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Cognitive outcome after stereotactic amygdalohippocampectomy

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ABSTRACT

Purpose: We sought to determine the neuropsychological outcome after stereotactic radiofrequency amygdalohippocampectomy performed for intractable mesial temporal lobe epilepsy.
Methods: The article describes the cases of 31 patients who were evaluated using the Wechsler Adult Intelligence Scale-Revised and the Wechsler Memory Scale-Revised prior to, and one year after, surgery.
Key findings: Patients showed increases in their mean Full Scale, Verbal and Performance IQ scores of 4, 3 and 4 IQ points respectively ($p < .05$). 5 (17.2%), 4 (13.8%) and 4 (13.3%) patients improved in their Full-scale, Verbal and Performance IQ respectively. No significant changes were found in memory performance – with a mean increase of 1, 3 and 0 MQ points in Global, Verbal and Visual memory respectively ($p < .05$). Global memory improved in 3 (10.3%) patients, verbal memory in 1 (3.4%) and 1 patient (3.3%) showed deterioration in visual memory.
Significance: Our results provide evidence for unchanged memory in patients with MTLE after the procedure. No verbal memory deterioration was detected in any of our patients, while improvements were found in intellectual performance. The results suggest that stereotactic radiofrequency amygdalahippocampectomy could be superior to open surgery in terms of its neurocognitive outcomes. A larger randomised trial of these approaches is justified.

1. Introduction

Surgery has become a treatment option for some patients with intractable epilepsy. Mesial temporal lobe epilepsy (MTLE) with mesial temporal sclerosis (MTS) is the most surgically amenable epilepsy diagnosis. The results of epilepsy surgery are clearly superior to prolonged medical therapy.[1,2] However, patients who could benefit from the procedure might be deterred from undergoing surgical evaluation due to concerns regarding surgery-induced memory deficits.[3,4]

The most frequently performed surgery for MTLE is anterior temporal lobectomy. During this procedure white matter tracts may be transected or functional tissue that is not necessarily epileptogenic may be removed. Sparing these structures may be important in terms of memory preservation. Results of some studies suggest that selective ablation of mesial temporal lobe structures (amygdalohippocampectomy) is an alternative to anterior temporal lobectomy with respect to seizure control.[5] Neuropsychological outcomes are reported to be somewhat better in more restricted procedures.[6–8] However, the minimal extent of mesial temporal resection necessary to obviate adverse neuropsychological outcomes with an equal chance of postoperative seizure freedom remains unclear.[9]

Stereotactic radiofrequency amygdalohippocampectomy (SAHE) is an alternative therapy for MTLE.[10] It was reintroduced in a modern setup by the London-Ontario group.[11] Stereotactic thermo-lesion of amygdalo-hippocampal complex (AHC) using a modified technical approach has been used at our institution since 2004 and studies describing the favorable epileptological outcome of this procedure have been published.[12,13]

We hypothesized that the less complete destruction of mesial temporal structures compared to microsurgical resection could preserve postoperative memory functions. The aim of this study is to summarize the neuropsychological results after SAHE.

Abbreviations: AHC, amygdalo-hippocampal complex; MTLE, mesial temporal lobe epilepsy; MTS, mesial temporal sclerosis; SAHE, stereotactic radiofrequency amygdalohippocampectomy.

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2. Methods

2.1. Patient selection

We prospectively studied neuropsychological changes in 31 patients who underwent SAHE (25 left-sided) at the Department of Stereotactic and Radiation Surgery at our institution during the period from 2004 to 2009. Only those who had been neuropsychologically evaluated by one neuropsychologist (LK) and followed up at our center were included. We excluded 8 patients who had been diagnosed and followed up elsewhere and 3 otherwise eligible patients who had failed to complete a neuropsychological evaluation one year after surgery (one seizure-free patient committed suicide, one Class II patient died due to an accident and one seizure-free subject refused to participate). 3 patients who have not had a two-year follow-up and 6 patients who have both not had sufficient follow-up and were followed-up elsewhere were also excluded.

Demographic data and the results of the diagnostic evaluation are summarized in supplementary material (Table A1). These patients are a subset of 51 patients on whom SAHE has been performed in our institution to date. There were 15 men and 16 women with a mean age at the time of operation of 37.7 (SD 11.2, 18–65) years and an illness duration of 22.1 (SD 11.1, 6–37) years. The mean duration of formal education was 11.8 (SD 2.1, 7–17) years. Mean seizure frequency 6 months prior to the operation was 5 per month (SD 4.5, 1–20). 24 patients were right-handed, 3 left-handed and 4 were ambidexterous. The larger proportion of left-sided patients is certainly a referral bias as referring physicians tend to send patients at risk for postoperative memory decline to our center for a procedure which, in the event of failure, could be followed by standard surgery.

