Prevalence and natural history of pineal cysts in adults

Clinical article

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Object. We reviewed our experience with pineal cysts to define the natural history and clinical relevance of this common intracranial finding.

Methods. The study population consisted of 48,417 consecutive patients who underwent brain MR imaging at a single institution over a 12-year interval and who were over 18 years of age at the time of imaging. Patient characteristics, including demographic data and other intracranial diagnoses, were collected from cases involving patients with a pineal cyst. We then identified all patients with pineal cysts who had been clinically evaluated at our institution and who had at least 6 months of clinical and imaging follow-up. All inclusion criteria for the natural history analysis were met in 151 patients.

Results. Pineal cysts measuring 5 mm or larger in greatest dimension were found in 478 patients (1.0%). Of these, 162 patients were male and 316 were female. On follow-up MR imaging of 151 patients with pineal cyst at a mean interval of 3.4 years from the initial study, 124 pineal cysts remained stable, 4 increased in size, and 23 decreased in size. Cysts that were larger at the time of initial diagnosis were more likely to decrease in size over the follow-up interval (p = 0.004). Patient sex, patient age at diagnosis, and the presence of septations within the cyst were not significantly associated with cyst change on follow-up.

Conclusions. Follow-up imaging and neurosurgical evaluation are not mandatory for adults with asymptomatic pineal cysts. (DOI: 10.3171/2011.6.JNS11506)

Key Words • natural history • pineal cyst • prevalence •
diagnostic and operative techniques

Although pineal cysts were once thought to be rare,16,66 they have been identified with increasing frequency since the advent of MR imaging.15,33,69 They are now a common incidental finding on imaging studies. Patients with pineal cysts discovered on imaging are often referred to neurosurgeons for clinical evaluation.52 The clinical significance and management of these cysts is not well defined. While generally considered asymptomatic, these cysts have been occasionally associated with headaches, hydrocephalus, extraocular movement abnormalities, and Parinaud syndrome.17,19,20,29,36,37,39,40,46,47,67,69

Previous studies on the prevalence of pineal cysts on intracranial imaging have reported a prevalence ranging from 1% to 4%.3,15,22,33,35,40,51,59,61 We previously reported on the prevalence and natural history of pineal cysts in children.34 In our current study, we evaluated a consecutive series of adult patients undergoing intracranial imaging to define the age-related prevalence of pineal cysts in this population. We then analyzed the outcome in those patients who presented for clinical evaluation of a pineal cyst found on intracranial imaging to better define the natural history of pineal cysts.

Methods

Following approval by the University of Michigan Institutional Review Board, we retrospectively reviewed the electronic medical records of all patients over the age of 19 years who had undergone brain MR imaging at the University of Michigan between January 1, 1997, and September 30, 2009, to identify those patients with a pineal cyst found on MR imaging. We used EMERSE (the Electronic Medical Record Search Engine)34 to identify our population of interest; EMERSE is a search engine that queries all free-text documents within the electronic medical records of a specified patient population. For this study, we used EMERSE to identify a population in which the terms “pineal” or “cyst” were noted. Afterward, we manually read and viewed the medical and radiological records of all patients in this population to identify those

Abbreviation used in this paper: EMERSE = the Electronic Medical Record Search Engine.
who met the inclusion criteria. During the study period, 48,417 patients in the desired age range underwent intracranial imaging. Only patients with pineal cysts that measured 5 mm or greater in at least one imaging plane (axial, sagittal, or coronal) were included in the pineal cyst group. Cysts in the pineal gland that measured less than 5 mm in maximum dimension were not considered pineal cysts for the purpose of our analysis. Patients with an initial diagnosis of a pineal region tumor were excluded. All MR imaging was performed on either a 1.5- or 3-T device. For each patient, we collected demographic information such as age and sex, clinical information such as the indication for imaging and symptoms, and imaging appearance. We recorded the presence of headaches, visual disturbances, hydrocephalus, and Parinaud syndrome.

