

# Microsurgical Treatment for Central Gyrus Region Meningioma With Epilepsy as Primary Symptom

Wen-shuai Deng, MD,\* Xiao-yang Zhou, BS,\* Zhao-jian Li, MD,\* Hong-wei Xie, BS,\*  
Ming-chao Fan, MS,† and Peng Sun, MD\*

**Background:** The objective of this article was to investigate the operation outcome, complications, and the patient's quality of life after surgical therapy for central gyrus region meningioma with epilepsy as the primary symptom.

**Methods:** All patients get at least 6 months of follow-up (range, 6–34 mo) after surgery. They underwent preoperative magnetic resonance imaging and video electroencephalography, and their clinical manifestations, imaging characteristics, microsurgical methods, and prognosis were retrospectively analyzed.

**Results:** The meningioma was located in the front and back of the central sulcus vein in 3 and 2 patients, respectively; in the compressed precentral gyrus and central sulcus vein in 3 patients; and in the precentral gyrus and postcentral gyrus each in 1 patient; beside the right sagittal sinus and invaded a thick draining vein on the brain surface in 1 patient and beside the right sagittal sinus and close to the precentral gyrus in 2 patients; invaded the superior sagittal sinus in 8 patients; crossed the cerebral falx and compressed cortex gyrus veins in 1 patient; invaded duramater and irritated skull hyperplasia in 3 patients; invaded duramater and its midline infiltrated into the superior sagittal sinus, was located behind the precentral gyrus, and enveloped the central sulcus vein. They were resected and classified by Simpson standards: 17 of the 26 patients had grade I, 6 patients had in grade II, and 3 patients had in grade III.

**Conclusions:** Resection of central gyrus region meningioma by microsurgical technique avoids injury to the cerebral cortex, central sulcus vein, and other draining veins. Microsurgery improves the total resection rate, reduces recurrence rate, and lowers disability or death rate.

**Key Words:** Microsurgery, meningioma, central gyrus region, epilepsy

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From the Departments of \*Neurosurgery and †Neurosurgical Intensive Care Unit, Affiliated Hospital of Medical College, Qingdao University, Qingdao, Shandong, China.

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Address correspondence and reprint requests to Peng Sun, MD, Department of Neurosurgery, Affiliated Hospital of Medical College, Qingdao University, Qingdao, Shandong 266003, China; E-mail: sunpengqd@163.com

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Meningiomas are the most common benign neoplasms that constitute approximately 20% of all primary central nervous system tumors.<sup>1</sup> They arise from arachnoidal cells,<sup>2</sup> most of which are near the vicinity of the venous sinuses, and this is the site of greatest prevalence for meningioma formation. They are most frequently attached to the dura over the superior parasagittal surface of frontal and parietal lobes, along the sphenoid ridge, in the olfactory grooves, which is the sylvian region. The tumor is well circumscribed and takes on the form of space it occupies.

Central gyrus region meningioma involves the falx, sinus, and falx-sinus meningiomas in middle one third of the sagittal sinus, and the cerebral convexity meningioma is in the precentral and postcentral gyrus. It is located in the sensorimotor function area and involves the central sulcus vein and some important draining veins. Epilepsy is a common primary symptom in those patients.

## METHODS

### Patients

A retrospective analysis of 26 patients (12 men and 14 women; mean age, 51.7 y; SD, 2.8 y) who underwent surgical treatment in the Department of Neurosurgery of the Affiliated Hospital of Medical College, Qingdao University, between 2006 and 2011 was performed. The inclusion criteria are as follows: (1) the primary symptom is epilepsy, (2) imaging examination shows that the tumor is in the central gyrus region, and (3) postoperative pathology proves that the tumor is meningioma.

### Preoperative Evaluation

All patients received radiologic examination and long-term video electroencephalography (EEG) monitoring.

### Intraoperative Management

Surgical intervention was undertaken on the basis of individual clinical, neuroradiologic, and electrical data. The direction of neurapophysis on the sagittal plane on head computed tomography (CT) and magnetic resonance imaging (MRI) and the surface of central sulcus preoperatively were used to locate the tumor and find its position from the functional area. A designed incision and normal craniotomy were performed to fully expose the tumor body. Surgical therapy was performed under a microscope for all patients.

The duramater was resected 1 to 2 cm away from the tumor margins, and cotton was used to protect the surrounding normal brain tissues, central sulcus vein, and other draining veins. The tumor was resected into masses to gradually reduce its volume and then free the capsule. The tumor body was isolated strictly along the capsule and arachnoid layers. The capsule was wrinkled by electrocoagulation, and then, the tumor was isolated and resected. If the tumor base was located in the cerebral falx and sagittal sinus and thus cannot be fully resected, electrocoagulation was used to burn the base. The extent of resection was assessed based on

preoperative and postoperative radiologic examinations; the Simpson scale<sup>3</sup> was used as well.

