Introduction to Epilepsy Surgery

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Goal of therapy in epilepsy

- No seizures
- No adverse events
- Improvement of quality of life

Randomized. Controlled trial of surgery for TLE

- In TLE, surgery is superior to prolonged medical therapy
- Seizure free, 58% surgery group vs. 8% medical group ($p<0.001$)

Wiebe S. NEJM 2001; 345:311-8.

Indication for epilepsy surgery

- Drug-resistant epilepsy (intractable, medically refractory)
  - "Failure of adequate trials of two tolerated and appropriately chosen and used antiepileptic medications to achieve sustained seizure freedom"
- Refer patients early to specialized epilepsy center to maximized their benefit for surgery

ILAE commission on therapeutic strategies. Epilepsia 2010; 51:1069-77.

Type of Epilepsy Surgery (Therapeutic)

- Resective Surgery
- Disconnective Surgery
- Thermocoagulation
- Radiosurgery
- Neurostimulation

Resective surgery

- Lesionectomy
- Topectomy, Gyrectomy, Corticectomy
- Lobectomy
- Multilobar resection
- Hemispherectomy

Disconnective surgery

- Hippocampal transection
- Hypothalamic hamartoma disconnection
- Corpus callosotomy
- Multiple subpial transection

Thermocoagulation

- Thermal
- Laser ablation

- Hippocampal sclerosis
- Hypothalamic hamartoma
- Heterotopia

Radiosurgery

- Gamma knife radiosurgery
- LINAC

- Hippocampal sclerosis
- Hypothalamic hamartoma
- Corpus callosotomy
- Cavernoma, AVM

Brain stimulation

- CNS stimulation
  - Cerebellum
  - Deep brain structures: CM-Pf, STN, ATN
  - Hippocampal stimulation
  - Direct stimulation of epileptogenic zone (RNS)
- PNS stimulation
  - VNS
  - Trigeminal nerve stimulation

Others

- Radiosurgery
- Thermocoagulation

Locations

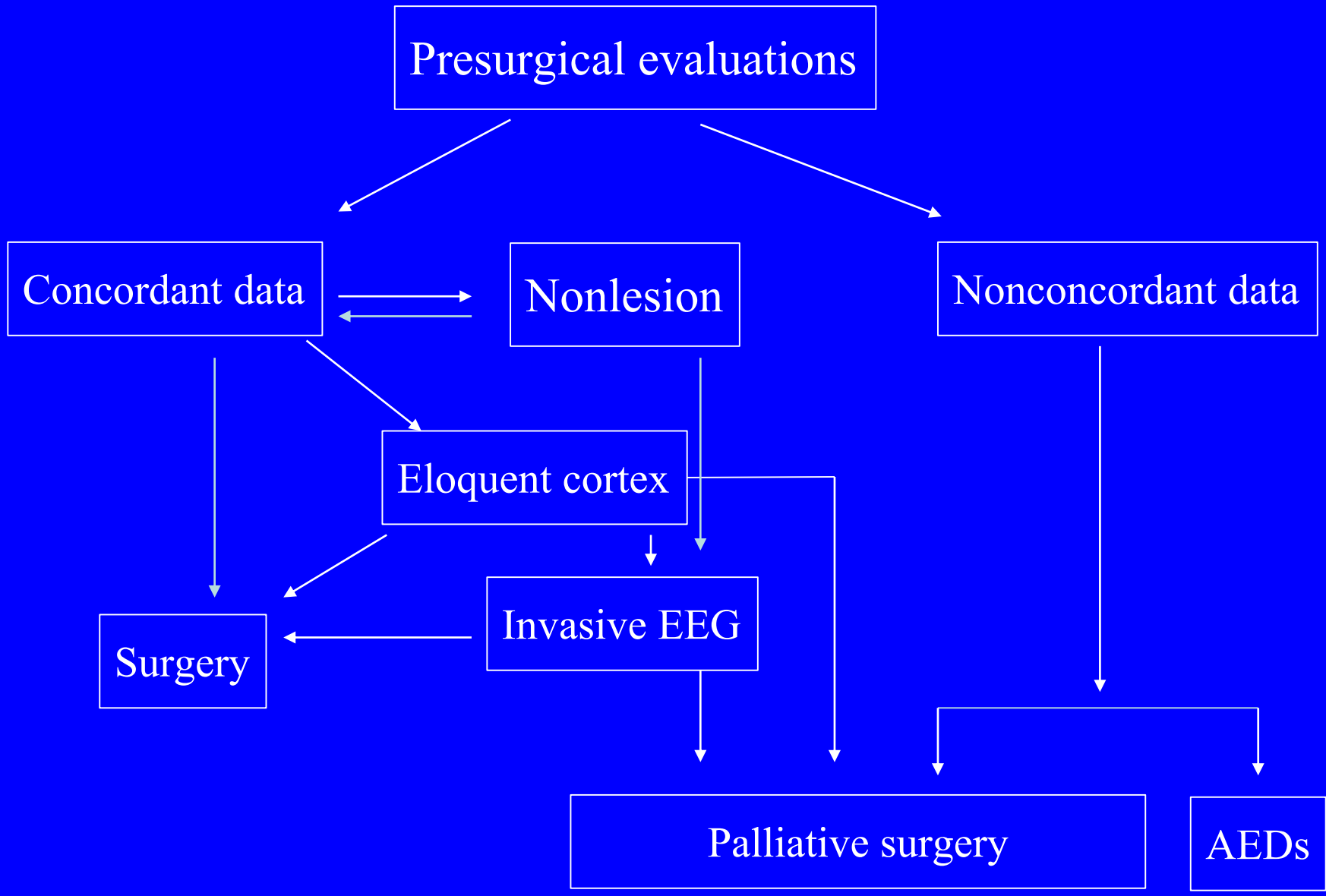
- Temporal
- Extratemporal
- Multi-lobar
- Hemispheric

Principal considerations

- Epileptogenic zone
- Symptomatogenic zone
- Irritative zone
- Ictal onset zone
- Epileptogenic lesion
- Functional deficit zone

Presurgical evaluations

- H&P
- Routine EEG, 24-hour video EEG, MRI
- Ictal SPECT, PET, fMRI
- Neuropsychological test
- WADA test
- Invasive monitoring
- Intraop EcoG


Presurgical evaluations
Concordant data
Nonlesion
Nonconcordant data
Eloquent cortex
Invasive EEG
Surgery
Palliative surgery
AEDs

Type of surgery

- Adults
  - Most common
    - Temporal lobe resection
- Pediatrics
  - Most common
    - Extratemporal
    - Multilobar
    - Hemispherectomy

Temporal lobe surgery

Etiologies

- Hippocampal sclerosis
- Tumors
  - Ganglioglioma, DNET, Glioma
- Cortical dysplasia
- Vascular malformations
- Trauma
- Inflammatory/ infectious
- Non-specific lesions

Anatomy

- Lateral temporal lobe
  - Superior, middle, inferior temporal lobe
- Inferior temporal lobe
  - Inferior temporal, fusiform, parahippocampus
- Mesial temporal lobe
  - Hippocampus, parahippocampus, amygdala

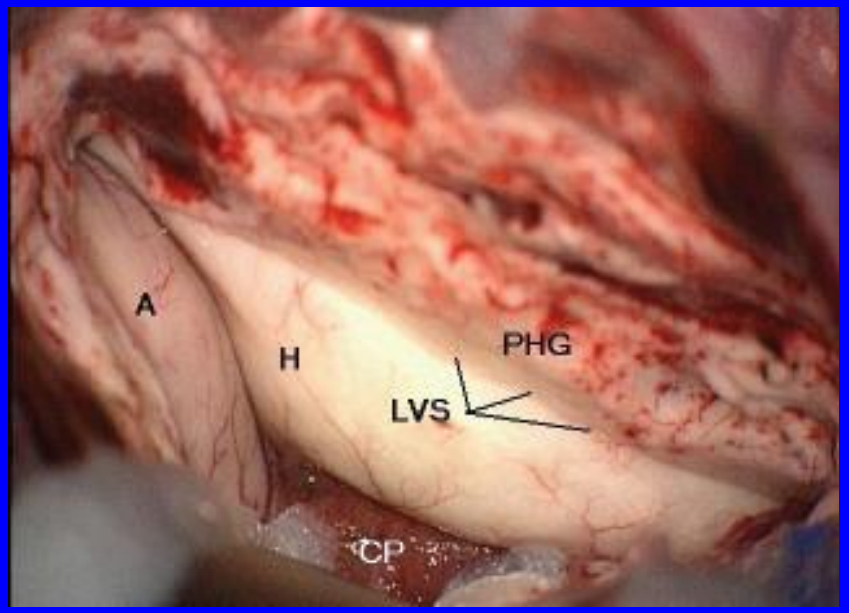
Temporal lobe resections

- Corticoamygdalohippocampectomy (standard temporal lobectomy)
- Amygdalohippocampectomy (Selective)
- Neocortical resection
- Lesion resection

Standard temporal lobectomy

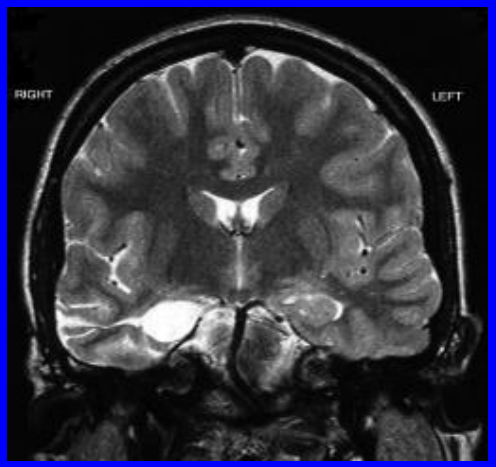
- Anterior temporal lobectomy (ATL)
- Corticoamygdalohippocampectomy
- Anterior one-third temporal lobectomy

