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Anterior Temporal Lobectomy with Tailored Hippocampectomy

- Review of 100 Cases with Intractable Temporal Lobe Epilepsy -

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= Abstract =

In terms of seizure control for the patients with medically intractable temporal lobe epilepsy(TLE), extensive medial resection, especially of the hippocampus, has been advocated in anterior temporal lobectomy. The relationship between the outcome of anterior temporal lobectomy for epilepsy and the size of the hippocampectomy tailored to intraoperative electrocorticographic findings was evaluated in 100 patients, with at least 12 months of follow-up. In 28 patients with small hippocampal resection(≤2.0cm), 21(72.7%) were class I (seizure-free), 2(7.1%) were class II (rare seizure), 4(14.3%) were class III (worthwhile improvement) and 1(3.6%) was class IV(no worthwhile improvement) according to Engel's outcome classification. In 72 patients with large hippocampal resection(over 2.2cm), the results were as follows ; 50(69.4%) were class I, 12(16.7%) were class II, 7(9.7%) were class III and 3(4.2%) were class IV. Statistically significant differences were not present between these two groups. Overall, 85(85%) patients have had successful results. Patients with dominant temporal lobe surgery underwent less resection of lateral temporal and hippocampus($p<0.001$) compared to the patients with non-dominant temporal lobectomy.

Intraoperative acute recording over the hippocampus and surrounding area can be useful in tailoring the extent of hippocampal resection to the individual pathophysiology.

KEY WORDS : Temporal lobe epilepsy · Hippocampus · Tailored hippocampectomy · Anterior temporal lobectomy · Electrocorticography · Surgical outcome.

Introduction

Extensive medial resection, especially of the hippocampus, has been advocated in anterior temporal lobectomy in terms of seizure control for medically intractable temporal lobe epilepsy(TLE), but the knowledge of where the epileptogenic focus is within temporal lobe in TLE is very imprecise, although abnormalities can be demonstrated in the hippocampus in most cases. Moreover, it has been suggested[9] that the most common cause of failed temporal lobe surgery is inadequate hippocampal resection.

The posterior extent of the medial resection is routinely tailored to include the extent of interictal epileptiform discharges on hippocampal and parahippocampal gyri. Here we examine the relation between the outcome and the extent of hippocampal resection.

Clinical Materials and Methods

Prospective study was performed in patients who underwent anterior temporal lobectomy with concomitant extended medial resection, particularly hippocampus, for intractable TLE at the Keimyung University since late 1992, when epilepsy surgery program was commenced. Sufficient data on hippocampal measurements were available for 100 consecutive patients with TLE undergoing operation bewteen 1992 and 1995, with at least 1 year of follow-up.

Preoperatively, all patients had scalp electroencephalographic studies, and most had noninvasive seizure monitoring with sphenoidal electrodes. Thirty one patients (31%) also had chronic monitoring from bitemporal subdural electrodes. All patients had modified Wada tests to evaluate the severity of memory loss.

A tailored temporal lobectomy, including both anterolateral temporal resection and amygdalohippocampectomy, was performed on all patients except four cases of hippocampal sparing with epileptiform abnormalities of ECoG on temporal neocortex alone. Surgical techniques are described in detail elsewhere[8]. We routinely varied the extent of hippocampal resections, depending on the intraoperative interictal epileptiform abnormalities on preresection ECoG recorded from the hippocampus(Fig.1) and parahippocampal gyrus, and the severity of memory loss in the preoperative Wada test. After initial removal, postresection recording of ECoG from the remaining hippocampus and parahippocampal gyrus was repeated to decide whether further hippocampal resection was needed or not.

Surgical outcome was determined by the change in seizure activity, according to the follow-up information by direct patient contact or chart review, which were categorized by Engel's classification[2].

Patients were divided into two groups based on the size of the hippocampal resection : (1) below 2.0cm(range 1.0–2.0cm) from the most anterior pes and (2) >2.0cm (range 2.2–5.0cm) along the body of hippocampi. These two groups are categorized as minimal(partial or complete resection of pes only) and maximal(resection of the pes plus part of anterior half or more of the body) hippocampal removal. Statistics were used to determine whether the extent of the hippocampal resection is related to the surgical outcome, with SPSS/PC software system.

