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Different effects of anterior temporal lobectomy and selective amygdalohippocampectomy on verbal memory performance of patients with epilepsy

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ABSTRACT

The advantage of selective amygdalohippocampectomy (SAH) over anterior temporal lobectomy (ATL) for the treatment of temporal lobe epilepsy (TLE) remains controversial. Because ATL is more extensive and involves the lateral and medial parts of the temporal lobe, it may be predicted that its impact on memory is more important than SAH, which involves resection of medial temporal structures only. However, several studies do not support this assumption. Possible explanations include task-specific factors such as the extent of semantic and syntactic information to be memorized and failure to control for main confounders. We compared preoperative vs. postoperative memory performance in 13 patients with SAH with 26 patients who underwent ATL matched on side of surgery, IQ, age at seizure onset, and age at surgery. Memory function was assessed using the Logical Memory subtest from the Wechsler Memory Scales — 3rd edition (LM-WMS), the Rey Auditory Verbal Learning Test (RAVLT), the Digit Span subtest from the Wechsler Adult Intelligence Scale, and the Rey–Osterrieth Complex Figure Test. Repeated measures analyses of variance revealed opposite effects of SAH and ATL on the two verbal learning memory tests. On the immediate recall trial of the LM-WMS, performance deteriorated after ATL in comparison with that after SAH. By contrast, on the delayed recognition trial of the RAVLT, performance deteriorated after SAH compared with that after ATL. However, additional analyses revealed that the latter finding was only observed when surgery was conducted in the right hemisphere. No interaction effects were found on other memory outcomes. The results are congruent with the view that tasks involving rich semantic content and syntactical structure are more sensitive to the effects of lateral temporal cortex resection as compared with mesiotemporal resection. The findings highlight the importance of task selection in the assessment of memory in patients undergoing TLE surgery.

1. Introduction

The effectiveness of neurosurgery for drug-resistant medial temporal lobe epilepsy (TLE) for seizure control is well established. The standard procedure is anterior temporal lobectomy (ATL), which consists of removing a part of the anterior area of the lateral temporal lobe and the underlying medial structures, including the hippocampus, the amygdala, and surrounding structures. This procedure has been associated with a significant improvement of seizures in about 60–80% of patients [1,2]. In order to limit the extent of resection and possibly minimize postsurgical complications, selective amygdalohippocampectomy (SAH), in which only medial temporal structures are removed, may also be conducted as an alternative. Despite a large amount of studies comparing the two surgical procedures, there is still no consensus regarding which one yields the best results in terms of seizure control. While some reviews and meta-analyses provide support for an advantageous effect of ATL over SAH, others found no such difference [3–6].

Besides seizure control, the selection of one type of TLE surgery over another should also take into consideration its impact on neuropsychological function. Deterioration of memory function following TLE surgery is well recognized [7]. However, it is unclear whether or not this effect is attenuated in SAH, which preserves the lateral temporal cortex, in comparison with standard TLE surgery. In some studies, SAH was associated with better preservation or even an improvement in cognitive function compared with ATL [1,6,8], but others have found similar decline following both types of surgeries [5,9–11].

Memory performance following TLE surgery largely depends on the hemisphere of resection and on the verbal and nonverbal nature of the material employed to assess memory. Indeed, resections in the

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dominant hemisphere have been associated with greater verbal memory decline, whereas resections in the nondominant hemisphere have been associated with greater visual memory deterioration, although with less consistency [1,8,12,13]. However, although ATL involves resection of the lateral temporal cortex involved in verbal information processing, several studies have failed to find greater deterioration for this type of surgery than for SAH in verbal memory performance [12,14,15]. This unexpected finding might be explained by task-specific rather than material-specific effects of ATL and SAH. According to Saling [16], tasks involving the learning of information rich in semantic content and syntactical structure, such as story learning, may be more sensitive to lateral temporal lobe damage than tasks at the lowest extreme of the semantico-syntactic continuum, such as learning of unrelated series or pairs of words, which are more specifically impaired after mesiotemporal resection. Findings from a recent study in patients with TLE surgery supported this assumption [15].

Other confounding factors such as age and preoperative cognitive function are also known to influence the neuropsychological impact of TLE surgery. Older age at seizure onset and older age at the time of surgery have both been associated with greater postoperative memory decline [11,17–19]. Poorer general cognitive skills prior to surgery have also been reported to be a predictor of greater verbal learning in patients with right temporal lobe resection [17]. However, the vast majority of studies on the effect of type of surgery for TLE on memory function did not control for these factors. The present study aimed to compare the impact of ATL and SAH on memory performance in two groups of patients matched on hemisphere of resection, preoperative IQ, age at disease onset, and age at surgery using verbal memory tasks differing in semantic–syntactic content, and one visual memory task.

