

# EPILEPSY AFTER BRAIN INJURY

Luke Tomycz, MD  
NJ Pediatric  
Neuroscience Institute  
Pediatric Neurosurgery



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# CONFLICTS OF INTEREST

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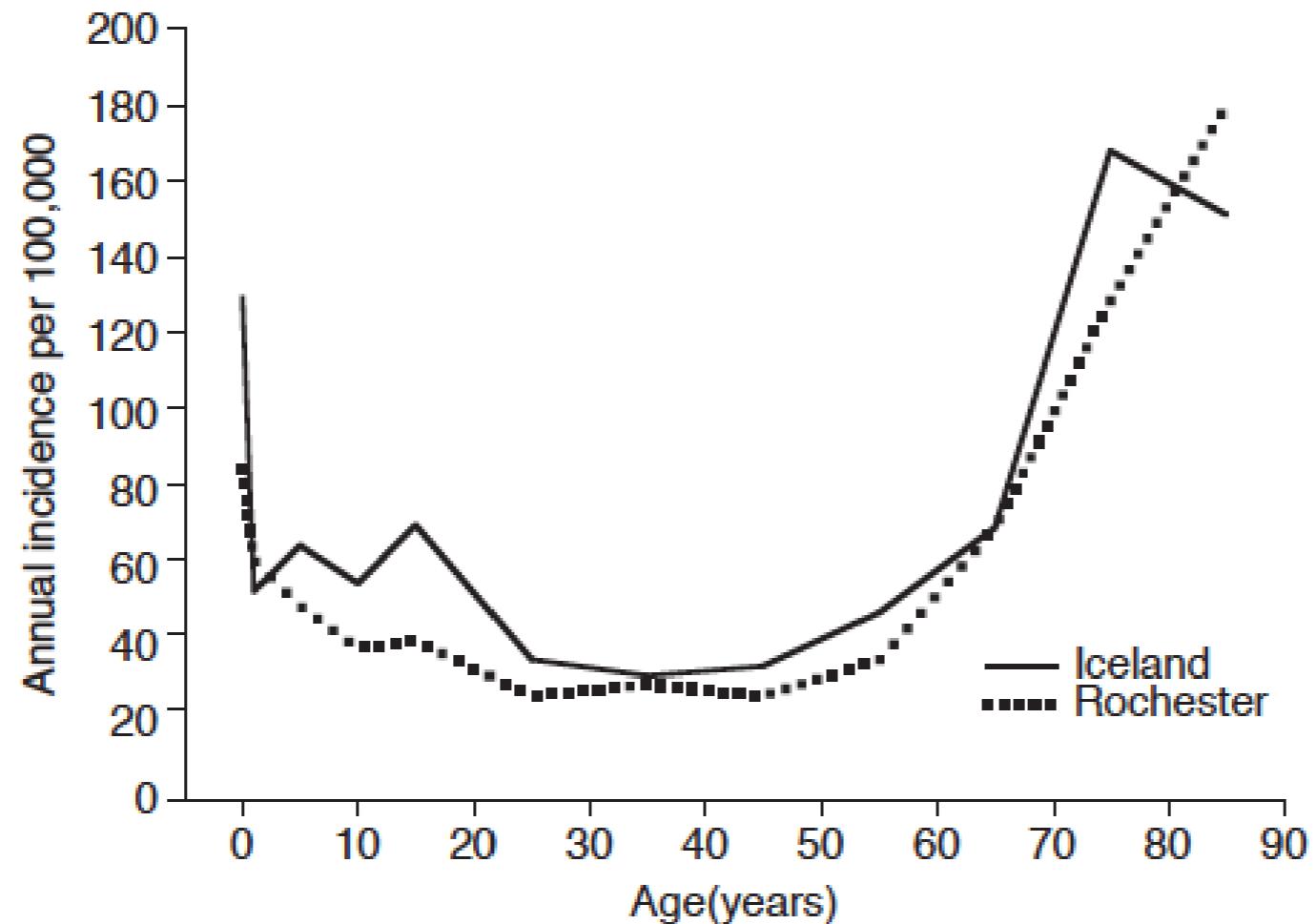
- . - expert clinic consultant for Philips ESI technology
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# TAKE HOME POINTS

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- epilepsy is common neurological ailment with tremendous global impact leading to significant morbidity, mortality, and healthcare costs
  - for over 1/3 of those afflicted, medical therapy does not afford good control of seizures, and early surgical referral is recommended
  - repeated seizure activity (and in some circumstances, the medicines used to control them) may be damaging to the developing brain and lead to impaired cognitive and psychosocial development
  - MRI negative epilepsy may still be amenable to tailored resections (and potential cure); but finding the epileptogenic focus is complicated and requires multiple types of imaging studies and icEEG
  - while no AED developed in the last ~30 years has had an impact on the incidence of MRE, three separate randomized control trials and experience with tens of thousands of patients has shown that surgery is a relatively safe and highly effective treatment for focal epilepsy
  - the community caring for patients with medically-refractory epilepsy has failed to develop systems that promptly and consistently identify patients who might benefit from existing technologies - new paradigms of care are needed
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# 50 M AFFECTED GLOBALLY!



**Figure 26.1** Incidence of epilepsy by age in Rochester, MN, US and Iceland. Data adapted from the original articles.<sup>26, 27</sup>

# SURGERY FOR EPILEPSY

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- . goal of surgery: to characterize and, when possible, fully resect and/or disconnect the epileptogenic cortex (EZ) while preserving adjacent eloquent tissue
    - . to achieve seizure freedom or significant improvement in severity and/or frequency of seizures
    - . to avoid adverse effects of AEDs and continued seizures on the developing brain and facilitate normalization of psychosocial development
  - . *Where are the seizures coming from?*
  - . *Can I resect the epileptogenic focus with acceptable morbidity?*
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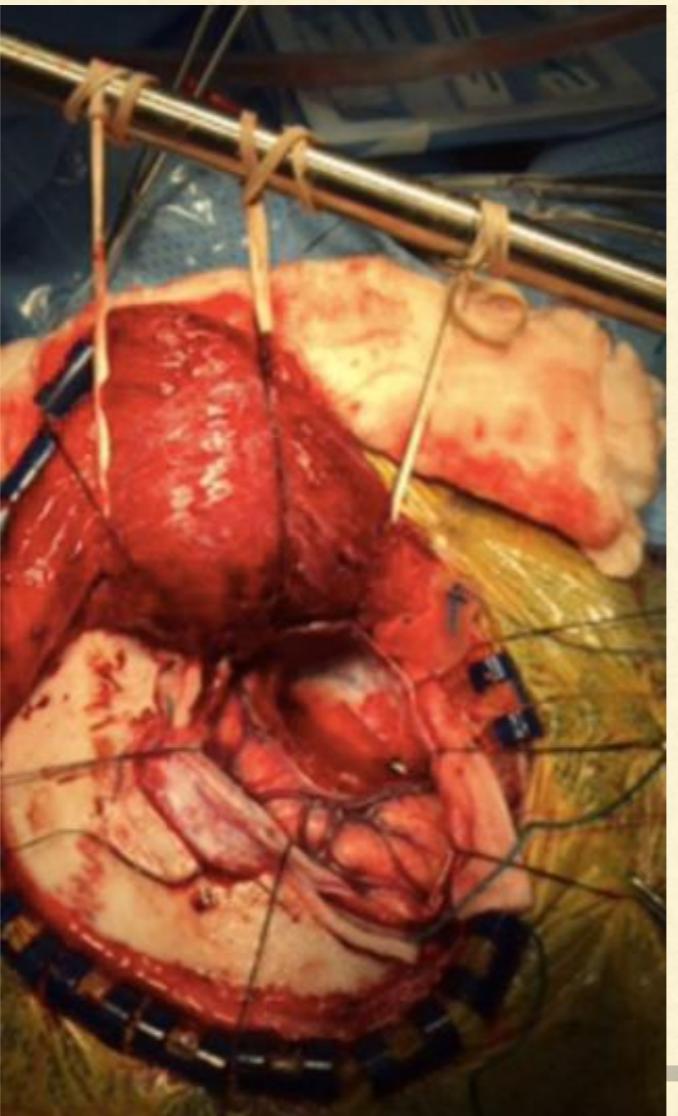
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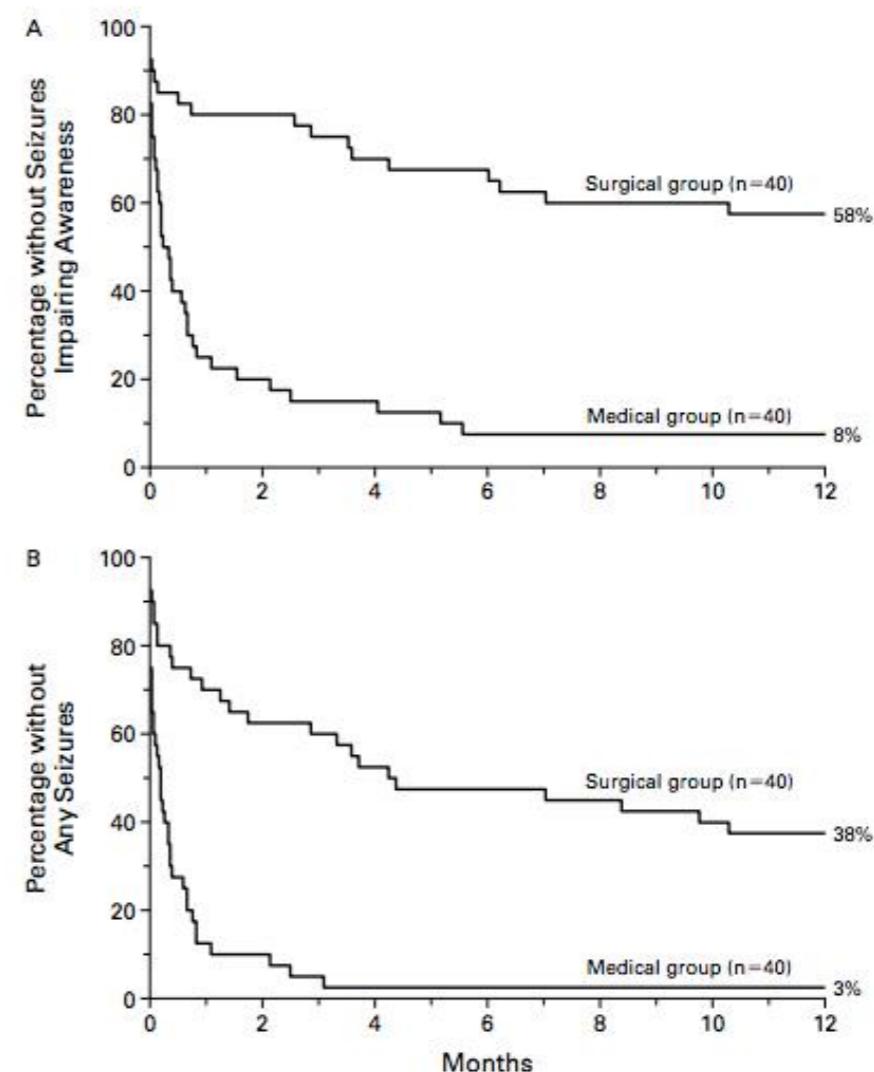


## A RANDOMIZED, CONTROLLED TRIAL OF SURGERY FOR TEMPORAL-LOBE EPILEPSY

SAMUEL WIEBE, M.D., WARREN T. BLUME, M.D., JOHN P. GIRVIN, M.D., PH.D., AND MICHAEL ELIASZIWI, PH.D.,  
FOR THE EFFECTIVENESS AND EFFICIENCY OF SURGERY FOR TEMPORAL LOBE EPILEPSY STUDY GROUP\*



• NNT = 2  
(NNT for CEA in  
high grade carotid  
stenosis = 12)



**Figure 2.** Kaplan-Meier Event-free Survival Curves Comparing the Cumulative Percentages of Patients in the Two Groups Who Were Free of Seizures Impairing Awareness (Complex Partial or Generalized Seizures) (Panel A) and Free of All Seizures (Including Auras) (Panel B).

In both analyses, more patients in the surgical group were free of seizures ( $P<0.001$  by the log-rank test). Follow-up began 1 day after surgery in the surgical group and 25 days after randomization in the medical group.

## Early Surgical Therapy for Drug-Resistant Temporal Lobe

### Epilepsy:

#### A Randomized Trial

**Jerome Engel Jr, MD, PhD, Michael P. McDermott, PhD, Samuel Wie Langfitt, PhD, John M. Stern, MD, Sandra Dewar, RN, Michael R. Spi Gardiner, RN, Giuseppe Erba, MD, Itzhak Fried, MD, PhD, Margaret Vinters, MD, Scott Mintzer, MD, Karl Kieburtz, MD, MPH, and for the Surgical Epilepsy Trial (ERSET) Study Group**

**Seizure Freedom in the Second Year of Follow-up**—In the medical group, 19 participants provided seizure logs and all had seizures recorded during year 2. Four participants who withdrew provided no seizure logs for year 2. One participant in the medical group (who did not have surgery) was seizure free for the last 50 weeks of follow-up. In the surgical group, 14 participants provided seizure logs and 2 participants had seizures during year 2. In the primary analysis, which considered participants who did not have complete follow-up during year 2 as not seizure free, 0 of 23 in the medical group and 11 of 15 in the surgical group (73%) were seizure free (odds ratio [OR]= $\infty$ ; 95% CI, 11.8 to  $\infty$ ;  $P<.001$ ). Analysis of only those participants who provided complete data in year 2 (or reported seizures in year 2) showed that 0 of 19 in the medical group (0%) vs 11 of 13 in the surgical group (85%) were seizure free (OR= $\infty$ ; 95% CI, 14.8 to  $\infty$ ;  $P<.001$ ). The sensitivity analysis using multiple imputation yielded an estimated OR of 12.4 (95% CI, 2.6–59.2;  $P=.002$ ).

**Seizure Frequency**—Seizure frequency over the 24 months of follow-up is shown in Table 3. Nine of the 11 participants in the surgical group who became free of disabling seizures never experienced a seizure after surgery; the other 2 participants last reported seizures 4 and 21 days after surgery. Seizure-free participants were also free of auras. One participant in the surgical group last reported a seizure 10 months after surgery but was only observed for 7 months in the second postoperative year. The 2 participants in the surgical group who continued to have seizures in year 2 experienced substantial improvement in seizure frequency (Table 3).

**Quality of Life**—QOLIE-89 data were available for 36 participants who were at least 17 years old. Adjusted mean overall T-scores at each follow-up visit are shown by treatment group in Figure 2. In the intention-to-treat analyses, participants in the surgical group had significantly higher increases in health-related QOL than those in the medical group at months 6, 12, and 18 ( $P<.009$ ; Figure 2), but not at month 24 ( $P=.08$ ; Table 4). When excluding data obtained after surgery from participants in the medical group ( $n=6$ ), the effect of surgery on overall QOL was statistically significant at month 24 ( $P=.01$ ). The effect of surgery on overall QOL was reflected in the Mental Health, Epilepsy-Targeted, and

ORIGINAL ARTICLE

## Surgery for Drug-Resistant Epilepsy in Children

Rekha Dwivedi, Ph.D., Bhargavi Ramanujam, M.D., D.M.,  
P. Sarat Chandra, M.Ch., Savita Sapra, Ph.D., Sheffali Gulati, M.D., D.M.,  
Mani Kalaivani, Ph.D., Ajay Garg, M.D., Chandra S. Bal, M.D.,  
Madhavi Tripathi, M.D., Sada N. Dwivedi, Ph.D., Rajesh Sagar, M.D.,  
Chitra Sarkar, M.D., and Manjari Tripathi, M.D., D.M.

- N = 116, age < 18
- Primary outcome: seizure freedom at 12 months
- Secondary outcomes: Hague Seizure Severity Scale, Child Behavior Checklist Inventory, Pediatric QOL Inventory, Vineland Social Maturity Scale, Binet-Kamat IQ
- The surgery performed ranged from temporal lobectomy to focal cortical resection to hemispherectomy based on pathology

- . patients were evaluated with inpatient video-EEG with the standard 10-20 scalp electrode montage
  - . 3T MRI with epilepsy protocol: T1W sagittal 3D and 3D FLAIR sequences (1mm slices without a gap); coronal T2 and FLAIR sequences (2.5mm without a gap); axial susceptibility weighted images
  - . functional imaging to localize the site of epileptogenicity (ictal and interictal SPECT, PET, or MEG) was performed in the following situations
    - . no lesion, lesion with poorly-defined margins, mult lesions on MR
    - . no definite localization on video-EEG
    - . discordance between localization of EEG and MRI
- Dwivedi R. et al; NEJM 377;17, October 2017

# SURGERY TYPE

- . no patients underwent phase I evaluation with placement of intracranial grids and/or depth electrodes
  - . patients with concordant EEG localization and lesion on MRI underwent resection of abnormal tissue
  - . those with multiple, subtle, or absent lesions underwent resection of region of brain that was concordant between EEG and PET, SPECT, or MEG
    - . 14 temporal lobe resections, 12 extratemporal resections, 6 hypothalamic hamartoma rsxn
  - . patients with multiple seizure types (including drop attacks) and had multiple bilateral lesions and/or seizure foci underwent corpus callosotomy [10]
  - . those with extensive lesions confined to a single hemisphere with significant weakness of contralateral limbs (weak pincer grip or worse) underwent hemispherotomy [15]
- . Dwivedi R. et al; NEJM 377;17, October 2017

# OUTCOME

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- complete seizure freedom at 1 year was reported in 77% of patients in the surgical arm as compared to 7% of those in the medical arm ( $P < 0.001$ )
- the surgical group as compared to the medical group showed significant improvements in all of the secondary endpoints except for IQ
- adverse events occurred in 33% of the surgical group (hemiparesis in all 15 patients who underwent hemispherotomy, mono paresis in two patients who underwent focal temporoparietal resections, and mixed aphasia in a patient who underwent dominant frontal resection)
- in the medical group, 1 patient had adverse event to AED, one developed autism in the observation period, and 10 had cuts, burns, fractures related to a seizure event; there was also a significant reduction in IQ over the course of a year in the medical group

# Surgery for epilepsy

Siobhan West<sup>1</sup>, Sarah J Nolan<sup>2</sup>, Jennifer Cotton<sup>3</sup>, Sacha Gandhi<sup>4</sup>, Jennifer Weston<sup>5</sup>, Ajay Sudan<sup>1</sup>, Roberto Ramirez<sup>6</sup>, Richard Newton

<sup>1</sup>

<sup>1</sup>Department of Paediatric Neurology, Royal Manchester Children's Hospital, Manchester, UK. <sup>2</sup>Department of Biostatistics, The University of Liverpool, Liverpool, UK. <sup>3</sup>Rheumatology and Orthopaedics, Royal Lancaster Infirmary, University Hospitals of Morecambe Bay NHS Foundation Trust, Lancaster, UK. <sup>4</sup>Undergraduate Medical Education, Manchester Royal Infirmary, Manchester, UK. <sup>5</sup>Department of Molecular and Clinical Pharmacology, Institute of Translational Medicine, University of Liverpool, Liverpool, UK. <sup>6</sup>Royal Manchester Children's Hospital, Manchester, UK

Contact address: Siobhan West, Department of Paediatric Neurology, Royal Manchester Children's Hospital, Hathersage Road, Manchester, M13 0JH, UK. [siohan.west@cmft.nhs.uk](mailto:siohan.west@cmft.nhs.uk). [Siochan.wykes@doctors.net.uk](mailto:Siochan.wykes@doctors.net.uk).

**Editorial group:** Cochrane Epilepsy Group.

**Publication status and date:** New, published in Issue 7, 2015.

**Review content assessed as up-to-date:** 4 July 2013.

## Surgery compared with medical treatment for epilepsy

**Patient or population:** adults with drug-resistant epilepsy suitable for surgical intervention

**Settings:** outpatients (following surgery in hospital)

**Intervention:** surgery

**Comparison:** medical treatment

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)
	Assumed risk <sup>1</sup>	Corresponding risk <sup>2</sup>	
	Medical treatment	Surgery	
Proportion free from seizure impairing awareness at 1 year	75 per 1000	500 more per 1000 (113 to 925 more)	RR 7.67 (2.50 to 23.51)
Proportion free from all seizures (including auras) at 1 year	23 per 1000	350 per 1000 (27 to 973 more)	RR 15.00 (2.08 to 108.23)

# Surgical outcomes in lesional and non-lesional epilepsy: A systematic review and meta-analysis

José F. Téllez-Zenteno<sup>a,\*</sup>, Lizbeth Hernández Ronquillo<sup>a</sup>,  
Farzad Moien-Afshari<sup>a</sup>, Samuel Wiebe<sup>b</sup>

<sup>a</sup> Department of Medicine, Division of Neurology, University of Saskatchewan, Saskatoon, Canada

<sup>b</sup> Department of Clinical Neurosciences, University of Calgary, Alberta, Canada

Received 17 October 2009; received in revised form 5 January 2010; accepted 13 February 2010

Available online 15 March 2010

**Table 1** Results by surgical topography, including all age groups.

Categories (n of studies)	Non-lesional			Lesional		
	Total N patients	Seizure-free %	95%CI	Total N patients	Seizure-free %	95%CI
<i>Temporal and extratemporal</i>						
Overall (n = 35)	697	43	39–46	2860	68	66–70
Using MRI (n = 19)	398	46	41–51	965	70	68–73
Using histopathology (n = 17)	302	39	34–44	1953	67	65–69
<i>Temporal lobe</i>						
Overall (n = 20)	398	45	40–49	1657	69	66–70
Using MRI (n = 12)	226	51	45–57	514	75	71–89
Using histopathology (n = 8)	172	36	29–43	1179	65	63–68
<i>Extratemporal</i>						
Overall (n = 13)	156	34	27–41	350	66	61–70
Using MRI (n = 9)	124	35	27–42	225	60	54–66
Using histopathology (n = 4)	35	32	18–47	125	74	67–82

Numbers in "Overall" category do not represent the sum of MRI and histopathology because studies reported different numbers of patients for each category. Some articles contributed more than one study (see text).

**Table 2** Results by age group.

Categories (n of studies)	Non-lesional			Lesional		
	Total N patients	Seizure-free %	95%CI	Total N patients	Seizure-free %	95%CI
<i>Children</i>						
Temporal and extratemporal (n = 9)	93	45	35–55	317	74	69–79
Temporal epilepsy (n = 5)	48	45	31–59	146	81	75–87
Extratemporal epilepsy (n = 4)	31	46	30–62	97	73	64–82
<i>Adults</i>						
Temporal and extratemporal (n = 7)	153	36	28–43	686	72	68–75
Temporal epilepsy (n = 5)	92	45	35–55	646	72	69–76
Extratemporal epilepsy (n = 2)	49	26	13–38	40	53	38–68

Numbers in "Overall" category do not represent the sum of MRI and histopathology because studies reported different numbers of patients for each category. Some articles contributed more than one study (see text).