Results

The consecutive 100 patients who underwent anterior temporal lobectomy with amygdalohippocampectomy were followed for 12–43 months, the mean follow-up period being 22.2 months. The characteristics of patients in the two groups are summarized in Table 1. The first group with less than 2.0cm of hippocampal removal included 28 out of 100 patients. 72 were in the second group.

The surgical outcome of these two groups is summarized in Table 2. Among 28 patients with below 2.0cm of hippocampal removal, 21(72.7%) were class Ⅰ(seizure-free), 2(7.1%) were class Ⅱ(rare seizure), 4(14.3%) were class Ⅲ(worthwhile improvement) and 1(3.6%) was class Ⅳ (no worthwhile improvement) according to Engel's outcome classification. Of the 72 patients with over 2.0cm of hippocampal removal, 50(69.4%) were class Ⅰ, 12(16.7%) were class Ⅱ, 7(9.7) were class Ⅲ and 3(4.2%) were class Ⅳ. Statistically significant difference were not present. Overall, 85(85%) patients have had successful results.

The demographic and seizure-related characteristics of the 100 patients with dominant and nondominant temporal lobectomy are listed in Table 3. The 59 patients with dominant temporal lobe surgery underwent less resec-

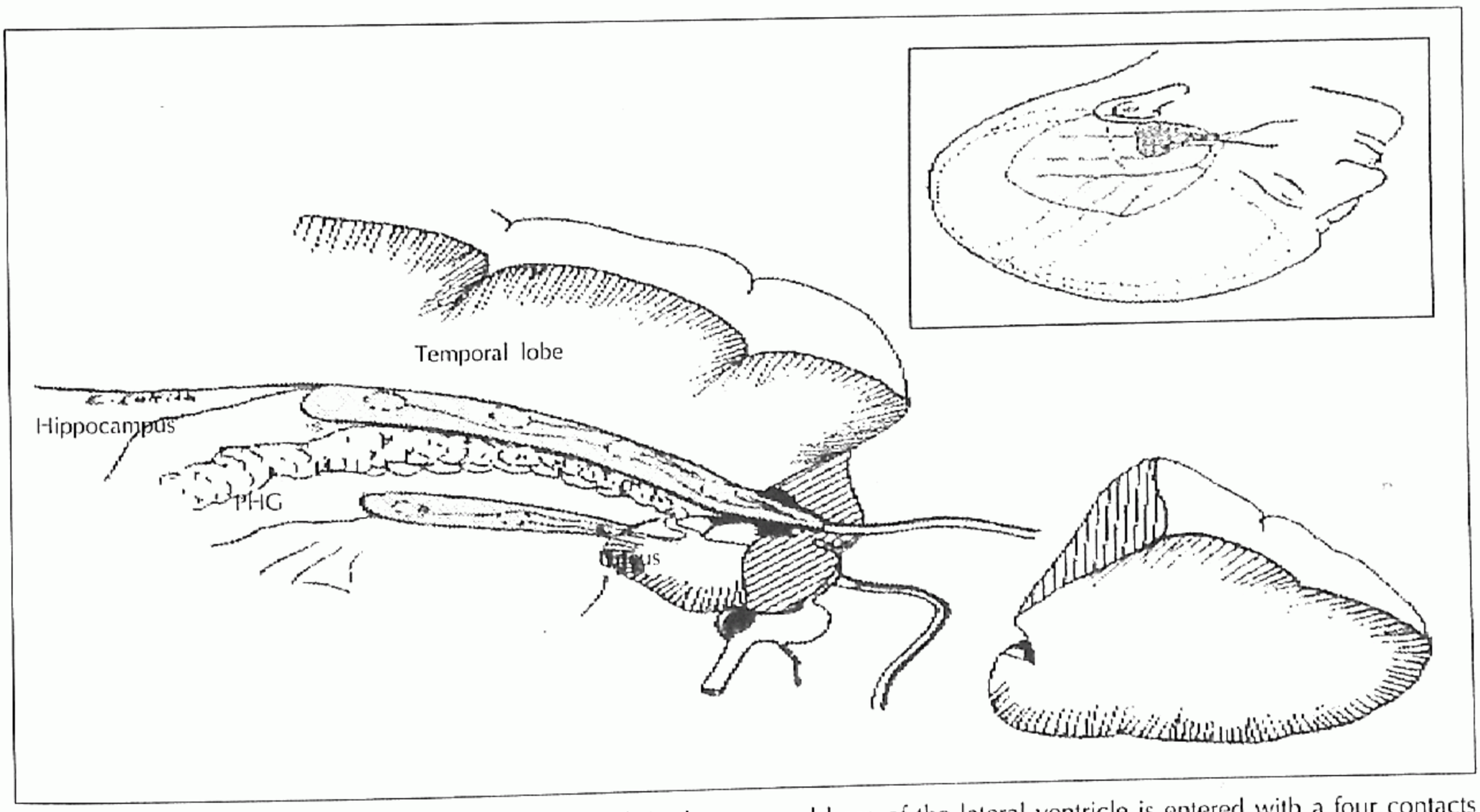

Fig. 1. Following the resection of the anterior temporal tip the temporal horn of the lateral ventricle is entered with a four contacts soft strip electrode which comes to rest on the hippocampus and is parallel to contacts on a strip electrode slipped under and along the parahippocampal gyrus.

Table 1. Characteristics of 100 patients with TLE according to the extent of hippocampal resection*

Characteristics	Hippocampal Resection		Total (range)
	≤ 2.0cm	>2.0cm	
No. of cases	28	72	100
Sex(M/F)	14/14	47/25	61/39
Follow-up period, months	20.8±6.6 (12-37)	22.7±8.2 (12-43)	22.2±7.9 (12-43)
