Meningiomas of the lateral ventricles

Neuroradiological and surgical considerations in 18 cases

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The clinical and neuroradiological findings and the surgical results in a series of 18 patients with meningiomas of the lateral ventricles, operated on over a 23-year period, are described. This experience is compared with previously reported series and the following conclusions are drawn: 1) these tumors have no characteristic symptomatology; 2) the preoperative diagnosis should be reached by means of both computerized tomography and carotid and vertebral angiography; 3) the safest surgical approach is through a sagittal paramedian parieto-occipital cortical incision; and 4) piecemeal removal is crucial for achieving total extirpation of the tumor with minimum damage of the surrounding brain tissue and for careful intraoperative hemostasis.

KEY WORDS : meningioma · lateral ventricle · carotid angiography · vertebral angiography · computerized tomography

MENINGIOMAS of the lateral ventricles are uncommon tumors. They represent about 2% of intracranial meningiomas, which, in their turn, account for 13% to 18% of all intracranial tumors. Most of the reports dealing with this subject are not recent. We reviewed 18 cases of meningiomas of the lateral ventricles operated on at the Neurological Institute of Milan from 1956 through 1978 (1.5% of the 1175 intracranial meningiomas operated on in that period) with special regard to the neuroradiological diagnosis and the surgical approach.

Summary of Cases

Clinical Features

The patients ranged in age from 12 to 60 years, with the greatest incidence in the fifth and sixth decades (11 cases). Fourteen were women and four men. In six cases, the tumor was in the right lateral ventricle, in 12 in the left.

The initial symptoms were: headache in eight patients, mental deterioration in five, focal deficits in three (hemiparesis, incoordination of limbs, and speech difficulty in one each), and epileptic seizures in two. One of the latter had a single generalized motor seizure, preceded by visual hallucinations, and the other had a 20-year history of partial motor seizures of the arm, on the same side as that where the tumor was unexpectedly found. Six patients had transient symptoms and signs: four had headaches and two had episodes of hemiparesis contralateral to the tumor side. The interval between the first symptom and admission ranged from 2 months to 20 years (average duration, 36 months), and in 10 cases it was less than 1 year.

At the time of admission, the presenting symptoms were: headache in 12 cases, personality changes in seven, speech difficulty in five, motor deficits in three, and epileptic seizures in two (Table 1). The neurological deficits were never severe, except in one patient who had already been operated on in another hospital. In this patient, the tumor, which was located in the dominant hemisphere, had not been reached and the bone flap had been removed as a decompressive measure. The patient came to us with mental deterioration, severe speech difficulty, right hemiparesis, unsteady gait, and a markedly bulging decompression site.
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**TABLE 1**

Neurological signs present on admission in 18 cases

<table>
<thead>
<tr>
<th>Neurological Signs</th>
<th>Cases No.</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>contralateral motor deficits</td>
<td>14</td>
<td>78</td>
</tr>
<tr>
<td>visual field defects*</td>
<td>12</td>
<td>67</td>
</tr>
<tr>
<td>mental deterioration</td>
<td>10</td>
<td>56</td>
</tr>
<tr>
<td>incoordination of limbs, ataxia, tremor</td>
<td>8</td>
<td>44</td>
</tr>
<tr>
<td>speech difficulty</td>
<td>7</td>
<td>58†</td>
</tr>
<tr>
<td>papilledema</td>
<td>6</td>
<td>33</td>
</tr>
<tr>
<td>contralateral sensory deficits</td>
<td>4</td>
<td>22</td>
</tr>
</tbody>
</table>

*Homonymous hemianopsia in 11 cases, quadrantanopsia in one case.
†Percentage refers to the 12 cases with tumor in the dominant hemisphere.

Diagnostic Investigations

**Electroencephalography.** Electroencephalography (EEG) was performed in 16 of the 18 patients. In all but one who had bilateral slow waves, the records clearly showed delta foci and/or focal epileptiform activity on the posterior regions on the tumor side.

**Cerebrospinal Fluid Studies.** The cerebrospinal fluid (CSF) was examined in four patients, and was normal in each case.

