Seizure 23 (2014) 20–24

Contents lists available at ScienceDirect

Seizure

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

Temporal lobe surgery in medically refractory epilepsy: A comparison between populations based on MRI findings

Tsz Lau [a], Timothy Miller [a], Travis Klein [a], Selim R. Benbadis [b], Fernando L. Vale [a,*]

[a] Department of Neurosurgery and Brain Repair, Morsani College of Medicine, University of South Florida, Tampa, United States
[b] Department of Neurology, Morsani College of Medicine, University of South Florida, Tampa, United States

ARTICLE INFO

Article history:
Received 14 May 2013
Received in revised form 12 August 2013
Accepted 6 September 2013

Keywords:
Epilepsy surgery
Temporal lobe
Nonlesional
Negative MRI
Ictal EEG
Outcomes

ABSTRACT

Introduction: High resolution MRI findings suggestive of mesial temporal sclerosis (MRI-MTS) correlate with good outcome after surgery. However, a large group of patients present with normal brain MRI (N-MRI) and temporal lobe epilepsy (TLE). We aim to compare pre-operative ictal EEG patterns in predicting surgical outcomes in the population with MRI-MTS vs. N-MRI after selective anterior-mesial temporal lobe (AMTL) resection.

Methods: 241 patients with unilateral anterior ictal EEG findings underwent selective AMTL resection. 143 MRI-MTS and 98 N-MRI patients were identified. Outcome was based on the modified Engel classification, ictal EEG pattern at seizure onset, demographics and MRI findings.

Results: Seizure-free outcome was seen in the MRI-MTS in 79% of patients, compared to 59.1% ($p < .005$) of the N-MRI group. No significant difference was identified in ictal EEG patterns at presentation between groups. Class I outcome was achieved in 78.9% of patients that had theta rhythm and MRI-MTS compared to 57.9% of patients that had theta rhythm and N-MRI ($p < 0.05$).

Discussion and conclusion: Surgical treatment for mesial TLE is effective. Positive MRI suggestive of mesial temporal sclerosis (MTS) predicts better seizure control after surgery. Theta rhythm is the most common ictal pattern and seems to carry the best prognosis for TLE. However, a well-selected group of patients with N-MRI will benefit from surgical intervention, and similar outcome to MRI-MTS patients can be achieved if delta ictal EEG pattern is presented at initial onset. Early referral to an epilepsy center cannot be emphasized enough, even in situations when high-resolution brain MRI is normal.

1. Introduction

Mesial temporal sclerosis (MTS) is typically seen in medically refractory mesial temporal lobe epilepsy. About 75% of patients with mesial temporal lobe epilepsy (TLE) are resistant to medical management.[1] Surgical resection usually provides excellent seizure control in patients with TLE,[2] especially in the setting of positive magnetic resonance imaging (MRI) evidence of mesial temporal sclerosis (MRI-MTS).[3–10]

Surgery for patients with temporal lobe epilepsy and normal MRI findings (N-MRI) is less effective.[11–17] Studies have shown 37–76% seizure control in this group of patients, but they were either retrospective in nature, included heterogeneous groups of patients with small a percentage of patients with normal MRI, or were based on small cohorts of patients.

Still to be well elucidated is the contribution of ictal EEG patterns to the outcome of temporal lobe surgery in treating TLE. Some small studies have demonstrated a difference in anterior temporal ictal rhythms (slow (delta) vs. faster (theta) rhythms) in patients with MRI-MTS vs. N-MRI, but further research into this issue is likely warranted.[18]

The goal of this study is to compare the surgical outcomes in patients with mesial TLE with either N-MRI or ipsilateral MRI-MTS, and to identify factors that would predict better outcome based on pre-operative clinical evaluation.

2. Methods

2.1. Patient population

Data were obtained from our institution's epilepsy surgery database. This is a prospective database established in 1998 after

Abbreviations: MTS, mesial temporal sclerosis; TLE, temporal lobe epilepsy; MRI-MTS, mesial temporal sclerosis positive MRI; N-MRI, normal MRI; AMTL, anterior mesial temporal lobe; MTLE, mesial temporal lobe epilepsy.

* Corresponding author at: Department of Neurosurgery and Brain Repair, University of South Florida, 2 Tampa General Circle, Tampa, FL 33606, United States. Tel.: +1 813 259 0605; fax: +1 813 259 0944.
E-mail address: fvale@health.usf.edu (F.L. Vale).

1059-1311/$ – see front matter © 2013 British Epilepsy Association. Published by Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.seizure.2013.09.004

receiving the institutional Internal Review Board approval. Informed consent was obtained from all patients. Patients with mesial temporal semiology and documented anterior temporal ictal recordings that underwent anterior-mesial temporal lobe (AMTL) resection for temporal lobe epilepsy were identified. Patients were divided into two groups based on results of pre-operative high resolution MRI. The first group included patients with MRI evidence of ipsilateral mesial temporal sclerosis, the second included patients with normal MRI.

Patient evaluation for surgical treatment as well as MRI protocol has been previously described.[19] All patients were initially evaluated by board certified, fellowship trained epileptologists. Patients with semiology that suggested mesial temporal lobe epilepsy (MTLE) proceeded to phase 1 evaluation: long-term video-EEG monitoring. Sphenoidal or nasopharyngeal electrodes were not used on any patients, but bilateral basilar temporal placement, such as T1, T2 electrodes, were done routinely. Ictal EEG pattern was recorded at seizure onset. Anterior temporal rhythms were recorded as follow: (a) Slow (delta) rhythm (2–4 Hz), (b) Faster rhythms (theta rhythm (5–7 Hz) or alpha (8–12 Hz)) and (c) delta–theta (progression from slow to faster rhythms within 5 s). All EEG recordings were reviewed in the weekly comprehensive epilepsy surgery conference. At least two board-certified epileptologists were present on each conference and consensus was achieved between the groups. Inter-ictal positron emission tomography (PET) was performed if possible. A FDG-PET scan was considered positive when it showed an area of hypometabolism in the ipsilateral mesial-basal temporal lobe. Subtraction ictal single photon emission CT (SPECT) coregistered to MRI (SISCOM) was not available at our institution and only a few of our patients had SPECT imaging for statistical analysis.

