Laser Interstitial Thermal Therapy in the Treatment of Thalamic Brain Tumors: A Case Series

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BACKGROUND: Surgical options for patients with thalamic brain tumors are limited. Traditional surgical resection is associated with a high degree of morbidity and mortality. Laser interstitial thermal therapy (LITT) utilizes a stereotactically placed laser probe to induce thermal damage to tumor tissue. LITT provides a surgical cytoreduction option for this challenging patient population. We present our experience treating thalamic brain tumors with LITT.

OBJECTIVE: To describe our experience and outcomes using LITT on patients with thalamic tumors.

METHODS: We analyzed 13 consecutive patients treated with LITT for thalamic tumors from 2012 to 2017. Radiographic, clinical characteristics, and outcome data were collected via review of electronic medical records

RESULTS: Thirteen patients with thalamic tumors were treated with LITT. Most had high-grade gliomas, including glioblastoma (n = 9) and anaplastic astrocytoma (n = 2). The average tumor volume was 12.0 cc and shrank by 42.9% at 3 mo. The average hospital stay was 3.0 d. Median ablation coverage as calculated by thermal damage threshold (TDT) lines was 98% and 95% for yellow (>43°C for >2 min) or blue (>10 min), respectively. Median disease-specific progression-free survival calculated for 8 patients in our cohort was 6.1 mo (range: 1.1-15.1 mo). There were 6 patients with perioperative morbidity and 2 perioperative deaths because of intracerebral hematoma.

CONCLUSION: LITT is a feasible treatment for patients with thalamic tumors. LITT offers a cytoreduction option in this challenging population. Patient selection is key. Close attention should be paid to lesion size to minimize morbidity. More studies comparing treatment modalities of thalamic tumors need to be performed.

KEY WORDS: Glioblastoma multiforme, GBM, Neurosurgery, Thalamic tumors, Laser therapy, Neuroblate, Thermal therapy, Brain ablation, Ablation, LITT

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Surgical resection is a cornerstone of the initial treatment of most primary brain tumors. Studies, particularly in high-grade gliomas, have demonstrated increased survival when resection is performed.[1-5] This is true even of some subtotal resections.[2] Unfortunately, because of the morbidity and mortality associated with traditional surgical resection of thalamic tumors,[6,7] adult thalamic tumors are rarely treated surgically. Yasargil[8] has described multiple surgical approaches to the thalamus, and there is a growing body of literature demonstrating moderate success in the pediatric population.[9-11] These tumors tend to be lower grade, however, and the neuroplasticity of pediatric patients makes these results nontransferable to adult populations.

A few case series of surgical resection of thalamic tumors have been published, which include adults. A group from India described 41 adult and pediatric patients with thalamic tumors treated surgically.[12] Only 12 of these patients were adults with glioblastoma

ABBREVIATIONS: ARDS, adult respiratory distress syndrome; **EBL,** estimated blood loss; **EMR,** electronic medical record; **GBM,** glioblastoma multiforme; **ICH,** intracerebral hematoma; **LITT,** laser interstitial thermal therapy; **KPS,** Karnofsky Performance Scale; **MRI,** magnetic resonance imaging; **RANO,** Response Assessment in Neuro-Oncology; **TDT,** thermal damage threshold

multiforme (GBM) and most were lost to follow-up (8 of 12). Of the remaining 4 patients, 2 died within 1 mo of surgery and 1 patient died at 5 mo. A group from China presented a case series of 49 pediatric and adult patients with surgically treated thalamic tumors.[13] They did not report outcomes on the subset of adult patients in their study, but their overall immediate postoperative complication rate was high at 81.6%. Some of these included minor or ambiguous complications like fever and decreased consciousness, but others were significant, including 36.7% of patients with a new motor deficit and 2 patients requiring re-operation for hematoma. Similar morbidity and mortality was reported in yet another case series from China with 111 patients age >18 yr old with surgically treated thalamic tumors.[6] The perioperative mortality rate for their patients with high-grade tumors was 10% (5 of 50 patients).

Taken in sum, these studies highlight the high morbidity and mortality associated with surgical resection of high-grade thalamic tumors in adults. This degree of perioperative morbidity and mortality is unlikely to be considered acceptable in most neurosurgical practices in advanced well-resourced countries.

Left with few surgical options, these patients have overall survival rates similar to unresected lobar tumors.[14] Laser interstitial thermal therapy (LITT) provides a surgical option for this patient population. LITT utilizes a stereotactically placed laser probe that induces hyperthermic ablation of brain tissues monitored in real time with magnetic resonance (MR) thermometry.[15] Studies have demonstrated the efficacy of LITT in a myriad of applications, including primary tumors, metastases, and radiation necrosis,[16] but few reports have explored its use exclusively in thalamic tumors.

We present our experience treating thalamic tumors using LITT at our institution over the past 5 yr.

