

Craniotomy

Overview

Craniotomy is a surgery to cut a bony opening in the skull. A section of the skull, called a bone flap, is removed to access the brain underneath. A craniotomy may be small or large depending on the problem. It may be performed to treat brain tumors, hematomas (blood clots), aneurysms or AVMs, traumatic head injury, foreign objects (bullets), swelling of the brain, or infection. The bone flap is usually replaced at the end of the procedure with tiny plates and screws.

What is a craniotomy?

Craniotomies are named according to the area of skull (cranium) to be removed (Fig. 1). After the surgeon repairs the problem, the bone flap is then replaced or covered with plates and screws. If the bone flap is not replaced, the procedure is called a craniectomy.

Craniotomies vary in size and complexity. Small dime-sized craniotomies are called burr holes; "keyhole" craniotomies are quarter-sized or larger. Stereotactic frames, image-guided computer systems, or endoscopes may be used to precisely place instruments through these small holes. Burr holes and keyholes are used for minimally invasive procedures to:

- insert a shunt into the ventricle to drain cerebrospinal fluid (to treat hydrocephalus)
- insert a deep brain stimulator (DBS)
- insert an intracranial pressure (ICP) monitor
- remove a sample of tissue cells (needle biopsy)
- drain a blood clot (hematoma aspiration)
- insert an endoscope to remove tumors

Complex skull base craniotomies involve the removal of bone that supports the bottom of the brain where delicate cranial nerves, arteries, and veins exit the skull. Reconstruction of the skull base may require the additional expertise of head-and-neck, otologic, or plastic surgeons. Surgeons often use image-guidance systems and endoscopes to plan the access for difficult-to-reach lesions to:

- remove deep tumors or AVMs; clip aneurysms
- remove tumors that invade the bony skull

While most skull openings are made as small as possible, large decompressive craniectomies are

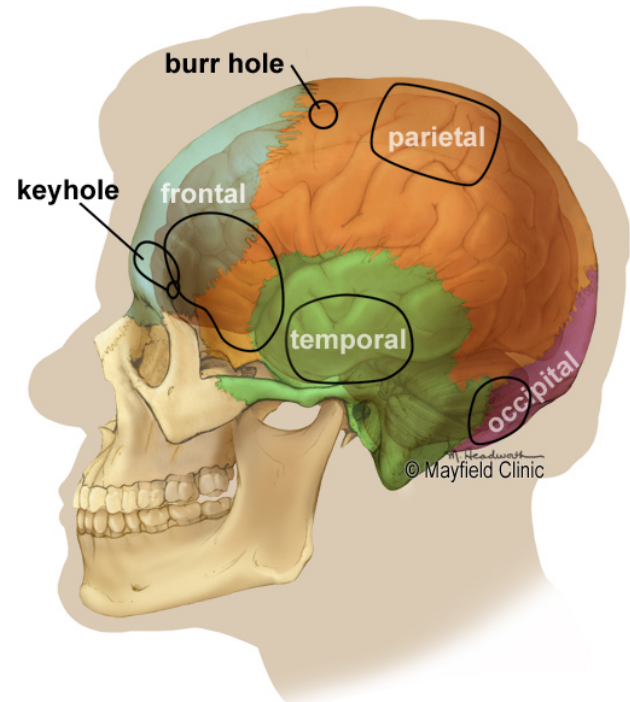


Figure 1. Craniotomies are often named for the bone being removed. Some common craniotomies include fronto-temporal, parietal, temporal, and suboccipital.

made to allow the brain to swell after a head trauma or stroke. The bone flap is frozen and replaced months later after recovery (cranioplasty).

Awake craniotomies are performed when a lesion is close to critical speech areas. The patient is asleep for the bone opening and then awakened to help the surgeon map areas at risk. A probe is placed on the brain surface while you read or talk. Called brain mapping, this process identifies your unique brain areas for speech and helps the surgeon avoid and protect these functions.

There are many kinds of craniotomies. Ask your neurosurgeon to describe where the skin incision will be made and the amount of bone removal.

Who performs the procedure?

A craniotomy is performed by a neurosurgeon; some have additional training in skull base surgery. A neurosurgeon may work with a team of head-and-neck, otologic, plastic, and reconstructive surgeons. Ask your neurosurgeon about their training, especially if your case is complex.

