Diagnosing and Treating Temporal Lobe Epilepsy: A Case Study

Abstract

Epilepsy is a neurological disorder that affects approximately 70 million people worldwide. There are several types and sub-types of epilepsy, with Temporal Lobe Epilepsy being the most common. Temporal Lobe Epilepsy is often amendable with Anti-epileptic Drugs. When these drugs do not work, surgery may alleviate seizures. In this paper 2 case studies are addressed involving patients who both have Temporal Lobe Epilepsy. They were diagnosed using several different imaging modalities and other tests. These tests and imaging modalities were also used in the surgical mapping and treatment plan for these patients. This paper will also discuss diagnostic tools and treatments for Temporal lobe epilepsy including electroencephalography, intracarotid sodium amobarbital, functional magnetic resonance imaging, and magnetic resonance imaging.

Introduction

Epilepsy is a common neurological disorder that affects about 1% of the general population. Temporal Lobe Epilepsy (TLE) is the most common type of epilepsy.¹ TLE was first recognized by John Hughlings Jackson in 1881. He described epilepsy as “uncinate fits, seizures arising from the uncal part of the temporal lobe and the ‘dreamy state.’”² In 1985, the International League Against Epilepsy (ILAE) defined TLE as a condition characterized by recurrent, unprovoked seizures originating from the medial or lateral temporal lobe. Seizures are characterized as either simple or complex. In a simple seizure there is no alteration of consciousness, versus a complex seizure where there is some alteration of consciousness. The ILAE divides TLE into three etiologies; cryptogenic, idiopathic, and symptomatic.²

There are various signs and symptoms that can help physicians diagnose TLE. The most obvious sign is of course a seizure; however, there are several more subtle signs. Some include memory loss, visual illusions and hallucinations, migraines, changes in heart rate, fear and anxiety, and dislocation. Physicians can use these symptoms along with a detailed personal and family medical history to help them diagnose patients, but the most helpful tools in diagnosing TLE patients are the different tests and imaging modalities that are used today. These tests
include, but are not limited to, electroencephalography (EEG), the intracarotid sodium amobarbital (WADA) test, functional Magnetic Resonance Imaging (fMRI) and Magnetic Resonance Imaging (MRI). These are the tests and procedures that are most often used to diagnose TLE patients and are also used to help determine surgical candidacy. Anti-epileptic Drugs (AEDs) are the first step in treating patients with TLE. AED’s are successful in about 2/3 of cases. The other 1/3 are either refractory to AEDs or have developed some sort of resistance or tolerance to the drugs. When treatment and medication do not work properly to control symptoms, surgery may help to dissipate seizures. Of the patients who have undergone surgery, 50-70% of them are now seizure free. Of the numerous tests done to determine if surgery is going to be helpful for the patient’s prognosis, many experts contest that MRI and fMRI is superior to the WADA test and the electrocortical stimulation mapping when it comes to lateralization and localization of epileptic zones.

**Electroencephalograms (EEG)**

Using EEGs for cerebral lateralization has been a paramount advancement in the diagnosis of epilepsy. EEGs help to visualize the neural networks of epileptonic regions or zones of the brain. These are essential tests performed in the initial patient evaluation. Due to its noninvasive nature and convenience, EEGs are often performed as an outpatient procedure. As stated by Mansouri et al, “scalp EEG analysis is an invariable test performed at all comprehensive epileptic centers. By detecting ictal and inter-ictal epileptic discharges, it enables an approximate delineation of the ictal onset and the irritative zones.” Prior to the era of sophisticated MRI machines Josephson and Eden state that EEG’s clinical usefulness and ability to classify and localize the epileptic zones of TLE surpass that of MRI. Their study was done from 1994-1996 and their findings state that MRI classified only 47% of TLE patients, while EEGs classified 77% of TLE patients, and 81% were classified with the use of both. They also mentioned that their low yield may have been improved by the use of modern MRI which was not available during the study period.

