RACHNOID cysts are intraarachnoid collections of cerebrospinal fluid. Mostly congenital in origin, they once were estimated to account for approximately 1% of all atraumatic intracranial mass lesions. With the widespread use of magnetic resonance (MR) imaging and computerized tomography (CT), however, this incidence rate seems to be higher. Although often an incidental finding, arachnoid cysts may cause neurological symptoms by compression of brain tissue. Many operative procedures for the therapy of arachnoid cysts have been recommended, including stereotactic aspiration, cyst excision, cystocisternostomy, ventriculocystostomy, and cystoperitoneal shunting; however, it remains controversial as to which is the best method of treatment. Since the development of neuroendoscopes properly adapted to neurosurgical demands, there is now a technique available for minimally invasive therapy of such lesions. There are only a few reports on endoscopic management of arachnoid cysts in the literature, and thus we report on our experience with a series of seven consecutive patients with arachnoid cysts treated endoscopically within 15 months.

Summary of Cases

Seven consecutive patients with arachnoid cysts were treated endoscopically at our institution between April 1993 and July 1994. A prospective study of each case was performed, including neurological examinations and CT or MR imaging before surgery and at 6, 12, 24, and 30 months postoperatively.

Age, Gender, and Presentation

The clinical characteristics of the patients are given in Table 1. There were four males and three females. Three patients were younger than 15 years at the time of surgery. Five patients suffered from headache, two from vomiting, two from dizziness, and two patients had balance problems. Precocious puberty and seizures were present in one patient each. The neurological examination on admission was unremarkable in all cases except Case 6, in which the patient scored in the unsafe range in Unterberger’s and Romberg’s tests and exhibited blind-gait deviation.

Diagnostic Workup

Computerized tomography and MR imaging demonstrated a mass effect of the cysts on neighboring brain tissue with flattening of gyri, compression of the ventricular system, and/or midline shift in all cases. Four cysts were located in the middle cranial fossa and two cysts in the posterior cranial fossa; one cyst was in the suprasellar–preptine area. In the patient who presented with seizures (Case 2), epidural intracranial pressure monitoring was performed before surgery to verify increased intracranial pressure.
Endoscopic Treatment

All procedures were performed after general anesthesia was induced in the patient. The field of operation was prepared and draped to allow immediate open microsurgical intervention in case of complications. We used the Gaab universal neuroendoscopic system developed by the senior author and manufactured by Karl Storz GmbH & Co. (Tuttlingen, Germany) and Codman & Shurtleff, Inc. (Randolph, MA). A small videocamera was attached to the eyepiece of the endoscope and the surgeon operated while looking at the video monitor screen. The operations were videotaped. A burr hole was made according to the best trajectory obtained from CT or MR imaging and the dura was opened. The outer cyst membrane was coagulated and incised. The operating sheath with trocar was inserted freehand into the cyst and fixed with two Leyla retractors. Then the trocar was removed and a rigid Hopkins rod-lens diagnostic scope was inserted to inspect the cyst. After orientation, the diagnostic scope was replaced by an operative scope with an angled eyepiece. In the case of posterior fossa cysts, a cystocisternostomy was performed by creating a wide opening between the cyst and cisterns (Fig. 1). The cyst’s inner membrane was incised and partially resected using scissors and grasping forceps. In the case of middle fossa cysts, a cystocisternostomy was created by perforating the cyst’s inner membrane and inflating a No. 3 French Fogarty balloon catheter. Subsequently a fimbrial ventricular catheter (Cordis Corp., Miami, FL) was placed into the adjacent basal cisterns to prevent occlusion of the opening by collapsing the cyst and later scarring (Fig. 2). In the patient with the suprasellar–preptontine cyst, the right lateral ventricle was approached via a parasagittal precoronal burr hole. A ventriculocystostomy was performed in the bulged floor of the third ventricle in front of the mammillary bodies with the aid of a bipolar coagulation probe and a No. 3 French Fogarty catheter. A fimbrial catheter was then inserted between the cyst and the ventricle (Fig. 3).

The operations were performed under continuous rinsing with Ringer’s solution at 36˚C. In this way minor bleeding was easily controlled and a blurred vision on the video monitor screen was avoided. Bleedings from larger vessels were coagulated by using a bipolar coagulation probe. The mean operation time was 55 minutes, ranging from 35 to 85 minutes. In one case of a middle fossa cyst (Case 7), significant bleeding occurred and, even under intensive rinsing, no clear image could be maintained. Because this prevented orientation and a safe operation, the endoscopic procedure had to be abandoned and an open craniotomy with microsurgical cystocisternostomy was performed.

