Surgical Management of Drug-Resistant Epilepsy

Epileptologists from the departments of Neurosurgery and Neurology at Penn Medicine have recently introduced a collection of innovative technologies to better treat patients with drug-resistant epilepsy (defined as having seizures refractory to two or more seizure medications).

Medications can control seizures in about two-thirds of persons with epilepsy. The approximate one-third of patients with drug-resistant epilepsy experience a significant impact on quality of life, elevated risk of injury and increased risk of sudden unexpected death.

For patients with drug-resistant epilepsy, the options available at Penn Medicine include resective surgery and vagus nerve stimulation (VNS), as well as newer approaches. Surgery has the potential to cure or decrease seizure frequency when an epileptogenic focus can be identified. Intracranial EEG evaluations are often performed to identify seizure foci prior to resection. Vagus nerve stimulation is an option for patients who are not resective surgical candidates. VNS reduces the frequency and intensity of seizures, but is not curative.

The new technologies available to treat patients with refractory epilepsy at Penn Medicine include Visualase® MRI-Guided Laser Ablation and the NeuroPace RNS® System. Penn neurosurgeons and neurologists have collaborated to introduce these advanced modalities, which can better identify the source of seizures and treat or prevent seizures in patients with drug-resistant epilepsy.

Visualase MRI-Guided Laser Ablation Technology

Visualase laser ablation is a technology that combines a saline-cooled 15 watt, 980-diode laser probe (<2 mm diameter) with real-time MRI-guidance to induce interstitial thermal ablation of targeted lesions in the brain (Fig. 1). Pre-treatment images are acquired for target planning and an intraoperative temperature map is used to minimize damage to healthy tissue. Open surgery is not required. Patients may be awake during therapy and are usually discharged the next day.

Neuropace RNS System

The Neuropace RNS System is a programmable responsive neurostimulation system designed to detect and treat abnormal electrical activity in the brain. The System employs brief bursts of electrostimulation from an RNS neurostimulator implanted in the cranium to abort pre-seizure EEG patterns programmed by physicians. In clinical trials, the median reduction in seizure frequency from 6 to 9 months after implant was ~30%, increasing to 39% at 12 months and 51% at 24 months with 8% of patients seizure free with the device.

Intracranial EEG (iEEG)

Structural MRI, fdg-PET and ictal scalp EEG recordings cannot identify the epileptic network in many refractory epilepsy patients having pre-surgical evaluation. For these patients, intracranial EEG (iEEG) hybrid depth and subdural grid and strip electrodes (Fig. 3) are required for long-term, high-resolution monitoring and mapping of the cortical surface. iEEG allows Penn clinicians to map the epileptic network and cortical function, making safe resective surgery with a goal of cure possible for many drug-resistant epilepsy patients.

Visualase®; 2015 Medtronic, Inc. Minneapolis, Minnesota.
Neuropace RNS® System; 2015 Neuropace, Inc. Mountain View, CA.
FACULTY TEAM
The Penn Epilepsy Center (PEC) is comprised of an interdisciplinary team of clinicians dedicated to advancing the fields of invasive neurophysiology, neuroimaging and neurosurgery for patients with epilepsy in all of its forms. The PEC offers state-of-the-art diagnostic techniques, medical treatments, surgery and support to patients with epilepsy.

Treating Epilepsy at Penn Medicine
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The Penn Epilepsy Center
The Penn Epilepsy Center offers a comprehensive, individualized evaluation and a wide variety of surgical treatments for patients whose epilepsy is difficult to manage. As a Level 4 epilepsy center, we have the expertise and facilities to provide the highest-level of medical and surgical evaluation and treatment for patients with epilepsy.

The Center offers comprehensive evaluation for people who have experienced:
- Long-standing seizures that are not adequately controlled
- One or more seizures
- Unacceptable side effects from epilepsy treatments
- Unusual events that a physician believes may have been seizures

Epilepsy Monitoring Unit
The Epilepsy Monitoring Unit features a modern eight-bed unit with video EEG for the evaluation of individuals who are candidates for surgery and for differential diagnosis of “spells.” Epilepsy patients are admitted for long-term monitoring (anywhere from 3 to 7 days) and are typically weaned from medications to determine the cause and origin of seizures. Some patients undergoing this treatment require intracranial electrode monitoring. A number of other diagnostic tools may also be used to locate the origin of the seizures, including MRI, MEG, EEG, SPECT and PET.