

Epilepsy Surgery

Overview

Epilepsy surgery is a procedure that either removes or isolates the area of your brain where seizures begin. It is a treatment option for people whose seizures are not well controlled with medication. About 30% of people with epilepsy have seizures that are "medically intractable," meaning the seizures continue to happen despite trying 3 or more antiepileptic drugs [1]. People who are considered for surgery undergo extensive testing to locate the source of their seizures and to ensure that removing that region of the brain will not impact their speech, mobility or quality of life [2,3].

What is epilepsy surgery?

Epilepsy surgery is a procedure to 1) remove the seizure-producing area of the brain or 2) limit the spread of seizure activity. Surgical results can be considered curative (stopping the seizures) or palliative (restricting the spread of the seizure). The type of surgery performed depends on the type of seizures and where they begin in the brain (Fig 1). Curative procedures, such as lobectomy, cortical excision, or hemispherectomy aim to remove the area of the brain (seizure focus) causing seizures. The goal is to remove all of the seizure focus area without causing loss of brain function. Palliative procedures, such as corpus callosotomy or vagus nerve stimulation (VNS), aim to reduce seizure frequency or severity.

Who is a candidate?

Epilepsy surgery may be an option if you have:

- seizures that are uncontrolled with medications (intractable) or you have severe side effects to the medications
- partial seizures that always start in one area of the brain (localized seizure focus)
- seizures that significantly affect your quality of life
- seizures caused by a lesion such as scar tissue, a brain tumor, arteriovenous malformation (AVM), or birth defect
- seizure discharge that spreads to the whole brain (secondary generalization)

Most experts recommend that a patient who continues to have seizures after trials of 2 or 3 different medications should have an evaluation at a comprehensive epilepsy treatment program. The

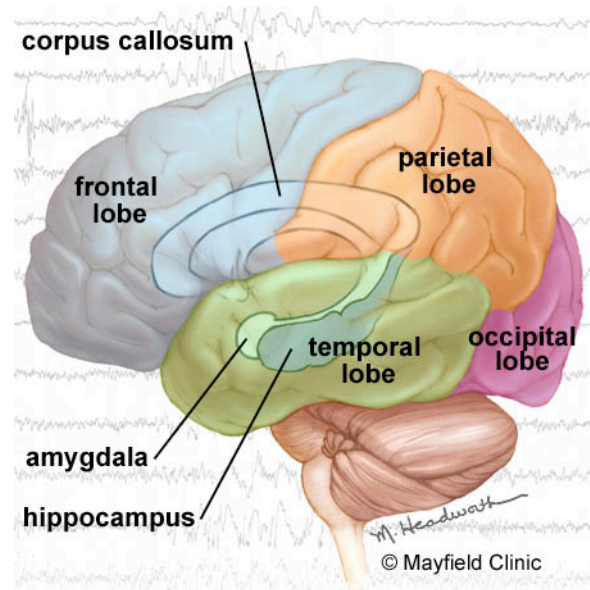


Figure 1. A seizure is an abnormal electrical discharge in the brain. This "short circuit" can cause a change in behavior (fall down, stare off into space, or make jerking movements) often without awareness of what is happening. Partial seizures arise from one part of the brain and include simple, partial, and complex partial seizures. Generalized seizures involve the entire brain and include generalized tonic-clonic, absence, myoclonic, tonic, and atonic seizures.

Types of epilepsy surgery

Curative procedures are performed when tests consistently point to a specific area of the brain where the seizures begin.

- **Temporal lobectomy** is the most common type of surgery for people with temporal lobe epilepsy. It removes a part of the anterior temporal lobe along with the amygdala and hippocampus. A temporal lobectomy leads to a significant reduction or complete seizure control about 70% to 80% of the time [4, 5]. However, memory and language can be affected if this procedure is performed on the dominant hemisphere.
- **Cortical excision** is the second most common type of epilepsy surgery. It removes the outer layer (cortex) of the brain at the seizure focus area. About 40% to 50% of patients have better seizure control.

likelihood of seizure freedom after failure of 3 different medications is less than 5% [1, 2]. The epilepsy team typically consists of epileptologists (neurologists with special expertise in epilepsy), neurosurgeons, neuropsychologists, epilepsy nurse clinicians, and EEG technicians.

