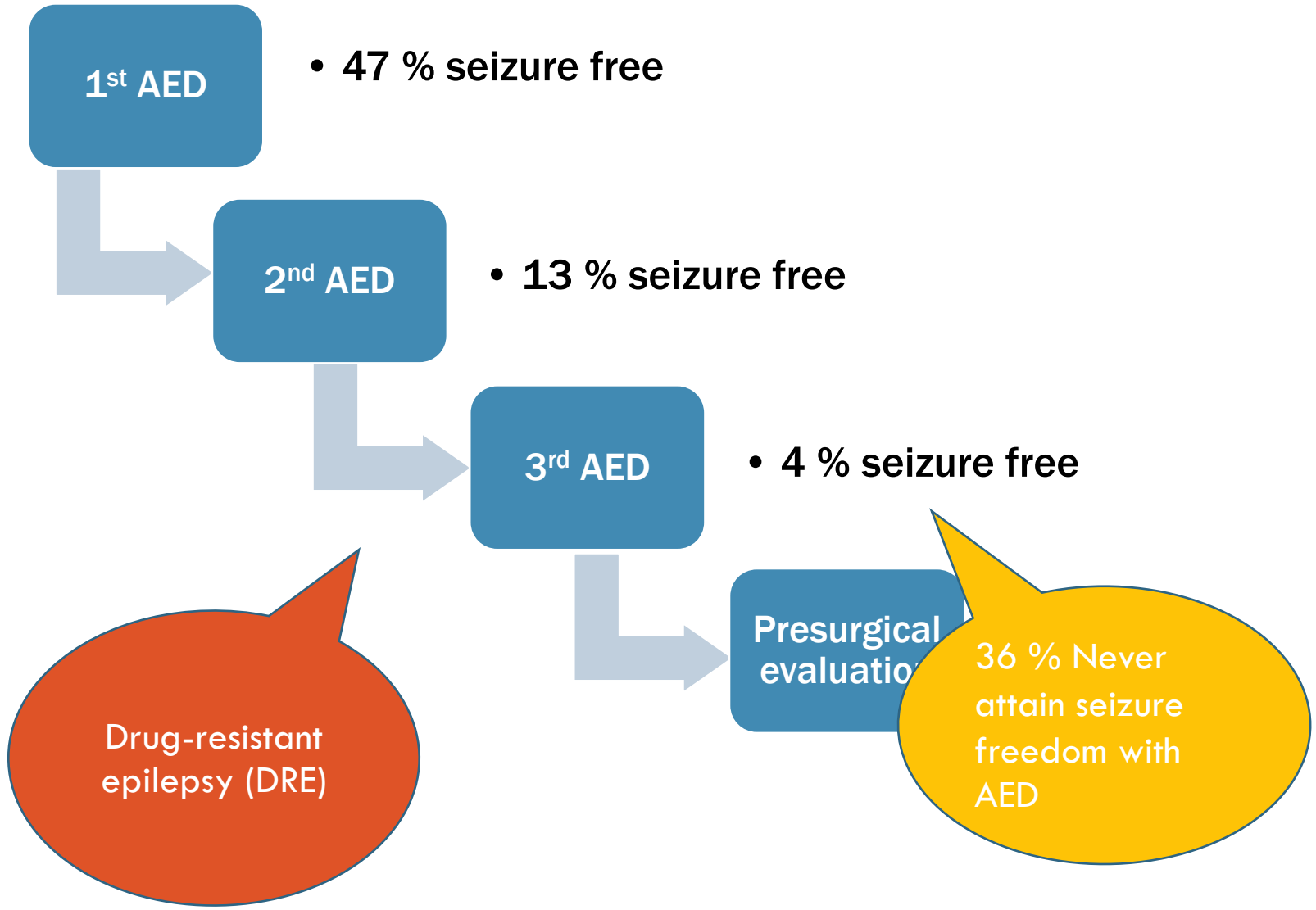
PRE-SURGICAL EVALUATION IN EPILEPSY AND EPILEPSY SURGERY

Suphasit Seoratanaphunt, MD

TOPIC OUTLINES

- Identifying candidate for presurgical evaluation
- Presurgical evaluation process in epilepsy
- Type of epilepsy surgery
- Outcome of epilepsy surgery

RESPONSE TO AED IN PATIENT WITH NEWLY DIAGNOSED EPILEPSY



Epilepsia, 51(6):1069–1077, 2010

DRUGS RESISTANT EPILEPSY (DRE)

Defined as :

- **Failure of adequate trials of 2 Anti-seizure medication**

  Tolerated

  Appropriately chosen

  Used AED schedules (whether as monotherapies or in combination)

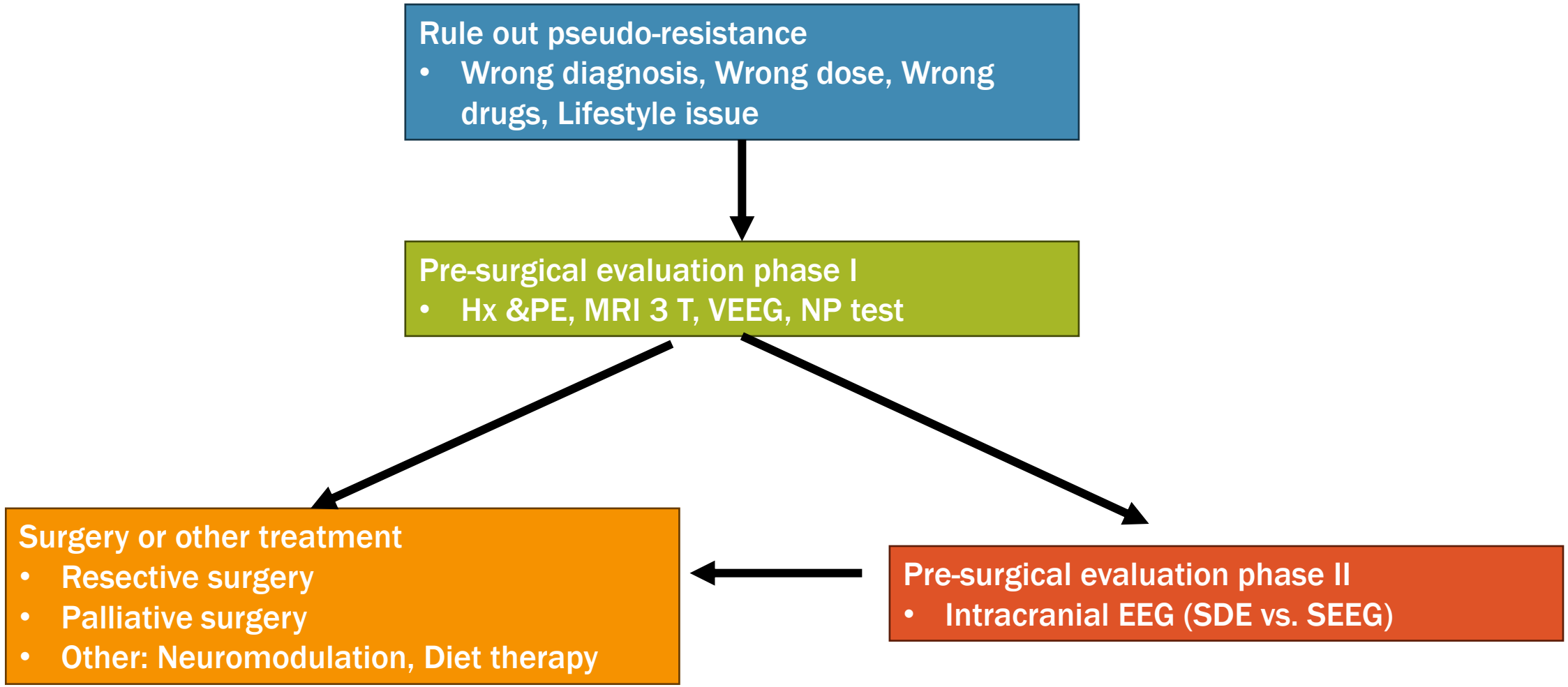
- **To achieve sustained seizure freedom (Whichever is longer of:)**

  3 times the longest pre-intervention inter-seizure interval

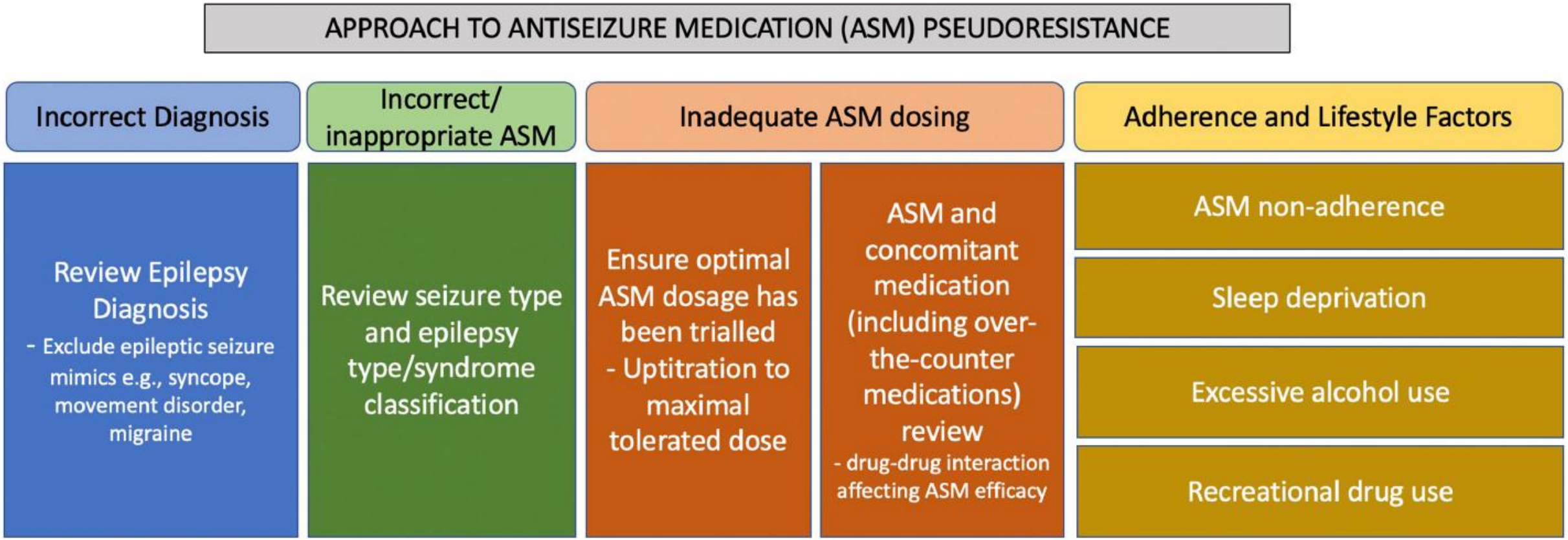
  12 months

Epilepsia, 51(6):1069–1077, 2010

EVALUATION OF DRUGS RESISTANT EPILEPSY



PSEUDO-DRUGS RESISTANCE OF EPILEPSY



Epileptic Disorders. 2023;25:649–669.

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DOI: 10.1111/epi.17350

Epilepsia®

SPECIAL REPORT

Timing of referral to evaluate for epilepsy surgery: Expert Consensus Recommendations from the Surgical Therapies Commission of the International League Against Epilepsy

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WHEN TO CONSIDER EPILEPSY SURGERY

- All patients with drug resistant epilepsy (DRE)
  - Focal epilepsy → resective surgery
  - Multi-focal or generalized epilepsy → palliative surgery and neuromodulation

- Patient who are seizure free with 1 – 2 medications but has lesion on non-eloquent cortex.

- Epilepsy surgery can be offered to patients in all age group if no contraindication for surgery (Even infant or elderly)

TABLE 2 Factors supporting early surgery and consequences of delay.

Factors supporting early surgery	Consequences of delay
Higher incidence of epilepsy in infants and toddlers	Decreased chances of surgical success due to ongoing epileptogenic processes
Epilepsy surgery proven safe and effective from a young age	Perpetuated cognitive decline related to seizures, epileptiform EEG discharges, and ASM, especially in developing brains
Higher rates of sustained seizure and ASM freedom in non-drug-resistant patients	Missed opportunity for superior reorganization and deficit compensation related to plasticity in early life
Improved quality of life (QoL) and developmental gains with early seizure freedom	Lifelong impact on cognition, behavior, socialization, education, and vocation
Early surgery viewed as disease-modifying with excellent outcomes in seizure and ASM freedom	Increased long-term epilepsy-related morbidity and mortality

Jehi L, et al. Epilepsia. 2022;63:2491–2506.

Schuele S, et al. Epileptic Disord. 2025;00:1–43.

SURGICAL REMEDIABLE EPILEPSY SYNDROMES

Can be selected by non-invasive	Required functional mapping or invasive evaluation
• Mesial temporal lobe epilepsy with hippocampal sclerosis (MTLE with HS)	• Malformation of cortical development

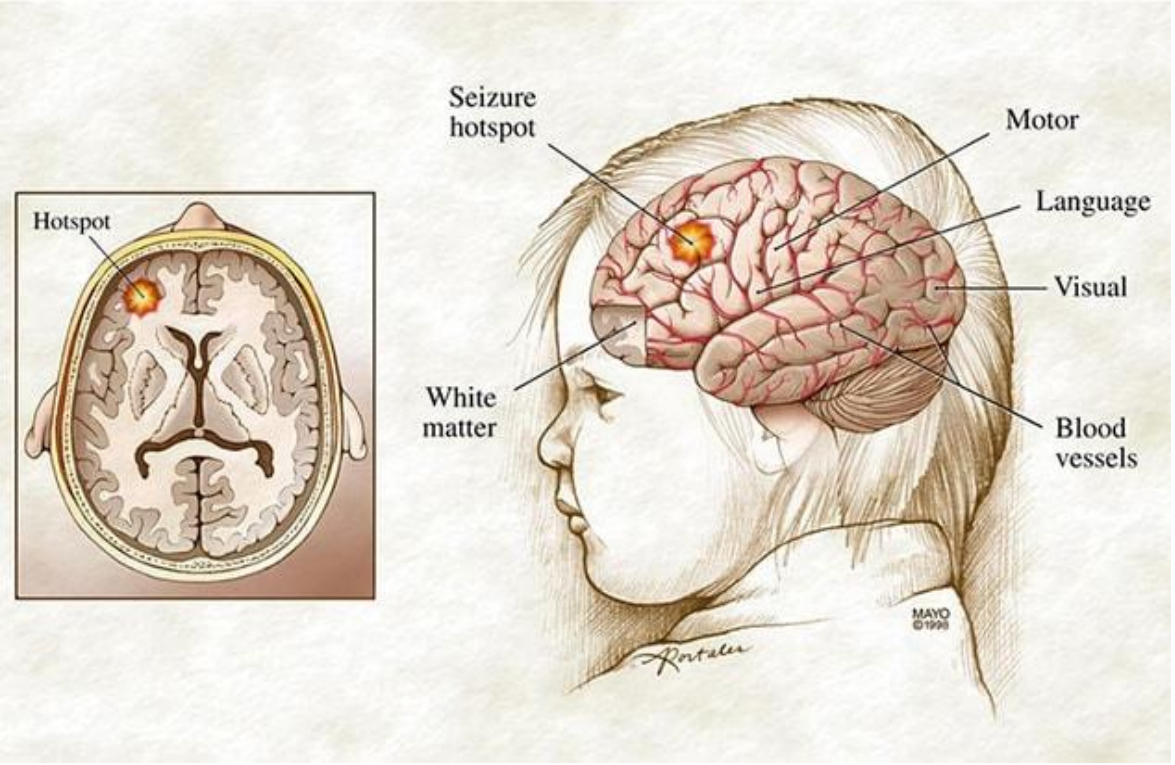
• Lesional epilepsy in non-eloquent cortex:
  • LEAT: DNET, Ganglioglioma
  • Vascular malformation: Cavernoma
  • Gliotic scar
	• Focal epilepsy with
	  • MRI negative
	  • Discordant electroclinical data
	  • Adjacent to eloquent cortex
	  • Multifocal pathology

• Hemispheric epilepsy
  • Hemimegalencaphy
  • Hemiconvulsion-Hemiplegia syndrome
  • Sturge-Weber syndrome
  • Rasmussen encephalitis	

Rathore, C. and Radhakrishnan, K. (2015),. Epileptic Disorders, 17: 19-31.

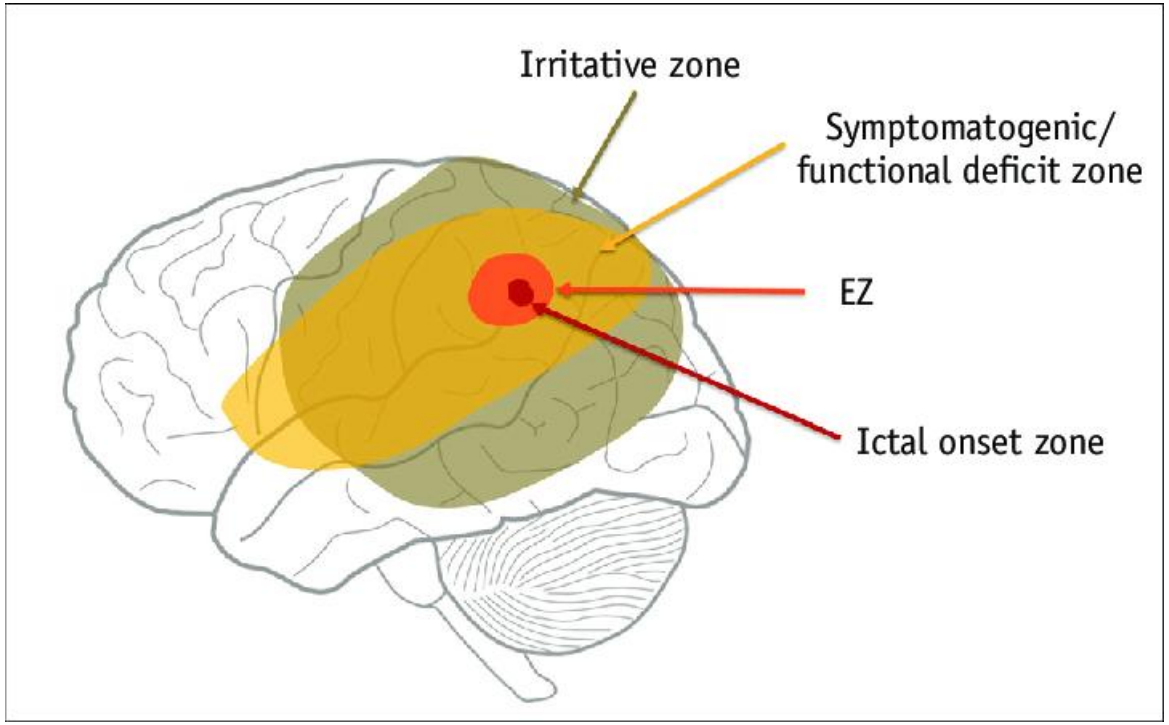
CONCEPTS OF PRE-SURGICAL EVALUATION IN EPILEPSY

- Identification of epileptic cortex → to resect → seizure free
- Preservation of functional cortex (Eloquent cortex) → to spare



Rathore, C. and Radhakrishnan, K. (2015),. Epileptic Disorders, 17: 19-31.

