Epilepsy Surgery

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Candidates for Epilepsy Surgery

- Persistent seizures despite appropriate pharmacological treatment (usually at least two drugs at limits of tolerability)
- Impairment of quality of life due to ongoing seizures

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Problems of intractable epilepsy

- Potential for injury
- Socially disabling
  - Employment (and schooling)
  - Driving
  - Living independently
  - Stigmatization

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Epilepsy Surgery

- As many as 100,000 patients with epilepsy in the United States are potential surgical candidates
- ~ 5,000 new potential cases occur each year
- 1,500 epilepsy surgeries are performed each year

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When should surgery be considered?

- After adequate trials of 2-3 good anti-epileptic medications
- The type of epilepsy and initial testing may influence this decision

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Treatment Sequence for Pharmacoresistent Epilepsy

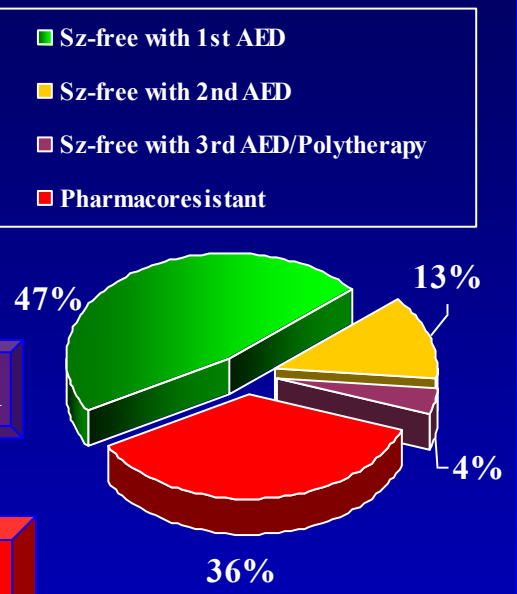
1st Monotherapy AED Trial

2nd Monotherapy AED Trial

3rd Monotherapy/Polytherapy AED Trial

Epilepsy Surgery/VNS Therapy Evaluation with videoEEG

Resective Surgery | VNS Therapy | Polytherapy AED Trials



Kwan P, Brodie MJ. *NEJM*;342:314-319.

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Presurgical Evaluation

- History and exam
- MRI scan
  - Mesial Temporal Sclerosis (MTS), tumor, vascular malformation, dysplasia
- Video/EEG monitoring with scalp EEG
  - interictal epileptiform discharges
  - ictal
    - Seizure semiology
    - Ictal EEG discharge
  - Additional electrodes

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Presurgical Evaluation

- Functional Imaging
  - PET
    - hypometabolism interictally
  - SPECT
    - hypoperfusion interictally
    - hyperperfusion ictally
    - subtraction and co-registration with MRI

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Presurgical Evaluation

- Neuropsychological testing
  - Pre-operative baseline
  - Aid in localization
  - Predicting risk of cognitive decline with surgery
- Wada (intracarotid amobarbital) test
  - language
    - lateralization
  - Memory
    - prediction of postoperative decline

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Inpatient Video EEG Monitoring

- Goal: to capture the patient's typical seizures
- Medications are tapered or withdrawn
- Sleep deprivation, hyperventilation, photic stimulation and possibly other provocative maneuvers are tried

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Inpatient Video EEG Monitoring

- Assess the interictal EEG using a longer recording
- Confirm the diagnosis of epilepsy
- Confirm the type of epilepsy
  - Generalized vs. partial
  - Temporal vs. extratemporal
- Localize the site of seizure onset

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MRI head- seizure protocol

- Coronal T2
- High resolution 3T MRI (coronal and axial)
- Thin coronal cuts through the temporal lobes

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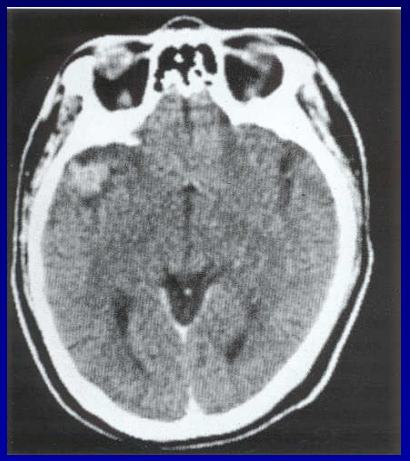
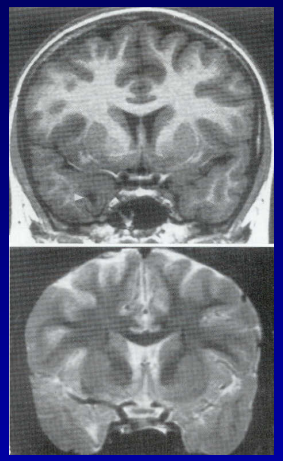
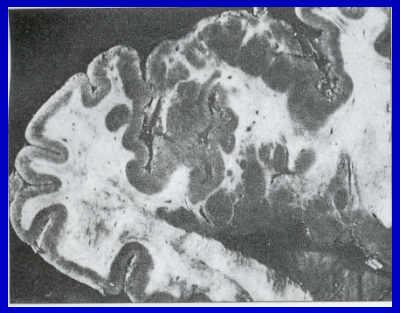
Epilepsy Surgery- Lesional