## Postoperative Evaluation

All the patients in this study received antiepileptic drugs (AEDs) postoperatively at least 1 month. The routine follow-up includes physical, neuroimaging, and EEG examinations that were performed for all the patients, which were scheduled at 1, 3, and 6 months and, thereafter, annually. We evaluated surgical and postoperative seizure outcomes by recording the duration of follow-up, the number taking AEDs at the end of follow-up, the number of participants in each Engel class<sup>4</sup> at the end of follow-up, and any factors that were correlated with a significantly improved outcome. Medical history data reviews and direct contacts with the patients were used to derive the follow-up and outcome data.

## RESULTS

### Clinical Presentation

In this study, seizure was the primary or only symptom, and the types of seizure were analyzed. Simple partial seizure occurred in 6 patients (23%), complex partial seizure occurred in 11 patients (42%), partial-to-generalized seizure occurred in 1 patient (4%), and generalized tonic-clonic seizure occurred in 8 patients (31%). The accompanying symptoms included physical fatigue (7 patients), dizziness (3 patients), nausea (2 patients), sleepiness (2 patients), numbness in the right lower limb (1 patient), and impaired vision (1 patient).

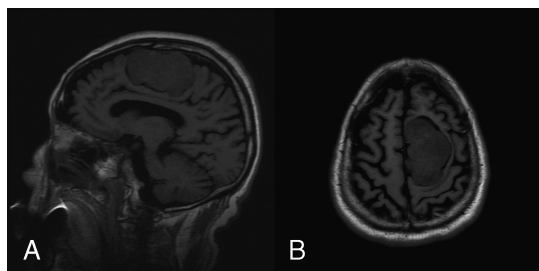
### Examination Results

All patients underwent long-term video EEG monitoring to exclude the cases which epileptogenic zone was not in the central gyrus region. Radiological examinations showed the tumor's situation. In five patients, it was beside the cerebral falx; in 6 patients, beside the superior sagittal sinus; in 3 patients, beside the falx-sinus; in 11 patients, in the cerebral convexity; and in the remaining 1 patient, beside the cerebral falx and sagittal sinus in the central gyrus region (Figs. 1A, B).

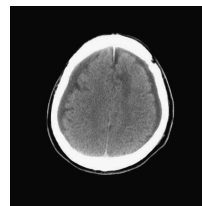
Five patients received magnetic resonance venogram. In 1 patient, the upper one third of the superior sagittal sinus was blocked due to tumor invasion, and in 1 patient, only a small portion of the superior sagittal sinus was opened and the sagittal sinus was enclosed by 2 thick draining veins each in the front and back of the tumor. Three patients received CT angiography, showing double blood supply from the external and internal carotid arteries.

### Surgical Results

The resection of the meningioma was classified by Simpson standards;<sup>3</sup> 17 of the 26 patients had grade I (Fig. 2A), 6 patients



**FIGURE 1.** Preoperative MRI of parasagittal meningioma in the central gyrus region. A, Sagittal position. B, Horizontal position.



**FIGURE 2.** Postoperative CT of a parasagittal meningioma in the central gyrus region. A, Horizontal position.

had grade II, 3 patients had grade III, and none had grade IV. Surgical results showed that the degree of tumor resection had close relation to the position of tumor limbic tissue. The position relations were displayed as follows: tumor invaded the superior sagittal sinus in 8 patients; compressed the precentral gyrus and central sulcus vein in 3 patients; was located in the front and back of the central sulcus vein in 3 and 2 patients, respectively; was located in the precentral gyrus in 1 patient; was located in the postcentral gyrus in 1 patient; was located beside the right sagittal sinus and close to the pre central gyrus in 2 patients; crossed the cerebral falx and compressed the cortex gyrus veins in 1 patient; invaded duramater and irritated skull hyperplasia in 3 patients (in 2 of the 3 patients, the hyperplastic skull was resected, and the defected skull was repaired by plastic titanium mesh); was located beside the right sagittal sinus and invaded a thick draining vein on the brain surface in 1 patient; and invaded duramater and its midline infiltrated into the superior sagittal sinus, was located behind the precentral gyrus, and enveloped the central sulcus vein in 1 patient.

