



Laser Interstitial Thermal Therapy Focal Epilepsy Evidence Compendium



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Introduction

The Visualase™ V2 MRI-guided laser ablation system is a neurosurgical tool and is indicated for use to ablate, necrotize, or coagulate intracranial soft tissue, including brain structures (for example, brain tumor, radiation necrosis, and epileptic foci as identified by non-invasive and invasive neurodiagnostic testing, including imaging) through interstitial irradiation or thermal therapy in pediatrics and adults with 980 nm lasers. The intended patients are adults and pediatric patients from the age of 2 years and older.

This evidence compendium is intended to highlight key studies that describe the use of laser interstitial thermal therapy (LITT) to ablate epileptic foci. Visualase™ MRI-guided laser ablation is a minimally invasive procedure that may be better tolerated than open resection of focal onset epileptic foci.¹⁻⁴ Studies by Steinbrenner et al (2023) and Sinha et al (2022) have shown the importance of the availability of a minimally invasive procedure, as patients with focal epilepsy may be fearful of open resection or prefer to try a less invasive option.^{5,6}

For the purposes of this evidence summary, publications with ≥ 10 patients receiving LITT for focal epilepsy were selected. Additionally, publications with mixed patient populations were only considered for inclusion if details for patients with focal epilepsy were analyzed and presented separately from patients receiving LITT for ablation of other types of lesions. The summaries on the following pages address outcomes such as length of hospital stay, extent of ablation, adverse events, and other procedural details that are important to take into account when considering LITT for patients with focal epilepsy. Publications are arranged by study design and then by number of patients included in the study. Please note data were presented as mean (standard deviation) unless otherwise noted and that seizure types have been reported using the International League Against Epilepsy's 2017 terminology.

Executive summary

Publication types (n, publications)

- Retrospective studies (7)
- Prospective clinical studies (5)
- Meta-analyses (4)
- Patient preference studies (2)

Epilepsy type (n, publications)

- Mesial temporal lobe epilepsy (13)
- Extratemporal lobe epilepsy (4)
- Temporal lobe epilepsy (3)
- Hypothalamic hamartoma (1)

Key data reported (n, publications)

- Complications (15)
- Length of stay (8)
- Ablation size (5)
- Cognitive changes (5)
- Reoperation or subsequent procedures (5)
- Patient preference for minimally invasive procedures (2)
- Factors leading to cranial nerve palsy (1)

Acronyms and abbreviations

Acronyms and abbreviations are defined in the table below, as well as upon first use in the text.

Acronyms and abbreviations

ASM	Antiseizure medication	LITT	Laser interstitial thermal therapy
ATL	Anterior temporal lobectomy	mm	Millimeter
CI	Confidence interval	MRgLITT	Magnetic resonance-guided laser interstitial thermal therapy
Cm	Centimeter	MRI	Magnetic resonance imaging
cm³	Cubic centimeter	MTS	Mesial temporal sclerosis
CN	Cranial nerve	N	Number
CVLT	California Verbal Learning Test	RFA	Radiofrequency ablation
DRE	Drug-resistant epilepsy	sAH	Selective amygdalohippocampectomy
EEG	Electroencephalogram	SEEG	Stereoelectroencephalogram
ETLE	Extratemporal lobe epilepsy	SLA	Stereotactic laser ablation
FA	Focal aware	SRS	Stereotactic radiosurgery
FBTC	Focal to bilateral tonic-clonic	SUDEP	Sudden unexpected death in epilepsy
FIA	Focal impaired awareness	TLE	Temporal lobe epilepsy
F/U	Follow-up	VEM	Video electroencephalogram monitoring
IQR	Interquartile range		

Importance of a minimally invasive procedure option for patients with epilepsy

Predictors and reasons for epilepsy patients to decline surgery: A prospective study.

Steinbrenner M, Tito T, Dehnicke C, et al. Journal of Neurology 2023; 270:2302-2307.⁵



Study design

Prospective single center study. Consecutive patients with drug-resistant epilepsy who underwent at least one scalp video-EEG monitoring (VEM) were screened between 2016 and 2018.

Patient population

- N = 116
- 55 women, 61 men
- Median Age: 32 years; IQR: 27-41 years
- Median duration of epilepsy: 15 years; IQR: 8-23 years

Epilepsy details

Seizure origin (number of patients):

- Temporal lobe epilepsy (58)
- Extratemporal lobe epilepsy (22)
- Unknown (36)

Procedural details

116 patients underwent a total of 165 VEM procedures. 20 patients were ineligible for resection. The remaining 96 patients' decisions were analyzed.

Decision-making

- Among the 96 patients, 51 patients declined and 45 agreed to the given recommendations for either resection or further intracranial or scalp VEM.
- Among the 45 patients agreeing to the given recommendations, 40 received resective surgery and 5 declined after scalp VEM.
- The most frequent reason for declining the recommendations: general fear of brain surgery (59%), currently perceived low seizure frequency (22%), fear of peri- or postoperative complications (18%), assumed low probability of seizure freedom by patients (18%).

