Seizure-related outcome after corticoamygdalohippocampectomy in patients with refractory temporal lobe epilepsy and mesial temporal sclerosis evaluated by magnetic resonance imaging alone

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Object. The authors conducted a study to assess the efficacy of surgery in patients who underwent magnetic resonance (MR) imaging alone for localization of foci in temporal lobe epilepsy (TLE).

Methods. One hundred patients (43 men, 57 women) with a clinical diagnosis of TLE were prospectively studied (mean age 28 ± 9 years [± standard deviation (SD)]). All patients underwent high-resolution MR imaging, and in all unilateral mesial temporal sclerosis (MTS) was diagnosed by visual inspection. All patients underwent interictal preoperative electroencephalography (EEG) and in 87 patients pre- and 1-year postoperative neuropsychological testing was performed. Both EEG and neuropsychological examinations were conducted in a blinded fashion, and these data were not taken into account during the surgery-related decision-making process. All patients underwent a corticoamygdalohippocampectomy at the side of the MTS. Surgery-related outcome was rated as Class I (seizure free or simple partial seizures only) or Class II (≥ 90% improvement). The follow-up period ranged from 18 to 48 months (mean 24 ± 5 months [±SD]). No patient underwent prolonged video-EEG monitoring, Wada testing, positron emission tomography, or single-photon emission computerized tomography.

In eighty-nine patients Class I results were achieved, and 11 Class II results were achieved postoperatively. There was no mortality in this series. Except for in two patients who underwent surgery in the dominant temporal lobe, there was no postoperatively cognitive decline. In these two patients verbal memory decline occurred, which was associated with posterior temporal cortical damage, demonstrated postoperatively on MR imaging. Twenty-five percent of the patients experienced improved memory function related to the nonoperated side, and 54% experienced a 10% gain in general intelligence quotient status.

Conclusions. In patients with clinically suspected TLE, MR imaging alone is able to localize temporal lobe foci correctly. Ruling out pseudoseizures remains the only indication for prolonged video-EEG recordings in this group of patients.

Key Words • temporal lobe epilepsy • surgery • electroencephalography • magnetic resonance imaging

Temporal lobe resection represents the most common procedure in the treatment of refractory epilepsy. The presurgical evaluation protocol, however, varies among centers. Neurophysiological data have been considered the gold standard for foci localization during the last decades. The preoperative diagnosis of MTS made possible after the introduction of MR imaging further increased our localizing capabilities. Recently, the authors of several papers have discussed the relative value of each test used preoperatively, and many stressed the value of the anatomical MR imaging and interictal EEG findings. We studied a series of patients who underwent temporal lobe resection and in whom imaging data were considered the gold standard for foci localization. Although the modality is widely available at our center, prolonged video-EEG monitoring was not performed in these patients.

CLINICAL MATERIAL AND METHODS

We prospectively studied 100 patients in whom a clinical diagnosis of refractory TLE was made. There were 43 men and 57 women with a mean age of 28 ± 9 years (± SD) and MR imaging–defined MTS treated between 1997 and 1999 in our center. This represented 70% of the patients with refractory TLE treated during this period. The remaining 30% with TLE presented with normal MR imaging–documented findings, bilateral MTS, dual disease, or temporal lobe non-MTS disease such as tumors or
cortical dysplasia. Temporal lobe epilepsy was clinically diagnosed when manifestations included typical simple partial seizures with deja vu or epigastric sensation, with or without associated fear and other autonomic symptoms, followed by a complex partial seizure consisting of staring and lip smacking, masticatory automatisms, or both, with or without accompanying upper-extremity automatisms and contralateral arm dystonia. There was no suspicion of pseudoseizures in any patient.

All patients underwent high-resolution MR imaging. A 1.5-tesla MR imager was used, and we obtained T1-weighted, T2-weighted, and fluid-attenuated inversion-recovery coronal slices perpendicular to the hippocampal axis. In all patients unilateral MTS had been diagnosed by visual inspection based on the finding of unilateral hippocampal atrophy on T1-weighted and increased signal on T2-weighted images. All images were evaluated by the neuroradiologist, neurologist, and neurosurgeon involved in the patient’s care, and agreement as to the diagnosis of unilateral MTS was reached in all cases (Fig. 1). No marginal cases in which there was disagreement concerning the MR imaging diagnosis of MTS were included.