**Radionuclide Brain Scan.** Radionuclide brain scan was performed in six of the 18 patients and demonstrated increased uptake in the deep temporoparietal regions.

**X-Ray Film.** Plain skull film examination showed no abnormalities in 11 cases, but sellar changes consistent with increased intracrani pressure were seen in seven. There was no correlation with papilledema or with the duration of the clinical history. In two cases the pineal gland was displaced contralaterally. Calcifications in the tumor were found in only one patient.

**Pneumoencephalography.** Five patients underwent pneumoencephalography (PEG), but in only two did it lead to the correct diagnosis of intraventricular tumor. In one case, PEG resulted in the misdiagnosis of deep parietal tumor bulging into the ventricle; in two cases, it was inconclusive because the ventricle on the tumor side was not visualized.

**Ventriculography.** Air ventriculography was performed in four cases, leading in three to the correct diagnosis of intraventricular tumor. In the fourth case, the tumor was punctured and intraventricular bleeding occurred, with catastrophic consequences.

**Carotid Angiography.** Carotid angiography was performed in 17 cases. After 1970, this investigation always led to the correct preoperative diagnosis. Of the first nine cases, studied before 1970, the correct diagnosis was made only in three; in the other six, it was mistakenly concluded that the tumors were deep-seated intrinsic tumors of the temporal or parietal lobe. However, on later review, characteristic or at least highly indicative angiographic features of intraventricular tumor were recognized in five of the six cases. The exception was the patient who had previously been operated on elsewhere, whose repeated angiography at our hospital showed a large avascular mass lesion deep in the parietal region; the posterior cerebral artery was also visualized by carotid injection, but there were no changes in the anterior or posterior choroidal arteries, which were small and did not supply any pathological circulation.

The features characteristic of intraventricular meningiomas, observed in 16 of 17 cases, consisted of enlargement, tortuosity, and displacement of the anterior choroidal artery, which supplied a circulation that was shown to be pathological to some degree.

On the lateral view, the anterior choroidal artery usually appeared displaced both in the cisternal and ventricular segments. The cisternal and the initial intraventricular segments were displaced upward by the dilated temporal horn, which was occluded by the tumor, and were pushed forward by the tumor itself. In the ventricle, the plexal branches usually surrounded the anterosuperior portion of the tumor, but in three cases the largest artery of the plexus was displaced downward and surrounded the tumor from below (Fig. 1).

The anterior choroidal artery supplied a pathological circulation in all cases, appearing as a stain of varying intensity projecting into the temporoparietal regions. Even in the three cases in which the anterior choroidal artery was thin, a faint pathological circulation could be detected by subtraction technique (Fig. 2A, B, and C). The tumor vascular blush was clear enough to completely delineate the tumor in five cases (Fig. 2D). Stereoscopic views were essential for the recognition of the origin of the pathological circulation from the anterior choroidal artery (Fig. 3).

The middle cerebral artery usually showed splaying of the posterior temporal and angular gyrus branches, and elevation of the Sylvian point. In a few cases, the marked upward displacement of the middle cerebral artery, produced by ballooning of the obstructed temporal horn, together with the tumor circulation in the trigonal region, gave rise to the "double tumor sign" (Fig. 1A).

In the anteroposterior view, the anterior choroidal artery was displaced medially or laterally with equal frequency to surround the medial or lateral aspect of the tumor (Fig. 4). Displacement of the anterior cerebral artery across the midline was either absent or moderate, certainly less than would be expected with an intraparenchymal tumor of the same size.

In four cases, carotid angiography also demonstrated the posterior cerebral artery and the lateral...
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FIG. 1. Carotid angiograms of two different patients, lateral views. A: The anterior choroidal artery (arrowheads) and middle cerebral artery are elevated and pushed forward mainly by the dilated temporal horn. The meningioma of the trigone, outlined in part by a pathological circulation (arrows), is surrounded anteriorly by plexal branches of the anterior choroidal artery. B: In this case, the anterior choroidal artery (arrowheads) surrounds the inferior and posterior aspect of the meningioma, reaching from behind its superior pole.

posterior choroidal artery. This vessel was normal in the patient who was initially treated elsewhere, whereas in the other three its curve was reversed, as will be described later.