Predictors

- Among the psychosocial variables included in the multivariate analysis, patients with less epilepsy-related fear were more likely to decline recommended surgery ($p = 0.02$).
- Among patients that declined recommendations, more were living alone and were less likely to have children living in the same household (differences were not statistically significant).

Authors' conclusion

"Half of the patients potentially eligible for resective surgery decline the operation or further VEM procedures. Patients who decline are more fearful of brain surgery than of ongoing disabling seizures. More insight is needed to improve counselling of patients."

Patient preferences pertaining to treatment options for drug-resistant focal epilepsy.

Sinha SR, Yang JC, Wallace MJ et al. *Epilepsy & Behavior* 2022;127:108529.⁶

Objective:

To determine patient acceptability of benefit-risk trade-offs in selecting treatment options for drug-resistant epilepsy such as open brain surgery, LITT or ASMs.



Study design

One discrete-choice experiment survey, with one of 20 versions randomly assigned to 2 cohorts of patients: adult patients treated at the Duke University Medical center (Duke cohort) and a web-based panel of adults in the U.S. (web cohort). This survey associated treatment options and varying levels of chance of seizure freedom for at least 2 years (20-70%), risk of 30-day mortality (0-10%), and risk of neurological deficits (0-40%) in order to quantify acceptable benefit-risk trade-offs.

Patient population

Duke cohort (n=106): patients with drug-resistant epilepsy. Web cohort (n=300): patients having tried at least 3 ASMs and experiencing at least 1 seizure in the past year.

Outcomes

Patients responding to the survey expressed a strong preference for LITT, as a less invasive procedure, over open brain surgery. The procedures and recovery period for each were described in the questionnaire. Given the option to undergo a less invasive initial procedure, patients were open to the possible decrease in benefit in favor of reduced risk for mortality and long-term neurological deficits.

Authors' conclusion

"Patients who are receptive to surgery would accept significantly lower treatment effectiveness to undergo a minimally invasive procedure relative to open brain surgery. They also were willing to accept lower treatment benefit to reduce risks of mortality or neurological deficits."

Systematic reviews and meta-analyses of LITT for epileptic foci ablation

Comparison of minimally invasive and traditional surgical approaches for refractory mesial temporal lobe epilepsy: A systematic review and meta-analysis of outcomes.

Kohlhase K, Zöllner JP, Tandon N, et al. *Epilepsia* 2021;62:821-845.⁷



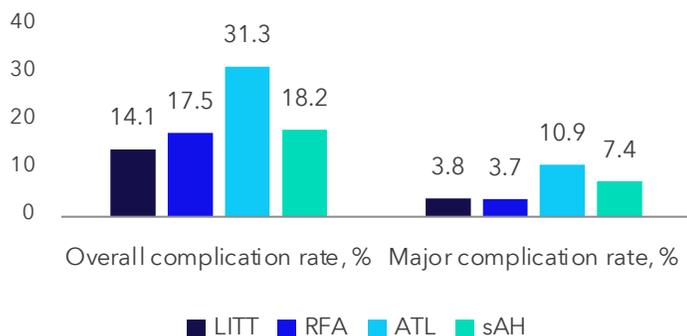
Study design

Systematic review and meta-analysis of articles involving LITT, radiofrequency ablation (RFA), anterior temporal lobe resection (ATL) and selective amygdalohippocampectomy (sAH) as treatment technique.

Patient population

43 articles, representing 3507 patients with drug-resistant mesial temporal lobe epilepsy (mTLE), have been included in the meta-analysis:

- 13 LITT studies with 554 patients, mean age: 43.1 (5.9) years
- Follow-up (F/U) period ranged from 6 to 70 months
- 6 RFA studies with 123 patients, mean age: 35.4 (6.1) years, F/U period ranged from 12 to 62 months
- 24 ATL and sAH studies with 1504 and 1326 patients, mean age: 29.9 (8.5) years and 31.1 (9.1) years, F/U period ranged from 12 to 116.4 months and 12-104.4 months, respectively



Complications

No significant differences in overall complication and major complication rates between the procedures.

Major complications

- **LITT**
 - Homonymous hemianopsia (5)
 - Intracranial hemorrhage (3)
 - Subdural hematoma (1)
- **RFA**
 - Infection (2)
 - Aphasia/anomia (1)
 - Intracerebral hemorrhage (1)
- **ATL**
 - Infection (10)
 - Vascular events (7)
 - Homonymous hemianopsia (4)
 - Hemorrhage (4)
- **sAH**
 - Homonymous hemianopsia (6)
 - Infection (2)
 - Vascular events (2)
 - Intracerebral hemorrhage (1)

Authors' conclusion

"In terms of complications, there was no significant difference in major complications between the procedures, whereas MRgLITT and RFA showed a tendency to be more advantageous compared to ATL and sAH."

