Brain and Spinal Cord Tumors in Children Early Detection, Diagnosis, and Staging

Detection and Diagnosis

Catching cancer early often allows for more treatment options. Some early cancers may have signs and symptoms that can be noticed, but that is not always the case.

- Can Brain and Spinal Cord Tumors in Children Be Found Early?
- Signs and Symptoms of Brain and Spinal Cord Tumors in Children
- How Are Brain and Spinal Cord Tumors Diagnosed in Children?

Stages and Outlook (Prognosis)

After a cancer diagnosis, staging provides important information about the extent of cancer in the body and anticipated response to treatment.

- How Are Brain and Spinal Cord Tumors in Children Staged?
- Survival Rates for Selected Childhood Brain and Spinal Cord Tumors

Can Brain and Spinal Cord Tumors in Children Be Found Early?

Screening is testing for a disease (such as brain or spinal cord tumors) in people without any symptoms. At this time there are no widely recommended screening tests for most children to look for brain or spinal cord tumors before they start to cause symptoms. These tumors usually are found as a result of signs or symptoms the child is having.
Most often, the outlook for people with brain or spinal cord tumors depends on the type of tumor and its location, not how early it is detected. But as with any disease, earlier detection and treatment is likely to be helpful.

For children with certain inherited syndromes that put them at higher risk for brain tumors, such as neurofibromatosis or tuberous sclerosis, doctors often recommend frequent physical exams and other tests. These tests might find tumors when they are still small. Not all tumors related to these syndromes may need to be treated right away, but finding them early might help doctors monitor them so that they can be treated quickly if they begin to grow or cause problems.

References
See all references for Brain and Spinal Cord Tumors in Children

Signs and Symptoms of Brain and Spinal Cord Tumors in Children

Signs and symptoms from brain and spinal cord tumors might occur gradually and become worse over time, or they can happen suddenly, such as with a seizure.

General symptoms

Tumors in any part of the brain might raise the pressure inside the skull (known as intracranial pressure). This can be caused by growth of the tumor, swelling in the brain, or blocked flow of cerebrospinal fluid. Increased pressure can lead to general symptoms such as:

- Headache
- Nausea
- Vomiting
- Crossed eyes or blurred vision
- Balance problems
- Behavior changes
- Seizures
- Drowsiness or even coma

Headaches that get worse over time are a common symptom of brain tumors. But not all brain tumors cause headaches, and most headaches are not caused by tumors.

In some children, seizures are the first symptom of a brain tumor. Most seizures in children are not caused by brain tumors, but if your child has a seizure, your child’s doctor may refer you to a neurologist (a doctor who specializes in brain and nervous system problems) to make sure it wasn’t caused by a brain tumor or other serious disease.

In the first few years of life, other symptoms of tumors can include irritability, loss of appetite, developmental delay, and a drop in intellectual and physical abilities. In very young children who can’t complain of symptoms, a parent may notice an increase in head size, sometimes along with bulging of the soft spots of the skull (fontanelles). This happens because the bones of the skull haven’t grown together yet, and increased pressure from a tumor can push them apart.

In the school-aged child, other general symptoms of tumors can include poor school performance, fatigue, and personality changes.

If the child can cooperate, the doctor can sometimes tell if pressure inside the skull is increased by looking inside the child’s eyes for swelling of the optic nerve (known as papilledema).

**Symptoms of tumors in different parts of the central nervous system**

Tumors in different parts of the brain or spinal cord can cause different symptoms. But these symptoms can be caused by any disease in that particular location – they don’t always mean a child has a brain or spinal cord tumor.

Brain and spinal cord tumors often cause problems with the specific functions of the region they develop in. For example:

- Tumors in the parts of the cerebrum (the large, outer part of the brain) that control movement or sensation can cause weakness or numbness in a part of the body, often on just one side.
- Tumors in or near the parts of the cerebrum responsible for language can cause
problems with speech or even understanding words.

- Tumors in the front part of the cerebrum can sometimes affect thinking, personality, and language skills.
- Tumors in an area of the brain called the basal ganglia typically cause abnormal movements and body positions.
- Tumors in the cerebellum, which controls coordination, can cause trouble walking or with other normal functions, even eating.
- Tumors in the back part of the cerebrum, or around the pituitary gland, the optic nerves, or certain other cranial nerves can cause vision problems.
- Tumors in or near other cranial nerves might lead to loss of hearing, balance problems, weakness of some facial muscles, or trouble swallowing.
- Spinal cord tumors may cause numbness, weakness, or lack of coordination in the arms and/or legs (usually on both sides of the body), as well as bladder or bowel problems.