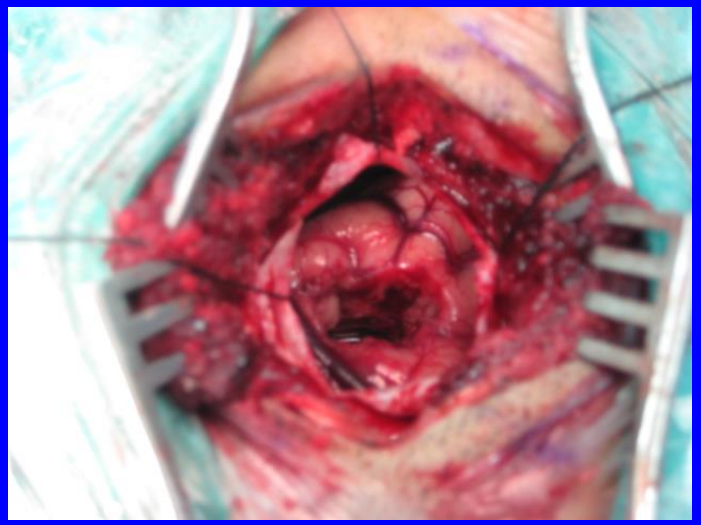
Anterior temporal lobectomy



Selective amygdalohippocampectomy (SAH)

- Transylvian AH
- Transcortical AH
- Subtemporal AH

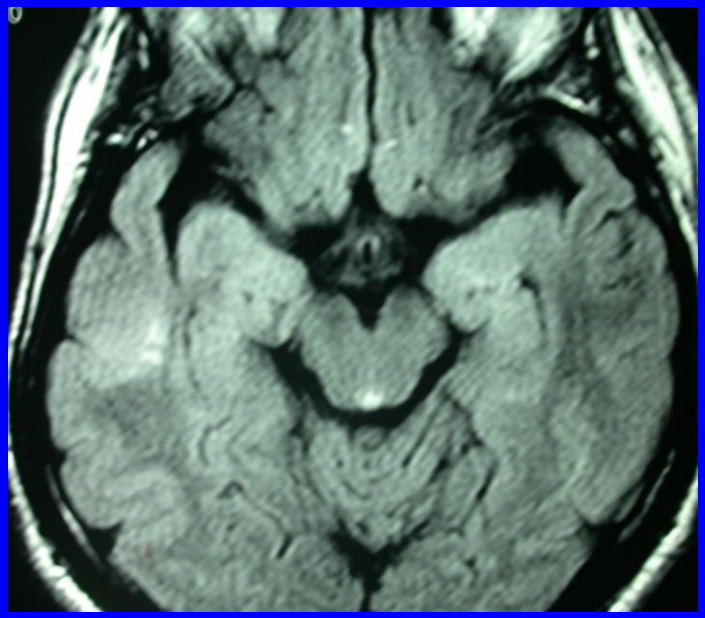


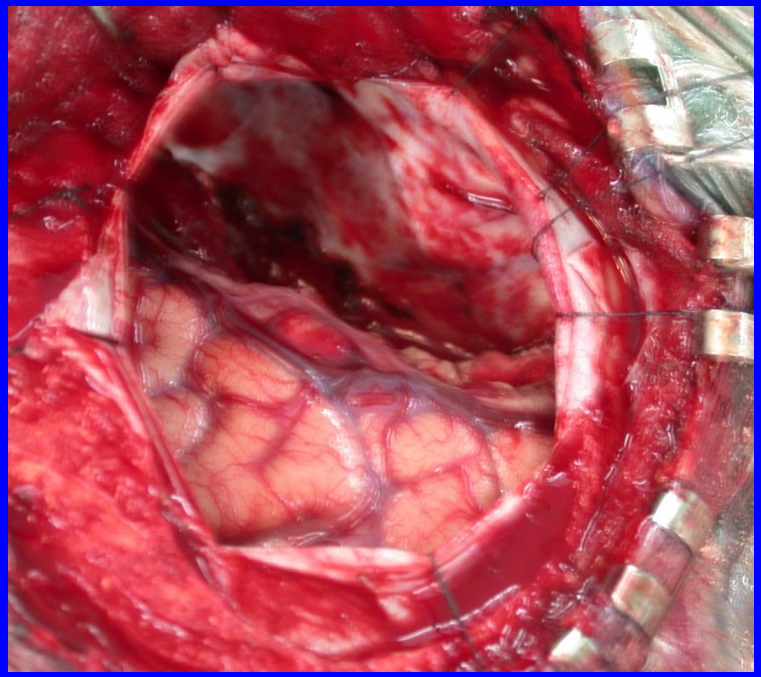


Tailored resection

- Temporal lobectomy with intraoperative ECoG (awake?)

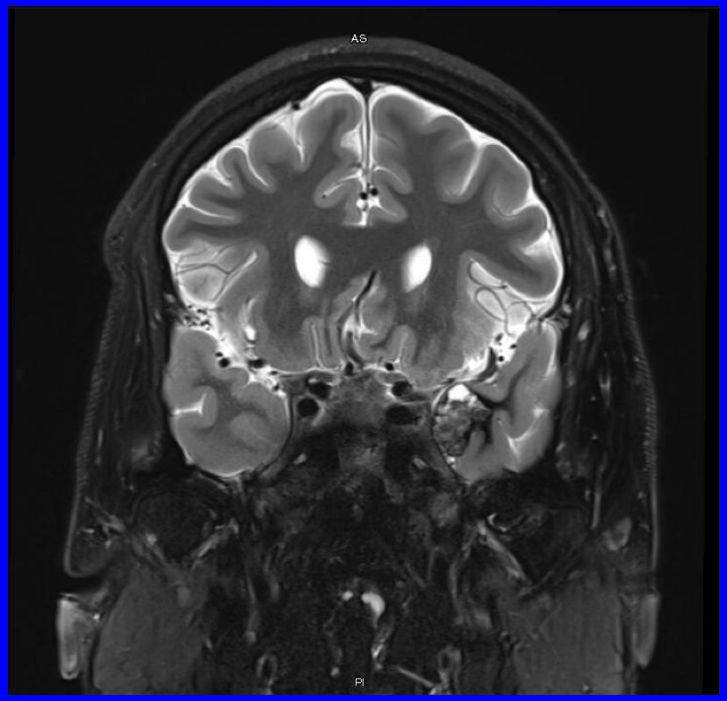
Focal cortical dysplasia (FCD)





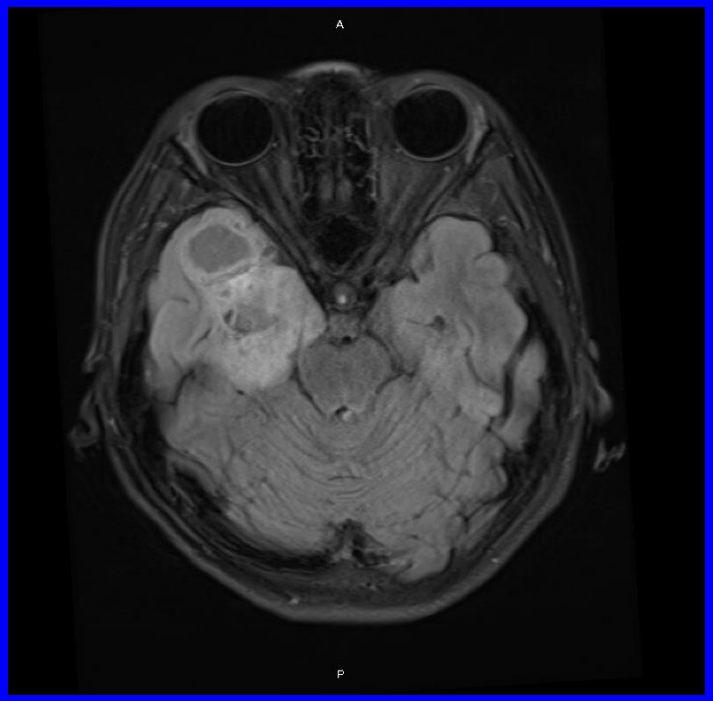
Cavernoma

- Lesionectomy
- Corticectomy ± Intraop ECoG
- ± Mesial structures

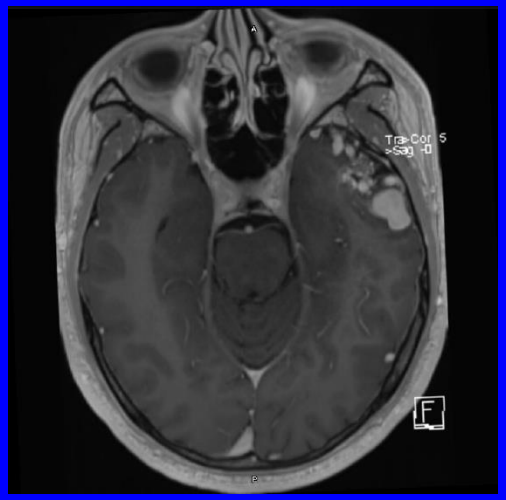


Tumor

- Lesionectomy
- ± Mesial structures
- ± Intraop ECoG



AVM



Complications (temporal lobectomy)

- Surgical complications
  - Hemiparesis
  - Visual field defect (superior quadrantanopia)
  - CN III, IV, VII
  - Infection
  - Intracranial hemorrhage

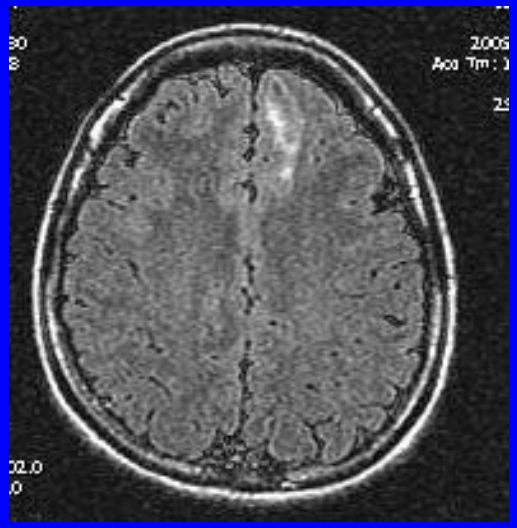
Complications (temporal lobectomy)

