

MEMORY FUNCTION RELATED TO HIPPOCAMPAL IMAGING FINDINGS

The Relationship Between Quantitative T2 Relaxometry and Memory in Nonlesional Temporal Lobe Epilepsy

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PURPOSE: We investigated the relationship between preoperative quantitative magnetic resonance imaging (MRI) T2 relaxometry and volumetry of the hippocampi and pre- and postoperative verbal memory in temporal lobectomy patients who had nonlesional temporal lobe epilepsy.

METHODS: Pre- and postoperative memory data based on the Logical Memory (LM) subtest of the Wechsler Memory Scale-Revised (WMS-R) and the 30-min delayed recall trial of the Rey Auditory Verbal Learning Test (AVLT) were obtained from 26 left and 15 right temporal lobectomy patients. Coronal MRI T2 maps were generated for these 41 temporal lobectomy patients as well as 61 control patients. Hippocampal T2 relaxation times and hippocampal volumes, converted to z scores using control group data, were correlated with neuropsychological performance in the patients.

RESULTS: In left temporal lobe-onset patients, high T2 in the left hippocampal body predicted higher LM performance after surgery. Asymmetrically high T2 in the left hippocampal body (i.e., the right-minus-left difference), compared with the right hippocampal body, also predicted higher LM performance after surgery. In right temporal lobe-onset patients, high T2 in the left hippocampal body predicted relatively lower AVLT performance after surgery. Multiple regression analysis in left temporal-onset patients revealed that high T2 in the left hippocampal body together with higher preoperative LM performance predict higher postoperative LM performance.

CONCLUSIONS: Our findings suggest that elevated (i.e., abnormal) hippocampal T2 signal is associated with memory ability (or hippocampal functional capacity) independent of MRI-determined hippocampal atrophy. Therefore, our findings support the use of quantitative T2 relaxometry as an independent predictor of verbal memory outcome in both left and right TLE patients who are candidates for temporal lobectomy.

COMMENTARY

It is widely appreciated that memory decline represents the primary neuropsychological morbidity following anterior temporal lobectomy (ATL). Postoperative memory difficulties are observed in some, but certainly not all, patients and are more commonly seen after left than right ATL. Considerable research has been devoted to identifying the risk factors for postoperative memory decline. The risk of postoperative verbal memory decline following left ATL has been associated with the absence of histopathologically confirmed left hippocampal sclerosis, a lack of preoperative magnetic resonance imaging volume reduction in the to-be-resected left hippocampus, intact memory performance on the Wada Test, intact verbal memory performance on a preoperative neuropsychological assessment, and a lack of focal left temporal lobe/hippocampal positron emission tomography with flurodeoxyglucose (FDG-PET) hypometabolism. These and other findings all suggest that an absence of structural and functional compromise of the to-be-resected left mesial temporal region is associated with an increased risk of postoperative verbal memory decline following left ATL. The picture is not as clear regarding memory decline following right ATL.

In this context, the authors note that quantitative T2 abnormalities have been associated with hippocampal cell loss, and given that relationship, an examination of quantitative T2 abnormalities might also relate to the risk of postoperative memory decline and might therefore be worth examining. This is especially the case in that the relationship between quantitative T2 abnormalities and memory performance, particularly preoperative to postoperative memory decline, has

not been fully characterized. Twenty-six left and 18 right temporal lobe epilepsy patients underwent careful preoperative workup, including magnetic resonance imaging morphometry and T2 imaging of the head and body of the hippocampus, as well as a preoperative and postoperative verbal memory assessment. Among left ATL patients, multiple regression analysis showed verbal memory decline to be associated with better preoperative performance on neuropsychological memory tests and less left hippocampal body T2 signal, both of which suggest a more intact left hippocampus, consistent with the literature reviewed here. For right ATL patients, multiple regression analysis showed verbal memory decline to be associated with left hippocampal body volume reduction and increased T2 signal, suggesting that greater pathology in the contralateral left hippocampus is associated with a risk of postoperative verbal memory decline.

In summary, for left ATL candidates, an absence of ipsilateral left hippocampal pathology (i.e., less hippocampal T2 signal, better preoperative verbal memory performance) was associated with an increased risk of postoperative verbal memory decline. For right ATL candidates, the presence of contralateral left hippocampal pathology (i.e., decreased left hippocampal volume and increased T2 signal) was associated with an increased risk of verbal memory decline. Quantitative T2 relaxometry appears to be a useful predictor of verbal memory decline for both left and right ATL candidates.

by Bruce Hermann, Ph.D.

Bilateral Hippocampal Atrophy: Consequences to Verbal Memory Following Temporal Lobectomy

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BACKGROUND: Bilateral hippocampal damage is a risk factor for memory decline after anterior temporal lobectomy (ATL).

