Factors Influencing the Recurrence Rate of Intracranial Meningiomas after Surgery

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Abstract

The postoperative recurrence rate was examined in 242 patients with intracranial meningiomas to identify correlations with age, location, histology, or extent of surgery (Simpson's grade). There was no significant difference in the recurrence rate among the histological subtypes, but malignant meningiomas and hemangiopericytomas tended to recur earlier. Anterior basal meningiomas demonstrated a higher recurrence rate, but this depended on the feasibility of complete surgical removal. The recurrence rates significantly decreased in the order Simpson's grade I surgery, grade II or III surgery, and grade IV surgery (p < 0.001). These results indicate that the most important factor to influence recurrence is the extent of surgical removal.

Key words: meningioma, recurrence, Simpson’s grade

Introduction

Meningiomas are generally benign and constitute approximately 15% of intracranial neoplasms. However, clearly malignant subtypes such as hemangiopericytoma and the so-called malignant meningioma are sometimes encountered. Incomplete removal of meningioma frequently results in recurrence, but even total removal of nonmalignant meningioma is associated with a significantly high incidence of recurrence, varying from 3 to 32% in different series. This study analyzed a series of 242 intracranial meningioma patients treated at our hospital to identify factors associated with recurrence.

Patients and Methods

291 patients who underwent surgical treatment for intracranial meningioma at our hospital between 1966 and 1988 were reviewed. Forty-two patients were excluded because they were lost to follow-up, and seven died postoperatively during the hospital stay from various causes. Thus, 242 cases were available for further analysis. The extent of surgical removal was determined from the operation report and classified according to Simpson’s grading system. The histological diagnosis was based on the World Health Organization (WHO) classification. This study defined malignant meningioma as a tumor demonstrating necrosis, mitotic figures, high cellularity, brain infiltration, and loss of architecture. Papillary meningioma was also included as malignant meningioma.

Recurrence was defined as the necessity for reoperation because of neuroradiological indications of an increase in the tumor size or progressive neurological deficits following partial or total removal. Patients were classified according to age, sex, location, extent of surgery, and histology. The prognostic significance of these factors were assessed by the Kaplan-Meier method. Significant differences in the length of recurrence-free survival were assessed using the Cox-Manntel method or Student’s t-test.

Received March 29, 1993; Accepted July 5, 1993

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Results

I. Age and sex

Figure 1 shows the distribution of patients according to age and sex at the first operation, peaking in the sixth decade of life. 159 patients were females and 83 were males, with a female to male ratio of 2:1. There was no statistically significant sex difference in the time to recurrence after the first operation. There was also no significant difference in the time to recurrence between patients under 50 years old and those 50 years old or over.

II. Histology

Histological types of the 242 meningiomas are shown in Table 1. Histologically nonmalignant meningiomas also showed no significant difference in the recurrence rate among the subtypes. Six of nine (66.7%) malignant meningiomas and two of five (40.0%) hemangiopericytomas recurred, and the time to recurrence tended to be shorter than that for nonmalignant meningiomas, but the number of patients was too small for statistical analysis (Fig. 2). The time to recurrence for malignant meningiomas and hemangiopericytomas ranged from 70 days to 7 years (mean 35.5 mos), while that for nonmalignant meningiomas ranged from 4 months to 16 years (mean 71.2 mos).

III. Operation

Table 2 shows the recurrence rates in patients with different extents of removal after various follow-up periods. The rate of recurrence 20 years after the first surgery was significantly less for grade I than for grade II (p < 0.02) or IV (p < 0.01). In addition, using the Kaplan-Meier method, the recurrence rate after grade I removal was significantly (p < 0.001) less than that after grade II or III removal, while that after grade IV removal was significantly (p < 0.001) greater than that after grade II or III removal (Fig. 3).

IV. Location

The recurrence rate was higher in anterior basal meningiomas (olfactory, middle fossa, and tuberculum sellae) as compared to convexity meningiomas, but this was related mainly to the feasibility of complete surgical removal (Table 3).
Table 2: Extent of removal and recurrence in 228 meningiomas

<table>
<thead>
<tr>
<th>Extent of removal*</th>
<th>No. of cases</th>
<th>5 yrs</th>
<th>10 yrs</th>
<th>15 yrs</th>
<th>20 yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>73</td>
<td>0</td>
<td>3 (4.1%)</td>
<td>3 (4.1%)</td>
<td>4 (5.5%)*</td>
</tr>
<tr>
<td>II</td>
<td>63</td>
<td>4 (6.3%)</td>
<td>9 (14.3%)</td>
<td>10 (15.9%)</td>
<td>12 (19.0%)</td>
</tr>
<tr>
<td>III</td>
<td>38</td>
<td>2 (5.3%)</td>
<td>3 (7.9%)</td>
<td>5 (13.2%)</td>
<td>6 (15.8%)</td>
</tr>
<tr>
<td>IV</td>
<td>54</td>
<td>14 (25.9%)</td>
<td>16 (29.6%)</td>
<td>16 (29.6%)</td>
<td>16 (29.6%)</td>
</tr>
<tr>
<td>Total</td>
<td>228</td>
<td>20 (8.8%)</td>
<td>31 (13.6%)</td>
<td>34 (14.9%)</td>
<td>38 (16.7%)</td>
</tr>
</tbody>
</table>

Malignant meningiomas and hemangiopericytomas are not included. *According to Simpson's grades. **Significantly less than grade II (p < 0.02) or IV (p < 0.01).

