Advances in epilepsy surgery

Remarkable advances in the diagnosis and treatment of epilepsy have been made in recent years. Elaborate electroencephalogram (EEG) monitoring with simultaneous videotaping; refined neuroradiologic techniques, including magnetic resonance imaging (MRI), positron emission tomography (PET) and single-photon emission computed tomography (SPECT); and sophisticated implantable electrodes help to pinpoint the source of seizures. Subspecialty trained physicians, improved anesthetic agents, intraoperative monitoring and innovative surgical techniques, such as awake craniotomy, have combined to make surgery a treatment option for many adults and children with medically intractable epilepsy — the 30 percent of epilepsy patients for whom drug therapy is either ineffective or produces intolerable side effects.

Successful epilepsy surgery

The success of epilepsy surgery is measured in terms of the operation’s impact on seizure control and improvement in quality of life. Successful surgery eliminates seizures in the majority of cases. In a minority of cases, seizure frequency is markedly reduced.

Ten years after epilepsy surgery, 68 percent of Cleveland Clinic patients who have undergone temporal lobe resection (removal of tissue) — the most common type of epilepsy surgery — continue to be seizure-free. Significant improvement in lifestyle and social interactions also may occur.

For some patients, anticonvulsant medications may be reduced or discontinued by a neurologist following a thorough evaluation of seizure status one to three years after surgery. Some patients may continue to experience auras (warning signs and sensations) and require long-term maintenance medication(s) in order to achieve complete seizure control.

Are you a candidate for surgery?

If anticonvulsant medications have failed to control your epilepsy, or you are experiencing intolerable side effects from anticonvulsants, you may be a candidate for epilepsy surgery. Please ask your doctor if surgery is an option for you.

The process to decide whether you are a candidate for surgery involves a thorough medical history and physical examination, including brain wave monitoring and other tests. The goal is to identify a specific source of seizures in your brain that can be safely removed without affecting important brain-controlled functions.
IF SURGERY IS NOT AN OPTION

In some cases, surgery is not possible. Seizures may come from multiple brain areas, or the risk on brain function may be too high. In these situations, other options are available. New treatments for epilepsy are continually being developed, and it may be possible to participate in an experimental trial of a new drug or other therapy. One therapy for use in patients when resective surgery is not possible is the Vagus Nerve Stimulator (VNS). This is an FDA-approved treatment for epilepsy. VNS involves minor surgery to implant a pacemaker to stimulate the vagus nerve in the neck. Ask your doctor about this and other alternative treatments.

FOCUSBING IN ON THE SOURCE OF SEIZURES

Your preliminary evaluation is performed by a board-certified neurologist with subspecialty training in epilepsy (epileptologist). First, we will take a detailed history of your seizure activity and the anticonvulsant drug regimens you have followed. This helps to define the type of epilepsy you have and to determine whether it is medically intractable (i.e., resistant to medical treatment).

The first phase of formal evaluation includes outpatient testing to screen for abnormalities within the brain. It also includes inpatient EEG recordings to identify where the seizure begins within the brain.

Patients are admitted to our state-of-the-art Adult Epilepsy Monitoring Unit (EMU) or Pediatric Epilepsy Monitoring Unit (PEMU), where a computerized EEG and simultaneous video recordings are performed. Multiple surface electrodes are placed on various areas of your scalp. Then, your dose(s) of anticonvulsant medication(s) is (are) lowered or discontinued so that seizures can occur and be recorded with prolonged video-EEG recordings. Seizures that result from medication withdrawal are brief and controllable in most situations. A staff of registered nurses and EEG technologists will care for you during this recording phase.

Monitoring may extend for several days so that brain waves can be examined during and between seizures. With the help of computers that continuously record and analyze the EEG signals, your physicians compare and correlate the recorded brain waves with the outward physical symptoms recorded on the videotape. This further pinpoints the origin of seizure activity, which may begin in one area of the brain and quickly spread to another.

After your Cleveland Clinic epileptologist thoroughly reviews your test results, the doctor will recommend whether or not you should proceed to the next phase of evaluation. Some patients choose not to continue at this point.

Other patients may choose to proceed with a complete presurgical evaluation that can lead to surgical treatment. Cleveland Clinic’s Epilepsy Center is a multidisciplinary

Anatomy of Your Epilepsy

Further localization efforts utilize several brain scan techniques:

Magnetic resonance imaging (MRI) is a sophisticated radiologic technique that uses harmless magnetic waves (rather than X-rays) to produce images. This technique aids in identifying both focal and more widespread abnormalities in brain tissue.

