Functional and epilepsy neurosurgery

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Introduction

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

Lesioning techniques

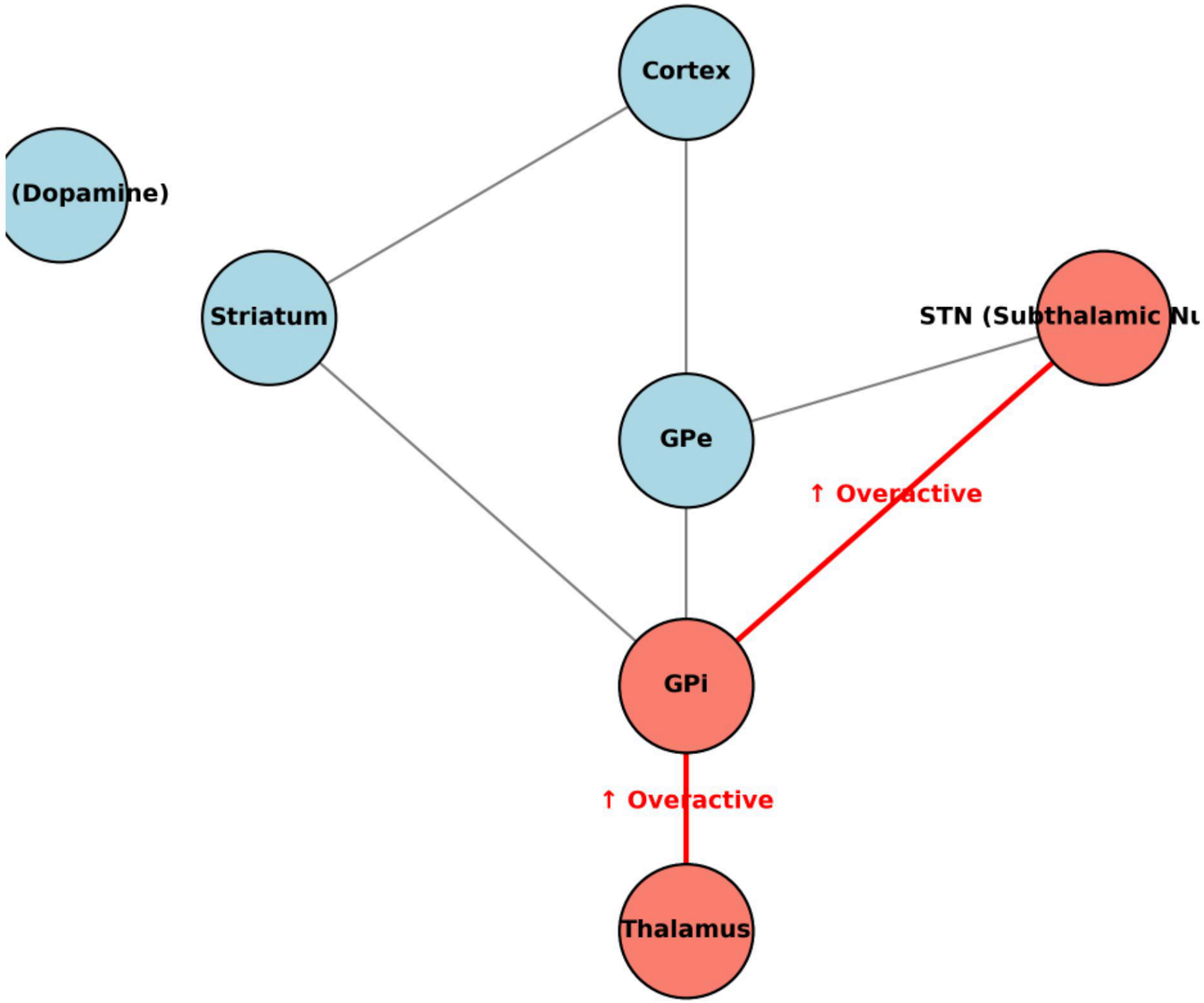
- Thalamotomy: Parkinson (Tremor), Essential Trmor
- Pallidotomy: Parkinson (Rigidity),
- Anterior cingulotomy: psychiatric illness

