2023 GW Epilepsy Board Review & Best Practices

Complications of Epilepsy Surgery

Chima Oluigbo, MD, FAANS

Professor of Neurological Surgery, Neurology and Rehabilitation Medicine, and Pediatrics,

Children’s National Hospital

George Washington University School of Medicin

Washington, D.C.

THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

Children’s National™ Health System

- No disclosures

Objectives

- Discuss physicians' conceptions (and misconceptions) about the risks associated with epilepsy surgery
- Characterize accurately the risks of epilepsy surgery
- Discuss the impact of advances in stereotaxy, advanced imaging and neuronavigation on risk minimization in epilepsy surgery

Epilepsy Res. 2015 December ; 118: 68–69. doi:10.1016/j.eplepsyres.2015.09.012.

The persistent under-utilization of epilepsy surgery

Dario J. Englot[a,b,*]

[a]UCSF Comprehensive Epilepsy Center, University of California, San Francisco, CA, United States

[b]Department of Neurological Surgery, University of California, San Francisco, CA, United States

- In part due to physicians' misconceptions about the risks associated with epilepsy surgery.

Misconceptions

- An inherent bias against brain surgery may exist due to concerns about the risks of epilepsy surgery (Sirven, 2010).
- 14% of patients who underwent epilepsy surgery had been advised by their primary neurologists not to have surgery, primarily because of its potential neurologic complications (Benbadis et al., 2003)

complication *noun*

Save Word

com·pli·ca·tion | \ ˌkäm-plə-ˈkā-shən \

Definition of *complication*

1 a : COMPLEXITY, INTRICACY

especially **:** a situation or a detail of character complicating the main thread of a plot

b : a making difficult, involved, or intricate

c : a complex or intricate feature or element

d : a difficult factor or issue often appearing unexpectedly and changing existing plans, methods, or attitudes

2 : a secondary disease or condition developing in the course of a primary disease or condition

Peculiarities of Epilepsy Surgery

- Removal or disconnection of functionally normal brain areas are often an essential part of epilepsy surgical strategy, which may lead to functional deficits.
- Also, some patients require invasive diagnostic procedures in order to lateralize and/or localize the epileptic focus, adding to the risk of complications.

Definitions

- No universal definition
- “An unwanted, unexpected and uncommon event after either a diagnostic or therapeutic procedure” – Andre Olivier

- Clarification: An expected paresis after a functional hemispherectomy would not be considered a complication

- Classification:
  - Minor: transient (< 3 months) and of no significant functional impact
  - Major: causing significant disability that can be permanent.

Classification

Annals of Surgery • Volume 240, Number 2, August 2004

FEATURE

Classification of Surgical Complications

A New Proposal With Evaluation in a Cohort of 6336 Patients and Results of a Survey

Daniel Dindo, MD, Nicolas Demartines, MD, and Pierre-Alain Clavien, MD, PhD, FRCS, FACS

TABLE 1. Classification of Surgical Complications

Grade	Definition
Grade I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions
	Allowed therapeutic regimens are: drugs as antiemetics, antipyretics, analgetics, diuretics, electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside
Grade II	Requiring pharmacological treatment with drugs other than such allowed for grade I complications
	Blood transfusions and total parenteral nutrition are also included
Grade III	Requiring surgical, endoscopic or radiological intervention
Grade IIIa	Intervention not under general anesthesia
Grade IIIb	Intervention under general anesthesia
Grade IV	Life-threatening complication (including CNS complications)* requiring IC/ICU management
Grade IVa	Single organ dysfunction (including dialysis)
Grade IVb	Multiorgan dysfunction
Grade V	Death of a patient
Suffix “d”	If the patient suffers from a complication at the time of discharge (see examples in Table 2), the suffix “d” (for “disability”) is added to the respective grade of complication. This label indicates the need for a follow-up to fully evaluate the complication.

*Brain hemorrhage, ischemic stroke, subarrachnoidal bleeding, but excluding transient ischemic attacks.
CNS, central nervous system; IC, intermediate care; ICU, intensive care unit.

Complications

- Complications of Invasive monitoring: subdural grid versus SEEG
- Complications of craniotomy – general versus neurological

Review

Stereotactic and Functional Neurosurgery

Stereotact Funct Neurosurg 2019;97:69–82
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Complications after Anterior Temporal Lobectomy for Medically Intractable Epilepsy: A Systematic Review and Meta-Analysis

Alexandros G. Brotis[a] Theofanis Giannis[a] Eftychia Kapsalaki[b] Efthymios Dardiotis[c] Kostas N. Fountas[a]

[a]Department of Neurosurgery, University Hospital of Larissa, School of Medicine, University of Thessaly, Larissa, Greece; [b]Department of Radiology, University Hospital of Larissa, School of Medicine, University of Thessaly, Larissa, Greece; [c]Department of Neurology, University Hospital of Larissa, School of Medicine, University of Thessaly, Larissa, Greece

Table 1. Criteria and definitions for ATL-associated complications reported among eligible studies

Complication	Definition
Infection	Meningitis, wound infection, osteomyelitis, empyema
Hemorrhage	Epidural hematoma, chronic subdural hematoma, intraparenchymal hemorrhage, hemorrhagic infarction
Pyramidal/sensory tract/language deficits	Hemiparesis, monoparesis, aphasia, dysphasia, hemisensory deficit
VFDs	Hemianopsia, quadranopsia
CNDs	Diplopia, paresis of frontal branch of facial nerve
CSF-related	CSF leak, hydrocephalus
Extra-axial fluid collections	Subgaleal fluid collection, subdural collections other than chronic subdural hematoma
Cognitive deficits	Memory, naming
Psychiatric	Depression, confusion, euphoria, psychosis, mania, anxiety
Medical complications	Deep vein thrombosis, pulmonary embolism, myocardial infarction, urinary tract infection, acute kidney or lung disorders, respiratory distress or failure
Other	Dysphagia, jaw pain, epileptic status
Morbidity	Cumulative frequency of complications
Mortality	Frequency of death

VFDs, visual field defects; CNDs, cranial nerve deficits; CSF, cerebrospinal fluid.

Table 5. Summary of evidence

	Studies (eligible population), *n*	Cases	Quality of pertinent evidence (GRADE)	Pooled proportion estimate (95% CI)	Rank	Pediatric considerations
Morbidity	25 (2,842)	458	Low quality (⊕⊕○○)	0.17 (0.12, 0.24)	1	
Infection	20 (2,695)	60	Low quality (⊕⊕○○)	0.03 (0.02, 0.04)	8	
Hemorrhage	9 (1,244)	18	Low quality (⊕⊕○○)	0.02 (0.01, 0.05)	9	
Pyramidal/ sensory tract/ language deficits	21 (2,345)	90	High quality (⊕⊕⊕⊕)	0.04 (0.03, 0.06)	5	
CSF-related complications	8 (991)	11	Moderate quality (⊕⊕⊕○)	0.02 (0.01, 0.04)	11	
Cranial fluid collections	5 (595)	11	Low quality (⊕⊕○○)	0.02 (0.01, 0.03)	12	
VFDs	13 (1,608)	129	Very low quality (⊕○○○)	0.06 (0.03, 0.11)	3	
CNDs	14 (1,815)	36	Low quality (⊕⊕○○)	0.03 (0.02, 0.05)	7	
Cognitive deficits	5 (825)	47	Very low quality (⊕○○○)	0.05 (0.02, 0.10)	4	
Psychiatric disorders	9 (836)	53	Low quality (⊕⊕○○)	0.07 (0.05, 0.09)	2	
Medical complications	8 (1,181)	17	Low quality (⊕⊕○○)	0.02 (0.01, 0.03)	13	
Other	4 (459)	17	Moderate quality (⊕⊕⊕○)	0.04 (0.02, 0.06)	6	
Mortality	16 (2,382)	19	Low quality (⊕⊕○○)	0.01 (0.01, 0.02)	10	

ATL, anterior temporal lobectomy; VFDs, visual field defects; CNDs, cranial nerve deficits; CSF, cerebrospinal fluid.