METHODS

Study Design

We performed an Institutional Review Board-approved retrospective analysis of 13 consecutive patients with thalamic tumors treated with LITT at our institution from 2012 to 2017. No ethical approval was needed for this case series. No consent was needed for this de-identified case series. Except for one, patients had not received any prior surgical or stereotactic radiation therapy for their thalamic tumors.

Setting

Our institution is a large, academic, tertiary referral center in the United States. Patients from 2012 to 2017 were analyzed.

LITT Procedure

Surgeries were performed electively after appropriate preoperative optimization (ie, hypertension optimization, holding anticoagulation, full medical assessment). Our institution uses the NeuroBlate System (Monteris Medical, Plymouth, Minnesota), which employs a side-firing, CO_2-cooled Nd-YAG range laser (1064 nm).[17] One or more probe trajectories were planned using the iPlan software (BrainLAB, Munich, Germany), and the surgery was performed in our intraoperative MRI suite with the patients under general anesthesia. In most cases, stereotactic biopsy was performed immediately prior to laser ablation using the same trajectory. MR thermometry was used in real time for monitoring of ablation progress. The M-Vision software (Monteris Medical, Plymouth, Minnesota) displays thermal damage threshold (TDT) lines based on temperature and time. Tissue heated above 43°C for greater than 2 or 10 min are enclosed in yellow and blue lines, respectively. These thresholds are in keeping with the original phase I clinical study of the NeuroBlate System[15] and are based off preclinical studies of thermal damage to tissue.[18] The primary surgeon for each case was either of the last 2 authors (GHB or AM) who use similar surgical protocols. Figure 1 demonstrates the LITT interface as seen during the procedure. Postoperatively, patients typically received a computed tomography brain without contrast, admitted to the hospital for observation at least overnight. Follow-up MRIs were performed at the 2- to 3-mo postoperative mark.

Data Collection

Clinical, radiographic, and outcome data were obtained from the electronic medical records (EMR). Follow-up data were recorded from office visits with neurosurgery, radiation oncology, and/or medical oncology. Data on the TDT line coverage were obtained from a separate database on patients treated with the NeuroBlate System then imported to the iPlan software for volumetric analysis.

Variables

Patient demographics collected from the EMR included age at time of LITT, gender, whether any prior surgery or radiosurgery had been performed, performance status, neurological exam, and histopathologic diagnosis. Most patients underwent biopsy at the same time LITT was performed, unless prior tissue biopsy had already been performed, which was the case in 5 out of the 13 patients. Tumor size and volumes were recorded from analyzing available contrasted MRI scans pre- and postoperatively. Perioperative mortality was defined as mortality within 30 d of surgery clearly attributable to the LITT procedure.

Karnofsky Performance Scale (KPS) was recorded where available and used in progression calculations. We used the Response Assessment in Neuro-Oncology (RANO) criteria to define progression and overall survival from time of LITT surgery.[19] Clinical progression was defined as a consistently documented decrease in KPS of 20 points or more postoperatively or a severe clinical deterioration (eg, hospital readmission for declining neurologic status). Radiographic progression was defined as an increase in T1-weighted, gadolinium-enhancing disease of 25% or more, a significant increase in T2-weighted/fluid-attenuated inversion-recovery signal surrounding the lesion, or the appearance of a new lesion. For patients who died, the date of death was also considered progression of disease in keeping with RANO criteria.[19]

RESULTS

Patient Characteristics

Table 1 shows characteristics of the 13 patients in this study. The median age at time of surgery was 58 yr. Of 13 patients, 6 were female. Most patients had high-grade