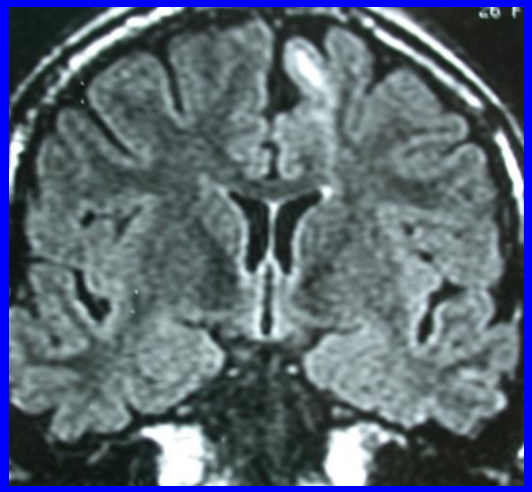
- Neurobehavioural complications
  - Memory
  - Cognitive
  - Language
  - Psychiatric
  - Psychosocial

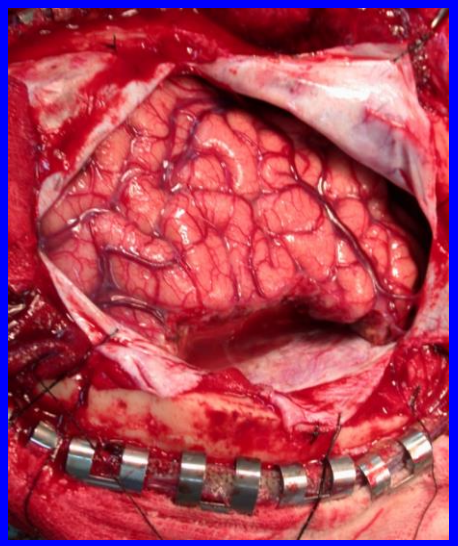
Extratemporal resections

- CD
- Tumor
- Cavernoma
- Nonlesional
- Frontal
- Parietal
- Occipital

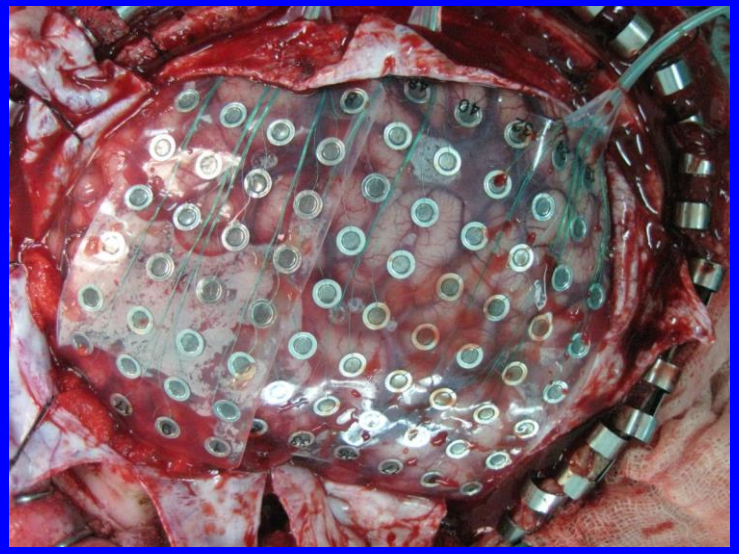
Left frontal FCD

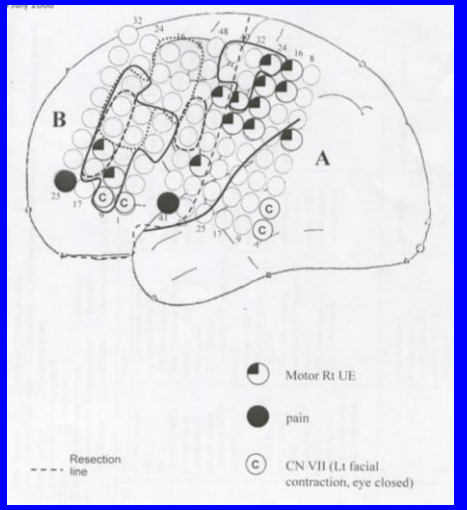


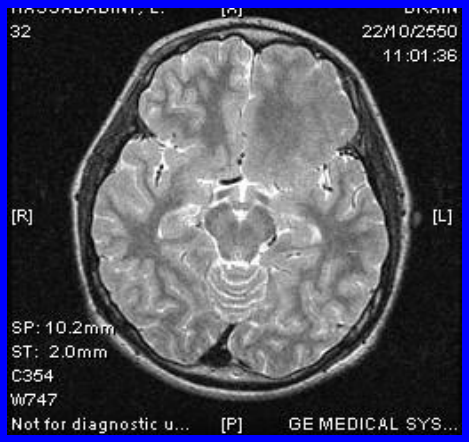


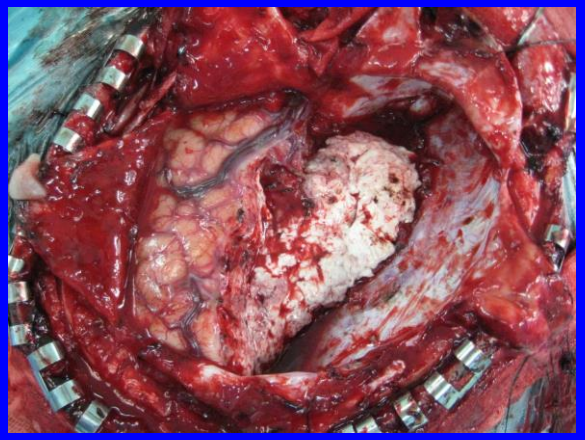


Left frontal CD

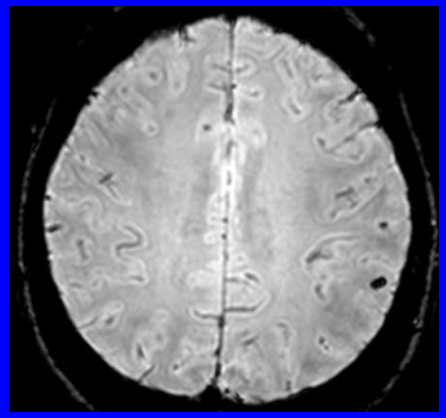


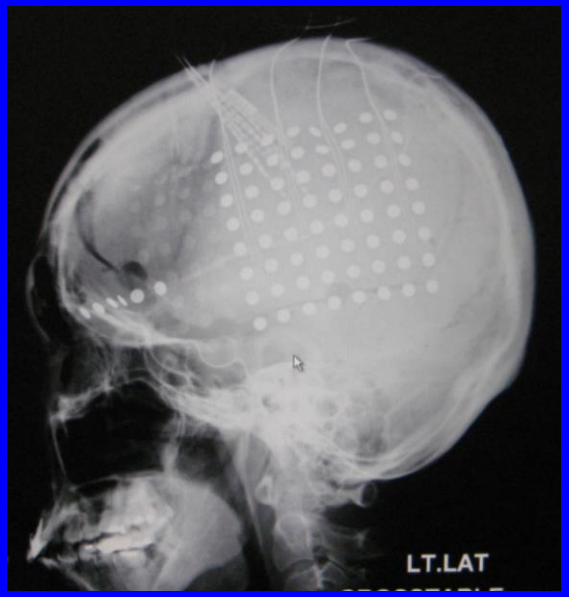


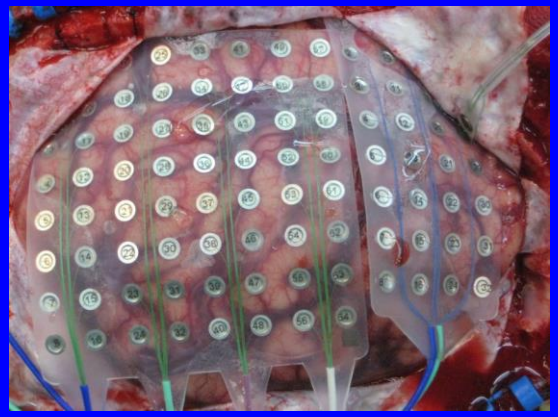




FLE (nonlesional)



