Resective Surgery without Invasive Intracranial EEG Monitoring in Patients with Temporal Lobe Epilepsy

측두엽 간질환자의 수술적 치료에서 비침습적 술전 평가

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국문초록

목 적 : 전측두엽절제술(anterior temporal lobectomy ; ATL)은 난치성 측두엽간질 환자들에서 효과적인 수술적 치료 방법으로 인정받아 왔고, 수술적 치료를 위해서는 여러 단계의 비침습적 및 침습적 술전 평가를 필요로 한다. 하지만 다양한 비침습적 술전 평가 방법만으로도 간질발생부위를 측향화는 물론 국재화할 수도 있기 때문에 침습적 술전 평가를 생략하고 직접 시행한 수술적 치료방법의 수술성적과 예후에 영향을 주는 요인들에 대해 알아보기 위하여 본 연구를 시행하였다. 방 법 : 1990년 2월부터 1995년 12월까지 집중적 약물치료에도 불구하고 난치성간질로 진단되어 수술적 치료를 위해 뉴욕대학병원 간질센타에 의뢰된 환자들 중 지속적 비디오-뇌파감시를 통한 임상양상과 발작간 및 발작중 두피적 뇌파검사, 동위원소검사 및 자기공명영상(MRI) 등 술전 평가를 마치고 일측성의 측두엽간질로 진단되어 침습적 평가를 생략한 채 ATL을 시행받은 35명의 측두엽간질 환자들을 대상으로 하였다. 이들 환자들은 Engel의 예후 평가기준에 의거 적어도 1년 이상 추시한 후 발작이 소실된 군(Class I)과 발작이 지속된 군(Class II-IV)으로 나누어 수술시 연령, 발작시작 연령, 발작기간, 성별, 열성경련의 기왕력, 임상양상, MRI상 병변의 유무 및 종류, Wada 검사 및 신경심리검사 결과 등 예후에 영향을 줄 것으로 추정된 잠재적 변인들을 비교 분석하였다. 결 과 : 평균 추시 기간은 35.1±15.5(12~60)개월이었으며, 기간 중 30명(85.7%)이 Class I에 속하였다. MRI상 병변의 존재(p=0.013)는 통계적으로 유의하게 술 후 발작의 소실을 예측할 수 있는 요인으로 나타났으며, MRI상 해마의 위축을 포함한 측두엽의 위축(p=0.074), 열성경련의 기왕력(p=0.13) 등은 통계적 유의성은 없으나 술 후 발작의 소실을 예측하는 데 도움을 줄 수 있을 것으로 생각되는 요인으로 나타났다. 결 론 : 비침습적 술전 평가를 마치고 선택된 난치성 측두엽간질 환자들의 수술성적은 매우 만족스러웠으며, MRI상 병변을 보였거나, 열성경련의 기왕력이 있는 경우는 모두 술 후 발작의 소실을 보였다. 따라서, 이러한 환자들은 침습적 술전 평가를 필요로 하지 않을 것으로 생각된다. (J Korean Epilep Soc 2 : 134-139, 1998)

중심 단어 : 전측두엽 절제술 · 비침습적 술전 평가 · 잠재적 변인.

INTRODUCTION

The International League Against Epilepsy[1] classifies the patients with epilepsy based on whether their seizures are generalized or localization-related. Localization-related epilepsy is further subdivided into specific clinical syndromes, depending on the location of the epileptogenic focus. Temporal lobe epilepsy is one of the most common localization-related epilepsy in adults, and large numbers of them are medically intractable.[2][3]

Since the pioneering work of the Montreal school,[4][5] the surgical treatment of epilpesy has continued to achieve worldwide acceptance as an alternative treatment for selected patients with medically intractable seizures.[6] The patients with temporal lobe epilepsy still constitute the most important group in the surgical series. In early surgical series, operations were performed only for removal of mass lesions or scars and were often successful in relieving seizures. In recent years, use of preoperative intracranial EEG recording has made the localization of many epileptogenic foci possible.[7]

Futhermore, the non-invasive techniques such as clinical seizure semiology, scalp EEG patterns, neuroimagings (MRI, single photon emission computed tomography (SPECT) and positron emission tomography (PET)), neuropsychologic tests and the intracranial amobarbital procedu-

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res (IAP) can help to lateralize hemispheric dysfunction.[8] Therefore, excellent seizure control after surgery can be obtained after meticulous review of the intracranial EEG and the other non-invasive studies in medically intractable epileptic patients.

However, chronically implanted intracranial electrodes are difficult to use, expensive, and risky. Moreover, localization of mesial temporal lobe epilepsy can be possible only with scalp EEG monitoring using sphenoidal electrodes.[9] In this study, we analyzed the outcome and the predictive value of various presurgical tests as potential predictors of outcome for resective surgery in patients with medically refractory temporal lobe epilepsy who had been evaluated only with non-invasive studies.