Having one or more of the symptoms above does not mean that your child definitely has a brain or spinal cord tumor. All of these symptoms can have other causes. Still, if your child has any of these symptoms, especially if they don’t go away or get worse over time, see your child’s doctor so that the cause can be found and treated, if needed.

- **References**

  See all references for Brain and Spinal Cord Tumors in Children

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**How Are Brain and Spinal Cord Tumors Diagnosed in Children?**

Brain and spinal cord tumors are usually found because of signs or symptoms a child is having. If a tumor is suspected, tests will be needed to confirm the diagnosis.

**Medical history and physical exam**
If your child has symptoms that suggest a brain or spinal cord tumor, the doctor will get a complete medical history, focusing on the symptoms and when they began. The doctor will also do a neurologic exam to check your child’s brain and spinal cord function, if possible. Depending on the child’s age, the exam may test reflexes, sensation, muscle strength, vision, eye and mouth movement, coordination, balance, alertness, and other functions.

If the results are abnormal, your child’s doctor may refer you to a neurologist (a doctor specializing in medical treatment of nervous system diseases) or a neurosurgeon (a surgeon specializing in nervous system diseases), who will do a more detailed exam and might order other tests.

### Imaging tests

Your child’s doctors may order one or more imaging tests. These tests use x-rays, strong magnets, or radioactive substances to create pictures of internal organs such as the brain and spinal cord. The pictures may be looked at by doctors specializing in this field (neurosurgeons, neurologists, and neuroradiologists) as well as by your child’s primary care doctor.

Magnetic resonance imaging (MRI) and computed tomography (CT) scans are used most often for brain diseases. These scans will show a brain or spinal cord tumor, if one is present, in almost all cases. Doctors can often also get an idea about what type of tumor it might be, based on how it looks on the scan and where it is in the brain (or spinal cord).

### Magnetic resonance imaging (MRI) scan

MRIs scans are very good for looking at the brain and spinal cord and are considered the best way to look for tumors in these areas. MRI images are usually more detailed than those from CT scans (described below). But they do not image the bones of the skull as well as CT scans and therefore might not show the effects of tumors on the skull.

MRI scans create detailed images using radio waves and strong magnets instead of x-rays, so they do not expose the child to radiation. A contrast material called gadolinium may be injected into a vein before the scan to help see details better.

MRI scans can take a long time – often up to an hour. Your child may have to lie on a table that slides inside a narrow tube, which is confining and can be distressing. The test also requires a person to stay still for several minutes at a time. Some children
might need medicine to help them relax or even be asleep during the test. Open MRI machines may be another option, though they might result in less detailed images. The MRI machine makes loud buzzing and clicking noises that your child may find disturbing. Some places provide headphones or earplugs to help block this noise out.

**Magnetic resonance angiography (MRA):** This special form of MRI may be done to look at the blood vessels in the brain. This can be very useful before surgery to help the surgeon plan an operation.

**Magnetic resonance spectroscopy (MRS):** This test is like an MRI, except it measures the radio wave interactions with different chemicals in the brain. MRS highlights some features of brain tumors that may not be seen clearly with MRI. It creates graph-like results called *spectra* (but crude images can also be created). This might give clues to the type of tumor, but in most cases a biopsy of the tumor is still needed to get an accurate diagnosis. MRS can also be used after treatment to help determine if an area that still looks abnormal on another test is remaining tumor or if it is more likely to be scar tissue.

**Magnetic resonance perfusion:** For this test, also known as *perfusion MRI*, a contrast dye is injected quickly into a vein. A special type of MR image is then obtained to look at the amount of blood going through different parts of the brain and tumor. Tumors often have a bigger blood supply than normal areas of the brain. A faster growing tumor may need more blood.

Perfusion MRI can give doctors an idea of the best place to take a biopsy. It can also be used after treatment to help determine if an area that still looks abnormal is remaining tumor or if it is more likely to be scar tissue.

