



# Epilepsy Surgery in Children with Lesional Partial Epilepsies

## *Lezyonel Parsiyel Epilepsili Çocuklarda Epilepsi Cerrahisi*

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### ABSTRACT

**AIM:** Surgery for epilepsy is a significant treatment alternative with favorable outcomes in the pediatric age group. In this study we present the surgical outcomes of pediatric population referred to our center.

**MATERIAL and METHODS:** The clinical data of 126 patients ( $\leq 18$  years) with lesional partial epilepsies operated in our center between 1995-2011 were evaluated retrospectively. Parameters investigated were gender, age at seizure onset, duration of epilepsy, etiology, type and location of operation and outcome. Seizure outcome was classified according to Engel's classification.

**RESULTS:** The study group consisted of 70 males (55,6%) and 56 females (44,4%). The most common etiology was malformation of cortical development followed by tumors and hippocampal sclerosis. Overall 73,8% of patients had Engel I, 13,5% Engel II and 11,9% Engel III+IV postoperative seizure outcome.

**CONCLUSION:** The results of our pediatric patients who underwent surgery were similar to previous reports in the literature. The seriousness of the clinical picture should tempt physicians to refer the patients as soon as possible to avoid long term complications like epileptic encephalopathies and the side effects of antiepileptic drugs during the development of the young brains.

**KEYWORDS:** Pediatric epilepsy, Epilepsy surgery, Seizure

### ÖZ

**AMAÇ:** Pediatrik hastalarda epilepsi cerrahisi olumlu sonuçlarıyla önemli bir tedavi seçeneğini oluşturmaktadır. Çalışmada, merkezimizde epilepsi cerrahisi uygulanan pediatrik hastaların cerrahi sonuçlarını sunmayı amaçladık.

**YÖNTEM ve GEREÇLER:** 1995-2011 yılları arasında merkezimizde lezyonel parsiyel epilepsi tanısıyla opere edilen 126 (yaş  $\leq 18$  yıl) hastanın klinik bilgileri retrospektif olarak gözden geçirildi. Değerlendirilen parametreler cinsiyet, nöbet başlangıç yaşı, epilepsi süresi, etiyoloji, ameliyat tipi ve lokalizasyonu ve sonlanımdan oluşuyordu. Nöbet sonlanımları Engel sınıflamasına göre sınıflandı.

**BULGULAR:** Çalışma grubu 70 (%55,6) erkek ve 56 (%44,4) kızdan oluşmaktaydı. En sık etiyoloji kortikal gelişimsel malformasyonlar iken bunu tümörler ve hipokampal skleroz takip etmekteydi. Tüm hastaların %73,8'i Engel I, %13,5'i Engel II ve %11,9'u Engel III ve IV postoperatif cerrahi sonlanım göstermekteydi.

**SONUÇ:** Cerrahi uygulanan pediatrik hastalarımızın sonuçları literatürdeki çalışmalar ile benzerlik gösterdi. Klinik tablonun durumuna göre klinisyenlerin hastaları en kısa zamanda cerrahiye yönlendirmeleri epileptik ensefalopatiler gibi uzun dönem komplikasyonlardan ve ilaç yan etkilerinden kaçınmak için önem taşımaktadır.

**ANAHTAR SÖZCÜKLER:** Pediatrik epilepsi, Epilepsi cerrahisi, Nöbet

### INTRODUCTION

Surgery for epilepsy is a significant treatment alternative with favorable outcomes in the pediatric age group (6). Surgery may be considered if medical intractability is the case or if there is a localized epileptogenic region (12). Etiologic factors for epilepsy surgery differs in children compared with the adults. While the majority of adult epilepsy surgery includes hippocampal sclerosis, it accounts for extratemporal lesions such as malformations of cortical development, tumors or sequel gliosis in children (6, 10, 12, 13). Consequently, extratem-

poral/multilobar resections and hemispherectomies are more frequent in this age group contrary to adults (12). Besides preventing the seizures; epilepsy surgery in childhood aims to avoid long term complications like epileptic encephalopathies and the side effects of antiepileptic drugs during the development of the young brains; thus, to avoid possible undesirable neuropsychological outcomes. Therefore it seems important to refer proper candidates for presurgical evaluation without delay. In this study we present and discuss the surgical outcomes of pediatric population referred to our center.

## MATERIAL and METHODS

The clinical data of 126 patients ( $\leq 18$  years) with lesional partial epilepsies operated in our center between 1995-2011 were evaluated retrospectively. Patients who had vagal nerve stimulation were not included in the study group. All patients had ictal and interictal video EEG monitoring, cranial MRI for presurgical evaluation. SPECT, PET and fMRI were performed when needed. Neuropsychological testings could not be performed to all patients thus not evaluated in this study. Patients are divided into four age group for further analyses as 0-1, 2-6, 7-12, 13-18 years additionally. Parameters investigated were gender, age at seizure onset, duration of epilepsy, etiology, type and location of operation and outcome. Patients who were followed up at least for one year following surgery were included in the study group. Seizure outcome was classified according to Engel's classification (4).

