Surgical Management in

Temporal Lobe Epilepsies

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Temporal lobe epilepsy

- Medial temporal lobe epilepsy (MTLE)
  - MTLE- hippocampal sclerosis (HS)
  - MTLE with medial structural lesion other than HS or MRI-negative
- Lateral temporal lobe epilepsy (LTLE)

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Histopathological Findings in Brain Tissue Obtained during Epilepsy Surgery

Table 2. Summary of the 10 Most Common Histopathological Diagnoses among 9523 Patients Who Underwent Epilepsy Surgery.*

Diagnosis	Category	Patients with Condition (N=9523)	Age at Onset of Seizures	Duration of Epilepsy	Localization†	
		no. (%)	*years*		*lobe*	*%*
Hippocampal sclerosis	Hippocampal sclerosis	3463 (36.4)	11.3±10.1	22.5±12.7	Temporal	100.0
Ganglioglioma	Tumor	986 (10.4)	12.1±10.3	11.4±10.4	Temporal	82.5
Focal cortical dysplasia type II	Malformation of cortical development	859 (9.0)	5.6±6.9	14.0±11.7	Frontal	51.6
No lesion	No lesion	738 (7.7)	13.0±10.6	15.4±10.6	Temporal	67.7
Dysembryoplastic neuroepithelial tumor	Tumor	565 (5.9)	14.0±10.9	12.0±10.7	Temporal	68.1
Glial scar	Glial scar	461 (4.8)	10.7±10.3	14.8±11.1	Temporal	37.1
Cavernous angioma	Vascular malformation	431 (4.5)	25.4±13.0	12.3±11.2	Temporal	74.7
Mild malformation of cortical development	Malformation of cortical development	279 (2.9)	9.6±10.0	13.7±11.5	Temporal	49.1
Focal cortical dysplasia type I	Malformation of cortical development	268 (2.8)	7.4±9.6	9.3±8.1	Temporal	35.1
Focal cortical dysplasia not otherwise specified	Malformation of cortical development	206 (2.2)	8.0±8.0	13.4±11.5	Temporal	45.1
Total		8256 (86.7)	11.6±10.8	17±12.6	Temporal	71.9

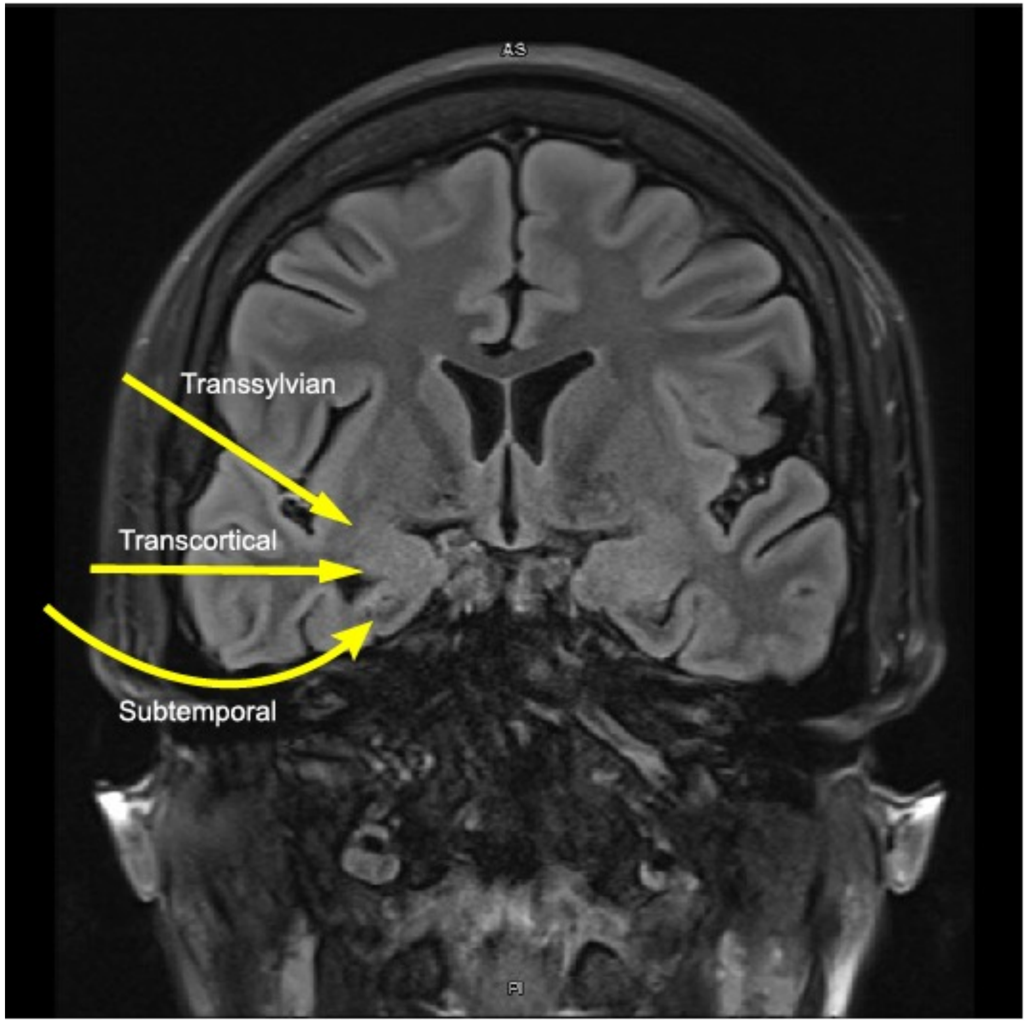
Blumcke I. N Eng J Med 2017.

Treatment options

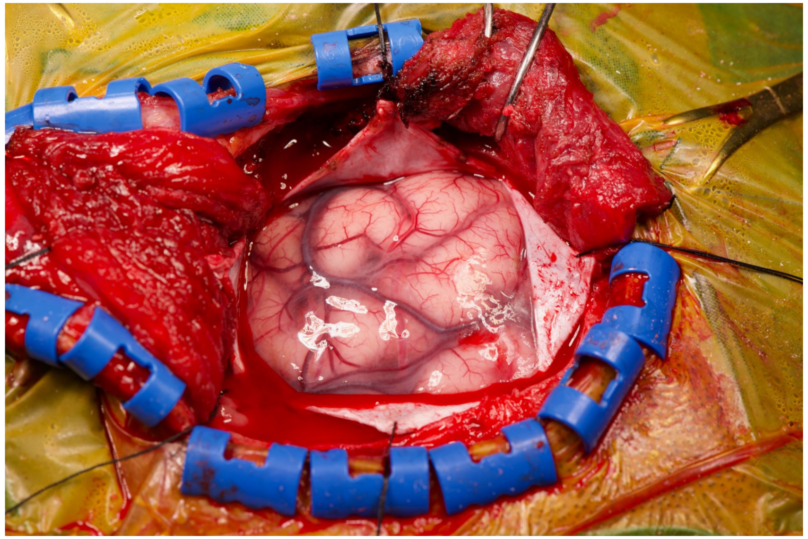
- Resection
    - Anterior temporal lobectomy (ATL)
    - Selective amygdalohippocampectomy (SelAH)
- Minimally invasive surgery
    - Stereotactic Radiofrequency Thermocoagulation (RF-TG)
    - Laser Interstitial Thermal Therapy (LITT)
    - Stereotactic Radiosurgery (SRS)
    - MR-guided focused ultrasound (MRgFUS)
- Neuromodulation
    - Deep brain stimulation (DBS)
    - Responsive Neurostimulation (RNS)

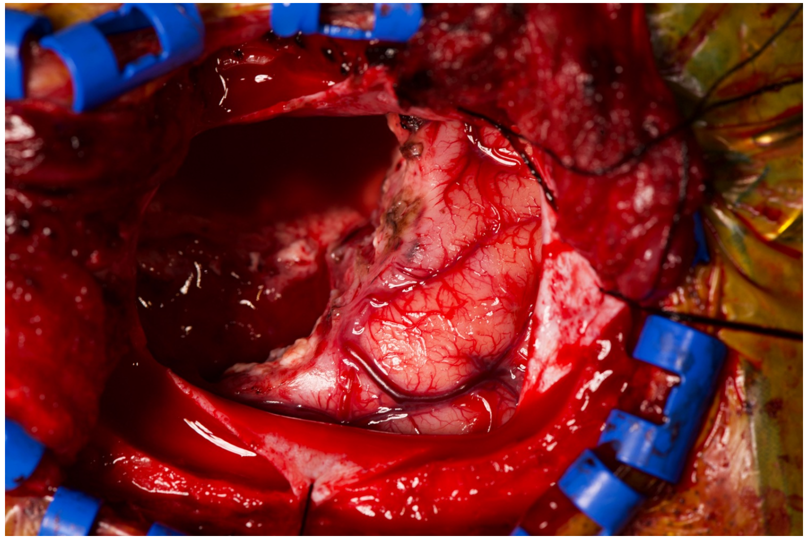
Resection

- Temporal lobectomy (Corticoamygdalohippocampectomy)
  - Standard temporal lobectomy
  - Anterior temporal lobectomy
- Selective amygdalohippocampectomy (SelAH)
  - Transylvian AH
  - Transcortical AH
  - Subtemporal AH
- Hippocampal transection

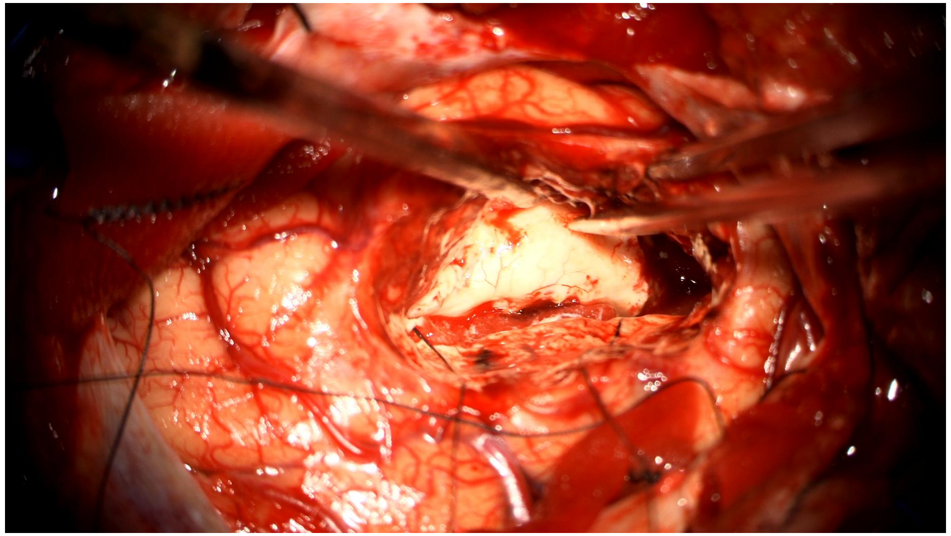


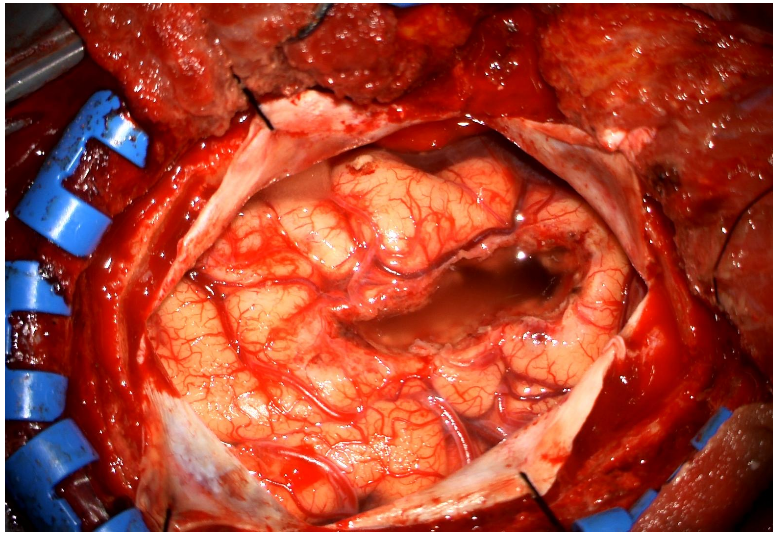
Anterior temporal lobectomy





Selective Amygdalohippocampectomy (SelAH)





ATL vs SelAH

Case # 1

- Female 61 years old, teacher
- Seizure onset @ 12 years
- PH: Head injury +ve
- MRI: Left HS
- Video EEG: Left F-T onset

Case # 2

- Female 32 years old
- Seizure onset @ 4 months
- PH: Family Hx +ve
- MRI: Left HS
- Video EEG: Left F-T onset

Case # 1 61 years old female	
Full IQ	85 (Low average)
Verbal IQ	89 (Low average)
Performance IQ	82 (Low average)
Immediate auditory	105 (Average)
Immediate visual	103 (Average)
Immediate memory	105 (Average)
Auditory delay	111 (High average)
Visual delay	112 (High average)
Auditory recognition	90 (Average)
General memory	108 (Average)
Working memory	102 (Average)

Case # 2 32 years old female	
Full IQ	81 (Low average)
Verbal IQ	74 (Borderline)
Performance IQ	82 (Low average)
Immediate auditory	59 (Extremely low)
Immediate visual	81 (Low average)
Immediate memory	63 (Extremely low)
Auditory delay	64 (Extremely low)
Visual delay	91 (Average)
Auditory recognition	60 (Extremely low)
General memory	69 (Extremely low)
Working memory	105 (Average)

ATL or SelAH

ARTICLE

Anterior temporal lobectomy versus selective amygdalohippocampectomy in patients with mesial temporal lobe epilepsy

Lobectomia temporal anterior versus amigdalohipocampectomia seletiva para epilepsia de lobo temporal mesial

Fábio A. Nascimento[1], Luana Antunes Maranha Gatto[2], Carlos Silvado[3], Maria Joana Mäder-Joaquim[4], Marlus Sidney Moro[2], Joao Candido Araujo[2]

J Neurosurg 108:517–524, 2008

Long-term seizure outcome after mesial temporal lobe epilepsy surgery: corticalamygdalohippocampectomy versus selective amygdalohippocampectomy

TANER TANRIVERDI, M.D.,[1] ANDRE OLIVIER, M.D., PH.D.,[1] NICOLE POULIN, R.N., M.ED.,[1] FREDERICK ANDERMANN, M.D.,[2] AND FRANÇOIS DUBEAU, M.D.[2]

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- Seizure and neuropsychological outcomes did not differ.
- Slight superiority on postoperative verbal memory in SelAH on dominant side

Selective amygdalohippocampectomy versus standard temporal lobectomy in patients with mesial temporal lobe epilepsy and unilateral hippocampal sclerosis

Anne-Sophie Wendling[a,b,c], Edouard Hirsch[b,c], Ilona Wisniewski[a,b,c], Céline Davanture[b], Isabell Ofer[a], Josef Zentner[d], Sofia Bilic[a], Julia Scholly[a], Anke M. Staack[a], Maria-Paula Valenti[b], Andreas Schulze-Bonhage[e], Pierre Kehrli[f], Bernhard J. Steinhoff[a,*]

- SelAH had better visual,verbal short term memory, long-term, working memory than ATL

J Neurosurg 104:70–78, 2006

Seizure and memory outcome following temporal lobe surgery: selective compared with nonselective approaches for hippocampal sclerosis

ELISEU PAGLIOLI, M.D., PH.D., ANDRÉ PALMINI, M.D., PH.D., MIRNA PORTUGUEZ, PH.D., EDUARDO PAGLIOLI, M.D., PH.D., NEY AZAMBUJA, M.D., M.SC., JADERSON COSTA DA COSTA, M.D., PH.D., HÉLIO FERNANDES DA SILVA FILHO, M.D., JOSÉ VICTOR MARTINEZ, M.D., M.SC., AND JOÃO RUBIÃO HOEFFEL, M.D.