CONCEPT OF EPILEPTOGENIC ZONE “EZ”



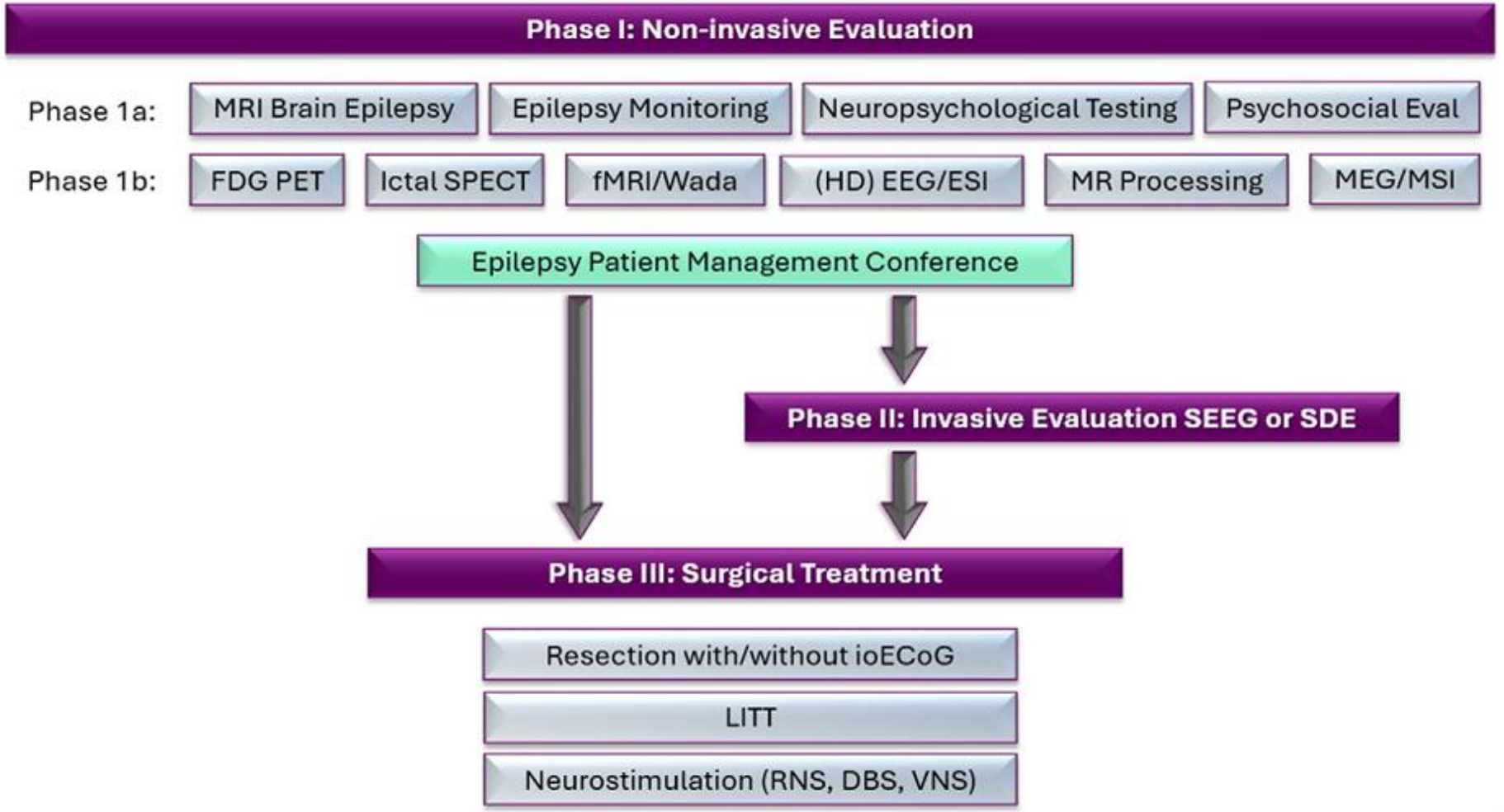
Epileptogenic zone (EZ)

- Zone whose resection is necessary and sufficient to render patient seizure free
- Is an imaginary zone but can be estimated using several data

Localization of EZ is done by

- History taking and Physical exam
- Clinical seizure (Semiology)
- EEG: Inter-ictal and Ictal (EEG onset)
- MRI: Epileptogenic lesion
- Neuropsychology test
- Etc.

PROCESS OF PRESURGICAL EVALUATION



Schuele S, et al. Seminars in epileptology presurgical epilepsy evaluation. Epileptic Disord. 2025;00:1–43.

PHASE IA: NON-INVASIVE PRESURGICAL EVALUATION

Detailed history taking & Physical examination

Admission to Epilepsy Monitoring Unit (EMU)
for Long term EEG monitoring (LVEEG)

MRI epilepsy protocol

Neuro-psychology test

DETAILED HISTORY TAKING AND PHYSICAL EXAM

Purpose of detailed history taking

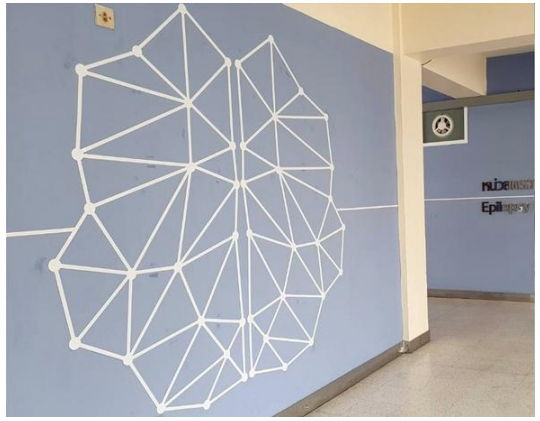
- Established true drug resistant
- Obtain information regarding semiology
- Postulate possible etiology of epilepsy

Epilepsy

- Epilepsy onset
- Detailed description of semiology, Seizure type
- Frequency, chrono-rhythmicity, trigger
- Epilepsy risk factor
- ASM: current, previous, allergy, compliance
- Associated neurological deficit

Rathore, C. and Radhakrishnan, K. (2015),. Epileptic Disorders, 17: 19-31.

EPILEPSY MONITORING UNIT (EMU)



LVEEG monitoring is conducted in EMU

- Designated bed for continuous monitoring of video and EEG
- Trained personnel to examine and assist patient during seizure

Presurgical evaluation

- ASMs are tapered to induce patient habitual seizure.
- Reviewed of EEG data include:
  - Interictal and background activity
  - Ictal EEG onset and clinical correlated
  - Detailed analysis of patient semiology

Schuele S, et al. Seminars in epileptology presurgical epilepsy evaluation. Epileptic Disord. 2025;00:1–43.

MRI EPILEPSY PROTOCOL

Gold standard for identifying epileptogenic lesion

MRI should be reviewed in the context of an electroclinical hypothesis to improve the yield of correctly identifying the often subtle abnormalities associated with DRE

An imaging protocol for people with epilepsy should provide both optimal volumes for visual assessment and ideal input data for postprocessing.

TABLE 3 MRI routine protocol optimized for individuals with epilepsy.

Sequence	Cut-plane orientation	Cut-plane angulation
3D T1	Three-dimensional	ac-pc
3D FLAIR	Three-dimensional	ac-pc
T2	Coronal	ac-pc[a]/lha[b]
FLAIR	Coronal	ac-pc[a]/lha[b]
T2	Axial	ac-pc[a]/lha[b]
FLAIR	Axial	ac-pc[a]/lha[b]
Hemo/Calc	Axial	ac-pc

Schuele S, et al. Seminars in epileptology presurgical epilepsy evaluation. Epileptic Disord. 2025;00:1–43.

SPECIAL REPORT

Epilepsia®

Recommendations for the use of structural magnetic resonance imaging in the care of patients with epilepsy: A consensus report from the International League Against Epilepsy Neuroimaging Task Force

Andrea Bernasconi[1] | Fernando Cendes[2] | William H. Theodore[3] | Ravnoor S. Gill[1] | Matthias J. Koepp[4] | Robert Edward Hogan[5] | Graeme D. Jackson[6] | Paolo Federico[7] | Angelo Labate[8] | Anna Elisabetta Vaudano[9] | Ingmar Blümcke[10] | Philippe Ryvlin[11] | Neda Bernasconi[1]

Epilepsia. 2019;60:1054–1068.

EPILEPSY PROTOCOL – 3D MRI

T1-weighted

Sequence type: gradient echo

Voxel size (mm): 1 x 1 x 1

Best to evaluate: anatomy and morphology (volume, thickness, sulco-gyral shape, grey-white matter interface integrity)

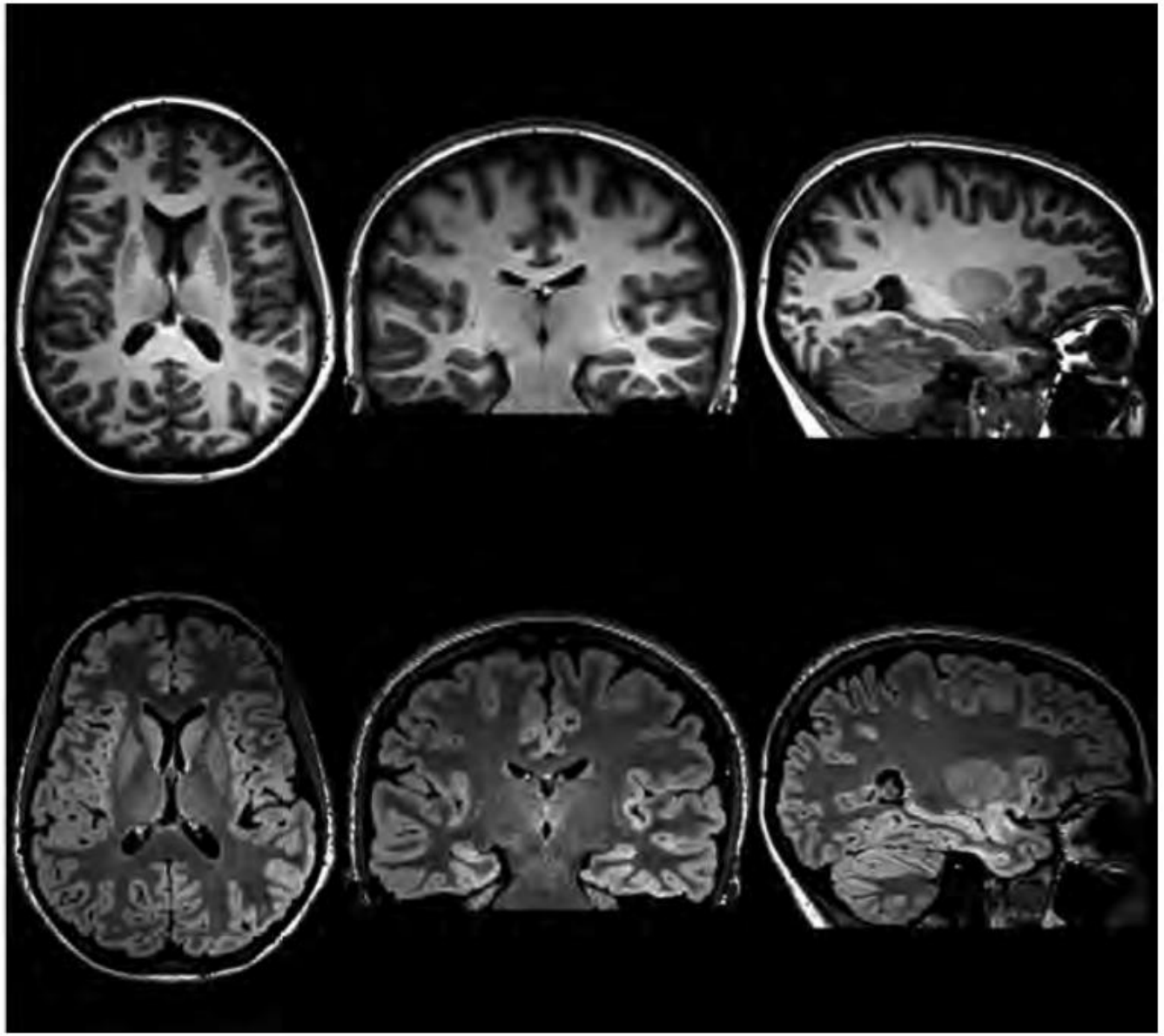
FLAIR

Sequence type: turbo spin echo

Voxel size (mm): 1 x 1 x 1

Best to evaluate: signal intensity

Caveat - Not sensitive in neonates and children <24 months of age due to incomplete myelination



Epilepsia. 2019;60:1054–1068.

EPILEPSY PROTOCOL – 2D MRI

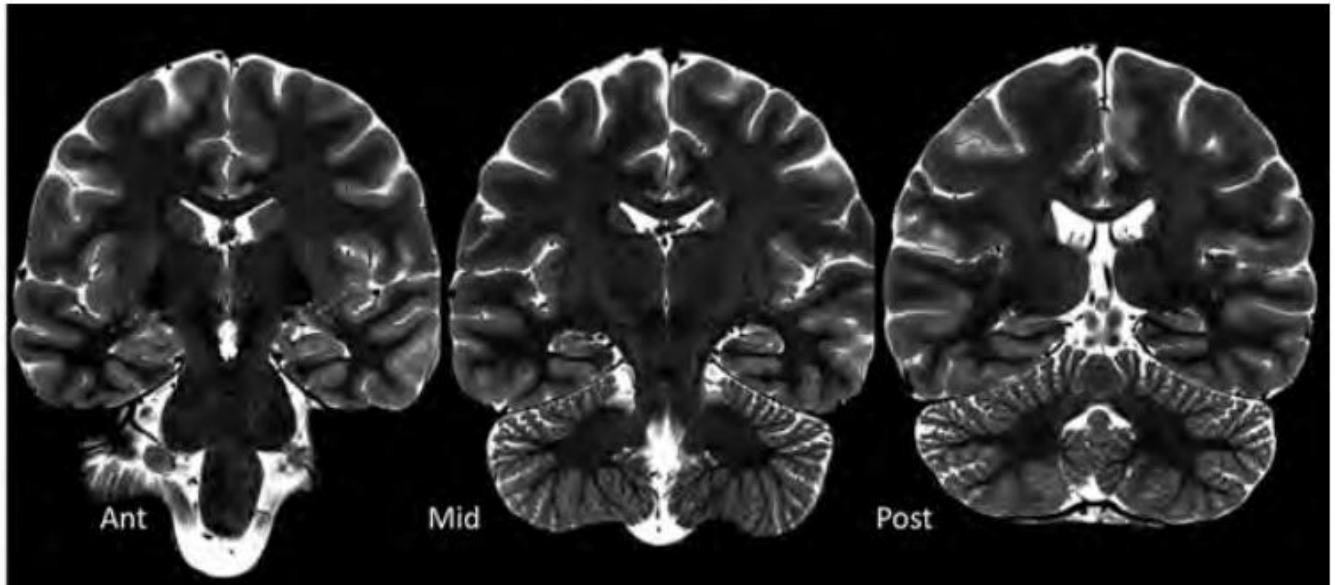
Coronal T2-weighted

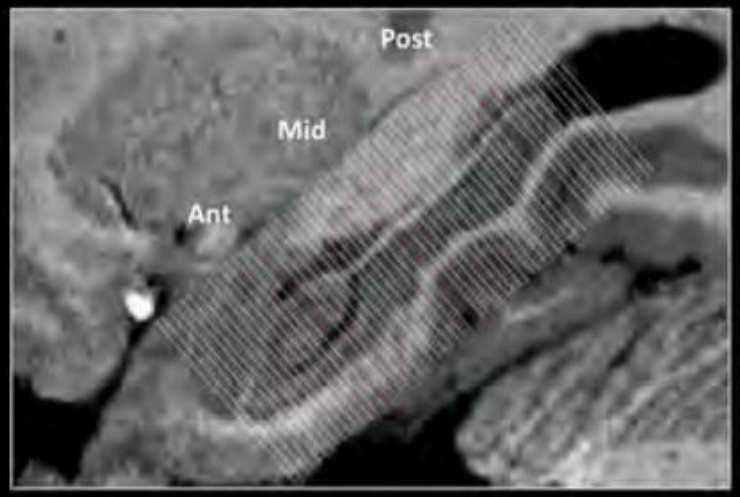
Acquired perpendicular to hippocampal long axis

Sequence type: turbo spin echo

Voxel size (mm): 0.4 x 0.4 x 2; no inter-slice gap

Best to evaluate: Hippocampal internal structure (distinction of CA subfields, dentate gyrus), amygdala, and parahippocampal cortices





Epilepsia. 2019;60:1054–1068.

NEUROPSYCHOLOGICAL EVALUATION

Assessment of pre-operative cognitive deficit and psychosocial status of patient

Providing localization and lateralization, when take into account other data: (Electroclinical, imaging)

Prediction of post-operative cognitive decline

Identify and treat comorbid psychiatric disorder: depression, anxiety etc.

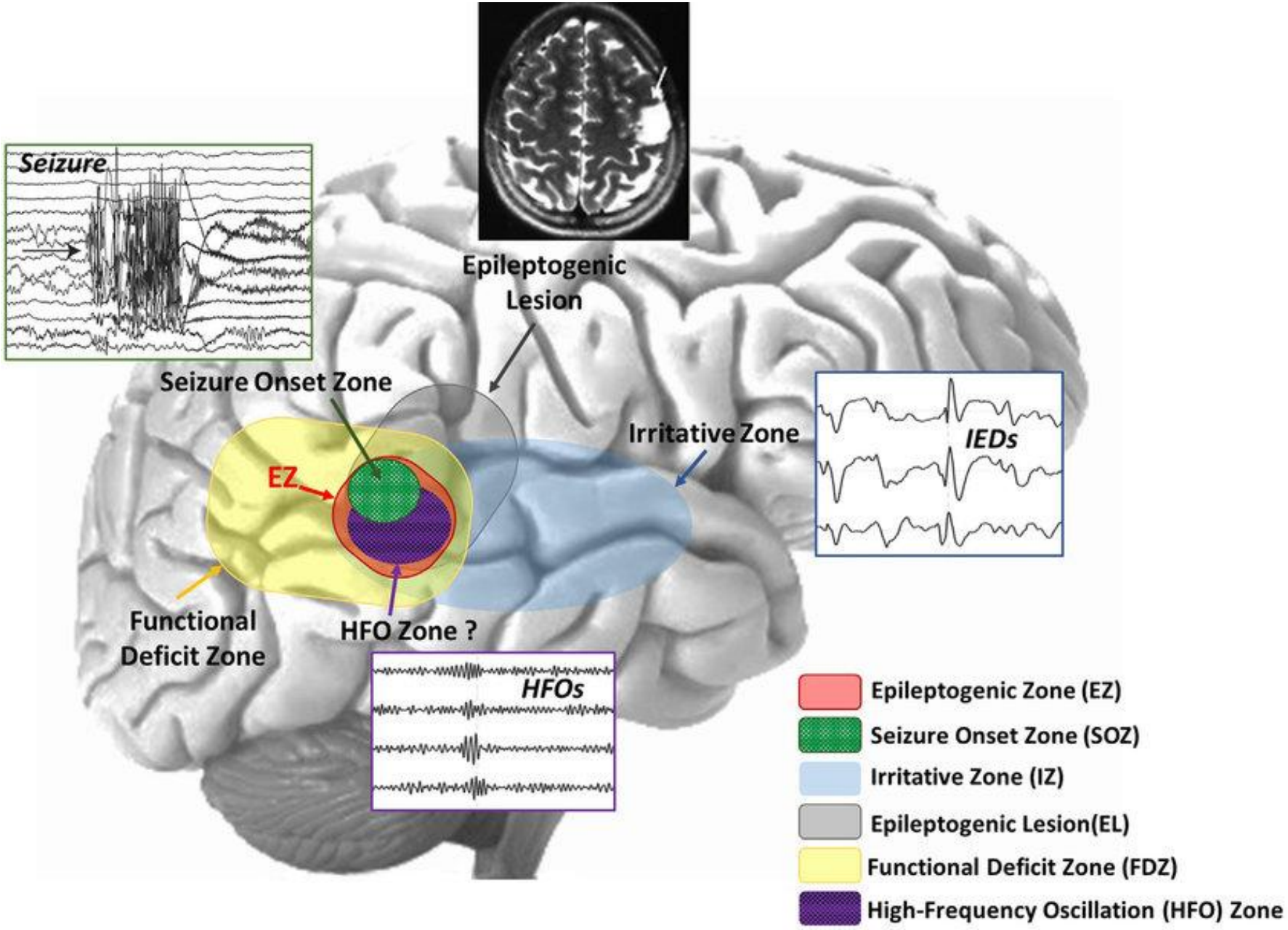
TABLE 4 Domains commonly assessed in a neuropsychological evaluation with test examples.

Domain	Abilities assessed	Test examples[a]
Intellectual ability	Estimate of premorbid function Verbal intellectual abilities Nonverbal intellectual abilities	Advanced Clinical Solutions Test of Premorbid Function, American National Adult Reading Test, Wide Range Achievement Test—Reading subtest Wechsler Verbal Comprehension Index or verbal subtests Wechsler Perceptual Reasoning Index or nonverbal subtests
Attention	Simple attention Complex attention/working memory Sustained attention	Wechsler Digit Span subtest Wechsler Letter-Number Sequencing subtest, Wechsler Arithmetic subtest Continuous Performance Test
Processing speed	Speeded mental/visuomotor skills	Wechsler Coding subtest, Wechsler Symbol Search subtest Trail Making Test – Part A
Language	Naming Verbal fluency	Boston Naming Test, Visual Naming Test Phonemic verbal fluency (e.g., Controlled Oral Word Association Test), Semantic verbal fluency (e.g., Animal Fluency)
Executive functioning	Problem-solving Planning Cognitive flexibility Response inhibition	Wisconsin Card-Sorting Test DKEFS Tower Test, Tower of London Trail Making Test—Part B DKEFS Color-Word Interference, Stroop
Visuospatial skills	Visuoperception Visuoconstruction	Judgment of Line Orientation Wechsler Block Design
Episodic memory	Verbal learning/recall/recognition Visual learning/recognition	Rey Auditory Verbal Learning Test, California Verbal Learning Test, Wechsler Logical Memory Wechsler Visual Reproduction, Brief Visual Memory Test
Motor functioning	Motor speed Manual dexterity	Finger Tapping Grooved Pegboard
Performance validity	Stand-alone and embedded measures of test-taking effort	Various tests (e.g., Victoria Symptom Validity Scale, Word Memory Test, Advanced Clinical Solutions Word Choice, Reliable Digit Span)
Subjective cognition	Self- or caregiver report measures of subjective cognitive abilities (e.g., memory, language)	Memory Assessment Clinics Scale – Epilepsy, Everyday Memory Questionnaire, Everyday Verbal Memory Questionnaire
Social cognition	Theory of mind Social behavior Emotion recognition Empathy Sensitivity to moral and conventional rules	Various tests (e.g., Faux-Pas Test, Strange Stories Test, Reading the Mind in the Eyes Task, Facial Emotion Recognition, Empathy Questionnaire Social Situation Test, Moral/Conventional Distinction Test)
Emotional/Behavioral function	Self- or caregiver-report screening measures of mood, anxiety, behavior	Various tests (e.g., Beck Depression Inventory, Neurological Disorders Depression Inventory in Epilepsy, Patient Health Questionnaire Depression, Child Depression Inventory, Beck Anxiety Inventory, Patient Health Questionnaire Generalized Anxiety Disorder, Child Behavior Checklist)
Psychosocial status/Function	Self- or caregiver report of adaptive functioning	Vineland Adaptive Behavior Scales
Quality of life	Self- or caregiver report measures of health-related quality of life	Quality of Life in Epilepsy, Quality of Life in Childhood Epilepsy

Schuele S, et al. Seminars in epileptology presurgical epilepsy evaluation. Epileptic Disord. 2025;00:1–43.

