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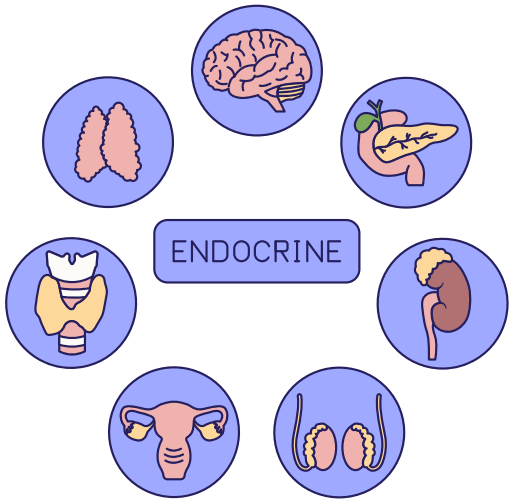
THE ENDOCRINE SYSTEM

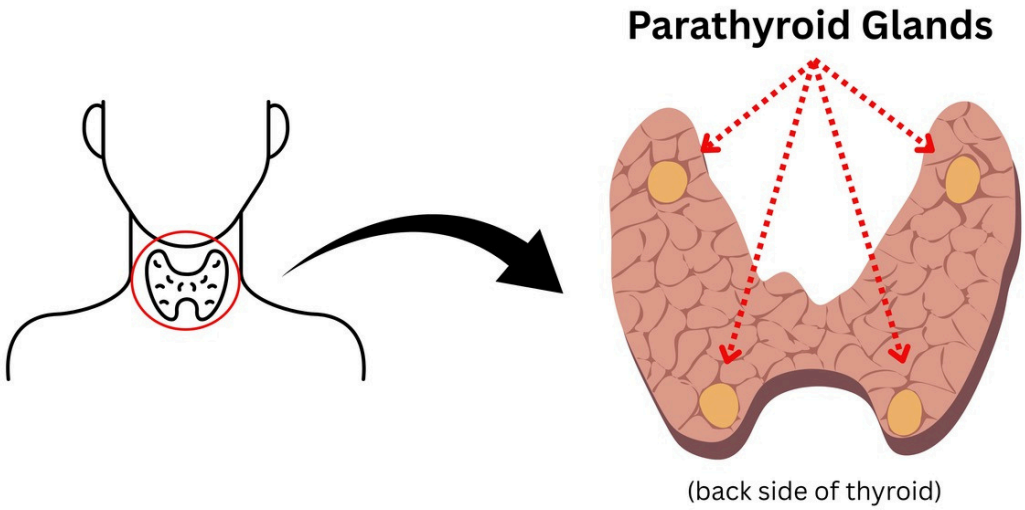
The endocrine system is a collection of different organs called “glands.” These glands produce hormones—chemical messages carried in the bloodstream—which help to regulate many functions in the body. The thyroid and parathyroid glands are both part of the endocrine system.



PARATHYROID DISEASE

THE ROLE OF THE PARATHYROID GLANDS

The parathyroid glands are four, small glands in your neck located near the four corners the back of the thyroid gland. Normal parathyroid glands are approximately the size of a grain of rice. The parathyroid glands produce parathyroid hormone (PTH), which helps to regulate your body’s calcium levels. Normal calcium levels are important to maintain healthy bones and to allow the cells in your heart, nerves, muscles, and digestive system to functional properly.