Preoperatively all patients underwent interictal EEG recording, and 87 patients underwent pre- and postoperative neuropsychological testing. These examinations were performed in a blinded fashion, and their results were not part of the surgery-related decision-making process. Routine interictal EEG monitoring involving zygomatic electrodes was conducted in all patients.

In the 87 patients in whom it was performed, neuropsychological testing included the dichotic listening test, Wechsler Adult Intelligence Scale, Wechsler memory test, Boston naming test, Wisconsin card-sorting test, and somesthetic (strength and two-point discrimination) testing.

After induction of general anesthesia, patients underwent a corticoamygdalohippocampectomy on the ipsilateral side of the MTS; intraoperative ECoG was not performed. Surgery consisted of a cortical resection, which included the superior, middle, and inferior temporal lobes, the fusiform and parahippocampal gyri, with its posterior border at the level of the central artery, total hippocampectomy, and resection of the intratemporal portion of the amygdala. The central artery is the cortical branch of the middle cerebral artery that irrigates the rolandic cortex. It exits the sylvian fissure, runs over the bridge of cortex uniting the somatomotor and -sensitive cortex related to the tongue, and drops into the central sulcus approximately 1 cm above the sylvian fissure. Its orientation is perpendicular to the temporal lobe axis; we preferred to use this as a landmark for the posterior border of the cortical resection (a proportional method), instead of measuring distances from the tip of the temporal lobe (a quantitative method).

Surgery-related outcome was rated as Class I (seizure free or simple partial seizures only), Class II (≥ 90% improvement), Class III (50–90% improvement), or Class IV (< 50% improvement; no worthwhile improvement). The follow-up period ranged from 18 to 48 months (mean 24 ± 5 months [± SD]).

No patient underwent prolonged video-EEG recording, Wada testing, positron emission tomography, or single-photon emission computerized tomography.

RESULTS

In 67 patients there was a positive history for febrile convulsions and in 13 for birth-related trauma. Sixty-five patients underwent dominant temporal lobe surgery. There were no cases of mortality or morbidity, except for the preceeding neuropsychological findings.

Temporal lobe spiking ipsilateral to the MTS was demonstrated in all patients. In 37 patients bilateral independent interictal temporal lobe spiking was documented, and in six patients spiking prevailed on the side contralateral to the MTS preoperatively (≥ 70% of the discharges).

Postoperatively Class I and Class II results were demonstrated in 89 and 11 patients, respectively. Results in five of the six patients in whom interictal spiking prevailed over the temporal lobe contralateral to the MTS were Class I, and results in one were Class II. Pathological examination showed MTS in all patients. In six patients cortical dysplasia was also present in the neocortical spec-
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In men. None of these dysplastic lesions was diagnosed preoperatively on MR imaging. Of these, five were Class I and one Class II postoperatively.

In 59 of the 87 patients who underwent neuropsychological testing surgery was performed in the dominant temporal lobe. Preoperatively 57 of these patients experienced verbal memory deficit and 32 visual memory deficit. Postoperatively 59 of these patients suffered verbal memory deficit and 14 visual memory deficit. In 35 patients who underwent to neuropsychological testing surgery was performed in the nondominant temporal lobe. Preoperatively 20 of these patients experienced visual memory deficit and eight verbal memory deficit. Postoperatively 20 of these patients suffered visual memory deficit and five patients had verbal memory deficit. Neurropsychological decline was noted in two patients who underwent dominant temporal lobectomy. In both patients MR imaging demonstrated additional postoperative posterior temporal cortical damage. No patient undergoing surgery in the nondominant temporal lobe exhibited additional cognitive impairment. On the other hand, 25% of the patients experienced improvement in memory function related to the nonoperated side and in 54% of them a 10% improvement in general intelligence quotient status was noted 1 year after seizure cessation.