Outcomes after laser interstitial thermal ablation for temporal lobe epilepsy: A systematic review and meta-analysis.

Alomar SA, Moshref RH, Moshref LH, et al. Neurosurgical Review. 2023;46:261.⁸



Study design

Systematic review and meta-analysis including 21 publications on LITT and temporal lobe epilepsy (TLE).

Patient population

- N = 836
- 50% (47.1-57.2%) women
- Median age: 40.8 (5.12) years
- Median F/U: 21.3 (10.42) months

Epilepsy details

Patients had TLE

Procedural details

Procedural details were not discussed.

Memory and naming

Outcome (n, studies)	Overall, Median % (95% CI)	Dominant hemisphere LITT, Median % (95% CI)	Nondominant hemisphere LITT, Median % (95% CI)
Verbal memory decline (7)	24.2 (8.6-52.0)	31.8 (13.2-58.7)	13.3 (2.2-52.1)
Verbal memory improvement (7)	20 (11.2-33.0)	8.5 (2.5-25.4)	25.7 (14.4-41.6)
Visual memory decline (3)	25.2 (8.3-55.8)	32.5 (13.5-59.9)	26.9 (4.1-75.9)
Visual memory improvement (3)	25.2 (8.3-55.8)	32.5 (13.5-59.9)	26.9 (4.1-75.9)
Naming decline (7)	13.4 (6.6-25.4)	17.3 (8.5-31.9)	16.4 (6.8-34.5)
Naming improvement (2)	20.7 (9.6-39.1)	14 (3.5-42.3)	28.6 (11.2-56.2)

Complications

- Overall complication rate was 19.8% (13.4-28.1%)
- "Complications included visual field deficits, intracranial hemorrhage, optic neuritis, headache, incisional pain, anxiety, depression, and a single case of missed lesion target."

Authors' conclusion

"Data on cognitive outcomes after LITT are scarce and heterogeneous. More prospective studies with detailed analyses using standardized cognitive outcomes after LITT are needed to further evaluate cognitive outcomes after LITT."

Surgical outcomes between temporal, extratemporal epilepsies and hypothalamic hamartoma: Systematic review and meta-analysis of MRI-guided laser interstitial thermal therapy for drug-resistant epilepsy.

Barot N, Batra K, Zhang J et al. J. Neurol Neurosurg Psychiatry 2022; 93:133-143.⁹



Study design

Systematic review and meta-analysis. Published articles from several databases between 2010 and 2020 were searched.

Patient population

- 28 articles, representing 559 patients, have been included in the meta-analysis.
- The mean/median F/U duration ranged from 6 to 42.9 months.

Epilepsy details

Main etiologies: mTLE; extratemporal lobe epilepsy (ETLE), and hypothalamic hamartoma.

Procedural details

- Patients underwent LITT to treat drug-resistant epilepsy. Manufacturers' names not specified.
- Reoperation rate was 9% (95% CI 0.05% to 0.14%), which included repeat ablation (75.3%) and resective surgery (24.7%).

Complications

- Prevalence of postoperative adverse events: 19% (95% CI 0.14% to 0.25%).
- Common adverse events in patients with mTLE: visual field deficits (30) and 3rd or 4th cranial nerve deficits (7).
- Adverse events from full cohort (519 patients):
 - Motor deficit (27)
 - Intracranial hemorrhage (13)
 - Device-related malfunctions, inaccurate fiber placement and software failures (4)

Authors' conclusion

"MRgLITT has become an increasingly used methodology in the treatment of DRE [drug resistant epilepsy]. As such, there is an increasing need to understand the effectiveness and limitations of this approach as it relates to the diversity of DRE etiologies."

Magnetic Resonance-Guided Laser Interstitial Thermal Therapy Versus Stereotactic Radiosurgery for Medically Intractable Temporal Lobe Epilepsy: A Systematic Review and Meta-Analysis of Seizure Outcomes and Complications.

Grewal SS, Alvi MA, Lu VM, et al. World Neurosurg. 2019;122:e32-e47.³



Study design

Systematic review and meta-analysis of articles involving LITT and stereotactic radiosurgery (SRS) as minimally invasive techniques. Published articles from several databases were searched up to 2018.

