AJNR

Pineal cysts: MR imaging.

A C Mamourian and J Towfighi

AJNR Am J Neuroradiol 1986, 7 (6) 1081-1086
http://www.ajnr.org/content/7/6/1081

Pineal Cysts: MR Imaging

Alexander C. Mamourian[1]
Javad Towfighi[2]

MR brain scans of 672 consecutive patients were examined prospectively to determine the incidence of high-signal pineal glands on T2-weighted images. The scans were obtained on either a 0.15-T or 0.5-T unit. This finding was present in 29 patients, none of whom had hydrocephalus or symptoms of a pineal mass. A CT scan was available in 17 of these cases and none of these demonstrated a solid pineal mass. Because of the frequency of this observation (4.3%) and the absence of associated findings, it was concluded that benign pineal cysts are the most likely explanation for this high signal. It is important for the radiologist to consider benign cysts in the differential diagnosis of a bright pineal gland on T2-weighted MR images.

Our investigation was prompted by the recognition of high-signal pineal glands on T2-weighted images in several patients without clinical or CT evidence of a pineal tumor. MR scans were evaluated prospectively to determine if this might reflect a variation of normal. When available, CT scans were correlated with the MR images. We also examined pineals obtained at autopsy from five patients, none of whom had MR scans.

Subjects and Methods

The T2-weighted MR images of 672 consecutive patients were evaluated prospectively for the presence of a high-signal pineal gland. All patients studied had neurologic symptoms that suggested intracranial pathology. Four hundred ninety patients were evaluated with a Technicare 0.15-T resistive scanner using a multislice, single-echo technique. Each patient had axial and sagittal repetition time (TR) 500–700, echo time (TE) 30 msec scans with 1.25-cm slice thickness. An axial TR 1500, TE 90–120 msec scan with 1.5-cm slice thickness was also obtained in each case. In many cases this sequence was repeated in the sagittal or coronal plane when a pineal abnormality was noted on the axial images.

One hundred eighty-two patients were scanned with a Siemens 0.5-T superconducting system. Scans were obtained with a multislice, multiecho technique. Axial TR 2000–2500, TE 35/80–90 msec images with 8–10-mm slice thickness as well as sagittal TR 500, TE 30 msec or TR 2000, TE 35/80 msec scans were obtained for each patient. A coronal TR 2000, TE 35/80 msec or axial TR 300–500, TE 20–30 msec scan was used in several cases with high-signal pineals. One other case was provided to us that was imaged on a General Electric 1.5-T superconducting system. These images were obtained with TR 2000, TE 40/80 msec and TR 600, TE 25 msec and are included to provide a high-field example of this finding.

Five pineal glands were obtained at autopsy from patients without clinical evidence of pineal pathology. None of these patients had MR brain scans. One pineal that contained a cyst was sectioned and evaluated microscopically.

Results

Of the 672 patients we studied, 29 (4.3%) had high-signal pineal glands on T2-weighted images and had no evidence of hydrocephalus. One other case with

Received December 19, 1985; accepted after revision May 28, 1986.

[1] Department of Radiology, Milton S. Hershey Medical Center, Pennsylvania State University, P.O. Box 850, Hershey, PA 17033. Address reprint requests to A. C. Mamourian.

[2] Department of Pathology, Milton S. Hershey Medical Center, Pennsylvania State University, Hershey, PA 17033.

AJNR 7:1081–1086, November/December 1986
0195–6108/86/0706–1081

these findings was available from another hospital. In every case the pineal had low or intermediate intensity on T1-weighted scans (Fig. 1). Aside from the pineal findings, the MR scans were normal in 25 of the 30 cases.

Twenty of these pineals were identified on the 0.15-T unit. Fifteen had additional sagittal or coronal T2-weighted scans. Nine cases were identified on the 0.5-T unit. Sagittal or coronal T2-weighted scans were available in four of these cases. In 12 of these 19 cases, the sagittal or coronal images demonstrated the high-signal pineal better than the axial T2-weighted scans did. In only three cases were the axial images superior; in the other four they were judged equal.

Among the 30 patients there were eight men (average age, 26 years) and 22 women (average age, 35 years). Clinical diagnoses at the time of scanning included 15 cases of suspected multiple sclerosis, four with seizures, 10 presumed tumors, and one spinal cord arteriovenous malformation. In no case did the symptoms correspond to a pineal lesion.