2. Materials and methods

2.1. Participants

Participants ($N = 39$) were retrospectively selected among patients who underwent neurosurgery for mesial TLE at Hôpital Notre-Dame (CHUM). Thirteen patients who had SAH during the period extending from June 2001 to May 2007 and for whom data on preoperative and postoperative memory performance were available were identified. Each patient was matched with two ATL patients, selected among a set of patients who had epilepsy surgery and neuropsychological assessments at our center between 1980 and 2007. Matching was first conducted based on side of surgery, and then according to presurgical IQ (verbal, performance, and full-scale) on the Wechsler Adult Intelligence Scale — Revised (WAIS-R) or the Wechsler Adult Intelligence Scales — 3rd Edition (WAIS-III) [20,21], age at seizure onset, and age at surgery. The following inclusion criterion was used: diagnostic of mesial TLE based on a multimodal investigation (semiology, magnetic resonance imaging, electroencephalography, positron emission tomography, single-photon emission computed tomography). Patients with a history of traumatic brain injury, stroke, neurologic (other than epilepsy) or psychiatric disorder, substance abuse, or psychoactive medication affecting cognition (antidepressants, beta-blockers) were excluded. Hemispheric language dominance was established for each patient on the Wada test.

2.2. Surgical procedures

Selective amygdalohippocampectomy was done through a horizontal 2-cm incision of the middle temporal gyrus, centered 4 cm from the temporal pole. Once in the temporal horn of the lateral ventricule, the following structures were removed: the inferior 3/4 of the amygdala, the hippocampus (radical resection reaching the tail, behind the quadrigeminal plate) and the entorhinal–parahippocampal gyrus as posteriorly as the hippocampal resection. The same structures were removed in ATL, plus the middle and inferior temporal gyri and the fusiform gyrus (4 cm on the dominant side, and 5 to 6 cm on the nondominant side). Prior to 2001 ($n = 23$ participants, 88.5% of patients with ATL), only ATL was performed for TLE at our center. After this date, SAH became the standard procedure, and decision to perform an ATL over a SAH was based on several variables, including the presence of temporal lobe atrophy, the presence of midtemporal or posterior temporal spikes on the EEG, extended hypometabolism on the PET scan, and surgery in the nondominant hemisphere.

2.3. Memory assessment

Standardized neuropsychological tests were used before and after surgery in order to compare the impact of each type of surgery on memory function. Verbal learning memory was assessed using the Rey Auditory Verbal Learning Test (RAVLT) [22,23] and the Logical Memory (Story A) subtest of the Wechsler Memory Scales — Third Edition (LM-WMS) [24]. In the RAVLT, a first 15-word list is presented orally to the participant, who must recall as many words as possible in any order during five successive learning trials. An immediate recall trial is performed after the presentation of an interfering list (immediate recall), and after a 20-minute delay (delayed recall). The delayed recall trial is followed by a yes/no recognition trial with targets and distractors. In the LM-WMS, the patient is read a short story at one occasion and is asked to recall the story immediately (immediate recall), and 30 min (delayed recall) after it has been read. Auditory–verbal working memory was assessed using the Digit Span subtest of the WAIS-R or WAIS-III. The examiner first reads sequences of numbers to the participant, who is asked to repeat them in the order presented (forward). Sequences lengthen until the participant fails two consecutive trials of the same length. Then, the participant is asked to recall new sequences in reverse order (backward). Longest digit span performance was examined for both conditions. Visual memory was assessed using the Rey–Osterrieth Complex Figure Test (ROCFT) [25]. In this task, the patient is asked to copy a complex figure on a blank sheet. Immediate and delayed reproduction trials are performed immediately (immediate reproduction) and 30 min (delayed reproduction) after the initial copy. Finally, language was also assessed in a subpart of our sample (56%; 11 from each group) using the Boston Naming Test (BNT) [26], a task of confrontational word retrieval in which the patient is required to name a series of line drawings of increasing difficulty. This task was added to the analyses to examine the possibility that deterioration on verbal memory assessments is due to language impairments.

All assessments were conducted or supervised by a licensed neuropsychologist as part of the comprehensive investigation for epilepsy surgery. Patients were assessed at least six months after neurosurgery (range: 0.6–9.0 years). All patients were native French speakers and were assessed in French. Seizure control following surgery was also assessed using Engel's classification at 6 months postsurgery [27]. The study protocol was approved by our institutional ethics committee.

2.4. Statistical analyses

Preoperative and postoperative memory performance was compared across surgery groups using repeated measures ANOVAs, with time (presurgery vs. postsurgery) as the within-subject factor and type of surgery (SAH vs. ATL) as the intersubject factor. The impact of the side of surgery was also assessed using similar models, but with side of surgery (right vs. left) as the intersubject factor. Additional chi-square analyses were also conducted to examine whether significant deterioration in memory performance, defined as a decrease of ≥1 S.D. in performance after surgery compared with baseline (using presurgical values from the entire sample as reference data) was more prevalent according to one type of surgery and one side of surgery than another.