Endoscopic Supracerebellar Infratentorial Approach for Pineal Cyst Resection: Technical Case Report

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OBJECTIVE: Accepted surgical strategies to address symptomatic pineal cysts include transventricular flexible or rigid endoscopy and supracerebellar infratentorial or occipital transtentorial microsurgical approaches. We report the first application of the endoscopic supracerebellar infratentorial approach for the complete resection of a pineal cyst. Unlike transventricular endoscopy, this technique poses no risk to the fornices and can be applied independent of ventricular size.

CLINICAL PRESENTATION: A 37-year-old woman sought treatment for intractable headaches. A thorough evaluation revealed only a pineal cyst exerting mass effect on the tectum but causing no hydrocephalus. A period of nonoperative management was unsuccessful, and the patient was referred for surgery.

TECHNIQUE: The patient was positioned in the semi-sitting position. The supracerebellar infratentorial corridor was accessed through a burr-hole. The pineal cyst was resected completely via the endoscope. Postoperatively, the patient's headaches resolved completely.

CONCLUSION: The endoscopic supracerebellar infratentorial approach involves minimal brain retraction, poses no risk to the fornices, allows visualization and avoidance of the Galenic veins, and can be performed regardless of the size of the ventricle. Consequently, it is an excellent minimally invasive surgical option for resection or fenestration of symptomatic pineal cysts.

KEY WORDS: Endoscopy, Pineal cyst, Supracerebellar infratentorial approach

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Glial cysts of the pineal gland are found in 1.8 to 4.3% of healthy subjects evaluated with magnetic resonance imaging (MRI) scans (5, 10, 21, 30). In young women, this incidence approaches 6% (30). Although usually asymptomatic, pineal cysts can grow sufficiently large to exert mass effect on the tectum, aqueduct, and surrounding venous structures and thereby necessitate treatment (3, 6, 7, 14, 16, 22–24, 32, 34–36). On computed tomographic and MRI scans, pineal cysts may also be indistinguishable from less benign pineal pathological lesions such as pineocytomas and epidermoid cysts (7, 8, 16, 18, 22, 33). Several surgical strategies have been described for the treatment of pineal cysts, including the supracerebellar infratentorial (3, 7, 22–24, 31) and occipital transtentorial (14, 25, 37) microsurgical approaches, the transventricular (9, 24, 35, 36) endoscopic approach, and stereotactic aspiration (32). We report the first patient whose pineal cyst was entirely excised transendoscopically through the supracerebellar infratentorial approach.

CASE PRESENTATION

History

A 37-year-old, previously healthy woman sought treatment after having severe, escalating occipital headaches associated with blurry vision and occasional nausea for 2 months. Her neurological examination disclosed nothing abnormal. Pertinent normal findings included the absence of papilledema, nystagmus, or abnormal extraocular movements. MRI examination of the brain demonstrated a 1.0 × 1.1 × 1.5-cm ring-enhancing lesion of the pineal region with an anterior nodular component and the suggestion of a small septation (*Figs. 1* and *2*). On T2-

weighted MRI sequences, the contents of the cyst were slightly hyperintense compared with cerebrospinal fluid (CSF). On fluid-attenuated inversion recovery sequences, the cystic contents were markedly hyperintense compared with CSF (*Fig. 3*). The cyst exerted mass effect on the superior colliculus, but the aqueduct was patent. No hydrocephalus was present. The imaging findings were most consistent with a pineal cyst.

Conservative management with reimaging at 1 year was recommended, and the patient was referred to a neurologist for further evaluation of her headaches. However, no other cause for the patient's symptoms was identified. Two months later, she returned for treatment because the persistent intractable headaches were affecting her quality of life. Her neurological examination again disclosed nothing abnormal. The patient was offered the option of undergoing an endoscopic supracerebellar infratentorial approach for cyst fenestration, biopsy and attempted resection. An additional rationale for surgery was to obtain histopathological diagnosis of the anterior nodular component of the lesion.

Operative Technique

The patient underwent preoperative contrast MRI examination of the brain to obtain thin-cut volumetric images. These images were transferred to the StealthStation Treon (Medtronic Navigation, Boulder, CO). The patient was placed in the semi-sitting position, and appropriate precautions for anesthesia were undertaken. A surface-merge registration to the patient was performed. The frameless stereotactic system was used to localize the torcula. A 15-mm burr hole was placed just inferior to the left transverse sinus, about 5 mm to the left of midline. The paramedian location was selected to avoid the occipital sinus. Bone was removed at the rostral margin of the burr hole until the inferior edge of the transverse sinus was exposed. The dura was opened in cruciate fashion. CSF was aspirated from the supracerebellar cistern, and intravenous mannitol was administered to relax the cerebellum.