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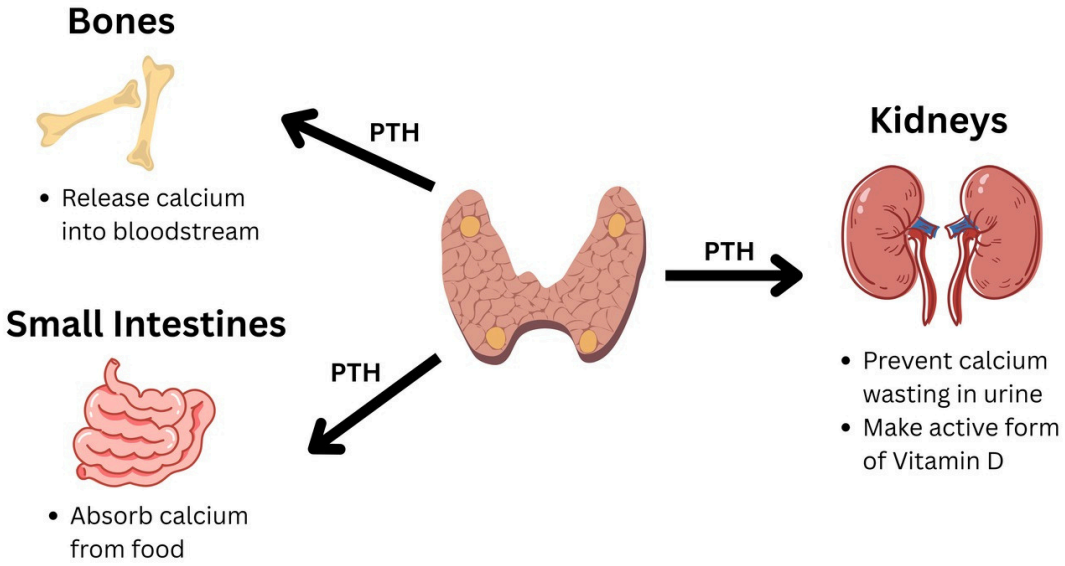
PARATHYROID HORMONE

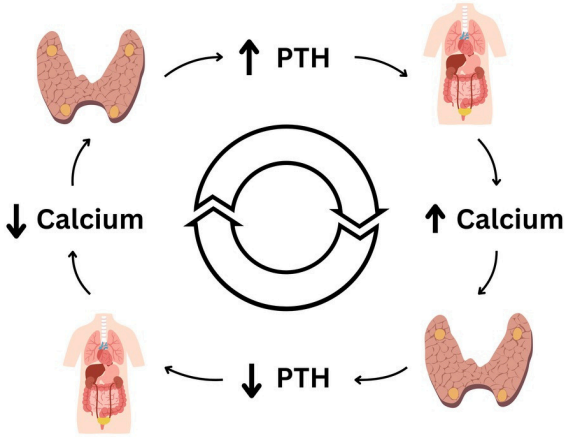
The parathyroid glands constantly monitor the body's calcium level. In response to low blood calcium levels, the parathyroid glands release PTH into the bloodstream. This hormone travels to other organs in the body to increase calcium levels in the bloodstream. PTH has the following effects:

- Bone - PTH triggers the release of calcium into the bloodstream. The bones are the largest storage area for calcium in the body.
- Kidneys - The body normally gets rid of calcium in the urine. PTH triggers the kidneys to keep calcium in the body, rather than to excrete it in the urine. PTH also enables the kidneys to convert vitamin D into its active form—calcitriol.
- Small intestines - PTH signals your intestines to absorb more calcium from the food that you eat.



Feedback Loop

Collectively, these actions cause an increase in blood calcium levels. The parathyroid glands detect the rising levels of calcium, and then reduce how much PTH they produce in response. When calcium levels drop again, the parathyroid glands produce more PTH and the cycle continues. This is called a feedback loop.



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TYPES OF PARATHYROID DISEASE

Parathyroid diseases can be classified into two main categories: conditions that result in PTH levels that are too low *(hypoparathyroidism)* and ones that result in PTH levels that are too high *(hyperparathyroidism)*.

Hypoparathyroidism is rare. It is most often caused by accidental damage to the parathyroid glands during thyroid surgery or if too much tissue is removed during parathyroid surgery. Certain genetic conditions can also cause hypoparathyroidism. With hypoparathyroidism, low PTH levels lead to low blood calcium levels.

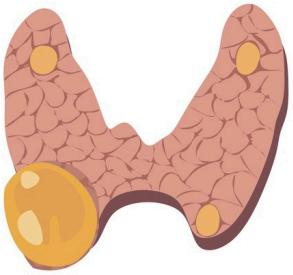
Hyperparathyroidism can be classified into three types: *Primary hyperparathyroidism, secondary hyperparathyroidism, and tertiary hyperparathyroidism*.

