Benign Glial Cysts of the Pineal Gland: Unusual Imaging Characteristics with Histologic Correlation

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PURPOSE: To describe the spectrum of MR and CT findings in clinically symptomatic pineal cysts and to determine whether there are certain diagnostic imaging features that allow one to distinguish a benign pineal cyst from other neoplasms of the pineal region. **METHODS:** MR and CT scans of 19 patients with clinically symptomatic pineal cysts were retrospectively reviewed. Age range was 15 to 46 years with a mean age of 28 years. There were five male and 14 female patients. **RESULTS:** Presenting features included headache (15 patients), diplopia (four), nausea and vomiting (four), papilledema (four), seizure (three), Parinaud syndrome (two), ataxia (one), and hemiparesis (one). All cysts were resected or biopsied to provide histopathologic confirmation of the diagnosis. Preoperative diagnoses included pineal neoplasm (14 of 19), pineal cyst (3 of 19), and dermoid cyst (2 of 19). The lesions ranged from 0.8 to 3.0 cm, with a mean diameter of 1.6 cm. Three cysts showed fluid/fluid levels consistent with hemorrhage. Slightly less than half (9 of 19) had evidence of hydrocephalus. The MR signal changes were variable but typically demonstrated low signal on T1-weighted images and high signal on T2-weighted images. More than half (7 of 12) demonstrated enhancement with gadolinium. Calcification of the cyst wall was observed in only four of nine patients who had CT studies but identified histologically in all cases. **CONCLUSION:** The MR appearance of benign pineal cysts is variable, ranging from that of an uncomplicated cystic mass to a mass associated with hemorrhage, enhancement, or hydrocephalus. This variability may make them indistinguishable from other pineal-region tumors.

Index terms: Pineal gland, cysts; Brain, cysts; Brain, neoplasms; Brain, magnetic resonance; Brain, computed tomography

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Primary lesions of the pineal region can be divided into four general categories: germ cell tumors (germinoma, benign teratoma, and teratocarcinoma), pineal parenchymal tumors (pineocytoma and pineoblastoma), gliomas, and cysts (epidermoid, dermoid, arachnoid, and glial). The incidence of benign pineal cysts depends on their size. Small (0.2-cm) benign pineal cysts are identified in as many as 40% of autopsy specimens (1). Cysts smaller than 0.5 cm can be an incidental finding on magnetic resonance (MR) scans in adults and have been observed in 1.4% to 4.3% of healthy subjects (2–4). They are nearly always asymptomatic, unlike other pineal region masses. In contrast, large symptomatic pineal cysts are rare, being limited to single cases or very small series (5–11). The MR and computed tomographic (CT) appearance and histopathologic features of these lesions are presented to determine whether there are certain MR and CT findings that allow the diagnosis of a benign pineal cyst.

Methods

The histories and imaging studies of 19 patients with histopathologically confirmed pineal cysts were retrospectively reviewed. All cases were acquired over a 10-year period (1982 to 1991) from the histopathologic files of the Mayo Clinic Tissue Registry and from the consultation files of one of us (B.W.S.). Patients ranged in age from 15 to 46 years at the time of their scans (mean age was 28 years, median age 27 years). Fourteen patients were women (74%) and five patients were men (26%).

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MR, CT, or both types of exams were performed in all patients. Ten of the patients underwent MR imaging only; seven underwent CT and MR; and two underwent CT only. Sixteen patients were examined with a 1.5-T instrument, and one was examined with a 0.5-T scanner. MR studies included short-repetition-time/short-echo-time T1-weighted images (400–800/15–25 [repetition time/echo time], long-repetition-time/short-echo-time proton-density images (2000–2900/20–45), and long-repetition-time, long-echo-time T2-weighted images (2000–2900/80–100). Axial, coronal, and sagittal images were obtained depending on the individual case. Twelve of the 17 patients (71%) who underwent MR imaging received gadolinium. Axial CT images and MR exams in more than one dimension were reviewed to determine: 1) mass size (cystic and solid components); 2) shape; 3) signal characteristics; 4) presence of calcification (CT only); 5) cyst margins; 6) midbrain involvement; 7) location relative to midline; 8) presence of hydrocephalus; and 9) enhancement characteristics with gadolinium.

