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## Full Scope of Options

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## Full Scope of Options

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## Abstract

**OBJECTIVE**—The purpose of Clinical Problem Solving articles is to present management challenges to give practicing neurosurgeons insight into how field leaders address these dilemmas. This illustration is accompanied by a brief review of the literature on the topic.

**PRESENTATION**—The case of a 16-year-old boy presenting with headaches is presented. The patient is found to have a typical colloid cyst at the foramen of Monro. Bilateral ventriculoperitoneal shunt placement had been performed as an initial treatment of the patient before presentation.

**RESULTS**—Surgeons experienced in open and endoscopic surgery discuss their individual approaches to colloid cysts, in the context of previous shunting, providing a varied perspective on the clinical challenges posed by these lesions.

**CONCLUSION**—Both open and endoscopic options remain viable for excision of a colloid cyst. Each has associated potential complications, as illustrated by the current case.

## Keywords

Colloid cyst; Endoscopic third ventriculostomy; Neuroendoscopy; Ventriculoperitoneal shunt

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Disclosure

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## CASE PRESENTATION

A 16-year-old, right-handed boy presented to the hospital with symptoms of nausea, headache, and intermittent memory loss. The patient described his headaches as occurring daily with progression in discomfort. One day before his emergency department evaluation, he developed a headache that was the “worst headache of his life.”

The patient received appropriate analgesia, and a computed tomography (CT) scan was performed that revealed a hyperdensity in the anterior third ventricle adjacent to the foramen of Monro with no ventriculomegaly present. The patient was referred to a tertiary care center for a neurosurgical evaluation after a magnetic resonance imaging (MRI) scan (Figure 1) was performed. The MRI demonstrated a well-circumscribed lesion measuring 7 mm in maximal diameter that was isointense on T1-weighted imaging with peripheral enhancement after the administration of gadolinium.

## VISITING COMMENTS

### Dr Barrow: What Is the Differential Diagnosis?

The differential diagnosis of this lesion in this clinical setting is limited. The imaging appearance on MRI (minimal enhancement after gadolinium administration) is typical for a colloid cyst as is the relationship of the lesion to the structures of the anterior third ventricle as seen on the sagittal view. Although less likely, the differential diagnosis of lesions in this region would include giant cell astrocytomas associated with tuberous sclerosis, astrocytomas arising from the wall of the third ventricle, subependymomas, papillary ependymomas, and craniopharyngiomas.

## DISCUSSION OF MANAGEMENT

### Visiting Comments

**Dr Barrow: Is Sudden Death Fact or Fiction With Colloid Cysts? How Important Is This in the Management of Colloid Cysts? What Management Options Would You Offer the Patient?**—Although sudden death caused by colloid cysts is fact and not fiction, it is certainly rare. Natural history studies have suggested that this is rare enough in asymptomatic patients that I generally advise against any treatment in those situations. For asymptomatic patients with no hydrocephalus, I recommend observation with serial imaging. For symptomatic patients, however, the risk is significantly higher of sudden death or sudden neurological deterioration caused by obstructive hydrocephalus. Patients with small colloid cysts can be symptomatic. Personally, managing a patient who arrived at our hospital with rapid neurological deterioration from acute obstructive hydrocephalus secondary to a colloid cyst has left a lasting impression of the reality of this clinical scenario.

With regard to management options, I would discuss observation with serial imaging as well as surgical treatment of the colloid cyst. The presenting symptoms are somewhat vague, and it is unclear whether they have any relationship to the cyst or whether this is a purely incidental finding. Given the lack of hydrocephalus and the small size of the cyst, I believe that medical treatment of the headaches and serial imaging are reasonable. Investigation of the patient’s “worst headache in his life” is warranted to rule out possible etiologies such as subarachnoid hemorrhage, aseptic meningitis, and migrainous headache. It is important to note that it is rare for patients younger than 18 years of age to have a symptomatic colloid cyst. Nevertheless, this patient needs to understand rapid neurological decline and sudden death can occur if the patient’s headaches are determined to be attributed by his colloid cyst. The patient needs to seek immediate medical attention if symptoms worsen (progressive headaches, lethargy, nausea, or vomiting), the cyst enlarges, or hydrocephalus develops.

The surgical options for a colloid cyst include bilateral shunting or unilateral shunting with simultaneous fenestration of the septum pellucidum, endoscopic fenestration, or removal of the cyst and craniotomy for direct removal of the cyst by either a transfrontal or transcallosal approach.