**Intracarotid Sodium Amobarbital (WADA)**

The intracarotid sodium amobarbital procedure is an invasive test used for the lateralization of the functional regions of the brain. The WADA test is done by injecting
medication into the internal carotid artery which temporarily renders the hemisphere ipsilateral to the injection site anaesthetized. While this hemisphere is paralyzed the memory and language functions of the hemisphere contralateral to the injection site can be tested. The test involves a series of tasks that the patient undergoes involving counting numbers, responding to verbal commands, naming months of the year, and other language paradigms. When a patient’s score from a WADA test is considered passing it is associated with a decreased likelihood of postoperative amnesia. As described by Mansouri et al, this test is also very helpful in lateralizing the epileptic zones in TLE patients. Wang et al states “although the WADA test has long been considered as the gold standard in preoperative language and memory testing, the test has several drawbacks since it is highly invasive and quite uncomfortable for most patients, and there is a small risk for morbidity.” (p.3) Figure 1 shows an axial T2 MRI image of a patient having a right middle cerebral artery stroke during a WADA test. This extreme side effect is rare and only occurs about 0.5-1% of the time. Other risks associated with the WADA test include seizures, contrast allergy, catheter site hematoma, dissection, stroke, and infection. Even with all of these contraindications to the WADA test it is still widely used and accepted in the medical community.1,4

fMRI and MRI

MRI has been established as the key imaging modality of choice, and has significantly aided in the diagnosis and treatment of TLE. Mansouri et al states that “if epilepsy is suspected, imaging protocol should include whole head thin sectioned high-resolution 3D T1 and T2 weighted images as well as gradient echo T2 sequence to investigate the presence of blood products.” Physicians’ prefer that these highly sensitive studies be done using a 3 tesla MRI machine. MRI is used with other diagnostic modalities to help localize the epileptogenic zones. If AEDs do not extinguish the symptoms of TLE, properly identifying these zones will aid in the surgical process. Sophisticated imaging is crucial to correctly identify TLE and other pathologies. Computed Tomography scans were used prior to the MRI era and only detected abnormalities in about 10% of patients suspected of having epilepsy.

fMRI is a high quality, non-invasive imaging technique that is used for the lateralization and localization of language and motor areas of the brain in TLE patients (see Figure 2). Due to
the non-invasiveness and superb image quality of fMRI it is replacing several other invasive tests such as the WADA test, and electrocortical stimulation in many clinical sites worldwide.\(^1\) With ever evolving software and specific algorithms, fMRI is well on its way to becoming a standard component of pre-surgical evaluations on TLE patients.\(^4\)

MRI and fMRI are great tools used for the lateralization and localization of epileptic zones in TLE patients. These modalities also help in determining surgical candidacy and can pinpoint specific areas where lobectomies and surgical resections need to be performed.\(^4\) However, MRI and fMRI do have disadvantages. The main drawback is patient motion. Patient motion can produce false positives and incorrect information. Motion can range from gross head movement to the minimal brain motion involved in the cardiac and respiratory cycles. Because the patient must lie motionless for the duration of the scan, MRIs can be difficult for children or the mentally disabled.\(^1,4\)

**AEDs**

There are numerous different AEDs available today and there is no specific formula used to choose which seizure medication to use for a particular patient. All people are different and each patient’s treatment needs to be tailored specifically to them. No one medicine dominates for effectiveness, and they all have various side effects. Several factors contribute to the decision of which AED to use. Some of these factors include which side effects to be avoided, convenience of use, cost, and physician experience. It is important to remember that AEDs are not a cure for epilepsy they just suppress seizures while the medication is in the body. Some of the most commonly used AEDs include Depakote, Dilantin, Lamictal, Tegretol, Tomamax, Trileptal, Zonegran, Neurontin, Keppra, Lyrica, Klonopin, Banzel, and Sebril. Klonopin is a member of the drug class known as benzodiazepines. Klonopin is a commonly used drug to treat seizure disorders and panic disorders. It is also used as a sedative, a muscle relaxer, and a tranquilizer.\(^6\) The precise mechanism by which clonazepam exerts its anti-seizure effects is unknown, although it is believed to be related to its ability to enhance the activity of gamma amino butyric acid, which is the major inhibitory neurotransmitter in the central nervous system. Klonopin can be used on its own to prevent seizures but is most often used with other AEDs.\(^6\)

Most AEDs are started with low doses and are gradually increased to minimize side effects. The low doses are not effective in treating seizures, however, the body needs time to get
accustom to the new drugs before moving to higher effective doses. Some of the most common and most worrisome side effects include fatigue, dizziness, unsteadiness, blurry vision, upset stomach, headache, reduced immune system, weight loss and weight gain per medication, thinking and memory problems. All AEDs can cause problems such as low blood counts, damage to the liver, and damage to other internal organs.\(^6\)

