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Original Article

# Factors Associated with Recurrence of Intracranial Meningiomas After Surgical Resection: A Retrospective Single-Center Study☆

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SUMMARY

*Background:* Meningioma is one of the most common primary brain neoplasms with poor outcomes. The present study was aimed to determine clinical and surgical characteristics of intracranial meningiomas associated with tumor recurrence and complications.

*Methods:* A total of 138 patients undergoing surgical resection of intracranial meningiomas between Jan 2003 and Dec 2014 were included and followed for the period of at least 12 months. The demographic and clinical characteristics possibly associated with tumor recurrence were assessed, including age, gender, clinical symptoms, pathology data, tumor parameters, preoperative and postoperative Karnofsky Performance Scale (KPS), complications and recurrence rate.

*Results:* One hundred and twenty one lesions were benign (classified as Grade I) and 17 were atypical/malignant (classified as Grade II/III). The patients were of a mean age of 60.5 years and a mean follow-up duration of 36.8 months (range, 16.3–62.9 months). The 1, 3, 5-year recurrence/tumor enlargement rates were 3.4%, 7.2%, and 15.7%, respectively. In multivariate analysis, symptoms of disturbance of consciousness and palpable cranial mass were associated with increased recurrence/tumor enlargement. In addition, patients with Simpson grade IV were more likely to have recurrence/tumor enlargement.

*Conclusion:* The pattern of intracranial meningioma in this series is typical to other studies. Presenting symptoms is suggested to be predictive of recurrence.



## 1. Introduction

Meningioma is one of the most common primary brain neoplasms, accounting for approximately 30% of tumors in central nerve system. It arises from the cells covering arachnoid layer of brain or spinal cord, characterized by a homogeneous enhancement of mass with a dural tail on magnetic resonance imaging. Based on World Health Organization (WHO) classification of tumor, meningiomas are graded into three categories on the basis of histological features[1]. Approximately 90% of meningiomas are benign (Grade I) and have slow growth, with incidence increasing with age[2]. However, some meningiomas are considered as atypical (Grade II) and malignant (Grade III), representing a major challenge to neurosurgeons.

Surgical resection is considered as an optimal therapeutic modality for symptomatic meningioma with the aim of complete removal of tumor. Although patients with benign meningiomas have high survival rates, patients with symptomatic meningiomas suffer from postoperative complications and long-term disability[2–4]. Recurrences after extent of surgical resection are reported more frequently in patients with higher-grade tumors[4]. In cases of recurrence or incompletely removed tumors, radiotherapy and radiosurgery are recommended. Nevertheless, the factors associated with recurrent meningiomas remain sketchy.

In the present study, we determined the recurrence rate and predictive factors for recurrence of meningiomas. We reviewed and presented the results of the clinical outcomes of the patients treated conservatively in our department over a period of 12-year. We compared the characteristics of intracranial meningiomas in our series with the pattern reported in the literatures.

☆ Conflicts of interest: All contributing authors declare that they have no conflicts of interest.

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## 2. Materials and methods

### 2.1. Patients

Patients undergoing surgery for meningioma at Mackey memorial hospital between Jan 2003 and Dec 2014 were included. The study protocol was reviewed and approved by institutional review board (IRB approval number: 15MMHIS077). All patients were diagnosed with meningioma using magnetic resonance imaging (MRI), radiological modalities and computed tomographic (CT) scanning incorporating with the results of histopathological examination. Exclusion criteria were previous radiation therapy, recurrence of meningioma and presence of other malignancy.

### 2.2. Clinical parameters and outcome assessment

The demographic and clinical characteristics possibly associated with tumor recurrence were assessed, including age, gender, clinical symptoms, pathology data, tumor parameters, preoperative and postoperative Karnofsky Performance Scale (KPS), post-surgery complications and recurrence rate[5]. Focal neurologica deficit were defined as impaired function of cranial nerve, including facial palsy, hemifacial spasm, anosmia, hearing loss and ptosis.

Tumor locations were classified into following sublocations based on radiologic studies using CT or MRI, which included parasagittal, convexity, sphenoid ridge, olfactory groove, parafalcine, posterior fossa, middle fossa, cerebellopontine angle, tuberculum sella, planum sphenoidale, tentorial and intraventricular. T1-weighted MRI and CT scanning were employed to determine the maximal size of the tumor. The extent of surgical removal of tumor was classified using Simpson's scale into 5 grades[6]. All meningiomas were graded according to the WHO classification system. KPS was utilized to evaluate the pre- and post-operative clinical status. Patients with KPS above 70 were considered as in good performance status.