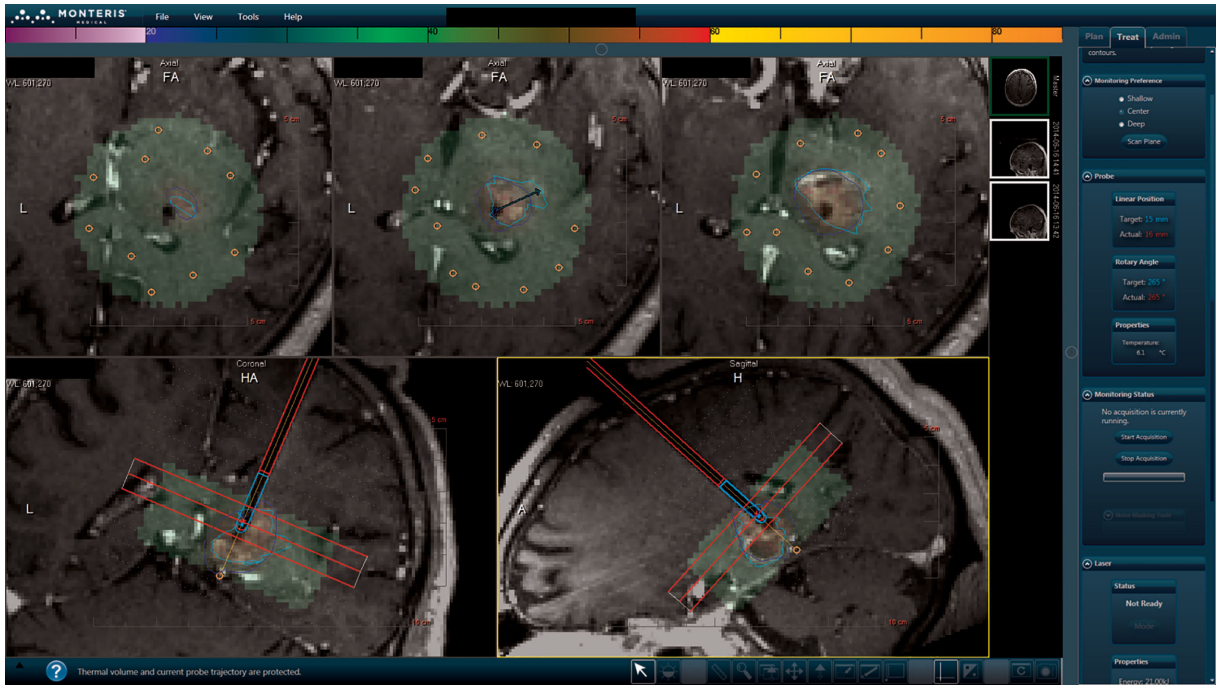

FIGURE 1. *Intraprocedural Monteris interface. Bottom left and bottom right panels show coronal- and sagittal-oriented T1-weighted gadolinium-enhanced images with LITT probe inserted. The wide green shaded area represents the area being actively monitored in real time by the MRI machine. The tumor is outlined in teal by the surgeon prior to the procedure. The ablation zone is outlined in dark blue and when ablation is complete corresponds to the blue TDT line. This represents tissue heated above 43° C for greater than 10 min. Each red line oriented perpendicular to the probe trajectory in bottom panels corresponds to slices in top 3 panels, respectively.*

TABLE 1. Patient Demographics

Patient	Age	Gender	Pathology	IDH-1 status	Previous treatments	Adjuvant therapies
1	46	F	Glioblastoma	Wild type	None	Stupp
2	20	F	Anaplastic astrocytoma	Unknown	None	Radiotherapy, temozolomide, bevacizumab
3	34	M	Glioblastoma	Wild type	None	Stupp
4	42	F	Double neg invasive ductal breast ca	N/A	Chemotherapy radiosurgery	Chemotherapy
5	72	F	Glioblastoma	Unknown	None	Stupp
6	59	F	Glioblastoma	Unknown	None	N/A
7	58	M	Anaplastic astrocytoma	Wild type	None	N/A
8	81	M	Nonsmall cell lung cancer	N/A	None	Radiosurgery, whole brain radiation
9	59	M	Glioblastoma	Wild type	None	Stupp
10	63	M	Glioblastoma	Unknown	None	Stupp
11	54	F	Glioblastoma	Unknown	Crani, STR, chemo/rads	Stupp, lumostine, tumor treating fields
12	48	M	Glioblastoma	Wild type	None	Stupp, tumor treating fields
13	61	M	Glioblastoma	Wild type	None	Stupp

Thirteen consecutive patients with thalamic tumors treated with LITT at our institution. Age at time of LITT surgery. "Stupp" refers to the standard of care Stupp protocol for glioblastoma, which includes adjuvant radiotherapy and chemotherapy (temozolomide).

gliomas, including glioblastoma (n = 9) and anaplastic astrocytoma (n = 2). The remaining 2 patients had metastatic breast and lung cancers, respectively. Among the patients with glioblastoma, genetic studies were available for 5 of 9 patients. All of these were IDH-1 wild type. Only 1 patient underwent LITT for recurrence (patient 11, pathology: GBM). This patient was also the only one who received prior treatment (ie, surgery, radiation, and chemotherapy) for their thalamic brain tumor.

Outcomes

The average tumor volume in our study was 12.0 cc (median: 13.77; range: 1.67-30.3 cc) and shrank by 42.9% at the 2- to 3-mo MRI. All patients with postoperative MRIs at 2 to 3 mo demonstrated a decrease in tumor volume (range: 29.5%-84.2% decrease). Figures 2 and 3 demonstrate example cases of thalamic glioblastoma from our report (patient #12 and #3, respectively). Both patients completed adjuvant radiotherapy and temozolamide per the Stupp protocol.[20]

Disease-specific survival was calculated for 8 patients (patients 1-4, 8, and 10-12), excluding 5 patients who died from other causes not directly related to progression of their intracranial disease. Median disease-specific survival was calculated on 8 patients. Disease-specific overall survival was 18.1 mo (range 4.1-69.5), whereas disease-specific progression-free survival was 6.1 mo (range 1.1-15.1 mo). Two of these patients progressed by RANO clinical criteria (ie, KPS decreased by 20 or more), 4 progressed by radiographic criteria, 1 patient died from presumed overall functional decline, although KPS scores were not documented (patient 4), and the final patient was alive without progression as of last follow-up. Mean time to last follow-up was 34.4 mo for alive patients, and 18.1 mo for all patients. Patients excluded from disease-specific survival include 3 patients with perioperative mortality within 30 d (2 patients with postop intracerebral hemorrhage (ICH), 1 patient with adult respiratory distress syndrome [ARDS], 1 patient who died of pneumonia and ARDS, and 1 patient who died of cardiac arrest). Table 2 lists the cause of death for each patient. Median overall survival including all patients was 6.7 mo. These results are summarized in a patient flowchart (Figure 4 patient flow chart).

