Pituitary Tumors

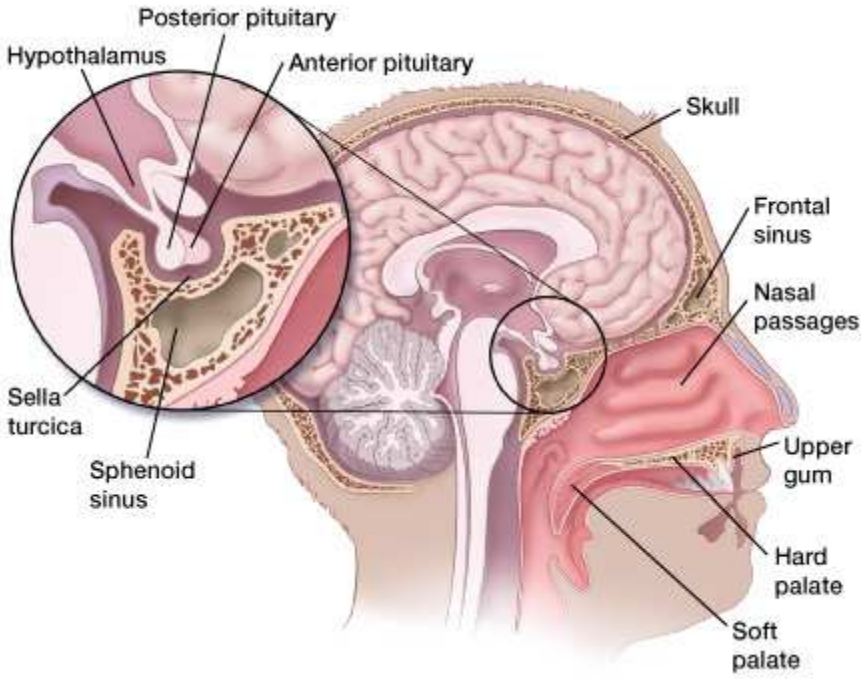
What are pituitary tumors?

A tumor is an abnormal growth of cells. Tumors can start nearly anywhere in the body. Tumors that start in the pituitary gland are called *pituitary tumors*.

To understand pituitary tumors, it helps to know about the normal pituitary gland and what it does.

The pituitary gland

The pituitary is a small gland found inside the skull just below the brain and above the nasal passages, which are above the fleshy back part of the roof of the mouth (known as the *soft palate*). The pituitary sits in a tiny bony space called the *sella turcica*. The nerves that connect the eyes to the brain, called the *optic nerves*, pass close by it.



The pituitary gland is connected directly to part of the brain called the *hypothalamus*. This provides a key link between the brain and the *endocrine system*, a collection of glands in the body that make hormones. Hormones are substances released into the blood that control how other organs work. The hypothalamus releases hormones into tiny blood vessels directly connected to the pituitary gland. These cause the pituitary gland to make its own hormones. The pituitary is considered the “master control gland” because the hormones it makes control the levels of hormones made by most other endocrine glands in the body.

The pituitary gland has 2 parts, the anterior pituitary and the posterior pituitary, each of which has distinct functions.

Anterior pituitary

Most pituitary tumors begin in the larger, front part of the pituitary gland known as the anterior pituitary. This part of the gland makes several hormones that control other endocrine glands.

- **Growth hormone** (GH, also known as *somatotropin*) promotes body growth during childhood. If too much is made in a child they will grow very tall. Normally, adults make only small amounts of growth hormone. If an adult makes too much growth hormone, the bones of the hands, feet, and face continue to grow and become quite large, causing their normal features to become distorted. This condition is called *acromegaly*.

- **Thyroid-stimulating hormone** (TSH, also called *thyrotropin*) stimulates growth of the thyroid gland and the release of thyroid hormone. Thyroid hormone regulates

metabolism. Too much makes you hyperactive and shaky, and too little makes you sluggish. If a pituitary tumor makes too much TSH, it can cause hyperthyroidism (an overactive thyroid gland).

- **Adrenocorticotropic hormone** (ACTH, also known as *corticotropin*) causes the adrenal glands to grow and to make steroid hormones (such as cortisol). Too much ACTH from the pituitary causes Cushing's disease, the symptoms of which can include rapid weight gain and the buildup of fat in certain parts of the body.

- **Luteinizing hormone (LH)** and **follicle-stimulating hormone (FSH)** are also called *gonadotropins*. In women their main effects are on the ovaries, where they regulate ovulation (the release of eggs) and the production of the hormones estrogen and progesterone. In men, LH and FSH control testosterone and sperm production in the testicles.

- **Prolactin** causes milk production in the female breast. Its function in men is not known.

Posterior pituitary

The smaller, back part of the pituitary gland, known as the posterior pituitary, is really an extension of brain tissue from the hypothalamus. The posterior pituitary is where hormones made by the hypothalamus (vasopressin and oxytocin) are stored and released into the bloodstream.

- **Vasopressin** (also called *antidiuretic hormone*, or ADH) causes the kidneys to keep water in the body and not lose it all in the urine. Without vasopressin, a person urinates too much and becomes dehydrated. This condition is called *diabetes insipidus*. Vasopressin also can raise blood pressure by causing blood vessels to constrict. It might have other functions as well.

- **Oxytocin** causes the uterus to contract in women during childbirth and the breasts to release milk when a woman nurses her baby. It might have other functions in both men and women as well.

Tumors rarely develop in the posterior pituitary.

Pituitary tumors

Almost all pituitary tumors are benign (non-cancerous) glandular tumors called *pituitary adenomas*. These tumors are considered benign because they don't spread to other parts of the body, like cancers can do. Still, even benign pituitary tumors can cause significant health problems because of their location near the brain and because many of them secrete excess hormones.

Pituitary cancers (called *pituitary carcinomas*) are very rare.

Pituitary adenomas

These benign tumors do not spread outside the skull. They usually remain confined to the sella turcica (the tiny space in the skull that the pituitary gland sits in). Sometimes they grow into the walls of the sella turcica and surrounding blood vessels, nerves, and coverings of the brain. They don't grow very large, but they can have a big impact on a person's health.

There is very little room for tumors to grow in this part of the skull. Therefore, if the tumor becomes larger than about a centimeter (about half an inch) across, it may grow upward, where it can compress and damage nearby parts of the brain and the nerves that arise from it. This can lead to symptoms such as vision changes or headaches (see "Signs and symptoms of pituitary tumors").

Microadenoma versus macroadenoma

Pituitary adenomas can be divided into 2 categories based on size:

- **Microadenomas** are tumors that are smaller than 1 centimeter (cm) across. Because these tumors are small, they rarely damage the rest of the pituitary or nearby tissues. But they can cause symptoms if they make too much of a certain hormone. Many people actually have small adenomas that are never detected because they never grow large enough or secrete enough hormones to cause a problem.

- **Macroadenomas** are tumors 1 cm across or larger. Macroadenomas can affect a person's health in 2 ways. First, they can cause symptoms if they make too much of a certain hormone. Second, they can cause symptoms by pressing on normal parts of the pituitary or on nearby nerves, such as the optic nerves.

Functional versus non-functional adenoma

Pituitary adenomas are also classified by whether they make too much of a hormone and, if they do, which type they make. If a pituitary adenoma makes too much of a hormone it is called *functional*. If it doesn't make enough hormones to cause problems it is called *non-functional*.

Functional adenomas: Most of the pituitary adenomas that are found make excess hormones. The hormones can be detected by blood tests or by tests of the tumor when it is removed with surgery. Based on these results, adenomas are classified as:

- Prolactin-producing adenomas (prolactinomas), which account for about 4 out of 10 pituitary tumors

- Growth hormone-secreting adenomas, which make up about 2 in 10 pituitary tumors

- Corticotropin (ACTH)-secreting adenomas (about 5% to 10%)

- Gonadotropin (LH and FSH)-secreting adenomas (less than 1%)

- Thyrotropin (TSH)-secreting adenomas (less than 1%)

Some adenomas secrete more than one type of hormone.

The kind of hormone an adenoma produces strongly affects what signs and symptoms the patient has. It also affects which tests are used for diagnosis, the choice of treatment, and the patient's outlook.

Non-functional adenomas: Pituitary adenomas that don't make excess hormones are called *non-functional adenomas* or *null cell adenomas*. They account for about 3 in 10 of all pituitary tumors that are found. They are usually detected as macroadenomas, causing symptoms because of their size as they press on surrounding structures.

Pituitary carcinomas

Cancers of the pituitary gland are rare. Only a few hundred have ever been described in medical journals. They can occur at any age, but most are found in older people. These cancers usually make hormones, just like many adenomas do.

Most pituitary carcinomas look very much like pituitary adenomas under a microscope, so doctors have trouble telling them apart. In fact, there is no good way to tell if a pituitary tumor is a carcinoma and not an adenoma until the tumor spreads to another part of the body. If this happens, it is typically 5 to 10 years after the first surgery. Most often it spreads to the brain, spinal cord, meninges (the covering of the brain and spinal cord), or bone around the pituitary. Rarely, these cancers spread to other organs such as the liver, heart, or lungs.

Other tumors of the pituitary region

There are several other types of benign tumors that grow in the region of the pituitary, as well as some malignant (cancerous) ones. All are much less common than pituitary adenomas.

Teratomas, germinomas, and choriocarcinomas are all rare tumors that usually occur in children or young adults. They don't develop from the hormone-making cells of the pituitary gland itself, but they can grow into the pituitary and damage it.

Rathke cleft cysts and gangliocytomas of the pituitary are rare tumors that are usually found in adults.

Craniopharyngiomas are slow-growing tumors that start above the pituitary gland but below the brain itself. They sometimes press on the pituitary and the hypothalamus, causing hormonal problems. They are more common in children, but they are sometimes seen in older adults. For more on these tumors, see our document *Brain and Spinal Cord Tumors in Children*.

Cancers that start in some other parts of the body (like the breast) can sometimes spread to the pituitary. These cancers are classified and treated based on where they started (their primary site) and are not thought of as pituitary tumors.

The rest of this document focuses mainly on benign pituitary tumors (pituitary adenomas).

What are the key statistics about pituitary tumors?

About 10,000 pituitary tumors are diagnosed each year in the United States. Almost all of these tumors are benign pituitary adenomas. Very few pituitary tumors are cancers (carcinomas).

