Intraventricular Meningiomas in Adults - Clinical Series and Review of the Literature

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Abstract

Background: Intraventricular meningiomas are rare tumors and pose clinical, radiological, and surgical challenges. Individualized approach helps to establish successful results. Methods: Thirteen patients underwent craniotomy for intraventricular meningioma resection from 1999 to 2007. The mean age was 45 years (23-64), time of presentation between 25 days to three years. There were ten females and three males. Headaches and seizures were the most frequent initial presentations. Tumors were located in the ventricular trigone in 11 patients and in the temporal horn in two. Results: There were seven posterior temporal and seven parieto-occipital transcortical craniotomies, one patient was operated two times. Resection grade was Simpson I in nine patients, Simpson II in four, and Simpson III in one case. Surgical mortality was zero. There were six complications. Two patients had ventriculitis, one patient had hematoma of the surgical bed, one patient had severe post-operative cognitive impairment and one presented with progression of motor deficits. In two patients, there was transient memory disturbance after the parieto-occipital approach. Conclusion: Correct understanding of microsurgical anatomy cooperates for further success in operation of intraventricular meningiomas. Pre-operative embolization is helpful to reduce bleeding when a suitable tumor feeder can be accessed with no reflux. Dynamic changes in the shape of the ventricular cavity have to be considered when planning the most suitable route. Rigorous hemostasis and ventricular drainage are important points to avoid main complication.

Key words: meningiomas, intraventricular, embolization, surgery.

Introduction

Intraventricular tumoral location is rare and accounts for 0.5% to 5% of all intracranial meningiomas. As compared to other intraventricular tumors, meningiomas are responsible for 20 to 30% of the cases and its incidence is higher in childhood and adolescence. Although meningiomas constitute only 1% to 4% of all intracranial tumors in pediatric age, intraventricular location is observed in 9.4% to 22% of all children. The is marked female predominance in all series presented.

Since intraventricular meningiomas are slow-growing tumors, they are generally large and silent at presentation. The most common location is the lateral ventricles, although they can be appreciated in the third and fourth ventricles as well. Reported topographic distribution is 77.8% in the left lateral ventricle atrium, 15.6% in the third ventricle, and 6.6% in the fourth ventricle.

We present our clinical series and discuss current literature in support of avoidance of complications, technical surgical and radiological approaches to these tumors.

Material and methods

Clinical materials

We analyzed primary intraventricular meningiomas in adults. In our series, we excluded falcine and tentorial secondary tumors.

At Hospital das Clínicas of the University of São Paulo, Division of Neurosurgery, we operated thirteen patients with diagnosis of intraventricular meningioma from 1999 to 2007. The Pediatric Neurosurgery group in our Institution manages all the meningiomas at their res-
The mean age was 45 years old (23-64 years old). There were ten females and three males. Duration of symptoms was between 25 days and three years. All tumors were located in the lateral ventricles. Headache was present in 12 patients. In four, there were signs of intracranial hypertension (vomiting). Three patients presented with cognitive impairment at onset. Three patients presented with motor impairment, manifested as hemi or monoparesis. Four patients presented with seizures. Papilledema was seen in seven patients, corticospinal signs in six, and homonymous hemianopia in four. Tumors were predominant on the left hemisphere (9 patients), in the ventricular trigone in 11 patients, in the temporal horn in two. In many occasions, diagnosis was delayed since complaints were transient or episodic. Complete clinical, radiological, histological and surgical characteristics are shown in Table 1.

On brain MRI, isointense signal was seen on T1 in ten patients, hypo signal in three, and Gadolinium enhancement on T1 in all patients. MRI angiography showed increased vascularization in 10 patients and hypo vascularization in three. In all patients, including the ones with tumors within the temporal horn, there was enlargement of the posterior choroid artery.

Results

Fourteen surgeries were performed in thirteen patients. There were seven posterior temporal and seven parieto-occipital transcortical craniotomies. Resection grade was Simpson I in nine cases, Simpson II in four, and Simpson III in one case. The patient with Simpson III resection grade underwent reoperation. There was no mortality. Complications were seen in 8 of 14 cases. Two patients had ventriculitis, one hematoma in the surgical bed, one had severe cognitive impairment post-surgery, and one presented with additional motor deficits. In two patients, there was transient memory disturbance after the parieto-occipital approach.

