

Epilepsy surgery programs in Taiwan

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Abstract

Currently there are 3 epilepsy surgery programs in Taiwan, Taipei Veterans General Hospital for adults and children from 1987, Linkou Cheng Gung Memorial Hospital from 1988, and Hualien Tzu Chi Medical Center from 2002. To date, more than 800 patients have been operated, including lesionectomy, callosotomy, hemispherectomy, deep brain stimulation and vagus nerve stimulation. The development of epilepsy surgery service was attributed to establishment of Taiwan Epilepsy Society in 1990, and availability of various modern techniques to determine the lesions, epileptogenic foci and cortical function.

INTRODUCTION

Taiwan has a population of about 23 millions. There are 3 epilepsy surgery programs: Taipei Veterans General Hospital (Taipei VGH) since 1987 (pediatric epilepsy surgery program since 1989), Linkou Cheng Gung Memorial Hospital (Linkou CGMH) since 1988, and Hualien Tzu Chi Medical Center since 2002. Sporadic cases were also operated in other medical centers as National Taiwan University Hospital, China Medical University Hospital, Taichung Veterans General Hospital, and Chung-Ho Memorial Hospital of the Kaoshiung Medical University.¹⁻²³

ADULT EPILEPSY SURGERY PROGRAM IN TAIPEI VETERANS GENERAL HOSPITAL

The adult epilepsy surgery program in Taipei VGH started in 1987 with a multidisciplinary team consisting of neurosurgeons, epileptologists, neuro-radiologists, psychiatrists, nuclear medicine specialists, pharmacists, nurses, social workers and technicians. Up to 2006, a total of 379 surgeries have been undertaken for adult patients. Among them, 280 patients had temporal lobe epilepsy with hippocampal sclerosis (74.0%). Other operations included temporal lobe and extratemporal lobe resections for tumors, vascular lesions, corpus callosotomy, hemispherectomy, and deep brain stimulation (2006). For epilepsy surgery in adults, presurgical evaluation included epilepsy history and semiology, serial EEG recording, long-term video-EEG monitoring, MRI, MR

Spectroscopy, neuropsychological assessment, positron emission tomography (PET), foramen ovale electrodes, subdural grid implantation, magnetoencephalography (MEG), fMRI, and Wada test. For extratemporal resection, cortical somatosensory evoke potentials (SSEP), cortical stimulation for localization of the epileptogenic zone and functional mapping, and image guided surgery were also used. Clinical follow up for postoperative seizure control in 280 intractable temporal lobe epilepsy (TLE) patients without structural lesions was Engel Grade I seizure free in 79% of patients. As for 2 years postoperative outcome of 47 intractable TLE patients with structural lesions, Engel Grade I seizure free was achieved in 25 (73%) patients in the neoplastic group, and 12 (100%) patients in the vascular group (Table 1, 2).

PEDIATRIC EPILEPSY SURGERY PROGRAM IN TAIPEI VETERANS GENERAL HOSPITAL

The first epilepsy surgery in children was performed in 1983 on a 12-year boy with hemangioma and chronic complex partial seizures. Anterior temporal lobectomy in addition to resection of the lesion was carried out and aided by electrocorticography (ECoG), by which independent epileptogenic foci were identified over temporal and inferior frontal gyrus. The boy had been seizure free for 14 years postoperatively.

Table 1. Lesionectomy of adult epilepsy patients in Taipei VGH from 1987-2006

Classification	No. of patients	Pathology	No. of patients			HS
TLE without structural lesions	280					207 (74%)
TLE with structural lesions	67	Neoplastic group	51			18 (43%)
		Low grade glioma		41		
		Low grade astrocytoma			28	
		Oligodendroglioma			7	
		Ganglioglioma			4	
		DNET, meningioma			2	
		Anaplastic astrocytoma		10		0 (0%)
		Vascular group	16			12 (73%)
		Arteriovenous malformation		7		
		Cavernous hemangioma		9		
Extratemporal structural lesions	22	Neoplastic group	13			
		Low grade astrocytoma		8		
		Oligodendroglioma		5		
		Vascular group	5			
		Arteriovenous malformation		1		
		Cavernous hemangioma		4		
		Malformation of cortical development group	3			
		Cortical dysplasia		3		
		Benign cyst group	1			
		Arachnoid cyst		1		