# Long-term seizure outcomes following epilepsy surgery: a systematic review and meta-analysis FREE

José F. Téllez-Zenteno , Raj Dhar, Samuel Wiebe

*Brain*, Volume 128, Issue 5, 1 May 2005, Pages 1188–1198,

However, the results are more similar than different. In fact, one of our most salient findings is that, overall, long-term surgical results were consistently similar to those of short-term studies, including those from a randomized trial (Wiebe *et al.*, 2001). This supports the durability of the benefits of surgery in general.

In carefully selected children, hemispherectomy results in seizure-free rates of 70–80% (Daniel *et al.*, 2001; Pulsifer *et al.*, 2004). The evidence from long-term reports indicates that the benefit of hemispherectomy is maintained over time; 60% remain seizure free after 5 years.

## FULL-LENGTH ORIGINAL RESEARCH

# Complications of epilepsy surgery: A systematic review of focal surgical resections and invasive EEG monitoring

\*Walter J. Hader, †Jose Tellez-Zenteno, \*‡Amy Metcalfe, †Lisbeth Hernandez-Ronquillo,  
\*‡§Samuel Wiebe, ¶Churl-Su Kwon, and \*‡§Nathalie Jette

\*Department of Clinical Neurosciences, University of Calgary, Calgary, Alberta, Canada; †Division of Neurology, University of Saskatchewan, Saskatoon, Saskatchewan, Canada; ‡Department of Community Health Sciences, University of Calgary, Calgary, Alberta, Canada; §Hotchkiss Brain Institute and Institute for Public Health, Calgary, Alberta, Canada; and ¶Department of Neurosurgery, Massachusetts General Hospital, Boston, Massachusetts, U.S.A.

surgery evaluation. Our study provides a detailed understanding of these risks for patients and physicians to ensure an informed decision can be made about epilepsy surgery, and to remove the fallacy that this type of surgery is very dangerous. Failure to offer epilepsy surgery for appropriately selected patients may withhold a treatment capable of providing seizure freedom, improved quality-of-life, and a reduction in the likelihood of premature mortality associated with ongoing intractable epilepsy for the majority of patients (Wiebe et al., 2001).

**Invasive monitoring. Resective surgery:** Minor and major medical complications were reported in 5.1% and 1.5% of patients respectively, most common being cerebrospinal fluid (CSF) leak. Minor neurologic complications occurred in 10.9% of patients and were twice as frequent in children (11.2% vs. 5.5%). Minor visual field defects were most common (12.9%). Major neurologic complications were noted in 4.7% of patients, with the most common being major visual field defects (2.1% overall). Perioperative mortality was uncommon after epilepsy surgery, occurring in only 0.4% of temporal lobe patients (1.2% extratemporal).

**Significance:** The majority of complications after epilepsy surgery are minor or temporary as they tend to resolve completely. Major permanent neurologic complications remain uncommon. Mortality as a result of epilepsy surgery in the modern era is rare.

# EPILEPSY SURGERY IN CHILDREN

## Panel 1: Specific epilepsy surgery issues in children

### General considerations

- Children should be assessed in a paediatric specialist epilepsy unit<sup>5,18</sup>
- Presurgical assessment should be done as early as possible in appropriate surgical candidates<sup>5,18</sup>
- Shortening the duration of epilepsy might result in improved long-term seizure outcome<sup>5,19</sup>
- Early surgery might improve cognitive development and quality of life in children<sup>5,19-21</sup>
- Developmental delay or psychiatric morbidity do not contraindicate paediatric epilepsy surgery<sup>5,22-26</sup>
- Optimised MRI and review is essential in young children to detect epileptogenic lesions<sup>5,18</sup>
- Diffuse electroencephalogram abnormalities, including early-onset catastrophic epilepsy, can be seen in children with resectable focal brain lesions<sup>5,26-28</sup>

Original Research

## Proposed Criteria for Referral and Evaluation of Children for Epilepsy Surgery: Recommendations of the Subcommission for Pediatric Epilepsy Surgery

\*J. Helen Cross, \*Prasanna Jayakar, \*Doug Nordli, \*Olivier Delalande, \*Michael Duchowny,  
†Heinz G. Wieser, ‡Renzo Guerrini, and \*Gary W. Mathern

*On behalf of the International League Against Epilepsy \*Subcommission for Paediatric Epilepsy Surgery, and  
the Commissions of †Neurosurgery and ‡Paediatrics*

- - “... earlier reduction in burden of chronic epilepsy should confer improved psychosocial benefit and improve quality of life in children ... surgical intervention at an earlier age would be expected to have a greater role in preventing cognitive regression.”
- the double argument of plasticity: “brain plasticity [in children] facilitates neurologic reorganization after surgery and may trigger deviant or delayed development in early-onset epilepsy”

# PRE-SURGICAL EVALUATION

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- Does the patient truly have epilepsy?
  - What is the etiology?
  - Are the seizures refractory or should other medicines/dosages and therapies be considered before surgery?
  - Given the seizure type and epilepsy syndrome, is surgery warranted or is there possibility of remission?
  - Are the patient and/or family prepared for surgery; do they understand the risks and psychological aspects of invasive monitoring and subsequent resection; have they been counseled on the possibility of failure?
-

# ASSEMBLING A TEAM

- pediatric or adult neurologist / epileptologist
- neurosurgeon
- neuropsychologist
- neuroradiologist / nuclear medicine
- developmental (adolescent) pediatrician / psychiatrist
- nutritionist (ketogenic diet)
- neuropathologist
- neurophysiologist (EEG montage)
- MEG-physicist
- physical/occupational/speech therapist
- geneticist



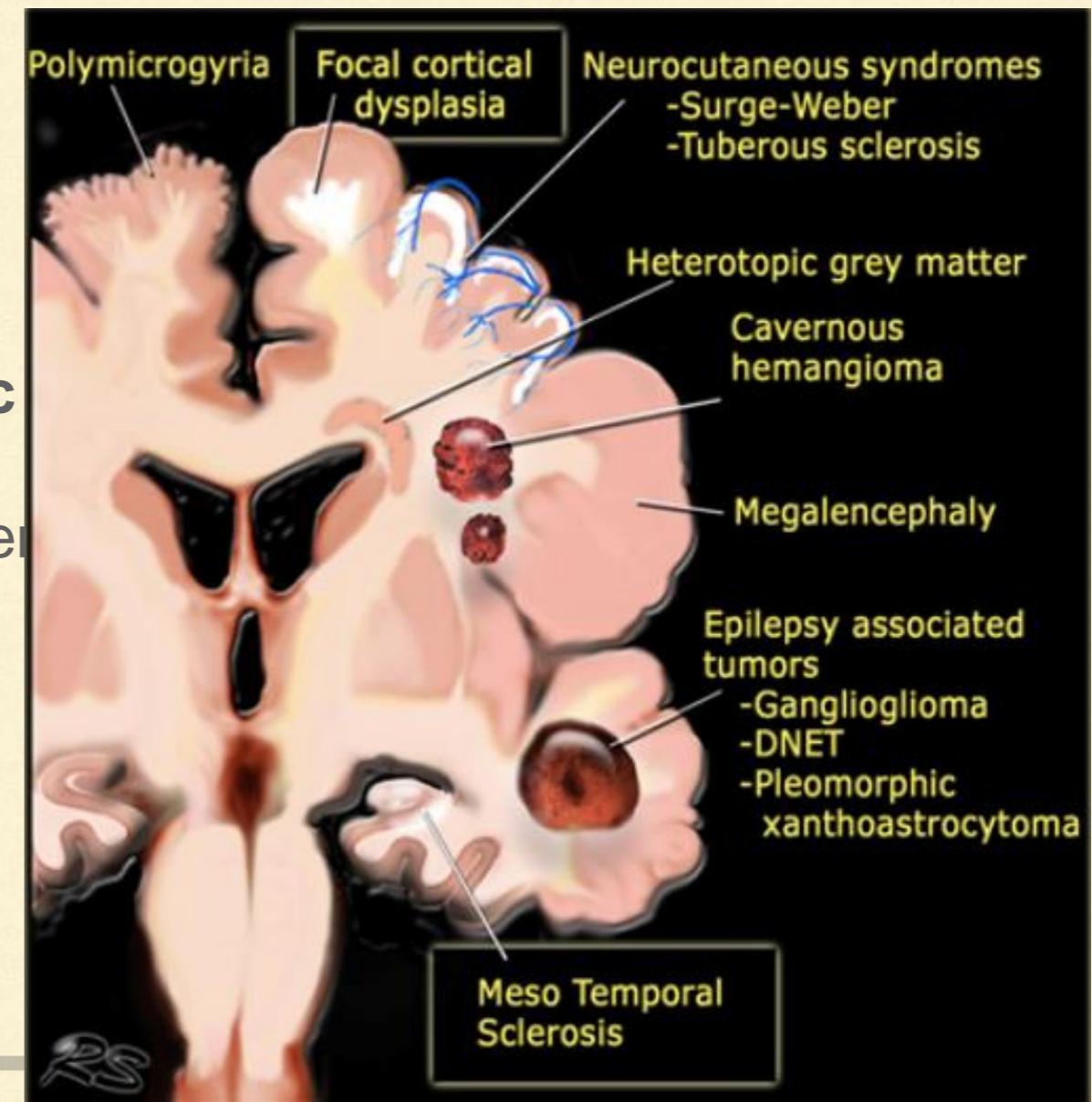
# SOME CHILDREN WITH SEIZURES MAY NOT BE SURGICAL CANDIDATES

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- childhood absence seizures (primary generalized)
  - juvenile myoclonic epilepsy (primary generalized)
  - benign epilepsy with centrotemporal spikes (benign Rolandic epilepsy)
  - early onset childhood epilepsy with occipital spikes (Panayiotopoulos type)
-

# SURGICAL EPILEPSY SYNDROMES

- lesional epilepsy (e.g. associated with tumor, cavernoma, AVM)
- mesial temporal sclerosis (MTS)
- focal cortical dysplasia (FCD)
- post-stroke, post-infectious, post-traumatic**
- hemispheric syndromes (e.g. SWS, Rasmussen)
- epileptic encephalopathies of infancy
- schizencephaly, polymicrogyria



# Brain Injury

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traumatic brain injury (TBI): a blow or jolt to the head (eg. MVA, sports injury) or penetrating injury (eg. GSW) often designated mild, moderate, or severe

acquired brain injury: includes stroke (eg. ischemic, hemorrhagic, SAH), metabolic disorders, meningitis (post-infectious), encephalitis (eg. Rasmussen's encephalitis), or brain tumors

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## Epidemiology of Posttraumatic Epilepsy: A Critical Review

Lauren C. Frey

*Department of Neurology, University of Colorado Health Science Center, Denver, Colorado, U.S.A.*

- 3-6% of new onset epilepsy is due to TBI (eg. MVA, blunt trauma, etc); however trauma is the most common cause of remote symptomatic epilepsy in those aged 15-34 years
- up to 10% of epilepsy may be related to prior cerebrovascular event (eg. stroke, ICH, SAH)
- epilepsy can occur after meningitis/encephalitis or other infection/inflammation of the brain

# Long-term outcome of extratemporal resection in posttraumatic epilepsy

**\*SHAHIN HAKIMIAN, M.D.,<sup>2,3</sup> AMIR KERSHENOVICH, M.D.,<sup>1,3,4</sup>  
JOHN W. MILLER, M.D., PH.D.,<sup>1,3</sup> JEFFREY G. OJEMANN, M.D.,<sup>1,3</sup> ADAM O. HEBB, M.D.,<sup>1,3</sup>  
RAIMONDO D'AMBROSIO, PH.D.,<sup>1,3</sup> AND GEORGE A. OJEMANN, M.D.<sup>1,3</sup>**

*Departments of <sup>1</sup>Neurological Surgery and <sup>2</sup>Neurology, University of Washington; <sup>3</sup>Regional Epilepsy Center, Harborview Medical Center and University of Washington Medical Center, Seattle, Washington; and <sup>4</sup>Department of Neurosurgery, Geisinger Medical Center, Danville, and Temple School of Medicine, Philadelphia, Pennsylvania*

**Object.** Posttraumatic epilepsy (PTE) is a common cause of medically intractable epilepsy. While much of PTE is extratemporal, little is known about factors associated with good outcomes in extratemporal resections in medically intractable PTE. The authors investigated and characterized the long-term outcome and patient factors associated with outcome in this population.

**Methods.** A single-institution retrospective query of all epilepsy surgeries at Regional Epilepsy Center at the University of Washington was performed for a 17-year time span with search terms indicative of trauma or brain injury. The query was limited to adult patients who underwent an extratemporal resection (with or without temporal lobectomy), in whom no other cause of epilepsy could be identified, and for whom minimum 1-year follow-up data were available. Surgical outcomes (in terms of seizure reduction) and clinical data were analyzed and compared.

**Results.** Twenty-one patients met inclusion and exclusion criteria. In long-term follow-up 6 patients (28%) were seizure-free and an additional 6 (28%) had a good outcome of 2 or fewer seizures per year. Another 5 patients (24%) experienced a reduction in seizures, while only 4 (19%) did not attain significant benefit. The presence of focal encephalomalacia on imaging was associated with good or excellent outcomes in 83%. In 8 patients with the combination of encephalomalacia and invasive intracranial EEG, 5 (62.5%) were found to be seizure free. Normal MRI examinations preoperatively were associated with worse outcomes, particularly when combined with multifocal or poorly localized EEG findings. Two patients suffered complications but none were life threatening or disabling.

**Conclusions.** Many patients with extratemporal PTE can achieve good to excellent seizure control with epilepsy surgery. The risks of complications are acceptably low. Patients with focal encephalomalacia on MRI generally do well. Excellent outcomes can be achieved when extratemporal resection is guided by intracranial EEG electrodes defining the extent of resection.

(<http://thejns.org/doi/abs/10.3171/2012.1.FOCUS11329>)

**KEY WORDS** • epilepsy surgery • posttraumatic epilepsy • frontal • magnetic resonance imaging • extratemporal • invasive monitoring

# Post-traumatic epilepsy following fluid percussion injury in the rat FREE

Raimondo D'Ambrosio , Jared P. Fairbanks, Jason S. Fender, Donald E. Born, Dana L. Doyle, John W. Miller

*Brain*, Volume 127, Issue 2, February 2004, Pages 304–314,

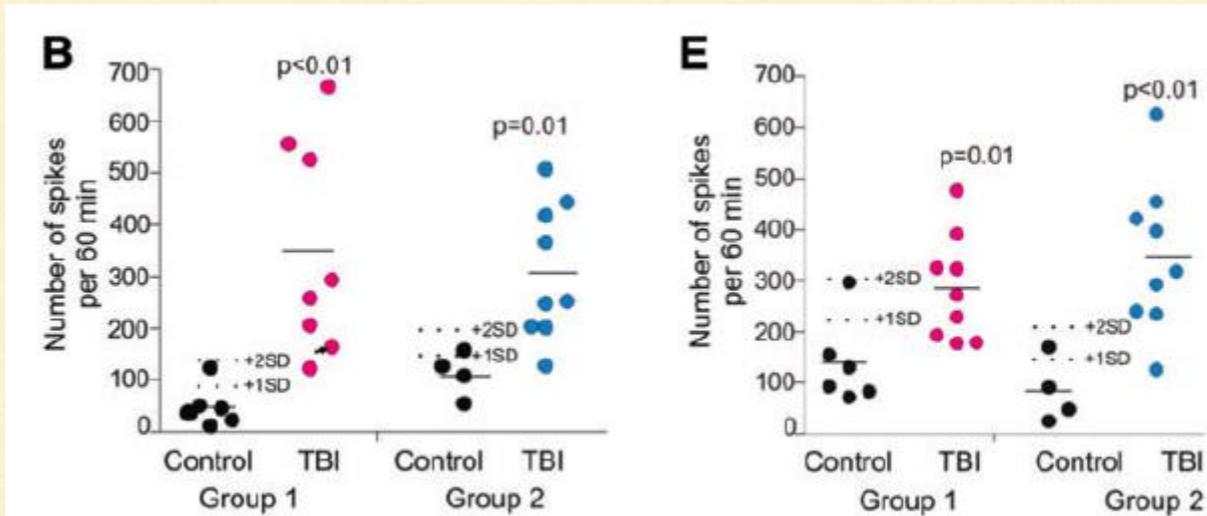
<https://doi.org/10.1093/brain/awh038>

Published: 01 February 2004 Article history ▾

JOURNAL OF NEUROTRAUMA 29:789–812 (March 20, 2012)  
© Mary Ann Liebert, Inc.  
DOI: 10.1089/neu.2011.1954

## Development of Post-Traumatic Epilepsy after Controlled Cortical Impact and Lateral Fluid-Percussion-Induced Brain Injury in the Mouse

Tamuna Bolkvadze<sup>1</sup> and Asla Pitkänen<sup>1,2</sup>



## Seizures and Epilepsy following Aneurysmal Subarachnoid Hemorrhage : Incidence and Risk Factors

[Kyu-Sun Choi, M.D.,<sup>1</sup>](#) [Hyoung-Joon Chun, M.D.,<sup>1</sup>](#) [Hyeong-Joong Yi, M.D.,<sup>✉1</sup>](#) [Yong Ko, M.D.,<sup>1</sup>](#)  
[Young-Soo Kim, M.D.,<sup>1</sup>](#) and [Jae-Min Kim, M.D.<sup>2</sup>](#)

### Risk factors of late epilepsy

Recent retrospective clinical studies found late or recurrent epilepsy in 7% to 12% of their SAH populations<sup>2,7,15,30</sup>). The observed frequency of epilepsy after SAH in our study of 3.1% at 22 months is comparable to that of prior reports of 7 to 12%. From these data, a number of predictors have been implicated, including ischemia and postoperative vasospasm, poor preoperative neurologic grade, anterior circulation aneurysm location, general severity of hemorrhage as reflected by blood on CT, rebleeding, large intracerebral hemorrhage and shunt-dependent hydrocephalus<sup>2,7,12,15,20,29</sup>). In our study (Table 3), late epilepsy was associated with hydrocephalus, cortical infarction, Fisher grade III and IV, and younger age (< 40 years). As stated above, onset seizures however, were not predictive of late epilepsy. The discrepancy of risk factors between previous reports and ours may accrue because of varying inclusion criteria and follow-up length, along with different treatment modality.

[World Neurosurg.](#), 2013 May-Jun;79(5-6):682-90. doi: 10.1016/j.wneu.2012.08.006. Epub 2012 Sep 25.

## **Seizures after aneurysmal subarachnoid hemorrhage: a systematic review of outcomes.**

[Raper DM<sup>1</sup>](#), [Starke RM](#), [Komotar RJ](#), [Allan R](#), [Connolly ES Jr.](#)

### **Author information**

#### **Abstract**

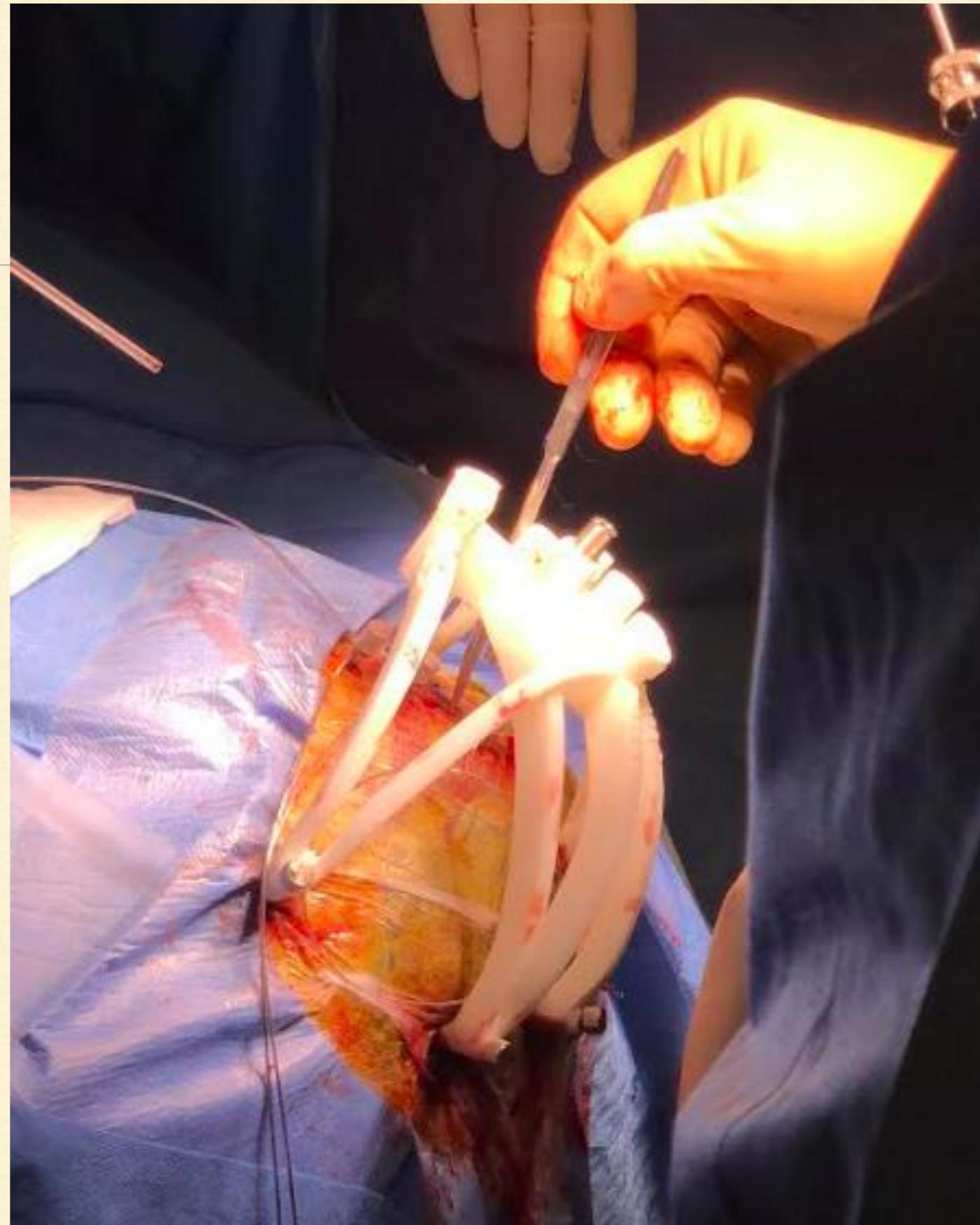
**OBJECTIVE:** The risk for early and late seizures after aneurysmal subarachnoid hemorrhage (aSAH), as well as the effect of antiepileptic drug (AED) prophylaxis and the influence of treatment modality, remain unclear. We conducted a systematic review of case series and randomized trials in the hope of furthering our understanding of the risk of seizures after aSAH and the effect of AED prophylaxis and surgical clipping or endovascular coiling on this important adverse outcome.