Porto Alegre Epilepsy Surgery Program, Hospital São Lucas da Pontifícia Universidade Católica do Rio Grande do Sol, Porto Alegre, Rio Grande do Sul, Brazil

- Similar favorable seizure control (70%)
- Better chance of memory improvement in verbal memory esp. dominant by transcortical AH

J Neurosurg 113:1164–1175, 2010

Memory outcome after temporal lobe epilepsy surgery: corticoamygdalohippocampectomy versus selective amygdalohippocampectomy

Clinical article

TANER TANRIVERDI, M.D.,[1] ROY WILLIAM ROLAND DUDLEY, M.D., PH.D.,[1] ALYA HASAN, M.D.,[1] AHMED AL JISHI, M.D.,[1] QASIM AL HINAI, M.D.,[1] NICOLE POULIN, R.N., M.ED.,[1] SOPHIE COLNAT-COULBOIS, M.D., PH.D.,[2] AND ANDRÉ OLIVIER, M.D., PH.D.[1]

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- Both ATL, SelAH had decreased verbal memory
- Old age, seziure frequency, duration of epilepsy

Meta-analysis

Selective amygdalohippocampectomy versus anterior temporal lobectomy in the management of mesial temporal lobe epilepsy: a meta-analysis of comparative studies

A systematic review

WEN-HAN HU, M.D., PH.D.,[1] CHAO ZHANG, M.D.,[2] KAI ZHANG, M.D., PH.D.,[2] FAN-GANG MENG, M.D., PH.D.,[1] NING CHEN, M.D.,[2] AND JIAN-GUO ZHANG, M.D., PH.D.[1,2]

[1]Beijing Neurosurgical Institute and [2]Department of Neurosurgery, Beijing Tiantan Hospital, Capital Medical University, Beijing, China

Conclusions. Selective amygdalohippocampectomy statistically reduced the odds of being seizure free compared with ATL, but the clinical significance of this reduction needs to be further validated by well-designed randomized trials. Selective amygdalohippocampectomy did not have better outcomes than ATL with respect to intelligence. *(http://thejns.org/doi/abs/10.3171/2013.8.JNS121854)*

Systematic review and meta-analysis of standard vs selective temporal lobe epilepsy surgery

Conclusions: Standard ATL confers an improved chance of achieving freedom from disabling seizures in patients with TLE. Improved seizure freedom must be balanced against the neuropsychological impact of each procedure. A randomized controlled trial is justified. **Neurology® 2013;80:1669–1676**

Epilepsy

RESEARCH PAPER

Systematic review and network meta-analysis of resective surgery for mesial temporal lobe epilepsy

Puneet Jain,[1] George Tomlinson,[2,3] Carter Snead,[1] Beate Sander,[2,3] Elysa Widjaja[1,3,4]

Conclusion Direct evidence, indirect evidence and NMA did not identify a difference in seizure-free outcome of ATL versus SAH.

Predictive factors

- Epilepsy duration is the most important predictor for long-term surgical outcome (Jansky J. Brain 2005)
  - Surgery for TLE-HS should be performed as early as possible
- History of status epilepticus, Preoperative use of intracranial EEG (Mathon B. Epilepsia 2017)
- History of febrile seizure, ATL predicted good outcome, Dysmnesic and olfactory aura predicted unfavorable outcome (Dalio MTRP. Front Neurol 2022)
- Secondarily generalized tonic-clonic seizures (2nd GTC) (Henessy MJ. Acta Neurol Scand 2001)
- Unilateral MRI abnormality (Arruda F. Ann Neurol 1996)

Outcomes

	1 year (n=8247)	2 years (n=8191)	5 years (n=5577)
Hippocampal sclerosis	76·0% (74–78; 2359/3103)	71·5% (70–73; 2108/2948)	70·3% (68–72; 1471/2092)
LEAT	80·3% (78–82; 1063/1323)	77·5% (75–80; 1027/1325)	75·9% (73–79; 681/897)
LGNET	71·6% (60–81; 58/81)	70·6% (61–79; 72/102)	68·9% (57–79; 51/74)
DNET	77·7% (74–81; 390/502)	74·8% (71–79; 362/484)	74·6% (70–79; 256/343)
Ganglioglioma	83·1% (80–86; 557/670)	80·4% (77–83; 540/672)	77·4% (73–81; 336/434)
LEAT-other	82·9% (72–90; 58/70)	79·1% (67–88; 53/67)	82·6% (68–92; 38/46)
FCD type II	69·4% (66–73; 496/715)	64·9% (62–68; 517/796)	67·4% (63–71; 370/549)
No lesion	60·2% (56–64; 435/723)	53·5% (50–57; 396/740)	51·2% (47–56; 247/482)
Gliosis	60·3% (56–64; 330/547)	53·2% (49–57; 311/585)	51·1% (46–56; 182/356)
Normal tissue	59·7% (52–67; 105/176)	54·8% (47–63; 85/155)	51·6% (43–61; 65/126)
Vascular malformation	77·1% (73–81; 357/463)	74% (70–78; 328/443)	72·2% (67–77; 205/284)
Vascular-other	72·5% (63–80; 87/120)	65·8% (57–74; 79/120)	61·6% (50–72; 53/86)
Cavernoma	78·7% (74–83; 270/343)	77·1% (72–81; 249/323)	76·8% (70–82; 152/198)
FCD type I and mild MCD	54·7% (49–60; 198/362)	50% (45–55; 213/426)	51·9% (46–58; 153/295)
Mild MCD	50·3% (42–59; 74/147)	45·5% (38–53; 81/178)	48·9% (40–57; 68/139)
FCD type I	57·7% (51–64; 124/215)	53·2% (47–60; 132/248)	54·5% (46–62; 85/156)
MCD-other	53·4% (48–58; 220/412)	52·3% (47–57; 212/405)	51·2% (45–57; 148/289)
Hypothalamic hamartoma	43·2% (34–52; 54/125)	43% (34–53; 46/107)	49·3% (38–61; 36/73)
Tuber	52·1% (43–61; 62/119)	50% (41–59; 58/116)	45·4% (35–56; 44/97)
Other	61·9% (54–69; 104/168)	59·3% (52–66; 108/182)	57·1% (48–66; 68/119)
FCD-not otherwise specified	71·3% (67–76; 303/425)	69·7% (65–74; 288/413)	59·5% (52–66; 122/205)
Non-LEAT	72·3% (67–77; 251/347)	68·4% (63–73; 212/310)	67·6% (61–74; 152/225)
Oligodendroglioma	67·2% (58–75; 80/119)	66·4% (56–75; 71/107)	67·9% (56–78; 55/81)
Tumour-other	75·0% (69–80; 171/228)	69·5% (63–76; 141/203)	67·4% (59–75; 97/144)
Glial scar	62·1% (56–68; 149/240)	59·4% (53–65; 155/261)	56·1% (48–64; 96/171)
Encephalitis	67·2% (58–75; 90/134)	59·7% (50–68; 74/124)	54·5% (44–65; 48/88)
Encephalitis-other	51·8% (38–65; 29/56)	42·3% (29–57; 22/52)	50% (34–66; 18/36)
Rasmussen	78·2% (67–86; 61/78)	72·2% (60–82; 52/72)	57·7% (43–71; 30/52)
Total	71·8% (71–73; 5921/8247)	67·5% (66–69; 5530/8191)	66·2% (65–67; 3693/5577)

Data are % (95% CI; n/N). Freedom from disabling seizures defined as Engel class 1. LEAT=low-grade epilepsy associated neuroepithelial tumour. LGNET=low-grade neuroepithelial tumour. DNET=dysembryoplastic neuroepithelial tumour. FCD=focal cortical dysplasia. MCD=malformation of cortical development.

Table 2: Freedom from disabling seizures at 1, 2, and 5 years after surgery, by histopathological diagnosis

	1 year (n=5861)	2 years (n=5461)	5 years (n=3753)
Hippocampal sclerosis	5·5% (5–7; 123/2228)	13·2% (12–15; 257/1940)	32·8% (30–35; 423/1290)
LEAT	5·2% (4–7; 48/924)	22·9% (20–26; 205/896)	47·1% (43–51; 288/612)
LGNET	4·9% (1–18; 2/41)	17·7% (10–30; 11/62)	42·3% (29–57; 22/52)
DNET	6·9% (5–10; 27/392)	21·4% (17–26; 74/346)	44·7% (38–51; 109/244)
Ganglioglioma	3·9% (2–6; 18/458)	25·2% (21–29; 115/457)	51·0% (45–57; 149/292)
LEAT-other	3·0% (0–18; 1/33)	16·1% (6–34; 5/31)	33·3% (16–55; 8/24)
FCD type II	5·8% (4–8; 29/504)	15·8% (13–19; 86/545)	34·9% (30–40; 147/421)
No lesion	3·4% (2–5; 20/593)	10·4% (8–13; 61/584)	20·2% (16–25; 77/381)
Gliosis	3·1% (2–5; 14/454)	10·6% (8–14; 50/470)	22·1% (18–27; 65/294)
Normal tissue	4·3% (2–10; 6/139)	9·6% (5–17; 11/114)	13·8% (8–23; 12/87)
Vascular malformation	6·7% (4–10; 21/315)	24·8% (20–30; 74/298)	36·6% (30–44; 70/191)
Vascular-other	11·5% (6–21; 10/87)	27·4% (18–38; 23/84)	36·5% (25–50; 23/63)
Cavernoma	4·8% (3–9; 11/228)	23·8% (18–30; 51/214)	36·7% (29–46; 47/128)
FCD type I and mild MCD	1·6% (0–4; 4/258)	7·1% (4–11; 19/268)	19·5% (15–25; 43/221)
Mild MCD	0 (0–5; 0/102)	9·3% (5–16; 11/118)	25·3% (17–35; 25/99)
FCD type I	2·6% (1–7; 4/156)	5·3% (3–11; 8/150)	14·8% (9–23; 18/122)
MCD-other	9·3% (6–14; 23/247)	20·3% (15–26; 44/217)	30·1% (23–38; 52/173)
Hypothalamic hamartoma	16·4% (9–28; 11/67)	19·6% (10–34; 9/46)	21·2% (10–39; 7/33)
Tuber	3·1% (1–12; 2/64)	11·3% (5–22; 7/62)	21·6% (12–36; 11/51)
Other	8·6% (4–16; 10/116)	25·7% (18–35; 28/109)	38·2% (28–49; 34/89)
FCD-not otherwise specified	6·4% (4–10; 20/314)	19·7% (15–25; 59/300)	37% (29–45; 57/154)
Non-LEAT	6·5% (4–11; 16/246)	19·5% (14–26; 40/205)	32·9% (26–41; 50/152)
Oligoastrocytoma	6·8% (3–15; 6/88)	14·7% (8–25; 11/75)	31·2% (21–44; 20/64)
Tumour-other	6·3% (3–12; 10/158)	22·3% (16–31; 29/130)	34·1% (25–45; 30/88)
Glial scar	5·6% (3–11; 8/144)	12·3% (7–20; 16/130)	24·3% (17–34; 25/103)
Encephalitis	12·5% (7–22; 11/88)	25·6% (17–37; 20/78)	32·7% (21–47; 18/55)
Encephalitis-other	10·3% (3–28; 3/29)	21·4% (9–41; 6/28)	15·8% (4–40; 3/19)
Rasmussen	13·6% (6–26; 8/59)	28% (17–43; 14/50)	41·7% (26–59; 15/36)
Total	5·5% (5–6; 323/5861)	16·1% (15–17; 881/5461)	33·3% (32–35; 1250/3753)

Data are % (95% CI; n/N). Freedom from disabling seizures defined as Engel class 1. LEAT=low-grade epilepsy associated neuroepithelial tumour. LGNET=low-grade neuroepithelial tumour. DNET=dysembryoplastic neuroepithelial tumour. FCD=focal cortical dysplasia. MCD=malformation of cortical development.

Table 3: Freedom from disabling seizures (Engel class 1) and complete discontinuation of antiepileptic drugs at 1, 2, and 5 years after surgery, by histopathological diagnosis

Lamberink H, et al. Lancet Neurol 2020,; 19:748-57.

Outcomes after Temporal Lobectomy for Temporal Lobe Epilepsy with Hippocampal Sclerosis

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Long-Term Seizure Outcome after Temporal Lobectomy for Hippocampal Sclerosis

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Table 2. The number of patients and seizure outcomes in longitudinal follow-up

Years of follow-up	Seizure free n (%)	Not seizure free n (%)	Total
5	93 (83.0)	19 (17.0)	112
6	78 (82.1)	17 (17.9)	95
7	70 (80.5)	17 (19.5)	87
8	57 (76.0)	18 (24.0)	75
9	41 (77.4)	12 (22.6)	53
10	32 (74.4)	11 (25.6)	43
11	3 (100)	-	3

Results: Sixty one patients (54.5%) were seizure free for the entire period after surgery. One hundred patients (89.3%) were seizure free for at least two years at the last follow-up. Forty three patients (38.4%) were able to stop antiepileptic medications. The mean follow-up was 8.1±1.9 years (range 5 to 11 years). A preoperative secondarily generalized tonic-clonic seizure was predictor for poor seizure outcome.

Complications

Complications After Surgery for Mesial Temporal Lobe Epilepsy Associated with Hippocampal Sclerosis

Bertrand Mathon[1,6], Vincent Navarro[2,5,6], Franck Bielle[3,6], Vi-Huong Nguyen-Michel[2], Alexandre Carpentier[1,5,6], Michel Baulac[2,5,6], Philippe Cornu[1,6], Claude Adam[2,5], Sophie Dupont[2,4-6], Stéphane Clemenceau[1]

Table 6. Morbidity and Mortality of MTLE Surgery: Literature Review

Reference (Period)	Institution	Surgical Approach	Number	Complications Overall/ Major/Permanent	Death
Rydenhag[11] (1990—1995)	Swedish National Epilepsy Surgery Register, Sweden	ATL	168	12.4%/2.9%/?	0%
Behrens[12] (1987—1997)	University of Bonn, Bonn, Germany	ts SAH	279	?/4.7%/2.3%	0%
Salanova[13] (1984—1999)	Indiana University, Indianapolis, Indiana, USA	?	104	9.5%/5.8%/1.3%	0%
Sindou[14] (1994—2003)	Pierre Wertheimer Hospital, Lyon, France	ATL, ts SAH	100	19.0%/7.0%/2.0%	0%
Bate[15] (1996—2004)	Walton Centre, Liverpool, GB	SAH, ATL	114	10.5%/6.1%/2.6%	0%
Tanriverdi[16] (1976—2006)	MNI, Montreal, Canada	?	1232	5.5%/2.8%/?	0%
Bandt[17] (1997—2007)	Washington University, St Louis, MO, USA	tcT2 SAH	76	?/3.0%/0.0%	0%
Iachinski[18] (1998—2010)	Curitiba Institute, Curitiba, Brazil	ATL	67	17.9%/13.4%/0.0%	0%
Vale[3] (1998—2012)	University of South Florida, Tampa, Florida, USA	tcT3 SAH	483	?/2.7%/0.2%	0%
Yang[19] (2004—2012)	Fuzhou General Hospital, Fuzhou, China	CAH	683	?/1.8%/?	0%
Josephson[20] (1997—2012)	Meta-analysis (5 studies)	SAH	309	?/?/0.0—3.1%	?
		ATL	392	?/?/0.0—2.4%	
Current series (1990—2015)	La Pitié-Salpêtrière University Hospital, Paris, France	**Total**	**389**	**15.4%/4.1%/0.5%**	**0%**
		tcT1 SAH	144	12.5%/2.1%/0.0%	
		ts SAH	36	16.7%/2.8%/0.0%	
		ATL	209	17.2%/5.7%/1.0%	

The boldface in the footnote is the result of our series compared to the literature.