Seventeen of the patients also had CT brain scans that failed to demonstrate a pineal mass in any case. Twelve of the CT scans were available for review. In two patients, normal calcified pineals were identified. Two patients had low-density areas consistent with cysts within enlarged pineals without calcification. Eight patients had both calcification and low-density cysts within the pineal. In three of these cases small, sandlike calcifications were seen along the cyst walls. In no case were large, amorphous, or eccentric calcifications identified.

The intensity of the pineals varied on the T2-weighted images. In those cases imaged on the 0.15-T or 1.5-T units, there was a marked intensity difference between the brain and pineal. This was less evident at 0.5 T and did not correspond to the size of the pineal. The pineal was usually not seen on T1-weighted images obtained at 0.15 T. In one patient there was increased signal in the dependent part of the gland on the T1-weighted scan (Fig. 2). At 0.5 T and 1.5 T the pineal was seen on the sagittal T1-weighted scans because it had an intermediate intensity relative to the black CSF. On the scan of the one patient studied at 1.5 T, a rim of slightly higher signal was seen around the enlarged pineal (Fig. 3). In all cases the intensity of the pineal was less than brain parenchyma on T1-weighted images.

The size of the pineals varied. In six of the 30 cases the pineal was clearly enlarged. These pineals had an ovoid or rounded contour and measured more than 10 mm in greatest diameter. In two cases the sagittal images indicated compression of the vein of Galen or midbrain but neither patient had clinical symptoms to support the MR findings (Fig. 4). The other 24 patients did not show this degree of pineal enlargement.

During the acquisition of pineal glands from autopsy cases one pineal cyst was encountered. This was fixed and sectioned. Microscopic study revealed that the cyst did not communicate with the ventricular lumen and was surrounded by a thick layer of fibrillary astrocytes (Fig. 5).

Discussion

The pineal gland arises from a diverticulation and proliferation of the cells in the roof of the third ventricle early in fetal development. The lumen of the diverticulum is eventually reduced to the pineal recess. In closing, the distal aspect of the diverticulum is commonly cut off giving rise to small cavities within the pineal gland [1]. These cavities are lined by primitive cells that are capable of differentiating into ependyma or neuroglia. Cooper [1] suggested that neuroglial cells play an important role in closing residual cavities in the pineal gland. Kappers [2] indicated that glial-lined cysts may also occur as a result of necrosis in preexisting glial plaques.

