Meningiomas of the velum interpositum: surgical considerations

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Meningiomas of the third ventricle are a rare subtype of pineal region tumor that arise from the posterior portion of the velum interpositum, the double layer of pia mater that forms the roof of the third ventricle. Whereas meningiomas are common primary brain tumors, those of intraventricular origin are unusual, accounting for fewer than 1% of all intracranial meningiomas. Likewise, pineal region tumors represent fewer than 1% of intracranial primary neoplasms in North American and European series and 4% of such lesions in Japanese series. Among pineal region lesions, meningiomas are extremely rare with an incidence of approximately 1%. Neither Cushing and Eisenhardt nor Sano reported any velum interpositum meningiomas in their extensive series. Only six such lesions were reported in the Japanese Brain Tumor Registry from a cohort of 14,672 cases with 583 pineal region tumors. Series comprising pineal lesions with higher percentages of meningiomas likely include an unspecified number of falcotentorial meningiomas. In this paper we review the literature regarding velum interpositum meningiomas and present one case of in which the lesion was resected via the supracerebellar–infratentorial approach.

KEY WORDS • velum interpositum • tela choroidea of the third ventricle • intraventricular meningioma • pineal region • third ventricle • supracerebellar–infratentorial approach

LITERATURE REVIEW

In the literature, 27 histologically verified velum interpositum meningiomas have been described among typical pineal region tumors. In our review, it was not always possible to determine the exact site of origin for every tumor presented as a pineal region meningioma, and in selected cases these have been excluded. Cushing and Eisenhardt mentioned two cases (a 48- and 44-year-old woman) of interpositum meningiomas, which were surgically treated by Horrax and Bailey (described by Araki in the Japanese literature), but provided such scant information that little is contributed to an understanding of these lesions. In the German literature, Heppner described three cases of velum interpositum meningiomas treated by Ollercrona (a 2-year-old girl, 21-year-old man, and 27-year-old woman). In the French literature, Asenjo reported a velum interpositum meningioma in a 3-year-old child presenting with hydrocephalus, but the location of the tumor within the third ventricle is unclear. Following Sachs, the extremely rare cases of meningiomas that arise in the anterior portion or the base of the third ventricle have been excluded. Many authors have grouped anterior- and inferior-projecting falcotentorial meningiomas with velum interpositum meningiomas under the heading of "pineal meningiomas." Prior to the introduction of MR imaging, it was often very difficult to discriminate between these two lesions; however, current combinations of CT scanning, MR imaging, and angiography facilitate differentiation of falcotentorial meningiomas from true posterior third ventricular or pineal body masses. Table 1 highlights the clinical, radiographic, and surgical features of 17 cases of posterior third ventricular meningiomas.

Abbreviations used in this paper: CSF = cerebrospinal fluid; CT = computerized tomography; MR = magnetic resonance; PChA = posterior choroidal artery.
without dural attachment in which sufficient information was available.

**Embryological Characteristics**

The velum interpositum is the potential space between the dorsal and ventral layers of tela choroidea that contains the internal cerebral veins and medial PChAs. The velum interpositum, the two layers of tela choroidea, and the body and crura of the fornices together form the roof of the third ventricle.\(^6\) The meaning of the term is often broadened to include the two layers of tela choroidea together with velum interpositum proper. The formation of the double-layered roof of the third ventricle is best understood in terms of comparative anatomy. In the shark, the cerebral hemispheres are small and do not overlap the diencephalon. The hippocampal formation occupies the roof of the lateral ventricle, lies above the interventricular foramen, and extends along the upper border of the wall of the third ventricle. The efferent fibers—the primordial fornix (hippocampal commissure)—extend through the medio-orostral and ventral wall of the cerebrum to the hypothalamus. The third ventricle roof is formed by a single layer of pia-arachnoid that has a posterior outpouching called the dorsal sac. Progressing up the phylogenetic tree, a major commissure (the corpus callosum) forms dorsal to the lamina terminals and extends posteriorly. The hippocampus is displaced posteriorly, and ultimately into the temporal lobe, carries a layer of pia-arachnoid on the inferior surface of the fornices. This layer overlies and fuses to the original single pial layer to form the velum interpositum. Posteriorly, the two layers separate, with the inferior layer following the roof of the third ventricle to the pineal body and tectum and the superior layer adhering to the fornices, before ultimately reaching the splenium of the corpus callosum. This separation may allow for the formation of a cistern (cisterna velum interpositum) that communicates with the quadrigeminal cistern. The dorsal sac is redirected poste-

