Functional and epilepsy neurosurgery

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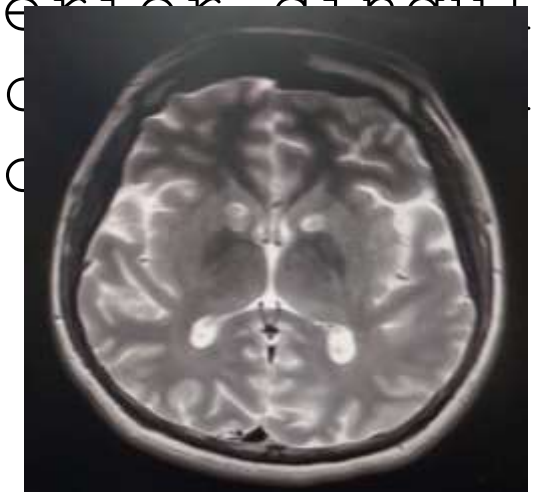
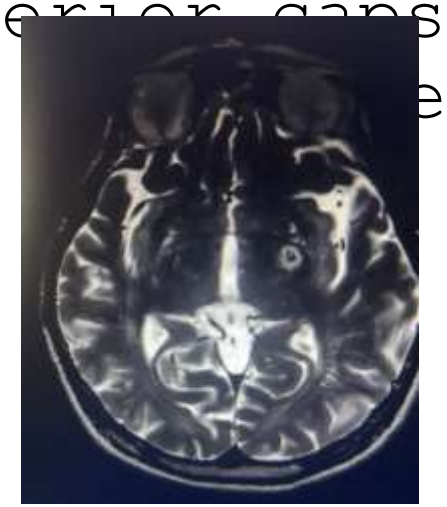
Introduction

- Definition of functional neurosurgery: neurosurgical procedures aimed at improving function rather than removing pathology.
- Historical perspective: early lesioning procedures → advent of stereotactic surgery → modern neuromodulation.

Lesioning techniques

- Thalamotomy: Parkinson (Tremor), Essential Tremor
- Pallidotomy: Parkinson (Rigidity and Bradykinesia)
- Anterior cingulotomy and anterior capsulotomy: psyc ness like OCD ety disc