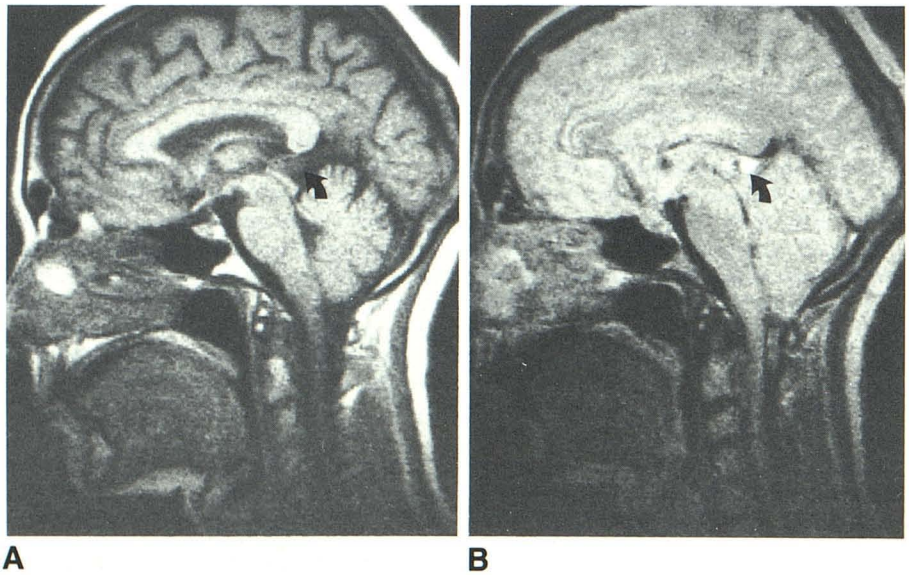
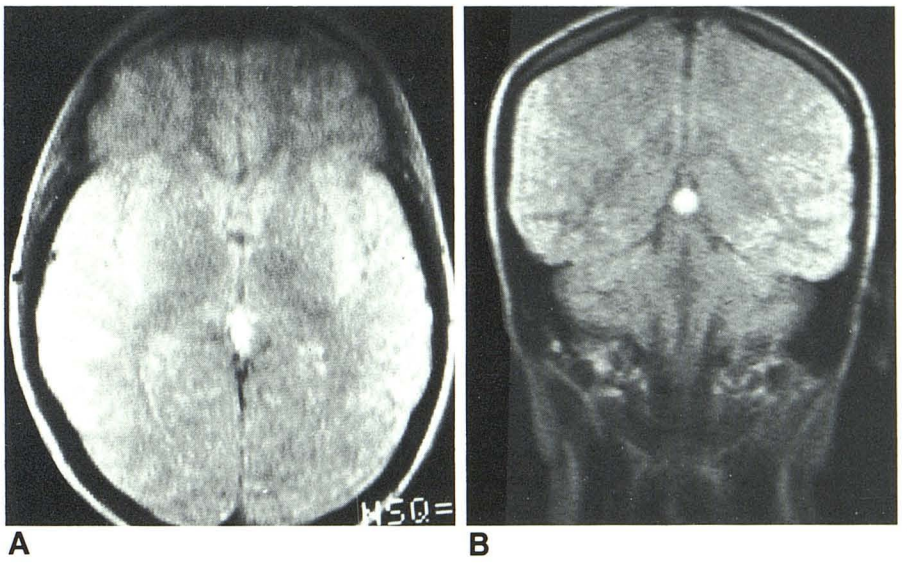


Fig. 1.—Sagittal T1- (**A**) and T2- (**B**) weighted MR images at 0.5 T show typical appearance of pineal cyst (*arrows*).



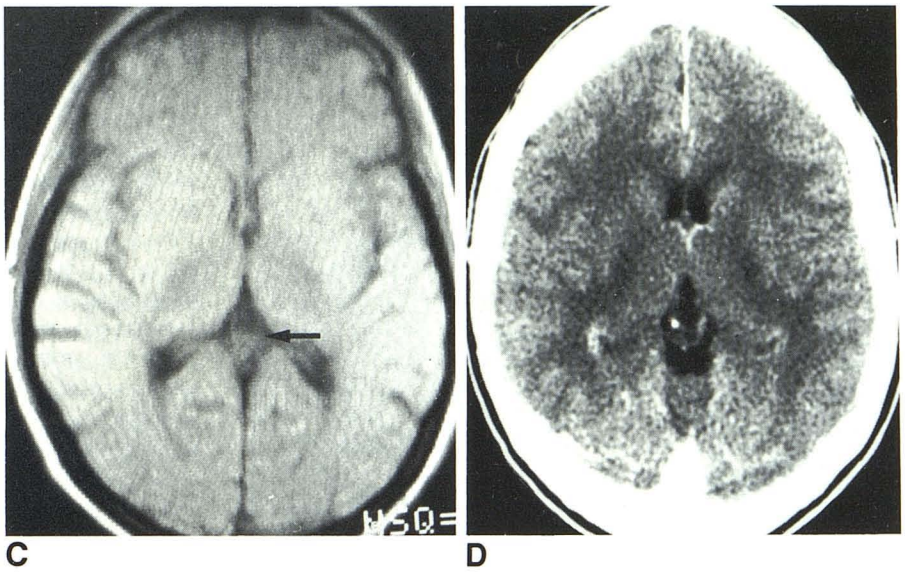


Fig. 2.—Large pineal cyst contrasts sharply with brain and CSF at 0.15 T on both axial (**A**) and coronal (**B**) T2-weighted images. There is appearance of fluid-fluid level (*arrow*) in cyst on T1-weighted scan (**C**), although cyst contents appear homogeneous on CT scan (**D**). CT image shows typical sandlike calcification in cyst wall.

