Treating Brain and Spinal Cord Tumors in Children

If your child has been diagnosed with a brain or spinal cord tumor, your child's treatment team will discuss the options with you. It’s important to weigh the benefits of each treatment option against the possible risks and side effects.

How are brain and spinal cord tumors treated?

The main treatments for children with brain and spinal cord tumors are:

- Surgery for Brain and Spinal Cord Tumors in Children

learning about parts of the medical system you probably haven't had contact with before.

Children and teens with brain and spinal cord tumors and their families have special needs that can be met best by cancer centers for children and teens, working closely with the child's primary care doctor. These centers offer the advantage of being treated

Your child might also see a psychologist or rehabilitation specialist before treatment begins. For example, if the tumor is slow growing and your child's condition is stable, they may be seen by a psychologist before treatment to assess any damage the tumor might have caused. Most of the work of these specialists takes place after treatment.

- Questions to Ask About Your Child's Brain or Spinal Cord Tumor
- How to Talk to Your Child's Cancer Care Team
- Seeking a Second Opinion

Thinking about taking part in a clinical trial

Today, most children and teens with cancer are treated at specialized children's cancer centers. These centers offer the most up-to-date-treatment by conducting clinical trials (studies of promising new therapies). Children's cancer centers often conduct many clinical trials at any one time, and in fact most children treated at these centers take part in a clinical trial as part of their treatment. Clinical trials are one way to get state-of-the art cancer treatment. Sometimes they may be the only way to get access to newer treatments (although there is no guarantee that newer treatments will be better). They are also the best way for doctors to learn better methods to treat these cancers. Still, they might not be right for everyone. If you would like to learn more about clinical trials that might be right for your child, start by asking the treatment team if your clinic or hospital conducts clinical trials.

- Clinical Trials

Considering complementary and alternative methods

You may hear about alternative or complementary methods that your doctor hasn't mentioned to treat your child's tumor or relieve symptoms. These methods can include vitamins, herbs, and special diets, or other methods such as acupuncture or massage, to name a few. Complementary methods refer to treatments that are used along with your regular medical care. Alternative treatments are used instead of standard medical treatment. Although some of these methods might be helpful in relieving symptoms or helping people feel better, many have not been proven to work. Some might even be harmful. Be sure to talk to your child's cancer care team about any method you are thinking about using. They can help you learn what is known (or not known) about the method, which can help you make an informed decision.

- Complementary and Integrative Medicine

Preparing for treatment

Before treatment, the doctors and other members of the team will help you, as a parent,

Surgery for Brain and Spinal Cord Tumors in Children

to remove a brain tumor. For this operation, the child may either be under general anesthesia (in a deep sleep) or may remain awake (with the surgical area numbed) for at least part of the surgery if brain function needs to be assessed during the operation.

Part of the head might need to be shaved before surgery. The neurosurgeon makes an incision (cut) in the skin over the skull near the tumor and then uses a special type of drill to remove a piece of bone from the skull. The opening is typically large enough for the surgeon to insert several instruments and view the parts of the brain needed to operate safely.

Many devices can help the surgeon see the tumor and surrounding brain tissue. The surgeon often operates while looking at the brain through a microscope. Imaging tests such as MRI or CT scans[4] can be done before surgery (or ultrasound can be used once the skull has been opened) to help locate the tumor and its edges.

The surgeon will remove or destroy as much of the tumor as is safely possible. This can be done in several ways depending on how hard or soft the tumor is, and whether it has many or just a few blood vessels:

- One way is to cut it out with a scalpel or special scissors.
- Some tumors are soft and can be removed with suction devices.
- In other cases, a probe attached to an ultrasonic aspirator can be placed into the tumor to break it up and suck it out.