Table 2 summarizes outcome data for the 13 patients in the study. The median length of stay postoperatively was 3 d (range: 1-19 d). Six patients had permanent postoperative morbidity, which most commonly was new contralateral partial hemiparesis. With the exception of patient 13, these patients remained at least antigravity on strength exam (3 out of 5). Patient 13, however, developed complete hemiplegia postoperatively, worsened from mild hemiparesis preoperatively (4 out of 5). This patient was also the only one for whom 100% TDT coverage was achieved at the yellow and blue lines. Across all patients, however, no significant correlation was found between postoperative hemiparesis and TDT coverage at the blue or yellow lines ($P = .512$ and 0.546, respectively, unpaired t-test) or tumor volume ($P = .654$, unpaired t-test). This analysis is limited, however, because of the small sample size. Additionally, only 3 patients demonstrated clear invasion and disruption of the internal capsule, only one of which had postoperative hemiparesis. Two patients also developed obstructive hydrocephalus postoperatively, both of which required a ventriculoperitoneal shunt. There were 2 mortalities (patients 6 and 7) in the immediate postoperative period. Both patients developed an ICH into their tumor bed resulting in brain herniation and death on postoperative day 2 and 3, respectively.

Both patients with immediate postoperative mortalities had tumors with maximum dimension >3 cm (3.6 and 3.9 cm, respectively), though perioperative morbidity was also noted for patients with either greater or less than 3 cm in maximum dimension.

Other Operative Data

Table 3 shows pertinent operative data. The average tumor volume treated was 12.0 cm^3 (range: 1.6-30.3 cc). Mean estimated blood loss (EBL) was 34 cc (median: 20 cc; range: 5-150 cc). Two probe trajectories were used in 5 cases, whereas a single trajectory was used in the remaining 8. The median TDT coverage by yellow and blue lines as a percentage of tumor volume was 98% and 95%, respectively. Two patients had 100% coverage at the TDT yellow line (patients 5 and 13) and 1 patient at the TDT blue line (patient 13).

DISCUSSION

Patients with thalamic tumors—particularly high-grade gliomas—can be challenging to manage. The increased morbidity and mortality associated with open surgical resection of these tumors limits their use as options.[6,7] Many of these patients forgo the mainstay of surgical cytoreduction prior to radiation and chemotherapy and generally have poorer prognosis.[21,22] LITT offers a minimally invasive cytoreduction therapy for this challenging population. In our retrospective chart review of patients from 2012 to 2017, we found 13 total thalamic tumor patients treated with LITT. Most of these patients were diagnosed with high-grade gliomas, including glioblastoma (n = 9) and anaplastic astrocytoma (n = 2). One patient had a craniotomy for subtotal resection and chemoradiation (Table 1, patient 11). The average tumor volume in our study was 12.0 cc and showed good radiographic response to treatment. By 3 mo postoperatively, tumor volumes shrank by 42.9% on average. Hospital stay was also short, averaging 3.0 d. Median ablation coverage as calculated by TDT lines was 98% and 95% for yellow and blue lines, respectively. Figure 4 summarizes key study findings in a flowchart.

Progression-Free Survival

Median disease-specific progression-free survival calculated for 8 patients in our cohort was 6.1 mo (range: 1.1-15.1 mo). This included 3 patients who progressed by clinical criteria,

