LASER INTERSTITIAL THERMAL THERAPY (LITT) PROCEDURE

Surgical Specialty:	Neurosurgery
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Background:

- General Considerations
  - Laser Interstitial Thermal Therapy (LITT) is a minimally invasive procedure that allows neurosurgeons to deliver targeted laser therapy to brain lesions. One or more probes are placed, then the tips are heated with simultaneous imaging to ensure precise tissue ablation. LITT is being used successfully in a variety of neurosurgical conditions, including brain lesions, metastases, intractable seizures, and radiation necrosis.[1]
  - LITT involves intraoperative placement of one or multiple fiberoptic probes under computed tomography (CT) guidance (Figures 1 and 2). The patient is then transported to magnetic resonance imaging (MRI) while under anesthesia, where probe placement is confirmed and fine adjustments made as needed (Figure 3). Laser ablation is completed under continuous MRI (Figure 4). After imaging, the neurosurgeon removes the probes and closes the incisions.
  - These procedures are sometimes staged, with an initial procedure to place the probes under general anesthesia, followed by a period of monitoring on an epilepsy monitoring floor or intensive care unit (ICU) to more accurately determine the seizure foci area. The child is then brought back to the operating room (OR) (usually within 3-10 days) for selective ablation and probe removal. In the staged approach, the child may be taken off anti-epileptics during the monitoring period to enhance the likelihood of capturing relevant seizures.

Figures:

Figure 1: Placement of catheter (Photo Credit: Joseph Sisk, MD, FAAP)

Figure 2: Catheter in place (Photo Credit: Joseph Sisk, MD, FAAP)

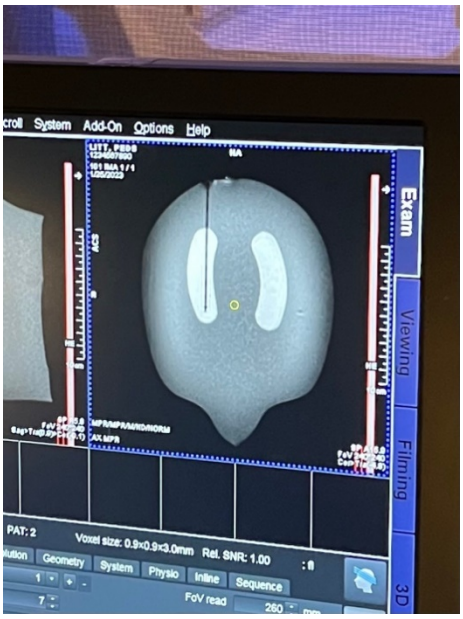

Figure 3: Pre-ablation MRI demonstrating catheter placement (Photo Credit: Joseph Sisk, MD, FAAP)

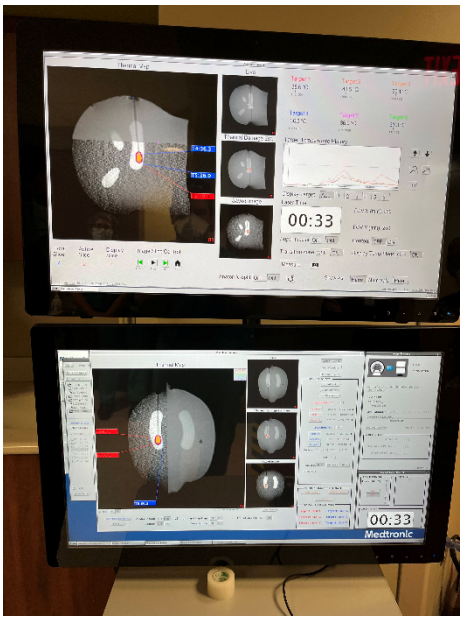

Figure 4: Thermal map demonstrating successful ablation(Photo Credit: Joseph Sisk, MD, FAAP)

- Patient Considerations
  - Disease Specific Considerations
    - LITT in the pediatric population is often performed for intractable seizures, but may also be performed for malignant brain lesions.
  - Associated Comorbidities/Syndromes
    - Intractable seizures are often associated with other syndromes such as cerebral palsy, Lennox-Gastaut syndrome, Rett syndrome, and more.
    - Malignant brain lesions may be primary or metastatic.

Anesthetic Planning:

- Pre-Anesthetic Evaluation
    - In addition to a standard preoperative evaluation, a focused neurological exam should be conducted.
    - Anti-epileptic medications are often prescribed and should be noted due to their possible interaction with neuromuscular blocking agents (shorter duration of effect).
    - High-dose steroids may already be prescribed and/or requested intraoperatively by the surgical team to reduce perilesional edema. A preoperative blood glucose check should be considered since intraoperative hyperglycemia may occur after steroid administration.[2]
- Specific or Unique Room Set-Up Requirements
    - Airway
        - Tracheal Intubation
    - Drugs/Infusions
        - The surgeon may request dexamethasone, anti-epileptics, and/or intracranial pressure (ICP) lowering agents such as mannitol.
        - Neuromuscular blockers should be utilized to ensure immobility
        - Propofol infusion for maintenance and transport
        - Consider using MRI-safe infusion pumps from the start, or bring IV tubing extensions for the MRI suite.
        - Consider having vasopressor and antihypertensive infusions available
    - Monitors
        - Standard American Society of Anesthesiologists monitors with MRI-compatible monitors for the MRI portion.
        - Arterial line placement is not routinely necessary
        - A Foley catheter should be placed due to the length of the procedure
            - Avoid temperature Foley catheters as they are MRI-incompatible
    - Blood Availability
        - Blood loss is typically minimal
    - PICU Bed Availability
        - Pediatric ICU admission may be needed for frequent neurochecks
    - Other Indicated Resources
        - Gather all materials & monitors needed to transport to the MRI under anesthesia.
            - If possible, transport on an MRI safe stretcher with an MRI safe oxygen tank to reduce transfers
        - The Operating room should be held for the entirety of the case, even while the patient is in the MRI.
            - Rarely, after initial MRI imaging, a significant adjustment to probe placement may be needed, requiring a return to the OR before completing ablation.
        - An MRI-compatible anesthesia machine with circuit extensions and emergency airway equipment (such as a video laryngoscope) should be checked and readily available outside the MRI Scanner
        - An area for emergence should be ready with an anesthesia machine. Often this is in an MRI induction bay, but the patient may also be transported back to the operating room for emergence.