I would discuss with the patient in great detail the risks and benefits of each of these options. Although I would discuss shunting for the sole purpose of being comprehensive, I would not recommend this as a treatment option for a young patient with a colloid cyst. Although it provides a relatively easy surgical option, shunting typically requires bilateral placement of shunts, the lifelong need for shunts, and the potential for future infection and ongoing risk of sudden death should the patient experience a shunt malfunction. Endoscopic removal or fenestration has the advantage of being minimally invasive in the sense that it can be performed through a smaller incision and no craniotomy. The disadvantage is the fact that the surgeon does not have as many options in dealing with intraoperative bleeding. Simple fenestration of the cyst by an endoscopic approach is associated with the risk of recurrence, whereas complete removal is perhaps less likely by using an endoscopic than a direct route. Of the 2 craniotomy approaches, the transcallosal approach has the advantage of avoiding an opening into the cortex and thus minimizes the risks of postoperative seizures. Furthermore, the transcallosal approach provides an excellent view of the third ventricle and foramen of Monro and the ability of the surgeon to bimanually manage the lesion and any associated bleeding.

### Surgical Decision Making

Initially, given the normal ventricular size and small size of the cyst, the patient and family opted to pursue medical management of the patient's headaches. Unfortunately, the patient began to experience more frequent and severe headaches over the course of 3 months despite medical management. Follow-up MRI (Figure 2) done 3 months later revealed new enlargement of the left lateral ventricle from obstructive hydrocephalus caused by the third ventricular mass. At this time, all surgical options were discussed again with the family including a craniotomy for either a transcallosal or transfrontal approach and microsurgical resection of the colloid cyst. A neuroendoscopic resection of the colloid cyst was discussed. Placement of a ventriculoperitoneal shunt (VPS) for cerebrospinal fluid (CSF) diversion and relief of the possible obstructive hydrocephalus was also discussed. The patient and his family wished to avoid any resection of the mass and instead to proceed with placement of a left VPS. The family was made aware that the patient might ultimately require the placement of a contralateral, right VPS in the future because bilateral obstructive hydrocephalus involving the right lateral ventricle could develop.

### Procedure

A left parietal shunt was placed with improvement in the patient's headaches. Postoperative imaging of the brain confirmed correct placement of the ventricular catheter. The patient returned for clinical follow-up, and further imaging demonstrated right lateral ventricle enlargement. One month after the initial left VPS placement, a contralateral right parietal VPS was placed under stereotactic guidance. Imaging once again confirmed adequate placement of the ventricular catheters from both operations (Figure 3).

**Dr Barrow: Under What Circumstances Is Placement of a VPS Acceptable in a Patient With a Colloid Cyst?**—As stated earlier, I believe that the placement of a shunt as the primary treatment of a colloid cyst is a poor choice, particularly for a young patient. Placement of a shunt carries the ongoing risk of shunt malfunction and infection. Bilateral shunts are often required unless the initial shunt placement is associated with fenestration of the septum pellucidum. Unilateral endoscopic shunt placement can help with septum pellucidum fenestrations for communication of both lateral ventricles and avoidance of

bilateral shunt placement. Furthermore, with continued enlargement of the colloid cyst, the associated mass effect can result in progressive memory loss by compression of the fornices.

### Evolution of Symptoms and Further Management

The patient returned to the emergency department 1 month after placement of the right VPS with diffuse abdominal pain. A CT scan of the abdomen at that time revealed a small fluid collection at the distal end of the right VPS catheter consistent with a pseudocyst. Bilateral shunt externalizations were performed. The distal right VPS catheter was cultured and found positive for growth of *Serratia marcescens*. After a 10-day course of antibiotics and sterilization of the CSF, the patient underwent replacement of both VPSs.

The patient continued to have abdominal pain and could not tolerate the presence of the peritoneal portion of his bilateral VPSs. Six months after placement of the initial VPS, the patient requested resection of his third ventricular mass and removal of both of his shunts.

### **Drs Barrow/Teo: How Have You Approached These Lesions Surgically? What Do You View as the Pros and Cons of Each Surgical Option for Resection of Colloid Cysts?**

**Dr Barrow:** My personal preference in the management of colloid cysts is a direct transcallosal approach. This almost always avoids the need for a permanent shunt and provides an opportunity for the surgeon to fenestrate the septum pellucidum in the unlikely event that a shunt is needed. As opposed to the transcortical approach, the transcallosal approach avoids a cortical incision and the attendant risks of postoperative seizures and provides a more direct view to the third ventricle and foramen of Monro. To minimize the risk of the operation, I prefer to place the patient in the supine position with the left shoulder elevated so that the head is turned to a point where it is parallel to the floor with the right side down and the vertex tilted slightly upward. One advantage of having the right hemisphere dependent is the use of gravity to allow the right hemisphere to fall away from the falx, thus eliminating the need for retraction of the brain. Furthermore, the interhemispheric fissure is then oriented in the same plane as the surgeon's eyes. This provides a distinct advantage over the more common practice of placing the patient supine with the head slightly flexed so that the right frontal lobe has to be retracted away from the falx with the surgeon's eyes oriented in a plane perpendicular to, rather than parallel to, the plane of the approach.