<table>
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<tr>
<th>Authors &amp; Year</th>
<th>Age (yrs), Sex</th>
<th>Symptoms &amp; Signs</th>
<th>Duration</th>
<th>Ventriculography</th>
<th>Angiography</th>
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<tr>
<td>Heppner, 1955</td>
<td>8, M</td>
<td>decreased visual acuity; optic atrophy</td>
<td>3 mos</td>
<td>mass in PTV; obstructive HCP arterial supply</td>
<td>tumor blush, pericallosal &amp; choroidal arterial supply</td>
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<td></td>
<td>14, F</td>
<td>divergent strabismus; headaches</td>
<td>10 yrs/9 mos</td>
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<td>no tumor blush</td>
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<td>39, F</td>
<td>decreased visual acuity; headache; optic atrophy; VI CN</td>
<td>3 mos</td>
<td>mass in PTV; obstructive HCP</td>
<td></td>
</tr>
<tr>
<td>Jinnai, et al., 1967</td>
<td>38, M</td>
<td>headache; NV; mild dementia; lt HP</td>
<td>3 mos</td>
<td>mass in PTV; obstructive HCP</td>
<td></td>
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<td>Rozario, et al., 1979</td>
<td>24, M</td>
<td>headache; decreased visual acuity; ataxic gait; optic atrophy; Parinaud syndrome</td>
<td>8 mos</td>
<td>no tumor blush</td>
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</tr>
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<td>Ito, et al., 1980 &amp; 1981</td>
<td>28, F</td>
<td>SAH (from tumor); meningismus headache; decreased visual acuity; atonic seizures; truncal ataxia; optic atrophy</td>
<td>NS</td>
<td>tumor blush; medial &amp; lat PChA supply; inferior displacement of plexal segment of medial PChA; superior displacement of internal cerebral vein</td>
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<td>Kameyama, et al., 1980</td>
<td>48, F</td>
<td>headache; ataxic gait</td>
<td></td>
<td>tumor blush, medial PChAs; SAH</td>
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<td>40, M</td>
<td>headache; mild dementia; mild lt HP</td>
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<td>tumor blush; SAH</td>
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<td>59, F</td>
<td>headache; ataxic gait; drop attacks; papilledema; upgaze palsy; limited convergence; reactive pupils &amp; mild lt HP</td>
<td>1 yr</td>
<td>tumor blush; upward displacement of the internal cerebral veins/OfG</td>
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<td>Piatt &amp; Campbell, 1983</td>
<td>58, M</td>
<td>headache; lassitude; memory loss; ataxic gait; mild dementia; mild lt HP</td>
<td>1 yr</td>
<td>tumor blush on carotid &amp; vertebral artery injections</td>
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<td>Sakaki, et al., 1984</td>
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<td>headache; mild dementia; ataxic gait; papilledema</td>
<td>2 mos</td>
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<td>9, F</td>
<td>headache; decreased mental status; NV; papilledema</td>
<td>10 days</td>
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<td>7 mos</td>
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<td>25, M</td>
<td>headache; upgaze limitation</td>
<td>incidental</td>
<td>tumor blush; PChAs</td>
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riorly as the suprapineal recess of the third ventricle. The human embryological changes that result in the formation of the velum interpositum are an ontogenic recapitulation of this phylogenetic process.29

Anatomical Relationships

The tela choroidea is the source of the arachnoid cap cell from which third ventricle meningiomas presumably arise. Meningiomas originating from the ventral tela choroidea reside in the posterior third ventricle and displace the internal cerebral veins dorsally. In contrast, meningiomas that arise from the dorsal tela choroidea displace the internal cerebral veins ventrally and bow into the roof of the third ventricle. The posterior tenia fornicis, the site of attachment of the dorsal tela choroidea, may also give rise to meningiomas that lie in the quadrigeminal cistern. Tumors that arise from these sites may be referred to as velum interpositum meningiomas, meningiomas of the tela choroidea, or third ventricular meningiomas without

