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Temporal lobe epilepsy surgery modulates the activity of auditory pathway

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Summary The purpose of this paper is to evaluate the effects of the anterior temporal lobectomy on the functional state of the auditory pathway in a group of drug-resistant epileptic patients, linking the electrophysiological results to the resection magnitude. Twenty-seven patients with temporal lobe epilepsy and a matched control group were studied. Auditory brainstem and middle latency responses (ABR and MLR respectively) were carried out before and after 6, 12 and 24 months surgical treatment. The volume and longitude of temporo-mesial resected structures were estimated on magnetic resonance images taken 6 months after surgery. Before the intervention the patients showed a significant delay of latency in waves III, V, Pa and Nb, with an increase in duration of I—V interval in comparison with healthy subjects (Mann—Whitney *U*-test, $p < 0.05$). After resection, additional significant differences in waves I and Na latency were observed. Na and Pa waveforms showed a tendency to increase in amplitude, which became statistically significant 12 months after surgery for right hemisphere lobectomized patients in the midline electrode, and in Pa waveform for all patients in the temporal electrodes ipsilateral to resection (Wilcoxon test, $p < 0.05$). In general, latency variations of MLR correlated with resection longitude, while changes in amplitude correlated with the volume of the resection in the middle temporal pole and amygdala (Pearson' correlation test, $p < 0.05$). As a result, we assume that anterior temporal lobectomy provokes functional modifications into the auditory pathway, probably related to an indirect modulation of its activity by the temporo-mesial removed structures.

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Introduction

Temporal lobe epilepsy is the most common type of focal epilepsy in adults. In most cases it involves the temporomesial structures (Gronich et al., 2002). The complex partial seizures in this entity often become drug-resistant, but it is a surgically remediable syndrome (Engel, 2009), showing a resolution of seizures in as much as 70—85% of patients after resection of the epileptogenic area (Karceski and Morrell, 2006).

The anterior temporal lobectomy may cause changes in the visual and auditory pathways considering their close relationships with the temporal horn of the lateral ventricles, and the projections to the occipital calcarine banks and the temporal operculum respectively (Sindou and Guenot, 2003). Some efferent projection fibers of the temporal cortex go to the amygdala and hippocampus (Kiernan, 2012), structures that are also total or partially resected during the anterior temporal lobectomy.

The most common sensorial sequel is a superior quadrantanopia contralateral to the side of resection secondary to the damage of the Meyer' loop of the geniculocalcarine tract (Compston, 2005; Winston et al., 2012). It has been well established using both anatomical (Winston et al., 2012; Yogarajah et al., 2009) and functional procedures (Babb et al., 1982; Baez Martin et al., 2010).

However, few reports have considered the possibility of changes in the primary auditory pathway after the resection of temporo-mesial structures (Bougeard and Fischer, 2002; Jacobson et al., 1990; Khalfa et al., 2001).

Standardized anterior temporal lobectomy removed 4—7 cm of the anterior temporal lobe, including mesial temporal structures (Engel, 2009) and sparing the superior temporal gyrus involved in auditory processing.

After this procedure, hearing may be impaired and dichotic listening scores reduced on the ear contralateral to the operated temporal lobe (Bougeard and Fischer, 2002). Contrary to these results, the improvement of the automatic central auditory change-detection after a successful resection of the temporal pole has been demonstrated using the mismatch negativity magnetic equivalent (Lin et al., 2007).

Auditory brainstem and middle latency responses (ABR and MLR respectively) have been widely used to evaluate the functional state of the auditory pathway. They represent the electrical activity associated with the sequential activation of the auditory pathway from the cochlear nerve to the primary auditory cortex (Legatt, 2005). The midline Na component of MLR appears to originate subcortically in either the inferior colliculi or medial geniculate body of the thalamus, while the Pa component is related to the activity of the auditory radiations and primary auditory cortex in the Heschl gyrus (Baez-Martin and Cabrera-Abreu, 2003). Other studies in patients with temporal and extratemporal epilepsy suggest that MLR may be generated subcortically but modulated by temporal lobe structures (Weate et al., 1996) some of them could be damaged during the temporal lobectomy.

This paper proposes the use of ABR and MLR to evaluate the effect of the anterior temporal lobectomy in the functional state of the auditory pathway of drug-resistant epileptic patients, measuring the relationship of the electrophysiological results with the magnitude of resection.

Subjects and methods

Subjects

Twenty-seven temporal lobe epileptic patients were evaluated at the Telemetric Unit of the International Center for Neurological Restoration in a prospective study. Presurgical evaluation was performed including the localization of ictal zone combining EEG-video, ictal and interictal SPECT, qualitative and quantitavive MRI (voxel-based morphometry) (Ashburner and Friston, 2000) and neuropsychological tests. Clinical and demographical data of patients and controls are shown in Table 1.

The most frequently used drugs for treatment were valproate, carbamazepine and clonazepam. Treatment was not changed after the surgical procedure.

All patients underwent standard anterior temporal lobectomy guided by electrocorticography. Tissue samples obtained during surgery were processed for histology. Hippocampal sclerosis was defined and focal cortical dysplasia in temporal neocortex classified according to Palmini' criteria (Palmini et al., 2004) (Table 1).

Sixteen age- and gender-matched healthy subjects (free of neurological and audiological diseases) were also neurophysiologically studied.

Hearing threshold level was evaluated both in patients and healthy subjects. All of them were right-handed and gave their signed consent to participate in the study.

Electrophysiological tests

To record the auditory evoked responses, surface electrodes (Ag/ClAg) were attached to the scalp according to the international 10-20 system (Table 2). The electrode impedance was kept below 5 kΩ. Records were made by an experienced technician under the supervision of a neurophysiologist, who controlled that subjects stayed awake during the recording of the MLR.

They were invited to lie on bed in a climate-controlled room during the tests. Patients were evaluated before surgical resection, as well as six, twelve and twenty-four months after surgery.

Recording conditions and equipment

Recording conditions are summarized in Table 2. The stimuli were 0.1 ms. alternating clicks delivered through a headphone (DR-531B-7, Elegas Acous Co. Ltd, Japan). The records were obtained using the evoked potentials measuring systems Neuropack four-mini and Neuropack M1 (Nihon Kohden, Japan).

Evaluation of records

Records were evaluated off-line in a visual inspection mode by two clinical neurophysiologists. Measured variables were absolute latency, interpeak intervals and amplitude of I, III, V, Na, Pa and Nb waveforms. Latencies 2.5 SD longer than the average value from normal subjects, and amplitudes lower