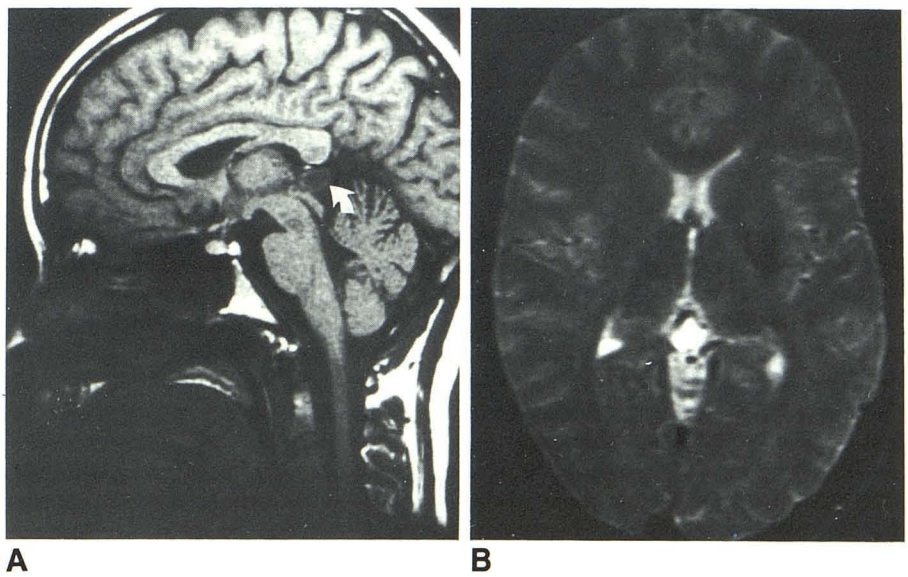


Fig. 3.—**A**, Sagittal T1-weighted image at 1.5 T reveals large pineal cyst. Rim has relatively higher signal than cyst contents (*arrow*). **B**, T2-weighted (TR 2000, TE 80 msec) image. Cyst can be identified by its high intensity.

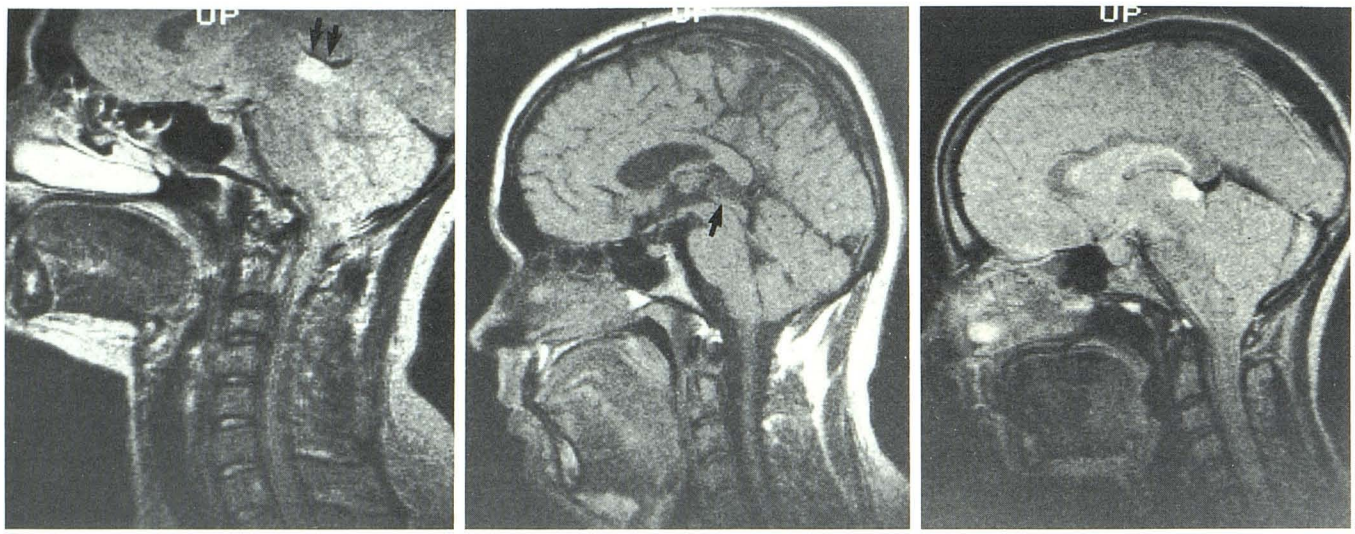


Fig. 4.—**A**, T2-weighted image at 0.5 T. Large pineal cyst appears to indent inferior wall of vein of Galen (*arrows*). **B** and **C**, Another patient. Superior colliculus appears flattened (*arrow*) on T1-weighted 0.5 T image (**B**) by pineal cyst, which is seen well on T2-weighted image (**C**).