In the venous phase, on the lateral view the internal cerebral vein appeared stretched, straightened, and displaced inferiorly and to the side away from the tumor. The great cerebral vein of Galen was elongated and straightened. In the anteroposterior view, the thalamostriate vein was less displaced and elongated than were the atrial veins surrounding the tumor, because the frontal horn of the ventricle was not generally much enlarged. However, the subependymal atrial veins did not always fill sufficiently because of the direct compression by the tumor. Therefore, the entirely intraventricular location of the tumor (that is, the tumor blush surrounded by the atrial veins) was unquestionably demonstrated in only four cases (Figs. 5 and 6).

Vertebral Angiography. Seven patients underwent vertebral angiography, leading to the correct diagnosis in all cases. On the lateral view, the lateral posterior choroidal artery was seen to be enlarged and displaced forward, and its curve was always reversed, exhibiting a large marked anterior convexity (Figs. 7 and 8). Adding these seven cases to the four in which the artery was visualized by carotid angiography, we found that the curve of the vessel was reversed in 10 of 11 cases. The circulation to the tumor, although it was visualized in all seven cases, was less clearly seen than by carotid angiography, and in five cases only the inferior part of the tumor was demonstrated (Fig. 7C).

In the other two cases, extensive pathological circulation was demonstrated.

On the anteroposterior view, the lateral posterior choroidal artery appeared either in its normal position or displaced medially or laterally with equal frequency (Figs. 7 and 8). A collateral finding in large tumors was the inferomedial displacement and stretching of the posterior cerebral artery and of its temporal branches. In two cases, compression of the artery against the tentorium impaired distal filling.

Computerized Tomography. Computerized tomography (CT) was performed in the last three cases. The intraventricular site of the tumor was easily detected in all of them because of the dilatation of the temporal and/or occipital horns and because of a recognizable attachment of the tumor to the choroid plexus in the two smaller lesions (Figs. 9 and 10). In these two cases, the tumor was hyperdense and had well defined margins, with marked uniform enhancement after contrast-medium injection. In one of these cases we observed calcifications, and in the other a decrease in the attenuation values of the white matter surrounding the tumor. In the third case, the tumor was enormous and, although hyperdense and with fairly sharp margins, it contained small isodense patchy areas that did not enhance like the bulk of the tumor (Fig. 11).

Comment. The neuroradiological investigations led to the correct preoperative diagnosis of intraventricular tumor in 13 cases. The tumor was misdiagnosed in five cases, where it was considered to be a deep-seated temporal tumor in two cases, and a deep-seated
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FIG. 2. A, B and C: Carotid angiography, lateral view, in the same patient. A: Arterial phase. The anterior choroidal artery (arrowheads) is very thin in the initial intraventricular segment, and becomes tortuous and convoluted around the tumor. B: Late arterial-capillary phase, showing irregular tumor circulation (arrowheads). C: Venous phase. A uniform tumor blush is clearly seen (arrowheads). A lateral atrial vein (arrows) surrounds the tumor. D: Right brachial angiography, lateral view, venous phase. In this different case a large tumor (arrowheads) presents an intense stain in its anterior part, and a fainter stain in its posterior segment.

parietal tumor in three. Four of these five cases were studied by carotid angiography before 1970, and on later review demonstrated characteristic signs of intraventricular tumor.

Surgical Treatment

In the two cases in which the tumor had been incorrectly diagnosed as located deep in the temporal horn, the lesion was reached by temporoparietal craniotomy and a straight incision along the posterior portion of the middle temporal gyrus. In one of these cases, the tumor was found in the left trigone and in the other in the right temporal horn.

