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Effectiveness of transsylvian selective amygdalohippocampectomy for preserving memory function in patients with hippocampal sclerosis

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Abstract

It remains unclear whether selective amygdalohippocampectomy, an operative technique developed for use in epilepsy surgery to spare unaffected brain tissue and thus minimize the cognitive consequences of temporal lobe surgery, actually leads to a better memory outcome. The present study was performed to investigate the effects of selective surgery on memory outcome in patients with intractable mesial temporal lobe epilepsy due to hippocampal sclerosis treated by transsylvian selective amygdalohippocampectomy (TSA). The results of the present study indicated that left TSA for hippocampal sclerosis tends to improve verbal memory function with preservation of other memory function. Right TSA for hippocampal sclerosis can lead to significant improvement in verbal and nonverbal memory function, with the memory improvement observed one month after right TSA persisting until one year after surgery.

INTRODUCTION

Selective amygdalohippocampectomy is an operative procedure originally developed to spare unaffected brain tissue from surgery to minimize the memory deficits after temporal lobe surgery. However, it has yet to be demonstrated conclusively whether selective surgery can actually preserve memory function, as some previous studies indicated significant verbal memory decline after left selective surgery[1,2], while others showed no such deficits.[3-5] This report described the effects of left and right transsylvian selective amygdalohippocampectomy (TSA) on memory in 88 patients with histopathological confirmation of hippocampal sclerosis, and also presents a discussion of the appropriate TSA surgical technique to avoid cortical damage, which may cause the memory decline after surgery.

METHODS

The surgical procedures

After wide exposure of the Sylvian fissure with standard frontotemporal craniotomy, we identify the inferior periinsular sulcus at the most inferior point of the insular gyri, and the inferior horn of the lateral ventricle is opened through this sulcus with 1.5cm-long cortical incision. After reaching the inferior horn of the lateral ventricle, the hippocampus can be seen to form the floor of the inferior horn. The amygdala faces the hippocampus and forms part of the roof of the inferior horn of the lateral ventricle. While aspirating the amygdala, the site of connection with the head of the hippocampus, *i.e.*, the uncus, is aspirated from the ventricle, which enables identification through the ventricle of the posterior cerebral artery, anterior choroidal artery, and oculomotor nerve in the pial membrane covering the uncus. The surgical field is moved posteriorly, and the choroid plexus is displaced medially to expose the choroidal fissure. The draining vein from the hippocampus is then coagulated and divided, the fimbria is dissected posteriorly, and the hippocampal tail and parahippocampal gyrus are dissected subpially at the site of division of the hippocampal tail.

The hippocampal head is dissected subpially toward the dorsal hippocampus, and the hippocampal body is cut dorsally in the innominate sulcus between the collateral eminence and hippocampal body. The feeding vessels to the hippocampus passing through the hippocampal fissure is coagulated and divided as close as possible to the hippocampal body. Finally, the hippocampal tail is dissected posteriorly and removed to permit *en bloc* resection of the

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hippocampus and parahippocampal gyrus. The residual hippocampal tail and parahippocampal gyrus are resected using a Cavitron ultrasonic surgical aspirator (CUSA) until the lateral aspect of the quadrigeminal plate (inferior and superior colliculi) can be identified. This procedure results in no cortical damage to the lateral frontal or temporal cortex. The pre-and post operative MRI of illustrative case is shown in Figure 1.

Clinical materials and methods

The study population consisted of 88 patients with left hemisphere language-dominance who underwent left (n=40) or right (n=48) selective amygdalohippocampectomy for mesial temporal lobe epilepsy using a transsylvian approach. All subjects were right-handed and completely left hemisphere language-dominant according to Wada testing and functional magnetic resonance imaging (MRI). All patients were shown to have seizures of unilateral temporal lobe origin by scalp or sphenoid EEG, and showed hippocampal sclerosis based on preoperative MRI and postoperative histopathological findings. All patients undergo