Primary Hyperparathyroidism

This occurs when one or more of the parathyroid glands grows in size and produces too much PTH. The cells in the enlarged gland also do not respond normally to signals to stop producing PTH. This leads to high blood calcium levels.

- This is the most common type of hyperparathyroidism.
- Approximately 70% of cases of primary hyperparathyroidism are caused by the growth of a benign (non-cancerous) tumor, called a parathyroid adenoma, within one of the parathyroid glands.
- Some patients (15%) will develop a parathyroid adenoma in two of the parathyroid glands.
- The remainder of cases (15%) are due to four-gland hyperplasia. In this condition, all four parathyroid glands develop abnormally from birth and grow slowly over time. This can happen spontaneously or be related to an underlying genetic disorder.
- Primary hyperparathyroidism may be caused by parathyroid cancer in very rare cases (<1%).

Parathyroid Adenoma



Parathyroid Hyperplasia

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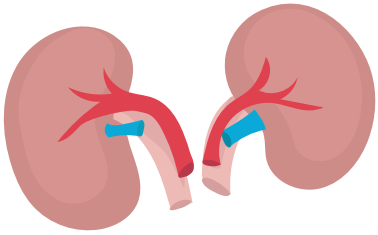
Secondary Hyperparathyroidism

This is the body's normal response to chronically low calcium levels.

In a healthy person, if calcium levels are low, the parathyroid glands produce more PTH which then acts throughout the body to raise calcium levels. When the calcium levels return to normal, the signal to the parathyroid gland shuts off and the PTH level also returns to normal.

If a person has an underlying condition, such as kidney failure or chronic vitamin D deficiency, the body cannot correct the low calcium levels. When calcium levels remain low for a long period of time, the parathyroid glands produce increasingly higher levels of PTH in response.



Tertiary Hyperparathyroidism

This occurs when someone with secondary hyperparathyroidism continues to have elevated PTH levels despite correction of their underlying condition and calcium levels that have returned to normal. It may lead to high blood calcium levels.

All four parathyroid glands become enlarged and produce too much PTH. They also stop responding normally to signals to turn off PTH production.

This situation is generally only seen in patients with kidney failure who then receive a kidney transplant.

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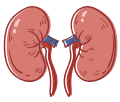
SYMPTOMS OF HYPERPARATHYROIDISM

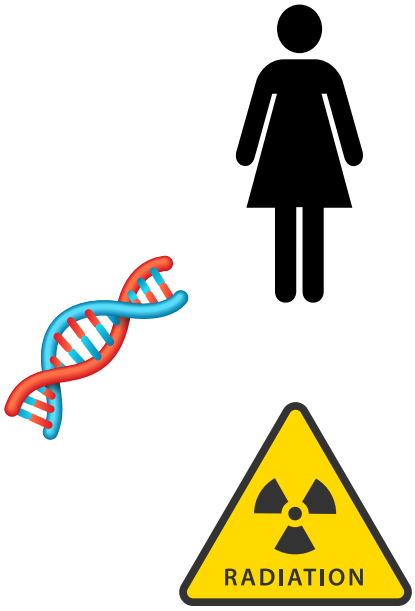
The high levels of PTH and calcium associated with hyperparathyroidism impact multiple body systems and cause a variety of symptoms. If left untreated, this may lead to damage of the bones, kidneys, and blood vessels over time. The most common effects on the body include:

Organ	Symptoms	Explanation
Bones	• Bone pain • Bone weakening (osteopenia/ osteoporosis) • Fractures	High PTH levels cause constant signaling to the bones to breakdown and release calcium. This leads to thinning and weakening of the bones. This can cause pain and increase the risk of fractures.
Kidneys 	• Increased urination • Kidney stones • Decreased kidney function	High levels of calcium in the urine can cause you to urinate more frequently. The calcium can also form stones in the kidney, which may lead to kidney damage over time.
Brain 	• Feeling tired • Memory loss or brain fog • Depression and anxiety	High levels of calcium in the blood prevent the cells in the brain from firing properly. This can make you feel tired and inhibit your ability to think clearly.
Intestines 	• Abdominal pain • Heartburn and nausea • Constipation	High levels of calcium in the blood interfere with the normal function of your intestines. This causes digestion of food to slow leading pain and other symptoms.
Muscles 	• Weakness • Muscle aches	Similar to the intestines, high levels of calcium in the blood prevents muscle cells from working properly. This can cause you to feel weak or achy.
Blood vessels 	• High blood pressure • Heart attack • Stroke	Calcium can deposit in the blood vessels causing them to stiffen and narrow. This may lead to high blood pressure and increases the risk of a heart attack or stroke.