ATL, anterior lobectomy lobectomy; ts, transylvian; SAH, selective amygdalohippocampectomy; tc, transcortical; T2, middle temporal gyrus; T3, inferior temporal gyrus; CAH, cortico-amygdalohippocampectomy; T1, superior temporal gyrus; ?, not applicable.

Complications of Epilepsy Surgery: Prasat Neurological Institute Experiences

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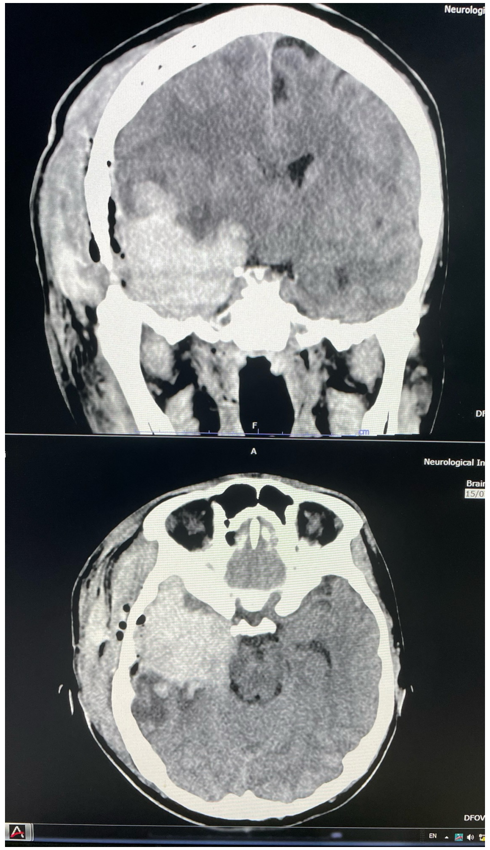
Table 1. Operative procedures and type of complications

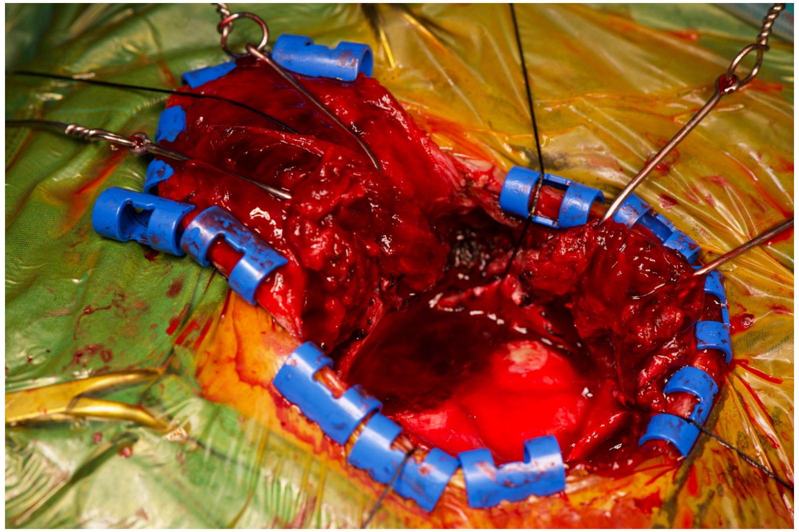
Type of surgery	Total n	Surgical complications, n (%)	Transient neurological complications, n (%)	Permanent neurological complications, n (%)
Temporal lobe surgery	125			
Temporal lobectomy + mesial structures	107 (100)	14 (13.1)	9 (8.4)	3 (2.8)
Temporal lobectomy sparing mesial structures	2 (100)	0 (0.0)	0 (0.0)	0 (0.0)
Selective amygdalohippocampectomy	4 (100)	2 (50.0)	0 (0.0)	0 (0.0)
Lesionectomy/corticectomy	12 (100)	0 (0.0)	0 (0.0)	0 (0.0)

Table 2. Complications after 199 therapeutic surgical procedures

Type of operations	Surgical complications (n)	Transient neurological complications (n)	Permanent neurological complications (n)
TL + mesial	- Infection 11 (meningitis 10, bone flap infection 1) - Hematoma 4 (CSDH 1, ICH 3) - CSF rhinorrhea 1 - Subdural hygroma - Upper GI bleeding 1 - Drug induced hepatitis 1	- Hemiparesis 2 - Dysphasia 1 - CN paresis (CN IV 2, CN VII branch 1)	- Hemiparesis 2 - Dysphasia 2 - Numbness 1
TL excluding mesial	-	-	- Dysphasia 1
Selective AH	- Drug allergy 1	-	-

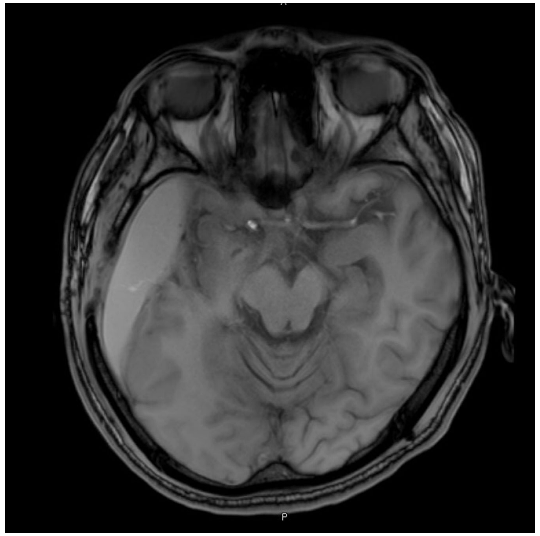
Complications

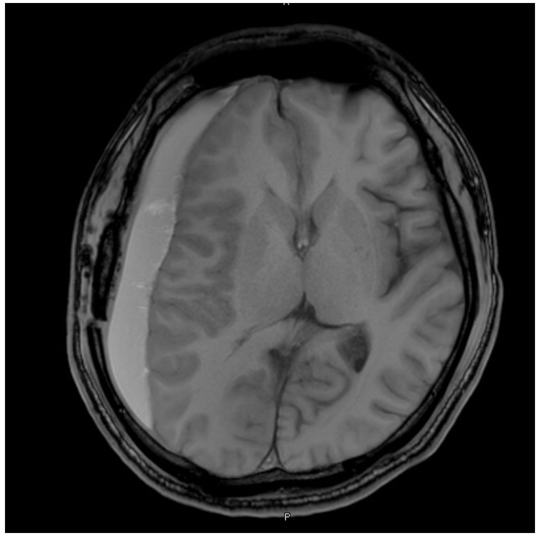




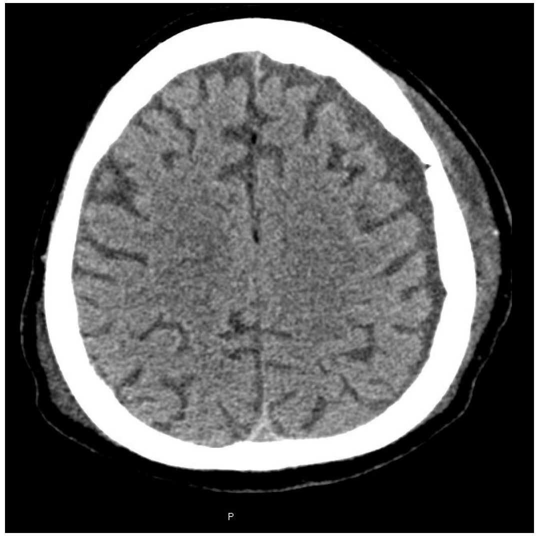
Intracerebral hemorrhage

Chronic subdural hematoma

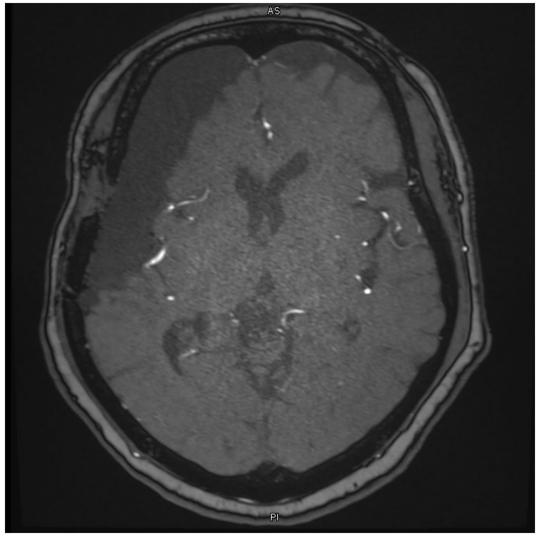


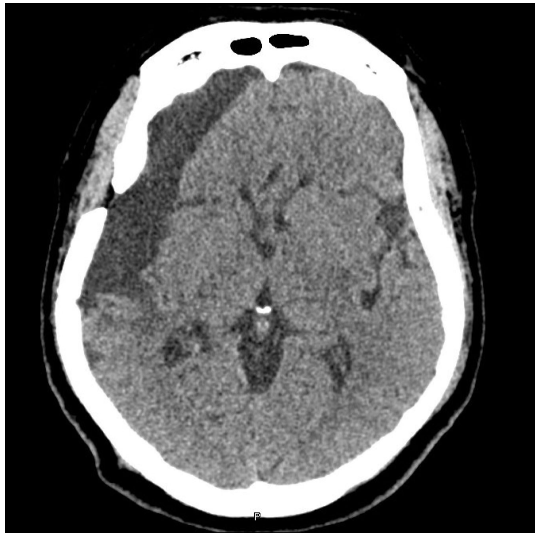


Complications

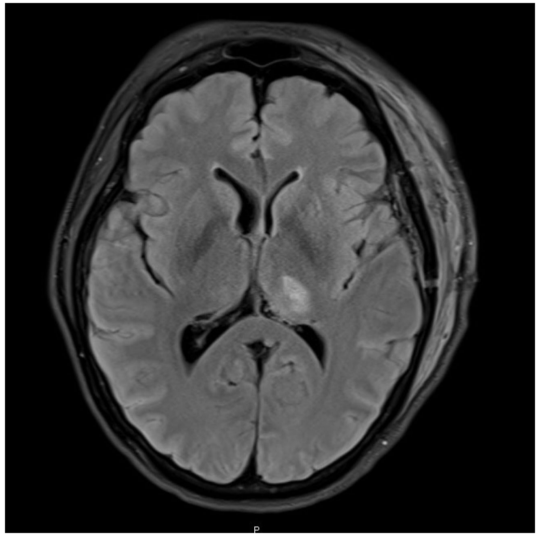


Subdural hygroma





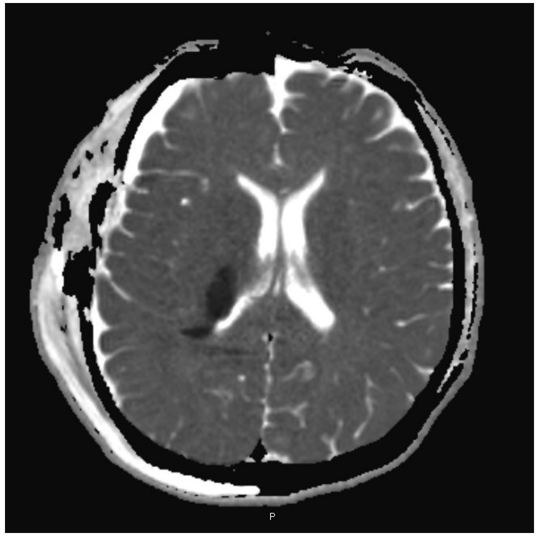
Complications

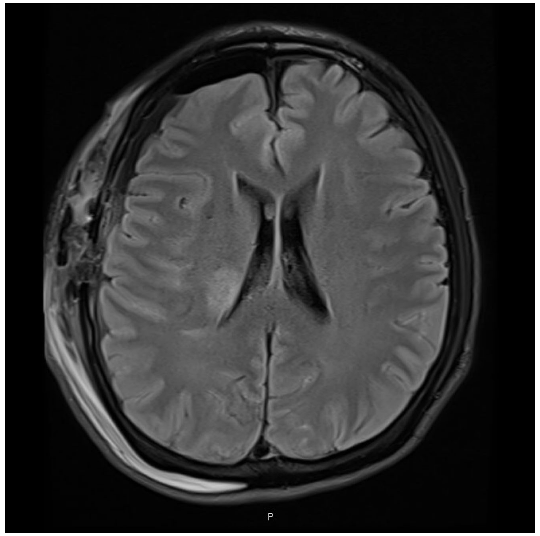


Right sided numbness

Ischemia

Left leg weakness





Outcome

Case #1 SelAH

- Immediate postop motor aphasia
- Gradually improved
- Seizure free 1 year
- Postop EEG: Sharp wave left F-T

- **Case # 2** ATL
- No complications
- Seizure free 1 year

Patient attitudes

- 62% of patients would only consider open surgery as a last option
- Brain surgery having a mean dangerousness of 8.3/10 among epilepsy patients
- 51% of the patient would not consider the treatment even if it was guaranteed to stop their seizures without causing any deficits

Physician atttitudes

Ablative Surgery

Stereotactic radiofrequency thermocoagulation

Clinical Study

Stereotactic and Functional Neurosurgery

Stereotact Funct Neurosurg 2014;92:372–380
DOI: 10.1159/000366003

Different Surgical Approaches for Mesial Temporal Epilepsy: Resection Extent, Seizure, and Neuropsychological Outcomes

Hana Malikova[a, f] Lenka Kramska[b] Zdenek Vojtech[c, g] Roman Liscak[d]
Jan Sroubek[e] Jiri Lukavsky[h] Rastislav Druga[f]

Departments of [a]Radiology, [b]Clinical Psychology, [c]Neurology, [d]Radiation and Stereotactic Neurosurgery and [e]Neurosurgery, Epilepsy Center, Na Homolce Hospital, [f]Institute of Anatomy, 2nd Medical Faculty, and [g]Department of Neurology, 3rd Medical Faculty, Charles University in Prague, and [h]Institute of Psychology, Academy of Sciences of the Czech Republic, Prague, Czech Republic

Epilepsy Research (2013) 106, 423–432

ELSEVIER

journal homepage: www.elsevier.com/locate/epilepsyres

Stereotactic radiofrequency amygdalohippocampectomy: Two years of good neuropsychological outcomes