The actual number of pituitary tumors may be much higher than the number of tumors that are found each year. When examining people who have died or who have had imaging tests (like MRI scans) of their brain for other health problems, doctors have found that as many as 1 out of 4 people may have a pituitary adenoma without knowing it. These tumors are often small and never cause any symptoms or health problems, so very few of them would normally be diagnosed at all.

Pituitary tumors can occur at any age (including in children), but they are most often found in older adults.

What are the risk factors for pituitary tumors?

A risk factor is anything that changes a person's chance of getting a disease. For example, smoking is a risk factor for cancer of the lung and many other cancers.

But having a risk factor, or even several risk factors, does not mean that you will get the disease. And many people who get the disease may have few or no known risk factors.

Pituitary tumors have very few known risk factors, and these are related to genetics. There are no known environmental or lifestyle-related risk factors for pituitary tumors.

Family history

Most people who develop pituitary tumors don't have a family history of the disease. But rarely, pituitary tumors can run in families.

Sometimes when pituitary tumors run in families, they are found along with other types of tumors as part of an inherited genetic syndrome (see the next section).

Sometimes, though, only pituitary tumors occur. Researchers have found that some of these are due to certain changes in a person's genes that are inherited from a parent (see "Do we know what causes pituitary tumors?").

Most often, though, the cause of pituitary tumors that run in families is not known.

Genetic syndromes

Pituitary tumors can be a part of a syndrome that includes an increased risk of other types of tumors. These syndromes are caused by abnormal changes (mutations) in a person's genes. They include:

Multiple endocrine neoplasia, type I (MEN1): This is a hereditary condition in which people have a very high risk of developing tumors of 3 glands: the pituitary, parathyroid, and pancreas. It is caused by changes in the gene *MEN1*, and is passed on to about half of the children of an affected parent. If the MEN1 syndrome affects your family, you should discuss testing for this condition with your doctor.

Multiple endocrine neoplasia, type IV (MEN4): This rare syndrome includes increased risks of pituitary tumors and certain other tumors. MEN4 is caused by inherited changes in a gene called *CDKN1B*.

McCune-Albright syndrome: This syndrome is caused by changes in a gene called *GNAS1* that aren't inherited but occur before birth. People with this syndrome have brown patches on their skin (called *café-au-lait spots*) and develop many bone problems. They can also have hormone problems and pituitary tumors.

Carney complex: This is a rare syndrome in which people can have heart, skin, and adrenal problems. They also have a high risk of a number of different types of tumors, including pituitary tumors. Many cases are caused by inherited changes in the gene *PRKAR1A*, but some are caused by changes in other genes that have not yet been identified.

You can learn more about inherited cancer syndromes in our document *Family Cancer Syndromes*.

Do we know what causes pituitary tumors?

Scientists don't know exactly what causes most pituitary tumors. During the past few years, they have made great progress in understanding how certain changes in a person's DNA can cause cells in the pituitary to produce a tumor. DNA is the chemical in each of our cells that makes up our *genes* – the instructions for how our cells function. We usually look like our parents because they are the source of our DNA. But DNA affects more than how we look.

Some genes control when cells grow, divide into new cells, and die. Genes that help cells grow, divide, and stay alive are called *oncogenes*. Genes that slow down cell division or

cause cells to die at the right time are called *tumor suppressor genes*. Tumors can be caused by DNA changes that turn on oncogenes or turn off tumor suppressor genes.

Some people inherit gene mutations (changes) from their parents that greatly increase their risk for developing pituitary tumors. Some of these mutations were described in the previous section, “What are the risk factors for pituitary tumors?” Members of families with these genetic syndromes can have genetic testing to find out if they are affected.

But often, gene mutations occur during life rather than having been inherited. In some types of cancer, these *acquired* mutations can be caused by outside exposures, such as radiation or cancer-causing chemicals. Most pituitary tumors are not cancers, and there are no known environmental causes for these tumors. The gene changes in these tumors might just be random events that sometimes happen when a cell divides, without having an outside cause.

Some non-hereditary (sporadic) pituitary tumors – those that don’t run in families – have acquired mutations in a gene called *AIP*. Many growth hormone-secreting adenomas have an acquired mutation in a gene called *GNAS1*. These mutations are much less common in other types of pituitary adenomas.

Changes in other genes have been found in other types of pituitary adenomas, but it’s not clear if abnormal genes are always needed for pituitary tumors to form. What is known is that there is a loss of the regulatory mechanism that normally keeps the pituitary cells from growing and making too much hormone.

Because there are no known lifestyle-related or environmental causes of pituitary tumors, it’s important to remember that there is nothing people with these tumors could have done to prevent them.

Can pituitary tumors be prevented?

The risk of many types of cancer can be reduced with certain lifestyle changes (such as staying at a healthy weight or quitting smoking). But pituitary tumors have not been linked with any known outside risk factors. As a result, there is no known way to prevent these tumors at this time.

Still, for people at high risk of pituitary tumors (because of certain inherited syndromes), there may be ways to find and treat them early, before they cause problems (see “Can pituitary tumors be found early?”).

Can pituitary tumors be found early?

No imaging tests or blood tests are recommended to screen for pituitary tumors in people who are not at increased risk. (Screening is testing for tumors in people without any symptoms.)

For members of families known to be at increased risk because of a genetic syndrome such as multiple endocrine neoplasia, type I (MEN1), doctors often recommend regular blood testing of pituitary hormone levels. These tests increase the odds of finding a tumor early so that it can be removed completely, increasing the chance for a cure.

Rarely, a pituitary tumor is found early because a person has a CT or MRI scan of the brain for an unrelated problem. These tumors are sometimes referred to as *incidentalomas*, meaning they are found incidentally (by accident).

Functional pituitary adenomas (tumors that make excess hormones like prolactin or ACTH) are often found when they are still small because the excess hormones cause symptoms.

Non-functional pituitary tumors are less likely to be found early because they don't cause symptoms until they've grown large enough to press on normal pituitary cells, nerves, or parts of the brain near the pituitary.

Signs and symptoms of pituitary tumors

Not all pituitary tumors cause symptoms. But when they do, they can cause many different types of symptoms. The first symptoms often depend on whether the tumor is *functional* (releasing excess hormones) or *non-functional* (not releasing excess hormones).

Functional adenomas can cause problems because of the hormones they release. Typically, a functional adenoma makes too much of a single pituitary hormone. These tumors are often found while they are still fairly small (microadenomas). Symptoms from functional adenomas are described below, based on which hormone they secrete.

Tumors that aren't making excess hormones often become large (macroadenomas) before they are noticed. These tumors cause symptoms when they press on nearby nerves, parts of the brain, or other parts of the pituitary.

Non-functional adenomas that cause no symptoms are sometimes found because of an MRI or CT scan done for other reasons. These tumors are now being found more often as more MRI and CT scans of the brain are done. These may be the most common pituitary tumors. As long as they aren't causing problems, they are typically just watched closely without needing treatment.

Large tumors (macroadenomas) and pituitary carcinomas

Pituitary macroadenomas (benign tumors larger than 1 cm) and carcinomas (cancers), whether functional or not, can be large enough to press on nearby nerves or parts of the brain. This can lead to symptoms such as:

- Blurred or double vision
- Loss of peripheral vision

- Sudden blindness
- Headaches
- Facial numbness or pain
- Dizziness
- Loss of consciousness (passing out)

Vision problems occur when the tumor “pinches” the nerves that run between the eyes and the brain. Sudden loss of vision, loss of consciousness, and even death can result from sudden bleeding into the tumor.

Macroadenomas and pituitary carcinomas can also press on and destroy the normal parts of the pituitary gland, causing a shortage of one or more pituitary hormones. This can lead to low levels of some body hormones such as cortisol, thyroid hormone, and sex hormones. Depending on which hormones are affected, the symptoms might include:

- Nausea
- Weakness
- Unexplained weight loss or weight gain
- Feeling cold
- Feeling tired or weak
- Menstrual changes or loss of menstrual periods in women
- Erectile dysfunction (trouble with erections) in men
- Decreased interest in sex, mainly in men

Diabetes insipidus: Large tumors can sometimes press on the posterior pituitary, causing a shortage of the hormone vasopressin (also called *anti-diuretic hormone* or ADH). This can lead to diabetes insipidus. In this condition, too much water is lost in the urine, so the person urinates often and becomes very thirsty as the body tries to keep up with the loss of water. If left untreated, this can cause dehydration and abnormal blood mineral levels, which can lead to coma and even death. Fortunately, this condition is easily treated with a drug called desmopressin, which replaces the vasopressin. (Diabetes insipidus is not related to diabetes mellitus, in which people have high blood sugar levels.)

Growth hormone-secreting adenomas

The major symptoms from these tumors are caused by having too much growth hormone (GH). These effects are quite different in children and adults.

In children, high GH levels can stimulate the growth of nearly all bones in the body. The medical term for this condition is *gigantism*. Its features typically include:

- Being very tall
- Very rapid growth
- Joint pain
- Increased sweating

In adults, the long bones (especially in the arms and legs) can't grow any more, even when GH levels are very high. But bones of the hands, feet, and skull can grow throughout life. Adults with GH-secreting adenomas don't grow taller and develop gigantism. Instead, they develop a different condition called *acromegaly*. The signs and symptoms are:

- Growth of the skull, hands, and feet, leading to increase in hat, shoe, glove, and ring size
- Deepening of the voice
- Change in how the face looks (due to growth of facial bones)
- Wider spacing of the teeth and protruding jaw (due to jawbone growth)
- Joint pain
- Increased sweating
- High blood sugar or even diabetes mellitus
- Kidney stones
- Heart disease
- Headaches
- Thickening of tongue and roof of mouth, leading to sleep disturbances such as snoring and sleep apnea (pauses in breathing)
- Thickened skin
- Increased growth of body hair

Many of these changes can occur very slowly, and people might not notice them until they look at an old picture of themselves (or try to put on a hat or ring they haven't worn in many years).

Corticotropin (ACTH)-secreting adenomas

High ACTH levels cause the adrenal glands to make steroid hormones such as cortisol. Having too much of these hormones causes symptoms that doctors group together as *Cushing's syndrome*. When the cause is too much ACTH production from the pituitary it is termed *Cushing's disease*. In adults, the symptoms can include:

- Unexplained weight gain (mostly in the chest and abdomen)
- Purple stretch marks on the abdomen
- New or increased hair growth (on the face, chest, and/or abdomen)
- Swelling and redness of the face
- Acne
- Fat areas near the base of the neck
- Moodiness or depression
- Easy bruising
- High blood sugar levels or even diabetes mellitus
- High blood pressure
- Decreased interest in sex
- Changes in menstrual periods in women
- Weakening of the bones, which can lead to osteoporosis or even fractures

Most of these symptoms can also occur in children. Children with Cushing's disease may also stop growing and have problems with school performance.