Patients are initially evaluated by an epileptologist. A complete medical history and physical exam helps identify critical information, such as age of onset and type of seizures (including frequency, severity, and duration) (see Seizures). A patient's physical exam is usually normal. However, some asymmetries may be seen related to early development when the structural brain lesions formed. For example, a difference in the size of one hand or foot compared to the other may correlate with atrophy of one of the brain's hemispheres.

The following diagnostic studies may be used during an evaluation for epilepsy surgery. Not all tests are required. The epilepsy team will decide which tests are appropriate.

- **Continuous video-EEG monitoring** requires a hospital stay in an epilepsy monitoring unit. For the EEG, a technician glues electrodes onto your scalp to record the electrical activity of the brain. With safe and continuous monitoring, movement/behavior and EEG activity are captured during a seizure with simultaneous recordings by video camera and electroencephalogram (EEG). Careful analysis of activity and brain waves both during and between seizures can provide critical information about where the seizure starts and spreads. Certain behaviors during seizures, such as abnormal posturing of an arm, or specific speech problems during or after a seizure, help your physician to identify where in the brain the seizure begins.
- **Magnetic Resonance Imaging (MRI)** helps identify structural brain abnormalities that can cause epilepsy. These include hippocampal atrophy, cavernous angiomas, cortical dysplasias, and tumors.
- **Positron Emission Tomography (PET)** allows the doctor to study brain function by observing how glucose (sugar) is metabolized in the brain. A small amount of radioactive glucose is injected into your bloodstream. The PET scanner takes pictures of the brain that are interpreted by a computer to examine glucose metabolism. Glucose use can increase (hypermetabolism) during a seizure and decrease (hypometabolism) when not having a seizure. These results may help locate areas of dysfunctional brain or other abnormalities, which could correspond to EEG localization of epileptogenic activity.
- **Single-Photon Emission Computed Tomography (SPECT)** provides information about blood flow to brain tissue. Analyzing blood flow to the brain may help determine how

- **Hemispherectomy** involves the removal of the brain's outer layer (cortex) and anterior temporal lobe on one half of the brain. It is usually performed in children who suffer intractable seizures, have a damaged hemisphere, and experience weakness on one side of the body. Surgery may control seizures for nearly 80% of these patients. Patients often improve in cognitive functioning, attention span, and behavior.

Palliative procedures are performed when a seizure focus cannot be determined or it overlaps brain areas critical for movement, speech, or vision.

- **Corpus callosotomy** prevents the spread of generalized seizures from one side of the brain to the other by disconnecting the nerve fibers across the corpus callosum. During surgery the anterior two thirds of the corpus callosum is sectioned. On occasion, a second surgery is performed to cut the posterior one third if the patient does not improve. This surgery is not curative. Rather, it prevents the spread and reduces seizure severity. Some patients experience disconnection syndrome after a complete callosotomy. They may have right-left confusion with motor problems, apathy, or mutism.
- **Multiple subpial transections** create small incisions in the brain to interfere with the spread of seizure impulses. This technique is used when the seizure focus is located in a vital area that cannot be removed. It may be used alone or in combination with a lobectomy.
- **Vagus nerve stimulation (VNS)** involves implantation of a device that produces electrical signals to prevent seizures. VNS is similar to a heart pacemaker. A wire (lead) is wrapped around the vagus nerve in the neck. The wire is connected to a generator-battery implanted under the skin near the collarbone. The generator is programmed to produce intermittent electrical signals that travel along the vagus nerve to the brain. In addition, some patients may turn on the device with a magnet when feeling a warning (aura) that a seizure is about to start. VNS is not a cure for epilepsy, it does not work for everyone, and it does not replace the need for anti-epileptic drugs. This procedure is reserved for those who are not candidates for potentially curative brain surgery. VNS reduces seizure frequency by about 30% (similar to the results of the newer AEDs) [6]. Common side effects are a tingling sensation in the neck and mild hoarseness in the voice, both of which occur only during stimulation.

specific areas are functioning. A SPECT scan shows that blood flow to a specific area of the brain can increase during a seizure but can decrease when not having a seizure.

