The Surgical Treatment of Epilepsy

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Ancient craniotomy

When Cao started complaining about splitting headaches in the last days of his life, his subjects recommended Hua Tuo, a physician with remarkable healing skills. Upon examination, Hua diagnosed Cao's illness to be a form of rheumatism in the skull. He suggested giving Cao a dose of hashish and then splitting open his skull with a sharp axe to extract the pus within.

Due to an earlier incident with another physician called Ji Ping, who attempted to poison him, Cao grew suspicious of any physician. Cao believed that Hua intended to kill him to avenge the death of Guan Yu. He had Hua imprisoned and Hua died a few days later. Without proper treatment, Cao died soon as well.

Epidemiology

- Epilepsy affects about 2 million Americans
- About 10% of people will experience a seizure sometime during their lifetime and about 1 in 26 will be diagnosed with epilepsy at some point in their lives
- About 140,000 new cases of epilepsy will be diagnosed in the United States each year
- Epilepsy results in an estimated annual cost of $15.5 billion in medical costs and lost or reduced earnings and production.

- 800,000 persons in the United States suffer from partial or focal epilepsy syndromes. Many of these syndromes (but not all) are characterized by partial complex seizures arising from the temporal lobes

- As many as 45% of patients with partial seizures remain poorly controlled despite new medication

Data: CDC, 2012

Who is a candidate for surgery?

- Surgery may be appropriate for a carefully selected group of patients who fail thorough trials of medical seizure control, or who are unable to tolerate side effects of anti-epileptic drugs
- As many as 25% of people with poorly controlled seizures may meet criteria as candidates for surgical treatment--90,000 people
- Only a few hundred people undergo evaluation and surgery each year
- The number of candidates going on to surgery has been *decreasing* despite Class I evidence in its favor*

*Epilepsy surgery trends in the United States, 1990-2008.
Englot DJ, Ouyang D, Garcia PA, Barbaro NM, Chang EF.
Source
Neurology. 2012 Apr 17;78(16):1200-6. Mar 21.

- Treatment objective: raise seizure threshold such that seizures no longer occur in the course of everyday life

- Medical: physiological specificity

- Surgical: anatomical specificity

Epilepsy surgery historical perspective

- Pre-EEG era (1886-1937): Pathology orientation: Epilepsy surgery was done to remove the pathology believed to be causing the seizures
- Sir Victor Horsley: Earliest resection for seizures, starting 1886
  - Localization by clinical exam
  - Resection of pathology (scar)
- Förster, Krause, Penfield
  - Stimulation of cortex at surgery for localization of function
  - Attempts to reproduce seizure semiology
- 1930's: EEG and ECoG as supplemental tools: application of scalp recordings and intraoperative interictal monitoring
- Penfield and Jasper, early 1930's: Jasper, Davis and Forbes, Lennox and Gibbs investigate the EEG as a tool in understanding epilepsy
- 1937: Penfield and Jasper, in Montreal, begin to use EEG, ECoG to assist in tailoring pathology-oriented resections
- Gibbs and Gibbs
  - Boston: Introduce concept of operation on an electrical focus
  - Chicago: Use EEG to localize in temporal lobectomies
- 1940's: EEG guidance in "nonlesional" epilepsy surgery: use of electrophysiology alone to guide resection
- 1950s: Talairach and Bancaud use stereotactic techniques for acute depth electrode recordings
- 1960s: Crandall and Adey, at UCLA, modify Talairach technique, add telemetry, introduce modern era of chronic monitoring and ictal localization

- Epilepsy is a syndrome of recurrent discharges reflecting the interaction of a pathological substrate with the neurophysiological mechanisms that control seizure threshold
- Spencer classification based on this concept*
- Goal of surgery: to raise the seizure threshold so that seizures no longer occur in the course of daily life, while sparing normal function

Spencer DD. Classifying the epilepsies by substrate. Clin Neurosci 2:104-109, 1994

Historical Approaches

- "epileptic cortex": electrophysiology, awake mapping, multistage, "tailored"
- "epileptic substrate": pathological substrate, lesion, planned standard resection

Evaluation of Surgical Candidates

This is a QUALITY OF LIFE operation!