Prolactin-secreting adenomas (prolactinomas)

Prolactinomas are most common in young women and older men. In women before menopause, high prolactin levels cause menstrual periods to become less frequent or to stop. High prolactin levels can also cause abnormal breast milk production, called *galactorrhea*. In men, high prolactin levels can cause breast growth, erectile dysfunction (trouble with erections), and loss of interest in sex.

If the tumor continues to grow, it can press on nearby nerves and parts of the brain, which can cause headaches and vision problems. In females who don't have periods (such as girls before puberty and women after menopause), prolactinomas might not be noticed until they cause these symptoms.

Thyrotropin (TSH)-secreting adenomas

These rare tumors make too much thyroid-stimulating hormone (TSH), which then causes the thyroid gland to make too much thyroid hormone. This can cause symptoms of hyperthyroidism (overactive thyroid), such as:

- Rapid heartbeat
- Tremors (shaking)
- Weight loss
- Increased appetite
- Feeling warm or hot
- Sweating
- Trouble falling asleep
- Anxiety
- Frequent bowel movements
- A lump (enlarged thyroid) in the front of the neck

Gonadotropin-secreting adenomas

These uncommon tumors make luteinizing hormone (LH) and/or follicle-stimulating hormone (FSH). This can cause irregular menstrual periods in women or low testosterone levels and decreased interest in sex in men.

Many gonadotropin-secreting adenomas actually don’t make enough hormones to cause symptoms, so they are basically non-functional adenomas. These tumors may grow large enough to cause symptoms such as headaches and problems with vision before they are detected (see the symptoms for large tumors above).

How are pituitary tumors diagnosed?

Pituitary tumors are usually found when a person goes to the doctor because of symptoms they are having. But sometimes these tumors don’t cause symptoms, and they are found by medical tests done for other health problems.

If there’s a reason to suspect you might have a pituitary tumor, your doctor will use one or more tests to find out. Signs and symptoms might suggest that you could have a pituitary tumor, but tests are needed to confirm the diagnosis.

Medical history and physical exam

If your symptoms lead your doctor to believe that you might have a pituitary tumor, the first step is take a complete medical history to check for risk factors and to learn more about your symptoms. Your doctor may ask about your family history of tumors or other problems to see if you might have an inherited genetic syndrome, such as multiple endocrine neoplasia, type I (MEN1).

Your doctor will also examine you to look for possible signs of a pituitary tumor or other health problems. This may include exams to look for vision or nervous system problems that could be caused by a tumor.

If a pituitary tumor is strongly suspected, your doctor may refer you to an eye doctor to check your vision, as pituitary tumors can damage nerves leading to the eyes. The most common test is to measure how well you can see. The doctor may also test your field of vision (or visual fields). At first, pituitary tumors only press on part of the optic nerves. This often leads to the loss of peripheral vision, meaning things that you can see off to the side without actually looking directly at them. Eye doctors have special instruments that can test for this.

You might also be referred to other doctors, such as an endocrinologist (a doctor who treats diseases in glands that secrete hormones) or a neurosurgeon (a doctor who uses surgery to treat brain and pituitary tumors), who might order other tests.

Blood and urine tests of hormone levels

If your doctor suspects you might have a hormone-producing pituitary tumor, hormone levels in your blood and/or urine will be measured.

Growth hormone-secreting adenoma

A physical exam may alert the doctor to look for this tumor because the signs and symptoms are often very distinctive.

The next step is to check the levels of growth hormone and insulin-like growth factor-1 (IGF-1) in your blood samples, which are taken the morning after an overnight fast. When growth hormone levels are high, they cause the liver to make more IGF-1. Testing the IGF-1 level can be more helpful than checking the level of growth hormone, because the IGF-1 level doesn’t change much during the day, while the level of growth hormone can go up and down.

If both levels are very high, the diagnosis is clearly a pituitary tumor. If the levels are slightly increased, another test called a *glucose suppression test* is often done to be sure. You will be asked to drink a sugary liquid, and the levels of growth hormone and blood sugar will be measured at intervals afterward. The normal response to suddenly taking in so much sugar is a drop in growth hormone levels. If the growth hormone levels remain high, a pituitary adenoma is probably the cause.

Corticotropin (ACTH)-secreting adenoma

Most of the signs and symptoms of ACTH-secreting tumors come from having too much cortisol (an adrenal steroid hormone). Quite a few diseases can cause Cushing's syndrome, in which the body makes too much cortisol. If you have symptoms suggesting this condition, you will need tests to determine if it's caused by a pituitary tumor or something else.

These tests may include measuring levels of cortisol and ACTH in blood samples taken at different times of the day. You may be asked to collect all of your urine over a 24-hour period, which is then tested to measure daily production of cortisol and other steroid hormones. Blood or urine cortisol levels may be checked again after taking a dose of a powerful, cortisone-like drug called dexamethasone. Levels of cortisol in the saliva late at night can also be checked. These tests help to distinguish ACTH-secreting pituitary tumors from other diseases, such as adrenal gland tumors, that can cause similar symptoms.

Prolactin-secreting adenoma (prolactinoma)

Blood prolactin levels can be measured to check for a prolactinoma.

Gonadotropin-secreting adenoma

Luteinizing hormone (LH) and follicle-stimulating hormone (FSH) blood levels can be checked to see if you have a gonadotropin-secreting tumor. Levels of related hormones, such as estrogen, progesterone, and testosterone, are often checked as well.

Thyrotropin-secreting adenoma

Tests to measure blood levels of thyrotropin (TSH) and thyroid hormones can usually identify people with a thyrotropin-secreting adenoma.

Non-functional (null cell) adenoma

A pituitary adenoma is considered non-functional if it doesn't make too much of a pituitary hormone. Pituitary hormone levels are not high in people with non-functional tumors. Sometimes, though, blood levels of some pituitary hormones may actually be low because the adenoma crowds out the cells that normally make these hormones.

Testing for diabetes insipidus

Diabetes insipidus can occur if the part of the pituitary that stores the hormone vasopressin (ADH) is damaged, which leads to too much water being lost in the urine. This condition can be caused by pituitary macroadenomas (or carcinomas in rare cases), or by tumors starting in parts of the brain or nerves next to the pituitary gland. It can also be a side effect of surgery to treat pituitary tumors or tumors next to the pituitary gland.

In many cases, this diagnosis is made with tests that measure the amount of urine made over a 24-hour period, sodium and glucose levels in the blood, and *osmolality* (total salt concentration) of the blood and urine. If these tests are inconclusive, then a water deprivation study may be done. In this test, you are not allowed to drink fluids for several hours. The test is often done overnight. If your body is not making enough vasopressin, you will continue to make urine even though you are not taking in any fluid. You may also be given an injection of vasopressin to see if this corrects the problem.

Venous blood sampling

Corticotropin (ACTH)-secreting adenomas may be too small to be seen on imaging tests such as MRI scans (see the next section). When the ACTH level is high, but a person's MRI scan is normal, a venous sampling test may be useful to find the tumor.

For this test, catheters (small tubes) are placed into veins on each inner thigh through small nicks in the skin and are guided all the way up into the petrosal sinuses near the base of the brain. The sinuses hold 2 small veins that drain the blood from each side of the pituitary gland. After an injection of corticotropin-releasing hormone (CRH, a hormone from the hypothalamus that normally causes the pituitary to secrete ACTH), blood samples are taken from both sides and compared to see if the ACTH level is higher on one side than the other. If it is, the source of the high ACTH level is a pituitary tumor.

Imaging tests

Imaging tests use x-rays, magnetic fields, or other means to create pictures of the inside of your body. They may be done to look for pituitary tumors or to see if they have grown into nearby structures. In some cases, an imaging test of the head done for another reason may detect a pituitary tumor.

Magnetic resonance imaging (MRI) scan

MRI scans use radio waves and strong magnets to create detailed pictures of the inside of the body. The energy from the radio waves is absorbed and then released in a pattern formed by the type of tissue and by certain diseases. A computer translates the pattern into a very detailed image of parts of the body. A contrast material called *gadolinium* is sometimes injected into a vein to improve the quality of the image.

MRI scans are very helpful in looking at the brain and spinal cord and are considered to be the best way to identify pituitary tumors of all types. MRI images are usually more detailed than those from CT scans (see below). They can show macroadenomas of the pituitary gland, as well as most microadenomas. But MRI might not detect microadenomas that are smaller than 3 mm (about 1/8 inch) across. Sometimes the MRI scan will show a small abnormality in the pituitary that has nothing to do with the patient's symptoms. Between 5% and 25% of

healthy people have some minor abnormality of the pituitary gland that shows up on an MRI scan.

MRI scans can take a long time – often up to an hour. You have to lie inside a narrow tube, sometimes with a small frame around your head, which can be confining and may upset people with a fear of enclosed spaces. Newer, open MRI machines may help with this, but the images might not be as detailed, so they can't be used in all cases. The MRI machine also makes buzzing and clicking noises that may be disturbing. Some people may need medicine to help them relax for the test.

Computed tomography (CT) scan

The CT scan uses x-rays to create detailed cross-sectional images of part of your body. CT scans can find a pituitary adenoma if it is large enough, but MRI scans are used much more often to look at the brain and pituitary gland.

A CT scanner has been described as a large donut, with a narrow table that slides in and out of the middle opening. You will need to lie still on the table while the scan is being done. CT scans take longer than regular x-rays, and you might feel a bit confined by the ring while the pictures are being taken. Instead of taking one picture, like a standard x-ray, a CT scanner takes many pictures as the camera rotates around you. A computer then combines these pictures into an image of a slice of your body.

Before the test, you may get an injection of a contrast dye through an IV (intravenous) line. This helps better outline any tumors that are present. The injection can cause some flushing (redness and warm feeling). A few people are allergic to the dye and get hives or, rarely, have more serious reactions like trouble breathing and low blood pressure. Be sure to tell the doctor if you have any allergies or have ever had a reaction to any contrast material used for x-rays.

Tests of pituitary tissue samples

In diagnosing tumors of most parts of the body, imaging tests and blood tests may strongly suggest a particular type of tumor, but a *biopsy* (removing a sample of the tumor to examine under a microscope) is usually the only way to be certain of the diagnosis. In many situations, doctors will not treat the tumor until a biopsy has been done.