### 2.3. Statistical analysis

The cumulative recurrence and tumor enlargement rate were performed using the Kaplan–Meier estimates. The factors associated with recurrence/tumor enlargement were examined using the Cox proportional hazard model. When there were two or more factors with p-value less than 0.2 in the univariable Cox proportional hazard models, the factors would be included into the multivariable model by using backward conditional method. The continuous data between two age groups were tested with the independent two samples *t*-test and the Mann–Whiney *U* test, respectively for normal-distributed and non-normal distributed continuous data. The Fisher's exact test was employed to test with the associations of age group versus categorical data. A p-value less than 0.05 was considered as statistical significance. Statistical analyses were performed using the software IBM SPSS Statistics 22.0 (IBM Corporation, Armonk, New York).

## 3. Results

A total of 138 patients with intracranial meningioma were enrolled in the study, including 95 females (68.8%) and 43 males (31.2%), with a mean age of 60.5 years (SD = 12.2 years). 36 (26.1%) patients had a preoperative embolization before operation. The most frequent presenting symptom of these patients was motor deficit (n = 45, 32.6%), followed by headache (n = 38, 27.5%) and dizziness (n = 30, 21.7%) (Table 1). Of 138 patients, 60 had tumors located in convexity (43.5%), 19 patients had parasagittal meningioma (13.8%), and 13 patients were with the tumors located in sphenoid ridge (9.4%). The pathology results showed that 87.7% (n = 121) of meningiomas were benign (Grade I). 8 patients who had focal neurologica deficit were defined as impaired function of cranial nerve, including 2 facial palsy, 1 hemifacial spasm, 2 anosmia, 2 hearing loss and 1 ptosis. Detailed clinical demographics and characteristics of the patients were summarized and presented in Table 1.

**Table 1**
Demographic and clinical data for the 138 patients with intracranial meningiomas.

| | N = 138 |
|---|---|
| Age† (year) | 60.5 (12.2) |
| Gender | |
| Female | 95 (68.8%) |
| Male | 43 (31.2%) |
| Tumor volume‡ ($mm^3$) | 32.0 (13.5, 62.5) |
| TAE before operation | 36 (26.1%) |
| KPS before operation | |
| ≤70 (dependent) | 59 (42.8%) |
| >70 (undependent) | 79 (57.2%) |
| Follow-up duration after operation‡ (month) | 36.8 (16.3, 62.9) |
| Presenting symptoms | |
| Motor deficit | 45 (32.6%) |
| Headache | 38 (27.5%) |
| Dizziness | 30 (21.7%) |
| Change in behavior/memory | 19 (13.8%) |
| Seizure | 19 (13.8%) |
| Visual disturbance | 16 (11.6%) |
| Disturbance of consciousness | 15 (10.9%) |
| Nausea/vomiting | 13 (9.4%) |
| Incidental | 12 (8.7%) |
| Language dysfunction | 9 (6.5%) |
| Focal neurologic deficit | 8 (5.8%) |
| Palpable cranial mass | 4 (2.9%) |
| Sensory alteration | 4 (2.9%) |
| Syncope | 2 (1.4%) |
| Tumor location | |
| Convexity | 60 (43.5%) |
| Parasagittal | 19 (13.8%) |
| Sphenoid ridge | 13 (9.4%) |
| Parafalcine | 10 (7.2%) |
| Olfactory groove | 8 (5.8%) |
| Posterior fossa | 8 (5.8%) |
| Middle fossa | 6 (4.3%) |
| Cerebellopontine angle | 5 (3.6%) |
| Tuberculum sella | 4 (2.9%) |
| Planum sphenoidale | 3 (2.2%) |
| Tentorial | 1 (0.7%) |
| Intraventricular | 1 (0.7%) |
| Pathology | |
| Grade I: benign | 121 (87.7%) |
| Grade II: atypical | 9 (6.5%) |
| Grade III: malignant | 8 (5.8%) |
| Simpson grade | |
| I | 52 (37.7%) |
| II | 61 (44.2%) |
| III | 8 (5.8%) |
| IV | 17 (12.3%) |

Data are presented by number with percentage except for †age is presented by mean with standard deviation and ‡ non-normal distributed continuous data (tumor volume and follow-up duration after operation) are presented by median with inter-quartile range.

The median hospitalized duration after operation was 12 days (IQR in 10–18 days), and 16 patients treated with radiotherapy after operation (11.6%). The majority of post-operative complications included 16 intracerebral hematoma (11.6%) and 10 pneumonia (7.2%). At the time of discharge, 88 (63.8%) of the patients had Karnofsky scores over 70 (undependent). In addition, ninety-nine patients (71.7%) had improved outcome but 17 (12.3%) had deteriorated outcome (Table 2).

We examined the recurrence/tumor enlargement rate of each time point. As shown Fig. 1, the 1, 3, 5-year recurrence/tumor enlargement rates were 3.4%, 7.2%, and 15.7%, respectively.

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