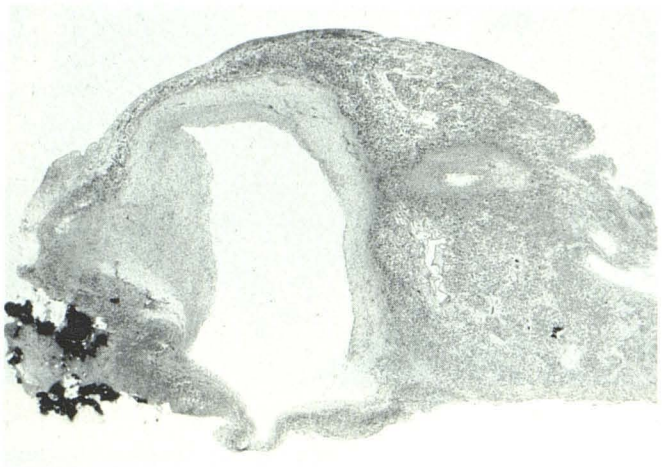


Fig. 5.—Section of pineal cyst (H and E ×20). Cavity was lined by dense zone of fibrillary astrocyte processes.

Those cavities with the ependymal lining may go on to become large cysts, termed *hydrops* by Megyeri [3]. The stimulus that causes the cells lining the cyst to produce fluid is unknown. A third type of cyst has no lining at all and may be the result of necrosis in the pineal parenchyma itself. In any event, cysts can be found in 20–40% of otherwise normal pineals at autopsy [4].

While these pineal cysts are benign, a report by Hajdu et al. [5] suggests an association between pineal cysts and cancer. Slitlike cavities in enlarged pineal glands with deposits resembling Rosenthal fibers were found in 31 of 275 pineals at autopsy. The highest association was in patients with leukemia. Although the control group size was not equal to the study population, these findings were absent in controls. The cysts were taken as evidence of premature pineal degeneration caused by the chemotherapy or metabolic changes induced by the neoplasm.

Pineal tumors may have a high intensity on T2-weighted scans, but pineal region tumors make up only 1% of all intracranial neoplasms [6, 7]. High-signal pineal glands were encountered in 4.3% of our patients who were referred for a variety of neurologic problems. This incidence is not consistent with the expected occurrence of pineal neoplasms. The clinical symptoms of a pineal tumor include diplopia, headache, dizziness, and Parinaud's syndrome [8]. While headache and dizziness are nonspecific complaints, the more characteristic visual symptoms or evidence of elevated intracranial pressure were absent in all our cases. The CT scan of a patient with a pineal tumor may show depression of the collicular plate, hydrocephalus caused by aqueductal obstruction, and an enhancing pineal mass. Coarse, nodular calcifications may be seen within the tumor, particularly with pineal germinomas [9, 10]. These CT findings were absent in all our patients in whom CT scans were obtained. Because of the absence of clinical or CT evidence of a pineal tumor and the incidence of these high-signal pineals, benign pineal cysts are the most likely explanation for this finding in all cases.

While pineal cysts could be identified on CT images in 10 patients, they were always more evident on the T2-weighted MR images. Even the larger cysts were easily overlooked on CT because the cyst fluid has the same density as CSF (Fig. 6). This may account for the scant radiology literature on pineal cysts.