### Pathologic Findings

The diagnosis of meningioma was confirmed by pathologic tissue analysis, which was based upon the World Health Organization classification system.<sup>5</sup>

Benign (grade I), 88%: meningothelial (8 patients), fibrous (8 patients), transitional (2 patients), psammomatous (2 patients), and angioloblastic (3 patients) (most aggressive)

Atypical (grade II), 8%: atypical (2 patients) (includes brain invasion) Anaplastic/malignant (grade III), 4%: anaplastic (1 patient)

### Postoperative Seizures and Clinical Outcome

All the patients got followed up; the mean follow-up was 16 months (range, 6–34 mo). In this duration, 23 of the 26 patients had no episodes of early or late postoperative seizures (Engel class I); 2 of the 26 patients had seizures twice (Engel class II). One recurrence occurred in 6 months after surgery. Karnofsky score (KS)<sup>6</sup> was used to evaluate the clinical outcome. Twenty-three patients got KS 100, 2 patients got KS 90, and 1 patient got KS 80.

## DISCUSSION

In the surgical therapy for central gyrus region meningioma with epilepsy as the primary symptom, the objective was to protect the brain functions, resect meningioma, and prevent seizure of epilepsy.<sup>7–9</sup> The tumor is located in the paracentral cortex, close to the superior sagittal sinus, and closely associated with the central sulcus vein and other important draining veins. The surgery may damage the cortex in the functional area or affect the gyrus veins in the cortex, which greatly increases the risks of postoperative disability and severe surgical complications.<sup>10,11</sup> Therefore, the key is that micro-technique should be used to process the central sulcus vein and the affected sagittal sinus.

Preoperative CT and MRI can be used to check tumor size; compression degree on brain tissues; and smoothness of the sagittal sinus, the cortex gyrus veins, and the feeding artery. Magnetic resonance venogram helps to understand the smoothness degree after the sagittal sinus is affected and the path of surrounding gyrus veins. These examinations help to process the sagittal sinus and draining veins intraoperatively and help to establish an operation scheme.

Microsurgery is the first therapeutic choice for the resection of meningioma. However, attention should be paid not only to the total excision alone but also to the intraoperative safety and postoperative quality of life and especially to the protection of the paracentral cortex, central sulcus vein, and other important draining veins.<sup>12,13</sup> Dura was cut carefully to isolate and expose tumor tissues, and adhesion was isolated from the shallower to the deeper along the arachnoid space; meanwhile, wet cotton was displaced with the filling between the tumor wall and the arachnoid so as to help isolate tumor and protect brain functions. The central sulcus vein guides the venous blood from the central gyrus to the sagittal sinus, and thus, a damage to the central sulcus vein may cause bleeding and permanent hemiplegia. If the central sulcus vein is located in 1 side of the tumor (2 patients in front and 3 patients at the back), it can be easily protected; but if it adheres closely to the tumor (in 1 patient), the arachnoid can be cut under microscope along the 2 sides of the vein to loosen the veins, and then the tumor tissues in front and behind the vein are resected into masses so as not to severely damage the central sulcus vein. If the tumor adheres strictly to the veins and cannot be isolated (in 1 patient, the tumor envelopes the central sulcus vein), then tumor slices can be reserved to avoid damage to the veins.

If an affected superior sagittal sinus is not processed, it is a major cause to postoperative recurrence, and thus, it is very important to correctly process the sagittal sinus. There are 2 relations between meningioma and sagittal sinus. (1) The tumor invades the sagittal sinus, whereas the sinus grows inward, in front of the coronal suture in the upper one third of the sagittal sinus, and despite the smooth degree of sagittal sinus, the sagittal sinus can be resected together. However, when the tumor invades the middle or the last one third of the sagittal sinus, the sinus is incompletely occluded. Many studies<sup>14–20</sup> proposed to resect the unilateral sagittal sinus wall and repair with duramater or excise the sagittal sinus and fit with autologous vein or artificial blood vessel. Most scholars advocate reserving a part of the tumor, slowly closing the superior sagittal sinus, and resecting the remaining tumor after collateral circulation is established. (2) The tumor is located in the base of the sagittal sinus lateral wall and grows outward the sinus. The part remnant on the lateral wall can be fulgerized; during fulgerization, normal saline is used for washing and cooling so as to avoid too heated fulgerization that will cause sinus thrombosis.

Modern neural physiology holds that the occurrence of epilepsy is related to the undamaged neuron membrane.<sup>21,22</sup> Therefore, a benign slow-growing brain tumor (especially meningioma) mostly induces epilepsy. However, the pathogenesis is unknown. Together with clinical and pathologic studies, meningioma may cause epilepsy in the following ways: (1) tumors are located in the spiritual, emotional, and motor area; (2) after brain tissues are damaged, the neural network forms a shortcut; and (3) fluid changes as local microenvironment changes. These 3 factors provide the condition for local abnormal discharge and induce epilepsy. Patients in this group continue to use AEDs postoperatively. According to the specific condition of a patient, the dose is gradually reduced until drug withdrawal.

When microsurgery is used to resect central gyrus region meningioma, avoiding damage to the cerebral cortex and maintaining the integrity of gyrus veins are the keys to reduce the mortality and disability rates and to improve prognosis.

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