Discussion

Symptoms and Signs

The histological origin of intraventricular meningiomas is uncertain. The choroid plexus stroma or remains of arachnoid within the choroid are the most likely histological origins of these tumors and may explain their predominant topography within the ventricular trigon. Most of the clinical symptoms of intraventricular meningiomas are related to increased intracranial pressure. Mass effect due to direct pressure on adjacent brain structures is another common clinical manifestation. They are slow growing tumors and reach a substantial size prior to becoming symptomatic. Symptoms may occur earlier if the tumor is located near a zone of cerebrospinal fluid (CSF) outflow. On literature review, duration of symptoms ranged from a few days to several years. Cardinal symptoms were signs of increased intracranial pressure (86%), followed by corticospinal tract signs (43%), visual field defects (36%), cognitive changes (29%), and seizures (7%) [3,38,45]. We had similar clinical presentation in our case series. There are few cases reported of intraventricular meningioma in adults [1,18]. There is rare association with intracranial hemorrhage [42-44]. Due to the rarity of these tumors, autopsy findings are scarce [45]. Case seven in our series presented with a primary intraventricular hemorrhage. Post-surgical pathological finding suggested a meningothelial meningioma. The tumor was highly vascular with an increased pattern of angiomatos and cavernous vessels. Subarachnoid hemorrhage at presentation was described in a few case series [46].

Differential diagnosis

The most important differential diagnosis is the Intraventricular solitary fibrous tumor [46,48]. Intraventricular meningioma is the most common trigon intraventricular tumor in adults [49].

The differential diagnosis of lateral trigon ventricular tumors and should include choroid plexus papilloma in patients under 10 years of age; low-grade gliomas, such as ependymoma, oligodendroglioma, and low-grade astrocytoma, in patients between 10 and 40 years of age; and metastases and lymphoma after the fourth decade of life [42,45,50].

Pathology

Histopathological features of these tumors are similar to those seen in meningiomas in other locations [46].

Bertalanfy found that most of intraventricular meningiomas were meningothelial, transitional (mixed), or lymphoplasmacyte-rich meningiomas (81%). Three tumors were classified as atypical (19%) and the MIB-1 proliferation index ranged from 1% to 40% [8]. In five of our cases, MIB-1 ranged from 1% to 5%. In the atypical tumors, the values were 13% in average. The same percentages have been demonstrated for meningiomas in other locations [61,52]. MIB-1 was not evaluated in eight cases.

Rare pathological types, such as rhabdoid, osteoblastic and chordoid types have been described [2,24,53]. In our series the majority were benign (12/13). There were nine meningothelial meningiomas, two transitional, and one fibrous. There was one atypical meningioma with secondary malignant transformation by occasion of the second surgery.

Pre-operative embolization

Pre-operative embolization of intracranial meningiomas has been performed since the late 1960s [54]. Better understanding of the angiographic anatomy, abnormal connections between the internal and external carotid artery systems, as well as potential communications between the carotid and vertebral arteries allowed for a better understanding of the potential dangers associated
with those therapies. When performed for the right conditions, it allows better tumoral resection with significant decrease in intra-operative hemorrhage.

Embollization of tumors supplied by intracranial vessels, in particular distal carotid artery branches or the choroid arteries carries the risk of embolization of unwanted vascular territories and development of permanent neurological deficits. Oyama et al, in 1992, described a successful embolization of a fibroblastic meningioma fed primarily by the anterior choroid artery. There was a small amount of hemorrhage during surgery and no permanent deficits after the combined therapy \(^{[66]}\). Correct understanding of the angiographic anatomy, possible unwanted anatomical connections, and utilization of a precise angiographic technique with the utilization of flow-directed catheters (smallest available is 1.2F in external diameter), the right embolic agent, and correct surgical planning after embolization. Attention for agent reflux is a crucial aspect of embolization, since the embolic agent may suddenly occlude an important cortical vessel. Pre-operative embolization for these tumors is, therefore, usually feasible.

**Surgery**

Bhatoe et al, 2006 presented a series of 12 intraventricular meningiomas (IVM). In their experience, a parieto-occipital (trigon) craniotomy should be performed through for lateral ventricular, transcortical-transventricular route for third ventricular, and sub-occipital craniotomy for fourth ventricular tumors \(^{[1]}\). Trigon IVMs are most commonly resected via intra-

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### Table I:
Clinical, radiological, and surgical results present on patients with intraventricular meningiomas (F: Female; M: Male)