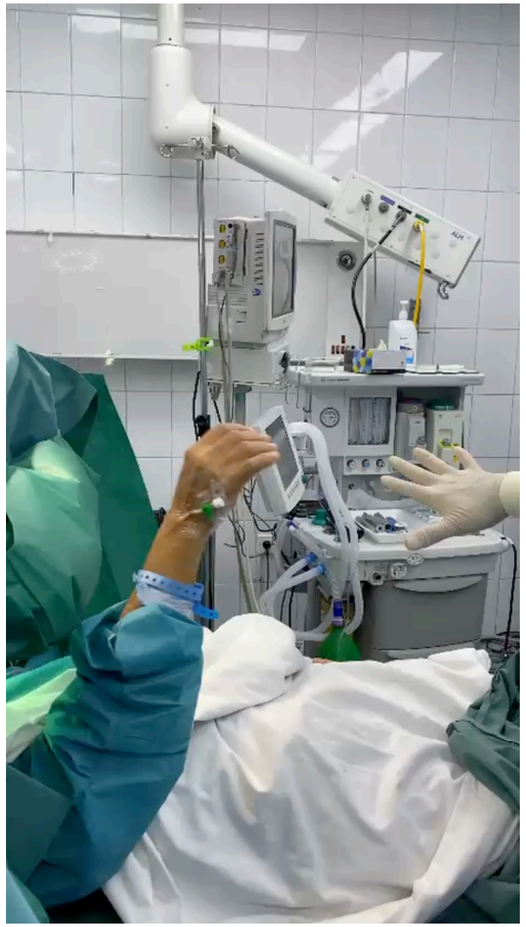
Ablative Approches

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

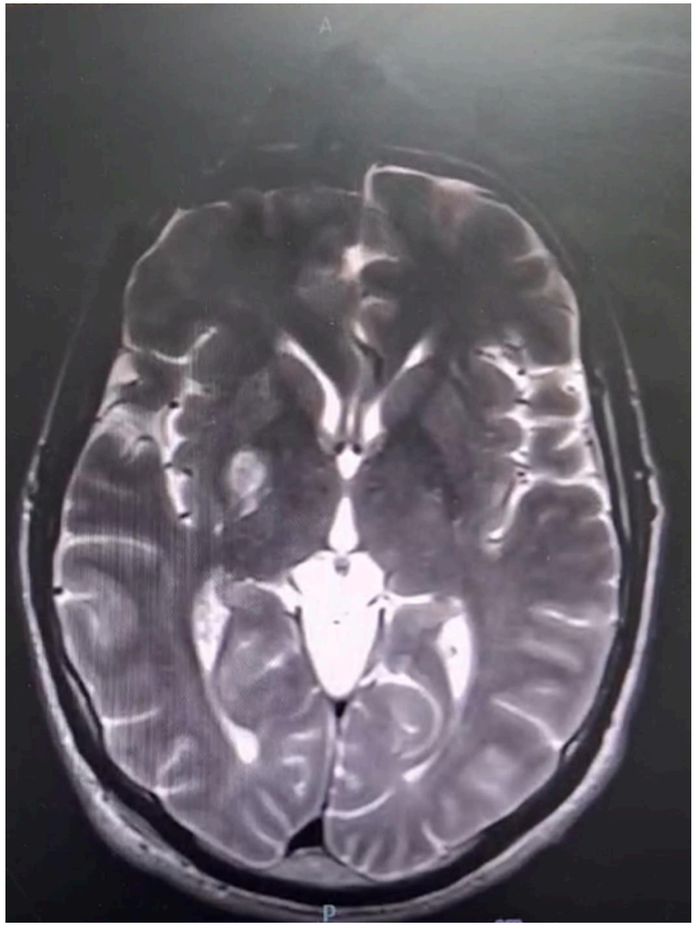
Functional neurosurgery in Parkinson’ s Disease.

