# Surgical Treatment of Cerebellar Cavernous Malformations: A Single-Center Experience with 58 Cases

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OBJECTIVE: **The goal of this study was to discuss the surgical indications, surgical approaches, and prognostic factors of cerebellar cavernous malformation (CM).**

METHODS: **We retrospectively reviewed the presentation, surgery, and outcome of 58 consecutive patients who underwent resection of cerebellar CMs between 2009 and 2013 in our center.**

RESULTS: **The study population consisted of 31 males and 27 females, mean age 39.9 years. Fifty-eight patients experienced 67 symptomatic hemorrhages. The median diameter of all lesions was 2.2 ± 0.9 cm (range, 0.8–4.8 cm). The locations were classified into 3 groups: group 1, cerebellar hemisphere (17 cases, 29.3%); group 2, vermis (18 cases, 31.0%); and group 3, cerebellar peduncle (23 cases, 39.7%). Complete resection was achieved in all patients without surgical mortality. Postoperatively, 11 patients developed new surgical complications, including facial paralysis in 6 patients, ataxia in 2 patients, dizziness in 2 patients, and decrease in facial sensation in 1 patient. The mean modified Rankin Scale (mRS) at final follow-up was significantly improved compared with the preoperative score (0.5 ± 0.5 vs. 1.4 ± 0.7, $P = 0.035$). The symptoms and neurologic deficits improved in most patients. The lesion location was the only factor that predicted a worse outcome, and the mRS was significantly lower in group 3 than groups 1 and group 2 ($P = 0.019$).**

CONCLUSIONS: **Patients with cerebellar CMs usually achieve favorable outcomes via surgery. Cerebellar peduncle CMs cause significantly more neurologic deficits than other locations. A reasonable surgical approach and meticulous manipulation are necessary to prevent impairment of neurologic function.**

## INTRODUCTION

The prevalence of cerebral cavernous malformations (CMs) is estimated to be approximately 0.4%–0.9% (13, 37, 39). CMs account for approximately 5%–10% of all cerebral vascular malformations (4, 7, 15, 16). CMs are a hamartomatous collection of blood vessels without normal brain tissue. The surrounding brain parenchyma is often gliotic with hemosiderin staining and may contain small low-flow feeding arteries and draining veins. CMs of the posterior fossa represent 10%–20% of all cases and the brainstem is the most common site of involvement in this compartment (6, 30, 35).

In large series, cerebellar CMs constitute 9.3%–52.9% of infratentorial cases (32). Cerebellar CMs are usually analyzed together with other intracranial CMs and the outcome is considered to be relatively benign (9-11, 24, 25, 47). However, both lesion enlargement and extralesional bleeding can cause significant symptoms and neurologic deficits. There have also been reports of significant hemorrhage of cerebellar CMs (42, 45, 47). The hemorrhage risk and outcomes for surgery are unclear with respect to cerebellar CMs because the number of published series is small (11). The surgical indication remains controversial. The necessity for surgery to eliminate the risk of hemorrhage and improve neurologic functions is still being

**Key words**
- Angioma
- Cavernoma
- Cavernous malformation
- Cerebellum
- Microsurgery
- Vascular disorders

**Abbreviations and Acronyms**
CM: Cavernous malformation
DSA: Digital subtraction arteriography
DVA: Developmental venous angioma
MRI: Magnetic resonance imaging
mRS: Modified Rankin Scale

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*Citation: World Neurosurg. (2015) 84, 4:1103-1111.*
*http://dx.doi.org/10.1016/j.wneu.2015.05.062*

*Journal homepage: www.WORLDNEUROSURGERY.org*

*Available online: www.sciencedirect.com*

defined. Fifty-eight consecutive cerebellar CMs have been treated surgically in our center. We retrospectively reviewed the clinical, neuroimaging, and therapeutic aspects to better define the surgical indications, management, and outcomes of cerebellar CMs.

