LASER INTERSTITIAL THERMAL THERAPY (LITT) FOR EPILEPSY

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JUNE 1, 2019

NEUROSURGICAL SOCIETY OF ALABAMA

DESTIN, FLORIDA

OVERVIEW

- Brief review of current epilepsy management and treatment
- Rationale for “minimally invasive” epilepsy surgery
- Overview of laser ablation
- Results
- Current uses

EPIDEMIOLOGY

- Incidence of epilepsy in US: 1.2% = 3.4 million people
- Refractory in ~1/3 of cases

Focal

- Mesial temporal lobe epilepsy (MTLE) - most common, 25% of cases
  - Unilateral
  - Bilateral
- Frontal
- Parietal
- Occipital
- Insular
- Cingulate
- Multi-focal

→ Several surgical options

→ Must localize seizure onset zone (SOZ)

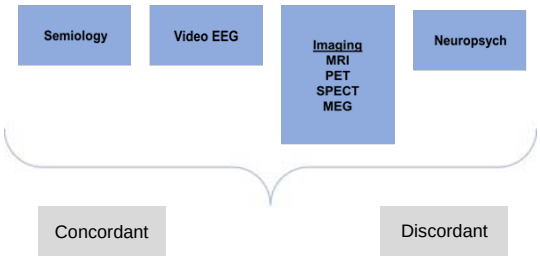
Diffuse

- Primary generalized
- Lennox-Gastaut
- West’s syndrome (infantile spasms)
- Juvenile myoclonic epilepsy
- Sturge-Weber
- Rasmussen’s encephalitis

→ Fewer options

→ VNS, disconnection

FOCAL EPILEPSY



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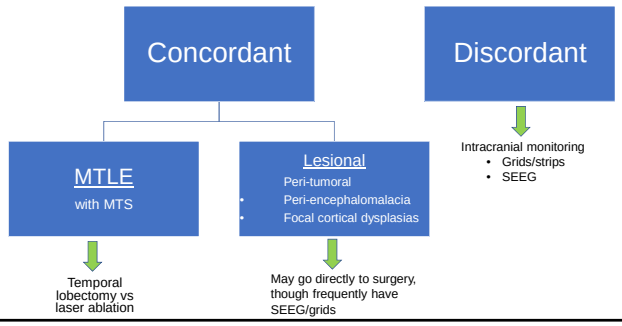
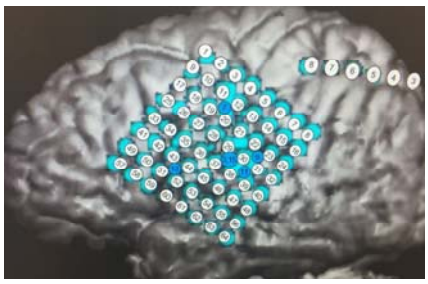
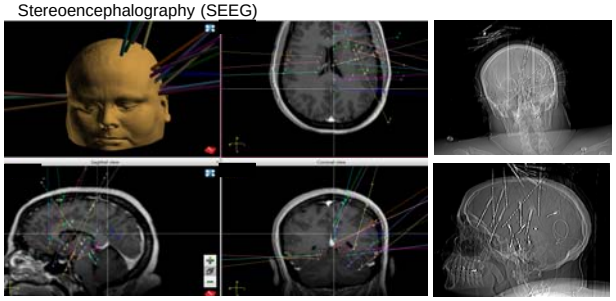
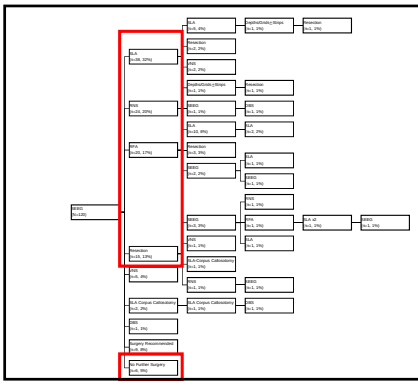




INTRACRANIAL MONITORING (ICM)