THE CORTICAL ZONES IN EPILEPSY

Cortical zone	Definition	Diagnostic tool	Notes
Epileptogenic zone	The zone which resection resulted in seizure free	-	Hypothetic zone estimate by using other zones
Symptomatic zone	The zone that generate semiology	History taking Video EEG	Non-eloquent cortex does not generate semiology. Non-primary cortex generates complex semiology, which hard to localize
Irritative zone	The zone that generate interictal discharge	Scalp EEG ESI, MEG	Deep source Area often wider than EZ
Ictal onset zone	The onset zone of EEG seizure	Scalp EEG ESI, ictal SPECT	Deep source Unclear onset in scalp
Functional deficit zone	The area that shows impairment in interictal period	NP test PET scan	-
Epileptogenic lesion	The lesion responsible for generating seizure	MRI brain VBM	Multifocal lesion Lesion negative MRI
Eloquent cortex	The zone which resection resulted in neurological deficit	NP test fMRI, WADA test	-



Tamilia E, et al Current and Emerging Potential of Magnetoencephalography in the Detection and Localization of High-Frequency Oscillations in Epilepsy. Front. Neurol. 8:14

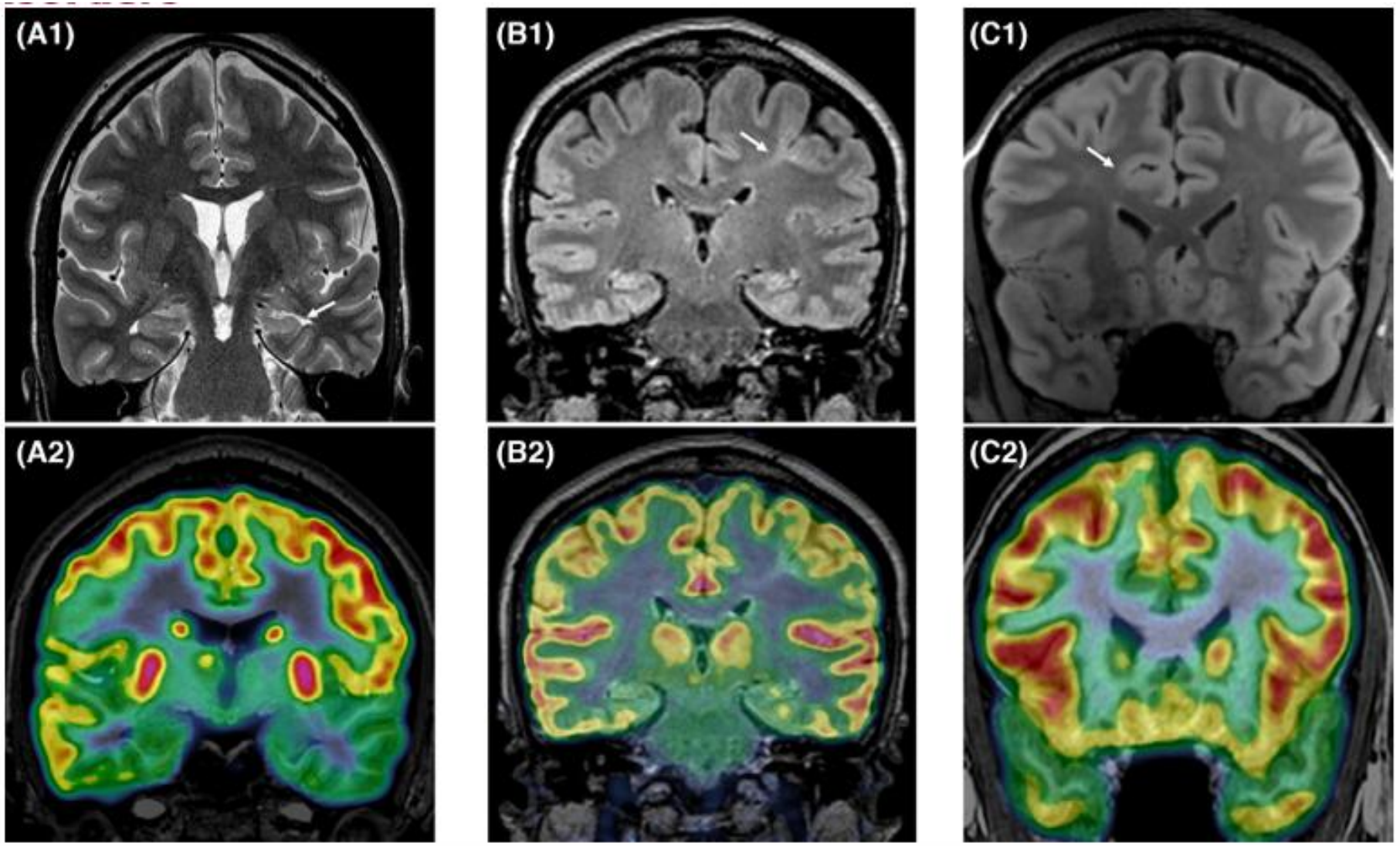
PHASE IB: (ADDITIONAL) NON-INVASIVE PRESURGICAL EVALUATION

Additional test done to complement the result of phase 1a and to generate hypothesis for phase 2

Test	Principle	Advantage	Disadvantage
FDG-PET	EZ demonstrated hypometabolism in PET during interictal period	• Provide the data of "Functional deficit zone" • Can be co-registered with MRI to search for epileptogenic lesion	• Area of hypometabolism tend to be wider than primary EZ
Ictal SPECT	Hyper-perfusion in the area of ictal onset	• Provide the data of "Ictal onset zone" • Can be subtracted (Ictal – interictal) and reregistered with MRI (SISCOM)	• The result depend on timing of injection, duration of seizure and generalization
MRI post-processing	Using voxel based morphometry to compare patient T1 MRI to large normative database and highlight abnormal in gray-white junction and abnormal cortical thickness	• Complement visual analysis of MRI • Can aid in detecting subtle MRI abnormality • Cheap and can be rapidly done can be integrated into routine practice	• False positive result

Schuele S, et al. Seminars in epileptology presurgical epilepsy evaluation. Epileptic Disord. 2025;00:1–43.

FDG-PET CO-REGISTERED WITH MRI



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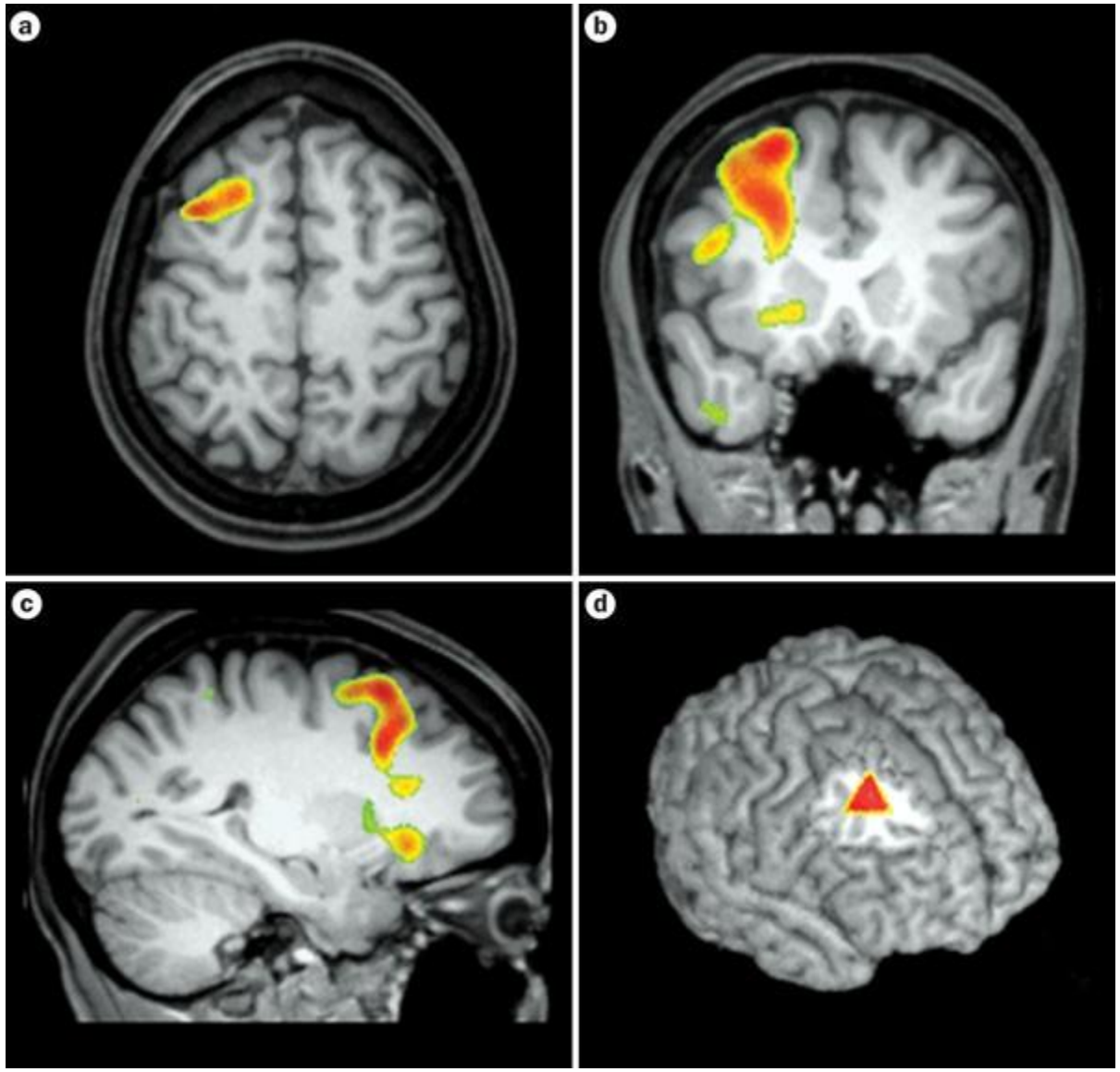
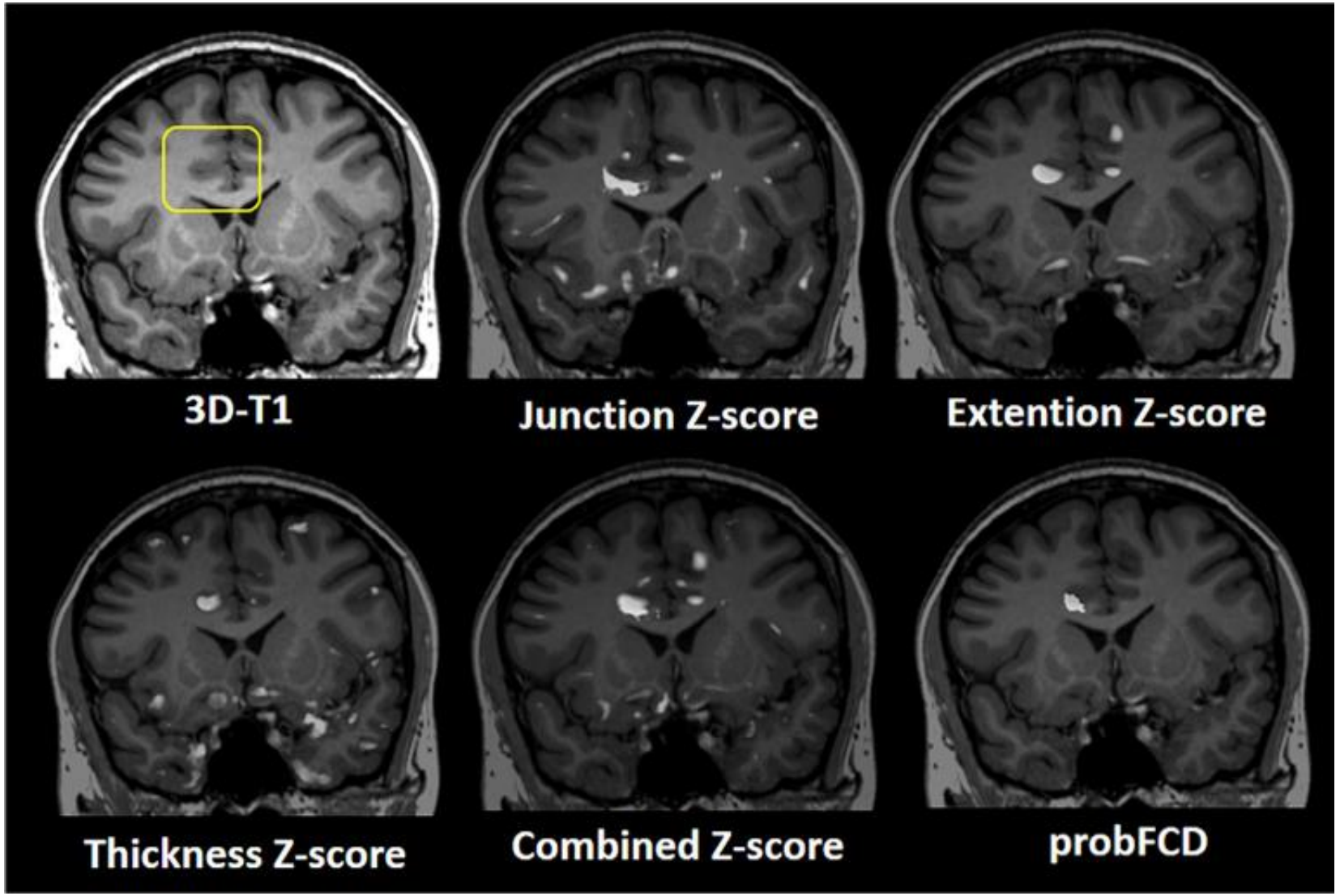


SISCOM

('subtraction ictal SPECT coregistered to MRI')

Nature Reviews Neurology **volume 7**, page240 (2011)

MRI POST-PROCESSING USING MAP18



Schuele S, et al. Seminars in epileptology presurgical epilepsy evaluation. Epileptic Disord. 2025;00:1–43.

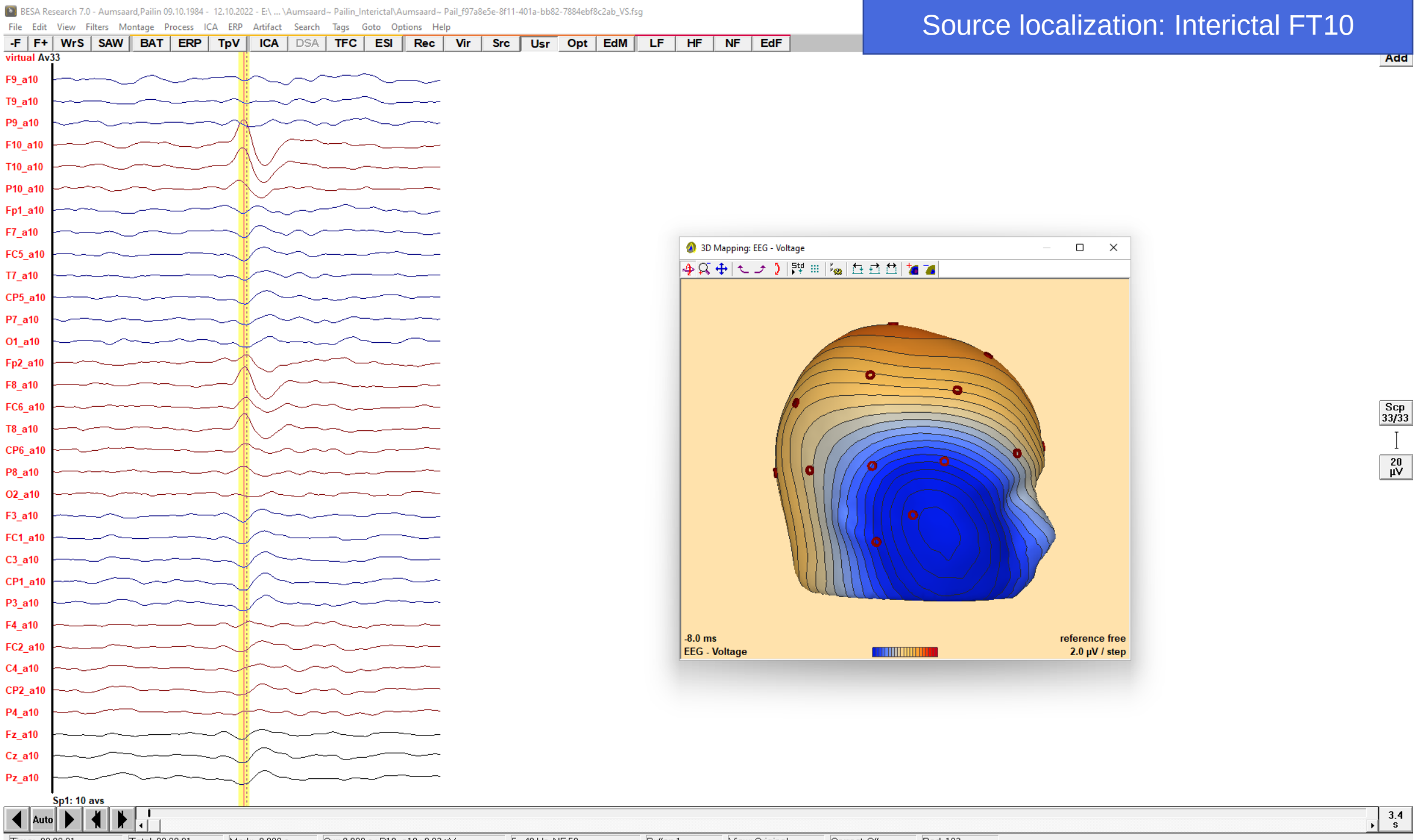
PHASE IB: (ADDITIONAL) NON-INVASIVE PRESURGICAL EVALUATION

Additional test done to complement the result of phase 1a and to generate hypothesis for phase 2

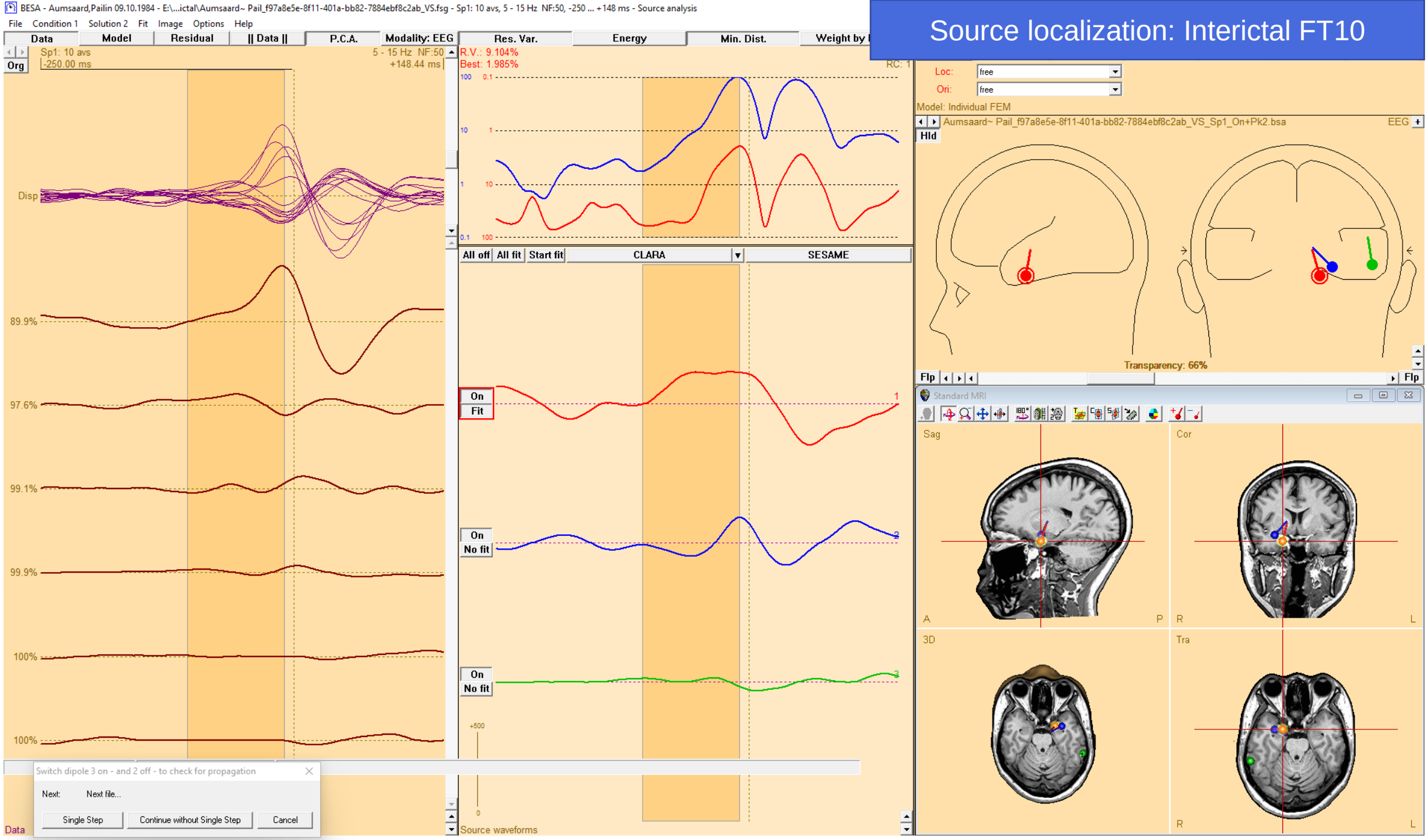
Test	Principle	Advantage	Disadvantage
Electrical source imaging	Mapping of electrical activity (interictal and ictal) to MRI brain	• Provide the data of “irritative zone” and “ictal onset zone” • Cheap and can be rapidly done can be integrated into routine practice	
Functional MRI	Task-based: Detect BOLD signal upon neural activation of each stimulation paradigms	• Identification of eloquent cortex: Broca, Wernicke, hemispheric dominance, Motor cortex • Non –invasive test	• Require cooperation of patient
WADA test	Performed by injecting anesthetic substances into the internal carotid artery in the interictal phase to temporarily inactivate the functions of one hemisphere.	• Determine the hemispheric lateralization of language function and the risk of postoperative memory impairment.	• Invasive procedure required angiogram • Limitation in assessment of memory (hippocampus is supplied by posterior circulation)

Schuele S, et al. Seminars in epileptology presurgical epilepsy evaluation. Epileptic Disord. 2025;00:1–43.