- **Neuropsychological testing** evaluates your current level of brain functioning, including memory and language. This test might correlate with diagnostic imaging and EEG.
- **Wada Test** (Intracarotid Amytal test) is used to determine which side of your brain is dominant for language and memory function. Identifying the dominant side, the surgeon plans the operation to avoid affecting these functions. The Wada test, which is performed as part of an angiogram, can show any vascular or blood flow problems (see Angiogram). Sodium amytal is a short-acting barbiturate that is injected into the carotid artery on the right or left side. For a short time, the drug puts one half of the brain (hemisphere) to sleep. You cannot move one side of your body and may be unable to speak. Next, you are asked to identify pictures, words, objects, or numbers. After 5 to 10 minutes when the drug wears off, you are asked if you remember what was shown. The Wada test is then repeated on the other side. Used with neuropsychological testing, results of the Wada test help identify memory and language deficits and predict surgical outcome.
- **Functional MRI (fMRI)** is used to determine the location of brain abnormalities in relation to areas of the brain responsible for speech, memory, and movement. FMRI also helps doctors predict the functional outcome of surgical treatment. FMRI is sometimes used instead of a Wada test.

Electrical brain mapping, or electrocorticography, are diagnostic tests that may be necessary if the seizure focus is believed to lie close to important functional areas or if the exact location of the seizure focus remains unclear despite standard EEG and other tests. During a craniotomy operation for these diagnostic tests, subdural or depth electrodes are placed directly on or in the brain through a hole in the skull (craniotomy).

- **Subdural electrodes**, aligned on a plastic grid, are placed directly on the brain's surface (Fig 2). Subdural electrodes allow for a wide area of EEG recording as well as cortical mapping of functional areas.
- **Intracerebral depth electrodes** look like a banded stick. These are placed stereotactically deep into the brain tissue, usually the amygdala and hippocampus of the temporal lobe. Depth electrodes are indicated for patients with bitemporal, bifrontal, or frontal temporal seizures.

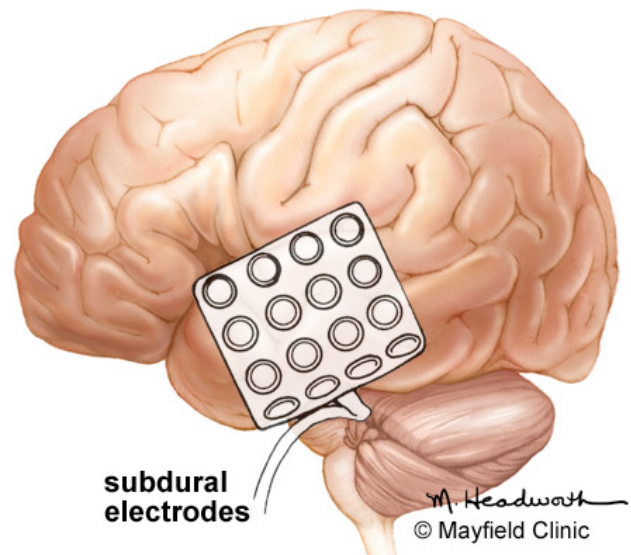


Figure 2. Subdural electrodes are placed directly on the brain surface to record electrical activity.

After the electrodes are placed, the wound is completely closed and bandaged. The patient is then moved to the epilepsy monitoring unit (EMU). The EEG technician will connect the electrodes (via wires that pass through small incisions in the skin) to an EEG machine that shows the brain waves and seizure activity. The patient remains in the hospital until sufficient information has been gathered to guide further treatment (typically 5-10 days). If the seizure focus is found and is not in an area of the brain involved in communication, a second surgery may be recommended to remove that brain area. If the seizure focus is not found, the electrodes are removed; follow up consultation with the epileptologist and neurosurgeon will follow. Risks associated with electrical brain mapping include infection and hemorrhage in about 2% to 5% of cases.