The cysts were considered symptomatic if there were findings of increased intracranial pressure (headache, papilledema, seizure, nausea, and vomiting) or focal signs and symptoms due to compression of neighboring structures (Parinaud syndrome, diplopia, ataxia, and hemiparesis) on history and physical exam (Table 1). They were surgically excised via an infratentorial/supracerebellar approach (18 cases) or stereotactically biopsied (one case). Excision, when performed, was considered complete.

Formalin-fixed, paraffin-embedded surgical specimens were cut at 5 μm and stained by hematoxylin and eosin, Luxol fast blue–periodic acid Schiff for myelin, and the Bielschowsky technique for neurofilaments. Immunostains for glial fibrillary acid protein, synaptophysin, and neurofilament protein also were performed using the streptavidin-biotin-peroxidase complex method.

Results

Clinical

The clinical features of the series are summarized in Table 1. The most common preoperative diagnosis was pineal neoplasm (14 of 19 cases), including pineocytoma or pineoblastoma (five), germinoma (three), or nonspecified tumor (six). Two patients were thought to have dermoid cysts. A correct preoperative diagnosis of pineal cyst was made only in three instances. Postoperative follow-up, ranging from 3 months to 5 years, was available in 17 of the 19 cases. Presenting symptoms had completely resolved in all patients. Three patients developed operative complications including a mild ocular deficit, Parinaud syndrome, which was gradually resolving at the time of follow-up, and a small cerebellar infarction.

Radiologic

The radiographic features of the series are also summarized in Table 1. In all cases the cysts were sharply marginated, midline, and did not invade the midbrain. All were round, ovoid, or lobulated in shape. Hydrocephalus was present in nine patients (47%). CT (nine patients) typically demonstrated a fluid-density pineal-region mass. In one case, a small 0.8-cm cyst was not detectable. Calcification in the cyst wall was observed in four of the nine patients, which correlated with relatively abundant calcium at histology (Fig 1).

MR imaging (17 patients) typically demonstrated a homogenous mass that was clearly separate from the midbrain tectum, although three cysts were heterogenous in appearance (18%). On T1-weighted images, the cysts typically demonstrated signal intensity greater than cerebrospinal fluid (CSF) but less than brain (47%), or isointense to CSF (41%). One signaled isointense and another hyperintense to brain. On T2-weighted images, more than half signaled isointense to CSF (59%) with the remainder signaling greater than brain and less than CSF (41%) (Figs 2 and 3). Three cysts demonstrated fluid/fluid levels consistent with recent hemorrhage (Fig 4A). Unexpectedly, seven of 12 cysts (58%) demonstrated enhancement with gadolinium. All of these enhanced in a somewhat nodular, irregular pattern, with two demonstrating a peripheral, ring-like pattern as well (Fig 5). In one instance an incidental lipoma in the perimesencephalic cistern immediately adjacent to the cyst led to an initial diagnosis of a teratoma or a dermoid (Fig 4B).

Pathologic

Gross pathologic examination of resected specimens revealed smooth-surfaced, soft, tan, thin-walled (0.5- to 2-cm) cysts containing clear-yellow fluid in the majority of cases. The content of one cyst was grossly hemorrhagic. Histopathologic examination of the cysts showed the walls to be generally composed of three layers: a delicate, often incomplete, outer fibrous layer; a middle layer of pineal parenchyma with or without microcalcifications; and an inner more uniform layer of glial tissue often exhibiting Rosenthal fibers or granular bodies. Hemosiderin deposition was observed in the three cases that had imaging evidence of hemorrhage (Fig 6).