Patient population

- 19 articles, representing 404 patients with drug-resistant mTLE, have been included in the meta-analysis:
 - 9 LITT studies with 239 patients
 - Mean age: 40.9 (14) years
 - Median F/U: 22.4 months
 - 10 SRS studies with 165 patients
 - Mean age: 29.5 (9.7) years
 - Median F/U: 43.12 months

Complications and subsequent procedures

	LITT	SRS	p-value
Overall complication rate	20% (95% CI 14% to 26%)	32% (95% CI 20% to 46%)	P=0.06
Main common complications	Visual field deficits (n = 13), cranial nerve deficits (n = 8), headache, nausea, and gait abnormalities (n = 9), and cerebral hemorrhage (n = 4)	Visual field deficits (n = 21), cerebral edema (n = 11), psychotic and cognitive symptoms (n = 7) and nerve deficits (n = 2)	
Reoperation rate	15% (95% CI 9% to 22%)	27% (95% CI 0.12% to 0.46%)	P=0.10
Repeated surgery: LITT, anterior temporal lobe resection (ATL)	29 patients Repeated LITT ± ATL (n=12), ATL alone (n=17)	11 patients, all underwent ATL	

Authors' conclusion

"MRgLITT and SRS are 2 commonly used minimally invasive procedures for medically intractable TLE, and they are alternative options to ATL and sAH. On the basis of current literature, we found that whereas seizure outcome rates and reoperation rates may be similar between the 2 procedures, MRgLITT may be associated with lower complication rates."

Prospective studies of LITT for epileptic foci ablation

Better object recognition and naming outcome with MRI-guided stereotactic laser amygdalohippocampotomy for temporal lobe epilepsy.

Drane DL, Loring DW, Voets NL, et al. Epilepsia. 2015;56(1): 101-113.¹⁰



Study design

Prospective parallel group study of naming and recognition skills in patients receiving LITT compared to patients undergoing standard surgical approaches

Patient population

LITT group:

- 10 patients with dominant hemisphere procedure; Age: 38.2 (17.1) years
- 9 patients with nondominant hemisphere procedure; Age: 36.2 (13.3) years

Surgical group:

- 22 patients with dominant hemisphere procedure; Age: 36.0 (11.4) years
- 17 patients with nondominant hemisphere procedure; Age: 36.5 (11.4) years

Epilepsy details

- mTLE
- 10 patients in LITT group and 19 patients in Surgical group with mesial temporal sclerosis (MTS)

Procedural details

- LITT: Visualase™ system used
- Surgery was either ATL with mesial temporal resection (22) or selective transcortical amygdalohippocampectomy (17)

Naming and recognition tests

- 32 of 39 patients in Surgical Group showed decline in 1 or more naming/recognition tests
- No patients in LITT Group showed decline on any naming/recognition tests
- $p < 0.0001$

Test	Surgery, dominant hemisphere	Surgery, nondominant hemisphere	LITT, dominant hemisphere	LITT, nondominant hemisphere
Boston Naming, % change (range)	-23.6 (-62.0 to 4.7)*	1.9 (-6.7 to 11.5)	8.6 (-7.1 to 75.0)	3.2 (-1.9 to 9.8)
Famous face naming, % change (range)	-28.3 (-94.2 to 19.2)*	1.4 (-13.9 to 20.6)	9.4 (-4.9 to 28.8)	7.6 (-5.8 to 25.7)
Famous face recognition, % change (range)	0.5 (-22.7 to 25.0)	-9.0 (-50.0 to 21.6)**	4.2 (-3.0 to 15.8)	5.0 (-1.5 to 11.0)

Surgical results from 1 year F/U; LITT results from 6-month F/U (*, $p < 0.01$; **, $p < 0.001$)
Red text indicates decline compared to baseline; green text indicates improvement.

Complications

Additional complications not discussed by the authors.

Authors' conclusion

"Our initial experience with stereotactic laser amygdalohippocampotomy suggests that it is a promising surgical approach that appears to minimize aspects of the cognitive morbidity associated with open surgical resection."

Laser interstitial thermal therapy (LITT): Seizure outcomes for refractory mesial temporal lobe epilepsy.

Le S, Ho AL, Fisher RS, et al. *Epilepsy & Behavior* 2018 89 ;37-41.¹¹



Study design

Prospective and single center study. Consecutive patients with mTLE treated by LITT between 2014 and 2017 were included.

Patient population

- N = 30 with 1 patient was lost to F/U
- 16 women, 14 men
- Median age: 43 years
- Median F/U: 18 months (range, 6-44 months)

Epilepsy details

- Patients with MTS, n = 23 (77%)
- Prior brain surgery for lesionectomy or epilepsy surgery, n = 3

Procedural details

- Visualase™ system
- Mean ablation number per case: 4.08
- Mean ablation length: 3.64 cm

Length of stay

- 83% of patients discharged at postoperative day 1
- Remaining patients discharged at postoperative day 2 or 3

Complications (number of patients)

- Perioperative seizures (10)
- Contralateral status epilepticus (1)
- Permanent superior quadrantanopia (1)
- Trochlear nerve palsy resolved at 7-month F/U (1)
- Aseptic meningitis and status migrainosus at day 7, responsive to valproic acid over the course of 4 months (1)
- Psychogenic nonepileptic events (1)
- Transient headaches and anxiety (1)
- During hospitalization and F/U, none of the patients had any new cognitive complaints

Authors' conclusion

"Our results support the previously published literature that MRI-guided stereotactic LITT is a minimally invasive and relatively safe alternative to conventional ATL in patients with drug-resistant mTLE."