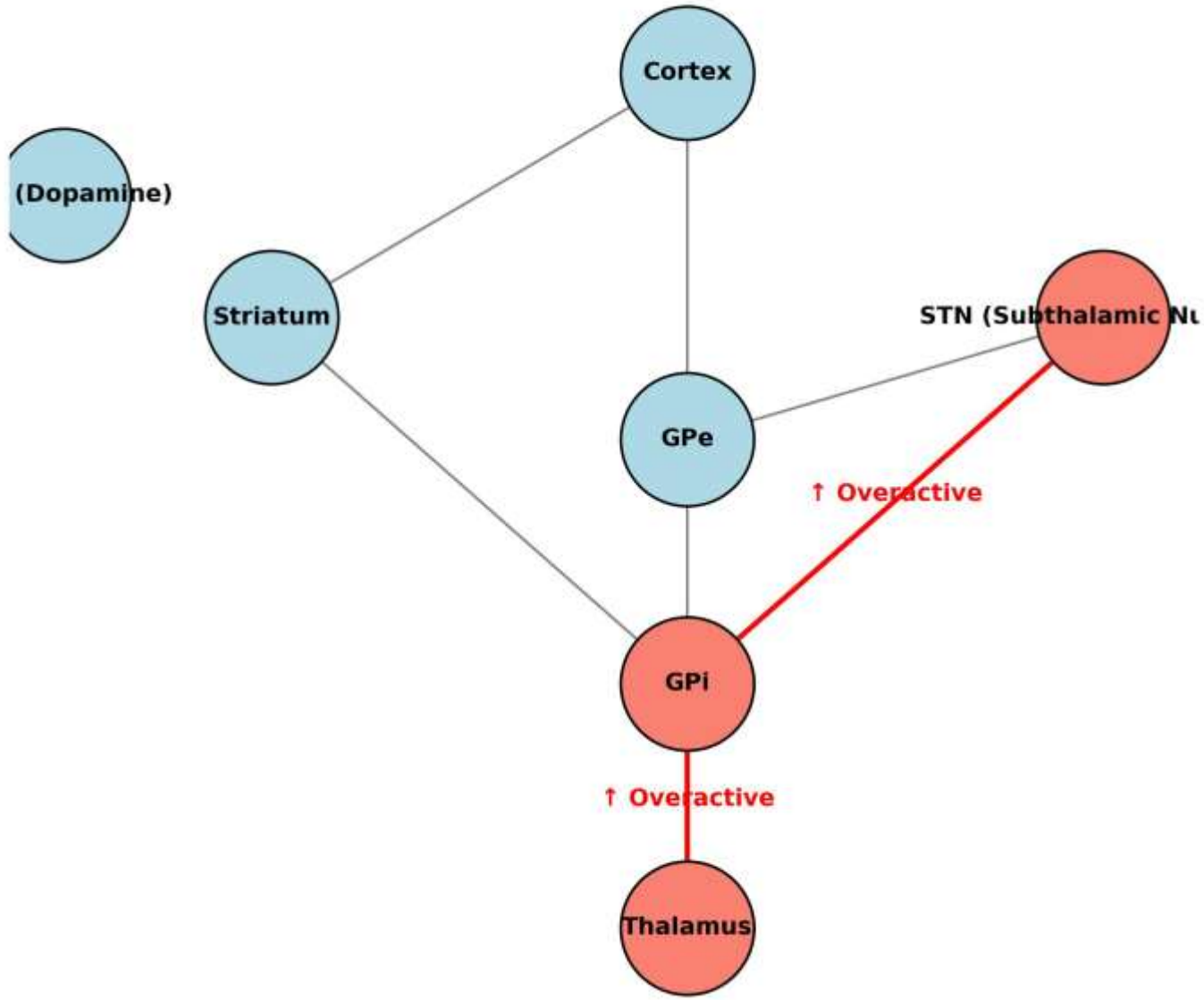


Ablative Approches

- Radiofrequency Ablation
- MR-guided focused ultrasound: Thalamotomy for Essential Tremor and Parkinson
- Radiosurgery (Gamma Knife): like Subthalamotomy for Parkinson

Functional neurosurgery in Parkinson's Disease.

- Parkinson's disease is caused by **dopaminergic neuron loss** in the substantia nigra → imbalance in the basal ganglia circuitry.
- This leads to **excessive activity** of certain nuclei (e.g., **subthalamic nucleus** and **globus pallidus internus**) that inhibit movement.
- The idea of **lesioning or Deep brain Stimulation** is to create a **permanent, controlled lesion** in these overactive regions to rebalance the circuitry and improve motor function.


Basal Ganglia Circuit in Parkinson's – Lesioning Rationale
Cortex
(Dopamine)
Striatum
STN (Subthalamic Nu
GPe
↑ Overactive
GPi
↑ Overactive
Thalamus

Preoperative and Postoperative video during thalamotomy for parkinson patient

- **Thalamotomy (Ventral Intermediate nucleus – VIM):**
  - Improves **tremor**.
  - Often unilateral (bilateral causes speech/cognitive problems).
- **Pallidotomy (Globus Pallidus Internus – GPi):**
  - Improves **dyskinesias, rigidity, and bradykinesia**.
  - Was popular in 1990s before DBS became mainstream.
- **Subthalamotomy (Subthalamic nucleus – STN):**
  - Reduces akinesia and rigidity.
  - Risk: hemiballismus (violent involuntary movements).