TABLE 1: The clinical and imaging findings in 19 patients with proved pineal cysts

Case	Sex	Age	Signs and Symptoms	Preoperative Diagnosis	Postoperative Follow-up	MR	CT	Size (cm)	Ca^{+2}	Hydrocephalus	MR Characteristics		
											T1	T2	Enhancement w/Gd-DTPA
1	F	30	HA, bilat papilledema	Dermoid cyst	Asymptomatic		X	3.0	−	+			
2	M	27	HA, seizures, Parinaud diplopia	Germinoma	Mild ocular deficit	X	X	0.8	−	+	↓	+	−
3	F	35	HA, left hemiparesis	Pineal neoplasm	Asymptomatic	X	X	1.5	+	+	↓↓	+	
4	F	26	HA, papilledema, Parinaud diplopia	Dermoid cyst	Asymptomatic	X		2.5		+	↑	+	−
5	F	25	HA, diplopia, vomiting	Pineal neoplasm	Asymptomatic	X		1.2		−	↓	+	+, Nodular
6	M	23	Seizure	Germinoma	Asymptomatic	X	X	1.5	+	−	↓	++	+, Nodular
7	F	41	Diplopia, difficulty w/ balance, unsteady	Pinealocytoma or pineaoblastoma	Asymptomatic	X		0.9		−	→	+	+, Nodular + ring-like
8	M	16	HA	Germinoma	Asymptomatic	X		1.0		−	↓	+	+, Nodular + ring-like
9	M	24	HA, papilledema	Pinealocytoma or pinealoblastoma	Resolving Parinaud		X	2.5	−	+			
10	F	29	HA, nausea & vomiting	Pineal neoplasm	Asymptomatic	X		2.0		−	↓	+	
11	M	23	HA, nausea & vomiting	Pineal neoplasm	No follow-up	X	X	1.2	−	+	↓	++	−
12	F	39	HA	Pinealocytoma or Pinealoblastoma	Asymptomatic	X		1.0		−	↓↓	++	+, Nodular
13	F	15	HA	Pineal cyst	Asymptomatic	X	X	1.5	−	+	↓↓	++	
14	F	36	HA	Pineal cyst	Asymptomatic	X		1.8		−	↓↓	++	−
15	F	46	HA	Pinealocytoma or pinealoblastoma	Asymptomatic	X		1.8		−	↓↓	++	+, Nodular
16	F	22	Seizures	Pineal neoplasm	Asymptomatic	X		2.2		+	↓	+	−
17	F	20	HA, nausea & vomiting, diplopia, papilledema	Pineal cyst	Asymptomatic	X	X	1.5	+	−	↓↓	++	
18	F	35	HA	Pinealocytoma or Pinealoblastoma	Venous cerebellar infarction	X	X	1.2	+	−	↓↓	++	+, Nodular
19	F	17	Diplopia	Pineal neoplasm	No follow-up	X		1.5		+	↓↓	++	

Note.—HA = headache; + = present; − = absent; T1: ↓↓ = CSF; ↓ = >CSF <brain; → = isointense to brain; ↑ = hyperintense to brain; T2: + = >brain <CSF; ++ = CSF.

Discussion

Large benign cysts of the pineal gland were first described in 1899 by Campbell (12). In 1932 Cooper (13) described the embryology of the pineal gland and the primitive pineal diverticulum of the third ventricle, which is divided into the pineal recess and cavum pineal by invading neuroglial cells during fetal life. Usually the cavum pineal undergoes obliteration by concentrically organized glial fibers. If obliteration is incomplete, a cavity remains, which may increase in size under some unknown provocation later in life (13). Other proposed theories regarding the origin of such large cysts include ischemic-glial degeneration, pineal involution secondary to atherosclerosis, hemorrhagic expansion, or enlargement of small incidental cysts secondary to hormonal influences associated with pregnancy or the menstrual cycle (5). Following the ischemic-glial degeneration and involution theories, a predilection for elderly patients would be expected. However, mean patient age in our series was 28 years, a figure similar to that reported by Klein and Rubenstein (5) (29 years, seven patients) and Oeckler and Feidan (6) (27 years, five patients). In our series 74% of patients were women, and four of the 19 cases (21%) had histopathologic evidence of hemorrhage. This prompts us to suggest that perhaps hemorrhagic expansion and hormonal influences in female patients each play some role in the development of large pineal cysts.