I believe that the endoscopic approach in the hands of an experienced endoscopic neurosurgeon is an excellent alternative. However, some case series reporting neuroendoscopic excision of colloid cysts have shown higher residual cyst rates (43%-80%) in comparison with microsurgical resection in which there is almost always complete excision.<sup>1-3</sup> In some cases, the endoscopic route has to be abandoned for a craniotomy and microsurgical resection because of forniceal adhesion of the colloid cyst.<sup>4</sup> If simple fenestration is performed, there is a higher risk of recurrence. Severe complications such as hemiparesis and memory impairment have been reported with endoscopic resections of colloid cysts. Furthermore, controlling any bleeding during surgery may be more difficult by using an endoscopic approach, but certainly in the hands of an experienced endoscopic surgeon, this is an excellent option. The benefits are the smaller incision and opening, the lack of need for an opening in the corpus callosum, and possibly a shorter hospital stay.

**Dr Teo:** At the start of my career, I removed colloid cysts through a transcallosal microsurgical approach. Having become familiar with the endoscope in the early 1990s, I have since used a closed, purely endoscopic approach. The efficacy of a purely endoscopic technique to achieve the goal of gross total colloid cyst excision has been well documented.<sup>1,4-8</sup> The advantage of the transcallosal microsurgical approach is the ability to use standard microsurgical technique

and instrumentation. Bleeding is more readily controlled, and larger cysts can be removed more expeditiously. The downside to this approach is access to the origin of the cyst. Colloid cysts grow and are attached to the roof of the third ventricle, and coming from above makes it impossible to see its attachment. Coagulation of the contralateral choroid plexus is difficult unless one performs a septum pellucidotomy. Splitting of the corpus callosum rarely gives the patient neurological deficits such as hemiplegic-aphasic syndrome and other disconnection problems. The endoscopic approach offers a more direct route to the cyst. A right frontal approach that is anterior (approximately 8 cm posterior to nasion) and lateral (7 cm off midline) in combination with stereotactic guidance avoids injury to the caudate nucleus and possible contralateral hemiparesis. This approach also allows positioning of the endoscope inferior to the fornix to minimize any memory impairment after surgery. It allows the surgeon to view the attachment of the cyst and coagulate the contralateral choroid plexus. The opening is through a burr hole and transventricular placement of the endoscope. This can be made faster than a craniotomy, interhemispheric split, and transcallosal incision. The risk of postoperative seizures with an endoscopic approach is unremarkable because of the small cortical opening (6 mm) required for insertion of the endoscope. The disadvantage of the endoscopic technique is the learning curve required to master such an operation, the inability to control heavy hemorrhage, and the time required to remove large lesions. Both endoscopic and microsurgical techniques are associated with possible memory impairment after colloid cyst removal. Fortunately, memory impairment is usually transient.

## Procedure

Due to the patient's continued abdominal pain and history of VPS infections, the patient elected to undergo a neuroendoscopic resection of his colloid cyst and removal of his bilateral VPS.

Before surgery, the patient underwent MRI of the brain for frameless stereotactic guidance. This would prove invaluable for ventricular access because the patient had small ventricles secondary to the presence of bilateral shunts. After induction of anesthesia, the patient was placed in the supine position in 3-point Mayfield fixation with the head in a neutral position. A curvilinear incision approximately 8 cm posterior to the nasion and 5 to 7.5 cm to the right of midline was placed, ensuring an anterior trajectory to the foramen of Monro for resection of the colloid cyst.<sup>4</sup> The frameless stereotactic guidance system was registered. Before placement of the incision, the rigid neuroendoscope, its associated working channel sheath (6.0 mm in diameter with 3 parallel working channels), and instrumentation (Aesculap Co, Tuttlingen, Germany) were confirmed to be working properly. Assembly of the light source and camera was performed, and a brilliant display was confirmed on the monitor. Suction and irrigation tubing were connected to the portals on the working channel sheath.

A 2.5-cm incision was made in the right frontal scalp extending down to the bony skull. A burr hole was placed with a high-speed drill and curettage was performed to ensure an opening over the dura measuring 6.5 mm. The image guidance probe was used to determine a trajectory to the foramen of Monro through the right lateral ventricle, avoiding the caudate nucleus. After opening of the dura and cauterization, a 19-French peel-away sheath (Aesculap Co) catheter was passed into the right lateral ventricle at 5.5 cm. Use of the peel-away sheath is helpful because of the frequent need for the removal and reinsertion of the endoscope from the ventricle. Removal of the trocar from the peel-away sheath confirmed drainage of CSF and positioning of the catheter in the ventricle. The sheath was peeled down to the level of the scalp and secured in place with staples. At this point, the 30-degree rigid neuroendoscope and its associated working channel sheath were inserted in the right lateral ventricle. Initially, a septum pellucidum fenestration was performed using the endoscopic bipolars and placement of the neuroendoscope system through to the opposite lateral ventricle. This was done to ensure optimal drainage of CSF from the lateral ventricular system after resection of the colloid cyst.