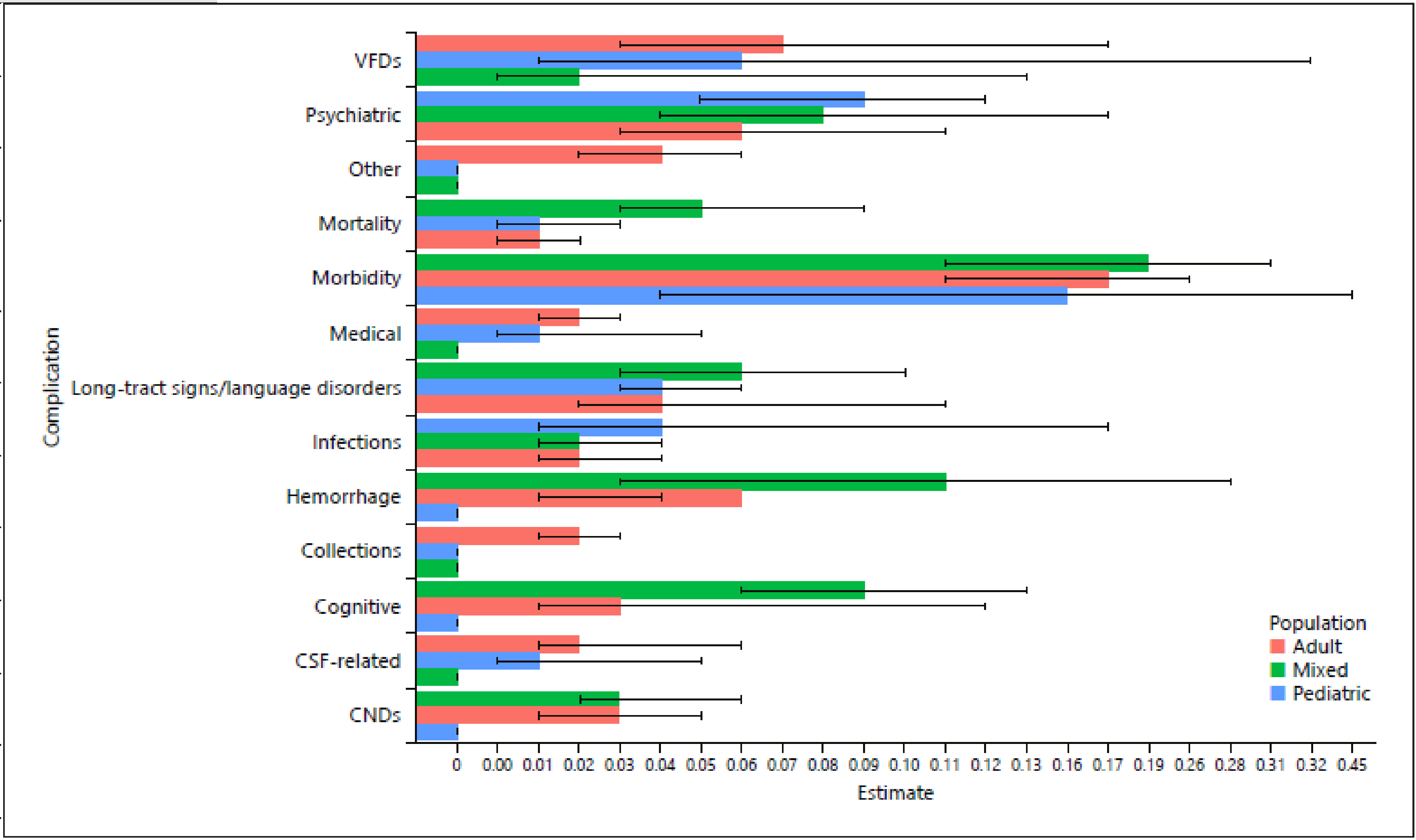


Fig. 4. Psychiatric disorders were the most common postoperative complication after anterior temporal lobectomy for intractable temporal lobe epilepsy, followed by visual field defects (VFDs) and cognitive disorders. CSF, cerebrospinal fluid; CNDs, cranial nerve deficits.

