Pineal Region Masses—Imaging Findings and Surgical Approaches

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The anatomy of the pineal region is complex. Despite advances in surgical techniques since the first reported successful pineal region surgery in the early 20th century, pineal region surgery remains challenging owing to the proximity of deep cerebral veins and dorsal midbrain structures critical for vision. In this article, we review the relevant surgical anatomy of the pineal region and discuss historically important and current surgical approaches. We describe specific imaging features of pineal region masses that may affect surgical planning and review neoplastic and nonneoplastic masses that occur in the pineal region.

Overview and Anatomy

The pineal gland is an endocrine gland composed of pineal and neuroglial cells that lies deep within the brain along the dorsal aspect of the diencephalon. Its primary function is the production and secretion of melatonin, a hormone that has been associated with human circadian rhythms, endocrine function, immune regulation, and aging.[1,2] The pineal gland lies outside the blood-brain barrier, which allows direct diffusion of melatonin into systemic blood vessels.[3]

The anatomy of the pineal region is complex (Fig 1), and the pineal region is difficult to access surgically. The major parenchymal components of the pineal region include the pineal gland, the posterior commissure, the habenular commissure, and the superior and inferior colliculi of the tectal plate.

The pineal region is defined anteriorly by the posterior recesses of the third ventricle, superiorly by the cistern of the velum interpositum and posteriorly by the quadrigeminal plate cistern. Important vascular structures include the paired internal cerebral veins, the vein of Galen, and the medial posterior choroidal artery.

Tumors of the pineal region may present with headache, impaired vision, nausea, impaired ambulation, and impaired memory. Common clinical signs include papilledema, ataxia, and abnormal eye movements including Parinaud syndrome (dorsal midbrain syndrome), loss of vertical gaze, nystagmus on attempted convergence, and pseudo–Argyll Robertson pupil, related to compression of the tectal plate.[4]

Cystic Pineal Region Masses

Cavum Velum Interpositum

Usually discovered incidentally, the cavum velum interpositum (CVI) is a true cerebrospinal fluid (CSF) cistern found more commonly in younger patients. Its clinical significance is uncertain, but CVI likely reflects a developmental variant. One study suggests that CVI may be seen in up to 6% of patients undergoing magnetic resonance imaging (MRI) of the brain.[5] CVI has not been associated with other brain malformations. On axial imaging, CVI has a characteristic triangular shape (Fig 2) with the triangle's base at the splenium of the corpus callosum and the apex at the foramen of Monro.[6] The density on computed tomography (CT) and signal intensity on MRI are identical to CSF. CVI always results in caudal displacement of the internal cerebral veins, a

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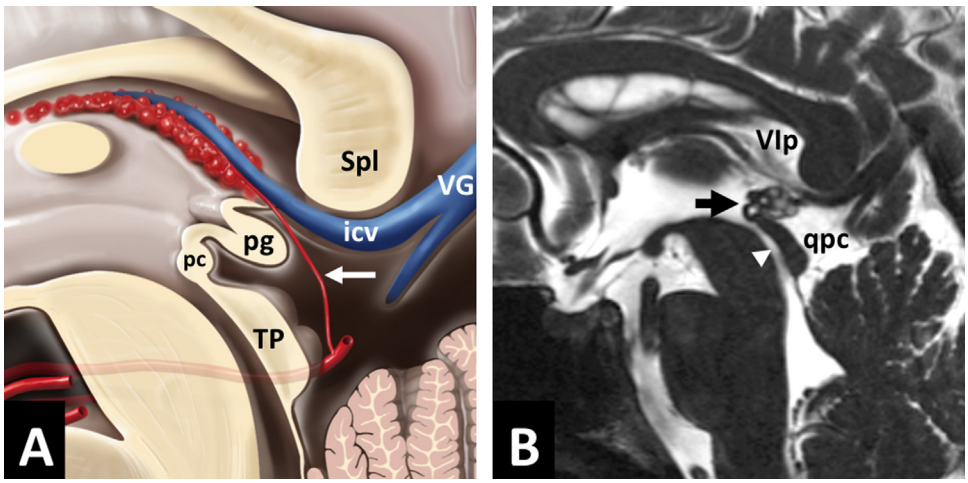