The symptoms accompanying large pineal cysts as seen in our patients reflect either compression of the cerebral aqueduct resulting in hydrocephalus (47%), obstruction of the vein of Galen leading to increased intracranial pressure, or a compression of the collicular plate with resultant Parinaud syndrome (10%). Less fre-

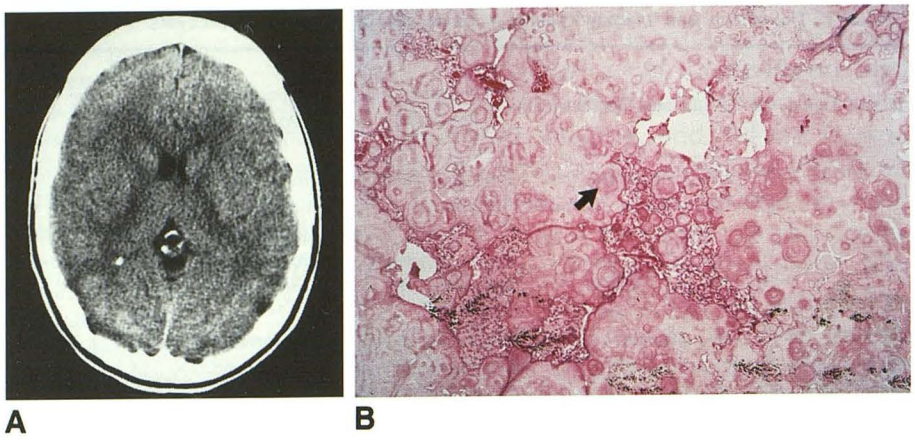


Fig. 1. Case 17. *A*, Noncontrast axial CT shows a 2-cm partially calcified cystic pineal region mass.

B, Magnified view of the middle layer of pineal parenchyma demonstrating abundant microcalcifications (*arrow*) (hematoxylin and eosin stain; magnification ×160). The preoperative diagnosis was pineal cyst.

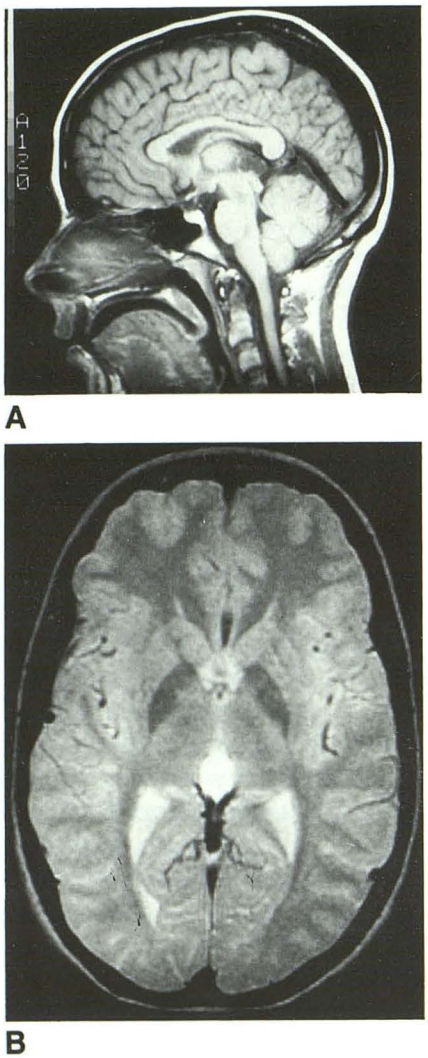


Fig. 2. Case 18. The classic pineal cyst on MR is homogeneous and isointense to CSF on T1- and T2-weighted sequences (600/20 [*A*], 2000/70 [*B*]). This pattern was observed in 41% of our cases. The preoperative diagnosis was pineal cyst.