After the septostomy was performed, the choroid plexus was identified in the right lateral ventricle and followed to the foramen of Monro. Readily apparent at the level of the foramen of Monro in the third ventricle was a greenish mass, consistent with a colloid cyst. Using the endoscopic cupped forceps, a small piece of the mass was removed and sent for frozen section, confirming the diagnosis of colloid cyst. A later permanent pathological analysis with hematoxylin and eosin staining also confirmed the diagnosis (Figure 4). By using a combination of unipolar and bipolar electrocautery, the colloid cyst was contracted in size to ultimately allow its removal. Cupped forceps were used to free the colloid cyst and remove it entirely. A small amount of postoperative hemorrhage was controlled using endoscopic bipolar electrocautery and copious amounts of irrigation. After careful endoscopic inspection in the third ventricle, a complete resection of the colloid cyst was confirmed. Removal of the neuroendoscope was followed by placement of an EVD catheter in the right lateral ventricle (see Video, Supplemental Digital Content 1, <http://links.lww.com/NEU/A310>).

After closure of the right frontal incision, attention was turned to the bilateral ventriculoperitoneal shunts. Small incisions were made on both parietal scars, and both shunts were removed entirely.

**Dr Hao: What Are the Typical Pathological Features of Colloid Cysts? Is There Any Variance in What Is Typically Observed?**—Colloid cysts of the third ventricle are mucus-filled, epithelium-lined cysts occurring in the anterosuperior third ventricle. They contain a turbid, tenacious material that is largely amorphous. The lining epithelium of colloid cysts is a simple layer of well-differentiated columnar cells that are mucin producing and ciliated. The epithelium of colloid cysts can exhibit distinctive immunoreactivity to cytokeratins or epithelial membrane antigen. Reactivity to carcinoembryonic antigen and focal S-100 reactivity has been found.

Colloid cyst epithelium has been compared with bronchial epithelium, and as many as 6 cell types have been described. They include ciliated cells, nonciliated cells with surface microvilli, goblet cells, basal cells, occasional electron-lucent basal horizontal cells with neurosecretory granules, and small cells without specific features of differentiation.

### Postoperative Course

The EVD was drained at 5 cm above the external auditory meatus for 2 days to allow removal of any debris from the ventricles. The EVD was elevated over the course of several days and clamped. Postoperative MRI of the brain confirmed a complete resection of the colloid cyst (Figure 5). A CT scan of the brain was performed postoperatively for monitoring of ventricular size. Stable ventricle size and intra-cranial pressures preceded removal of the EVD. Three days after removal of the EVD, the patient became somnolent, and a CT scan showed dilation of the lateral and third ventricles (Figure 6A).

**Dr Teo: What Is Your Interpretation of This Result? Is Your Endoscopic Resection of Colloid Cysts Different From the One Described? Why Do You Think That the Patient's Ventricles Are Larger Now Than Before the Procedure? How Would You Manage This Complication?**—This is most perplexing. I have seen delayed unilateral hydrocephalus after complete removal of a colloid cyst. I explored this patient and found a gliotic membrane over the foramen of Monro. There are several theoretical explanations: (1) The colloid cyst was dropped into the ventricles and has now obstructed the aqueduct. (2) There are bilateral gliotic membranes over both foramina of Monro. (3) Communicating hydrocephalus has developed in the patient as a result of previous infection, aseptic meningitis from colloid cyst material spilt at the time of surgery, and constant drainage for several days postoperatively.

My technique is identical to the one described except for postoperative external ventricular drainage. I would strongly discourage this act. I would manage this problem by asking the patient for consent to insert a shunt but exploring the ventricles before making a commitment to lifelong CSF diversion. If there were membranes, I would fenestrate them. If there were aqueduct stenosis, I would perform a third ventriculostomy.

Because the patient had enlargement of the lateral and third ventricles but not the fourth ventricle present on the CT scan of his brain, the patient consented to undergo a neuroendoscopic third ventriculostomy. A separate vertical incision was placed 12 cm posterior to the nasion and 3 cm to the right of midline measuring 2 cm. A small burr was placed and insertion of a 0 degree rigid neuroendoscope and its associated working channel sheath (3 mm; Karl Storz, Tuttlingen, Germany) into the right lateral ventricle was performed. Upon entry into the ventricle, it was readily apparent that postsurgical adhesions of the ependymal surface of the right lateral ventricle had obstructed the foramen of Monro. After re-opening of the foramen of Monro with the tip of the neuroendoscope, visualization within the third ventricle showed the presence of postsurgical debris within the cerebral aqueduct. An initial hole was made in the floor of the enlarged third ventricle with the endoscopic cup forceps and the neuroendoscope was inserted through the floor of the third ventricle to complete the neuroendoscopic third ventriculostomy.

The patient had a marked improvement in headaches postoperatively. Follow-up MRI 3 months after neuroendoscopic colloid cyst excision and neuroendoscopic third ventriculostomy demonstrated normal ventricular size and no residual or recurrent colloid cyst (Figure 6B and C). The patient has been seen in follow-up 15 months after his initial evaluation and 6 months after neuroendoscopic resection of his colloid cyst and removal of his bilateral shunts. He is pain free and actively participating in karate and plays the drums in a band.