Phase I

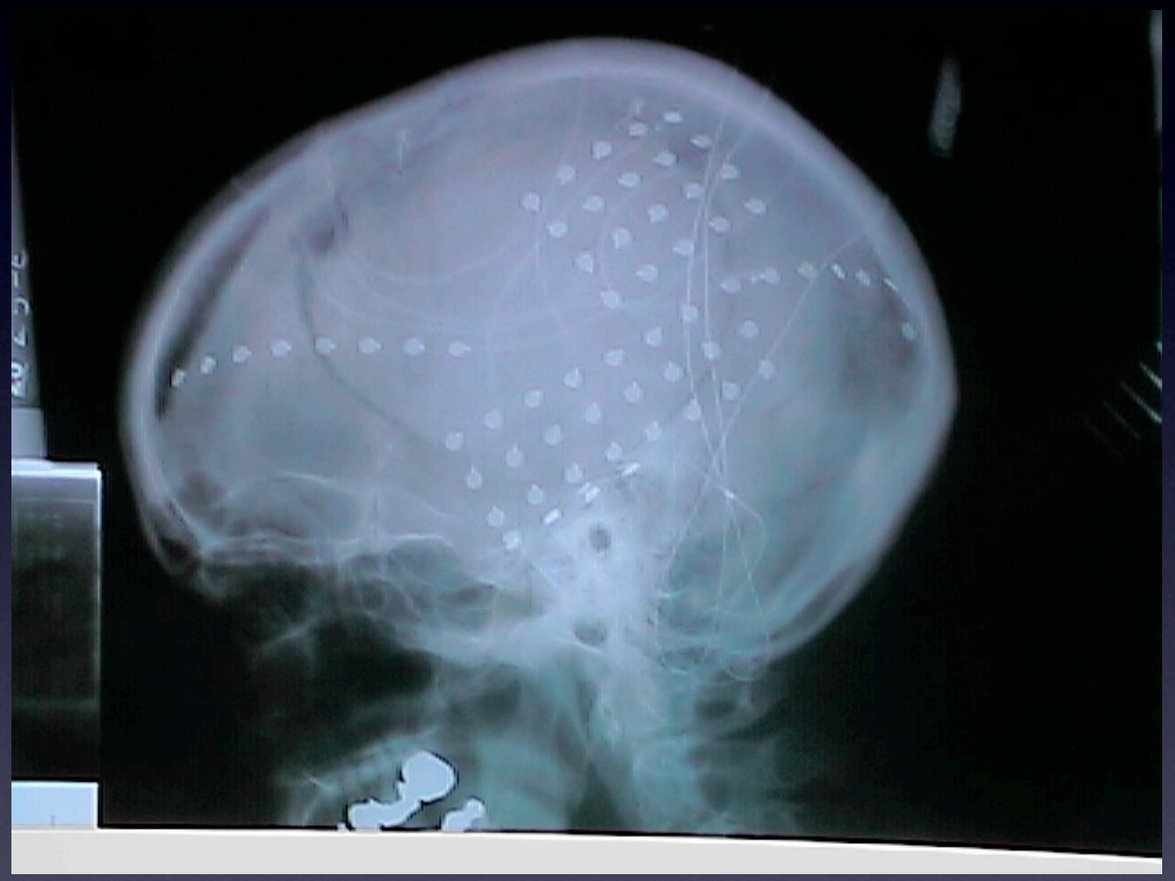
- Chronic scalp EEG monitoring
- Imaging studies--CT, MRI, SPECT, PET, newer modalities

