Endoscopic cistoventriculostomy for treatment of paraxial arachnoid cysts

Clinical article

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Object. The optimal therapy of arachnoid cysts is controversial. In symptomatic extraventricular arachnoid cysts, fenestration into the basal cisterns is the gold standard. If this is not feasible, shunt placement is frequently performed although another endoscopic option is available.

Methods. Between March 1997 and June 2006, 12 endoscopic cistoventriculostomies were performed for the treatment of arachnoid cysts in 11 patients (4 male and 7 female patients, mean age 52 years [range 14–71 years]). All patients were prospectively followed up.

Results. In 11 cases, the arachnoid cysts were frontotemporoparietal and fenestration was performed into the lateral ventricle. In 1 case, the arachnoid cyst was located in the cerebellum and the cyst was fenestrated into the fourth ventricle. Neuroradiological guidance was used in all but 1 case. Endoscopic cistoventriculostomy was performed in all cases without complications. No stents were placed. The mean surgical time was 71 minutes (range 30–110 minutes). The mean follow-up period was 42.7 months (range 19–96 months) per surgical case and 48.8 months (range 19–127 months) per patient. Symptoms improved after 11 of the 12 procedures; 7 of the 11 patients became symptom-free and the others had only mild residual symptoms. The patient who did not experience clinical improvement suffered from depression and demonstrated a significant decrease of the cyst size on the postoperative MR imaging. After 11 of 12 procedures, a decrease in cyst size was observed. In 1 case, a subdural hematoma developed; it required surgical treatment 3 months after surgery. In another case, reclosure of the stoma required repeated endoscopic cistoventriculostomy more than 7 years after the initial procedure.

Conclusions. Overall, endoscopic cistoventriculostomy represents a useful treatment option for patients with paraxial arachnoid cysts in whom a standard cistocisternotomy is not feasible. Based on the results in this case series, stent placement appears not to be required. Despite the long mean follow-up of almost 4 years, however, a longer follow-up period seems to be required before definite conclusions can be drawn. (DOI: 10.3171/2008.7.JNS0841)

KEY WORDS • arachnoid cyst • endoscopic cistoventriculostomy • neuroendoscopy

Arachnoid cysts are mostly incidental findings, but they may also account for specific neurological symptoms requiring surgical therapy. Open surgery with cyst excision,7 cyst fenestration,1 cystocisternotomy,2 ventriculocystostomy31 as well as cystoperitoneal shunting5 and stereotactic aspiration16 have all been suggested by various authors as the optimal treatment. In the last decade, endoscopic techniques have often been particularly favored as less invasive procedures, and reports on successful endoscopic techniques have been very frequent.3,4,6,9,11,13,15,17–20,23–25,29,31–34,36–41 Although endoscopic cystocisternotomies to the basal cisterns as well as endoscopic ventriculocystostomies of intraventricular cysts have frequently been addressed,5,9,11,12,15,23,24,30,33,38 to date there have been no reports on endoscopic cistoventriculostomy for paraxial arachnoid cysts without contact to the basal cisterns. Here the authors present their experience with 12 such procedures over a 15-year period.

Methods

Of 47 patients with arachnoid cysts treated endoscopically at our institution between April 1994 and January 2008, 11 suffered from extraventricular paraxial arachnoid cysts without contact to the basal cisterns. Follow-up was performed in each case and included MR imaging studies as well as neurological examinations. Four procedures were performed between March 1997 and February 2003.
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at the Department of Neurosurgery of the Ernst Moritz Arndt University, Greifswald, Germany. Eight arachnoid cysts were treated surgically at the Department of Neurosurgery, Krankenhaus Nordstadt, Hannover, Germany between February 2003 and June 2006. Follow-up examinations were performed at 3, 6, and 12 months postoperatively and then on a yearly basis. The final follow-up before publication of this study was carried out in the form of a telephone interview conducted by an independent researcher who is not a coauthor of this study.

Age, Gender, and Clinical Presentation

The clinical characteristics of the patients are summarized in Table 1. There were 4 male and 7 female patients in the study population. Their mean age was 52 years (range 14–71 years). The main presenting symptoms were headache (5 patients), various hemisymptoms (4 patients), and seizures as well as psychosyndrome (3 patients each).