Parathyroid crisis - Very high calcium levels can cause severe impairment of the cells in the heart and brain leading to abnormal heart rhythms, coma, and even death.

Sometimes patients with primary hyperparathyroidism do not have obvious symptoms and may be diagnosed on routine blood tests. It may also be identified as part of a work-up for another condition, such as osteoporosis.

RISK FACTORS FOR PARATHYROID DISEASE



- Most cases of primary hyperparathyroidism occur spontaneous without an obvious underlying cause.
- Women are more likely than men to be diagnosed with primary hyperparathyroidism.
- Certain genetic conditions, such as Multiple Endocrine Neoplasia I and II, are associated with primary hyperparathyroidism.
- Radiation to the head and neck may increase the risk of developing a parathyroid adenoma or cancer.
- Vitamin D deficiency and kidney disease can lead to secondary hyperparathyroidism.

EVALUATION OF PARATHYROID DISEASE

History and Exam

Your doctor will ask about your symptoms and medical history, including your family history, other medical problems, prior procedures, and medications.

Blood Tests

Your doctor will perform blood tests. This will include tests to check your calcium, PTH, vitamin D, and kidney function. Hyperparathyroidism is diagnosed based on the results of these blood tests.

You may also have other blood tests, such as thyroid studies.

Urine Tests

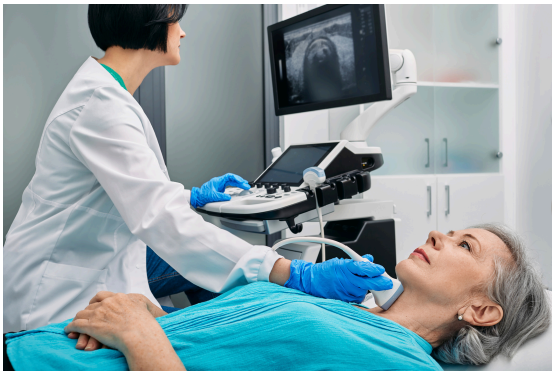
Your doctor will perform a urine study to evaluate for high levels of calcium in the urine. This test is performed by collecting urine in a jug at home for 24 hours and then bringing the sample to the lab for testing.

Imaging

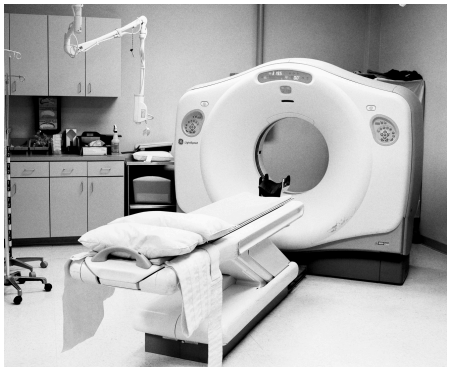
You will have imaging of your neck as part of your evaluation. Imaging studies are used to identify abnormal parathyroid glands and plan for possible surgery, but are not necessary to diagnose hyperparathyroidism. Since the diagnosis is made based on blood tests, you may have a diagnosis hyperparathyroidism, but normal imaging studies.

In the office, you will have an ultrasound, which uses sound waves delivered with a small probe, to produce images of structures in your neck.

Parathyroid adenomas may be seen with the ultrasound, but it is only successful about 80% of the time. Normal parathyroid glands cannot be seen with an ultrasound.



The ultrasound will also be used to evaluate the size and shape of the thyroid gland and to assess for thyroid nodules or other abnormalities. Since the parathyroid glands are located behind the thyroid gland, abnormalities of the thyroid may affect parathyroid surgery.