Josephson and Eden\(^5\) reported on a study done in Victoria, Australia regarding TLE patients. The study proclaimed that 31% of the individuals were able to achieve up to 2 years free of seizures using AEDs, while the other 69% continued to suffer from seizures. The study lasted for 4 years. All of the patients who were still taking the AEDs and had not undergone surgery were still experiencing seizures. The studies emphasize that the drugs fail more often than not in the prognosis for the patients. AEDs are a possible treatment option for those suffering from TLE however AED’s only work about 2/3 of the time. The other 1/3 of patients are either refractory to AEDs or have developed a tolerance to the drugs. These patients and their physicians must seek seizure relief elsewhere. Most of the time surgery is an appropriate option however, surgery is a very serious decision and all aspects of the patient’s health need to be assessed.\(^5\)

**Case Study**

Ms. X is a 34-year-old woman who suffers from TLE. She had her first convulsive seizure at the age of 27, although her medical history reports that she has had numerous simple partial seizures without the loss of awareness for several years prior to that. These seizures were visualized and confirmed on an EEG. After conformation on the EEG, Ms. X was placed on AEDs, 400mg of carbamazepine per day. This rendered her seizure free for approximately 7 years until she again suffered from complex convulsive seizures. Her dose was doubled to 800mg per day which did not fully extinguish the seizures. She reported having about 6-7 complex partial seizures a month. Some of the symptoms leading up to the seizures were; a blank stare, nausea, a funny feeling up and down her spine, poor memory, blunted emotions, and lip smacking. Ms. X was admitted to an Epilepsy Monitoring Unit (EMU) where 7 seizures were visualized and documented, all of which came from the temporal lobe. EEG, MRI, and neuropsychological tests confirmed the origin of the seizures which were onset in the right temporal lobe. A right selective amygdalohippocampectomy was recommended and carried out.
with no complications. A follow up on Ms. X was conducted 6 months after the operation and she reported being seizure free. She continues her AEDs and has noted significant improvement in memory, concentration, and life altogether.\(^4\)

Mr. Z is a 28-year-old man who has been suffering from TLE since the age of 10. He was first seen at the age of 22 for evaluation of his long standing seizure disorder. Mr. Z has been tormented with complex partial seizures for the better part of 18 years. These seizures were described as disorientation, twitching, convolutions, lip smacking, and difficulties with speech. He also described auras of epigastric discomfort and fear. These fits usually lasted about 2-3 minutes. He was prescribed 3 different types of AEDs all of which were unsuccessful. Previous MRI of the brain with supplementary detailed views of the temporal lobes was normal. He was admitted to the EMU for EEG scalp monitoring. The EEG revealed interictal slow wave activity localizing to the left temporal lobe. The ictal activity always began on the left side starting anteriorly and proceeding posteriorly; fMRI revealed left hemispheric language dominance. Subsequent monitoring in the EMU demonstrated the middle temporal subdural strip electrode to be most epileptogenic. An additional MRI was done and correlated with these results. Surgical resection was successfully completed with the guidance of language mapping, images from MRI and fMRI, and electrocorticography. At a 2 year post-operative follow up, Mr. Z was seizure free and still continues 400mg of topiramate per day. He only complains of a few side effects which are poor memory, difficulty finding words, and reading difficulties. However, he says that he does not let these side effects interfere with his daily life and he has been able to maintain a full time job.\(^4\)

Ms. X and Mr. Z were both able to achieve seizure freedom with the help of specific surgical resection of the brain. They both went through similar processes that led up to surgery. Ms. X and Mr. Z both tried AEDs that didn’t fully control their symptoms. They both had MRIs, EEGs, and when their conditions were bad enough they were placed in the EMU to fully recognize the extent and location of the epileptic zones. After surgery they only complained about minimal symptoms and most importantly, they were seizure free. Also they both continued to take their AED’s after the surgery as an extra precaution.