<table>
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<tr>
<th>Authors &amp; Year</th>
<th>Age (yrs), Extent</th>
<th>Observation</th>
<th>Op</th>
<th>Extent Resected</th>
<th>Outcome</th>
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<td>8, M</td>
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<td>residual visual deficit</td>
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<td></td>
<td>14, F</td>
<td>occipital craniot</td>
<td>GTR</td>
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<td>Sachs, et al., 1962</td>
<td>39, F</td>
<td>attaches to choroid plexus nodular, firm, avascular</td>
<td>SCIT</td>
<td>death due to postop complications</td>
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<td>Jinnai, et al., 1967</td>
<td>38, M</td>
<td>rt frontal craniot</td>
<td>GTR</td>
<td>Parinaud syndrome</td>
<td></td>
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<td>Rozario, et al., 1979</td>
<td>24, M</td>
<td>HCP; CE mass in pineal &amp; PTV</td>
<td>SCIT</td>
<td>intact</td>
<td></td>
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<td>Kamayama, et al., 1980</td>
<td>48, M</td>
<td>HCP; CE mass in PTV</td>
<td>bifrontal transcallosal</td>
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<td>Nakayama, et al., 1980</td>
<td>40, M</td>
<td>HCP; CE mass in PTV</td>
<td>bifrontal transcallosal</td>
<td>NS</td>
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<td>Roda, et al., 1982</td>
<td>59, F</td>
<td>HCP; peripherally hyperdense, uniformly enhancing mass in pineal &amp; PTV</td>
<td>adherent to BVR</td>
<td>small residual normal</td>
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<td>Piatt &amp; Campbell, 1983</td>
<td>58, M</td>
<td>HCP: CE mass in quadrigeminal cistern</td>
<td>fibrous, well encapsulated</td>
<td>GTR</td>
<td>postop hemorrhage, lt HHA, lt hemiparesis dependent</td>
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<td>Sakaki, et al., 1984</td>
<td>61, M</td>
<td>HCP; high density, uniformly CE mass in pineal &amp; PTV</td>
<td>vascular</td>
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<td>Byard, et al., 1989</td>
<td>9, F</td>
<td>HCP: uniformly hyperdense CE mass in PTV</td>
<td>well circumscribed</td>
<td>transcallosal</td>
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<td>Huang, et al., 1993</td>
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<td>HCP; uniformly enhancing mass</td>
<td>homogenous strong enhancement; sup displacement of internal cerebral veins</td>
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<td>bifrontal, transcallosal</td>
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<td>Mallucci &amp; Obukhov, 1996</td>
<td>32, M</td>
<td>HCP; uniformly CE mass in pineal &amp; PTV</td>
<td>hard, VOG fused to upper capsule, vascular</td>
<td>rt OTT</td>
<td>GTR</td>
</tr>
<tr>
<td></td>
<td>30, M</td>
<td>uniformly CE mass in pineal &amp; PTV</td>
<td>hard, VOG fused to upper capsule, vascular</td>
<td>staged rt &amp; lt OTT</td>
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<td>soft, globular, avascular</td>
<td>SCIT</td>
<td>GTR</td>
</tr>
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* BVR = basal vein of Rosenthal; CE = contrast-enhancing; CN = cranial nerve; GTR = gross-total resection; HCP = hydrocephalus; HHA = homonymous hemianopsia; HP = hemiparesis; NV = nausea and vomiting; NS = not specified; OTT = occipitotransventricular approach; PTV = posterior third ventricle; SCIT = supracerebellar–infratentorial approach; SOC = suboccipital craniectomy; sup = superior; VOG = vein of Galen.

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dural attachment. These tumors derive their blood supply from the posterior choroidal arteries and occasionally from the anterior choroidal and PChAs if the tumor is very large.23

**Imaging Characteristics**

Despite significant advances in neuroimaging during the last 30 years and the availability of numerous imaging modalities, differentiating among the many possible pineal region masses by examination of imaging-based characteristics alone remains difficult.34,56

Typically CT scanning demonstrates a relatively homogeneous lesion that is iso- to hyperdense to brain and enhances strongly after contrast administration.14,24,33,50,51 Peripheral calcification may be evident; focal calcification may actually represent a displaced pineal body.33

The case we describe (see Case Illustration [Fig. 1]) is the second description in which MR imaging findings are associated with a histologically verified velum interpositum meningioma in the pineal region. Whereas Huang, et al.,22 reported uniform and robust imaging enhancement after Gd administration in their case, the present example is notable for its weak and heterogeneous enhancement on MR images. As has been reported for anterior third ventricular meningiomas, the entire pattern of signal characteristics and enhancement may not be typical of a dural-based meningioma when the tumor lacks a dural attachment. Gadolinium-enhanced MR imaging will reveal the relationship of the tumor to the internal cerebral veins and the vein of Galen. Magnetic resonance venography may be helpful in evaluating the patency of the deep venous system.