FIG 1. Sagittal graphic (A) and sagittal T2W image illustrating surgical anatomy of the pineal region. Pineal gland (pg and black arrow), splenium of the corpus callosum (Spl), posterior commissure (pc) internal cerebral vein (icv), vein of Galen (VG), tectal plate (TP) medial posterior choroidal artery (white arrow in A), posterior commissure (black arrow in B), velum interpositum (VIp), quadrigeminal plate cistern (qpc), and cerebral aqueduct (white arrowhead in B). (Adapted and used with permission from Amirsys, Inc.) (Color version of figure is available online.)

feature that may distinguish it from other intracranial cysts in the pineal region.

Pineal Cysts

Also usually discovered incidentally, pineal cysts are rarely associated with clinical symptoms, and the advent of high-resolution MRI techniques has increased the rate of detection of pineal cysts.[7] Pu et al[8] reported a prevalence of 23% of pineal cysts in healthy adult volunteers, and macroscopic cysts or cystic changes within the pineal gland are seen in 22% of autopsy specimens.[9] Surgical treatment and radiologic follow-up of nonobstructing pineal cysts remains controversial.[10,11] Occasionally, pineal cysts may be large enough to exert mass effect on the dorsal midbrain or obstruct CSF flow through the cerebral aqueduct and may require surgical removal or shunting.

On imaging, cysts may be isodense to slightly hyperdense to CSF on CT. Calcifications may be present in the cyst wall. On MRI, cysts are usually isointense to slightly hyperintense to CSF on T1-weighted imaging (T1WI) and may incompletely suppress on fluid-attenuated inversion recovery (FLAIR) images (Fig 3). Postcontrast images typically show thin linear enhancement of the cyst wall.[12] Pineal cysts with typical features and wall thickness

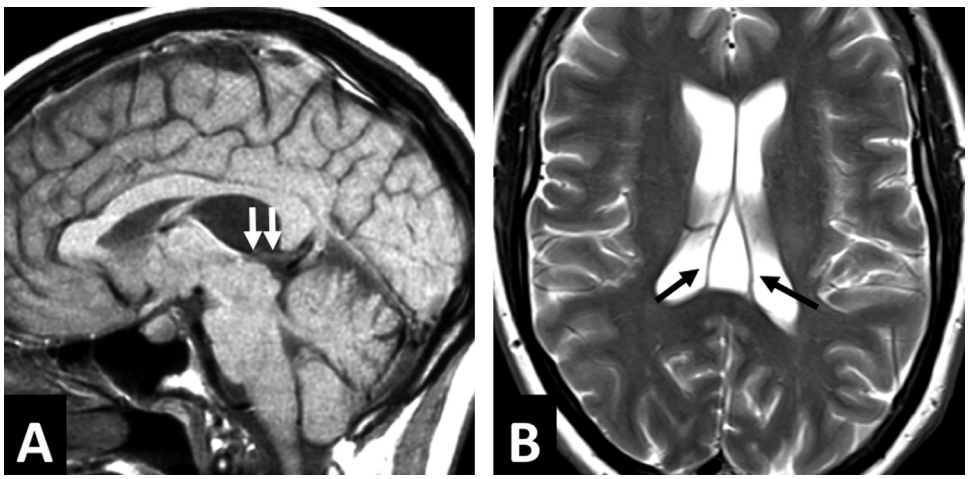

FIG 2. Cavum velum interpositum. On sagittal T1W image (A), the internal cerebral veins are displaced downward (white arrows). Axial T2WI (B) demonstrates the characteristic triangular shape of this anatomical variant (black arrows).