The MR images were directly examined for all patients with pineal cysts. The images and records were reviewed by the senior author (C.O.M.) to confirm the diagnosis in every case and to evaluate for the presence of symptoms. Cyst size and imaging characteristics were recorded. The size of the pineal cyst was measured using sagittal, axial, and coronal images when available. For purposes of this analysis, pineal cysts were considered to have “normal” imaging characteristics if cyst contents were homogeneous and isointense to slightly hyperintense to CSF on both T1- and T2-weighted imaging, if the pineal cyst rim was smooth and thin, if there was no evidence of abnormal masses or nodularity, and if there was no evidence of multiple septations or a multicystic appearance.

The prevalence of pineal cysts in this consecutive series of MR imaging evaluations was calculated for all patients as well as for sex-specific and age-specific groups. For purposes of this analysis, patients were grouped according to age by decade. An analysis was performed to identify the effect of age and sex on the presence of pineal cysts and on pineal cyst size. Pineal cyst size in the anteroposterior direction on sagittal images was used for the size analysis. When evaluating age and sex, the prevalence of pineal cysts was evaluated using univariate and multivariate logistic regression with sex. Pineal cyst size versus age was evaluated using linear regression. Data were analyzed using SPSS version 16.0 software (SPSS, Inc.).

Natural History Data Collection

Patients were included in our natural history analysis only if at least 6 months of clinical and imaging follow-up was achieved. Therefore, all patients included in this analysis had at least 2 MR imaging scans obtained over a period of at least 6 months from cyst detection. Eleven patients included in the natural history portion of this study were followed up clinically and radiologically. If multiple MR images were obtained, we included the first and last MR imaging studies that accounted for the longest follow-up interval within the date range of the study. On imaging, cysts were evaluated for any changes in size or appearance. Changes in size of less than 2 mm were considered to be within the margin of measurement error and were not identified as changes. We recorded any change in neurological symptoms over the follow-up interval.

Natural History Data Analysis

Univariate and multivariate logistic regression was performed to evaluate whether demographic factors or initial imaging appearance predicted change in cyst size over time. Data were analyzed using SPSS version 16.0 software.

Results

Prevalence

We examined the records of 48,417 consecutive adult patients who underwent brain MR imaging. A large number of MR images were obtained within each age group (Table 1). More brain MR imaging was performed in women (28,090) than men (20,327) over the study period. We found 478 pineal cysts in this population (prevalence of 1.0%). Of the 20,327 MR images performed in men, 162 pineal cysts were identified (0.8%). Of the 28,090 MR images performed in women, 316 pineal cysts were identified (1.1%). The peak prevalence in the adult age range was in the ages of 19–30 years, with a prevalence of 2.0%. The prevalence of pineal cysts significantly decreased with increasing age ($p < 0.00001$, Fig. 1). Women had a significantly increased prevalence of pineal cysts compared with men ($p = 0.0001$, Fig. 2). After multivariate analysis, both younger age ($p < 0.00001$) and female sex ($p = 0.004$) were found to be independently associated with an increased prevalence of pineal cysts in adults.

In patients diagnosed with pineal cysts, the most common indications for intracranial imaging were neurological or mental status change (in 50%), headaches (in 21%), and concern for seizure (in 10%). Other intracranial findings in these patients were recorded. The most common findings were other cysts (in 6.4%) and intracranial tumors (in 13%). The most common cysts were choroid plexus cysts (in 2%) and arachnoid cysts (in 1.5%). The most common tumors were pituitary adenomas (in 3.3%), gliomas (in 2.9%), and meningiomas (in 2.7%).

Symptoms

Of the patients undergoing imaging for headaches, none were thought to have headaches related to the pineal cysts. In 14 patients, ophthalmoplegia had been diagnosed by a physician. In each of these cases, the pineal cyst was not thought to be causing the ophthalmoplegia. Of these patients, 4 had ophthalmoplegia caused by intracranial tumors, 3 had a history of extraocular muscle abnormalities that were diagnosed by an ophthalmologist, and 1 case each were a result of trauma, stroke, and multiple sclerosis. In 4 patients, the cause of the ophthalmoplegia was not known but was not thought to be a result of the pineal cyst. Hydrocephalus was diagnosed in 7 patients, and none of these patients had hydrocephalus secondary to aqueductal stenosis or mass effect from the pineal cyst. Parinaud syndrome was not diagnosed in any patient.
with a mean (± SD) follow-up interval of 3.4 ± 2.9 years (range 6 months to 13 years). The mean age at diagnosis for this group was 40.1 ± 14.5 years. Forty-three patients were male and 108 were female.