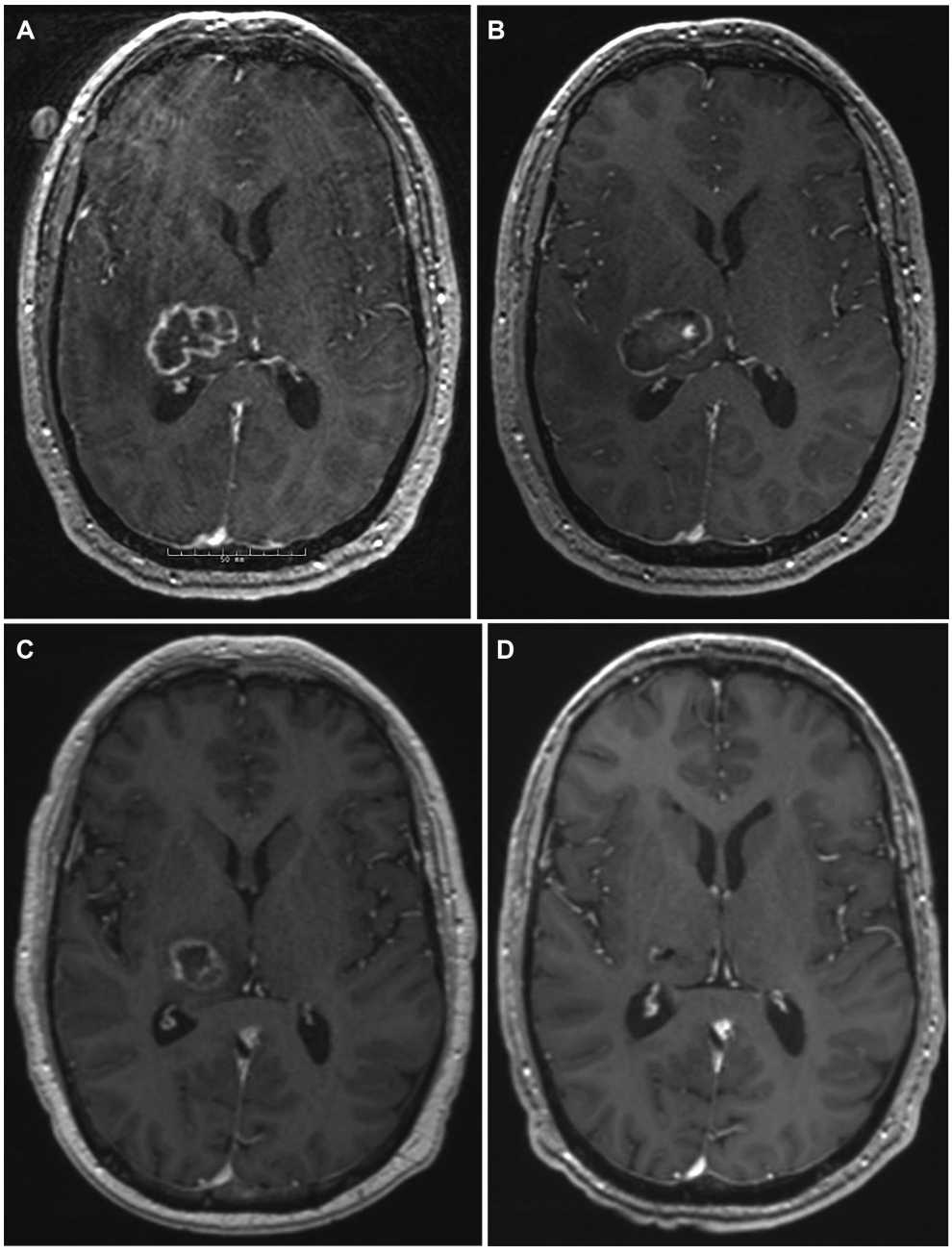

FIGURE 2. *T1-weighted, gadolinium-enhanced serial MRIs from example case. The patient is a 48-yr-old male with right thalamic tumor, confirmed glioblastoma after biopsy.* **A**, *Preoperative MRI demonstrating lesion (total volume: 17.1 cc).* **B**, *Postoperative day 1 MRI. Some hemorrhage is seen in the surgical site.* **C**, *Three-month postoperative scan with interval significant decrease in lesion size.* **D**, *Twelve-month postoperative scan with near complete involution of lesion. The patient received adjuvant radiotherapy and temozolamide per the Stupp protocol.*