TLE: Temporal lobe epilepsy; HS: Hippocampal sclerosis

Epilepsy program in children was established since 1989 by a multidisciplinary team consisting of pediatric neurosurgeons, pediatric neurologists and epileptologists, pediatric psychiatrists, pediatric psychologists, neuroradiologists, clinical nurse specialists, social workers, and

EEG technicians. The main surgical procedures were corpus callosotomy for palliative operation, temporal and extratemporal lesionectomy for palliative or curative resection. Up to 2006, in children of less than 18 years old, 156 callosotomies and 86 lesionectomies (including 3

Table 2. Postoperative outcome of seizure control in 280 intractable TLE patients without structural lesions in Taipei VGH

Outcome grade	No. of cases	%
Engel grade I seizure free	221	79
Engel grade II rare seizure	32	11
Engel grade III worthwhile improvement	23	8
Engel grade IV no improvement	4	2
Total	280	100

anatomical hemispherectomies) were performed. Four patients received both corpus callosotomy and lesionectomy. In contrast to corpus callosotomy, vagus nerve stimulation (VNS) was performed in only 7 patients as a palliative procedure, and 5 of them had previous callosotomy (Table 3).

CORPUS CALLOSOTOMY IN CHILDREN

In children, corpus callosotomy is an effective palliative operation to control or ameliorate different types of seizures in medically intractable specific epilepsy syndromes. This include Lennox-Gastaut syndrome (majority), infantile spasms/West syndrome, severe epilepsy with multiple independent spike foci, hemiconvulsive-hemiplegia epilepsy syndrome, other symptomatic partial epilepsies and secondary generalized epilepsy. Other than infantile spasms, VNS is also effective for seizure control in children with resistant epilepsy. Because the surgical risk is relative lower and the adjunctive improvement of alertness and sense of well-being, VNS has been proposed to be performed before callosotomy. However, in spite of higher surgical risk, the Taiwanese parents usually prefer callosotomy for their children because of financial consideration. The implant device of VNS therapy is not covered by the national health insurance.

For corpus callosotomy in children, we selected patients whose seizures were antiepileptic drug resistant without resectable epileptogenic tissue or unsuitable for resective surgery. We followed the staged callosotomy policy. Anterior callosotomy was performed through a right (majority) or left anterior frontal interhemispheric approach in supine position for anterior 1/2 to total splitting of corpus callosom. We achieved >2/3 to >4/5 callosotomy in 114 (71.2%) and single staged total callosotomy in 4 (2.7%) of patients. Seizure outcome in patients reviewed in different periods, with varied follow up durations, showed that over half of the patients had more than 50% reduction of seizure frequency. However, seizure control remained to be fluctuating in many of the patients.

LESIONECTOMIES IN CHILDREN

The goal of lesionectomy for epilepsy surgery in pediatric age group is to control seizures by removal of a focal or hemispheric lesion. Early surgery should be considered in most patients. Pharmacological intractability is not the only selection criteria. We follow the following

guidelines for patient selection. For lesionectomy in temporal lobe, the hemispheric dominance is based on handedness, fMRI and Wada test in selected children who can cooperate with the procedures. For extratemporal resection, the lesions, the epileptogenic zone, and the functional cortex are determined by structural MRI (central sulcus), MEG, and fMRI whenever possible. The resection is usually under the guidance of ECoG and image guided surgery. We have no experience in using subdural grid implantation or intraoperative cortical stimulation for epileptogenic zone localization or functional mapping. Contrary to reported series, for lesionectomy in children with epilepsy, we had less malformation of cortical development, gangliogliomas, DNT, and Rasmussen encephalitis (Table 3). Excluding 4 mortalities for malignancy, with average follow up of 7.2 years, we achieved seizure free (with or without antiepileptic drugs) in 64.6% of patients. Seizure free was achieved in 37 (72.6%) children of the neoplastic group, 9 (77.8%) children of vascular malformation group, and only in 2 (15.4%) children with cortical dysplasia.