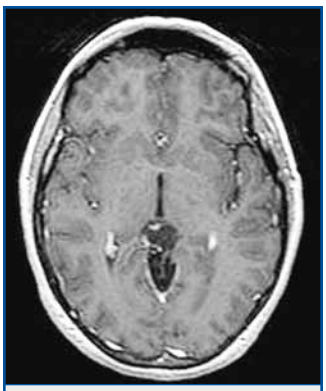

FIGURE 1. *Axial postgadolinium T1-weighted magnetic resonance imaging (MRI) scan showing a cystic lesion of the pineal region.*

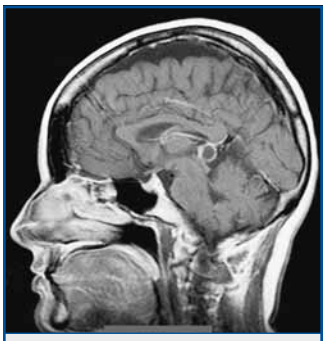

FIGURE 2. *Sagittal postgadolinium T1-weighted MRI scan showing a cystic lesion of the pineal region.*

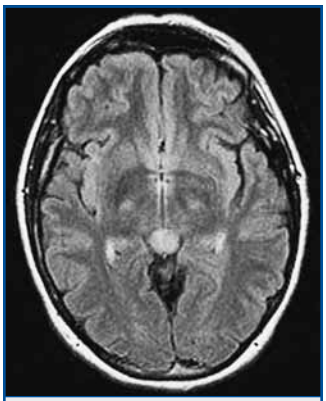

FIGURE 3. *Axial fluid-attenuated inversion recovery MRI scan showing that the cystic contents are markedly hyperintense compared with cerebrospinal fluid.*

A SureTrak Universal Instrument Adaptor (Medtronic Navigation) was affixed to the 6-mm trocar (Aesculap Instruments Corp., South San Francisco, CA) to enable neuronavigation with the endoscope. The 30-degree endoscope, ensheathed within the trocar, was advanced along the supracerebellar infratentorial trajectory. Bridging veins from the cerebellar hemisphere were coagulated and divided to aid cerebellar relaxation and to eliminate the risk of avulsion. Maintaining the endoscope parallel to the tentorium leads directly to the vein of Galen rather than to the pineal region located caudal to the venous confluence. The endoscope was therefore directed slightly inferior to the tentorium along a trajectory guided by the frameless stereotactic system. There was ample room for the endoscope along this trajectory, and no additional cerebellar retraction was required.

The thick arachnoid tethering the superior vermis was dissected sharply to expose the precentral cerebellar vein (*Fig. 4*). The pineal cyst was slightly eccentric to the left side, tightly juxtaposed between the left pulvinar nucleus and precentral cerebellar vein. The capsule was cauterized, and the cyst was fenestrated (*Figs. 5* and *6*). After decompression, the cyst was separated from overlying vessels with sharp dissection. Pediatric grasping forceps, inserted from the side port of the trocar, were used to provide traction while endoscopic scissors were wielded through the main port. This "mother-daughter" technique allowed a semblance of "bimanual" dissection (*Fig. 7*). The cyst was removed piecemeal but completely (*Fig. 8*). The dural opening was sealed with a piece of Gelfoam (Upjohn Co., Kalamazoo, MI), followed by a layer of DuraSeal (Confluent Surgical, Waltham, MA). The remainder of the closure was accomplished in the standard way.

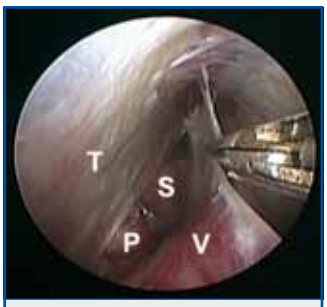

FIGURE 4. *Intraoperative photograph showing the endoscopic release of vermis (V) tethered by thickened arachnoid. The tentorium (T), splenium of corpus callosum (S), and pulvinar nucleus (P) are visible.*

FIGURE 5. *Intraoperative photograph showing the posterior pineal cyst wall before fenestration.*

FIGURE 6. *Intraoperative photograph showing the decompressed cyst wall within the jaws of the grasping instrument.*

Postoperatively, the patient had no neurological deficit. On postoperative Day 1, she was discharged to her home in excellent condition.