- 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



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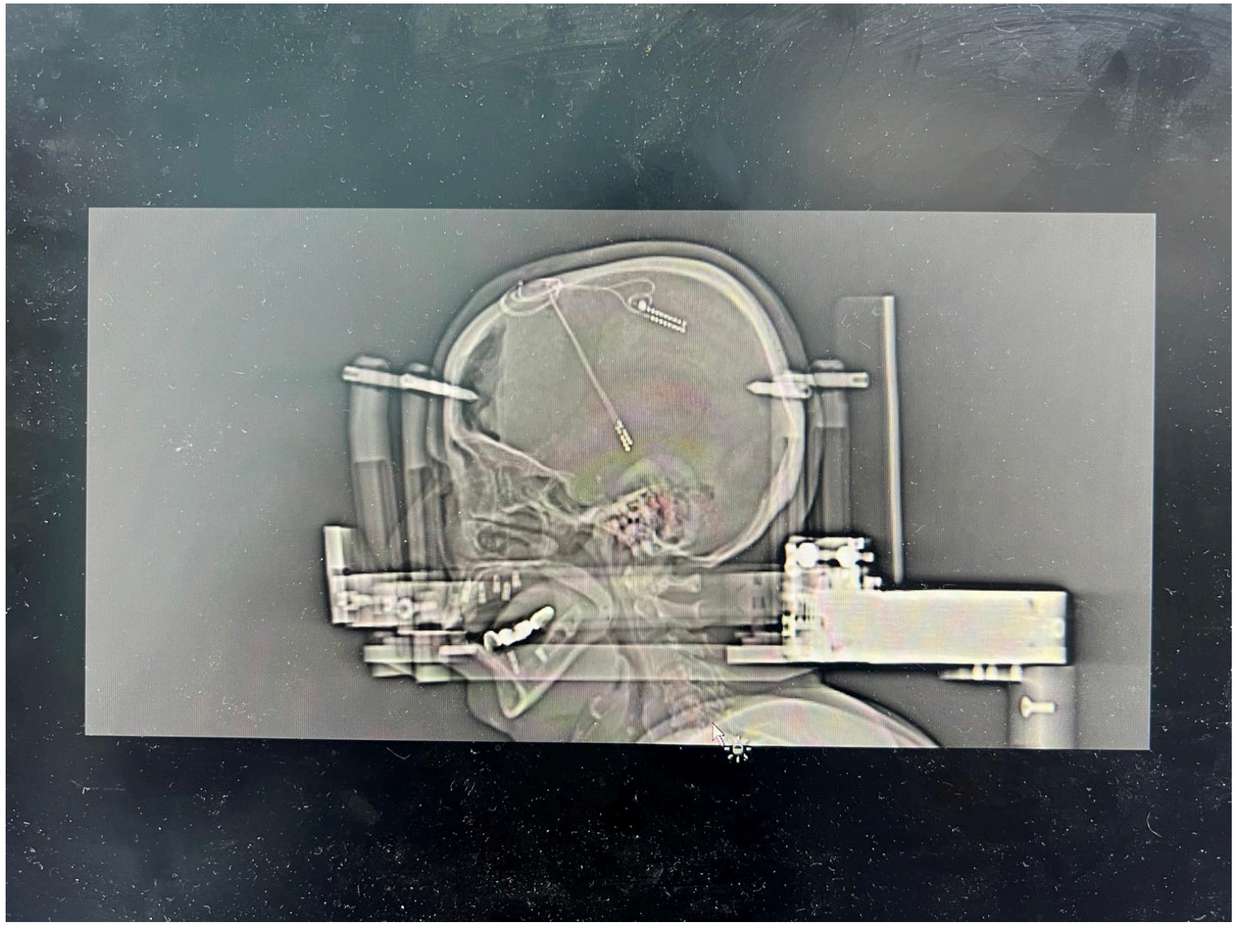
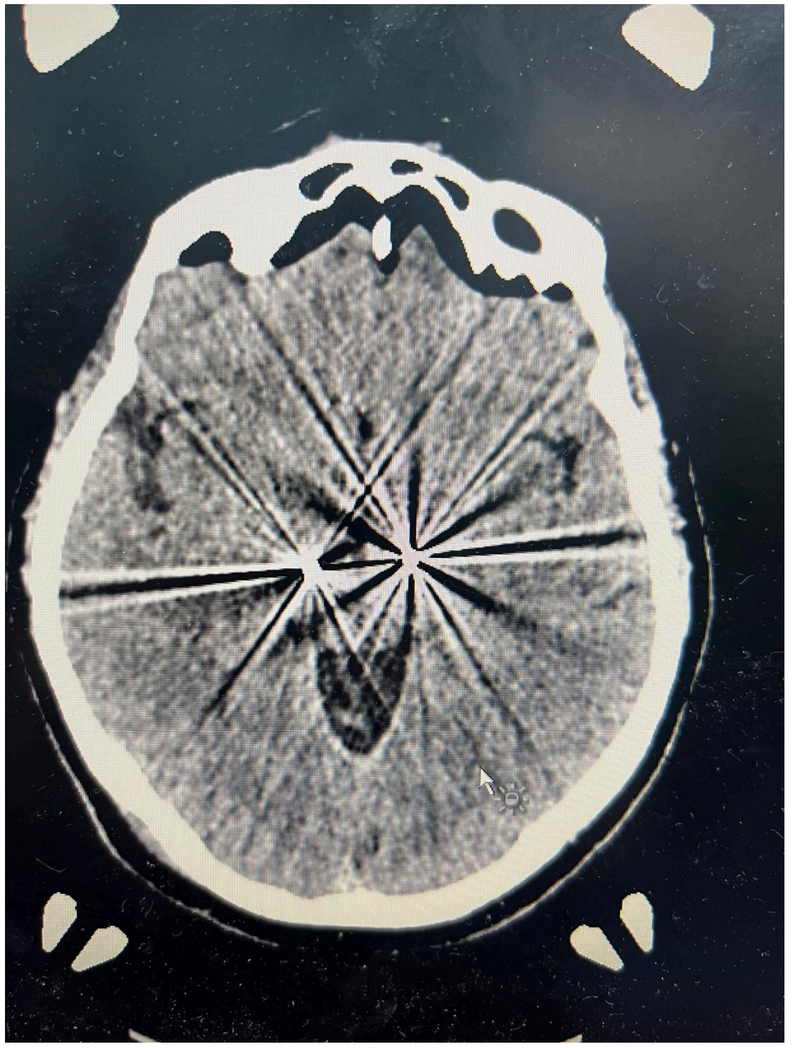
- **Stereotactic neurosurgery** used to precisely localize the target.
- Methods of creating the lesion:
- Radiofrequency thermocoagulation.
- Focused ultrasound (MRgFUS – incisionless)
- Gamma Knife radiosurgery.

