대 한 소 아 신 경 학 회 지
Vol. 18, No. 1, May, 2010

Surgical Outcomes and Prognostic Factors after Epilepsy Surgery in Children with Extratemporal Lobe Epilepsy

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= Abstract =

Purpose : In this study, we reviewed surgical outcomes in children with extratemporal lobe epilepsy in our institution and suggested prognostic factors from these results.

Methods : We retrospectively analyzed the records of 59 patients(males n=35, females n=24; mean age of 10 years, mean age of seizure onset of 3 years, mean age of epilepsy surgery of 8 years) who received extratemporal lobe surgery between October 2003 to May 2008. Every patients were performed preoperative evaluation to determine the anatomical location of the ictal onset zone employing video electroencephalography(EEG) monitoring, intraoperative electrocorticography, intracranial EEG monitoring and neuroimagings such as Magnetic Resonance Imaging (MRI), positron emission tomography, interictal/ictal single photon emission computed tomography. Developmental test was taken at pre- and post-operation.

Results : Postoperative outcome as defined by Engel's classification were as follows; class I in 42(71.2%), II in 6(10.2%), III in 4(6.8%), and IV in 7(11.9%) patients. We considered six favorable prognostic factors from our data; age at operation, matching accuracy of video-EEG monitoring results, presence of a structural lesion on MRI, using specialized neuromodalities, involvement of lobe at surgery, and nature of the epileptogenic lesion. We also focused on unfavorable prognostic factors; no structural lesion on MRI, low grade of surgical pathology, postoperative epileptiform discharges on EEG.

Conclusion : Early surgical intervention in pediatric patients with medically refractory seizure who possess focal epileptogenic foci of extratemporal lobe origin has been an effective and safe treatment.

Key Words : Epilepsy, Surgery, Child, Outcome assessment, Prognosis

Introduction

As new diagnostic modalities such as video electroencephalography(EEG) monito-

접수 : 2010년 3월 30일, 승인 : 2010년 5월 6일
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ring in 1980s, and positron emission tomography(PET), single photon emission computed tomography(SPECT) in 1990s have become attainable, epilepsy surgery is considered a treatment option for patients with intractable epilepsy. In carefully selected children, intractable seizure may be eliminated or greatly reduced by cortical resection. Several studies have demonstrated postoperative effectiveness and complication in adult epilepsy patients, and also were reviewed about temporal lobectomy in children and adult[1-3]. However there were few studies in extratemporal lobe resection of children in intractable epilepsy. Extratemporal lobe surgery compared with temporal lobe surgery has been shown to be less successful in seizure-free and may be associated with an increased neurological morbidity[1, 2].

The reason less successful seizure-free rate in resective surgery of extratemporal lobe epilepsy compared with that of temporal lobe epilepsy is that difficulty in location and impossible to remove large portions of the frontal, parietal, or occipital lobes without sequelae. But less aggressive resection in combination with different pathology(focal cortical dysplasia) often results in less successful surgical outcome and a higher relapse rate. A high index of suspicion and directed imaging based on clinical and electroencephalographic investigation is necessary in this group of patients.

We evaluated the efficacy, safety, comprehensive outcome of extratemporal lobectomy for the treatment of intractable epilepsy in children with epileptogenic foci of extratemporal origin.

Methods

1. Patient selection

A retrospective analysis was conducted of 59 patients who received extratemporal lobe surgery between October 2003 to April 2008 at the Yonsei University Severance Hospital. The age at operation ranged from 5 months to 22 years. All patients were chosen by using selection criteria for epilepsy surgery; frequent seizures interfering with the patient's life, intractable to medical treatment more than 2 drugs or diet therapy, originate from extratemporal focus in the brain, and no significant deficit to the patients after operation.