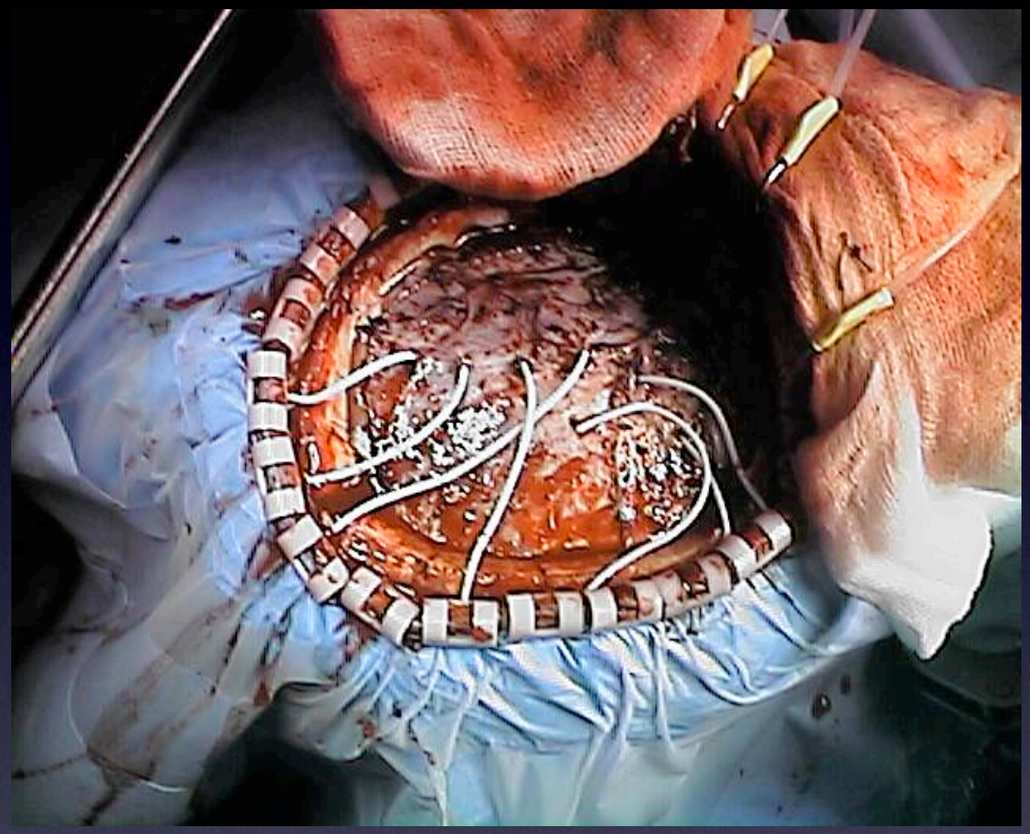
Phase II

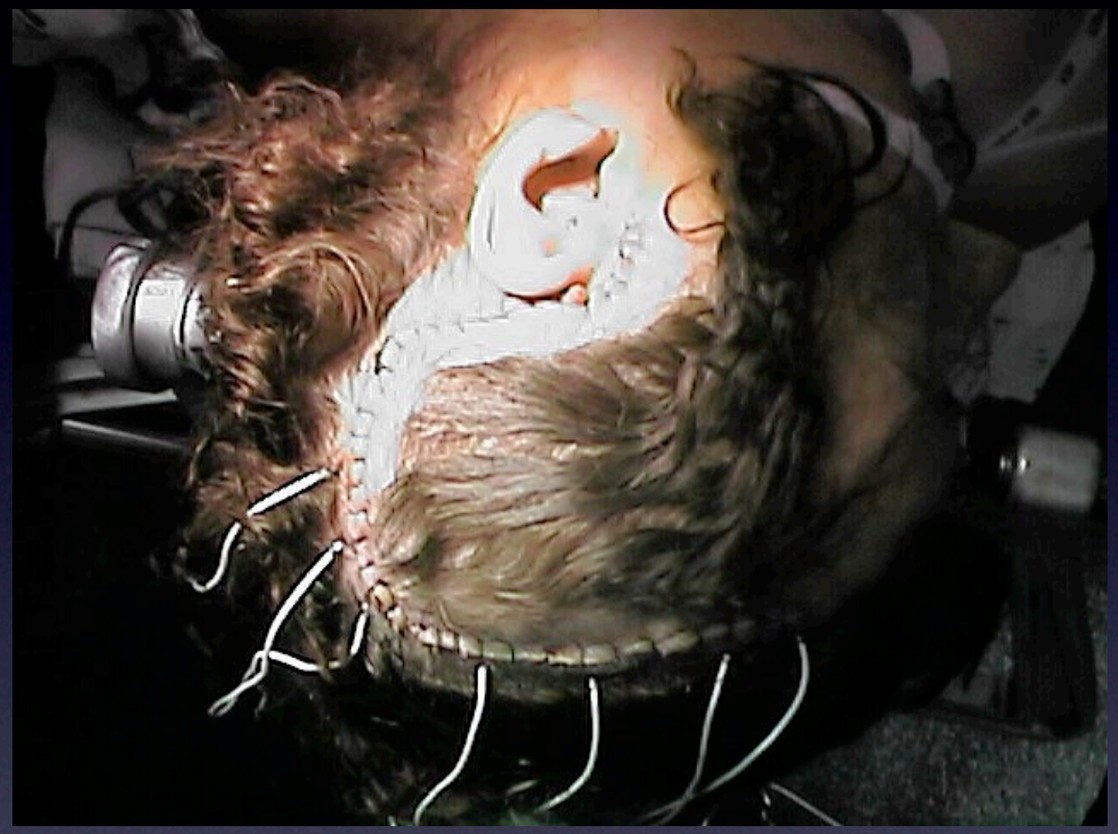
- Neuropsychological testing
- Carotid amobarbital testing