#### **Drs. Teo and Barrow: Summary Comments**

**Dr Teo:** This case presentation is a very honest and open account of an extremely problematic clinical scenario. It demonstrates superbly why neurosurgeons dislike shunts and hence developed endoscopic techniques for such pathologies. There is really no place for placement of shunts in patients with noncommunicating hydrocephalus. If the obstruction is from a tumor, then it should be removed, and if it is from obstruction at or beyond the posterior third ventricle, then the patient should have an endoscopic third ventriculostomy. Once a decision is made to undergo resection, then open vs endoscopic is mostly a matter of surgeon preference. I strongly favor endoscopic for its ability to visualize the origin of the cyst and its minimally invasive nature. I defer to the open technique when cysts are greater than 3 cm in diameter, mostly for the economy of time. When I do them open, I use an endoscopically assisted transcortical approach.

**Dr Barrow:** This illustrative case demonstrates the clinical course and clinical decision making involved in the management of patients with colloid cysts. The patient initially presented with a likely asymptomatic colloid cyst that was appropriately treated with medical management. As unilateral enlargement of the lateral ventricle and progressive headaches developed in the patient, surgical management of his colloid cyst was provided with bilateral shunts. The case illustrates some of the disadvantages of treatment options such as biventricular shunting. Fortunately, in this case, the patient ultimately had his lesion adequately treated endoscopically and had both shunts removed with a good outcome. The development of obstructive hydrocephalus after endoscopic removal of the colloid cyst and removal of both shunts is likely caused by postsurgical debris and adhesions. It is unclear whether open microsurgery and/or leaving the shunts in place would have avoided this complication. The choice of an open or endoscopic approach is often one of personal experience and surgeon preference.

## DISCUSSION

Colloid cysts represent approximately 0.5% to 1% of brain tumors in the adult population.<sup>9</sup> They are predominantly located in the rostral third ventricle near the foramen of Monro. Case reports have described frontal, prepontine, and the fourth ventricle as other locations.<sup>10,11</sup> The etiology of colloid cysts remains controversial. Initially, colloid cysts were thought to originate from detachments of developing neuroepithelium from the tela choroidea, remnants of respiratory epithelium, choroid plexus, ependyma, or the paraphysis, a rudimentary midline structure in the roof of the third ventricle.<sup>12</sup> More recently, colloid cysts have been shown to have endodermal origins.<sup>13</sup>

The most common presentation of a colloid cyst is headache, although many are found incidentally on imaging of the brain.<sup>14</sup> Headaches are often frontal, intermittent, and severe in nature. Other symptoms described include gait disturbance, vomiting, memory deficits, and tinnitus.<sup>9,15</sup> Sudden death is a well-known phenomenon of colloid cysts and is the result of bilateral foramen of Monro obstruction and acute hydrocephalus.<sup>16-18</sup>

### Imaging

Imaging characteristics vary greatly in colloid cysts. On a noncontrast CT of the brain, colloid cysts are well circumscribed, appearing either hyperdense or isodense to the surrounding brain parenchyma, depending on the viscosity of the cyst contents.<sup>19</sup> They routinely do not enhance with administration of intravenous contrast. On MRI, they are most commonly hyperintense on T1-weighted imaging.<sup>20-22</sup> On T2-weighted imaging, they are usually hypointense, although they can be hypo- to hyperintense.<sup>23</sup> MRI is the imaging modality of choice, although some colloid cysts can be more apparent on CT.<sup>19</sup>

### Treatment

The case presented illustrates the potential difficulty in treating a patient with a symptomatic colloid cyst. Symptoms associated with colloid cysts have been associated with 4 variables: cyst size, cyst imaging characteristics, ventricular size, and patient age.<sup>24</sup> Different management options are available for the treatment of colloid cysts (observation, craniotomy for microsurgical resection, neuroendoscopic removal, stereotactic drainage, and CSF diversion with bilateral VPS placement).<sup>1,3,8,25-29</sup> The goals of removal of a colloid cyst are complete resection to avoid potential long-term recurrence,<sup>30</sup> restoration of CSF pathways, and minimal morbidity and mortality related to the treatment chosen. The option of observation of colloid cysts in symptomatic patients becomes risky because acute neurological decline and sudden death have been reported.<sup>16,17,31</sup> In a study from the Netherlands, the risk of acute deterioration in a symptomatic patient with a colloid cyst was estimated to be 34%.<sup>16</sup> In patients who are asymptomatic, colloid cysts can be cared for safely with observation and serial neuroimaging.<sup>24,32</sup> According to Pollack et al,<sup>24</sup> the incidences of patient symptomatic progression related to the colloid cyst are 0%, 0%, and 8% at 2, 5, and 10 years, respectively.