The surgeon is very careful to avoid damaging normal brain tissue as much as possible. To lower the risk of removing or damaging vital parts of the brain, different techniques can be used, such as:

- **Functional MRI:** Before surgery, this type of imaging test (described in Tests for Brain and Spinal Cord Tumors in Children[5]) can be done to locate a particular function of the brain. This can be used to help preserve that region during the operation.
- **Intraoperative cortical stimulation (cortical mapping):** During surgery, the surgeon can often detect the function of brain areas in and around the tumor by electrically stimulating them and monitoring the response. This will show if these areas control an important function, helping the surgeon to avoid them.
- **Intraoperative imaging:** In some cases, the surgeon uses MRI (or other) images taken at different times during the operation to show the location of any remaining tumor. This might allow some brain tumors to be removed more safely and extensively.

- **Newer techniques:** Newer types of MRI, as well as other techniques such as fluorescence-guided surgery, might be helpful in some situations. Some of these are described in What's New in Research for Brain and Spinal Cord Tumors in Children?[6]

After removing the tumor, the surgeon replaces the piece of skull bone and closes the incision. (If any metal screws, wires, or plates are needed to fasten the bone, they are usually made from titanium, which allows the child to get follow-up MRIs and will not set off metal detectors.)

For 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 (ablate) the tumor. This technique, known as **laser interstitial thermal therapy (LITT)**, is still fairly new, so doctors are still learning about the best ways to use it.

What to expect after surgery

After the operation to remove the tumor, the child may have a tube (called a *drain*) coming out of the incision that allows excess cerebrospinal fluid (CSF) to drain from the skull. Other tubes may be placed to allow blood that builds up after surgery to drain from under the scalp. The drains are usually removed after a few days. An imaging test such as an MRI or CT scan is typically done 1 to 3 days after the operation to confirm how

often, the heart (and would then be referred to as a *ventriculoatrial shunt*). The tube runs under the skin of the neck and chest, and allows the excess CSF to flow into the abdomen (or heart), where it mixes in with other fluids. The flow of CSF is controlled by a valve in the tubing.

Shunts can be temporary or permanent. They can be placed before or after the surgery to remove the tumor. Placing a shunt normally takes about an hour. Most children will need to stay in the hospital for about 1 to 3 days after the surgery. As with any operation, complications may develop, such as bleeding or infection. Sometimes shunts get clogged and need to be replaced.

Making an opening in the third ventricle

Another option to treat increased pressure in the skull in some cases is an **endoscopic third ventriculostomy**. In this operation, the surgeon makes an opening in the floor of the third ventricle at the base of the brain to allow the CSF to flow again. This operation is done through a small hole in the front of the skull. An advantage of this approach is that it does not require a shunt, but there is a chance that the opening made in the ventricle might close up again.

Placing an external drain

If the pressure inside the head needs to be relieved for a short time, an **external ventricular drain (EVD)** might be put in place to allow the excess CSF to drain out of the body. The drain is a small tube. One end is put into a ventricle, and the other end is attached to a collection bag outside the body. Along with collecting the excess CSF, the drain can also be used to measure the pressure inside the skull, as well as to look for tumor cells, blood, or signs of infection in the CSF.

The drain can be placed either during surgery or during a procedure at the hospital bedside. It can be put in place to relieve the pressure in the days before surgery, or to help drain the fluid that collects after an operation. If the pressure inside the skull needs to be lowered for more than a few days, the doctor might need to change this to a VP shunt.

Surgery to place a ventricular access catheter

Surgery may also be used to insert a **ventricular access catheter** to help deliver chemotherapy directly into the CSF later on. One type is called an Ommaya reservoir. A small incision is made in the scalp, and a small hole is drilled in the skull. A flexible tube is then inserted through the hole until the open end of the tube is in a ventricle, where it

3. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/detection-diagnosis-staging/signs-and-symptoms.html
4. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/detection-diagnosis-staging/how-diagnosed.html
5. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/detection-diagnosis-staging/how-diagnosed.html
6. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/about/new-research.html
7. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/after-treatment/follow-up.html
8. www.cancer.org/cancer/managing-cancer/treatment-types/surgery.html
9. www.cancer.org/cancer/managing-cancer/side-effects.html

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Radiation Therapy for Brain and Spinal

Cord Tumors in Children

Radiation therapy uses high-energy x-rays or small particles to kill cancer cells. This type of treatment is given by a doctor called a **radiation oncologist**.

