Surgical and Nonpharmacological Treatment of Epilepsy

Last updated: September 5, 2017

20-30% patients are not controlled adequately with AED!
(≈ ½ of them are potential surgery candidates)

Despite reported success, surgery for pharmacoresistant seizures is often seen as a last resort. Patients are typically referred for surgery after 20 years of seizures, often too late to avoid significant disability and premature death

- among all patients with epilepsy, 60-70% are expected to become seizure-free with AEDs:
  47% of patients respond to first AED
  additional 14% respond to second AED
  additional 3% respond to third AED
  Kwan P, Brodie MJ. Early identification of refractory epilepsy. N Engl J Med. 2000;342(5):314–319

- CRT (16 U.S. centers) of 38 patients with mesial temporal lobe epilepsy of < 2 years duration who failed 2 brand-name AEDs: 0 of 23 patients assigned to continued medical optimization achieved seizure freedom with drug adjustments alone during 2 years of follow up (vs. 11 of 15 in the surgical group became seizure free).
  Engel J Jr, McDermott MP, Wiebe S, et al. Early surgical therapy for drug-resistant temporal lobe epilepsy: a randomized trial. JAMA. 2012 Mar 7;307(9):922-30.

- given that **individuals who have continued seizures after treatment with ≥ 2 AEDs has failed** are very unlikely to achieve seizure freedom with medical treatment alone, guidelines recommend that these patients be **referred to a comprehensive epilepsy center**.
  Engel J Jr, Wiebe S, French J, et al. Practice parameter: temporal lobe and localized neocortical resections for epilepsy: report of the Quality Standards Subcommittee of the American Academy of Neurology, in association with the American Epilepsy Society and the American Association of Neurological Surgeons. Neurology. 2003;60(4):538–547.
  Labiner DM, Bagic AI, Herman ST, et al. Essential services, personnel, and facilities in specialized epilepsy centers-revised 2010 guidelines. Epilepsia. 2010;51(11):2322–2333.
  Cross JH, Jayakar P, Nordli D, et al. Proposed criteria for referral and evaluation of children for epilepsy surgery: recommendations of the Subcommission for Pediatric Epilepsy Surgery. Epilepsia. 2006;47(6):952–959.

> Patients with epilepsy in whom ≥ 2 AEDs have failed should be considered drug resistant and referred to a comprehensive epilepsy center for surgical evaluation

- positive therapeutic expectations of AEDs vary according to epileptic syndrome:
  - 80-90% of patients with idiopathic generalized seizures are expected to become seizure-free;
  - only 50% of patients with focal seizure disorders are expected to become seizure-free (seizure-freedom may decrease to 30% in cases of temporal lobe epilepsy secondary to mesial temporal sclerosis or be as high as 95% in cases of benign rolandic epilepsy of childhood).

DEFINITIONS

Epileptogenic lesion – lesion able to ***produce seizures***; needs to be included in resection.

Epileptogenic zone (ictal onset zone + ictal forming zone) – cortical area that ***needs to be resected*** (in order to make patient seizure free); may be *larger than lesion* (includes lesion and surrounding margin, sometimes extends beyond brain lobe boundaries; e.g. cavernoma itself is not epileptogenic but adjacent hemosiderin-lade cortex is) – epileptogenic zone may be larger than lesions visible on MRI (H: **intracranial EEG**).

Irritative zone – cortical area generating epileptiform discharges but whose ***resection is not necessary****; usually *larger than epileptogenic zone*.

*__**irritative spikes** cease after surgical resection of epileptogenic zone__!

Symptomatogenic zone – cortical area that ***produces clinical symptoms*** but whose removal is not necessary (e.g. seizures may begin silently in frontal lobe and produce typical temporal lobe complex partial seizure when discharge has spread there); cortical stimulation studies have shown that often region producing auras is *much larger than epileptogenic zone*.

Functional deficit zone – cortical area showing ***hypometabolism*** on **FDG-PET**; *much larger than epileptogenic zone* (e.g. in medial TLE, hypometabolism involves both medial and lateral temporal lobe cortex ± subtle regions of hypometabolism in frontal lobe).

INDICATION

- seizures **refractory** to appropriate **medical** management + seizures seriously **limit** patient's **activities*** + **well-defined** epileptogenic **focus** not involving eloquent cortex**.

* patients' **quality of life** must be included (e.g. even as few as 2-3 seizures year may be disabling to individual whose occupation requires transportation with motor vehicle; vs. homebound patients who are not physically harmed by their seizures are not considered for surgical intervention).

**cortical resection must not intentionally produce significant neurologic deficit such as aphasia or hemiparesis; this is obsolete – RNS can treat those!

Medical intractability (pharmacoresistant epilepsy)

A. 2 medications

2 trials of AEDs at optimal doses with appropriate medications are sufficient to consider referral of patients with focal seizure disorder for presurgical evaluation

– Commission on Therapeutic Strategies of the International League Against Epilepsy (ILAE) definition (officially adopted at the ILAE's 2009 meeting in Budapest, Hungary):

"DRUG-RESISTANT EPILEPSY - failure of adequate trials of two tolerated and appropriately chosen and used AED schedules (whether as monotherapies or in combination) to achieve sustained seizure freedom." – i.e. complete epilepsy control!