MRI spectroscopy (MRS) is an MRI test showing chemical imbalances that may indicate seizure activity or poorly functioning areas of the brain.

Positron emission tomography (PET) is a procedure that shows changes in brain metabolism associated with seizures.

Single-photon emission computed tomography (SPECT) is a test that measures blood flow in the brain and how this flow changes with seizure activity.
center with integrated and well-coordinated testing and delivery of care. This unique organization enables very efficient and coordinated scheduling of various state-of-the-art studies that are part of the surgical evaluation.

Usually those who choose to proceed must wait several weeks before beginning the next phase. This allows ample opportunity to carefully consider the decision. It also gives your physician an opportunity to try other anticonvulsant medications. Depending on circumstances, urgent cases may proceed more rapidly.

**FUNCTIONAL TESTING**

Once a seizure focus is located, the next step is to identify regions of the brain responsible for movement, cognitive activity (thought processing), speech and memory functions. If none of these functions are controlled by the area where seizures begin, that focus can be safely removed. A variety of healthcare professionals will work in coordination to assess these areas. Your testing may include:

- **Intracarotid amobarbital/methohexital test** (Wada test) temporarily inactivates one brain hemisphere to permit testing of the opposite side of the brain for speech and memory functions. It helps to identify which hemisphere is responsible for these functions. This test is an invasive procedure performed by a neuroradiologist and an epileptologist.

- **Neuropsychological evaluation** is an extensive battery of IQ and memory tests designed to aid in localizing areas of impaired function in the brain. This information also can help to locate the seizure focus, provide a baseline evaluation of your cognitive function and, in some cases, determine risks for surgery.

- **Psychosocial evaluation** is a screening process that aids in identifying any pre-existing psychological or lifestyle disturbances that could interfere with your quality of life or the benefits of surgery. This evaluation also allows you and your doctor to set appropriate goals for the surgery.

**PATIENT MANAGEMENT CONFERENCE**

After the necessary tests are completed, your case will be presented at the Cleveland Clinic Epilepsy Center’s weekly Patient Management Conference. Here, a multidisciplinary group — including epileptologists, neurosurgeons, neuropsychologists, neuroradiologists, nuclear medicine physicians, a bio-ethicist, social workers and nurses — gathers to review and discuss all the data collected. If the data clearly shows a definite, localized seizure focus that can be removed without creating significant risk of loss of function, the decision to offer surgery can be made at this point.

Other professionals may be consulted to further assist with the surgical experience. Special Child Life workers help prepare children by explaining procedures and touring monitoring units and operating rooms before surgery. Social workers and bioethicists work closely with the epilepsy team to help resolve issues patients may have related to surgery.

**INVASIVE MONITORING**

In a small percentage of patients, testing to this point fails to definitively confirm a seizure focus. These patients may need additional continuous EEG monitoring, which involves surgery to temporarily implant electrodes on or within the brain. These electrodes provide even greater detail and more exact locations of seizure origins, as well as a more precise indication of the function of surrounding tissue, compared with standard and prolonged EEG testing with electrodes on the scalp.

Several types of electrodes can be used. Depth electrodes are thin wire electrodes placed within the brain to localize
seizures, or to determine in which half of the brain seizures originate.

Subdural electrode plates (also called strips or grids) are a grouping of 3-millimeter, flat electrodes embedded in paper-thin plastic that are placed directly on the brain surface. These electrodes, in addition to recording seizures, also can be used to stimulate areas of the brain to determine the functions these areas control (brain mapping).

After the electrodes have been implanted, you will be cared for in one of our intensive care areas overnight, and then you will be transferred to the monitoring unit the following day. After the procedure most patients feel fatigued for 24 to 48 hours and experience a headache that diminishes over the next four or five days. Anticonvulsant medications are discontinued. Once the necessary number of seizures are monitored, your medications will be restarted and the stimulation process will begin.

The stimulation process is painless. However, while it is being done, you may experience brief, temporary muscle twitches, tingling, minor distortion of your vision or hearing, or minor speech or memory difficulties. You will undergo a variety of simple tests (including reading, calculating and naming objects) while a mild electrical current is passed through the brain electrodes. The effect of this stimulation indicates whether a specific brain region is linked to a particular brain function. Results are charted on an anatomical brain map and compared with brain maps made during earlier studies showing where the seizure focus is located.