**Functional MRI (fMRI):** This newer type of MRI looks for tiny blood flow changes in an active part of the brain. It can be used to determine what part of the brain handles a function such as speech, thought, sensation, or movement. Doctors can use this to determine which parts of the brain to avoid when planning surgery or radiation therapy.

This test is similar to a standard MRI, except that your child will be asked to perform specific tasks (such as answering simple questions or moving their fingers) while the scans are being done.

**Computed tomography (CT) scan**

The CT scan uses x-rays to produce detailed cross-sectional images of your child’s brain and spinal cord. Instead of taking one picture, like a regular x-ray, a CT scanner
takes many pictures as it rotates around your child while he or she lies on a table. A computer then combines these pictures into images of slices of the body. Unlike a regular x-ray, a CT scan creates detailed images of the soft tissues in the body.

For brain and spinal cord tumors, CT scans are not used as often as MRI scans, which give slightly more detailed images and do not use radiation. Still, there are instances where CT scans may have advantages over MRI scans:

- CT scans take much less time than MRIs, which can be particularly helpful for children who have trouble staying still.
- CT scans provide greater detail of the bone structures near the tumor than MRIs do.
- CT angiography (CTA), which is described below, can provide better details of the blood vessels in and around a tumor than MRA in some cases.

Before the scan, your child may get an injection of a contrast dye through an IV (intravenous) line. This helps better outline any tumors that are present. The contrast contains iodine and may cause some flushing (a feeling of warmth, especially in the face). Some people are allergic to the dye and get hives. Rarely, more serious reactions like trouble breathing or low blood pressure can occur. Be sure to tell the doctor if your child has any allergies or has ever had a reaction to any contrast material used for an imaging test.

**CT angiography (CTA):** For this test, your child gets an injection of contrast material through an IV line while he or she is in the CT scanner. The scan creates detailed images of the blood vessels in the brain, which can help doctors plan surgery. CT angiography can provide better details of the blood vessels in and around a tumor than MR angiography in some cases.

**Positron emission tomography (PET) scan**

For this test, a radioactive substance (usually a type of sugar known as FDG) is injected into the blood. The amount of radioactivity used is very low and passes out of the body within a day or so. Because tumor cells in the body are growing quickly, they absorb larger amounts of the sugar than most other cells. After about an hour, your child is moved onto a table in the PET scanner. He or she will lie on the table for about 30 minutes while a special camera creates a picture of areas of radioactivity in the body. If your child is not able to stay still for the test, this might require sedation.

The PET scan image is not as detailed as a CT or MRI scan, but it can provide helpful information about whether abnormal areas seen on other tests (such as MRIs) are likely to be tumors or not.
This test is also useful after treatment to help determine if an area that still looks abnormal on an MRI scan is remaining tumor or if it is more likely to be scar tissue. Any remaining tumor will show up on the PET scan, while scar tissue will not.

**Angiogram**

For this test, a special dye is injected into blood vessels near the tumor, and then the area is viewed with x-rays. This helps doctors look at a tumor’s blood supply. This test is not done much for brain or spinal cord tumors anymore, as it has largely been replaced by magnetic resonance angiography (MRA) or computerized tomographic angiography (CTA).

**Brain or spinal cord tumor biopsy**

Imaging tests such as MRI and CT scans may show that a child has a brain or spinal cord tumor. But usually the type of tumor can be determined only by removing a sample of it, which is called a *biopsy*. A *biopsy* may be done as a procedure on its own for diagnosis, or it may be part of surgery to treat the tumor.

The biopsy samples are looked at under a microscope by a pathologist (a doctor specializing in diagnosis of diseases by lab tests). Sometimes it might need to be looked at by a neuropathologist, a pathologist who specializes in nervous system diseases. The pathologist determines if the tumor is benign or malignant (cancerous) and exactly what type of tumor it is.

In some cases (such as for many astrocytomas or brain stem gliomas), it may not be necessary or possible to biopsy the tumor safely, so the diagnosis is made based only on how the tumor looks on imaging tests.

Biopsies can be done in different ways.

**Stereotactic needle biopsy**

This type of biopsy may be used if imaging tests show surgery to remove the tumor might be too risky (such as with some tumors in vital areas or deep within the brain) but a sample is still needed to make a diagnosis.