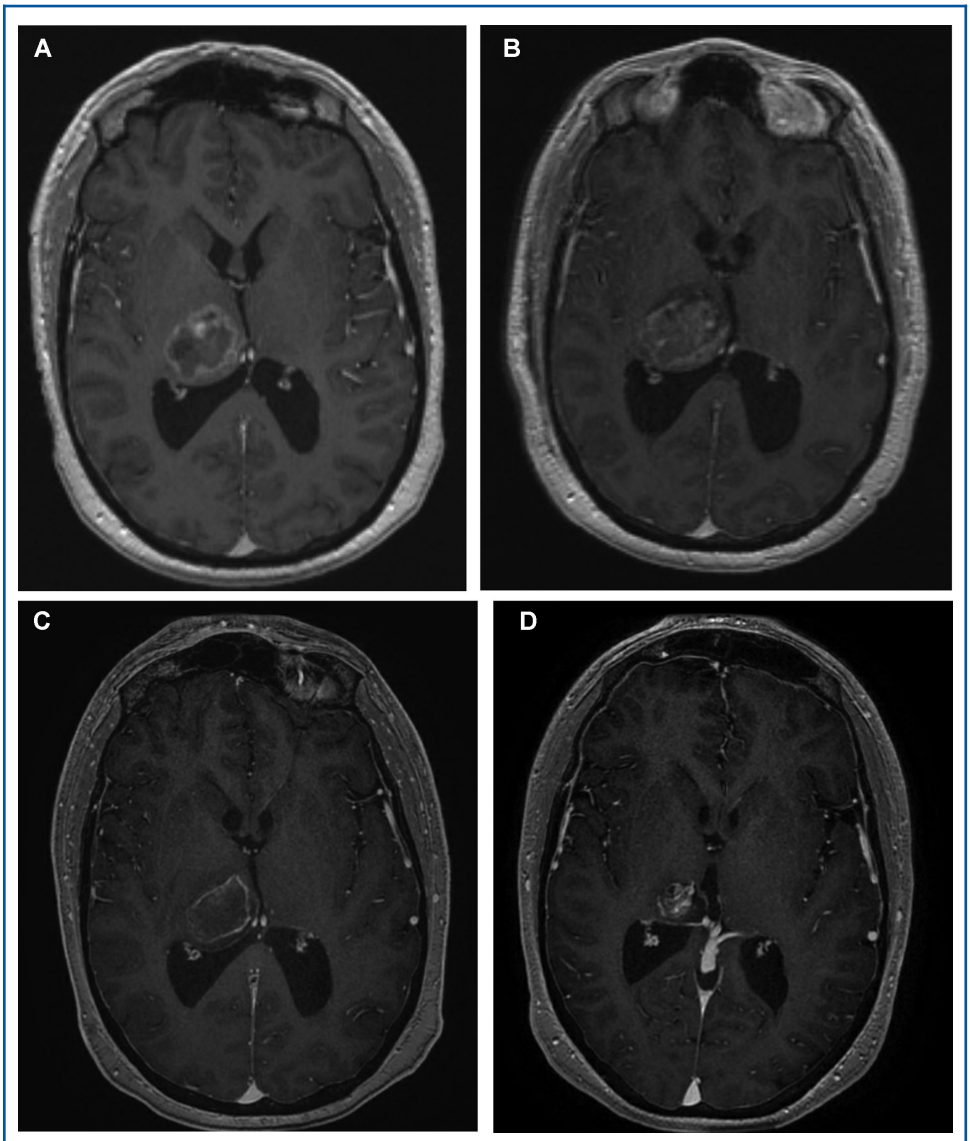

FIGURE 3. *T1-weighted, gadolinium-enhanced serial MRIs from example case. The patient is a 34-yr-old male with a right thalamic tumor.* **A**, *Preoperative MRI demonstrates 16.9 cc enhancing tumor of the thalamus. Confirmed glioblastoma multiforme (GBM) after biopsy. LITT was subsequently performed.* **B**, *Postoperative day 2 MRI demonstrates a slight increase in lesion size.* **C**, *Three-month postoperative MRI. Total lesion volume has decreased by 73.1% and shows a further decrease in lesion size.* **D**, *Nine-month postoperative MRI. The patient received adjuvant radiotherapy and temozolomide per the Stupp protocol.*

4 who progressed by radiographic criteria, and 1 patient who was alive without progression as of last follow-up. This is roughly in keeping with previous studies on LITT, though direct comparisons are difficult to make. Hawasli et al[23] described 17 patients treated with LITT. Their median progression-free survival was 7.6 mo, though their study only included 5 thalamic or basal ganglia tumors and included 1 epileptic focus. Mohammadi et al[24] reported on 34 patients who underwent LITT for high-grade gliomas. Median progression-free survival in their study was 5.1 mo, though again only 10 of 34 patients had thalamic lesions.

Here, we quote disease-specific progression-free survival that excluded 5 patients in our study because of morbidity and mortality not directly attributable to progression of intracranial disease. This exclusion was important in assessing the direct effect of LITT on this population's disease. However, if all patients

TABLE 2. Outcome Data

Patient	LOS	Periop morbidity	Periop mortality	Delta volume	Preop KPS	Time to progression (mo)	Progression type	Survival (mo)	Cause of death
1	10	Weakness, HCP, shunt	–		90	1.1	Clinical (KPS)	6.7	
2	13	Weakness, facial droop	–	–47.8%	80	2.9	Radiographic	Alive	n/a
3	3	Weakness	–	–73.1%	80	11.7	Radiographic	22.8	Clinical deterioration
4	6		–	–48.0%	–	10.0	Death	10.0	Not documented
5	3	Weakness	–	–29.5%	–	2.7	Death	2.7	Pneumonia, ARDS, pulmonary embolism
6	2		POD2, ICH, herniation		–	0.1	Death	POD2	ICH, brain herniation
7	3		POD3, ICH, herniation		70	0.1	Death	POD3	ICH, brain herniation
8	5	Weakness	–	–63.7%	80	2.5	Clinical (KPS)	4.1	Global decline due to stage 4 lung ca
9	3		–		60	3.3	Death	3.3	Cardiac arrest
10	2		–	–84.2%	90	4.9	Radiographic	13.4	Clinical deterioration
11	1		–	–25.8%	70	7.3	Radiographic	Alive	n/a
12	1		–	–76.4%	80	n/a	n/a	Alive	n/a
13	19	HCP, shunt	See cause of death		70	0.9	Death	0.9	ARDS, septic shock

ARDS = adult respiratory distress syndrome, Ca = cancer, Crani = craniotomy, EBL = estimated blood loss, HCP = hydrocephalus, ICH = intracerebral hemorrhage, LOS = length of stay, KPS = Karnofsky Performance Scale, POD = postoperative day, Rads = radiotherapy, TDT = thermal damage threshold (line).
LOS = length of postoperative hospital stay (days).
Delta volume is percentage change in tumor volume from preoperative MR to 2 to 3-mo postoperative MR. Progression as defined by RANO criteria.

were considered in the analysis, progression-free survival would be significantly lower, as mortalities are also considered progression per RANO criteria.