2. Electrophysiologic and Neuroimaging techniques

We reviewed preoperative and postoperative clinical evaluation, seizure profiles, EEG, magnetic resonance imaging(MRI), neuropsychologic testing, video-EEG monitoring, intracranial electrode monitoring, functional imagings including PET and interictal/ictal SPECT, and also we performed special PET analyzer by Dr. Joon Soo Lee and subtraction ictal SPECT coregistered with MRI (SISCOM) if needed. Preoperative evaluation was performed to localize the epileptogenic zone for resection.

All video EEG monitoring were performed in electroencephalographic monitoring unit (EMU) before the epilepsy surgery to focus the epileptogenic foci. The international 10-20 system was used for tracing.

We also used brain MRI in all patients,

including seizure-specialized sequences such as conventional spin-echo T1-weighted sagittal, T2-weighted axial, flair axial, oblique coronal, and flair oblique coronal sequences, as well as with ultrafast gradient echo T1-weighted 3D coronal sequences.

PET images were acquired using a GE ADAVANCE PET Scanner(GE, Milwaukee, WI, USA) in 3D mode. The transaxial resolution of the system was 5.2 mm FWHM (full-width-half maximum) at the center of FOV(field of view). Approximately 5 mCi of 18F-FDG was injected intravenously after 6 h of fasting, and patients were either sedated if uncooperative, or if cooperative, asked to lie still with their eyes closed in a quiet, dimly lit room during injection and following 40 min. The emission scan started at 40 min after injection and lasted 15 min, and an 8 min transmission scan was subsequently acquired for the purpose of attention correction. EEG was performed during FDG uptake using portable EEG with an international 10-20 system, and its tracing was later examined for presence of possible ictal discharges during acquisition of the images.

For acquisition of SISCOM images, patients underwent ictal and interictal SPECT studies at an interval of less than 1 week. As a radiotracer, approximately 740-925 MBq of technetium-99m ethyl cysteinate dimer was administered intravenously. Continuous video EEG monitoring was performed at the EMU and the radiotracer was intravenously injected during the ictal period for acquisition of ictal SPECT. Seizure onset was defined as the time of earliest indication of auras or the beginning of the rhythmic ictal discharges on EEG. Seizure termination was defined as the time when ictal movement ceased or the time of termination of the ictal discharge. Brain images were obtained using a brain-dedicated annular crystal gamma camera(Digital Scintigraphic Incorporated, Waltham, MA) equipped with low-energy, high-resolution parallel-hole collimators. The full-width at half maximum of a high-resolution collimator is typically 7.5 mm at the center of rotation and 5.8 mm at the peripheral regions 9 cm from the center of rotation. SPECT studies were acquired for 20 min in a 128×128 matrix with 38 angular increments. Transaxial images were obtained by the filtered back-projection method using a Butterworth filter(cutoff frequency of 1.1 cycles/cm, order no. 10). Attenuation correction was performed by Chang's method after correcting for scatter by the dual-energy window method, and coronal and sagittal images were generated. After acquisition of ictal and interictal SPECT images, 32 transaxial slices of both ictal and interictal scans were reconstructed and each paired image was generated with the same orientation and level for the construction of subtraction images. Paired ictal and interictal transaxial images were normalized to the total counts, and interictal images were subtracted from ictal images on a CeraSPET workstation(Digital Scintigraphic Incorporated, Waltham, MA). Subtraction images were generated without applying a threshold and were qualitatively evaluated. Seizure localization was determined when pixels on ictal scans showed higher values than on interictal scans in corresponding regions. Epileptic focus was defined as the area that resulted in seizure ablation upon resection.

3. Neuropsychological evaluation

We performed global developmental assessment in all children who received extratemporal lobectomy to screen about focal or global brain dysfunction before epilepsy surgery. Bayley scale was performed in children under the 3 years old, and using K-WPPSI between three to 9 years old, K-WISC between nine to 14 years, and K-WAIS between over 15 years old according to age. The neuropsychological battery also provides baseline data for comparison with postoperative data and conjecture for brain plasticity.