At time of initial diagnosis, the mean pineal cyst size was 9.7 ± 3.8 mm in the sagittal anteroposterior dimension, 6.8 ± 2.9 mm in sagittal craniocaudal dimension, and 7.0 ± 2.8 mm in axial width. Of the pineal cysts measured, 75 (50%) were less than 10 mm in the maximum dimension. There was no significant difference in size of pineal cysts between male and female patients, with the mean anteroposterior diameter of the pineal cysts measuring 9.7 mm in women and 10.3 mm in men (p = 0.4). Age had no effect on pineal cyst size. Atypical findings were present in 11% of cysts, most often due to a multicystic appearance or as a result of abnormal enhancement.

On follow-up MR imaging evaluation, 4 cysts (2.6%) increased in size, 23 (15%) decreased in size, and 124 (82%) remained stable (Fig. 3). When evaluating all patients, the mean change in size over the follow-up period was an overall decrease in size by 0.2 mm. Of the 4 cysts that increased in size, the mean change in maximum diameter was 3.5 mm. Of the 23 cysts that decreased in size, the mean decrease in maximum diameter was 2.8 mm. No patients developed symptoms related to the pineal cyst in the follow-up period. No patients in the natural history analysis underwent surgical treatment of the pineal cyst.

Patient and cyst factors were analyzed to identify variables associated with a change in cyst size. No factors were found that correlated significantly with cyst enlargement. The 4 patients with an increase in cyst size were younger at the time of diagnosis, but this difference was not statistically significant (p = 0.9). The mean age of patients with an increase in cyst size was 28.5 years compared with a mean age of 40.4 years for all others. Cysts that were larger at initial diagnosis were more likely to decrease in size over the follow-up period (p = 0.004, based on multivariate analysis). The mean initial size of cysts that decreased was 12.2 mm versus 9.5 mm for all others. Patient sex, age, and atypical cyst characteristics were not significantly associated with a decrease in cyst size. Smaller cyst size at the time of diagnosis was associated with a lack of change in cyst size at follow-up (p = 0.008).

**Discussion**

Pineal cysts are a common incidental finding on MR imaging and their discovery frequently results in a neurosurgical consultation.6,19,52,59 There have been several prior attempts to analyze the prevalence of pineal cysts in patients undergoing intracranial imaging, with estimates ranging from 1.0% to 4.3%.3,7,15,22,33–35,40,51,61 In the largest series of pineal cysts in adults prior to our current study, Sawamura et al.59 evaluated MR images from 6023 patients and found 79 pineal cysts (prevalence of 1.3%). In an age-specific prevalence analysis, these authors found a decrease in the prevalence of pineal cysts on imaging in adults. Other investigators evaluated pineal cyst prevalence on MR imaging without specifically examining

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**TABLE 1: Number of pineal cysts found in 48,417 consecutive patients undergoing brain MR imaging at a single institution, stratified by patient age and gender***

<table>
<thead>
<tr>
<th>Age Group (yrs)</th>
<th>No. of MRIs</th>
<th>No. of Pineal Cysts</th>
<th>MRI Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Pts</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>19–30</td>
<td>7,230</td>
<td>2,618</td>
<td>4,612</td>
</tr>
<tr>
<td>31–40</td>
<td>8,510</td>
<td>3,151</td>
<td>5,359</td>
</tr>
<tr>
<td>41–50</td>
<td>10,004</td>
<td>4,156</td>
<td>5,848</td>
</tr>
<tr>
<td>51–60</td>
<td>9,052</td>
<td>4,079</td>
<td>4,973</td>
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<td>61–70</td>
<td>6,646</td>
<td>3,235</td>
<td>3,411</td>
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<td>71–80</td>
<td>4,913</td>
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<td>2,601</td>
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<td>81–90</td>
<td>1,933</td>
<td>734</td>
<td>1,199</td>
</tr>
<tr>
<td>91–100</td>
<td>129</td>
<td>42</td>
<td>87</td>
</tr>
<tr>
<td>&gt;100</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>total</td>
<td>48,417</td>
<td>20,327</td>
<td>28,090</td>
</tr>
</tbody>
</table>