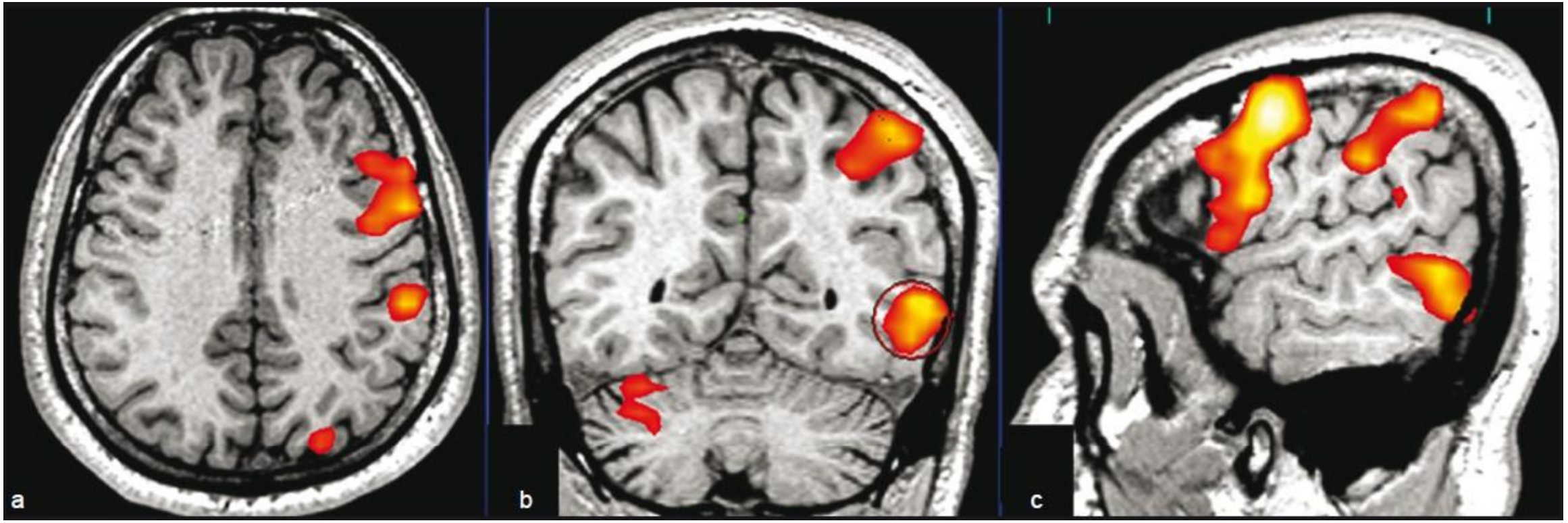
Source localization: Interictal FT10



Source localization: Interictal FT10

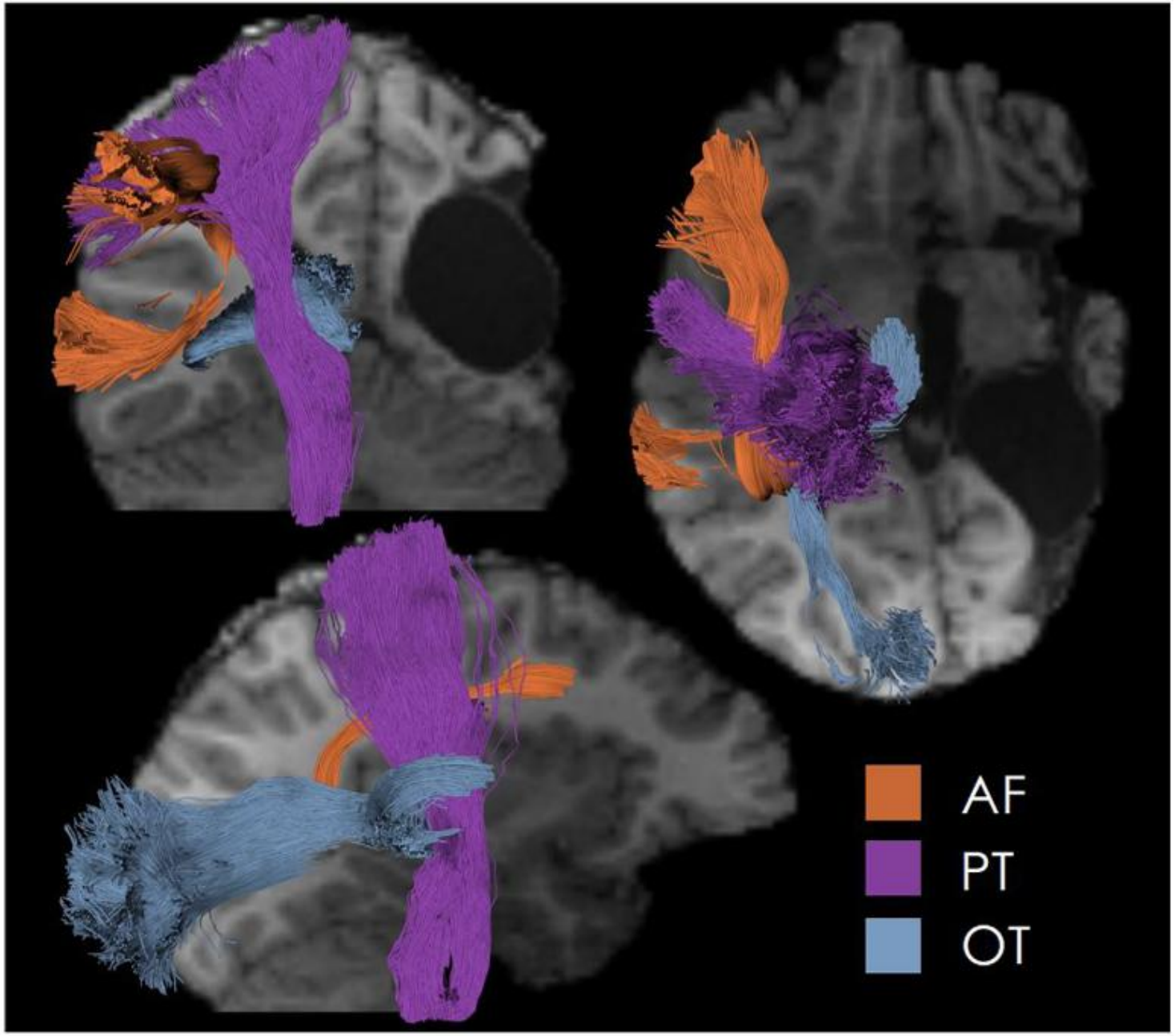


TASK-BASED FMRI



Left language lateralization on verbal fluency task: real-time fMRI processing

Vaghela V, Neurol India 2010;58:879-85



DIFFUSE TENSOR IMAGING (DTI)

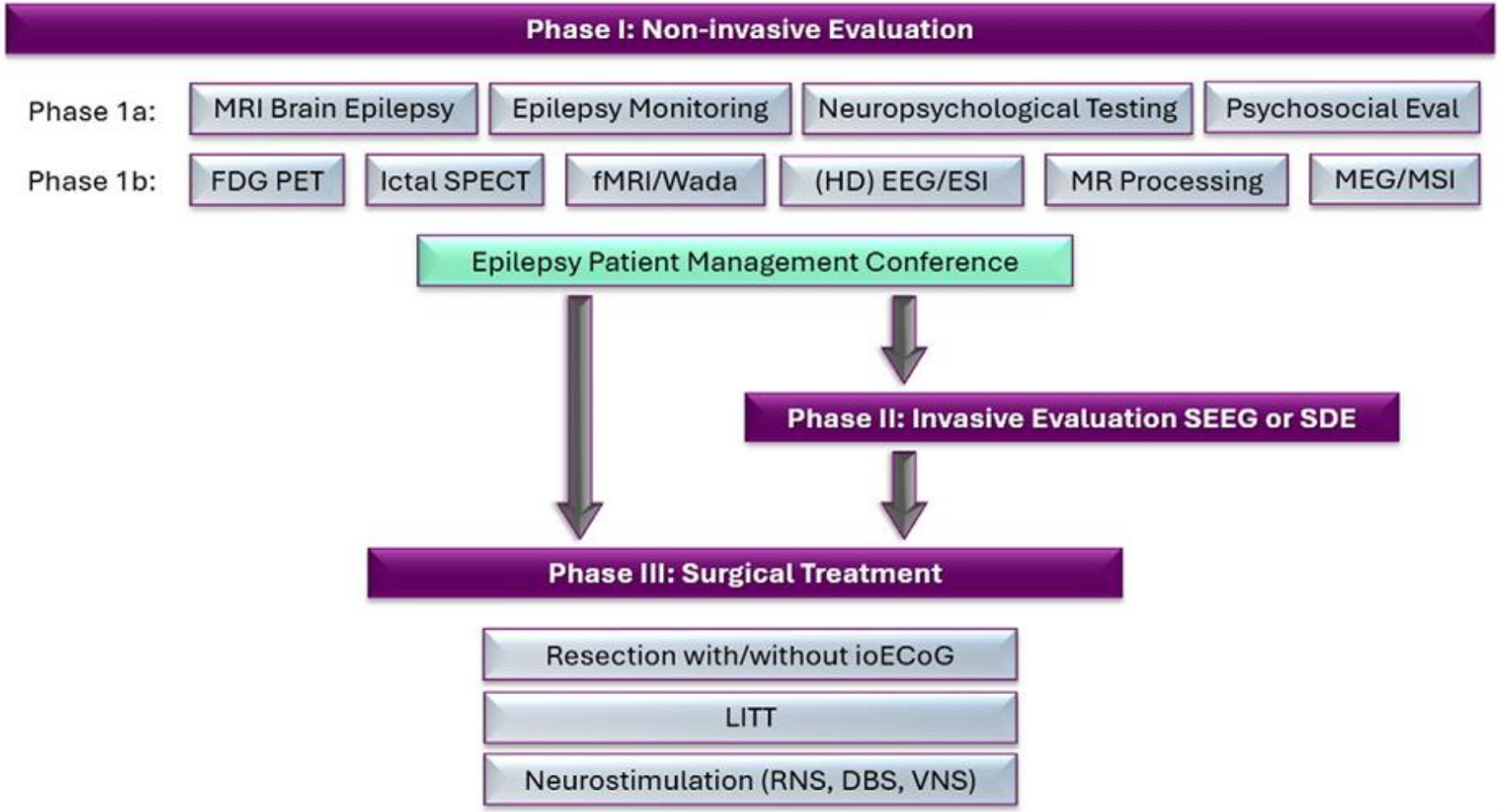
Schuele S, et al. Seminars in epileptology presurgical epilepsy evaluation. Epileptic Disord. 2025;00:1–43.

PATIENT MANAGEMENT CONFERENCE (PMC)

- Multi-disciplinary, presurgical conference to provide optimal, consensus based surgical management of individual patient
- The presurgical data of each patient are presented and discussed including: History, Video-EEG, Neuroimaging, Neuropsychological test (NP)
- The goal of the conference is to provide a consensus process determining if the patient is a suitable surgical candidate, identifying the best procedure given all available information, and estimating the chance of success and potential risks of the procedure.

Lado FA, Ahrens SM, Riker E, Muh CR, Richardson RM, Gray J, et al. Guidelines for specialized epilepsy centers: executive summary of the report of the National Association of epilepsy centers guideline panel. Neurology. 2024;102(4):e208087.

PROCESS OF PRESURGICAL EVALUATION



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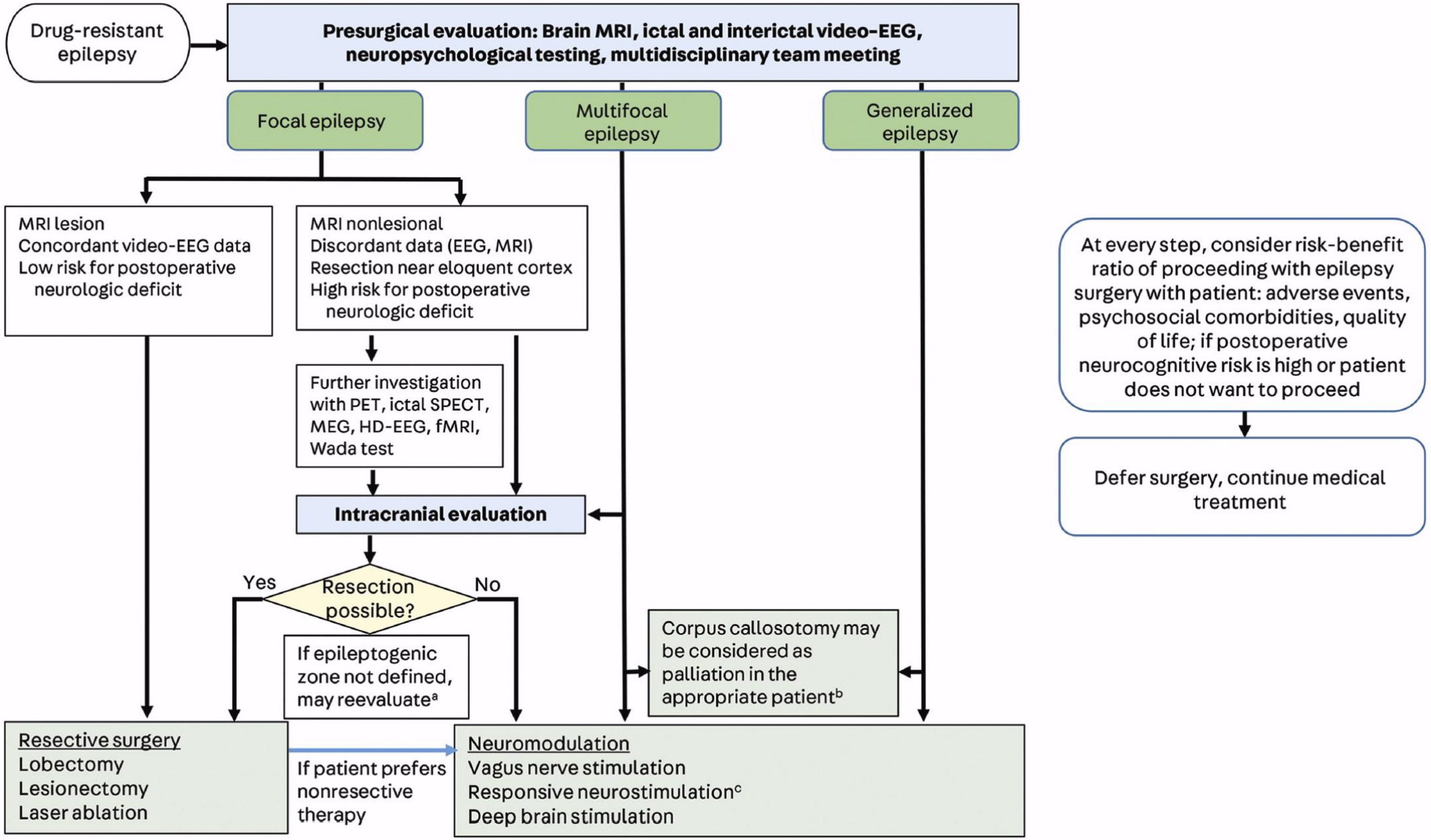


CONTINUUM (MINNEAP MINN)2022;28(2, EPILEPSY):536–558.

PHASE II: INVASIVE EVALUATION

Indication for invasive evaluation

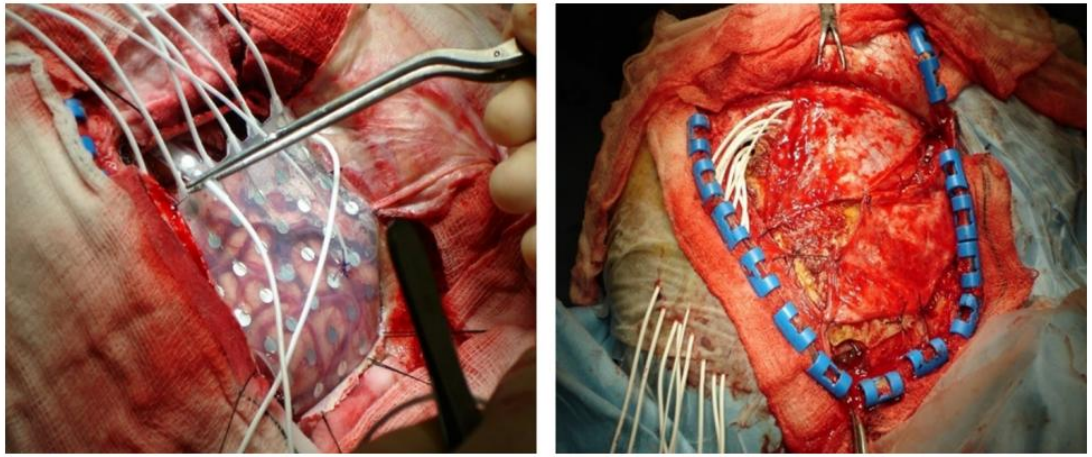
- Phase I data can generate strong hypothesis of single epileptogenic focus but data is insufficient to proceed directly to surgery
  - MRI negative
  - Discordant electroclinical or imaging features
  - Resection close to eloquent cortex
- Invasive EEG is used to confirm hypothesis regarding the epileptogenic zone

Types of invasive evaluation

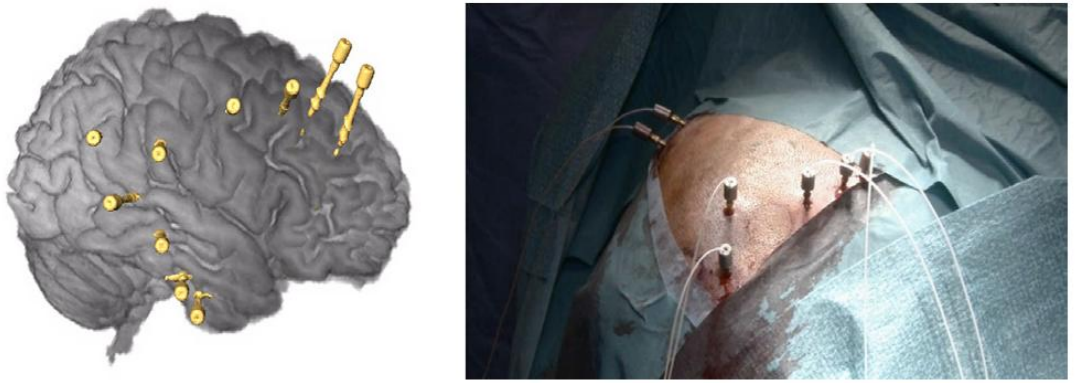
1. Subdural grid (SDG)
2. Stereo-electroencephalography (SEEG)

Process during invasive monitoring

1. EEG: Background activity, inter-ictal activity
2. Anatomo-electrico-clinical-correlation (AEC) of patient habitual seizure
3. Electrical stimulation and mapping



Subdural grid (SDG)



Stereo-electroencephalography (SEEG)