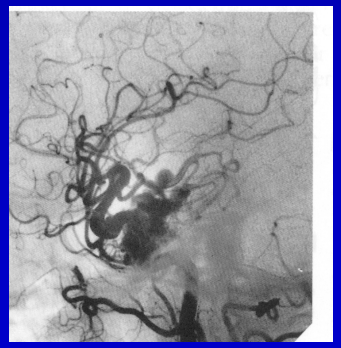
Ganglioglioma



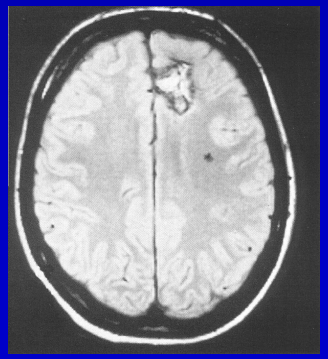
DNT



Cortical Dysplasia



AVM



Cavernous Angioma

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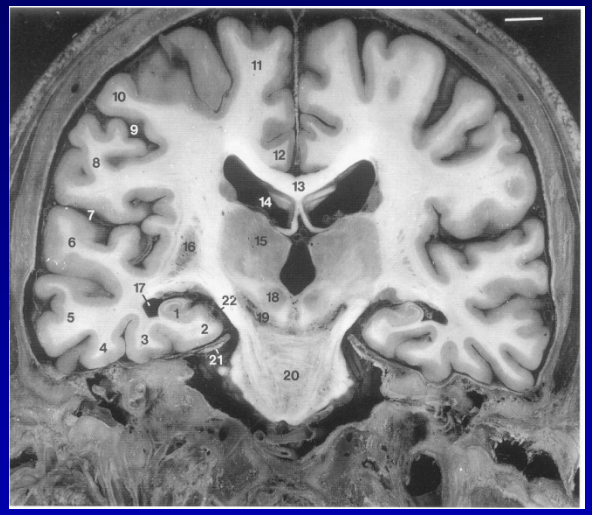
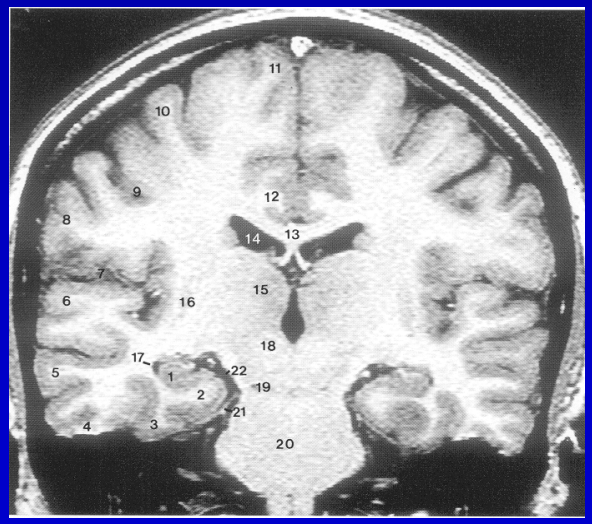
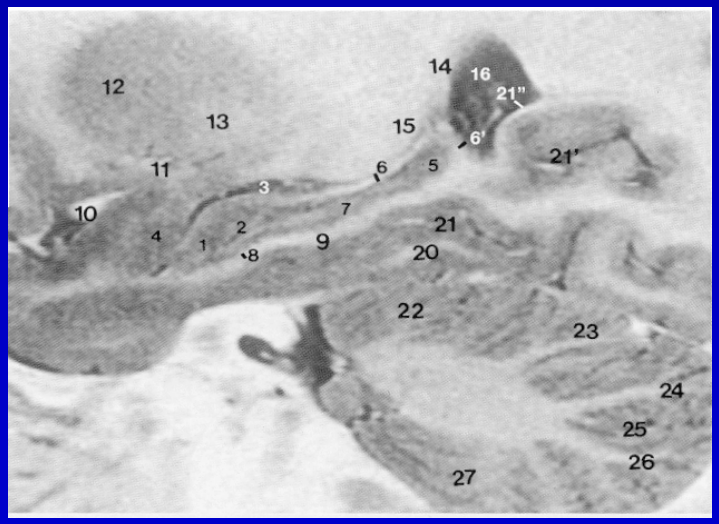
Temporal Lobe Epilepsy- Hippocampal Anatomy







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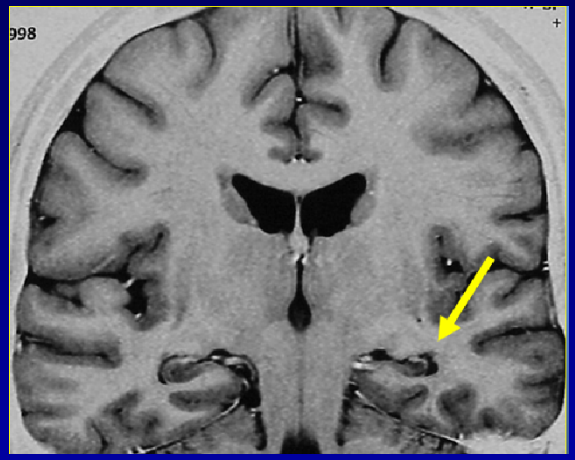
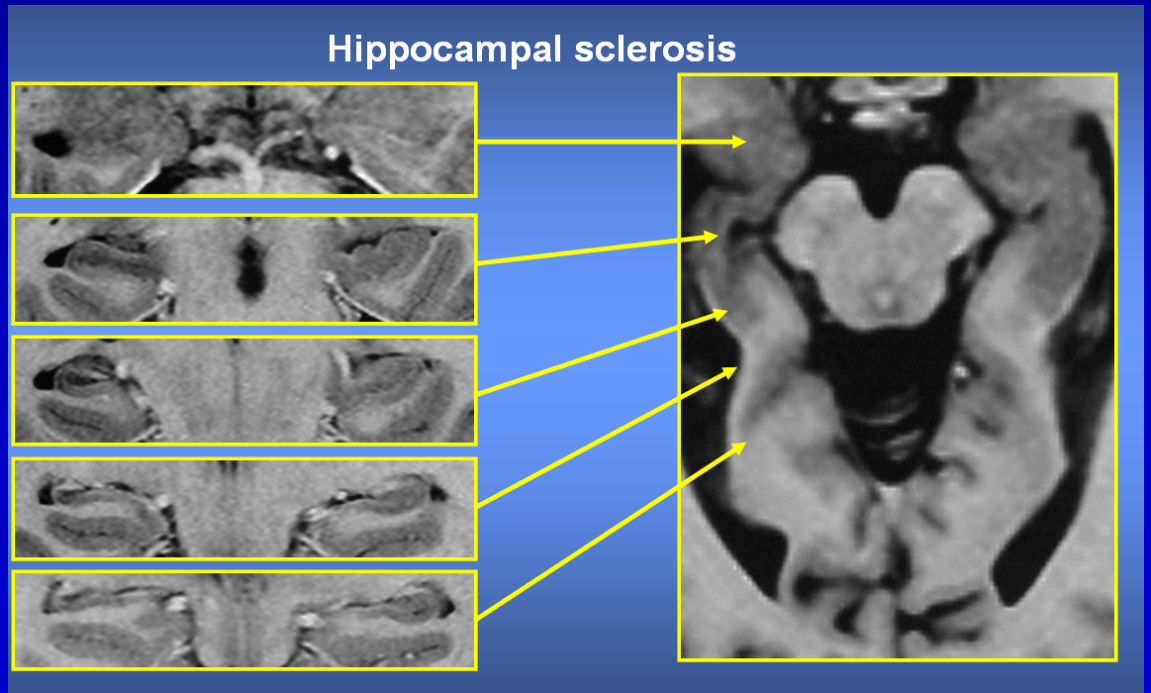
Temporal Lobe Epilepsy- Hippocampal Atrophy