Hana Malikova[a,*,1], Lenka Kramska[b,1], Zdenek Vojtech[b], Jiri Lukavsky[c], Roman Liscak[d]

[a] Epilepsy Center Na Homolce Hospital, Department of Radiology, Roentgenova 2, 150 00 Prague 5, Czech Republic
[b] Epilepsy Center Na Homolce Hospital, Department of Neurology, Roentgenova 2, 150 00 Prague 5, Czech Republic
[c] Institute of Psychology, Academy of Sciences of the Czech Republic, Politickych veznu 936/7, 110 00 Prague 1, Czech Republic
[d] Epilepsy Center Na Homolce Hospital, Department of Stereotactic and Radiation Neurosurgery, Roentgenova 2, 150 00 Prague 5, Czech Republic

- Stereotactic radiofrequency amygdalohippocampectpmy (SAHE) vs Standard temporal lobectomy (TL)
- No difference in seizure free outcome 76%
- Good neuropsychological outcomes in SAHE

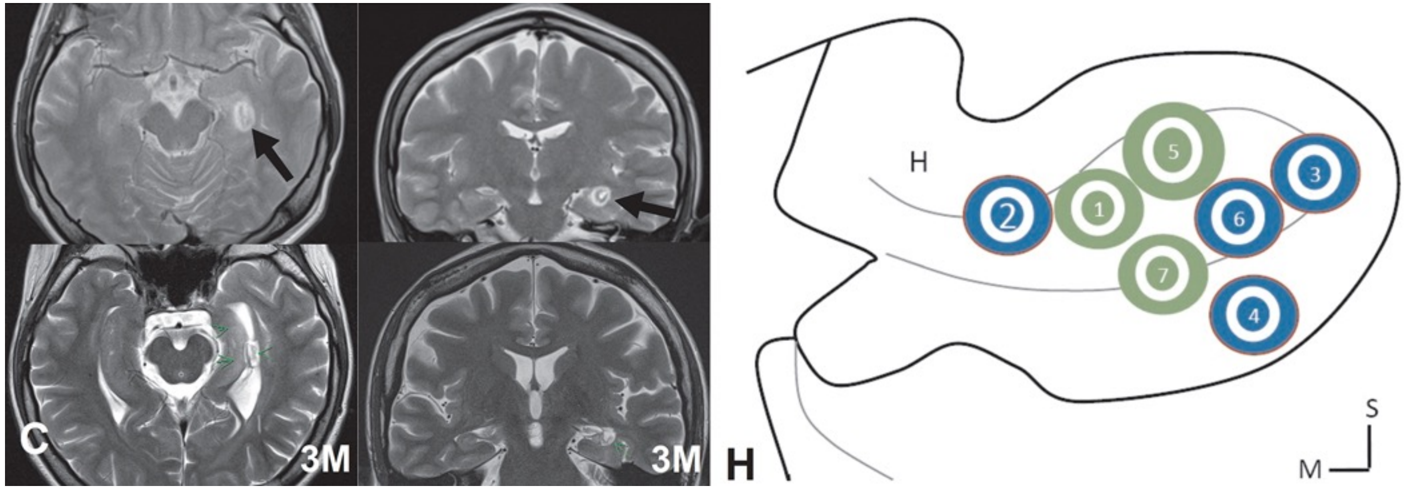
JNS
CLINICAL ARTICLE
J Neurosurg 131:781–789, 2019

Efficacy of limited hippocampal radiofrequency thermocoagulation for mesial temporal lobe epilepsy

Ching-Yi Lee, MD,[1] Han-Tao Li, MD,[2] Tony Wu, MD, PhD,[2] Mei-Yun Cheng, MD, PhD,[2] Siew-Na Lim, MD, PhD,[2] and Shih-Tseng Lee, MD[1]

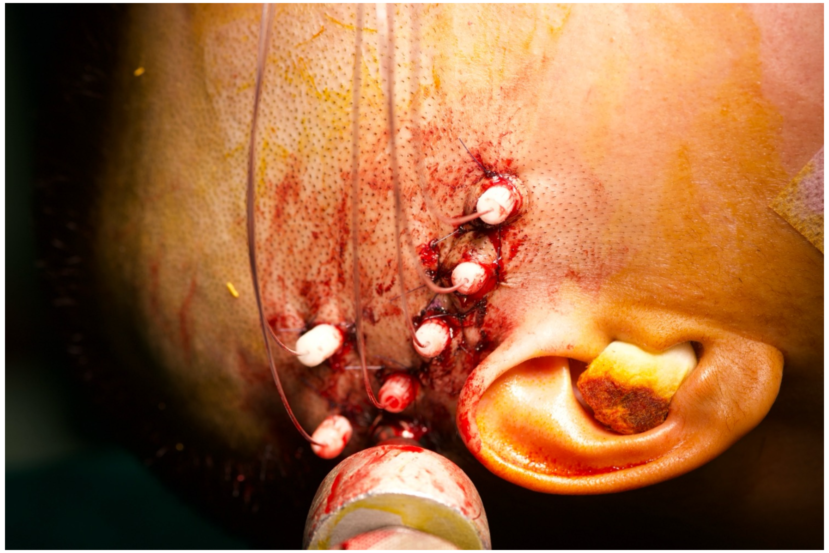
[1]Department of Neurosurgery; and [2]Section of Epilepsy, Department of Neurology, Chang Gung Memorial Hospital Linkou Medical Center and Chang Gung University College of Medicine, Taoyuan, Taiwan

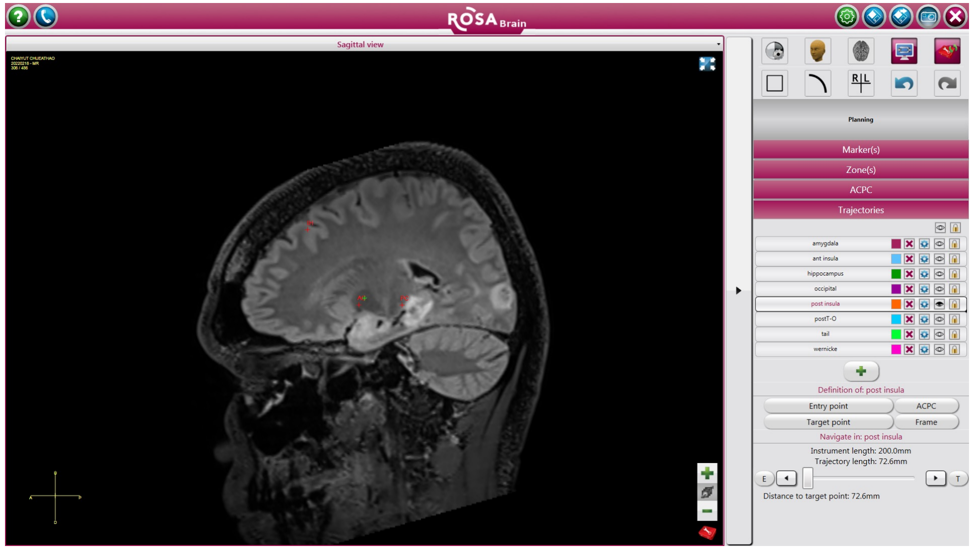
- MTLE (HS 1/7)
- Mean seizure reduction 78%
- Seizure free 57% (FU 6 months)
- Good outcome correlated with location of RFTC target (dendate)
- Preservation of IQ, memory

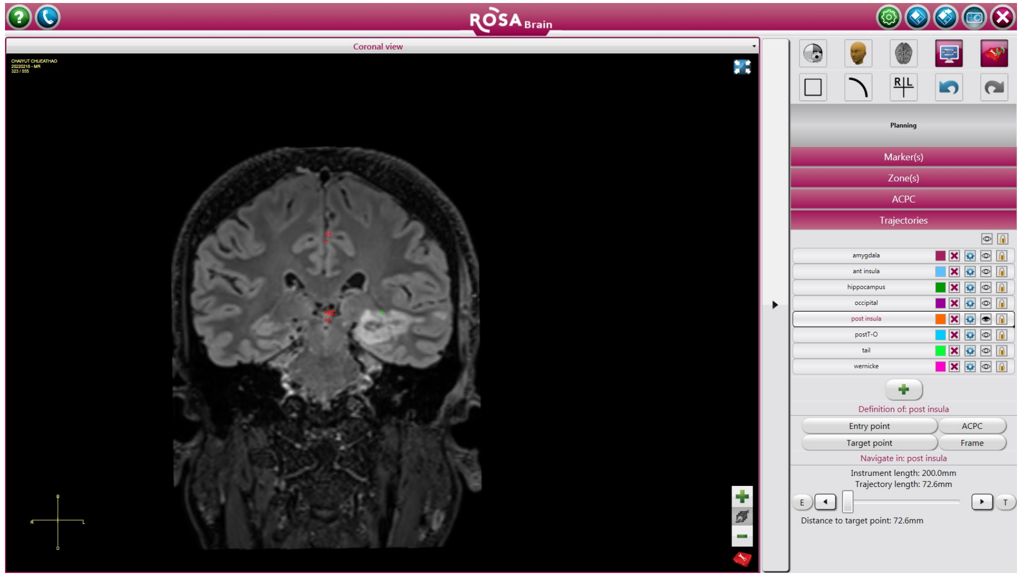


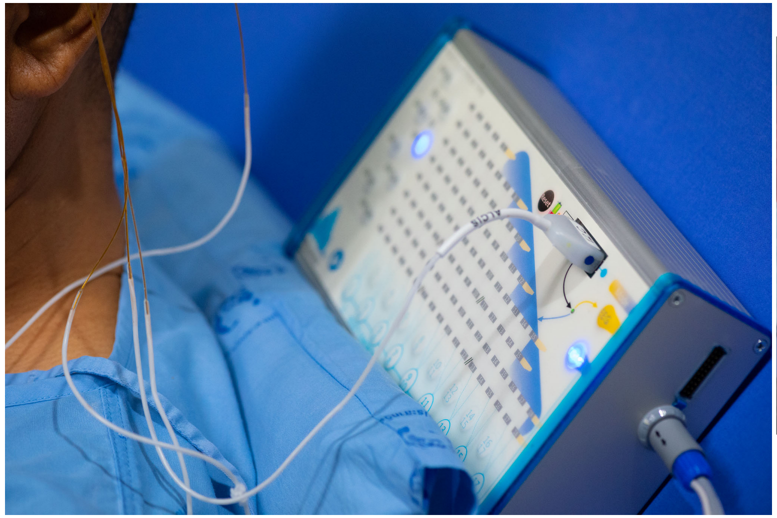
SEEG-guided radiofrequency thermocoagulation

- No additional bleeding risk
- Accurate targeting seizure onset zone (previously delinated by intracranial recording)
- Multiple lesions can be performed
- Functional mapping through direct electrical stimulation on SEEG (anticipate possible adverse effects)
- Cognitive outcome, visual field









SEEG guided thermocoagulation

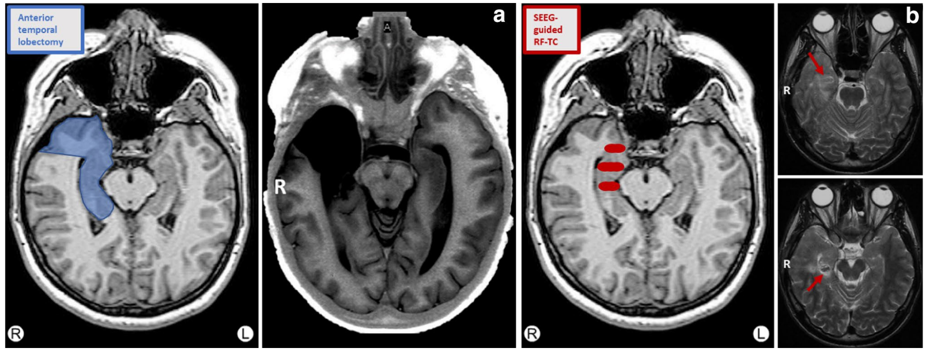
Journal of Neurology (2018) 265:1998–2004
https://doi.org/10.1007/s00415-018-8958-9

ORIGINAL COMMUNICATION

SEEG-guided radiofrequency coagulation (SEEG-guided RF-TC) versus anterior temporal lobectomy (ATL) in temporal lobe epilepsy

Alexis Moles[1,2,3] · Marc Guénot[1,4,5] · Sylvain Rheims[4,6,7] · Julien Berthiller[8] · Hélène Catenoix[6] · Alexandra Montavont[9] · Karine Ostrowsky-Coste[9] · Sebastien Boulogne[4,6] · Jean Isnard[6] · Pierre Bourdillon[1,4,10,11]

- None of SEEG-guide RF-TC patients group was seizure free
- ATL group 75.5% seizure free
- No memory impairment following SEEG-guided RF-TC
- MTLE (various etiologies)



Contents lists available at ScienceDirect

Seizure: European Journal of Epilepsy

journal homepage: www.elsevier.com/locate/seizure

Optimized SEEG-guided radiofrequency thermocoagulation for mesial temporal lobe epilepsy with hippocampal sclerosis

Xiaotong Fan[a,1], Yongzhi Shan[a,1], Chao Lu[a], Yang An[a], Yihe Wang[a], Jialin Du[b], Di Wang[b], Penghu Wei[a], Robert S. Fisher[c], Yuping Wang[b,d], Liankun Ren[b,**,2], Guoguang Zhao[a,d,*,2]

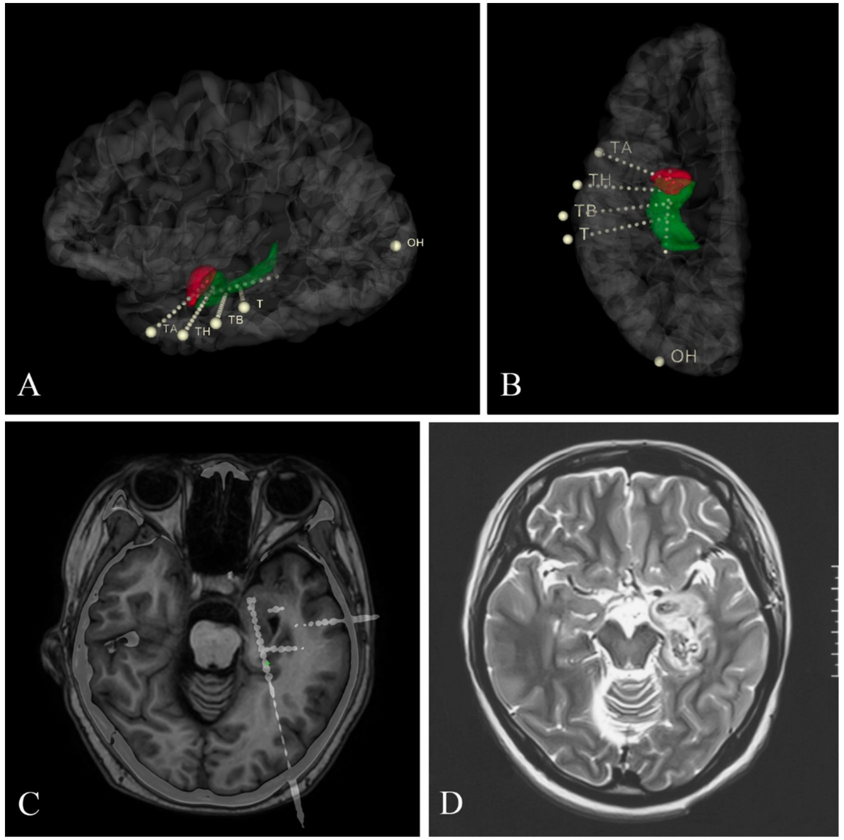
[a] Department of Neurosurgery, Xuanwu Hospital, Capital Medical University (CMU), Beijing, China
[b] Department of Neurology, Xuanwu Hospital, Capital Medical University (CMU), Beijing, China
[c] Department of Neurology and Neurological Sciences, Stanford University, Stanford, California, USA
[d] Beijing Institute for Brain Disorders, Beijing, China

