Original Article

Complications of Epilepsy Surgery: Prasat Neurological Institute Experiences

Teeradej Srikijvilaikul MD[1,2]

[1] Department of Neurosurgery, Prasat Neurological Institute, Bangkok, Thailand
[2] Prasat Neurological Epilepsy Center, Prasat Neurological Institute, Bangkok, Thailand

Objective: To study complications of surgery in patients with drug-resistant epilepsy whom underwent surgery at Prasat Neurological Institute.

Materials and Methods: Patients with drug resistant epilepsy whom underwent surgical treatment at Prasat Neurological Institute between 2011 and 2015 were retrospectively reviewed. Surgical and neurological complications were analyzed into transient and permanent complications. All patients had a minimum of one year follow-up.

Results: One hundred ninety-four epileptic patients were reviewed. There were 199 therapeutic operations and 21 diagnostic operations without operative mortalities. Thirty-one patients (15.6%) had surgical complications. The most common surgical complication was infection (70%). Fifteen patients (7.5%) had transient neurological complications and seven patients (3.5%) had permanent neurological complications. Dysphasia resulting from surgical resection in the dominant hemisphere was the most common cause of permanent neurological complication. Side and type of surgery were the predictor of complication after epilepsy surgery ($p<0.05$).

Conclusion: Complications of epilepsy surgery at Prasat neurological institute had comparable rate to other epilepsy centers. Epilepsy surgery is safe but carries some risks. The data are beneficial for preoperative counseling to the patients before the surgery.

Keywords: Complication, Epilepsy surgery, Epilepsy, Morbidity

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Despite the many new antiepileptic drugs in recent years, about 30% of epilepsy patients are still refractory to medical treatment[1]. Surgical treatment of epilepsy is efficacious in carefully selected drug-resistant patients and provides freedom from seizures[2]. Prospective controlled study showed surgical treatment was better than medical treatment in refractory temporal lobe epilepsy [TLE] patients[3,4].

Epilepsy surgery is an elective surgical procedure. Many studies of complications of epilepsy surgery reported low morbidity and low mortality[5-12]. A detailed knowledge of the surgical risk is beneficial for presurgical counseling. Epilepsy surgery in Thailand is widely accepted as an effective therapy for drug-resistant epilepsy patients. Outcomes of epilepsy surgery in Thailand has been reported[13-15] but the overall complications of epilepsy surgery in Thailand has never been reported. The aim of the present study was to investigate the complications of epilepsy surgery at Prasat Neurological Epilepsy Center, a referral center for epilepsy surgery in Thailand.

Correspondence to:

Srikijvilaikul T. Department of Neurosurgery, Prasat Neurological Institute, Rajavithi Road, Ratchathewi, Bangkok 10400, Thailand.
Phone: +66-2-3069818, **Fax**: +66-2-3547084
Email: srikijt@gmail.com

Materials and Methods

Data of epilepsy surgery patients from epilepsy clinic and complications were prospectively collected in the epilepsy database. Patients who had epilepsy surgery performed between 2011 and 2015 were included in the present study. Neurostimulation surgery and hypothalamic hamartoma resection were not included in the study. One hundred ninety-five patients underwent epilepsy surgery between 2011 and 2015 at Prasat Neurological Institute. One patient was excluded because the patient died from unrelated cause (ruptured posterior inferior cerebellar artery aneurysm after surgery). Complications were analyzed in both therapeutic and diagnostic procedures[7]. For the study design, the required sample size was 185 if absolute error was 0.05. The number of patients in the present study was 194 and reserved for missing data in 5%, which had adequate power for statistical analysis. The primary outcome was complication rate of epilepsy surgery. All surgeries were performed by

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a single neurosurgeon.

The author defined the complication as an unwanted, unexpected, and uncommon event after a diagnostic or therapeutic procedure. The expected worsened hemiparesis after hemispherectomy, superior quadrantanopia after temporal lobe resections or hemianopia after occipital lobectomy were not regarded as complications. Complications after epilepsy surgery were categorized into surgical complications and neurological complications. Surgical complications were defined as any adverse events after surgery during postoperative hospitalization. Complication had been defined as permanent when it persisted and affected activities of daily living more than one year, and transient when it was transient and resolved within one year.

Descriptive statistics had been used to report the complication rates. Univariate logistic regression analysis was used to assess the prognostic significance of the clinical factors (age, side of operation and type of surgery) on complications. Odds ratios with corresponding 95% confidence intervals were calculated. The significant level (p) was set at 0.05. SPSS software version 16.0 was used for all statistical analysis.

The present study was approved by the Institutional Review Board of Prasat Neurological Institute.