**METHODS:** We performed a MEDLINE (1985-2011) search to identify randomized controlled trials and retrospective series of aSAH. Statistical analyses of categorical variables such as presentation and early and late seizures were carried out using  $\chi^2$  and Fisher exact tests.

**RESULTS:** We included 25 studies involving 7002 patients. The rate of early postoperative seizure was 2.3%. The rate of late postoperative seizure was 5.5%. The average time to late seizure was 7.45 months. Patients who experienced a late seizure were more likely to have MCA aneurysms, be Hunt/Hess grade III, and be repaired with microsurgical clipping than endovascular coiling.

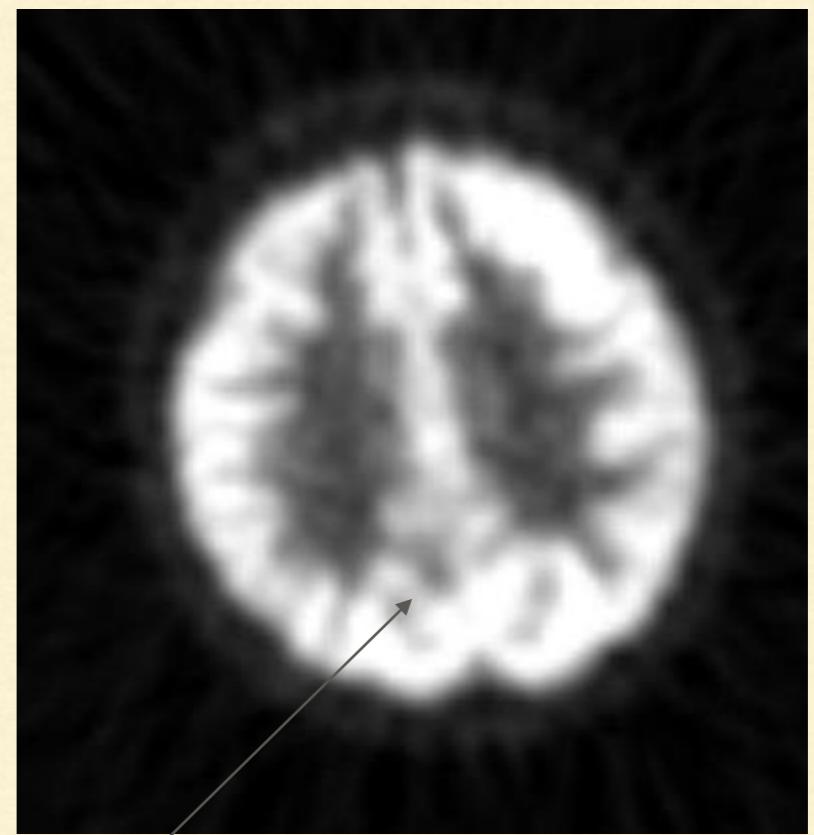
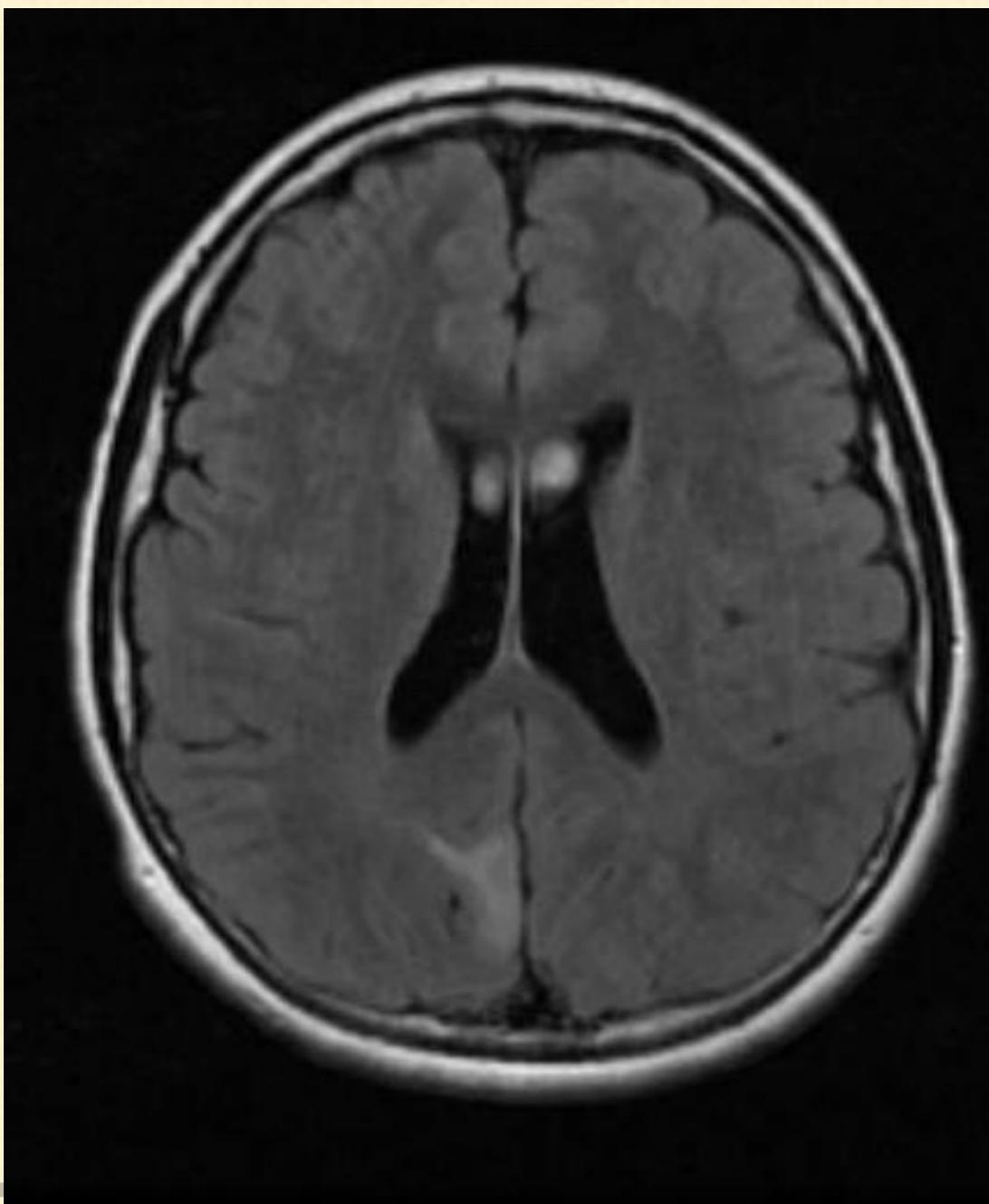
**CONCLUSIONS:** Despite improved microsurgical techniques and antiepileptic drug prophylaxis, a significant proportion of patients undergoing aneurysm clipping still experience seizures. Seizures may occur years after aneurysm repair, and careful monitoring for late complications remains important. Furthermore, routine perioperative AED use does not seem to prevent seizures after SAH.

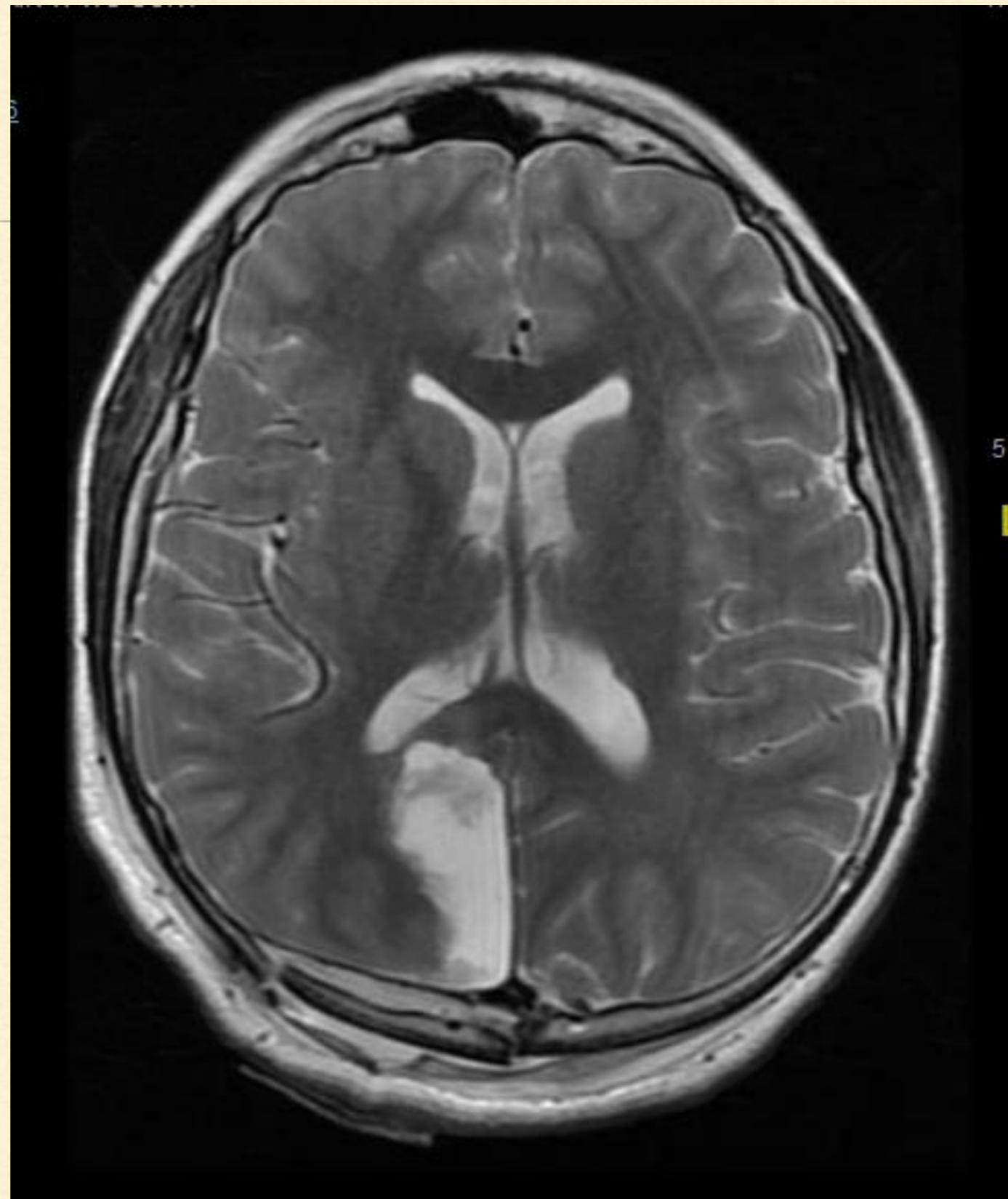
# CASES



# BRAIN TUMORS

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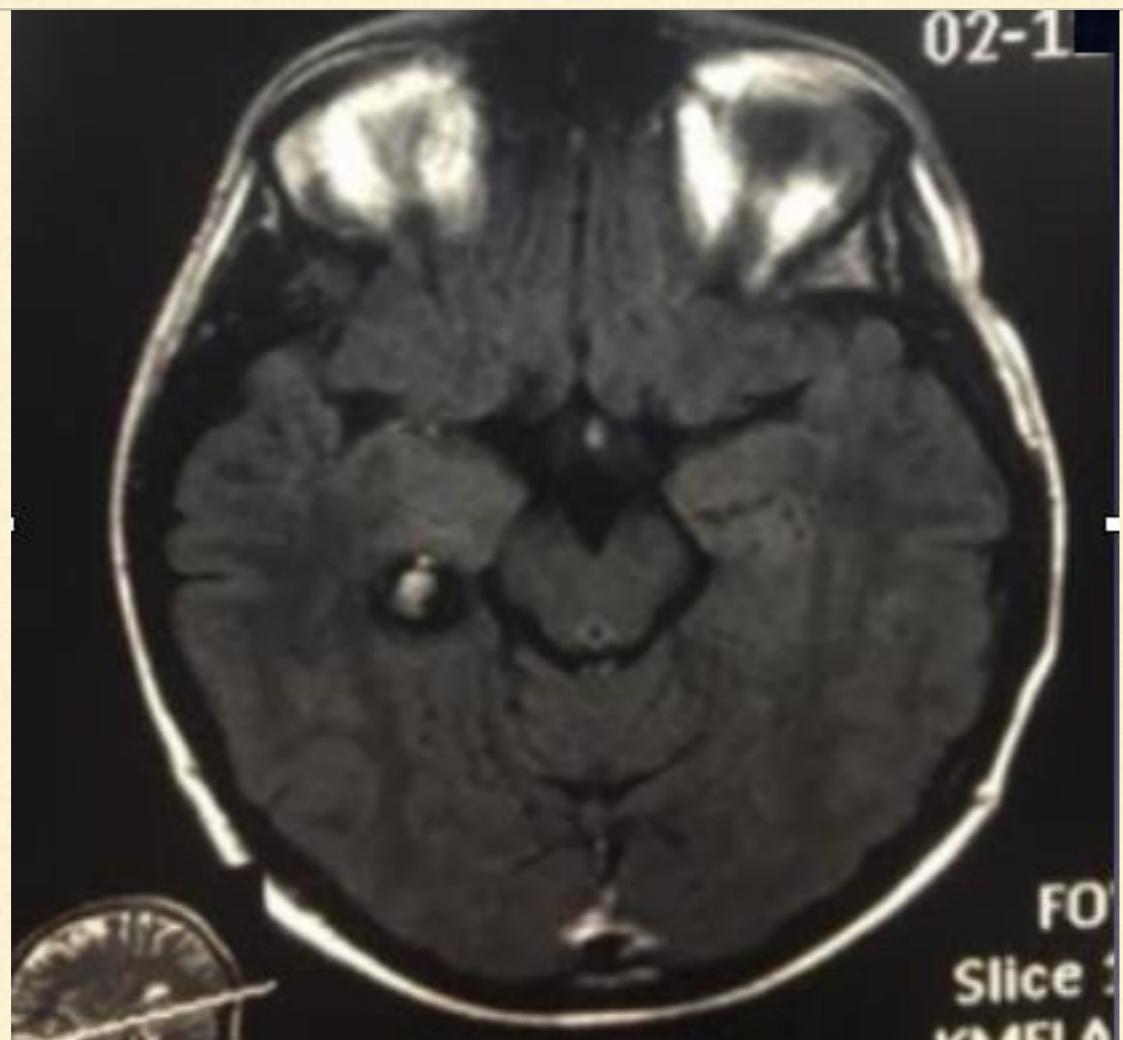


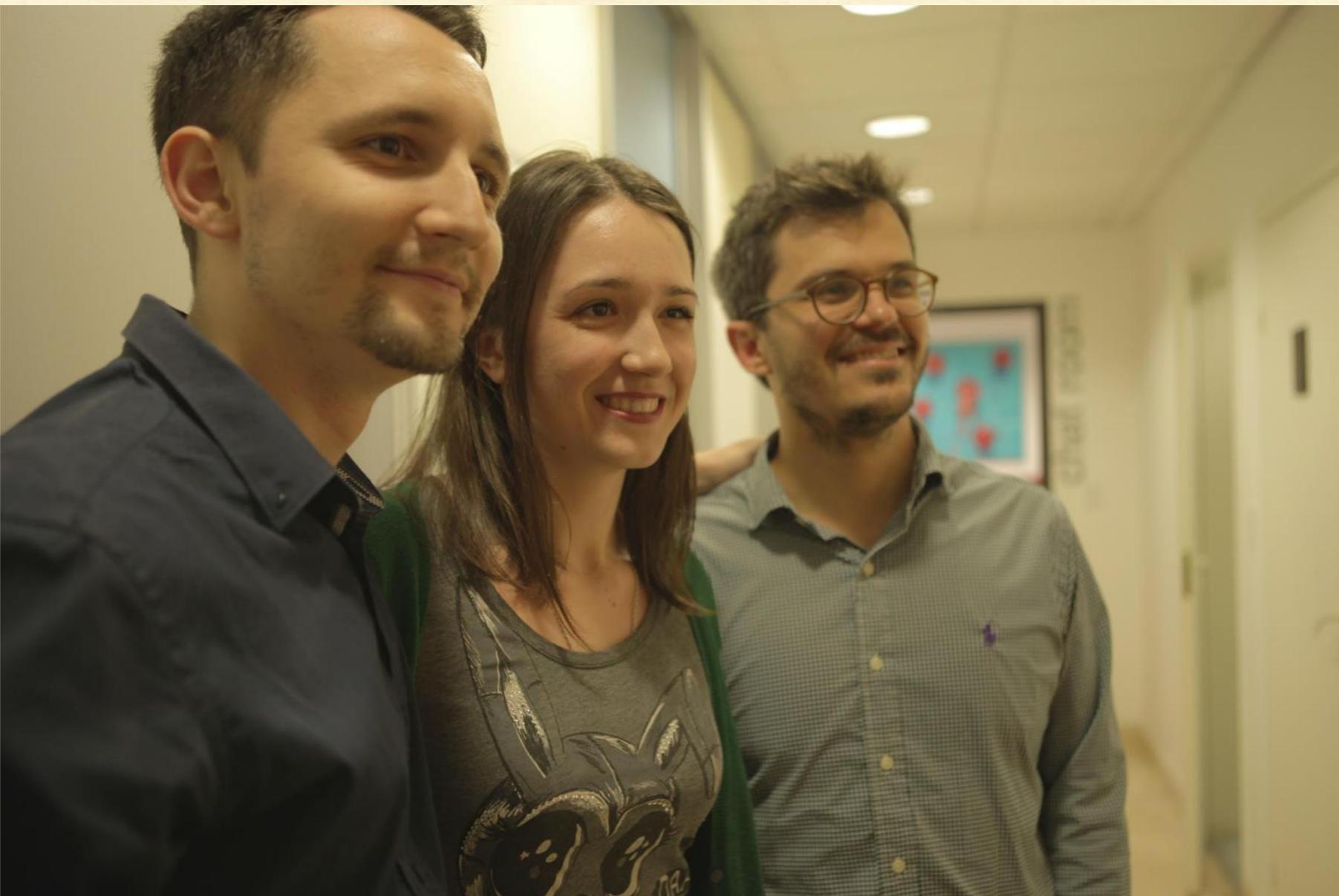


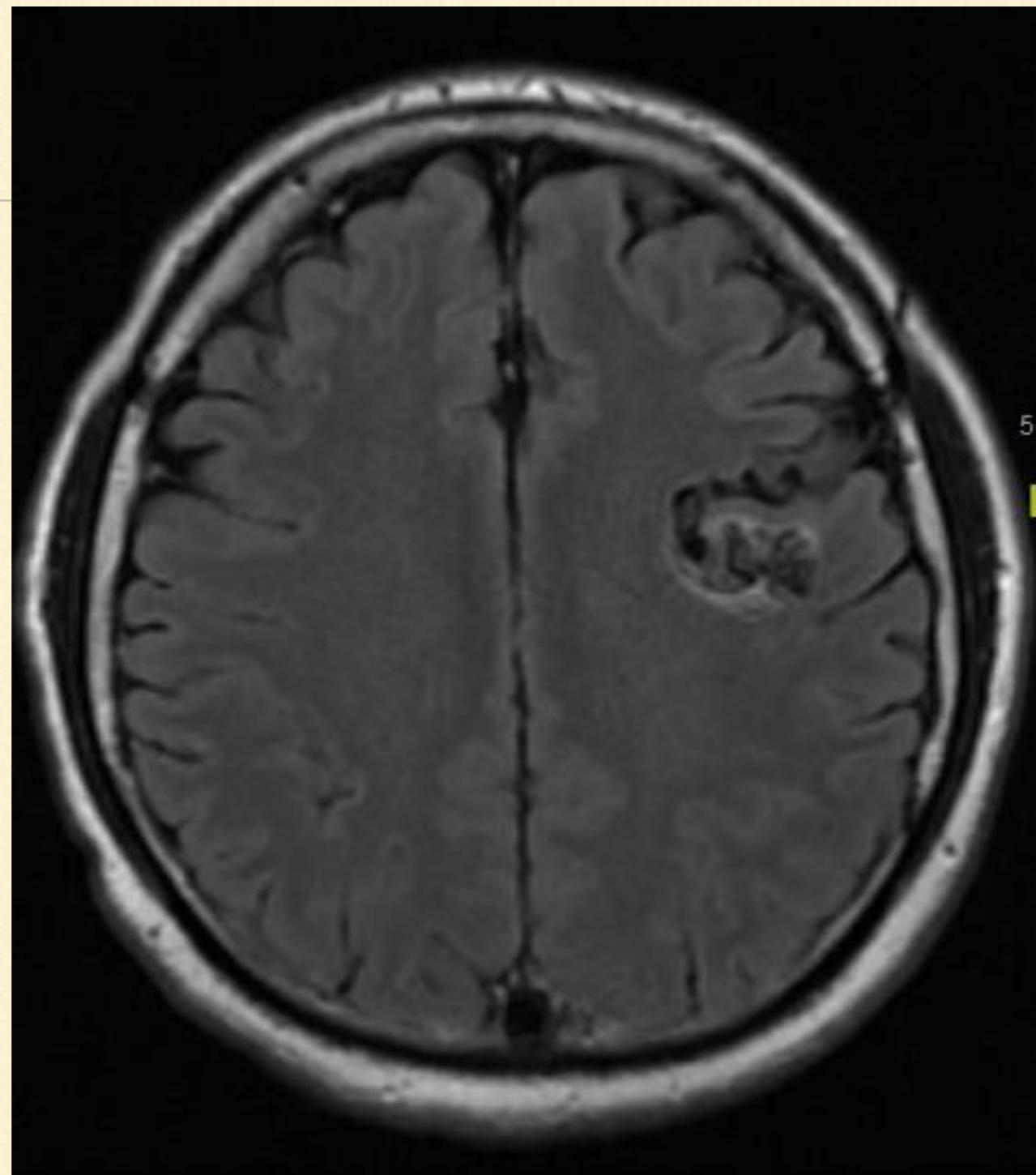
## Epilepsy surgery for pediatric low-grade gliomas of the cerebral hemispheres: neurosurgical considerations and outcomes