4. Surgical procedure

All patient received resective surgery involving extratemporal lobe, and 17 of 59 (28.8%) patients already got the epilepsy surgery including 7 corpus callostomy, 7 hemispherec(o)tomy, or 3 extratemporal lobectomy before.

A two-stage surgery was planned in all patients. Grid or strip surface electrodes were implanted on the cortical surface, covering the presumed epileptogenic area in first craniotomy. Then patient returned to the epilepsy monitoring unit for video-EEG monitoring. After the epileptogenic zone and the adjacent functional cortex were identified and mapped, surgery for a definitive resection of extratemporal lobe origin was performed with removal of electrode.

5. Intraoperative EEG

Intraoperative EEG was used in all cases to guide the extent of resection. Invasive procedures with chronically implanted subdural or depth electrodes were carried out in all patients to obtain additional information about the ictal focus or as a mapping procedure in eloquent areas, whenever non-invasive recordings revealed inconclusive results. Adjacent functional cortex was mapped was performed and we also had done motor stimulation, somatosensory evoked potential, visual evoked potential and language stimulation.

6. Histopathological studies

Pathologic results were classified into four categories, Malformation of cortical developments(MCD), benign brain tumor, gliosis, and normal brain tissue. The diagnosis and classification of MCD were subdivided into cortical dysplasia and microdysgenesis, and benign brain tumors were subdivided into dysembryoplastic neuroepithelial tumor (DNET) and ganglioglioma.

7. Postoperative evaluation

Seizure outcome was classified according to the classification of Engel. All patients had a computerized tomography(CT) scan on postoperative day 1. After discharge, patients were followed in the pediatric epilepsy clinic at 1 and 3 and 6 and 12 months after surgery and yearly thereafter. Follow up MRI, EEC, and neuropsychological evaluation also were performed in all patients after extratemporal surgery.

8. Complications were assessed before hospital discharge and at the last clinic visit

Postoperative antiepileptic drug(AED) treatment and socioeconomic outcome were evaluated with seizure outcome.

9. Statistical analysis

Clinical and surgical variables were analyzed using commercially available statistical program SPSS version 12.0. The kai test, the Fisher exact test and the rank sum test were sued for univariate analysis. Time-to-event analysis was performed using Kaplan-Meier curves and Cox regression models to evaluate the risk factors associated with outcomes.

Results

1. Clinical characteristics

Between 2003 and 2008, 59 children(35 boys and 24 girls) had surgery for extratemporal lobe epilepsy. The clinical features in 59 patients after extratemporal lobe resection are listed in Table 1. The mean age was 10 years(range 1-23 years) and mean age of onset of first seizure was 3 years (range at birth-13 years). The average time interval between the onset of seizures and surgery(duration of seizure) was 5 years (range 3 months-14 years) and mean age of extratemporal lobectomy was 8 years(range 5 months-22 years). Approximately one third of our patients had seizure duration of 3 years or longer. The mean follow-up duration after operation was 26 months. The mean duration between first grid insertion and second resective surgery was 6 days. The extratemporal operations included 37 (62.7%) single lobar resection, and as well as 22(37.3%) multilobar resections except hemisphreotomy. Our epilepsy surgery is involved 47 frontal lobe resection, 6 parietal lobe resection, 12 occipital lobe resection, 16 temporal lobe resection, and 6 insular resection. A hypothalamic hamartoma was removed from 10 patients with gelastic epilepsy. The data of operation method are mentioned in Table 2.

