Laser Interstitial Thermal Therapy: Lessons Learned.

Alexander James Gamble DO; Cynthia Harden MD; Harold L. Rekate MD; Michael Schulder MD; Ashesh Mehta MD PhD
North Shore Long Island Jewish Health Systems
Cushing Institute of the Neurosciences

Introduction

From 2009 to present 34 fibers have been placed in 29 patients for Laser Interstitial Thermal Therapy (LITT) at our institution. We have used LITT to treat intractable epilepsy secondary to mesial temporal sclerosis (MTS) and hypothalamic hamartoma, as well as recurrent tumors in patients who have exhausted their treatment options. This poster serves to describe our overall experience, success and complications with this exciting and relatively novel treatment modality.

Methods

Visualase™ probes were placed using CT and MRI guidance with frameless stereotaxy on four occasions, frame-based placement 23 times, under direct MRI guidance once and endoscopically once. Probe placement for the initial four tumor patients were assessed with intraoperative MRI before the LITT treatment was performed in the MRI suite. Early in our experience which was limited to tumors, frameless stereotactic probe placement with the Medtronic™ Navigus® and Precision Aiming Device® systems was utilized as it allowed for intraoperative MRI compatibility. From the 6th patient in our series on, intraoperative MRI was abandoned and the frame based Integra™ CRW® system used exclusively.

Results

For MTLE, favorable Engel (1+2) outcome was seen in 14/15, 8/11, 4/9 and 1/2 at 3 months, 6 months, 1 year and 2 years, with one failure undergoing temporal lobectomy. 7/10 tumor patients had progression-free survival, with one requiring subsequent craniotomy. All 4 patients with hypothalamic hamartoma have experienced excellent resolution of their symptoms to date without complication. Malposition occured in one epilepsy patient when an alignment rod was not used to create a track. In one tumor patient, a probe was malpositioned when using FS, and this was not visualized with intraoperative MRI. The malposition was detected in the MRI suite resulting in abortion of the procedure. This case, in addition to the cumbersome use of the Navigus® trajectory guide outside the OR prompted the move to a frame based procedure only. Two hemorrhages occurred in patients with MTLE: One intraparenchymal temporal likely secondary to a vascular injury and an intraventricular hemorrhage which occurred in a patient with excessive movement in MRI under sedationlikely resulted in the breakage of the cooling catheter. Thereafter, in all patients a preoperative CT Angiogram was merged with the stereotactic MRI used for probe trajectory planning. In addition, all further cases were done under general anesthesia. Two complications resulted from the LITT itself. One patient with a glioblastoma of the deep vermis developed bilateral CN 6 and 7 palsies. A patient with a filum terminale ependymoma developed paraparesis and incontinence the day after treatment and required surgical resection.

Hypothalamic Hamartoma

Subject DOS	Age Sex	Pathology	Symptoms and Previous Treatment	Approach and Adjustments	Response to Treatment to Date
16 2/12/14	40M	9x8mm, midline with left predominance	Complex partial seizures, rage attacks and MR.	Left frontal	Seizure free. Significant improvement in rage attacks
17 2/14/14	25F	Bilat reminant, R=4mm, L=2mm	Transcallosal resection age 13 for gelastic and generalized seizures. Return of gelastic and simple partial seizures at age 23.	Right frontal Probe advanced 3mm. SRS performed to left remnant POD3	Complete resolution
18 5/28/14	3F	14x14mm Left	Gelastic and generalized seizures. Rage attacks.	Left frontal Probe advanced 5mm. Found to be in cistern and withdrawn 1cm	Complete resolution
19 7/24/14	16M	9.5x9.5 Right	Endoscopic resection at age 7 for gelastic seizures and rage attacks with minimal improvement.	Right frontal Withdrawn 1.5cm	Complete Resolution

Seizure

Subject DOS	Age Sex	Pathology	Anesthesia	Number of Probes Lesions Created	Complications	Rationale
1 1/18/12	32M	R MTS, Prev R occipital astrocytoma resection	Sedation	1 Probe Anterior and posterior hippocampus (2)	Probe placed 2cm posterior to amygdala. Only hippocampal ablation performed	Improper placement in OR
2 3/29/12	30F	L MTS	Sedation	1 Probe Amygdala, ant/post hippocampus (3)	Quadrantanopsia without hematoma	Lesion created too large
3 5/30/12	50F	R MTS	GETA	1 Probe Amygdala, ant/post hippocampus (3)		
4 9/11/12	60M	R MTS	Sedation	1 Probe Amygdala, Ant/medial/post hippocampus (4)		
5 10/2/12	32F	R Parietal focus, R MTS	Sedation	1 Probe Amygdala, ant/post hippocampus (3)		
6 11/19/12	75F	L Mesial Temporal DNET	Sedation	1 Probe Amygdala + tumor (2)		
7 12/10/12	49F	Bitemporal R>>L	Sedation	1 Probe Amygdala, ant/post hippocampus (3)		
8 1/4/13	40F	R MTS	Sedation	2 Probes (ant/medial and posterior) Amyg/hippocampal head (2), tail (1)	Intraventricular hemorrhage	Patient motion caused breakage of cooling catheter
9 1/11/13	60F	Bitemporal R>>L	GETA	2 Probes (ant/medial and posterior) Amyg/hippocampal head (2), tail (1)	5cm temporal hematoma resulting quandrantanopsia.	Anterior probe pass caused vascular injury. All subsequent cases have CTA/MRI fusion
10 5/28/13	43M	R MTS	GETA	1 Probe Amygdala and hippocampal head (2)		
11 8/28/13	52F	L MTS	GETA	1 Probe Temporal tip, Amygdala, hippocampal head, body and tail (6)		
12 10/2/13	57F	L MTS	GETA	1 Probe Temporal tip, amygdala, hippocampal head and body (4)		
13 11/4/13	42M	L MTS	GETA	1 Probe Temporal tip, amygdala, hippocampal head and body (4)		
14 11/4/13	32F	L MTS	GETA	1 Probe Temporal tip, amygdala, hippocampal head and body (4)		
15 1/17/14	41M	L MTS	GETA	1 Probe Temporal tip, amygdala, hippocampal head and body (4)		