– these therapeutic trials can be accomplished within *6-12 months*.

B. 3 medications

– some advocate at least 3 regimens, including *2 trials of high-dose monotherapy* + *1 trial of 2-drug therapy*.

– if ***3 trials of monotherapy with first-line drugs*** are not successful, chance to respond to fourth drug as monotherapy or polytherapy is only < 5%.

Kwan P, Brodie MJ Early identification of refractory epilepsy. N Engl J Med. 2000;3;342:314-319.

- first monotherapy trial can achieve freedom from seizures in 47% of patients; among remaining 53% of patients, a switch-over to second AED trial in monotherapy yields freedom from seizures in only 13% of patients, whereas a third trial increases total number of seizure-free patients by only 4%.

Prevalence of pharmacoresistance: 17% (if count > 1 sz / month) or 26% if count > 1 sz / year)

Surgery should be *performed as early as possible*!!! (surgery is no longer therapy of last resort)

- intractable seizures, the longer they persist, portend poorer prognosis for seizure remission and psychosocial outcome (e.g. "mirror" foci can become established as independent foci).
- strategy of *trying all combinations of drugs* is not acceptable in syndromes known to have excellent chances of benefiting from surgery.
- it is especially important in ***children***, when epileptogenic discharges interfere with normal development! (language can shift to opposite hemisphere if surgery is performed while patient is < 6 years).

N.B. even patients only few months of age are treated surgically if surgery is treatment of choice!

Complex partial seizures or **partial seizures with secondary generalization** are seizure types most amenable to surgical resection

Today, most "ideal" pathology for surgery is **right-sided temporal lobe epilepsy**.

N.B. temporal lobe epilepsy is *most medical refractory* but surgical results are the best!

- studies show that surgical results for frontal lobe epilepsy are also good.

CONTRAINDICATIONS

1) generalized epilepsy (indication for corpus callosotomy)
2) benign partial childhood epilepsy
3) significant noncompliance
4) progressive neurologic diseases
5) severe concurrent medical illness

Relative contraindications:

1) mental retardation / low IQ (< 70)
2) psychiatric disease (psychosis or other serious psychiatric disorder)
3) multiple seizure types arising from different brain regions (unless one seizure type is most frequent and disabling)
4) coexistence of epileptic and nonepileptic seizures.
5) age > 50 yrs.

Not contraindications:

1) epileptogenic focus in ***dominant hemisphere***
2) ***bilateral*** or ***multifocal*** epileptogenic foci (surgery is rarely considered for seizures arising from > 1 epileptogenic focus)
3) ***neurological deficits*** on examination

PRESURGICAL EVALUATION

- goal is to define **EPILEPTOGENIC ZONE**.

N.B. MRI and ictal EEG can be discordant or negative in up to 40% of potentially preoperative cases!

Surgical treatment is presently limited by our ***inability to localize epileptogenic focus***.

- final results of noninvasive testing are presented to **multidisciplinary epilepsy surgery conference** (neurologist specializing in epilepsy, epilepsy neurosurgeon, neuropsychologist, epilepsy nurse, speech pathologist, neuroradiologist, and psychiatrist).

EEG

All surgical candidates should begin presurgical evaluation with **EEG-audio-video monitoring** to record actual seizures (***weaning from anticonvulsants*** may be necessary) – so called PHASE I MONITORING.

SURFACE EEG

N.B. ***seizures*** may begin in areas distant from (or even contralateral to) location of ***interictal*** epileptiform activity - *ictal discharges* are most reliable means of localization!

- since it is impossible to record from all cortical & subcortical structures from which seizures may arise, exact onset may not involve recording electrodes until spread of discharge has occurred (i.e. early ictal changes are often not identified in scalp recordings).
- foci in *mesial* or *basal* cortical areas are particularly apt to escape detection; *extratemporal seizures* are more difficult to localize (e.g. epilepsy of occipital or frontal lobe origin may have interictal activity at temporal region).
- **modified electrode placements, dense array,** and **semi-invasive techniques** increase yield.

INTRACRANIAL EEG

(subdural strips and grids, depth electrodes) – so called PHASE III MONITORING – only when noninvasive studies fail to adequately delineate epileptogenic zone. see p. E13 >>

- it may include Stimulation Cortical Mapping - determines **areas of eloquent cortex** that should not be encroached upon at time of operation. see p. E13 >>

NEUROIMAGING

see also p. E1 >>, p. E9 >> (temporal lobe epilepsy, diagnosis)

All patients with partial epilepsy should undergo **MRI**.

FDG-PET - determines ***functional deficit zone*** in some patients with partial epilepsy.

- shows hypometabolism lateralized to side of temporal lobe focus in 70% of patients.
  N.B. PET often shows hypometabolism in temporal lobes of pediatric patients – ignore it (esp. if symmetric)
- *not necessary* in most surgical workups, because PET:
  - has highest accuracy for temporal lobe foci, which are diagnosed most easily with MRI and EEG.
  - is least reliable for extratemporal nonlesional foci, which also are most difficult to define with MRI and standard EEG.
- indications:
  a) discordant MRI and EEG findings
  b) normal MRI findings.