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Concordance

- Interictal EEG findings
- Ictal semiology
- Ictal EEG onset
- MRI

- Tests should show concordant findings
- If a contradictory or unclear picture emerges, additional testing is warranted

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If not concordant

- MEG
- Metabolic studies
  - PET
  - Ictal SPECT (SISCOM)

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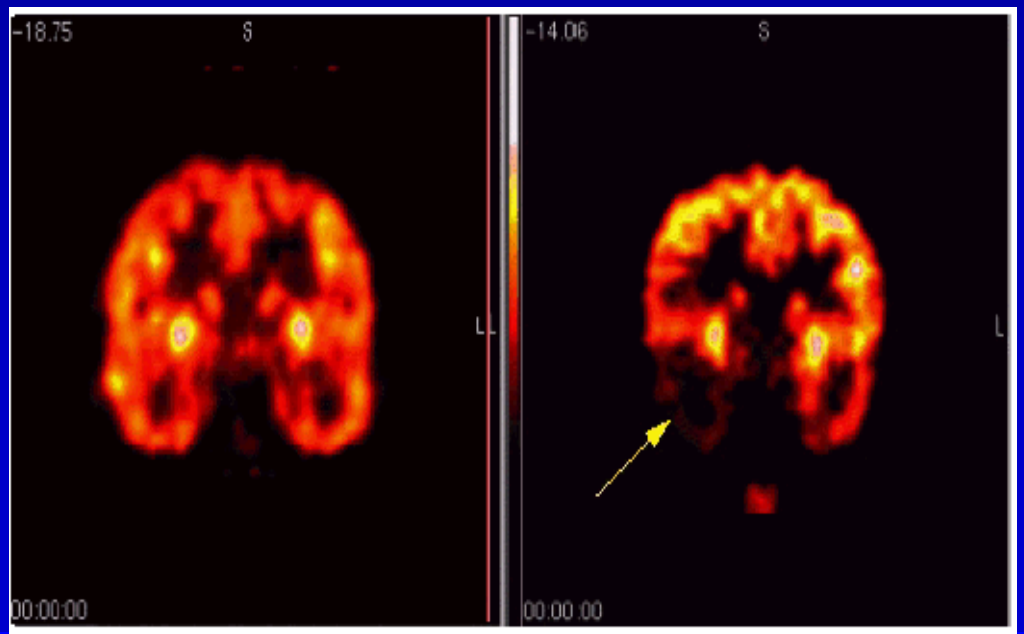
PET

- Glucose metabolism
  - FDG (18-F-2-deoxyglucose)
- Cyclotron required- limits availability
- Short half life (FDG- 150 minutes) -limits ictal studies
- Mostly useful for temporal lobe epilepsy



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FDG-PET localization as judged by EEG criteria

- Spencer, et al.
  - 312 patients from the literature
    - Temporal lobe epilepsy
      - Sensitivity: 84%
      - Specificity: 86%
    - Extra-temporal epilepsy
      - Sensitivity: 33%
      - Specificity: 95%

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Ictal SPECT

- SISCOM (subtraction ictal SPECT with co-registration onto MRI)
  - Ictal injection at the time of the seizure with scan
  - Interictal injection with scan
  - Co-registration onto MRI

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Ictal SPECT

- Good confirmatory test- added utility in
  - Non-lesional (MRI negative) temporal and extra-temporal epilepsies
  - Limiting resection in cases of diffuse hemispheric abnormalities
- Due to regulations regarding administration of radiopharmaceuticals not currently feasible in many states (including Texas)

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Criteria for "skip" vs Phase 2

- CONCORDANT DATA = 'skip' to resection
  - EEG/ MRI/ Neuropsych
    - 2 concordant tests and no discordant test
    - usually EEG + MRI

- If data NOT Concordant
  - Unilateral seizure activity = subdural grids
  - Bilateral temporal lobe seizure activity = bilateral depths

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The WADA Test

- Helps determine which side of the brain controls **language function** and how each side of the brain controls **memory function**
  - Language is usually controlled on the L, Memory can be controlled by both sides of the brain (the test tells physicians which side has the better memory function)

- Need this information to help the patient /family make an informed decision based on **possible risk factors for specific neurologic deficits** such as memory problems or aphasia

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The WADA Test

- Two doctors perform the test: usually a **neuroradilogist /interventional neurologist** and an **epileptologist** (neurologist specializing in epilepsy)
- Patients remain NPO from 12 midnight **the night prior** to the test
- Hospitalization is required
- Pt usually kept overnight and taught to not participate in strenuous activity for up to 48 hours after the test has been completed

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The WADA Test

- An angiogram is conducted prior to the WADA test
- A catheter is directed through the groin, into the right or left internal carotid artery in the neck (these are the main arteries that supply blood supply to the brain)
- Once the catheters are in place, dye is injected into these arteries
- Radiographic images are then taken of the blood flow through the brain

after complete angiogram, WADA test is performed…

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The WADA Test

- One side of the brain is anesthetized with a short acting barbiturate called Brevitol ®.
- NON- anesthetized side of the brain remains fully awake.
  - EEG waveform tracings are done at the same time as a neurological exam by the neurologist to confirm this
- Epileptologist will then evaluate the patients' ability to speak
- The epileptologist will also show the patient individual cards of pictures and words. The awake side of the brain will try to recognize and remember what it sees.
- When anesthesia wears off, and both sides of the brain are awake, the epileptologist will ask the patient what was shown.
  - This tests both language and memory
  - Each response is recorded.