Phase III

- Intracranial electrode placement
- Recording, stimulation and mapping

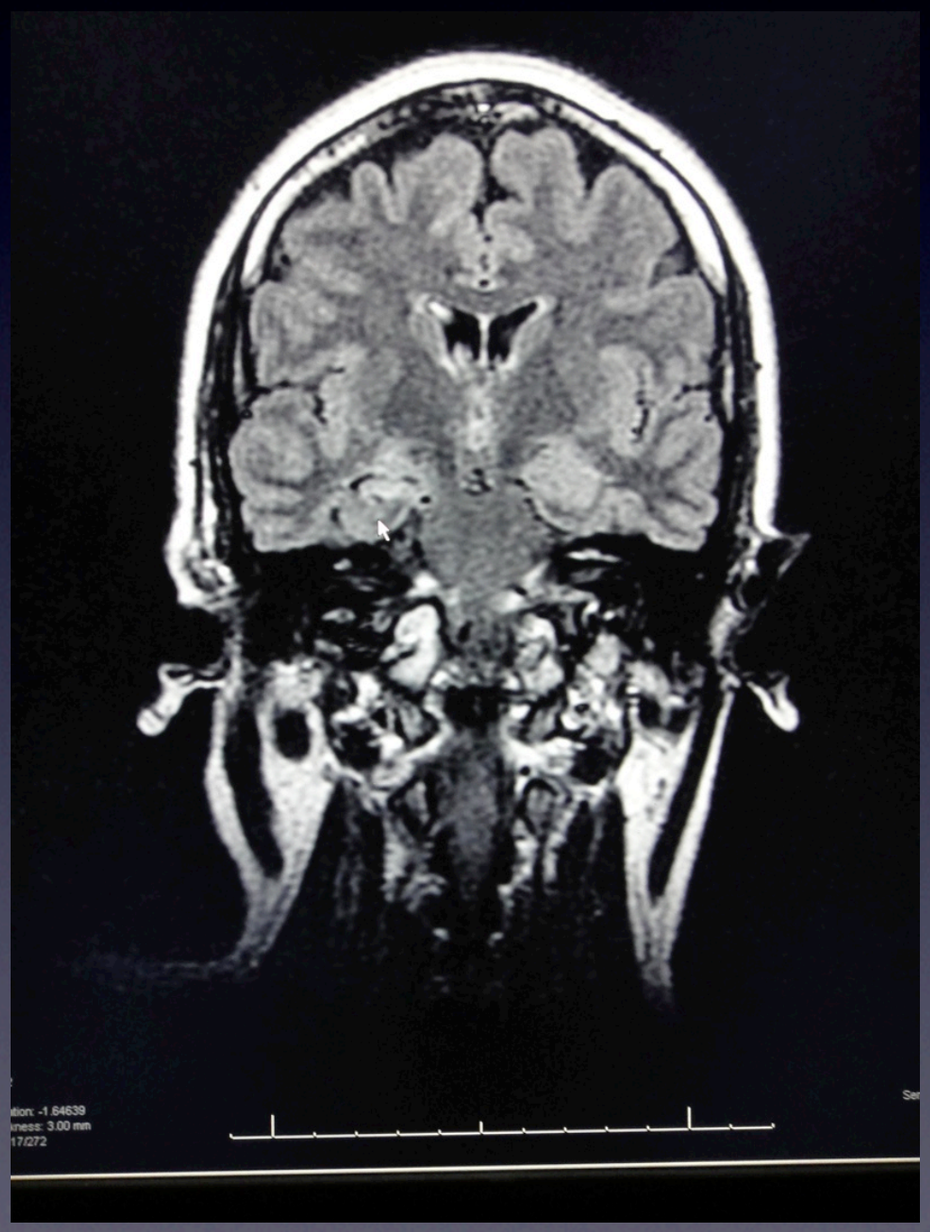


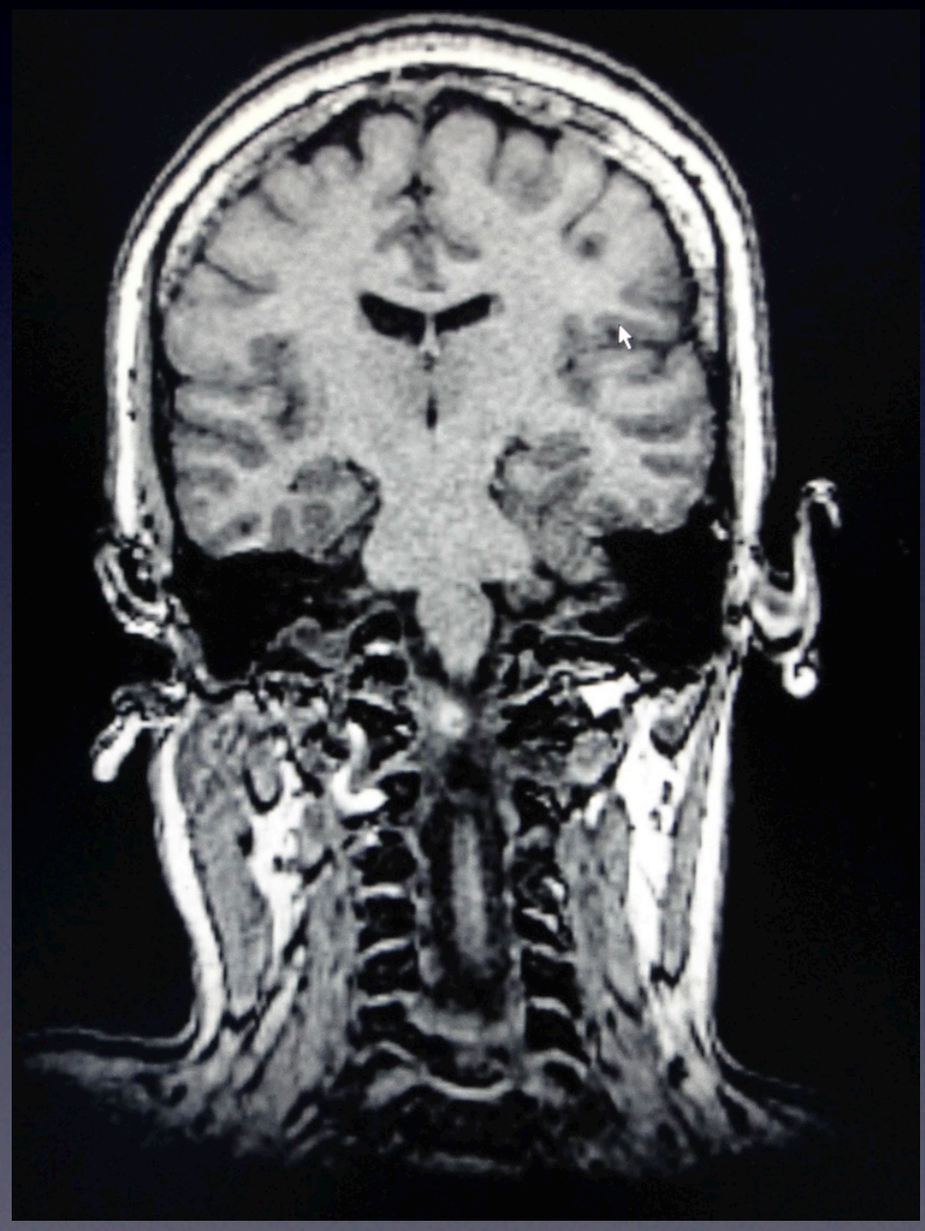