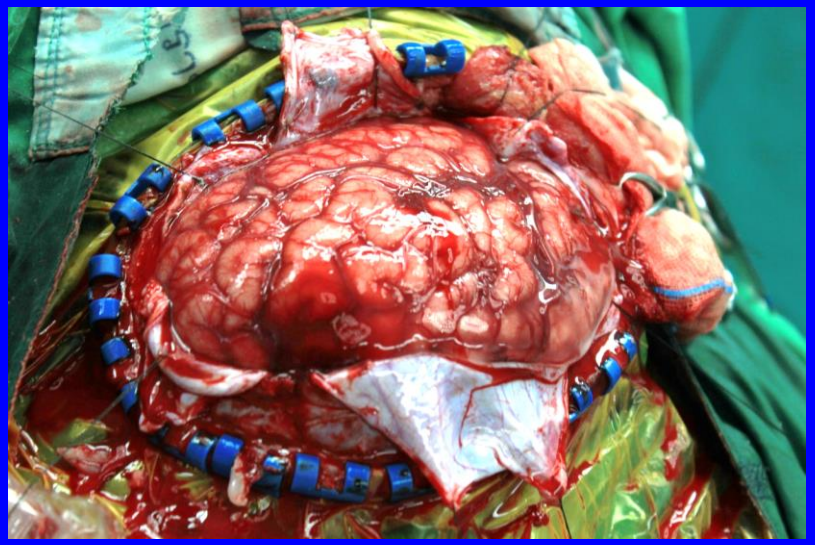


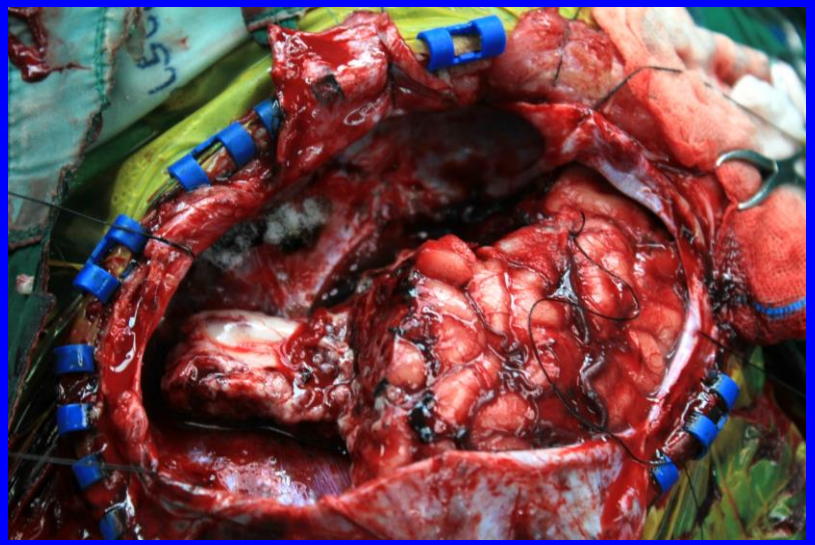


Multilobar resections

- Cortical dysplasia
- Encephalomalacia
- Sturge-Weber syndrome
- F-T
- T-P-O

L) T-P-O resection (CD)





Hemispherectomy

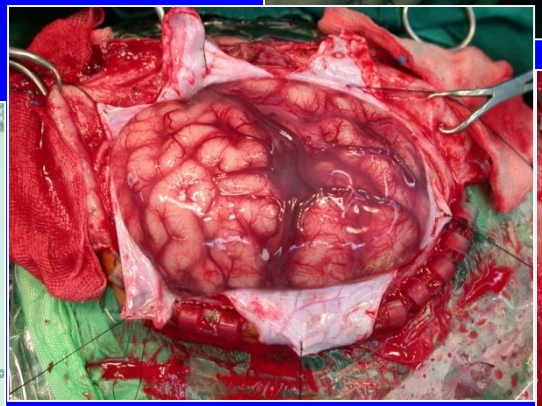
Hemispherectomy

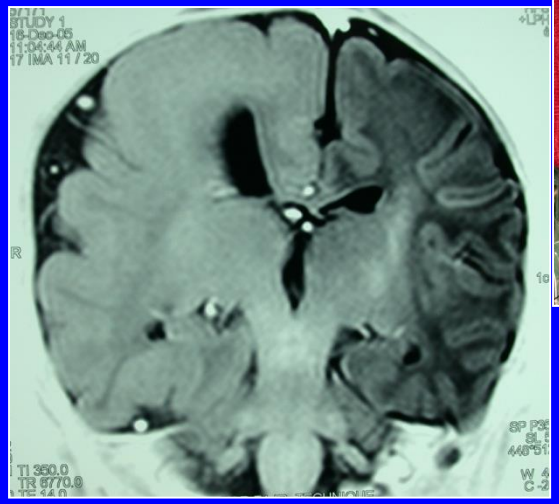
- Indications:
  - Rasmussen's encephalitis
  - Sturge-Weber syndrome
  - Hemimegalencephaly
  - Infantile hemiplegic epilepsy

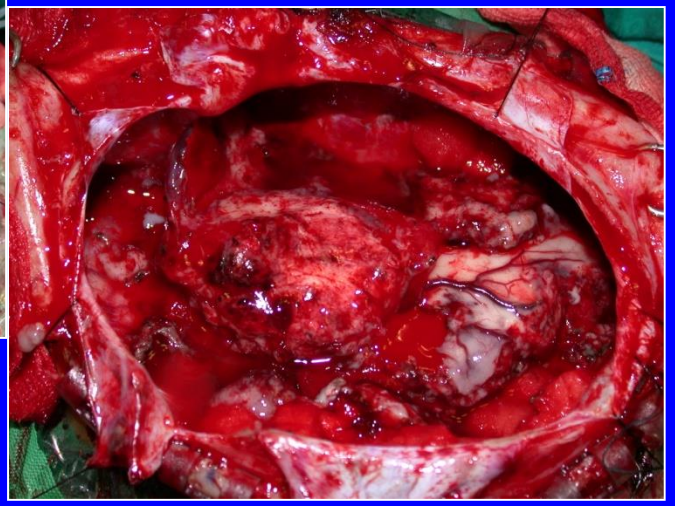
Hemispheric Surgical Procedures

- Anatomic hemispherectomy
- Modified anatomic hemispherectomy
- Functional hemispherectomy
- Hemidecortication