Interictal SPECT - shows hypoperfusion; resolution is inferior to that of PET.

Ictal SPECT - increased blood flow during seizure - high localizing value* (only if ictal injection occurs within 20 seconds of ictal onset - then may scan within next several hours).

*accuracy is not sufficient to justify routine use

Subtraction SPECT co-registered to MRI (SISCOM SPECT)
- much higher accuracy than either ictal or interictal SPECT! (may provide alternative to depth electrode studies)

- requires two scans (separated by ≥ 48 h to accommodate radionuclide washout) - during ***interictal*** period and ***within seconds of seizure onset***.
- using computer software, these scans are subtracted from each other.
- subtracted scan then can be co-registered onto MRI to provide support for focus location.

N.B. in *MRI-negative* cases, reliability of functional neuroimaging is much reduced, and positive result from *functional imaging* generally requires verification by *depth electrode recordings*!

Magnetoencephalography is emerging method for 3D detection of deep epileptic foci; requires sophisticated suite (well isolated, far from highways)

Tractography
- displays of optic radiation and pyramidal tracts are the most relevant for epilepsy surgery.

CT
- seizure focus may enhance with IV contrast shortly following a seizure.

Intracarotid Amobarbital (Wada) test

- injection of 100-150 mg SODIUM AMOBARBITAL (AMYTAL®) / PROPOFOL into *carotid artery* - to temporarily anesthetize (inactivate) hemisphere in ipsilateral carotid artery distribution (includes amygdala and anterior hippocampus) - allows independent testing **function of contralateral hemisphere**.

Clinical uses (once epileptogenic focus has been identified) - injection ipsilateral to epileptogenic zone:

1. Which hemisphere contains **LANGUAGE** function (dominant hemisphere inactivation → aphasia; nondominant → dysarthria); fMRI is much less useful here.
2. Functional adequacy of contralateral hippocampus to sustain **MEMORY** (before anterior temporal lobectomy to avoid permanent amnesia).
   N.B. failure of memory function is contraindication to resection of hippocampus and parahippocampal structures on injected side!
3. Prognosing **seizure-free OUTCOME**.

- instruct patient as to what is expected.
- catheter is passed from femoral artery (as for standard carotid arteriograms).
- **4-vessel arteriography** must verify that blood flows to corresponding hemisphere (not to brainstem or contralateral side – i.e. no *cross flow*, no *persistent trigeminal artery* – will cause brainstem failure)
  N.B. fetal PComA is not contraindication but will cause cortical blindness
  N.B. Significant cross-flow is relative contraindication to anesthetizing side of dominant supply (patient goes to sleep).
- start on side of lesion.
- have patient hold both arms in air and count loudly - ***contralateral hemiparesis*** and ***ipsilateral EEG slowing*** (> 50%) must appear (confirmed adequacy of injection); if not add 25 mg more of drug.
- inject Amytal rapidly; effect starts almost instantaneously, begins to subside after ≈ 8 minutes.
- patient is monitored to make certain that *recirculation* has not affected both sides simultaneously during testing.