DISCUSSION

In the early days of epilepsy surgery, invasive ictal recording was considered the gold standard for focus localization. After this period, noninvasive ictal neurophysiological data were used in the majority of patients. The introduction of modern neuroimaging established new insight into the pathophysiological basis of epilepsy. It has only been in the last several years that some centers have begun to discuss openly the actual need for prolonged video-EEG recording in all epilepsy surgery candidates.11,15

In our study we found that in a series of patients with clinically suspected refractory TLE and MR imaging–defined MTS, anatomical MR imaging data alone are enough to localize temporal lobe foci correctly. Seizure-related outcome rates were comparable with or better than those obtained in series of patients who underwent extensive video-EEG monitoring, which included heterogeneous MR imaging findings.16,17,32,33 These results might seem to represent an unprecedented success rate. On the other hand, if we compare these results with those obtained in series conducted within the MR imaging era and select only patients with MR imaging–defined MTS, the results became very similar.16,20,25,26,28 This is, to the best of our knowledge, the largest prospective series of cases in which the aforementioned paradigm was used to guide surgery.

In fact, it is very hard to believe that, any of these patients would have been offered surgery contralateral to the MTS, irrespective of any preoperative clinical, neurophysiological, or functional findings. The latter would most probably lead to severe memory impairment and poor seizure control. Intraoperative CCoG was used early in our practice but was discontinued after analysis of its role in seizure-related outcome showed no correlation between its findings and outcome.

In some patients with bilateral asymmetrical MTS in whom depth electrodes were implanted, seizure origin has been shown to be located over the less atrophic hippocampus. In our patients with asymmetrical bilateral MTS in whom invasive monitoring was conducted, seizures came consistently from the smaller hippocampus, further emphasizing the role of the anatomical MR imaging findings. In this series the good outcome in five of six patients in whom neurophysiological data prevailed over the nonoperated side also reinforces this idea. A major pathophysiological role for MTS alone would be suggested if these findings could be confirmed in a larger series of patients with unilateral MTS in whom independent bitemporal spiking was present.

Potential neuropsychological decline has always been a major concern in patients undergoing cortical resection. Magnetic resonance imaging–defined MTS has been correlated to higher degrees of preoperative memory deficits and significantly lower postoperative morbidity.5,18,23,30 The results in our series suggested that in patients with clinically suspected refractory TLE with MR imaging–defined MTS, postoperative memory function decline is not a major issue. Both patients who experienced postoperative verbal memory deterioration underwent dominant temporal lobe surgery; they suffered unpredicted posterior temporal cortical damage, supposedly caused by venous infarction at the posterior border of resection. There is an ongoing discussion on the relative role of the cortex and mesial structures in memory function in these patients. In a significant portion of the literature the role of the cortex may be neglected. The widespread use of tests such as the Wada test as a way of predicting postoperative memory deficits remains controversial. The most commonly used protocols for Wada testing include the injection of the drug in the internal carotid artery. In this setting, only a small part of the head of the hippocampus is perfused by the anterior choroidal artery. The rest of the hippocampus is fed by the posterior cerebral artery and is not usually perfused. On the other hand, internal carotid artery injections of amobarbital lead to extensive frontotemporal cortical inactivation. The Wada procedure tests mainly the cortical and not the hippocampal role in memory function in this type of case.

The most consistent neuropsychological finding was cognitive function improvement, not decline. In 25% of the patients memory function improved in relation to the nonoperated temporal lobe. This has already been described in the literature and is related to improved contralateral temporal lobe function after seizure cessation. Furthermore, 54% of the patients experienced at least 10% improvement in general intelligence quotient status. This fact is easily recognized by the family and caregivers and is generally accompanied by improvement in quality of life. The absence of surgery-induced memory deficits is not so surprising in patients in whom preoperative deficits were already noted, especially in those with dominant TLE.

This series included patients with clear-cut MTS detected by visual inspection and excluded those with bilateral MTS, marginal hippocampal asymmetry (or in whom disagreement occurred), normal MR imaging findings, dual disease, and non-MTS temporal lobe lesions. It is not yet clear what would be the surgery-related results in patients...
with hippocampal atrophy as defined by formal volumetric findings and normal or slightly abnormal hippocampi on visual inspection. Ruling out pseudoseizures remains the major indication for prolonged video-EEG recordings in this group of patients.

References


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