## RESULTS

The study group consisted of 70 males (55.6%) and 56 females (44.4%). Mean age at surgery was  $11.5 \pm 4.8$ , at seizure onset was  $5.1 \pm 4.3$  years. Out of 126 patients 45.2% had daily seizures, 34.9% had seizures 1-6/week, 14.3% had 1-4/month and 5.6% had less than a seizure for a month. At the time of the surgery 45.2% of patients was on three or more, 38.1% was on two and 16.7% was on one type of antiepileptic drug. Mean duration of epilepsy from diagnosis to surgery was  $6.4 \pm 4.6$  years the highest group being 13-18 yr age group with a mean of 8.5 years. Mean follow up was  $5.8 \pm 3.7$  years (1-17). The data according to age groups is summarized at Table I.

Overall the most common etiology was malformations of cortical development (MCD) dominated by focal cortical dysplasias type I (11 patients) and type II (28 patients) additionally a few patients with polymicrogyria, pachygyria, schizencephaly; followed by tumors and hippocampal sclerosis (HS). The most common etiology for 13-18 yr age group was hippocampal sclerosis, whereas it was MCD for 7-12 yr and tumors for 2-6 yr age group (Table I). Most common tumor was DNET (39.3%) followed by gangliogliomas (35.7%) where oligodendrogliomas constituted 7.1% of the them.

Thirty-two patients underwent intracranial recordings before surgery (14 subdural, 13 depth and 5 both).

Most of the patients had temporal (46%), remaining had extratemporal and multilobar resections (42.9%), and a minority underwent hemispherectomy (4.8%) and callosotomy (5.6%). While the majority of temporal resections includes patient over 12, extratemporal and multilobar resections and hemispherectomies were more frequently performed for patients under 12. Overall 73.8% of patients had Engel I, 13.5% Engel II and 11.9% Engel III+IV postoperative seizure outcome. One patient died at 3th month postoperatively possibly due to SUDEP. Eight patients had different degrees of hemiparesis as surgical complication.

Overall 73.8% of patients had Engel I outcome. This incidence was lower for MCD (65.1%). Patients with HS had better results where majority achieved seizure freedom (87.5%) without any patients in class III or IV. Contrary to these results, gliotic lesions which were either vascular, traumatic or due to an undetermined cause showed a relatively high percentage of unfavorable outcome (15.4% in class III and IV) comparing with HS and tumors.

When we compare outcomes according to ages, older age groups had higher seizure freedom rates than patients under 7 years. This may be due to difference of the etiologies.

Outcome according to age, pathology and surgery is summarized at Table II.

## DISCUSSION

The aim of our study was to report surgical results of pediatric epilepsy patients who underwent surgery in our center.

In our study group the most common etiology was MCD as previously reported elsewhere (3, 6, 10, 12). Other most common etiologies were tumors, HS and gliosis. MCD and tumors predominate under 12 years but in patients over 12 years HS is more commonly observed, likewise in other series (10). Five patients had both MCD and HS in pathological specimens which are classified as dual pathology. In 4 of them both lesions were in the same temporal lobe, 3 of them having focal cortical dysplasia (FCD) type I and II B and remained seizure free after surgery where the 4th with a large porencephalic cavity extending from occipital to temporal lobe has still seizures. In the fifth patient the pathologies were localized to two different lobes at the right side with cortical dysplasia type IIB at the frontal lobe in addition to HS. This patient underwent both frontal lesionectomy and anterior temporal resection in the same intervention after being evaluated with subdural electrodes which revealed early involvement of cortical dysplasia during the ictal episode and concluded with complete seizure freedom for 8 years.

The lower incidence of complete seizure freedom in patients with MCD which is consistent with previous reports may be related to incomplete resection of the epileptogenic zone as proposed in previous reports (7). The lesions at temporal lobe have a tendency for better seizure freedom rates. A recent meta analysis reported that, in addition to a temporal lobe location, partial seizures, detection with MRI and a Type II histopathology, complete resection of the anatomical or electrographic abnormality were the most important predictors of overall seizure freedom of FCD (9).

Resection of tumors have better outcomes than of MCD's. The tumor location was more common in the temporal lobes compared to extratemporal and the seizure freedom rate as high as 85.1% similar to previous reports (5, 10).