Following initial evaluation with video-EEG monitoring, patients received imaging with high-resolution MR using a 1.5 or 3.0-T magnet with special focus on the temporal lobes. Coronal and axial T2-weighted and FLAIR images were obtained and reviewed by a board-certified neuro-radiologist. Abnormal signal on FLAIR and T2-weighted images, decreased volume and loss of anatomical configuration of the hippocampal formation are considered the hallmarks of radiographically confirmed MTS. In addition, most patients also underwent Wada testing to evaluate for memory asymmetry. Memory recall $\geq$2.5/8 points difference was considered asymmetric. Some of these pre-operative evaluations were not performed due to patient financial restraints, patient refusal, or patient non-compliance due to young age or low intelligence quotient. Decisions regarding surgical therapy were made after a review of all the clinical data for each patient in conjunction with the epilepsy neurologists, neurosurgeon and neuroradiologist of the Comprehensive Epilepsy Center. Invasive subdural contact electrode placement (phase II evaluation) along the basal and lateral neocortex was considered when: (i) there was an inadequate ictal recording due to extensive muscle artifact or poorly localized ictal onset in the setting of typical mesial temporal semiology or (ii) there was discordant pre-operative evaluation. All patients were followed at 3, 6, and 12 months, then yearly after. All patients with $<$1 year follow-up were excluded from analysis. Clinical outcome was based on the modified Engel classification: Class I, seizure free or residual aura (CL-I); Class II, rare disabling seizures ($<$3 complex partial seizures per year) (CL-II); Class III, worthwhile seizure reduction; and Class IV, no worthwhile improvement.[20]

2.2. Surgical technique

Details of the surgical technique have been previously well described.[21] In brief, a temporal trephine craniotomy is performed. The inferior temporal gyrus is identified and resected. Cortical resection is performed from lateral to medial structures. Landmarks along the way from lateral to medial are the occipitotemporal sulcus, fusiform gyrus, and collateral sulcus. Next, the floor of the temporal horn is opened, followed by the resection of parahippocampal gyrus, amygdala, and uncus. Lastly, the hippocampus is resected *en bloc*, which can then be used for pathological analysis. Subpial fashion dissection of the mesial structure ensures protection of the underlying brain stem and perimesencephalic vasculature.

2.3. Statistical analysis

Microsoft Excel (Microsoft, Redmond, WA, USA) software was used to store prospective clinical data. IBM Statistical Package for the Social Sciences 19.0 for Windows was used to perform statistical analysis. Results of pre-operative work-up (Wada test, ictal EEG pattern at seizure onset, PET) were evaluated to identify predictors of surgical outcome based on the modified Engel Classification. Fisher Exact test and Chi-squared were used to analyze categorical variables. The non-parametric Mann–Whitney *U*-test was used to test the distribution of age among the two groups. Statistically significant is defined as p value $\leq$0.05.

3. Results

A total of 299 patients with TLE and unilateral ictal EEG findings that underwent selective AMTL resection were identified from our database. After excluding patients with less than 1-year follow-up, or dual pathology, 241 patients remained for statistical analysis. One hundred and forty three patients had evidence of mesial temporal sclerosis on preoperative high resolution MRI and 98 patients had normal high resolution MRI. 17 patients in the N-MRI group underwent phase II invasive monitoring as opposed to 5 patients in the MRI-MTS group. Demographics and background characteristics are summarized in Table 1. Mean follow-up was 2.9 years for the N-MRI group and 3.4 years for the MRI-MTS group. The average age for both groups was 38-year-old. Sex distribution and the results of Wada testing between the two groups were also well matched. The only difference in pre-operative evaluation was a higher percentage of patients in the MRI-MTS group with positive PET study compared to the N-MRI group (94% vs. 81%, respectively). PET scan was performed in 94 (96%) patients in the N-MRI, whereas 76 (81%) demonstrated ipsilateral hypometabolism. In the MRI-MTS group, 99 (71%) studies were performed, while 93 (94%) studies were deemed positive. On the other hand, Wada test was performed in 91 patients in the N-MRI whereas 45 (49%) demonstrated significant asymmetry. In the MRI-MTS group, 130 tests were performed; however, only 69 (53%) patients demonstrated significant difference.

Overall outcome based on modified Engel classification was statistically significant between the two groups ($p < 0.05$). In the MRI-MTS group, 79% had class I outcome ($n = 113$) compared to 59.2% ($n = 58$) in N-MRI group at last follow-up (Fig. 1). In patients with positive PET, similar percentages were observed ($p < 0.05$)

Table 1
Patient characteristics.

	Negative MRI ($n = 98$)	MRI-MTS ($n = 143$)	p-Value
Avg. age (range)	38 (10–65)	38 (7–68)	0.857
Avg. F/U (range)	2.9 years (1–11.5)	3.4 years (1–11.5)	
Sex			0.905
M	40%	41%	
F	60%	59%	
PET scan	$n = 94$	$n = 99$	
Positive	81%	94%	0.006
Negative	19%	6%	
Wada test	$n = 91$	$n = 130$	
Asymmetry	49%	53%	0.595
No Asymmetry	50%	47%	