Stereoencephalography (SEEG)





Only 5% of patients were unable to be offered treatment following SEEG

60% offered definitive resection or ablation
- Potentially curative

Complications low
- Symptomatic IPH ~4%
- Infection ~2%
- Sensorimotor deficit ~2%
- Displacement ~1%

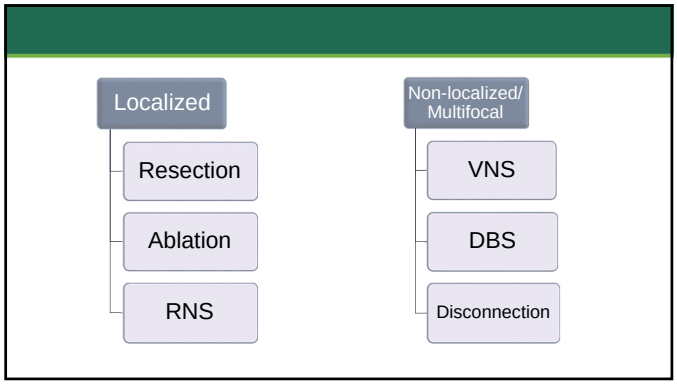
Gupta, et al. *unpublished results*

CURRENT TREATMENTS & INDICATIONS

- Resection/Ablation
  - Resection
    - Non-dominant MTLE with MTS
    - Lesional
    - Need for urgent tx
  - Ablation
    - Dominant MTLE with MTS
    - Non-dominant MTLE
  - Similar rates of SF

Neuromodulation
- VNS
- Responsive neurostimulation (RNS)
  - Bilateral MTLE
  - Dominant MTLE without MTS
  - Well-localized foci
- Ant nucleus of thalamus DBS
  - Multi-focal
  - Non-localized

- Disconnection
  - Callosotomy
  - Functional hemispherectomy
  - Multiple subpial transections



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RATIONALE

- Adverse neurocognitive outcomes in standard temporal lobectomies
  → Selective amygdalohippocamectomy (SAH)
- SAH itself associated with deficits, “collateral damage”
  - Dominant hemisphere – verbal learning, naming
  - Non-dominant – Object recognition, visuospatial memory
- “Less invasive” option = smaller incision, smaller opening, less tissue disruption
  - *Not* non-invasive

ABLATION

- Creates irreversible lesions in tissue
- Achieved by several methods
  - Radiofrequency
    - High frequency current → heat → destruction of cells
    - Can be stereotactically performed
    - Monitor heat at device tip, but not elsewhere
  - Radiosurgery
    - ROSE trial
      - Lower rate of SF than ATL (52%)
      - Higher rate of AE than ATL (39%, compared to 11%)
  - Laser ablation
    - Laser interstitial thermal therapy (LITT)

LASER ABLATION

1. Thermocoagulation via laser-induced heating
   - Stereotactically-placed optical fiber
   - MTLE
     - Lesioning of mesial structures (Amyg/HC)
     - Sparing of anterior, basal, lateral structures
2. MRI thermometry
   - Thermal imaging to visualize heating in real-time
   - Enables visually monitoring extent of lesion
   - Measures heat beyond device tip

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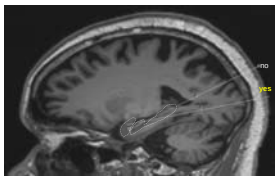
STEREOTACTIC PLANNING - MTLE