Stereotactic EEG-guided laser interstitial thermal therapy for mesial temporal lobe epilepsy.

Tao JX, Wu S, Lacy M et al. J Neurol Neurosurg Psychiatry 2018;89:542-548.¹²



Study design

Prospective single center study. Patients with medically refractory mTLE undergoing LITT between 2014 and 2017 were included.

Patient population

- N = 21
- 12 women, 9 men
- Mean age: 40 (13) years
- Mean F/U: 24 (11) months

Epilepsy details

- All patients had mTLE
- Patients with MTS, n = 11

Procedural details

- Visualase™ system
- Ablation location: amygdalohippocampal complex
- Ablation volume, range: 0.6-6.6 cm³

Length of stay

- 19/21 discharged within 24 hours postablation.
- Remaining patients discharged 2-4 days after ablation due to dizziness and unsteady gait (patient 19) or visual field deficit (patient 8).

Complications

- Decline in verbal memory (2)
- Decline in confrontational naming (2)
- Decline in logical memory (2)
- Homonymous hemianopia due to thermal injury to the lateral geniculate nucleus (1)
- Acute postoperative psychiatric symptoms (anxiety, insomnia, depression, auditory hallucination and suicidal ideation) 2 weeks post-LITT. Resolved in the following 3 months with admission for psychiatric care (1)
- Dizziness, unsteady gait (1)
- Visual field deficit (1)

Authors' conclusion

"MRI-guided stereotactic LITT was well tolerated by the patients in our study."

Laser interstitial thermal therapy for medically intractable mesial temporal lobe epilepsy.

Kang JY, Wu C, Tracy J, et al. Epilepsia. 2016;57(2): 325-334.¹³



Study design

Prospective study of patients undergoing LITT between December 2011 and December 2014 at a single center.

Patient population

- N = 20
- 12 women, 8 men
- Median age: 42 years
- Median F/U: 13.4 months (range, 1.3 months-3.2 years)

Epilepsy details

- 17 patients had MTS
- Seizure type (patient number):
 - FIA and FBTC (8)
 - FIA (7)
 - FIA, FA, and FBTC (4)
 - FIA and FA (1)

Procedural details

- Visualase™ system
- Mean number of ablations along long axis of the amygdalohippocampal complex: 3

Subsequent procedures

4 patients underwent ATL after LITT

Length of stay

- 1 day: 17 patients
- 2 days: 3 patients

Cognitive changes

- 6 patients underwent verbal memory testing
- 3 patients had "significant decline" in California Verbal Learning Test (CVLT) total learning scores
- No change observed on Logical Memory test

Return to work

Patients allowed to return to work 3 days post-procedure

Complications

- Headache (4)
- Transient worsening mood symptoms (2)
- Insomnia (1)
- Scalp numbness (1)
- Brain edema with internal hemorrhage and incongruous superior quadrantanopsia;
- no evacuation required (1)
- Cranial nerve palsy with vertical binocular diplopia (1)
- Suicide 4.4 months after LITT in patient with pre-existing depression and suicidal ideation

Authors' conclusion

"We conclude that MRI-guided stereotactic LITT is a safe alternative to temporal lobectomy in some patients with mTLE...Because of reduced surgical morbidity, discomfort, and disability, LITT offers clear advantages over open surgery. ... We believe the data support offering LITT as initial therapy for refractory mTLE, reserving anterior temporal lobectomy for LITT failures."

Real-time magnetic resonance-guided stereotactic laser amygdalohippocampotomy for mesial temporal lobe epilepsy.

Willie JT, Laxpati NG, Drane DL, et al. Neurosurgery. 2014;74(6): 569-585.¹⁴



Study design

Prospective study of consecutive patients offered open surgical resection or LITT. Patients selecting LITT were included in the analysis.

Patient population

- N = 13
- 7 women, 6 men
- Median age: 24 years
- Median F/U: 14 months (range, 5-26 months)

Epilepsy details

- All patients had mTLE with FIA seizures
- 9 patients with MTS

Length of stay

- 1 day (10)
- 2 days (3)
- 3 days (2)
- 4 patients spent 1 day in intensive care

Complications

- Seizure due to missed medication (2)
- Homonymous hemianopia (1)
- Psychogenic nonepileptic seizure (1)
- Acute subdural hematoma without neurological deficit (1)

Procedural Details

- Visualase™ system
- Median of 3 contiguous ablation zones in amygdalohippocampal complex
- Mean ablation time: 9.6 minutes (range, 3.4-26.1 minutes)
- Mean ablation volume: 5.32 cm³ (range, 3.52-7.59 cm³)
- % ablation of amygdalohippocampal complex: 60% (range, 49-76%)
- 2 patients underwent repeat LITT procedures

Authors' conclusion

"In sum, stereotactic laser amygdalohippocampotomy has significant potential advantages compared with alternative procedures, include the gold standard open resection, stereotactic radiosurgery, and radiofrequency ablation."