An MRI scan performed immediately after the operation confirmed complete resection of the pineal cyst (*Fig. 9*). Pathological analysis demonstrated that the cyst wall was lined by pineocytes and gliotic tissue with scattered Rosenthal fibers and dystrophic calcifications. At her 2-week and 4-month postoperative visits, the patient reported resolution of her headaches and required no pain medications. At a 15-month follow-up examination conducted on the telephone, the patient remained headache-free and independent of medications.

DISCUSSION

As discussed by Horwitz (13), Krause first described the supracerebellar-infratentorial approach to the pineal region in 1913. Stein (31) popularized the approach in the microsurgical era, and it remains a dependable method for accessing the pineal region (31). In the past two decades, neuroendoscopy has come to the forefront for the management of complex hydrocephalus and intracranial cysts. Ruge et al. (29) first reported purely endoscopic fenestration of arachnoid cysts involving the quadrigeminal region via the supracerebellar-infratentorial corridor. In a cadaver-based anatomic study, Cardia et al. (2) demonstrated the viability of the supracerebellar-infratentorial approach for endoscope-assisted techniques. They were able to access not only the pineal region but also the posterior third ventricle via a parapineal entry point.

In practice, most endoscopists have avoided use of the supracerebellar approach to pineal cysts, preferring to access the third ventricle either with a flexible endoscope through a precoronal burr hole (9, 24, 35, 36) or with a rigid endoscope through an anterior frontal burr hole (9, 15, 26, 28). The perceived advantages of the flexible endoscope are the ability to fenestrate the pineal cyst and to perform a ventriculostomy in the floor of the third ventricle in one surgical procedure. This technique, however, also has disadvantages. Use of the flexible endoscope is more disorienting to the surgeon and its image quality is substantially inferior. Its use poses a risk of injury to the fornix at the foramen of Monro (12). Transventricular, transforaminal pineal cyst fenestration is also possible with a rigid endoscope. Frameless navigation is used to determine an entry point and linear trajectory that traverses the foramen of Monro to access the posterior third ventricle. Whereas use of the rigid endoscope provides high-quality images, there is still a risk to the fornix. Additionally, treatment of hydrocephalus with a third ventriculostomy requires a second precoronal burr hole. Both endoscopic transventricular techniques also require traversal of brain tissue, however noneloquent, with the attendant potential for hemorrhage.

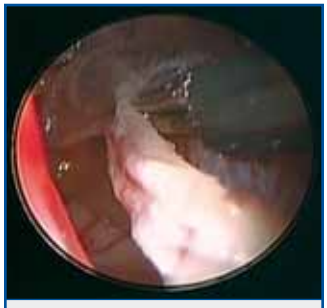

FIGURE 7. *Intraoperative photograph showing an example of the mother-daughter technique. The pineal cyst capsule is under gentle traction from a grasping instrument (not visualized) inserted via the trocar side port. The bipolar forceps is simultaneously inserted via the main port and is used to cauterize the pedicled attachment of the capsule.*

FIGURE 8. *Intraoperative photograph showing the resection bed after gross total removal. The internal cerebral veins (*asterisk*), the pineal vein (*P*), and the precentral cerebellar vein (*C*) are apparent.*

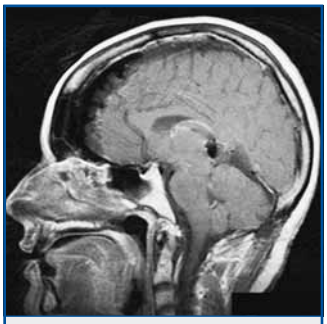

FIGURE 9. *Postoperative sagittal T1-weighted MRI scan after gadolinium administration showing postoperative changes and confirming complete resection of the cyst.*

The endoscopic supracerebellar infratentorial approach for pineal cysts compares favorably with the endoscopic transventricular approaches. In the sitting position, gravity facilitates an ideal anatomic pathway for supracerebellar endoscopic access to the pineal region. Cerebellar relaxation is aided by CSF diversion, mannitol, and sacrifice of superior bridging veins. The resulting working corridor is 1 to 1.5 cm (17). The rigid endoscope provides excellent illumination and magnification and is easily oriented by the surgeon. The sitting position reduces engorgement of the vein of Galen complex, thereby facilitating sharp dissection of the arachnoid.