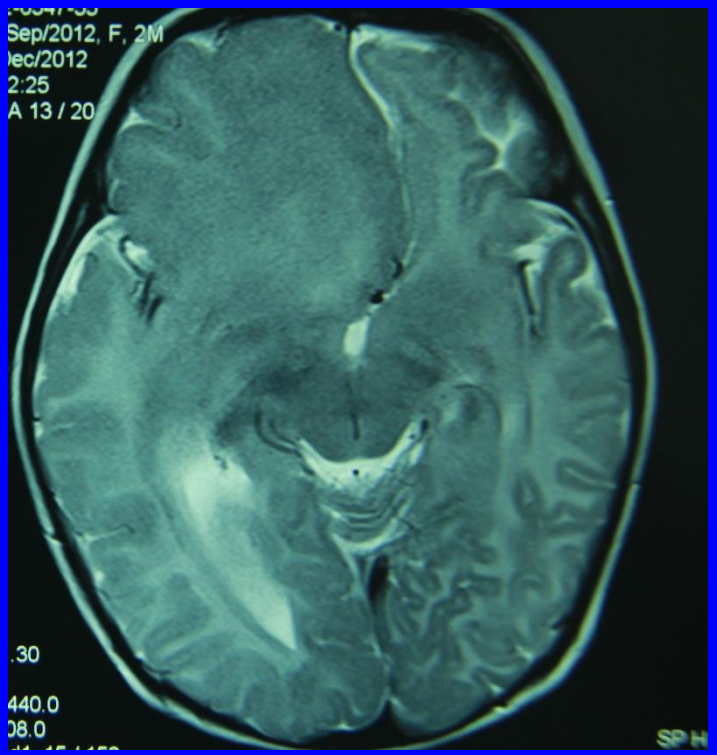
Anatomical hemispherectomy

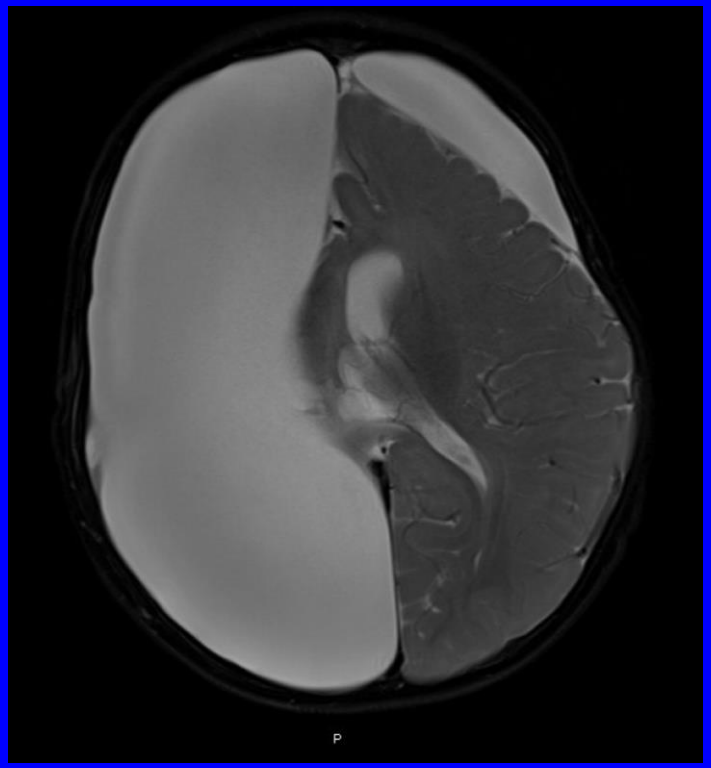




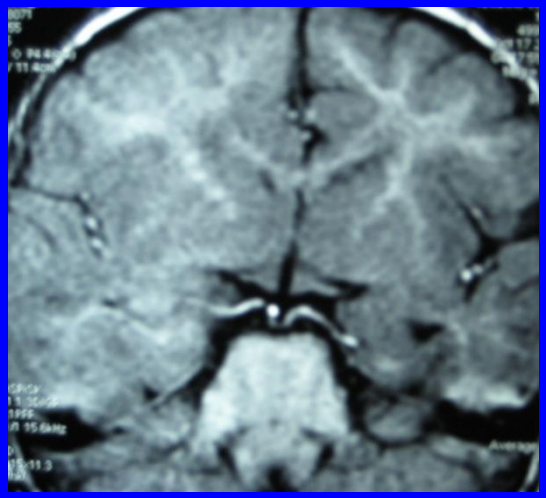


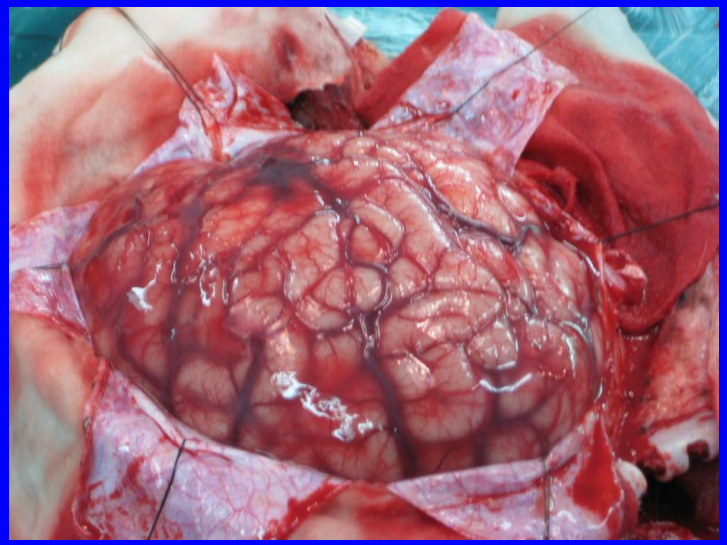
Anatomical Hemispherectomy

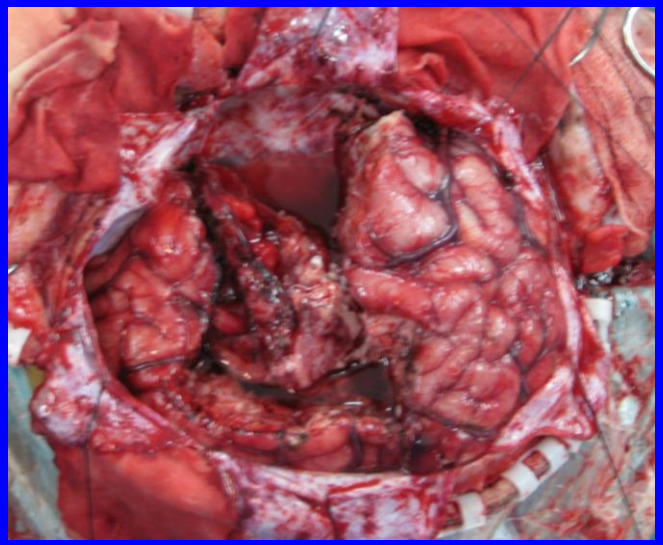




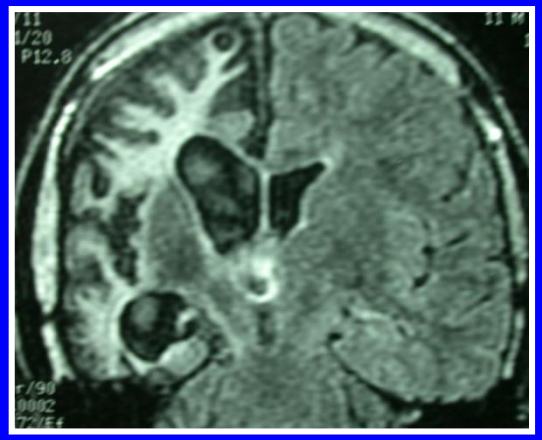
Functional hemispherectomy

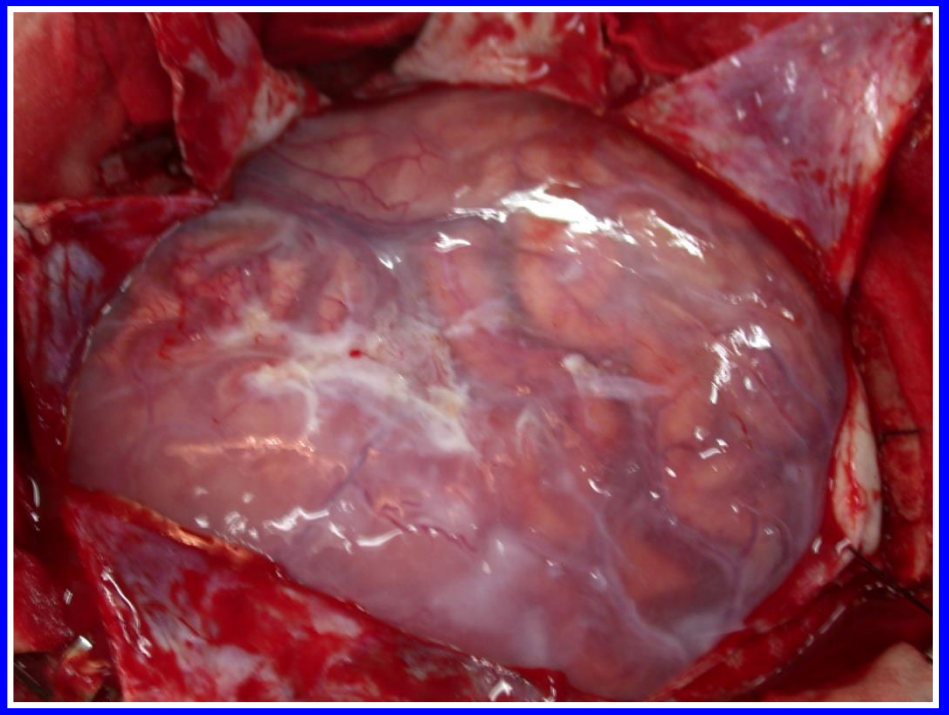


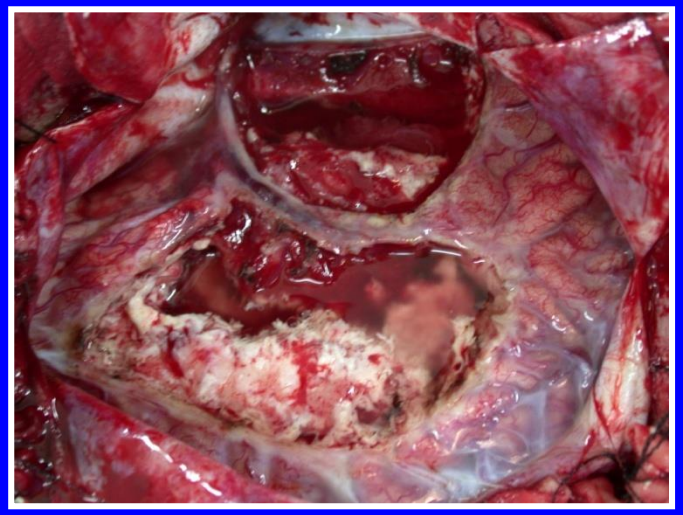




Rasmussen's encephalitis



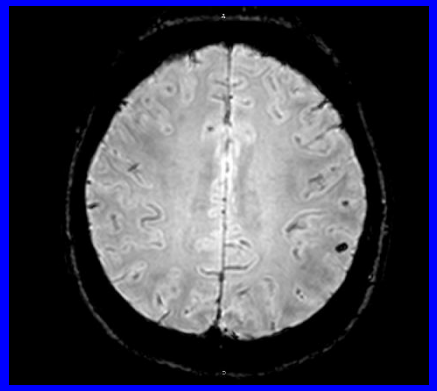


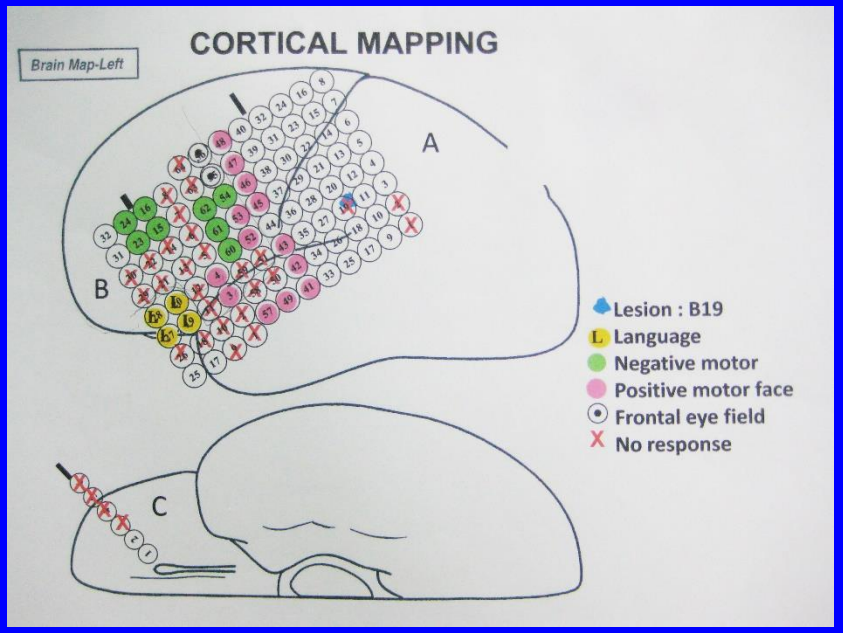


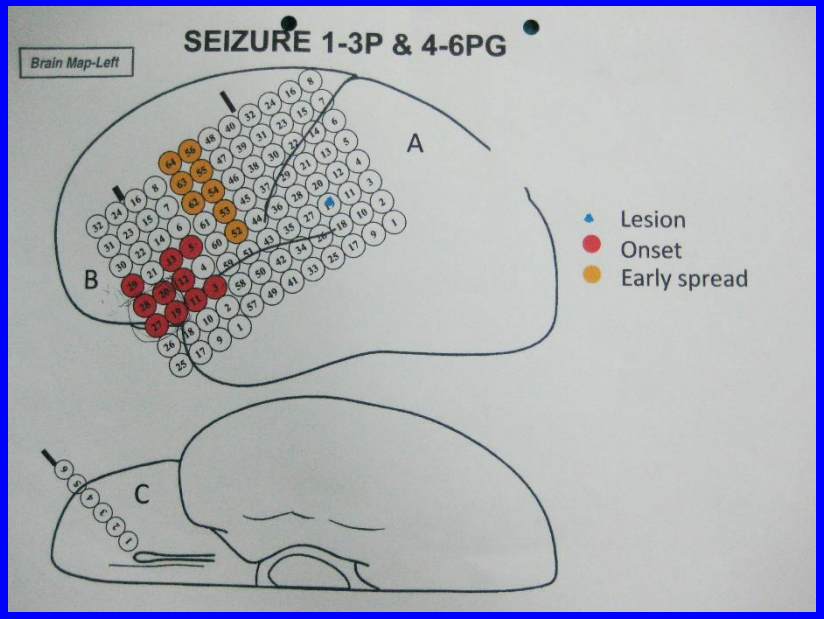
Complications (Hemispherectomy)