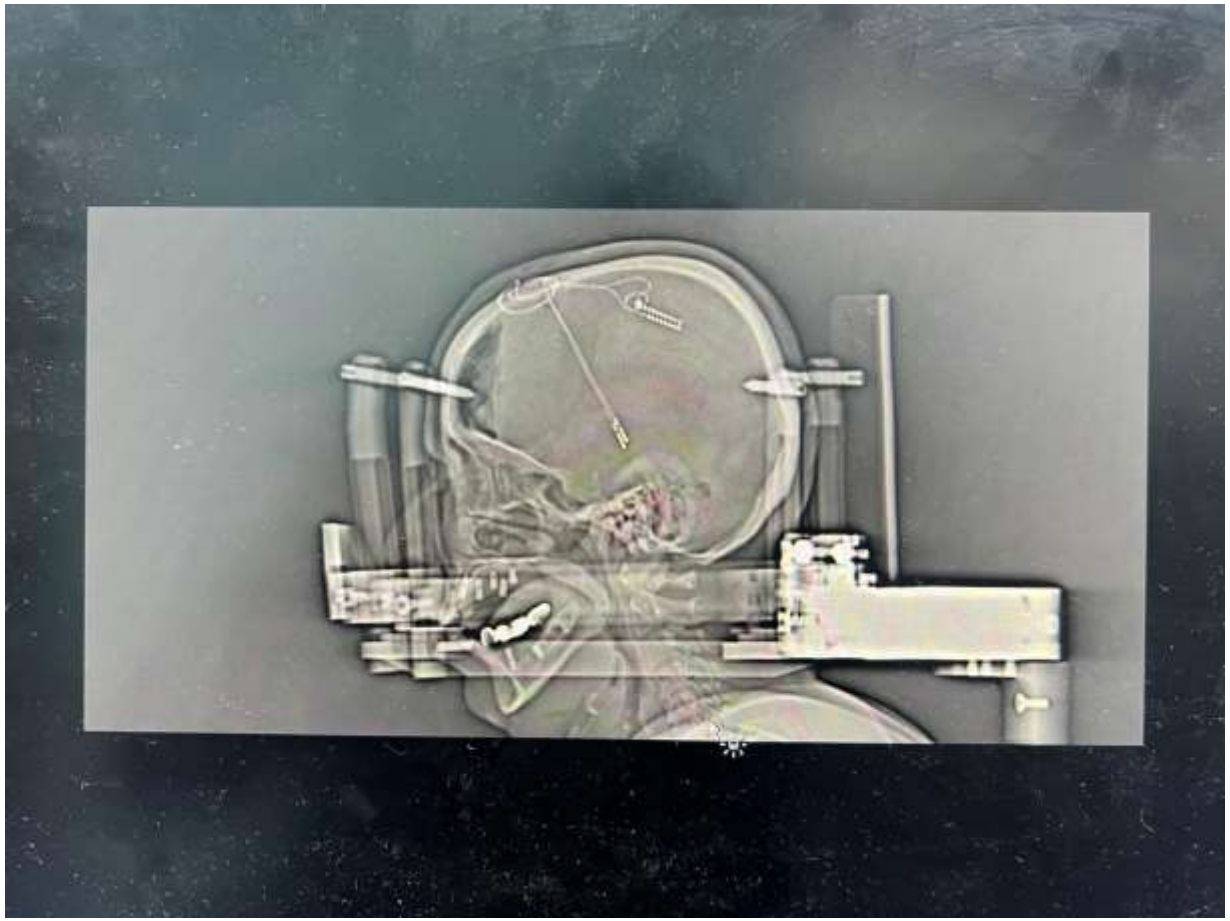
- **Stereotactic neurosurgery** used to precisely localize the target.
- Methods of creating the lesion:
- Radiofrequency thermocoagulation.
- Focused ultrasound (MRgFUS – incis
- Gamma Knife radiosurgery.

Limitations of lesioning

- **Irreversible** – if too much tissue destroyed, side effects permanent.
- **Bilateral lesions risky** → speech, cognition, swallowing problems.
- DBS now preferred (reversible, adjustable, bilateral possible).

- **Lesioning in PD works by destroying overactive basal ganglia targets (thalamus, GPi, STN) to restore motor balance.** Today, DBS is favored, but lesioning still has a role, especially with new noninvasive approaches like focused ultrasound.

DBS electrode insertion in STN for Parkinson



Advantages

- No implanted hardware (unlike DBS).
- Lower cost, useful where DBS is not available.
- Immediate effect once lesion is made.

Epilepsy Surgery

- **Introduction**
- Epilepsy = recurrent unprovoked seizures.
- ~30% of patients → **drug-resistant epilepsy (DRE).**
- Surgery is an option when seizures cannot be controlled with medication.
- Goal: **seizure freedom or reduction** with preservation of neurological function.