## CONCLUSION

The decision to proceed with treatment in this patient was related to several factors. The patient demonstrated symptoms of severe headache and memory difficulty combined with the presence of ventricular dilation discovered after serial imaging of the brain. Unilateral and ultimately bilateral VPS placement was performed in this patient initially because surgical resection was declined and obstructive hydrocephalus developed.

The complications associated with a VPS<sup>33-36</sup> led the patient to pursue surgical resection of his colloid cyst. Many centers have shown that endoscopic removal of colloid cysts is an

effective and safe means to remove the lesion.<sup>1,2,4,7,8,37-39</sup> The choice depends a great deal on the neurosurgeon's own comfort and skill level with the neuroendoscope, but clearly is an important tool in cyst management. In this case, not only was the cyst able to be removed safely, but a second endoscopic procedure prevented the need for long-term CSF diversion.

## ABBREVIATIONS

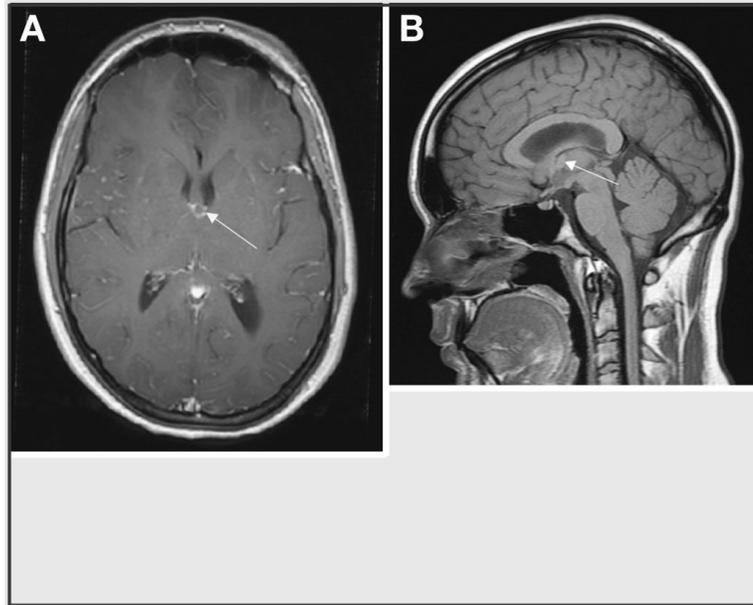
CSF	cerebrospinal fluid
CT	computed tomography
EVD, MRI	magnetic resonance imaging
VPS	ventriculoperitoneal shunt