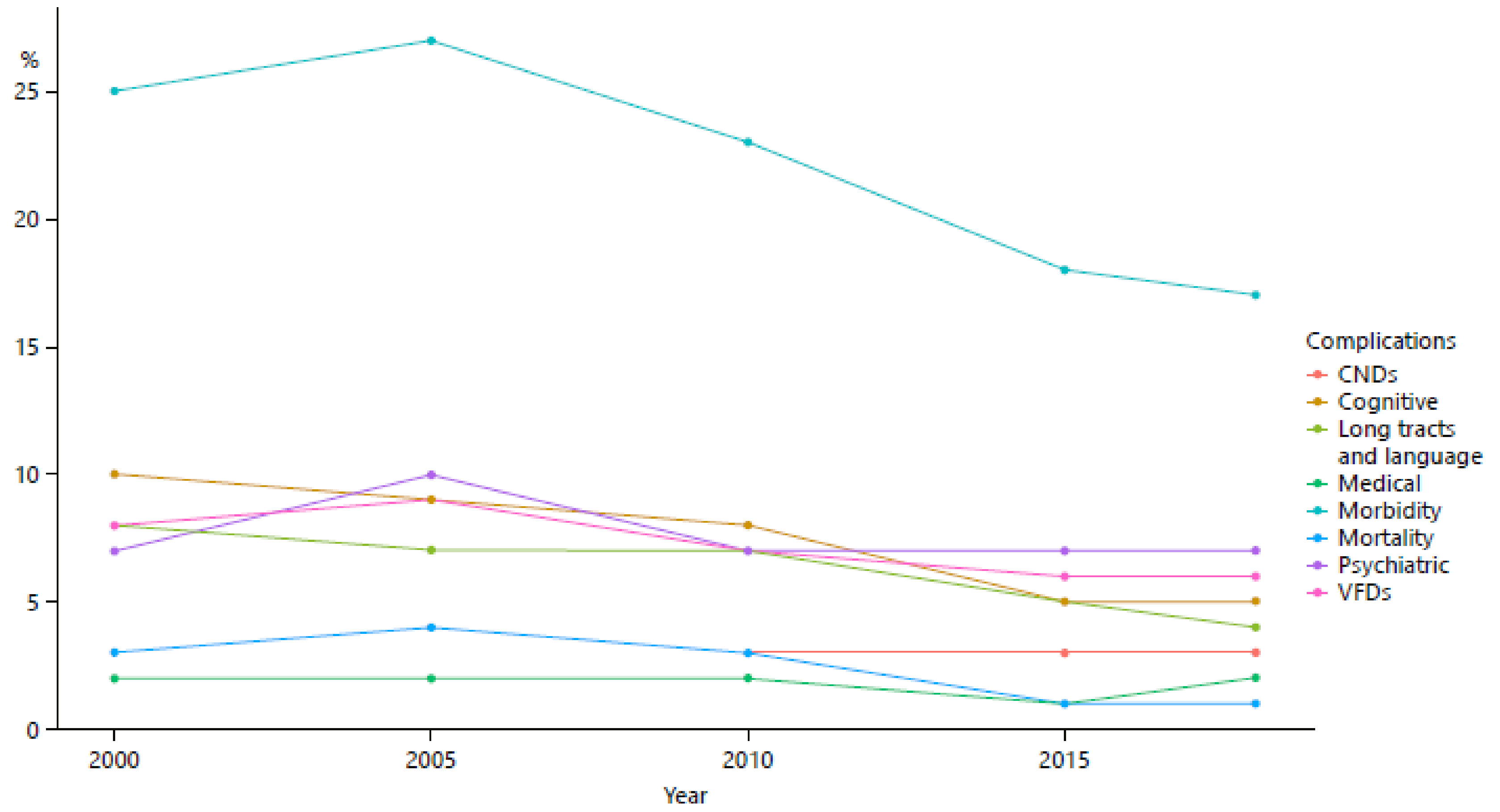


Fig. 5. There has been a steady improvement in both mortality and morbidity after anterior temporal lobectomy for temporal lobe intractable epilepsy since its initial description. CNDs, cranial nerve deficits; VFDs, visual field defects.

Epilepsia, 54(5):840–847, 2013
doi: 10.1111/epi.12161

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.

Summary

Purpose: Underutilization of epilepsy surgery remains a major problem and is in part due to physicians' misconceptions about the risks associated with epilepsy surgery. The purpose of this study was to systematically review the literature on complications of focal epilepsy surgery.

Methods: A literature search was conducted using PubMed and Embase to identify studies examining epilepsy surgery complications. Abstract and full text review, along with data extraction, was done in duplicate. Minor medical and neurologic complications were defined as those that resolved completely within 3 months of surgery, whereas major complications persisted beyond that time frame. Descriptive statistics were used to report complication proportions.

Key Findings: *Invasive monitoring*: Minor complications were reported in 7.7% of patients, whereas major complications were reported in only 0.6% of patients undergoing 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.

KEY WORDS: Surgical risk, Epilepsy, Mortality, Neurologic deficits.

JNS

CLINICAL ARTICLE

J Neurosurg 122:519–525, 2015

Complications of epilepsy surgery in Sweden 1996–2010: a prospective, population-based study

Johan Bjellvi, MD,[1] Roland Flink, MD, PhD,[2] Bertil Rydenhag, MD, PhD,[1] and Kristina Malmgren, MD, PhD[1]

[1]Epilepsy Research Group, Institute of Neuroscience and Physiology, The Sahlgrenska Academy, University of Gothenburg, Sweden; and [2]Department of Clinical Neurophysiology, Uppsala University Hospital, Uppsala, Sweden

OBJECT Detailed risk information is essential for presurgical patient counseling and surgical quality assessments in epilepsy surgery. This study was conducted to investigate major and minor complications related to epilepsy surgery in a large, prospective series.

METHODS The Swedish National Epilepsy Surgery Register provides extensive population-based data on all patients who were surgically treated in Sweden since 1990. The authors have analyzed complication data for therapeutic epilepsy surgery procedures performed between 1996 and 2010. Complications are classified as major (affecting daily life and lasting longer than 3 months) or minor (resolving within 3 months).

RESULTS A total of 865 therapeutic epilepsy surgery procedures were performed between 1996 and 2010, of which 158 were reoperations. There were no postoperative deaths. Major complications occurred in 26 procedures (3%), and minor complications in 65 (7.5%). In temporal lobe resections (n = 523), there were 15 major (2.9%) and 41 minor complications (7.8%); in extratemporal resections (n = 275) there were 9 major (3.3%) and 22 minor complications (8%); and in nonresective procedures (n = 67) there were 2 major (3%) and 2 minor complications (3%). The risk for any complication increased significantly with age (OR 1.26 per 10-year interval, 95% CI 1.09–1.45). Compared with previously published results from the same register, there is a trend toward lower complication rates, especially in patients older than 50 years.

CONCLUSIONS This is the largest reported prospective series of complication data in epilepsy surgery. The complication rates comply well with published results from larger single centers, confirming that epilepsy surgery performed in the 6 Swedish centers is safe. Patient age should be taken into account when counseling patients before surgery.

http://thejns.org/doi/abs/10.3171/2014.9.JNS132679

KEY WORDS epilepsy; epilepsy surgery; neurosurgery; adverse effects; multicenter study