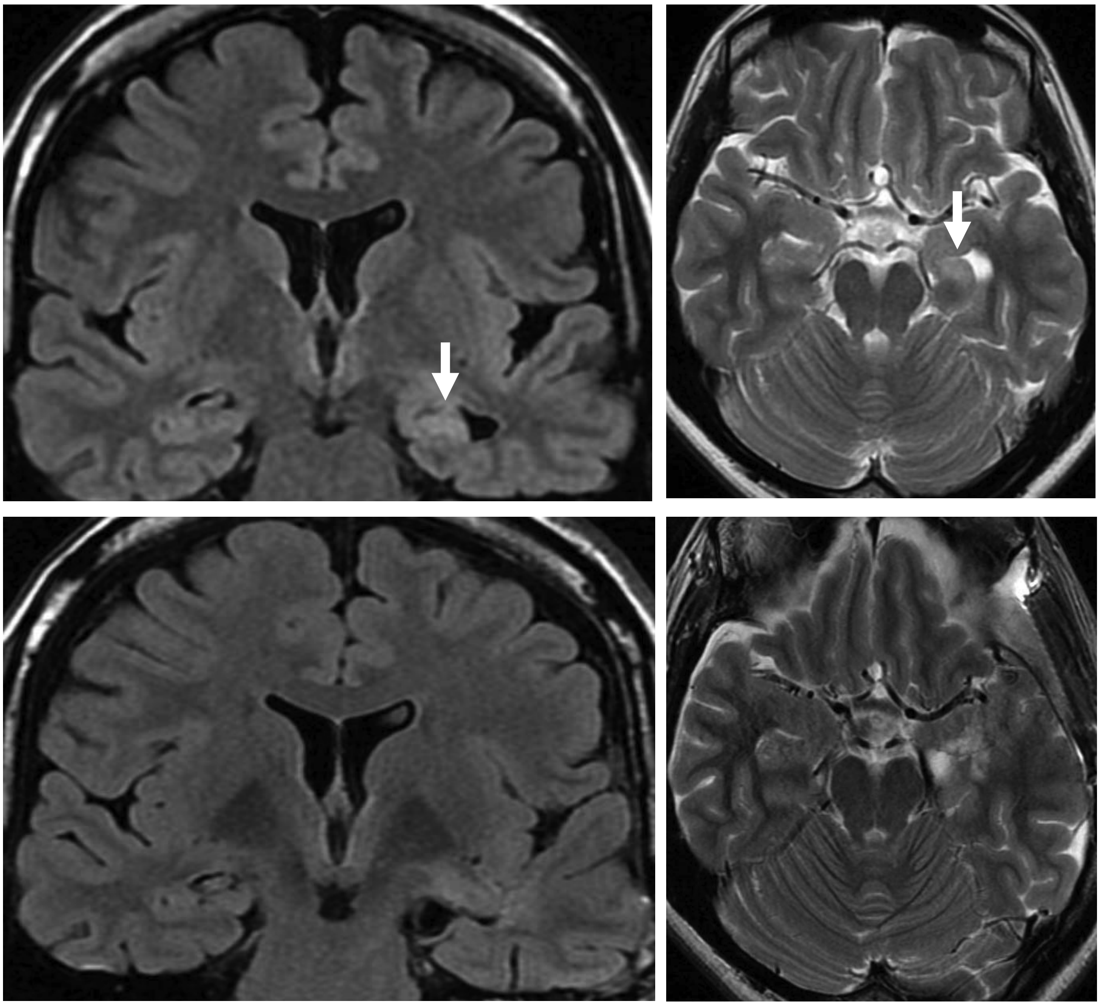

Figure 1. A 31-year-old woman had been suffering from intractable complex partial seizures since she was 13 years old. The frequency of the seizures was once a month. The findings of MRI, EEG, seizure semiology indicated left mesial temporal lobe epilepsy. Left transsylvian selective amygdalohippocampectomy was performed. *Upper*: MRI FLAIR (coronal) and T2 weighted image (axial) showing the atrophy and high signal of the left hippocampal formation (white arrows). *Lower*: Post-operative MRI FLAIR (coronal) and T2 weighted image (axial) indicating selective resection of the mesial temporal structures and no cortical damage to the lateral temporal cortex.

Table 1. Demographic and clinical data of the patient

	Left TSA (n=40)	Right TSA (n=48)	p value
Gender, Male (%)	47.5	45.8	0.876
Age at surgery (yr)	34.5 (1.9)	33.3 (1.7)	0.591
Age at onset of epilepsy (yr)	13.3 (1.4)	17.9 (1.4)	0.023
Preoperative TIQ	78.1 (2.6)	79.1 (2.2)	0.495
Seizure free (%)	90	93.6	0.537

Data are expressed as mean (standard error) unless otherwise indicated.
TSA, transsylvian selective amygdalohippocampectomy; yr, years
Kruskal-Wallis test, ANOVA and Chi-square test were used where appropriate.

neuropsychological memory function evaluation before, and at both one month and one year after surgery. All patients were prescribed the same dose and the same kinds of antiepilepstic drugs with their preoperative medication for two years after surgery. They are under medication at one year after surgery. Verbal memory, nonverbal memory, attention, and delayed recall are assessed using the Wechsler Memory Scale-Revised (WMS-R).

RESULTS

Demographic and clinical variables

As shown in Table 1, there were no differences in patient characteristics between the left and right TSA groups. There were no significant differences in preoperative verbal memory score or IQ score between the two groups.