* Pts = Patients.
Pineal cysts

the effect of age on prevalence. Lum et al.34 examined MR images from 1000 patients and found 14 pineal cysts (1.4%). Lee et al.33 evaluated MR imaging studies performed in 1000 patients and found 15 pineal cysts (1.5%). Golzarian et al.22 evaluated MR imaging from 500 patients and found 12 pineal cysts (2.4%). Di Costanzo et al.15 evaluated MR imaging from 400 patients and found 7 (1.8%) with pineal cysts. Mamourian et al.35 found 29 pineal cysts (4.3%) in 672 consecutive patients undergoing MR imaging. We found 478 pineal cysts in 48,417 consecutive patients undergoing MR imaging, for a prevalence of 1.0%. We also found a marked decline in prevalence with advancing age throughout the adult age range. This trend was true for both men and women.

Our analysis revealed a significant relationship between age and imaging prevalence for pineal cysts. In our previous report on cyst prevalence in children,3 we found a 1.9% MR imaging prevalence of pineal cysts in children. In addition, we found that cyst prevalence increased with increasing age during childhood. In our current analysis of age-related prevalence in adults, we found that prevalence decreases with advancing age during adulthood. Taking these findings together, it is clear that prevalence rises to a peak late in childhood and then falls throughout the adult age range (Fig. 4). This trend was true for both men and women.

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Pineal cysts are more common in women than men. We found this to be true in both the pediatric and adult populations. In children, we found a 2.4% prevalence in girls and 1.5% in boys, with a peak female prevalence of 3.7% in children 6–12 years of age. In adults, we also found a statistically significant difference between prevalence in men (0.8%) and prevalence in women (1.1%). A female preponderance has been noted in most of the previous studies.6,19,29,36,40,54,59,69 No large series has found a male predominance.

The natural history of these cysts has not been well described, and many patients undergo repeated intracranial imaging or clinical evaluations. A better understanding of the natural history of pineal cysts may help to define the role of repeated clinical evaluation and follow-up imaging. Several smaller series reported on the imaging changes of pineal cysts over time. Barboriak et al.6 evaluated 32 patients with pineal cysts with a mean follow-up interval of 3.7 years and found a change in cyst size in 8 patients. In these patients, 3 cysts decreased in size by 2–4 mm, and 2 cysts had completely involuted at time of follow-up examination. They found 2 cysts that had enlarged and 1 that had formed de novo. None of those changes in imaging appearance were associated with any discernible change in symptoms. Tamaki et al.58 reported on 31 pineal cysts with a follow-up interval ranging from 3 months to 4 years. They found that 29 remained stable in size and 2 cysts involuted. Sawamura et al.59 examined follow-up images for 20 patients at a median interval of 18 months. They found no instances of notable change in the size of these cysts. Similarly, Golzarian et al.32 noted that after repeat imaging of 12 patients with pineal cysts with a follow-up interval greater than 1 year, all of their patients remained asymptomatic and the pineal cysts did not change in size. Our data support the findings of these smaller studies. We found that the majority of patients with pineal cysts had no change on follow-up imaging and clinical evaluation. After a mean follow-up of 3.4 years in 151 patients with pineal cysts, no patients developed new symptoms that were attributed to their pineal cyst. In that group, 4 pineal cysts had a minimal increase.
in size, while 23 pineal cysts decreased in size. We found that cysts that were larger at initial diagnosis were more likely to decrease in size over time. In our prior analysis of pineal cysts in the pediatric age range, no patient had a change in size or appearance of the pineal cyst after 13 years of age. We concluded that older children are less likely than younger children to have growth or change in the cysts. In the adult age range, we found that cysts that did change in size were more likely to decrease. Taken together, the results of our prevalence and natural history analyses in children and adults suggest that pineal cysts frequently arise and change during childhood, reach a period of relative quiescence, and then involute later in adulthood.