Diagnostic Workup

All patients underwent MR imaging before a decision was made about the surgical procedure. In all cases, a mass effect of the cyst on neighboring brain tissue with flattening of gyri, compression of the ventricular system, and in some cases even midline shift were demonstrated. Of the 11 cysts, 7 were mainly located in the middle fossa, 3 primarily in the anterior fossa, and 1 cyst was found in the posterior fossa.

Endoscopic Treatment

All procedures were performed while the patient was in a state of general anesthesia. In all cases, MR images were obtained preoperatively for intraoperative neuro-navigational guidance. Also, preoperatively, the approach via a trajectory from the skin incision through the body of the cyst and through the thinnest part of the cyst wall to the ventricle was planned. After the neuronavigation system was referenced, the surgical field was prepared and draped to allow a switch to microsurgery in the event of complications. The Gaab universal neuroendoscopic system, which was developed by the senior author and manufactured by Karl Storz GmbH & Co., was used in all procedures. (For a detailed description of the instrument and the general endoscopic technique please refer to Gaab et al.15) In brief, a standard 0° rod lens Hopkins scope and a standard digital camera were used. A skin incision was made, and a bur hole was placed according to the best trajectory obtained from MR images. After opening of the dura mater, the outer cyst membrane was coagulated, and the cyst was entered with the endoscopic work sheath and the trocar. The endoscope was fixed to the endoscope holder, the trocar was removed, and the cyst was inspected with the 0° and the various angled diagnostic Hopkins rod-lens scopes. After switching to the working scope, the cystoventriculostomy was made at the assumed smallest point between the cyst and the ventricle. At the end of the procedure, the cystoventriculostomy was inspected with the 0° diagnostic scope, and the work sheath was withdrawn.

Results

Surgical Technique

A successful endoscopic cystoventriculostomy was achieved in all cases without intraoperative complications. An ideal case is illustrated in Fig. 1. However, the surgical technique presented some peculiar problems that have to be addressed. In all cases, after the endoscopic work sheath was referenced as a neuronavigational tool, direct entry of the cyst was successfully accomplished by the approach chosen under neuronavigational guidance. Particular attention was paid to avoid any significant CSF loss in order to minimize brain shift and keep the neuronavigation as accurate as possible. Thus, the bur hole was packed around the work sheath with wet cottonoids as soon as the cyst was entered with the work sheath. Additionally, in- and outflow channels of the endoscope were closed, and the working channel was blocked by insertion of the 4-mm 0° Hopkins scope. By these measures, brain shift was limited to a minimum. Clear CSF drained out of the cysts under moderate pressure. The cysts were inspected with the 0, 30, 45, and 70° scopes. The cyst wall relief resembled the typical cortical relief and did not include any identifiable landmarks in any case (Fig. 1–3). In some patients with a very small rim of brain parenchyma between the cyst wall and the ventricle, there seemed to be a more vivid cyst wall pulsation at the border to the ventricle. However, this finding was equivocal in all these cases. Thus, the ideal point of the cystoventriculostomy was localized exclusively by neuronavigational guidance. After the switch to working scope, the bipolar probe was referenced and the perforation of the cyst wall into the ventricle was performed with the bipolar probe under neuronavigational guidance. With the described technique, the cystoventriculostomy was performed at the ideal perforation point without any difficulties if neuronavigation was available, even in 2 cases in which rather profound irrigation was performed prior to the cystoventriculostomy (see below). After the initial perforation, the stoma was enlarged by use of the perforation forceps and/or of a Fogarty balloon catheter until an open stoma of 4–5 mm diameter resulted. At the end of the procedure, the successful cystoventriculostomy was checked by inspection of the ventricle through the stoma with the 0° diagnostic scope. No stent was implanted. After removal of the work sheath, the bur hole was closed with Gelfoam, and the wound tightly sutured. There was no CSF leak in any case. Video of an ideal endoscopic surgical case is presented (Video 1).

VIDEO 1: Clip illustrating an ideal example of an endoscopic cystoventriculostomy in a paraxial arachnoid cyst.