<table>
<thead>
<tr>
<th>Case</th>
<th>Age/sex</th>
<th>Figure Number</th>
<th>Presenting symptoms</th>
<th>Histology</th>
<th>Localization in ventricle</th>
<th>Surgery and grade of resection</th>
<th>Surgical Approach</th>
<th>Postoperative course</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28/F</td>
<td>Figure 2</td>
<td>Headache, mild hemiparesis, and visual disturbance</td>
<td>Fibrous/Benign</td>
<td>Left trigone</td>
<td>Transcranial parieto-occipital approach</td>
<td>Simpson I</td>
<td>Simpson I</td>
</tr>
<tr>
<td>2</td>
<td>59/F</td>
<td>Figure 3</td>
<td>Sudden onset of headaches, associated with primary intraventricular hemorrhage on head CT</td>
<td>Meningothelial/Benign</td>
<td>Left trigone</td>
<td>Transcranial parieto-occipital</td>
<td>Simpson II</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>28/M</td>
<td></td>
<td>Headache and vomiting</td>
<td>Meningothelial with extensive areas of pia-mater, Benign</td>
<td>Right trigone</td>
<td>Posterior temporal gyrus approach</td>
<td>Simpson I</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>33/F</td>
<td></td>
<td>Headache + seizure + vomiting</td>
<td>Meningothelial/Benign</td>
<td>Right trigone</td>
<td>Posterior temporal gyrus approach</td>
<td>Simpson I</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>54/F</td>
<td>Figure 4</td>
<td>Headache + seizure</td>
<td>Meningothelial/Benign</td>
<td>Left trigone</td>
<td>Transcranial parieto-occipital approach</td>
<td>Simpson II</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>48/F</td>
<td></td>
<td>Headache + vomiting</td>
<td>Meningothelial/Benign</td>
<td>Right trigone</td>
<td>Posterior temporal gyrus approach</td>
<td>Simpson II</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>61/F</td>
<td>Figure 5</td>
<td>Headache + cognitive changes + Hemiparesis + visual disturbance</td>
<td>Meningothelial/Benign</td>
<td>Left temporal horn</td>
<td>Posterior temporal gyrus approach</td>
<td>Simpson I</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>56/F</td>
<td></td>
<td>Seizure + cognitive changes + visual disturbance</td>
<td>Transiental/Benign</td>
<td>Left Temporal horn</td>
<td>Posterior temporal gyrus approach</td>
<td>Simpson II</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>34/M</td>
<td>Figure 6</td>
<td>Headache + vomiting + mild hemiparesis + visual disturbance</td>
<td>Malignant at second surgery (after 3 weeks)</td>
<td>Right trigone and Right temporal horn</td>
<td>First surgery, posterior temporal gyrus. Second, transcortical parieto-occipital</td>
<td>Simpson III first surgery, Simpson I second</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>48/F</td>
<td></td>
<td>Headache and mild hemiparesis</td>
<td>Meningothelial/Benign</td>
<td>Left trigone</td>
<td>Transcranial parieto-occipital approach</td>
<td>Simpson I</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>58/F</td>
<td></td>
<td>Headache + seizure + mild hemiparesis</td>
<td>Meningothelial/Benign</td>
<td>Left trigone</td>
<td>Transcranial parieto-occipital approach</td>
<td>Simpson I</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>48/F</td>
<td>Figure 7</td>
<td>Headache + mild hemiparesis</td>
<td>Meningothelial/Benign</td>
<td>Left trigone</td>
<td>Posterior temporal gyrus approach</td>
<td>Simpson I</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>64/F</td>
<td>Figure 8</td>
<td>Headache + cognitive changes</td>
<td>Transiental/Benign</td>
<td>Left trigone</td>
<td>Transcranial parieto-occipital approach</td>
<td>Simpson I</td>
<td></td>
</tr>
</tbody>
</table>
parietal/inter-parietal or parietal-occipital approach. Neuronavigation based on pre operative exams is very useful for precise localization and avoidance of neurological morbidity, but during the tumor removal and dynamic brain shift it is not suitable anymore. Since the majority of the tumors are on the dominant side, determination of the best surgical avenue is very helpful in achieving the maximal surgical respectability with the minimal risk. Bertalanfy et al utilized neuronavigation in 8/16 of their patients. This was the preferred route for lateral ventricular tumors, due to the shorter distance from the cerebral cortex to the tumor. If we cannot determine the shorter surgical route, we choose the temporal access for right-sided and parieto-occipital for left side lesions, avoiding the dominant arcuate fascicle, involved in cognitive tasks.