**Surgery**

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Epilepsy surgery is a highly successful treatment option for patients who are refractory to AEDs. Helmstaedter\textsuperscript{7} reported on a study where 58\% of the patients who had surgery were seizure free and only 8\% of the medically treated patients were seizure free. Seizure freedom is the ultimate goal of epilepsy surgery.\textsuperscript{7} Several studies suggest that 60-80\% of patients who have undergone surgery are now seizure free.\textsuperscript{2} Successful seizure control significantly reduces behavioral and mood problems and improves overall quality of life. However, seizure control aside, brain surgery can have detrimental effects on cognition, memory, behavior, and language skills. The most commonly affected cognitive domains in TLE patients are verbal and figural memory, as well as language, attention, and motor functions.\textsuperscript{7}

There are considerable differences in impairments in right versus left sided brain surgery. Patients who undergo left sided surgery have more side effects that diminish their language functions as compared to patients who have right sided surgery. While in some cases, after undergoing right sided surgery language functions tend to improve. In a study which included 193 TLE patients, baseline recordings of the patient’s cognitive, verbal, memory, and speech skills were recorded. After the surgeries there was a 44\% decline in verbal memory in left sided patients, compared to a 20\% decline in right sided patients. The gains in verbal memory were only 7\% in left sided patients versus a 14\% gain in right sided patients. The average decline in language naming was 34\%. Overall patients with left sided temporal surgery had an increased risk of cognitive decline in memory and language functions.\textsuperscript{7}

Two major factors determine the cognitive outcome of temporal lobe epilepsy surgery. First, is the functionality of the epileptic areas of the brain that are to be removed. Second, is the functionality of the brain areas that are not affected by epilepsy, as well as the parts of the brain that are not affected by the surgery. These areas of the brain are referred to as the mental reserve. These areas of the brain help compensate for the defects of the resected portion. The reserve capacity and the functionality of the brain greatly depend on the patient’s age at the time of the surgery. The most opportune time to do the surgery is after puberty, and before the age of 30. This is because after the age of 30 the brain’s capabilities for comprehension and reserve capacities start to decline. One of the main objectives in epilepsy surgeries is to remove only what is necessary to control seizures, and leave as much functional brain tissue as possible in order to maintain the patient’s cognitive functions. This is why selective surgery is preferred to
total lobectomies. Selective surgeries often leave more brain tissue than total lobectomies which gives the patient a better quality of life.

Looking back at the case studies involving Ms. X and Mr. Z, Ms. X had right sided surgery, and she did not complain about any side effects after the surgery. She experienced improvement in memory and concentration. Mr. Z, had left sided surgery, and experienced problems with memory, reading, and the ability to recall words. This is just one example, but it does show that in this case that right sided surgery had fewer side effects than left sided surgery.

Conclusion

TLE is the most common type of epilepsy that is diagnosed and treated in a clinical setting. There are many tests used to diagnose and treat TLE. EEGs have been used for a great length of time and are still very important for diagnosing and locating epileptic zones. Before there were advanced imaging technologies, EEGs were the main diagnostic tool in epilepsy treatment. The WADA test was considered to be the “gold standard” in postoperative memory and language testing just years ago. However, the WADA test is highly invasive and there are several complications that accompany it. Furthermore, fMRI is a high quality, noninvasive imaging technique that is used for the lateralization and localization of epileptic zones. fMRI is replacing many other more invasive techniques that were used to locate epileptic zones. MRI has been established as the primary imaging modality of choice for TLE. Due to its incredible detail, MRI and fMRI are essential for diagnosing and for surgical mapping in TLE patients. AEDs are usually used first to try to suppress seizures. However about 20-30% of patients are refractory to AEDs and surgery could be the only means of seizure relief. Surgery is done as a last resort. TLE is the most common epilepsy syndrome that is responsive to surgical treatment. Surgery is effective at eliminating seizures about 60-80% of the time. There are several side effects that accompany surgery and all aspects of the patient’s health need to be taken into consideration before surgery takes place. Patients who qualify and undergo surgery may benefit from improved psychosocial function, long term seizure freedom, a greater degree of independence, and also have significant monetary savings.
References


Figures and Captions

Figure 1. Images of a TLE patient who experienced a stroke in the right middle cerebral artery territory secondary to a traumatic dissection of the right internal carotid artery during the sodium amobarbital testing. Images courtesy of: Wang A, Peters TM, de Ribaupierre S, Mirsattari SM. Functional magnetic resonance imaging for language mapping in temporal lobe epilepsy. Epilepsy Res Treat. 2012;2012:198183.