Length of hippocampal resection, cm	1.7±0.6 (0-2.0)	3.2±0.7 (2.2-5.0)	2.8±0.9 (1.0-5.0)
Length of lateral temporal resection, cm	3.8±0.9 (3.0-5.5)	4.2±0.7 (3.0-8.0)	4.1±0.8 (3.0-8.0)

*Values are indicated as means±standard deviation with ranges

Table 2. Follow-up classification of outcome in 100 patients with TLE according to the extent of hippocampal resection

Outcome Classification	Hippocampal Resection		Total,(%)
	≤2.0cm	>2.0cm	
I	21(72.7)	50(69.4)	71
II	2(7.1)	12(16.7)	14
III	4(14.3)	7(9.7)	11
IV	1(3.6)	3(4.2)	4

Figures in parentheses represent percentage.
*Outcome according to Engel's classification : class I : seizure free, II : rare seizure(almost seizure free), III : worthwhile improvement, IV : no worthwhile improvement
†Statistical significance between two groups : p=0.616

Table 3. Characteristics of 100 patients with dominant vs. non-dominant anterior temporal lobectomy*

Characteristics	Dominant temporal group	Non-dominant temporal group
No. of cases	59	41
Sex(M/F)	35/24	26/15
Age(yrs)	27.5(14-38)	27.0(12-46)
Length of hippocampal resection, cm†	2.5±0.8 (1.5-4.5)	3.2±0.9 (2.0-5.0)
Length of lateral temporal resection, cm†	3.8±0.7 (3.0-8.0)	4.5±0.6 (3.0-5.5)
Outcome**		
Seizure free	45(76.3%)	26(63.4%)
Rare seizure	6(10.2%)	8(19.5%)
Worthwhile improvement	6(10.2%)	5(12.2%)
No worthwhile improvement	2(3.4%)	2(4.9%)

*Values are indicated as means±standard deviation with ranges.
**Outcome according to the Engel's classification reached no statistical significance by between-group comparisons.
†Patients with dominant temporal group underwent less hippocampal and lateral temporal resection($p<0.001$).

tion of lateral temporal and hippocampus($p<0.001$) compared to the 41 patients with non-dominant temporal lobectomy. None of the other between-group comparisons reached statistical significance.