The typical MR imaging appearance of a pineal cyst includes homogeneous cyst contents that are isointense to slightly hyperintense to CSF on T1-weighted and hyperintense on T2-weighted imaging.15,18,34,36,37,40,67,68 The cyst contents frequently do not follow CSF signal on FLAIR imaging.48 The cyst rim is usually smooth and thin (≤2 mm) without evidence of nodularity. Multiple septations within the cysts are a common finding in pathology reports.8,25,65 Fleege et al.20 demonstrated that many benign pineal cysts show evidence of irregular nodular enhancement on MR images. Similarly, Fain et al.17 found that 50% of the histologically proven benign cysts had abnormal rim enhancement on intracranial imaging. This abnormal peripheral rim enhancement is thought to be either a result of surrounding venous structures or a result of the surrounding pineal tissue.2,22,31 We were unable to identify imaging characteristics that predicted interval growth or change in pineal cysts in either the evaluation of children in our previous report, or adults in our current report. Cysts with septations were not significantly more likely to grow or change. Other recent studies have reported similar findings.9,48 Cauley et al.9 followed 26 patients with indeterminate pineal cystic lesions, most of which were considered “atypical,” and found that all of these lesions were stable on imaging at a follow-up interval of at least 6 months. Pastel et al.48 found that internal septations were present in 6 of 24 patients with pineal cysts followed up over time. This “atypical” feature was not associated with a worse prognosis in that study.

Various theories on the etiology of pineal cysts have been proposed. In 1932, Cooper10 suggested that pineal cysts may originate from sequestration of the pineal recess of the third ventricle. This theory has been supported by the occasional histological finding of ependymal cells lining the pineal cyst.5,65 Others propose that pineal cysts are formed as a result of ischemia and degeneration of glial plaques, accounting for the nearby glial scar.8,17,65 According to another theory, pineal cysts form as a result of clusters of degenerated pinealocytes.8,17 Cyst enlargement was seen in only 4 patients in our series. Several mechanisms have been proposed to explain the enlargement of pineal cysts, including the coalescence of smaller cysts,8,29 growth due to hemorrhage into the pineal cyst,17,29,37,38 and growth as a result of hormonal influences.17,29,59 Although this may account for the female predilection, there is very little evidence to support any of these theories.

It is not surprising that autopsy studies, because they include cysts that may be too small to be detected on MR imaging, have reported consistently higher prevalence rates for pineal cysts, ranging between 21% and 41%.25,65 In contrast to imaging studies, autopsy studies have included small or even microscopic cysts. For example, in the series reported by Hasegawa et al.,25 45% of all pineal cysts were 2 mm or less in maximum diameter.

**Fig. 4.** Bar graph showing pineal cyst prevalence in 48,417 consecutive adult patients and 14,516 consecutive pediatric patients undergoing MR imaging. Data for the pediatric age range are adapted from our prior analysis of pineal cyst prevalence in children. Cyst prevalence on MR imaging increases and peaks during childhood, then declines throughout adulthood.
Pineal cysts

This detection variability may be a factor even between different estimates of prevalence on MR imaging. For example, we specifically excluded all cysts smaller than 5 mm to increase specificity of pineal cyst identification. Others have included smaller cysts and have reported higher rates of cyst prevalence on MR imaging. For example, Pu et al.54 examined brain imaging performed on high-resolution (1.9-T) MR imaging units in 100 healthy adults. They included all cysts with a diameter greater than 2 mm and found a prevalence of 23%.54 Most of the cysts identified in that study were very small (mean 4.3 mm) and would not have been included in our own analysis.54 Because ours was an imaging series rather than an autopsy series, it was necessary to set a minimum size for inclusion. Although the 5 mm minimum size requirement eliminated the difficulty in specifically identifying small cysts on imaging, the prevalence would have been greater with a more inclusive definition of minimum size required for pineal cyst diagnosis.