Seizure outcome

Overall, 81 (92%) of the 88 patients were classified as completely seizure-free one year after surgery. No significant differences in seizure outcome were detected between left and right TSA.

Memory outcome

As shown in Table 2, MANOVA indicated that right TSA patients showed significant improvements in verbal memory (preoperative *vs*. one month postoperatively, $p < 0.0001$; and preoperative *vs.* one year postoperatively, $p < 0.0001$), nonverbal memory (preoperative *vs*. one month postoperatively, $p = 0.0035$; and preoperative *vs.* one year postoperatively, $p = 0.0023$), delayed recall (preoperative *vs.* one month postoperatively, $p = 0.0058$; and preoperative *vs*. one year postoperatively, $p = 0.0103$) at both follow-ups. In the left TSA group, verbal memory was maintained one month after surgery, and the verbal memory score one year after surgery increased significantly ($p = 0.0239$). No significant changes in nonverbal memory, attention, or delayed recall were found at either one month or one year follow-up.

DISCUSSION

Anterior temporal lobectomy for intractable temporal lobe epilepsy is known to lead to memory deficits, with verbal memory functions at particular risk in patients undergoing left anterior temporal lobectomy.[6,7] To ameliorate these complications, several methods of selective amygdalohippocampectomy have been developed for use in epilepsy surgery to achieve comparable seizure control and better cognitive outcome than anterior temporal lobectomy. Selective amygdalohippocampectomy was first reported in 1958 by Niemeyer, who gained access to mesial temporal structures *via* the transcortical–transventricular approach.[8] Subsequently, Yasargil[9] and Wieser[4] described TSA, which can avoid injury to the lateral temporal cortex. However, the transsylvian approach has not been widely used for a number of reasons, including the high degree of skill required for wide exposure of the Sylvian fissure, and the need for familiarity with the anatomical orientation to gain access to the inferior horn of the lateral ventricle.

Examination of postoperative verbal memory outcome in the present study indicated significantly better WMS-R scores in patients who underwent right as compared with left TSA. Although verbal memory after left TSA was preserved at one month postoperatively and showed slight improvement beyond preoperative level one year after surgery, significant verbal memory improvements were found in the right TSA group at both one month

Table 2. Memory performance before and after TSA

	Left (n=40)						Right (n=48)					
	Preop.	**1MP**	**1YP**	**Preop.-1MP**	**Preop.-1YP**	**1MP-1YP**	**Preop.**	**1MP**	**1YP**	**Preop.-1MP**	**Preop.-1YP**	**1MP-1YP**
Verbal memory	76.4(2.9)	72.5(3.0)	77.3 (3.0)	p=0.0465	p=0.6566	*p=0.0239	77.6 (2.5)	87.1 (2.6)	86.5 (2.6)	*p<0.0001	*p<0.0001	p=0.7364
Non verbal memory	90.7 (2.9)	94.9 (3.0)	93.7 (3.1)	p=0.0648	p=0.2072	p=0.6480	86.5 (2.6)	92.3 (2.6)	93.1 (2.7)	*p=0.0035	*p=0.0023	p=0.7253
General memory	78.1 (3.1)	75.9 (3.1)	79.5 (3.2)	p=0.2376	p=0.4742	p=0.0785	75.9 (2.6)	85.9 (2.7)	86.1 (2.7)	*p<0.0001	*p<0.0001	p=0.9162
Attention	89.0 (3.3)	90.6 (3.3)	91.1 (3.4)	p=0.3781	p=0.2954	p=0.8049	86.5 (2.9)	89.6 (2.9)	89.4 (2.9)	p=0.0511	p=0.0884	p=0.9085
Delayed recall	74.8 (3.1)	76.4 (3.2)	77.0 (3.3)	p=0.5049	p=0.4002	p=0.8239	74.9 (2.7)	80.6 (2.7)	80.5 (2.8)	*p=0.0058	*p=0.0103	p=0.9404

Cells provide the mean standardized scores with the standard errors in parentheses.
TSA, transsylvian selective amygdalohippocampectomy; MP, month postoperative; YP, year postoperative.

and one year follow-ups. These results, together with the observation that the left temporal lobe is frequently associated with verbal memory and the right temporal lobe is instead associated with nonverbal memory processing[10], suggested that verbal memory improvement after right TSA may be due to activation of the left hippocampus following release from the influence of the affected right hippocampus.

In conclusion, the results of the present study indicated that TSA for unilateral hippocampal sclerosis is useful for improvement of verbal memory. The results indicated that avoidance of collateral damage due to the operative procedure may have a significant effect on memory outcome after TSA.

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