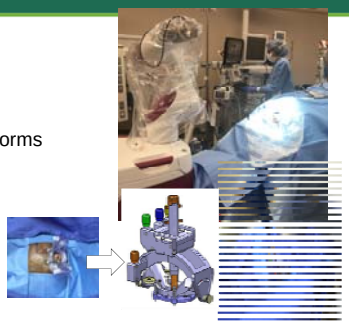
Subventricular trajectory

- Medial to uncus
- Posterior to lateral mesencephalic sulcus of MB

~5 cm up & over from inion

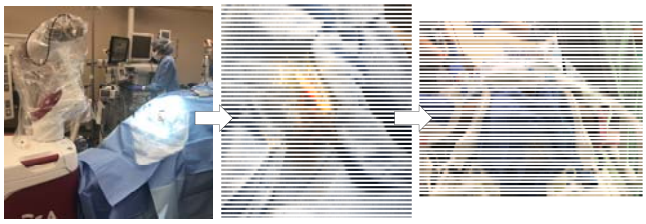
STEREOTACTIC APPROACH

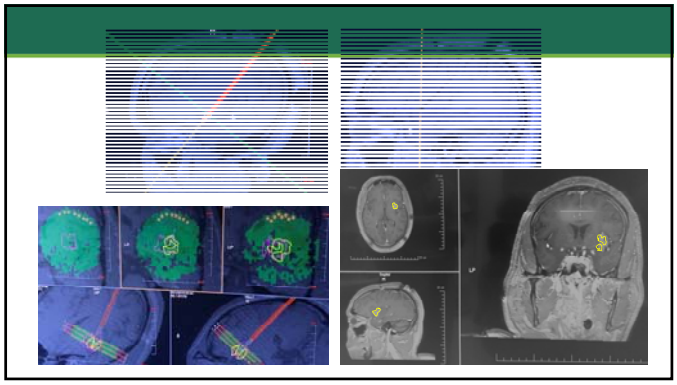
- Frame-based
- ROSA robot
- MRI-compatible platforms



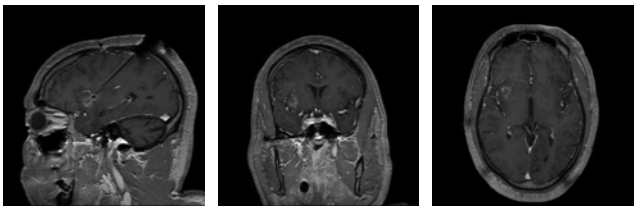
UAB LITT FOR EPILEPSY

OR MRI





POST-OP IMAGING



Total OR Time = 3.5 hours (ROSA + MRI)
Ablation time = 6 min
LOS = 1 day

POST-OP MANAGEMENT

- Typically home on POD 1
- ICU vs step-down/floor
- Steroid taper
- Home AED regimen
  - Counsel pt re: remaining on meds at least 6 mos – 1 year
- Follow-up with neurosurgery and neurology
- Re-image in ~1 & 6 months

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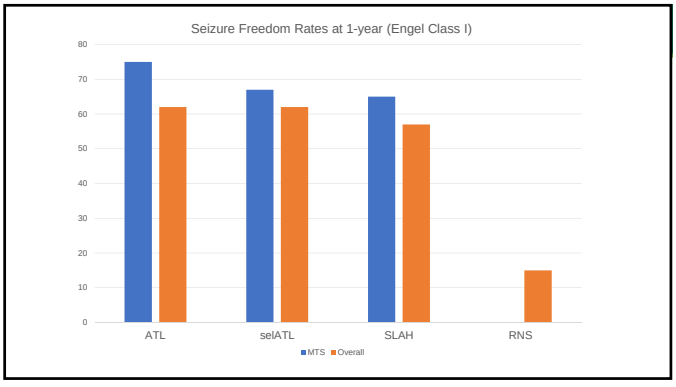
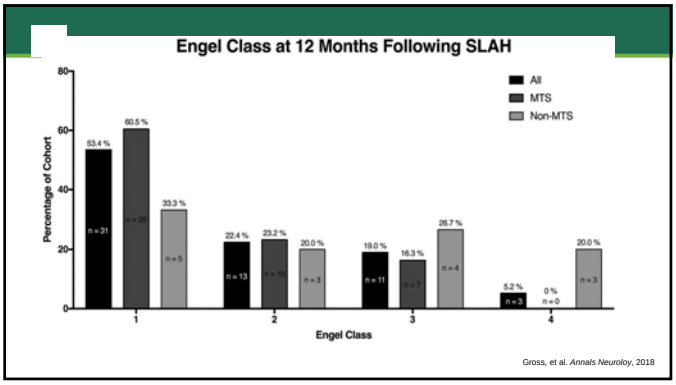
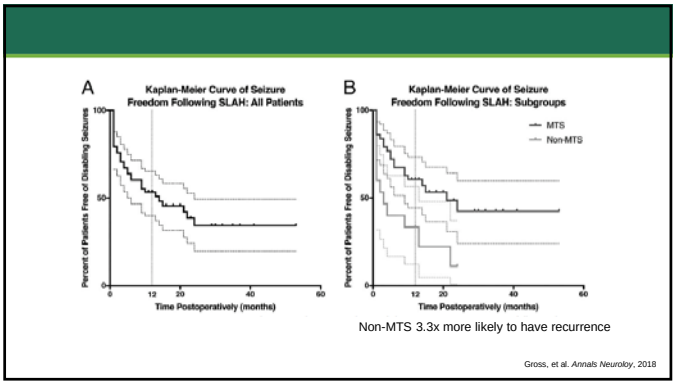