Michielsen et al. (24) reported that the posterior (pineal) cyst wall is often highly vascularized. The transventricular endoscopic approach is not optimal for the complete resection of cysts because bleeding from the posterior pineal cyst wall is difficult to control and the adjacent vein of Galen complex is poorly visualized. Although endoscopic fenestration of cysts is usually sufficient, symptomatic pineal cysts are known to recur after subtotal resection or simple fenestration (22, 35). The endoscopic supracerebellar infratentorial approach affords more control over the vasculature that invests and abuts the posterior pineal cyst wall. This additional control reduces the chance of uncontrolled hemorrhage and increases the likelihood of attaining complete resection. The feasibility of complete resection also depends on the adherence of the cyst to the tectum (37).

The presence of hydrocephalus greatly facilitates the use of flexible or rigid endoscopes in a transventricular approach. However, the size of ventricles in patients with symptomatic pineal cysts can be normal (6–8, 22, 24, 37). The endoscopic supracerebellar infratentorial approach can be used independent of ventricular size. In the absence of hydrocephalus, cyst resection or posterior fenestration into the quadrigeminal cistern is sufficient. If hydrocephalus is present, a "posterior"

third ventriculocystostomy can be performed by fenestrating the anterior wall of the pineal cyst into the third ventricle.

Hayashi et al. (11) reported a patient with triventricular hydrocephalus caused by an arachnoid cyst involving the quadrigeminal region. These authors established communication between the third ventricle and the quadrigeminal cistern by fenestrating both the anterior and posterior walls of the cyst. Daniel et al. (4) performed a posterior third ventriculostomy by fenestrating the thinned suprapineal recess in a patient with triventricular hydrocephalus. Both groups used a transventricular endoscopic approach. This anterior-to-posterior fenestration can place critical structures, including the vein of Galen complex and major arteries, at risk (4). Theoretically, posterior-to-anterior communication of the quadrigeminal cistern to the third ventricle is safer because the vascular structures are readily visualized and bypassed.

The endoscopic supracerebellar infratentorial approach also compares favorably with the open supracerebellar infratentorial approach in the sitting position. Foremost, the latter is associated with a significant risk of venous air embolism (1, 19, 20, 27). Although this complication can also occur with an endoscopic supracerebellar infratentorial approach, it is less likely because the dural sinuses are not exposed. It is also easier to flood the operative field with irrigation fluid and to occlude ingress of air with a simple burr hole. Operating via the microscope on a patient in the semi-sitting position can be fatiguing for the surgeon, whose arms must remain extended and shoulders abducted. The endoscope can be held at the level of the surgeon's chest and is easily manipulated without strain. Furthermore, the wound associated with an endoscopic supracerebellar infratentorial approach is relatively small, thereby decreasing postoperative pain and morbidity compared with the open approach. The opening and closure proceed more rapidly with the endoscopic supracerebellar infratentorial approach.

Given the current technology for endoscopic hemostasis and dissection, use of the endoscopic supracerebellar infratentorial approach should be limited to small or collapsible, relatively avascular lesions such as pineal cysts. With larger or more vascular lesions, microsurgery retains a significant advantage because the instrumentation is superior and true bimanual dissection is possible. As with any endoscopic procedure, the surgeon should always be prepared to proceed with a craniotomy in the event of catastrophic hemorrhage.

Use of the endoscopic supracerebellar infratentorial approach is not without pitfalls. Our experience with this and similar procedures has led to several refinements in our preoperative and operative methodology. An anesthesiologist familiar with the sitting position and with management of its potential complications is requisite. Intraoperative frameless navigation is essential to avoid the dural sinuses during placement of the burr hole. To obtain the greatest accuracy for navigation, we advocate that patients in whom an endoscopic supracerebellar infratentorial approach is to be used have skin fiducial markers placed over the occipital region before undergoing the preoperative MRI scan.

The patient is placed in the semi-sitting position with the top of the operating table at least 15 cm below his or her shoulders. This position provides sufficient clearance for the pistol grip of the endoscope to avoid contact with the table. We prefer the Minop 2.7-mm endoscope (Aesculap Instruments Corp.) because of its excellent optics and ergonomics. The scope is ensheathed within a 6-mm trocar, which has a main working channel and two side ports. Instrumentation designed for the pediatric endoscope, such as grasping forceps or scissors (Aesculap Instruments Corp.), can be used from a side port, together with standard endoscopic instrumentation introduced via the main working channel. In this mother-daughter technique, one instrument is used to apply traction while the other is used for dissection. The burr hole is generous and positioned slightly off midline to avoid the occipital sinus. Bone edges are waxed thoroughly.