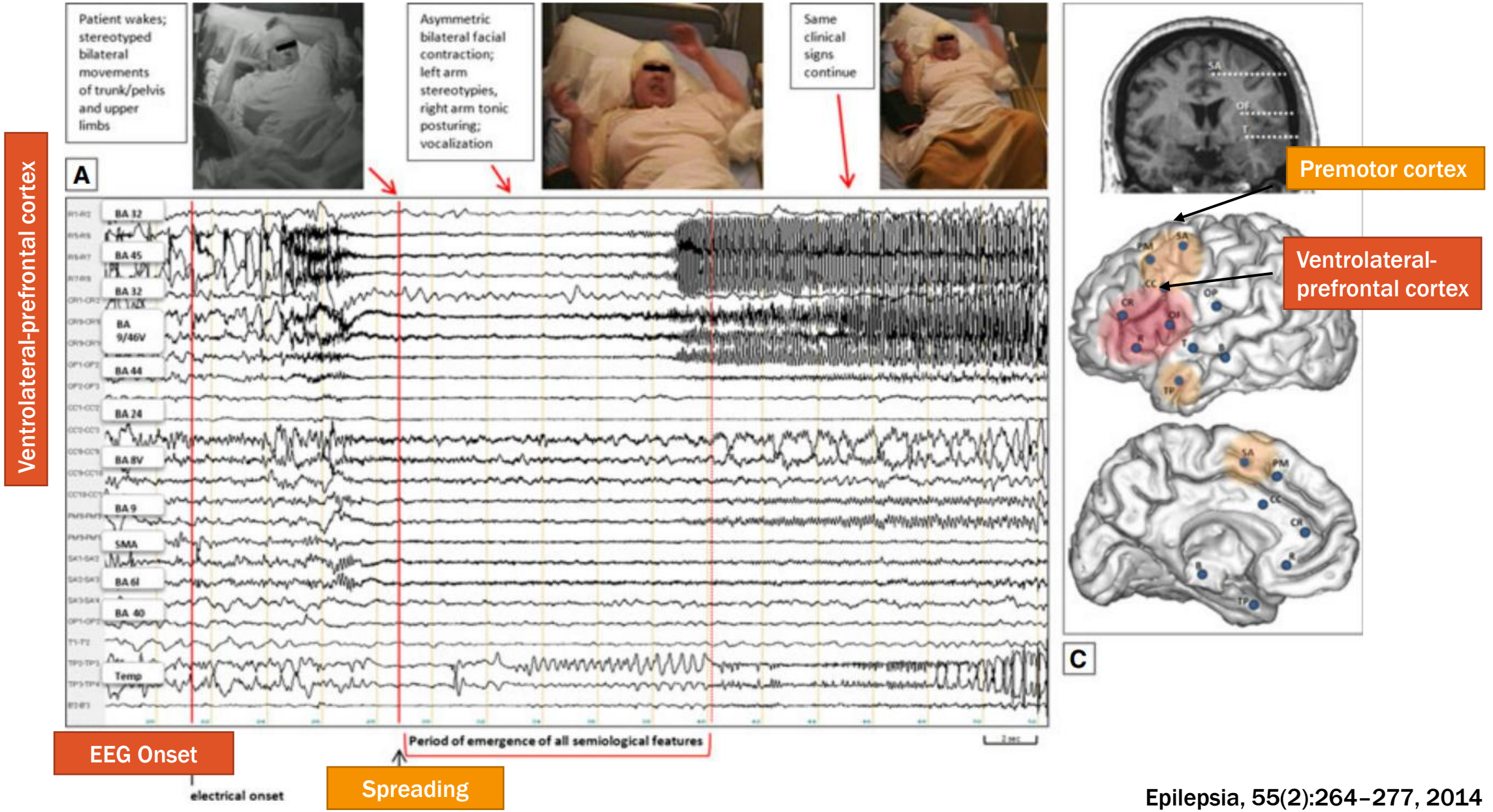
Rugg-Gunn F, et al. Pract Neurol 2019;0:1–13.

COMPARISON: SDG VS. SEEG

	Advantages	Disadvantages
Stereo-EEG	Maps three-dimensional epileptogenic networks, including easier sampling of spatially distinct and deep regions (eg, periventricular gray matter heterotopia, insular, depth-of-sulcus regions) Easily samples bilateral hemispheres No craniotomy, decreased perioperative pain, and shorter recovery time Lower rate of serious adverse events	Limited spatial sampling of electrical activity from tissue directly around each electrode Does not map spatially continuous coverage of brain surface gyri Less feasible in young children (requires bone thickness > 2 mm)
Subdural grid electrodes	More precise functional mapping when the epileptogenic zone involves cortical regions adjacent to eloquent cortex Craniotomy has been performed, and resection can occur when electrodes come out Depth electrodes may be added to sample deep structures of interest; however, the accuracy may be affected because of shifting of the brain after craniotomy	Higher rates of serious adverse events Sampling of insula is difficult and high risk Sampling bilateral hemispheres is challenging (ie, bilateral craniotomies) Cannot sample gray matter in sulci (eg, depth-of-sulcus lesions)

CONTINUUM (MINNEAP MINN)2022;28(2, EPILEPSY):536–558.

EXAMPLE OF AEC (ANATOMO-ELECTRICO-CLINICAL CORRELATION)



Epilepsia, 55(2):264–277, 2014

ELECTRICAL STIMULATION AND MAPPING

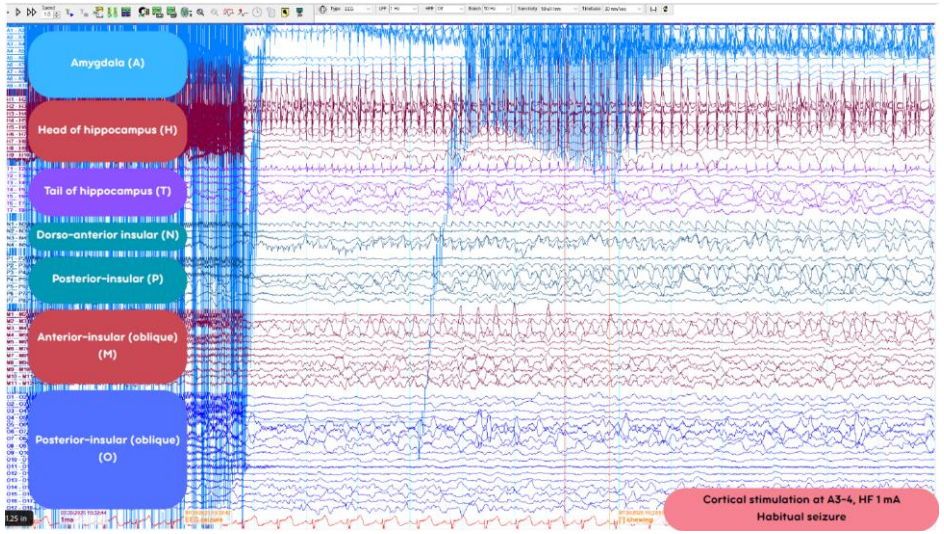
Electrical stimulation delivered via invasive electrodes.

Objective

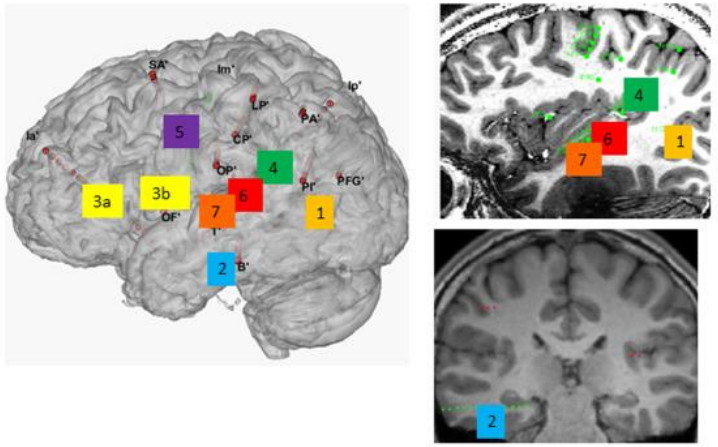
- Mapping of eloquent cortex: Language, Motor, Visual etc.
- Eliciting seizure
- To assess overlapping of EZ and functional cortex

Perform at the end of invasive EEG recording

ASM should be resumed prior to stimulation.



A



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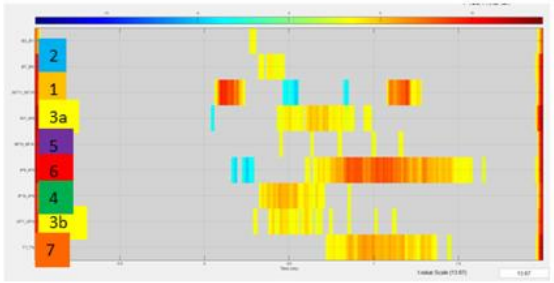
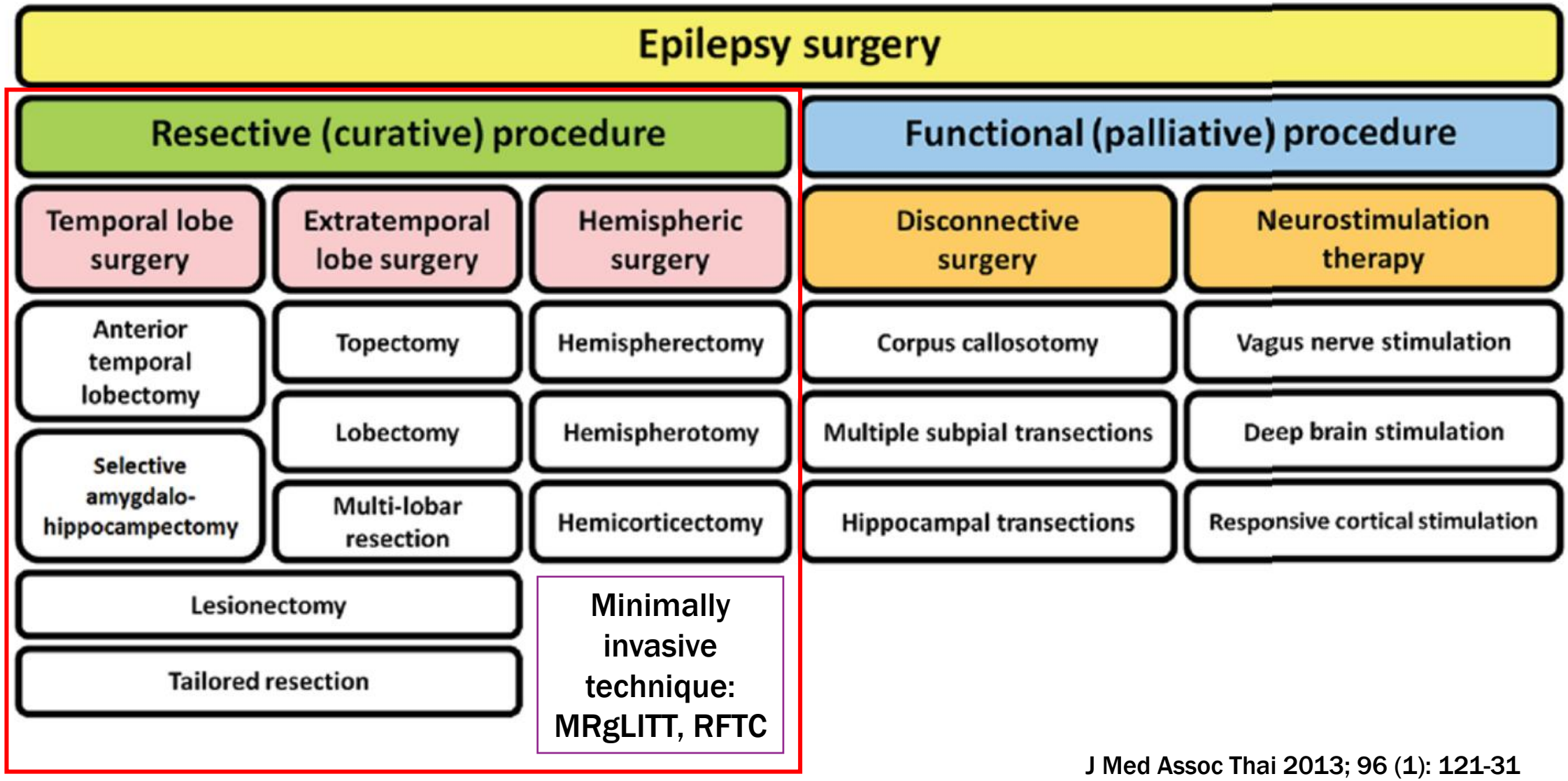


C

Anatomical	N°	s	mA	AD	Task	
Occipital Lateral	1	5	1,5	0	Naming	Visual perceptive deficit of the picture (black form masks the picture)
aBTA	2	5	1,5	0	Naming	Naming deficit with access to semantic information (gesture of "crab")
IFG (PreC)	3b	5	1,5	0	Naming	No deficit
IFG (pars Tri)	3a	5	1,5	0	Naming	Naming latency >5s to find 'artichoke'
sTPJ	4	5	1,5	0	Words repetition	Stop repetition, difficulty maintaining phonological loop, "difficult to keep the word in mind"
sTPJ	4	5	1,2	0	Pataka	Slight slowing of motor aspect
Pre Motor	5	5	1,5	0	Automatic speech	Counting slow and stops repetitive gesture
Auditoty Cortex (PAC)	6	5	1	0	Words repetition	No repetition deficit, auditory hallucination
Auditoty Cortex (AAC)	7	5	1,5	0	Words repetition	Stop repetition, auditory illusion

Agnès Trébuchon, Daniel L. Drane, Chapter 10 - Electrical Stimulation for Functional Mapping During SEEG Exploration, Editor(s): Patrick Chauvel, Aileen McGonigal, Guy M. McKhann II, Jorge álvaro González-Martínez, Fundementals of Stereoelectroencephalography, Elsevier, 2025, Pages 129-153,

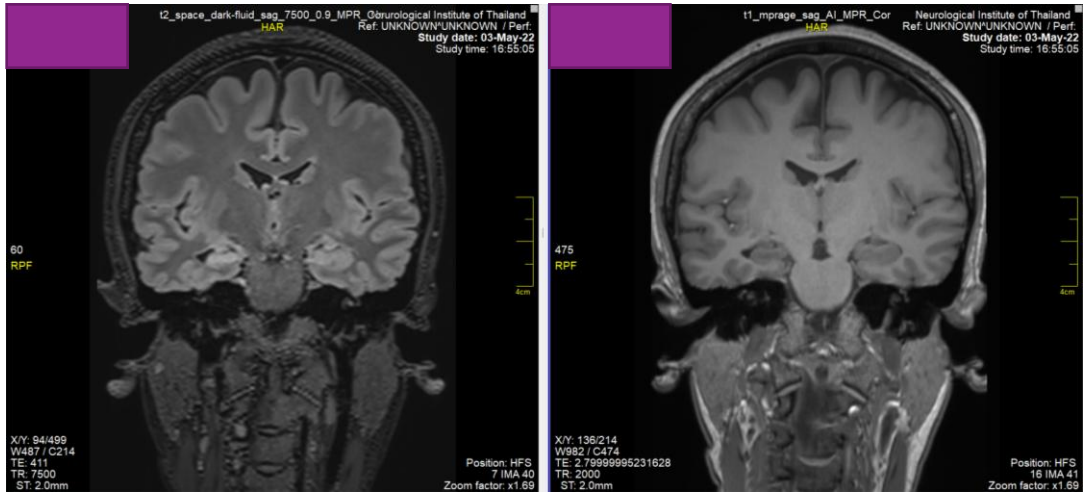
TYPE OF EPILEPSY SURGERY



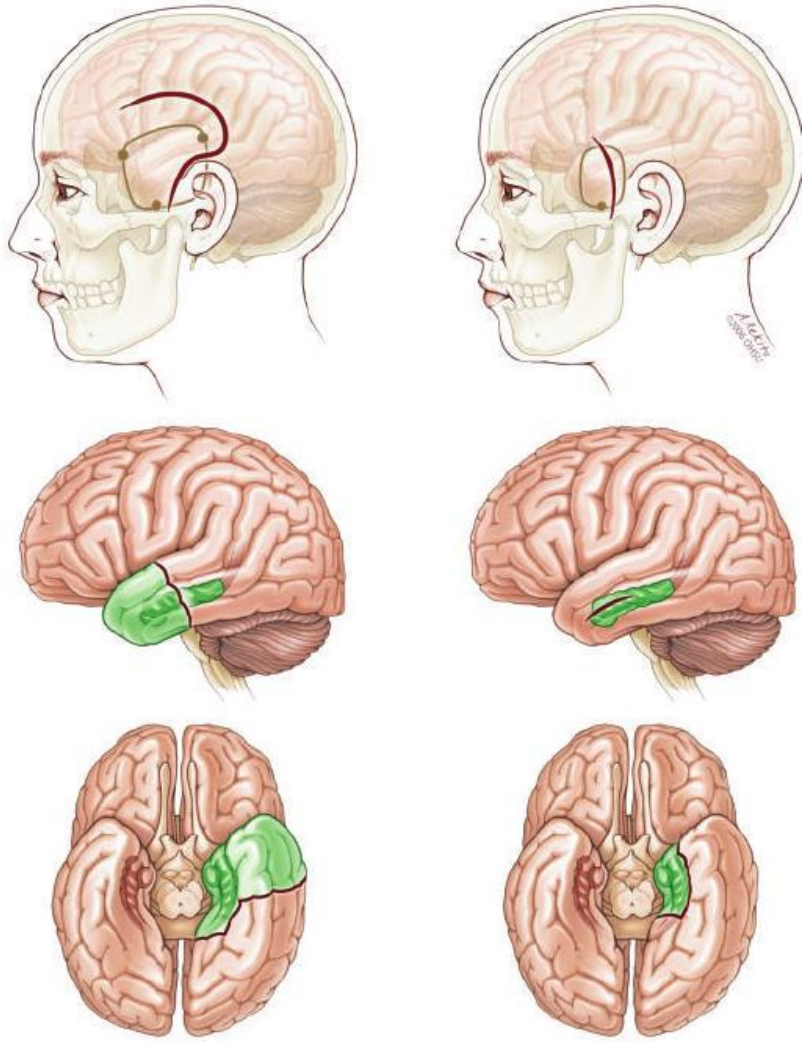
J Med Assoc Thai 2013; 96 (1): 121-31

TEMPORAL LOBE SURGERY

- Substrate: Hippocampal sclerosis (HS)
- Choice of surgery
  - Anterior temporal lobectomy (ATL)
  - Selective amygdalo-hippocampectomy (SAH)
  - Minimally invasive technique:
    - MRI-guided Laser interstitial thermal therapy (MRgLITT)
    - Radiofrequency Thermocoagulation (RFTC)

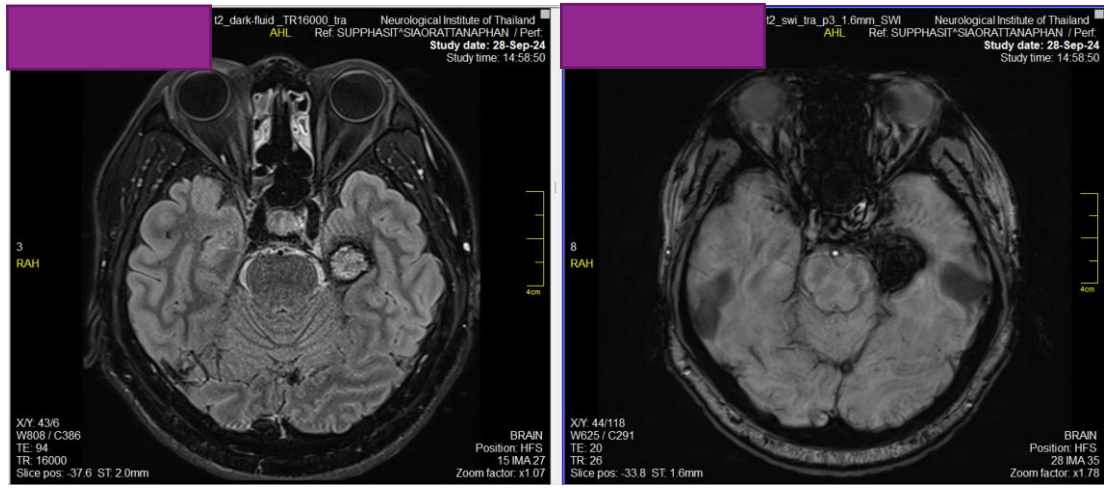


Right mesial temporal sclerosis

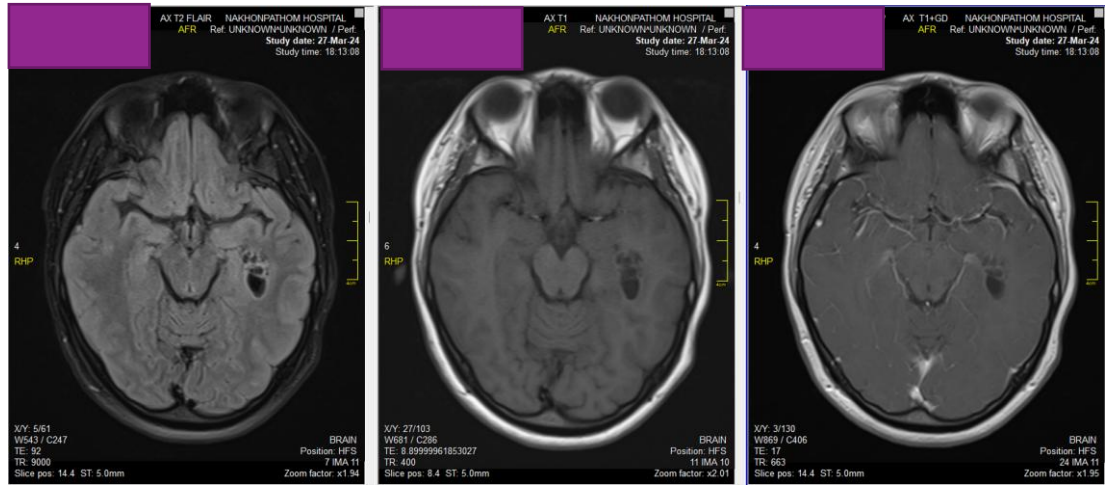


LESIONECTOMY

- Surgical resection of epileptogenic lesion
- May guided by intraoperative electrocorticography
- Substrate
  - LEAT (Long term epilepsy associated tumor: DNET, Ganglioglioma)
  - Vascular malformation (Cavernoma)
  - Gliotic scar
  - Malformation of cortical development