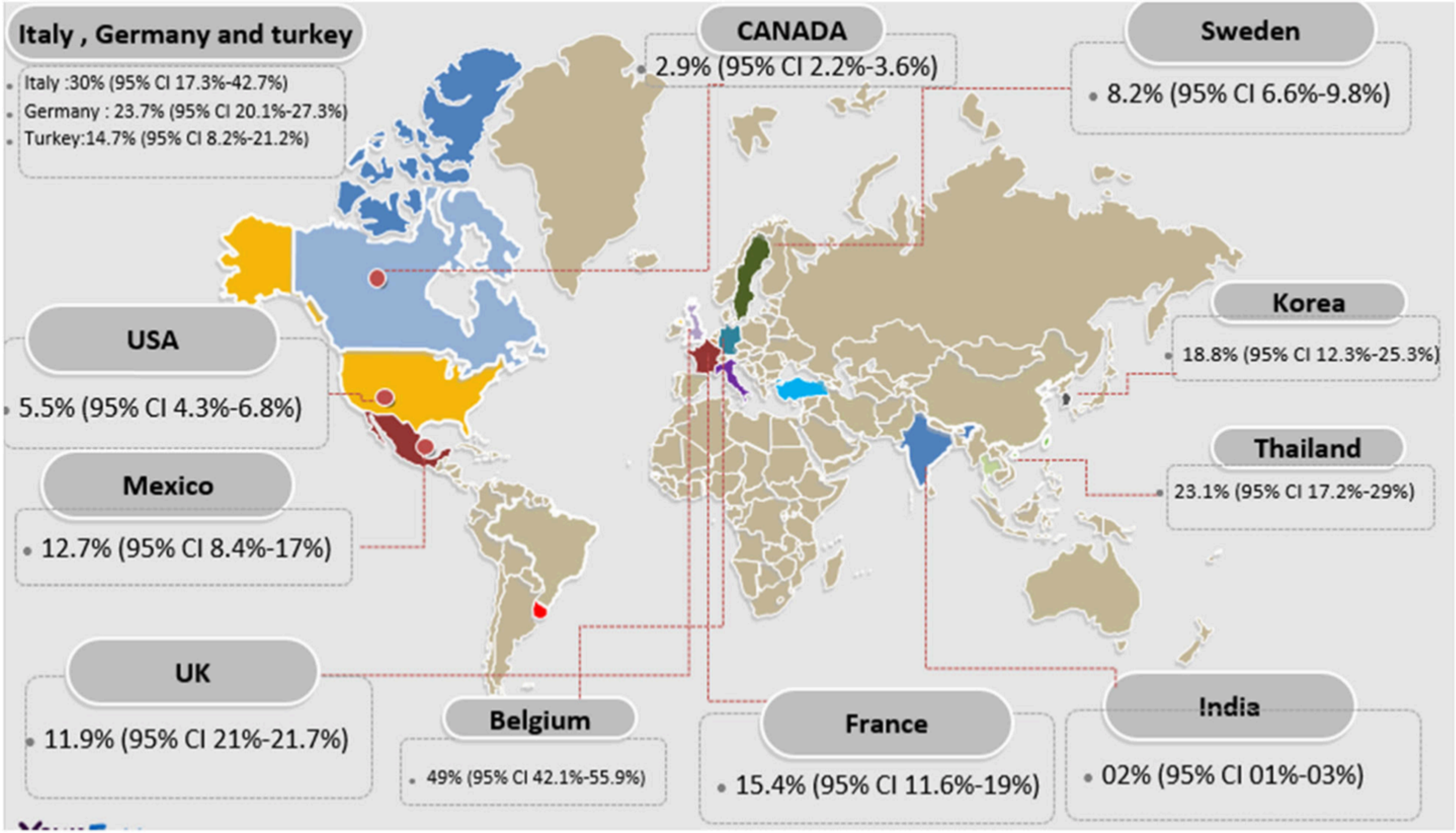
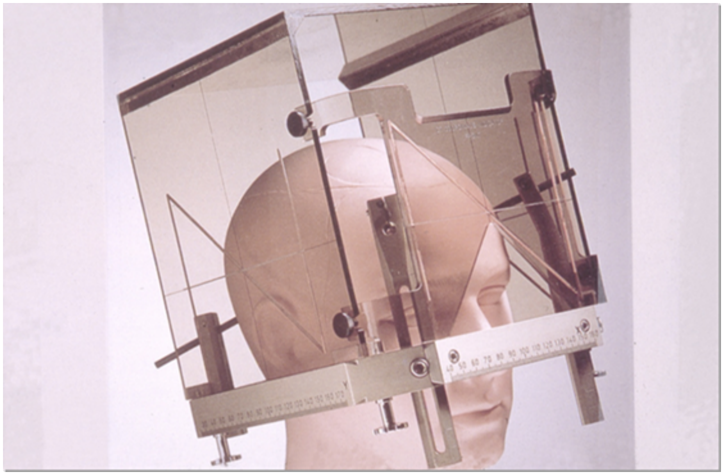
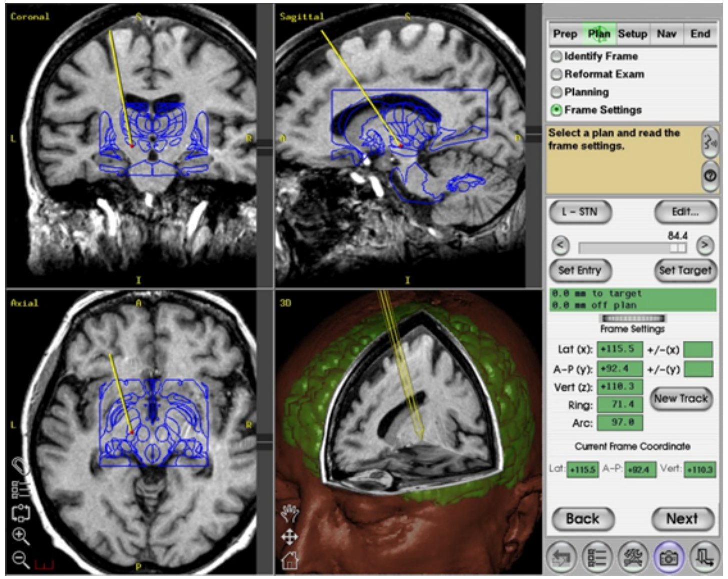


Fig. 7 Prevalence of epilepsy surgery complications based on country

Impact of Advances in Stereotactic Neuronavigation





SEEG: Technique & Electrode Placement Accuracy

Accuracy of intracranial electrode placement for stereoelectroencephalography: A systematic review and meta-analysis

*Vejay N. Vakharia, †Rachel Sparks, ‡Aidan G. O'Keeffe, *Roman Rodionov, *Anna Miserocchi, *Andrew McEvoy, *†Sebastien Ourselin, and *John Duncan

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doi: 10.1111/epi.13713

- Robotic trajectory guidance systems

Robot-Assisted Stereotaxy Reduces Target Error: A Meta-Analysis and Meta-Regression of 6056 Trajectories

Lucas R. Philipp, MD, MPH
Caio M. Matias, MD, PhD
Sara Thalheimer, BA
Shyle H. Mehta, MA
Ashwini Sharan, MD
Chengyuan Wu, MD, MSBmE

Department of Neurological Surgery, Thomas Jefferson University Hospitals, Philadelphia, Pennsylvania

An early iteration of the manuscript abstract was accepted as a digital poster for display at the 2019 CNS Annual Meeting in San Francisco, California, October 19-23, 2019.

Correspondence:
Lucas R. Philipp, MD, MPH,
Department of Neurological Surgery,
Thomas Jefferson University Hospitals,
909 Walnut St, Third Floor,
Philadelphia, PA 19107, USA.
Email: Lucas.Philipp@Jefferson.edu

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BACKGROUND: The pursuit of improved accuracy for localization and electrode implantation in deep brain stimulation (DBS) and stereoelectroencephalography (sEEG) has fostered an abundance of disparate surgical/stereotactic practices. Specific practices/technologies directly modify implantation accuracy; however, no study has described their respective influence in multivariable context.

OBJECTIVE: To synthesize the known literature to statistically quantify factors affecting implantation accuracy.

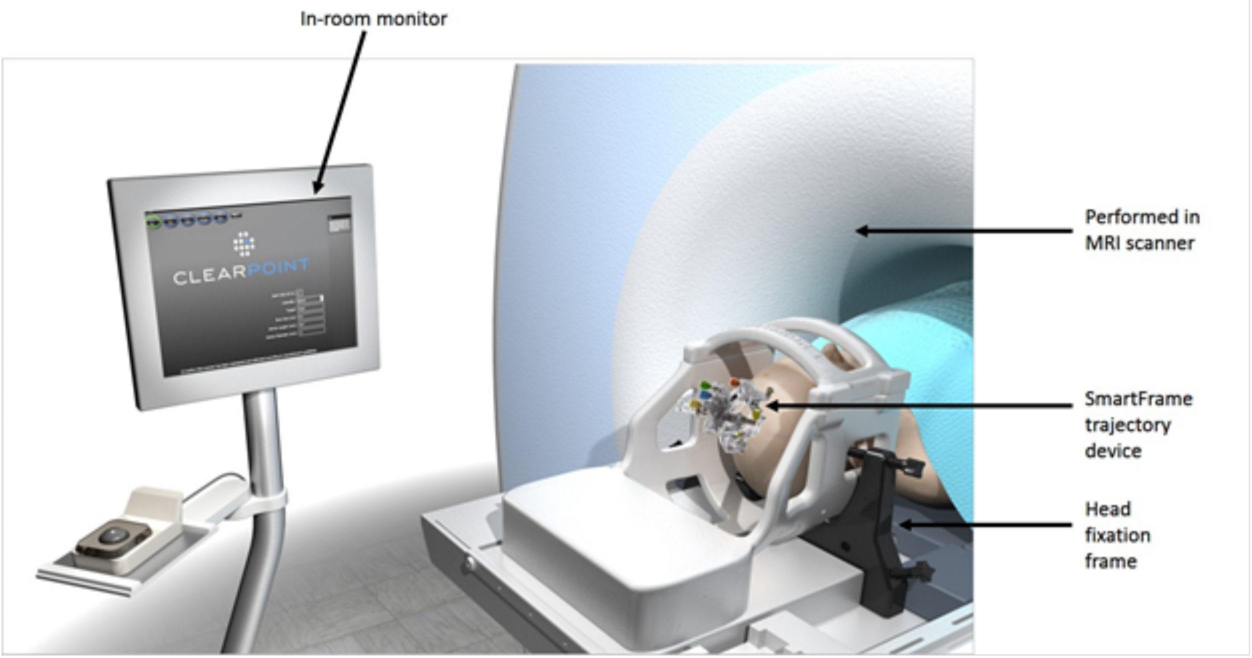
METHODS: A systematic review and meta-analysis was conducted to determine the inverse-variance weighted pooled mean target error (MTE) of implanted electrodes among patients undergoing DBS or sEEG. MTE was defined as Euclidean distance between planned and final electrode tip. Meta-regression identified moderators of MTE in a multivariable-adjusted model.