In patients without hydrocephalus, preoperative placement of a lumbar drain greatly aids and hastens cerebellar relaxation. Further relaxation is aided by judicious use of intravenous mannitol and sacrifice of superior bridging veins. The sitting position not only is conducive to cerebellar relaxation but also allows significant reduction of venous pressure and permits an "air" working environment. The former facilitates dissection of the arachnoid around the vein of Galen complex, and the latter makes bleeding points easier to identify and control with the endoscope.

Glial cysts of the pineal gland are usually asymptomatic findings that require no intervention (5, 10, 21, 25). Surgical treatment of pineal cysts is generally limited to lesions that are causing hydrocephalus by aqueductal obstruction. Other reported indications include mass effect on juxtapineal structures causing headaches in conjunction with symptoms such as ataxia, motor and sensory deficit and seizures (7, 8, 34), and signs such as diplopia and Parinaud's syndrome (7, 8, 37). The pathophysiological mechanism behind motor and sensory deficits and seizures is not well understood.

There is a challenging subset of patients with a presumed pineal cyst on imaging in the absence of hydrocephalus who present with headaches but for whom there are no clinical findings at physical examination. In one series, four of 33 patients with symptomatic pineal cysts had headaches as the only symptom, with no clinical signs or hydrocephalus (37). The patient we have presented falls into this category. She exhibited paroxysmal headaches, at times accompanied by nausea and blurred vision. We believe these symptoms were probably indicative of intermittent CSF outflow obstruction at the aqueduct caused by compression by the pineal cyst. Wisoff and Epstein (37) described this pathophysiological mechanism and its association with paroxysmal headache. In a series of pediatric patients with these characteristics, Mandera et al. (22) also attributed the headaches to disturbance of flow through the aqueduct and noted gliosis around the aqueduct in 54% of patients. Tamaki et al. theorized that the headaches result from venous outflow obstruction attributable to compression of the vein of Galen by the pineal cyst (33).

Nevertheless, a symptomatic pineal cyst in the absence of hydrocephalus is a rare entity. The first line of management should be a conservative approach focused on medical control of the headaches and serial MRI scans to monitor the lesion. If medical management fails, surgical intervention can be considered judiciously. The paroxysmal, as opposed to chronic, nature of the headaches is an important feature of the clinical presentation that favors surgical intervention. There are several reports in the literature regarding the surgical treatment of patients with pineal cysts and headaches in the absence of hydrocephalus (7, 8, 22, 24). In the case we have presented, the durable resolution of symptoms supports our treatment methodology.

CONCLUSION

This is the first reported case of a purely endoscopic supracerebellar infratentorial approach used for resection of a pineal cyst. This minimally invasive technique can be used to resect or fenestrate pineal cysts, regardless of whether or not hydrocephalus is present. It presents no risk of forniceal injury, requires minimal brain retraction, and allows visualization and avoidance of the vein of Galen complex. The endoscopic supracerebellar infratentorial approach should be considered as a viable alternative to transventricular flexible endoscopy and microsurgical approaches for the treatment of symptomatic pineal cysts.

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COMMENTS

In this original article, Gore et al. present us with the first reported case of an entirely endoscopic infratentorial supracerebellar resection of a pineal cyst. In the past, Ruge et al. (1) reported the case of an arachnoid cyst treated by endoscopic fenestration through the same surgical corridor, but no case of a complete resection performed in such a manner has been presented in the international literature so far. We believe their experience is extremely valid and opens the way for further procedures. In this technical note, the authors were confronted with a rather small cyst, exerting a moderate mass effect but not provoking hydrocephalus in a patient complaining of headache. An accurate examination of the preexisting literature and a study of possible physiopathological causes of the symptom allowed the authors to correctly pose an indication for surgery that would otherwise have been controversial. A well-planned surgical maneuver was performed, allowing complete removal of the lesion and minimal invasiveness through a "bimanual" endoscopic technique. However, it is our opinion that a minicraniectomy performed by enlargement of the burr hole by just a few millimeters would not have significantly influenced the invasiveness and the patient's tolerance of the procedure, permitting bimanual techniques with micro instruments and better management of possible intraoperative complications. Finally, we want to compliment the authors for the innovative and scrupulous work they have performed on the road to reducing invasiveness of neurosurgical procedures.