When might radiation therapy be used?

Radiation therapy may be used in different situations for brain or spinal cord tumors:

- After surgery to try to kill any remaining tumor cells
- As part of the main treatment if surgery is not a good option
- To help prevent or relieve symptoms from the tumor

Children younger than 3 years are usually not given radiation because of possible long-term side effects with brain development. Instead, they are treated mainly with surgery and chemotherapy. Radiation can also cause some problems in older children. Radiation oncologists try very hard to deliver enough radiation to the tumor while limiting the radiation to normal surrounding brain areas as much as possible.

Getting radiation therapy

Most often, the radiation is focused on the tumor from a source outside the body. This is called **external beam radiation therapy (EBRT)**.

Before your child's treatments start, the radiation team will take careful measurements to determine the correct angles for aiming the radiation beams and the proper dose of radiation. This planning session, called *simulation*, usually includes getting imaging tests such as CT or MRI scans[1].Your child might be fitted with a plastic mold like a body cast to keep them in the same position so that the radiation can be aimed more accurately.

Most often, the total dose of radiation is divided into daily fractions (usually given Monday through Friday) over several weeks. For each treatment session, your child lies on a special table while a machine delivers the radiation from precise angles. Each

(SRS) or in a few sessions (SRT). It may be useful for some tumors in parts of the brain or spinal cord that can't be treated with surgery or when a child isn't healthy enough for surgery. (The term "radiosurgery" is used because the radiation is delivered so precisely, but there is no actual surgery involved in either SRS or SRT.)

For either procedure, a head frame is usually attached to the skull to help aim the radiation beams. Sometimes a face mask is used to hold the head in place instead. Once the exact location of the tumor is known from CT or MRI scans, radiation is focused at the tumor from many different angles. This can be done in 2 ways:

- In one approach, thin radiation beams are focused at the tumor from hundreds of different angles for a short period of time. Each beam alone is weak, but they all converge at the tumor to give a higher dose of radiation. The Gamma Knife is an example of a machine that uses this approach.
- Another approach uses a movable linear accelerator (a machine that creates radiation) that is controlled by a computer. Instead of delivering many beams at once, this machine moves around the head to deliver a thin beam of radiation to the tumor from many different angles. Several machines with names such as X-Knife, CyberKnife, and Clinac deliver stereotactic radiosurgery in this way.

SRS typically delivers the whole radiation dose in a single session, though it may be repeated if needed.

For SRT (also called *fractionated radiosurgery*) doctors give the radiation in several treatments to deliver the same or a slightly higher dose, which can now often be done without the need for a head frame.

Other types of radiation therapy

Brachytherapy (internal radiation therapy): Unlike the external radiation approaches above, in brachytherapy a radiation source is put directly into or near the tumor. The radiation it gives off travels a very short distance, so it affects only the tumor. This technique is most often used along with external radiation. It provides a high dose of radiation at the tumor site, while the external radiation treats nearby areas with a lower dose.

Whole brain and spinal cord radiation therapy (craniospinal radiation): If tests such as an MRI scan or lumbar puncture show the tumor has spread along the covering of the spinal cord (meninges) or into the surrounding cerebrospinal fluid, then external radiation may be given to the whole brain and spinal cord. Some tumors such as

ependymomas and medulloblastomas are more likely to spread this way, and therefore may require craniospinal radiation.

Possible effects of radiation therapy

Radiation is more harmful to tumor cells than it is to normal cells. Still, radiation can also damage normal brain tissue, especially in children younger than 3 years, which can lead to side effects.

Side effects during or soon after treatment: During radiation therapy, some children may become irritable and tired. Nausea, vomiting, and headaches are also possible but are uncommon. Spinal radiation causes nausea and vomiting more often than brain radiation. Sometimes dexamethasone (a corticosteroid) or other drugs can help relieve these symptoms. Some children might have hair loss in areas of the scalp that get radiation.