Histologically, pineal cysts can be difficult to distinguish from well-differentiated astrocytomas and pineocytomas. Pineal cysts are known to have fibrillar astrocytes and occasional Rosenthal fibers and demonstrate reactivity on glial fibrillary acidic protein and S100 protein staining.17,20,39 There are multiple reported examples of histological misdiagnosis.17,20,26,29,39,69 Fain et al.17 reported that 3 of the 24 pineal cysts in their series were previously histologically misdiagnosed as tumors. Wisoff and Epstein69 reported on 6 pineal cysts of which 2 were originally misdiagnosed as pineocytomas. Finally, Klein and Rubinstein29 found that 4 of their 7 cases of pineal cysts were originally misdiagnosed as pineocytomas, 1 of which resulted in improper radiation treatment. None of the patients in our series were treated surgically, and therefore, no histological analysis of these cysts was performed.

Many reports have attempted to correlate pineal cyst size with symptoms. Prior reports found that cysts greater than 1 cm in maximum dimension are rare and are more likely to be symptomatic.20,29,34,65,69 Fetell et al.19 reported on 33 patients with pineal cysts who presented for medical attention. In that series, 7 patients had associated hydrocephalus and cysts greater than 2 cm in anteroposterior diameter.29 However, many other authors have reported that even large cysts may be completely asymptomatic. In the report of Golzarian et al.,22 6 of 12 asymptomatic pineal cysts were at least 1 cm in greatest dimension. Mammourian and Towfighi35 found that 6 of 29 patients with asymptomatic pineal cysts had a maximum cyst dimension greater than 1 cm. Barboriak et al.5 reported that 17 of 32 asymptomatic pineal cysts had a maximum diameter of at least 1 cm, and 2 asymptomatic patients had a cyst diameter greater than 2 cm. We found that 50% of patients in our population had pineal cysts greater than 1 cm in size, all of which were asymptomatic. Although it is probable that larger cysts are more likely to be symptomatic, our data support the view that the vast majority of even large cysts may be expected to be found incidentally and remain asymptomatic. Furthermore, if a very large pineal region cystic structure is diagnosed, especially if it is causing symptoms, consideration should be given to other diagnoses such as quadrigeminal cistern arachnoid cysts or a cystic pineal region tumor. At our institution, size alone is not used as an indication for surgical treatment in the absence of definitive symptoms.

Pineal cysts are usually asymptomatic. In rare cases, hydrocephalus as a result of cerebral aqueductal obstruction may result from pineal cysts.50 None of the patients in our series presented with symptoms from hydrocephalus that was verified on MR imaging. Rarely, pineal cysts have been associated with gaze palsy or Parinaud syndrome.11,17,20,29,36,40,46,47,66,69 We did not have any patients with either of these clinical manifestations in our series. The frequent association of other, likely incidental, symptoms with pineal cysts will make the clinical interpretation of any symptoms challenging. In our practice, we would limit the signs and symptoms that may be confidently attributed to a pineal cyst to Parinaud syndrome, focal cranial neuropathies, or signs and symptoms due to hydrocephalus resulting from aqueductal compression. There have been reports of pineal cysts associated with various symptoms and syndromes, including resting tremor,43 retinoblastoma,27,55 polycystic kidney disease,1 Aicardi syndrome,2,44 precocious puberty,14,21,32 and even schizophrenia.13 We doubt there are any causal associations between pineal cysts and these various conditions.

Headaches in patients with pineal cysts can present the clinician with a challenging management dilemma.42 Some have suggested that pineal cysts can cause headaches in the absence of hydrocephalus or hemorrhage.50,60 Possible explanations for this association include disturbances in melatonin production50,60 and intermittent obstruction of the cerebral aqueduct;23,36,69 these theories remain entirely unproven. Headaches are common in all age groups.12,25,55 Since pineal cysts are also common, a substantial number of patients will present for medical attention with headaches and a pineal cyst that is coincidentally larger than causally associated. In a surgical series of 11 patients with pineal cysts, Fetell et al.19 found that patients with headaches can be expected to have postoperative symptomatic relief only if the headaches were caused by hydrocephalus. Although there are reports of surgical treatment of pineal cysts for the treatment of chronic headaches,20,25,29,62 we do not regard a history of chronic headache in the absence of hydrocephalus as an indication for surgical treatment of a pineal cyst at our institution.