RESULTS: A total of 37 eligible studies were identified from a search return of 2,901 potential articles (2002-2018) – 27 DBS and 10 sEEG. Random-effects pooled MTE = 1.91 mm (95% CI: 1.7-2.1) for DBS and 2.34 mm (95% CI: 2.1-2.6) for sEEG. Meta-regression identified study year, robot use, frame/frameless technique, and intraoperative electrophysiologic testing (iEPT) as significant multivariable-adjusted moderators of MTE ($P < .0001$, $R^2 = 0.63$). Study year was associated with a 0.92-mm MTE reduction over the 16-yr study period ($P = .0035$), and robot use with a 0.79-mm decrease ($P = .0019$). Frameless technique was associated with a mean 0.50-mm (95% CI: 0.17-0.84) increase, and iEPT use with a 0.45-mm (95% CI: 0.10-0.80) increase in MTE. Registration method, imaging type, intraoperative imaging, target, and demographics were not significantly associated with MTE on multivariable analysis.

CONCLUSION: Robot assistance for stereotactic electrode implantation is independently associated with improved accuracy and reduced target error. This remains true regardless of other procedural factors, including frame-based vs frameless technique.

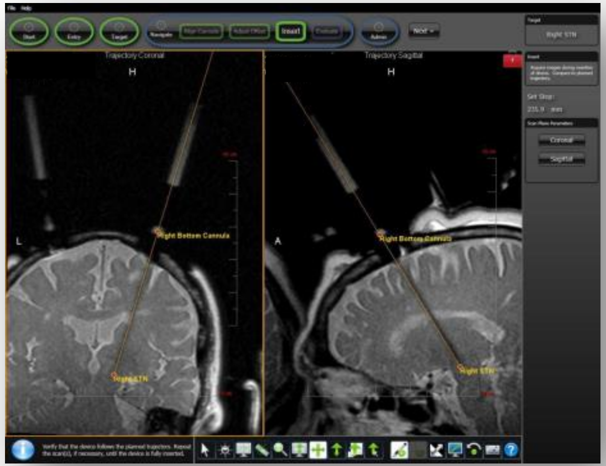
KEY WORDS: DBS, Electrode implantation, Meta-analysis, sEEG, Stereotactic accuracy, Stereotactic techniques, Target error