Some weeks after radiation therapy, children may become drowsy or have other nervous system symptoms. This is called the *radiation somnolence syndrome* or *early-delayed radiation effect*. It usually passes after a few weeks.

Problems with thinking and memory: Children may lose some brain function if large areas of the brain get radiation. Problems can include memory loss, personality changes, and trouble learning at school. These may get better over time, but some effects may be long-lasting[2].

Other side effects: Other effects could include seizures and slowed growth. There may also be other symptoms depending on the area of the brain treated and how much radiation was given.

Radiation necrosis: Rarely, a large mass of dead (necrotic) tissue forms at the site of the tumor in the months or years after radiation treatment. It can often be controlled with corticosteroid drugs, but surgery may be needed to remove the necrotic tissue in some instances.

Increased risk of another tumor: Radiation can damage genes in normal cells. As a result, there is a small risk of developing a second cancer in the area that got the radiation – for example, a meningioma of the coverings of the brain, another brain tumor, or less likely a bone cancer in the skull. If this occurs, it's usually many years after the radiation is given. This small risk should not keep children who need radiation from getting treatment. It’s important to continue close follow-up with your child’s doctor so that if problems do come up they can be found and treated as early as possible.

Balancing the risks and benefits

The risk of all of these side effects must be balanced against the risks of not using radiation and having less control of the tumor. If problems are seen after treatment, often it's hard to determine whether they were caused by damage from the tumor itself, from surgery or radiation therapy, or from some combination of these. Doctors are constantly testing lower doses or different ways of giving radiation to see if they can be as effective while causing fewer problems.

Normal brain cells grow quickly in the first few years of life, making them very sensitive to radiation. Because of this, radiation therapy is often not used or is postponed in children younger than 3 years old to avoid damage that might affect brain development. This needs to be balanced with the risk of tumor regrowth, because early radiation therapy may be lifesaving in some cases. It's important that you talk with your child's doctor about the risks and benefits of treatment.

More information about radiation therapy

To learn more about how radiation is used to treat cancer, see Radiation Therapy[3].

To learn about some of the side effects listed here and how to manage them, see Managing Cancer-related Side Effects[4].

Hyperlinks

1. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/detection-diagnosis-staging/how-diagnosed.html
2. www.cancer.org/cancer/survivorship/children-with-cancer/late-effects-of-cancer-treatment.html
3. www.cancer.org/cancer/managing-cancer/treatment-types/radiation.html
4. www.cancer.org/cancer/managing-cancer/side-effects.html

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younger.

Which chemo drugs are used to treat brain and spinal cord tumors?

Some of the chemo drugs used to treat children with brain or spinal cord tumors include:

- Carboplatin
- Carmustine (BCNU)
- Cisplatin
- Cyclophosphamide
- Etoposide
- Lomustine (CCNU)
- Methotrexate
- Temozolomide
- Thiotepa
- Vincristine

These drugs may be used alone or in various combinations, depending on the type of brain tumor. Doctors give chemo in cycles. Each cycle generally lasts for a few weeks and is followed by a rest period to give the body time to recover.

closely for any side effects. There are often ways to lessen these side effects. For example, drugs can be given to help prevent or reduce nausea and vomiting.

Some chemo drugs can also have other, less common side effects. For example, cisplatin and carboplatin can also cause kidney damage and hearing loss. Your child's kidney function and hearing will be checked periodically if they are given these drugs.

Be sure to ask your child's doctor or nurse about medicines to help reduce side effects, and let them know if your child has side effects so they can be managed. In some cases, the doses of the chemo drugs may need to be reduced or treatment may need to be delayed or stopped to prevent the effects from getting worse.

More information about chemotherapy

For more general information about how chemotherapy is used to treat cancer, see Chemotherapy[1].

To learn about some of the side effects listed here and how to manage them, see Managing Cancer-related Side Effects[2].