- Seizures often arise from a specific brain region (epileptogenic zone).
- Removing/disconnecting that zone can stop seizures.
- Earlier surgery = better outcomes (especially in children).

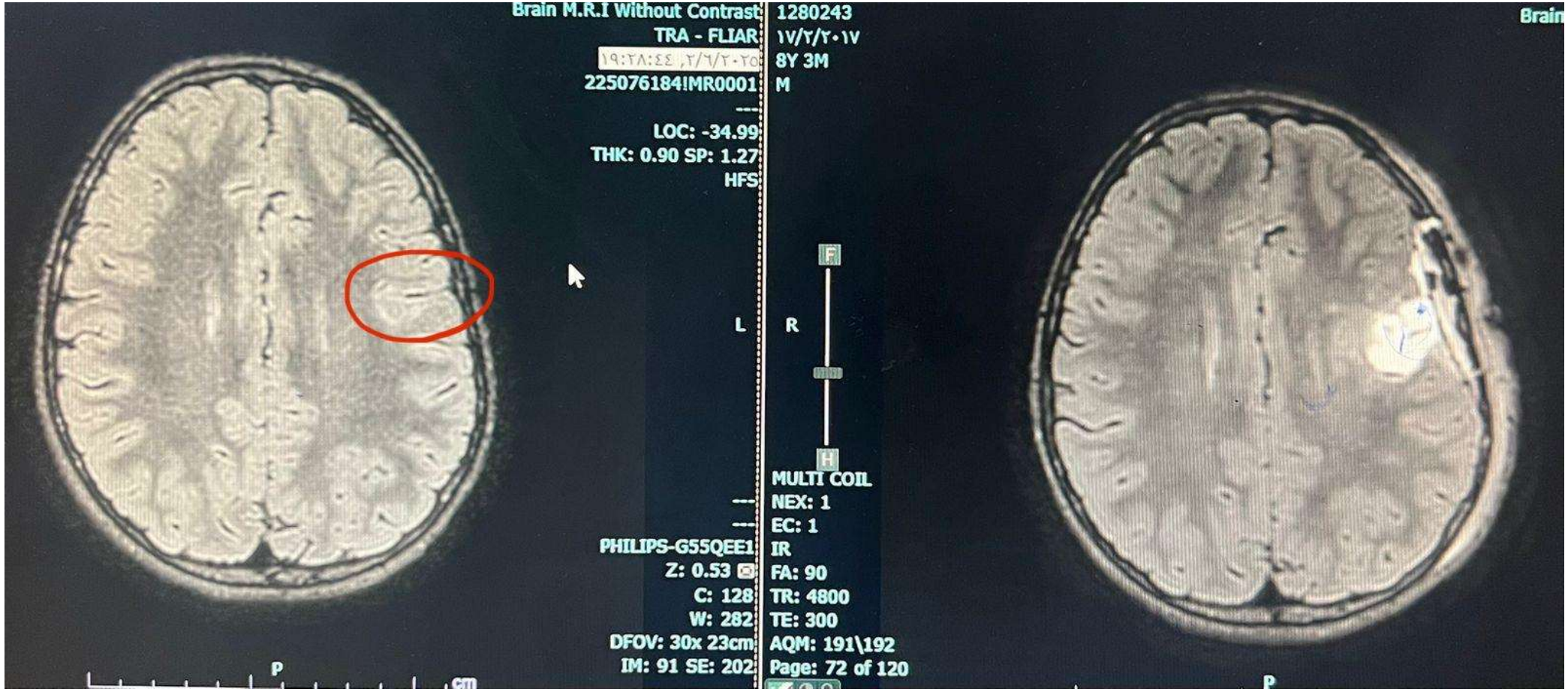
Types of Epilepsy Surgery

1. Resective Surgery (curative intent)