Results

During the inclusion period, 199 therapeutic procedures and 21 diagnostic procedures were performed in 194 patients. Of these, nine were reoperations. Five patients had repeated epilepsy surgeries during the study period. The mean age at surgery were 27.9±15.1 years (ranges 1 month to 69 years) and 98 patients (50.5%) were male.

Of the 199 therapeutic procedures, 125 (62.8%) were temporal, 32 (16.1%) extratemporal, 16 (8%) corpus callosotomies, 12 (6%) multilobar, nine (4.5%) reoperations, and five (2.5%) hemispherectomies. Temporal lobectomy including mesial structures [TL + mesial] was the most common surgery performed (Table 1). There was no surgery-related mortality. Infection especially meningitis after surgery was the most frequent surgical complication (n = 15; 7.5%), followed by intracranial hematoma (n = 7; 3.5%) (Table 2). Three intracerebral hemorrhages [ICH] occurred after TL + mesial. Two chronic subdural hematomas occurred following TL + mesial and corpus callosotomy, each. Two epidural hematomas occurred after multilobar resection. All patients with intracranial hematoma underwent surgical hematoma removal. All surgical complications were transient with no sequelae.

In the therapeutic procedures, there were 31 (15.6%) surgical complications. Transient neurological complications occurred in 15 patients (7.5%) and permanent neurological complications occurred in seven patients (3.5%). Four patients had transient surgical complications and permanent neurological complications and two patients had transient surgical complications and transient neurological complications.

Hemiparesis and dysphasia were the common neurological complications after surgery. Transient hemiparesis occurred following temporal lobectomy and frontal lobectomy in two patients each. Two patients had permanent hemiparesis following temporal

Table 1. Operative procedures and type of complications

Type of surgery	Total n	Surgical complications, n (%)	Transient neurological complications, n (%)	Permanent neurological complications, n (%)
Temporal lobe surgery	125			
Temporal lobectomy + mesial structures	107 (100)	14 (13.1)	9 (8.4)	3 (2.8)
Temporal lobectomy sparing mesial structures	2 (100)	0 (0.0)	0 (0.0)	0 (0.0)
Selective amygdalohippocampectomy	4 (100)	2 (50.0)	0 (0.0)	0 (0.0)
Lesionectomy/corticectomy	12 (100)	0 (0.0)	0 (0.0)	0 (0.0)
Extratemporal lobe surgery	32			
Frontal lobectomy*	15 (100)	1 (6.7)	4 (26.7)	3 (20.0)
Occipital lobectomy	5 (100)	2 (40.0)	0 (0.0)	0 (0.0)
Lesionectomy/corticectomy (frontal, parietal, occipital)	12 (100)	0 (0.0)	0 (0.0)	0 (0.0)
Multilobar resection**	12 (100)	6 (50.0)	2 (16.7)	0 (0.0)
Hemispherectomy	5 (100)	2 (40.0)	0 (0.0)	0 (0.0)
Corpus callosotomy	16 (100)	4 (25.0)	0 (0.0)	0 (0.0)
Reoperation	9 (100)	0 (0.0)	0 (0.0)	1 (11.1)
Total	199 (100)	31 (15.6)	15 (7.5)	7 (3.5)

* Three patients had frontal lobectomy and multiple subpial transection

** One patient had multilobar resection and multiple subpial transection

Table 2. Complications after 199 therapeutic surgical procedures

Type of operations	Surgical complications (n)	Transient neurological complications (n)	Permanent neurological complications (n)
TL + mesial	- Infection 11 (meningitis 10, bone flap infection 1) - Hematoma 4 (CSDH 1, ICH 3) - CSF rhinorrhea 1 - Subdural hygroma - Upper GI bleeding 1 - Drug induced hepatitis 1	- Hemiparesis 2 - Dysphasia 1 - CN paresis (CN IV 2, CN VII branch 1)	- Hemiparesis 2 - Dysphasia 2 - Numbness 1
TL sparing mesials	-	-	- Dysphasia 1
Selective AH	- Drug allergy 1	-	-
Frontal lobectomy	-	- Hemiparesis + dysphasia 1 - Hemiparesis 1	- Dysphasia 2
Occipital lobectomy	- Infection 2 (meningitis 1, bone flap infection 1) - CSF collection 1	-	-
Multilobar resection	- Infection 4 (meningitis 2, stitch abscess 1, UTI 1) - Hematoma 2 (EDH 2)	- Hemiparesis 1	-
Hemispherectomy	- Infection 1 (pneumonia 1) - Drug allergy 1	-	-
Corpus callosotomy	- Infection 3 (pneumonia 2, meningitis 1) - Hematoma 1 (CSDH 1) - Massive blood loss 1	-	-
Redo	- Infection 1 (meningitis 1)	-	- Dysphasia 1