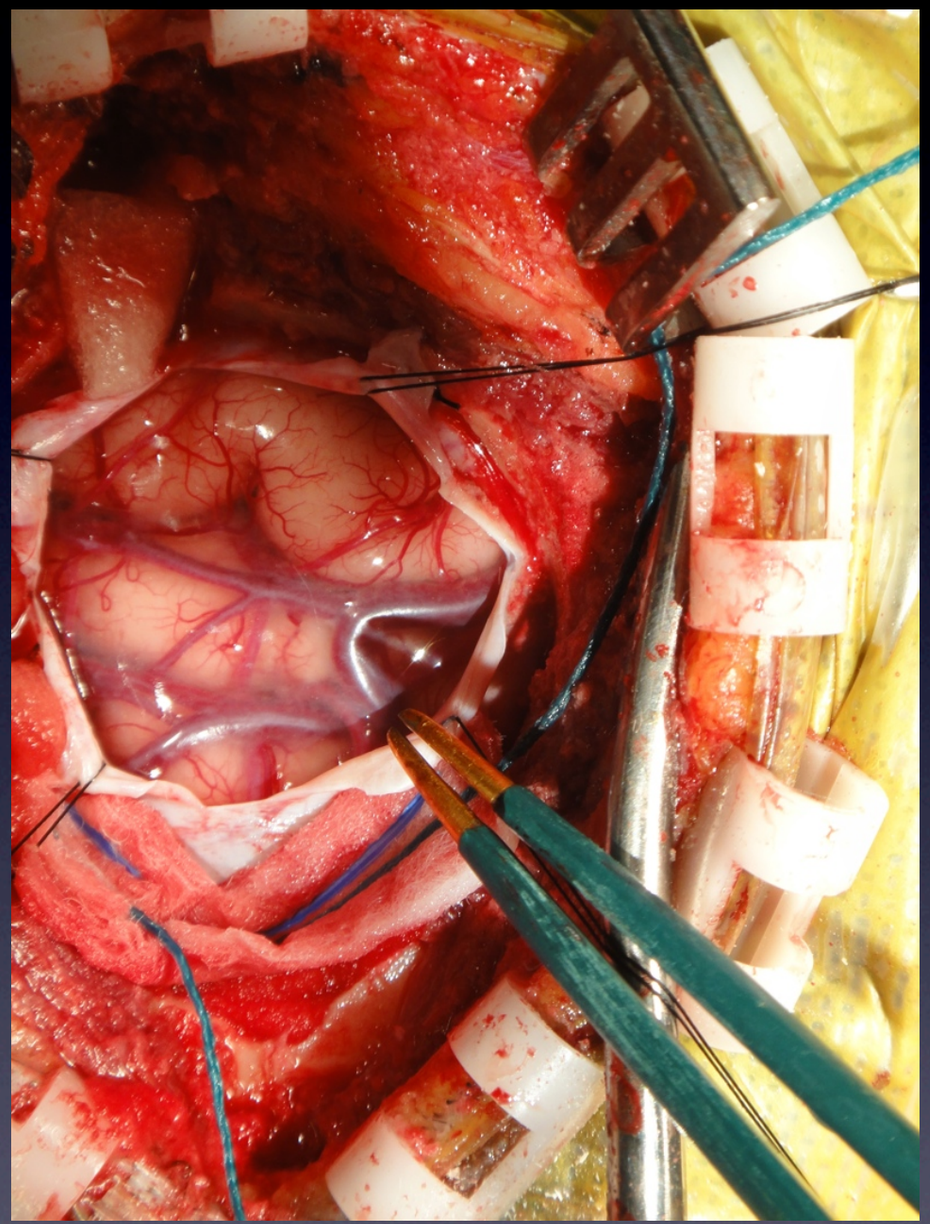
Phase IV

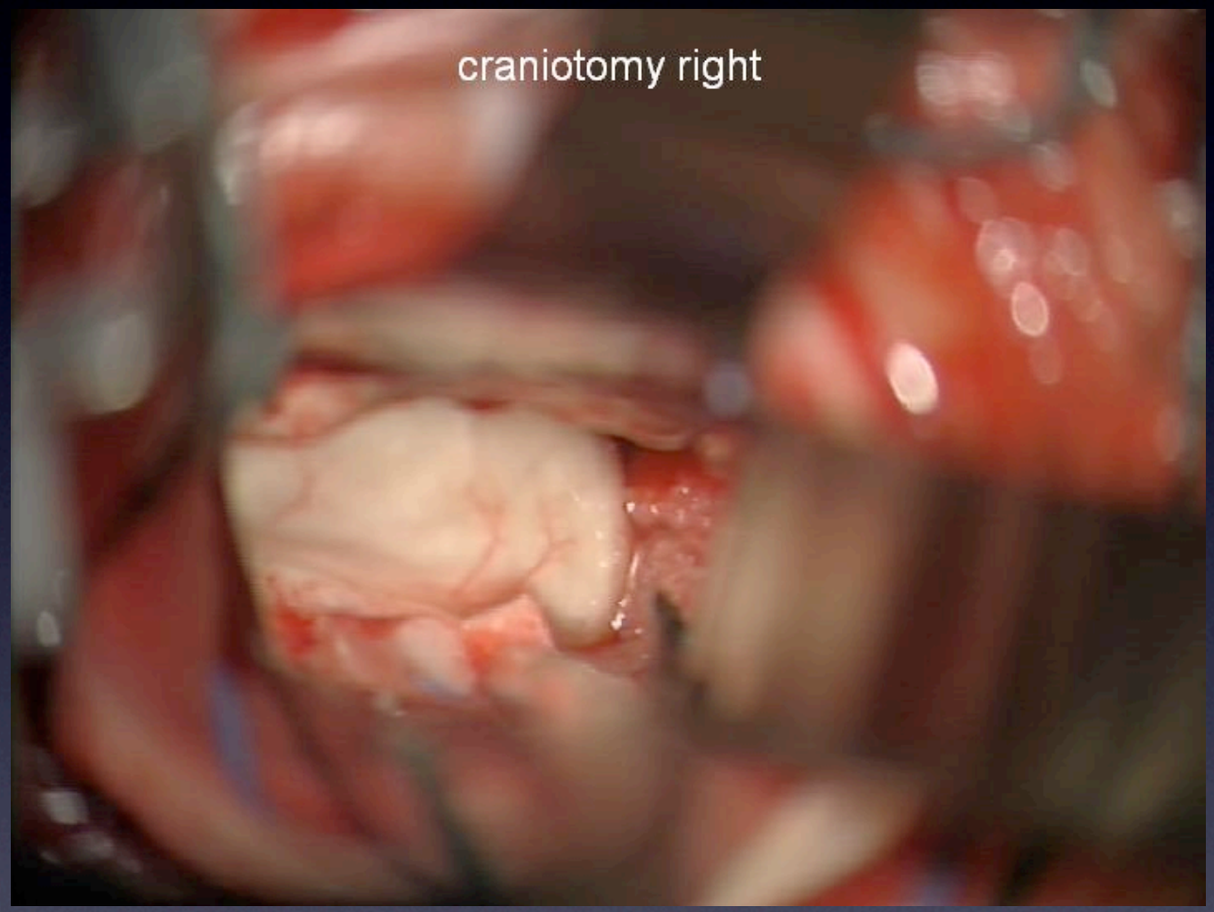
- Surgical resection





This is a QUALITY OF LIFE operation




craniotomy right