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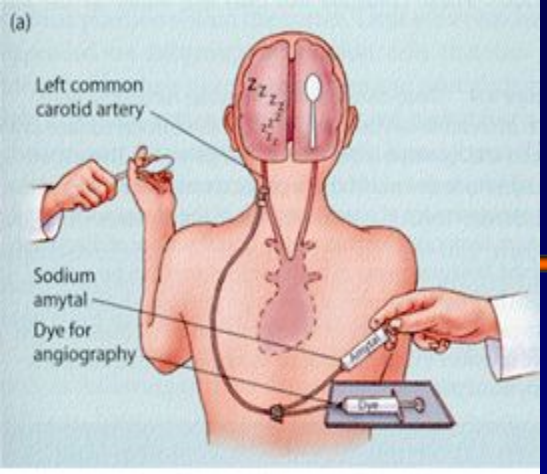
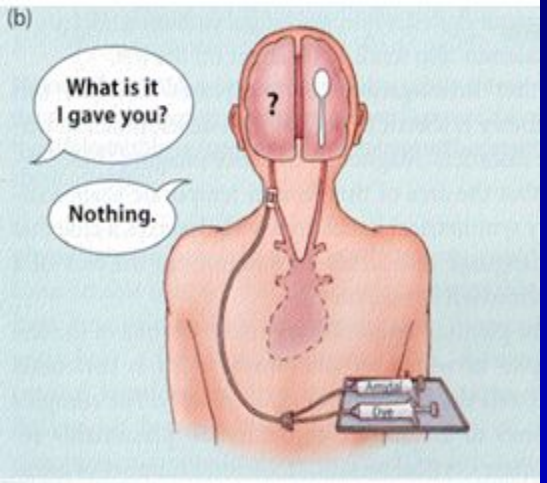
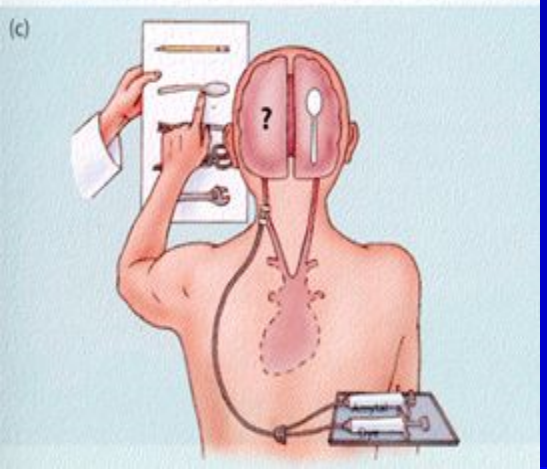






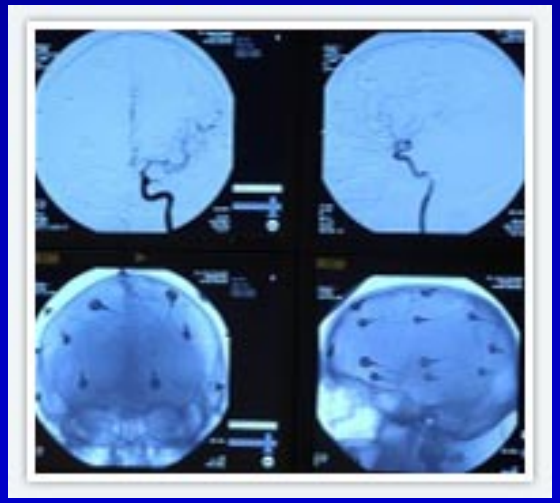
The WADA Test

- Procedure is repeated for the other side of the brain
  - A new angiogram is done for that side of the brain
  - Different pictures and objects are shown

- Once both sides are awake again, the patient will be asked what was shown the second time. The items are shown one at a time and the patient is asked to name them.

The WADA Test

- The physicians will determine which side of the brain is the dominant side
- Test may last from 60 to 90 minutes (varies)



Angiogram images

Neuropsychological testing

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Presurgical Evaluation

- Intracranial EEG when needed
  - Grids and strips, most commonly subdural
  - Parenchymal "depth" electrodes, especially for recording from hipppocampus
  - Identification of ictal onset
  - Brain mapping
    - cortical stimulation
    - SSEPs
    - Functional MRI