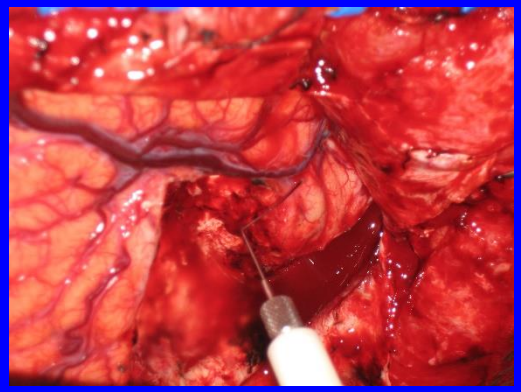
- Bleeding
- Hydrocephalus
- Postoperative fever
- Superficial hemosiderosis

Multiple subpial transection









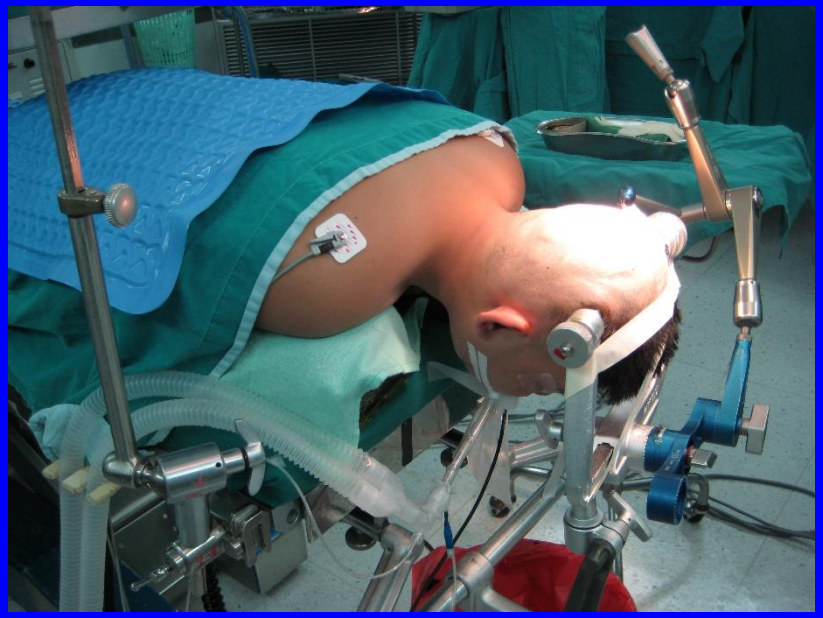
Corpus callosotomy

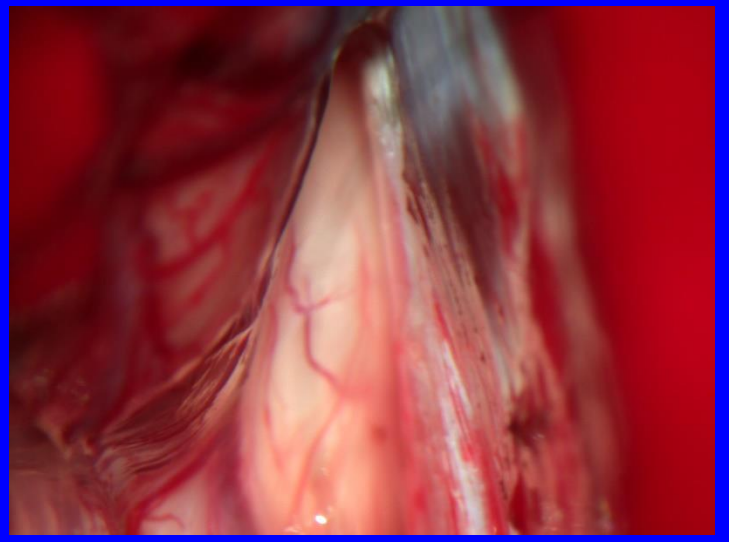
Corpus callosotomy

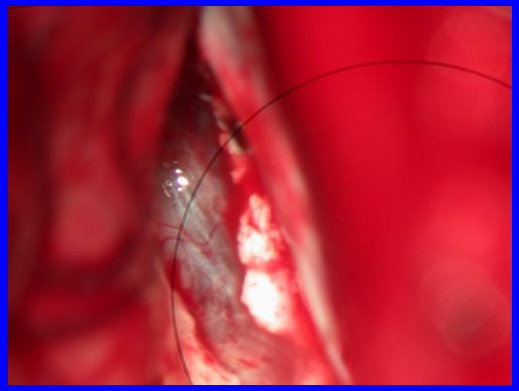
- Palliative surgery
- Indications
  - Drop attacks (atonic, tonic, GTC)
  - Lennox-Gastaut syndrome
  - Infantile spams
  - Multiple independent spike foci
  - Refractory idiopathhic generalized epilepsy

Anterior corpus callosotomy

Posterior corpus callosotomy







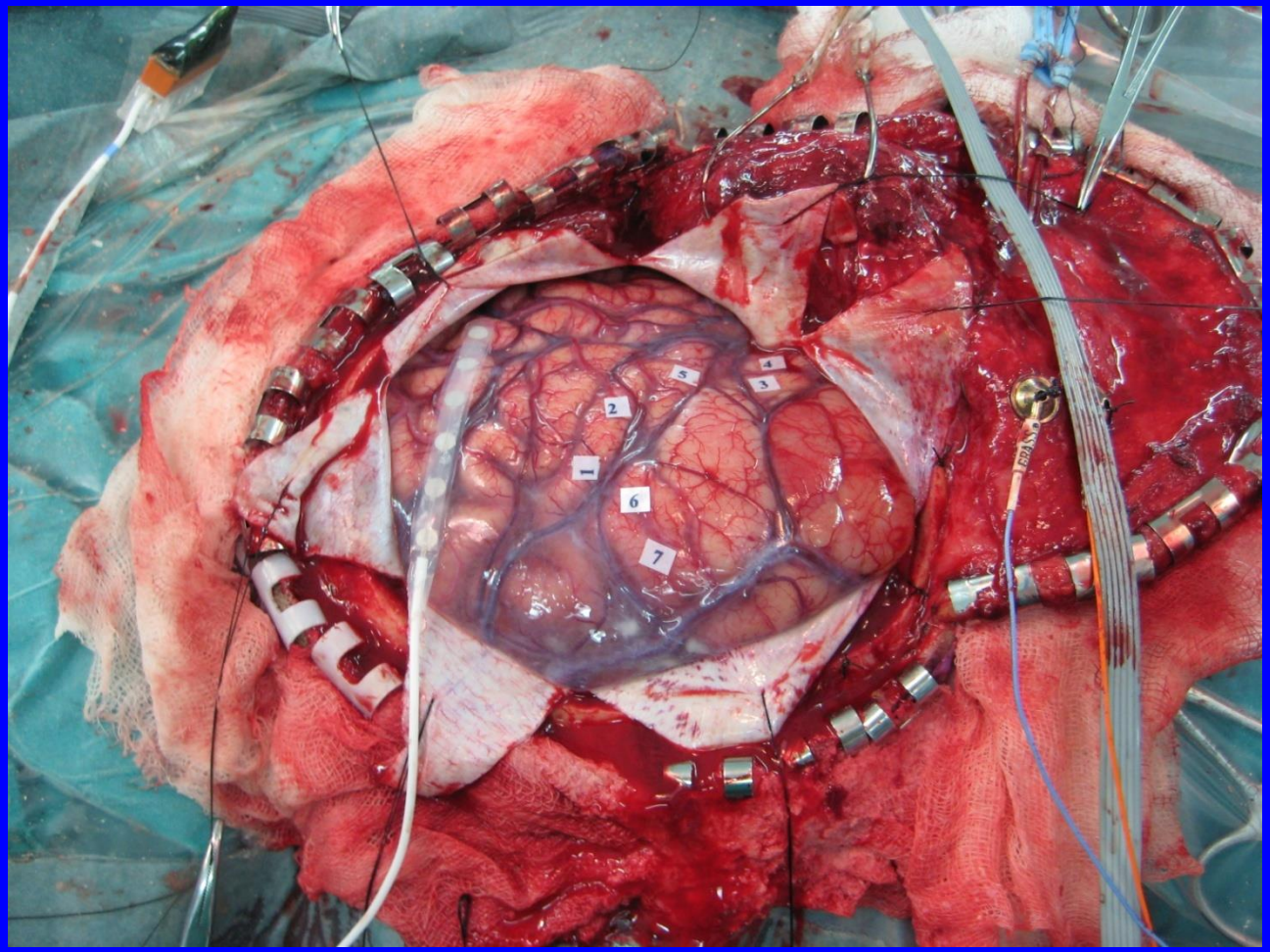
Invasive EEG

- Sphenoidal electrodes
- Epidural electrodes
- Subdural strip/ Grid
- Depth electrodes
- Stereoelectrocorticography (SEEG)