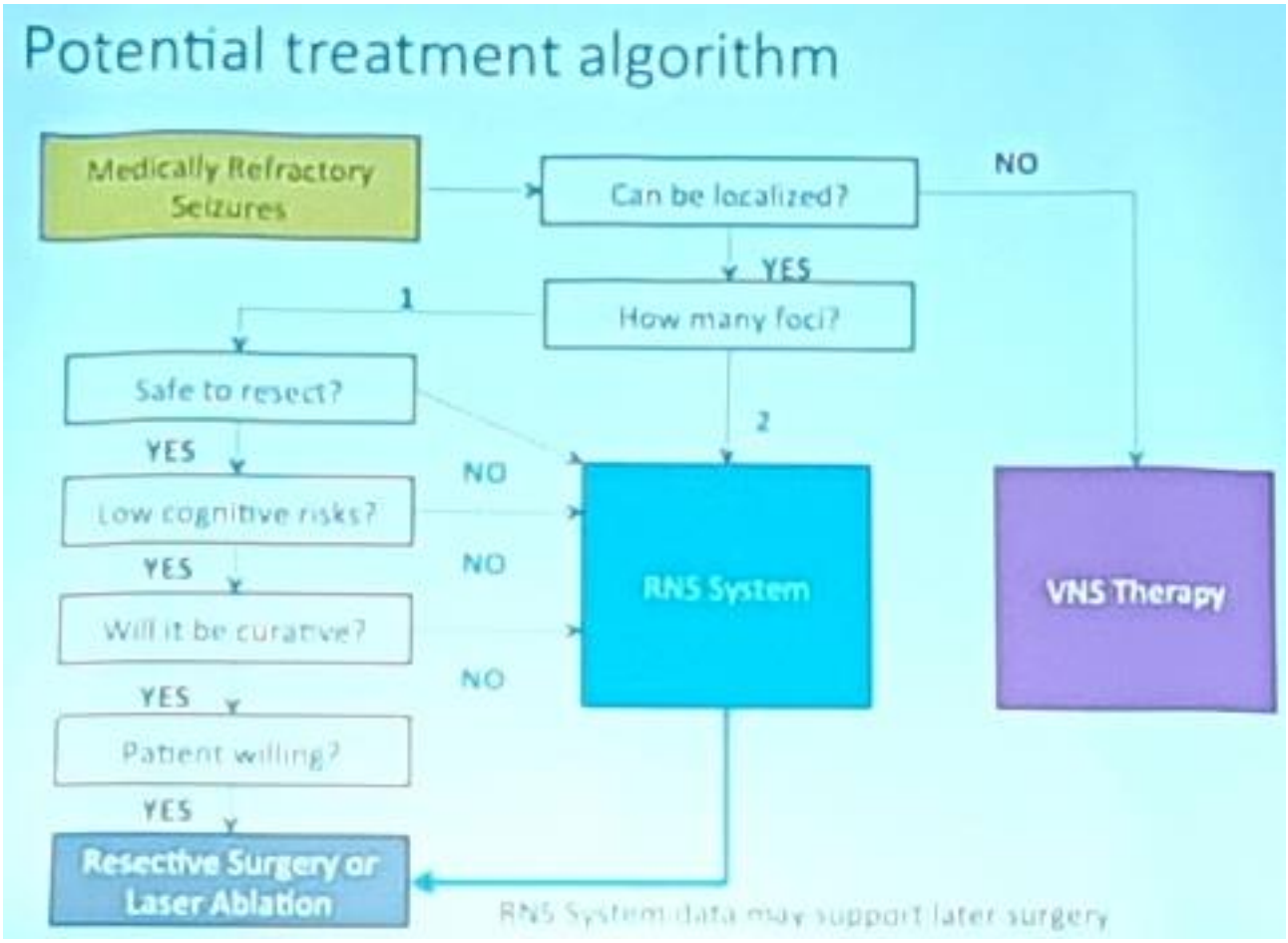
- assess ***language*** by showing patient pictures of objects and ask them to name each one out loud and remember each one.
- assess ***memory*** by asking patient to name as many of pictures as they can 15 minutes after test: if they have difficulty, ask them to pick out pictures from a group that contains additional ones not shown to patient.
- may repeat procedure on other side (use lower Amytal doses with each subsequent injection).
- never has been standardized, but many centers insist on Wada tests even when clearly right-handed patient is diagnosed with right temporal focus.
- possible future alternatives to Wada test – fMRI, magnetoencephalography, $H_2{}^{15}O$-PET.
- caveats:
  - Wada test may be grossly inaccurate with high flow AVM.
  - portions of hippocampus may be supplied by posterior circulation (not anesthetized by ICA injection).

NEUROPSYCHOLOGICAL TESTING

- routinely, ***all surgical candidates*** undergo extensive neuropsychological testing.
- testing is not standardized between centers.
- test battery contains:
  1) **personality** inventory (e.g. Minnesota Multiphasic Personality Inventory)
  2) tests of **memory** and **language**
     temporal mesial sclerosis in dominant hemisphere – memory↓
  3) tests for **interhemispheric transfer** (before callosotomy) - cross-retrieval and naming of objects, cross-replication of hand postures, cross-localization of fingertips.
  4) other tests, depending upon interests of neuropsychologist.
- goals of testing:
  1) to help ***localize epileptogenic focus*** (subtle deficits in cognitive functioning might provide additional localization that neurologic examination misses); it is not reliable because very few tests reliably measure frontal and temporal lobe function.
  2) identification of ***significant memory problems*** (might not be candidate for temporal lobectomy).
  3) formulating ***postoperative vocational goals***.