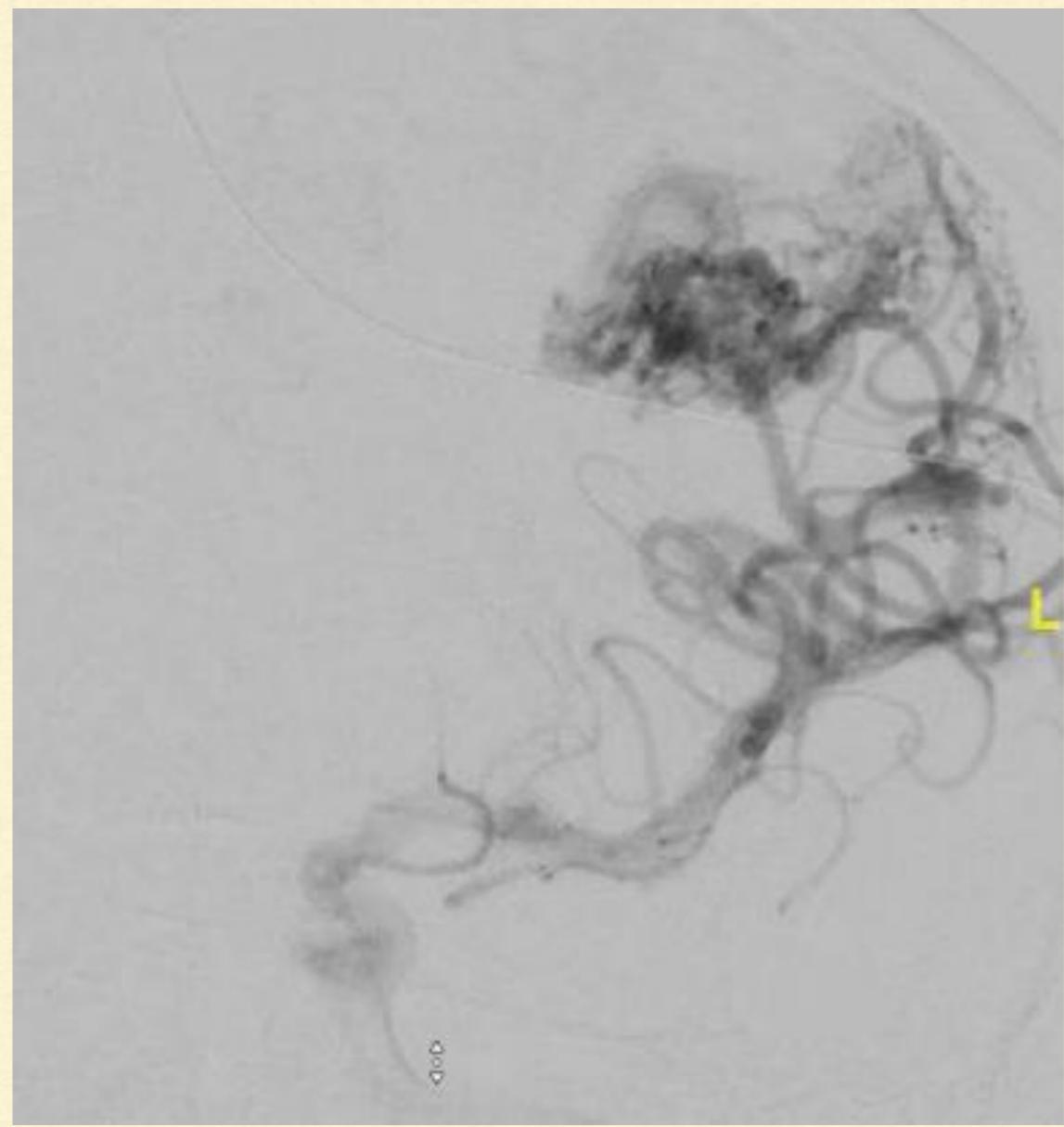
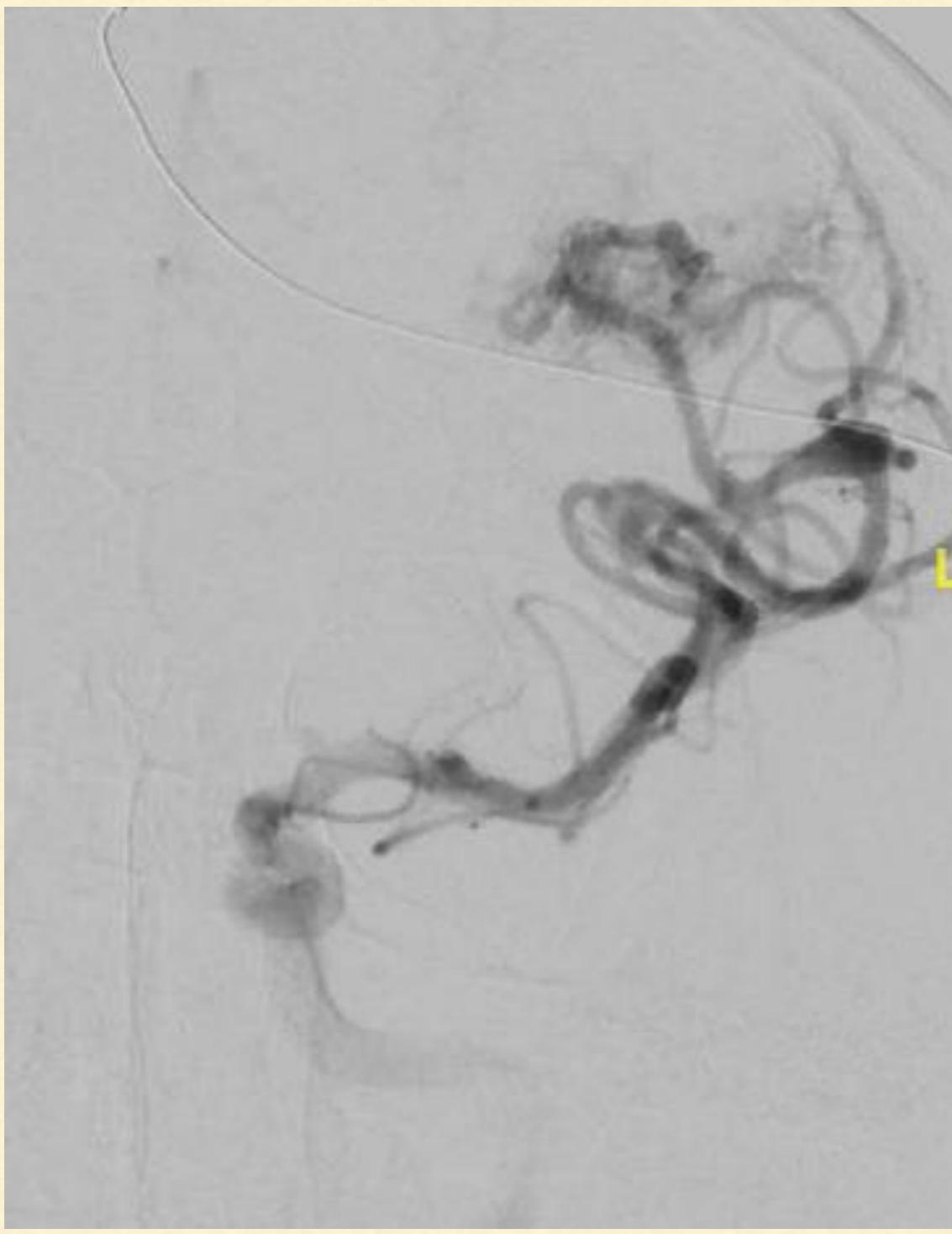
Matthew T. Brown<sup>1</sup> · Frederick A. Boop<sup>1,2</sup>

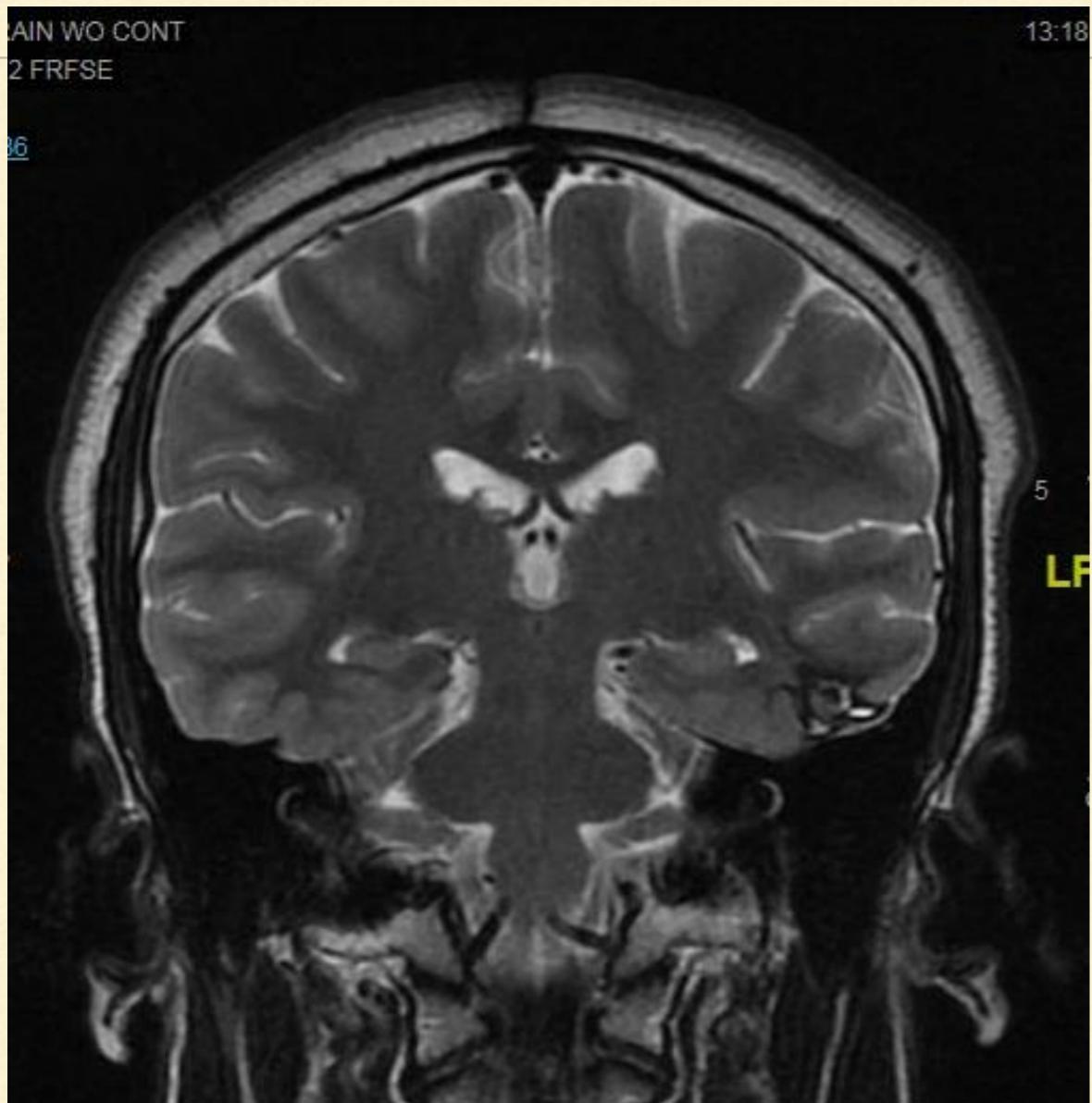
- 1-3% of children with epilepsy have an associated tumor on MRI; very often, these are focal seizures that are medically refractory
- Typically these are low grade tumors (e.g. LGG, DNET, ganglioglioma) and epileptic considerations may outweigh oncological considerations
- 80-90% of patients with tumor and epilepsy have good seizure outcomes with lesionectomy alone; fMRI/MEG/invasive monitoring may play a role in various situations (e.g. close to eloquent brain, surrounding T2 signal)
- temporal lobe tumors are more often associated with “dual-pathology”; some studies have shown that up to 50% of patients with DNET of temporal lobe may be associated with a second area of FCD or gliosis/sclerosis that if not resected may result in continuing seizures









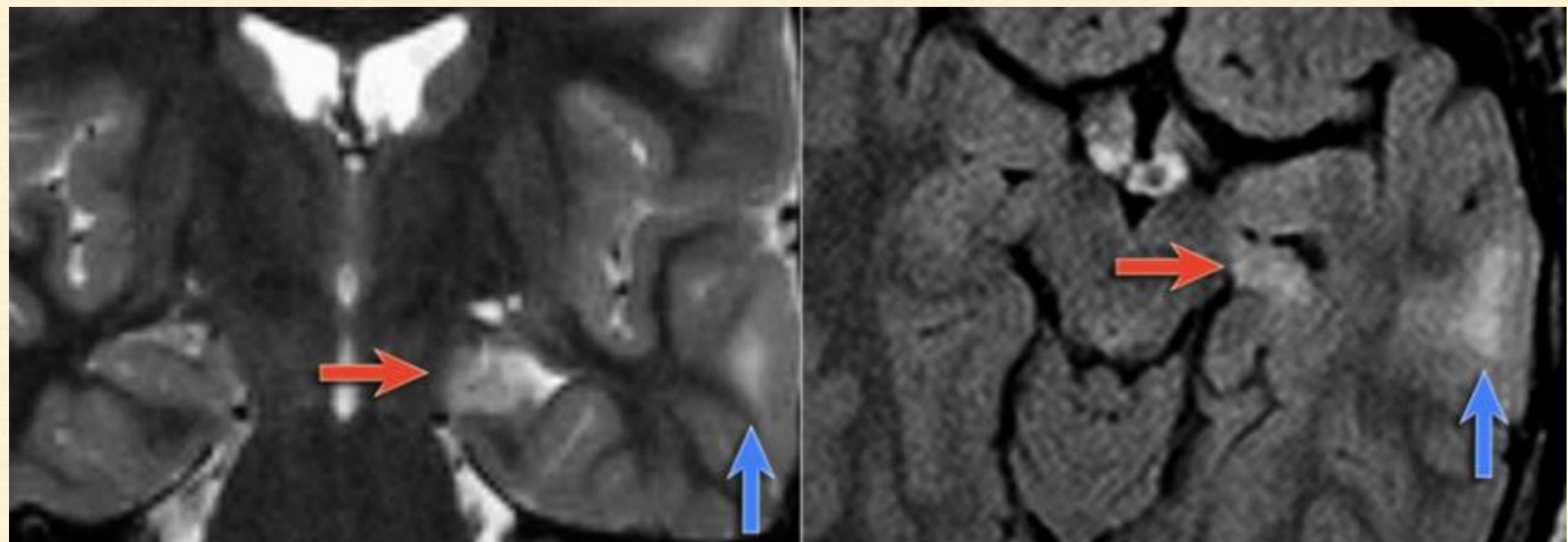


## Temporal lobe epilepsy due to hippocampal sclerosis in pediatric candidates for epilepsy surgery

A. Mohamed, E. Wyllie, P. Ruggieri, P. Kotagal, T. Babb, A. Hilbig, C. Wyllie, Z. Ying, S. Staugaitis, I. Najm, J. Bulacio, N. Foldvary, H. Lüders and W. Bingaman

First published June 26, 2001, DOI: <https://doi.org/10.1212/WNL.56.12.1643>

studied with FLAIR images. On histopathology, there was an unexpectedly high frequency of dual pathology with mild to moderate cortical dysplasia as well as HS, seen in 79% of children and adolescents. Seventy-eight percent of patients were free of seizures at follow-up (mean, 2.6 years). A tendency for lower seizure-free outcome was observed in patients with bilateral temporal interictal sharp waves or bilateral HS on MRI. The presence of dual pathology did not portend poor postsurgical outcome.



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# What if there's no lesion?

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FDG-PET

Ictal SPECT

MEG/MSI

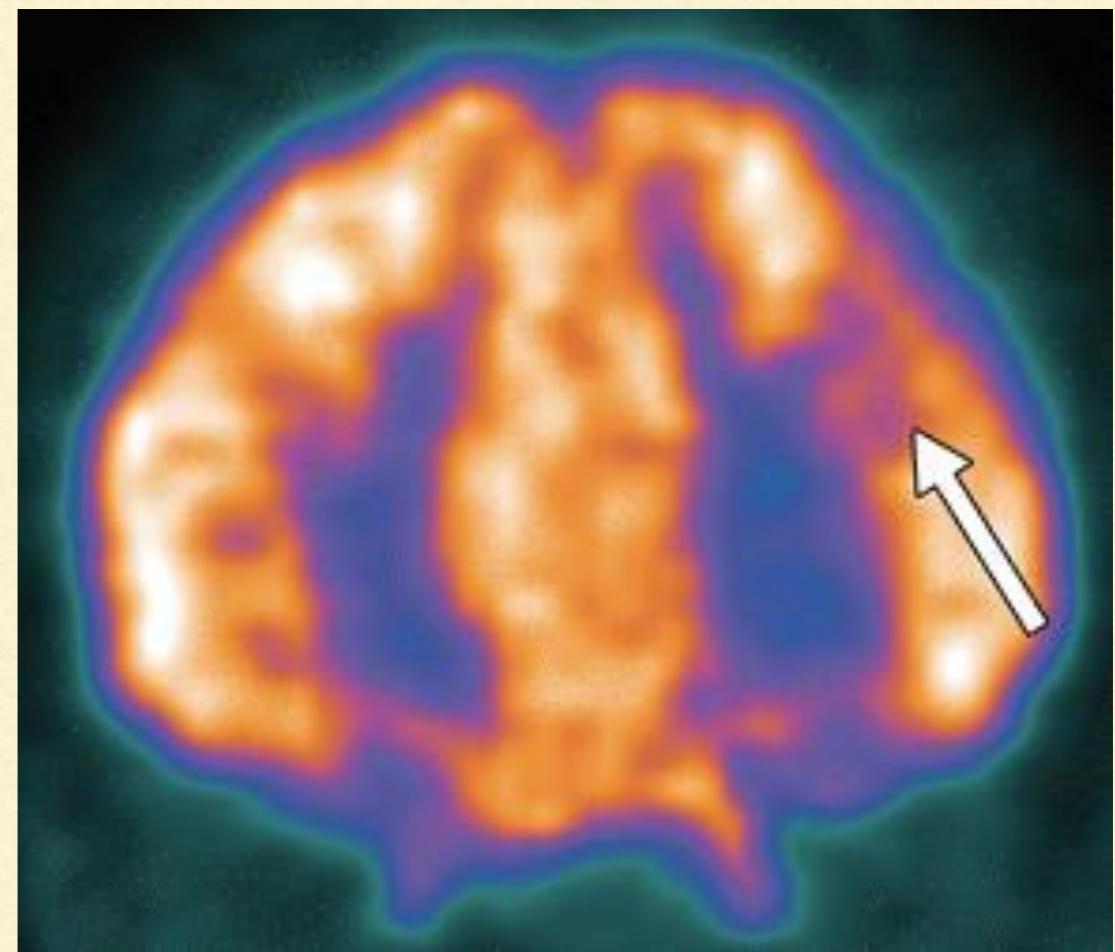
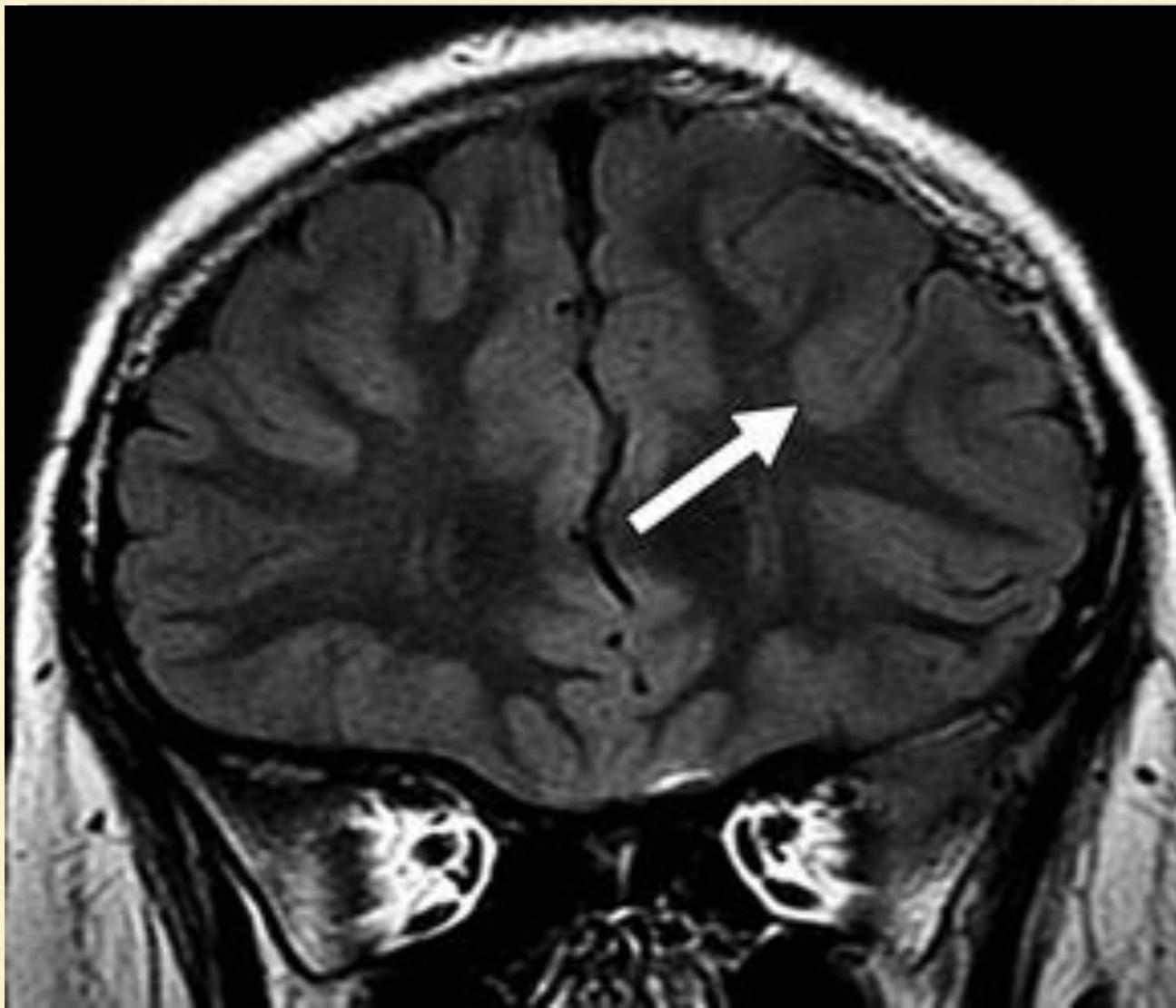
fMRI