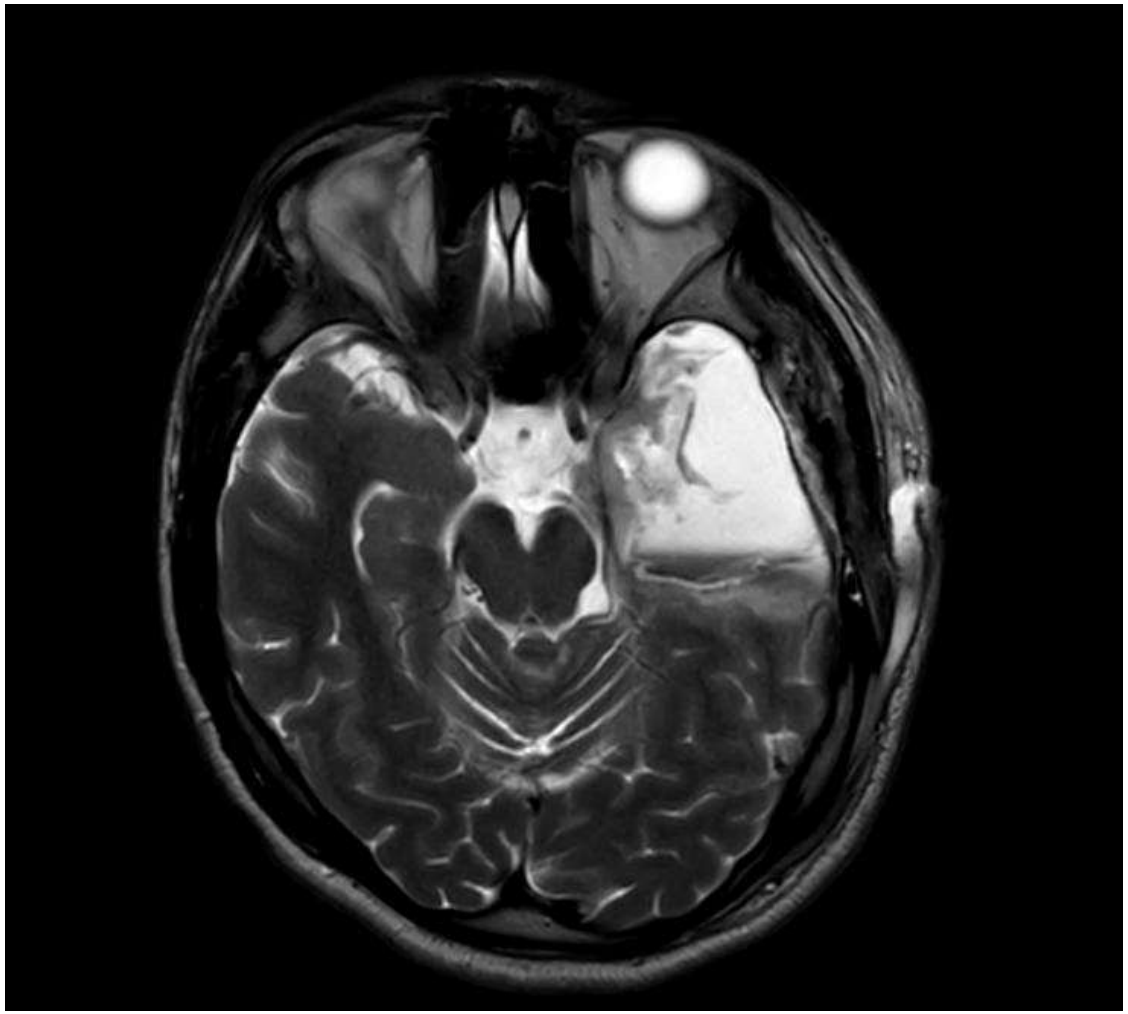
- **Anterior temporal lobectomy (ATL)**
  - Most common.
  - Best for mesial temporal lobe epilepsy (MTLE).
  - Seizure-free in 60–80%.
- **Lesionectomy**
  - Removal of lesion (tumor, cavernoma, cortical dysplasia).
- **Frontal, parietal, occipital resections** (less common, more complex).