## MATERIALS AND METHODS

### Patient Population

During the 5 years from 2009 to 2013, 58 consecutive patients were diagnosed with cerebellar CMs and received surgical treatment at the Department of Neurosurgery of Beijing Tiantan Hospital, Capital Medical University. Surgery was performed on patients with the following indications: symptomatic; the lesion had at least 1 hemorrhage or a significant mass effect; and/or neurologic deficits; and the patient had a strong desire to have the lesion removed. Patients from the outpatient department who declined surgery or were recommended observation were not included in the study. All patients underwent preoperative magnetic resonance imaging (MRI) including standard T1-and T2-weighted sequences and gradient recalled echo or susceptibility weighted imaging, and the diagnosis of CM was established in most cases before surgery. Hemorrhage was defined as the presence of intra- or extralesional hemorrhage accompanied by a change in clinical status. All patients underwent pre- and postoperative clinical examination. The clinical course was documented using the modified Rankin Scale (mRS).

### Treatment Modalities

The surgical route for resection of a CM depended on the size and detailed localization of the CM. During surgery, the location of the lesion was detected by intraoperative ultrasonography (in 16 cases) or hemosiderin stained brain parenchyma found on the surface. Neuronavigation was applied in 3 patients. Facial nerve electromyography was used in 27 patients when lesions were located near the brainstem. Histopathologic examinations were done by 2 independent neuropathologists. Postoperative MRI scans were performed to determine the extent of resection.

### Statistical Analysis

Univariate analyses were performed to evaluate the predictors of postoperative functional status. The $\chi^2$ test was used for dichotomous variables (e.g., gender). Unpaired t-tests were used for continuous variables (e.g., age and follow-up time). Statistical analyses were performed with the SPSS Statistical Package 17.0 (SPSS Inc. Chicago, Illinois, USA). A $P$ value $<0.05$ was considered significant.

## RESULTS

### Patient Characteristics

The study population of 58 patients consisted of 31 males and 27 females. Mean patient age was 39.9 ± 14.8 years (range, 6–72 years) (Table 1). Table 2 summarizes the clinical presentation of these 58 patients. Most patients (54 of 58, 93.1%) presented with hemorrhage and related sequelae. Symptoms and signs associated with hemorrhage included headache (18 of 58, 31.0%), nausea and/or vomiting (23 of 58, 39.7%), dizziness, vertigo, or imbalance (29 of 58, 50.0%). Twenty-one patients (36.2%) had neurologic deficits, including cranial nerve deficit (ipsilateral decrease in facial sensation, facial paralysis, or diplopia), limb weakness, or paresthesia on neurologic

**Table 1.** Characteristics of the Patients

| Variable | Value |
|---|---|
| Age (years) | |
| Range | 6–72 |
| Mean ± SD | 39.6 ± 14.8 |
| Gender | |
| Male | 31 |
| Female | 27 |
| Interval to surgery (months) | |
| Range | 0–720 |
| Mean ± SD | 6.4 ± 10.1 |
| Tumor size (cm) | |
| Range | 0.8–4.8 |
| Mean ± SD | 2.2 ± 0.9 |
| Number of hemorrhages | |
| No hemorrhage | 2 |
| 1 | 45 |
| 2 | 11 |
| Lesion location | |
| Cerebellar hemisphere | 17 |
| Involving the vermis | 18 |
| Involving the cerebellar peduncle | 23 |
| Follow-up (months) | |
| Range | 6–60 |
| Mean ± SD | 32.5 ± 16.9 |

SD, standard deviation.

**Table 2.** Preoperative and Follow-up Symptoms of 58 Patients

| | Preoperative Symptoms | Symptoms at Follow-Up | Improvement (%) |
|---|---|---|---|
| Headache | 18 | 2 | 88.9 |
| Nausea and vomiting | 23 | 0 | 100 |
| Dizziness and/or ataxia | 29 | 8 | 72.4 |
| Facial paralysis | 5 | 5 | 0 |
| Decrease in facial sensation | 8 | 5 | 37.5 |
| Diplopia | 4 | 3 | 25.0 |
| Paresthesia | 5 | 2 | 60.0 |
| Limb weakness | 3 | 1 | 66.7 |