TL + mesial = temporal lobectomy including mesial structures; TL sparing mesials = temporal lobectomy excluding mesial structures; Selective AH = selective amygdalohippocampectomy; EDH = epidural hematoma; CSDH = chronic subdural hematoma; ICH = intracerebral hematoma; UTI = urinary tract infection; CN = cranial nerve

lobe surgery. Three patients had permanent dysphasia following temporal lobe surgery and in one patient after frontal lobectomy near Broca area. Temporal lobe surgery resulted in 2.4% permanent neurological complications and extratemporal lobe surgery resulted in 9.4% permanent neurological complications. One patient whom underwent reoperation had permanent dysphasia after insular resection. Dysphasia in these patients were mild, involved difficulty finding word but persisted for more than one year. In patients who had hemiparesis after surgery, they had spastic hemiparesis grade 4/5 but the weakness persisted.

Diagnostic procedure was performed as follow, bitemporal strip placement in seven, subdural electrode placement in 12, depth electrode placement in one, and stereo-electroencephalography in one. Electrode dislocation required surgical correction occurred in one of subdural electrode placement and in one of bitemporal strip placement. Two patients had inadequate subdural electrode coverage and needed repositioning. Two patients had bone flap infection and required bone flap removal after subdural electrode investigations and surgical resections. The number of patients that underwent invasive EEG was too small for statistical analysis.

In the univariate analysis, type of surgery was a predictive factor of complication. Complications were more common in patients who underwent TL and mesial (Table 1, 2). Side of surgey was a predictor of complication and left-sided surgery increased risk of complications (OR 2.5, 95% CI 1.239 to 5.046, p = 0.011). Univariate logistic regression analysis showed no association of age and complications (OR 1.228, 95% 0.618 to 2.439, p = 0.558).

Discussion

The risks of epilepsy surgery after therapeutic procedures at Prasat Neurological Institute were 15.6% for surgical complications, 7.5% for transient neurological complications, and 3.5% for permanent neurological complications. Temporal lobe surgery resulted in 2.4% permanent neurological deficit and 9.4% of patients underwent extratemporal lobe surgery had permanent neurological deficits. There was no surgical mortality.

A multicenter study from the Swedish National Epilepsy Surgery Register during 1990 to 1995 reported minor complications in 8.9% and major complication in 3.1% after therapeutic procedures and only minor complications (6.3%) after invasive electrode procedures[6]. In a prospective study of complication after epilepsy surgery between 1996 and 2010 from the same group, the complication rates seem to be lower than previous study but with no statistical significance. They also found that risk for any complication increased significantly with age[9].

Complications were subdivided into minor and major complications that approximately correspond to the definitions of transient and permanent complications in the present study. However, the Swedish series used three months of outcome instead of one year as the author's series.

In the Swedish series[6,9], permanent deficits occurred in 2.2 and 2.9% of temporal resections, 3.3 and 4.9% of extratemporal resections (extratemporal lobe surgeries + multilobar resections + hemispherectomies), and 1.5 and 3% of corpus callosotomies, which is comparable to the author's series (temporal lobe surgeries 2.4%, extratemporal lobe surgeries 6.1%, and corpus callosotomies 0%).

The reports of complications after epilepsy surgery from a single center were also low[5,7,8,12], comparable to the author's series. In a single center study of 429 therapeutic surgical procedures, the total rate of neurological complications was 5.4% with 3.03% causing transient morbidity and 2.33% causing permanent morbidity[5]. Heller et al[7] reported 8% major and 5% minor complications. In a large cohort of 2,449 epilepsy procedures from a single center, surgical complications occurred in 2.9%, and there were 2.7% minor and 0.5% major neurological complications[8]. A recent report of epilepsy surgery complications from a single center reported an unexpected persistent neurological complications in 2.2%[12].

Temporal lobe surgery was the most common procedure in epilepsy surgery. Previous report of temporal lobe surgery for hippocampal sclerosis in Thailand showed low morbidity and mortality[13]. In a review of complications and side effects of temporal lobe surgery for medically intractable epilepsy, mortality rates varied between 0% to 3.5% and morbidity rates ranged between 3.2% and 88%[16]. In a single center study of 329 temporal lobe surgeries, surgical complications occurred in 8.5%, all without permanent sequelae. Transient neurological morbidity occurred in 2.4% and permanent neurological morbidity occurred in 2.7%[17]. Gooneratne et al reported 2.5% unexpected permanent and 1.2% unexpected transient complications[12]. In a multicenter study at six different centers in Sweden[9], there were 2.9% major and 7.8% minor complications after temporal lobe resections. A population-based analysis of temporal lobe surgery in the United States reported the overall morbidity 10.8% with no mortality[18]. By using a national surgical registry, thirty-day postoperative morbidity and mortality after temporal lobectomy demonstrated a mortality rate of 1.4% and a major complication rate of 6.5%[19]. In a series of temporal lobe surgery for hippocampal sclerosis, complications occurred in 15.4% and 4.1% of patients had major complications with 0.5% of patients had persistent neurological deficits[11]. In the author's study, there were 12.8% surgical complications, 7.2% transient neurological complications, 2.4% permanent neurological complications and no surgical mortality comparable to the literatures.