Cerebral angiography was performed in 11 of the reported cases.19,24,25,28,36,40,43,46,51,53 Variable degrees of tumor blush were observed in nine cases. The PChAs supplied the tumor in all cases; in only one case was the medial PChA not visualized.36 Although discrepancy of the direction of displacement between the plexal segment of the medial PChA and the internal cerebral veins is pathognomonic of a tumor originating within the velum interpositum, this sign is not reliable because meningiomas of the tela choroidea may displace both arteries and veins together either superiorly or inferiorly.24 During the venous phase, lack of opacification of major deep veins may indicate that intraoperative sacrifice of the deep venous system might be tolerated.53

**Histopathological Features**

Histopathological features have been described in 14 cases. The two predominant patterns are fibroblastic8,24,27,39,46 and meningothelial.1,19,40,52,53 Angioblastic,20,51 transitional,51 and psammomatous characteristics19,40 have also been reported. All but one tumor documented in an adult exhibited benign features.53 In those found in children, atypical features were observed in one case22 and have also been exhibited by anterior third ventricular meningiomas.51

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Fig. 1. Preoperative MR images. **Upper Left:** Midsagittal unenhanced T1-weighted image demonstrating a 3-cm discrete mass in the posterior third ventricle and quadrigeminal cistern. Gadolinium-enhanced sagittal (upper center), coronal (upper right), and axial (lower left) T1-weighted images revealing weak and heterogeneous contrast enhancement. The mass directly obstructs the cerebral aqueduct, producing triventricular hydrocephalus. The internal cerebral veins are displaced dorsally. The mass is not contiguous with the falcotentorial junction. **Lower Right:** Axial T1-weighted image demonstrating a hyperintense rim of CSF surrounding the lesion.
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Presentation and Natural History

Velum interpositum meningiomas occur with approximately equal frequency in males and females and have been reported in both pediatric and adult populations. The mean age at presentation in the reviewed cases was 32.6 ± 19.7 years. Symptoms usually developed insidiously and over a protracted course, often resulting in a significant delay in diagnosis. The most common signs and symptoms, which were due to increased intracranial pressure and hydrocephalus, included headache, papilledema, gait disturbances, and altered mental status. Extracranial movement and pupillary abnormalities, including cranial nerve palsies and Parinaud syndrome, were relatively uncommon findings (occurring in 21% of patients in this series). In contrast, ocular findings are common in patients with primary pineal tumors.41

The natural history of velum interpositum meningiomas is not understood with certainty because most have presented with symptoms and signs of increased intracranial pressure secondary to hydrocephalus or midbrain compression. If left untreated, hydrocephalus may progress and lead to dementia or herniation. Compression of the quadrigeminal plate may lead to ocular motility disturbances or central auditory abnormalities in a minority of patients.33 As an increasing number of patients undergo cranial MR imaging for other indications, it is likely that the frequency of asymptomatic pineal region masses will increase.

Management Considerations

Velum interpositum meningiomas are usually evaluated and treated according to standard algorithms for pineal masses. Germ cell markers should be measured to rule out the presence of a malignant germ cell tumor. Symptomatic hydrocephalus must be addressed prior to definitive surgery. An endoscopic third ventriculostomy should be performed in most patients harboring a pineal mass because it avoids the risk of shunt-related complications.