We believe that the parieto-occipital route for left lateral ventricular meningiomas mainly is a safe surgical approach and is not commonly associated with post-operative visual deficits. Neuronavigation and intra-operative ultrasound have been excellent technological advances in the safe resection of these lesions. Neuronavigation was utilized in our last case and intra-operative ultrasound in eight of the 13 cases.

Piecemeal tumor removal can be easily achieved. Special intra-operative attention should be paid to the choroid vessels. Once significant tumor debulking occurs, devascularization ensues. There should be constant monitoring for development of hydrocephalus or ventricular sequestration. Continuous post-operative external ventricular drainage avoids some of the complications appreciated with hydrocephalus.

Functional MRI is helpful in the surgical planning and avoidance of the optical tract. In our series, MRI tractography was useful in planning the surgical assessment between the optic radiation and the splenium of the corpus callosum in case 13.

Figure 1: Surgical and clinical management algorithm of intraventricular meningiomas

Figure 2: Case 5 – 54 year old female patient with small left trigone meningioma. Figure 2A: Supine position and surgical view demonstrate occipito-parietal sulcus resection; Figure 2B: After plan dissection, the tumor capsule is identified and the tumor is resected along its cleavage plan, as demonstrated on the figure.

Figure 3: Case 7 - 51 year old female patient. Figure 3A: Preoperative CT scan shows a large left peri-cortical ventricular meningioma. The posterior temporal gyrus approach was chosen to avoid cortical damage; Figure 3B: Postoperative CT shows complete tumor removal and small area of pneumocephalus.
Outcome

One of our cases had the diagnosis of atypical meningioma at first operation and malignant recurrence on reoperation, three months afterward. Drop subarachnoid metastasis of intraventricular meningiomas has been described in the literature (8,60,61). The clinician should continuous follow-up for development of further neurological symptoms even though these tumors have a high likelihood of benign outcomes.

Conclusions

Intraventricular meningiomas in adults are rare. Suitable surgical plan based on neuroradiological information and correct judgment is the main point for successful outcome. Main complication can be avoided using ventricular drainage, rigorous hemostasis and careful management of blood pressure.

Table II: Review of the main case series in the literature. (F: Female, M: Male, N: Number of Cases, NA: Not Available)

<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Number of Cases</th>
<th>Period of Treatment</th>
<th>Mean Age (years)</th>
<th>Gender</th>
<th>Left</th>
<th>Trigone or left ventricle</th>
<th>Temporal horn</th>
<th>3rd Ventricle</th>
<th>Foramen of Monro</th>
<th>Posterior fossa or 4th Ventricle</th>
<th>Total resection</th>
<th>Main access to trigone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nakamura</td>
<td>2003</td>
<td>16</td>
<td>1976-2001</td>
<td>41.7</td>
<td>6/4M</td>
<td>13</td>
<td>11</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>15</td>
<td>Truncortical parieto-occipital -11 cases</td>
</tr>
<tr>
<td>Erman</td>
<td>2004</td>
<td>8</td>
<td>1965-2003</td>
<td>44.6</td>
<td>67/2M</td>
<td>7</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>Truncortical parieto-occipital -0 cases</td>
</tr>
<tr>
<td>Bertalanffy</td>
<td>2008</td>
<td>16</td>
<td>1980-2004</td>
<td>44</td>
<td>19/15M</td>
<td>15</td>
<td>14</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>15</td>
<td>Truncortical parieto-occipital/interparietal</td>
</tr>
<tr>
<td>Bhatie</td>
<td>2006</td>
<td>12</td>
<td></td>
<td>34.6</td>
<td>9/3M</td>
<td>9</td>
<td>9</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>NA</td>
<td>Truncortical parieto-occipital</td>
</tr>
<tr>
<td>Liu</td>
<td>2006</td>
<td>25</td>
<td>1989-2003</td>
<td>39</td>
<td>19/1M</td>
<td>24</td>
<td>20</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>24</td>
<td>Truncortical parieto-occipital -0 cases</td>
</tr>
<tr>
<td>Lyngdoh</td>
<td>2007</td>
<td>9</td>
<td>1989-2003</td>
<td>34.6</td>
<td>15/4M</td>
<td>7</td>
<td>7</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>Interparietal – 02 cases</td>
</tr>
<tr>
<td>Present study</td>
<td>2008</td>
<td>13</td>
<td>1999-2007</td>
<td>40.2</td>
<td>10/3M</td>
<td>13</td>
<td>11</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>Truncortical parieto-occipital -07 cases</td>
</tr>
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</table>

Reference List