When outcome results were analysed according to the localization temporal lobe resections were found to be the most common which was performed for HS, followed by MCD and tumoral lesions. The second most commonly encountered

**Table I:** Age at Onset, Surgery, Duration and Etiology according to Age Groups

Age (years)	13-18 yr	7-12 yr	2-6 yr	0-1 yr	Total
Number	63	43	15	5	126
Age at seizure onset	6.9±4.6	4.1±3.2	1.9±1.8	0.1	5.1±4.3
Age at surgery	15.4±1.7	9.7±1.7	4.0±1.6	0.5±0.3	11.5±4.8
Duration of epilepsy(years)	8.5±4.8	5.5±3.1	2.1±1.6	0.4±0.3	6.4±4.6
<b>Etiology, number</b>					
MCD	15	19	5	4	43
HS	20	4	-	-	24
Tumor	12	10	6	-	28
Gliosis	5	7	1	-	13
Neurocutaneous syndromes*	2	-	2	-	4
Dual pathology	4	1	-	-	5
Rasmussen	2	-	-	-	2
Vascular	1	1	1	-	3
LGS**	-	1	-	-	1
Hemimegalencephaly	-	-	-	1	1
Miscellaneous	2	-	-	-	2

\*Sturge Weber syndrome+Tuberous sclerosis

\*\*Lennox-Gastaut syndrome

**Table II:** Age, Pathology and Surgery Related to Outcome

Age	n	%	Engel I (%)	Engel II (%)	Engel III+IV (%)
13-18	63	50	74.6	15.9	9.5
7-12	43	34.1	74.4	11.6	13.9
2-6	15	11.9	66.7	13.4	20
0-1	5	3.9	60	40	-
<b>Pathology</b>					
MCD	43	34.1	65.1	16.3	16.3
HS	24	19.1	87.5	12.5	-
Tumor	28	22.2	82.1	10.7	7.1
Gliosis	13	10.3	76.9	7.7	15.4
<b>Surgery</b>					
Temporal resection	58	46.0	82.8	10.3	6.9
Extratemporal resection	54	42.9	73.6	13.2	13.2
Frontal	25	19.8			
Parietal	11	8.7			
Occipital	11	1.6			
Multilobar	16	12.7			
Hypothalamic	1	0.8			
Hemispherectomy	6	4.8	83.3	16.7	-
Callosotomy	7	5.6	14.3	28.6	57.1

resection was frontal followed by multilobar resections. The majority of the patients who underwent temporal resection had a favorable outcome (Engel I 82.8%) which is consistent with the literature (6, 13). Extratemporal resections comprising 42.9% of the patients showed less successful results when compared with temporal lobe resections but more than 70% of patients achieved seizure freedom. Surgery for temporal regions have been reported to be associated with better outcomes in other series including pediatric patients. A similar study reports 73% Engel I outcome for temporal resections, 64% for extratemporal resections (11).

Hemisferectomy was applied to 6 children. The etiologies were gliotic lesions, Rasmussen encephalitis, SWS, hemimegalencephaly and FCD. All had favorable outcomes (Engel class I & II) without any complications after surgery. A recent study that evaluated the results of hemispherectomies in 45 pediatric patients also reported 73.5% Engel I outcomes (1).

Although timing of surgery is reported to be as long as 10 years after the onset of seizures for patients older than 12 years, this time is shorter for patients younger than this age (10). This may be due to relatively lower frequency of seizures in older patients which was shown in our results as well. Timing of surgery was between 2-5 years after the onset of seizures for children below 12 years, however it was much longer (mean  $8.5 \pm 4.8$ ) for children above 12 years. The frequencies of the seizures differed between age groups and daily seizures occurred in almost 60% of younger but about only 30% of older patients, which was partially similar to previous reports (10, 12). Apparently a delay in referral to a surgical center is a general problem in many countries.

Continuous discharges in EEG are known to be related to cognitive impairment during childhood. In 5 of our patients, EEG revealed generalized spike and wave discharges, which was diagnosed to be electrical status epilepticus during sleep (ESES) in one patient with polymicrogyri at frontal lobe. In addition to termination of her seizures after surgery, her cognitive functions markedly improved which is concordant with the beneficial effects of surgery on ESES in the literature (8). Behavioral improvement after surgery was observed in another patient who was suffering from seizures due to ischemic gliotic lesions, supporting the beneficial effects of early surgery on behavioral as well as cognitive development in childhood. In two patients with the clinical features of encephalopathy, the lesions were unilateral diffuse cortical dysplasia and gliosis and the EEG was not contributory to localize the epileptogenic zone with bilateral epileptiform discharges. Both of these patients were seizure free after hemispherectomy, the surgical procedure which has been reported to be useful in patients with bilateral findings related to a structural lesion in one hemisphere (1).

The results of our pediatric patients who underwent surgery were similar to previous reports in the literature. Although the first aim of epilepsy surgery is seizure control, improvement

of the neuropsychological and behavioral outcome of the child after seizure control is also an important aspect of epilepsy surgery (2). Although the outcomes after epilepsy surgery are more or less similar in children compared to adult patients, the timing of surgery in the pediatric population is much more critical than adults. The seriousness of the clinical picture should tempt physicians to refer the patients as soon as possible to avoid long term complications like epileptic encephalopathies and the side effects of antiepileptic drugs during the development of the young brains.

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