Depending on the situation, the biopsy may be done with the child awake or under general anesthesia (asleep). If the child is awake, the neurosurgeon injects a local anesthetic into areas of skin over the skull to numb them. (The skull and brain itself do
not feel pain.)

A rigid frame may then be attached onto the child’s head. This helps make sure the surgeon will target the tumor precisely. A small cut is made in the scalp, and a small hole is drilled in the skull. An MRI or CT scan is used along with the frame to help the neurosurgeon guide a hollow needle into the tumor to remove small pieces of tissue.

Another approach is to get an MRI or CT scan, use scalp markers or facial and scalp contours to create a map of the inside of the head, and then use an image-guidance system to direct the needle into the tumor. This still requires making an incision and drilling a small hole into the skull.

The biopsy samples are then looked at under a microscope by a pathologist. The doctor can usually tell exactly what type of tumor it is. This helps determine the best course of treatment and the prognosis (outlook).

**Craniotomy**

If imaging tests show the tumor can be treated with surgery, the neurosurgeon may not do a needle biopsy. Instead, he or she may do an operation called a *craniotomy* (described in the Surgery section) to remove all or most of the tumor. (Removing most of the tumor is known as *debulking.*)

Small samples of the tumor are looked at right away by the pathologist while the child is still in the operating room, to get a preliminary diagnosis. This can help guide treatment, including whether further surgery should be done at that time. A final diagnosis is made within a few days in most cases.

You can read more about the kinds of tests that are done on biopsy or tissue samples in *Testing Biopsy and Cytology Specimens for Cancer.*

**Lumbar puncture (spinal tap)**

This test is used to look for cancer cells or chemicals released by tumors in the cerebrospinal fluid (CSF), which is the liquid that bathes the brain and spinal cord. For this test, the doctor first numbs an area in the lower part of the back over the spine. The doctor may also recommend that the child be given something to make them sleep so the lumbar puncture can be done more easily and safely. A small, hollow needle is then placed between the bones of the spine to withdraw some of the fluid.
The fluid is looked at under a microscope for cancer cells. The CSF can also be tested for certain substances released by some germ cell tumors.

Lumbar punctures are often used if a tumor has already been diagnosed as a type (such as a medulloblastoma) that can commonly spread through the CSF. Information from the spinal tap can influence treatment.

**Bone marrow aspiration and biopsy**

Because some tumors (especially medulloblastomas) can spread beyond the nervous system, in some instances the doctor may recommend looking at cells in your child’s bone marrow (the soft, inner part of certain bones) to see if tumor cells have spread there.

The bone marrow aspiration and biopsy are often done at the same time. The samples are usually taken from the back of the pelvic (hip) bone, but in some cases they may be taken from other bones.

In bone marrow *aspiration*, the skin over the hip and the surface of the bone is cleaned and then numbed with local anesthetic. In most cases, the child is also given other medicines to make them drowsy or even asleep during the procedure. A thin, hollow needle is then inserted into the bone, and a syringe is used to suck out (aspirate) a small amount of liquid bone marrow.

A bone marrow *biopsy* is usually done just after the aspiration. A small piece of bone and marrow is removed with a slightly larger needle that is pushed down into the bone. Once the biopsy is done, pressure is applied to the site to help stop any bleeding.

The specimens are then looked at under a microscope for tumor cells.

**Blood and urine tests**

These *lab tests* are rarely used to diagnose brain and spinal cord tumors, but if your child has been sick for some time they may be done to check how well the liver, kidneys, and some other organs are working. This is especially important before any planned surgery.

If your child is getting *chemotherapy*, blood tests will be done routinely to check blood counts and to see if the treatment is affecting other parts of the body.
How Are Brain and Spinal Cord Tumors in Children Staged?

The stage of a cancer is a measure of how far it has spread. The extent of spread is based on the results of imaging tests (see How are brain and spinal cord tumors in children diagnosed?) and any other tests that have been done.

For most types of cancer, the stage is one of the most important factors in selecting treatment options and in determining the outlook (prognosis). But tumors of the brain and spinal cord differ in some important ways from cancers in other parts of the body. One of the main reasons other cancers are dangerous is that they can spread throughout the body. Tumors starting in the brain or spinal cord can spread to other parts of the central nervous system, but they almost never spread to other organs. These tumors are dangerous because when they grow, it can interfere with essential functions of the brain.