Hyperlinks

1. www.cancer.org/cancer/managing-cancer/treatment-types/chemotherapy.html
2. www.cancer.org/cancer/managing-cancer/side-effects.html

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Williams & Wilkins; 2016.

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Targeted Therapy Drugs for Brain and Spinal Cord Tumors in Children

As researchers have learned more about the changes in the inner workings of cells that cause cancer or help cancer cells grow, they have developed newer drugs that target these changes. These targeted drugs work differently from standard chemotherapy[1] drugs. They sometimes work when chemo drugs don't, and they often have different side effects.

Targeted drugs do not yet play a large role in treating brain or spinal cord tumors, but some of them might be helpful for certain types of tumors.

Drugs that target tumors with *BRAF* gene changes

In some low-grade gliomas, the tumor cells have changes (mutations) in the *BRAF* gene, which causes them to make certain proteins that help the cells grow.

Dabrafenib (Tafinlar) and trametinib (Mekinist)

Dabrafenib and trametinib are targeted drugs that affect some of these proteins. (Dabrafenib targets the BRAF protein, while trametinib affects the related MEK protein.) Combining these drugs might be an option for children at least one year of age with any type of low-grade glioma[2] with a *BRAF* V600E mutation that needs treatment other than surgery or radiation. If your child has a low-grade glioma, the tumor cells might be tested[3] for this gene change to see if these drugs might be helpful.

These drugs are typically taken daily, either as pills or as liquids.

Common **side effects** can include skin changes, rash, itching, sensitivity to the sun, headache, fever, chills, joint or muscle pain, fatigue, cough, hair loss, nausea, diarrhea, and high blood pressure.

Less common but serious side effects can include bleeding, heart rhythm problems, liver or kidney problems, lung problems, severe allergic reactions, severe skin or eye problems, and increased blood sugar levels.

IDH1 and IDH2 proteins, which seems to help the tumor cells mature into more normal cells.

This drug can be used after surgery in children 12 years of age and older with a grade 2 astrocytoma or oligodendroglioma[6], if the tumor cells are found to have an *IDH1* or *IDH2* gene mutation. The doctor can get tests of the tumor cells to see if they have one of these mutations.

This drug is taken by mouth as tablets, once a day.

Common **side effects of vorasidenib** can include feeling very tired, headache, nausea, muscle aches or stiffness, diarrhea, seizures, and changes in lab tests showing the drug is affecting the liver.

Sometimes this drug might have more serious effects on the liver, which could lead to symptoms such as jaundice (yellowing of the eyes and skin), dark urine, loss of appetite, or pain in the upper right side of the belly. It's important to let the health care team know if any of these symptoms appear.

Everolimus (Afinitor)

For subependymal giant cell astrocytomas (SEGAs) that can't be removed completely by surgery, everolimus may shrink the tumor or slow its growth for some time. This drug works by blocking a cell protein known as mTOR, which normally helps cells grow and divide into new cells.

Everolimus is a pill taken once a day.

Common **side effects of everolimus** can include mouth sores, increased risk of infections, nausea, loss of appetite, diarrhea, skin rash, feeling tired or weak, fluid buildup (usually in the legs), and increases in blood sugar and cholesterol levels. A less common but serious side effect is lung damage, which can cause shortness of breath or other problems.

Many other targeted drugs are now being developed and studied in clinical trials. Some of these are described in What's New in Research and Treatment for Brain and Spinal Cord Tumors in Children?[7]

More information about targeted therapy

To learn more about how targeted drugs are used to treat cancer, see Targeted Cancer

Therapy[8].

To learn about some of the side effects listed here and how to manage them, see Managing Cancer-related Side Effects[9].