What happens before surgery?

In the doctor's office you will review the procedure with your neurosurgeon and have time to ask questions. Consent forms are signed and paperwork completed to inform the surgeon about your medical history (e.g., allergies, medicines, anesthesia reactions, previous surgeries). Several days before surgery, your primary care physician will conduct tests (e.g., electrocardiogram, chest x-ray, and blood work) to make sure that you are cleared for surgery.

It is important that you discontinue all non-steroidal anti-inflammatory medicines (Naproxen, Advil, etc.) and blood thinners (Coumadin, heparin, aspirin, Plavix, etc.), typically at least 1 week before surgery. Additionally, stop smoking, chewing tobacco, and drinking alcohol 1 week before and 2 weeks after surgery because these activities can cause bleeding problems.

If image-guided surgery is planned, an MRI will be scheduled before surgery. Fiducials (small markers) may be placed on your forehead and behind the ears. The markers help align the preoperative MRI to the image guidance system. The fiducials must stay in place and cannot be moved or removed prior to surgery to ensure the accuracy of the scan.

Do not eat or drink after midnight the night before surgery.

Morning of surgery

- Shower using antibacterial soap. Dress in freshly washed, loose-fitting clothing.
- Wear flat-heeled shoes with closed backs.
- If you have instructions to take regular medication the morning of surgery, do so with small sips of water.
- Remove make-up, hairpins, contacts, body piercings, nail polish, etc.
- Leave all valuables and jewelry at home.
- Bring a list of medications with dosages and the times of day usually taken.
- Bring a list of allergies to medication or foods.

Patients are admitted to the hospital the morning of surgery. The nurse will explain the preoperative process and discuss any questions you may have. An anesthesiologist will talk with you to explain the effects of anesthesia and its risks.

What happens during surgery?

Depending on the underlying problem being treated, surgery can take 3 to 5 hours or longer.

Step 1: prepare the patient

You will lie on the operating table and be given general anesthesia. Once you are asleep, your head is placed in a 3-pin skull fixation device that attaches to the table and holds your head absolutely still during surgery (Fig. 2). A brain-relaxing drug called mannitol may be given.



Figure 2. The patient's head is placed in a three-pin Mayfield skull clamp. The hair is shaved along the skin incision line (dashed line).

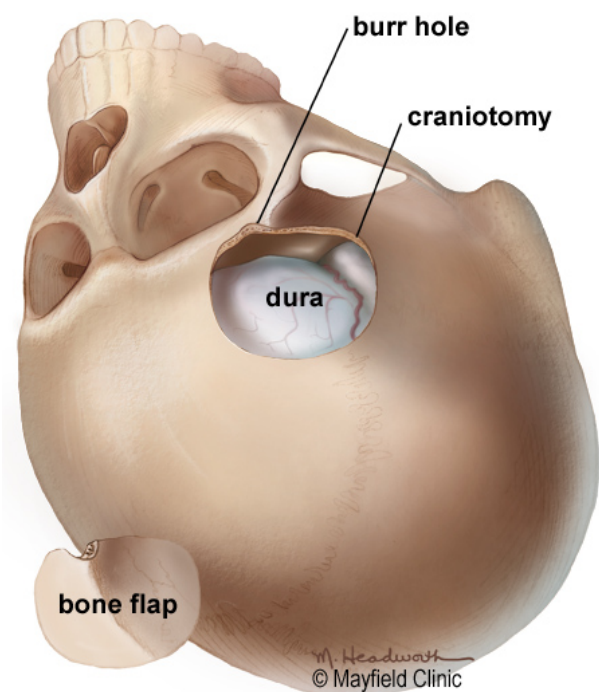


Figure 3. A craniotomy is cut with a special saw called a craniotome. The bone flap is removed to reveal the protective covering of the brain called the dura.

If image-guidance is used, your head will be registered with the infrared cameras to correlate the “real patient” to the 3D computer model created from your MRI scans. The system functions as a GPS to help plan the craniotomy and locate the lesion. Instruments are detected by the cameras and displayed on the computer model.