Intraoperative bleeding due to injury of vessels of the cyst wall was not an issue in any of the procedures. In 2 cases, however, the intraoperative view was blurred by bleeding from the dura mater (Cases 2 and 3). After vigorous irrigation with Ringer solution for ~ 40 minutes, both procedures could be continued endoscopically, and
the ideal perforation point could be localized by neuronavigation without any difficulty.

Dysfunction of the neuronavigation system occurred in 1 case (Case 5). In this case, dysfunction of the neuronavigation system occurred after the referencing of the system and after the initial entering of the cyst with the work sheath. The cystoventriculostomy was carefully performed freehand by the surgeon at the point where a more vivid movement of the cyst wall gave the impression of immediate vicinity to the lateral ventricle. The lateral ventricle was opened directly and the endoscopic procedure was continued.

**Postoperative Clinical Status**

There were no deaths and no immediate postoperative complications. All patients suffered from some degree of nausea and vomiting postoperatively and these symptoms improved within the first postoperative week. The preoperative signs improved to a variable degree immediately postoperatively in all patients. A decrease of cyst size was observed in 11 of 12 cases on the early postoperative MR image within the first postoperative week. On MR images, the maximum anterior-posterior diameter in the axial plane decreased from a mean of 6.08 cm to a mean of 4.18 cm, and the maximum medial-to-lateral diameter in the axial plane decreased from a mean of 5.6 cm to a mean of 3.64 cm. An open stoma was demonstrated in 10 of 12 cases. Flow of CSF through the stoma was observed on 5 of 7 MR imaging studies. Details of the early postoperative course are given in Table 1.

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Clinical Findings</th>
<th>Cyst Location</th>
<th>Surgical Procedure</th>
<th>Op Time (min)</th>
<th>Neuro-navigation</th>
<th>FU (mos)</th>
<th>Complications</th>
<th>Outcome</th>
<th>Change of Cyst Size</th>
<th>Open Stoma on MRI</th>
<th>Stoma on MRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>71, F</td>
<td>hemiataxia</td>
<td>middle fossa, temporal</td>
<td>cystoventriculostomy</td>
<td>75</td>
<td>yes</td>
<td>96</td>
<td>no</td>
<td>Sx-free</td>
<td>decr</td>
<td>yes</td>
<td>NI</td>
</tr>
<tr>
<td>2</td>
<td>49, M</td>
<td>gait difficulties, coordination problems</td>
<td>middle fossa, parietal</td>
<td>cystoventriculostomy</td>
<td>100</td>
<td>yes</td>
<td>72</td>
<td>no</td>
<td>impr</td>
<td>decr</td>
<td>yes</td>
<td>NI</td>
</tr>
<tr>
<td>3</td>
<td>66, F</td>
<td>hemiparesis, somnolence, psychosis</td>
<td>middle fossa, temporoparietal</td>
<td>cystoventriculostomy</td>
<td>100</td>
<td>yes</td>
<td>48</td>
<td>no</td>
<td>impr</td>
<td>decr</td>
<td>yes</td>
<td>NI</td>
</tr>
<tr>
<td>4</td>
<td>14, F</td>
<td>cephalgia</td>
<td>middle fossa, parietal</td>
<td>cystoventriculostomy</td>
<td>75</td>
<td>yes</td>
<td>48</td>
<td>no</td>
<td>Sx-free</td>
<td>decr</td>
<td>yes</td>
<td>NI</td>
</tr>
<tr>
<td>5</td>
<td>56, F</td>
<td>hemiparesis, coordination problems, psychosis</td>
<td>middle fossa, temporoparietal</td>
<td>cystoventriculostomy</td>
<td>110</td>
<td>no</td>
<td>48</td>
<td>no</td>
<td>Sx-free</td>
<td>decr</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>6</td>
<td>66, M</td>
<td>cephalgia, seizures</td>
<td>middle fossa, temporoparietal</td>
<td>cystoventriculostomy</td>
<td>30</td>
<td>yes</td>
<td>30</td>
<td>yes (subdural hematoma 3 mos postop)</td>
<td>Sx-free</td>
<td>decr</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>7</td>
<td>65, M</td>
<td>seizures</td>
<td>anterior fossa</td>
<td>cystoventriculostomy</td>
<td>70</td>
<td>yes</td>
<td>31</td>
<td>no</td>
<td>Sx-free</td>
<td>decr</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>8</td>
<td>59, F</td>
<td>cephalgia, psychosis</td>
<td>anterior fossa</td>
<td>cystoventriculostomy</td>
<td>45</td>
<td>yes</td>
<td>20</td>
<td>no</td>
<td>depresion</td>
<td>decr</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>9</td>
<td>65, F</td>
<td>hemiparesis, aphasia</td>
<td>middle fossa, temporoparietal</td>
<td>cystoventriculostomy</td>
<td>63</td>
<td>yes</td>
<td>19</td>
<td>no</td>
<td>Sx-free</td>
<td>decr</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>10</td>
<td>43, F</td>
<td>cephalgia, gait difficulties, ataxia</td>
<td>posterior fossa</td>
<td>cystoventriculostomy</td>
<td>30</td>
<td>yes</td>
<td>19</td>
<td>no</td>
<td>impr</td>
<td>no change</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>11</td>
<td>29, M</td>
<td>cephalgia, seizures</td>
<td>anterior fossa</td>
<td>cystoventriculostomy</td>
<td>90</td>
<td>yes</td>
<td>89</td>
<td>yes (recurrence, see Case 12)</td>
<td>Sx-free (until recur)</td>
<td>decr (until recur)</td>
<td>yes</td>
<td>NI</td>
</tr>
<tr>
<td>12</td>
<td>36, M</td>
<td>cephalgia, seizures</td>
<td>anterior fossa</td>
<td>repeated cystoventriculostomy</td>
<td>92</td>
<td>yes</td>
<td>28</td>
<td>yes (brain abscess 12 mos postop)</td>
<td>Sx-free</td>
<td>decr</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