The surgical decision

The epilepsy team meets to review all testing performed to decide if surgery is the best treatment option. All tests should point to a single region in the brain as the source for seizures. If this is the case, and the region of seizure onset is a safe distance away from areas of the brain that control language, movement, and vision, then surgery can be recommended to reduce or eliminate seizures.

Who performs epilepsy surgery?

Epilepsy surgery is done by a neurosurgeon specifically trained in this field. A patient should have a presurgical evaluation at a comprehensive epilepsy treatment program by a multidisciplinary team of specialists (neurologists, neurosurgeons, neuropsychologists, and nurse clinicians).

What happens before surgery?

First, in consultation during the office visit, the neurosurgeon will explain the procedure, its risks and benefits, and answer any questions. Next, you will sign consent forms and complete paperwork to inform the surgeon about your medical history (i.e., allergies, medicines, vitamins, bleeding history, anesthesia reactions, previous surgeries). Discuss all medications (prescription, over-the-counter, and herbal supplements) you are taking with your health care provider. Some medications need to be continued or stopped the day of surgery. You may be scheduled for presurgical tests (e.g., blood test, electrocardiogram, chest X-ray) several days before surgery.

Stop taking all non-steroidal anti-inflammatory medicines (Naprosyn, Advil, Motrin, Nuprin, Aleve) and blood thinners (coumadin, Plavix, aspirin) 1 week before surgery. Additionally, stop smoking and chewing tobacco 1 week before and 2 weeks after surgery as these activities can cause bleeding problems. No food or drink is permitted past 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 (including wedding bands).
- Bring a list of medications (prescriptions, over-the-counter, and herbal supplements) with dosages and the times of day usually taken.
- Bring a list of allergies to medication or foods.
- Take your AED medication as usual.

Arrive at the hospital 2 hours before your scheduled surgery time to complete the necessary paperwork and pre-procedure work-ups. Your nurse will ask your name, date of birth, and what procedure you're having. The nurse will explain the pre-surgery process and answer any questions you may have. An intravenous (IV) line will be placed in your arm. An anesthesiologist will talk with you and explain the effects and risks of anesthesia.

What happens during surgery?

There are five main steps to the anterior temporal lobectomy. The surgery generally takes 3 to 4 hours.

Step 1: prepare the patient

You will lie on your back on the operative table and be given anesthesia. Once asleep, your head is placed in a skull fixation device attached to the

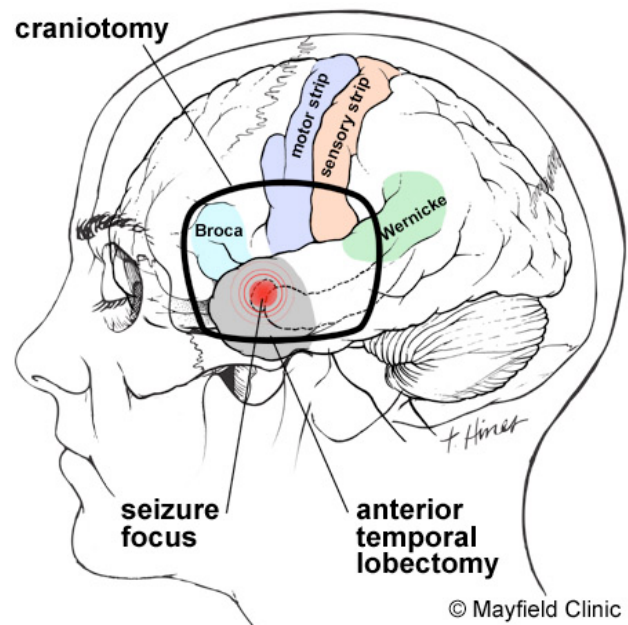


Figure 3. In an anterior temporal lobectomy, a bone flap (craniotomy) is cut in the skull to expose the brain. A part of the temporal lobe is removed along with the amygdala and a portion of the hippocampus (grey area).

table that holds your head in position during the surgery. Depending on where the incision will be made, your hair may be shaved.

Step 2: perform a craniotomy

After your scalp is prepped, the surgeon will make a skin incision to expose the skull. A circular opening in the skull, called a craniotomy, is drilled (see Craniotomy) (Fig 3). This bony opening exposes the protective covering of the brain, called the dura mater, which is opened with scissors.