Retrospective studies of LITT for epileptic foci ablation

Long-term outcomes of mesial temporal laser interstitial thermal therapy for drug-resistant epilepsy and subsequent surgery for seizure recurrence: a multi-centre cohort study.

Youngerman BE, Banu MA, Khan F, et al. Journal of Neurology, Neurosurgery & Psychiatry. 2023;94(11):879-886.¹⁵



Study design

Multicenter, retrospective cohort study with data collected between 2012 and 2018. Patients included in this study had been previously reported on by Wu et al (2019).¹⁶

Patient population

- N = 268
- 144 women, 124 men
- Median Age: 43 years; IQR: 30-54 years

Subsequent procedures (patient number)

- Anterior temporal lobectomy (22)
- Repeat LITT (9)
- Vagus nerve stimulation (3)
- Anterior temporal lobectomy and responsive neurostimulation (1)
- Temporal responsive neurostimulation (1)

Procedural details

- LITT system manufacturer not reported
- Ablation location: amygdalohippocampal complex

Epilepsy details

- Lesion location: Mesial Temporal Lobe
- Seizure type (patient number); patients may have had more than one seizure type:
 - FIA (252)
 - FBTC (129)
 - FA (51)

Complications (n)

- Visual field deficit (12)
- Extraocular movement dysfunction (7; persistent in 3)
- Hemorrhage (5; symptomatic in 1)
- Chronic headache (1)
- Facial sensory disturbance in V1 distribution (1)
- Transient hemiparesis (1)
- Death during F/U period (3): suicide < 1 year after LITT, suicide 4 years after LITT, SUDEP 1 year after LITT

Authors' conclusion

"LITT is also less invasive with a favorable safety profile making it appealing to many patients, including some who would not consider an open surgical option. Moreover, LITT does not preclude a future successful anterior temporal lobectomy or more extensive ablation if seizures persist or recur."

Effects of surgical targeting in laser interstitial thermal therapy for mesial temporal lobe epilepsy: A multicenter study of 234 patients.

Wu C, Jermakowicz WJ, Chakravorti S, et al. *Epilepsia* 2019;60:1171-1183.¹⁶



Study design

Retrospective multicenter (11 centers in the US) study of 234 patients who underwent LITT to treat mTLE between 2011 and 2017.

Patient population

- N = 234
- 124 women, 110 men
- Mean Age: 42 (15) years
- Mean F/U: 30 (14) months

Complications (number of patients)

- 42 complications recorded for 35 patients (15%):
 - Transient neurologic deficits, n = 8: visual field deficit (2), double vision (2), language or memory deficit (1), new onset affective disorder (1), sensory loss (1), motor deficit (1)
 - Persistent at last F/U, n = 34: worsening of baseline affective disorder (10), visual field deficit (9), language or memory deficit (6), new onset affective disorder (4), double vision (3), chronic headache (1), sensory loss (1)
- Postoperative hemorrhage (3), including 1 associated with clinical symptoms (transient double vision)
- SUDEP (1), 12 months post-procedure

Epilepsy details

- Patients with radiographic hippocampal sclerosis, n = 172
- Seizure type (patient number); patients may have had more than one seizure type:
 - FIA (223)
 - FBTC (107)
 - FA (38)

Procedural details

- No standard procedure between the centers (procedure performed according to its own practices); LITT system manufacturer not reported
- All ablations were along the long axis of the amygdalohippocampal complex
- Overall diameter of the ellipsoid of all possible related voxels was approximately 30 mm in diameter, indicating an estimated variation in probe position of 15 mm

Authors' conclusion

"Consideration of surgical factors—with a focus on ablation location more so than ablation volumes alone—is imperative to the complete assessment of LITT."

Laser ablation for mesial temporal lobe epilepsy: Surgical and cognitive outcomes with and without mesial temporal sclerosis.

Donos C, Breier J, Friedman E, et al. Epilepsia 2018;59:1421-1432.¹⁷



Study design

Data analysis of consecutive patients undergoing LITT, between 2012 and 2017 in one center, to treat mTLE with or without MTS.

Patient population

- N = 43
- 23 men, 20 women
- Mean Age: 39.8 (15.3) years;
- 34 patients with mTLE with MTS
- Mean F/U: 20.3 (13.8) months

Length of stay

- All patients were released from the hospital within 24 hours after LITT.

Complications

- No hemorrhage, infection, cranial nerve deficits, or new neurological deficits reported immediately after LITT.
- Optic neuritis developed about 6 weeks postprocedure (1)

Cognitive deficits

- Dominant hemisphere procedures:
 - No change in naming or categoric and semantic fluency
 - Significant decline in Verbal Intelligence Quotient ($p = 0.011$), verbal memory ($p = 0.049$) and logical memory ($p = 0.018$)
- Nondominant hemisphere procedures:
 - Significant decline in score on the Nonverbal Selective Reminding Test ($p = 0.045$)
 - No change in other cognitive measures

Procedural details

- Visualase™ system
- Median (median absolute deviation) percent ablation:
 - Amygdala: 73.7% (13.4%)
 - Hippocampus: 70.9% (12.6%)
 - Parahippocampal gyrus: 30.8% (9.9%)
 - Entorhinal cortex: 28.3% (15.3%)

Authors' conclusion

"Cognitive declines following MTL-LITT [mesial temporal lobe-LITT] are modest, and principally affect memory processes."