In the 16 cases in which the correct diagnosis of intraventricular tumor (13 cases) or the misdiagnosis of deep-seated tumor of the parietal lobe (three cases) was made, a parieto-occipital craniotomy was performed. In two of these 16 cases (the first patient in the series and the patient operated on elsewhere), the tumor was reached by the removal of a portion of the occipital lobe, 4 to 5 cm in diameter. In the other 14

FIG. 3. Carotid angiography, lateral view. Examination of the whole sequence, but especially the stereoscopic views, allows identification of the full course of the anterior choroidal (black arrows) and lateral posterior choroidal (open arrows) arteries.
FIG. 4. Carotid angiograms of two different patients, anteroposterior views. A: The anterior choroidal artery (arrowheads) runs a rather medial course, reaching from behind the superior medial aspect of the tumor. Same case as in Fig. 1B. B. In this case, the anterior choroidal artery (arrows) surrounds the inferior lateral aspect of the meningioma. Same case as in Fig. 3.

FIG. 5. Carotid angiography, venous phase. Left: Lateral view, showing flattening and depression of the internal cerebral vein, which is minimally displaced contralaterally on the anteroposterior view. Right: Anteroposterior view. Arrowheads surround a faint, uniform tumor blush. The thalamostriate vein (single arrow) indicates a ventricle of fairly normal size in front of the tumor. A medial atrial vein is indicated by two arrows.
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FIG. 6. Carotid angiography, venous phase. Lateral view (left) and anteroposterior view (right). Open arrows surround the tumor blush which extends anteriorly into the pars centralis. The medial atrial vein (two arrows), much more elongated than the thalamostriate vein (single arrow), indicates a marked enlargement of the trigone and of the occipital horn. Arrowhead points to an irregular vein which surrounds the lateral aspect of the tumor.

cases, the tumor was reached through a sagittal paramedian incision in the parietal cortex, at a distance of 3 to 4 cm from the interhemispheric fissure and extending for 4 to 5 cm from 1 cm behind the postcentral fissure as far as the parieto-occipital fissure. In all 16 cases, the tumor was found in the trigone. The tumors were operated on by several surgeons but mostly by one of us (G.M.).

Complete removal was achieved in all the cases. In five cases removal was en bloc, and in 13 cases piece-meal. In these last cases the feeding vessels were clipped when the tumor had been reduced in size and could be mobilized. The meningiomas were all large, measuring from 5 to 10 cm in diameter. Five tumors were fibromatous, four were endotheliomatous, and nine were mixed in type.

FIG. 7. Vertebral angiography in one patient. Left: Anteroposterior view, arterial phase. The left lateral posterior choroidal artery (arrows) is stretched and runs first laterally and then medially over the superior aspect of the tumor. Center: Lateral view, arterial phase. Typical inverted curvature of the lateral posterior choroidal artery, which surrounds the anterior aspect of the tumor with an anterior convexity. Arrowhead indicates a medial posterior choroidal artery with a fairly normal course. Right: Lateral view, venous phase, showing a uniform tumor blush (arrowheads).
Surgical Results

Four patients, all of whom had undergone removal en bloc, died immediately or shortly after the operation. One of them had undergone ventriculography, in the course of which heavy bleeding occurred through the burr hole. Surgery followed at once: the tumor was excised en bloc, an intraventricular hematoma was removed, and a portion of the infarcted occipital lobe was amputated, but the patient died during the operation. Two patients who were neurologically intact immediately after the operation died suddenly without warning, one on the 1st and the other on the 3rd postoperative day. In one of these, a large intraventricular hematoma was found at autopsy; in the other, permission for autopsy was not granted. The fourth patient remained well until the 9th postoperative day, when he exhibited mydriasis on the tumor side, contralateral hemiparesis, and rapid impairment of consciousness. A large intraventricular hematoma was immediately removed and the infarcted occipital pole amputated. The patient’s neurological condition improved greatly, but 40 days after the operation he died of bronchopneumonia. The overall mortality was 22%.

The follow-up period for the 14 surviving patients ranged from 1 to 15 years (average, 4 years). No recurrence was observed. The operation caused no lasting motor deficits or speech difficulties. Preexisting motor and speech deficits disappeared in almost all the patients. In three cases, only mild weakness remained, and in the patient previously operated on in another hospital the speech difficulty remained unchanged. After surgery, the visual field defects cleared in one patient and were unchanged in seven; there were permanent defects in five and none in one. Personality changes disappeared in all cases. Four patients (29%) had postoperative epileptic seizures, which were controlled by appropriate antiepileptic medications. All the survivors, except for the patient with severe speech difficulties, resumed normal life.