Table 1. Patients' Profiles

	Total(%)
Male : Female	35:24 (59.3:40.7)
Mean age (yr, mean±SD)	10.71±5.51
Mean age of seizure onset (yr, mean±SD)	3.06±3.71
Mean age of operation (yr, mean±SD)	8.48±5.30
Mean follow up duration after operation(yr, mean±SD)	2.19±1.17
Diagnosis	
Infantile spasm	10(16.9)
Lennox-Gastaut Syndrome	20(33.9)
Partial seizure	29(49.2)
Mean duration between grid insertion and resection (days, mean±SD)	6.23±2.46

2. Electroencephalograms

Every patient required preoperative video-

Table 2. Operation Method and Engel's Class I

	Number	Engel's class I (%)
Single lobe involved	37	28(76)
Multilobar involved	22	14(64)
Two lobe involve	16	10(63)
Three lobe involve	6	4(67)
Before operation	17	9(53)
Corpus callosotomy	7	4(57)
Hemisphrec(o)tomy	7	3(43)
Extratemporal cortisectomy	3	2(67)
Hypothalamic hamartoma	10	4(40)

EEG monitoring and invasive recording with intracranial electrodes to delineate the epileptogenic zone. The interictal EEG results were abnormal discharges in all patients with extratemporal lobe epilepsy, which included focal slowing, focal epileptic discharge, and slow & disorganized. 23 patients(39%) exhibited localized foci upon preoperative video EEG monitoring in extratemporal lobe epilepsy.

3. Neuroimaging techniques

Every patients also was received MRI to find out abnormal lesions. In the group of extratemporal lobe epilepsy, results for 40 of 59 patients were reported as abnormal, and we also found 23 patients in focal lesions on MRI without localization in EEG from our study. In the extratemporal group, the pathology missed by neuroimaging included focal cortical dysplasia and low-grad brain tumors was demonstrated by new neuroimaging modalities including PET and SPECT, and 19 patients with normal MRI findings manifested a lesion with PET or SPECT. 58 patients had got received PET. PET results were reported as abnormal in 54 patients and normal in 4 patients and 16 patients showed localization of the lesion in PET with normal MRI findings. The 49 of 55 patients with taking interictal SPECT showed localization by SPECT, and 16 of 49 patients had localized lesion by SPECT in spite of normal MRI findings. Detailed localization of neuroimaging comparing with Engel's class is summarized in Table 3.

Table 3. Localization of Neurologic Imaging and Engel's Class

	Engel's class I-II	Engel's class III-IV
MRI(n=40)	33 (82.5%)	7 (17.5%)
PET(n=54)	43 (79.6%)	11 (20.4%)
SPECT		
Interictal(n=49)	41 (83.7%)	8 (16.3%)
Ictal(n=35)	30 (85.7%)	5 (14.3%)

4. Surgical outcome

Surgical outcome with extratemporal lobe epilepsy is basically determined by the capability to improve seizure and to avoid imposing new neurological deficits after operation. Postoperative outcome as defined by Engel's classification were as follows; class I in 42(71.2%), II in 6(10.2%), III in 4(6.8%), and IV in 7(11.9%) patients.

5. Pathological subgroups and location of resection

Most common pathology from resected tissues was cortical dysplasia and microdysgenesis. Abnormal pathology was observed in 45 patients, whereas 14 patients were reported as manifesting normal or nonspecific gliosis. The pathology at operation for extratemporal lobe epilepsy included brain tumor (6), focal cortical dysplasia(39), gliosis(2), and normal(12). Surgical outcomes are generally favorable in patients with tumors. Our study showed similar seizure free rate between tumors and malformation of cortical development.; 83.3%(5/6) seizure-free in patients with tumors compared to 76.9%(30/39) seizure-free in patients with malformation of cortical development. But poor seizure-free rate(50%) described in patients

without pathological abnormalities. Pathologic data and postoperative seizure outcomes are summarized in Table 4. The pathologic results of brain tumors showed characteristics of low grade tumors including 3 gangliogliomas, and 3 dysembryoplastic neuroepithelial tumors. For patients with 24 cortical dysplasia and 15 microdysgenesis, 76.9%(30/39) were seizure-free at last follow-up. And for patients with normal pathologies, only 50%(6/12) were seizure-free and 50%(1/2) were seizure-free with diffuse subpial gliosis. These results can be explained decision of the more exact epileptogenic zone because of multiple preoperative evaluation and intracranial electrode monitoring.