But a biopsy is not usually needed before treating a pituitary tumor. One reason is that the hormone tests for some types of adenomas are very accurate, so a biopsy isn't likely to provide much more information. Biopsies in this part of the body can also pose a very small risk of serious side effects. On top of this, some types of adenomas can be treated without surgery, using medicines or radiation therapy.

When pituitary tumors are removed by surgery, they are examined under a microscope to determine their exact type. Special stains may be used on the tumor to color the areas making hormones, which helps classify the tumor.

How are pituitary tumors staged?

Staging is the process of determining how far a cancer has spread. This is done to guide treatment and to help determine the most likely outcome for the patient. But pituitary tumors are nearly always benign (not cancer), so there is no staging system for them. Pituitary carcinoma (cancer) is too rare for a staging system to have been developed.

The most useful information for guiding the treatment of a pituitary adenoma is:

- Whether it is a microadenoma (smaller than 1 centimeter across) or macroadenoma (1 centimeter across or larger)
- Whether it has grown into nearby structures (such as bones of the skull)
- Whether it is causing symptoms such as vision changes
- Whether it is functional (making excess hormones) or non-functional
- Which hormone it releases

How are pituitary tumors treated?

This information represents the views of the doctors and nurses serving on the American Cancer Society's Cancer Information Database Editorial Board. These views are based on their interpretation of studies published in medical journals, as well as their own professional experience.

The treatment information in this document is not official policy of the Society and is not intended as medical advice to replace the expertise and judgment of your medical care team. It is intended to help you and your family make informed decisions, together with your doctor.

Your doctor may have reasons for suggesting a treatment plan different from these general treatment options. Don't hesitate to ask him or her questions about your treatment options.

General treatment information

Nearly all pituitary tumors are adenomas (benign tumors). Treatment of a pituitary adenoma depends on whether or not it makes excess hormones and, if it does, which hormone it makes. Treatment also depends on whether it is a microadenoma (smaller than 1 centimeter across) or a macroadenoma (1 centimeter across or larger).

Treatment for pituitary tumors may include:

- Surgery

- Radiation therapy
- Medicines that block tumor hormone secretion or block the symptoms caused by these hormones

Sometimes a combination of treatments is used. For example, surgery may be done to remove some of the tumor, while drugs can be used to relieve symptoms and sometimes shrink the remaining tumor.

Your doctor will discuss treatment options with you. It's important to take time and think about your choices, weighing the benefits of each option against the possible risks and side effects. It's also important to ask questions if there is anything you're not sure about. You can find some good questions to ask in the section "What should you ask your doctor about pituitary tumors?"

If time permits, it's often a good idea to get a second opinion. Because pituitary tumors are uncommon, not many doctors have much experience with them. Your doctor shouldn't mind if you want to get a second opinion.

No matter what treatment you decide on, it should be done by doctors who have experience treating pituitary tumors. Pituitary tumors often require care from a team of doctors. Doctors on your team may include:

- Neurosurgeon: a doctor who uses surgery to treat brain and pituitary tumors
- Endocrinologist: a doctor who treats diseases in glands that secrete hormones
- Neurologist: a doctor who diagnoses and treats brain and nervous system diseases
- Radiation oncologist: a doctor who uses radiation to treat cancers and other tumors
- Medical oncologist: a doctor who uses chemotherapy and other medicines to treat cancers and other tumors

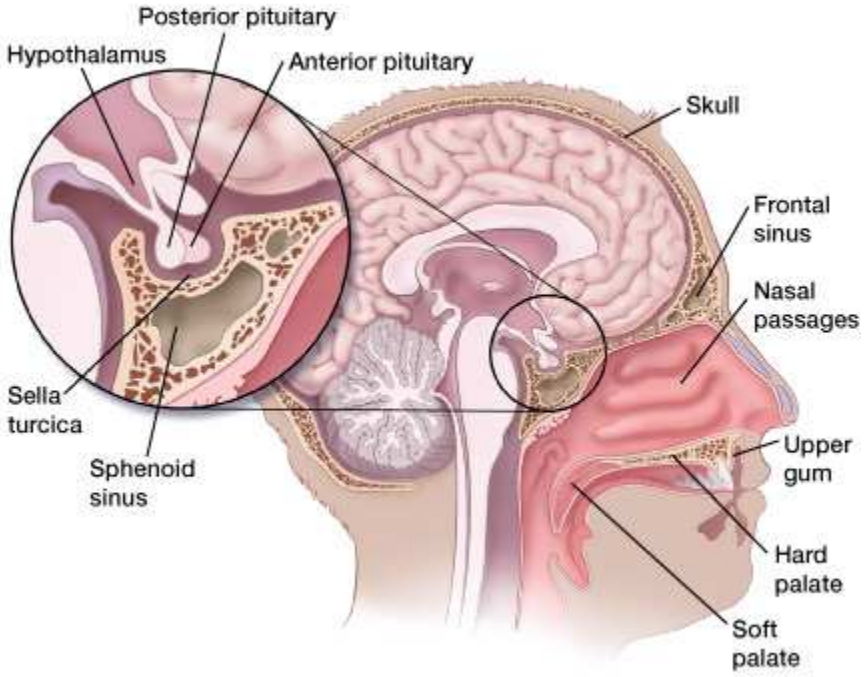
Many other specialists might be part of your treatment team as well, including physician assistants, nurse practitioners, nurses, psychologists, social workers, rehabilitation specialists, and other health professionals. See *Health Professionals Associated With Cancer Care* for more on this.

The next few sections describe the types of treatments used for pituitary tumors. This is followed by a description of the most common approaches based on the type of tumor (functional tumors, non-functional tumors, and carcinomas).

Surgery for pituitary tumors

The main treatment for many pituitary tumors is surgery. How well the surgery works depends on the type of tumor, its exact location, its size, and whether it has spread into nearby structures.

Transsphenoidal surgery: This is the most common way to remove pituitary tumors. Transsphenoidal means that the surgery is done through the sphenoid sinus, a hollow space in the skull behind the nasal passages and below the brain. The back wall of the sinus covers the pituitary gland.



For this approach, the neurosurgeon makes a small incision along the nasal septum (the cartilage between the 2 sides of the nose) or under the upper lip (above the upper teeth). To reach the pituitary, the surgeon opens the boney walls of the sphenoid sinus with small surgical chisels, drills, or other instruments depending on the thickness of the bone and sinus. A newer approach is to use an endoscope, a thin fiber-optic tube with a tiny camera lens at the tip. In this approach, the incision under the upper lip or the front part of the nasal septum is not needed, because the endoscope allows the surgeon to see well through a small incision that is made in the back of the nasal septum. The surgeon passes instruments through normal nasal passages and opens the sphenoid sinus to reach the pituitary gland and remove the tumor. The use of this technique is limited by the tumor's position and the shape of the sphenoid sinus.

The transsphenoidal approach has many advantages. First, no part of the brain is touched during the surgery, so the chance of damage to the brain is very low. There is also no visible

scar. But it's hard to remove large tumors this way. When the surgery is done by an experienced neurosurgeon and the tumor is a microadenoma, the cure rates are high (greater than 80%). If the tumor is large or has grown into the nearby structures (such as nerves, brain tissue, or the tissues covering the brain) the chances for a cure are lower and the chance of damaging nearby brain tissue, nerves, and blood vessels is higher.

Craniotomy: For larger or more complicated pituitary tumors, a craniotomy may be needed. In this approach the surgeon operates through an opening in the front and side of the skull. The surgeon has to work carefully beneath and between the lobes of the brain to reach the tumor. Although the craniotomy has a higher chance of brain injury than transsphenoidal surgery for small lesions, it's actually safer for large and complex lesions because the surgeon is better able to see and reach the tumor and nearby nerves and blood vessels.

For both transsphenoidal surgery and craniotomies, the doctor may use image-guidance with MRI or CT scans before surgery to help plan the best surgical approach. Some centers also use intraoperative MRI (where MRI scans are done in the operating room one or more times during the surgery), but many doctors still consider this to be experimental.

As a general rule, smaller pituitary tumors are easier to treat with surgery. The larger and more invasive the tumor, the less likely the tumor can be cured by surgery.

Possible side effects of surgery

Surgery on the pituitary gland is a serious operation, and surgeons are very careful to try to limit any problems either during or after surgery. Complications during or after surgery such as bleeding, infections, or reactions to anesthesia are rare, but they can happen. Most people who have transsphenoidal surgery will have a sinus headache and congestion for up to a week or 2 after surgery.

If surgery causes damage to large arteries, to nearby brain tissue, or to nerves near the pituitary, in rare cases it can result in brain damage, a stroke, or blindness.

When doctors use the transsphenoidal approach to operate on the pituitary gland, they create a temporary pathway between the nasal sinuses and airways and the brain. Until this heals, a person can get meningitis, which is infection and inflammation of the meninges (the thin protective layers covering the brain). Damage to the meninges can also lead to leakage of cerebrospinal fluid (the fluid that bathes and cushions the brain) out of the nose.

Diabetes insipidus (discussed in "Signs and symptoms of pituitary tumors") may occur right after surgery, but it usually improves on its own within 1 to 2 weeks after surgery. If it is permanent, it can be treated with a desmopressin nasal spray.

Damage to the rest of the pituitary can lead to other symptoms from a lack of pituitary hormones. This is rare after surgery for small tumors, but it may be unavoidable when treating some larger macroadenomas. If pituitary hormone levels are low after surgery, this

can be treated with medicine to replace certain hormones normally made by the pituitary and other glands.

For more general information about surgery as a treatment for tumors, see our document *Understanding Cancer Surgery: A Guide for Patients and Families*.

Radiation therapy for pituitary tumors

Radiation therapy uses high energy x-rays or particles to kill tumor cells. This type of treatment is given by a doctor called a *radiation oncologist*. Radiation is directed at the tumor from a source outside the body.

Radiation therapy may be recommended if surgery is not an option, if a pituitary tumor remains or comes back after surgery, or if the tumor causes symptoms that aren't relieved by medicines.

Radiation therapy is much like getting an x-ray, although the doses of radiation used are much higher. Before your treatments start, the radiation team will get imaging tests such as MRI scans to define the exact size and shape of the tumor. This is used to determine the correct angles for aiming the radiation beams, the shape of the beams, and the proper dose of radiation.