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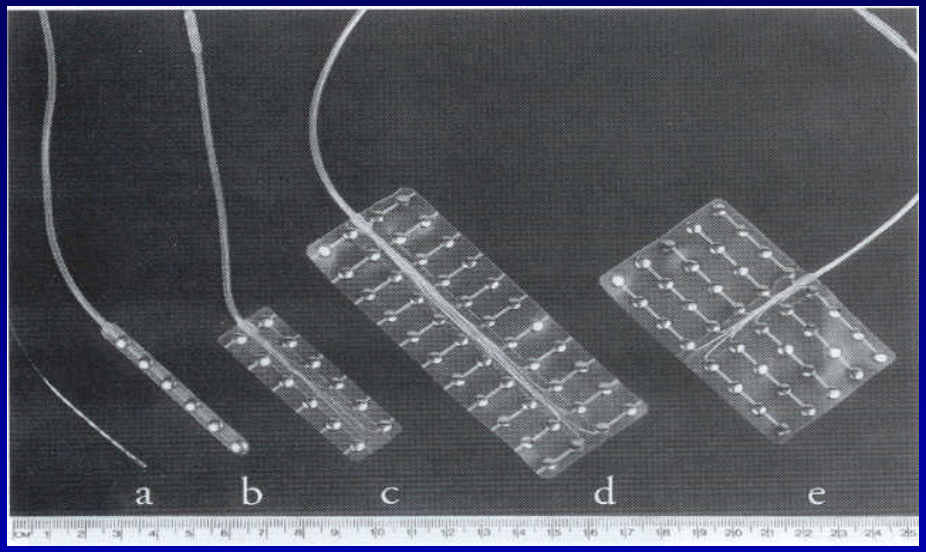
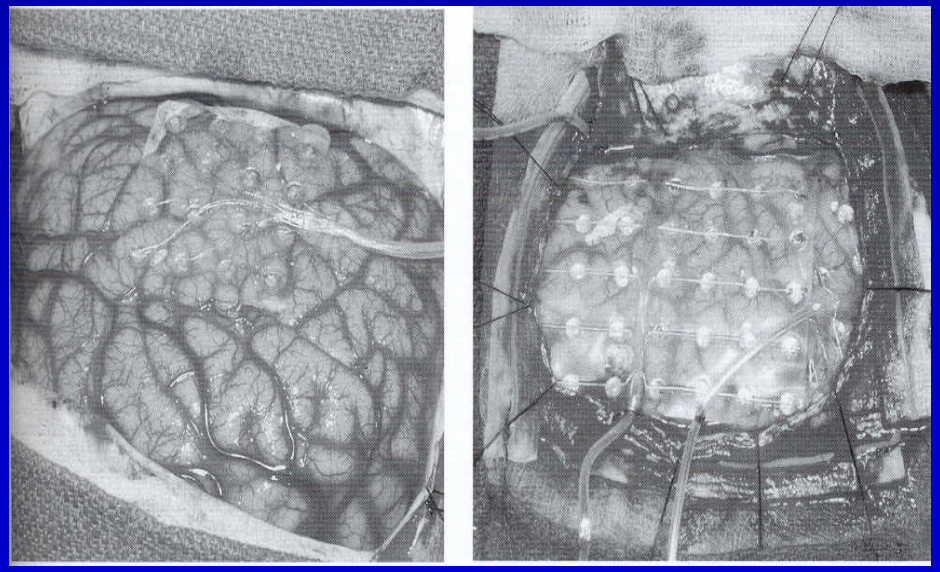
Evaluation for Surgery- Subdural Grid Electrodes





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Depth Electrodes

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Types of Surgical Procedures

- Resective Surgery: single seizure focus in non-eloquent region.
- Palliative Surgery:
  - For drop attacks: corpus callosotomy
  - For Rasmussen's encephalitis or hemimegalencephaly: hemispherectomy

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Surgical Treatment of Epilepsy

Figure 2

Curative ⟷ *Palliative*

Pathologies

MTS TLE	Non-MTS TLE
Lesional	Frontal Lobe epilepsy
- Low Grade Glioma	SMA/cingulate epilepsy
- Cav. Malformation	Malformations of cortical development

Procedures

Lesionectomy	Hemispherectomy	Disconnection
Lobectomy	Topectomy	(Callosotomy)
	MST's	

Modified from McKhann G.M. and Howard M.A.: Epilepsy Surgery: Disease Treatment and Investigative Opportunity, in Diseases of the Nervous System: Clinical Neurobiology, 2002.

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Consideration of intracranial monitoring

- Options
  - Subdural strips
  - Subdural grids
  - Depth electrodes
- Record additional seizures with the intracranial electrodes in place to better localize seizure onset

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Cortical stimulation

- Can be done at the time of surgery or through implanted intracranial electrodes to localize functional cortex including
  - Language cortex
  - Motor cortex
  - Sensory cortex

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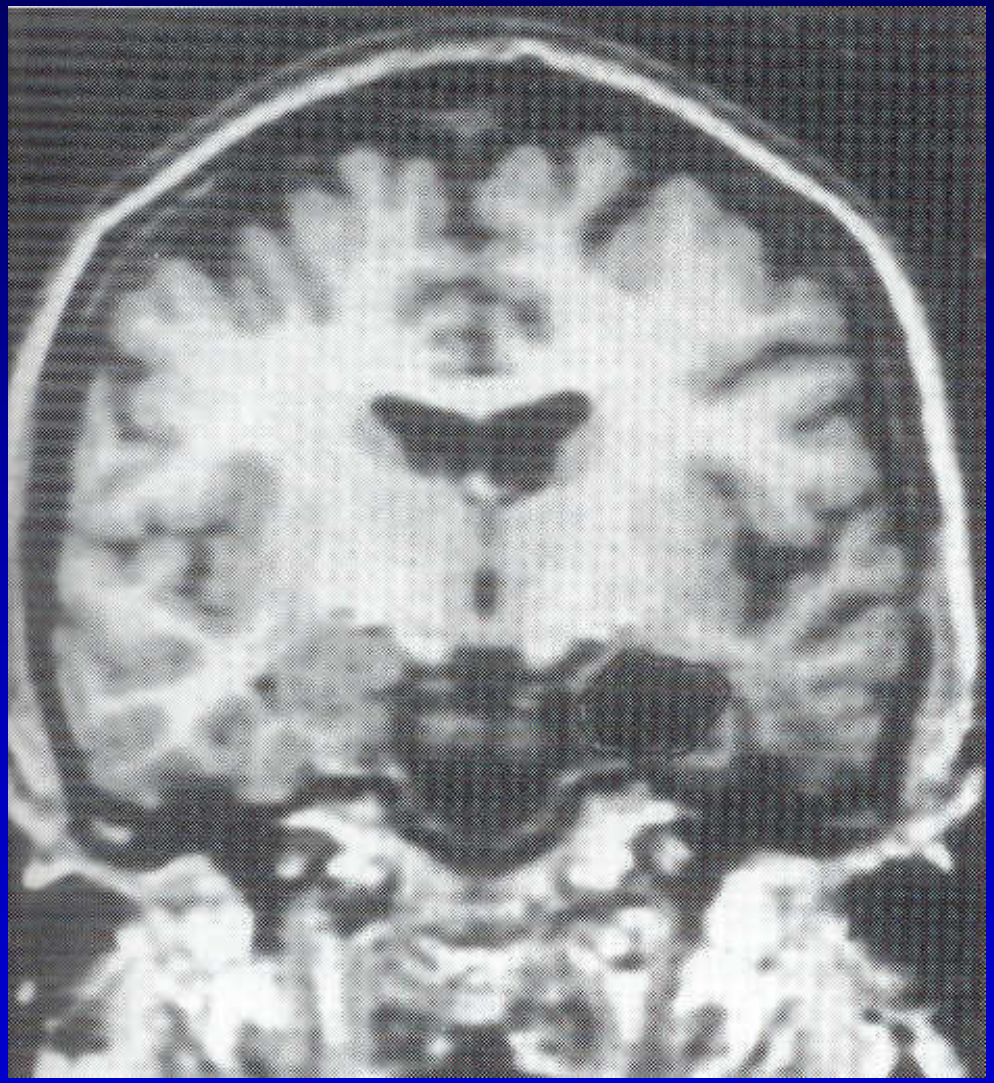
Post-op MRI for Mesial ATL