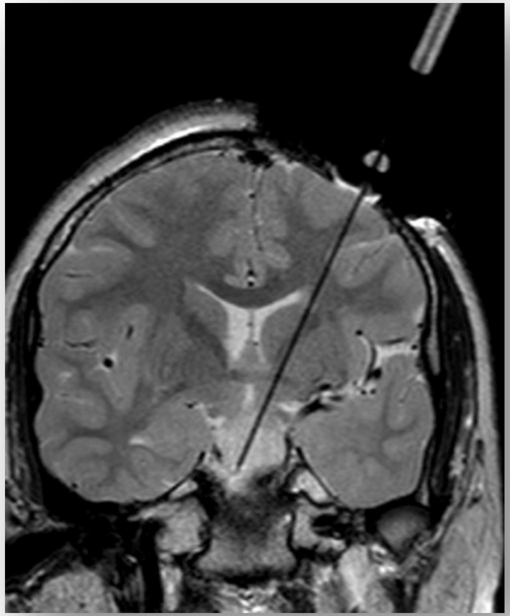
Real-Time MRI Guided Interventions



Placement of Electrodes

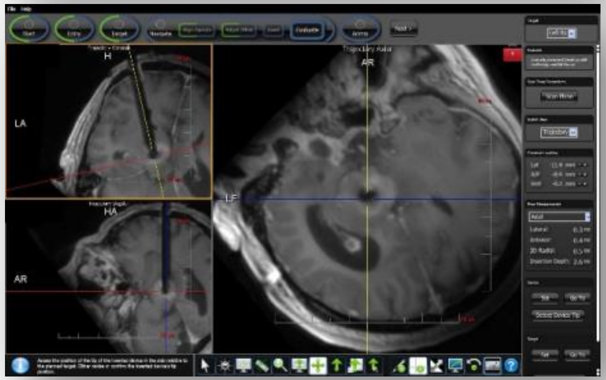
Depth and location…





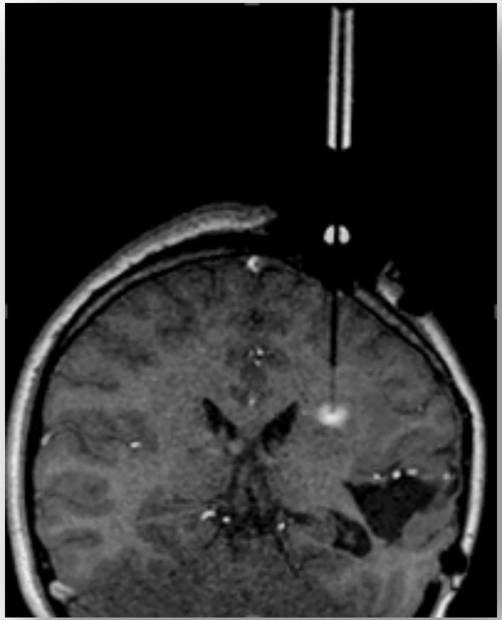
Placement of Laser Ablation Catheters

For hippocampal ablation, ablation of tumor, ablation of radiation necrosis…



Placement of Biopsy Needles

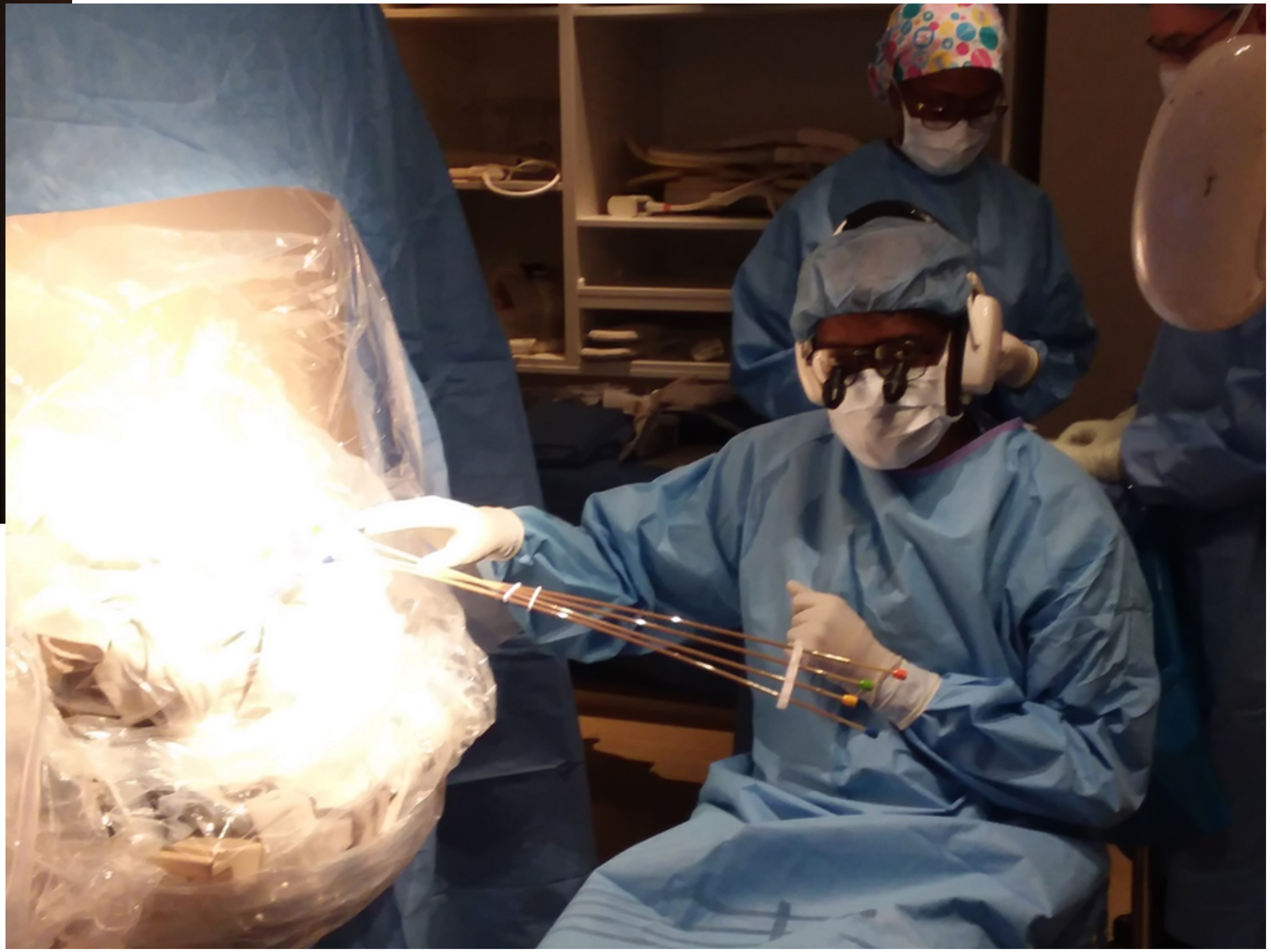
Small, deep tumors, brain stem gliomas…



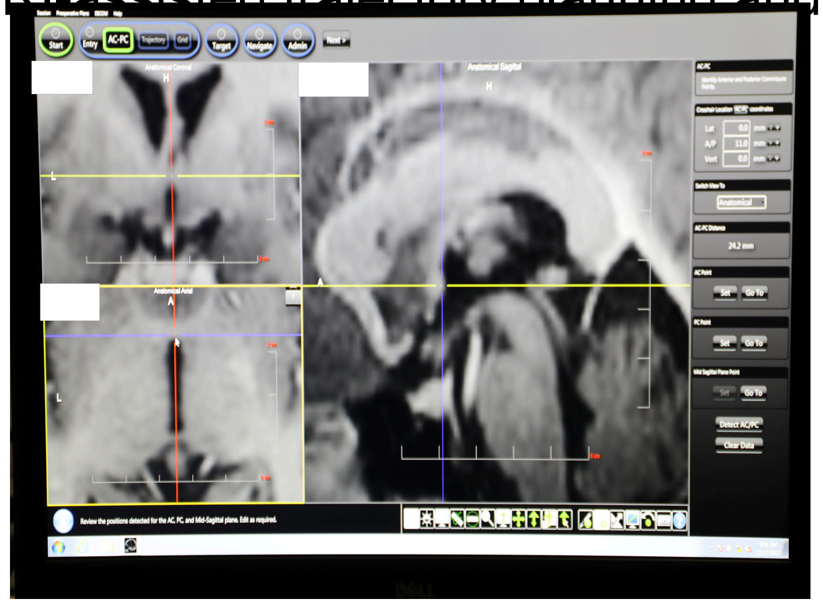
Placement of Drug Delivery Catheters

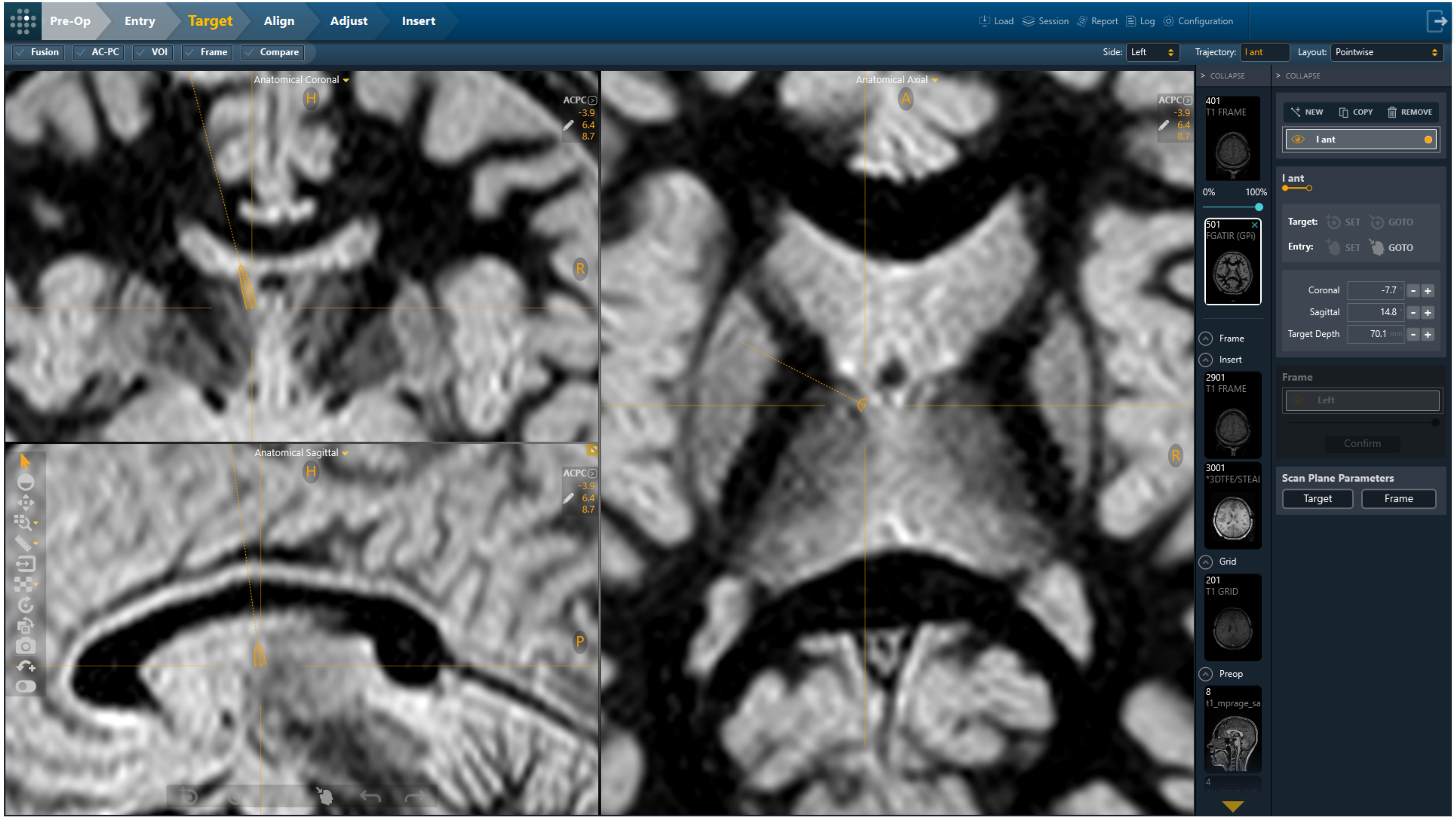
Clinical trials, research…


FIRE
REC



Realtime MRI-assisted trajectory planning and lead placement





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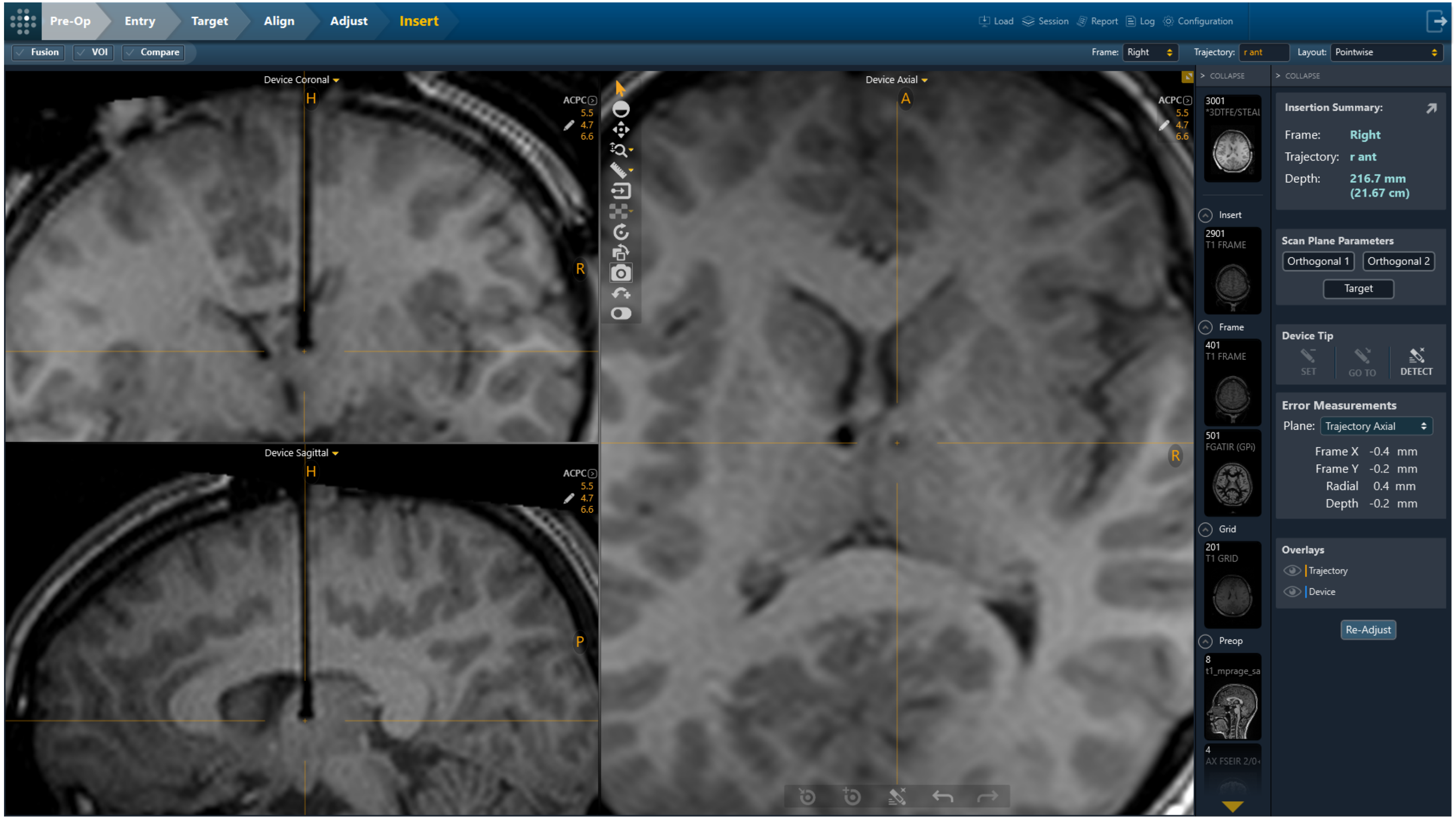

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Impact of Minimization of the “Surgical Corridor”

Epilepsy

RESEARCH PAPER

OPEN ACCESS

Complications to invasive epilepsy surgery workup with subdural and depth electrodes: a prospective population-based observational study

Emelie Hedegärd,[1] Johan Bjellvi,[1] Anna Edelvik,[1] Bertil Rydenhag,[1] Roland Flink,[2] Kristina Malmgren[1]

ABSTRACT

Objective In some patients who undergo presurgical workup for drug-resistant epilepsy invasive seizure monitoring is needed to define the seizure onset zone and delineate eloquent cortex. Such procedures carry risks for complications causing permanent morbidity and even mortality. In this study, prospective data on complications in a national population-based sample were analysed.

Design Complication data from the prospective Swedish National Epilepsy Surgery Register were analysed for 271 patients in whom therapeutic surgery was preceded by invasive monitoring 1996–2010.

Results Complications occurred in 13/271 patients (4.8%). Subdural grids carried the highest risk of complications (7.4%). There was no surgical mortality or permanent morbidity. Subdural haematomas were most common (n=7) followed by epidural haematomas (n=3). Valproate treatment and having a haematoma was