The cysts were slightly more intense than CSF on T1-weighted images and usually much more intense than CSF on T2-weighted images. This appearance is similar to that described for tumoral or infected cysts by Kjos et al. [11]. They attribute this to an elevated protein content, which

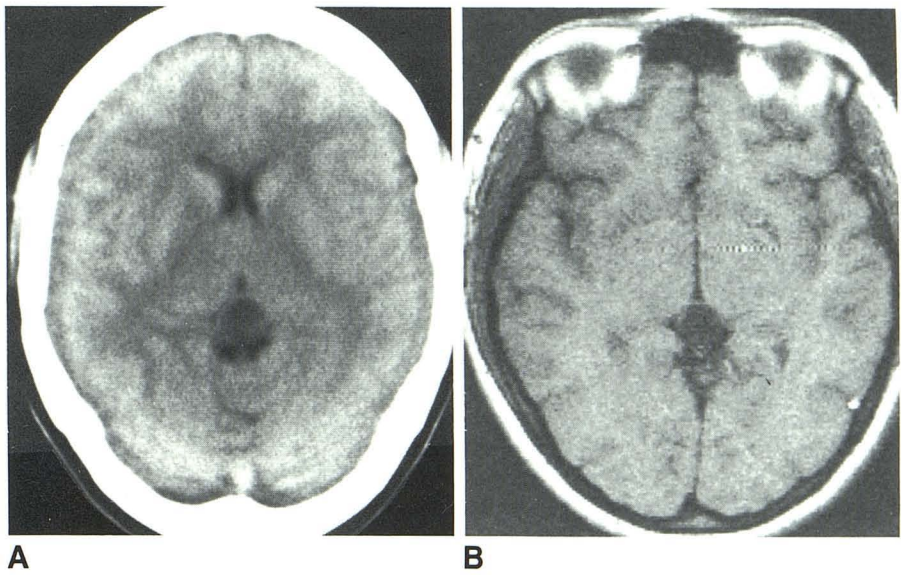


Fig. 6.—Large cyst could be easily overlooked on axial CT (**A**) and T1-weighted 0.5 T MR (**B**) images.

causes a T1 and T2 shortening of the cyst fluid. They explain that although there is both T1 and T2 shortening, the T1 effect predominates. Thus, on the T1-weighted image the shortened T1 allows the cyst fluid to look brighter than CSF. On the T2-weighted image, although conceptually the shortened T2 should make the cyst fluid look darker, it still appears brighter than CSF because of the predominance of the T1 effect. It is important to recognize that the T1 and T2 of the cyst fluid and CSF are much longer than the brain. At the TR values used in conventional T2-weighted images, the protons in these fluids have not completely relaxed. Although we did not study the cyst fluid directly, a previous study by Cooper [1] described cellular debris or coagulated fluid in some pineal cysts at autopsy. In one of our cases a relatively brighter zone was seen in the dependent portion of a cyst on T1-weighted images with what appeared to be a fluid-fluid level in the cyst. This could have been from sedimentation of the heavier protein elements during scanning.

There are few reports in the literature on the MR appearance of pineal tumors. In one report of seven cases, only one showed high signal on T2-weighted images [12]. Thus, while high signal on T2-weighted images is usually associated with disease in the brain, it was absent with many pineal tumors.

None of our cases came to autopsy nor was surgery indicated in any of these patients. We thought, however, that if pineal cysts were as common as the literature reports we should be able to find them in routine autopsy cases. We found one moderate-sized pineal cyst in the five that we examined.

Large pineal cysts can cause hydrocephalus from aqueductal obstruction [13]. They may also compress the quadrigeminal plate or the vein of Galen. This may lead to a lethal elevation of intracranial pressure [1]. Sagittal T1- and T2-weighted images are helpful in the evaluation of the aqueduct and the vein of Galen in those cases in which a pineal abnormality is suspected [12]. Sagittal or coronal T2-weighted images demonstrated the cysts better than the axial images did in most cases. This is probably because of the horizontal orientation of the pineal, which allows more averaging with CSF in the axial plane.

The cysts varied in both size and intensity on T2-weighted images. Many of the cysts identified on the 0.5-T unit did not have as much contrast with brain and CSF as those seen on the other two units. There are many factors that determine image contrast aside from TR and TE [14]. Kneeland et al. [15] showed changes in contrast by varying the separation of slices. Variations of image contrast in a phantom was demonstrated between different commercial MR scanners by Anderson et al. [16]. They attributed this to differences in gradient and RF pulse parameters, which was also suggested by Yamanashi et al. [17]. While variations in the protein content of the cyst fluid may also play some role, we believe that a combination of these other factors causes the cyst-to-brain contrast to be lower on T2-weighted images obtained on the 0.5-T unit. This creates some difficulty when trying to characterize these cysts by their intensity alone. While this may be feasible for a single site, the results would not necessarily be applicable to other scanners. We did find that in all 30 cases these benign pineal cysts had a well circumscribed rounded contour with high signal intensity on T2-weighted scans and low intensity relative to brain on T1-weighted images. These findings could be seen with a pineal tumor, but should be accompanied by hydrocephalus or clinical evidence of a pineal mass. In such cases a CT scan may be necessary to differentiate a cyst from a solid pineal tumor. It is important for the radiologist to recognize, however, that a high-signal pineal on T2-weighted scans is usually caused by benign cysts, a normal variant.