Intraoperative Considerations:

- General
  - Consider avoiding anxiolytic premedication to avoid post-operative delirium and facilitate accurate neurological exams soon after emergence.
  - If ablation is being performed for epilepsy with monitoring of depth electrodes on the floor prior to ablation (staged procedure), it may be advisable to avoid medications that suppress seizure activity (benzodiazepines, propofol). In these cases, patients may be asked to discontinue their antiepileptic medications prior to surgery, and pre-operative/PACU staff should be aware of the increased risk of seizures in these patients.
- Induction
  - Induction and intubation may be accomplished using traditional methods
  - Access
    - At least two peripheral intravenous (IV) catheters should be obtained due to the length of the procedure and positioning requirements.
    - Consider lower-extremity access for ease of access during MRI.
    - Arterial line placement is typically unnecessary unless indicated by other patient factors.
  - Scalp blocks are helpful to reduce perioperative hemodynamic instability and provide postoperative pain relief.[3] Alternatively, local skin infiltration may be performed by the surgical team.
- Positioning
  - The patient will be turned 90° or 180°, and Mayfield pins will be applied for probe placement.
  - Once the probes are placed, head movement must be minimized.
  - In MRI, ensure all OR monitors and metal-containing materials are removed from the patient and providers who will enter the MRI suite.
    - Take care to remove the temperature probe, EKG pads, and pulse-oximetry sensor, as well as any other incompatible monitors or stickers.
  - In the OR and MRI, ensure proper padding to avoid pressure injury
- Maintenance
  - As with most neurosurgical procedures, a propofol infusion is frequently preferred to reduce ICP and cerebral metabolic oxygen demand while maintaining cerebral perfusion pressure (CPP). Volatile agents at high doses decrease CPP and increase ICP.[4]
    - A combination of propofol and volatile is often utilized with 0.5MAC of sevoflurane to ensure adequate depth of anesthesia while under paralysis. This approach leverages the neuroprotective benefits of propofol while minimizing the adverse effects of volatile agents.
  - Neuromuscular blockade is necessary throughout the procedure to prevent patient movement, which could dislodge the intracranial probes.
    - Children on anti-epileptic medications may require more frequent redosing of neuromuscular blockade, and train-of-four should be monitored throughout the procedure to ensure adequate paralysis while in pins/head frame.
- Hemodynamic/Physiologic goals
  - Efforts should be made to maintain cerebral perfusion pressure and avoid ICP elevation.
  - Hypertension should be avoided to reduce the risk of intracranial bleeding

- Surgical Considerations
    - Catheter placement is performed in the OR
        - Catheter placement is confirmed using intraoperative CT Scan prior to transport to MRI.
    - Numerous MRI scans will then be completed pre-, peri-, and post-thermal therapy.
    - Overall, MRI time varies substantially depending on the number of lesions
    - After ablation is completed, the patient is removed from the MRI and may be transported to a pre-designated area for emergence from anesthesia.
- Emergence/Disposition
    - Prioritize a quick, smooth emergence/extubation to facilitate an accurate postoperative neuro exam.
        - Consider dexmedetomidine infusion or bolus for smooth emergence
    - Typically, disposition is to PICU, but this varies by institution and neurosurgeon preference.[2]
- Post-op Care
    - Post-operative pain is usually minimal
    - Small risk of seizures or increased ICP requires close monitoring[1]

Case-Specific Complications/Pitfalls

- Probe placement is generally well tolerated, especially with local anesthetic infiltration, but, as with any neurosurgical procedure, brief hemodynamic instability due to tissue manipulation is possible.
- Probe dislodgement or fracture can be catastrophic and must be avoided.
    - Careful attention should be given at all times when transporting and repositioning the patients while the probes are in place.
- Post-ablation hemorrhage is rare but possible.
    - Urgent return to the OR for re-exploration may be needed if this occurs.
- Post-operative bucking and vomiting
    - If extensive, this can cause cerebral edema or intracranial hemorrhage.[5]
    - Prophylactic anti-emetics such as ondansetron should be used; however, limit the use of agents that may cause sedation, as this may interfere with post-op neuro exams.
- MRI-related burn and projectile injuries
    - Extreme vigilance must be used when transitioning into an MRI suite with an anesthetized patient.
    - Remove all metal-containing burn and projectile hazards. Some of which include non-MRI safe IV poles, oxygen tanks, stethoscopes, EKG pads, etc. Discuss with radiology staff if unsure about the MRI compatibility of specific items.

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