Epilepsy Surgery in Adults: Who should be considered? How will patients do?

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Why is epilepsy surgery considered?

- Approximately 1/3 of patients with partial epilepsy are resistant to medical therapy.
- Persistent uncontrolled seizures are associated with psychosocial dysfunction, increased morbidity, and increased mortality, including accident related mortality and sudden unexpected death (SUDEP).
- Some forms of epilepsy may be progressive.
Epilepsy Surgery - purpose

- Curative - good chances of complete seizure control
  - Resective surgery
  - Multiple subpial transections

- Palliative - expected to reduce seizure severity or number of seizures, not to stop seizures completely
  - Corpus callosotomy
  - (vagus nerve stimulation)
  - Resective surgery under certain circumstances
Who are the best candidates for epilepsy surgery

- Any patient with medication-resistant epilepsy should be considered.
- The most likely to benefit are those with:
  - Unilateral mesial temporal lobe epilepsy with hippocampal sclerosis
  - Lesional partial epilepsy
- Other partial epilepsies may become completely controlled, though with slightly lower success rate.
MRI - Hippocampal Sclerosis

T2-weighted
Hippocampal sclerosis
Hippocampal sclerosis
Presurgical Evaluation

- Purpose: localize the epileptogenic zone
- **Epileptogenic zone**: zone whose resection is necessary and sufficient to eliminate seizures
- The epileptogenic zone cannot be identified directly. It is a theoretical zone that can be estimated by a number of other “zones”
Zones in Partial Epilepsy

- **Ictal onset zone** or **pacemaker zone**: zone in which seizures are originating. This zone is always contained in the epileptogenic zone, but may be smaller than the epileptogenic zone.

- **Epileptogenic lesion**: lesion (scar or tumor or malformation) causing epilepsy.

- **Irritative zone**: zone in which “interictal” epileptiform discharges originate.

- **Symptomatogenic zone**: zone that produces the first clinical manifestations of seizures.

- **Functional deficit zone**: zone responsible for functional deficits (function can be measured in a variety of ways).
Presurgical Epilepsy Localization

- History (etiologic factors, age at risk factor/injury) (association with specific pathology)
- Physical examination: focal/generalized deficits
- Seizure description (description of aura, focal features during seizure progression, mouth movements, language manifestations, postictal manifestations)
Presurgical Epilepsy Localization

EEG, EEG-CCTV

- “Interictal” slow activity, attenuation
- “Interictal” sharp waves and spikes
- Ictal EEG onset - the first EEG changes with a seizure
- Clinical seizure signs on video review: early head turning, oro-alimentary automatisms, dystonic posturing, ictal language, ictal vomiting/spitting, adverse head turning and focal tonic/clonic activity in transition to generalization, postical aphasia, postictal nose wiping
Presurgical Epilepsy Localization

- MRI (epileptogenic lesion)
  - Focal structural “foreign tissue” lesions: tumors, cavernous angiomas, arteriovenous malformations
  - Hippocampal sclerosis
  - Developmental malformations: focal cortical dysplasia, heterotopias, other

Warning: some lesions usually have a weak association with epilepsy (venous angioma, arachnoid cyst)
MRI - Hippocampal Sclerosis
MRI - Cavernous angioma

T2-weighted

FLAIR
MRI - left frontal gangliocytoma
MRI- DNET tumor
Presurgical Epilepsy Localization functional neuroimaging

- Positron Emission Tomography (interictal PET)
  - Hypometabolism zone (functional deficit zone)
FDG PET - Temporal lobe epilepsy
Presurgical Epilepsy Localization

Neuropsychology

- Neuropsychological testing (functional deficit zone)
- Intracarotid amobarbital procedure (Wada test)- injection of anesthetic in each carotid artery to examine language and memory function in the other isolated hemisphere
Multidisciplinary Epilepsy Surgery Conference

- Attended by
  - adult and pediatric epileptologists (neurology epilepsy specialists)
  - adult and pediatric epilepsy surgeons
  - adult and pediatric neuropsychologists
  - neuro-radiologists
  - epilepsy nurses
  - EEG technologists
  - Epilepsy surgery coordinator
What if it is still not clear where seizures start?

- Ictal SPECT- injection of a substance at seizure onset- substance is picked most by brain regions with highest blood flow (the region of seizure activity)
  - Focal/regional hyperperfusion (ictal onset zone)
- Magneto-encephalography (MEG)- test measuring the magnetic field of spikes and sharp waves
Ictal SPECT
What if it is still not clear where seizures are starting?

