# Surgical treatment for secondary epilepsy under the monitoring of Electrocorticography

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**Abstract: Objective**: To retrospectively study the original lesion resection for the treatment of secondary epilepsy under the monitoring of electrocorticography (ECoG) during operations and discuss the value of intraoperative ECoG monitoring. **Methods**: By means of observing the treatment of 72 patients with secondary epilepsy, we analyzed the significance of intraoperative ECoG monitoring in the treatment of secondary epilepsy. Among the 72 cases, 15 patients were meningiomas, 28 were gliomas, 15 were cavernous hemangiomas, 5 were arachnoid cysts, 5 were post-traumatic changes, 2 were cholesteatomas and 2 were arteriovenous malformations. **Results**: There was no epileptic wave in all the studied patients revealed by the regular postoperative EEG. No death or new neurological dysfunctions were recorded following the surgeries. A follow-up investigation lasting from 1to 5 years revealed that there was no epilepsy recurrence in all the patients except for partial seizures in two patients. **Conclusion**: The monitoring of electrocorticography (ECoG) would significantly improve the efficiency of surgical management for the patients with secondary epilepsy.

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**Keywords**: ECoG monitoring; secondary epilepsy; surgery

## 1. Introduction

The secondary epilepsy is a common manifestation of intracranial occupying lesions and may be the earliest and sole clinical presentation (Yu 2006). Its average occurrence rate is 30%, while the epilepsy is easier induced by slow-growing tumor, those occurrence rate is 75%. Furthermore, it is significant for the patients who suffer both intracranial lesions and secondary epilepsy to deal with the epileptogenic cortex by surgery, because most lesions are with abnormal peripheral cortical changes. Our institution has successfully cured 72 secondary epilepsy patients by surgery which performed under the monitoring of ECoG from June 2006 to June 2011.

## 2. Materials and Methods

The 72 patients, 38 males and 34 females, who were aged from 17 to 51 years old and their mean age was 35.2 years, were included into this study. All the epilepsy patients had intracranial occupying lesions with disease courses ranging from 1 week to 3 years. According to the international classification system, there were 40 cases of generalized seizure, 10 cases of complex partial seizure, 10 cases of simple partial seizure, and 12 cases of partial to generalized seizure. Seizure frequency: 19 patients had at least a seizure per day, 33 patients had at least a seizure per week, 13 patients had at least a seizure per month and 7 patients had at least a seizure per year. In which 48 patients never took any antiepileptic drugs. All the patients have been confirmed the presence of intracranial occupying lesions through MRI and (or) CT examination prior to hospital admission. At the same time, they all have a history of seizures, and have been performed a long term video electroencephalogram to locate and delimitate the pathologic cortex. The lesions of 34 cases were located in the frontal lobe, 18 in the temporal lobe, 14 in the parietal lobe and 6 in the occipital lobe.

The multifunction nerve electrophysiology monitor we used was the type of Nicolet Endeavor Bravo which made in America. Technical parameters: we chose 1x6 or 1x8 superficial strip recording electrodes to record in the exposed cortex. Reference electrode was Fz or the connection of both sides of the mastoid processes. Sensitivity: 1mV, baseline time of 5 s, bandwidth of 35 Hz.

The patients discontinue antiepileptic drugs on the operating day and the preoperative management is similar to that of intracranial tumors' surgeries. The skin incision is able to expose normal brain tissue at least 3 cm around the lesion. After the dura mater is incised electrodes are placed on the exposed cortex to record the epileptic waves (sharp waves and spikes). Deep electrodes are used in case of deep temporal lobe pathologies prior to the microscopic resection. If widespread epileptic waves are observed in the temporal pole the lesion along with the temporal lobe will be excised. An ECoG is performed following the microsurgical resection to ensure complete removal of epileptic foci. If the epilepsy waves are still exist, then determine to resect the amygdala and the hippocampus. Important functional areas with abnormal epileptic waves can't resect as described previously; rather use the bipolar coagulation to deal with the brain surface. Bands of coagulation are 3-5 mm apart. The coagulation time and intensity are guided by the area or thickness of the brain cortex to cauterize. In the surgery area, we should carefully stop bleeding as much as possible avoid making the subarachnoid residual blood and suture tightly dura mater to prevent forming new scars because postoperative cortical softening and adhesion.

## 3. Results

There was no death in the 72 secondary epilepsy cases of the surgical treatment. No case of postoperative new neurological dysfunction was noted. Postoperative pathological reports revealed 15 meningiomas, 28 gliomas, 15 cavernomas, 5 arachnoid cysts, 5 posttraumatic malacias, 2 cholesteatomas and 5 arteriovenous malformations. We followed up from 1 to 5 years. 70 patients absolutely recovered from the seizures and 2 still had partial seizures with about 90% decrease in fits frequency, longer inter -ictal period and a good response to antiepileptic drugs.(Fig 1 and 2)

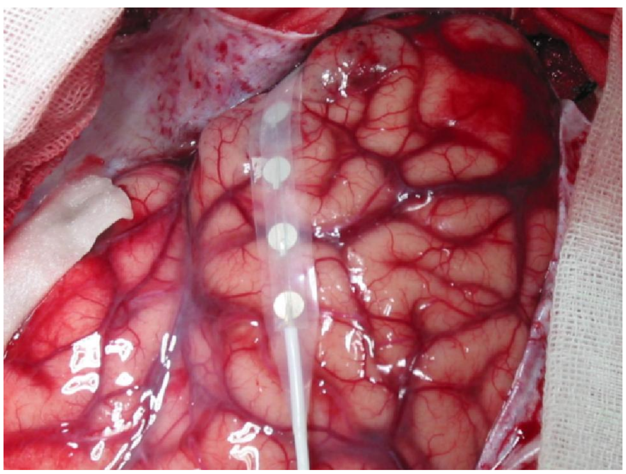

Fig 1. The location of surgery method.