You will also have a sestamibi scan or a CT scan, which are studies where a small amount of special contrast is injected through an IV, and then 3-D pictures of the neck and chest are obtained. These studies also help to identify parathyroid adenomas and plan for surgery. In rare cases, abnormal parathyroid glands can be found in unusual locations, such as in the chest cavity, and these studies assist with locating them. Some patients will have both of these studies.

Bone Density Study

Hyperparathyroidism can lead to bone weakening or thinning over time. Mild bone thinning is called osteopenia. More severe bone damage is called osteoporosis. Your doctor will order a bone density study, also known as a DEXA scan, to evaluate for damage to your bones. This does not impact your treatment for hyperparathyroidism, but it is important for your overall health. If osteoporosis is found, it may require additional treatment.

Fine-Needle Aspiration

If a thyroid nodule is identified on ultrasound, you may need to have a biopsy, called a fine-needle aspiration (FNA). This is performed in the office using the ultrasound to locate the nodule. A small needle is then inserted through the skin to take a small sample of cells. The cells are examined under the microscope by a pathologist to determine whether the nodule is benign or cancerous.

Sometimes, if the answer is not clear, a repeat biopsy or additional testing of the cells may be necessary.

Fine-Needle Aspiration

PARATHYROID SURGERY

Surgery may be the best treatment for many people with hyperparathyroidism. If you also have a problem with your thyroid gland, sometimes this will be addressed during the same surgery. You and your doctor will decide together if surgery is the best option for you.

Mild cases of primary hyperparathyroidism may be managed with monitoring only. If you are young or experiencing symptoms, surgery is more likely to be recommended. Surgery is usually recommended if you have one or more of the following:

- Age younger than 50
- High levels of calcium in the blood or urine
- Osteoporosis
- Kidney stones or decreased kidney function

Surgery is the only way to cure primary hyperparathyroidism and it is successful more than 95% of the time. Most people feel better very quickly after parathyroid surgery. Surgery can also prevent bone disease from getting worse and some people will have partial healing of their bones after their parathyroid disease is cured.

Secondary and tertiary hyperparathyroidism are less common, but may also be treated with surgery in certain cases.

If you are too sick to have surgery, sometimes a medication can be used to reduce PTH levels. Medication may help with some of the symptoms of hyperparathyroidism, but it cannot cure the disease.

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PREPARING FOR SURGERY

Before Surgery

You and your doctor will discuss all the details of surgery at your pre-op clinic appointment. You will be given a detailed list of instructions to prepare for surgery. These will include instructions such as when to stop eating and drinking before surgery and directions about what medications are safe to take or must be stopped. Be sure to follow all instructions carefully since failing to do so may result in delay or need to reschedule your surgery.

During Surgery

Parathyroid surgery typically takes 2-3 hours depending on the type of problem and how many parathyroid glands need to be removed.

- Parathyroid surgery is performed under general anesthesia, meaning that you are totally asleep during surgery, and a tube is placed in your throat to help you breathe.
- A small incision is then made in your neck.
- Most of the time, all four parathyroid glands are identified before any are removed. Sometimes, the surgery is limited to looking for one abnormal gland that was identified on imaging before surgery.

- If one or two parathyroid adenomas are found, those abnormal glands are removed and the normal parathyroid glands are left in place.
- If all four parathyroid glands are found to be abnormal, then your surgeon will remove 3 or 3.5 glands. Some parathyroid tissue must be left in your body to maintain normal calcium levels.
- Any tissue that is removed will be checked by a pathologist to confirm that it is parathyroid tissue.

Your PTH levels will also be monitored during surgery. PTH is metabolized by your body very quickly. After the correct number of abnormal glands have been removed, the PTH level should drop by at least half within 10 minutes. Most of the time it will return to the normal range within that time. If the PTH level remains too high, then your surgeon will look for additional abnormal parathyroid glands that need to be removed.