Discussion

Traditionally, the extent of medial resection was limited as no more than 1.5-2.0cm of the hippocampus. However, extensive medial resection has been advocated in anterior temporal lobectomy for seizures[4,5,10]. Nevertheless, only a few studies have evaluated the relationship between size of hippocampal removal and outcome[3,11], and how to decide the extent of that removal. However, Ojemann et al. previously reviewed the relationship between the extent of mesial temporal resection and seizure frequency in those patients[9], finding a significantly larger proportion of them seizure-free when the anterior hippocampus was included in the resection compared to those where it was spared. Another report[5] also indicated that patients with hippocampal removal has significantly better outcome (success rate of 86.4%) than patients with hippocampal sparing(success rate of 65%).

However, hippocampal lesions are known to vary in the posterior extent, sometimes extending beyond the standard area of temporal lobe resection[4]. Histopathologically, Babb et al[1]. have indicated that patients lacking full benefit from the standard anterior tomporal lobectomy had a decreased number of hippocampal neurons equally distributed from the anterior to the posterior hippocampus.

The experience of Olivier et al[6]. indicates that the most common cause for failed temporal lobe surgery is inadequate hippocampal resection, which suggests that more extensive resection of the posterior hippocampus should be considered. However, the amount of hippocampus that must be removed is hard to quantify. The posterior extent of the medial temporal resection also is tailored to include the extent of discharges on hippocampal and parahippocampal gyri, varying from 1.0-3.5cm or occasionally 4cm of hippocampus and including all more medial temporal structures inferior to the choroidal fissure back to that level. Our data indicate that the rate of seizure control was equally high in patients with large or small hippocampal resection when that resection was tailored to intraoperative ECoG recorded from the hippocampus and the parahippocampal gyrus. Larger hippocampal resections did not increase the number of seizure-free patients and are probably not indicated in patients with only an anterior hippocampal epileptogenic zone. The interictal spikes[7,8] that indicate areas requiring resection to control seizure are those that persist in the awake patients on

therapeutic levels of antiepileptic drugs, particularly interictal spikes that are spreading over a substantial area.

Our data also demonstrated that the patients with dominant temporal lobe surgery underwent less resection of lateral temporal and hippocampus compared to the patients with non-dominant temporal lobectomy, which showed the tendency of minimal resection in dominant temporal lobe surgery to minimize postoperative sequellae.

Intraoperative acute recording over the hippocampus and surrounding area can be useful in tailoring the extent of hippocampal resection to the individual patient's pathophysiology.

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측두엽 절제술에서 해마의 재단절제
- 난치성 측두엽 간질 환자 100명의 수술결과 분석 -

계명대학교 의과대학 신경외과학교실 및 간질센타
유 영 상·손 은 익

=국문초록=

난치성 측두엽 간질 환자의 수술에 있어서 측두엽 내측의 광범위 절제가 측두엽 절제술에서 관건이 되고 있다. 그러나 측두엽 간질에서 정확한 간질 유발 부위에 대한 지식의 향상으로, 일반적으로 해마-편도체 부위나 측두엽 피질 부위 등의 구별은 어느정도 가능하나, 측두엽 절제, 특히 해마절제에 있어서 그 범위와 기준이 일정치 않아 논란이 많은 실정이다.

이에 본 교실에서는 지난 1992년부터 난치성 측두엽 간질로 수술한 환자중에서 1년이상 추적 기간이 지난 연속적인 100명을 대상으로 수술중에 해마부위의 뇌피질파(ECoG)소견에 근거하여 재단절제한 해마의 크기와 수술결과와의 관계를 비교하였다. 절제된 해마의 크기에 따라서 2cm 이하의 소절제군(28명)과 2cm이상의 대절제군(72명)으로 각각 나누어 수술결과를 분석한 결과, 양군간에 통계학적인 차이가 없이 85%의 높은 성공률을 보였다. 한편, 전측두엽 피질과 해마의 절제 정도를 좌(59명), 우(41명)측 측두엽간질 환자군과 비교하면 우위대뇌반구(dominant hemisphere)인 좌측 측두엽 수술에서 절제범위가 작았다($p<0.001$).

따라서 술전 평가에서 간질유발부위가 확인된 측두엽 간질 환자에서 수술중 해마에 대한 뇌피질파 검사소견이 간질유발부위의 최대 절제와 후유증의 최소화를 위한 해마의 절제범위 결정에 유용한 지표가 될 것으로 사료되어 보고하는 바이다.