OBJECTIVE: To investigate verbal memory outcome in patients with temporal lobe epilepsy (TLE) with either unilateral or bilateral hippocampal atrophy as measured by MRI.

METHODS: The authors selected 60 patients with TLE who had undergone ATL (left = 31, right = 29). They determined normalized MRI hippocampal volumes by cursor tracing 1.5-mm slices from three-dimensional MRI acquisition. Hippocampal volumes were defined as

atrophic if the volumes were below 2 SD for control subjects. Bilateral hippocampal atrophy was present in 10 patients with left TLE and 11 patients with right TLE. The authors assessed acquisition, retrieval, and recognition components of verbal memory both before and after ATL.

RESULTS: Groups did not differ across age, education, intelligence, age at seizure onset, or seizure duration. Seizure-free rates after ATL were 70% or higher for all groups. Before surgery, patients with left TLE displayed worse verbal acquisition performance compared with patients with right TLE. Patients with left TLE with bilateral hippocampal volume loss displayed the lowest performance across all three memory components. After surgery, both groups of patients with left TLE exhibited worse verbal memory outcome compared with patients with right TLE. Bilateral hippocampal atrophy did not worsen outcome in the patients with right TLE. A higher proportion of patients with left TLE with bilateral hippocampal atrophy experienced memory decline compared with the other TLE groups.

CONCLUSION: Bilateral hippocampal atrophy in the presence of left TLE is associated with worse verbal memory before and after ATL compared with patients with unilateral hippocampal volume loss or right TLE with bilateral hippocampal volume loss.

COMMENTARY

Surgical treatment for partial epilepsy has been shown to be an effective and safe operative procedure for selected patients with medically refractory seizure disorders. Individuals with a successful operative outcome may experience a significant reduction in seizure tendency and an improvement in quality of life. The most common surgically remediable epileptic syndrome is temporal lobe epilepsy (TLE). The ictal onset zone in patients with TLE often involves the “detonator structures” of the mesial temporal lobe, that is, the amygdala or hippocampus. The hallmark surgical pathology associated with TLE is mesial temporal sclerosis characterized by hippocampal cell loss and gliosis. An anterior temporal lobectomy (ATL) is the most frequent operative method used in the management of TLE. This procedure includes an amygdalohippocampotomy and a lateral temporal neocortical resection. An important adverse effect of an ATL is an impairment in cognitive function. A significant decrement in verbal memory postoperatively is most likely to occur in patients with left TLE. Quantitative magnetic resonance imaging (MRI)-based hippocampal formation (HF) volumetry is of prognostic importance in determining the seizure and neuropsychological out-

comes of ATL. Individuals with left HF atrophy and a normal right HF volume are less likely to experience a decline in verbal memory following a left ATL than those with symmetrical HF volumes or right HF atrophy. The structural MRI complements the intracarotid sodium amobarbital study in the preoperative evaluation of the patient's neurocognitive risk associated with epilepsy surgery.

Martin et al. evaluated the effect of bilateral HF atrophy on verbal memory in patients undergoing an ATL. The investigators identified 60 patients with TLE (left = 31, right = 29) who had a comprehensive presurgical evaluation prior to a TLE that comprised quantitative HF measurements, neuropsychological studies, and long-term EEG monitoring. Unilateral HF atrophy occurred in 39 patients (left = 21, right = 18). Twenty-one patients had bilateral HF atrophy (left = 10, right = 11). The patients were separated into four groups based on the neuroimaging studies: left TLE with left HF atrophy, left TLE with bilateral HF atrophy, right TLE with right HF atrophy, and right TLE with bilateral HF atrophy. Preoperatively, patients with left TLE and bilateral HF atrophy had the "lowest performance" on verbal memory testing. Postoperatively, both groups of patients with left TLE exhibited a significant reduction in verbal memory performance. Patients with left TLE and bilateral HF atrophy appeared to

have the least favorable outcome. The results of the MRI study did not affect the neuropsychological outcome in patients with right TLE. The authors concluded that patients with left TLE and bilateral HF atrophy should be "carefully consulted regarding the risk for memory change after surgery."

This study provides further evidence indicating the pivotal role of the left HF in determining verbal memory in patients with left TLE who proceed with epilepsy surgery. Previous studies have shown that patients with symmetrical HF volume measurements (with or without atrophy) and left TLE are at risk of a decline in verbal memory following surgery. Here we see that patients with left TLE and bilateral HF atrophy are at the highest risk for experiencing a postoperative significant reduction in verbal memory. Other clinical factors that may affect memory after an ATL include preoperative cognitive performance and surgical outcome. A presurgical neuroimaging evaluation may be useful in counseling and guiding the patient with left TLE. Ultimately, the decision regarding surgical treatment in patients with left TLE needs to be individualized. The potential risk of a clinically significant verbal memory decline must be balanced with the putative beneficial effects of successful surgery.

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