Stereotactic MRI-guided laser interstitial thermal therapy for extratemporal lobe epilepsy.

Gupta K, Cabaniss B, Kheder A, et al. *Epilepsia* 2020;61(8):1723-1734.¹⁸



Study design

Retrospective single center study. Data analysis of consecutive patients with ETLE treated by LITT between 2012 and 2019.

Patient population

- N = 35
- 22 women, 13 men
- Mean age at surgery: 36.4 (12.7) years;
- Mean F/U: 28.2 (19.1) months
- Prior neuromodulation (16)
- Prior resective procedure (9)

Length of stay

Mean length of stay between procedure and discharge: 1.75 days (range, 1-12 days)

Procedural details

- Visualase™ system
- Ablation location (number of patients) and ablation volume per target:
 - Frontal (15); 6.06 (5.12) cm³
 - Cingulate (6); 11.5 (7.14) cm³
 - Insular (5); 13.3 (8.80) cm³
 - Parietal (5); 10.8 (8.93) cm³
 - Occipital (2); 12.2 (5.46) cm³
 - Hypothalamus (2); 1.61 (1.28) cm³
- Mean ablation volume per procedure: 8.84 cm³ (range, 1.0-26.4 cm³)
- Number of trajectories per procedure by targeting method:
 - Overall: 2.50 (1.32)
 - MRI guidance platform: 1.79 (0.83), n = 19
 - Stereotactic robot: 3.37 (1.24), n = 15
 - Headframe: 2, n = 1

Epilepsy details

All patients had ETLE

Seizure type (number of patients):

- Focal impaired awareness (34)
- Focal aware motor (1)

Complications (number of patients)

- Asymptomatic intracranial tract hemorrhages (4)
- Postoperative headache, medication encephalopathy, and transient vague complaints (3)
- Transient speech disturbances (3)
- Transient procedure related weakness (3)
- Persistent hyperphagia and transient short-term memory impairments (1)
- Hyponatremia (1)
- Infection (1)
- Seizures (1)
- Deep vein thrombosis (1)
- Delayed anticoagulation-related symptomatic subdural hematoma (1)
- Intracranial abscess at the site of ablation (1)
- Death from SUDEP 15 mos postprocedure (1)
- Death from SUDEP 7 months postprocedure (1)
- Death from suicide 5 yrs postprocedure (1)

Authors' conclusion

"Adverse events after MRg-LITT were few and the procedure was well tolerated overall."

The impact of stereotactic laser ablation at a typical epilepsy center.

Petito GT, Wharen RE, Feyissa AM et al. *Epilepsy & Behavior* 2018;78:37-44.¹



Study design

Retrospective single center study of 100 procedures in patients with epilepsy between 2013 and 2015. Data analysis included patients receiving LITT or open resection. Additional procedures performed, but not included in the analysis were vagus nerve stimulation (23), intracranial EEG (19), and responsive neurostimulation (4).

Patient population

LITT group:

- N = 32
- Age: 46.7 years (range, 18-74 yrs)
- 17 men, 15 women
- F/U: 21.7 months (range, 12-42 months)

Open resection group:

- N = 20
- Age: 35.35 yrs (range, 19-68 yrs)
- 11 women, 9 men
- F/U: 21.3 mos (range, NR)

Epilepsy details

- LITT (number of procedures):
 - TLE (32); 25 with MTS
 - ETLE (1)
- Open resection (number of procedures):
 - TLE (15)
 - ETLE (6)

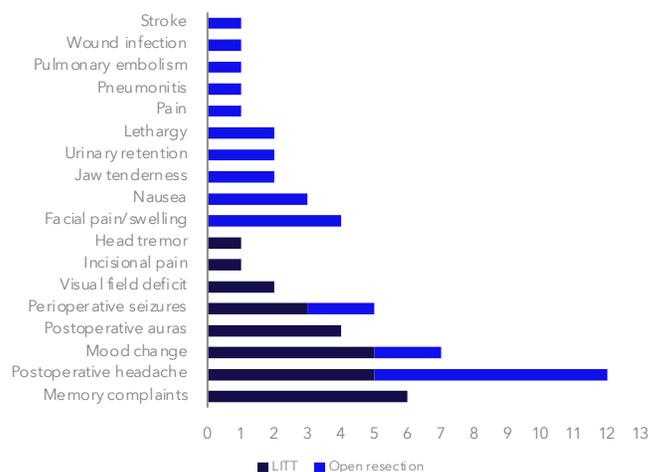
Length of stay

- LITT: 1.18 days (range: 1-3 days)
- Open resection: 3.43 days (range: 1-14 days)
- Difference in discharge length of time between LITT and resection was highly significant ($p = 0.0002$)
- 87.9% of patients were discharged the day following LITT