SIMPLISTIC ALGORITHM

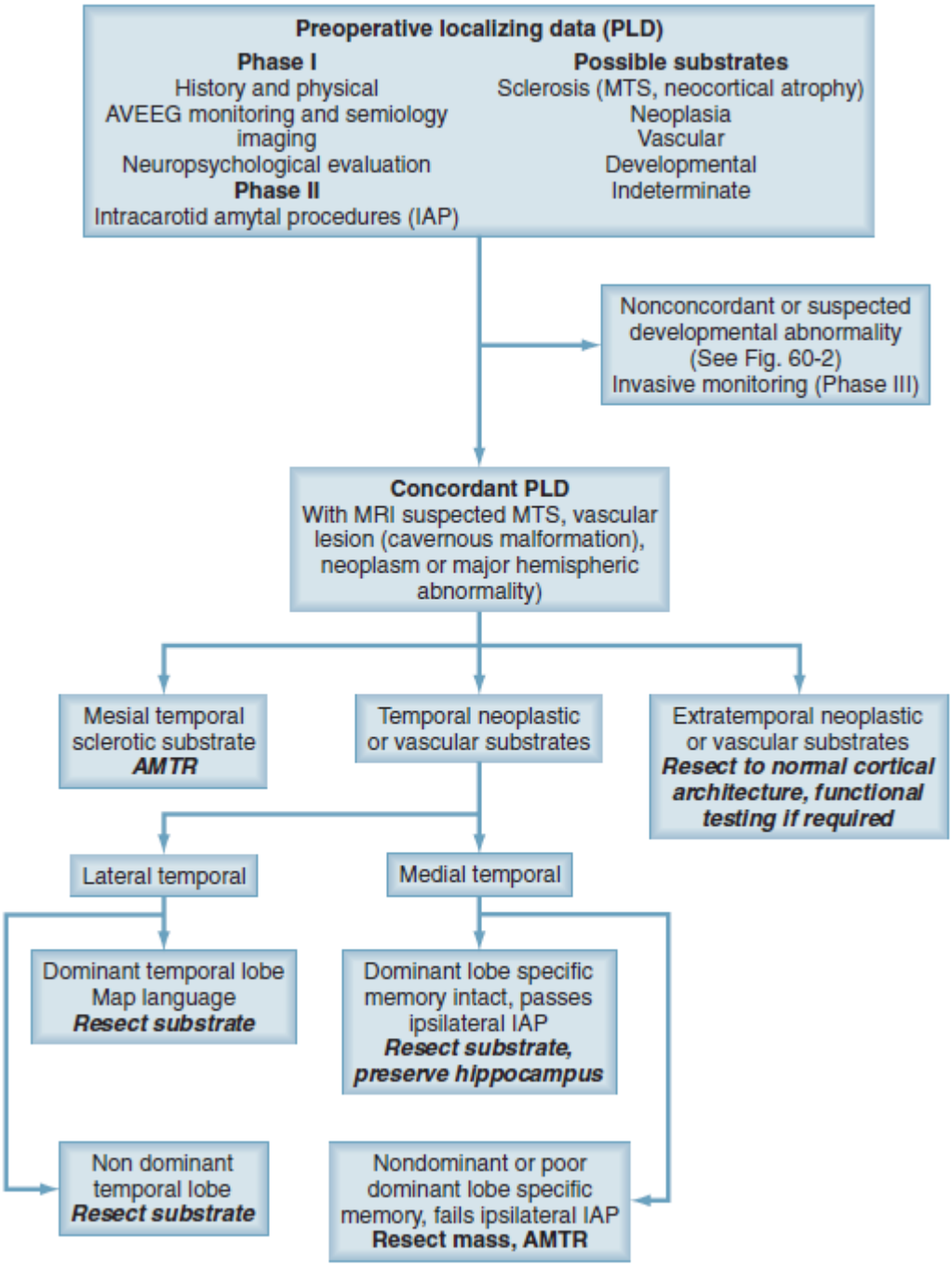
Seizure **semiology** is extremely important in diagnosing ictal zone and seizure propagation network!



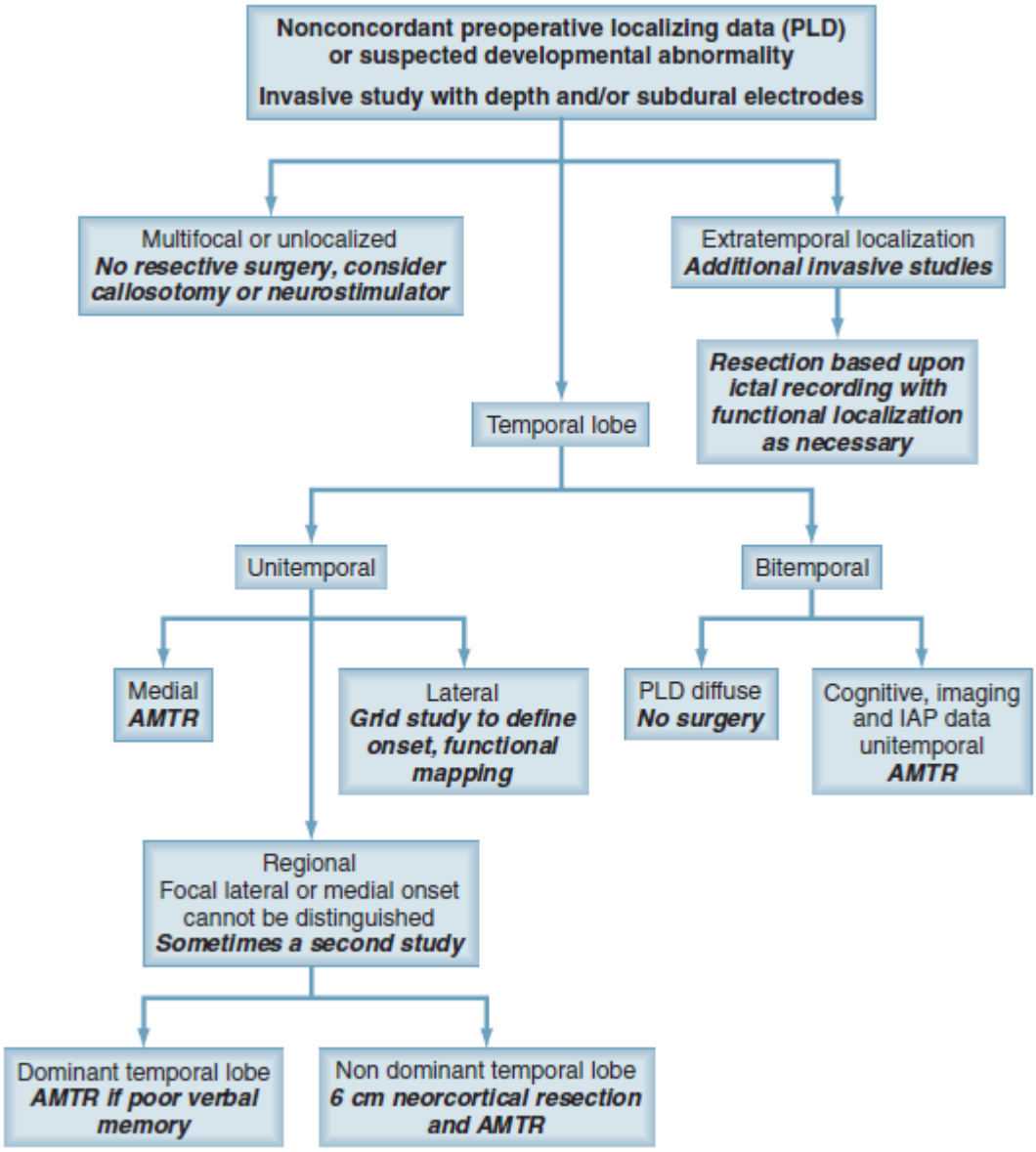
<u>Medically refractory seizures</u>
↓
Can be localized → NO → **VNS**
↓YES
How many foci → 2 → **RNS**
↓1
Safe to resect and cognitive risk is low → NO → **RNS** (or **multiple subpial transections**?)
↓YES
Will it be curative → NO → **RNS**
↓YES
Resection / laser ablation