Conventional radiation is usually given in a series of treatments 5 times a week over 4 to 6 weeks. At each session, you lie on a special table while a machine delivers the radiation from precise angles. The treatment is not painful. Each session lasts about 15 to 30 minutes. Much of that time is spent making sure the radiation is aimed correctly. The actual treatment time each day is much shorter.

This therapy can be very effective, but it also has some drawbacks:

- It works slowly, so it can take months or years before the tumor growth and/or excess hormone production is fully controlled.
- It can damage the remaining normal pituitary. In most cases, normal pituitary function will be lost over time, requiring treatment with hormones.
- It may damage some normal brain tissue, particularly near the pituitary gland, which could affect mental function years later.
- The optic nerves may be damaged, resulting in impaired vision.
- The radiation may increase the risk of developing a brain tumor later in life, although this risk is still likely to be low.

These risks are likely to be lower with the use of newer techniques that focus the radiation more precisely on the pituitary, such as intensity modulated radiation therapy (IMRT),

stereotactic radiation, and proton beam therapy. The use of these techniques might be limited for some tumors that are very close to the optic nerves.

Intensity modulated radiation therapy (IMRT)

IMRT is an advanced form of three-dimensional radiation therapy. It uses a computer-driven machine that actually moves around the patient as it delivers the radiation. IMRT lets the doctor shape the radiation beams and aim them at the tumor from several angles. The intensity (strength) of the beams can also be adjusted to limit the dose reaching the most sensitive nearby normal tissues. This may result in fewer side effects. Many major hospitals and cancer centers now use IMRT.

Stereotactic radiosurgery/stereotactic radiation therapy

This type of treatment delivers a large, precise radiation dose to the tumor area in a single session (radiosurgery) or in a few sessions (radiotherapy). It targets the tumor more precisely than standard radiation, causing less harm to the remaining normal pituitary gland and limiting the radiation exposure to the rest of the brain.

For this treatment, a lightweight metal frame is often attached to the head with small pins or screws to help aim the radiation beams very precisely. (The areas on the scalp where the frame is attached are numbed first.) Sometimes a face mask is used to hold the head in place instead of a frame. 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 from a machine 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. An example of such a machine is the Gamma Knife.
- 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 radiation to the tumor from different angles. Several machines do stereotactic radiosurgery in this way, with names such as X-Knife, CyberKnife, and Clinac.

Stereotactic radiosurgery typically delivers the whole radiation dose in a single session, though it may be repeated if needed. (There is no actual surgery involved in this treatment.) Sometimes doctors give the radiation in several treatments to deliver the same or a slightly higher dose. This is called *fractionated radiosurgery* or *stereotactic radiotherapy*.

The benefit of stereotactic radiation is usually seen a bit sooner than with other forms of radiation therapy, although it can still take months to be fully effective.

Unfortunately, this therapy can’t be used for tumors that are very close to the optic nerves. It also might not be helpful for tumors that have an unusual shape.

Proton beam radiation therapy

This form of treatment uses a beam of protons rather than x-rays to kill cancer cells. Protons are positive parts of atoms. X-rays release their energy both before and after they hit their target, which can damage nearby healthy tissues. Protons, on the other hand, cause little damage to tissues they pass through and only release their energy after traveling a certain distance. Doctors can use this property to deliver more radiation to the tumor with less damage to nearby normal tissues. Like stereotactic radiation, it has the advantage of focusing the radiation more precisely on the pituitary tumor.

But proton beam radiation therapy requires highly specialized equipment and is not widely available – there are only a handful of proton beam centers in the United States at this time. It is not a standard treatment for pituitary tumors. Studies are still needed to see if it is safer or more effective than stereotactic radiosurgery or stereotactic radiotherapy.

For more general information about radiation therapy, please see the "Radiation Therapy" section of our website or our document *Understanding Radiation Therapy: A Guide for Patients and Families*.

Medicines to treat pituitary tumors

Several medicines can be used to treat pituitary tumors that are making hormones.

Drugs for prolactin-secreting tumors (prolactinomas)

Drugs called *dopamine agonists*, such as cabergoline and bromocriptine (Parlodel®), can often both stop prolactinomas from making too much prolactin and shrink these tumors. Both drugs work well, although cabergoline seems to work better and lasts longer than bromocriptine, so it doesn't need to be taken as often.

Most people with prolactinomas can control their prolactin levels with these medicines. The drugs also shrink most prolactin-secreting macroadenomas. In fact, these drugs work so well that surgery usually isn't needed for prolactinomas. Only about 1 out of 5 of these tumors doesn't shrink with treatment. Even if the tumor doesn't shrink, these drugs often can keep prolactinomas from growing larger. If successful, the drug treatment may be continued for life.

Possible side effects of these drugs include drowsiness, dizziness, nausea, vomiting, diarrhea or constipation, confusion, and depression. For women whose high prolactin levels had been causing infertility, these drugs may restore fertility. Cabergoline may cause fewer side effects than bromocriptine, but it might also increase the risk of heart valve problems. However, this is rare when taking this drug for prolactinomas.

Drugs for growth hormone-secreting tumors

These tumors can cause acromegaly in adults and gigantism in children (discussed in “Signs and symptoms of pituitary tumors”). Medicines are often not as effective for these tumors as they are for prolactinomas, so they’re not usually the first treatment used.

Somatostatin analogs: Drugs such as octreotide (Sandostatin®), lanreotide (Somatuline® Depot), and pasireotide (Signifor® LAR) are man-made forms of the natural hormone somatostatin. Somatostatin, which is made in the pituitary and other glands, blocks growth hormone (somatotropin) production by adenomas and returns insulin-like growth factor-1 (IGF-1) to normal levels in about two thirds of patients.

Octreotide is first given as an injection under the skin 3 times per day. A longer acting form is available, which can be given as a monthly injection. Lanreotide and pasireotide are given as an injection about once a month. Doctors measure how well these drugs are working by testing blood growth hormone and IGF-1 levels. Tumors tend to shrink very slowly with these drugs.

These drugs can have side effects, such as a slowed heart rate, nausea, vomiting, diarrhea, stomach pain, dizziness, headache, and pain at the site of injection. Many of these side effects improve or even go away with time. They can also cause gallstones and may cause diabetes or worsen it if a person already has it.

Growth hormone antagonists: Pegvisomant (Somavert®) is a newer drug that works by blocking the action of growth hormone on other cells. It is very effective in lowering blood IGF-1 levels, but it doesn’t block growth hormone secretion by the pituitary gland or shrink pituitary tumors. It has few side effects, although it can lower blood sugar levels and cause mild liver damage in some people. It is given by daily injection under the skin.

Dopamine agonists: Drugs such as cabergoline or bromocriptine can reduce growth hormone levels in about 1 out of 5 patients. Unfortunately, higher doses are needed for these tumors than for prolactinomas, and some patients have trouble with the side effects they can cause (discussed above). An advantage of these drugs is that they can be taken as a pill.

Drugs for corticotropin (ACTH)-secreting tumors

These tumors cause the adrenal glands to make excess steroid hormones such as cortisol, which leads to Cushing’s disease (discussed in “Signs and symptoms of pituitary tumors”). Medicines are not usually part of the treatment of these tumors unless surgery and radiation therapy don’t work (or if the effects of radiation have not yet been felt).

Several different kinds of drugs can be used, although medicines aren’t always as effective in ACTH-secreting tumors as they are in some other types of pituitary tumors.

- Pasireotide (Signifor®) is a newer somatostatin analog. This drug can help some people who have Cushing’s disease from ACTH-secreting tumors when surgery is not an option

or has not been effective. Along with side effects such as nausea, vomiting, and diarrhea, this drug can cause high blood sugar levels and gallstones.

- Cyproheptadine (Periactin®) is an antihistamine drug that can suppress ACTH production in some of these tumors.
- Drugs called *steroidogenesis inhibitors* can be used to keep the adrenal gland from making cortisol, although they don't affect the pituitary tumor itself. These include ketoconazole, aminoglutethimide, etomidate, metyrapone, and mitotane. These drugs can sometimes be helpful after surgery or radiation (or if surgery is not an option), but they can be hard to take because of side effects.
- Mifepristone (Korlym®) is a type of drug called a *cortisol receptor blocker*. It limits the effects of cortisol on other tissues in the body. This drug can help treat high blood sugar levels in people with Cushing's disease, although it doesn't affect the pituitary tumor itself. It can have serious side effects and requires close monitoring.
- Dopamine agonists such as cabergoline or bromocriptine can also be tried if other drugs are not effective.

Drugs to treat thyrotropin (TSH)-secreting tumors

For these tumors, somatostatin analogs such as octreotide and lanreotide can usually reduce the amount of TSH that is produced. Dopamine agonists such as cabergoline or bromocriptine can also be used. These drugs are discussed in more detail above.

Clinical trials for pituitary tumors

You may have had to make a lot of decisions since you've been told you have a pituitary tumor. One of the most important decisions you will make is choosing which treatment is best for you. You may have heard about clinical trials being done for your type of tumor. Or maybe someone on your health care team has mentioned a clinical trial to you.

Clinical trials are carefully controlled research studies that are done with patients who volunteer for them. They are done to learn more about promising new treatments or procedures.

Clinical trials are one way to get state-of-the art treatment. Sometimes they may be the only way to get some newer treatments. They are also the only way for doctors to learn better methods to treat tumors. Still, they are not right for everyone.

If you would like to learn more about clinical trials that might be right for you, start by asking your doctor if your clinic or hospital conducts clinical trials. You can also call our clinical trials matching service for a list of studies that might meet your medical needs. You can reach this service at 1-800-303-5691 or on our website at www.cancer.org/clinicaltrials. You can also get a list of current clinical trials by calling the National Cancer Institute's

Cancer Information Service at 1-800-4-CANCER (1-800-422-6237) or by visiting the NCI clinical trials website at www.cancer.gov/clinicaltrials.

You must meet certain requirements to take part in any clinical trial. If you do qualify for a clinical trial, it's up to you whether or not to enter (enroll in) it.

You can get a lot more information on clinical trials in our document *Clinical Trials: What You Need to Know*.

Complementary and alternative therapies for pituitary tumors

When you have a pituitary tumor you are likely to hear about ways to treat your tumor or relieve symptoms that your doctor hasn't mentioned. Everyone from friends and family to social media groups and websites might offer ideas for what might help you. These methods can include vitamins, herbs, and special diets, or other methods such as acupuncture or massage, to name a few.