Procedural details

- LITT: n = 33 in 32 patients - mainly with Visualase™ system
 - Mesial temporal lobe (26)
 - Medial temporal lobe (3)
 - Amygdalohippocampectomy (1)
 - Amygdala and hippocampus (1)
 - Posterior hippocampus (1)
 - Frontal seizure focus (1)
- Open resection: n = 21 in 20 patients
 - Temporal lobe (15)
 - Extratemporal lobe (6)

Complications (number of patients)



Authors' conclusion

"In one hundred neurosurgical procedures performed for patients with drug-resistant focal epilepsy, the introduction of SLA [LITT] has made a substantial influence on our approach to surgical intervention for epilepsy, especially in respect to candidates for open resection. For TLE, the staged approach from minimally invasive (SLA) to maximally invasive (resection) should be considered in appropriate patients."

Anatomic and Thermometric Analysis of Cranial Nerve Palsy after Laser Amygdalohippocampotomy for Mesial Temporal Lobe Epilepsy.

Huang Y, Leung SA, Parker JJ, et al. Oper Neurosurg. 2020;1;18(6):684-691.¹⁹



Study design

Retrospective single center study to identify the cause of postoperative cranial nerve (CN) palsy in patients with mTLE treated by LITT between 2014 and 2018.

Patient population

- N = 26, including 4 patients with postoperative CN palsy
- Patients with CN palsy visual deficit:
 - 45 year-old woman
 - CN III palsy
 - Symptoms: mild left eye ptosis and diplopia
 - 64 year-old woman
 - CN III palsy
 - Symptoms: complete left eye ptosis and diplopia
 - 36 year-old man
 - CN IV palsy
 - Symptoms: mild vertical diplopia
 - 42 year-old woman
 - CN IV palsy
 - Symptoms: severe vertical diplopia
- 3 patients with CN palsy had MTS
- F/U range: 6-18 months

Procedural details

- Visualase™ system
- Ablation location: amygdalohippocampal complex
- No significant difference in thermal ablation parameters between CN palsy patients and no palsy patients (total energy, longest burn duration, max power, and median number of burns)

CN distance to mesial temporal lobe border

- CN III palsy was more likely to occur when the nerve was within 0 to 1 mm of the uncus border ($p = 0.036$)
- CN IV palsy was more likely to occur when the nerve was within 1 mm of the parahippocampal gyrus ($p < 0.001$)

Thermometric analysis

Comparing temperature changes to CNs that were within 0 to 1 mm of the tissue border, higher temperature rise is observed at the tissue border in patients who developed CN palsy than those who did not ($p = 0.025$).

Authors' conclusion

- "Thermal injury to the CNs that ran at extreme proximity to the border of mesial temporal lobe is likely the cause for postoperative CN palsy."
- "Low-temperature thresholds set at the border of the mesial temporal lobe in patients whose CNs are at close proximity may reduce the risk of this complication."

Laser thermal ablation for mesiotemporal epilepsy: Analysis of ablation volumes and trajectories.

Jermakowicz WJ, Kanner AM, Sur S, et al. *Epilepsia* 2017;58(5):801-810.²⁰



Study design

Retrospective study of consecutive patients with drug-resistant mTLE treated by LITT who had at least 12 months of postablation F/U.

Patient population

- N = 23
- 10 women, 13 men
- Mean Age: 40.9 (11.9) years;
- Mean F/U: 22.4 months (range, 12-37 months)

Epilepsy details

- 15 patients had MTS

Procedural details

- Visualase™ system
- Ablation location: amygdalohippocampal complex

Complications

- Transient headache, nausea or unsteady gait increasing hospital stay (4)
- Left homonymous hemianopia, partially resolved (1)

Cognitive change after ablation

- Clinically significant decline for dominant hemisphere ablation patients: verbal memory deficit (2), naming deficit (1), visual memory deficit (1), both naming and visual memory deficit (1)
- Clinically significant decline for non-dominant hemisphere ablation patients: naming deficit (1), verbal memory deficit (1), verbal memory deficit (1)
- 9 patients (7 dominant hemisphere ablation patients and 2 non-dominant hemisphere ablation patients) experienced postablation cognitive improvement (better visual and/or verbal memory scores or confrontational naming)

Length of stay

- 78% (18/23) discharged the morning after surgery
- In 4 patients, discharge was delayed by one or two days because of transient headache, nausea and unsteady gait that resolved 2 days after ablation. (Length of stay not reported for 1 pt)

Authors' conclusion

"Patients had a rapid recovery with very short hospital stay and low incidence of neurologic and cognitive complications."

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