associated with an OR of 1.53 (CI 0.38 to 6.12) compared to having a haematoma without valproate treatment. Having a complication during invasive monitoring was associated with a significant OR of 6.27 (CI 1.32 to 29.9) of also having a complication at therapeutic surgery compared to the risk of having a complication only at surgery.

Conclusions In this prospective population-based epilepsy surgery series, the most common complications were haematomas, and subdural grids carried the highest risk. Close supervision and rapid interventions led to avoidance of permanent morbidity. The clinical implications of the slightly increased risk of haematomas with valproate treatment needs further investigation as does the finding of an increased risk for complications at epilepsy surgery for patients who had a complication during invasive monitoring.

Is the use of Stereotactic Electroencephalography Safe and Effective in Children? A Meta-Analysis of the use of Stereotactic Electroencephalography in Comparison to Subdural Grids for Invasive Epilepsy Monitoring in Pediatric Subjects

Matthew F. Sacino, MD*
Sean S. Huang, PhD‡
John Schreiber, MD§
William D. Gaillard, MD§
Chima O. Oluigbo, MD*

*Department of Neurosurgery, Children's National Medical Center, George Washington University, Washington, District of Columbia; ‡Department of Health Systems Administration, Georgetown University, Washington, District of Columbia; §Department of Neurology, Children's National Medical Center, George Washington University, Washington, District of Columbia

Correspondence:
Chima O. Oluigbo, MD,
Departments of Neurosurgery,
Children's National Medical Center,
111 Michigan Avenue NW,
Washington, DC 20010.
E-mail: coluigbo@cnmc.org

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BACKGROUND: Stereoelectroencephalography (SEEG) is an alternative addition to subdural grids (SDG) in invasive extra-operative monitoring for medically refractory epilepsy. Few studies exist on the clinical efficacy and safety of these techniques in pediatric populations.