In extratemporal lobe surgery (including multilobar resection and hemispherectomy), there were 3.3% major and 8% minor complications[9]. In the author's study, extratemporal lobe surgeries resulted in 6.1% permanent and 12.2% transient neurological complications. The percentage of complications was higher but the number of surgeries in the present study was small (n = 49) compared to other studies[5,6,8,9]. Most of neurological complications were transient and involved resection near the motor cortex. The number of surgeries in multilobar resections, hemispherectomies, lesionectomies, or corticectomies in temporal lobe or extratemporal lobe were small comparison to the literature reports, but there was no permanent complication or mortality from the surgery.

Diagnostic epilepsy surgery with subdural grid carried the highest risk of complication[20]. Infection was the most common complication after subdural grid placement in the Cleveland clinic's report and higher than strip and depth electrode placement[21]. In the author's study, two patients had bone flap infection and requiring bone flap removal after respective surgeries. Invasive surgery with stereoelectroencephalography [SEEG] had been reported with low morbidity[8], but the experience in our center was still low.

Infection was the most common surgical complication followed by intracranial hematoma in most studies as in the present study[6,8,12]. Hemiparesis, following temporal lobe surgery, resulted from manipulation of middle cerebral artery (manipulation hemiplegia)[22] or injury to the anterior choidal artery[5]. In the present study, hemiparesis following temporal lobe resections mostly resulted from the resection of mesial temporal lobe tumors. Transient hemiparesis occurred following resection near the motor cortex in extratemporal lobe surgeries. Intracerebral hemorrhage occurred most in TL + mesial, which may have resulted from surgical hemostasis. Large craniotomy followed by multilobar resection and large volume of resection resulted in large dead space that may contribute to epidural hematoma after extratemporal lobe resections.

From univariate analysis, type of surgery and side of surgery were the predictive factor of complication. Temporal lobe resection including mesial structures had the highest percentage of complications because the resection of mesial structure and mesial temporal tumor had the risk of hemiparesis compare to other type of resections. The number of extratemporal lobe surgeries was small compared to temporal lobe surgery, therefore, complications might be difficult to compare to TL and mesial structures. There was no report of side of surgery to be a risk factor of complication. The author found left sided surgery increased risk of complication. The patient selection, number of patient, and type of surgery may be different among the reports.

The number of reoperation was reported to be a risk factors associated with hematomas and infection[8]. In the author's series, reoperation was not a predictive factor of complication, but the number of reoperation patients was small. The risk of surgery had been reported related to age[6,8,9]. Patients younger than 35 years had a lower risk of epilepsy surgery[6] but from the same register, there was a trend toward lower complication rates in patients older than 50 years. In the present study, age at surgery was not a risk factor of surgery. Previous report of temporal lobe surgery for older age in Thailand showed a trend of increased morbidity but did not reach a statistical significance[23]. Report of national registry in the United States revealed that increasing age was an independent predictor of discharge disposition other than home after temporal lobectomy[19]. Patient population or selection bias of healthy older age for epilepsy surgery may make different results among different studies.

In conclusion, epilepsy surgery at Prasat Neurological Institute is safe and have a complication rate in the same range as other large series. Direct comparisons of complications with other series are difficult because definition of complication used, the number and type of surgeries, and the characteristic of cohorts. The risk of epilepsy surgery is low but presurgical counseling is important for the patients to understand the risk of this treatment option.

What is already known on this topic?

Epilepsy surgery is widely accepted as a treatment option in drug-resistant epilepsy. Surgical treatment of epilepsy has a low morbidity and low mortality rate but is not without risk. Detailed discussion of the risks and benefits of the surgery is important for preoperative consent and expectation of the patient and family.

What this study adds?

Epilepsy surgery in Thailand has long been performed but data of surgical complication are lacking. The study provides data of complications of epilepsy surgery in Thailand from a referral center for epilepsy surgery in Thailand. The data is homogeneous because the operation was performed by an experienced neurosurgeon, not affected by a learning curve.

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Potential conflicts of interest

The author declares no conflict of interest.

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