Table 3: Location and recurrence in 228 meningiomas

<table>
<thead>
<tr>
<th>Location</th>
<th>No. of cases</th>
<th>No. of gross total removal*</th>
<th>No. of recurrences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convexity</td>
<td>47</td>
<td>46</td>
<td>1 (2.1%)</td>
</tr>
<tr>
<td>Parasagittal</td>
<td>36</td>
<td>25</td>
<td>8 (22.2%)</td>
</tr>
<tr>
<td>Falx</td>
<td>29</td>
<td>25</td>
<td>5 (17.2%)</td>
</tr>
<tr>
<td>Olfactory</td>
<td>14</td>
<td>12</td>
<td>3 (21.4%)</td>
</tr>
<tr>
<td>Sphenoidal</td>
<td>25</td>
<td>19</td>
<td>4 (16.0%)</td>
</tr>
<tr>
<td>Middle fossa</td>
<td>10</td>
<td>8</td>
<td>2 (20.0%)</td>
</tr>
<tr>
<td>Tuberculum sellae</td>
<td>20</td>
<td>11</td>
<td>6 (30.0%)</td>
</tr>
<tr>
<td>Tentorial</td>
<td>20</td>
<td>12</td>
<td>3 (15.0%)</td>
</tr>
<tr>
<td>CP angle</td>
<td>19</td>
<td>10</td>
<td>3 (15.8%)</td>
</tr>
<tr>
<td>Others</td>
<td>8</td>
<td>6</td>
<td>3 (37.5%)</td>
</tr>
<tr>
<td>Total</td>
<td>228</td>
<td>174</td>
<td>38 (16.7%)</td>
</tr>
</tbody>
</table>

Malignant meningiomas and hemangiopericytomas are not included. *Simpson's grades I–III. CP: cerebellopontine.

Discussion

The present study agrees with previous works in that the degree of removal is the most important factor in recurrence.\textsuperscript{2,19,25,27} We and others found that age and sex are irrelevant, although Kajiwara \textit{et al.}\textsuperscript{25} reported that recurrence occurred more often in patients under 40 years old or in males. The location was an important factor in recurrence because anterior basal meningiomas can only be removed subtotally or partially.\textsuperscript{19}

Borovich \textit{et al.}\textsuperscript{3} suggested that meningiomas locally recur as regrowth within the limit of the previous dural flap, so wide resection of the dura around the attachment zone of the meningioma might reduce the recurrence rate. Recently, Goldsher \textit{et al.}\textsuperscript{8} found that gadolinium-enhanced magnetic resonance imaging of meningiomas showed a linear enhanced structure, the so-called "meningeal tail sign," in 18 of 30 cases, and suggested that this is a highly specific feature of meningiomas. Though this sign is frequently found to correlate with tumor infiltration along the dural surface, the precise pathological explanation is controversial. This radiological sign may be important for surgical treatment.

The histological malignancy of meningiomas is not always a useful guide to the clinical behavior, and the histological features that indicate malignancy in meningiomas have long been debated.\textsuperscript{4,12,26} De la Monte \textit{et al.}\textsuperscript{7} reported that histological features such as large prominent nucleoli, tumor growth in sheets, individual cell necrosis, and nuclear pleomorphism indicate that subtotally removed nonmalig-
nant meningiomas will recur. Jaaskelainen et al. found a significant difference in the recurrence rate in their series of 936 tumors, of which 93% were benign, 4.7% atypical, and 1.0% anaplastic according to WHO criteria. Histologically benign tumors recurred in 3% at 5 years; atypical tumors, 38% at 5 years; and anaplastic tumors, 78% at 5 years. The measurement of cell kinetics by bromodeoxyuridine (Brdu) labeling and Ki-67 immunoreactivity has been used to estimate the proliferative potential and risk of recurrence of meningiomas, as well as other human brain tumors, and a high Brdu or Ki-67 labeling index is thought to be related to recurrence and malignancy.18) Recently, the argyrophilic nucleolar organizer region (Ag-NOR) staining method, apparently a simple and useful method for differentiating between high and low malignancy grades in various tumors,9,11,20) has been applied to meningioma specimens.11,20) We previously found that the mean number of Ag-NOR per nucleus may be of value in predicting the recurrence of histologically nonmalignant meningiomas.11

This study indicates that a greater extent of surgical removal will reduce the probability of recurrence of meningioma, but histological malignancy may also be important.

References

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Neurol Med Chir (Tokyo) 34, February, 1994


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