N.B. RNS data may support later resection / laser ablation

<u>Alternative algorithm</u>



Alternative algorithm (fig. 60-2)



PREOPERATIVELY

AED

- VALPROATE can cause ***bleeding disorders*** - routinely check coags and bleeding time - if values are abnormal, decrease or discontinue* valproate and recheck values before surgery!
  * at least 3 weeks prior to surgery (replace with another medication).
- on surgery morning, patient receives usual medication dosage with few sips of water.
- some centers taper anticonvulsants, and completely D/C 1 day before surgery.

TYPES OF SURGERY

ABLATIONS (curative) - resection of seizure focus (up to entire hemisphere):

1) lesionectomy
2) neocortical resections

DISCONNECTIONS (palliative) - used when eloquent brain is involved to disconnect seizure focus from other functional parts of brain:

1) callosotomy
2) hemispherectomy
3) multiple subpial transections

STIMULATION on demand at epileptogenic focus:

1) responsive neurostimulation
2) DBS
3) VNS

Nodes vs. Networks – biggest debate about ***pathophysiology of epilepsy*** and may affect surgical philosophy (lesion resection vs. network disconnection by lesioning).

Temporal Resections

see p. E15 >>

Lesionectomy (focal cortical resection)

– for structural lesions delineated by **MRI** ± **electrocorticography**.

- most often in frontal lobe.
- all larger arteries or veins adjacent to or crossing gyri should be preserved.
- avoid resection of deep fiber pathways in white matter.
- most common mistake is to remove only gross tumor and not immediate surrounding tissue (leaving epileptogenic tissue and clinical seizures).
  e.g. small vascular abnormalities surrounded by hemosiderin can be extremely epileptogenic.
- unilateral ***insular*** resection – no deficits to anticipate.

Lesioning

a) for structural lesions delineated by **MRI** ± **electrocorticography**.
b) for disconnecting (e.g. callosotomy)

Available modalities:

1. Laser ablation
2. RF-ablation (e.g. guided by SEEG)

Tailored Neocortical Resection

– for nonlesional extratemporal epilepsy – resection guided by **SEEG** or intraoperative **electrocorticography** (under local anesthesia).

Tailored - no two operations are identical!

- epileptiform discharges recorded acutely during surgery define boundaries of cortical resection.
- *eloquent cortical regions* are spared.

Multilobar Resection

a) corticectomy (resection of grey matter)
b) lobe excision (resection of grey and white matter)
c) lobe disconnection
d) combination.

- usually involves *frontoparietal*, *parieto-occipito-temporal*, or *parieto-occipital lobes*.
- indications as for functional hemispherectomy.

Multiple Subpial Transections (MST)

see p. E17 >>

Hemispherectomies (functional, anatomical)

see p. E19 >>

Corpus Callosotomy

see p. E21 >>

DBS

ANTERIOR nuclei of thalamus (AN)

- project to superior frontal and temporal lobe structures commonly involved in seizures

Stimulation of the Anterior Nucleus of Thalamus for Epilepsy (SANTE) trial (for medically refractory partial seizures) - positive effects of bilateral stimulation appear to be long-lasting + patients had improved quality of life

- patients with ≥ 50% reduction in seizures:
  13 month 43% (n=99)
  25 months 54% (n=81)
  37 months 67% (n=42)
- statistically significant reduction in seizure frequency only in temporal epilepsies - 44.2%, (vs. controls - 21.8%)
- side effects:
  1. Depression 14.8% (vs 1.8% in controls)
  2. Memory impairment 13% (vs 1.8% in controls); all resolved with no group differences in neuropsychological testing.