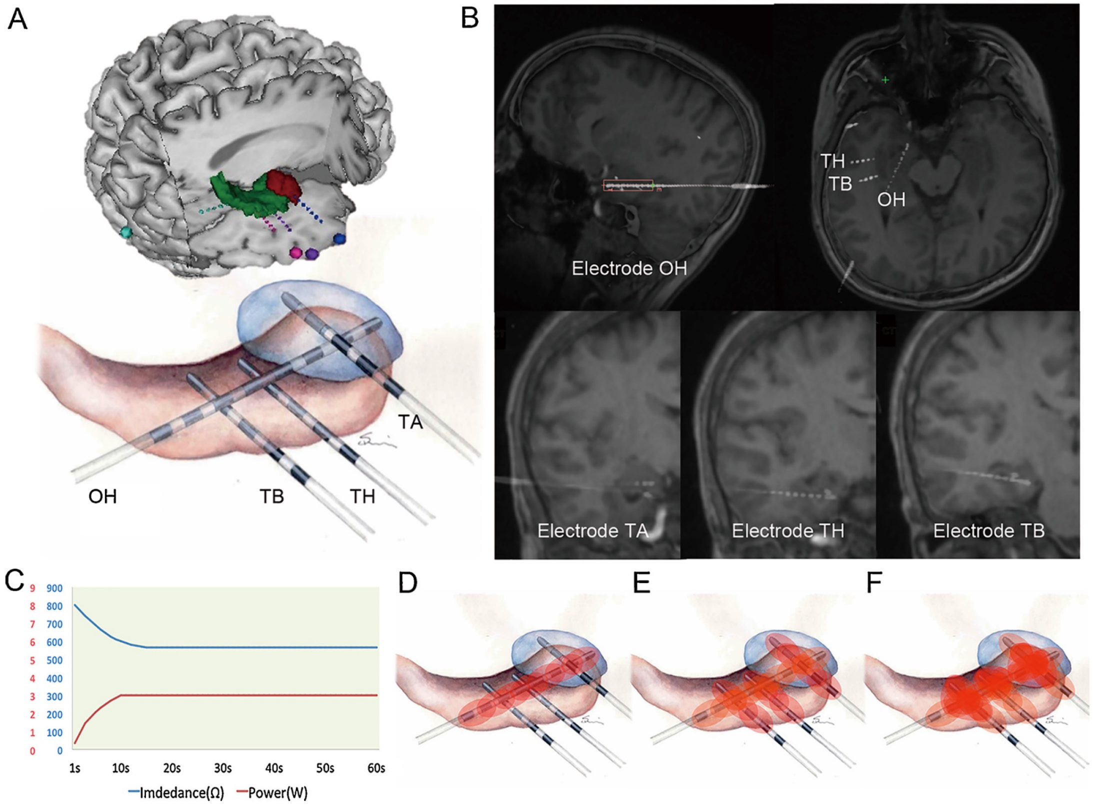
- 95.2% patient had >90% decrease in seizure frequency, (Engel I 76.2%) @ 12 months
- Thermocoagulation versus anterior temporal lobectomy for mesial temporal lobe epilepsy with hippocampal sclerosis (STARTS)

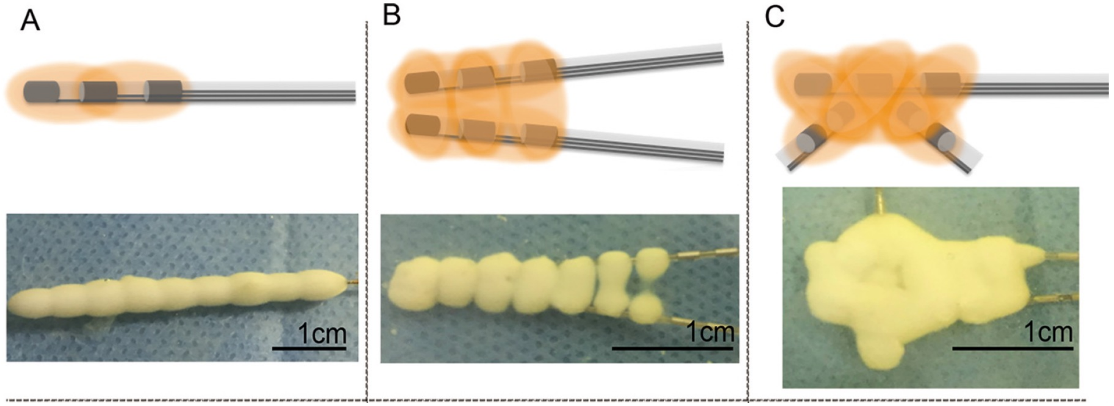
STUDY PROTOCOL Open Access

Stereotactic EEG-guided radiofrequency thermocoagulation versus anterior temporal lobectomy for mesial temporal lobe epilepsy with hippocampal sclerosis: study protocol for a randomised controlled trial

Yi-He Wang[1†], Si-Chang Chen[1†], Peng-Hu Wei[1], Kun Yang[2], Xiao-Tong Fan[1], Fei Meng[1], Jia-Lin Du[3], Lian-Kun Ren[3], Yong-Zhi Shan[1*] and Guo-Guang Zhao[1,4*]







SEEG-guided three dimensional cross bonding RF-TC

DOI: 10.1002/epi4.12866

ORIGINAL ARTICLE

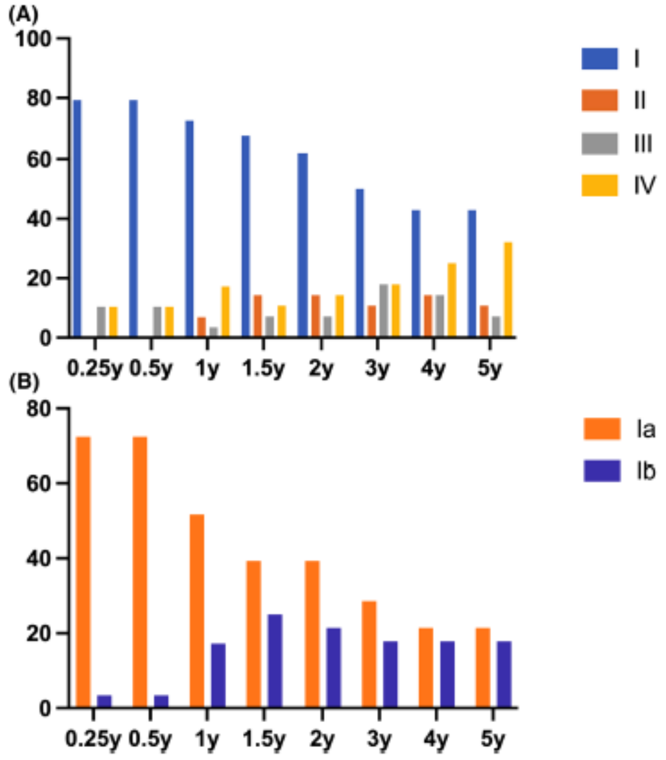
Epilepsia Open® Open Access

Stereo-electroencephalography-guided three-dimensional radiofrequency thermocoagulation for mesial temporal lobe epilepsy with hippocampal sclerosis: A retrospective study with long-term follow-up

Kaiwei Li[1,2] | Jianwei Shi[1,2] | Penghu Wei[1,2] | Xiaosong He[3] | Yongzhi Shan[1,2] | Guoguang Zhao[1,2]

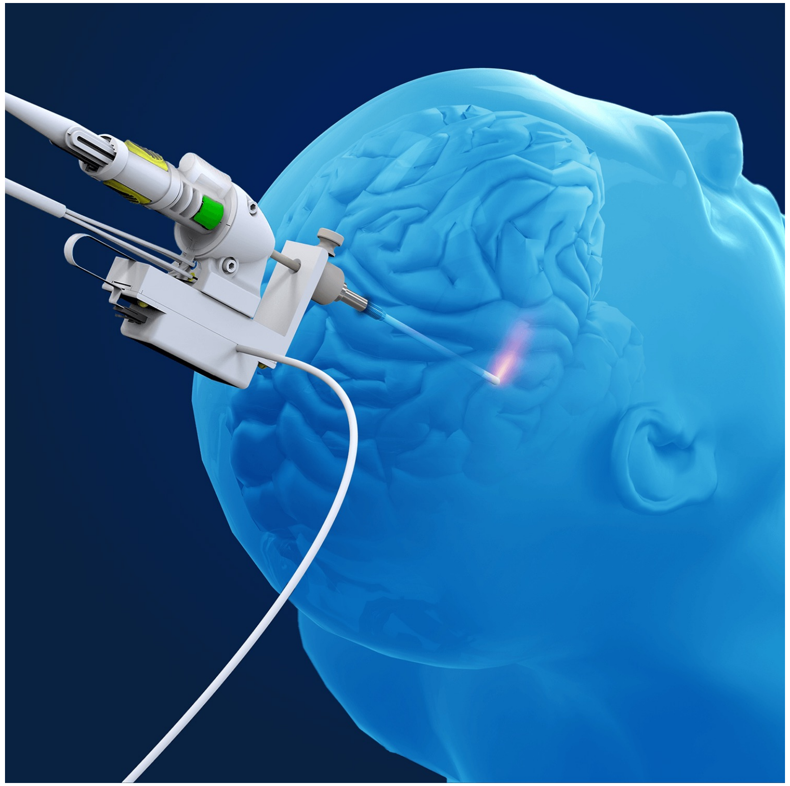
Engel I

- 72.41% (12 months)
- 67.86% (18 months)
- 62.07% (24 months)
- 50.00% (36 months)
- 42.86% (48 months)
- 42.86% (60 months)



MRI guided Laser Interstitial thermal therapy

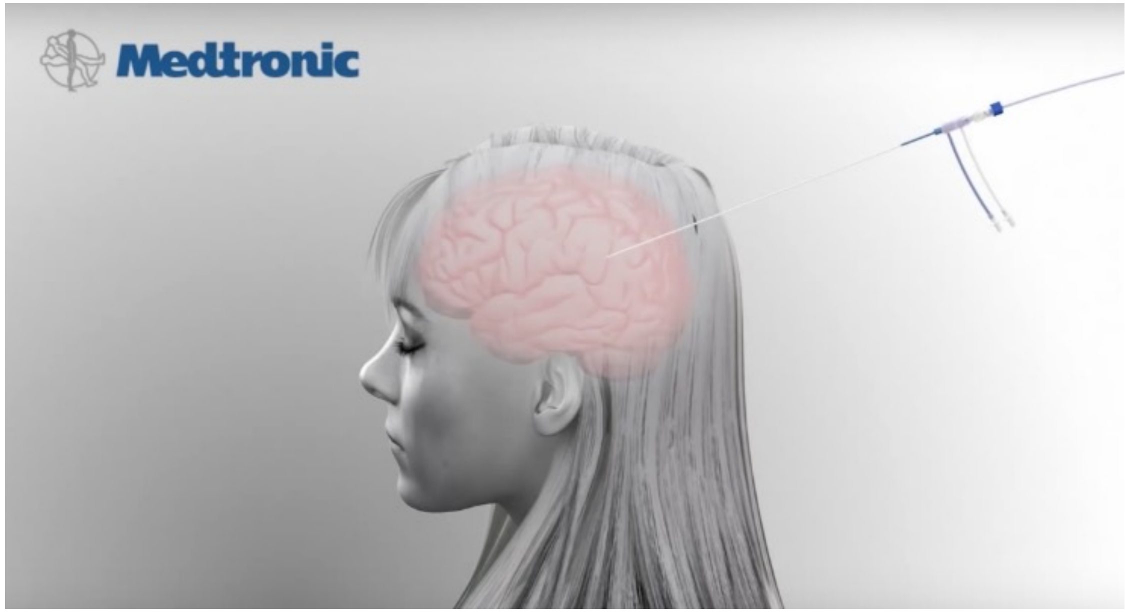
(MRgLITT)



NeuroBlade (Monteris)

6 mm cylindrical tip, or side fire tip

CO_2 coolant

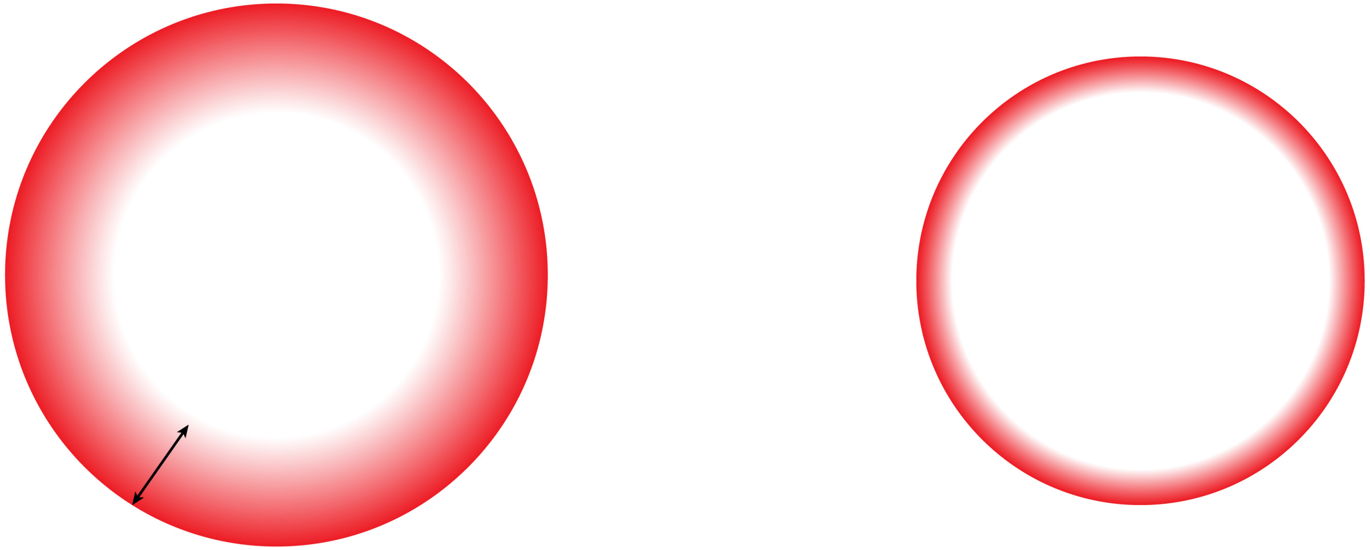


Visualase (Medtronic)

3- or 10 mm cylindrical tip

Saline coolant

Transition zone between dead and viable tissue



Radiofrequency (5-10 mm)

Laser (<1 mm)