Wada

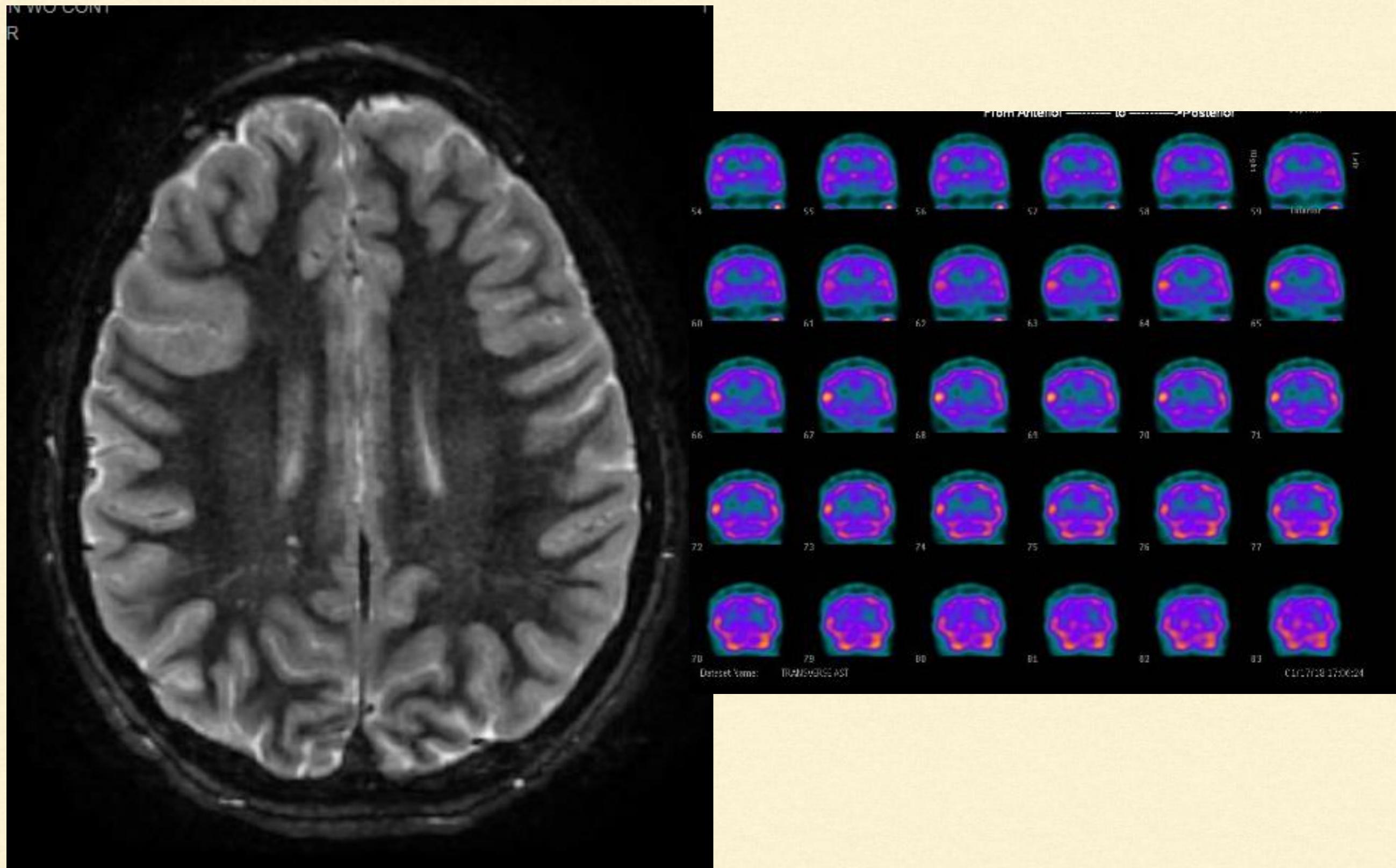
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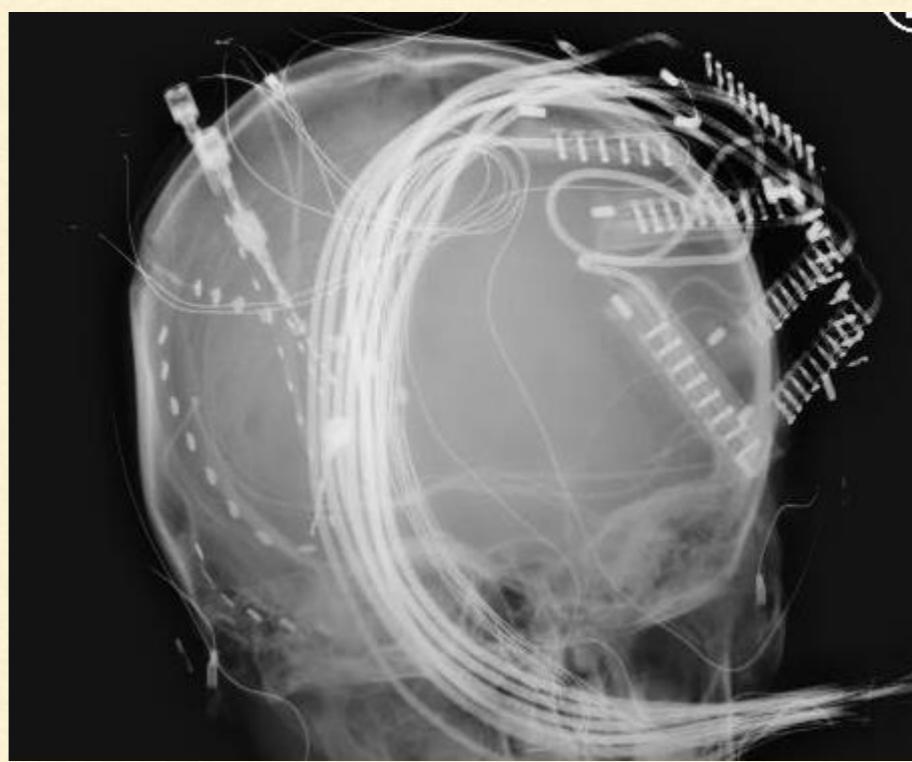
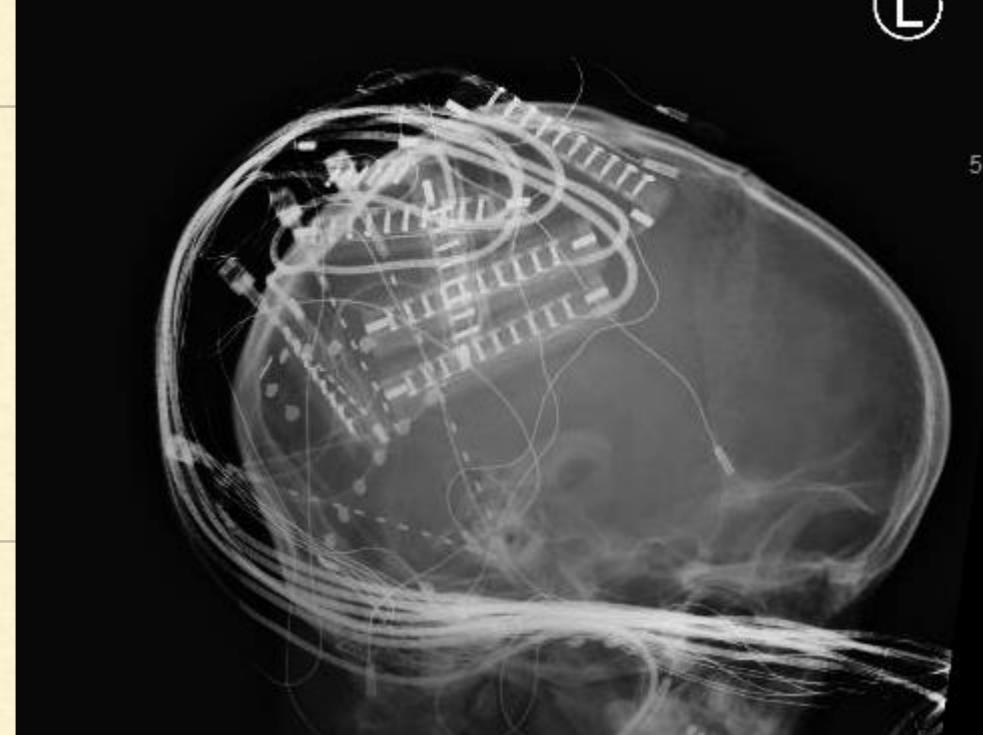
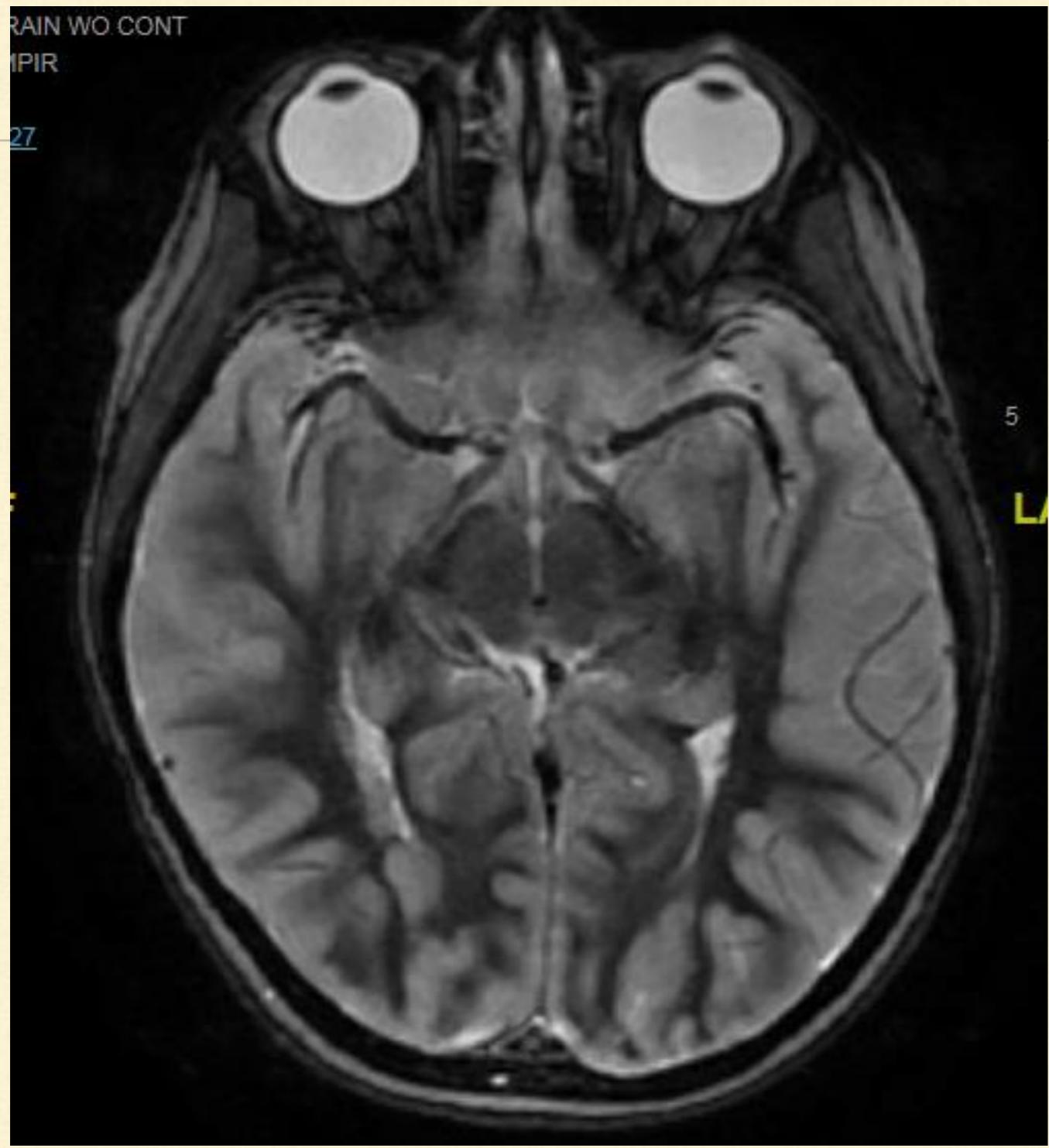
# PET SCAN

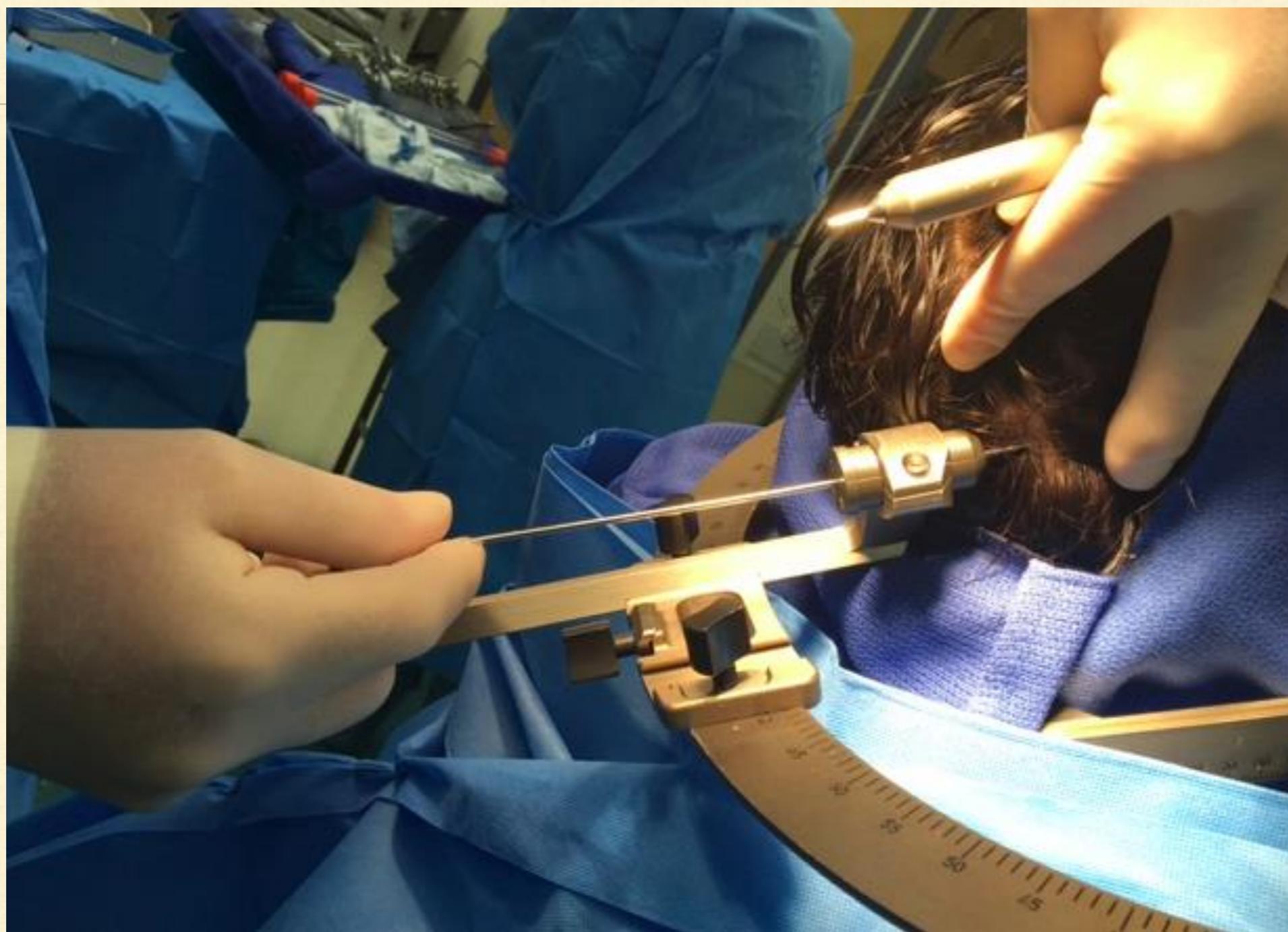
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# SPECT





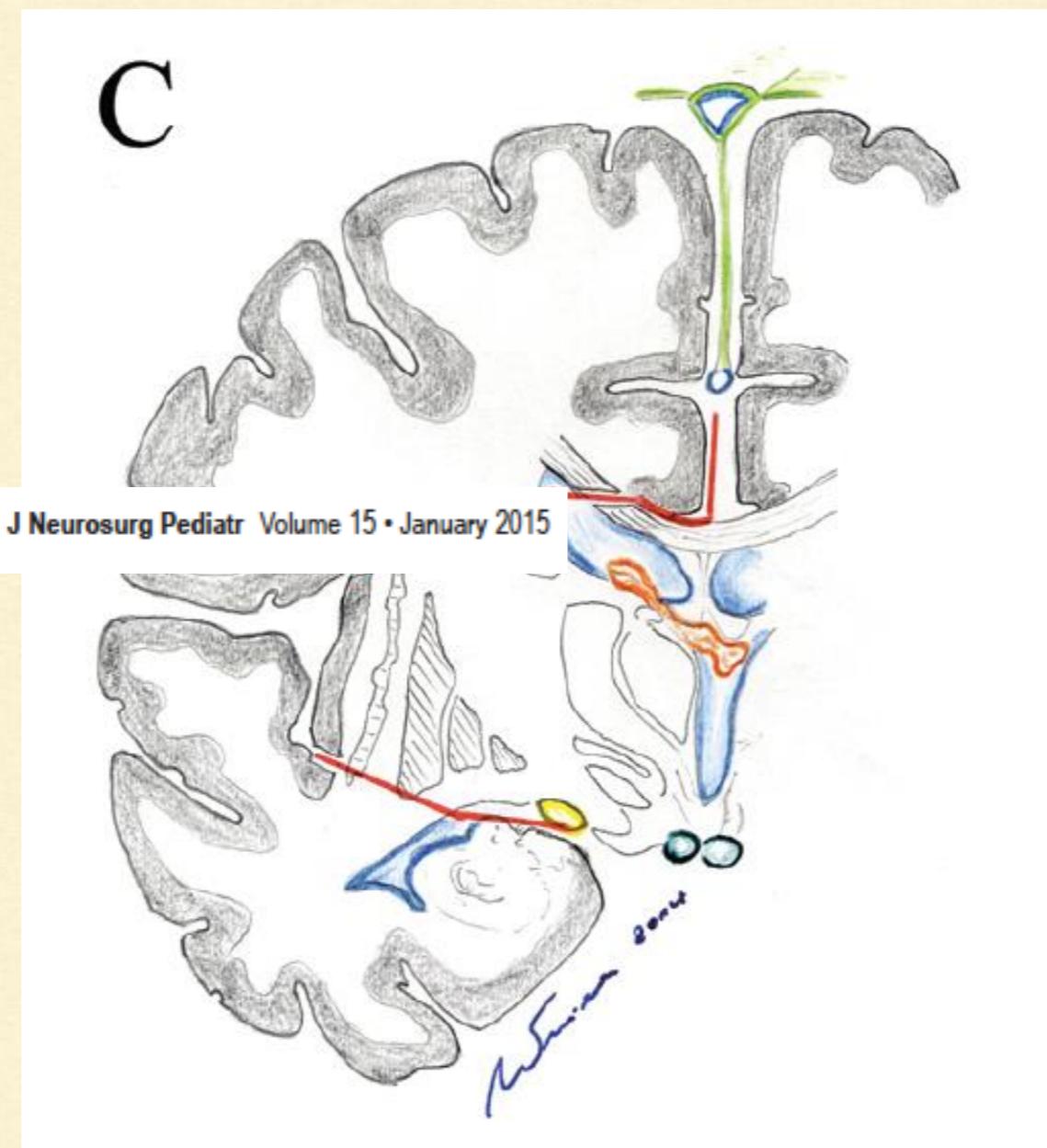


# HEMISPHERIC SYNDROMES

---

- . conditions characterized by diffuse damage to a single hemisphere resulting in treatment refractory epilepsy
    - . acquired: **peri-natal stroke**
    - . developmental: hemimegacephaly
    - . progressive: **Rasmussen's encephalitis**, Sturge Weber syndrome
  - . anatomic hemispherectomy done throughout the 1950s and 1960s was associated with a high complication rate including hydrocephalus and superficial cerebral hemosiderosis
  - . functional disconnection of the epileptogenic cortex of one hemisphere from deeper brain structures and the contralateral hemisphere
-

# PERISYLVIAN FUNCTIONAL HEMISPHEROTOMY

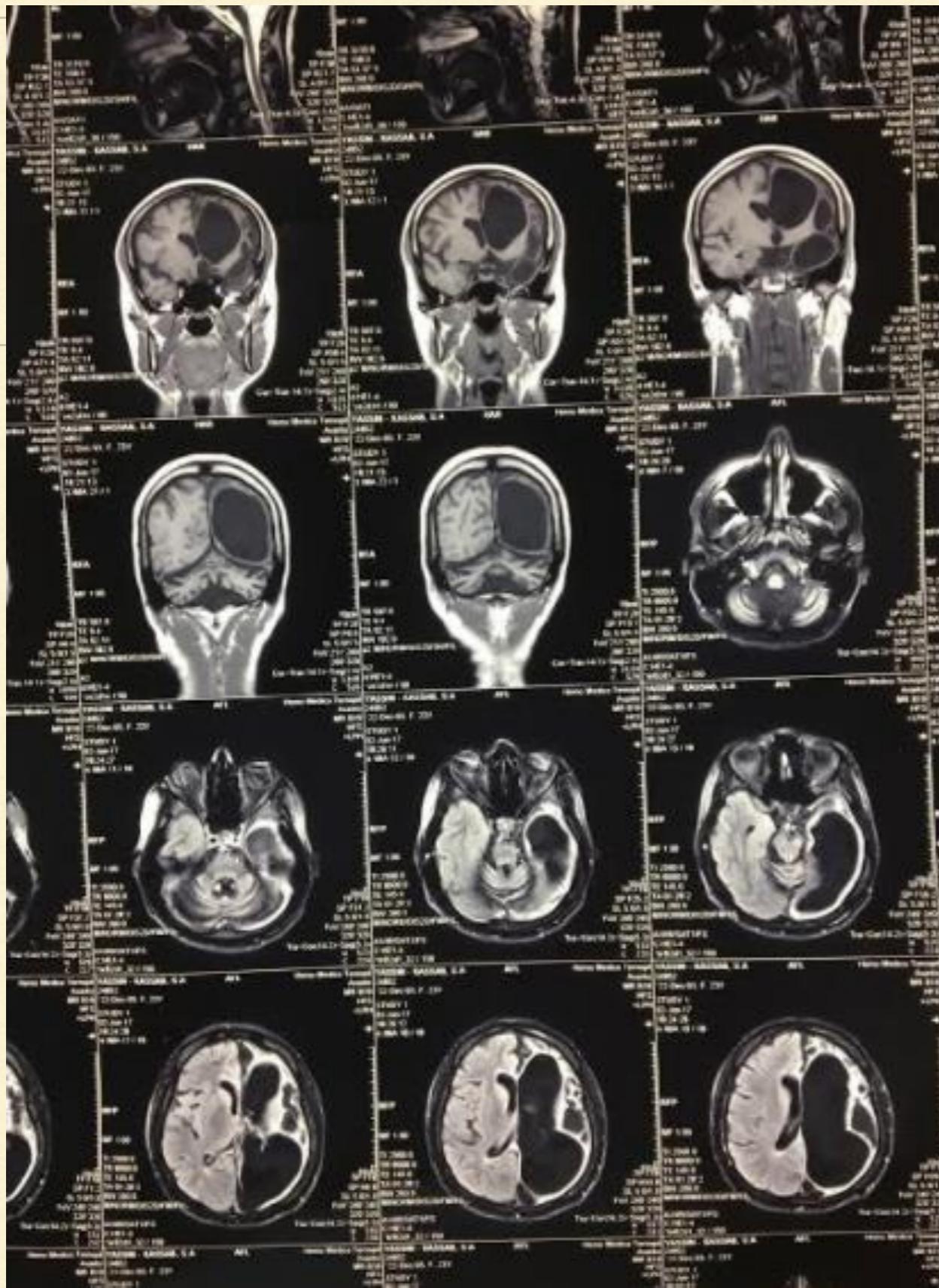


## Hemispherectomy for treatment of refractory epilepsy in the pediatric age group: a systematic review

Christoph J. Griessenauer, MD,<sup>1</sup> Smeer Salam, MD,<sup>1</sup> Philipp Hendrix, MD,<sup>2</sup> Daxa M. Patel, MD,<sup>1</sup> R. Shane Tubbs, MS, PA-C, PhD,<sup>1</sup> Jeffrey P. Blount, MD,<sup>1</sup> and Peter A. Winkler, MD, PhD<sup>3</sup>