Step 2: make a skin incision

The incision area of the scalp is prepped with an antiseptic. Skin incisions are usually made behind the hairline. A hair sparing technique is used, where only a 1/4-inch wide area along the proposed incision is shaved. Sometimes the entire incision area may be shaved.

Step 3: perform a craniotomy

The skin and muscles are lifted off the bone and folded back. Next, small burr holes are made in the skull with a drill. The burr holes allow entrance of a special saw called a craniotome. Similar to using a jigsaw, the surgeon cuts an outline of a bone window (Fig. 3). The cut bone flap is lifted and removed to expose the protective covering of the brain called the dura. The bone flap is safely set aside and will be replaced at the end of the surgery.

Step 4: expose the brain

The dura is opened to expose the brain (Fig. 4). Retractors may be used to gently open a corridor between the brain and skull. Neurosurgeons use magnification glasses, called loupes, or an operating microscope to see the delicate nerves and vessels.

Step 5: correct the problem

Enclosed inside the bony skull, the brain cannot be easily moved aside to access and repair problems. Neurosurgeons use a variety of very small instruments to work deep inside the brain. These include long-handled scissors, dissectors and drills, lasers, and ultrasonic aspirators (uses a fine jet of water to break up tumors and suction up the pieces). In some cases, evoked potential monitoring is used to stimulate specific cranial nerves while the response is monitored in the brain. This is done to preserve function of the nerve during surgery.

Step 6: close the craniotomy

After the problem has been removed or repaired, any retractors are removed, and the dura is closed with sutures. The bone flap is put back in its original position and secured to the skull with titanium plates and screws (Fig. 5). The plates and screws remain permanently to support the area, and they sometimes can be felt under your skin. A drain may be placed under the skin for a couple of days to remove blood or fluid from the area. The muscles and skin are sutured back together. A soft adhesive dressing is placed over the incision.

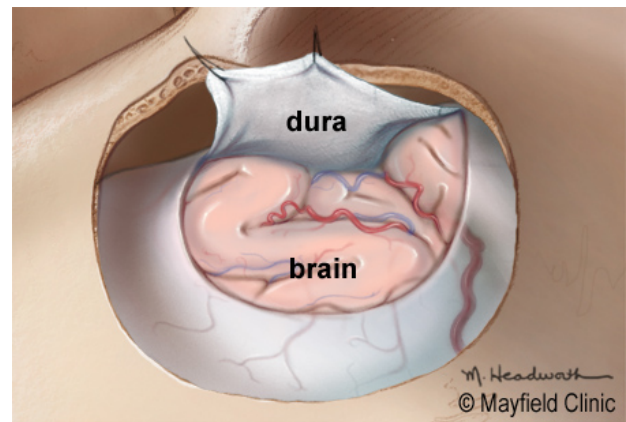


Figure 4. The dura is opened and folded back to expose the brain.

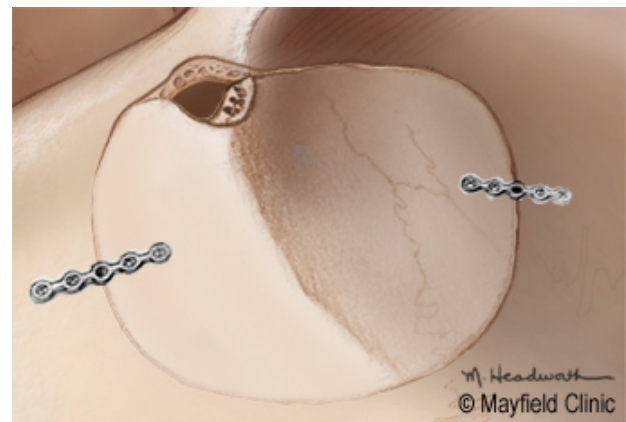


Figure 5. The bone flap is replaced and secured to the skull with tiny plates and screws.

What happens after surgery?

After surgery, you are taken to the recovery room where vital signs are monitored as you awake from anesthesia. The breathing tube (ventilator) usually remains in place until you fully recover from the anesthesia. Next, you are moved to the neuroscience intensive care unit (NSICU) for close monitoring. You are frequently asked to move your arms, fingers, toes, and legs. A nurse will check your pupils with a flashlight and ask questions, such as “What is your name?” You may experience nausea and headache after surgery. Medication can control these symptoms. Depending on the type of brain surgery, steroid medication (to control brain swelling) and anticonvulsant medication (to prevent seizures) may be given. When your condition stabilizes, you’ll be transferred to a regular room where you’ll begin to increase your activity level.