Advantage

- Low morbidity
- Small incision,
- Confirmation of targeting before ablation
- Immediate effect, minimal hospital stay
- Easily coupled to stereoEEG
- Increased acceptance/referrals
    - Patient refusing open surgery
    - Referring neurologists refusing open surgery
- Less suited to large onset zone

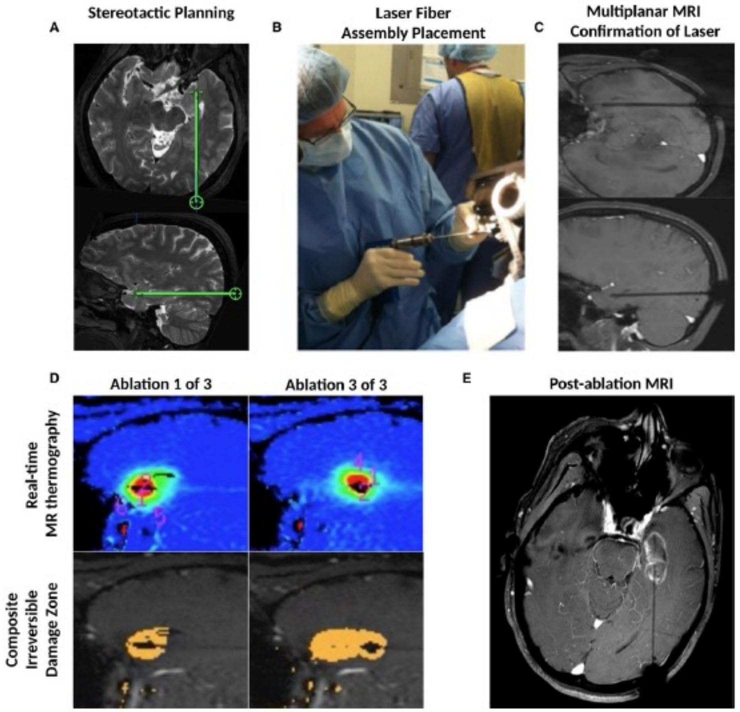
Accepted: 17 December 2017
DOI: 10.1111/epi.14004

FULL-LENGTH ORIGINAL RESEARCH

Epilepsia

Laser ablation is effective for temporal lobe epilepsy with and without mesial temporal sclerosis if hippocampal seizure onsets are localized by stereoelectroencephalography

Brett E. Youngerman[1] | Justin Y. Oh[1] | Deepti Anbarasan[2,3] | Santoshi Billakota[2,3] | Camilla H. Casadei[2,3] | Emily K. Corrigan[1] | Garret P. Banks[1] | Alison M. Pack[2,3] | Hyunmi Choi[2,3] | Carl W. Bazil[2,3] | Shraddha Srinivasan[2,3] | Lisa M. Bateman[2,3] | Catherine A. Schevon[2,3] | Neil A. Feldstein[1,3] | Sameer A. Sheth[1,3] | Guy M. McKhann II[1,3] | For the Columbia Comprehensive Epilepsy Center Co-Authors*



- Less invasive, shorter LOS and recovery, low morbidity
- Seizure free MTLE-HS 56%, MTLE 58%
- First option for MTLE?

Magnetic Resonance–Guided Laser Interstitial Thermal Therapy for Mesial Temporal Epilepsy: A Case Series Analysis of Outcomes and Complications at 2-Year Follow-Up

Iahn Cajigas[1], Andres M. Kanner[2], Ramses Ribot[2], Amanda M. Casabella[1], Anil Mahavadi[1], Walter Jermakowicz[1], Samir Sur[1], Carlos Millan[2], Anita Saporta[2], Merredith Lowe[2], Naymee Velez-Ruiz[2], Gustavo Rey[2], George M. Ibrahim[3], Michael E. Ivan[1], Jonathan R. Jagid[1]

- Seizure free
  - MTS 68%, non-MTS 43% (p=0.23)
- Complications (7.7%)
  - Transient (1), permanent (1) homonymous hemianopia

LITERATURE REVIEW

Check for updates

Surgical Outcomes of Laser Interstitial Thermal Therapy for Temporal Lobe Epilepsy: Systematic Review and Meta-analysis

Panagiotis Kerezoudis[1], Veronica Parisi[1], W. Richard Marsh[1], Timothy J. Kaufman[2], Vance T. Lehman[2], Gregory A. Worrell[3], Kai J. Miller[1], Jamie J. Van Gompel[1]

- TLE seizure free 58%
- TLE & MTS seizure free 66%
- Not associated with total ablation volume, hippocampal volume, amygdala volume
- Complication 17% (visual field deficits)
  - Transient 10%
  - Permanent 5%

Comparison of minimally invasive and traditional surgical approaches for MTLE: A systematic review and meta-analysis of outcome

	Engel Class I	Major complications
MRgLITT	57%	3.8%
Radiofrequency ablation	44%	3.47%
ATL	69%	10.9%
sAHE	66%	7.4%

"Cognitive outcome might be more favorable after MRgLITT compared to ATL and sAHE"

Kohlhase K. Epilepsia 2020

Stereotactic radiosurgery (SRS)

Radiosurgery for MTLE-HS

- 18,20,25 Gy to 50% isodose
- European multicenter study 62% seizure free (Regis 2004)
- 9/15 (60%) seizure free (24 Gy) at 8-year follow-up (Bartolomei 2008)
- US pilot study 77% seizure free

Acta Neurol Scand 2016: 134: 442–451 DOI: 10.1111/ane.12562

ACTA NEUROLOGICA
SCANDINAVICA

Stereotactic radiosurgery for the treatment of mesial temporal lobe epilepsy

Feng E-S, Sui C-B, Wang T-X, Sun G-L. Stereotactic radiosurgery for the treatment of mesial temporal lobe epilepsy.
Acta Neurol Scand 2016: 134: 442–451.

Objectives – Stereotactic radiosurgery (RS) is a potential option for some patients with temporal lobe epilepsy (TLE). The aim of this meta-analysis was to determine the pooled seizure-free rate and the

E.-S. Feng[1], C.-B. Sui[2], T.-X. Wang[3], G.-L. Sun[3]

[1]Department of Neurosurgery, Beijing Ditan Hospital, Capital Medical University, Beijing, China; [2]Department of Neurology, Beihai Hospital, Yantai, Shandong, China; [3]Department of Neurosurgery, Yidu Central Hospital of Weifang, Weifang, Shandong, China

- 50.9% seizure free (6 months-9 years)
- 14 months to seizure cessation

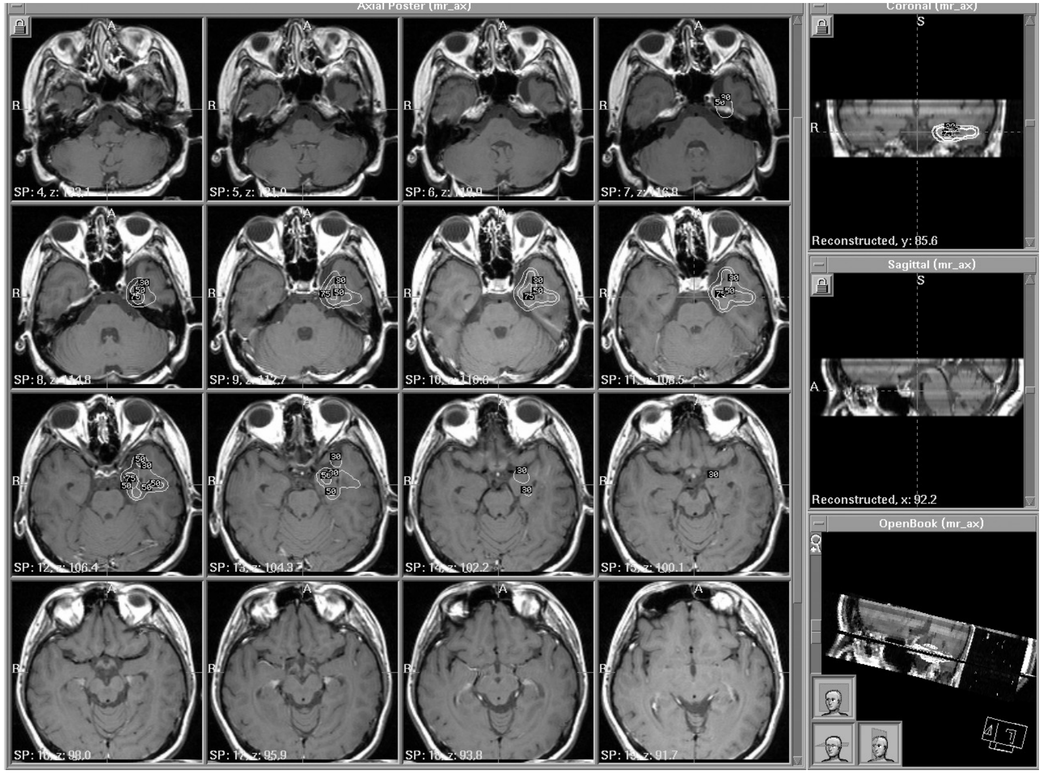
CLINICAL STUDIES

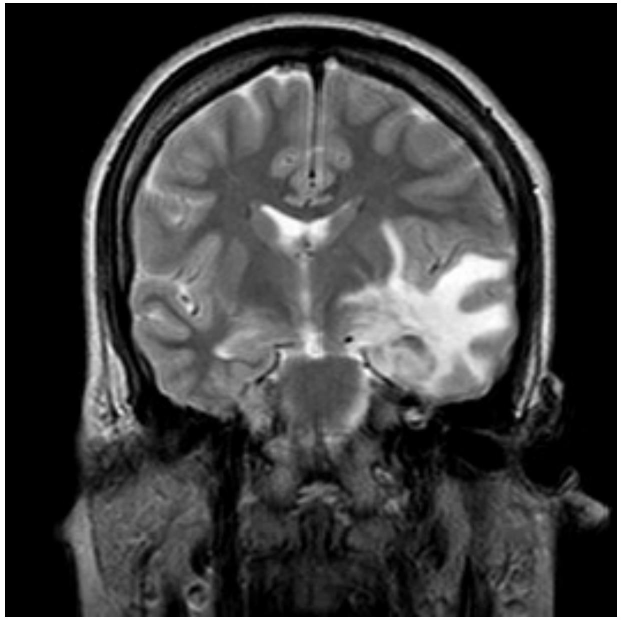
FAILURE OF GAMMA KNIFE RADIOSURGERY FOR MESIAL TEMPORAL LOBE EPILEPSY: REPORT OF FIVE CASES

Srikijvilaikul, Teeradej M.D.; Najm, Imad M.D.; Foldvary-Schaefer, Nancy D.O.; Lineweaver, Tara Ph.D.; Suh, John H. M.D.; Bingaman, William E. M.D.

Author Information

Neurosurgery 54(6):p 1395-1404, June 2004. | *DOI:* 10.1227/01.NEU.0000124604.29767.EB





Accepted: 14 February 2018
DOI: 10.1111/epi.14045

FULL-LENGTH ORIGINAL RESEARCH

Epilepsia

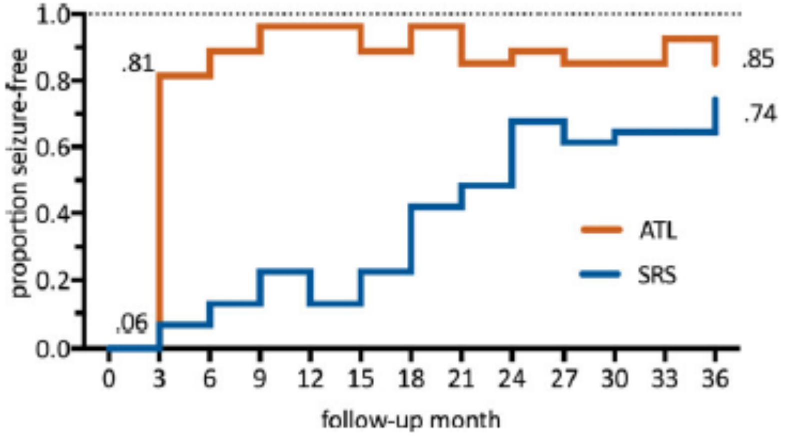
Radiosurgery versus open surgery for mesial temporal lobe epilepsy: The randomized, controlled ROSE trial

Nicholas M. Barbaro[1] | Mark Quigg[2] | Mariann M. Ward[3] | Edward F. Chang[3] | Donna K. Broshek[4] | John T. Langfitt[5] | Guofen Yan[6] | Kenneth D. Laxer[7] | Andrew J. Cole[8] | Penny K. Sneed[9] | Christopher P. Hess[10] | Wei Yu[6] | Manjari Tripathi[11] | Christianne N. Heck[12] | John W. Miller[13] | Paul A. Garcia[14] | Andrew McEvoy[15] | Nathan B. Fountain[2] | Vincenta Salanova[16] | Robert C. Knowlton[14] | Anto Bagić[17] | Thomas Henry[18] | Siddharth Kapoor[19] | Guy McKhann[20] | Adriana E. Palade[21] | Markus Reuber[22] | Evelyn Tecoma[23]

Published in final edited form as:
Epilepsia. 2011 May ; 52(5): 909–916. doi:10.1111/j.1528-1167.2011.02987.x.

Neuropsychological outcomes after Gamma Knife radiosurgery for mesial temporal lobe epilepsy: a prospective multicenter study

Mark Quigg, MD MSc[1], Donna K. Broshek, PhD[2], Nicholas M. Barbaro, MD[3,4], Mariann M. Ward, NP MS[3], Kenneth D. Laxer, MD[5], Guofen Yan, PhD[6], Kathleen Lamborn, PhD[3], and the Radiosurgery Epilepsy Study Group



- 31 SRS, 27 ATL
- 16 (52%) SRS, 21 (78%) ATL seziure free
- Verbal memory chnages were not different
- QOL associated with seizure remission
- SRS, ATL appear to have effectiveness and reasonable safety as treatment for MTLE
- SRS is an alternative to ATL in patients with contraindication for or with reluctance to undergo open surgery

REVIEW

A Systematic Review of Minimally Invasive Procedures for Mesial Temporal Lobe Epilepsy: Too Minimal, Too Fast?

