

Epilepsy Surgery

Matthew D. James and Adam C. Adler

A nine-month-old boy born at 39 weeks of gestation was noted to have “seizure like” activity at three weeks of age and was found to have a hypothalamic hamartoma.

His current vital signs are: blood pressure 90/52 mmHg; heart rate 116/min; respiratory rate 24; SpO₂ 100% on room air. Weight is 8.6 kg. The patient is taking levetiracetam.

What Is the Incidence of Seizures in the Pediatric Population?

In 2015, 1.2% of the total US population had active epilepsy; this includes about 470,000 children. About 0.6% of children aged 0–17 years have active epilepsy, such that an elementary school with 500 students would have 3 children with epilepsy.

What Are the Treatment Options for Subcortical Epilepsy?

Treatment includes medical therapy and is usually the first option including: antiepilepsy drugs (AEDs), and maintenance of a ketogenic diet. Surgical options vary greatly from implantation of a vagal nerve stimulator to gamma knife radiosurgery, stereotactic thermocoagulation (radiofrequency or laser, with or without MR thermography), transcallosal interforaminal resection, transventricular endoscopic resection, or pterional (orbitozygomatic) resection.

What Is the Incidence of Hypothalamic Hamartoma?

Hypothalamic hamartomas (HH) are relatively rare. HH with epilepsy occurs in 1 of 200,000 children. A small number of patients with HH only have precocious puberty and are much less likely to have cognitive disabilities. Males appear to have a slightly higher risk than females (approximately 1.3:1) for HH

with epilepsy. There are no identified maternal risk factors for developing HH, and there are no known geographical or ethnic concentrations.

How Is a Ketogenic Diet Employed in Epilepsy Patients?

Originally developed in the 1920s for control of seizures prior to development of AEDs, the ketogenic diet has made a resurgence when seizures are refractory to medical treatment. It consists of a high fat and low protein and carbohydrate diet to produce ketosis. The mechanism of action in treating seizures is highly multifactorial but centers around reduced neuronal firing and activation and can have a profound effect on seizure frequency.

What Is a Vagal Nerve Stimulator?

Vagal nerve stimulators (VNS) have been used as an adjunct to treat intractable epilepsy in children. The exact mechanism of action remains unknown but may be related to changes in regional blood flow during stimulation. Most vagal nerve stimulators are MRI compatible and each institution should have protocols involving the pre- and postinterrogation of these devices in relation to the MRI. At Texas Children's Hospital, the VNS is turned off immediately prior to the MRI and restarted on completion of the scan.

Who Is a Candidate for Laser Ablation?

Any patient with medically refractory epilepsy and MRI discrete lesions like an HH is a candidate for laser ablation therapy.

What Are the Major Anesthetic Considerations for Laser Ablation Procedures?

Most of the anesthetic considerations for seizure ablation surgery have to do with the intraoperative

imaging. If intraoperative MRI is not available then there are major considerations with respect to both transporting the patient, and the time spent in the remote location. Depending on your facility, transportation may be required from the OR to CT and MRI. The MRI metal screening sheet should be completed by the parents prior to the procedure. Neuromuscular blockade is requested throughout because of the stereotactic nature of the procedure. Intravenous steroids are requested to treat expected swelling of the treated and surrounding tissues; usually a single dose of dexamethasone is given at the initiation of ablation.

Do Laser Ablation Cases Require Intraoperative Neuromonitoring?

Because of technologic limitations, as of 2018, a total intravenous anesthetic (TIVA) is not required. But in the near future there may be MR-compatible tools for intraoperative neuromonitoring.

What Are the Considerations Involved with Transporting a Patient Between Surgery and MRI?

Patients often lose heat and may become hypothermic during transport outside of the OR and while in the MRI machine. Warm blankets and disposable gel heating pads should be applied just before leaving each location. If possible, an MRI-compatible stretcher should be brought to the OR to avoid additional patient transfers which may increase the likelihood for laser lead malposition.

Supplies, medications, and airway equipment should accompany these patients during transport.

TIVA should be started to assure continued anesthesia and amnesia during transport.

What Are the Possible Complications Involved with an Extended Anesthetic Taking Place in the MRI?

Temperature maintenance remains an important focus in this phase of the case. After the patient is positioned in the MRI the surgical team will discourage touching of the patient – including reapplying new blankets or wrapping of the extremities. The ablation may be affected if the patient's temperature changes significantly over the course of the time in

MRI if the degree of ablation is based on thermography. Inability to adjust the patient's position during the lengthy ablation may increase the risk of pressure ulcers and deep venous thrombosis. Careful padding when the patient is first placed into the scanner is important because repositioning may not be allowed for several hours.

What Are the Postoperative Considerations Following Ablation Surgery?

One of the major advantages of laser ablation over open surgery is a faster recovery. If the operation was uncomplicated then usually the patient can go to a regular inpatient floor. Occasionally, these patients may be discharged on postoperative day one. A postablation MRI scan is generally done to confirm absence of intracranial bleeding. If your MRI is at a site remote from the operating room, then there is always the question of whether or not to transport the patient back to the OR to manage the airway versus extubating in the MRI suite. The risks versus benefits of remote airway management must be considered.

What Is Electrocorticography (ECOG)?

Electrocorticography (ECOG) is a technique in which a grid is placed on the brain surface to allow for epileptic foci to be mapped for surgical excision.

What Are the Important Anesthetic Implications for ECOG?

Unless the grids are in place and the seizure foci have been well localized, all benzodiazepines should be avoided. If possible, propofol should be avoided in cases where seizures need to be stimulated. In cases where "light anesthesia" is required to stimulate seizure activity, patients should be well secured to avoid injury or dislodgement of tubes and lines.

Volatiles should be discontinued prior to electrocorticography.

Commonly, infusions of opioids and dexmedetomidine are used after pinning and exposure, during times of seizure stimulation. Ketamine may be added when required to enhance sedation and should be discussed with the surgeon and neuromonitoring staff when used.

When motor evoked potentials are not employed, muscle relaxation may be used. However, soft bite blocks such as rolled gauze should be carefully placed prior to any motor evoked potential to assure protection to the tongue and oral structures.

During surgical resection of the seizure focus, a volatile agent may be used; however, occasionally, the surgeon will perform a post resection ECOG, in which case TIVA should be resumed.

Suggested Reading

- Chui J, Manninen P, Valiante T, et al. The anesthetic considerations of intraoperative electrocorticography during epilepsy surgery. *Anesth Analg.* 2013;117(2):479–86. PMID: 23780418.
- Curry DJ, Gowda A, McNichols RJ, et al. MR-guided stereotactic laser ablation of epileptogenic foci in children. *Epilepsy Behav.* 2012;24(4):408–14. PMID: 22687387.
- Russ SA, Larson K, Halfon N. A national profile of childhood epilepsy and seizure disorder. *Pediatrics.* 2012;129:256–64. PMID: 22271699.
- Zack MM, Kobau R. National and state estimates of the numbers of adults and children with active epilepsy United States, 2015. *MMWR Morb Mortal Wkly Rep.* 2017;66(31):821–5. PMID: 28796763.