Epilepsy & Behavior 51 (2015) 152–157

Contents lists available at ScienceDirect

Epilepsy & Behavior

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

Laser ablation therapy: An alternative treatment for medically resistant mesial temporal lobe epilepsy after age 50

Hena Waseem [a], Katie E. Osborn [b], Mike R. Schoenberg [a,b,c], Valerie Kelley [c], Ali Bozorg [c,d], Daniel Cabello [e], Selim R. Benbadis [c], Fernando L. Vale [a,*]

[a] Department of Neurosurgery and Brain Repair, Morsani College of Medicine, University of South Florida, 2 Tampa General Circle, USF Health, 7th Floor, Tampa, FL 33606, USA
[b] Department of Psychiatry and Behavioral Neurosciences, Morsani College of Medicine, University of South Florida, 3515 East Fletcher Ave., Tampa, FL 33613, USA
[c] Department of Neurology, Morsani College of Medicine, University of South Florida, 2 Tampa General Circle, USF Health, 6th Floor, Tampa, FL 33606, USA
[d] UCB BioSciences, Inc., 8010 Arco Corporate Drive, Raleigh, NC 27617, USA
[e] Department of Neurology, Morton Plant Mease Hospital, 300 Pinellas Street, Clearwater, FL 33756, USA

A R T I C L E I N F O

Article history:
Received 4 June 2015
Revised 16 July 2015
Accepted 18 July 2015
Available online xxxx

Keywords:
Laser ablation
Medically resistant epilepsy
Temporal lobe epilepsy
Epilepsy surgery
Magnetic resonance-guided laser interstitial thermal therapy

A B S T R A C T

Selective anterior mesial temporal lobe (AMTL) resection is considered a safe and effective treatment for medically refractory mesial temporal lobe epilepsy (MTLE). However, as with any open surgical procedure, older patients (aged 50+) face greater risks. Magnetic resonance-guided laser interstitial thermal therapy (MRgLITT) has shown recent potential as an alternative treatment for MTLE. As a less invasive procedure, MRgLITT could be particularly beneficial to older patients. To our knowledge, no study has evaluated the safety and efficacy of MRgLITT in this population.

Seven consecutive patients (aged 50+) undergoing MRgLITT for MTLE were followed prospectively to assess surgical time, complications, postoperative pain control, length of stay (LOS), operating room (OR) charges, total hospitalization charges, and seizure outcome. Five of these patients were assessed at the 1-year follow-up for seizure outcome. These data were compared with data taken from 7 consecutive patients (aged 50+) undergoing AMTL resection.

Both groups were of comparable age (mean: 60.7 (MRgLITT) vs. 53 (AMTL)). One AMTL resection patient had a complication of aseptic meningitis. One MRgLITT patient experienced an early postoperative seizure, and two MRgLITT patients had a partial visual field deficit. Seizure-freedom rates were comparable (80% (MRgLITT) and 100% (AMTL) ($p > 0.05$)) beyond 1 year postsurgery (mean follow-up: 1.0 years (MRgLITT) vs. 1.8 years (AMTL)). Mean LOS was shorter in the MRgLITT group (1.3 days vs. 2.6 days ($p < 0.05$)). Neuropsychological outcomes were comparable.

Short-term follow-up suggests that MRgLITT is safe and provides outcomes comparable to AMTL resection in this population. It also decreases pain medication requirement and reduces LOS. Further studies are necessary to assess the long-term efficacy of the procedure.

1. Introduction

Anterior mesial temporal lobe (AMTL) resection has been considered the gold standard for treatment of refractory mesial temporal lobe epilepsy (MTLE) and is more efficacious in seizure control than medical therapy alone [1]. Minimally invasive surgery for epilepsy has continued to evolve and focuses on treating epilepsy to achieve seizure freedom while avoiding the adverse effects and cognitive deficits potentially associated with an open surgical procedure.