Hyperlinks

1. www.cancer.org/cancer/managing-cancer/treatment-types/chemotherapy.html
2. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/about/types-of-brain-and-spinal-tumors.html
3. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/detection-diagnosis-staging/how-diagnosed.html
4. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/about/types-of-brain-and-spinal-tumors.html
5. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/detection-diagnosis-staging/how-diagnosed.html
6. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/about/types-of-brain-and-spinal-tumors.html
7. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/about/new-research.html
8. www.cancer.org/cancer/managing-cancer/treatment-types/targeted-therapy.html
   www.cancer.org/cancer/managing-cancer/side-ng Cancgw1H06bL8ancer.org/l5 types-of-

Drugs to Help with Symptoms in Children with Brain or Spinal Cord Tumors

Children with brain or spinal cord tumors can often be given drugs to help with symptoms from the tumor or side effects of treatment. These drugs do not treat the tumor directly, but they can be important an important part of your child's treatment.

Corticosteroids

Cortisone-like drugs such as dexamethasone (Decadron) are often given to reduce the swelling that can occur around brain tumors. They are often given before and for a few days after surgery, and might be used during radiation therapy as well. This may help relieve side effects such as headaches, nausea, and vomiting.

Anti-seizure drugs (anticonvulsants)

Drugs may be given to lower the chance of seizures in children with brain tumors. Many different anti-seizure drugs can be used.

Hormones

The pituitary gland, which lies at the base of the brain, helps control the levels of many different hormones in the body. If the pituitary has been damaged by the spread of the tumor or by treatments (surgery or radiation therapy), your child may need to take pituitary hormones or other hormones to replace those that are no longer being made by the body.

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Treating Specific Types of Childhood Brain and Spinal Cord Tumors

The treatment options for brain and spinal cord tumors in children depend on many factors, including:

- The type of tumor[1]

- Craniopharyngiomas
- Germ cell tumors

Non-infiltrating (grade I) astrocytomas (pilocytic astrocytomas and subependymal giant cell astrocytomas)

Many doctors consider these to be benign tumors because they tend to grow very slowly and do not grow into (infiltrate) nearby tissues. **Pilocytic astrocytomas** occur most often in the cerebellum in young children, while **subependymal giant cell astrocytomas (SEGAs)** grow in the ventricles and are almost always seen in children with tuberous sclerosis[2].

Most children with these astrocytomas can be cured by surgery alone. They may be given radiation therapy if the tumor is not removed completely, although many doctors will wait until there are signs the tumor is growing back before considering it. Even then, another operation to remove the remaining tumor may be the first option. The outlook is not as good if the tumor is in a place that does not allow it to be removed surgically, such as the hypothalamus or brain stem. In these cases, radiation therapy is usually the best option.

For SEGAs that can't be removed completely by surgery, treatment with the targeted drug everolimus (Afinitor) might shrink the tumor or slow its growth for some time.

Other targeted drugs might also be an option for some of these tumors.*

Diffuse astrocytomas (grade II)

These tumors tend to grow slowly, but they can grow into nearby tissues. The initial treatment for these tumors is surgery if it can be done, or biopsy to confirm the diagnosis[3] if surgery is not feasible. Because these tumors often grow into nearby normal brain tissue, they are hard to cure with just surgery. Usually the surgeon will try to remove as much of the tumor as safely possible. If the surgeon can remove it all, the child may be cured with no further treatment.

Radiation therapy may be given after surgery, especially if a lot of tumor remains. Otherwise, radiation may be postponed until the tumor starts to regrow. (Sometimes, a second surgery might be tried before giving radiation.) Radiation may also be used as the main treatment if surgery is not a good option because of the tumor's location.

For children younger than 3, if the tumor can't be removed completely or if it grows

back, chemotherapy may be used to try to slow the tumor's growth until they are older. They may then be treated with radiation.

Targeted drugs might also be an option for some of these tumors.*

Higher-grade (grade III or IV) astrocytomas (anaplastic astrocytomas and glioblastomas)

Surgery is often the first treatment for these fast-growing astrocytomas if it can be done,

some of the tumor is left behind, a second operation may be done in some cases (often after a short course of chemotherapy).

Most of these tumors are astrocytomas, although a small number are ependymomas or other tumors. These tumors usually look a certain way on MRI scans[8], so the diagnosis can often be made without surgery or a biopsy.