The length of the hospital stay varies, from only 2–3 days or 2 weeks depending on the surgery and any complications. When released from the hospital, you’ll be given discharge instructions.

Discharge instructions

Discomfort

1. After surgery, pain may be managed with narcotic medication. Because narcotics are addictive, they are used for a limited period of 2 to 4 weeks. Their regular use may also cause constipation, so drink lots of water and eat high-fiber foods. Stool softeners (e.g., Colace, Docusate) and laxatives (e.g., Dulcolax, Senokot, Milk of Magnesia) can be bought without a prescription. Thereafter, pain is managed with acetaminophen (e.g., Tylenol).
2. Ask your surgeon before taking nonsteroidal anti-inflammatory drugs (NSAIDs) (e.g., ibuprofen, Advil, Motrin, Nuprin; naproxen sodium, Aleve). NSAIDs may cause bleeding and interfere with bone healing.
3. A medicine may be prescribed to prevent seizures. Common anticonvulsants include Dilantin (phenytoin), Tegretol (carbamazepine), and Neurontin (gabapentin). Some patients develop side effects (e.g., drowsiness, balance problems, rashes) from the anticonvulsants. In these cases, blood samples are taken to monitor the drug levels and manage the side effects.

Restrictions

1. Do not drive after surgery until discussed with your surgeon and avoid sitting for long periods of time.
2. Do not lift anything heavier than 5 pounds (e.g., 2-liter bottle of soda), including children.
3. Housework and yard work are not permitted until the first follow-up office visit. This includes gardening, mowing, vacuuming, ironing, and loading/unloading the dishwasher, washer, or dryer.
4. Do not drink alcoholic beverages.

Activity

5. Fatigue is common after surgery. Gradually return to your normal activities.
6. Gentle stretches for the neck may be advised.
7. Walking is encouraged; start with short walks and gradually increase the distance. Wait to participate in other forms of exercise until discussed with your surgeon.

Bathing/Incision Care

8. You may shower and get your incision or sutures wet. Use mild baby shampoo with no harsh fragrances. Be careful not to let the water directly hit your incision. Gently clean any old dried blood from the incision area.
9. Do not submerge your head in a bath.

10. Inspect your incision daily and check for signs of infection, such as swelling, redness, yellow or green discharge, warm to the touch. Minimal swelling around your incision is expected.

When to Call Your Doctor

11. If you experience any of the following:
 - A temperature that exceeds 101.5° F
 - An incision that shows signs of infection, such as redness, swelling, pain, or drainage.
 - If you are taking an anticonvulsant, and notice drowsiness, balance problems, or rashes.
 - Decreased alertness, increased drowsiness, weakness of arms or legs, increased headaches, vomiting, or severe neck pain that prevents lowering your chin toward the chest.

Recovery

You will be given a follow-up appointment 10 to 14 days after surgery. The recovery time varies from 1 to 4 weeks depending on the underlying disease being treated and your general health. Full recovery may take up to 8 weeks. Walking is a good way to begin increasing your activity level. Do not overextend yourself, especially if you are continuing treatment with radiation or chemotherapy. Ask your surgeon when you can expect to return to work.

What are the risks?

No surgery is without risks. General complications of any surgery include bleeding, infection, blood clots, and reactions to anesthesia. Specific complications related to a craniotomy may include stroke, seizures, swelling of the brain, nerve damage, and CSF leak.

What are the results?

The results of your craniotomy depend on the underlying condition being treated.

Sources & links

If you have more questions, please contact New England Neurological Associates at 978-687-2321.

Glossary

cerebrospinal fluid (CSF): a clear fluid produced by the choroid plexus in the ventricles of the brain that bathes the brain and spinal cord giving them support and buoyancy to protect from injury.

seizure: uncontrollable convulsion, spasm, or series of jerking movements of the face, trunk, arms, or legs.

stroke: an interruption of the blood supply to the brain; may cause loss of ability to speak or to move parts of the body.



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