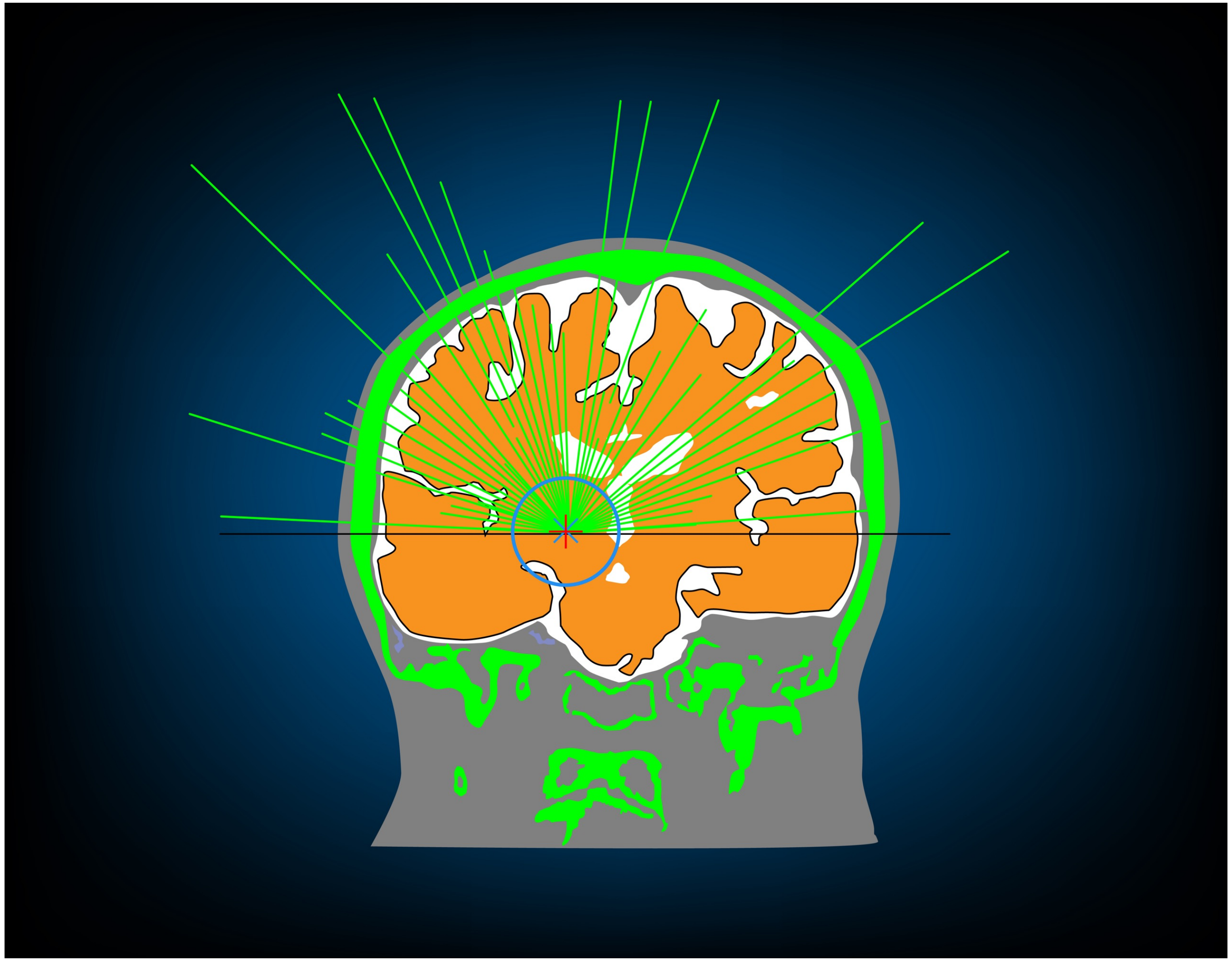
Ryan Wang, BSc [*]
Usman Beg, BSc [‡]
Varun Padmanaban, MD [§]
Taylor J. Abel, MD [¶,||]
Nir Lipsman, MD, PhD [#,**]
George M. Ibrahim, MD, PhD [‡‡,§§]
Alireza Mansouri, MD, MSc, FRCSC [§,¶¶]

BACKGROUND: Cortico-amygdalohippocampectomy (CAH) is effective for mesial temporal lobe epilepsy (mTLE). Concerns regarding surgical morbidity have generated enthusiasm for more minimally invasive interventions. A careful analysis of current data is warranted before widespread adoption of these techniques.
OBJECTIVE: To systematically review the use of laser interstitial thermal therapy (LITT), stereotactic radiosurgery (SRS), radiofrequency thermocoagulation (RF-TC), and focused ultrasound for mTLE.

- LITT has compelling evidence of efficacy
- SRS has a latency period and inferior to CAH
- RF-TC is a less resource-intensive alternative to LITT

Stereotactic ablation techniques		
Technique	Pros	Cons
Radiofrequency	Reduced collateral damage Immediate benefit Low cost	Temperature monitored only at tip
Radiosurgery	Noninvasive	Delayed benefit, risk of SUDEP Potential radiation injury, dose limitations High cost
LITT	Minimal collateral damage Immediate benefit Near real-time magnetic resonance thermography guides therapy and confirms ablation zone	High cost/ disposables

Transcranial Focused Ultrasound



Abe *et al. BMC Neurology* (2020) 20:160
https://doi.org/10.1186/s12883-020-01744-x

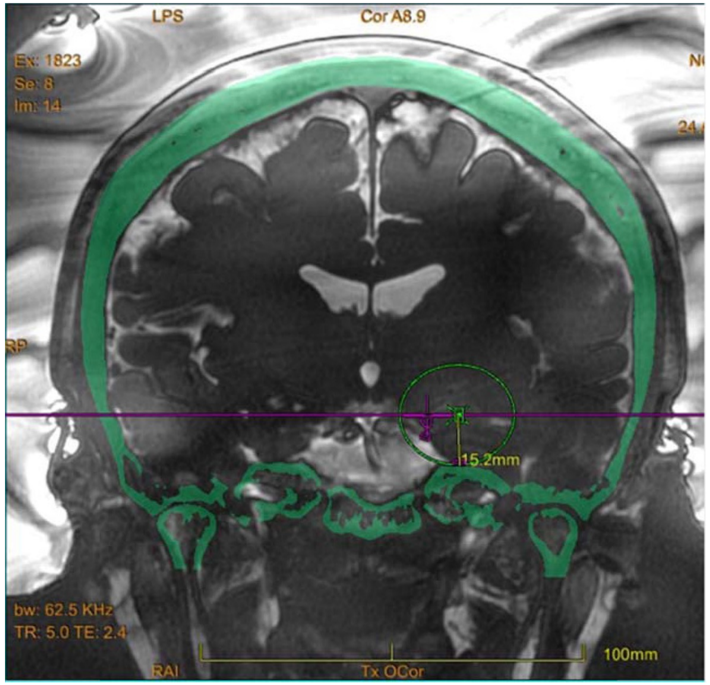
BMC Neurology

CASE REPORT Open Access

Check for updates

Magnetic resonance-guided focused ultrasound for mesial temporal lobe epilepsy: a case report

Keiichi Abe[1*], Toshio Yamaguchi[2], Hiroki Hori[3], Masatake Sumi[1], Shiro Horisawa[1], Takaomi Taira[1] and Tomokatsu Hori[4]



- 36-year-old woman with left MTLE
- Sub-ablations temperatures (48 C)
- Post-op MRI: no lesion
- Post-op PET: Increased metabolism left lateral temporal, bilateral striata, bilateral frontal base, posterior cingulate
- Seizure outcome: Engel III

	Advantage	Disadvantage
ATL	Class I evidence, best seizure outcomes	Largest incision, questionable neuropsychological implications of lateral cortex resection
SelAH Transylvian approach Transcortical approach Subtemporal approach	Preservation of lateral cortex Complete preservation of lateral cortex Technically less chanllenging Avoid both sylvian fissure and lateral cortex	Slight worse seizure outcomes than ATL; still requires open surgery Technicallly challenging, damage to temporal stem Damage to lateral cortex Possible retraction damage to basal temporal lobe
Gamma knife radiosurgery	No invasive surgery	Antiseizure effects delayed by 12-24 months
Stereotactic laser thermo-ablation Stereotactic radiofrequency thermocoagulation	Only burr hole required, preliminarily favorable neuropsychological outcomes	Higher risk of persistent seizures than resection; long-term outcomes require further study
Device implantation Responsive neurostimulation Vagus nerve stimulation Deep brain stimulation	No brain resection Direct closed-loop therapy to EZ EZ localization not required EZ localization not required	Palliative; worsen seizure freedom than resection/ablasion EZ locaization required; seizure freedom is rare Seizure freedom is rare Seizure freedom is rare

Adapted from Chang E, et al. Epilepsy Behav 2015

Trends in the Utilization of Surgical Modalities for the Treatment of Drug-Resistant Epilepsy: A Comprehensive 10-Year Analysis Using the National Inpatient Sample

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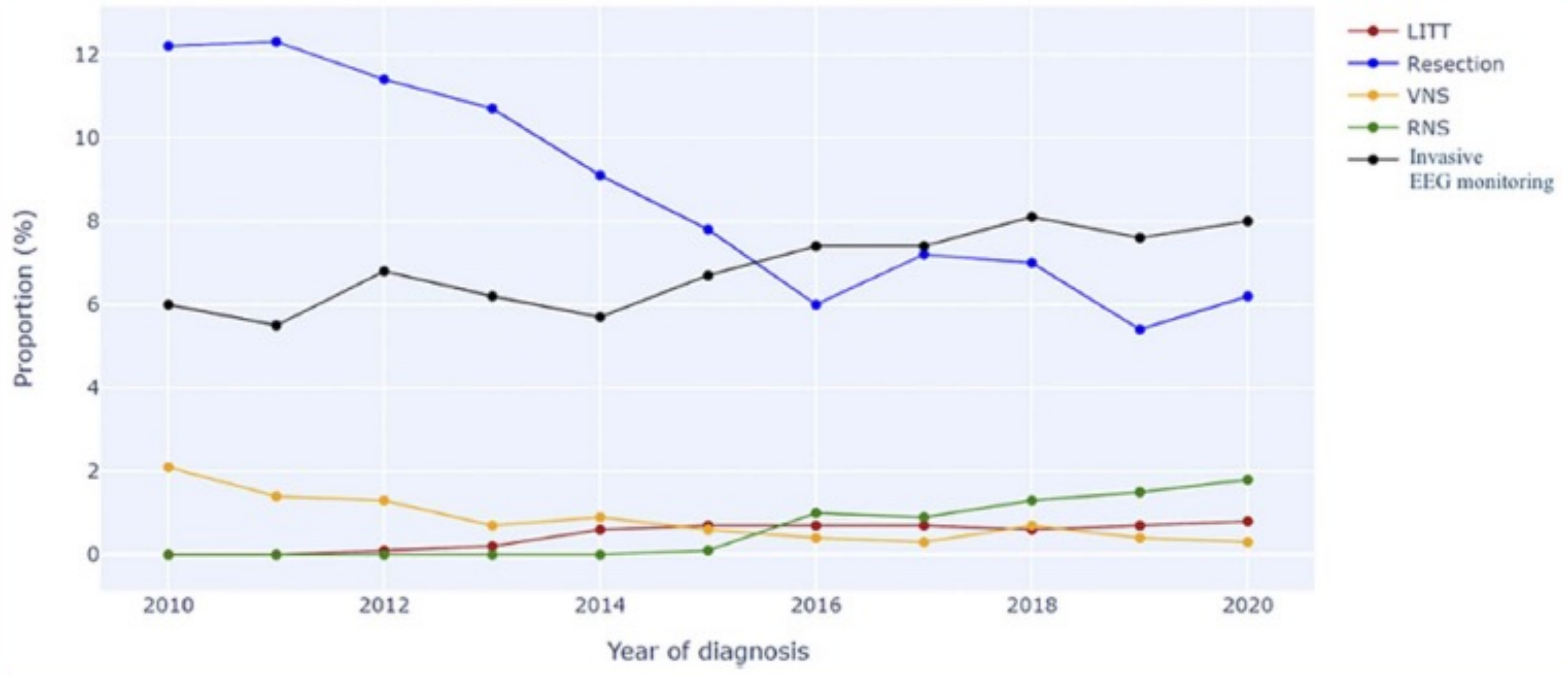


FIGURE 2. *Trends indicating the proportion of patients with drug-resistant epilepsy receiving the different surgical treatment modalities as well as with invasive EEG monitoring between 2010 and 2020. LITT, laser interstitial thermal therapy; RNS, responsive neurostimulation; VNS, vagus nerve stimulation.*

Neurosurgery 2024

TABLE 2. Perioperative and Postoperative Complications and Charges Associated With Each of the Treatment Approaches for Refractory Epilepsy

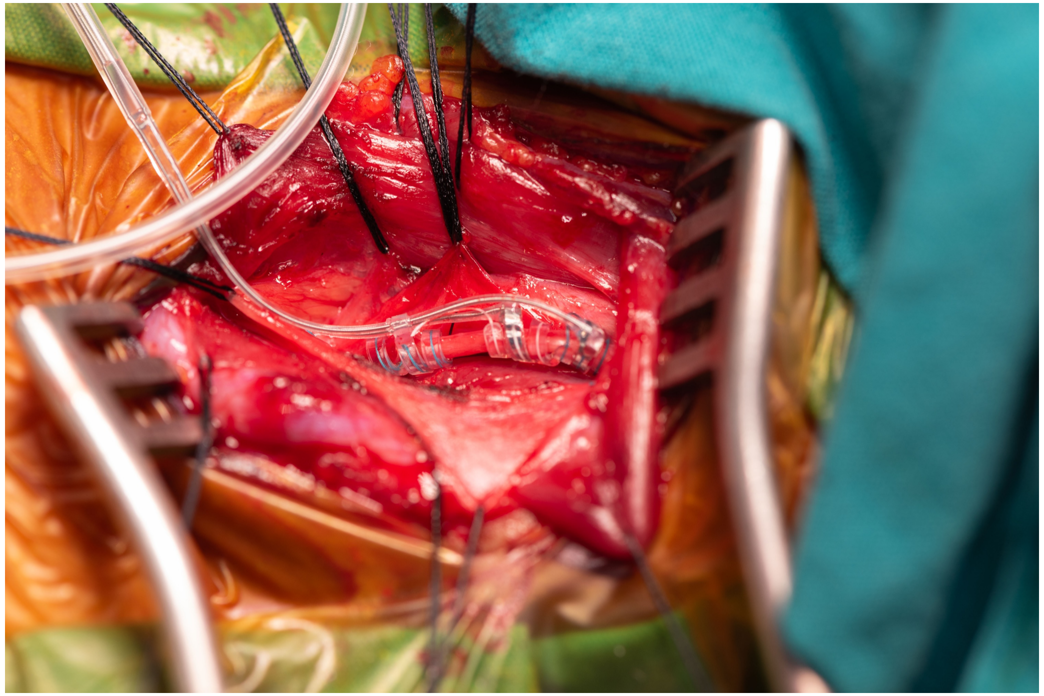
Variable	LITT (N = 205)	Resection (N = 2602)	RNS (N = 262)	VNS (N = 274)	Total (N = 3343)	*P* value
Ischemic stroke	0 (0.0%)	34 (1.3%)	0 (0.0%)	1 (0.4%)	35 (1.0%)	**.049**
Postoperative SAH	0 (0.0%)	12 (0.5%)	0 (0.0%)	0 (0.0%)	12 (0.4%)	.330
Neurological complications	0 (0.0%)	89 (3.4%)	1 (0.4%)	1 (0.4%)	91 (2.7%)	**<.001**
Pulmonary complications	1 (0.5%)	36 (1.4%)	0 (0.0%)	4 (1.5%)	41 (1.2%)	.185
DVT/PE complications	1 (0.5%)	16 (0.6%)	1 (0.4%)	1 (0.4%)	19 (0.6%)	.922
Cardiac complications	1 (0.5%)	6 (0.2%)	0 (0.0%)	0 (0.0%)	7 (0.2%)	.585
Urinary complications	0 (0.0%)	17 (0.7%)	2 (0.8%)	2 (0.7%)	21 (0.6%)	.695
Hematoma	5 (2.4%)	26 (1.0%)	8 (3.1%)	0 (0.0%)	39 (1.2%)	**.002**
Wound dehiscence	0 (0.0%)	8 (0.3%)	1 (0.4%)	1 (0.4%)	10 (0.3%)	.868
Wound infection	0 (0.0%)	8 (0.3%)	0 (0.0%)	0 (0.0%)	8 (0.2%)	.516
Mean LOS in days (95% CI)	2.5 (2.1-2.9)	7.8 (7.7-8.1)	3.3 (2.9-4.3)	—	6.9 (6.6-7.2)	**<.001**
Nonhome discharge	9 (4.4%)	459 (17.6%)	25 (9.5%)	32 (11.7%)	525 (15.7%)	**<.001**
Death	0 (0.0%)	10 (0.4%)	0 (0.0%)	1 (0.4%)	11 (0.3%)	.616
Mean total charges in USD (95% CI)	140 604 (129 000-152 000)	180 093 (173 800-186 200)	272 968 (250 000-296 000)	167 688 (122 000-214 00)	183 892 (178 000-191 000)	**<.001**