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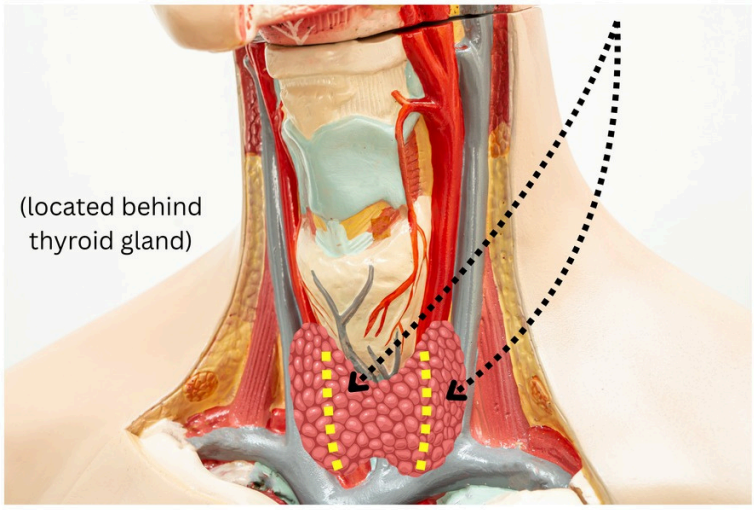
RISKS OF PARATHYROID SURGERY

For people who are healthy, parathyroid surgery is generally very safe. Like all surgery, however, there are some risks. The most common risks and complications include:

- Reactions to medication or anesthesia given during the surgery
- Bleeding
- Infection
- Injury to nearby structures, including the recurrent laryngeal nerves (include picture). These nerves run behind the thyroid gland on both sides and control movement of the vocal cords. Injury to one of these nerves may lead to temporary or permanent hoarseness in the voice.

Recurrent Laryngeal Nerves



- Temporary or permanently low calcium levels. Many patients experience short term low calcium levels after parathyroid surgery as the body resets itself. Symptoms of low calcium include numbness or tingling around the face or in the hands and feet, and muscle cramping. If too much parathyroid tissue is removed or normal glands are damaged during surgery, this can result in permanently low PTH and calcium levels.
- Other complications related to underlying heart or lung problems or other medical conditions, such as heart attacks, blood clots, or pneumonia.

RECOVERING FROM PARATHYROID SURGERY

You will be kept in the recovery unit for at least 4 hours after surgery for observation. Rarely, patients will need to spend the night in the hospital.

Most patients have a sore throat and mild hoarseness after surgery from the breathing tube, as well as soreness or tightness in the neck. These symptoms are very common and usually go away after 1-2 weeks.

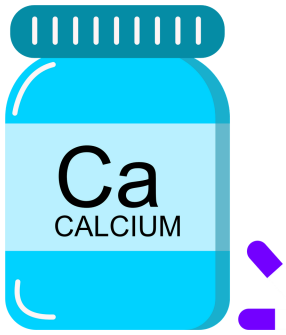
Most patients do not require strong pain medications, such as opiates, after parathyroid surgery.

You will likely have skin glue and small white strips (steri-strips) covering your incision to keep it protected. These usually fall off on their own in 2-3 weeks.

Most patients can take a shower 24 hours after surgery, but you should check with your doctor. It is generally recommended to avoid swimming or submerging your incision in water until it is completely healed.

You will be instructed to take a calcium supplement for 1-2 weeks after surgery. This is to help prevent low calcium symptoms, which are very common after parathyroid surgery. If your vitamin D level was low before surgery, you may also be started on a vitamin D supplement.

Sometimes patients can develop low calcium symptoms even while taking a calcium supplement. This usually requires increasing the dose of oral calcium and taking a strong form of vitamin D to help your body absorb the calcium better. In rare cases, very low calcium levels can occur and patients must go to the emergency room to receive calcium through an IV.



You will be asked to avoid strenuous activity and heavy lifting for 1-2 weeks after surgery, but you should be able to complete most daily activities, including walking, taking stairs, eating, and other self-care tasks.

Most patients take 1-2 weeks off of work to recover from parathyroid surgery. You will be given detailed instructions for your post-operative care at home, including signs to monitor for and when to call your surgeon. Please follow all instructions carefully.

You will have a follow up appointment with your surgeon within 1-2 weeks of surgery. Your wound will be checked. Most patients do not have sutures that need to be removed.

Pathology results from your surgery will be discussed at this appointment and any follow-up tests or appointments will be arranged. Once parathyroid disease is cured, most patients do not require long term monitoring or follow-up with a surgeon.