Preoperatively (supplementary material, Table A2), patients underwent a standard non-invasive evaluation protocol (magnetic resonance imaging – MRI, interictal and ictal scalp video-electroencephalography – video-EEG, ^{18}F-fluorodeoxyglucose positron emission tomography – PET, Wada test, visual field and complex neuropsychological assessment). In one patient, the MRI showed right-sided MTS but PET hypometabolism and the ictal EEG pattern were bilateral. This patient was evaluated using a combination of depth and subdural electrodes. In two patients, the MRI was normal but temporal hypometabolism and the ictal pattern collocalized to the same temporal lobe. In one patient, the ictal pattern was bilateral but the MRI showed MTS and the PET confirmed this. In two patients, PET was not performed. In one patient, a more widespread mesiotemporal dysplastic lesion on the same side as the mesial temporal sclerosis was evident. All patients were subsequently diagnosed with intractable MTLE.

After completion of the preoperative evaluation, the patients were informed of their treatment options and SAHE was mentioned as one of these. If they chose SAHE, they signed an informed consent form. The methodology for this study was approved by our hospital's ethics committee.

2.2. Surgical technique

The surgical procedure used in this study has been described in detail in our previous paper.[13] The Leksell stereotactic system was used to plan a single trajectory along the long axis of the hippocampus, avoiding the ependymal surface of the ventricles. A percutaneous drill-hole was performed under local anesthesia at the entry point in the occipital region. The target point was placed in the amygdala. Thermo-coagulation of the amygdalohippocampal complex (AHC) and part of the parahippocampal gyrus, depending on the individual anatomy of the patient, was carried out using a string electrode with a 10 mm bold active tip. A mean of 26.4 lesions (17–38) were placed in each patient along the trajectory in AHC (Fig. 1). The local temperature was 75 °C or 88 °C, depending on the probe thickness.

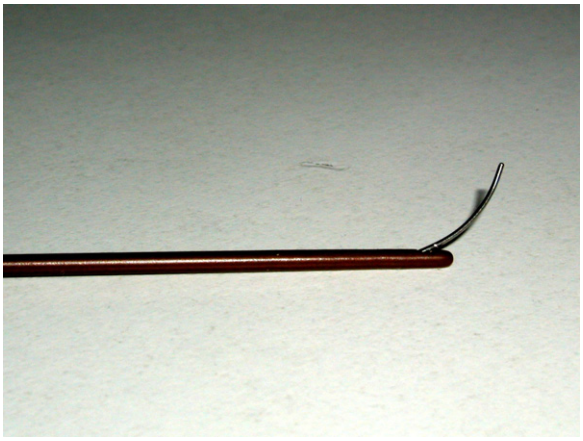

Fig. 1. Therapeutic electrode with a telescopic tip. During the procedure the active tip is exserted 8 mm from the guiding tube (external diameter 1.8 mm). After the coagulation is accomplished the tip is retracted, the guiding tube is rotated 45° and the tip is exserted again to make another lesion. After lesioning is complete in one position the probe is withdrawn by 55 mm and another series of thermolesions is performed.

We have reported the radiological results elsewhere.[13–15] For the purpose of this article, it may be important to mention that only part of the confluent lesion seen on MRI scans obtained on the day following surgery (Fig. 2a), was converted into a pseudocyst one year after operation (Fig. 2b).

2.3. Neuropsychological evaluation

All patients underwent neuropsychological assessment preoperatively and 12 months after surgery. They were tested in two sessions over two consecutive days, each lasting 60–90 min. During the first day a psychological interview was performed and WAIS-R presented. Memory, verbal functions and quality of life were assessed using WMS-R, a Verbal Fluency Test (standardized Czech versions) and a Quality of Life Questionnaire (Qolie-89) respectively, on the second day (the Qolie-89 and the Verbal Fluency Test were not used in this study). The patients were informed of the test results at the end of the session.

2.4. Statistics

We compared Full-Scale (FS-IQ), Verbal (VIQ) and Performance IQ (PIQ), all subtests of the WAIS-R, Global, Verbal and Visual Memory Quotients (MQ), and all WMS-R subtests in the pre- and postoperative sessions.

Changes at group level were assessed using paired *t*-tests. We also tried to estimate the operation benefit at an individual level and employed the Reliable Change Index (RCI) classification.[16,17]

Using this classification, patients were divided into groups according to whether they demonstrated a significant postoperative improvement when performing the task, deterioration or no change.

We used test–retest reliability coefficients for each test score from which the standard error (SE) of difference was derived. From this we calculated a 95% confidence interval (CI) for the change. Score changes which fell within the specific CI would represent changes that could occur by chance 95% of the time. Score changes outside the CI would represent a statistically reliable change that would occur $<$2.5% of the time in patients without surgical intervention. The RCI classification is based on the extent of the