Focal brain stem gliomas: A small number of brain stem gliomas are small tumors with very distinct edges (called *focal* brain stem gliomas). Some of these tumors grow so slowly that treatment might not be needed unless the tumor causes problems. If treatment is needed, these tumors can often be treated successfully with surgery. If surgery can't be done, radiation therapy may be used to slow its growth. Radiation can also be used if surgery doesn't remove the tumor completely.

Diffuse brain stem gliomas: Most brain stem gliomas grow diffusely throughout the brain stem, rather than as a distinct (focal) tumor. These tumors often start in the pons, where they are called *diffuse intrinsic pontine gliomas* (DIPGs). The brain stem is vital to life and can't be removed, so surgery in these cases would most likely do more harm

Pineoblastomas are no longer considered a type of embryonal tumor, but they are treated in a similar way.

These tumors also tend to grow quickly, and they are generally harder to treat than medulloblastomas (although treatment is often like that used for high-risk medulloblastomas).

These slow-growing tumors are usually benign and are cured by surgery. In some centers, small vestibular schwannomas (also known as *acoustic neuromas*) are treated by stereotactic radiosurgery. For larger schwannomas where complete removal is likely to cause problems, as much as possible is safely removed, and what's left is treated with radiosurgery.

Spinal cord tumors

These tumors are usually treated similarly to those of the same type in the brain.

Astrocytomas of the spinal cord usually can't be removed completely. They may be treated with surgery to remove as much tumor as possible, followed by radiation therapy, or with radiation therapy alone. Chemotherapy may be used after surgery instead of radiation in younger children. It may also be used after radiation therapy in older children if the tumor appears to be growing quickly.

Meningiomas near the spinal cord are often cured by surgery. Some ependymomas can be cured by surgery as well. If an ependymoma can't be removed completely, radiation therapy will be given after surgery.

Choroid plexus tumors

The most common germ cell tumor, **germinoma**, can usually be cured by radiation therapy alone (after it is diagnosed by surgery or looking at a cerebrospinal fluid sample). Chemotherapy may be added if the tumor is very large or if radiation doesn't destroy it completely. To try to reduce side effects in children who have not yet reached puberty, some doctors use chemotherapy followed by a reduced dose of radiation as the main treatment. In very young children, chemotherapy may be used instead of radiation therapy. If other types of germ cell tumors are present, either mixed or not mixed with germinoma, the outlook is usually not as good.

Other types of germ cell tumors (such as teratomas and yolk sac tumors) are rarely cured by surgery. Both radiation therapy and chemotherapy are used to treat them, but in some cases this might not control the tumor completely. Sometimes these tumors spread to the cerebrospinal fluid (CSF), and radiation therapy to the spinal cord and brain is needed as well.

Hyperlinks

1. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/about/types-of-brain-and-spinal-tumors.html
2. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/causes-risks-prevention/risk-factors.html
3. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/detection-diagnosis-staging/how-diagnosed.html
4. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/detection-diagnosis-staging/how-diagnosed.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
7. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/causes-risks-prevention/risk-factors.html
8. www.cancer.org/cancer/diagnosis-staging/tests/imaging-tests/mri-for-cancer.html
9. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/causes-risks-prevention/risk-factors.html
10. www.cancer.org/cancer/managing-cancer/making-treatment-decisions/clinical-trials.html
11. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/about/types-of-

brain-and-spinal-tumors.html
12. www.cancer.org/cancer/types/brain-spinal-cord-tumors-children/detection-diagnosis-staging/staging.html
13. www.cancer.org/cancer/managing-cancer/treatment-types/stem-cell-transplant.html
14. www.cancer.org/cancer/managing-cancer/treatment-types/stem-cell-transplant.html

References

Chang SM, Mehta MP, Vogelbaum MA, Taylor MD, Ahluwalia MS. Chapter 97: Neoplasms of the central nervous system. In: DeVita VT, Lawrence TS, Rosenberg SA, eds. *DeVita, Hellman, and Rosenberg's Cancer: Principles and Practice of Oncology*.

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