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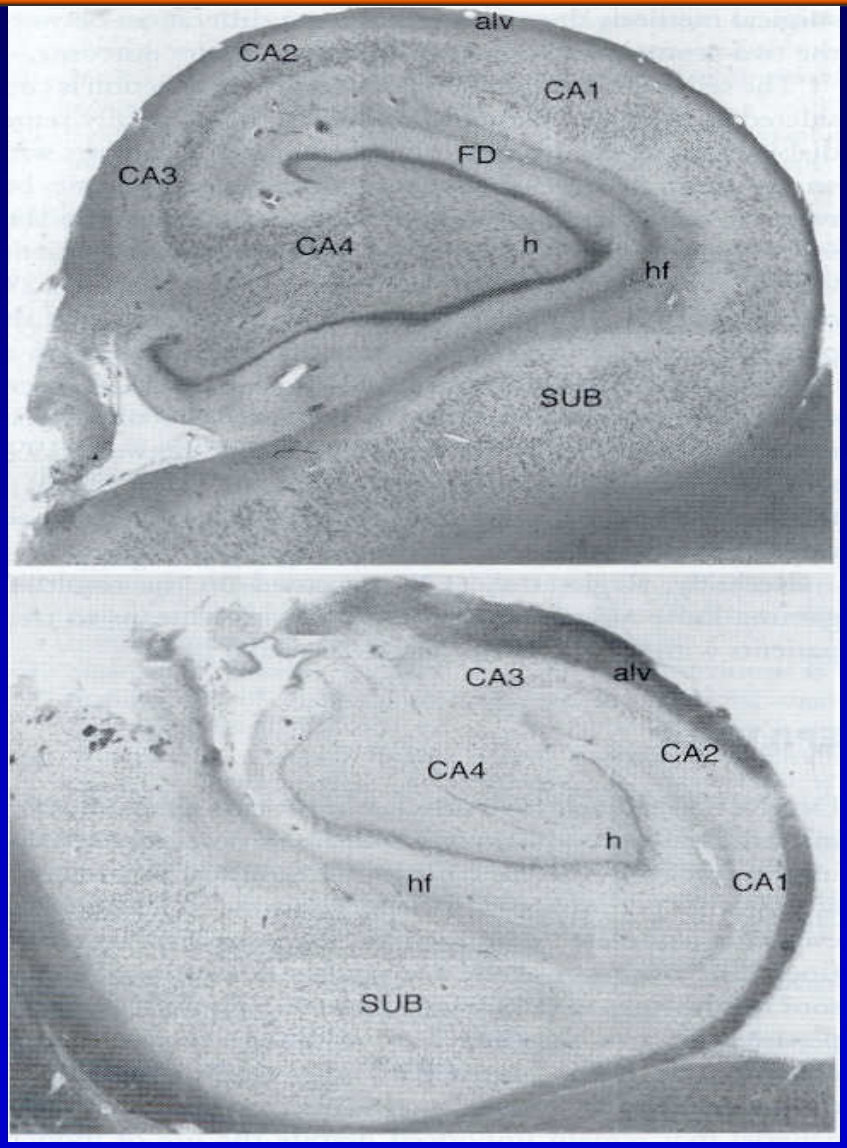
Temporal Lobe Epilepsy- Hippocampal Sclerosis



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Lesional Epilepsy Syndromes

- Predictive of
  - An unfavorable response to AED medication
  - A favorable response to surgery
- Operative success
  - Lesional pathology
  - Location of lesion
  - Completeness of resection

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Lesional Epilepsy Syndromes

	Lesionectomy (Engel et al)
Seizure-free	195 (66.6%)
Improved	63 (21.5%)
Not improved	35 (11.9%)
Total	293 (100)

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Lesional Epilepsy Syndromes- Tumors

- Commonly low grade gliomas, DNETs, gangliogliomas
- With full resection 43-90% seizure free depending on the study

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Lesional Epilepsy Syndromes- Vascular Malformations

- AVMs, Cavernous hemangiomas
  - Seizures presenting symptom in 30-70%
  - 56-89% seizure free

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Lesional Epilepsy Syndromes- Vascular Malformations

	Piepgras, et al. Mayo	Yeh, et al.	Dodick, et al Mayo
# of pts total	280	54	20
# of pts w/ >3 Sz	68	54	20
Type of malformation	AVMs	AVMs	AVMs & cavernous malf
% Sz free post surg- on AED	76%, better in 97%	70.4%, 88.9% >90%	75%, 90% >90%
% Sz free post surg- no AED	41%		10%

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Lesional Epilepsy Syndromes- Neuromigrational abnormalities

	Palmini, et al. (McGill/MNI)
# of patients	30 (24)
Pathology	Focal NMD
% seizure free >90%/>50%	8% 42%/67%
Excision- complete or major & outcome	77% w/ good/excellent outcome
Excision- minor (<50%) & outcome	0% w/ good/excellent outcome

