and Spinal Cord Tumor Research?

Research is always being done in the area of brain and spinal cord tumors. Scientists and doctors are looking for causes and ways to prevent these tumors, better tests to help characterize these tumors, and better ways to treat them.

Lab tests of brain tumors

In recent years, researchers have found some changes in genes, chromosomes, and proteins inside brain tumor cells that can be used to help predict a person's outlook (prognosis) or help guide treatment. Some examples of changes that can now be tested for include:

- *IDH1* or *IDH2* gene mutations
- Chromosomal 1p19q co-deletions
- MGMT promoter methylation

For more on how these tests are used, see Tests for Brain and Spinal Cord Tumors in Adults[1].

Testing might also be done in certain situations to look for changes in other genes, such as *ATRX*, *TERT*, *H3F3A*, *BRAF*, and *HELA*.

Researchers are also looking for other changes in tumor cells that might help guide treatment.

Imaging and surgery techniques

Recent advances have made surgery for brain tumors much safer and more successful. Some of these newer techniques include:

Magnetic resonance spectroscopic imaging (MRSI)

In this approach, specially processed information from magnetic resonance spectroscopy (MRS, described in Tests for Brain and Spinal Cord Tumors in Adults[2]) is used to make a map of important chemicals involved in tumor metabolism. MRSI can help surgeons direct their biopsies to the most abnormal areas in the tumor. It can also help doctors direct radiation to the right areas and evaluate the effects of chemotherapy or targeted therapy.

Diffusion tensor imaging (DTI) or tractography

This is a type of MRI test that can show where the major pathways (tracts) of white matter are in the brain. Surgeons can look at this information before operating to help avoid these important parts of the brain when removing tumors.

Fluorescence-guided surgery

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video camera lens at the tip, is used to allow the surgeon to see the small area around the tumor in 3 dimensions. The surgeon passes the endoscope through a small hole made in the back of the nose to operate through the nasal passages, limiting the potential damage to the brain. A similar technique can be used for some tumors in the ventricles, where an endoscope is inserted through a small opening in the skull near the hairline. The tumor's size, shape, and position determine if this technique can be used.

Laser interstitial thermal therapy (LITT)

For some tumors that are hard to treat surgically, another option might be to insert a thin probe with a tiny laser on the end through a small hole in the skull and into the tumor. The laser is then used to heat and destroy[3] (ablate) the tumor. This technique is still fairly new, so doctors are still learning about the best ways to use it.

Radiation therapy

Some newer types of external radiation therapy planning can help doctors deliver radiation more precisely to the tumor, which helps spare normal brain tissue.

Modern radiation techniques such as intensity modulated radiation therapy (IMRT), volumetric modulated arc therapy (VMAT), proton beam therapy, and image-guided radiation therapy (IGRT) are described in Radiation Therapy for Adult Brain and Spinal Cord Tumors[4].

Other new methods of planning and delivering radiation therapy are also being studied.

Chemotherapy

Along with developing and testing new chemotherapy drugs, many researchers are testing new ways to get chemotherapy to the brain tumor.

Many chemotherapy drugs are limited in their effectiveness because the tightly controlled openings in the brain capillaries, sometimes referred to as the **blood-brain barrier**, prevents the drugs from getting from the bloodstream to the brain. Researchers are now trying to modify some of these drugs by putting them in tiny droplets of fat (liposomes) or attaching them to molecules that normally cross the blood-brain barrier, to help them work better. This is an area of active research and clinical trials[5].

Other new treatment strategies

Researchers are also testing some newer approaches to treatment that may help doctors target tumors more precisely. This could lead to treatments that work better and cause fewer side effects. Several of these treatments are still being studied.

Tumor vaccines and other types of immunotherapy

Several vaccines are being tested against brain tumors. Unlike vaccines against infections, these vaccines are meant to help treat the disease instead of prevent it. The goal of the vaccines is to stimulate the body's immune system to attack the brain tumor. Early study results of vaccines to help treat glioblastoma have shown promise, but more research is needed to determine how well they work.

Researchers are also looking at other types of treatments that could boost the immune response against brain tumors.

At this time, brain tumor vaccines and other types of immunotherapy are available only through clinical trials[6].

Targeted drugs (such as growth factor inhibitors)

Tumor cells are often very sensitive to proteins called **growth factors**, which help them grow and divide. Newer drugs target some of these growth factors, which may slow the growth of tumor cells or even cause them to die. Many targeted drugs are already used for other types of cancer, and some are being studied to see if they will work for brain tumors as well.

Hyperlinks

1. www.cancer.org/cancer/types/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/how-diagnosed.html
2. www.cancer.org/cancer/types/brain-spinal-cord-tumors-adults/detection-diagnosis-staging/how-diagnosed.html
3. www.cancer.org/cancer/managing-cancer/treatment-types/lasers-in-cancer-treatment.html
4. www.cancer.org/cancer/types/brain-spinal-cord-tumors-adults/treating/radiation-therapy.html
5. www.cancer.org/cancer/managing-cancer/making-treatment-decisions/clinical-

trials.html
6. www.cancer.org/cancer/managing-cancer/making-treatment-decisions/clinical-trials.html

References

Dorsey JF, Salinas RD, Dang M, et al. Chapter 63: Cancer of the central nervous system. In: Niederhuber JE, Armitage JO, Doroshow JH, Kastan MB, Tepper JE, eds. *Abeloff's Clinical Oncology*. 6th ed. Philadelphia, Pa: Elsevier; 2020.

National Comprehensive Cancer Network. NCCN Clinical Practice Guidelines in Oncology: Central Nervous System Cancers. V.3.2019. Accessed at www.nccn.org/professionals/physician_gls/pdf/cns.pdf on February 7, 2020.

Scaringi C, Agolli L, Minniti G. Technical advances in radiation therapy for brain tumors. *Anticancer Res*. 2018;38(11):6041-6045.

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