Limitations

- **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.

Advantages

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

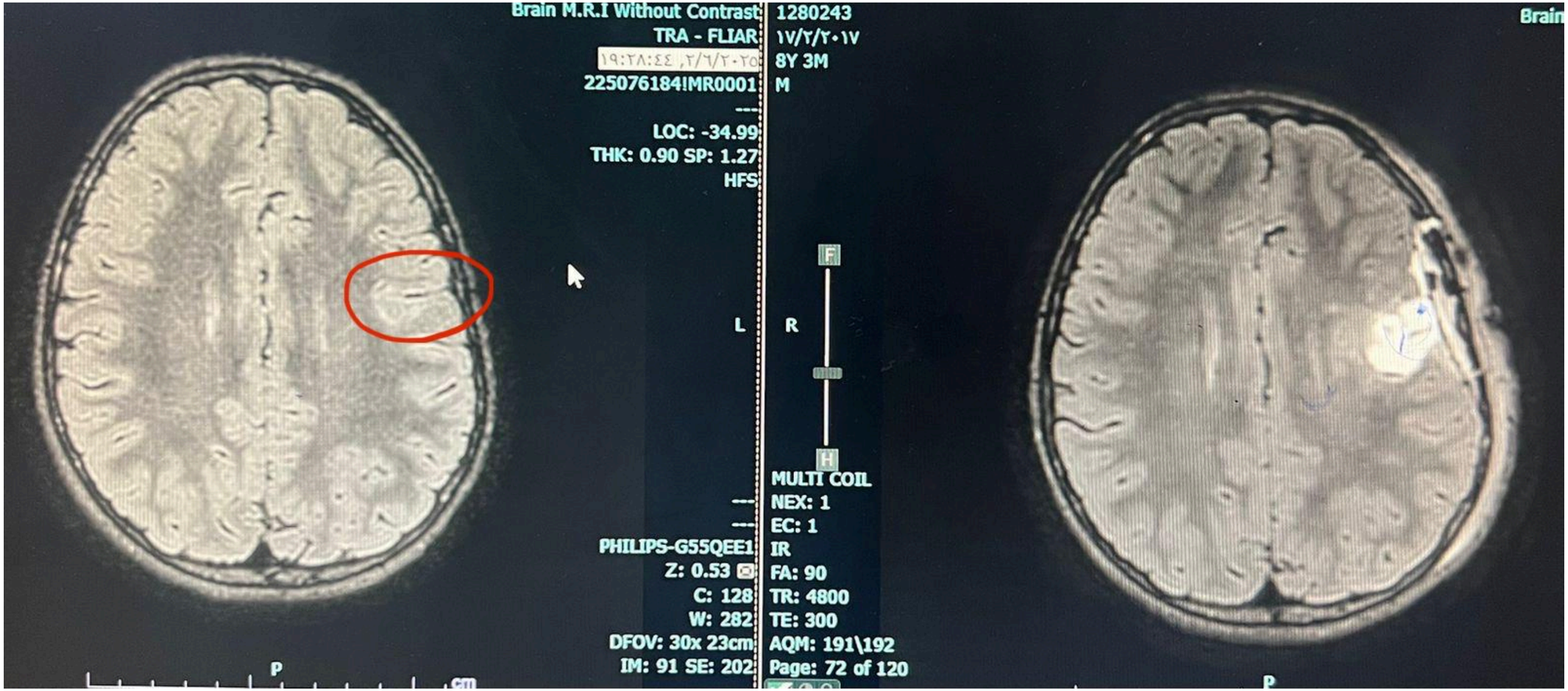
Epilepsy Surgery

- **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

- **A. 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).


Brain M.R.I Without Contrast
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THK: 0.90 SP: 1.27
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FA: 90
TR: 4800
TE: 300
AQM: 191\192
Page: 72 of 120
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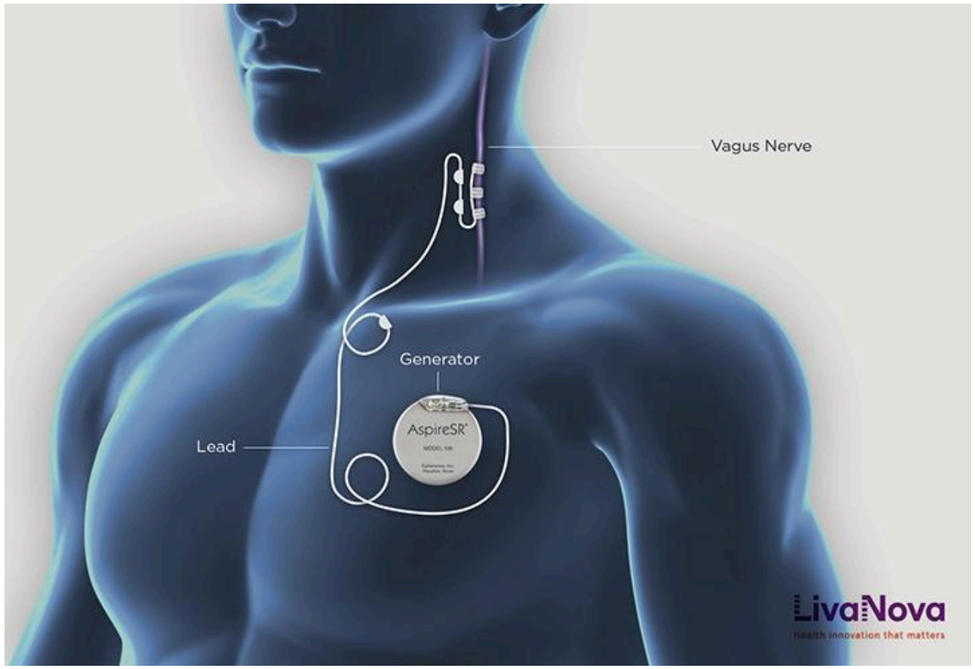
DFOV: 30x 23cm
IM: 91 SE: 202
P
1280243
8Y 3M
M
Brain