PATIENTS AND METHODS

We retrospectively reviewed the database of 217 consecutive patients who had surgery for intractable epilepsy at the comprehensive epilepsy center in New York University (N.Y.U.) between February 1, 1990 and December 31, 1995. Out of these 217 patients, we selected 46 patients who underwent ATL without invasive monitoring. Among them, we included 35 patients who had finished an at least one year follow-up evaluation, whether they have a definite lesion in the temporal lobe or not. All patients were evaluated with the audiovisual and the scalp EEG monitoring of interictal and ictal activity. All seizures were recorded with the Telefactor Beehive digital video-monitoring system (West Conshohocken, PA), and EEGs were analyzed in bipolar and referential montages with the Telefactor Beekeeper system. All the patients had 2 seizures recorded at a minimum, and at least one of them was arising from the unilateral temporal lobe. They were also evaluated with MRI with 3-mm coronal cuts through the temporal lobes. We used the following criteria for interpretation of hippocampal sclerosis on MRI findings : 1) anterior temporal lobe atrophy, 2) asymmetry of temporal horns, 3) hippocampal atrophy, and 4) increased signal intensity at the hippocampus.[10] All the patients in our series underwent ATL if the ictal onset zone was exclusively confined to the unilateral temporal lobe, if it was concordant or not disconcordant with PET or SPECT, if MRI disclosed unilateral hippocampal atrophy or a foreign tissue lesion, and if they had passed IAP language test.

The average follow-up period was 35.1±15.5 months (range 12－60 months). The surgical outcomes of these patients were classified according to Engel's classification.[11] Out of 35 patients, 30 patients belonged to the Class Ⅰ, and 5 patients belonged to the Class Ⅱ or Ⅲ.

We analyzed the following potential variables to determine their predictive value : age at seizure onset, age at the time of surgery, sex, duration of seizure, a history of febrile seizure, seizure type i.e. type I and type II complex partial seizure depending on clinical semiology[12], congruity of preoperative IAP memory, and neuropsychological tests in addition to the presence of a lesion on MRI. These potential predictors of outcome were analyzed for two types of outcome groups : the seizure-free group (Class I) and the persistent seizure group (Class Ⅱ and Ⅲ).

The statistical tests were performed either with the Student t-test or the Pearson chi-square test. The Fisher's exact test was used for dichotomous variables. The significance level of the tests was 5 percent.

RESULTS

Table 1 summarizes the results of the statistical analysis. Out of 35 temporal lobe epilepsy (TLE) patients, 13 were men and 22 were women. The mean age of the patients at the time of operation was 32.4 years (range 13－54 years), and the mean duration of seizures was 16.9 years (range 1－52 years). Thirty two right-handed and one ambidextrous patients were underwent right temporal lobectomy, and two left-handed patient underwent left temporal lobectomy. During the follow-up period, thirty (85.7%) out of 35 patients were seizure-free, while 5 persisted seizures. Nineteen patients (54.3%) had a clearly identifiable lesion on MRI, and all of them belonged to the seizure-free group. Among these 19 patients, eleven, four, and four patients had hippocampal sclerosis, brain tumor and vascular malformation, respectively. Eleven patients (31.4%) had a history of febrile convulsion.

The differences in sex and handedness between two groups were not statistically significant. All 19 patients (100%) that had a visible lesion on MRI were seizure-free, while only 11 (66.8%) out of the 16 patients without a lesion were seizure-free. This shows that a visible lesion on MRI predicts seizure-free at a statistically significant level (p=0.013). All the 11 patients (100%) with a history of febrile convulsion and 19 (79.2%) out of the 24 patients without a history of febrile convulsion were seizure-free, and hen-