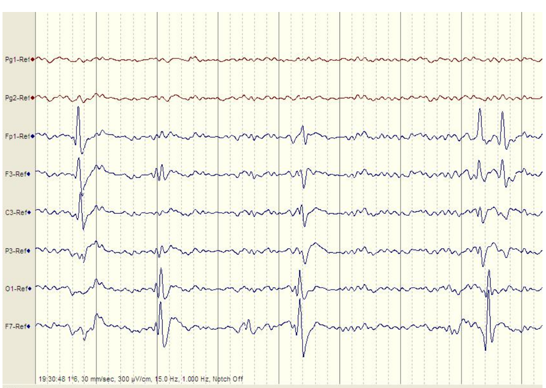

Fig 2. The ECoG wave during surgery.

## 4. Discussion

The common causes of secondary epilepsy include congenital diseases, antenatal and puerperal diseases, febrile fits, trauma, infections, intracranial tumors, surgery, cerebrovascular diseases, systemic diseases, degenerative and demyelinating diseases and so on. Brain tumors, cerebrovascular diseases and brain injuries are the three main causes (Hitiris et al., 2007).

Intracranial tumors induced seizures are surgically treated in most institutions in China but very few institutions go beyond the simple resection of the primary pathology by the monitoring of ECoG.(Wang 1998; Parisi et al.,2008) Postoperative seizures are then existing and medically intractable.

The mechanism underlying space occupying lesion induce seizures is not limited to the direct irritation by the lesion but also associated with the changes of the cerebral blood flow, amyloid degeneration what a long term pressure leads the surrounding brain tissue to, hydrocephalus or other structural changes and changes in the micro-metabolism. Therefore the resection of the primary lesion and the postoperative antiepileptic drugs are not sufficient to control the seizures. (Palmini 2006)

ECoG is more accurate than the traditional scalp EEG in monitoring the epileptic waves and localizing the epileptic foci as it’s spike waves are clearly traced with a 5-10 times taller amplitudes and shorter periods. (Cai and Li 2007). This technique is already internationally used to resect primary epileptic focus and serves as an accuracy guide in the area of the cortex to be cauterized or resected. (Yoshida et al., 2007).

For our study we used an ECoG monitoring system developed by the American company Nicolet. It’s a multifunctional device with high precision, clear tracing system, equipped with an anti-jamming function. It can record 16 input channels simultaneously. Its sensitivity is demonstrated in localizing the epileptic focus in the non important areas and preserving neurological functions in the important areas. (Liang et al.,2004; Li et al.,2004)

Synchronized electrical discharge observed in epilepsy originates mainly comes from superficial cortical layers I and II. Clinically evident epilepsy requires a minimum surface area of pathologic cortex. Low frequency cauterization technique’s target is small islands of epileptic cortex. The cortices are too small to generate sufficient electric discharge to trigger the epileptic wave formation. Larger islands are localized by ECoG following the resection of the primary epileptic foci and dealt with by low frequency cauterization. (Xiang et al.,2010)

Traditional resection of the primary lesion on patients with secondary epilepsy failed to control seizures and improve the quality of life because the epileptic foci have been overlooked. Intraoperative ECoG monitoring performed in our institution has successfully helped to eradicate the epileptic foci and ameliorate the quality of life of the patients and their relatives. The ECoG monitoring requires the operating theater to provide enough time to detect the pathologic waves which fail to appear during short time surgeries. The recording of the ECoG system is affected however by anesthetic drugs and the areas covered by the electrodes.

Low frequency bipolar cauterization is an easier technique than the multiple subpial transection (MST). For deep seated frontal or sylvian fissure lesions slight dissection and obliquely oriented forceps can reach the targeted area. If a poorly exposed cortical area is detected to generate epileptic waves, brain spatula is used to retract the brain and forceps tips are introduced under the dura mater to cauterize.

Two patients still have seizures after surgery, a patient with glioma and another with arteriovenous malformation. Postoperative CT scan revealed obvious cerebral cortex malacias and scar formation. Postoperative localized malacias and scar formation appear to be important reasons of seizure recurrence. Microscopic resection is the technique of choice to reduce the unnecessary injuries which may subsequently result in epileptic focus.

The lesions of 18 cases located in the temporal lobe all have been monitored by intraoperative ECoG, in which the lesions of 18 cases have spike waves in the anterior temporal lobe and 9 in the amygdala and hippocampus. We recommend that the anterior temporal lobe should be resected in all secondary epilepsy induced by the lesion of temporal lobe. Prior to the decision that whether the temporal internal structures should be resected or not, the preoperative epilepsy symptoms and imaging findings and the intraoperative ECoG monitoring all should be taken into consideration.

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