* Cases 11 and 12 involved the same patient. Stents were not placed in any case. Abbreviations: decr = decreased; FU = follow-up; impr = improved; NI = not investigated; probs = problems; recur = recurrence.
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Patient Follow-Up

The mean follow-up period was 42.7 months (range of 19–96 months) per surgical case, and 48.8 months (range 19–127 months) per patient. Details of the long-term follow-up are given in Table 1. On follow-up, 10 of 11 patients were found to have experienced further improvement, with 1 patient suffering from cyst recurrence later on. Seven of 11 patients were symptom-free at most recent follow-up. All 5 of the patients who complained of headache preoperatively reported clinical improvement after surgical treatment, and none required pain medication on a permanent basis. All patients who suffered from seizures became seizure free and none are being treated with any anticonvulsant medication. In 1 patient a chronic subdural hematoma developed 3 months after cystoventriculostomy (Fig. 2). The hematoma required surgical treatment, but the patient has been symptom free since. Another patient suffered from a recurrence of the arachnoid cyst 89 months after initial cystoventriculostomy. A repeated cystoventriculostomy was performed, and the patient’s condition improved postoperatively. Nevertheless, 12 months after the second surgery, he suffered from brain abscess formation in the area of the cyst (Fig. 3). A further decrease of cyst size was observed in some patients during follow-up. An ideal case with a significant decrease of cyst size at 3-month follow-up is illustrated in Fig. 4.

Discussion

Arachnoid cysts are usually incidental findings, but if they become symptomatic they require surgical treatment. The optimal therapy—which may include endoscopic surgical techniques, shunt placement, and microsurgical techniques—remains controversial. With the further development and improvement of endoscopic neurosurgical techniques the confidence in endoscopic options has increased in recent years. Reports on endoscopic treatment of arachnoid cysts appear to be significantly more frequent in the current literature than reports on open microsurgical techniques. Nevertheless, a large number of neurosurgeons still perform microsurgical procedures or even shunt placement for the treatment of these cysts. This is probably particularly true in cases involving arachnoid cysts in the middle fossa close to the
basal cisterns (the most frequent location), which can be easily accessed and treated by endoscopic or open microsurgical cystocisternostomy. For intraventricular cysts and particularly for suprasellar arachnoid cysts, the endoscopic technique represents the procedure of choice for the vast majority of neurosurgeons.