Laser-induced thermal therapy was investigated as early as 1991 for the treatment of cerebral gliomas [2]. The therapy uses thermal energy to induce cell death by damaging DNA and protein denaturation [3]. The current therapy is performed with simultaneous MRI guidance and real-time feedback from the ablated lesion and is referred to as MR-guided laser interstitial thermal therapy (MRgLITT). This therapy was first described for epilepsy by Curry et al. in 2012 as a minimally invasive alternative to open resection in children, allowing for a faster recovery time and a decreased complication rate [4].

Abbreviations: AMTL, anterior mesial temporal lobe; MTLE, mesial temporal lobe epilepsy; MRgLITT, magnetic resonance-guided laser interstitial thermal therapy; VNS, vagus nerve stimulator; LTM, Long-term vidoe-EEG monitoring; MRI, magnetic resonance imaging; PET, positron emission tomography; FDG, fluorodeoxyglucose; rCMR, regional cerebral metabolic rate; LOS, length of stay; FSIQ, full-scale IQ; MTS, mesial temporal sclerosis.

* Corresponding author. Tel.: +1 813 259 0605; fax: +1 813 259 0944.
E-mail addresses: hwaseem@health.usf.edu (H. Waseem), keichsta@health.usf.edu (K.E. Osborn), mschoenb@health.usf.edu (M.R. Schoenberg), vkelley@tgh.org (V. Kelley), abozorg@health.usf.edu (A. Bozorg), drdanielcabello@gmail.com (D. Cabello), sbenbadi@health.usf.edu (S.R. Benbadis), fvale@health.usf.edu (F.L. Vale).

http://dx.doi.org/10.1016/j.yebeh.2015.07.022
1525-5050/

Previous reports have documented the safety and efficacy of temporal lobectomy for an older population [5,6]. However, concerns persist regarding the rate of surgical complications or associated comorbidities [6]. We report our most recent fourteen consecutive patients with MTLE over the age of fifty, seven of whom received MRgLITT and seven of whom underwent AMTL resection. This pilot program may help to define the indications of MRgLITT and allow studies of long-term surgical outcomes for the procedure. To our knowledge, there are no reports solely dedicated to patients with epilepsy greater than 50 years of age treated using MRgLITT.

2. Materials and methods

2.1. Patient selection

Patient data were collected in a prospective epilepsy surgery database established in 1998 after approval from the Institutional Review Board. A prospective review of the last fourteen consecutive patients over fifty years of age with mesial temporal clinical semiology and electrophysiology [7–9] who underwent AMTL resection or MRgLITT was performed. The last seven consecutive cases of MRgLITT were compared to the last seven consecutive AMTL resection patients.

Two patients had a history of vagus nerve stimulator (VNS) placement prior to surgery. All patients with prior VNS implantation waited at least one year before either procedure was performed. All surgical procedures were performed by a single neurosurgeon (F.L.V.).

All preoperative findings were discussed at a multidisciplinary epilepsy conference. Preoperative evaluation included a history and physical examination, surface long-term video-EEG monitoring (LTM), magnetic resonance imaging (MRI), Wada testing, positron emission tomography (PET) scan, and neuropsychological examination. Patient evaluations for surgical treatment as well as other preoperative evaluation protocols have been previously described in detail [10].

Long-term monitoring was conducted according to the international 10–20 system using XLTEK (Oakville, Ontario, Canada) software. Bilateral basilar temporal electrodes, such as T1 and T2 electrodes, were routinely used. Sphenoidal electrodes were not used.

Patients received imaging with high-resolution MRI using a 1.5- or 3.0-Tesla magnet with special focus on the temporal lobes. Coronal and axial T2-weighted and FLAIR images were obtained and reviewed by a board-certified neuroradiologist. Abnormal signal on FLAIR and T2-weighted images, decreased volume, and loss of anatomical configuration of the hippocampal formation were used as the hallmarks of radiographically confirmed MTS.

A fluorodeoxyglucose (FDG) PET scan of the brain was performed to evaluate for a focal abnormality in regional cerebral metabolic rate (rCMR) in the mesial temporal lobe. An FDG-PET scan was considered positive when it showed an area of hypometabolism.