ACKNOWLEDGMENTS

We thank Richard Briggs, Sharon Hurst, Michele Mease, Debbie Belovich, Ida Gorman, and Judy Perry for assistance. The 1.5-T

images were provided by Geisinger Medical Center, Danville, PA, courtesy of Linda Coleman.

REFERENCES

1. Cooper ER. The human pineal gland and pineal cysts. *J Anat* **1932**;67:28–46
2. Kappers JA. Epipysis. In: Crosby EC, Humphrey T, Lauer EW, eds. *Correlative anatomy of the nervous system*. New York: Macmillian, **1962**:268–271
3. Megyeri L. Cystische Veränderungen des Corpus pineale. *Frankfurter Z Pathol* **1960**;70:699–704
4. Tapp E, Huxley M. The histological appearance of the human pineal gland from puberty to old age. *J Pathol* **1972**;108:137–144
5. Hajdu SI, Porro RS, Lieberman PH, Foote FW. Degeneration of the pineal gland of patients with cancer. *Cancer* **1972**;29:706–709
6. Fitz CR, Rao KC. Primary tumors in children. In: Lee SH, Rao KC, eds. *Cranial computed tomography*. New York: McGraw-Hill, **1983**:295–343
7. Zimmerman RA, Bilaniuk LT, Wood JH, Bruce DA, Schut L. Computed tomography of pineal, parapineal, and histologically related tumors. *Radiology* **1980**;137:669–677
8. Futrell NN, Osborn AG, Cheson BD. Pineal region tumors. Computed tomograhic-pathologic spectrum. *AJR* **1981**;137:951–956
9. Ganti SR, Hilal SK, Stein BM, Silver AJ, Mawad M, Sane P. CT of pineal region tumors. *AJNR* **1986**;7:97–104, *AJR* **1986**;146:451–458
10. Chang CG, Kageyama NK, Kobayashi T, Yoshida J, Negoro M. Pineal tumors: clinical diagnosis with special emphasis on the significance of pineal calcification. *Neurosurgery* **1981**;8:656–668
11. Kjos BO, Brant-Zawadzki M, Kucharczyk W, Kelly WM, Norman D, Newton TH. Cystic intracranial lesions: magnetic resonance imaging. *Radiology* **1985**;155:363–369
12. Kilgore DP, Strother CM, Starshak RJ, Haughton VM. Pineal germinoma: MR imaging. *Radiology* **1986**;158:435–438
13. Sevitt S, Schorstein J. A case of pineal cyst. *Br Med J* **1947**;2:490–491
14. Wehrli FW, MacFall JR, Newton TH. Parameters determining the appearance of NMR images. In: Newton TH, Potts DG, eds. *Advanced imaging techniques*, vol 2. *Modern neuroradiology*. San Anselmo, CA: Clavadel, **1983**:81–117
15. Kneeland JB, Shimakawa A, Wehrli FW. Effect of intersection spacing on MR image contrast and study time. *Radiology* **1986**;158:819–822
16. Anderson DW, Yamanashi WS, Ross-Duggan JW, et al. Pixel intensity and contrast values as functions of relaxation times and pulse intervals in several commercial MR imagers. Presented at the annual meeting of the Society of Magnetic Resonance Imaging, Philadelphia, March **1986**, *Magnetic Resonance Imaging* **1986**;4:129
17. Yamanashi WS, Anderson DW, Lester PD, Hewik D, Frazer JW. Dependence of magnetic resonance image (MRI) intensity values on relaxation times, pulse intervals and other signal attenuation factors. *Physiol Chem Phys Med NMR* **1985**;17:81–100