6. Antiepileptic drugs

In 22%(13/59) of the patients AEDs were successfully withdrawn and 36.9%(17/46) had decreased their AEDs without seizure. There were some articles about important implications for patient counseling and postoperative discontinuation of anticonvulsant medications. Seizure-free with the reduction or discontinuation of the AEDs appears to have an excellent effect on cognitive function after extratemporal surgery. More studies involving standardized postoperative neuropsychological testing and quality of life assessment will help address these issues.

7. Complications

There was no postoperative mortality. Postsurgical complications were noted 22% in 13 cases without lasting sequelae. In our study, 6 patients showed acute postoperative seizure in one week and these patients also had poor postoperative seizure outcome. These results showed postoperative seizures usually correlated with poor seizure outcomes. There were 5 complications with epidural hematoma associated with the invasive monitoring during insertion of subdural electrodes. A temporary mild hemiparesis or hemihypesthesia after extratemporal surgery was seen in 11 patients after the resection of near motor cortex and a superior quadrant field cut was detected in 2 patients after occipital lobe surgery. Detailed of postoperative complications are summarized in Table 5.

Table 4. Pathologic Data and Engel's Class

	Seizure free	75-99% seizure reduction	50-74% seizure reduction	<50% seizure reduction	Total number
Malformation of cortical development	30	4	3	2	39
Microdysgenesis	10	2	2	1	15
Cortical dysplasia	20	2	1	1	24
Brain tumor	5	0	0	1	6
Ganglioglioma	3	0	0	0	3
DNET	2	0	0	1	3
Gliosis	1	1	0	0	2
No abnormal findings	6	1	1	4	12
Total No	42	6	4	7	59

Abbreviations : DNET; dysembryoplastic neuroepithelial tumor

8. Developmental outcome

Improvements of cognition were found in 91.5%(54/59) patients. 72.9%(43/59) patients were reported significant improvement in cognitive function and behavior during the first year after surgery, showing Table 6.

Discussion

This is the study to analyze the seizure outcome in children with intractable epilepsy originated from extratemporal lesion. Thirty percentages of children with epilepsy continue to have seizures despite of the best medical and diet therapy. For these patients with intractable epilepsy, surgery can be an effective treatment. Cohen-Gadol et al.[3] reported 399 patients who underwent epilepsy surgery at Mayo Clinic in Rochester, Minnesota, between 1988 and 1996. 372(93%) patients underwent temporal and 27(7%) had extratemporal resection of their epileptogenic focus. The rate of Class I outcomes remained 72% for 73 patients with more than 10 years of follow up. Factors predictive of poor outcome from surgery were normal pathological findings in resected tissue(P=0.038), male sex(P=0.035), previous surgery(P<0.001), and an extratemporal origin of seizures(P<0.001). Although epilepsy surgery for adults with intractable epilepsy has been an accepted method of treatment, relatively lower rate in the operation in children. So it is very important to assess the outcome and complication of epilepsy surgery in children, which is an irreversible intervention for the developing brain. The epileptogenic zone may be extended beyond the pathological cortical area found on neuroimaging. Invasive EEG or electrocorticography can help to define the resection border. We established excellent seizure control after surgical treatment for extratemporal lobe epilepsy: 71.2% (42/59) of patients were seizure free. This result showed similar seizure outcome after extratemporal resection compared with tem-

Table 5. Surgical Procedures and Complication

Surgical procedure/ complication	Number of patients (n=59)
Epidural hematoma	5(8.4%)
Early complication	18(30.5%)
Acute postop. Seizure	6
Fever more than 3 days	1
Temporary hemiplegia	7
Visual disturbance	3
Aphagia	1
Late complication	13(22%)
Mild temporary hemiplegia	11
Visual disturbance	2

Table 6. Development Outcome and Engel's Classification

	Seizure free	75-99% seizure reduction	50-74% seizure reduction	<50% seizure reduction	Total No.
Marked improvement	37	5	0	1	43
Mild improvement	5	1	4	1	11
No change	0	0	0	2	2
Stagnation	0	0	0	3	3
Total No	42	6	4	7	59

poral resection in children with intractable epilepsy.