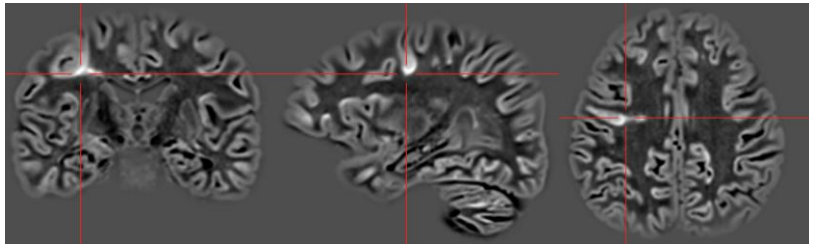
Left mesial temporal cavernoma

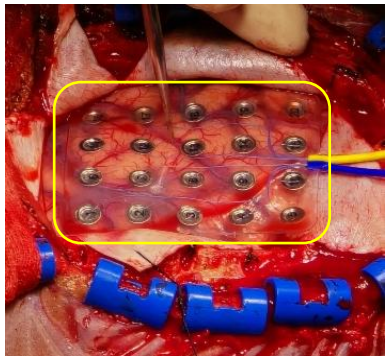


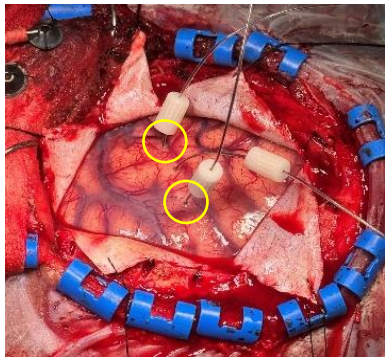
Ganglioglioma at left parahippocampal gyrus

INTRAOPERATIVE ELECTROCORTICOGRAPHY (ECOG)

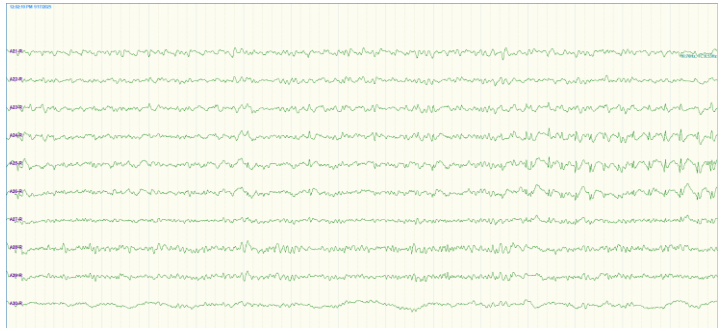
- Placing of electrodes (SDG) during surgery
- Allow instantaneous assessment of irritative zone and guided resection of epileptogenic lesion
- Especially useful in superficial lesion: FCD, cortical based tumor
- Can identify epileptiform discharge post-resection

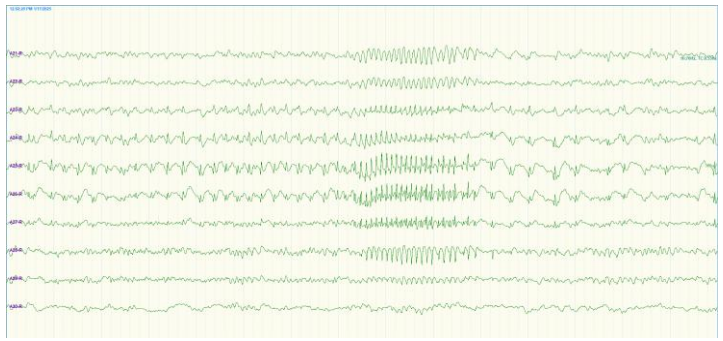




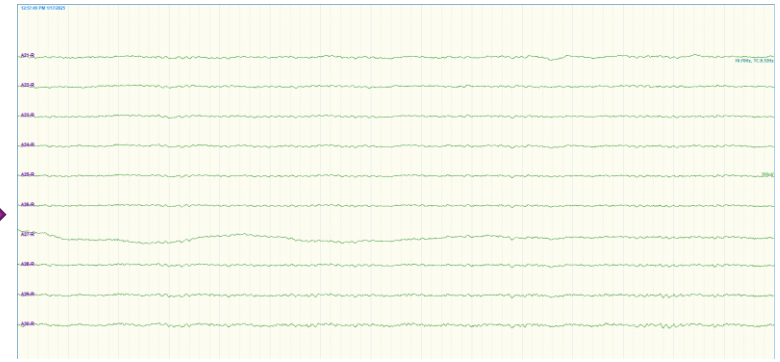


SDG + Depth electrode





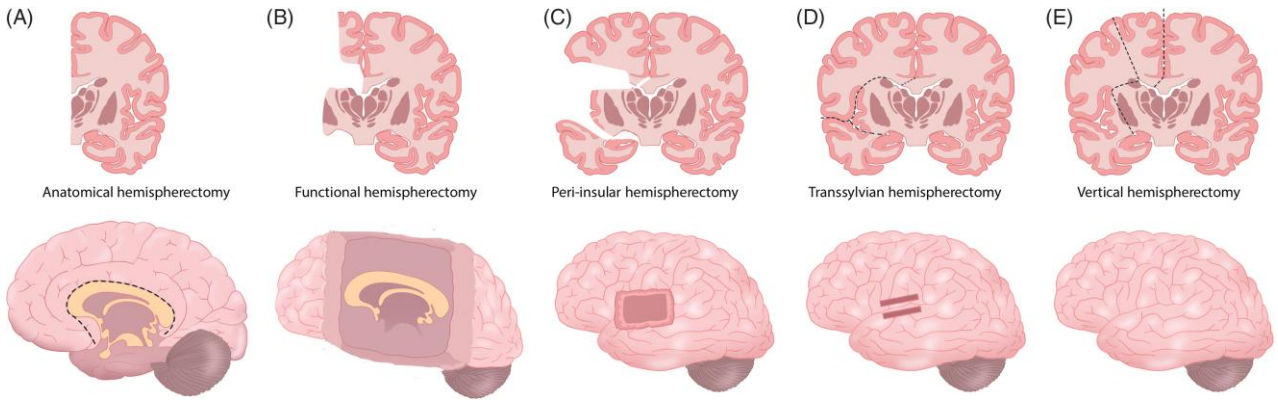
Pre-resection

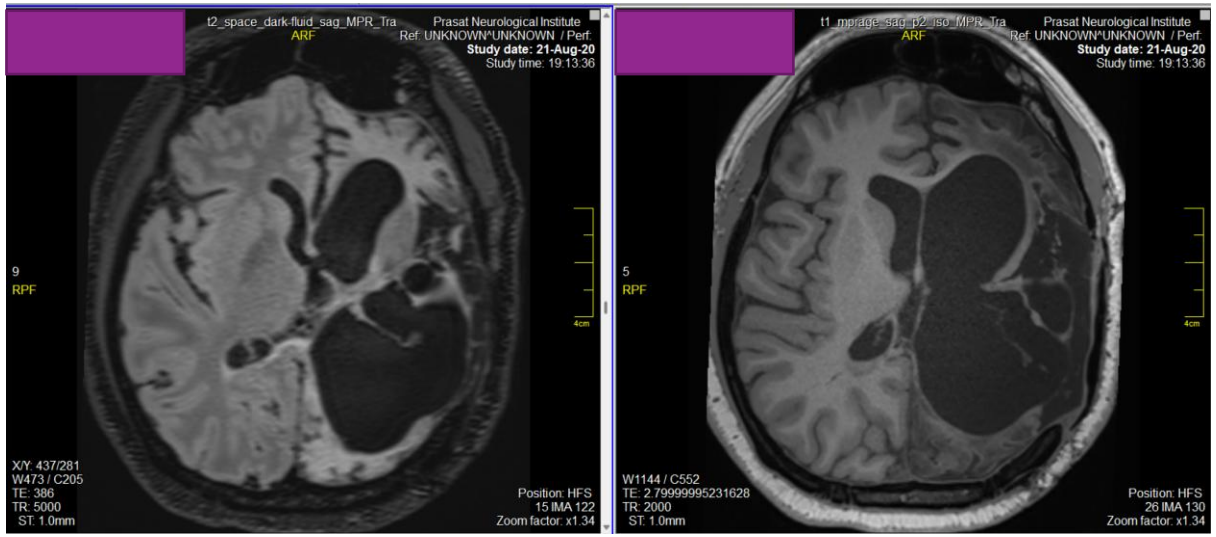


Post-resection

HEMISPHERECTOMY

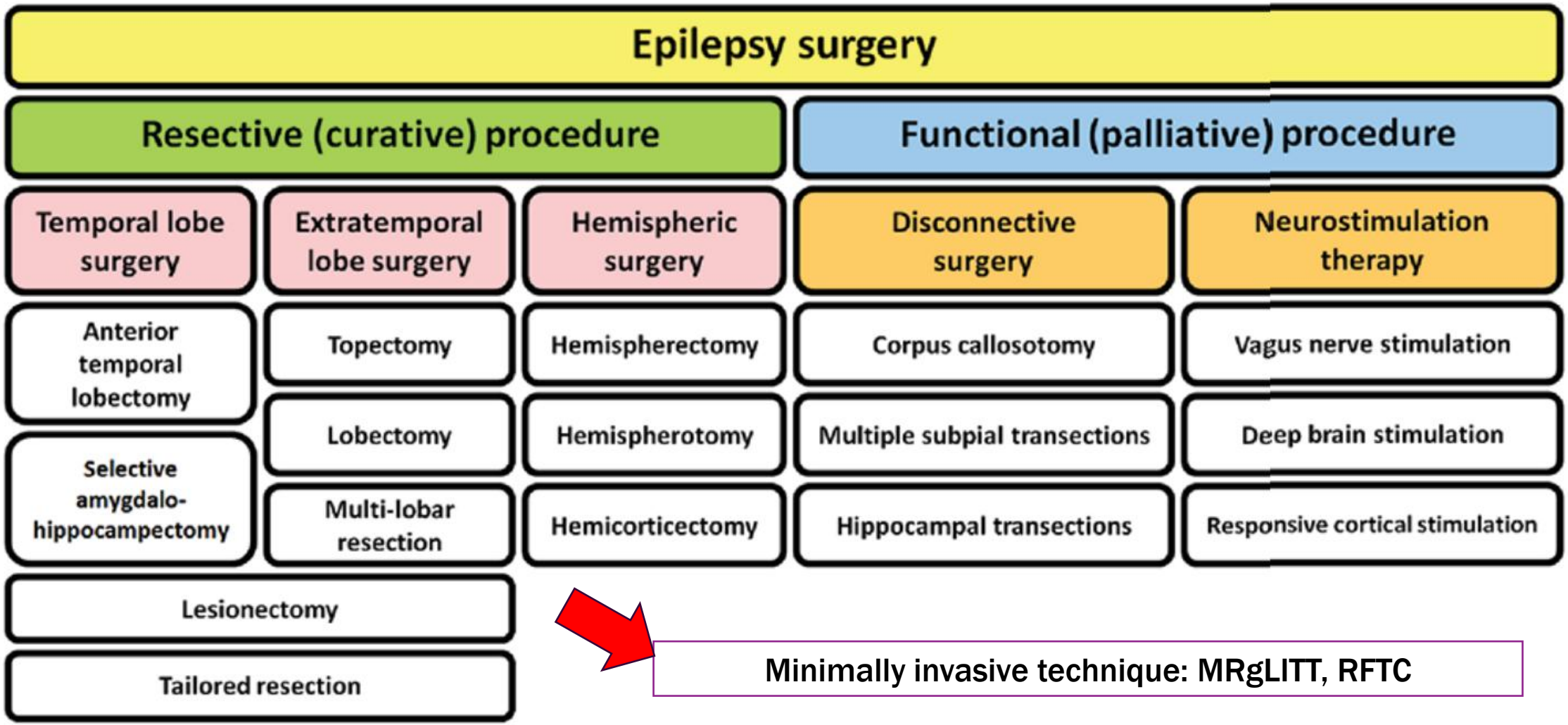
- Anatomical hemispherectomy:
  - Anatomical removal of one hemisphere
- Functional hemispherectomy
  - Disconnecting the hemisphere from brainstem and contralateral hemisphere
- Candidate for hemispherectomy
  - Large hemispheric lesions:
    - Hemimegaloencephaly
    - Rasmussen encephalitis
    - Sturge weber syndrome
    - Hemi-convulsion-hemiplegia syndrome etc.
  - Pre-existing neurological deficit related to hemispheric dysfunction
  - Minimal to no risk for new acceptable deficit





Cystic encephalomalacia of entire left hemisphere

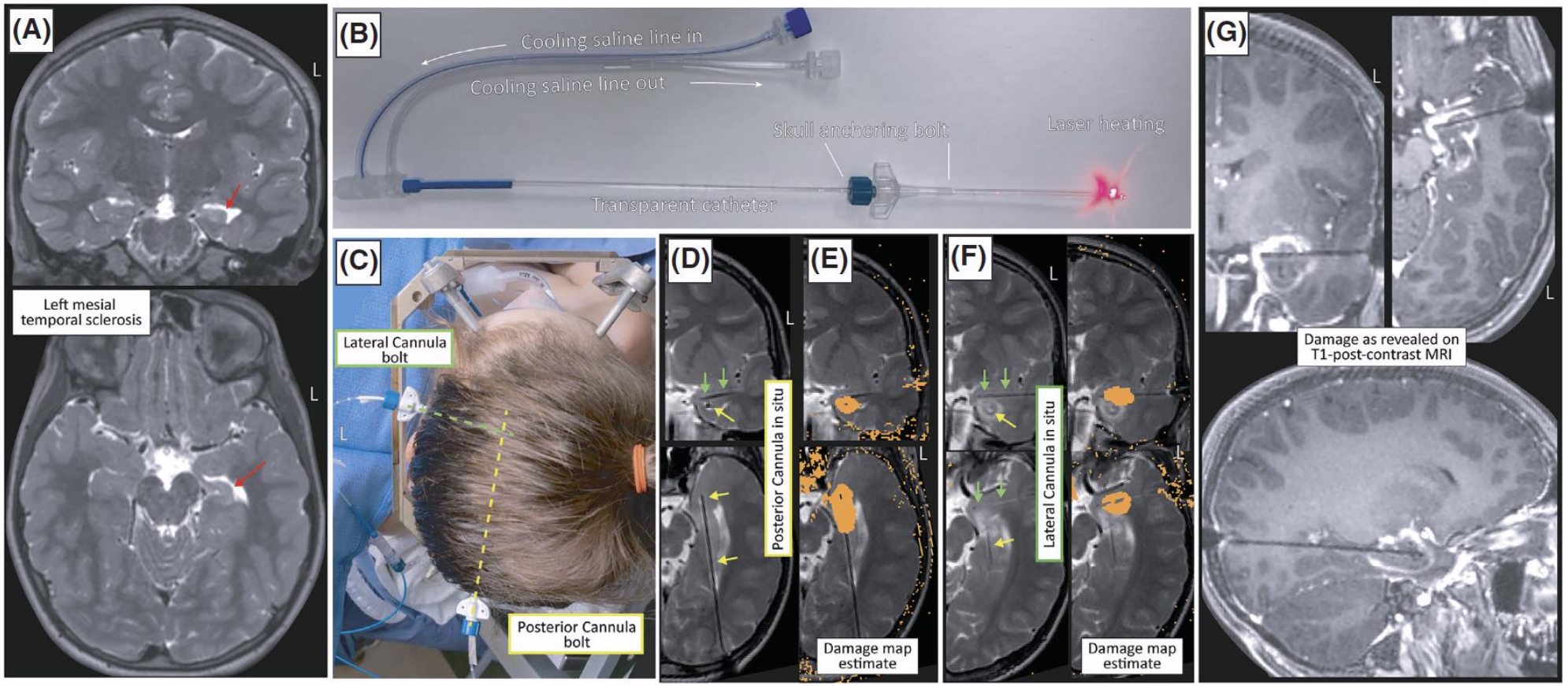
TYPE OF EPILEPSY SURGERY



J Med Assoc Thai 2013; 96 (1): 121-31

MGLITT

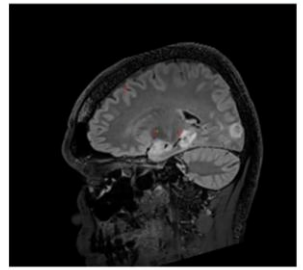
- Using Laser catheter inserted by stereotactic to burn brain tissue of interest
- Real-time damage estimation using continuous MRI
- Perform after SEEG identification of SOZ

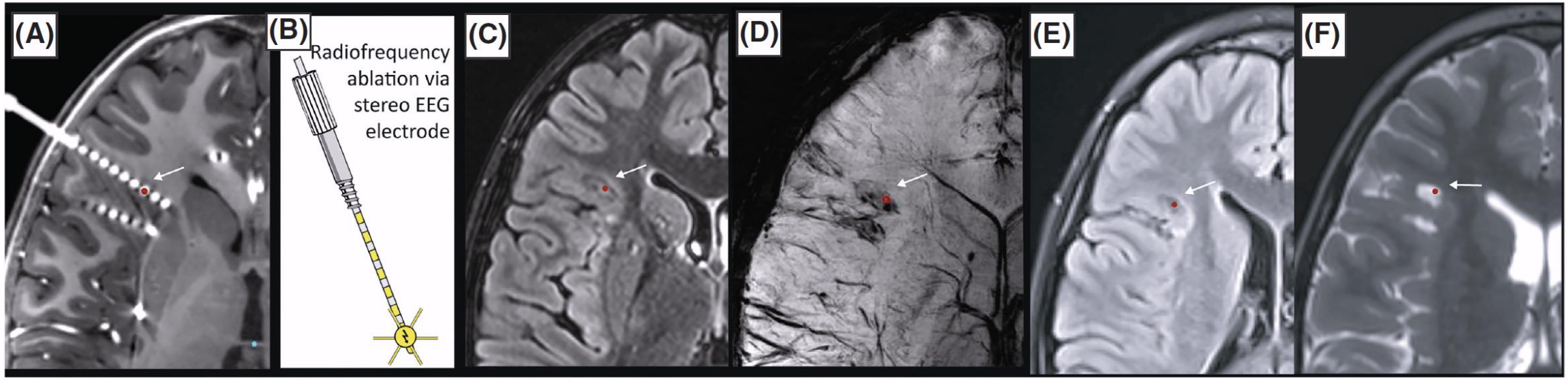


Miller KJ, Fine AL. Decision- making in stereotactic epilepsy surgery. Epilepsia. 2022;63:2782–2801.