Twelve of the survivors had been operated on by the paramedian parieto-occipital approach. In none of these patients did the operation cause motor deficits or speech difficulty, even though the tumor was in the dominant hemisphere in eight cases.

Discussion

There is nothing noteworthy in our series in regard to clinical history, apart from the fact that, in comparison with the largest reported series, fewer of our patients had preoperative epileptic seizures and more (six out of 18) had intermittent symptoms. Gassel and Davies also reported a high incidence of patients (55%) with paroxysmal and transient symptoms; the occurrence of episodic headache as well as of transient focal deficits, as in two of our cases, has already been reported. According to some authors, such transient neurological episodes are influenced by the position of the head, and could be due to the intermittent obstruction of the outflow of CSF from the ventricles caused by the tumor, which behaves like a mobile intraventricular mass. This is an acceptable hypothesis in cases of small tumors but not...
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**FIG. 9.** *Upper:* Postcontrast computerized tomography scans 8 months before operation showing adhesion of the meningioma to the choroid plexus (right). The meningioma completely fills the trigone, dilating the temporal horn (not shown), but the anterior part of the ventricle is not enlarged. An area of hypodensity of the white matter surrounds the tumor. *Center:* Preoperative scan shows considerable increase in size of the tumor. *Lower:* Control scan 1 year after surgery. The trigone remains large without evidence of tumor. A small hypodense slit indicates the route of the surgical approach.

In those of meningiomas large enough to be embedded in the brain parenchyma, as in three of our six patients with intermittent symptoms.

The neuroradiological evidence gathered over a span of 23 years is bound to be of uneven quality, but it is useful for suggesting which investigation is most likely to yield the correct diagnosis. Plain skull films, useful in meningiomas of the vault and base, give poor information in cases of intraventricular tumors. Radionuclide brain scanning always identifies an area of increased uptake in cases of meningiomas and retains its value as a screening examination. Pneumoencephalography and ventriculography are not recommended now in cases of intraventricular tumors: they carry a potential risk and supply less complete information than CT scanning.

Angiography and CT are the only investigations that identify the exact site and, often, the nature of these tumors. If CT scanning is performed first, angiography must follow to demonstrate the blood supply to the tumor and the surrounding vascular anatomy. If angiography is carried out first and supplies images that suggest the presence of an intraventricular meningioma, CT is still helpful in better defining the size of the tumor, and the size of the occipital and temporal horns of the lateral ventricles, and in confirming the exclusively intraventricular location of the tumor. However, in agreement with other authors, we found that the angiographic and CT features described above are characteristic but not pathognomonic of meningiomas, for they may occur with other tumors (such as ependymomas, papillomas, gliomas, pineal germinomas, and metastases) that develop in the lateral ventricles. However, even if CT and angiography do not yield a 100% positive diagnosis of tumor type, they provide basic information for the surgical approach: the intraventricular site of the lesion and details of its blood supply.

Our experience emphasizes the value of stereoscopic angiography, which always identifies the entire course of the anterior choroidal artery and the origin of the tumor blood supply, which is sometimes difficult or impossible to recognize with two-dimensional angiography. This point is important, because, if the tumor circulation is mistakenly identified as originating from the middle cerebral artery, one may be led, as happened in six of our cases, to the misdiagnosis of intraparenchymal tumor, which may be inoperable if the tumor is within the dominant hemisphere.

Vertebral angiography is of value for complete demonstration of tumor circulation. Mani, et al., reported a case in which a pathological circulation was demonstrated more clearly on vertebral angiography than on carotid angiography. Such an occurrence is probably more likely in meningiomas developing toward the pars centralis rather than toward the temporal horn of the lateral ventricle, although the proven existence of multiple anastomoses between the anterior and lateral posterior choroidal arteries makes this rare. As to the exact location of the tumor, in our series of 17 tumors of the trigone and one of the temporal horn there is nothing for or against the distinction between "true plexus meningiomas" and "lateral meningiomas of the velum," made by Cushing and Eisenhardt. This differentiation was accepted by Delandsheer, but criticized by others.