Morbidity/Mortality

Perioperative morbidities occurred in 6 patients (46.1%) in this series (Table 2). Most commonly, this was worsening of contralateral hemiparesis. One of these patients, however, did develop complete contralateral hemiplegia postoperatively, which did not improve significantly. This patient was the only patient with 100% TDT coverage by the yellow and blue lines, though this was likely coincidence. There was no clear correlation between postoperative hemiparesis and tumor volume, tumor invasion and disruption of internal capsule, or TDT coverage noted in our study. Careful attention to trajectory placement and use of postoperative high-dose steroids are important considerations in mitigating and treating postoperative hemiparesis.

Overall, TDT coverage was high (median 98% and 95% for yellow and blue lines, respectively), and 2 patients had 100% coverage by yellow TDT lines. Mohammadi et al[24,25] demonstrated in 2 studies a group of patients with so called "favorable coverage" for whom progression-free survival was significantly higher in their cohort. Salehi et al[26] showed a somewhat similar correlation between TDT coverage and progression-free survival in their metastatic brain tumor LITT study.

Favorable coverage was defined as patients with the combination of <0.05 cm^3 tumor volume not covered by the yellow TDT line and <1.5 cm^3 additional tumor volume not covered by the blue TDT line. Three patients in our study met these criteria (patients #5, 11, and 13). It is difficult to draw conclusions about these patients, although one is still alive as of 6 yr after LITT. The other 2 died within a couple months of surgery from other medical causes (ie, ARDS and pulmonary embolism).

Median EBL was 20 cc but ranged up to 150 cc. There were 2 patients for whom a small craniotomy bone flap was created to accommodate 2 tricky ablation trajectories. As expected, these patients had higher EBL at 75 cc and 150 cc. Two patients developed hydrocephalus requiring placement of a shunt. Both patients had extension of their tumor into the midbrain with early effacement of the cerebral aqueduct on preoperative imaging that worsened postoperatively. Three patients died during the perioperative period (ie, within 30 d). One patient died of ARDS on postoperative day 28. The other 2 developed an ICH, herniated, and died within 3 d of surgery. Both these patients were treated during our early experience with LITT. They also had larger than average tumors with maximal diameter and volumes of 3.6 cm (22.05 cm^3) and 3.9 cm (17.0 cm^3), respectively. We subsequently were more cautious in the treatment of patients with thalamic tumors greater than 3 cm in maximal dimension and have not had another postoperative mortality because of ICH

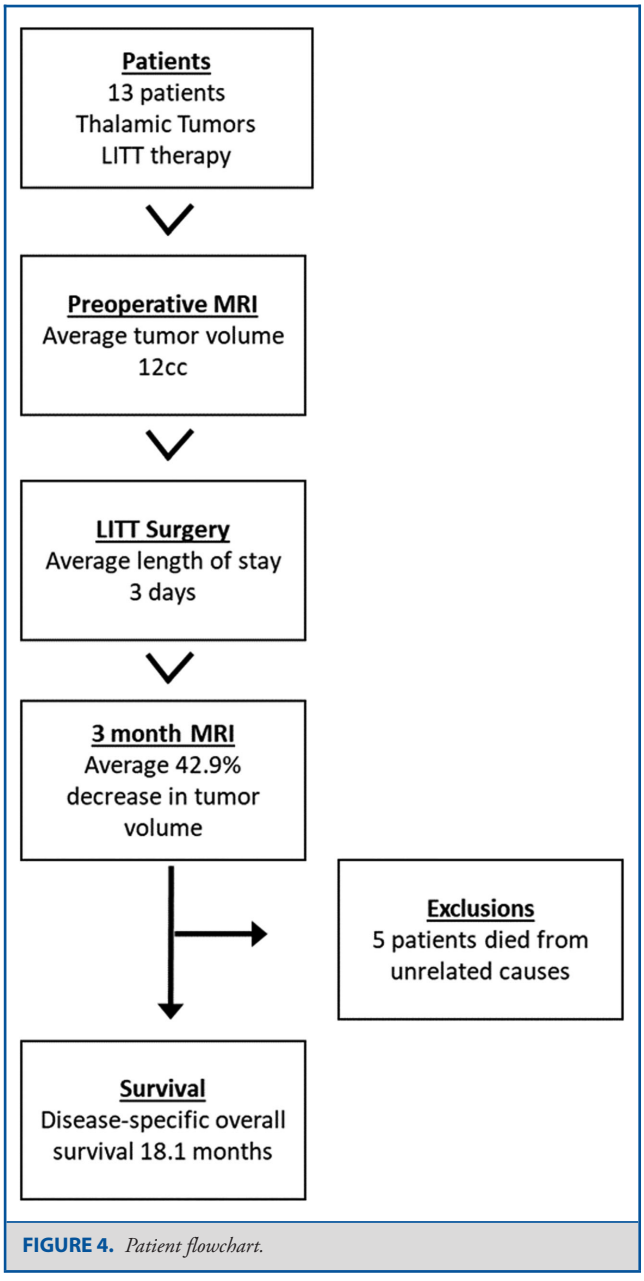

FIGURE 4. *Patient flowchart.*

since. Other studies of LITT also reported multiple postoperative ICHs with at least 1 death in the immediate perioperative period.[24]