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Nonlesional Epilepsy

- As determined by MRI (Hajek et al.)
  - 20% seizure free
  - 55% with improvement

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Hemispherectomy

- Current practice is to perform a modified radical hemispherectomy leaving the frontal and occipital poles in place though disconnected
- Reserved for certain catastrophic childhood epilepsies
  - Rasmussen's encephalitis
  - Hemimegalencephaly

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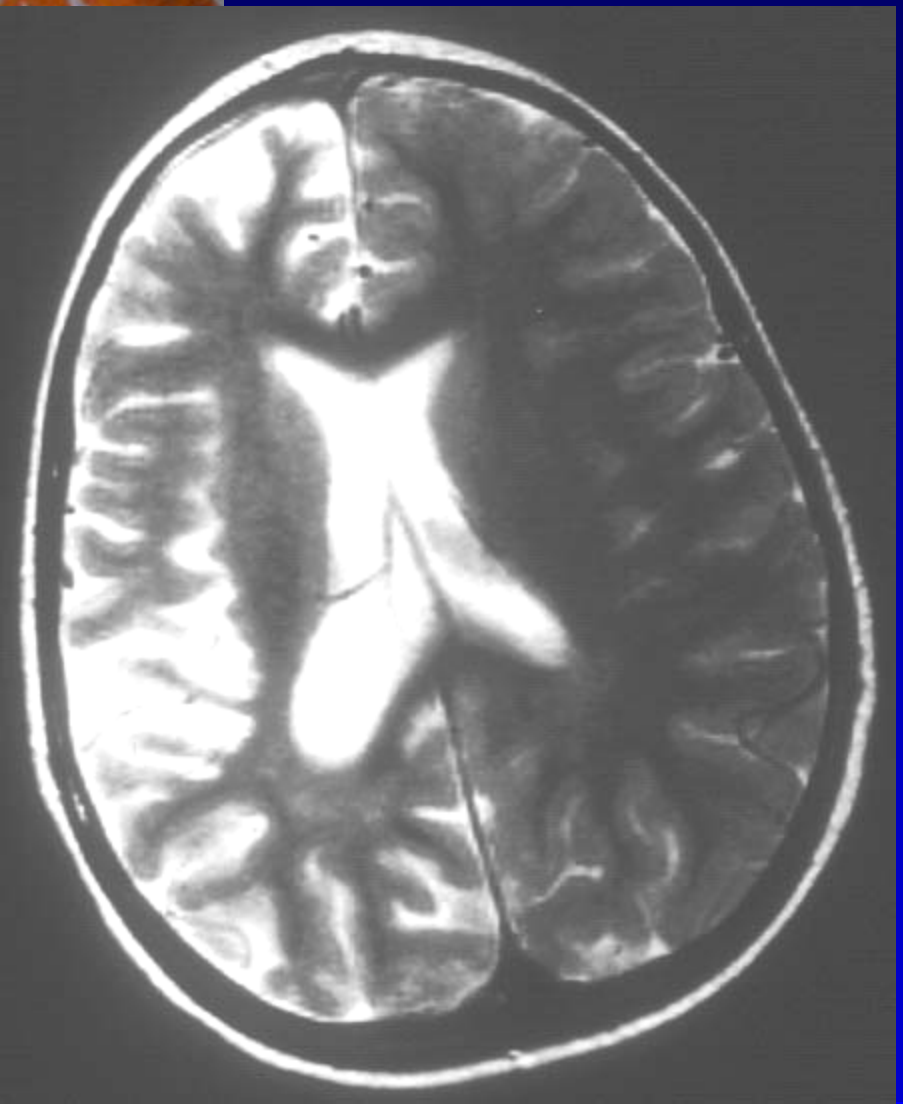
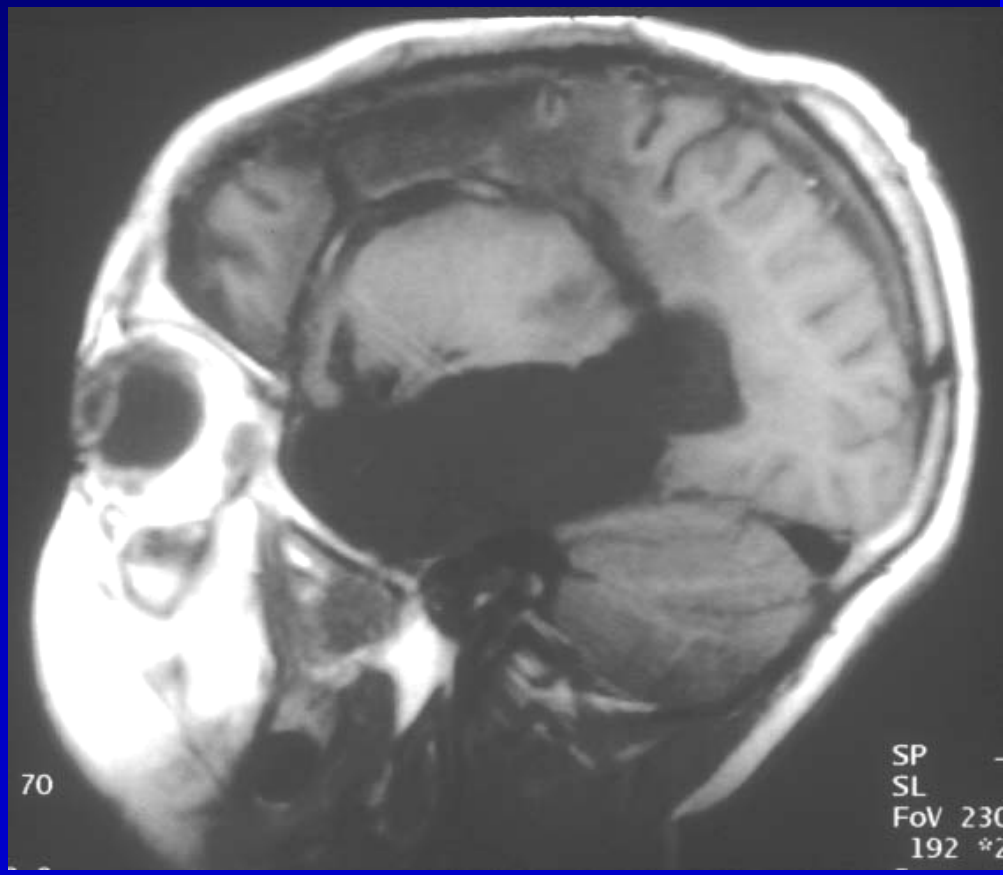
Hemispherectomy