What exactly are complementary and alternative therapies?

Not everyone uses these terms the same way, and they are used to refer to many different methods, so it can be confusing. We use *complementary* to refer to treatments that are used *along with* your regular medical care. *Alternative* treatments are used *instead of* a doctor's medical treatment.

Complementary methods: Most complementary treatment methods are not offered as cures. Mainly, they are used to help you feel better. Some methods that are used along with regular treatment are meditation to reduce stress, acupuncture to help relieve pain, or peppermint tea to relieve nausea. Some complementary methods are known to help, while others have not been tested. Some have been proven not to be helpful, and a few have even been found harmful.

Alternative treatments: Alternative treatments may be offered as cures. These treatments have not been proven safe and effective in clinical trials. Some of these methods may pose danger, or have life-threatening side effects. But the biggest danger in most cases is that you may lose the chance to be helped by standard medical treatment. Delays or interruptions in your medical treatments may give the tumor more time to grow and make it less likely that treatment will help.

Finding out more

It is easy to see why people with tumors think about alternative methods. You want to do all you can to fight the tumor, and the idea of a treatment with few or no side effects sounds great. Sometimes medical treatments can be hard to take, or they may no longer be working. But the truth is that most of these alternative methods have not been tested and proven to work in treating pituitary tumors.

As you consider your options, here are 3 important steps you can take:

- Look for “red flags” that suggest fraud. Does the method promise to cure all or most tumors? Are you told not to have regular medical treatments? Is the treatment a “secret” that requires you to visit certain providers or travel to another country?
- Talk to your doctor or nurse about any method you are thinking about using.
- Contact us at 1-800-227-2345 or see the “Complementary and Alternative Medicine” section of our website to learn more about complementary and alternative methods in general and to find out about the specific methods you are looking at.

The choice is yours

Decisions about how to treat or manage your tumor are always yours to make. If you want to use a non-standard treatment, learn all you can about the method and talk to your doctor about it. With good information and the support of your health care team, you may be able to safely use the methods that can help you while avoiding those that could be harmful.

Treatment of functional (hormone-making) pituitary tumors

The treatment of functional pituitary tumors depends on which type of hormone they make.

Treatment of prolactin-secreting adenomas (prolactinomas)

Unlike most other pituitary tumors, surgery is usually not the first treatment for these tumors. Instead, medicines that block the production of prolactin (cabergoline or bromocriptine) are used first (see “Medicines to treat pituitary tumors”). They work so well that surgery is usually not needed. Although both of these drugs are effective, cabergoline seems to work better and may have fewer side effects. It also lasts longer, so it does not need to be taken as often as bromocriptine.

Most patients can control their prolactin levels with these medicines. The drugs also shrink most prolactin-secreting macroadenomas. Only about 1 out of 5 of these tumors doesn’t shrink after treatment. Even when the tumors don’t shrink, these drugs usually keep them from growing larger.

Within 3 months of starting treatment, the blood prolactin level is measured again and an MRI scan of the pituitary is done to check if the medicine is working. If so, treatment may be continued for the rest of the patient’s life. In some people, if treatment with these medicines has been successful and MRI scans show a prolonged period with no tumor remaining, the treatment may be stopped. These people will need to have regular MRIs to see if the tumor comes back. On the other hand, if after 6 months the tumor hasn’t responded well enough to treatment, or if serious side effects occur, then surgery is considered.

Some doctors recommend surgery in special situations such as in men whose tumors are at an advanced stage, or in women who want to become pregnant (the drugs must be stopped during pregnancy, and pregnancy might cause the tumor to grow quickly). Surgery can also be used to treat very large tumors after first shrinking them with drug treatment.

Radiation may be used if drug treatment and surgery are not successful.

Treatment of growth hormone-secreting adenomas

Adults with these tumors often have acromegaly, while children have gigantism.

Surgery is usually the first treatment for these adenomas, although often it can't remove all of the tumor. If growth hormone and insulin-like growth factor-1 (IGF-1) levels remain high after surgery, many experts recommend treating with medicine first. Radiation therapy is another option, although it is used most often when drug treatment doesn't work. This is because radiation is very slow to act and over time it can lead to lowered levels of other pituitary hormones.

Octreotide (Sandostatin), lanreotide (Somatuline Depot), and pasireotide (Signifor LAR) are man-made forms of the natural hormone somatostatin that return IGF-1 to normal levels in about two thirds of patients. They are taken as injections, usually about once a month. The dose of these drugs may need to be adjusted based on blood IGF-1 levels.

Because these drugs work well and only need to be given monthly, doctors have started to question whether surgery should always be the first treatment for people with growth hormone-secreting adenomas. In those who might have problems with surgery, such as people with other major health problems, these drugs might be a good choice as the first treatment.

Sometimes, drug treatment may be given for a short time before surgery. This may cause the tumor to shrink, which could improve the chance that the surgery will remove all of the tumor, but doctors can't be certain before trying that this will help.

Another drug, pegvisomant, works by blocking the action of growth hormone. It can be used if somatostatin analogs (octreotide, lanreotide, or pasireotide) aren't doing enough to block growth hormone production.

Drugs such as cabergoline or bromocriptine can reduce growth hormone levels in about 1 out of 5 patients. Unfortunately, some patients have trouble tolerating the high doses often needed for these drugs to be effective. The main advantage of these drugs is that they are in pill form.

If surgery and drug treatments don't work, then radiation therapy may be used.

Treatment of corticotropin (ACTH)-secreting adenomas

These tumors cause the adrenal glands to make too much of the steroid hormone cortisol, which leads to Cushing's disease (discussed in "Signs and symptoms of pituitary tumors").

Surgery is usually the main treatment. If the surgery doesn't remove the tumor completely or if it grows back, the 2 main options are a second surgery or radiation therapy. Radiation can often take months or years to work, so medicines may be given to help control cortisol levels in the meantime.

If surgery and radiation don't control cortisol levels, treatment options may include using medicines or removing both of the adrenal glands (see below).

Several different types of medicines can be used to help control cortisol levels or limit the effects of this hormone in the body (see "Medicines to treat pituitary tumors"). Unfortunately, medicines aren't always as effective in ACTH-secreting tumors as they are in some other types of pituitary tumors, and some of these drugs can have serious side effects that make them hard to take for long periods of time.

If medicines aren't helpful, or if the patient can't take them because of side effects, both adrenal glands can be removed with an operation called a *bilateral adrenalectomy*. This can usually be done with laparoscopic surgery, using several small incisions in the abdomen instead of one large one. The surgeon works through these small incisions with special long, thin instruments, including one with a tiny video camera lens on the end (called a laparoscope) for looking into the abdomen. Adrenalectomy stops all cortisol production, so high cortisol levels will no longer be a problem. But after the surgery patients will need to take pills to replace the adrenal steroid hormones for the rest of their life.

If the adrenal glands are to be removed, the pituitary gland will first be treated with radiation. If this isn't done, removing the adrenals can cause the pituitary tumor to get larger and even start growing into the structures near the pituitary. This is known as *Nelson syndrome*. When the adenoma gets large, it can damage the normal parts of the pituitary gland, causing problems from hormone deficiency. It can also lead to high levels of ACTH. Because ACTH is similar to the hormone that causes tanning of the skin, the high ACTH levels make the skin darker.

Treatment of thyrotropin (TSH)-secreting adenomas

The treatment of choice for these tumors is usually surgery, sometimes along with radiation therapy. Radiation is not always helpful, and medicines may be needed to control the tumor's hormone production. Some of the drugs that can be helpful include octreotide, lanreotide, cabergoline, and bromocriptine. These are used only if other treatments have failed to control the tumor.

It's important to treat the pituitary tumor to prevent it from damaging nearby structures. Drugs that stop the thyroid gland from making thyroid hormone can actually make things

worse because reducing thyroid hormone production may cause the TSH-secreting pituitary tumor to grow.

Treatment of gonadotropin (FSH/LH)-secreting adenomas

The hormones made by these tumors rarely cause major symptoms, so these tumors are often not found until they are large (macroadenomas) and pressing on nearby structures.

Treatment of these tumors is similar to that used for non-functional adenomas. Surgery is often the best option because it works right away. Radiation may be given after surgery.

Follow up with frequent MRI scans will show if the tumor is growing back. If it is, options include radiation (if it hasn't been given already) or medicines such as dopamine agonists (cabergoline, bromocriptine) or somatostatin analogs (octreotide, lanreotide).

Treatment of non-functional pituitary tumors (tumors that don't make excess hormones)

Not all pituitary tumors need to be treated right away, especially if they're not growing or causing symptoms. But larger tumors and those that are clearly growing typically require treatment.

Large tumors

Large tumors (macroadenomas) that are causing symptoms are often treated with surgery. This helps get rid of the symptoms and danger to nearby vital structures quickly. As with gonadotropin-secreting tumors, frequent MRI scans are done early after treatment. If there is re-growth of the adenoma, further surgery or radiation therapy may be used. Drug treatment is usually not helpful in treating these tumors, but doctors have reported some success using the chemotherapy drug temozolomide for fast-growing tumors.

Incidentalomas

These are small pituitary tumors (microadenomas) that are detected on MRI or CT scans done for other reasons. They usually don't cause symptoms because they're not large enough to press on nearby structures and they don't secrete high levels of any hormone.

Most doctors recommend just watching these tumors, with regular physical exams and repeat MRI scans to see if they are growing. Hormone levels may be checked at least once as well. If the tumor starts growing or causing symptoms, it can then be treated. But the important point is that people with incidentalomas shouldn't get unnecessary tests or treatments.

Treatment of pituitary carcinomas

Pituitary carcinomas are rare tumors that have already spread to other parts of the body when they are found. Surgery and radiation therapy are the main forms of treatment and may slow tumor growth and prevent or relieve symptoms. But in general, these tumors are very hard to control.

Chemotherapy and newer targeted therapy drugs may be tried, but it's not clear if these treatments can improve survival. Because pituitary carcinoma affects so few patients, it's hard to study which treatments might be effective. Taking part in a clinical trial of a new treatment may be a good option.

More treatment information for pituitary tumors

For more details on treatment options – including some that might not be addressed in this document – the National Cancer Institute (NCI) is a good source of information.

The NCI, part of the US National Institutes of Health, provides treatment information by phone (1-800-4-CANCER) and on its website (www.cancer.gov). Detailed information intended for use by health professionals is also available on www.cancer.gov.

What should you ask your doctor about pituitary tumors?