CM
1
2
3
4
5
INCHES
1
2

Engel classification system[1]

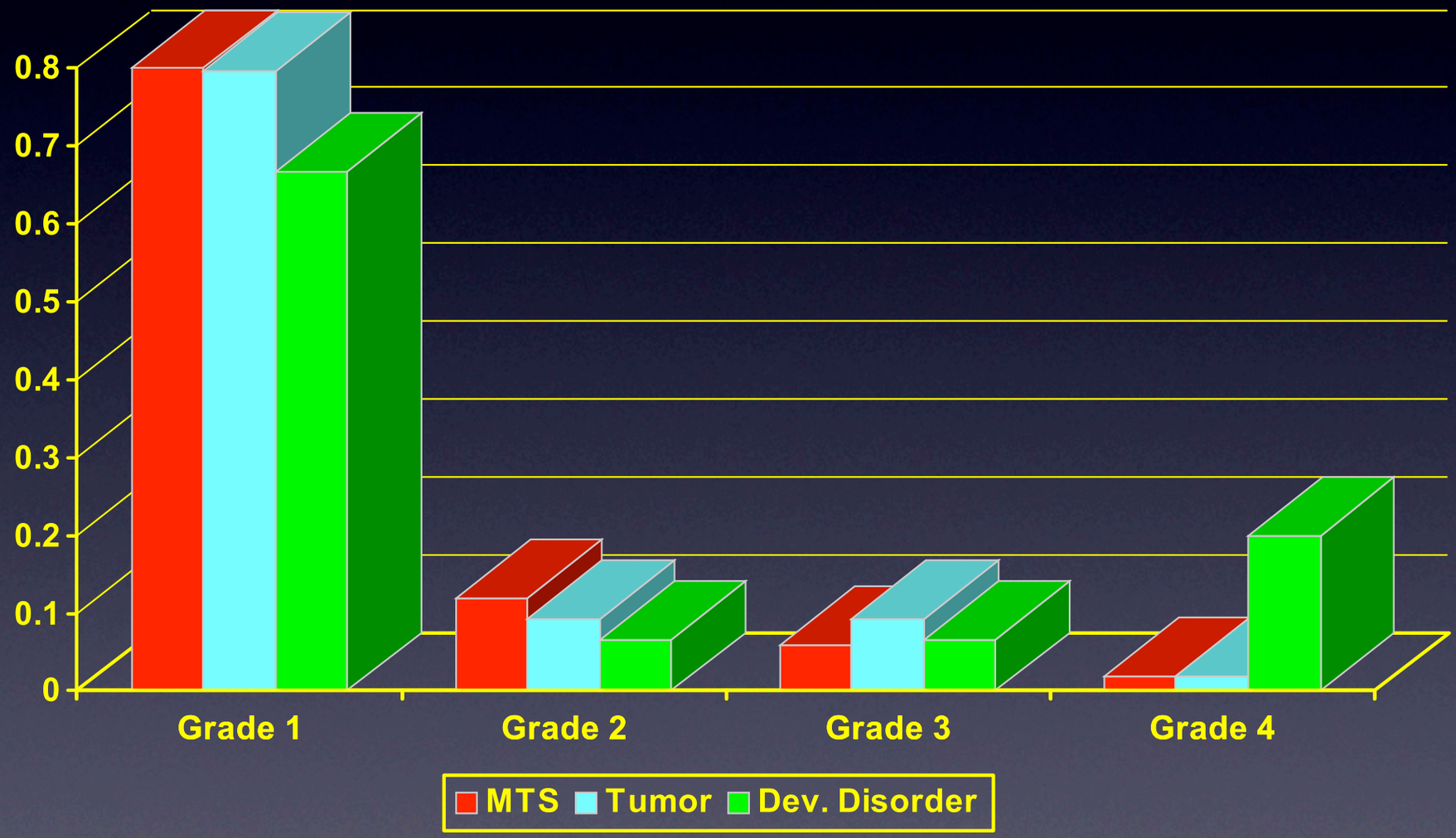
Class 1: Free of disabling seizures
- Completely seizure free
- Nondisabling, simple partial seizures only
- Some disabling seizures, but free of disabling seizures for at least 2 years
- Generalized convulsion with antiepileptic drug withdrawal only