Regarding the surgical approach, in rare cases meningiomas develop in the anterior portion of the lateral ventricle, although we saw none in our series.
There seems to be no difficulty in removing such tumors by the most direct route, that is, through an incision in the frontal lobe. Problems arise in the removal of meningiomas in their much more common location in the trigone or in the temporal horn. Several approaches have been proposed, including resection of the occipital lobe, a straight or curved incision in the lower posterior portion of the parietal lobe, a straight incision along the posterior portion of the second temporal gyrus in order to allow the prior occlusion of the anterior choroidal artery, a linear occipitoparietal incision, and incision of the splenium and adjacent posterior portion of the corpus callosum and removal of the tumor through the choroid fissure after occlusion of the posterior choroidal arteries (Fig. 12).
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Approaches that involve incision of the inferior parietal or of the temporal lobe very often cause transient and sometimes permanent motor and speech deficits. Furthermore, with these routes there seems to be no way of avoiding damage to the optic radiation. The approach via the corpus callosum has been reported so far in only four cases; it is, according to Kempe and Blaylock, completely safe, although Levin and Rose recently reported a disconnection syndrome in their only case operated on by this route. This approach is suitable only for small tumors and those that are supplied only by the posterior choroidal arteries.

The paramedian parieto-occipital route, proposed only theoretically by Cramer, does not appear to have been used systematically in series other than ours. This approach has been criticized because it does not allow prior access to the supplying vessels and because it could cause damage to the optic radiation. It must be said that no approach allows a preliminary occlusion of all the feeding vessels of such tumors. Indeed, with the temporal approach, it is only possible to reach the intraventricular segment of the anterior choroidal artery, provided that the artery is not displaced medially by the tumor and therefore hidden deep behind it, an occurrence angiographically proven in half of our cases. With the approach via the corpus callosum, as stated earlier, it is possible to have prior access only to the posterior choroidal arteries. With the parieto-occipital approach used by us, the occlusion of the choroidal arteries becomes possible as soon as the tumor, which has been reduced in size by piecemeal removal, can be mobilized to expose its supplying vessels.

Regarding the second criticism of the paramedian parieto-occipital approach, that is, the risk of damage
to the optic radiation, it is worth mentioning that in one of our cases no visual field defects occurred after the operation and, in another, those previously existing disappeared postoperatively. Therefore, the parieto-occipital approach does not itself cause visual damage. This assumption is confirmed by the anatomical studies of Salamon and Shaltenbrand and Wahrend by which it appears that the ventricular trigone can be reached through a paramedian incision 3 to 4 cm from the interhemispheric fissure and extending from the postcentral fissure to the parieto-occipital fissure, without interrupting the optic radiation, which lies inferolaterally to the ventricle. The persistence of visual field defects after operation in six of our patients and their appearance in four others was probably due to previous irreversible damage to the optic radiation caused by the tumor itself and/or during dissection of the tumor from the ventricular walls. In fact, Wall demonstrated in one autopsy case that, when the intraventricular meningioma becomes large, the normal ependymal layer of the ventricle disappears and the tumor adheres closely to a gliotic surface-layer of the periventricular white matter. Thus, it is likely that damage to the optic radiation can be avoided during dissection of the tumor only if the lesion is small and does not distort the surrounding structures.

The operative mortality reported in the majority of the series ranges from 0 to 42%, with an average of about 25%. Olivecrona and Tönnis presented the largest personal series (18 cases), and reported a mortality of 27.7%.

In our series the operative death rate was four out of 18 (22%). Excluding the patient who died during operation, probably from puncture of the tumor in attempted ventriculography, three of the four patients with tumor removal en bloc died, while none of the patients died after piecemeal removal. Therefore, we think that intraventricular meningiomas should be removed only by this last technique, as it permits better preservation of the surrounding structures and a more careful hemostasis.

References


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