Corpus Callosotomy

- Useful as a palliative procedure in patients with symptomatic generalized epilepsy associated with certain seizure types
  - Tonic
  - Atonic
- Almost always done as a staged procedure
  - Anterior 2/3's corpus callosotomy first
  - Completion of corpus callosotomy if initial surgery ineffective or not effective enough

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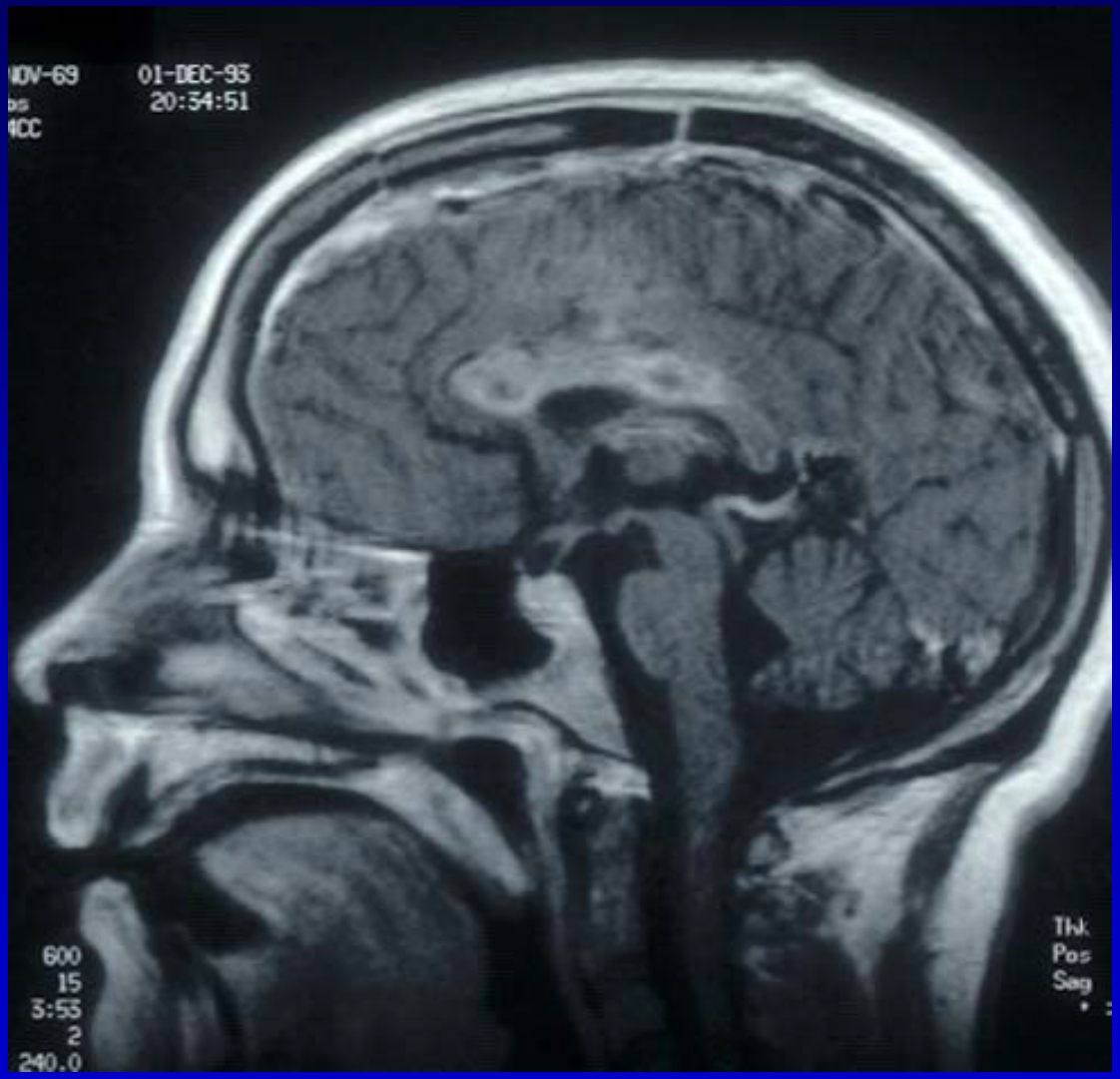
Corpus Callosotomy



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Corpus Callosotomy- Results

	Reutens, et al 29 mo	Oguni, et al (MNI) 39 mo	Wyler
# of patients	64 (15 CCC)	43 (all ACC)	66 (11 CCC)
Seizure free	8 (12%)	5 (12%)	7 (11%)
>50%	31 (48%)	24 (56%)	45 (68%)
Worse	1 (2%)	0%	0% (2 died)
Seizure Type Outcome	Astatic- 71% Tonic- 43% GTC- 50% CPS– 50%	Astatic- 65% Tonic- 60% GTC- 38% CPS- 50%	

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Vagus Nerve Stimulation

- Adjunctive treatment for medically refractory epilepsy patients
  - Not ideal surgical candidates
  - Patient and family not interested in a surgical option

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Vagus Nerve Stimulation- Advantages

- Minimal surgical complications, NO mortality
- No “down stream” effects
- No evidence of increased mortality or SUDEP
- Localized stimulation related effects:
  - Hoarseness/ voice change
  - Throat pain
  - Cough
  - Dyspnea
- During Stimulation
- Diminish over time
- Controllable

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Vagus Nerve Stimulation-Disadvantages

- Surgical procedure

- Adjunctive treatment for seizures
  - Does not obviate the need for medications though fewer meds at lower doses may be required

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