2. Palliative Surgery (not curative, goal is reducing the frequency and intesity of the seizure)

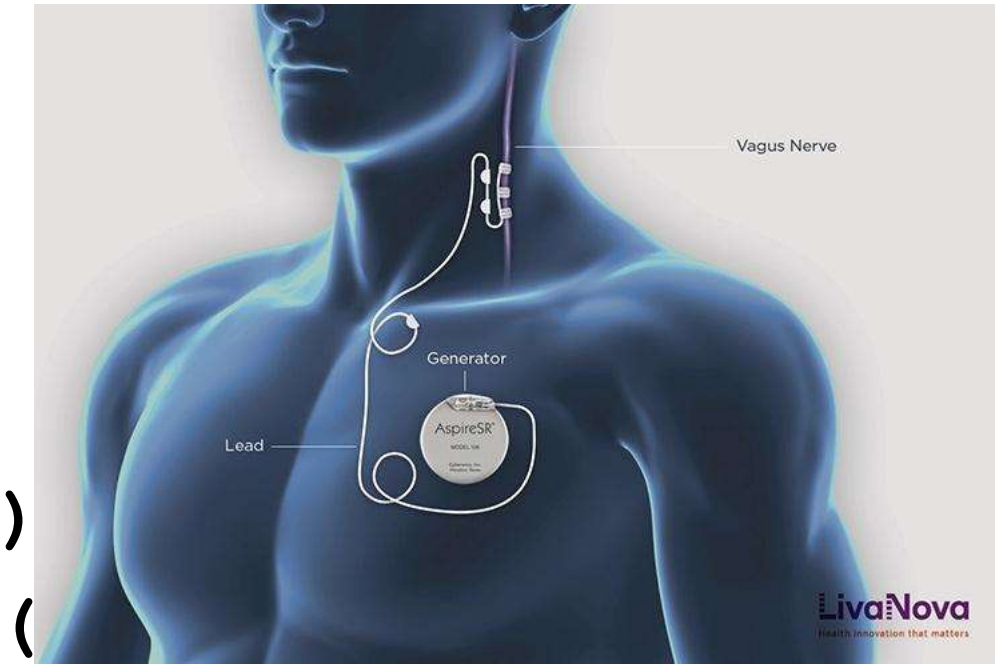
Lesionectomy of benign tumor



Postoperative MRI after left temporal lobectomy



Palliative surgery



- **Neuromodulation (palliative)**
- **Vagus nerve stimulation (VNS)**
- **Responsive neurostimulation (**
- **Deep brain stimulation (DBS)** of anterior thalamus.
- Disconnection procedure

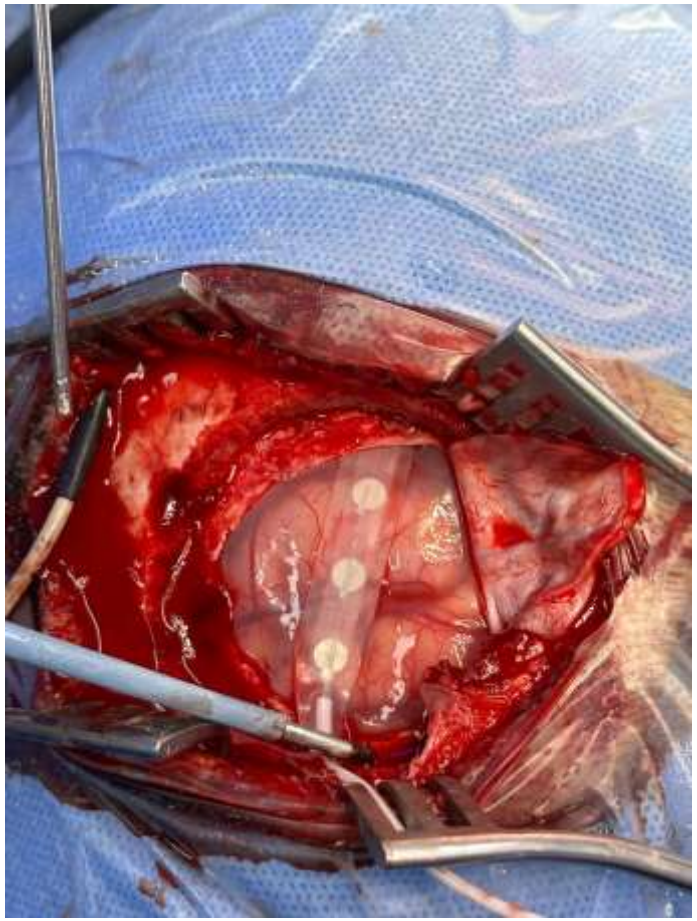
Disconnection Procedures

- **Corpus callosotomy**
  - For drop attacks/atonic seizures.
  - Palliative, reduces severity not seizure-free.
- **Multiple subpial transections (MST)**
  - For eloquent cortex (speech/motor areas).