Because most tumors in the brain or spinal cord do not usually spread, they are not formally staged. Some of the most important factors that determine your child’s prognosis include:

- The type of tumor (such as astrocytoma, ependymoma, etc.)
- The grade of the tumor (how quickly the tumor is likely to grow, based on how the cells look under a microscope)
- The location and size of the tumor
- How much of the tumor can be removed by surgery (if it can be done)
- Your child’s age
- Your child’s functional level (whether the tumor is affecting normal brain functions and everyday activities)
• Whether or not the tumor has spread through the cerebrospinal fluid (CSF) to other parts of the brain or spinal cord
• Whether or not tumor cells have spread beyond the central nervous system

**Medulloblastoma risk groups**

A *staging system* is a standard way for the cancer care team to describe the extent of tumor spread. Formal staging systems have been proposed for some childhood brain tumors.

For example, many clinical trials for treating medulloblastoma use a system that places children into either standard-risk or high-risk groups. Children are placed in the high-risk group if any of these apply:

• The child is younger than 3
• A lot of the tumor can’t be removed during surgery
• Tumor cells are in the CSF or have spread to other parts of the brain or elsewhere

Doctors are still refining this system to make it as accurate as possible.

Recent research has shown that medulloblastomas can be divided into 4 types, based on the major gene changes found in the cancer cells. Each type of medulloblastoma has a different outlook, so doctors may be able to use this to better tailor the treatment each child gets (see [What’s new in research and treatment for brain tumors in children?](#)).

- **References**

  See all references for Brain and Spinal Cord Tumors in Children

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**Survival Rates for Selected Childhood Brain and Spinal Cord Tumors**
Survival rates are often used by doctors as a standard way of discussing a person’s prognosis (outlook). Some parents may want to know the survival statistics for children in similar situations, while others may not find the numbers helpful, or may even not want to know them. If you do not want to read about the survival statistics for brain and spinal cord tumors given in the next few paragraphs, skip to the next section.

The 5-year survival rate refers to the percentage of children who live at least 5 years after their cancer is diagnosed. Of course, many children live much longer than 5 years (and many are cured).

To get 5-year survival rates, doctors have to look at children who were treated at least 5 years ago. Improvements in treatment since then might result in a better outlook for children now being diagnosed with brain tumors.

The numbers below come from the Central Brain Tumor Registry of the United States (CBTRUS) and are based on children aged 19 or younger who were treated between 1995 and 2010. There are some important points to note about these numbers:

- These numbers are for some of the more common types of tumors. Numbers are not readily available for all types of tumors that occur in children, often because they are rare or are hard to classify.
- In some cases, the numbers include a wide range of different types of tumors that can have different outlooks. For example, the survival rate for PNETs below includes medulloblastomas, pineoblastomas, and PNETs in other parts of the brain. Medulloblastomas tend to have a better outlook than the other PNETs. Therefore the actual survival rate for medulloblastomas would be expected to be higher than the number below, while the number for other PNETs would likely be lower.

<table>
<thead>
<tr>
<th>Type of Tumor</th>
<th>5-Year Survival Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilocytic astrocytoma</td>
<td>About 95%</td>
</tr>
<tr>
<td>Fibrillary (diffuse) astrocytoma</td>
<td>About 80% to 85%</td>
</tr>
<tr>
<td>Anaplastic astrocytoma</td>
<td>About 30%</td>
</tr>
<tr>
<td>Glioblastoma</td>
<td>About 20%</td>
</tr>
<tr>
<td>Oligodendroglioma</td>
<td>About 90% to 95%</td>
</tr>
<tr>
<td>Ependymoma/anaplastic ependymoma</td>
<td>About 75%</td>
</tr>
<tr>
<td>PNETs (includes medulloblastoma and pineoblastoma)</td>
<td>About 60% to 65%</td>
</tr>
</tbody>
</table>

Survival rates are often based on previous outcomes of large numbers of children who had the disease, but they can’t predict what will happen in any particular child’s case. Knowing the type of a child’s brain tumor is important in estimating their outlook. But many other factors can also affect a child’s outlook, such as the location and extent of
the tumor and how well it responds to treatment. Even taking these other factors into account, survival rates are at best rough estimates. Your child’s doctor knows your child’s situation and is your best source of information on this topic.

- **References**
  [See all references for Brain and Spinal Cord Tumors in Children](#)

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