If invasive monitoring successfully identifies the origin of seizures and it is not in a functional area, surgical resection can be recommended. Removal of the seizure focus is often performed when the subdural electrodes are removed. Depth electrodes are removed following recording, and the resective surgery may be scheduled at a later date.

If you are among those for whom surgery is not recommended, you will continue on your medical regimen and the electrodes will be surgically removed. Don’t be discouraged! New, increasingly effective medications and surgical strategies are continually being developed.

SURGICAL RESECTIONS

Once a decision is made to recommend surgery, you and your family will meet with your surgeon to discuss all the details of surgery, including benefits and risks. This is the time to ask your surgeon any questions about the surgery. Surgery will be scheduled through our neurosurgery scheduler.

Immediately prior to surgery, routine preoperative testing is required. This includes laboratory testing and an appointment with anesthesia. An additional MRI scan may be required the day prior to surgery for stereotactic localization used in surgery. External scalp markers called fiducials will be applied prior to the scan and will remain in place until you are asleep in surgery. Be sure to inform your doctor if you require sedation during the scan. Please make sure you shampoo your hair the night before or the morning of the scan, as you will not be able to wash it once the markers are applied. This test will be booked with the other preoperative testing.

Various seizure disorders require different surgical procedures and different forms of anesthesia. Your surgeon will discuss this in detail with you; however, the following overview of the types of surgery may be helpful.

LOBECTOMY

The brain has several areas known as lobes — the temporal, frontal, parietal and occipital lobes — and seizures may originate in any of these areas. A lobectomy is an operation to remove part or all of a lobe. Generally, seizures that originate in either of the two temporal lobes (one on each side of the head, just above each ear) are complex partial seizures. Anterior (front) and mesial (deep middle) temporal lobe resections are the most common of all epilepsy surgical procedures.

Operations to remove sections of other lobes are also possible, providing tests show that no vital functions are controlled by these areas.

LESIONECTOMY

A lesionectomy is performed to remove isolated lesions, such as tumors or congenital malformations of blood vessels in the brain that have been identified as the primary seizure focus.
State-of-the-art stereotactic (three-dimensional) imaging and surgical localization techniques are often used to further aid the surgeon in defining the specific area to be resected and can help limit the size of the incision required for the resection.

An awake craniotomy is performed when speech, motor control and/or vision centers of the brain are adjacent to the area of resection. This type of surgery is performed with local anesthesia and short-term anesthetic agents. The anesthesiologist tightly controls the patient’s level of consciousness throughout the case. Heavy sedation required for making the incision is lightened to allow speech testing by the epileptologist as the neurosurgeon applies low-voltage electrical current to stimulate areas of the brain. Functional areas are mapped and avoided when the epileptic focus is resected.

HEMISPHERECTOMY

In rare instances, a child may have severe, uncontrollable, incapacitating seizures coupled with weakness or paralysis of one side of the body. This typically results from damage to the brain caused by an underlying disease. For such patients, a hemispherectomy may be considered. There are several types of hemispherectomies:

Functional hemispherectomy involves removing a portion of the brain’s hemisphere. The remaining tissue and fibers that communicate with the other side of the brain are disconnected.

Anatomic hemispherectomy involves removing the entire half of the brain, including the frontal, parietal, temporal and occipital lobes. Deeper brain structures, such as the basal ganglia and thalamus, are left in place.

Peri-insular hemispherectomy involves disconnecting certain fibers, interrupting the communication network of the affected brain hemisphere.

Based on the underlying cause of a patient’s epilepsy, our epilepsy neurosurgeons will recommend which procedure is the most optimal treatment option.

In many cases, following the surgery, the other side of a person’s brain takes over many of the functions that were previously controlled by the side that was removed or disconnected.

CORPUS CALLOSOTOMY

This surgery may be warranted if seizures are disabling, if they cause dangerous and frequent falls, or if they are intractable, generalized (grand mal) seizures that begin on one side of the brain and spread quickly to the other. In this procedure, nerve fibers connecting the two halves of the brain are severed, interrupting the spread of seizures. The surgery may be performed in several stages. Though seizures generally do not stop entirely with this surgery, they usually become less severe.