<sup>1</sup>Division of Pediatric Neurosurgery, Department of Neurosurgery, University of Alabama at Birmingham, Alabama; <sup>2</sup>Department of Neurosurgery, Saarland University Hospital, Homburg/Saar, Germany; and <sup>3</sup>Department of Neurosurgery, Paracelsus Medical University, Salzburg, Austria

- 29 studies in children (<20y) undergoing hemispherectomy were reviewed, including 1161 total patients
- 73.4% rate of seizure freedom at 1 year follow-up; patients with acquired and progressive variants of hemispheric pathology had better seizures outcomes than those with “developmental” pathologies
- 14% rate of shunt dependent hydrocephalus
- 1.3% rate of mortality assessed at 30 day postoperatively



•••• Sprint LTE

8:09 PM

\* 19%

< 8,395 ^ v

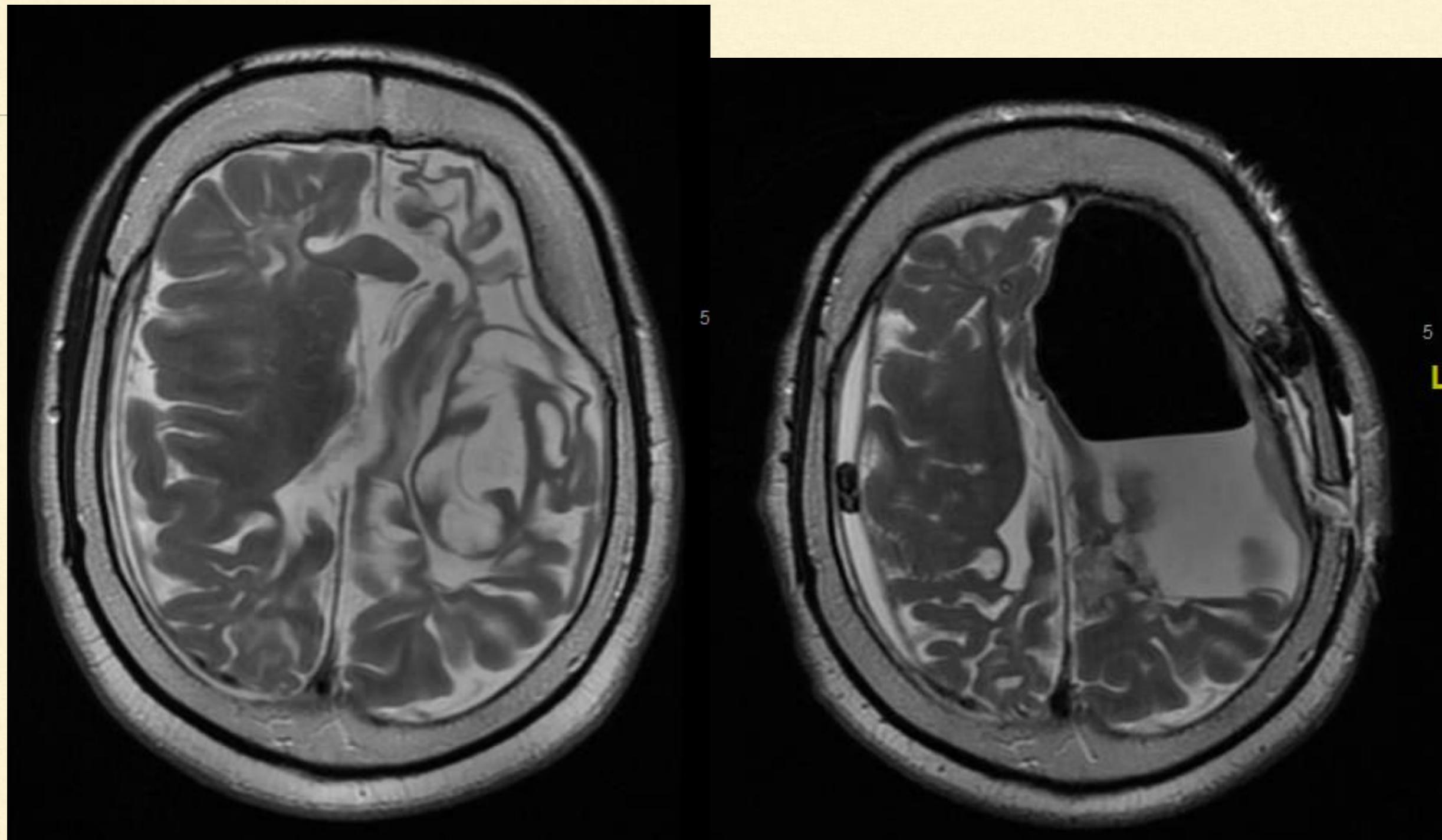
## Gratitude from Samira's mother

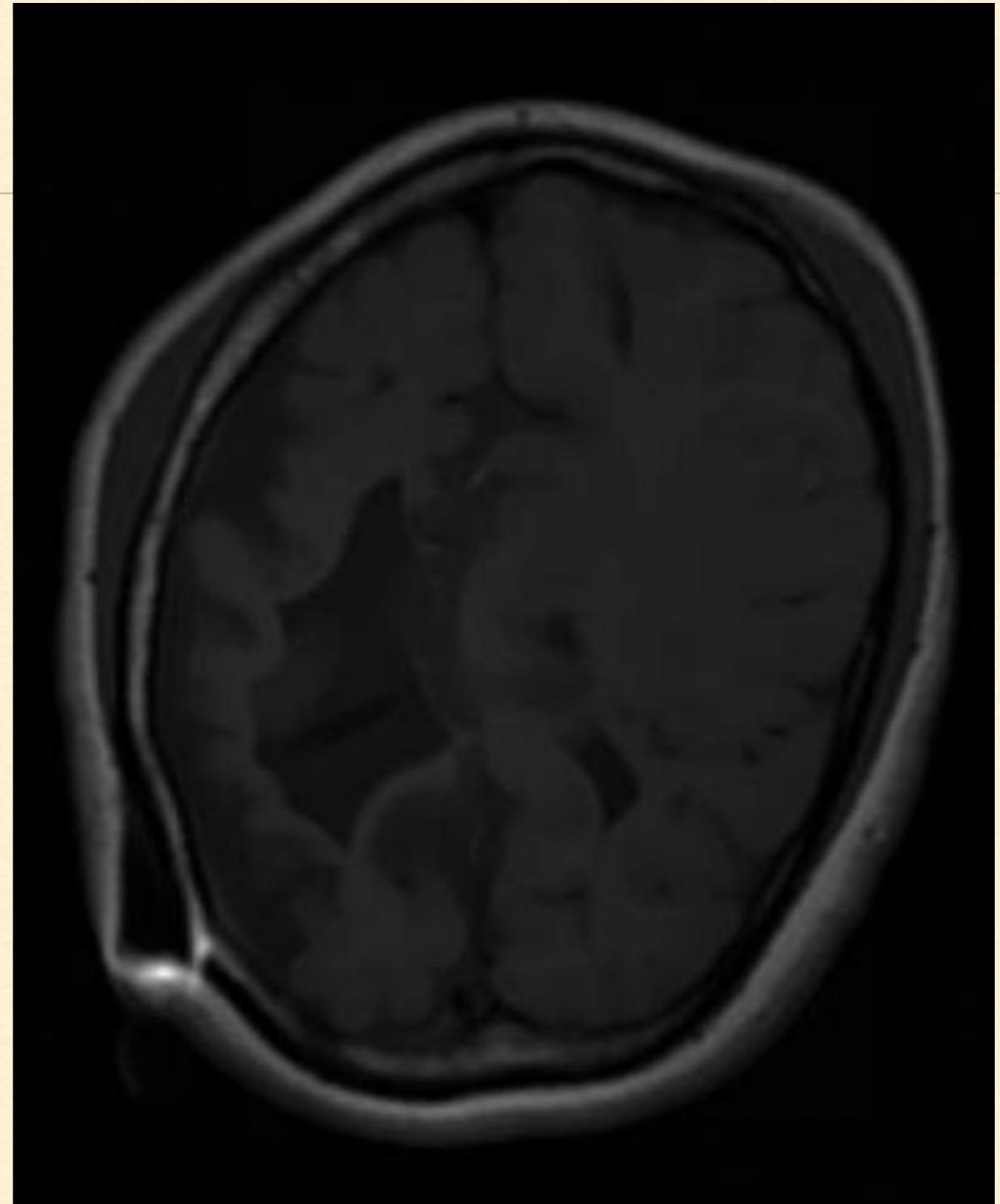
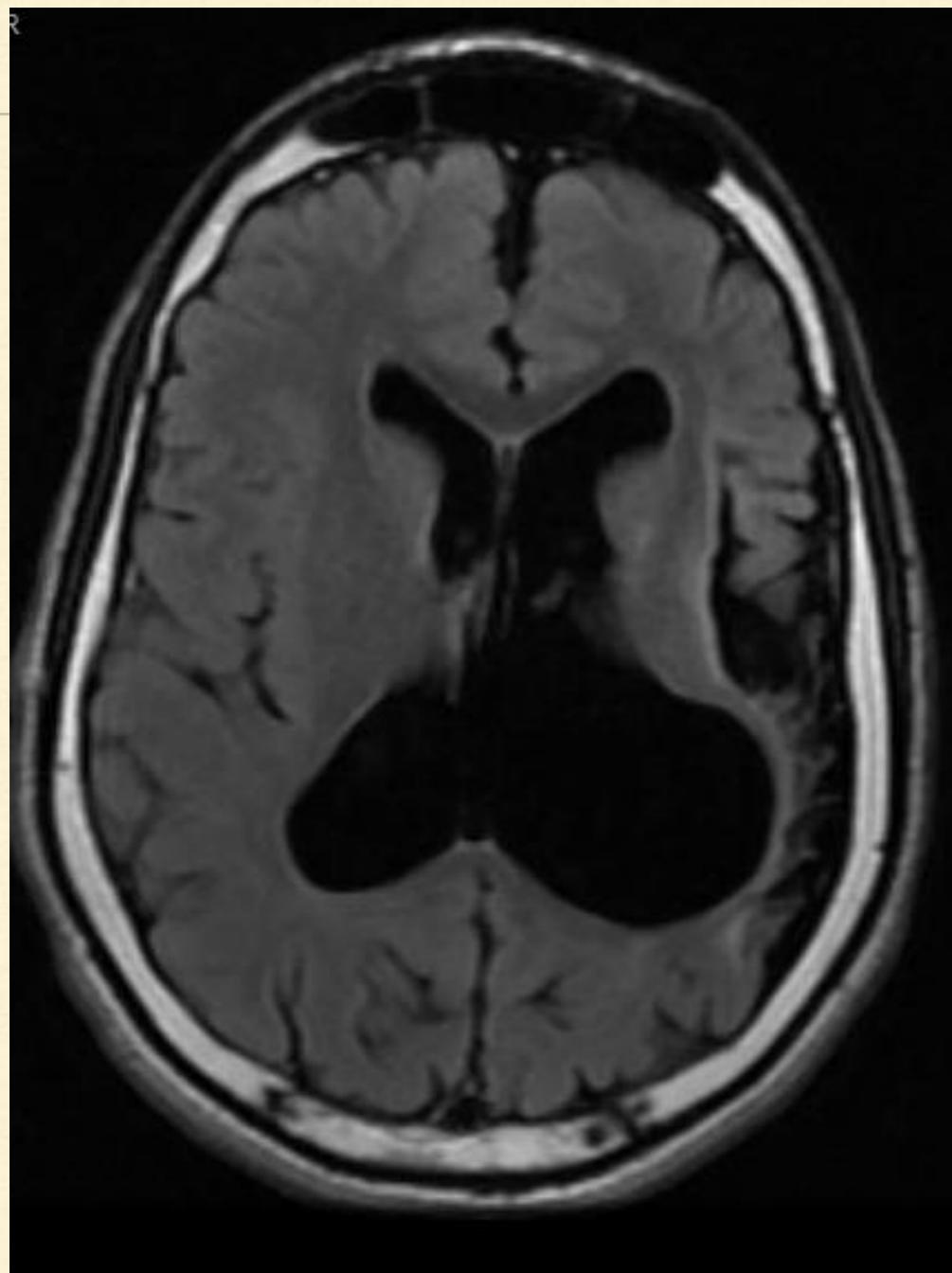
September 4, 2017 at 2:23 PM

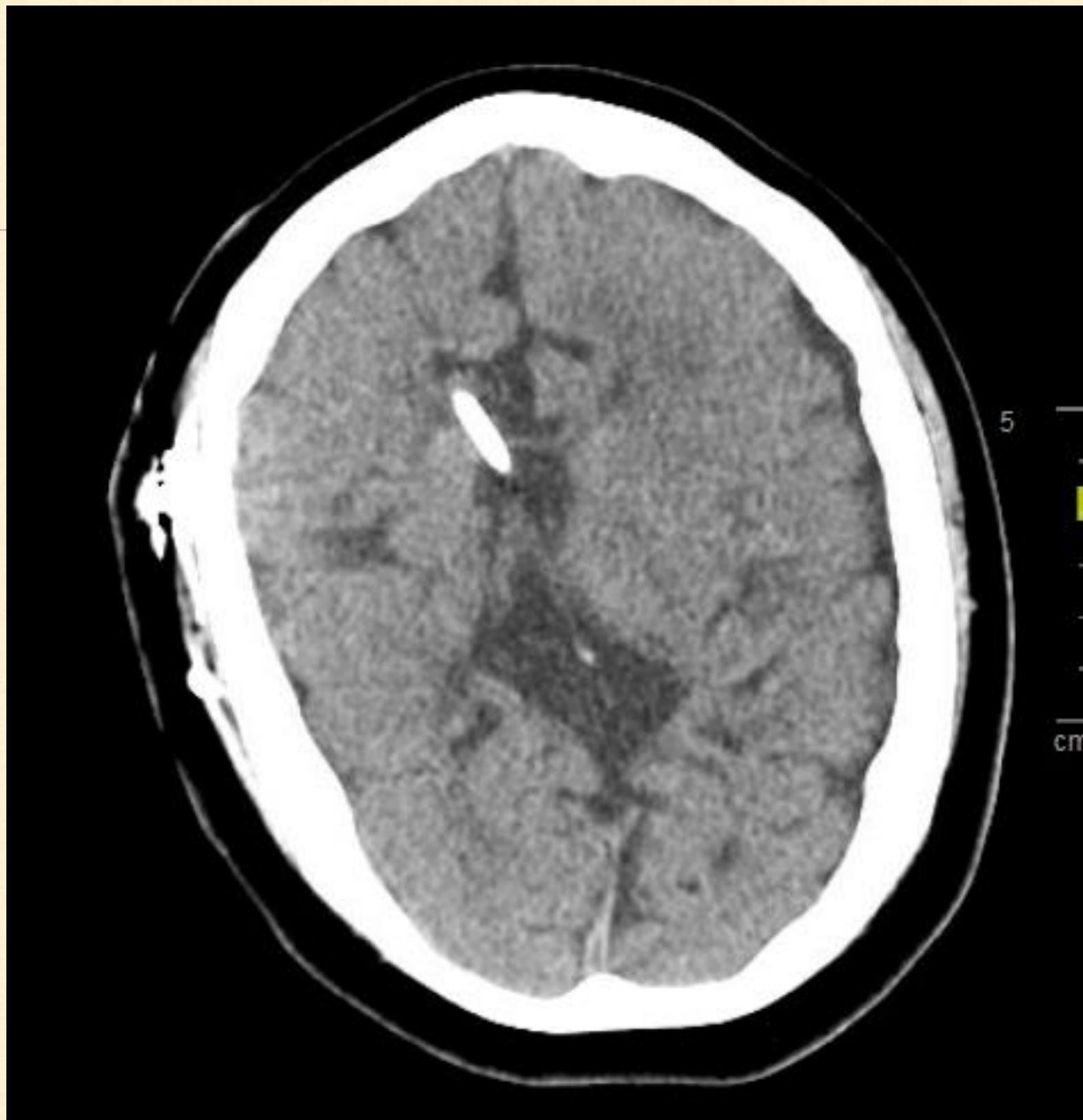
Found in Gmail All Mail Mailbox

Добрий день Люк! Ось пройшло більше місяця з дня операції.Хочу написати про стан Саміри за цей час. Дня через 3 ,4 після операції Саміра вночі не могла спати,її будили судоми,при тому що в свідомості судом не було. Судом не має і зараз,та все ж вночі є не сильні посмикування правої сторони які її ще пробуджують.Та навіть коли вона пробує поспати вдень,то також є короткі судоми від яких вона пробуджується. По зовнішньому вигляді,то ще залишилася припухлість лівої сторони на скроні. Знаєте Саміра зовсім інша. Більше стала розуміти.Запитань і запитань! Читає та старається розуміти прочитане. К.Р.Костюк призначив нам на місяць лікування ,якого ми дотримуємося та запросив десь у грудні на обстеження.Ще раз дякую за Вашу працю і за Вашу не байдужість!









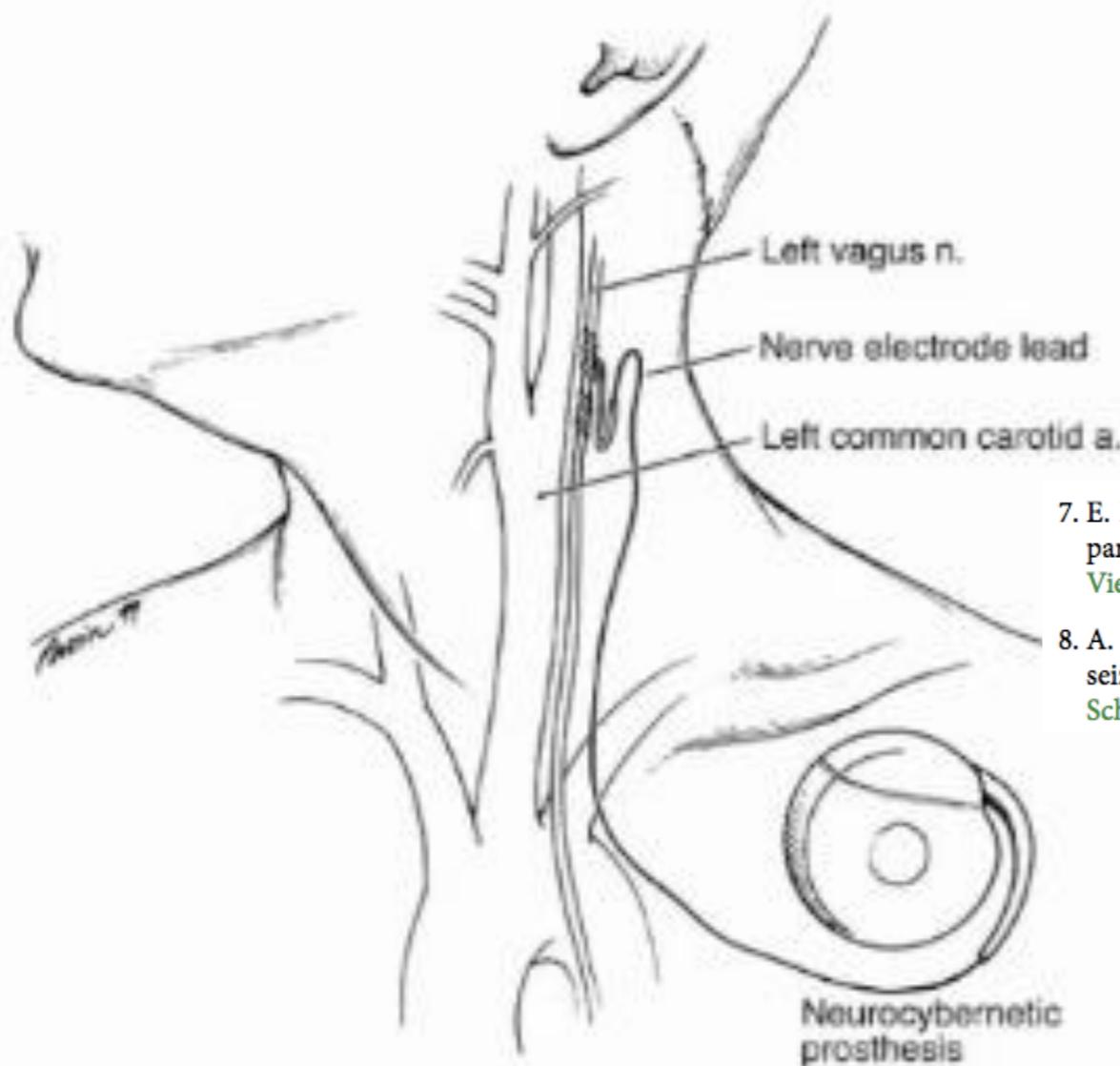
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IF THE PATIENT IS NOT CANDIDATE FOR FOCAL RESECTION ....