Results

There was no mortality or morbidity in this series. The follow-up review periods ranged from 15 to 30 months (mean 20 months). Patient outcomes and the changes observed on CT and MR imaging are given in Table 1. The follow-up neurological examinations were unremarkable in six patients. In Case 6, the patient’s balance problems markedly improved. At the 12-month follow-up examination only a slight deviation in the blind-gait test was found. Initially headaches disappeared in all patients, but in Case 7, a headache of lower intensity and of a different kind recurred after 7 months. In Case 3, the precocious puberty continued. This girl was referred to an endocrinologist for endocrine treatment. The patient in Case 2 experienced no seizures after surgery and required no antiepileptic medication. In five patients, the cysts decreased in size remarkably. In the patient with seizures (Case 2), the MR imaging showed no change in the size of the cyst. Magnetic resonance imaging in Case 6 demonstrated only a slight cyst reduction. Follow-up CT and MR imaging yielded no dislocation of the implanted catheter in any case (Fig. 4).

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex, Clinical Findings</th>
<th>Cyst Location</th>
<th>Surgical Procedure</th>
<th>Duration of Follow Up (mos)</th>
<th>Outcome</th>
<th>Change on MR/CT Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8, M headache, nausea, vomiting, balance problems</td>
<td>posterior fossa</td>
<td>cystocisternostomy</td>
<td>30</td>
<td>no complaint</td>
<td>cyst reduction</td>
</tr>
<tr>
<td>2</td>
<td>29, M seizures</td>
<td>middle fossa</td>
<td>cystocisternostomy with catheter</td>
<td>28</td>
<td>no complaint</td>
<td>no change</td>
</tr>
<tr>
<td>3</td>
<td>6, F precocious puberty</td>
<td>suprasellar– preptontine</td>
<td>ventriculocystostomy with catheter</td>
<td>19</td>
<td>continued precocious puberty</td>
<td>cyst reduction</td>
</tr>
<tr>
<td>4</td>
<td>14, M headache, vomiting</td>
<td>middle fossa</td>
<td>cystocisternostomy with catheter</td>
<td>17</td>
<td>no complaint</td>
<td>cyst reduction</td>
</tr>
<tr>
<td>5</td>
<td>24, F headache, dizziness</td>
<td>middle fossa</td>
<td>cystocisternostomy with catheter</td>
<td>17</td>
<td>no complaint</td>
<td>cyst reduction</td>
</tr>
<tr>
<td>6</td>
<td>47, M headache, dizziness, balance problems</td>
<td>posterior fossa</td>
<td>cystocisternostomy</td>
<td>16</td>
<td>no complaint</td>
<td>cyst reduction</td>
</tr>
<tr>
<td>7</td>
<td>17, F headache</td>
<td>middle fossa</td>
<td>endoscopy abandoned, microsurgical cystocisternostomy with catheter</td>
<td>15</td>
<td>headache markedly improved</td>
<td>cyst reduction</td>
</tr>
</tbody>
</table>

* CT = computerized tomography; MR = magnetic resonance.
Endoscopic treatment of arachnoid cysts is rarely reported in the literature. Most authors have published sporadic cases without details concerning the endoscopic technique, complications, and outcome. Auer, et al., mentioned one case of arachnoid cyst in the left frontal lobe in their summary of endoscopically treated cystic brain tumors. No surgical details or outcomes were given. Cohen reported one suprasellar arachnoid cyst treated successfully by endoscopic fenestration and ventriculoperitoneal shunting. Eiras Ajuria and coworkers performed a cystoventriculostomy for a frontotemporal cyst with a noticeable reduction in the size of the cyst after 8 months. No complications occurred. Caemaert, et al., described four cases of suprasellar arachnoid cysts with favorable outcome after a follow-up period that extended up to 36 months. They advocated a large fenestration into the lateral ventricle and into the basal cisterns as the treatment of choice. The three suprasellar arachnoid cysts reported by Dhooge and colleagues seem to be included in the report by Caemaert, et al. In a series of 21 endo-

**Discussion**

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In a series of 21 endo-

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**Fig. 1. Case 1.** Upper: Endoscopic view into the cyst showing the pons (P), facial nerve (FN), and trigeminal nerve (TN). Lower Left: Axial T1-weighted magnetic resonance (MR) image revealing an arachnoid cyst in the cerebellopontine angle with compression of the fourth ventricle and midline shift. Lower Right: Axial T1-weighted MR image obtained 30 months after surgery demonstrating cyst reduction and disappearance of the midline shift.