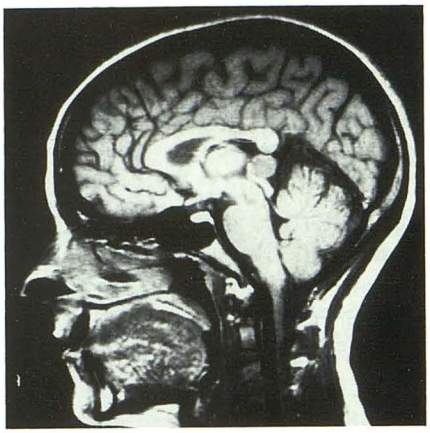
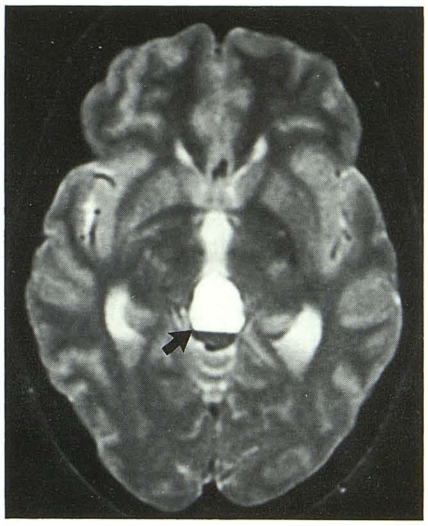


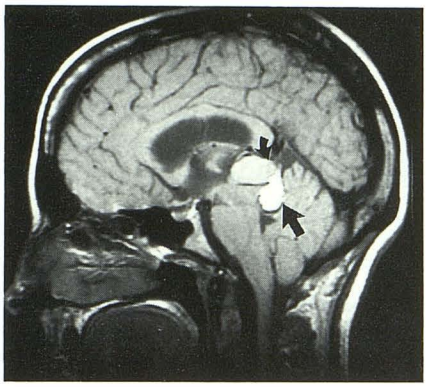
Fig. 3. Case 5. The cysts signaled greater then CSF but less than brain on T1-weighted (800/25) scans in another 47%. See Figs 4 and 6 for other unusual signal changes. The preoperative diagnosis was pineal neoplasm.

quently observed signs include ataxia, hemiparesis, diabetes insipidus, and hypopituitarism (14).

Whereas incidental small asymptomatic pineal cysts are not uncommon, both in imaging studies (2–4) and at autopsy (1) cysts larger than 0.5 cm that cause symptoms are rare. In reviewing the radiologic literature, we found two case reports (7, 8), each with pathologic confirmation. Osborn et al reported a hemorrhagic pineal cyst in a patient with headache and Parinaud syndrome, (8), and Welton et al found a nonhemorrhagic pineal cyst in a patient with a Parinaud syndrome alone (7). There are also isolated case reports and small series in the nonradiologic literature (5, 6, 9–11). For instance, Klein and Rubenstein (5) and Oeckler and Feider (6) reviewed seven and five cases of symptomatic pineal cysts, respectively. Lesion size in our series ranged from 0.8 to 3.0 cm. In Klein and Rubenstein's series (5) of seven symptomatic patients, cyst size ranged from 1.0



A



B

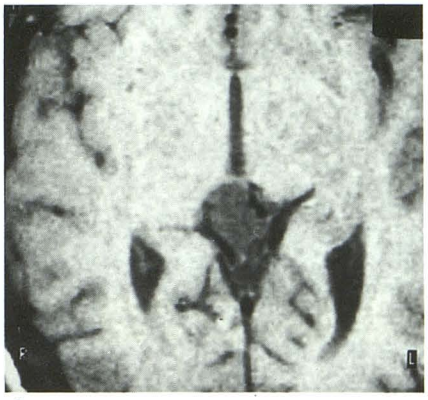
Fig. 4. Case 4. *A,* A fluid-blood level with hematocrit effect is well demonstrated on this axial T2-weighted (2500/80) image (*arrow*).