---

- **GOAL #1: RESECTION OF EZ FOR CURE**
  - corpus callosotomy
  - VNS
  - DBS??
  - RNS??
-

# VAGUS NERVE STIMULATION



7. E. Ben-Menachem, R. Manon-Espaillat, R. Ristanovic et al., "Vagus nerve stimulation for treatment of partial seizures: 1. A controlled study of effect on seizures," *Epilepsia*, vol. 35, no. 3, pp. 616–626, 1994. [View at Publisher](#) · [View at Google Scholar](#) · [View at Scopus](#)
8. A. Handforth, C. M. DeGiorgio, S. C. Schachter et al., "Vagus nerve stimulation therapy for partial-onset seizures: a randomized active-control trial," *Neurology*, vol. 51, no. 1, pp. 48–55, 1998. [View at Google Scholar](#) · [View at Scopus](#)

# DRAVET SYNDROME

[J Child Neurol.](#) 2017 Apr;32(5):494-498. doi: 10.1177/0883073816687221. Epub 2017 Jan 12.

## **Vagus Nerve Stimulation in Intractable Epilepsy Associated With SCN1A Gene Abnormalities.**

[Fulton SP<sup>1</sup>](#), [Van Poppel K<sup>2</sup>](#), [McGregor AL<sup>1</sup>](#), [Mudigoudar B<sup>1</sup>](#), [Wheless JW<sup>1</sup>](#).

[Childs Nerv Syst.](#) 2016 Sep;32(9):1703-8. doi: 10.1007/s00381-016-3201-4. Epub 2016 Jul 27.

## **Palliative epilepsy surgery in Dravet syndrome-case series and review of the literature.**

[Dlouhy BJ<sup>1,2</sup>](#), [Miller B<sup>3,4</sup>](#), [Jeong A<sup>5</sup>](#), [Bertrand ME<sup>5</sup>](#), [Limbrick DD Jr<sup>3</sup>](#), [Smyth MD<sup>3</sup>](#).

[Eur Neurol.](#) 2014;71(1-2):65-74. doi: 10.1159/000353979. Epub 2013 Dec 5.

## **Combination of corpus callosotomy and vagus nerve stimulation in the treatment of refractory epilepsy.**

[Guillamón E<sup>1</sup>](#), [Miró J](#), [Gutiérrez A](#), [Conde R](#), [Falip M](#), [Jaraba S](#), [Plans G](#), [Garcés M](#), [Villanueva V](#).

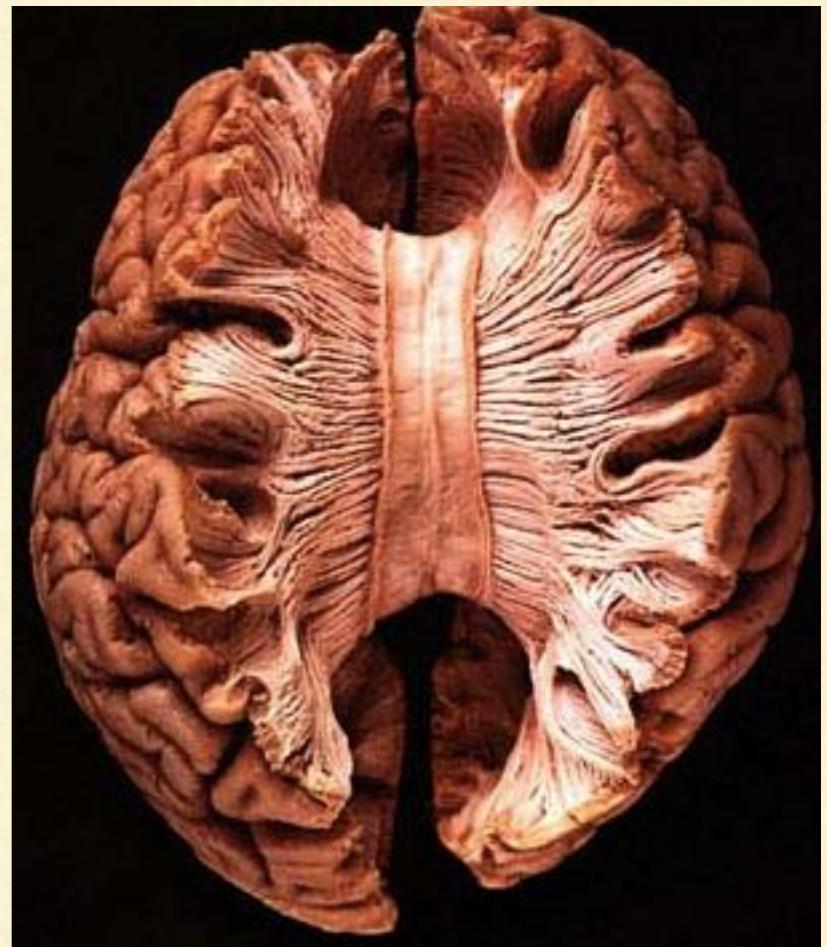
[J Neurol Sci.](#) 2017 Apr 15;375:146-149. doi: 10.1016/j.jns.2017.01.057. Epub 2017 Jan 21.

## **Use of social media to assess the effectiveness of vagal nerve stimulation in Dravet syndrome: A caregiver's perspective.**

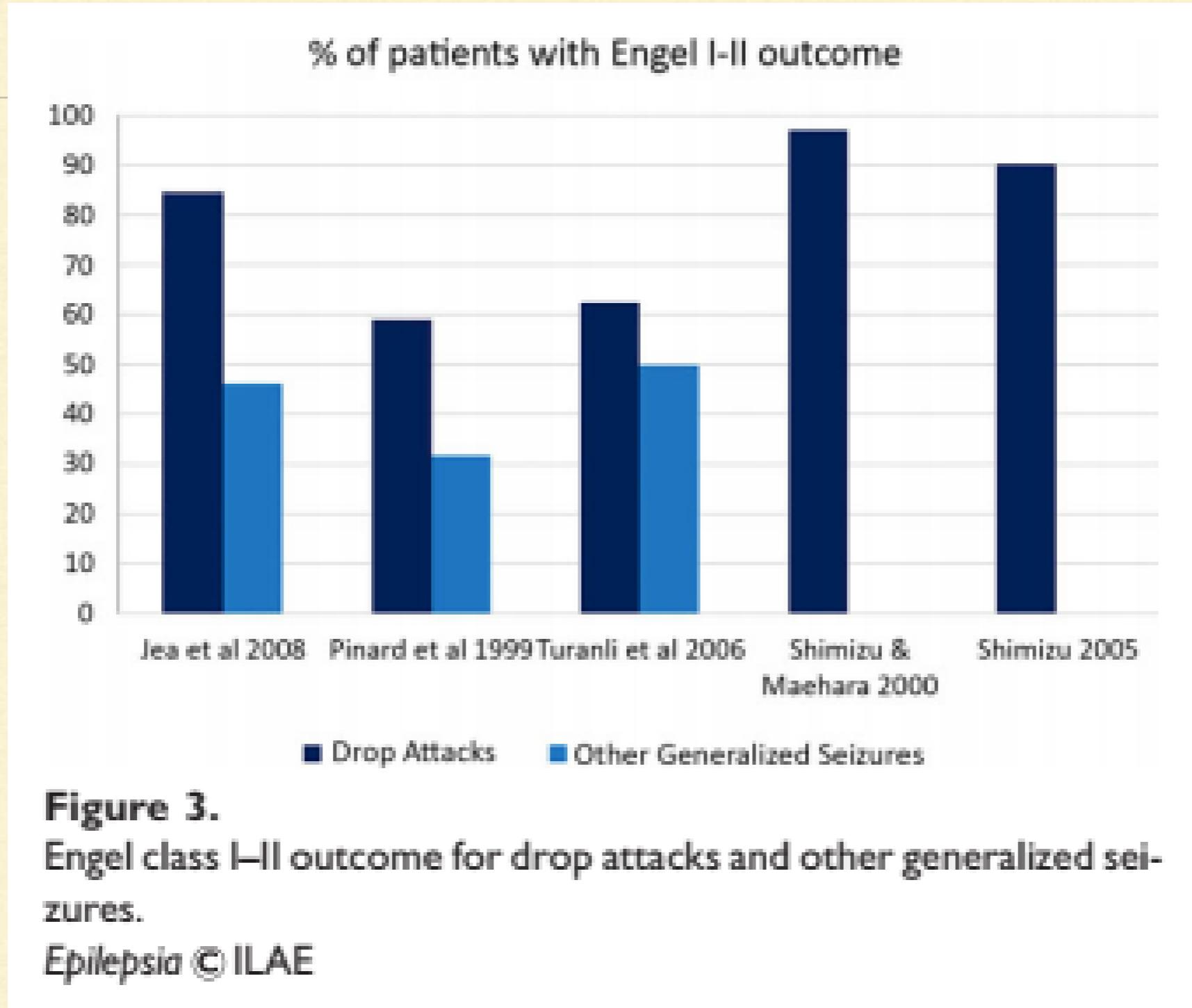
[Ali R<sup>1</sup>](#), [Elsayed M<sup>2</sup>](#), [Kaur M<sup>3</sup>](#), [Air E<sup>3</sup>](#), [Mahmood N<sup>4</sup>](#), [Constantinou J<sup>4</sup>](#), [Schwalb J<sup>3</sup>](#).

# CORPUS CALLOSOTOMY

- a palliative surgical option for patients with generalized or multifocal refractory epilepsy
- indications for this surgery are not rigorously standardized
- anterior 2/3 callosotomy does not afford as good seizure outcomes as total callosotomy but is also much less likely to result in postoperative “disconnection syndrome”



# CORPUS CALLOSOTOMY



# Complete remission of seizures after corpus callosotomy

## Clinical article

MASAKI IWASAKI, M.D.,<sup>1</sup> MITSUGU UEMATSU, M.D.,<sup>2</sup> YUKO SATO, M.D.,<sup>2</sup>  
TOJO NAKAYAMA, M.D.,<sup>2</sup> KAZUHIRO HAGINOYA, M.D.,<sup>3</sup> SHIN-ICHIRO OSAWA, M.D.,<sup>1</sup>  
HISASHI ITABASHI, M.D.,<sup>4</sup> KAZUTAKA JIN, M.D.,<sup>4</sup> NOBUKAZU NAKASATO, M.D.,<sup>4</sup>  
AND TEIJI TOMINAGA, M.D.<sup>1</sup>

*Departments of <sup>1</sup>Neurosurgery, <sup>2</sup>Pediatrics, and <sup>3</sup>Epileptology, Tohoku University Graduate School of Medicine; and <sup>4</sup>Division of Pediatric Neurology, Takuto Rehabilitation Center for Children, Sendai, Japan*

**Object.** Corpus callosotomy is usually intended to alleviate—not to achieve total control of—epileptic seizures. A few patients experience complete seizure control after callosotomy, but the associated clinical factors are unknown. The object of this study was to investigate clinical factors associated with long-term seizure remission after total corpus callosotomy in patients with infantile or early childhood onset epilepsy.

**Methods.** Thirteen consecutive patients with infantile or early childhood onset epilepsy underwent 1-stage total corpus callosotomy for alleviation of seizures. Their age at surgery ranged from 1 year and 5 months to 24 years (median 7 years). Eleven patients had West syndrome at the onset of disease, and the other 2 had Lennox-Gastaut syndrome. All patients suffered from spasms, axial tonic seizures, or atonic seizures. Six patients had proven etiology of epilepsy, including tuberous sclerosis, polymicrogyria, trauma, and Smith-Magenis syndrome. The association between postoperative seizure freedom and preoperative factors including age at surgery, no MRI abnormalities, proven etiology, and focal electroencephalographic epileptiform discharges was examined.

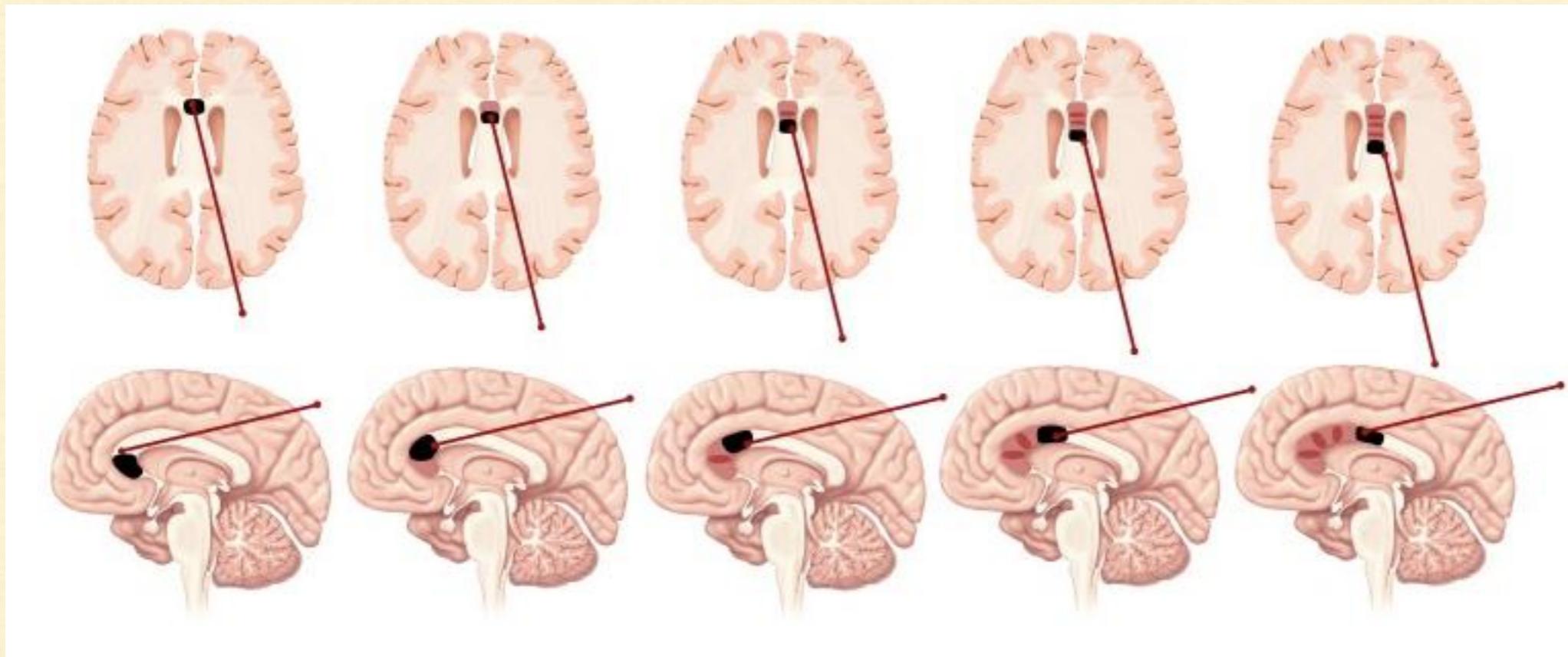
**Results.** Postoperative seizure freedom was achieved in 4 of 13 patients for a minimum of 12 months. All 4 patients had no MRI abnormalities and no identified etiology. None of the 8 patients with MRI abnormality, 6 patients with known etiology of epilepsy, or 4 patients aged older than 10 years at surgery achieved seizure freedom. Two of the 7 patients with focal electroencephalographic abnormalities became seizure free. Absence of MRI abnormalities was significantly associated with postoperative seizure freedom ( $p < 0.01$ ).

**Conclusions.** Complete seizure remission is achieved after total corpus callosotomy in a subgroup of patients with intractable epilepsy following West syndrome or Lennox-Gastaut syndrome. One-stage total corpus callosotomy at a young age may provide a higher rate of seizure freedom, especially for patients with no MRI abnormalities and no identified etiology of epilepsy.

(<http://thejns.org/doi/abs/10.3171/2012.3.PEDS11544>)

**KEY WORDS** • epilepsy surgery • West syndrome • corpus callosotomy •  
seizure outcome • pediatric epilepsy

# MRLITT DISCONNECTION



Cureus. 2017 Feb; 9(2): e1021.  
Published online 2017 Feb 10. doi: [10.7759/cureus.1021](https://doi.org/10.7759/cureus.1021)

## Brain-responsive neurostimulation in patients with medically intractable seizures arising from eloquent and other neocortical areas

<sup>1</sup>Barbara C. Jobst, <sup>2</sup>Ritu Kapur, <sup>3</sup>Gregory L. Barkley, <sup>4</sup>Carl W. Bazil, <sup>5</sup>Michel J. Berg, <sup>6</sup>Gregory K. Bergey, <sup>7</sup>Jane G. Boggs, <sup>8</sup>Sydney S. Cash, <sup>9</sup>Andrew J. Cole, <sup>10</sup>Michael S. Duchowny, <sup>10</sup>Robert B. Duckrow, <sup>11</sup>Jonathan C. Edwards, <sup>12</sup>Stephan Eisenschken, <sup>5</sup>A. James Fessler, <sup>13</sup>Nathan B. Fountain, <sup>14</sup>Eric B. Geller, <sup>15</sup>Alicia M. Goldman, <sup>16</sup>Robert R. Goodman, <sup>17</sup>Robert E. Gross, <sup>18</sup>Ryder P. Gwinn, <sup>19</sup>Christianne Heck, <sup>20</sup>Aamr A. Herekar, <sup>10</sup>Lawrence J. Hirsch, <sup>21</sup>David King-Stephens, <sup>22</sup>Douglas R. Labar, <sup>23</sup>W. R. Marsh, <sup>24</sup>Kimford J. Meador, <sup>9</sup>Ian Miller, <sup>15</sup>Eli M. Mizrahi, <sup>25</sup>Anthony M. Murro, <sup>26</sup>Dileep R. Nair, <sup>27</sup>Katherine H. Noe, <sup>28</sup>Piotr W. Olejniczak, <sup>25</sup>Yong D. Park, <sup>29</sup>Paul Rutecki, <sup>30</sup>Vicenta Salanova, <sup>31</sup>Raj D. Sheth, <sup>32</sup>Christopher Skidmore, <sup>33</sup>Michael C. Smith, <sup>34</sup>David C. Spencer, <sup>4</sup>Shraddha Srinivasan, <sup>35</sup>William Tatum, <sup>15</sup>Paul Van Ness, <sup>36</sup>David G. Vossler, <sup>35</sup>Robert E. Wharen Jr, <sup>23</sup>Gregory A. Worrell, <sup>15</sup>Daniel Yoshor, <sup>27</sup>Richard S. Zimmerman, <sup>2</sup>Tara L. Skarpas, and <sup>2,24</sup>Martha J. Morrell

*Epilepsia*, 58(6):1005–1014, 2017  
doi: 10.1111/epi.13739

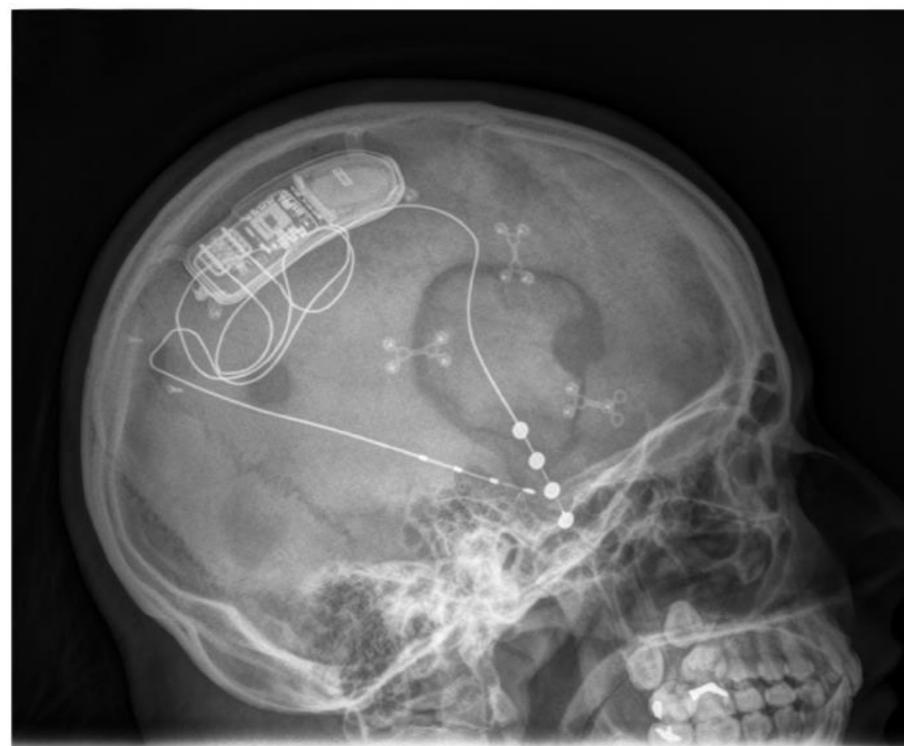


Figure 2 RNS stimulator with depth and surface electrodes.

Notes: Example of a patient with both neocortical surface electrodes and hippocampal depth electrodes.  
Abbreviation: RNS, responsive neurostimulator.



Open Access Full Text Article

## Critical review of the responsive neurostimulator system for epilepsy

This article was published in the following Dove Press journal:  
Medical Devices: Evidence and Research  
1 October 2015  
Number of times this article has been viewed

George P Thomas  
Barbara C Jobst

Dartmouth-Hitchcock Medical Center,  
Geisel School of Medicine, Dartmouth  
College, Lebanon, NH, USA

**Abstract:** Patients with medically refractory epilepsy have historically had few effective treatment options. Electrical brain stimulation for seizures has been studied for decades and ongoing technological refinements have made possible the development of an implantable electrical brain stimulator. The NeuroPace responsive neurostimulator was recently approved by the FDA for clinical use and the initial reports are encouraging. This device continually monitors brain activity and delivers an electric stimulus when abnormal activity is detected. Early reports of efficacy suggest that the device is well tolerated and offers a reduction in seizure frequency by approximately half at 2 years.

**Keywords:** medically refractory epilepsy, seizures, brain surgery, brain stimulation, neurostimulation

The initial trial of the NeuroPace RNS system that led to FDA approval was published by the RNS system in Epilepsy Study Group in 2011.<sup>57</sup> The double-blinded, randomised, placebo-controlled study involved 191 adults (mean age 34.9 years) who underwent intracranial placement of subdural depth electrodes covering one or two predetermined epileptogenic foci. After recovery from surgery for device implantation, patients were randomised to either stimulation or sham stimulation for 3 months, followed by an open-label period where all patients received stimulation. There was an initial reduction in seizure frequency in both groups; however, a sustained reduction of 37.9% was seen in patients randomised to stimulation compared with 17.3% of patients who underwent sham stimulation ( $p=0.012$ ).<sup>57</sup> Forty-six per cent of patients had a 50% reduction in mean seizure frequency with an improvement in secondary outcomes, which included health-related quality-of-life metrics.<sup>59,60</sup> Long-term reduction in seizure frequency was seen in nearly two-thirds of patients over a 5.5-year follow-up, again with improved quality-of-life metrics.<sup>61</sup>

# DBS - SANTE TRIAL

**Results:** The median percent seizure reduction from baseline at 1 year was 41%, and 69% at 5 years. The responder rate ( $\geq 50\%$  reduction in seizure frequency) at 1 year was 43%, and 68% at 5 years. In the 5 years of follow-up, 16% of subjects were seizure-free for at least 6 months. There were no reported unanticipated adverse device effects or symptomatic intracranial hemorrhages. The Liverpool Seizure Severity Scale and 31-item Quality of Life in Epilepsy measure showed statistically significant improvement over baseline by 1 year and at 5 years ( $p < 0.001$ ).