OBJECTIVE: To provide a comparative quantitative summary of surgical complications and postoperative seizure freedom associated with invasive extra-operative presurgical techniques in pediatric patients.

METHODS: The systematic review was conducted following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). A literature search was conducted utilizing Ovid Medline, Embase, Pubmed, and the Cochrane database.

RESULTS: Fourteen papers with a total of 697 pediatric patients undergoing invasive SDG monitoring and 9 papers with a total of 277 pediatric patients undergoing SEEG monitoring were utilized in the systemic review. Cerebral spinal fluid (CSF) leaks were the most common adverse event in the SDG studies (pooled prevalence 11.9% 95% confidence interval [CI] 5.7-23.3). There was one case of CSF leak in the SEEG studies. Intracranial hemorrhages (SDG: 10.7%, 95% CI 5.3-20.3; SEEG: 2.9%, 95% CI −0.7 to 10.8) and infection (SDG: 10.8%, 95% CI 6.7-17) were more common in the SDG studies reviewed. At the time of the last postoperative visit, a greater percentage of pediatric patients achieved seizure freedom in the SEEG studies (SEEG: 66.5%, 95% CI 58.8-73.4; SDG: 52.1%, 95% CI 43.0-61.1).

CONCLUSION: SEEG is a safe alternative to SDG and should be considered on an individual basis for selected pediatric patients.

KEY WORDS: SEEG, Pediatric, Epilepsy, Invasive monitoring frontiers in Neurology

ORIGINAL RESEARCH
published: 09 December 2021
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Superior Verbal Memory Outcome After Stereotactic Laser Amygdalohippocampotomy

Daniel L. Drane[1,2,3*], Jon T. Willie[4], Nigel P. Pedersen[1,5], Deqiang Qiu[6], Natalie L. Voets[7], Scott R. Millis[8], Bruno P. Soares[9], Amit M. Saindane[6], Ranliang Hu[6], Michelle S. Kim[3], Kelsey C. Hewitt[1], Shahin Hakimian[3], Thomas Grabowski[3], Jeffrey G. Ojemann[10], David W. Loring[1,2], Kimford J. Meador[11], Edward Faught Jr.[1,2], John W. Miller[3,10] and Robert E. Gross[1,5,12]

[1] Department of Neurology, Emory University School of Medicine, Atlanta, GA, United States, [2] Department of Pediatrics, Emory University School of Medicine, Atlanta, GA, United States, [3] Department of Neurology, University of Washington School of Medicine, Seattle, WA, United States, [4] Department of Neurosurgery, Washington University School of Medicine, St. Louis, MO, United States, [5] Coulter Department of Biomedical Engineering, Emory University, Atlanta, GA, United States,

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Results: Using RCI scores, patients undergoing open resection (12/40, 30.0%) were more likely to decline on verbal memory than those undergoing SLAH (2/40 [5.0%], $p = 0.0064$, Fisher's exact test). Patients with language dominant procedures were much more likely to experience a significant verbal memory decline following open resection (9/19 [47.4%]) compared to laser ablation (2/19 [10.5%], $p = 0.0293$, Fisher's exact test). 1 SD verbal memory decline frequently occurred in the open resection sample of language dominant temporal lobe patients with mesial temporal sclerosis (8/10 [80.0%]), although it rarely occurred in such patients after SLAH (2/14, 14.3%) ($p = 0.0027$, Fisher's exact test). Memory improvement occurred significantly more frequently following SLAH than after open resection.

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The persistent under-utilization of epilepsy surgery

Dario J. Englot[a,b,*]

[a]UCSF Comprehensive Epilepsy Center, University of California, San Francisco, CA, United States

[b]Department of Neurological Surgery, University of California, San Francisco, CA, United States

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Epidemiologist's view: Addressing the epilepsy surgery treatment gap with minimally-invasive techniques

Nicholas K. Schiltz[a,*], Guadalupe Fernandez-Baca Vaca[b]

[a] *Department of Population & Quantitative Health Sciences, Case Western Reserve University, School of Medicine, Cleveland, OH, United States*
[b] *Epilepsy Center, Department of Neurology, University Hospitals Cleveland Medical Center, Cleveland, OH, United States*

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ABSTRACT

Despite the fact that epilepsy surgery is both safe and effective, a considerable "surgical treatment gap" remains in that most persons who are eligible for surgery do not receive it. It has been argued that epilepsy surgery is one of the most underutilized of all accepted medical treatments in the world. In this article, we review the epidemiology of the epilepsy surgery treatment gap, and consider the role minimally-invasive epilepsy surgery may play in reducing this gap.

- Most patient preferred MIES as initial intervention when offered the option between open or minimally invasive surgery (Willie JT, *Neurosurgery* 2014)

- May increase willingness to access epilepsy surgery

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Brief Communication

What can Google Trends and Wikipedia-Pageview analysis tell us about the landscape of epilepsy surgery over time?

Michael Owen Kinney [a,*], Francesco Brigo [b,c]

[a] Department of Clinical Neurophysiology, National Hospital for Neurology and Neurosurgery, Queen Square, London, United Kingdom
[b] Department of Neuroscience, Biomedicine and Movement Sciences, University of Verona, Verona, Italy
[c] Division of Neurology, "Franz Tappeiner" Hospital, Merano, Italy

Table 1
Results from Google Trends search between first and final epoch of study.

Google Trends search term	First [3 years] epoch Average relative search volume (RSV)	Final [3 years] epoch Average relative search volume (RSV)	Percentage change in relative search volume (RSV) between the epochs
"Epilepsy surgery"	26.9	11.8	−56.1
"Temporal lobe epilepsy"	57.3	27.5	−52.0
"Frontal lobe epilepsy"	26.4	12.8	−51.5
"Occipital lobe epilepsy"	10.2	9.2	−9.8
"Hippocampal sclerosis"	36.9	12.8	−65.3
"Focal cortical dysplasia"	30.2	20.9	−30.8
"Hypothalamic hamartoma"	30.0	16.5	−45.0
"Anterior temporal lobectomy"	14.3	4.6	−67.8
"Frontal lobectomy"	31.9	6.6	−79.3
"Vagal nerve stimulation epilepsy"	2.8	10.8	+285.7
"Laser ablation epilepsy"	0	30.3	+30.3
"Intracranial EEG"	17.8	6.6	−62.9
"Long-term video-EEG monitoring"	39.4	25.5	−35.3
"Insular epilepsy", "extratemporal epilepsy", "posterior quadrant epilepsy", "epilepsy surgery center", "epilepsy surgeon", "frontal lobe epilepsy surgery", "parietal epilepsy surgery", "parietal lobectomy", "occipital epilepsy surgery", "occipital lobectomy"	Returned no results.		

Conclusion

- Epilepsy surgery is safe and effective, it is not free of complications.
- Literature reports low morbidity for epilepsy surgery.
- Potential complications should be well-recognized and the surgeon must inform the patient and their families.