B, The T1-weighted sagittal view demonstrates that this lesion is complex and has a fatty component (*arrow*). The fluid/blood level is again identified (*curved arrow*). At surgery, a hemorrhagic pineal cyst was found, which was separate and unrelated to the incidental lipoma in the perimesencephalic cistern. The preoperative diagnosis was dermoid cyst.

to 4.5 cm. Cyst size was not reported in Oeckler and Fieden's review (6). In Mamourian and Towfighi's study (2) the cysts were less than 1 cm in 23 of 29 cases (79%), none of which caused symptoms. These findings suggest those less than 1 cm are unlikely to cause symptoms because of mass effect, and that symptomatic cysts are typically larger than 1 cm.

As described in the literature, pineal cysts typically are seen as homogenous, round lesions with signal intensity lower than that of brain parenchyma but higher than CSF on T1-weighted images. On T2-weighted images they are hyperintense relative to brain and CSF (2). Although all of our cysts were hyperintense to CSF on intermediate-weighted images, none of the cysts signaled greater than CSF with T2 weighting. The most common pattern we observed (in 41% of the cases) was that of a homogeneous mass that signaled equal to CSF on both T1- and T2-weighted sequences. Three cysts were heterogenous (18%) on both T1- and T2-weighted sequences, and two cysts (12%) had signal intensity that was equal to or greater than brain parenchyma with T1 weighting.

More than half (58%) of the cyst walls enhanced in a nodular fashion, with two demonstrating a peripheral ring-like pattern as well. The remaining cysts (42%) did not enhance. This enhancement pattern varies somewhat from the enhancement noted by Mamourian and Yarnell (15) in six cases of asymptomatic pineal cysts. They reported circumferential rim enhancement



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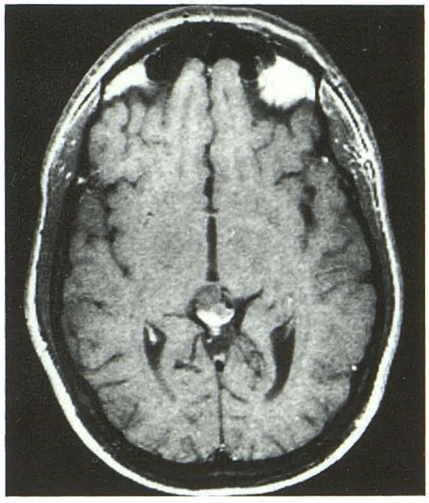
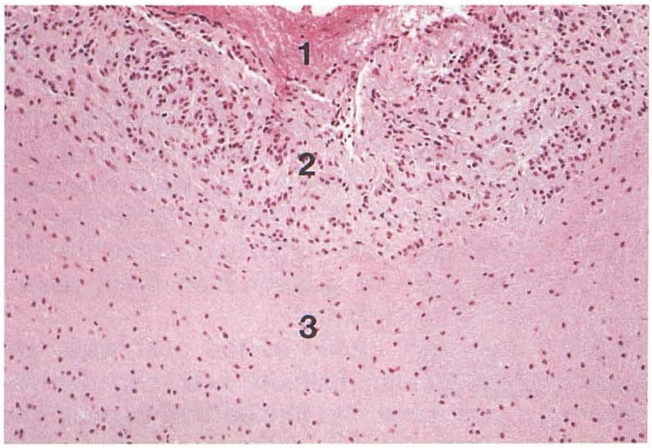


B

Fig. 5. Case 6, A variety of enhancement patterns were observed including irregular nodular enhancement.