**Fig. 2. Case 4.** Upper and Center: Endoscopic views of the inner cyst wall overlying the frontal lobe (FL), temporal lobe (TL), sylvian vein (SV), and petroclinoid fold (PF). A catheter (C; center) is shown inserted into the basal cisterns. Lower Left: Coronal T1-weighted magnetic resonance (MR) image revealing a large middle fossa cyst with midline shift and ventricular compression. Lower Right: Coronal T1-weighted MR image obtained 12 months after the cystocisternostomy showing a marked decrease in the size of the cyst with expansion of the ventricular system and nearly no midline shift.
Endoscopic procedures, Grunert and associates treated one suprasellar arachnoid cyst successfully; however, no details were given. Endoscopic ventriculocystostomies performed with the aid of a neodymium-yttrium-aluminum garnet (Nd–YAG) laser and subsequent shunting were effective and without complication in one suprasellar arachnoid cyst and another unspecified midline cyst, as reported by Lange, et al. Marsupialized an arachnoid cyst uneventfully using a Nd–YAG laser. A larger series was reported by Walker and colleagues: 14 arachnoid cysts, including cysts of the septum pellucidum, suprasellar cistern, interhemispheric fissure, and lateral ventricles were ventriculoscopically fenestrated with favorable results and shunt independence in nine patients. No complications were mentioned. Zamorano, et al. treated eight patients with arachnoid cysts by endoscopic Nd–YAG laser stereotaxy, but no details were presented. In a series of 15 percutaneous ventriculocystostomies used to treat arachnoid cysts, Pierre-Kahn and associates performed four ventriculocystostomies under endoscopic control without complications. Caemaert and colleagues reported 10 cases of para- and intraventricular cysts managed by laser-assisted fenestration into the ventricle. It appears as though this series probably included three arachnoid cysts; however, no exact description was given. All endoscopic procedures were uneventful, but one infant with an associated meningocele died 12 hours later of severe acute respiratory distress syndrome.

Endoscopic treatment of arachnoid cysts via a minimally invasive burr-hole approach proved to be an effective and safe technique in our series. The symptoms of the patients treated purely endoscopically were relieved completely, except the precocious puberty observed in Case 3. Although this patient’s precocious puberty continued, we also consider this endoscopic ventriculocystostomy to be successful because the cyst decreased significantly in size. Complete reversal of precocious puberty after decompression of arachnoid cysts has been reported; however, often the endocrine dysfunctions do not regress. Compression and distortion of the hypothalamus is suspected of reversing the inhibitory mechanism of gonadotropin secretion in arachnoid cyst–related precocious puberty. After decompression of the cyst, the inhibitory mechanism may be restored, but in some cases it appears to be irreversibly damaged.
Neuroendoscopic approach to arachnoid cysts

Although in six patients the size of the arachnoid cyst decreased after surgery, in the patient in Case 2 the cyst remained unchanged. This patient is completely free of symptoms and no further interventions are indicated. Nevertheless, an insufficient cystocisternostomy cannot be ruled out. In the younger patients (Cases 1, 3, and 4) the reduction of the cysts was more prominent than in the older patients. This may be explained by the greater elasticity of the young brain and the shorter period of brain compression leading to gliosis.8

In the patient in whom the endoscopic procedure had to be discontinued (Case 7), the headache initially disappeared but recurred after 7 months. Because the cyst remained diminished in size and the newer headache displayed a different character from the one experienced preoperatively, we suspect other factors are responsible for the more recent headache. This hypothesis is supported by the increased intensity of this headache in response to psychological stress.