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).

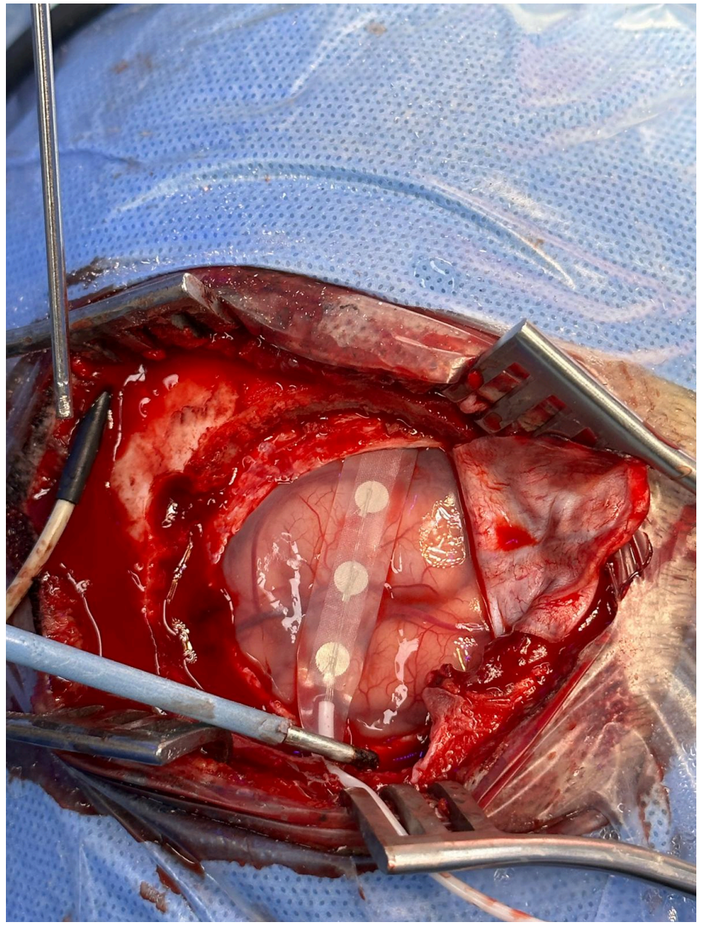
Palliative surgery

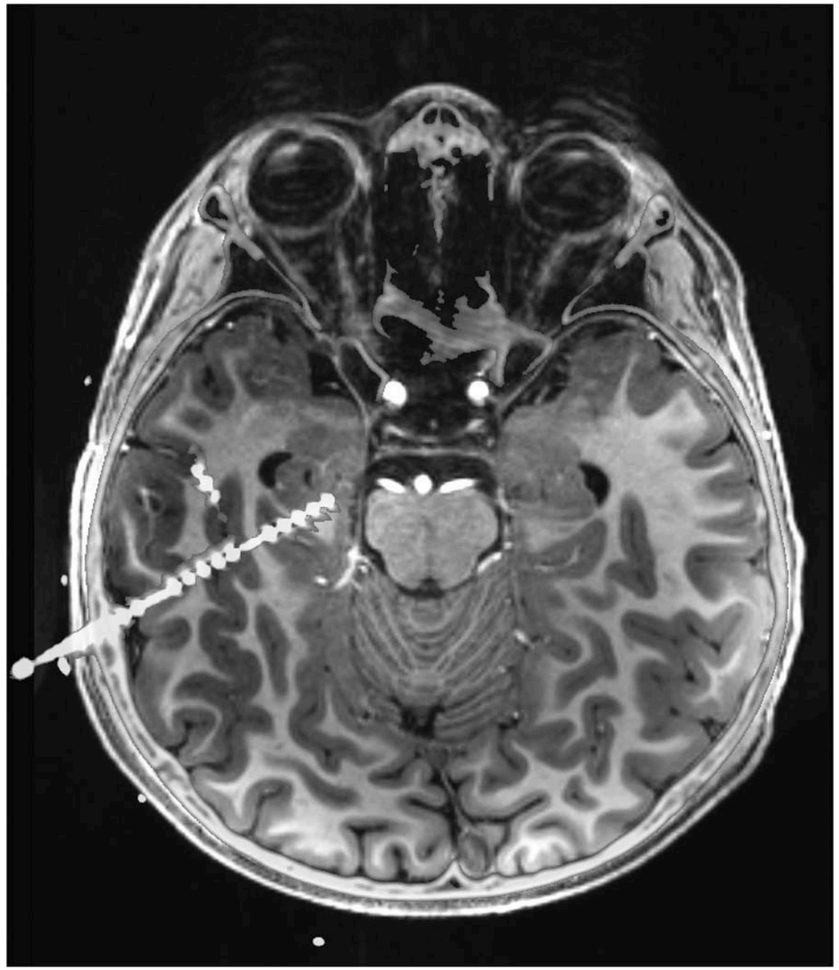


- **Neuromodulation (palliative)**
- **Vagus nerve stimulation (VNS)**.
- **Responsive neurostimulation (RNS)**.
- **Deep brain stimulation (DBS)** of anterior thalamus.

Patient Selection