A, Precontrast image (650/25).

B, Postcontrast image (650/25). The preoperative diagnosis s germinoma.



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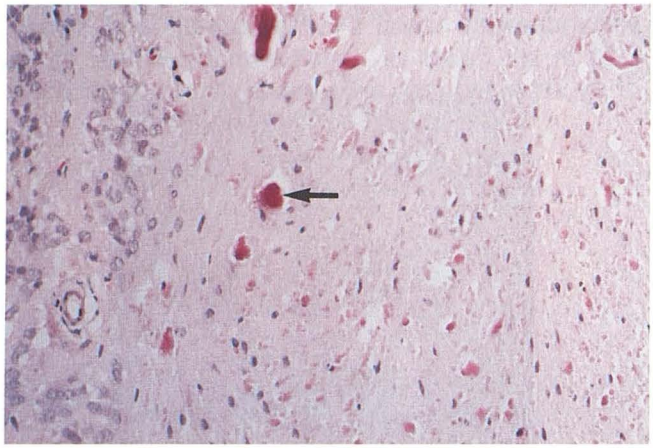

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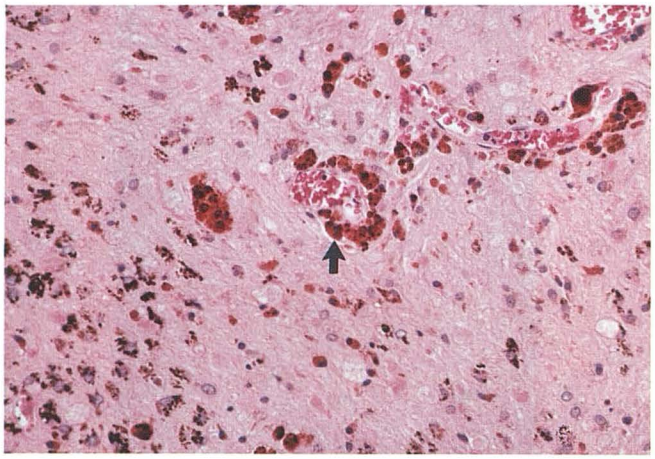

C

Fig. 6. *A,* The three layers of the cyst wall are demonstrated: outer fibrous layer, middle layer of pineal parenchyma, and an inner glial layer (hematoxylin and eosin stain; magnification ×64).

B, Magnified view of the inner glial layer exhibiting Rosenthal fibers, a nonspecific reactive glial tissue that can be seen adjacent to inflammation or neoplasm (*arrow*) (hematoxylin and eosin stain; magnification ×250).

C, Magnified view of the inner glial layer showing evidence of perivascular hemosiderin deposition (*arrow*) (hematoxylin and eosin stain; magnification ×250).

on the immediate postcontrast images, with contrast material filling in the central portion of the cyst on delayed scans (60–90 minutes after injection), mimicking a solid tumor. They postulated that the initial enhancement reflects the surrounding pineal tissue, which does not have a blood-brain barrier with subsequent passive diffusion of contrast into the cyst fluid. We would agree that the enhancement we observed may reflect the distribution of displaced pineal tissue. The nodular, irregular pattern we observed may be due to fragmentation of the pineal parenchyma as the cyst enlarges. Although this fragmentation was often evident histologically, it was difficult to correlate the location of enhancement with histologic findings. Delayed imaging was not performed in any of our patients.

In our series, 14 of 17 cysts (82%) imaged with MR demonstrated heterogeneity, hemorrhage, enhancement, or evidence of mass effect in addition to being hypointense on T1 and bright on T2. The unusual imaging appearance in these 14 cases made it difficult to distinguish a larger pineal cyst from cystic neoplasm.

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