RADIOFREQUENCY THERMOCOAGULATION (RFTC)

- Delivering high levels of electrical current through the implanted SEEG leads to burn adjacent epileptogenic tissue
- Performed at the bedside, typically with a neurosurgeon attaching RF cables to the SEEG leads and delivering high-power (typically ~5 W) current sequentially through a set of predetermined contacts using a clinical RF generator





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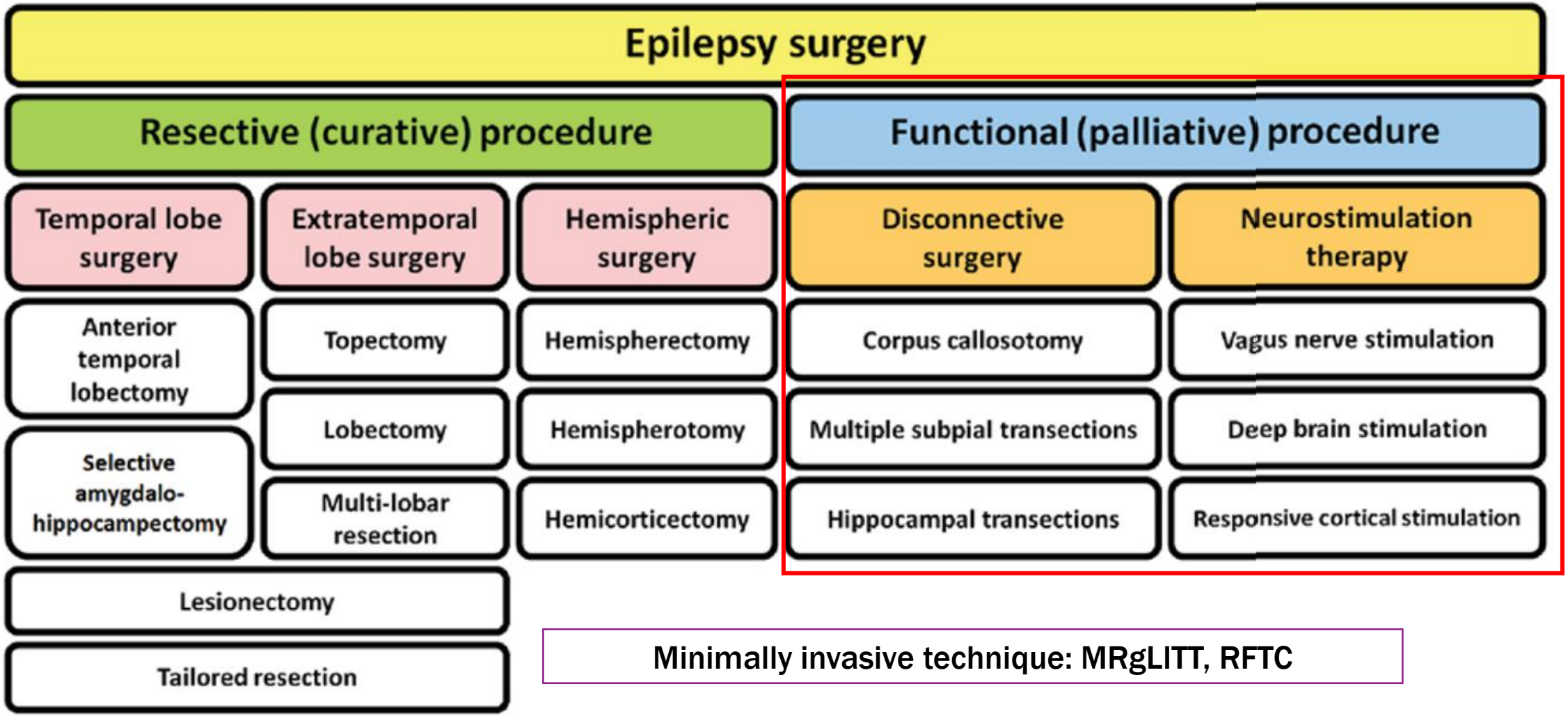
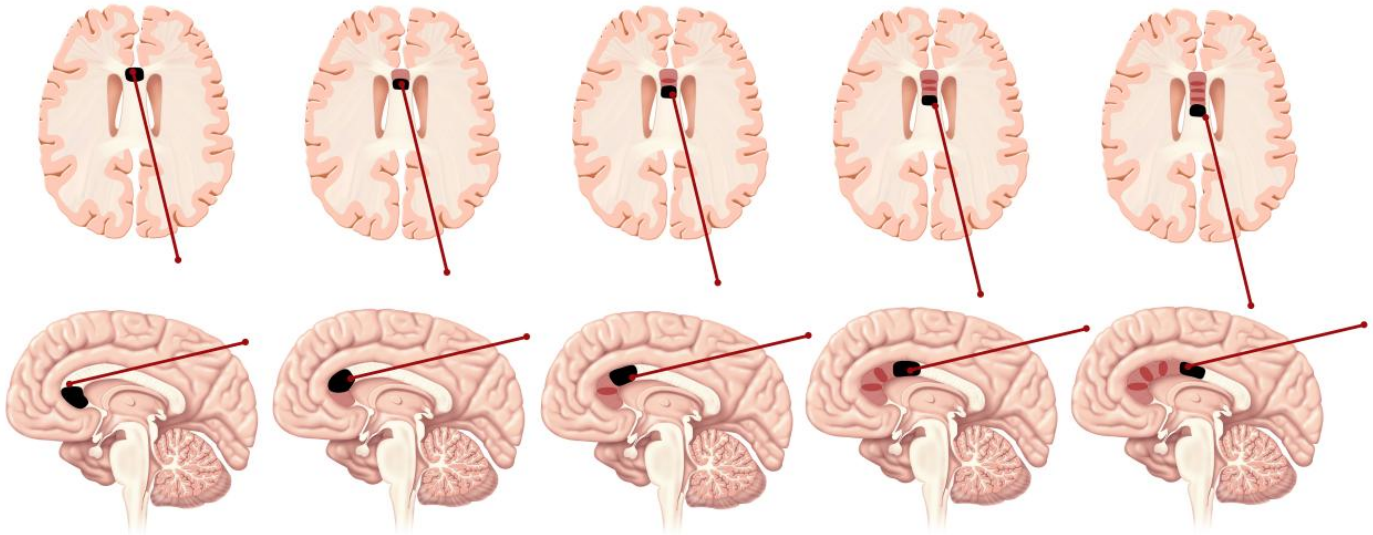


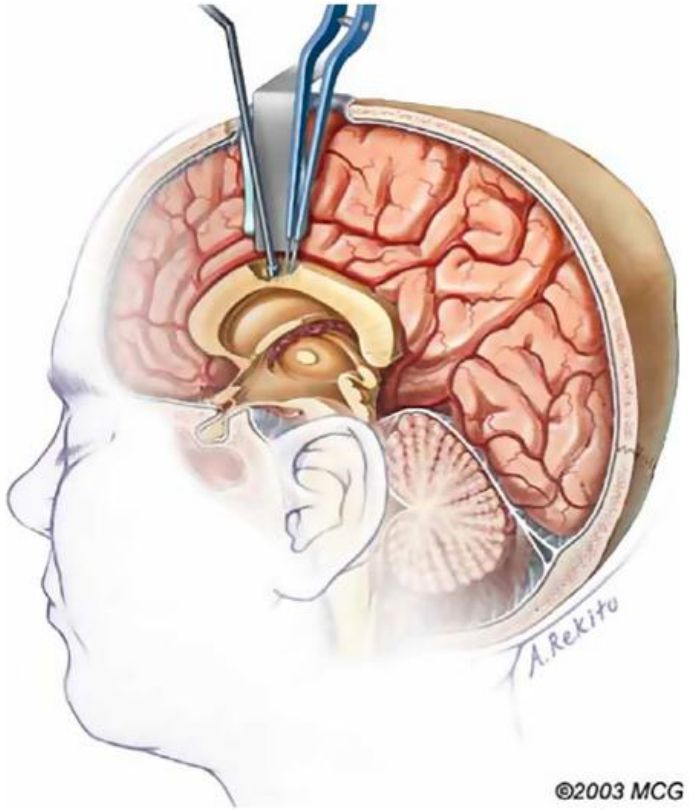
Minimally invasive technique: MRgLITT, RFTC

J Med Assoc Thai 2013; 96 (1): 121-31

CORPUS CALLOSOTOMY (CC)

- Use in patient with intractable drop attacks such as LGS
- Decrease drop attacks by prevent interhemispheric spreading of seizure activity

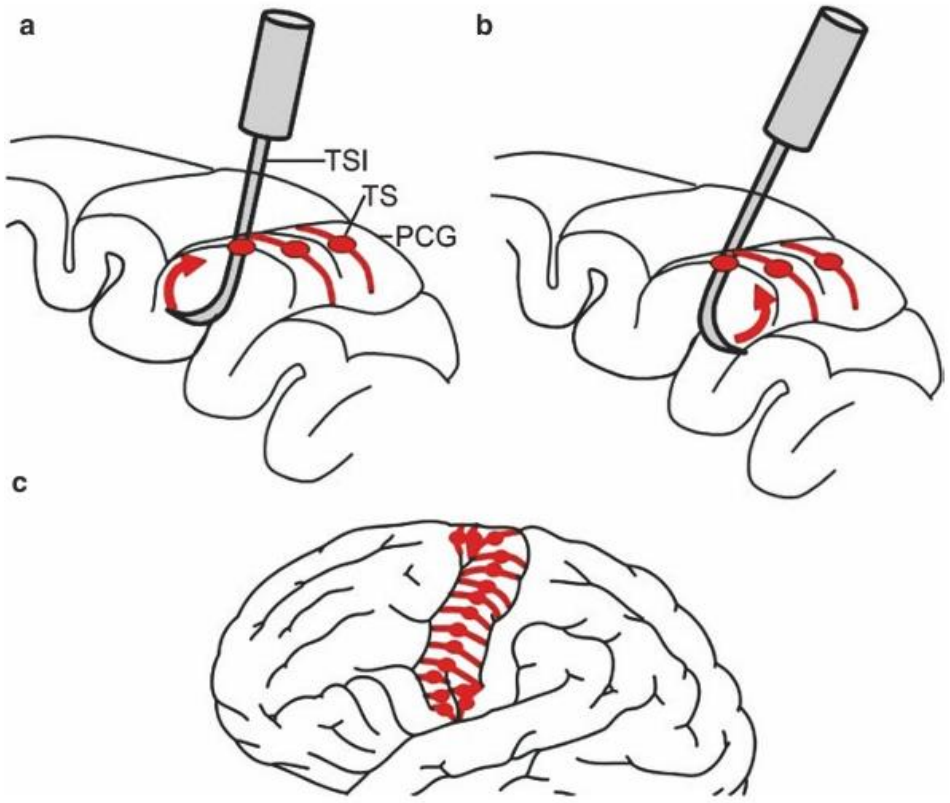




Epilepsia, 55(Suppl. 4):21–28, 2014

MULTIPLE SUBPIAL TRANSECTION (MST)

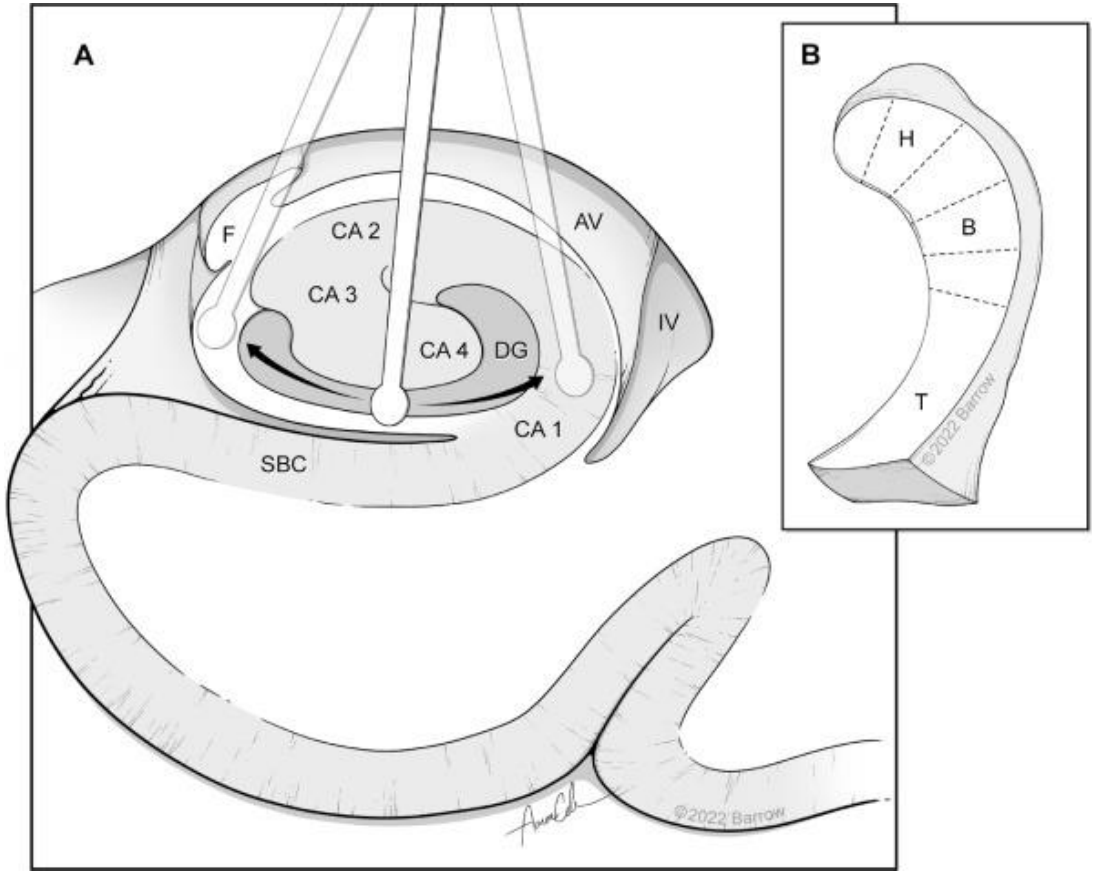
- Disconnective surgery used in patient with EZ localized to eloquent cortex
- Based on the observation that a neuronal functional unit is organized vertically while the seizures spread horizontally, and that a minimal contiguous cortical surface area is necessary for the maintenance of cortical activity
- Have been shown effective in patient with Landau kleffner syndrome



https://doi.org/10.1007/978-3-030-48748-5

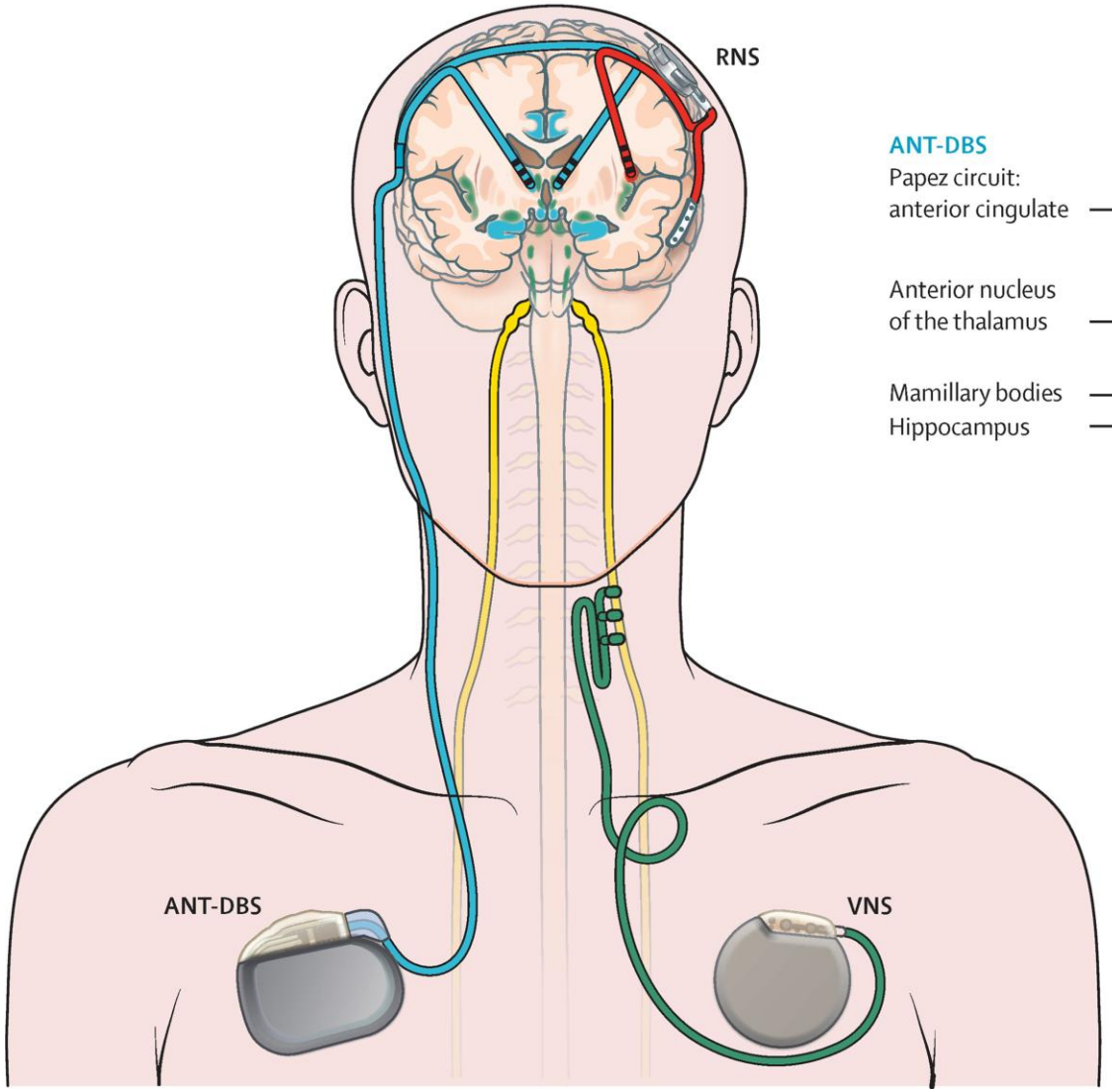
MULTIPLE HIPPOCAMPAL TRANSECTION (MHT)

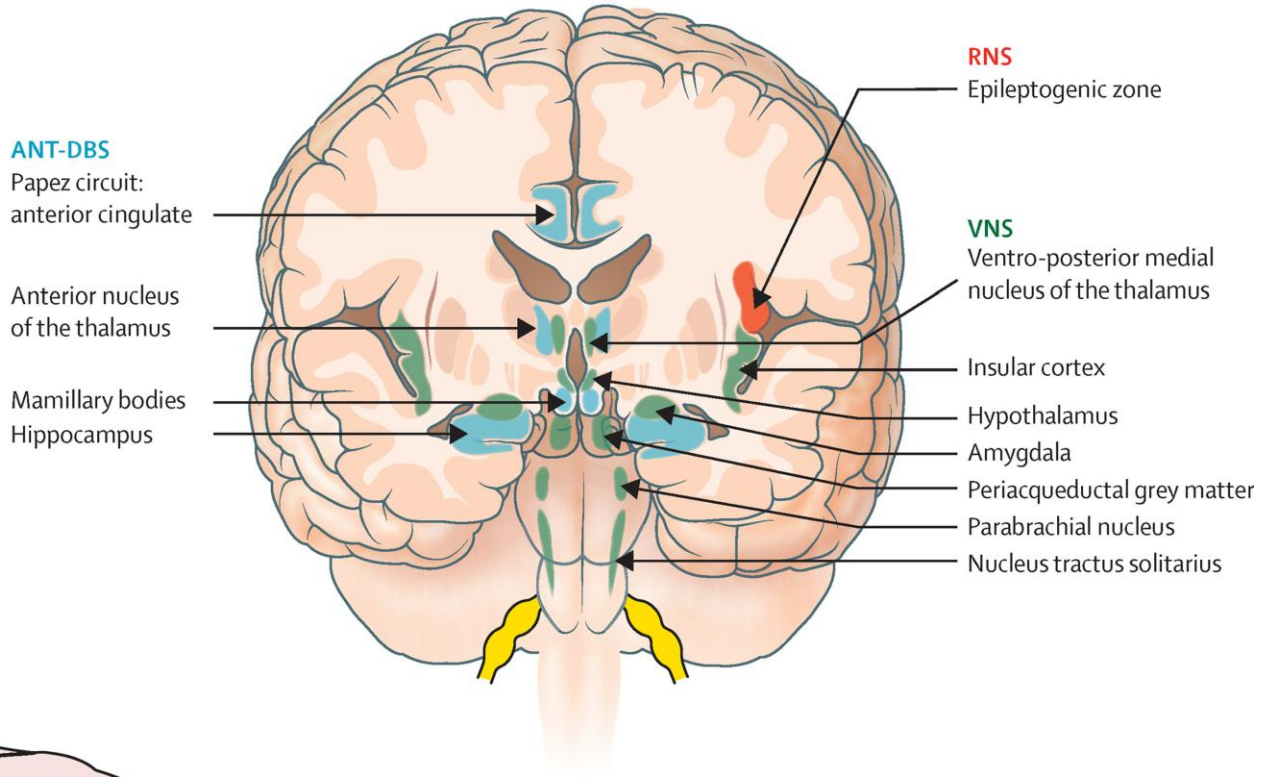
- Disconnective surgery used in patient with EZ localized to dominant hippocampus to preserve verbal memory
- MHT aims to interrupt the longitudinal fibers responsible for seizure spread while preserving the transverse memory circuits, with the goal of minimizing memory impairment.