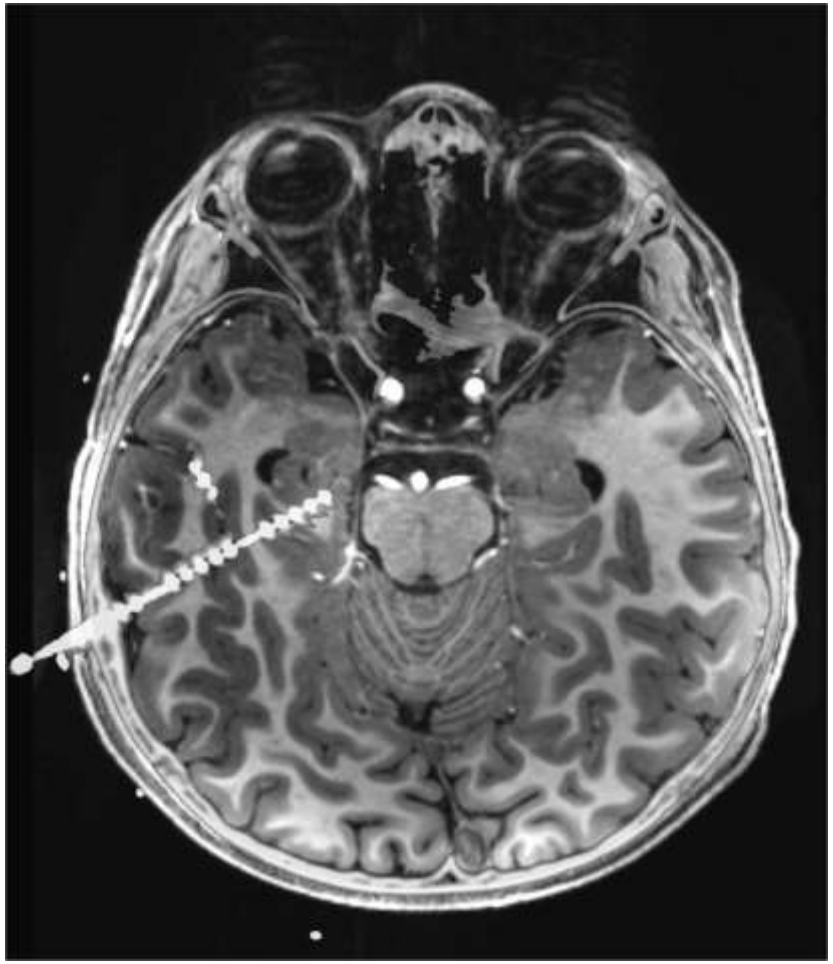
Patient Selection

- Criteria:
  - **Drug-resistant epilepsy** (failure of ≥2 appropriate medications).
  - Localized epileptogenic zone.
  - Acceptable risk profile.
- Contraindications:
  - Generalized epilepsy.
  - Poor localization.
  - Major uncontrolled comorbidities.

Invasive EEG (subdural electrode)



Invasive EEG (depth electrode)



Outcomes

- **Temporal lobe epilepsy**: best results (up to 70% seizure freedom). Lt tempral lobectomy (awake surgery)
- **Extra-temporal**: lower but still meaningful benefit.
- Neuromodulation: usually **50% reduction** rather than full seizure freedom.

Risks & Complications

- Cognitive/psychological changes (memory, language).
- Neurological deficits (hemiparesis, visual field cuts).
- Surgical risks: infection, bleeding, stroke.

- Epilepsy surgery is **life-changing** for selected patients.
- Requires **multidisciplinary evaluation**.
- Best outcomes in temporal lobe epilepsy.
- Increasing role of neuromodulation and minimally invasive surgery.