Neuromodulation

Epilepsy Review

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There have been so many advances in the treatment of epilepsy in the last 10 years. We have new medications with novel mechanisms of action. We also have new devices that serve as *Neurostimulation* or *Neuromodulation* in epilepsy. With new devices coming out, this topic can become quite complicated. I would like to provide a simple review of three forms of FDA approved neuromodulation for epilepsy: vagus nerve stimulation, responsive neurostimulation and deep brain stimulation.

First, it is important to understand that, although neurostimulation devices can reduce the number of seizures a person experiences, they are significantly less likely to stop seizures completely. In patients with drug resistant epilepsy (those who continue to have seizures despite trying 2-3 appropriate seizure medications), removal of the region of the brain that produces the seizures, after a thorough pre-surgical evaluation at a comprehensive epilepsy center, is typically the surgery that has the most effectiveness in this regard.

The pre-surgical evaluation consists of a variety of tests such as video EEG monitoring, epilepsy protocol MRI of the brain, PET scan, neuropsychological testing and others. These tests can help determine what the most appropriate surgical treatment options are for a given patient. Some patients are not candidates for removal of the brain region that produces seizures. This could be due to multiple areas on both sides of the brain being identified as the culprit or due to seizures arising from vital regions of the brain (speech and movement, for example). This is where neurostimulation can serve as a great treatment option.

The most recent type of stimulator device to be FDA approved is deep brain stimulation (DBS) for epilepsy. In 2018, it was FDA approved for adults who have drug resistant focal epilepsy. It consists of two electrodes being inserted into the right and left thalami (one on each side) via two small skull openings on top of the head and with stereotactic guidance. These specifically go into the anterior nucleus of the thalamus while the person is under general anesthesia. The generator is placed under the chest. The device is overall well tolerated. In the pivotal study, side effects included brain bleed that caused no disability, infection of the device, depression and memory complaints. At one year, there was a median reduction in seizures of 40%; this has increased to about 70% at 6 years.

Another type of device is responsive neurostimulation (RNS). It was FDA approved in 2013 for adults who have drug resistant focal epilepsy. The RNS device consists of 1-2 electrodes that are placed in the brain at the region/s where seizures originate. There is also a generator that is implanted within the skull. The electrodes record the brain activity. When the device senses the very beginning of a seizure, it sends an electrical impulse. In the first few months after implantation, the epileptologist works to identify the pattern that should result in a stimulation. The strength of the stimulation is also gradually increased. The device is overall well tolerated.

In the pivotal study, side effects included brain bleed and infection. At one year, there was a median reduction in seizures of 44%; this increased to about 66% at 6 years.

Finally, the vagus nerve stimulator (VNS) is the neurostimulation device that has been available the longest. It was FDA approved in 1997. This is the only procedure that is done on an outpatient basis; the patient goes home the same day. Like the DBS, the generator for the VNS is in the chest area. Unlike the DBS and RNS, the VNS requires no brain surgery. The leads (or electrodes) go from the generator into the neck and connect to the left vagus nerve. At the first clinic visit, the physician turns on the device at a low current. There are multiple visits that occur in the initial weeks/months to increase the stimulation to the desired, tolerated and effective settings. VNS is well tolerated. The most common side effect is hoarseness. Cough can also occur. Surgical risks include device infection. In the initial studies, 37% of patients had at least a 50% reduction in their seizures at one year. This increased to 43% of patients at 3 years.

In conclusion, patients with epilepsy now have more treatment options available than we've ever had to offer. Neurostimulation is a growing field in epilepsy. In general, all three devices (DBS, RNS, VNS) seem to work better with time. There is a greater reduction in seizures several years after placement when compared to the first year. In my opinion, the most important factor in deciding which is the best surgical option for you is to get as much information about your epilepsy as possible and have a thorough evaluation at a Comprehensive Epilepsy Center.

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