In contrast to these frequently reported entities, the type of cyst that is the focus of the present report is very rare and mainly becomes symptomatic in adults, at least in our experience. Detailed reports of endoscopic techniques on this rare entity are absent in the literature. The current presentation illustrates the authors’ results of endoscopic cystoventriculostomy in those arachnoid cysts in which cystocisternostomy was not feasible. In all cases, successful drainage into the ventricle could be achieved without major complications. No stents were inserted. With a mean follow-up period of almost 4 years, there was a recurrence after only 1 of the 12 procedures. Thus, the technique appears to be safe and successful. Nevertheless particular reference has to be paid to some peculiar findings of this study.

First, we would like to emphasize the value of neuronavigation for this technique. The successful combination of frameless neuronavigation with neuroendoscopy even in the treatment of intracranial cysts has been reported previously. In the current type of arachnoid cysts, neuronavigation is of the utmost importance since no anatomical landmarks are found within the cysts. Fortunately, neuronavigation worked very precisely even in the 2 cases that required vigorous irrigation for blurred vision, and a successful localization of the thinnest area of the cyst separating the lesion from the ventricle could be achieved without complications. In the near future, an endoscopic ultrasound probe might overcome the dependence on neuronavigation for this kind of endoscopic cystoventriculostomy, but at present we believe that neuronavigation is absolutely mandatory for this kind of endoscopic procedure.

Second, a rather small stoma was achieved using a 3 Fr Fogarty balloon catheter and/or a forceps without insertion of a stent in the present study. This stands in contrast to previous reports on arachnoid cyst surgery. Particularly, the size of cyst fenestration has been described as important for avoiding cyst recurrence. Also, insertion of a stent has been credited with avoiding reclosure of the cyst fenestration. The present report gives evidence that even a small stoma without stent insertion might be sufficient for cyst drainage. Although a higher rate of late recurrence cannot be excluded in the very long run, a small opening is sufficient in endoscopic cystoventriculostomies.

Fig. 2. Case 6. a–c: Preoperative coronal T2-weighted (a), axial T2-weighted (b), and sagittal T1-weighted (c) MR images demonstrating left frontal paraxial space-occupying arachnoid cyst with midline shift. d: Neuronavigational planning of the ideal trajectory from the bur hole through the body of the cyst to the lateral ventricle. e: Intraoperative neuronavigational localization of the ideal perforation point, and coagulation and perforation of the cyst wall with the bipolar forceps. f and g: Enlargement of the stoma with the perforation forceps (f) and a Fogarty balloon catheter (g). h: Resulting cystoventriculostomy. i: View through the cystoventriculostomy in the left lateral ventricle with the 0° scope. j and k: Postoperative coronal (j) and axial (k) T2-weighted MR images demonstrating the reduction of the cyst size by the cystoventriculostomy to the left lateral ventricle as well as small bihemispheric hygromas. l: Coronal MR image obtained 3 months postoperatively revealing a left-side subdural hematoma.
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for paraxial noncisternal arachnoid cysts. One of the reasons might be that there is no cyst membrane that can reclose in these cysts. Basically a corticotomy is performed for cyst drainage similar to an endoscopic third ventricu-

lostomy in acute obstructive hydrocephalus where also a rather small opening gives sufficient CSF flow through the stoma with very low recurrence rates.28,35

In all, the endoscopic cystoventriculostomy repre-
sents the procedure of choice for paraxial symptomatic arachnoid cysts without contact to the basal cisterns in the opinion of the authors. It should be preferred to cys

toventricular or cistoperitoneal shunting. Cystoventricu-

lar stenting appears to be unnecessary; however, longer

follow-up is required before definite conclusions can be
drawn. Nevertheless, the key issue in the treatment of

arachnoid cysts is the careful selection of the patients to
avoid any surgery in cases of asymptomatic lesions.

Conclusions

The present study reports successful treatment of
paraxial noncisternal arachnoid cysts by endoscopic cys-
toventriculostomy. There were only minor complications
including 1 late-onset chronic subdural hematoma and 1
very late–onset brain abscess. Additionally, there was 1

cyst recurrence. In all, the endoscopic cistoventriculosto-

my represents, for us, the procedure of choice for paraxial

noncisternal symptomatic arachnoid cyst. The technique

should be preferred to placement of a cystoventricular or
cystoperitoneal shunt. Nevertheless, because recurrences
tend to occur very late, longer follow-up is required be-
fore definite conclusions can be drawn.

Disclosure

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