More successful seizure-free outcome after surgery for extratemporal lobe epilepsy in our study compared with other studies depends on many factors.

First, plasticity is very important in infancy and early childhood. If surgery were to be done lately, patients had no chance to improve their brain development and were associated with highly permanent psychologic, behavioral, and educational problems[4]. In the course of our research, we have compared the seizure-free outcome by measuring the seizure duration before surgery and during surgery. The rationale for early surgical intervention is to stop the seizure and to prevent further brain injury from either the underlying abnormality causing seizures, seizures themselves, or the AEDs[5]. Centeno et al.[6] recommended early surgery for children with intractable epilepsy because the immature brain is more plastic than when mature, the recovery of functions after surgery is greater in children than in adults. Recently, there has been considerable interest in the early surgical treatment of childhood epilepsy as the potential adverse effect of repeated seizures on the developing brain[7]. Especially concept of brain plasticity, ongoing epilptic seizures appear to have a devastating effect on the developing brain, which appears to be reversible upon gaining seizure control by early surgery. The cessation of seizures, coupled with the decrease or discontinuation of the antiepileptic drug[8], appears to have a powerful effect on cognitive outcome. Previous studies have demonstrated that many patients experience improvement in cognitive and psychosocial functions following surgery. Asarnow et al.[9] assessed about two-year postsurgical developmental outcomes in 24 children with infantile spasms who underwent resective surgery. There was a significant increase in developmental level at 2 years postsurgery compared with presurgical levels. Sinclair et al.[10] also reviewed seizure-free and developmental outcome in children undergoing extratemporal resection for epilepsy[11-13]. Many families reported improvement in behavior and psychosocial function after surgery. Also Gulliam et al.[7] reported about improvement of cognition after epilepsy surgery in children.

Secondly, observing the matching accuracy of video-EEG monitoring results, concordance of video-EEG was correlated with seizure-free outcome.

Third of all was the presence of a structural lesion on MRI. The presence of lesions on MRI is a favorable prognosis indicator for seizure outcome in patients with extratemporal lobcetomy[14]. In many research, the outcome of surgery were found to be successful in the presence of opinions of abnormal findings in brain MRI. Elsharkawy et al.[15] investigated seizure outcome and prognostic factors after frontal lobe epilepsy surgery in 97 adult patients who underwent resective surgery for intractable partial epilepsy between 1991 and 2005. Engel Class I outcome was found to be 54.6% at 6 months, 49.5% at 2 years, 47% at 5 years and 41.9% at 10 years. Factors predictive of good long-term outcome were the presence of a well-circumscribed lesion in preoperative MRI, surgery before age of 30 and short

epilepsy duration prior to surgery.

Fourthly, case of observing epileptogenic foci, using specifying neuromadalities such as PET and SPECT, increased the seizure-free outcomes after extratemporal surgery. Kurian et al.[16] also reported 78% seizure-free outcome in children and adolescents with intractable epilepsy. The seizure-free outcome after extratemporal surgery in this study was significantly higher if localization with more imaging modalities including MRI, PET and SPECT were concordant with respect to the resected brain area. Preoperative PET examination provided better localizing information in patients with extratemporal epilepsy and/or dysplastic lesions[17], whereas SPECT was found to be superior to PET in patients with temporal lobe epilepsy and/or tumors. Recent developments in neuroradiology, computer software, and the neuronavigation systems allow more frequent identification and better definition of a lesion in children who suffer from extratemporal epileptic focus. The development of structural and functional neuroimaging techniques allows the diagnostic of lesions previously not seen. The better knowledge of some pathology also contributes to increase the number of centers performing epilepsy surgeries in pediatric groups. It is apparent from these and other recent reports that the use of modern techniques has effected a considerable improvement in seizure relief for children and adults with extratemporal lobe epilepsy. However, patients without lesions present on neuroimaging studies remain a challenge. It is likely that other noninvasive localization techniques such as ictal/interictal SPECT related technologies will offer the possibility of effective surgery to those patients[18]. It provides great hope to children with medically intractable epilepsy.