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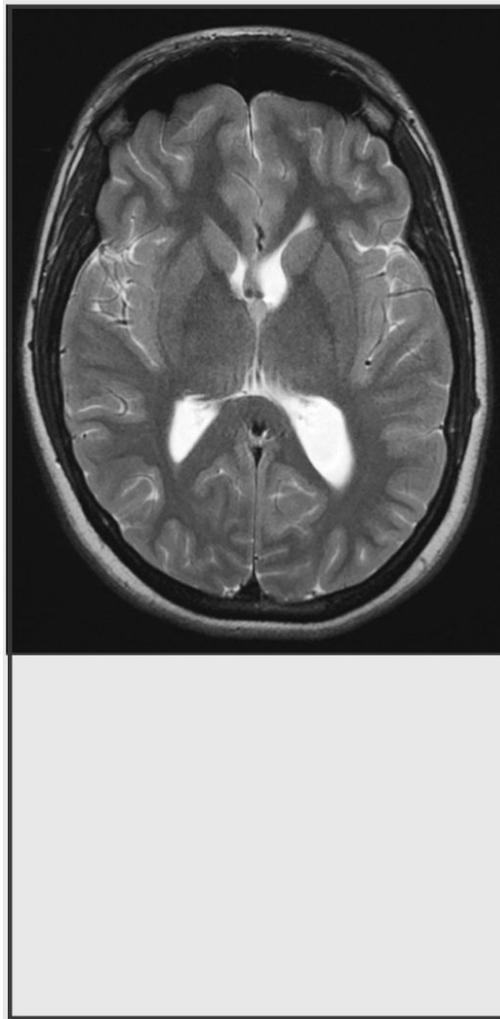
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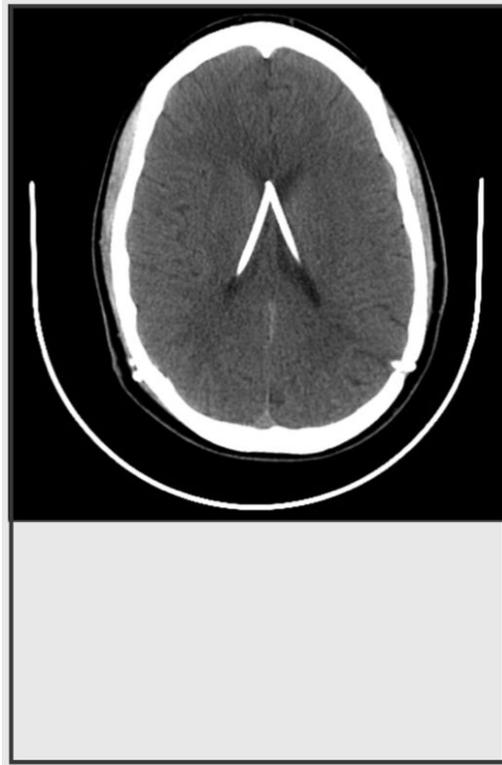
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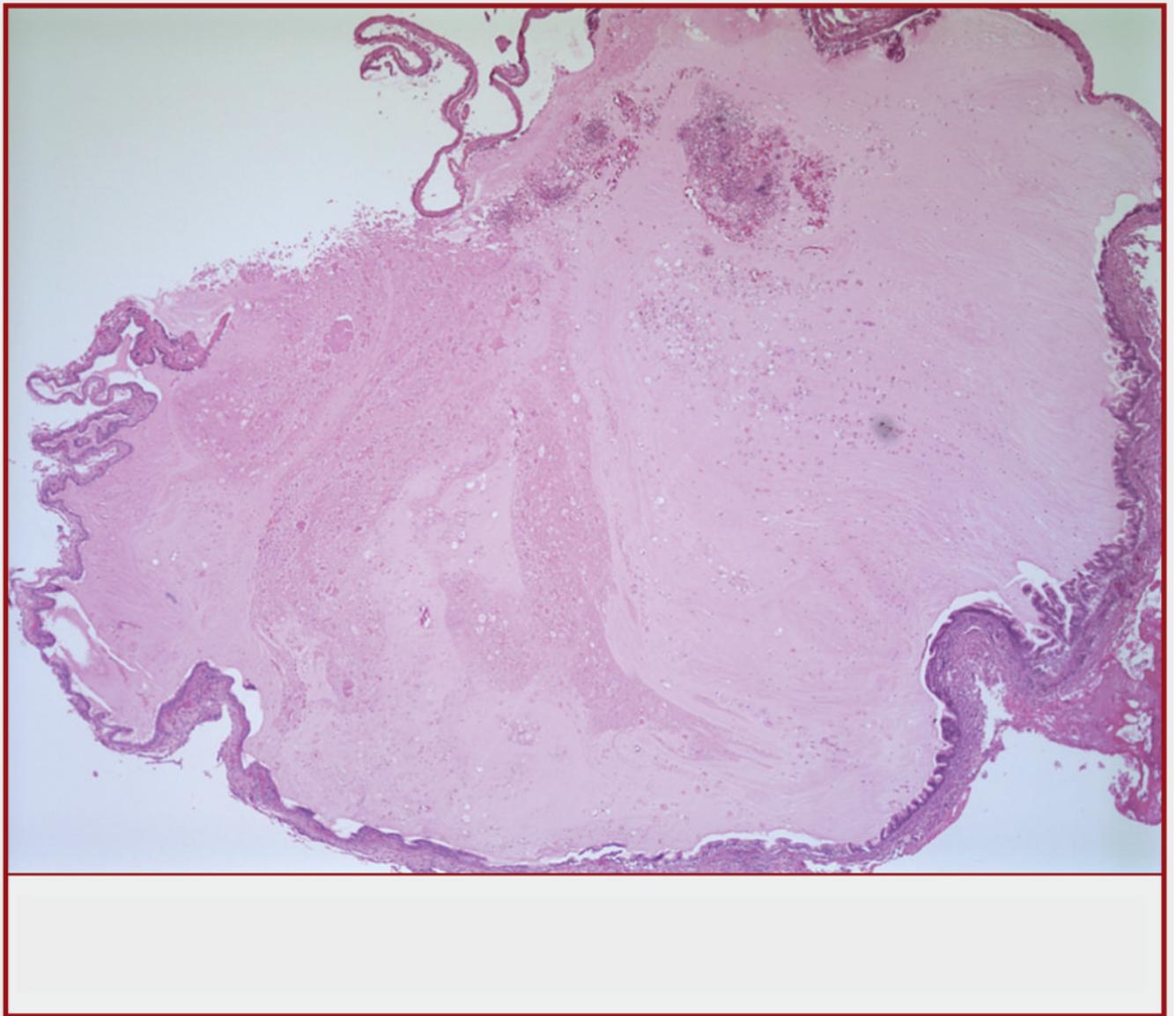
**FIGURE 1.** Magnetic resonance imaging (MRI) scan of the brain confirming the presence of an anterior third ventricle mass. **A**, T1-weighted imaging after gadolinium administration revealing partial contrast enhancement of the third ventricle mass (arrow). **B**, sagittal T1-weighted MRI of the brain revealing lesion in anterior and superior portion of the third ventricle (arrow).



**FIGURE 2.** Magnetic resonance imaging of the brain performed 3 months after presentation revealing a left lateral ventricular enlargement and possible obstructive hydrocephalus caused by a third ventricle mass. T2-weighted imaging revealing isointense lesion in the third ventricle.