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1. Ruge J, Johnson RF, Bauer J: Burr hole neuroendoscopic fenestration of quadrigeminal cistern arachnoid cyst: Technical case report. **Neurosurgery** 38:830–837, 1996.

Gore et al. describe a purely endoscopic method for resection of a pineal cyst. They highlight important technical features of the procedure including stereotactic guidance for localizing the transverse sinus, the sitting position to facilitate cerebellar relaxation and working in an air medium, and the use of a "bimanual" endoscopic technique. We have used a similar technique for fenestration of quadrigeminal plate arachnoid cysts and have not been impressed with the purported benefits over conventional microsurgery. The endoscopic technique in our experience used a cranial opening similar in size to that of a microsurgical technique, whereas the actual cyst fenestration or resection is more tedious. This debate is reminiscent of the ongoing discussion regarding endoscopic fenestration of middle fossa arachnoid cysts.

As a cautionary comment, with the reported reduction in morbidity associated with "minimally invasive" techniques, one needs to remain disciplined in patient selection. Symptoms of headache ascribed to the presence of relatively small pineal cysts without hydrocephalus remains dubious. However, the complete cessation of headaches during the postoperative interval supports the authors' recommendation. Although it is likely that any procedure that positively affects the risk-benefit analysis may expand surgical indications, the endoscopic surgeon will need to maintain vigilant in patient selection. Last, we respect the authors' willingness to explore innovative applications of endoscopic surgery in the hopes of creating a greater demand for equipment modification.

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This case report is unique in that it describes a purely endoscopic supracerebellar infratentorial approach to resect a pineal cyst. Gore et al. are to be congratulated for a minimally invasive "tour de force." Several observations come to mind in reviewing this excellent article. The true incidence of pineal cysts in a population is not known, simply because many subjects are probably asymptomatic. Those that come to medical attention often do so for evaluation of headaches or an unrelated issue, such as a head injury. The patient with headaches and a magnetic resonance imaging (MRI) scan consistent with a pineal cyst, without hydrocephalus, becomes a diagnostic dilemma. In my practice, few, if any, patients ever reach the operating room unless there is a question about the pathological condition in the face of growth. Although I remain skeptical about the hypothesis of intermittent aqueduct obstruction in such patients, each surgeon must make a judgment about this sort of complex clinical situation. However, the endoscopic approach may be an excellent alternative to a transventricular approach or an open approach to a pineal tumor in a patient when a biopsy is warranted. The technical issues that the authors have tested and improved upon are the portion of the article that I found most helpful. The selection of the scope, position of patient, and treatment of the veins made the article a useful addition to our repertoire of endoscopic approaches to deep structures.

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Gore et al. describe a case report of a patient whose pineal cyst was removed through a supracerebellar infratentorial endoscopic approach. The patient presented with headaches but did not have hydrocephalus. Despite the favorable outcome in this patient, I would strongly urge caution in treating patients with "symptomatic" pineal cysts. Patients are undergoing MRI scans with increasing frequency for nonspecific neurological complaints, such as headache or balance problems. Given the high prevalence of pineal cysts in the normal population, it is likely that many of the patients with these nonspecific complaints will have pineal cysts. In my experience, however, it is extremely rare to encounter a symptomatic cyst without radiographic evidence of hydrocephalus or at least aqueductal compression (best seen on a thin-cut sagittal MRI scan). Without aqueductal compression, I would recommend extreme caution before advocating surgery in these patients. Conservative management with follow-up MRI scans is preferable.

The authors provide a detailed description of their minimally invasive approach with some points deserving emphasis. A cyst is considerably easier to remove than a vascular, solid tumor attached to surrounding structures that would present a much greater challenge with an endoscopic approach. Endoscopically, even a small amount of bleeding can be difficult to control while one is working within the quadrigeminal cistern or third ventricle where there is no soft tissue pressure to help tamponade minor bleeding. Bleeding potentially can occur from small vascular branches over the dorsal surface of the cyst that ultimately form part of the posterior choroidal arteries. In addition, any tears of bridging veins between the cerebellum and tentorium can be problematic. Last, pineal region anatomy can be confusing unless the surgeon is well versed with the surrounding structures because the initial endoscopic trajectory is directed toward the vein of Galen and must therefore be adjusted inferiorly. The quadrigeminal arachnoid is thick, and cisternal vessels are vulnerable while one is attempting to open and dissect the arachnoid. These caveats notwithstanding, the endoscopic approach is provocative, and it will be instructive to see whether a larger series will replicate this excellent outcome.

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