Irakliy Abramov, et al, Multiple hippocampal transection for mesial temporal lobe epilepsy: A systematic review, Seizure: European Journal of Epilepsy, Volume 101, 2022, Pages 162-176,

NEUROMODULATION

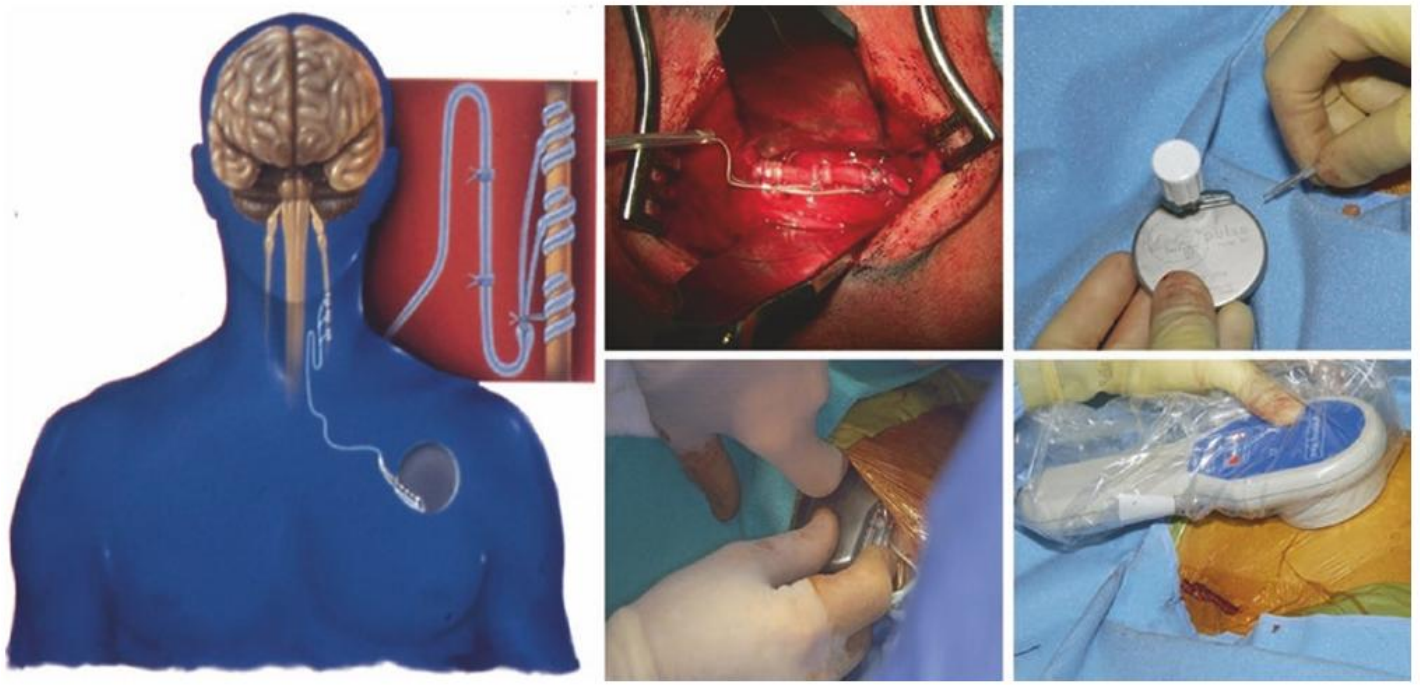




Neuromodulation in epilepsy: state-of-the-art approved therapies. Ryvlin, Philippe et al. The Lancet Neurology, Volume 20, Issue 12, 1038 - 1047

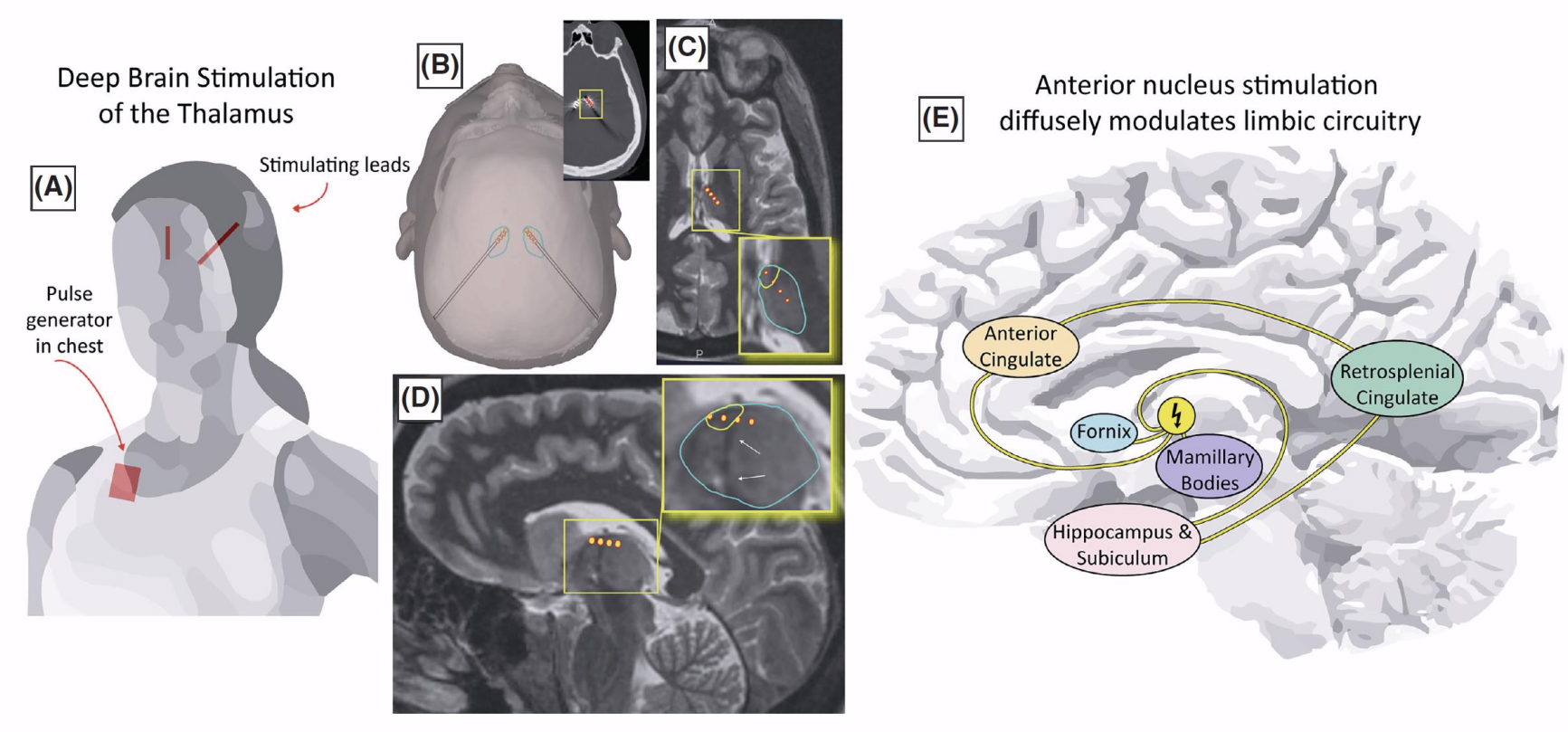
VAGAL NERVE STIMULATION (VNS)

- Open loop stimulation of left vagal nerve
- The device resembles a cardiac pacemaker and delivers intermittent electrical impulses to the left vagus nerve
- Reduce seizure by modulate brainstem, thalamic, and cortical afferent projections, including catecholaminergic nuclei and limbic regions.
- Newer generation of VNS
  - Closed-loop VNS: deliver shock upon detection of heart rate increase
  - On-demand: patient or their relative can use magnet to deliver shock upon having seizure



https://doi.org/10.1007/978-3-030-48748-5

DEEP BRAIN STIMULATION (DBS)

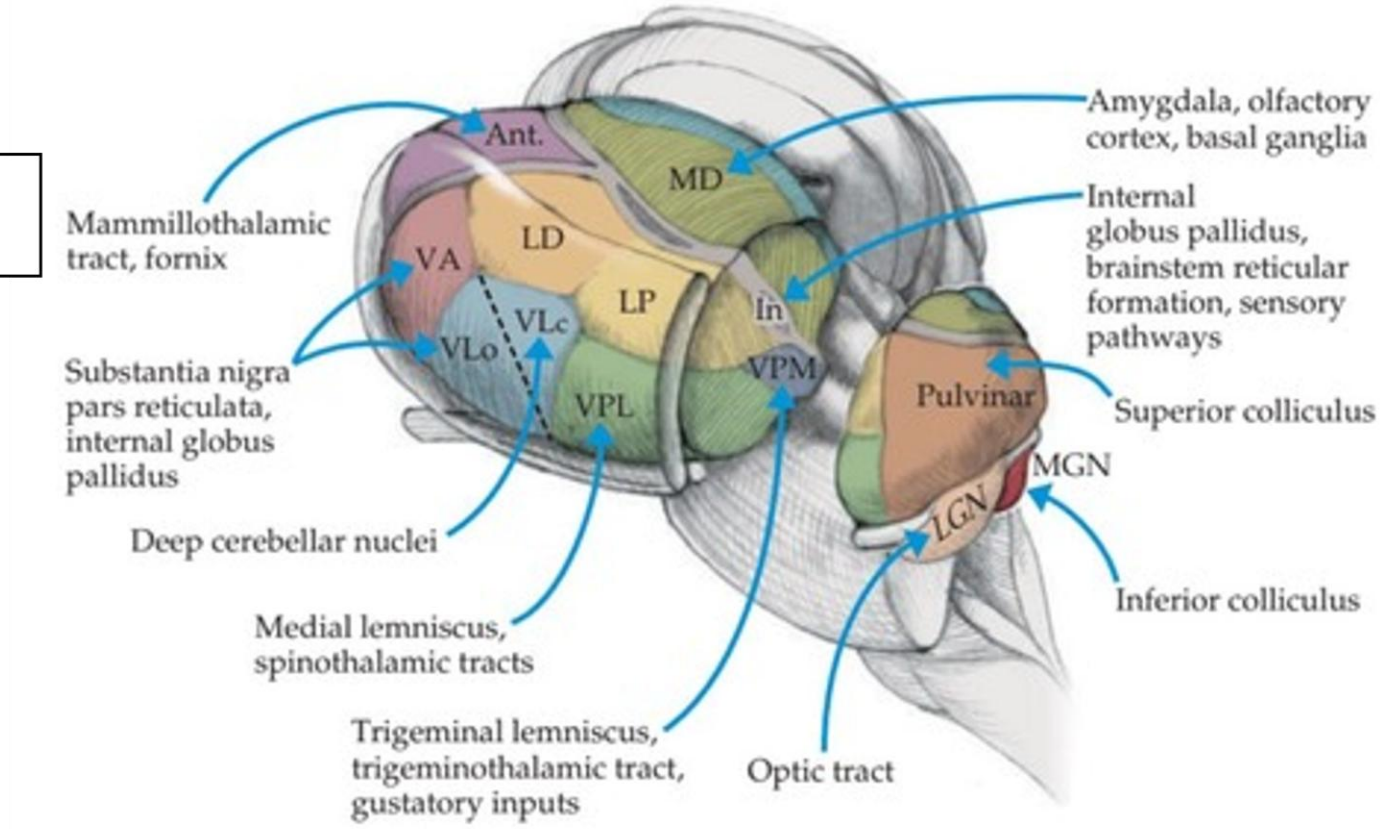


- Open loop stimulation of possible to target central brain nodes (thalamus) where propagating seizure activity converges
- The device delivers continuous therapy to the nuclei of the thalamus.
- Currently, Anterior Nuclear of Thalamus (ANT) is only FDA approved target
- However, the ANT is a component of limbic circuitry and is not a universal node in all seizure networks

Miller KJ, Fine AL. Decision- making in stereotactic epilepsy surgery. Epilepsia. 2022;63:2782–2801.

DEEP BRAIN STIMULATION (DBS) TARGET

Anterior :
Limbic system



Centromedian :
Basal ganglia, motoric and generalized epilepsy

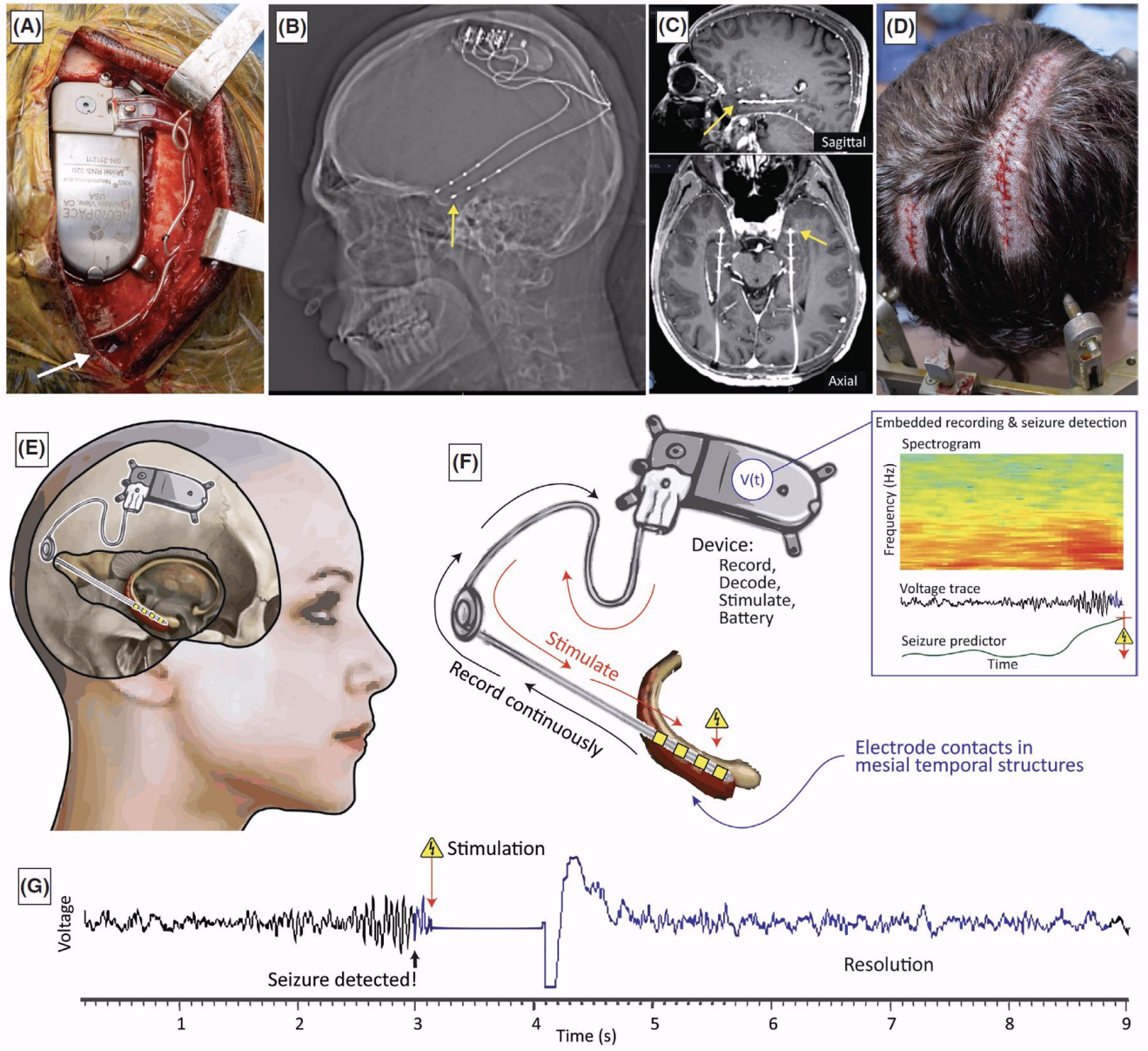
Intralaminar :
Seizure with impaired awareness

Pulvinar :
Occipital lobe epilepsy, seizure with eye movement semiology

Miller KJ, Fine AL. Decision- making in stereotactic epilepsy surgery. Epilepsia. 2022;63:2782–2801.

RESPONSIVE NEUROSTIMULATION (RNS)

- Closed loop neurostimulation with continuous EEG monitoring at SOZ
- Detected seizure and delivered short burst of electrical stimulation to terminate seizure
- A device implanted in the skull and two subdural or depth four-contact leads electrodes for recording and stimulation.
- The closed-loop RNS system can treat two foci simultaneously including those in opposite hemispheres



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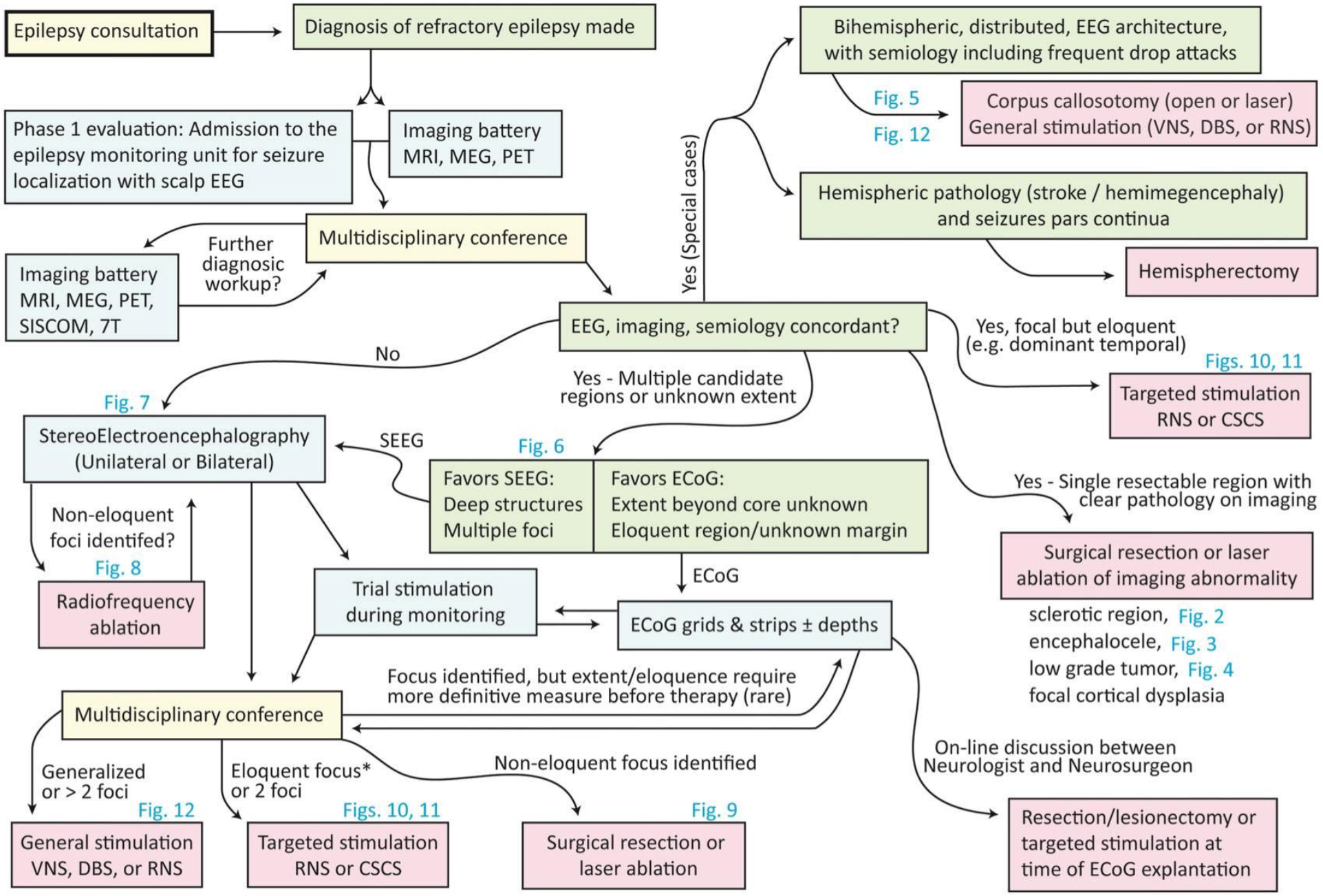

Miller KJ, Fine AL. Decision- making in stereotactic epilepsy surgery. Epilepsia. 2022;63:2782–2801.

SURGICAL OUTCOME AFTER EPILEPSY SURGERY

Engel Epilepsy Surgery Outcome Scale[33]

- Class I: free of disabling seizures (Ia); nondisabling focal aware seizures or auras only (Ib); some disabling seizures after surgery but free of disabling seizures for ≥2 years (Ic); convulsions with seizure medication withdrawal only (Id)
- Class II: initially seizure free (IIa) but had rare disabling seizures (IIb) in the past 2 years (IIc); nocturnal seizures only (IId)
- Class III: worthwhile seizure reduction (IIIa); prolonged seizure-free periods last less than 2 years but >50% of follow-up period (IIIb)
- Class IV: no worthwhile improvement; significant seizure reduction (IVa); no change (IVb); worsened seizures (IVc)

International League Against Epilepsy Classification[34]

- Class 1: completely seizure free (if since surgery, 1a); no auras
- Class 2: only auras; no other seizures
- Class 3: 1-3 seizure days per year; with or without auras
- Class 4: 4 seizure days per year to 50% reduction in baseline number of seizure days; with or without auras
- Class 5: <50% reduction in baseline number of seizure days to 100% increase in baseline number of seizure days; with or without auras
- Class 6: >100% increase in baseline number of seizure days; with or without auras

CONTINUUM (MINNEAP MINN)2022;28(2, EPILEPSY):536–558.

TAKE HOME MESSAGE (1)

- All patient with DRE should be considered for presurgical evaluation
- Goal of presurgical evaluation: identify epileptogenic cortex + preservation of eloquent cortex
- Mandatory tool for presurgical evaluation:
  - Long-term EEG, MRI epilepsy, Neuropsychology test
- Indication for invasive evaluation:
  - MRI negative, discordant electroclinical data, EZ near eloquent cortex, Multifocal pathology

TAKE HOME MESSAGE (2)

- PMC: multidisciplinary approach to provide consensus based surgical management for patient with epilepsy
- Types of epilepsy surgery: Resective surgery vs. palliative surgery
- Resective surgery is selected based on epileptic substrate
- Palliative surgery aim to reduce seizure frequency of patient