CENTROMEDIAN nucleus of thalamus (CM)

- placed under general anesthesia with recruiting response

- response rates from 0% (Andrade et al Neurology 2006;66:1571–1573) to 100% (Cuikert et al Seizure 18 (2009) 588–592)
- best responders more anterior and lateral in CM, concentrated in parvocellular portion
- less effective in focal epilepsies although it did help with secondary generalization.
- causes no change in neuropsychological tests; benefit - improved attention.

Study	**Velasco et al**	**Cuikert et al**	**Andrade et al**
N	13	4 pts s/p CC	2
Pathology	LGS	IGE 2 LGS 2	SGE 1 Multifocal 1
Targeting	Recruiting response	Recruiting response	
Stim parameters	130 Hz, **450 µs**, 2-3 v	130 Hz, **300µs,** 2v	100-185 Hz, **90-120 µs**, 1-10v
Outcome	Sz free 2 87-95% 6 50-80% 3 <50% 1	100 % RR Av 78%	Initially worsened, no clear diff in on and off
Neuropsych outcome	Improvement related to Sz Outcome	Improved alertness (SNAP IV)	N/A
Comments	Anterolateral nucleus in parvocellular best response	Improvement in alertness at 0.5v and sz control at 1.5 v	

HIPPOCAMPUS

- patients selected from population undergoing invasive electrodes: diagnostic electrodes replaced with stimulation electrodes at site of seizure focus.
- 25-100% response rates (50% reduction in seizures; some become seizure free).
- causes no change in neuropsychological tests.

Study	n	Randomization	Stim Param	Seizure Outcome	Neuro-psych	Comment
Velasco et al Epilepsia '07	9	Immediate on vs 1 mo delay	130 Hz 450 us cyclic	100% RR 4/9 sz free	No decline	Absence of MS on MRI predicts success
Boon et al Epilepsia '07	10	no	130 Hz 450 us cont	70% RR 1/10 sz free (+MS)	No decline	Pts selected based on dec in spikes with stim
Telez-Zellento et al Neurol '06	4	Alternating 1 mo blocks over 6 mo	190 Hz 90 us cont	25% RR ¼ sz free	No decline	Design of randomiz not optimal

STN

Author	N	Localization of epilepsy	Outcome
Benabid/Chabardes *2002*	3	sensory motor cortex	67-87%
	2		< 50%
	1		0
Shon (Seoul) *Stereotact Funct Neurosurg 2005;83:84–90*	2	FLE s/p failed resection	87-89%
Handforth (UCLA) *Epilepsia 47(7):1239–1241, 2006*	1	Bitemporal epilepsy	50%
	1	Frontal encephalomalacia	33%
Neme (Santiago)	1		> 50%
	3		< 50%

Vagus Nerve Stimulation (VNS)

see p. E23 >>

RESPONSIVE NEUROSTIMULATION (RNS)

see p. E25 >>

TRANSCRANIAL MAGNETIC STIMULATION (TMS)

- cortical stimulation
- results vary (some studies show ne efficacy).

Randomized Double Blind Sham Controlled Trials

Study	**Theodore** (NIH) 2002 Neurology	**Fregni** (Sao Paulo) 2006 Ann Neurol	**Cantello** (Multicenter Italy) 2007 Epilepsia
N	24	21	43
Sz Type /Location	Mesial TLE 10 Lateral TLE 10 Frontal 3 Parietal 1	neocortical	mTLE 7 Neocortical 34

MRI	all lesions except MS were excluded	all malformation of cortical development (MCD)	Postraumatic 6 MTS 5 Hemiatrophy 4 Cortical dysplasia 2 Tuberous Sclerosis 1
Stim Target	EEG identified ***seizure focus***	***MRI abnormality*** in 17, ***vertex*** in 4 with diffuse MCD	***Vertex***
Stim Parameters	1 Hz, 120% MT, 900 stim bid x 7 days	1 Hz, 70% max coil output, 1,200 stim/day x 5 days	0.3Hz, 120% MT, 1,000 stim/day x5 days
Outcome	No sig diff in stim vs sham, trend for better results in neocortical	Stimulated 2 weeks 72% p=0.003 4 weeks 53% p= 0.002 8 weeks 58% p=0.001 Sham – no change	No effect

TYPE OF TREATMENT ACCORDING TO SEIZURE TYPE

GENERALIZED seizures (LENNOX - GASTAUT syndrome)

1. **VNS** – 44-67% response
2. **ANT DBS** – Sante trial limited to CPE
3. **CM DBS** – 0-100% response
4. RNS – by definition excluded
5. Hippocampal DBS - by definition excluded
6. STN DBS- N/A
7. TMS – N/A

Seizure localized to BILATERAL or NON-RESECTABLE TEMPORAL LOBE

1. **VNS** – 60-62.5% response
2. **ANT DBS** – Sante trial - 44.2% response
3. **RNS** - 74 % response in hippocampal epilepsy
4. **Hippocampal DBS** – 25-100% response in hippocampal epilepsy
5. CM DBS – not as effective on focal epilepsy
6. STN DBS – too limited data
7. TMS – probably ineffective for mesial TLE

EXTRATEMPORAL seizures

1. **VNS** – efficacy in focal epilepsy does not appear to be limited to temporal lobe
2. **RNS** – 37% response rate in neocortical epilepsy
3. CM DBS – not as effective on focal epilepsy
4. ANT DBS – Sante trial did not demonstrate efficacy in this subgroup
5. STN DBS – was efficacious in small #'s tested and FLE was main target
6. TMS – may be effective for MCD
7. Hippocampal DBS - N/A

POSTOPERATIVELY

- patient is returned to seizure monitoring room in epilepsy unit (vs. overnight ICU).