Step 3: perform brain mapping

Depending on your specific case, intraoperative EEG recording and stimulation with subdural electrodes may be performed to map brain areas (Fig. 4), or reconfirm the epileptic zone, particularly how much of the lateral temporal cortex is involved. Using a small electrical probe, the surgeon tests locations on the brain's surface one after another to create a map of functions. During mapping, areas involved with movement can be identified electrically even if the patient is under anesthesia. However, to map areas such as language, sensation, or vision, the patient is awakened to be able to communicate with the surgeon. Local anesthesia and numbing agents are given so you won't feel any pain.

Step 4: remove the seizure focus area

Looking through an operative microscope, the surgeon gently retracts the brain and opens a corridor to the seizure focus area. The surgeon then removes that area of brain where seizures occur.

Step 5: close the craniotomy

The retractors are removed and the dura is closed with sutures. The bone flap is replaced and secured to the skull with titanium plates and screws. The muscles and skin are sutured back together.

What happens after surgery?

After surgery you'll be taken to the recovery room, where vital signs are monitored as you awake from anesthesia. You'll be transferred to the neuroscience intensive care unit (NSICU) for overnight observation and monitoring. Pain medication will be given as needed. If you experience nausea and headache after surgery, medication can be given to control these symptoms. Once your condition is stable, you will be moved to a room on the Neuroscience floor where you will stay for about 1 to 3 days.

If you had a VNS implanted, you may go home after recovery from anesthesia. It is important to work with your neurologist to adjust your medications and refine the programming of the neurostimulator.

Discharge instructions

Discomfort

1. After surgery, headache pain is managed with narcotic medication. Because narcotic pain pills are addictive, they are used for a limited period (2 to 4 weeks). Their regular use may also cause constipation, so drink lots of water and eat high fiber foods. Laxatives (e.g., Dulcolax, Senokot, Milk of Magnesia) may be bought without a prescription. Thereafter, pain is managed with acetaminophen (e.g., Tylenol) and nonsteroidal anti-inflammatory drugs (NSAIDs) (e.g., aspirin; ibuprofen, Advil, Motrin, Nuprin; naproxen sodium, Aleve).
2. A medicine (anticonvulsant) may be prescribed temporarily to prevent seizures. Common anticonvulsants include Dilantin (phenytoin), Tegretol (carbamazepine), and Neurontin (gabapentin). Some patients develop side effects (e.g., drowsiness, balance problems, rashes) caused by these anticonvulsants; in these cases, blood samples are taken to monitor the drug levels and manage the side effects.

Restrictions

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

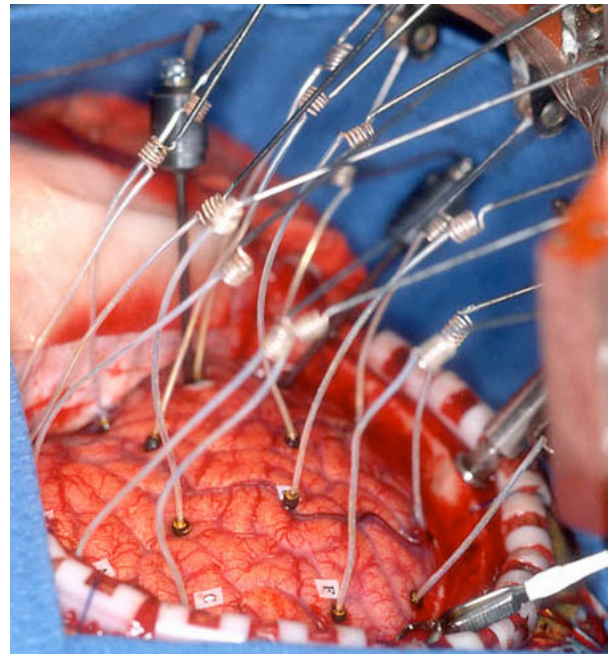


Figure 4. Brain mapping with electrodes placed directly on the brain confirms the area of seizure focus before brain tissue is removed.