Fifthly, we could find correlation with seizure-free outcome and involvement of lobe at surgery. The location of the lesion(temporal compared with extratemporal) has often been implicated as a factor with potential influence on the outcome of epilepsy surgery. Single lobe resection is more successful seizure-free outcome than multilobar resection more than two lobes in our study. This result showed that extent of lobar resection is correlated with seizure-free outcome.

Finally nature of the epileptogenic lesion may significantly influence surgical outcome. Cortical dysgenesis has been associated with the worst surgical outcomes due to more extensive than the visible lesion in cortical dysplasia and involvement of multilobe. Kan et al.[1] reported 74%(43/58) of all patients who underwent epilepsy surgery were seizure-free, and mentioned about seizure-free rates for specific conditions were 88%(14/16) for mesial temporal sclerosis, 33%(1/3) for dual pathology, 81%(13/16) for tumor, 62%(8/13) for cortical dysplasia, and 80%(4/5) for cavernous malformation at last follow-up.

The pathology in the extratemporal group was much different, with focal cortical dysplasia being the predominant pathology observed at surgery, which likely explains, as mentioned previously, the lower success rate and higher relapse rate in the extratempral group. Brain tumors, malformation of cortical development were also observed. However, not much difference was found in seizure-free outcome of tumor and cortical

dysplasia. But case of extratemporal lobe epilepsy with normal pathologic finding still carries low seizure-free outcome. Paolicchi et al.[19] reported seizure outcome of 75 children younger than 12 years of age who undergoing focal resections for medically intractable partial epilepsy. This study showed that complete excision of epileptogenic zone was the only significant predictor of good seizure-free outcome: 92% of patients who underwent complete resection of the epileptogenic zone achieving good outcome compared with 50% of patients who had incomplete resections. Authors pronounced complete resection of the lesion and the electrographically abnormal region was the main determinant of outcome after focal resections. If the epileptogenic zone could be identified and completely resected surgically, the results were good even with long-term follow-up, regardless of how long the children manifested epilepsy. Needless to say, a thorough testing to check epileptic foci is crucial prior to an eradication of complete epileptogenic zone and this is the most important good prognostic factor. Identified lesions on MRI and foreign tissue pathology are favorable prognosis indicator for seizure outcome in patients undergoing extratemporal lobectomy.

Patients with unfavorable seizure outcome shared common clinical features. First, MR imaging demonstrated no structural abnormality. Second, surgical pathology was usually associated with a development lesion. Developmental lesions are poorly circumscribed and are related to widespread epileptogenic zone. Third, postoperative EEG confirmed widespread disease such as dual disease, and multilobar seizure. As a result, less favorable results may be related to the inclusion of patients who underwent multilobar resection in the extratemporal resection.

High overall seizure control rate can be achieved after surgery for focal epilepsy in children when decision for surgery is based on a good correlation between clinical, electrophysiological, and neuroradiological data. Interictal and ictal video-EEG, high-resolution MRI, and neuropsychological testing are essential for patient selection for epilepsy surgery. Functional imaging such as PET and SPECT can help with lateralization and localization when the clinical picture is less clear. Invasive monitoring also offered the advantage of cortical stimulation as a means to define eloquent cortex and was useful for lesions adjacent to functional cortex. Intraopertive EEG was used in all cased and was valuable in guiding the extent of resection. Undoubtedly extratemporal epilepsy surgery in children is already a good option of treatment in a very large group of well-selected pediatric patients. The ultimate goal of epilepsy surgery is to remove the epileptogenic zones or to interrupt its connections with the surrounding brain without creating new deficits or worsening an existing one.