Because neuroimaging is not consistently diagnostic for third ventricle meningiomas, it may be necessary first to obtain a tissue diagnosis. Most tumors have reasonably well-defined capsules that can be visualized on MR imaging, which should guide most surgeons to undertake resection as the initial procedure rather than first obtaining a stereotactic biopsy sample. Biopsy sampling provides limited quantities of tissue from lesions that may be histologically diverse and thus lead to sampling error. Additionally, the risk of hemorrhage and hemorrhagic complications is increased in stereotactic biopsy procedures in the pineal region compared with other locations. Once a tissue diagnosis is made, either by stereotactic or open biopsy, the goal of surgery is squarely focused on complete resection. Gross-total resection is generally curative. There is no role for chemotherapy; indications for radiation therapy are limited to recurrent tumors or those with aggressive histopathological features.

Selection of Surgical Approach

The selection of surgical approach depends primarily on the relationship of the tumor to the deep venous system and other surrounding structures. The supracerebellar–infratentorial approach is favored for tumors that arise from the ventral leaf of the tela choroidea and displace the internal cerebral veins dorsally. This approach allows the tumor to be reached through a midline trajectory below the deep venous system. The corridor between the cerebellum and the tentorium does not violate any normal tissue, and the ability to perform surgery with the patient sitting minimizes venous bleeding and facilitates dissection of the tumor from the deep venous system.

The use of other standard pineal approaches depends on particular tumor characteristics or the degree of the surgeon’s familiarity and comfort. Meningiomas that arise from the dorsal leaf of the tela choroidea, displace the internal cerebral veins ventrally, and do not extend posteriorly to the splenium of corpus callosum are best approached via the posterior interhemispheric corridor. This approach follows the shortest route to the lesion and has the advantage of allowing the surgeon to work anterior to the confluence of the deep venous system. Meningiomas centered in the quadrigeminal cistern are usually approached via the occipitotransventricular route, which is particularly useful if the tumor displaces the deep venous system inferiorly, but makes it difficult to dissect the tumor off of the tela choroidea within the third ventricle.

Supracerebellar–Infratentorial Approach

The supracerebellar–infratentorial approach is generally performed with the patient in the sitting position and has been detailed elsewhere. The accompanying Video Clip illustrates the supracerebellar–infratentorial approach used in the illustrated case.

Click here to view Video Clip with sound. Video clip illustrating the supracerebellar–infratentorial approach in the sitting position for resection of a velum interpositum meningioma.

A midline incision is extended from approximately 4 cm above the external occipital protuberance to the level of the C-2 spinous process. The suboccipital musculature is dissected through the avascular nuchal ligament and retracted using a single curved self-retaining retractor placed from above. The suboccipital plate is exposed to a level just above the foramen magnum; the suboccipital muscles inserting on the spinous processes of C-1 and C-2 are left undisturbed. A craniotomy is preferred over a craniectomy because it reduces the incidence of aseptic meningitis, fluid collections, and posterior fossa syndrome. The craniotomy is centered just below the torcular with slots drilled over the superior sagittal sinus approximately 2 cm above the external occipital protuberance, over the transverse sinus 3 to 4 cm off the midline, and over the occipital sinus 1 to 2 cm above the foramen magnum. A craniotome is used to connect the slots, and the rectangular bone flap is elevated. A sufficient amount of bone is removed from above the transverse sinus to ensure that the view along the tentorium will not be obscured. Bone edges are waxed meticulously and all venous bleeding controlled to protect against air emboli. If the dura mater is tense, CSF may be released from a ventricular drain (if available) or the foramen magnum, and mannitol may be administered.

A gentle semilunar durotomy is created by beginning at the lateral aspects of the exposure and working toward the...
falk cerebelli and occipital sinus. The occipital sinus is divided between titanium clips, and the falx cerebelli is transected. The dural flap is reflected superiorly and placed in slight tension by using tenting sutures, taking care not to obstruct the sinuses. The infratentorial corridor to the pineal region is opened by cauterizing and dividing arachnoid adhesions and bridging veins between the dorsal surface of the cerebellum and the tentorium. The extensive collateral circulation in the posterior fossa minimizes the risk of complications due to venous sacrifice. Care is taken not to divide bridging veins too close to the tentorial surface, because subsequent dural bleeding can be difficult to control with cautery. After division of these attachments, the cerebellum drops away from the tentorium, providing an excellent corridor with minimal retraction. The dural surface of the cerebellum is protected with Telfa padding. A small malleable retractor provides additional cerebellar retraction in a posterior and inferior direction. As the cerebellum is retracted, additional adhesions and bridging veins encountered near the anterior vermis should be cauterized and divided.