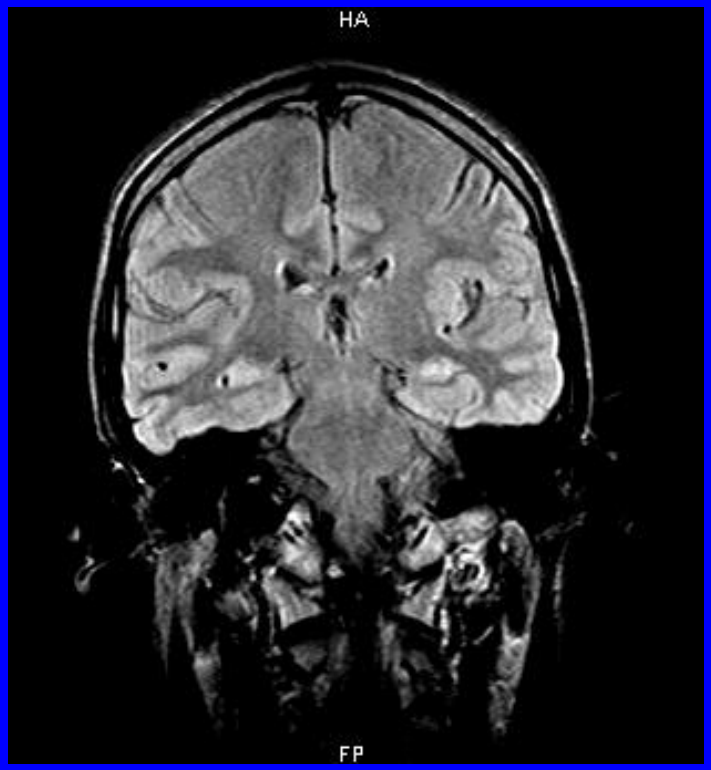
Indications

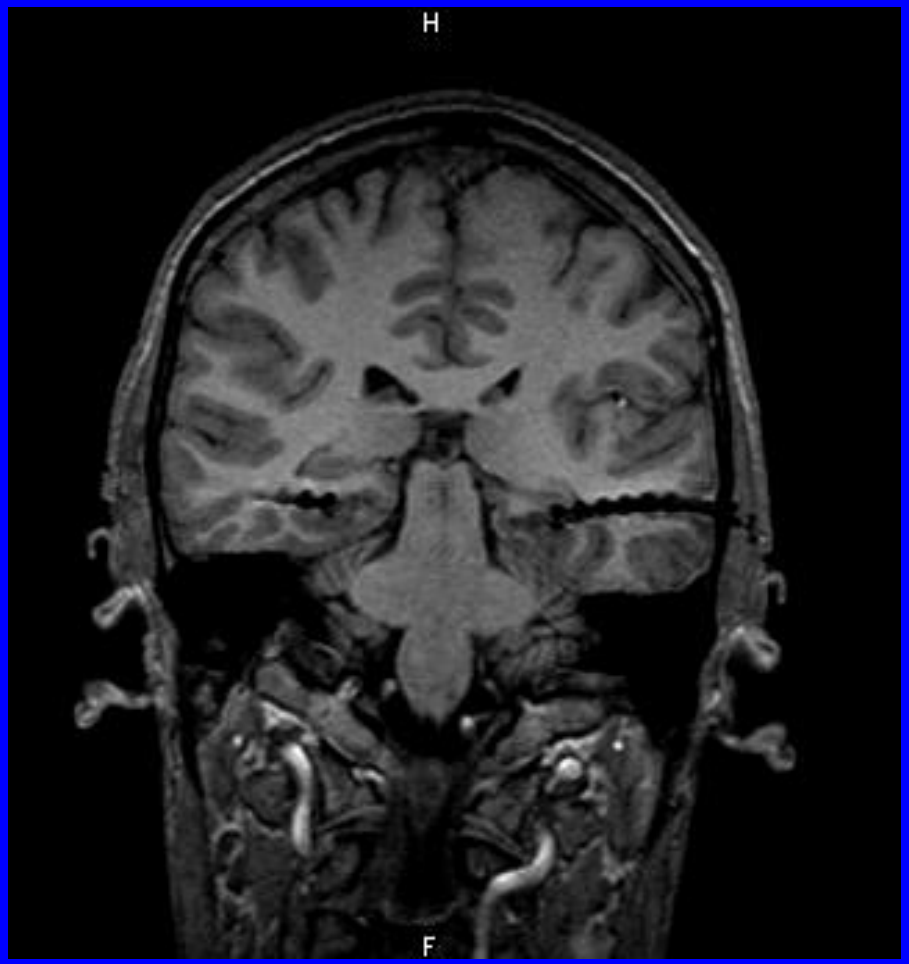
- Nonconcordant, Nonlocalized
- Extent of resection
- Mapping functional cortex

Intraoperative ECoG

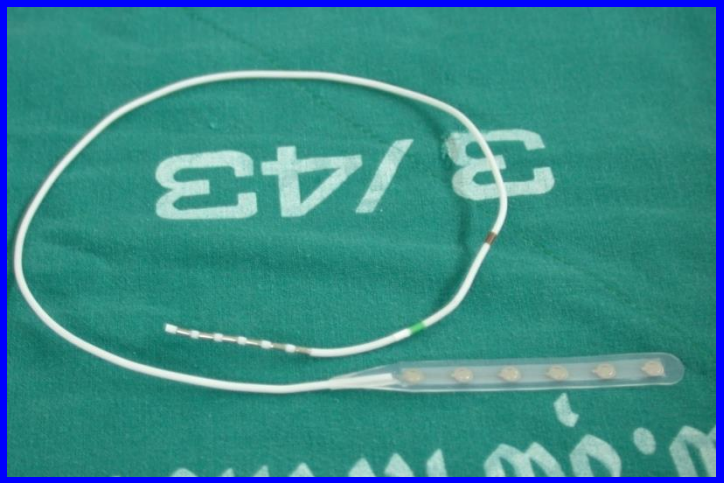


Depth electrodes

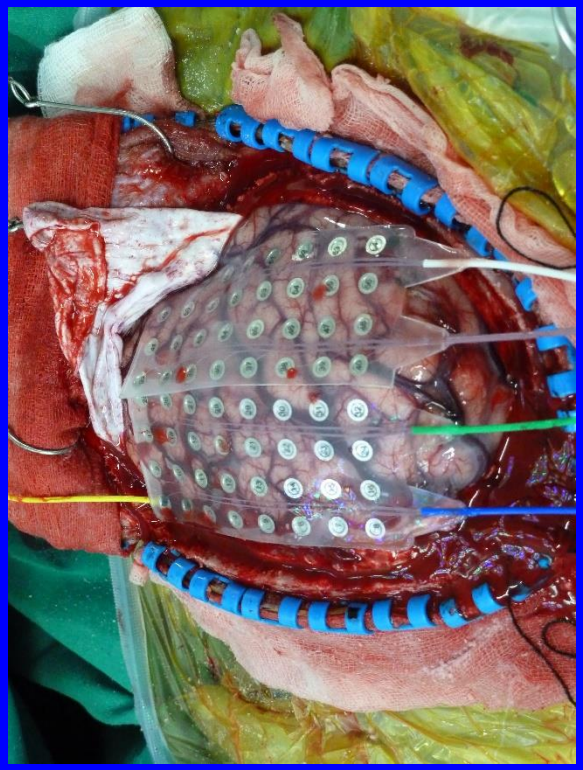


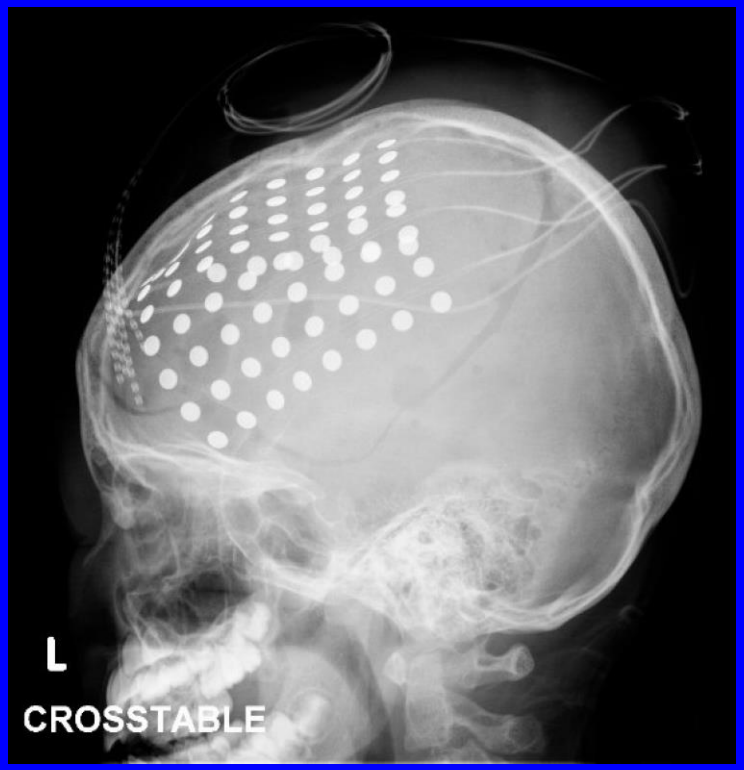


Bitemporal subdural strips



Subdural electrode





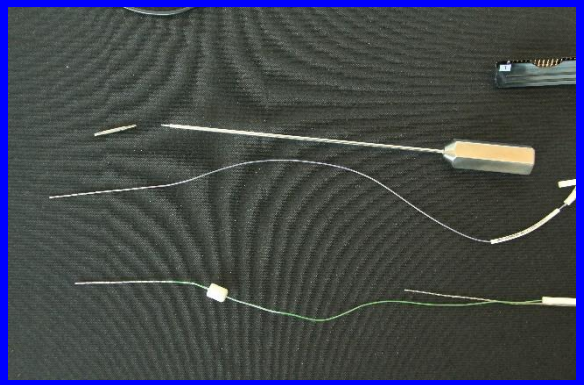
Advantages and disadvantages of the different modalities of invasive monitoring