Arachnoid cysts most commonly have been treated by cyst fenestration/resection2,13,15,20,29,32 or by cystoperitoneal shunting;7,16,23 however, controversy continues regarding which surgical treatment is best. Major complications of cyst fenestration/resection and shunting procedures have been reported: they include meningitis, hemiparesis, oculomotor palsy, subdural hematomas, new grand mal seizures, and even death in the case of the former procedure.1,7,22,10 and shunt malfunction and infection in the case of the latter.1,6,20 Shunting is obviously safer; but it is accompanied by a higher incidence of additional surgical procedures and the disadvantage of life-long shunt dependence.20,25 Endoscopic techniques can replace open surgery or shunting procedures with similar or even better results. In a review of five of his own cases as well as six major operative series covering 42 cases of suprasellar arachnoid cysts, Rappaport28 discussed four procedures including subfrontal fenestration of the cyst to the basal cisterns, transcallosal fenestration into the lateral ventricles with optional shunting, cystoperitoneal shunting, and percutaneous ventriculocystostomy. He concluded that percutaneous ventriculocystostomy had the lowest incidence of reoperation and thus offered the best chance for definitive treatment. In 15 arachnoid cysts managed by percutaneous ventriculocystostomy, Pierre-Kahn and associates27 experienced two failures to perforate the resistant cyst wall using a blunt leukotome under x-ray control. In one case, subarachnoid bleeding, recurrent hydrocephalus, and oculomotor palsy occurred under ultrasound control. Four ventriculocystostomies performed using ventriculoscopic guidance were uneventful. Because of obstruction of the opening, one patient had to undergo a second ventriculocystostomy 12 years later. For the treatment of suprasellar arachnoid cysts, Caemaert, et al.,9 prefer a wide endoscopic fenestration into the lateral ventricle using a Nd–YAG laser. This opening should be as large as possible (10–15 mm) to prevent later closing. In our case, the communication had to be created in the floor of the third ventricle. Such a large fenestration could not be achieved without risk of damaging the neighboring brain structures. Therefore, we perforated the cyst wall by means of bipolar coagulation and enlarged the perforation with a Fogarty catheter. To prevent closure of the opening by scarring, we subsequently inserted a fimbrial catheter.

Details of endoscopic therapy of arachnoid cysts located in the middle cranial fossa have not yet been published. The main difficulty faced in this procedure is an increased bleeding rate compared to other neuroendoscopic procedures, such as ventriculoscopy. Each operation has to be performed under continuous irrigation with Ringer’s solution to maintain a clear operative image. It is of utmost importance to coagulate the fragile arachnoid blood vessels in the entry zone of the endoscope to prevent bleeding after movements of the operating sheath. In addition, one should take care not to detach the outer wall of the cyst from the dura mater; this would result in collapse of the cyst. For orientation we looked for the sylvian vein and the middle cerebral artery and used them as the primary landmarks, and we then followed them to the basal cisterns. In our cases, there was only a limited area to place the cystocisternostomy between the frontal lobe, temporal lobe, and small sphenoid wing or petroclinoid fold. We perforated the cyst wall and created an opening as large as possible using a No. 3 French Fogarty catheter. This relatively small opening would be at risk of occlusion by later scarring. For that reason we inserted a fimbrial catheter into the basal cisterns. Care was taken not to injure the oculomotor nerve or branches of the carotid artery. To date, no catheter dislocation has been detected on the follow-up CT or MR images. Minor oozing from small vessels stopped spontaneously during irrigation. Bleeding from larger vessels was coagulated with bipolar diathermia.

For the endoscopic treatment of arachnoid cysts we prefer rigid rod lens endoscopes. Their optical quality is superior compared to that of the flexible endoscopes. Additionally, the guidance and effectiveness of the surgical instruments is much better.

In general, we only operate on symptomatic arachnoid cysts. Despite sporadic reports of spontaneous regression of arachnoid cysts,3 we agree that in children asymptomatic arachnoid cysts that exert a mass effect should be treated. The potential for hindering normal development and function of the adjacent brain in this group outweighs the risk of operative treatment.7,16 Microsurgical cyst fenestration as well as shunting have a high failure rate and various complications have been reported.7,16,29 The endoscopic procedures used in our cases were safe and rapid. The postoperative course was uneventful in all cases. There was no mortality or morbidity and the surgical trauma could be kept to a minimum. Five patients recovered completely and one improved markedly. The cysts decreased in size in six cases. Hence, endoscopic treatment may be a promising alternative to microsurgical management and shunting. This treatment combines the minimal invasiveness of shunting with the shunt independence of microsurgical fenestrations. However, the follow-up periods of our series are too short and the number of patients evaluated is too low to compare our results with the standard approaches. Nevertheless, we recommend the endoscopic treatment of arachnoid cysts as the first therapy of choice. Should the endoscopic procedure fail, established treatment options such as microsurgical fenestration or cystoperitoneal shunting can subsequently be performed without causing additional risk to the patient.
References


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