Deeper dissection is conducted under the microscope. A free-standing arm rest is useful at this point to support the surgeon’s arms in an outstretched position. The opalescent arachnoid of the quadrigeminal cistern is opened using an arachnoid knife, long bayonet scissors, and irrigating bipolar cautery. The precentral cerebellar vein, located in the midline extending from the anterior vermis up to the vein of Galen, is cauterized and divided. At this point the trajectory of dissection is directed several degrees inferiorly away from the tentorium and toward the center of the lesion. Further pursuit of the initial trajectory would lead to a direct encounter with the vein of Galen and the confluence of the deep venous system.

The posterior aspect of the tumor should now be visible (Fig. 2). Most lesions are well encapsulated and are soft. The tumor is initially debulked internally through its posterior surface, and specimens are sent for frozen section. The accuracy of frozen tissue diagnosis may be unreliable, and this fact should be taken into consideration intraoperatively when the extent of resection must be chosen.

Internal debulking is facilitated using a variety of instruments such as bipolar cautery, cupped forceps, pressure-adjustable macrosuction, and ultrasonic aspiration if necessary. After an adequate internal decompression has been achieved, the capsule is separated from the surrounding thalamus. The majority of vessels along the capsular wall are of choroidal origin and can be safely sacrificed. The lateral dissection eventually leads to the third ventricle, which becomes apparent as CSF enters the operative field. The tumor can then be dissected off of the midbrain. This maneuver is the most difficult portion of the tumor dissection and is facilitated by retracting the tumor superiorly and bluntly dissecting the mass off of the collicular plate under direct visualization. The final attachment is at the tumor’s origin, located superiorly along the velum interpositum and deep venous system. These attachments are cauterized and sharply divided, taking care not to create a rent in the deep venous system.

After the tumor is removed, the view into the posterior third ventricle is unobstructed. A flexible mirror may be useful to inspect the inferior portion of the tumor bed and to examine the orifice of the cerebral aqueduct. Meticulous hemostasis achieved using direct, low-intensity cautery is essential because there is little tissue turgor to tamponade bleeding in the tumor bed. Extensive use of hemostatic agents should be avoided because they may float into the ventricle and cause obstructive hydrocephalus, shunt malfunction, or chemical meningitis. The dura is then reaproximated in a watertight fashion. The craniotomy flap is secured using titanium miniplates. To avoid excessive brain shift, extubation should be performed and the patient maintained with a significant degree of head elevation and flexion.

**Potential Surgical Complications**

In the majority of patients some degree of impairment of extraocular movements is displayed, particularly upgaze and difficulty with convergence. Any preoperative oculomotor deficit should be expected to be exacerbated by the surgery. Fortunately, these problems are generally transient, tending to resolve within weeks to months. Permanent deficits are rare, although a mild limitation of upgaze may persist, usually with limited clinical consequences.

When the infratentorial–supracerebellar approach is performed with the patient in the sitting position, potential complications include air embolism, pneumocephalus, supratentorial hemorrhage, midcervical flexion myelopathy, and shunt malfunction. Very rarely, cerebellar infarction has been observed. When supratentorial approaches are undertaken, complications secondary to brain retraction can be problematic. In the parietal region, brain retraction during the transtental approach may lead to contralateral sensory deficits or, rarely, to hemiparesis. Sacrifice of bridging veins may lead to cortical infarction, particularly if more than one vein is taken. Occipital lobe retraction during the transtental approach may result in cortical visual field deficits. Disconnection syndromes may occur if the splenium is divided.

Hemorrhage from the tumor bed is unusual in cases of velum interpositum meningioma because the blood supply is derived from small choroidal branches that are easily
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controlled as the tumor is resected. Nevertheless, difficulty controlling intraoperative tumoral bleeding has been reported in four cases, and one case of postoperative hemorrhage has been described. Although engulfment and occlusion of portions of the deep venous system are more common in cases of falcotentorial meningiomas, one example of occlusion of the deep venous system has been reported in association with a velum interpositum meningioma. More frequently, the internal cerebral veins will be adherent to, but not incorporated into, the tumor capsule. Injury or sacrifice of part of the deep venous system may be tolerated if adequate collateral drainage has developed anteriorly through subependymal veins. Active hemorrhage, however, from the deep venous system may be profuse, is usually only controlled by direct tamponade, and often heralds disastrous consequences for the patient.