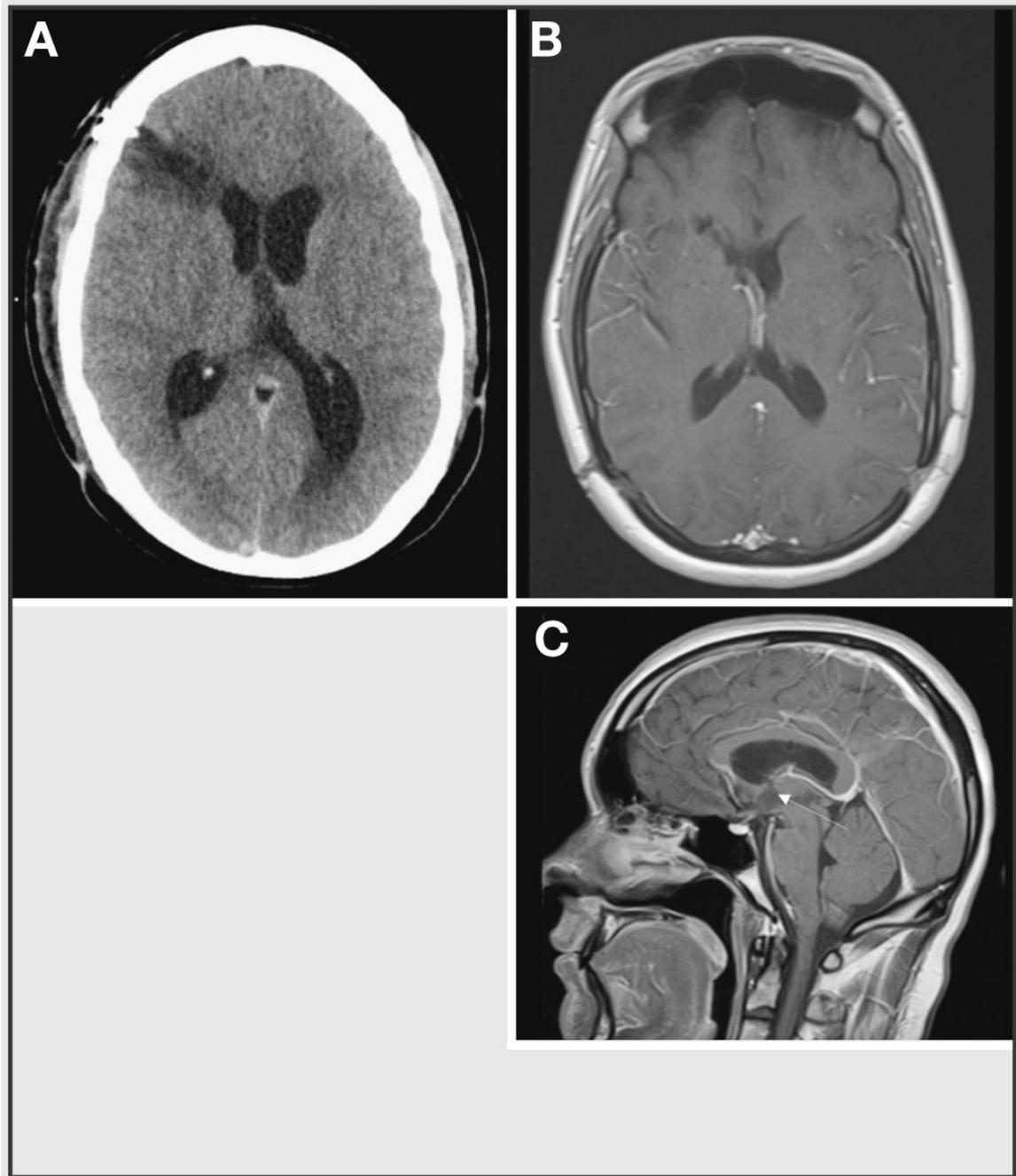
**FIGURE 3.** Computed tomography of brain revealing adequate positioning of bilateral ventricular catheters from ventriculoperitoneal shunt placement.



**FIGURE 4.**  
Hematoxylin and eosin staining of colloid cyst revealing lining epithelium and cyst content.



**FIGURE 5.** Axial T1-weighted magnetic resonance imaging of brain revealing tract of peel-away sheath to the right frontal lateral ventricle and a complete resection of the colloid cyst in the third ventricle.

**FIGURE 6.**

Imaging of the brain before and after neuroendoscopic re-exploration and third ventriculostomy placement. **A**, computed tomography scan of the brain revealing a ventricular enlargement (lateral and third ventricles) after neuroendoscopic colloid cyst resection. Axial (**B**) and sagittal (**C**) contrast-enhanced magnetic resonance imaging of the brain 3 months after reopening of the right foramen of Monro and a neuroendoscopic third ventriculostomy revealing adequate ventricular decompression and no residual or recurrent colloid cyst (arrowhead).