AED

Patients generally need to remain on AED therapy (for ≈ 2 years); some continue to require AED therapy to remain seizure free (e.g. if pathology showed heterotopia, then other foci of heterotopia likely exist).

N.B. surgery is not indicated if patient expects to be AED-free!

- if patient is taking 2 AEDs, least effective drug is tapered after 1 year.
- if patient is seizure free at 2 years, remaining drug can be tapered.
- one seizure during or after withdrawal → resume single medication therapy.
- **postoperative seizures**:
  - seizures *within first 24 hours ("honeymoon seizures")* do not correlate with poor long-term seizure outcome - may be due to irritation and edema of tissues adjacent to resection (neighborhood seizures).

    Convulsions in immediate postop phase are common in first 3-5 days, if they are stereotypic of seizures prior to surgery, they may indicate lower changes of success and seizure freedom, but otherwise, they are not of huge concern unless they do not stop.

    Acute postoperative seizures (up to 1 week after surgical resection) are not counted as evidence of recurrent epilepsy
  - seizures *after 48 hours* (with adequate serum AED levels) do not bode well for eventual outcome.

N.B. many patients may continue to have ***components of preoperative auras***;

- some may have ***occasional seizures for few years*** which then cease (*wind down*);
- others may be ***seizure-free for few years***, then have recurrence.

Alternative view – early withdrawal of AEDs - safe and does not affect long-term seizure outcome or cure, might unmask incomplete surgical success sooner (identifying patients who need continuous drug treatment and preventing unnecessary continuation of AEDs in others).

BEFORE DISCHARGE

1) neuropsychiatric evaluation
2) serum anticonvulsant levels
3) EEG

SURGERY OUTCOMES

The only reliable predictor of seizure-free outcome – resection of lesional focus! (unclear if laser ablation qualifies for that)

- goal of epilepsy surgery:

  palliative epilepsy surgery - seizure reduction (still can be very desirable for some patients, e.g. getting rid of convulsive seizures)

  radical epilepsy surgery - seizure freedom
- in medical therapy, > 50% reduction in seizures = success
- seizure control is assessed at 1, 3 & 6 most post op, and then annually.
- MRI is performed at 3 months post op.
- 90% of seizures that recur do so within 2 years; per Dr. R. Gross – if seizures recur, they do it within 6 months (therefore, outcomes are measured earliest at 12 months).

Procedure	Seizure Free (%)	Improved* (%)
Anterior temporal lobectomy	55.5-67.9	24.0-27.2
Amygdala-Hippocampectomy	68.8	22.3
Extratemporal cortical resection	25.0-45.1	18.2-35.2
Lesionectomy	66.6	21.5
Hemispherectomy	67.4-77.3	18.2-21.1
Corpus callosotomy	7.6-8.0	60.9-80.0

*50% reduction of seizure frequency

- ablative surgery is associated with IMPROVEMENT in ***intelligence***, in ***psychiatric*** and ***behavioral*** disorders, in ***social*** and ***vocational*** function (abnormal brain tissue resection may remove undesirable functional effects which are interfering with function of other cortical areas).
  N.B. cognitive function starts to improve after successful surgery but after the lag period
- parents often wonder whether their child's personality will change or if he or she will become more depressed or anxious after undergoing resection of temporal or frontal lobe surgery – *surgery doesn't appear to have major effect on mood or anxiety in children*, and some kids even do better.
- **RUNNING DOWN phenomenon** - gradual decline of seizures over several months or years until seizure freedom is achieved after surgery.

Jerome ENGEL'S classification of postoperative outcome:

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 at least 2 years
D. Generalized convulsions with AED discontinuation only

- class 1 includes patients with ***residual auras***.
  1) auras do not bother patient if they are infrequent.
  2) depending on nature of auras (e.g. intense fear), they can affect quality of life.

Class II: Rare disabling seizures ("almost seizure free")
A. Initially free of disabling seizures but has rare seizures 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

Class III: Worthwhile improvement (> 90% reduction)
A. Worthwhile seizure reduction
B. Prolonged seizure-free intervals amounting to greater than half the followed-up period, but not < 2 years

Class IV: No worthwhile improvement (< 90% reduction)
A. Significant seizure reduction
B. No appreciable change
C. Seizures worse

ILAE classification of postoperative outcome:

1. Completely seizure free; no auras
2. Only auras; no other seizures
3. 1-3 seizure days per year; ± auras
4. 4 seizure days per year to 50% reduction of baseline seizure days; ± auras
5. Less than 50% reduction of baseline seizure days; ± auras
6. More than 100% increase of baseline seizure days; ± auras

Factors predictive of freedom from seizures:

1) MRI-detectable ***lesion*** (unless functional constraints limit extent of resection); better temporal than extratemporal.
2) concordant interictal ***epileptiform discharges***.
3) more extensive ***resections***.

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