Gross, et al. *Annals Neuroloy*, 2018



Non-MTS 3.3x more likely to have recurrence

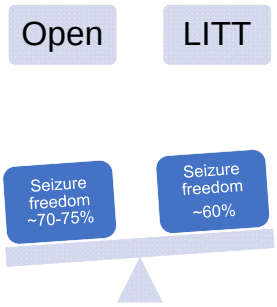
Gross, et al. *Annals Neuroloy*, 2018

COMPLICATIONS

- Visual field deficits – 8.6%, permanent in 1.7%
- Hemorrhage
  - IPH – 3-4%
  - SDH – 1-2%
- Cranial nerve palsy (III, IV) – 7%, none permanent

- 1/58 with permanent deficit
- Effect of learning curve

NEUROCOGNITIVE OUTCOMES



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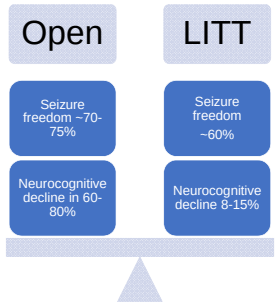

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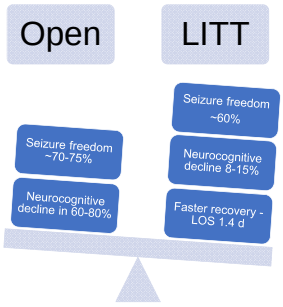

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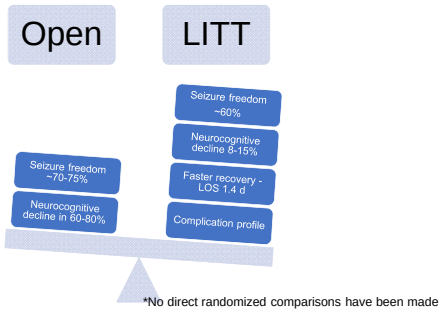

*No direct randomized comparisons have been made

LASER ABLATION

- →Comparable rates of seizure freedom
- →Low complication rate
  - 1.7% permanent injury, 3% hemorrhage
- →Better neurocognitive outcomes
  - 8-15% rate of verbal memory decline compared to 30-60%
  - Preserved naming
- →Shorter LOS
  - Mean = 1.4 days
  - +/- floor admission postop

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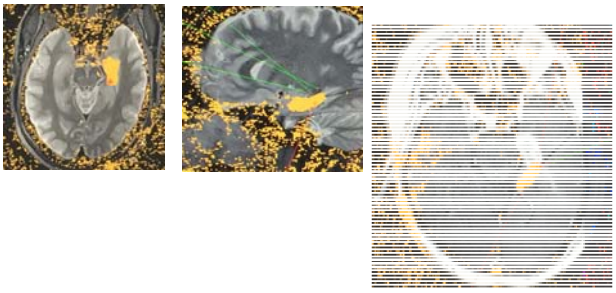
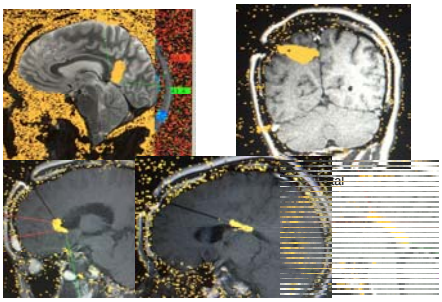
CURRENT USES