- We may need to repeat video EEG testing
- We may consider placing electrodes on or in the brain (invasive EEG), but only if we have an idea of where to look
When is invasive intracranial monitoring indicated?

- Epileptogenic zone well lateralized but not well localized (example: frontal versus temporal or posterior-lateral temporal versus anterior-mesial temporal)
- Bilateral temporal epileptic activity
- Epileptogenic zone may overlap with functional cortex (example: language or motor)
- Epileptic zone is outside the temporal lobe and there is no lesion
- Epileptogenic zone not well-defined or data not in agreement
  - This is only we have valid theories about where seizures are starting.
Invasive EEG techniques

- Subdural grid electrodes
  - For better localization and functional mapping
- Depth electrodes
- Subdural or epidural strip electrodes
- Foramen ovale electrodes
  - For lateralization of bilateral mesial temporal epilepsy
- Epidural peg electrodes
Who is the best candidate for focal resection?

- Partial (focal) epilepsy
  - All zones are in agreement
  - Epileptogenic zone does not have essential functions (motor, sensory, language)
  - Epileptogenic zone not functioning well
  - There is an associated focal structural lesion, or hippocampal sclerosis on one side
Modalities of Surgical Therapy and Indications

Lesionectomy
- Focal lesion associated with single epileptogenic zone

Temporal lobectomy
- Well localized temporal lobe focus, particularly non-dominant, but no clear lesion

Selective amygdalohippocampectomy
- Well localized mesial temporal focus, with hippocampal sclerosis

Tailored neocortical resection
- Localized neocortical epileptogenic zone
Standard Temporal Lobectomy
Selective Amygdalo-hippocampectomy
Modalities of Surgical Therapy & Indications—continued

- **Hemispherectomy**
  - Well-lateralized widespread epileptogenic zone and severe associated or anticipated motor deficit (ex: Rasmussen syndrome)—if there are no independent finger movements, no significant worsening in motor function will be expected in the long-term

- **Multiple subpial transections**
  - Neocortical epileptogenic zone well localized over functional (eloquent) cortex
  - Most often used with motor, sensory or language cortex
  - May be combined with resection
MRI post hemispherectomy
Multiple Sub-pial Transection
Multiple Sub-pial Transection
Outcome from epilepsy surgery - Pooled studies from 100 facilities

- Class I outcome (free of disabling seizures) in:
  - 56% of 2,336 anterior temporal lobectomies before 1986
  - 68% of 3,579 anterior temporal lobectomies after 1986
  - 69% of 413 amygdalohippocampectomies after 1986
Predictors of outcome in temporal lobe epilepsy

- **Preoperative:**
  - (1) unilateral hippocampal atrophy on MRI
  - (2) all scalp interictal epileptiform discharges concordant with the location of seizure onset.

- **Postoperative**
  - (1) absence of interictal epileptiform discharges at 3 months
  - (2) complete seizure control during the first postsurgical year
  - (3) having only nondisabling seizures for those who did not become seizure free.
Other predictors in temporal lobe epilepsy

- Antecedent febrile convulsions (favorable)
- Head trauma (unfavorable)
- Frequent generalized tonic clonic seizures (unfavorable)
- Absence of PET hypometabolism (unfavorable)
Extratemporal epilepsy

- **Favorable factors**
  - well-circumscribed lesion (such as tumor, cavernoma)
  - complete lesion resection (location of lesion does not affect the probability of a seizure-free outcome, unless functional constraints limit the extent of the resection).

- **Unfavorable factors**
  - a generalized spike-and-wave EEG pattern
  - Absence of a lesion
Late seizure relapse after surgery

- 210 patients seizure-free after epilepsy surgery
- Follow-up at 5 years post-op
  - 7% relapse with no AED change
  - 14% relapse with partial AED reduction
  - 36% relapse with full AED withdrawal
- Surgery may render refractory epilepsy responsive to AEDs, without a cure
Thirty-nine (68%) of 57 patients who discontinued AED therapy remained seizure-free.

Patients remaining seizure-free had a younger age at surgery than the group with seizure recurrence (p = 0.01).

Earlier surgery may be a favorable predictor for seizure freedom after AED discontinuation.
Epilepsy surgery—future prospects

- Improved presurgical evaluation to identify patients with erroneous localization
  - New structural imaging techniques
  - Functional imaging techniques
  - MEG
- Improved surgical techniques (ex: intraoperative MRI to help surgical resection)
- Earlier surgery for surgery candidates
- Brain stimulation