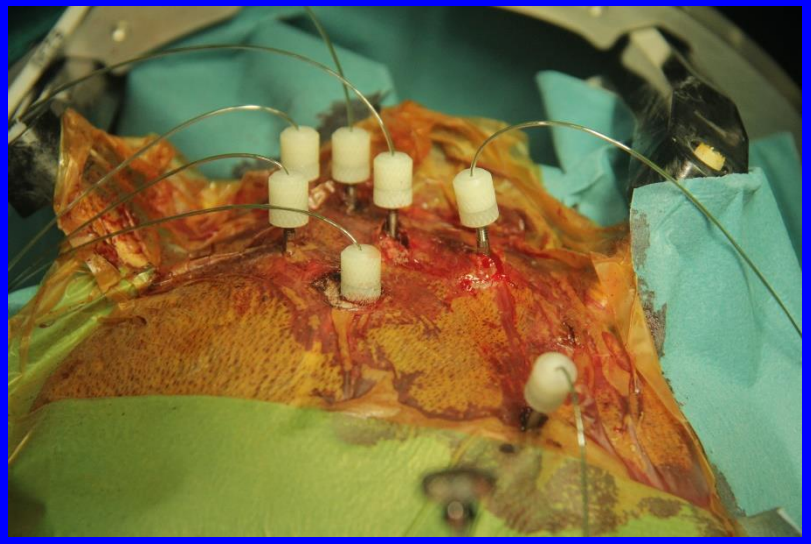
Invasive modality	Advantages	Disadvantages
Depth electrodes	·Stereotaxic placement of contacts ·Accurate lateralization and localization ·Interictal and ictal recordings	·Increased morbidity ·Limited region of study ·Unable to map eloquent area
Grid/strip electrodes	·Easier to implant with direct visualization ·Covers lager explanses of cortex ·Lesser morbidity compared to depth electrodes ·Mapping of eloquent areas of cortex through cortical stimulation	·Cannot map hippocampus nor amygdala as well as depth electrodes ·For SGE, requires craniotomy for placement and removal

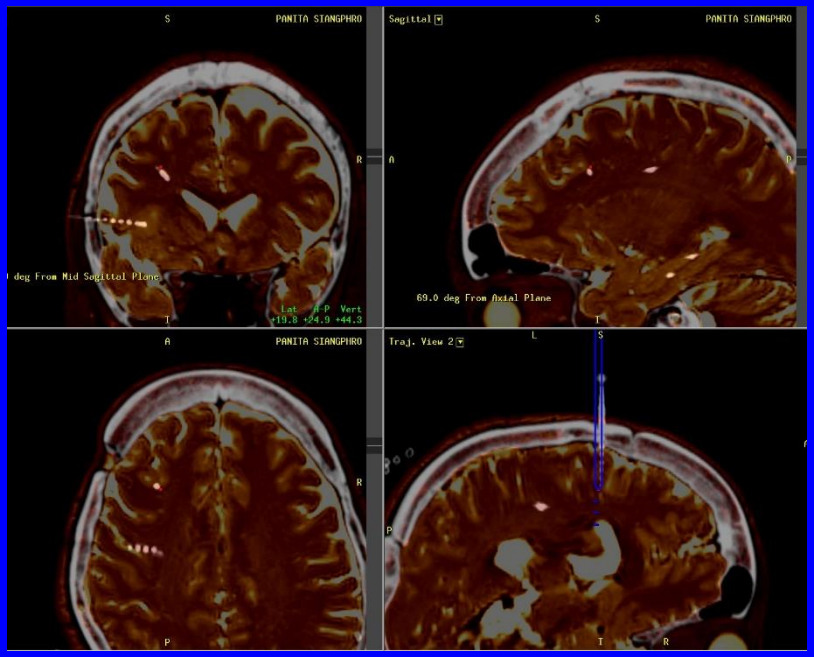
Advantages and disadvantages of the different modalities of invasive monitoring

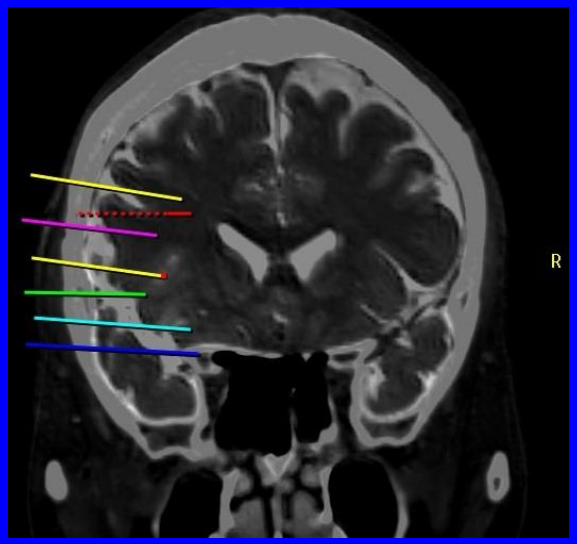
Invasive modality	**Advantages**	**Disadvantages**
Intraoperative EcoG	•No long-term hospital stay •Mapping of eloquent areas of cortex •Location and distance between electrodes can be changed during the procedure	•Interictal recording only •Long operating room time •Impractical in young children

SEEG



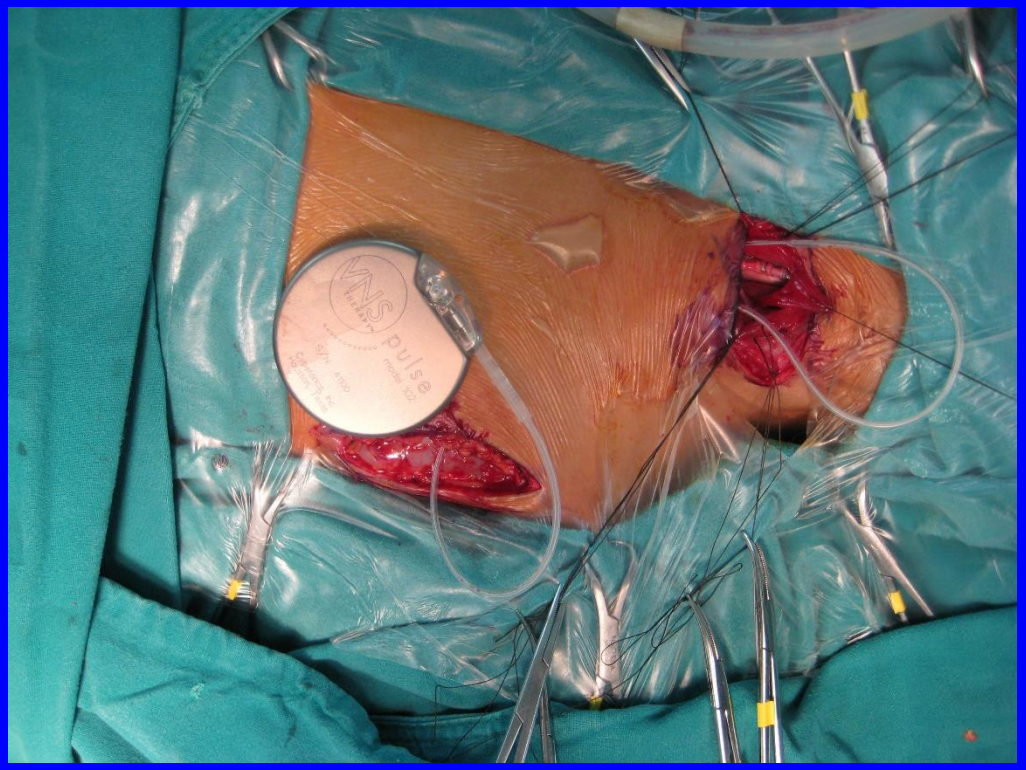



PANITA SIANGPHRO
Sagittal
PANITA SIANGPHRO
deg From Mid Sagittal Plane
69.0 deg From Axial Plane
PANITA SIANGPHRO
Traj. View 2


R

VNS

VNS



Outcome after surgery

- Seizure outcome
- Quality of life outcome
- Psychiatric outcome
- Psychosocial outcome

Seizure outcome after epilepsy surgery (Engel's classification)

- Class I: Free of disabling seizures

  A: Completely seizure free since surgery

  B: Nondisabling simple partial seizures only since surgery

  C: Some disabling seizures after surgery, but free of disabling seizures for $\geq$ 2 years

  D: Generalized convultions with AED withdrawal only

- Class II: Rare seizures ("almost seizure-free")

  A: Initially free of disabling seizures but has rare seizure now

  B: Rare disabling seizures since surgery

  C: More than rare disabling seizures since surgery but rare seizures for the last 2 years

  D: Nocturnal seizures only

Engel's classification

- Class III: Worthwhile improvement

  A: Worthwhile seizure reduction

  B: Prolonged seizure-free intervals amounting to greater than half the follow-up period, but not $\leq$ 2 years

- Class IV: No worthwhile improvement

  A: Significant seizure reduction

  B: No appreciable change

  C: Seizures worse

ILAE Classification

1: Completely seizure free; no aura

1a: Completely seizure free since surgery

2: Only auras; no aura other seizures

3: One to three seizure days per year, ± auras

4: Four seizure days per year to 50% reduction of baseline seizure days; ± auras

5: Less than 50% reduction of baseline seizure days to 100% increase of baseline seizure days; ± auras

6: More than 100% increase of baseline seizure days; ± auras

Surgery: long-term outcome

- Meta-analysis of 78 trials on resective epilepsy surgery. Median follow-up> 5 years
- Seizure-free (Engle I)
  - Temporal: n=3895 66%
  - Parietal: n=82 46%
  - Occipital: n=35 46%
  - Frontal: n=486 27%
  - Extratemporal: n=169 34%
  - Hemispherectomy: n=169 61%
  - Tumor related 76%

Téllez-Zenteno JF. Brain 2005; 128:1188-98

Thank you