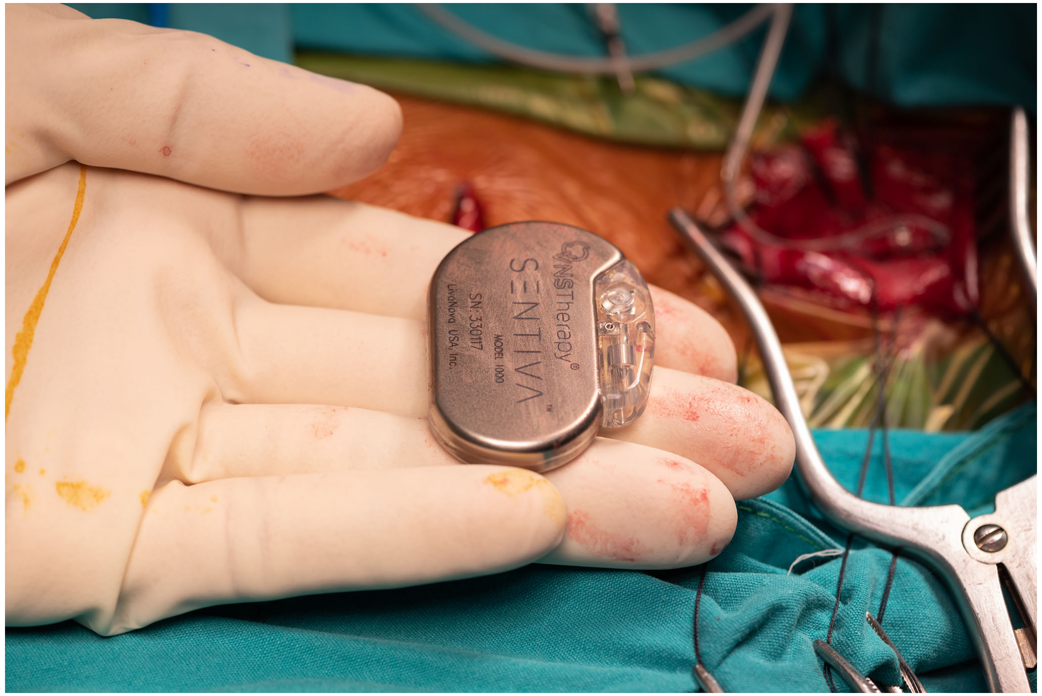
DVT/PE, deep vein thrombosis/pulmonary embolism; LITT, laser interstitial thermal therapy; LOS, length of stay; RNS, responsive neurostimulation; SAH, subarachnoid hemorrhage; VNS, vagus nerve stimulation. Bold entries indicate $P < 0.05$.

Neurostimulation

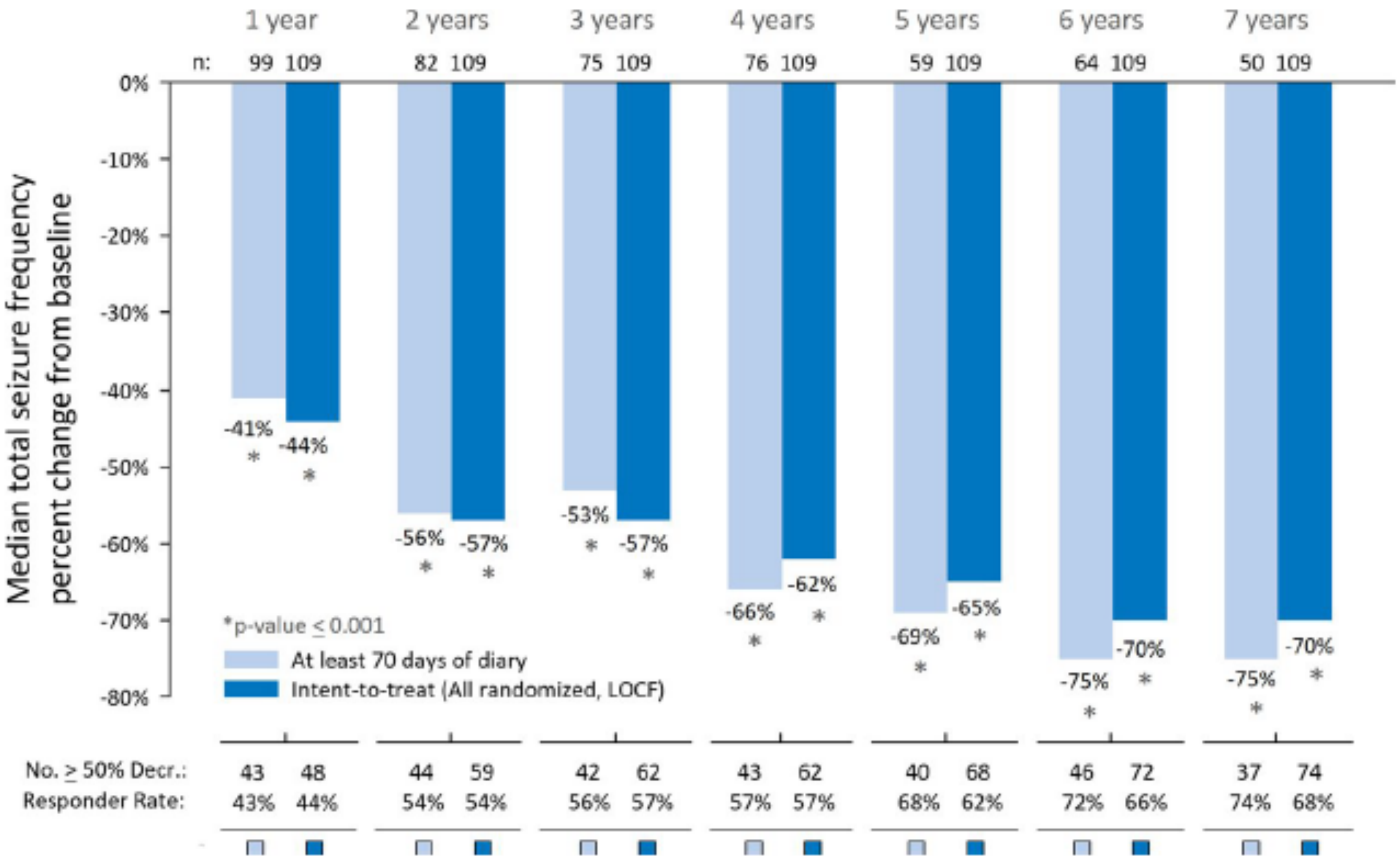
- Bitemporal lobe epilepsy
- Failed temporal lobectomy
- Cognitive concern of resection

VNS





Anterior thalamic DBS

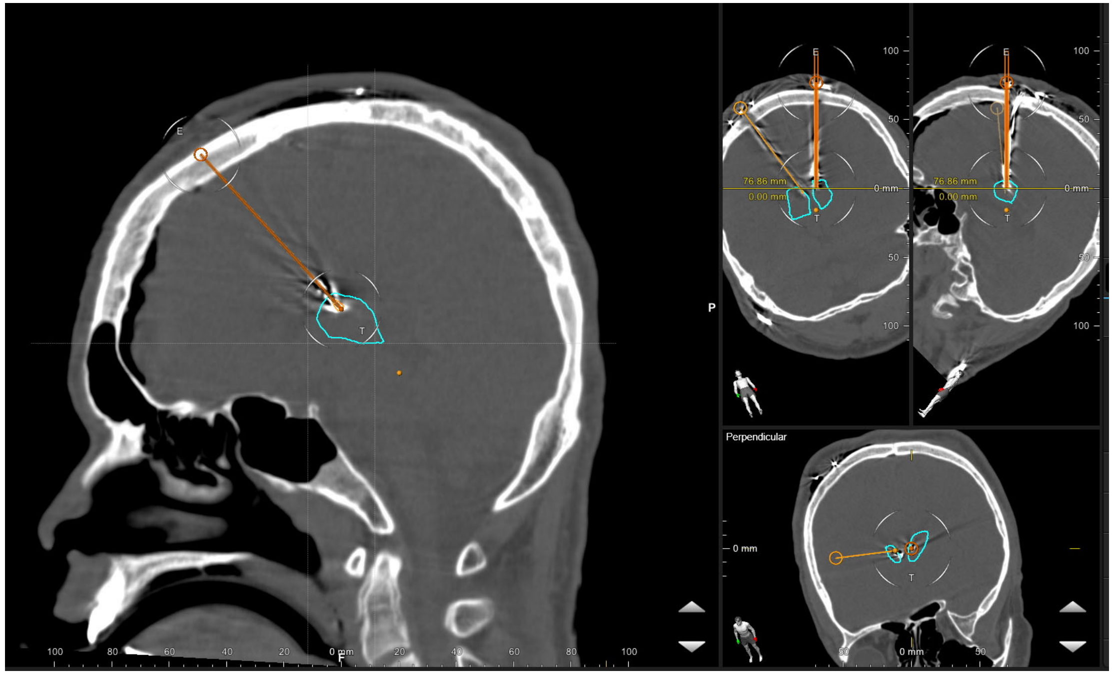


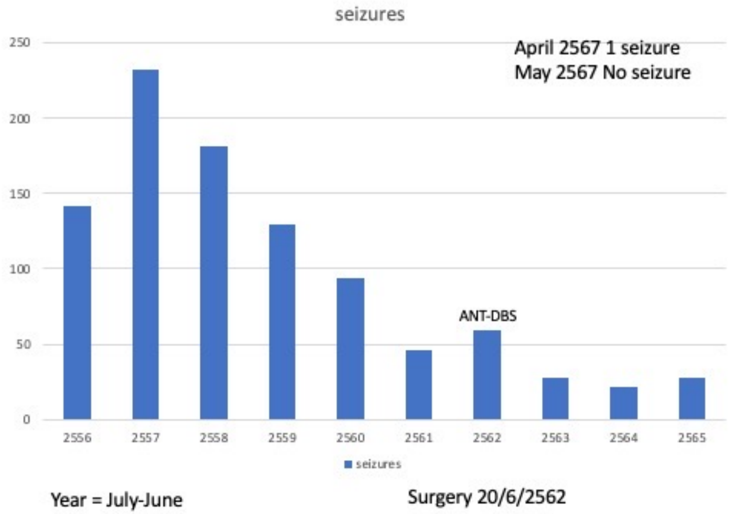
75% median seizure reduction
18% seizure freedom >6 months

ANT-DBS (SANTE study)

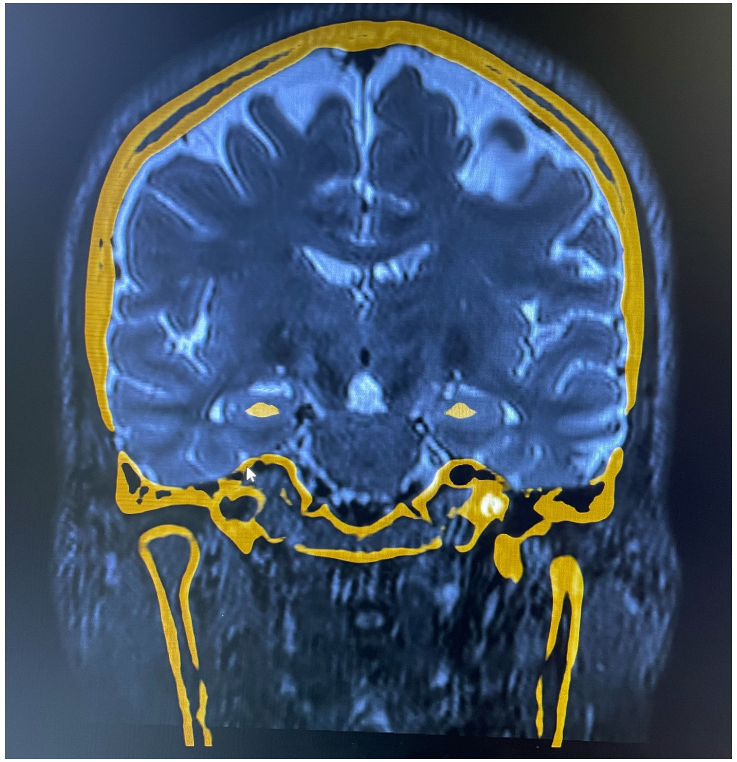
Salanova V, et al. Epilepsia 2021

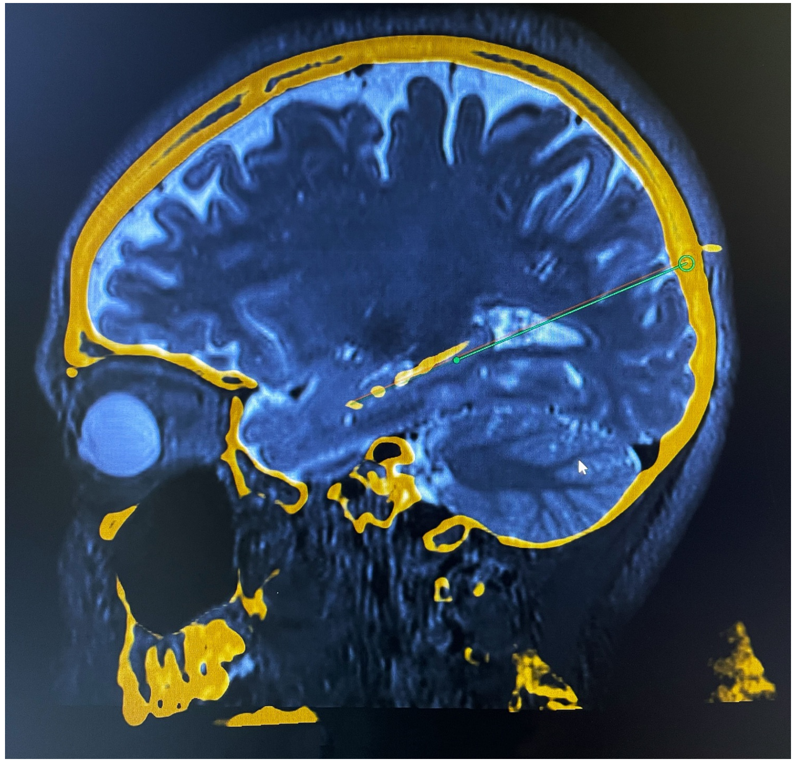
Anterior thalamic DBS





Hippocampal DBS





Conclusions

- Surgical treatment of MTLE-HS is safe and effective.
- ATL or SelAH are the standard treatment.
- Minimally invasive surgery is an option in selected patients.


Thank you