DEVELOPMENT OF EPILEPSY SURGERY IN TAIPEI VETERANS GENERAL HOSPITAL

In terms of history of development of epilepsy surgery in Taipei VGH, we established ECoG in 1983, surgical program in adult in 1987, surgical program and callosotomy in children in 1989, multiple subpial transaction in 1995, fMRI in 1996, image guidance epilepsy surgery in 1997, vagus nerve stimulation in 1999, MEG in 2001, and deep brain stimulation in 2006. Anatomical hemispherectomy was first performed for hemimegalencephaly in 1990, for Surge-Weber syndrome in 2002 and for Rasmussen syndrome in 2005.

EPILEPSY SURGERY PROGRAM IN LINKOU CHANG GUNG MEMORIAL HOSPITAL

In Linkou CGMH, Epilepsy Surgery Program in adult was established since 1988. The first operation for epilepsy was performed in 1989. Types of epilepsy surgery performed included temporal and extratemporal resections, functional hemispherectomy, callosotomy, and deep brain stimulation of anterior thalamic nucleus since 2001. For extratemporal resection, subdural grid implantation and cortical functional mapping were selectively applied. Up to 2006, more than 200 epilepsy surgeries had been performed in adult and children.

Table 3. Epilepsy Surgery in children aged less than 18 in Taipei VGH from 1983-2006

Classification	No. of patients	Pathology	No. of patients		
Lesionectomy	86				
TLE with structural lesions	46	Neoplastic group	31		
		Astrocytic tumor		22	
		Astrocytoma			20
		Anaplastic astrocytoma			2
		Mixed glioma		2	
		Oligodendroglioma		1	
		Neuronal & mixed neuronal-glial tumor		6	
		Ganglioglioma			2
		DNET			4
		Vascular group	5		
		Arteriovenous malformation		2	
		Cavernous hemangioma		2	
		Hemangioma		1	
Extratemporal Structural lesions	37	Neoplastic group	24		
		Astrocytic tumor		11	
		Pilocytic astrocytoma			1
		Astrocytoma			5
		Anaplastic astrocytoma			5
		Mixed glioma		2	
		Oligodendroglioma		1	
		Neuronal tumor & mixed neuronal-glial tumor		9	
		Ganglioglioma			3
		Anaplastic ganglioglioma			2
		DNET			4
		Hamartoma		1	
		Vascular group	3		
		Carveronous hemangioma		2	
		Venous malformation			1
		Malformation of cortical development group	4		
		Focal cortical dysplasia		2	
		Pachygyria		2	
		Gliosis	3		
		Scar	1		
Hemispherectomy	3	Hemimegalencephaly	1		
		Sturge-Weber syndrome	1		
		Rasmussen encephalitis	1		
Callosotomy	156	Combined with lesionectomy	4		
VNS	7	After callosotomy	5		
MST	1				

VNS: Vagus nerve stimulation; MST: Multiple subpial transaction

EPILEPSY SURGERY PROGRAM IN HUALIEN TZU CHI MEDICAL CENTER

The Buddhist Tzu Chi Medical Center in Hualien has been established for 20 years. The epilepsy surgery program started in 2002. Up to January 2006, a total of 40 epilepsy surgeries were performed. Types of epilepsy surgery performed included lesionectomy, disconnection surgery and neuro-modulation surgery by deep brain stimulation of subthalamic nucleus.

CONCLUSIONS

Taiwan Epilepsy Society was established in 1990 with the objective of improving the medical care of epilepsy patients. Founding members included epileptologists, neurologists, neurosurgeons, neuroimaging specialists, neuropsychologist and psychiatrist. By 2006, the society has grown to have over 360 members. Epilepsy surgery sprouted in two medical centers in 1980s. The development of the service was attributed to growth of Taiwan Epilepsy Society, and the availability of modern techniques such as EEG monitoring, imaging for epileptogenic foci and lesion localization, cortical functional mapping, and neuronavigation in 1990s. Presently, 3 epilepsy surgery programs for adult and children have been established. With gradual accumulation of experience, we managed to perform safe and effective surgeries for selected patients. Techniques and types of epilepsy developed included lesionectomy, disconnecting surgery, and neuro-modulation by VNS and deep brain stimulation.

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