As you deal with your tumor and its treatment, you need to have honest, open discussions with your health care team. Feel free to ask any question, no matter how small it might seem. Here are some questions you might want to ask. Be sure to add your own questions as you think of them. Nurses, social workers, and other members of the treatment team may also be able to answer many of your questions.

- Is my tumor benign or malignant? How certain is the diagnosis?
- Has my tumor spread into the nearby brain tissue or other structures?
- Is my tumor secreting excess amounts of hormone? If so, which one?
- Do I need other tests before we can decide on treatment?
- Do I need to see other doctors?
- How much experience do you have treating this type of tumor?
- Should I get a second opinion? Can you recommend a doctor or hospital?
- What are my treatment choices? What do you recommend? Why?

- What is the goal of treatment (cure, keeping the tumor in check, etc.)?
- Is treatment needed right away?
- What are the possible risks or side effects of treatment?
- Will this treatment affect my ability to have children?
- What should I do to be ready for treatment?
- How long will treatment take? What will it be like? Where will it be given?
- What is my expected prognosis (outlook), based on my tumor as you view it?
- What would we do if the treatment doesn't work or if the tumor comes back?
- What type of follow-up will I need after treatment?

Along with these sample questions, be sure to write down any others you want to ask. For instance, you might want information about recovery times so that you can plan your work and activity schedule. Or you may want to ask about clinical trials for which you may qualify.

What happens after treatment for pituitary tumors?

For most people with pituitary tumors, treatment can remove or destroy the tumor. Completing treatment can be both stressful and exciting. You may be relieved to finish treatment, but find it hard not to worry about tumor growing or coming back. (When a tumor comes back after treatment, it is called *recurrence*.) This is a very common concern in people who have had a pituitary tumor.

It may take a while before your fears lessen. But it may help to know that many pituitary tumor survivors have learned to live with this uncertainty and are living full lives. Our document *Living With Uncertainty: The Fear of Cancer Recurrence* gives more detailed information on this.

For other people, the tumor might never go away completely. Some people may continue to get medicines or other treatments to help keep the tumor in check. Learning to live with a tumor that does not go away can be difficult and very stressful. It has its own type of uncertainty. Our document *When Cancer Doesn't Go Away*, talks more about this.

Follow-up care

Follow-up care is very important after treatment for pituitary tumors. Even if you have completed treatment, your doctors will still want to watch you closely. Keep all of your

appointments with your health care team and follow their instructions carefully. Report any new or recurring symptoms to your doctor right away. Ask questions if you don't understand what your doctor says.

Surgery is often the first treatment for many types of pituitary adenomas. If you had a functional (hormone-making) pituitary adenoma, hormone measurements can often be done within days or weeks after surgery to see if the treatment was successful. Blood tests will also be done to see how well the remaining normal pituitary gland is functioning. If the results show that the tumor was removed completely and that pituitary function is normal, you will still need periodic visits with your doctor. Your hormone levels may need to be checked again in the future to check for recurrence of the adenoma. Regardless of whether or not the tumor made hormones, MRI scans are often done as a part of follow-up. Depending on the size of the tumor and the extent of surgery, you may also be seen by a neurologist to check your brain and nerve function and an ophthalmologist (eye doctor) to assess your vision.

After radiation treatment, you will need checkups for several years. The response of the tumor to radiation therapy is hard to predict, and although the benefits and side effects of treatment can occur within months, some might take years to appear. Your pituitary function will be checked at regular intervals. MRI scans will be the main follow-up tests, along with testing hormone levels if your tumor made hormones.

It's common for people to develop pituitary hormone deficiencies after surgery or radiation therapy. These people will need hormone replacement. Thyroid hormone and adrenal steroids can be taken as pills. In men, testosterone can be given to restore sex drive and help prevent osteoporosis (weak bones). Testosterone is available as a gel, liquid, or patch applied to the skin. It can also be given as a monthly injection or implanted as a pellet under the skin every few months. In young women, estrogen is given either by pills or a skin patch to avoid early menopause. Often, progesterone is given along with estrogen. Pituitary hormone deficiency can affect a woman's ability to have children. However, if she wishes to become pregnant, it may be possible to restore fertility with hormone therapy.

If you are taking medicine for a prolactinoma, you will have your hormone levels checked at least once or twice a year. If an MRI shows that the tumor has shrunk after treatment, the MRI might not need to be repeated, depending on the size of the tumor and whether the response is partial or complete. If you have a prolactin-producing microadenoma, you may be able to stop drug treatment after several years of therapy. Your doctor might recommend stopping the drug and then checking your prolactin level. If it remains normal, you may be able to stay off the drug.

For patients getting drug therapy for corticotropin (ACTH)-producing or growth hormone-producing adenomas, follow-up may be more frequent. Your hormone levels and symptoms will be monitored carefully. People with growth hormone-producing adenomas have an increased risk of developing high blood pressure and heart failure. They also have a higher risk of getting colon cancer. Periodic checkups for these conditions are recommended.

Diabetes insipidus (see “Signs and symptoms of pituitary tumors”) can be a short-term result of surgery, although in some cases it might last longer. It can usually be treated effectively. If the problem is mild, simply taking in enough fluids might treat this problem. For more severe problems, the drug desmopressin is given either by nasal spray or by tablet. It is always important to drink enough fluids to avoid dehydration.

It’s also important to consider whether your pituitary tumor might be a clue to a genetic syndrome in your family. In the near future, people with pituitary tumors might be able to have genetic tests done on a sample of the tumor and blood tests to look for certain gene changes. If a change is found, family members might want to be tested as well to see if they are at increased risk.

Occasionally, people with large or fast-growing pituitary adenomas may be disabled or have their lives shortened because the tumor or its treatment destroys vital brain tissue near the pituitary gland, but this is rare. In general, when a pituitary tumor is not cured, people live out their lives but may have to deal with problems caused by the tumor or its treatment, such as vision problems or hormone levels that are too high or too low.

Keeping medical insurance and copies of your medical records

At some point after your treatment, you may find yourself seeing a new doctor who doesn’t know about your medical history. It’s important to be able to give your new doctor the details of your diagnosis and treatment. Gathering these details during and soon after treatment may be easier than trying to get them at some point in the future. Make sure you have this information handy and always keep copies for yourself:

- A copy of the pathology report(s) from any biopsies or surgeries
- Copies of imaging tests (CT or MRI scans, etc.), which can usually be stored digitally (on a DVD, etc.)
- Copies of lab tests showing hormone levels both before and after treatment
- If you had surgery, a copy of the operative report(s)
- If you stayed in the hospital, copies of the discharge summaries that the doctor prepared when you were sent home
- If you were or are taking medicines to treat your tumor, a list of the drugs and drug doses
- If you had radiation therapy, a summary of the type and dose of radiation and when and where it was given
- The names and contact information of the doctors who treated your tumor

It’s also very important to keep health insurance. Tests and doctor visits cost a lot, and even though no one wants to think of their tumor coming back, this could happen. For more about

costs and health insurance, see our document *Health Insurance and Financial Assistance for the Cancer Patient*.

Lifestyle changes after having a pituitary tumor

You can't change the fact that you have had a pituitary tumor. What you can change is how you live the rest of your life – making choices to help you stay healthy and feel as well as you can. This can be a time to look at your life in new ways. Maybe you are thinking about how to improve your health over the long term. Some people even start during treatment.

Make healthier choices

For many people, a diagnosis of a pituitary tumor helps them focus on their health in ways they may not have thought much about in the past. Are there things you could do that might make you healthier? Maybe you could try to eat better or get more exercise. Maybe you could cut down on alcohol, or give up tobacco. Even things like keeping your stress level under control may help. Now is a good time to think about making changes that can have positive effects for the rest of your life. You will feel better and you will also be healthier.

You can start by working on the things that worry you most. Get help with those that are harder for you. For instance, if you are thinking about quitting smoking and need help, call the American Cancer Society at 1-800-227-2345. A tobacco cessation and coaching service can help increase your chances of quitting for good.

Eating better

Eating right can be hard for anyone, but it can get even tougher during and after treatment. Some treatments might change your sense of taste. Nausea can be a problem. You may not feel like eating and lose weight when you don't want to. Or you may have gained weight that you can't seem to lose. All of these things can be very frustrating.

If treatment causes weight changes or eating problems, do the best you can and keep in mind that these problems usually get better over time. You may find it helps to eat small portions every 2 to 3 hours until you feel better. You may also want to ask your health care team about seeing a dietitian, an expert in nutrition who can give you ideas on how to deal with these treatment side effects.

Some drug treatments for pituitary tumors, such as octreotide and lanreotide, can affect how the body absorbs fats, which might cause changes in bowel movements. Eating a low-fat diet may help with this.

One of the best things you can do after treatment is put healthy eating habits into place. You may be surprised at the long-term benefits of some simple changes, like increasing the variety of healthy foods you eat. Getting to and staying at a healthy weight, eating a healthy

diet, and limiting your alcohol intake may lower your risk for a number of types of cancer, as well as having many other health benefits.

Rest, fatigue, and exercise

Extreme tiredness, called *fatigue*, is common after treatment. This is not a normal tiredness, but a bone-weary exhaustion that often doesn't get better with rest. For some people, fatigue lasts a long time after treatment, and can make it hard for them to be active and do the things they want to do. But exercise can help reduce fatigue. Studies have shown that patients who follow an exercise program tailored to their personal needs feel better physically and emotionally and can cope better, too.

If you were sick and not very active during treatment, it's normal for your fitness, endurance, and muscle strength to decline. Any plan for physical activity should fit your own situation. A person who has never exercised won't be able to take on the same amount of exercise as someone who plays tennis twice a week. If you haven't been active in a few years, you will have to start slowly – maybe just by taking short walks.

Talk with your health care team before starting anything. Get their opinion about your exercise plans. Then, try to find an exercise buddy so you're not doing it alone. Having family or friends involved when starting a new activity can give you that extra boost of support to keep you going when the push just isn't there. You can read more about healthy eating and exercise in our document *Nutrition and Physical Activity During and After Cancer Treatment: Answers to Common Questions.*

If you are very tired, you will need to learn to balance activity with rest. It's OK to rest when you need to. Sometimes it's really hard for people to allow themselves to rest when they're used to working all day or taking care of a household, but this is not the time to push yourself too hard. Listen to your body and rest when you need to. (For more information on dealing with fatigue, please see *Fatigue in People With Cancer* and *Anemia in People With Cancer*.)