Activity

7. Gradually return to your normal activities. Fatigue is common.
8. An early exercise program to gently stretch the neck and back may be advised.
9. 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

10. You may shower and shampoo 3 to 4 days after surgery unless otherwise directed by your surgeon.
11. Sutures or staples, which remain in place when you go home, will need to be removed 7 to 14 days after surgery. Ask your surgeon or call the office to find out when.

When to Call Your Doctor

12. If you experience any of the following:
 - A temperature that exceeds 101° 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

Patients usually can resume their normal activities after 3 to 4 weeks. However, you cannot drive an automobile until you have approval from your neurologist. Doctors usually recommend that surgical patients stay on AEDs for up to two years after the operation. Some people may have to continue with medication indefinitely for seizure control. If language or memory problems continue past the recovery period, your doctor may recommend speech or physical therapy.

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, which may require a second craniotomy
- nerve damage, which may cause muscle paralysis or weakness
- CSF leak, which may require repair
- loss of mental functions
- permanent brain damage with associated disabilities

Specific complications may include:

- Memory and language problems after temporal lobectomy.
- Temporary double vision after temporal lobectomy.
- Increased number of seizures after corpus callosotomy, but the seizures should be less severe.
- Reduced visual field.
- Partial, one-sided paralysis after a hemispherectomy. Intense rehabilitation often brings back nearly normal abilities.

Sources & links

If you have more questions or would like to schedule an appointment with one of our neurosurgeons, please call (515) 241-5760. Our offices are located on the Iowa Methodist Campus.

Sources

1. Wiebe S, Blume WT, Girvin JP, Eliasziw M: A randomized, controlled trial of surgery for temporal-lobe epilepsy. *N Engl J Med* 345:311-8, 2001

2. Yasuda CL, Tedeschi H, Oliveira EL, et al: Comparison of short-term outcome between surgical and clinical treatment in temporal lobe epilepsy: a prospective study. *Seizure* 15(1):35-40, 2006.
3. Engel J Jr, Wiebe S, French J, Sperling M, et al: Practice parameter: temporal lobe and localized neocortical resections for epilepsy. *Epilepsia* 44(6):741-751, 2003.
4. Sperling MR, O'Connor MJ, Saykin: Temporal lobectomy for refractory epilepsy. *JAMA* 276(6):470-475, 1996.
5. Dupont S, Tanguy ML, Clemenceau S, et al: Long-term prognosis and psychosocial outcomes after surgery for MTLE. *Epilepsia* 47(12):2115-24, 2006.
6. Schachter SC: Vagus nerve stimulation therapy summary. *Neurology* 59:S15-20, 2002.

Links

Epilepsy Foundation of America, www.efa.org
American Epilepsy Society, www.aesnet.org
www.epilepsy.com

Glossary

antiepileptic drug (AED): a medication used to control epileptic seizures

cortical mapping: direct brain recording or stimulation to identify language, motor, and sensory areas of the cortex

cortex: the outer layer of the brain containing nerve cell bodies

disconnection syndrome: the interruption of information transferred from one brain region to another

generalized seizure: a seizure involving the entire brain

hippocampal atrophy: A wasting or decrease in size of the hippocampus

hypermetabolism: faster than normal metabolism

hypometabolism: slower than normal metabolism

ictal: that which happens during a seizure

interictal: that which happens between seizures

intractable: difficult to control

localization: finding the location in the brain where epileptic seizures start

lobectomy: surgical removal of a lobe of the brain

seizure focus: a specific area of the brain where seizures begin

palliative: to alleviate without curing

partial seizure: a seizure involving only a portion of the brain

video EEG monitoring: simultaneous monitoring of a patient's behavior with a video camera and the patient's brain activity by EEG



updated > 2.2013

reviewed by > Ellen Air, MD, PhD, and David Ficker, MD, University of Cincinnati Department of Neurosurgery, Ohio

Mayfield Certified Health Info materials are written and developed by the Mayfield Clinic & Spine Institute. We comply with the HONcode standard for trustworthy health information. This information is not intended to replace the medical advice of your health care provider. © Mayfield Clinic 1998-2013.