- Essentially first-line in dominant-hemisphere MTLE with mesial temporal sclerosis (MST)
  - Without MST, consider RNS
- In non-dominant cases, dependent on patient urgency for seizure-freedom versus risk aversion
  - Most efficient route to seizure-freedom remains temporal lobectomy
  - LITT may be used first, followed by re-ablation or resection if fails



CURRENT USES

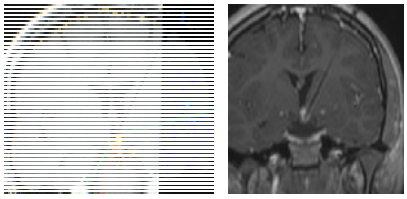
- Epilepsy
  - MTLE
  - Temporal pole
  - Extratemporal
    - Frontal
    - Orbitofrontal
    - Parietal
    - Insular
    - Cingulate
    - Precuneus
    - Occipital
  - Callosotomy



Callosotomy

CURRENT USES

- Tumors
- Hamartomas
- Radiation Necrosis
- Cavernous malformations

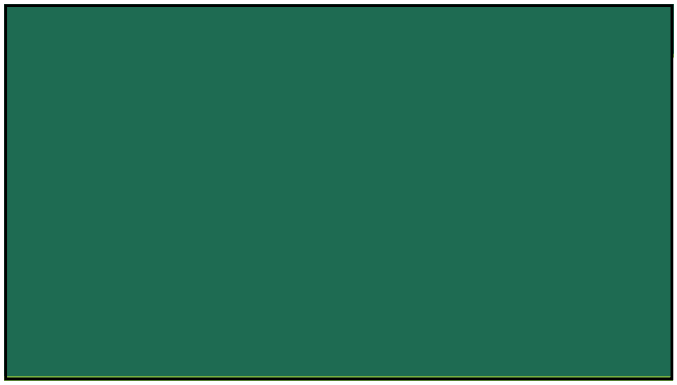


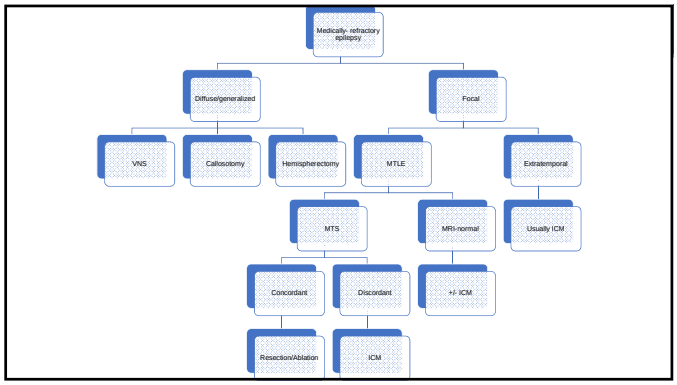
TECHNICAL CONSIDERATIONS

- Size
- Proximity to bone
- Proximity to heat sinks
  - Vascular structures
  - Venous sinuses
  - Cisterns
  - Ventricles
- Trajectories
- Relative Contraindications
  - Large confluent areas
  - Multi-focal
  - Eloquent cortex
    - Awake?

ACKNOWLEDGEMENTS

- Kristen Riley, MD
- Jim Markert, MD
- UAB Neurology, Division of Epilepsy




Medically- refractory epilepsy
Diffuse/generalized
Focal
VNS
Callosotomy
Hemispherectomy
MTLE
Extratemporal
MTS
MRI-normal
Usually ICM
Concordant
Discordant
+/- ICM
Resection/Ablation
ICM