Our overall morbidity and mortality was higher than that expected for biopsy alone. However, our perioperative ICH mortalities occurred early in the case series, which suggests a learning curve in this patient population. Specifically, we no longer perform LITT on large primarily thalamic tumors and also thoroughly counsel patients on the morbidity and mortality associated with ICH after ablation. With experience, overall morbidity is expected to decrease while still providing a surgical cytoreductive option for these patients.

Treatment of any kind in this population appears to be associated with high morbidity and mortality. Open surgery is rarely performed but has been reviewed in a handful of studies. Recently, Esquenazi et al[14] presented a review of 57 cases of thalamic tumors in which 10 patients underwent craniotomy with subtotal resections. A few studies have also evaluated open surgical treatment of thalamic tumors.[6,12,27] There appears to be no clear survival benefit compared with biopsy alone and aggressive resection is associated with significant morbidity. Our knowledge of the importance of cytoreduction suggest that LITT is a potentially important component of the treatment regimen for these tumors, though rigorous studies comparing LITT to biopsy alone have yet to be performed. Studies making this direct comparison are needed to further validate the utility of this procedure.

LITT vs Radiosurgery

Two patients in our study had metastatic lesions. We generally prescribe radiosurgery (ie, Gamma Knife; Elekta, Stockholm, Sweden) for patients with small metastatic brain lesions, the efficacy of which has been well studied.[28] However, the 2 patients in our study had unique considerations. Patient 4 presented with refractory, recurrent, metastatic double-negative invasive ductal breast cancer after prior chemotherapy and radiosurgery. Ultimately, LITT was chosen for salvage therapy after discussion with the patient. The literature is limited on this population subset, but LITT for treatment of refractory brain metastases after prior chemotherapy and radiosurgery has been described.[29-31] Patient 8 presented with a newly diagnosed singular thalamic brain lesion without a clear primary source on staging workup. Preliminary results from biopsy at time of LITT were equivocal, and laser therapy was performed. Subsequent final pathology was consistent with non-small cell lung cancer and the patient received Gamma Knife radiosurgery 3 wk later.

Limitations

Our study is limited by sample size and a retrospective, single-institution design. As a case series, it also does not have a comparison cohort who received another intervention.

CONCLUSION

LITT is a feasible treatment for patients with thalamic tumors. LITT offers an option for cytoreduction in this challenging patient population. Because morbidity is higher than biopsy alone, patient selection is key. Close attention should be paid to lesion size minimize morbidity, particularly postoperative ICH. Ultimately, more studies directly comparing treatment modalities of thalamic tumors need to be performed.

TABLE 3. Operative Data

Patient	Diagnosis to LITT (d)	Tumor volume (cc)	EBL	Trajectories	TDT coverage (yellow)	TDT coverage (blue)
1	39	13.8	10	1	97%	95%
2	60	30.3	25	2	95%	90%
3	34	16.9	25	2	98%	95%
4	–	5.5	25	2	98%	95%
5	–	4.5	30	1	100%	98%
6	22	22.1	75	2	85%	80%
7	31	17.0	150	2	98%	96%
8	11	2.2	20	1	–	–
9	20	2.0	20	1	–	–
10	7	18.4	20	1	92%	85%
11	22	1.6	5	1	98%	90%
12	6	17.1	20	1	99%	97%
13	39	4.7	10	1	100%	100%

EBL = estimated blood loss.
Thermal damage threshold (TDT) coverage indicates percentage of total volume of tumor treated above 42°C for at least 2 min (yellow) or 10 min (blue).

Disclosures

Drs Mohammadi and Barnett are consultants for Monteris Medical. The other authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

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COMMENT

Laser interstitial thermal therapy (LITT) is a welcome addition to a neurosurgeon's armamentarium in the management of primary and metastatic brain tumors. In this study the authors present their results of 13 patients treated using LITT for thalamic tumors. Although the LITT presented to be effective in cytoreduction as described by the authors, the results of this series show the morbidity to be higher compared to when biopsy was performed alone, and also failing to present significant survival advantage over biopsy alone. While searching for alternative treatment options, one should not underestimate the efficiency of radical tumor resection which seems to prolong the survival of patients with thalamic tumors. It looks like microneurosurgical radical removal of thalamic tumors is still the most effective technique of treating these patients with acceptable morbidity.

The neurosurgical community is looking forward to experiencing the benefits of LITT shown in studies performed by various institutions and larger series, leading to the validation of this alternative technique for the patients with challenging tumors.

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