Table 1. Analysis of outcome predictors after surgury in 35 TLE pat

	Seizure free group (n=30)	Persistent seizure group (n=5)	Significance (p-value)
Age (year ; mean±S.D.)	32.3 ± 9.5	33.0 ± 13.9	0.809
Age of seizure onset (year : mean±S.D.)	16.3 ± 8.7	10.4 ± 7.6	0.161
Duration of epilepsy (year : mean±S.D.)	16.0 ± 10.4	22.6 ± 17.6	0.243
Sex (%)			
Male	12 (92.3)	1 (7.7)	0.374
Female	18 (81.8)	4 (18.2)	
Handedness (%)			
Right	27 (83.4)	5 (16.6)	0.436
Left	2 (100.0)	0 (0.0)	
Bilateral	1 (100.0)	0 (0.0)	
History of febrile convulsion (%)			
Yes	11 (100.0)	0 (0.0)	0.131
No	19 (79.2)	5 (20.8)	
Seizure type (%)			
Type Ⅰ	22 (81.5)	5 (18.5)	0.436
Type Ⅱ	8 (100.0)	0 (0.0)	
Presence of lesion on MRI (%)			
Yes	19 (100.0)	0 (0.0)	0.013*
No	11 (68.8)	5 (31.2)	
Etiology (%)			
HS with/without DS	11 (100.0)	0 (0.0)	0.074
Tumor	4 (100.0)	0 (0.0)	
Vascular malformation	4 (100.0)	0 (0.0)	
No	11 (68.8)	5 (31.2)	
IAP memory failure (%)			
Ipsilateral	2 (100.0)	0 (0.0)	0.332
Contralateral	13 (92.9)	1 (7.1)	
None	5 (71.4)	2 (28.6)	
Neuropsychological test (%)			
Congruous	18 (81.8)	4 (18.2)	0.374
Incongrous	12 (92.3)	1 (7.7)	

+ Student t-test, Pearson chi square test or Fisher Exact test used : *p<0.05
Abbreviations : MRI signify magnetic resonance imaging ; IAP, intracarotid amobarbital procedure ; HS, hippocampal sclerosis ; DS, diffuse sclerosis

ce a history of febrile convulsion tended to predict seizure-free, although not statistically significant (p=0.131).

We found that the age at seizure onset of the persistent seizure group (10.4±7.6 year) was earlier than the seizure-free group (16.3±8.7 year). On the contrary, the duration of epilepsy of the seizure-free group (16.0±10.4 year) was shorter than the persistent seizure group (22.6±17.6 year). So, earlier seizure onset and longer duration of epilepsy tend to predict persistent seizure, although not statistically significant (p=0.161, 0.243, respectively).

Twenty two (81.5%) out of the 27 patients who had a type Ⅰ seizure were seizure-free, while all 8 patients (100%) who had a type Ⅱ seizure were seizure-free. However, the difference in the seizure type between two groups was not statistically significant.

The IAP memory test was performed for 23 patients in our series. Memory was lateralized on the contralateral side of surgery in 14 patients and on the bilateral side in 7 patients. Eighteen (85.7%) out of these 21 patients who had adequate memory on the contralateral side of surgery were seizure-free. All 2 patients (100%) that had lateralized momory on the ipsilateral side of surgery were seizure-free after surgery. Eighteen (81.8%) out of 22 patients whose neuropsychological test results were congruent with the side of seizure onset were seizure-free, while 12 (92.3%) out of 13 patients whose results were incongruent were seizure-free. The correlation between the surgical outcome and the IAP memory failure or congruity of neuropsychological tests is not significant.

DISCUSSION

Thirty (85.7%) out of 35 TLE patients were seizure-free after ATL. The seizure outcome in our series was similar to those reported previously.[13-16] Considering that an extensive invasive monitoring was used as a presurgical evaluation in some of these studies, our result compares favorably in terms of seizure control with those of other series. All patients in our series underwent ATL if the ictal onset zone was exclusively confined to the unilateral temporal lobe, if MRI disclosed unilateral hippocampal atrophy or a foreign tissue lesion, and if the other investigations were either concordant or not discordant. Morris et al.[17] and Risinger et al.[18] reported that some scalp EEG findings such as unilateral epileptic focus and initial lateralized EEG features could predict a good outcome. Based on these studies, our surgical results can easily be expected, because the ictal onset zone of all patients in this study was confined to the temporal lobe. Moreover, several different presurgical tests yielded concordant results that localized the epileptogenic focus to one temporal lobe.

Only the presence of a lesion on MRI predicts seizure-free after ATL ($p<0.05$). The presence of an identifiable etiology, regardless of an etiology ($p=0.074$) and a history of febrile convulsion ($p=0.013$) tended to predict seizure-free, although not statistically significant. As suggested by previous studies,[19-22] the presence of a lesion and a history of hippocampal sclerosis correlates with a good outcome after ATL. Because the hippocampal pathology was not available from all surgical specimens, we did not consider this factor. Considering that the mesial temporal sclerosis is the most common pathologic finding in medically intractable TLE patients who respond surgically well,[15,23,24] we believe that most of these non-lesional individuals had microscopic mesial temporal sclerosis.

Some researchers found that there is a correlation between a shorter duration of epilepsy before surgery and a better outcome.[16] There is some evidence that patients with earlier onset and longer duration of epilepsy generally have more severe epilepsy.[25] Salanova et al.[16] suggested that earlier onset of seizures and longer duration of epilepsy may allow progression of the epileptogenic process by secondary epileptogenesis. We also found that earlier seizure onset and longer duration of epilepsy tend to predict persistent seizure, although not significant ($p=0.161$, 0.243, respectively).