**Conclusion:** Long-term follow-up of ANT deep brain stimulation showed sustained efficacy and safety in a treatment-resistant population.

**Classification of evidence:** This long-term follow-up provides Class IV evidence that for patients with drug-resistant partial epilepsy, anterior thalamic stimulation is associated with a 69% reduction in seizure frequency and a 34% serious device-related adverse event rate at 5 years.

**Neurology® 2015;84:1017-1025**

# A SYSTEMIC RETICENCE TOWARD SURGICAL THERAPY

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- . About 15 years ago, the American Epilepsy Society (AES), the American Academy of Neurology (AAN), and the AANS put forth a joint statement recommending early surgical referral for any patient with medically refractory epilepsy
  - . Beyond seizure freedom, numerous studies document the improvement in cognition and QOL measures in pediatric patients undergoing resective surgery
  - . Despite this recommendation, a US population-based study showed no increase in epilepsy surgery from 1990 to 2008, and surgery continues to be profoundly under-utilized
  - . Average elapsed time between seizure onset and surgery is 17-23 years
  - . What explains the continued under-utilization of surgery?
-

# “A NATIONAL DISASTER”

An estimated 100 000–500 000 patients with DRE are surgical candidates in the USA annually, but <1% receive an operation for treatment of DRE.<sup>6 7</sup> In an effort to improve patient care and access/referral to epilepsy surgery and close the treatment gap, the American Academy of Neurology published a recommendation for surgery as the treatment of choice for certain patients with DRE.<sup>8</sup> This recommendation is a mandate for early patient referral and evaluation to minimise the adverse developmental and social effects of uncontrolled seizures.<sup>8</sup> Despite this, there have been no improvements in the time from diagnosis to surgical consultation for children with DRE.<sup>9 10</sup> An online tool to evaluate the appropriateness for a surgical evaluation in the setting of DRE for paediatric patients >12 years old incorporates data about seizure type, frequency, epilepsy duration, seizure severity, previous medication use, side effects to medication regimen and previous electrical (EEG) and structural (MRI) evaluation.<sup>11</sup>

The hesitation to refer patients for surgical evaluation in the context of DRE is multifactorial. The most commonly cited reasons are fear of surgical comorbidity, cost, hope that new pharmaceutical therapies will stop seizures in patients in whom multiple other medications have not and limited knowledge of minimally invasive surgical options.<sup>6 7</sup>

# Time to pediatric epilepsy surgery is related to disease severity and nonclinical factors

**Table 3** Times to referral and surgery (years) by race and insurance status (n = 389)<sup>a</sup>

	Private insurance		Medicaid/CCS		Log-rank p
	White (n = 275)	Hispanic (n = 35)	White (n = 32)	Hispanic (n = 47)	
<b>Time to surgery</b>					0.049
Mean (SD)	4.13 (3.69)	3.31 (2.93)	5.92 (4.04)	4.99 (3.93)	
Median (IQR)	2.75 (1.27-6.00)	2.72 (1.07-5.00)	5.83 (1.50-8.75)	4.65 (1.25-7.83)	
<b>Time to referral</b>					0.097
Mean (SD)	3.02 (3.28)	2.46 (2.67)	4.49 (3.79)	3.73 (3.74)	
Median (IQR)	1.80 (0.60-4.20)	1.40 (0.60-3.37)	4.50 (1.09-7.30)	2.10 (0.50-6.70)	

Abbreviations: CCS = California Children's Services; IQR = interquartile range.

<sup>a</sup>n = 389 based on total sample N = 430 minus missing data (n = 12; race/ethnicity, n = 2; and insurance type, n = 10) and those of other race/ethnicity (n = 29). Log-rank test was used to test significance with time to surgery and time to referral across all 4 categories.

Epilepsy surgery is recognized as a safe and effective treatment option for children with medically intractable epilepsies associated with structural lesions.<sup>1-8</sup> Timely referral may be important because preliminary evidence suggests that shorter intervals from epilepsy onset to surgery are associated with better short-term cognitive outcomes.<sup>9,10</sup> However, a substantial proportion of children do not receive surgery in a timely manner.<sup>11,12</sup> Furthermore, during testimony for the Institute of Medicine report on epilepsy, parents of children with epilepsy reported concern regarding delays in receipt of epilepsy specialty care, including surgery.<sup>13</sup>

# A SYSTEMIC RETICENCE

Despite the established effectiveness of surgery, referral rates for surgical evaluation continue to be low. In 2010, <750 individuals in Ontario (3.75% of the potential 20,000 surgical candidates) were assessed for candidacy [33]. The estimated wait-time from first seizure to surgery can be as long as 22 years [34–37]. Ontario is not unique for this “treatment gap,” which is reflective of the state of epilepsy care in Canada, North America, and much of the rest of the world [7]. The medical community’s skepticism toward surgery [38, 39] and variable definitions of MRE [39, 40] have contributed to these statistics. However, despite class I evidence in favor of early referral for surgical assessment, a change in practice has not been observed [41].

At least one-third of people with epilepsy are drug-resistant after 2 adequate trials of antiseizure medications.<sup>1</sup> Drug-resistant epilepsy accounts for 75% of the cost of epilepsy<sup>2</sup> and is associated with an increased risk of mortality,<sup>3</sup> cognitive decline,<sup>4</sup> and reduced quality of life.<sup>5</sup>

Two randomized controlled trials<sup>6,7</sup> and numerous observational studies<sup>8</sup> have demonstrated that epilepsy surgery is superior to medical management in temporal lobe epilepsy, and that early surgery is highly successful. Epilepsy surgery is cost-effective<sup>9</sup> and associated with improved social outcomes such as employment.<sup>10</sup> Even complex patients deemed ineligible for focal resection often receive significant benefit from palliative surgical procedures such as vagus nerve stimulation, corpus callosotomy, or deep brain stimulation.<sup>11</sup>

Epilepsy surgery remains underutilized,<sup>12</sup> and patients average nearly 20 years before being referred for a surgical evaluation.<sup>13</sup> Neurologists are often reluctant to consider epilepsy surgery in the early stages of disease,<sup>14</sup> have difficulties defining drug-resistant epilepsy,<sup>14</sup> may not be informed about the risks and benefits of epilepsy surgery, and may be poorly equipped to identify patients who are potential surgical candidates.<sup>15</sup>

# Neurologists' knowledge of and attitudes toward epilepsy surgery

## A national survey

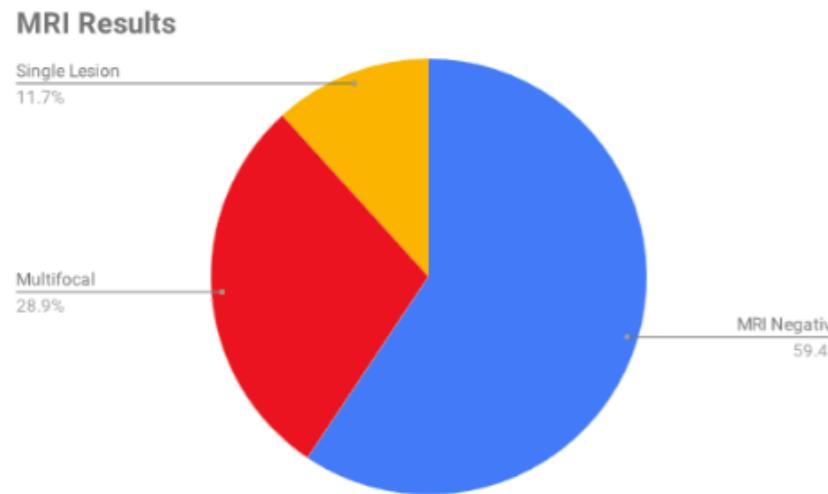
Jodie I. Roberts, BSc  
Chantelle Hrazdil, MD  
Samuel Wiebe, MD, MSc  
Khara Sauro, MSc  
Michelle Vautour, BN  
Natalie Wiebe  
Nathalie Jetté, MD, MSc

Overall, this study demonstrates that neurologists have substantial knowledge gaps regarding indications for epilepsy surgery. Only 43.4% of neurologists appropriately answered that anyone with ongoing seizures should be referred, and only 51.4% correctly identified that a patient only needs to fail 2 drugs to be considered drug-resistant. In addition, only 54.1% recognized the need to refer a patient as soon as they meet the definition of drug-resistant epilepsy. Although this is of grave concern, these findings are greatly improved in comparison to a recent survey of neurologists practicing in Michigan where only 3% of neurologists would refer a patient with yearly seizures.<sup>14</sup> In a separate study of Swedish neurologists, 68.1% of physicians responded that a high seizure frequency (>1/month) was “very important” in regard to eligibility for an epilepsy surgery assessment.<sup>20</sup> Recently, only 18% of Swedish<sup>20</sup> and 14% of Michigan (United States)<sup>14</sup> neurologists correctly identified that epilepsy surgery should be considered once 2 drugs have failed.<sup>21</sup> Despite the fact that our estimates are somewhat more promising than previous studies, it is clear that a substantial proportion of neurologists are not aware of recommended standards of practice for epilepsy surgery and drug-resistant epilepsy. As a result, we are concerned that epilepsy patients are not receiving adequate care.

# Identifying Factors in the Underutilization of Surgery for Patients with Drug Resistant Epilepsy (DRE): An Analysis of 250 Patients Referred to a Multidisciplinary Epilepsy Center, and Systematic Review of the Literature

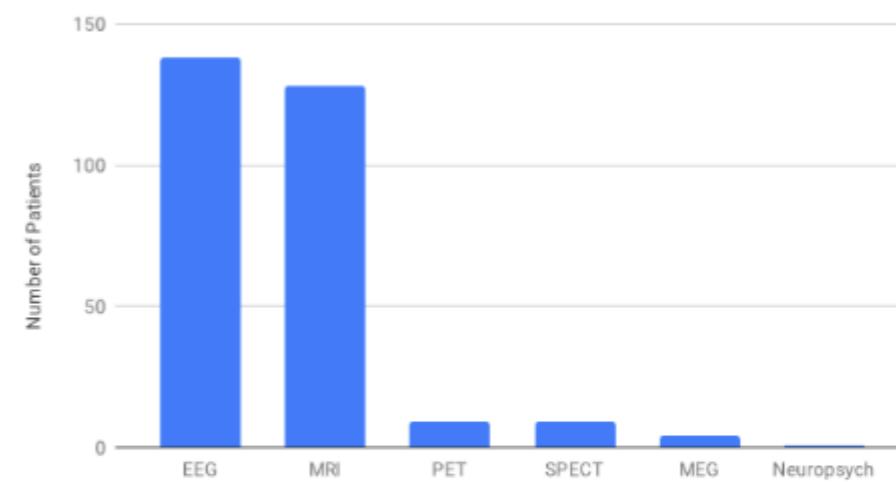
Elena Solli MD, Irene Say MD, Nicole A. Colwell MD, Anmol Johal BA, Rebecca Houston BS, Jayoung Pak MD, Luke Tomycz MD

Department of Neurosurgery, Rutgers New Jersey Medical School, Newark, NJ



**Figure 3:** Out of the 128 patients with DRE who had completed MRI, 76 patients were MRI negative (59.4%), 37 were found to have multifocal abnormalities (28.9%), and 15 were found to have a single lesion (11.7%).

Completed Workup Elements in DRE Patients



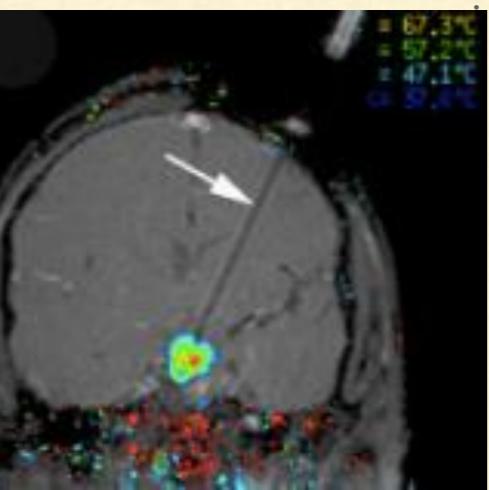
**Figure 2:** Out of the 138 patients with DRE, 138 (100%) underwent video EEG, 128 (92.8%) completed MRI, 9 (6.5%) completed PET, 9 (6.5%) completed SPECT, 4 completed MEG (2.90%), and 1 (0.72%) completed neuropsychology evaluation.

# NEUROSURGEONS

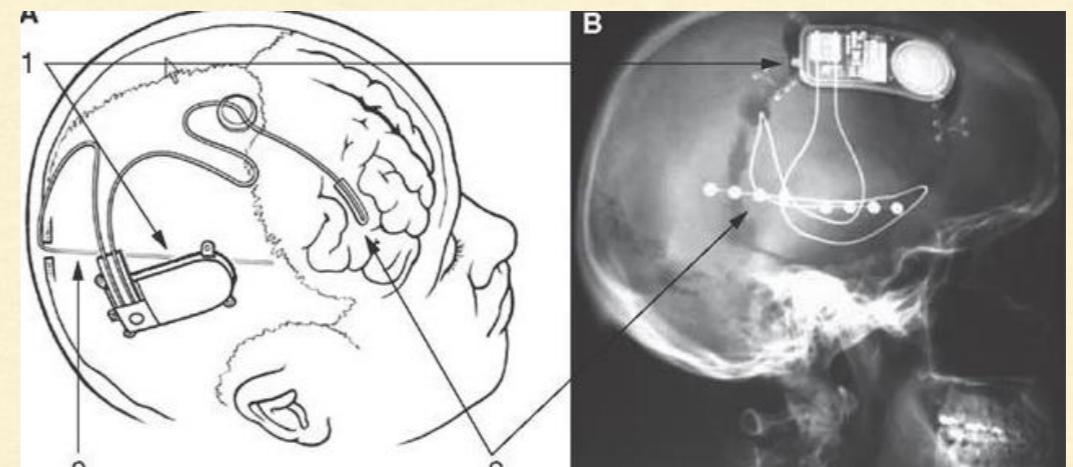
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- . changing attitudes of patients and fellow health-care professionals
  - . empower patients to be more involved in management of their condition
  - . knowledge gap / lack of proactive behavior
  - . the neurosurgeon as the technician >>> the neurosurgeon as key player in multi-disciplinary teams for patients with MRE
-

# THE FUTURE

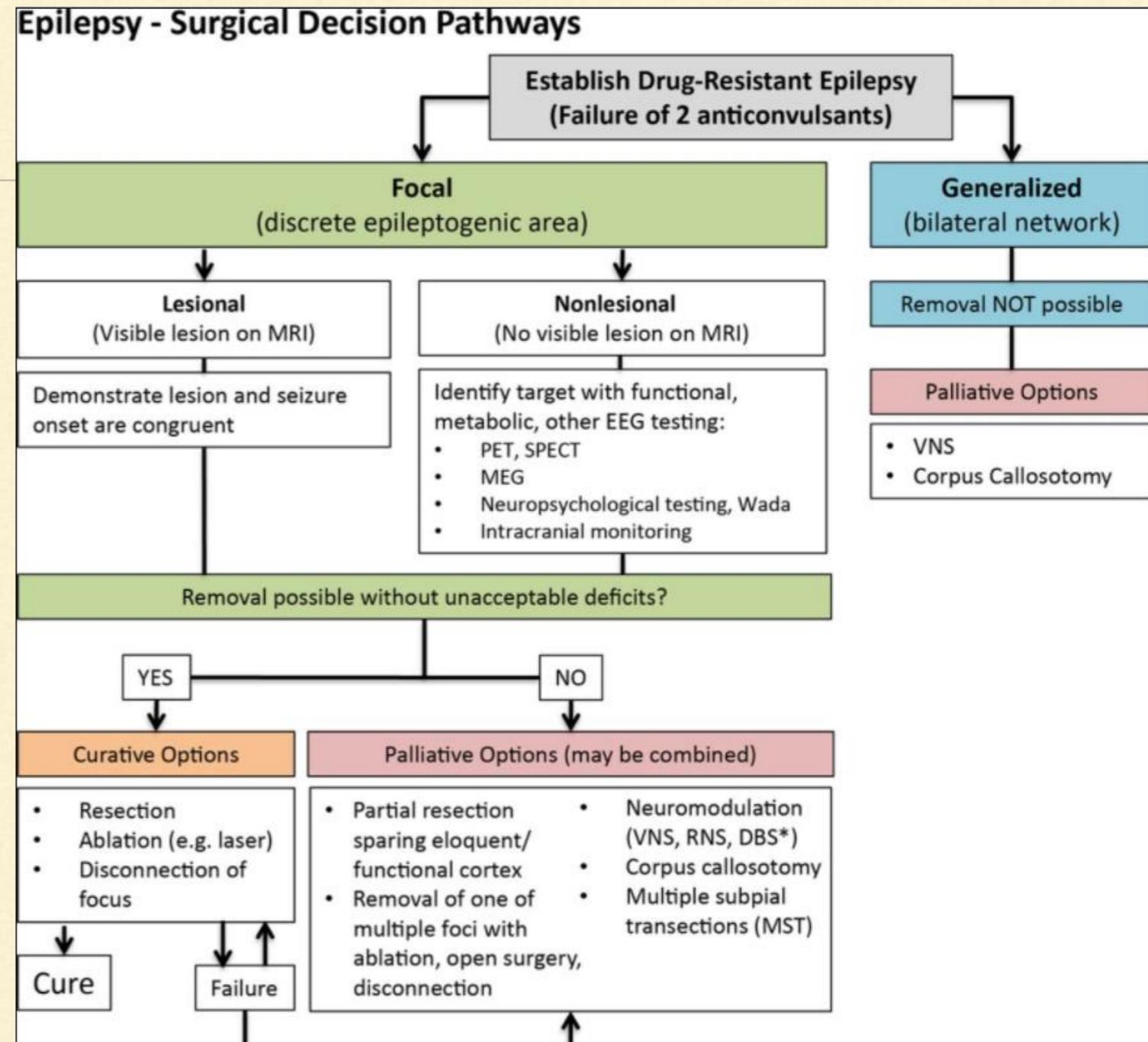


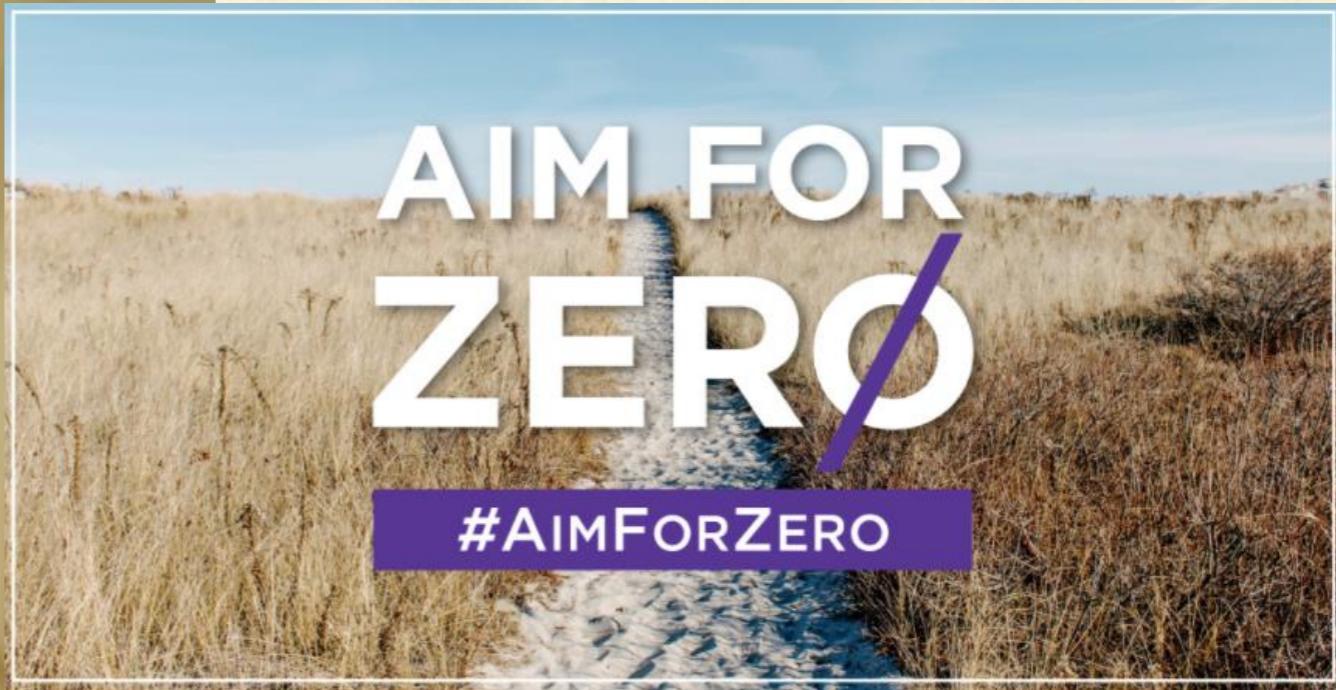
- continued development of drugs and technologies
- development of advanced imaging (e.g. EEG-fMRI, ESI, PET, SPECT, MSI)
- device implantation (e.g. VNS, Neuropace, DBS, grids and depths)
- radio-frequency and laser thermoablation (e.g. PVNH, hypothalamic hamartoma)
- robotic surgery (e.g. ROSA)
- endoscopic techniques



# MOVING FORWARD?

- building a truly multi-disciplinary team clinical care and research
- implement a process for periodic neuropsychological assessments
- structured guidelines to trigger advanced imaging in children with epilepsy (**HD-EEG/ESI**, PET, ictal SPECT, MEG); we won't find a focus if we never look
- internet-based tools for patients
- out-reach to pediatricians, ED physicians
- research: ED, volumetry, underutilization, FH





[tomyczluke@gmail.com](mailto:tomyczluke@gmail.com)  
615-484-5175

Family  
**Seizures**  
Risks  
Caregivers  
Safety  
Support  
**Self-management**  
Fib Tests  
Stress  
Triggers  
**Epilepsy**  
Healthy Information  
Modifications  
Diet  
Medicines  
Lifestyle