Conclusions

LITT may be used to treat brain tumors, HH and MTLE with comparable outcomes to open procedures. To optimize outcome, we suggest:

1. Use of an alignment rod to create a tract for deep structures
2. Use of frame-based techniques
3. Orthogonal entry of the laser probe
4. General anesthesia to reduce movement during transport and ablation procedure
5. Caution for spinal tumors
6. Maintain a margin beyond the treatment region near critical structures (e.g. the brain stem)

Epilepsy/ Hypothalamic Hamartoma

Subject	LOS	Engel Classification			
	(Days)	3 Month	6 Month	1 Year	2 Year
1	1	2	2	3	3
2	1	1	2	2	2
3	1	1	1	1	1
4	1	1	4	3	
5	1	1	2	3	
6	1	1			
7	3	3	4	4	
8	3	1	3	3	
9	3	1	1	1	
10	1	2			
11	1	1	1	4	
12	1	1	3	2	
13	1	1	1		
14	1	1	1	1	
15	2	1			
16	1	1	1		
17	1	1	1		
18	1				
19	1				
Ave	1.37	1.24(17)	1.8(15)	2.45(11)	2(3)

Subject	LOS	Previous Treatment	Local Control? (Days to Recurrence)	Nature of Recurrence
1	6	WBRT for multiple tumors 18 mo prior. One right frontal tumor grew, treated with SRS with further growth	Yes	
2	12	WBRT for multiple tumors with continued growth of pontine tumor not controlled by SRS	Yes	
3	4	Three transphenoidal and two transcranial resections. XRT. Failed dopamine agonist and temozolomide	Yes	
4	3	Multiple lesions, large cerebellar tumor resection. SRS to all lesions with good control except left temporal mass	No (44)	Hemorrhagic lesion continued to grow. Underwent craniotomy and resection at 71 days post LITT
5	3	Single falcine based right parietal mass with recurrences after 3 resections, WBRT and SRS	Yes	
6	27	Previous laminectomy and resection on two occasions, a decade apart. XRT. Temodar	Yes	
7	10	Previous resection, WBRT and SRS	No (57)	MRI demonstrating regrowth
8	2	One previous resection, WBRT and SRS	Yes	
9	10	One previous resection, WBRT and SRS	Yes	
10	21	Two previous resections, SRS, XRT, Temodar	No (17)	Regrowth and massive leptomeningeal spread

Tumor

Subject Age/Sex DOS	Pathology	Location	Anesthesia Stereotactic Method	#Of Fibers #Of Lesions	Complications
1 73M 3/26/09	Lung	Right Temporal	Sedation Frameless (Navigus®) Intraoperative MRI	1 4	
2 39F 11/18/09	Breast	Pontine	GETA Frameless (Navigus®) Intraoperative MRI	1 3	
3 68F 5/14/10	Macroadenoma	Sellar, Suprasellar	GETA Endoscopic Intraoperative MRI	2 6	
4 63F 11/1/10	Melanoma	Left Temporal	GETA Frameless (PAD®)	2 4	
5 56F 2/7/11	Lung	Right Parietal	GETA 1. Frameless (PAD®) 2.Frameless (Navigus®) Both Intraoperative MRI	2 6	Inaccurate placement, first attempt aborted. Successful ablation on later visit
6 72F 8/2/11	Spinal Myxopapillary Ependymoma	Cauda Equina	Sedation MRI Guidance	1 1	Paraparesis and incontinence POD 1 resulting in laminectomy and resection
7 87F 11/9/12	Adenocarcinoma(unknown primary)	Right Parietal	GETA Frame Based (CRW®)	1 3	
8 43F 5/1/13	Breast	Right Frontal	GETA Frame Based (CRW®)	1 2	
9 64F 7/3/13	Lung	Right Frontal	GETA Frame Based (CRW®)	1 3	
10 29M 8/1/13	Glioblastoma	Cerebellar, paraventricular	GETA Frame Based (CRW®)	1 3	Bilateral CN 6 and 7 palsy