Keep in mind exercise can improve your physical and emotional health.

- It improves your cardiovascular (heart and circulation) fitness.
- Along with a good diet, it will help you get to and stay at a healthy weight.
- It makes your muscles stronger.
- It reduces fatigue and helps you have more energy.
- It can help lower anxiety and depression.
- It can make you feel happier.
- It helps you feel better about yourself.

And long term, we know that getting regular physical activity plays a role in helping to lower the risk of some cancers, as well as having other health benefits.

Can I lower my risk of the tumor progressing or coming back?

Most people want to know if there are specific lifestyle changes they can make to reduce their risk of the tumor progressing or coming back. Unfortunately, for most tumors there isn't much solid evidence to guide people. This doesn't mean that nothing will help – it's just that for the most part this is an area that hasn't been well studied.

At this time, not enough is known about pituitary tumors to say for sure if there are things you can do that will help. Adopting healthy behaviors such as eating well and staying at a healthy weight may help, but no one knows for sure. However, we do know that these types of changes can have positive effects on your health that can extend beyond your risk of tumor recurrence.

How might having a pituitary tumor affect your emotional health?

During and after treatment, you may find yourself overcome with many different emotions. This happens to a lot of people.

You may find yourself thinking about death and dying. Or maybe you're more aware of the effect the tumor has on your family, friends, and career. You may take a new look at your relationships with those around you. Unexpected issues may also cause concern. For instance, you might be stressed by financial concerns resulting from your treatment. You might also see your health care team less often after treatment and have more time on your hands. These changes can make some people anxious.

Almost everyone who is going through or has been through treatment can benefit from getting some type of support. You need people you can turn to for strength and comfort. Support can come in many forms: family, friends, cancer support groups, church or spiritual groups, online support communities, or one-on-one counselors. What's best for you depends on your situation and personality. Some people feel safe in peer-support groups or education groups. Others would rather talk in an informal setting, such as church. Others may feel more at ease talking one-on-one with a trusted friend or counselor. Whatever your source of strength or comfort, make sure you have a place to go with your concerns.

The journey can feel very lonely. It's not necessary or good for you to try to deal with everything on your own. And your friends and family may feel shut out if you don't include them. Let them in, and let in anyone else who you feel may help. If you aren't sure who can help, call your American Cancer Society at 1-800-227-2345 and we can put you in touch with a group or resource that may work for you. You can also read our document *Distress in*

People with Cancer or see the Emotional Side Effects section of our website for more information.

What's new in pituitary tumor research and treatment?

Research into pituitary tumors is taking place in many university hospitals, medical centers, and other institutions around the world.

Doctors now have a better understanding of the genetic basis of pituitary tumors. This is already leading to improvements in genetic testing for people who are suspected of having multiple endocrine neoplasia, type I (MEN1) or other syndromes. This work is also shedding light on the characteristics of non-functioning adenomas, which may lead to new medical therapies for these tumors.

Imaging tests such as MRI scans continue to improve, leading to better accuracy in finding and determining the extent of new and recurrent tumors.

Surgical techniques are improving, allowing doctors to remove tumors with fewer complications than ever before. Radiation therapy techniques are improving as well, letting doctors focus radiation more precisely on tumors and limiting the damage to nearby normal tissues.

Progress is also being made in the medicines used to treat both pituitary tumors and the side effects of some other forms of treatment. For example, growth hormone is now produced by DNA technology and has been approved for treating adults who don't make enough growth hormone after treatment for a pituitary tumor.

Doctors are looking to see if combining some of the drugs used to treat pituitary tumors (at lower doses) might work better than using a single drug for some types of tumors. Researchers are also studying some newer drugs. An example is lapatinib (Tykerb), a drug that targets a protein called HER2, which is found in large amounts on some fast-growing cells (including some pituitary tumor cells). This drug is already used to treat breast cancer, and it is now being studied for use against pituitary tumors.

Other drugs are now being studied in clinical trials as well.

Additional resources for pituitary tumors

More information from your American Cancer Society

The following related information may also be helpful to you. These materials can be viewed on our website or ordered from our toll-free number, 1-800-227-2345:

Dealing with diagnosis and treatment

Coping With Cancer in Everyday Life (also in Spanish)

After Diagnosis: A Guide for Patients and Families (also in Spanish)

Health Professionals Associated With Cancer Care

Talking With Your Doctor (also in Spanish)

Nutrition for the Person With Cancer During Treatment: A Guide for Patients and Families (also in Spanish)

Living with a tumor

Distress in People With Cancer

Anxiety, Fear, and Depression

Guide to Controlling Cancer Pain (also in Spanish)

Living With Uncertainty: The Fear of Cancer Recurrence

When Your Cancer Comes Back: Cancer Recurrence

Understanding treatments

Understanding Cancer Surgery: A Guide for Patients and Families (also in Spanish)

Understanding Radiation Therapy: A Guide for Patients and Families (also in Spanish)

Clinical Trials: What You Need to Know

Treatment side effects

Caring for the Patient With Cancer at Home: A Guide for Patients and Families (also in Spanish)

Nausea and Vomiting

Anemia in People With Cancer

Fatigue in People With Cancer

Family and caregiver concerns

What It Takes to Be a Caregiver

Family and Medical Leave Act (FMLA)

Talking With Friends and Relatives About Your Cancer (also in Spanish)

Helping Children When a Family Member Has Cancer: Dealing With Diagnosis (also in Spanish)

Work, insurance, and finances

Health Insurance and Financial Assistance for the Cancer Patient (also in Spanish)

Working During Cancer Treatment

Returning to Work After Cancer Treatment

Your American Cancer Society also has books that you might find helpful. Call us at 1-800-227-2345 or visit our bookstore online at cancer.org/bookstore to find out about costs or to place an order.

National organizations and websites*

Along with the American Cancer Society, other sources of information and support include:

American Brain Tumor Association
Toll-free number: 1-800-886-2282 (1-800-886-ABTA)
Website: www.abta.org

> Has information for patients and caregivers about brain tumors (including pituitary tumors) in adults, teens, and children, online and by phone. Also has lists of support groups across the US.

Hormone Health Network
Toll-free number: 1-800-467-6663 (1-800-HORMONE)
Website: www.hormone.org

> Offers information about hormones in general, including pituitary disorders, and has fact sheets on the different types of pituitary problems.

National Cancer Institute
Toll-free number: 1-800-422-6237 (1-800-4-CANCER)
TTY: 1-800-332-8615
Website: www.cancer.gov

> Offers a wide variety of free, accurate, up-to-date information about many types of cancer (and pituitary tumors) to patients, their families, and the general public; has information about coping and family matters; and can also help people find clinical trials in their area.

National Coalition for Cancer Survivorship
Toll-free number: 1-888-650-9127
1-877-622-7937 (1-877-NCCS-YES) for some publications and Cancer Survivor Toolbox® orders
Website: www.canceradvocacy.org

> Has publications on many cancer-related topics; also offers the Cancer Survival Toolbox – a free program that teaches skills that can help people with cancer meet the challenges of their illness.

National Endocrine and Metabolic Diseases Information Service (NEMDIS)
Toll-free number: 1-888-828-0904
Website: www.endocrine.niddk.nih.gov

> A service of the US National Institutes of Health (NIH). Has information on some pituitary tumors and the syndromes they can cause, including prolactinomas, acromegaly, and Cushing syndrome.

Pituitary Network Association
Phone number: 1-805-499-9973
Website: www.pituitary.org

> An international organization for patients with pituitary tumors and disorders, their loved ones, and their health care providers. It offers resources and help in getting proper testing and finding treatment options. The PNA has satellite websites for Cushing syndrome, acromegaly, and other hormone disturbances.

Pituitary Society
Phone number: 1-212-263-6772
Website: www.pituitarysociety.org

> Offers information about pituitary gland disorders and help with finding doctors to treat pituitary conditions.

**Inclusion on this list does not imply endorsement by the American Cancer Society.*

No matter who you are, we can help. Contact us anytime, day or night, for information and support. Call us at 1-800-227-2345 or visit www.cancer.org.

References: Pituitary tumor detailed guide

Colao A, Petersenn S, Newell-Price J, et al. A 12-month phase 3 study of pasireotide in Cushing's disease. *N Engl J Med*. 2012;366:914-924.

Dorsey JF, Hollander AB, Alonso-Basanta M, et al. Chapter 66: Cancer of the central nervous system. In: Niederhuber JE, Armitage JO, Dorshow JH, Kastan MB, Tepper JE, eds. *Abeloff's Clinical Oncology*. 5th ed. Philadelphia, Pa. Elsevier: 2014.

Feelders RA, de Bruin C, Pereira AM, et al. Pasireotide alone or with cabergoline and ketoconazole in Cushing's disease. *N Engl J Med*. 2010;362:1846-1848.

Hornyak M, Couldwell WT. Multimodality treatment for invasive pituitary adenomas. *Postgrad Med*. 2009;121:168-176.

Klibanski A. Prolactinomas. *N Engl J Med*. 2010;362:1219-1226.

Lake MG, Krook LS, Cruz SV. Pituitary adenomas: An overview. *Am Fam Physician*. 2013;88:319-327.

Lamberts SW, Hofland LJ. Future treatment strategies of aggressive pituitary tumors. *Pituitary*. 2009;12:261-264.

Loeffler JS, Shih HA. Radiation therapy in the management of pituitary adenomas. *J Clin Endocrinol Metab*. 2011;96:1992-2003.

National Cancer Institute. Physician Data Query (PDQ). Pituitary Tumors Treatment. 2012. Accessed at www.cancer.gov/cancertopics/pdq/treatment/pituitary/HealthProfessional on April 9, 2014.

Ostrom QT, Gittleman H, Farah P, et al. CBTRUS Statistical Report: Primary Brain and Central Nervous System Tumors Diagnosed in the United States 2006-2010. *Neuro-Oncol*. 2013 Nov; 15(sup 2): ii1 – ii56.

Ragel BT, Couldwell WT. Pituitary carcinoma: A review of the literature. *Neurosurg Focus*. 2004;16: E7.

Tritos NA, Biller BM. Advances in medical therapies for Cushing's syndrome. *Discov Med*. 2012;13:171-179.

Vierimaa O, Georgitsi M, Lehtonen R, et al. Pituitary adenoma predisposition caused by germline mutations in the AIP gene. *Science*. 2006; 312:1228-1230.

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1-800-227-2345 or www.cancer.org