Wada testing to evaluate short-term memory asymmetry and language dominance was performed, and a recognition memory asymmetry of greater than 3 out of 8 shown objects was considered lateralizing [11]. The procedure was performed according to the protocol of Loring et al., with a methohexital adaptation [12].

Neuropsychological evaluation included assessment of task engagement using performance validity tests, intellect, attention/executive functioning, language, learning and memory, visuospatial/visuoconstruction, processing speed, and mood/anxiety symptoms that incorporated NIH toolbox Common Data Elements-suggested measures [13]. For 2 subjects, 1 subject in the AMTL resection group and 1 subject in the MRgLITT group, the complete neuropsychological battery could not be administered because of fatigue and patient noncompliance. The standard epilepsy assessment battery was adapted to the unique needs and capabilities of these 2 subjects in accordance with a flexible hypothesis formulation and hypothesis-testing approach [14]. Thus, the RAVLT and ROCFT test data are not available for these two subjects. Tests were administered and scored based on each test's respective manuals. Standardized scores were employed in interpretation and statistical analysis to correct for the patient's age and educational level on neuropsychological scores. These tests were evaluated by a board-certified neuropsychologist blinded to the allotted procedures for each participant in this study. Interpretation for abnormalities and potential evidence of focal temporal dysfunction was based on clustered deficits in language and material-specific memory domains [15].

2.2. Surgical technique

Selective AMTL resection was performed via an inferior temporal gyrus approach. A small corticectomy was performed to access mesial temporal structures followed by resection of the amygdala, entorhinal cortex, and the hippocampal formation to the level of the superior colliculi. Details of the surgical technique have been previously described [16].

The MRgLITT procedure was performed using frame-based stereotaxis. An MRI-compatible stereotactic head frame was affixed to the cranium in the standard fashion. A contrast-enhanced stereotactic CT scan was performed. Using commercially available stereotactic software, the CT scan was fused to the preoperative high-resolution MRI to target the mesial structures. An occipital entry point was chosen to achieve maximal tissue ablation (long axis of the hippocampus). A twist-drill burr hole was made. The alignment rod was inserted into the parenchyma. The laser applicator assembly (Visualase-Medtronic Inc., Houston, Texas) containing a cooling catheter and laser optical fibers was inserted. The Visualase workstation software was used for real-time MR thermal imaging and for estimating the thermal necrosis zone. The lesions were made along the amygdalohippocampal complex as the laser fiber was retraced in overlapping increments to the lateral mesencephalic sulcus.

After the procedure, an MRI with contrast was obtained to verify lesion location and volume. The incision was closed in the usual fashion. Patients were placed on a dexamethasone taper for 7–10 days. Further details of the technique have been previously described [17].

Each patient was evaluated at a 3-month follow-up visit with a repeat MRI and clinical evaluation for any complications from surgery. Follow-up was repeated after 9–12 months, with another MRI and a full neuropsychological evaluation.

2.3. Demographics and outcomes measured

Patient data included age, age at seizure onset, MRI, LTM, PET, Wada results, side of surgical intervention, surgical time, complications, postoperative pain control, length of stay (LOS), OR charges, total hospitalization charges (as a surrogate value for the total cost to the hospital), and seizure outcome. Surgical time did not include preoperative stereotactic frame placement and planning in the MRgLITT cohort. This presurgical preparation would have approximately been an additional 2–3 h of time to the case. Pain control was measured in IV morphine equivalents per day.

Surgical outcomes were classified according to reduction in seizure frequency based on the Engel classification: I (seizure freedom, 100% reduction), II (rare, almost seizure-free), III (worthwhile improvement), and IV (no worthwhile improvement). Potential differences between groups (AMTL vs. MRgLITT) in preoperative neuropsychological performance were analyzed using nonparametric Wilcoxon–Mann–Whitney U tests, and groups were found to be similar. Between-group differences in pre- to postoperative change scores on neuropsychological measures were also evaluated using Wilcoxon–Mann–Whitney U tests. Alpha was set at .05. Individual subject neuropsychological change scores from the preoperative level were evaluated, with changes exceeding 1 standard deviation determined to be clinically meaningful, in accordance with previous studies [18,19].