Our study supports the conclusion that epilepsy surgery for intractable extratemporal lobe epilepsy in children can be efficacious and safe. The seizure outcome of extratemporal lobectomy in children is related to the region of surgery and correlation of presurgical evaluation using multimodality. The most important evaluations of extratemporal lobe epilepsy in children are high resolution MRI and ictal EEG. If no structural

abnormality is identified, additional noninvasive testing(PET, ictal/interictal SPECT), additional neuroradiologic analysis(3D PET analysis, SPM, SISCOM), and intracranial electrode implantation should be considered. Furthermore more comprehensive multidisciplinary team at an established tertiary care epilepsy center is required.

한 글 요 약

측두엽외 간질 소아 환자의 간질 수술 후 결과 및 예후 인자

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목 적: 본 연구는 난치성 소아 간질 환자에서 측두엽외절제술 시행한 후, 수술 결과와 예후 인자를 알아보고자 한다.

방 법: 연세대학교 신촌 세브란스 병원에서 2003년 10월부터 2008년 5월까지 측두엽외절제술을 시행받은 환자의 의료 기록을 후향적으로 조사하였다. 모든 환자에서 수술 전 비디오 뇌파 검사, 뇌영상학적 검사를 시행하였으며, 수술 전후의 발달 검사가 시행되었다. 수술 후 간질유발부위의 조직학적검사가 시행되었으며, 수술 합병증에 대해서 확인하였다.

결 과: 총 59명의 소아 환자를 대상으로 하였으며, 남자 35명, 여자 24명이었고, 평균 나이는 10.71±5.51세였다. 간질 발작 시기는 3.06±3.71세, 측두엽외절제술은 8.48±5.30세에 시행하였으며, 수술 후 평균 2.19±1.17년의 기간을 관찰하였다. 간질은 영아연축 10명, 레녹스-가스토 증후군 20명, 그리고 부분간질이 29명이었다. 수술적 방법은 한 개의 엽만 수술한 경우가 37명으로 가장 많았으며, 두개이상의 엽을 동시에 절제한 경우가 22명이었다. 시상하부과오종 절제술은 10명의 환자에서 시행하였다. 수술적 결과는 Engel's 분류를 기준으로 하였으며, 수술 전 시행한 뇌영상검사상 MRI에서 병변이 확인된 경우에 수술 후 class I-II의 경우는 33(82.5%) 였고, PET에서 병변이 확인된 경우는 43(79.6%) 의 경우 class I-II 의 결과를 보였다. 수술 중 합병증은 경막외 출혈이 5명이었고, 수술 후 초기 합병증은 18명, 후기 합병증은 13명으로, 후기 합병증에는 일시적 편측마비가 11명, 시야장애가 2명이었다. 발달검사결과 수술 후 간질발작이 나타나지 않는 환자에서 호전은 더욱 뚜렷했다.

결 론: 소아 간질 환자에서 빠른 간질치료는 삶의 질 향상에 큰 영향을 줄 수 있다. 특히 난치성 간질 환자에서 국소간질유발부위가 확인된 경우에는 수술적 치료를 통한 간질 조절 및 인지발달의 호전까지 기대해 볼 수 있다. 본원에서 5년간의 측두엽외 절제술을 시행한 소아간질 환자의 결과를 확인한 결과 간질 조절은 42(71%)명으로 높은 결과가 나왔다. 이는 난치성 소아 간질 환자 중에서 수술전 비디오뇌파와 뇌 영상 검사를 통해 측두엽외 국소간질유발부위가 확인된 경우에 측두엽외절제술은 효과적이고 안전한 치료 방법임을 보여준다.

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