AFTER SURGERY

After surgery, you will be cared for overnight in one of our specialized care areas. This overnight stay will be followed by a hospital stay of two to five days, depending on the type of surgery you received. We encourage patients to get up the day after surgery and to begin walking with assistance. The dressing over your incision will be removed before you go home.

It is normal to be uncomfortable right after surgery, but pain medication helps to minimize the discomfort. Nurses will administer this medication only when you ask for it to prevent over-sedation. Ice may be applied for short periods to decrease swelling and help control discomfort. Swelling along the incision line is common. Likewise, a modest amount of fluid may collect under the wound flap and will be reabsorbed over the first several weeks of recovery. Sleeping with your head elevated on several pillows and being as active as possible during the day will minimize the swelling.

One year after epilepsy surgery, 80 percent of Cleveland Clinic patients who have undergone temporal lobe resection (removal of tissue), the most common type of epilepsy surgery, continue to be seizure-free.
After surgery, you will need to continue anticonvulsant medication. If you remain seizure-free over an extended period, your neurologist may gradually reduce or even eliminate anticonvulsants, although this is rarely done. It is important to note isolated seizures may occur immediately following surgery. It is also essential to stay in contact with your epileptologist or neurologist to monitor seizure activity and anticonvulsant doses.

Some patients may experience increased feelings of anxiety or depression following surgery. If you have a history of mental illness, it is imperative to follow up with your mental health-care provider for evaluation and treatment if symptoms recur.

Most patients are ready to resume many routine activities, with some restrictions, by the time they go home. Sutures are removed 10 to 14 days following the surgery. This can be done by a neurosurgical nurse clinician at Cleveland Clinic or by your local medical doctor. Once home, however, patients should not be left alone during the first several weeks after surgery. Work or school activities are generally restricted for a minimum of six weeks following surgery, or until your first post-operative checkup. Your doctor will provide you with detailed instructions.

Feel free to contact your epileptologist with any medical questions and your surgeon about any questions relating to your incision or recovery.

**FOLLOW-UP VISITS**

Six weeks after surgery, you will see your neurologist or epileptologist and surgeon, as well as have blood work done. Six months after surgery, a more extensive battery of tests is administered, including those measuring intellectual and psychological functions (neuropsychological testing), an MRI scan and a routine EEG. These tests are scheduled by the Epilepsy Center.

**SUPPORT SERVICES**

We recognize the concerns of epilepsy patients are not totally resolved with good medical management or successful surgery alone. Your psychological, social and emotional needs also are very important. Epilepsy Center nurse specialists, physicians and other team members — neurologists, psychologists, child life specialists, social workers,
The Cleveland Clinic Epilepsy Center is committed to delivering world-class care for patients with epilepsy by providing excellent clinical management and the use of state-of-the-art diagnostic and therapeutic techniques and approaches. We perform clinical and translational research to improve the knowledge and treatment of epilepsy, and strive to train world-class academic epileptologists and clinical neurophysiologists.

INSURANCE

Before beginning the evaluation process, we recommend you speak to your insurance company representative to determine your coverage and any financial responsibilities you may have.

APPOINTMENTS

We encourage you to see your neurologist or epileptologist at the Epilepsy Center or your local doctor on a regular basis. Often the two will work together in caring for you.

To schedule appointment an with a Cleveland Clinic Epilepsy Center specialist, please call 866.588.2264. For more information please visit our Web site at clevelandclinic.org/epilepsy.

RESEARCH

At Cleveland Clinic, we are continually developing new methods to diagnose and treat epilepsy. During your evaluation, you may be asked to participate in a research study. Your participation is completely voluntary. Your medical care will not be affected based on whether or not you choose to participate.

SPECIAL ASSISTANCE FOR OUT-OF-STATE PATIENTS

Cleveland Clinic’s Global Patient Services has a Medical Concierge program that is a complimentary service for patients who travel to Cleveland Clinic from outside Ohio. Our patient care representatives facilitate and coordinate the scheduling of multiple medical appointments; provide access to discounts on airline tickets and hotels, when available; make reservations for hotel or housing accommodations; and arrange leisure activities. For more information, call 800.223.2273, ext. 5580, visit clevelandclinic.org/services or email medicalconcierge@ccf.org.
Cleveland Clinic

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Cleveland Clinic is a nonprofit multispecialty academic medical center. Founded in 1921, it is dedicated to providing quality specialized care and includes an outpatient clinic, a hospital with more than 1,000 staffed beds, an education institute and a research institute.

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