Temporal lobe epilepsy is subdivided into type I and type II complex partial seizure depends on clinical semiology,[12] although differentiating neocortical temporal lobe epilepsy from mesial temporal lobe epilepsy clinically is very difficult.[26,27] Those who had a seizure characterized by Type I, generally known to originate from the hippocampus, can be a good surgical candidate, while those who had a type II seizure originating from lateral neocortex cannot. However, there is no statistical differences between seizure types in this study. Some ictal behaviors such as head turning, dysphasia and contralateral dystonia may help to lateralize the side of seizure origin, but further prospectively designed case-controlled study must be needed for these factors.

Bengzon et al.[28] found that patients undergoing non-dominant temporal resection had a better outcome, and Wyllie et al.[29] observed that the outcome did not correlate with the site of surgery. Because most of the patients included in this study were underwent the non-dominant hemisphere resection, we could not evaluate this factor.

The IAP is a procedure commonly used to assess patients for epilepsy surgery. It identifies the language dominant hemisphere and can evaluate long-term memory in the nonoperated temporal lobe to assess the likelihood of postoperative memory impairment. Because hippocampus is essential for long-term memory, the IAP serves as an indirect means of assessing its functional and structural integrity. Sperling et al.[30] found that the surgery of the side of IAP memory failure predicts seizure-free. But in this study the difference is not statistically significant. This result is due to that most patients in our series were underwent right temporal lobectomy. Comprehensive neuropsychological test can help to lateralize the side of seizure origin.[31,32] Boon et al.[32] reported that abnormal findings on neuropsychological tests were congruent with lesion lateralization in 56% of patients and were localized to the region in 26%. And 39 (83.0%) of 47 patients who underwent a subtotal temporal lobectomy are seizure-free after longer than or equal to 1 year of follow-up. In this study 22 (62.9%) of 35 patients were congruent with the side of surgery and 81.8% of them were seizure-free. But there is no correlation between neuropsychological tests and outcome.

Interictal and ictal SPECT and PET scan also help to lateralize epileptogenic zone.[33][34] We could not include MRI volumetrics and PET scan due to a lack of these data for most patients. We used SPECT data mainly for selecting patients for surgery without any invasive studies.

CONCLUSIONS

Eighty five percent of patients were benefited from resective surgery in our series. Therefore excellent surgical outcome could be obtainable in highly selected medically refractory temporal lobe epileptic patients without an extensive invasive intracranial EEG evaluation, especially those who have a lesion or a hippocampal sclerosis in MRI and the history of febrile convulsion. We conclude that those patients do not require the extensive invasive EEG monitoring.

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Resective Surgery without Invasive Intracranial EEG Monitoring in Patients with Temporal Lobe Epilepsy

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ABSTRACT

Purpose : Anterior temporal lobectomy (ATL), the most common operation for intractable temporal lobe epilepsy (TLE), sometimes requires several stages of non-invasive and invasive presurgical evaluations. Various non-invasive presurgical tests can help to lateralize and/or localize the epileptogenic zone, therefore it is possible to resect epileptogenic zone without invasive intracranial studies. We performed this study in order to analyze the predictive value of the predictors of outcome after ATL. ***Methods*** : Prior to surgery, all patients were evaluated with non-invasive scalp interictal and ictal EEG, clinical seizure semiology, MRI, intracarotid amobarbital (Wada) and neuropsychological tests. If these results were converge to one temporal lobe, we performed ATL without invasive intracranial EEG monitoring. In order to analyze the predictive value of these presurgical tests as well as the following potential predictors of outcome, we reviewed 35 patients with medically refractory epilepsy who were consecutively underwent ATL : age at the time of surgery, age at seizure onset, sex, duration of seizures, the presence of a lesion or hippocampal sclerosis in MRI. The average follow up period was 35.1±15.5 months (range 12-60 months). The outcome factors analyzed were compared to two types of outcome group ; seizure free group (Class I) and persistent seizure group (Class II-IV) according to Engel's classification. ***Results*** : Thirty (85.7%) out of 35 patients were seizure free during follow up. Only the presence of a lesion in MRI significantly predicted seizure free at the significance level of 5 percent. The presence of diffuse sclerosis including hippocampal sclerosis in MRI and the history of febrile convulsion tended to seizure free, but only at the significance level of 7 and 13 percents, respectively. ***Conclusions*** : We conclude some intractable TLE patients, especially those who have a lesion or a hippocampal sclerosis in MRI and the history of febrile convulsion, do not require invasive intracranial EEG monitoring.

KEY WORDS : Anterior temporal lobectomy · Non-invasive presurgical evaluation · Predictors of outcome.