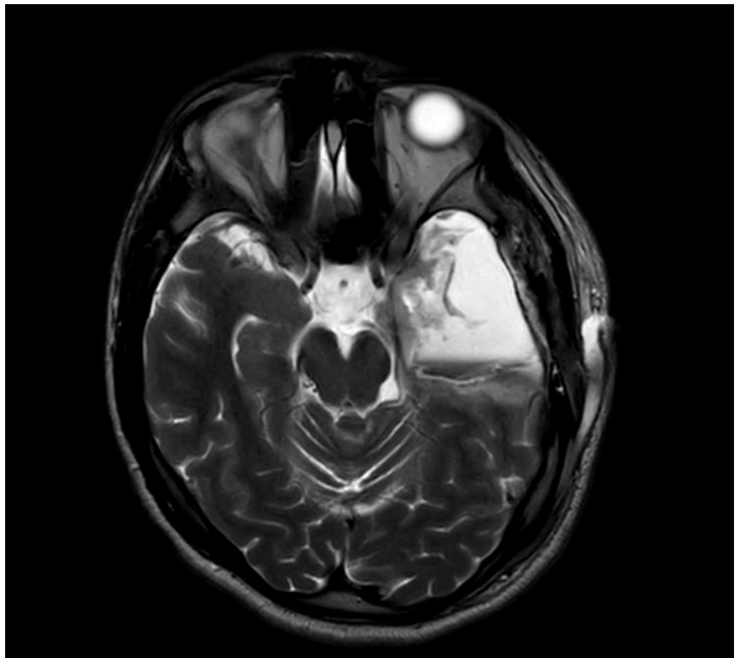
- Criteria:
  - **Drug-resistant epilepsy** (failure of ≥2 appropriate medications).
  - Localized epileptogenic zone.
  - Acceptable risk profile.
- Contraindications:
  - Generalized epilepsy.
  - Poor localization.
  - Major uncontrolled comorbidities.





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.