Class II: Rare disabling seizures (almost seizure free)
- Initially free of disabling seizures, but rare seizures now
- Rare disabling seizures since surgery
- More than rare disabling seizures, but rare seizures for at least 2 years
- Nocturnal seizures only

Class III: Worthwhile improvement
- Worthwhile seizure reduction
- Prolonged seizure-free intervals amounting to more than half the follow-up period, but not less than 2 y

Class IV: No worthwhile improvement
- Significant seizure reduction
- No appreciable change
- Seizures worse

2 Year Outcome for Resective Surgery

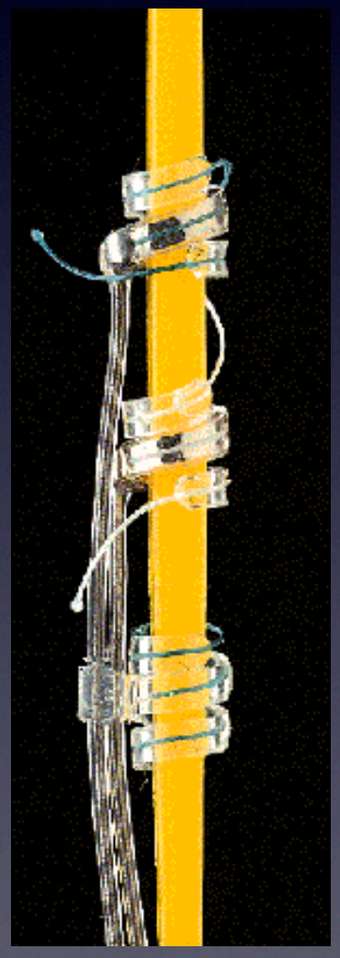


Engel J Jr, Wiebe S, French J, Sperling M, Williamson P, Spencer D, et al. Practice parameter: temporal lobe and localized neocortical resections for epilepsy: report of the Quality Standards Subcommittee of the American Academy of Neurology, in association with the American Epilepsy Society and the American Association of Neurological Surgeons. *Neurology*. Feb 25 2003;60(4): 538-47.

Kaiser LAMC 2 year outcomes

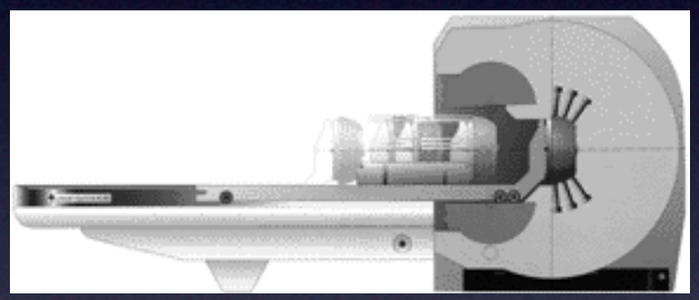
- 112 patients 2001-2008
- 21 lost to followup
- 83.5% seizure free (no seizures since surgery)

Vagus nerve stimulation



- Technique is non-destructive and potentially reversible
- Side effects include hoarseness, coughing and dyspnea, usually temporary
- Patients remain candidates for other surgical therapies

Radiosurgical amygdalohippocampectomy



- Potential alternative to open surgery for resection candidates
- Effect may take one year or longer
- Short and long term risks under investigation
- May be more patient-acceptable than craniotomy

Conclusions

- Epilepsy surgery is among the oldest, safest and most effective procedures in the neurosurgical armamentarium
- Surgery is a greatly underutilized tool in the treatment of chronic seizure disorders
- Advances in imaging and localization have increased the number of potential candidates and decreased the time and difficulty of evaluation
- New techniques make surgery more patient--acceptable and increase the options available
- Surgical evaluation should be considered early when conscientious and thorough efforts at medical control are unsuccessful.

"Good God, Man! Drilling holes in his head's not the answer...Now stand back so I can save this patient."

--Leonard "Bones" McCoy, MD, USS Enterprise; Star Trek: The Voyage Home, 1986