Hemorrhage into pineal cysts, sometimes referred to as “pineal apoplexy,” is a rare event. It may be associated with an increased likelihood of symptomatic presentation,5,19,20,40,46,63 and sudden death from pineal hemorrhage with acute hydrocephalus has been reported.40,55 Fleege et al.20 found fluid-fluid levels consistent with previous hemorrhage in 3 of 19 patients who presented with symptomatic pineal cysts. In 2009, Sarikaya-Seiwert et al.58 surveyed the literature and found 28 reported cases. They found that 21 of the 28 reported cases involved female
patients, and 18 of the cases involved female patients between the ages of 4 and 35. Not all patients with evidence of hemorrhage on imaging present with symptoms. Mamourian and Towfighi reported on a single asymptomatic patient with a fluid-fluid level suggestive of a clinically silent hemorrhage within the pineal gland. Koenigsberg et al. described a patient who presented with a headache following a hemorrhage into a pineal cyst that was managed without surgery. In our own series, we found no clear evidence of hemorrhage in our population of patients with pineal cysts. No patients presented with symptomatic hemorrhage of the pineal cyst. The natural history of cysts in patients who present with symptomatic hemorrhage remains unclear. Although it is possible that these cysts have a worse long-term prognosis, it is also possible that the expected spontaneous resolution of the hemorrhage would lead to a corresponding improvement or resolution of symptoms. Evidence of hemorrhage on MR imaging would not, by itself, be an indication for surgical treatment of an otherwise typical-appearing cyst in our practice. We reserve surgical treatment for cysts in patients who present with hydrocephalus or severe symptoms from mass effect of the hemorrhage.

There are several limitations to our analysis. This is a retrospective review evaluating a series of patients at a large referral center. Therefore, there is a selection bias since patients who are referred for brain MR imaging evaluation may have a higher rate of intracranial findings than is expected in the general population. Referral bias may affect our results, as physicians may be more likely to refer patients with neurological symptoms. The impact of this bias is mitigated by the lack of symptoms resulting from these cysts. In order for a cyst to be identified in this analysis, there must be a comment about a cyst, tumor, or mass within the pineal region in the patient’s clinical evaluation notes or radiology reports. If cysts were not recognized or commented on, this would result in an underestimate of the true prevalence. Also, we excluded pineal cysts less than 5 mm in size. Although this is useful in properly determining the presence of a pineal cyst due to imaging resolution, it has resulted in a lower prevalence estimate.

Conclusions

In a consecutive series of 48,417 patients older than 18 years of age, we identified 478 pineal cysts on MR imaging (overall prevalence of 1.0%). Although pineal cysts occur across all ages, we found that older age was associated with a decreased prevalence. Female gender was associated with an increased prevalence. Follow-up imaging and clinical evaluations were conducted in 151 patients with pineal cysts. At a mean follow-up interval of 3.4 years, most pineal cysts were stable on imaging studies and no patients developed clinical symptoms. Of the pineal cysts that changed in size, 4 increased while 23 decreased, and even among those pineal cysts that did change in size, none were judged to have any clinical significance. Based on this evidence, early follow-up imaging and neurosurgical evaluation should be considered merely optional in patients with pineal cysts. Pineal cysts are usually incidentally identified and once identified, do not result in clinical symptoms in the most cases. Although pineal cysts almost never require surgery, our practice has been to offer these patients a neurosurgical evaluation to directly review the imaging studies and confirm the impression of the referring physician and radiologist.

Disclosure

The authors have no conflicts of interest to report pertaining to the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Maher, Garton, Al-Holou. Acquisition of data: Al-Holou, Terman, Kilburg, Maher. Analysis and interpretation of data: Maher, Al-Holou, Terman, Kilburg, Ibrahim. Drafting the article: Maher, Al-Holou. Critically revising the article: Maher, Garton, Chandler, Muraszko. Statistical analysis: Al-Holou, Terman, Kilburg. Study supervision: Maher, Garton, Muraszko.

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Pineal cysts

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