Surgery-Related Outcomes

Among the 17 reviewed cases in Table 1, supratentorial approaches were performed in 12 and infratentorial approaches in five. Gross-total resection was achieved in 13 patients (in two cases after a second staged operation). Perioperative outcomes were good (no new deficits/visual deficits only) in 10 cases, poor (dependent) in two cases, and death in two cases. One adult patient with an atypical meningioma died of disease progression within 2 years of the first operation.

CASE ILLUSTRATION

Velum Interpositum Meningioma

Presentation. This 25-year-old man with no significant medical history presented after suffering a brief loss consciousness following a blow to the head during a barroom fight. A CT scan demonstrated hydrocephalus and a 3-cm pineal region mass. In retrospect, the patient described experiencing intermittent headaches during the last several years and increasing malaise and lethargy. He denied any visual symptoms, sexual difficulties, or altered mentation.

Examination. Physical examination showed responses within normal limits except for mild upgaze limitation. An MR image revealed a 3-cm, well-demarcated, spherical mass occupying the posterior third ventricle and quadrigeminal cistern (Fig. 1). The mass directly obstructed the aqueduct of Sylvius, producing triventricular hydrocephalus. The internal cerebral veins were displaced dorsally. After contrast administration, the tumor exhibited a weak and heterogeneous enhancement pattern. A clear separation was evident between the tumor and the falcotentorial junction. There was no evidence of a dural attachment. Serum α-fetoprotein and β-human chorionic gonadotropin levels were within normal limits. A ventriculoperitoneal shunt had been placed at an outside hospital prior to his referral for definitive tumor resection.

Operation. The tumor’s midline position, ventral to the internal cerebral veins, prompted selection of the supracerebellar–infratentorial approach in the sitting position. A suboccipital craniotomy was performed, and the tumor was approached via the supracerebellar corridor. The tumor’s degree of encapsulation was not initially apparent until the lesion was partially debulked. It was relatively soft and of moderate vascularity, which facilitated debulking. After debulking, the tumor was dissected away from its attachments laterally and then inferiorly along the quadrigeminal plate. It became apparent that the tumor had no dural attachment but was arising from the tela choroidea ventral to the internal cerebral veins. Finally, its attachments to the tela choroidea were cauterized and sharply divided and a gross-total resection was achieved.

Postoperative Course. Postoperatively, the patient made an excellent recovery. High-dose corticosteroid therapy was tapered off over a 10-day period. Postoperative CT scanning demonstrated a complete resection of the tumor and low-pressure pneumocephalus. Results of his neurological examination were notable only for an upgaze palsy, convergence nystagmus, and gait unsteadiness. His gait difficulties and nystagmus resolved within 1 week as did the upgaze palsy after one month. Follow-up MR imaging demonstrated resolution of the pneumoceph-
The use of the supracerebellar–infratentorial approach. Preoperative imaging provides a strong rationale for displacement of the internal cerebral veins demonstrated on preoperative imaging. Displacement of the most advantageous surgical approach. Dorsal relationship of the tumor to the deep venous system and no residual tumor (Fig. 3).

**Pathological Features.** On microscopic analysis, the tumor was composed of meningotheial cells growing in a syncytial pattern with abundant whorl formation and frequent psammoma bodies. H & E, original magnification × 10.

**CONCLUSIONS**

Velum interpositum meningiomas are a rare subset of pineal region tumors whose clinical and imaging characteristics, like those of most pineal masses, do not allow for a definitive preoperative diagnosis. After the diagnosis has been established, however, a complete resection for cure is the management objective. Although direct surgical approaches to the pineal region are difficult and pose significant operative risk, refinements in surgical and anesthetic techniques have led to a more favorable outlook in patients with these uncommon tumors. Management decisions must be individualized, taking into account patient age, general medical condition, preoperative symptomatology, and the presence of hydrocephalus. The relationship of the tumor to the deep venous system and the splenium of the corpus callosum will guide the selection of the most advantageous surgical approach. Dorsal displacement of the internal cerebral veins demonstrated on preoperative imaging provides a strong rationale for use of the supracerebellar–infratentorial approach.

**References**
