



Long-Term Results After Endoscopic Resection of Colloid Cysts

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■ **BACKGROUND:** Endoscopic resection of colloid cysts is a widely accepted treatment option instead of microsurgery. However, there is still a debate about a potentially higher rate of incomplete resections and recurrence.

■ **OBJECTIVE:** The aim of this retrospective study was to evaluate long-term results after endoscopic removal of colloid cysts.

■ **METHODS:** Twenty patients underwent endoscopic treatment in our department. Eighteen patients agreed to follow-up examinations. In 17 patients, magnetic resonance images were obtained.

■ **RESULTS:** Total cyst resection was achieved in 16 procedures. In 1 patient, only plexus coagulation and widening of the ipsilateral foramen of Monro were performed. In 3 patients, small remnants of the cyst membrane were left behind. Conversion to microsurgery became necessary in 1 patient. Mild temporary complications occurred in 6 patients. Preoperative symptoms were completely relieved in 16 patients and improved in 2 patients. The average follow-up period was 188 months. In the patient with plexus coagulation, the cyst did not change. Recurrence occurred in 2 of 3 patients with cyst remnants. To date, no cyst remnant or recurrence has caused any symptoms or required surgical treatment.

■ **CONCLUSIONS:** Our results indicate that endoscopic treatment of colloid cysts is a safe and effective treatment option that provides excellent long-term results. However, we determined that a significant risk for recurrence exists when even small parts of the cyst capsule were left behind.

Therefore, we advocate an attempt at total endoscopic cyst resection.

INTRODUCTION

There has been a debate over decades as to which surgical technique is the best and most effective for colloid cysts of the third ventricle. Microsurgery and endoscopy are mostly proposed as a safe and effective treatment option. Although endoscopy offers a minimally invasive approach via a simple burr hole, the total resection rate in most studies is less than in the microsurgical series, resulting in an increased risk for recurrence.¹⁻¹⁵ The long-term recurrence rate has only rarely been investigated.¹⁶ Therefore, we reviewed our early 20 patients who underwent endoscopic colloid cysts resection. The aim of this study is to evaluate long-term results after endoscopic colloid cyst resection regarding the rate of total resection, cyst recurrence, and patient outcome. Furthermore, we intend to show that endoscopy achieves favorable results compared with microsurgical procedures. The initial results for the first 12 patients were reported previously.¹⁷

METHODS

We performed a retrospective study of data that were collected in our prospectively maintained endoscopy database. From September 2009 until November 2011, follow-up investigations were performed. Local ethics committee approval was obtained. All patients signed informed consent for study participation. Seventeen patients agreed to follow-up examinations and were invited to our outpatient center. One patient was interviewed by telephone and refused magnetic resonance imaging (MRI). In

Key words

- Colloid cyst
- Endoscopic resection
- Long-term result
- Neuroendoscopy
- Neuronavigation

Abbreviations and Acronyms

- CSF:** Cerebrospinal fluid
- MRI:** Magnetic resonance imaging
- PR:** Percentile rank

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2017, follow-up was updated by telephone interview with all patients, and patients with a follow-up period <10 years underwent MRI again. Neuropsychological testing was accomplished with NeuroCog FX 2.0 (by C. Hoppe, K. Fließbach, C. Helmstaedter, University Hospital Bonn, Bonn, Germany), a computed assessment battery, in which 8 subtests investigate short-term and working memory, psychomotor speed, selective attention, verbal and figural memory, and verbal fluency.¹⁸ The test results are expressed as percentile rank (PR). A PR >84 was stated as above average, 16–84 as average, <16 as borderline, <3 as abnormal, and 0 as very abnormal. Instructions and testing were carried out by the same investigator throughout (C.V.).

Clinical outcome was evaluated by self-assessment of patients comparing preoperative and postoperative symptom relief as well as neurologic examination and quality-of-life questionnaire (Short-Form 36). Outcome was described as symptoms completely relieved, symptoms improved, symptoms unchanged, and symptoms worsened. Descriptive statistical methods were used to analyze data.

Radiologic Diagnosis

All patients were evaluated on the basis of preoperative, postoperative, and long-term follow-up computed tomography scans and/or MRI. Follow-up MRI included T1-weighted contrast-enhanced, T2-weighted, T2-weighted sagittal inversion recovery turbo spin echo, and constructive interference in steady state sequences for exact evaluation of cerebrospinal fluid (CSF) diversion and cyst recurrences.

Operative Technique

The surgical technique has been described previously.¹⁷ The optimal entry point was determined with the aid of neuronavigation. Usually, the approach was on the right side; in only 4 patients, the approach was left sided because of asymmetric ventricular dilatation (Table 1). The position of the burr hole was moved more anteriorly over the years. In the last surgeries, it was made approximately 5–6 cm in front of the coronal suture. In the first 16 procedures, the GAAB endoscope (Karl Storz SE & Co. KG, Tuttlingen, Germany), and in the last 4 procedures, the LOTTA ventriculoscope (Karl Storz SE & Co. KG) were used.¹⁹ At first, the choroid plexus and capsule vessels were coagulated. Then, the cyst capsule was incised and the cyst content was aspirated. After the cyst had been evacuated, the cyst membrane was grasped and carefully mobilized into the lateral ventricle. Care was taken when the contralateral choroid plexus was adherent to the cyst. The plexus was coagulated and cut before full translocation of the cyst. Via one side channel of the LOTTA ventriculoscope, a small grasping forceps was used to hold the cyst capsule up, allowing visualization of the cyst pedicle, fixing the cyst to the tela choroidea of the third ventricle. Then, the bipolar diathermy probe was introduced via the main working channel and the vessels within the pedicle were coagulated. Thereafter, the pedicle was cut with scissors and the cyst was removed.

At the end, the ventricles were inspected with 30° and 45° diagnostic scopes to confirm that there is no cyst remnant left behind and no aqueductal obstruction by solid cyst contents. The burr hole was packed with gelatin sponge and the galea was

sutured tightly. The skin was closed with a running atraumatic suture.

RESULTS

Between August 1993 and December 2008, 20 patients underwent endoscopic treatment of symptomatic third ventricle colloid cysts in our department (Table 1).

The average patient age was 39 years old (range, 14–61 years) at the time they underwent surgery. Gender distribution was 10 females and 10 males. The cysts were located within the anterior third ventricle, causing partial occlusion of the foramina of Monro and consecutive obstructive hydrocephalus in all patients but one. One patient harbored 2 colloid cysts, one within the third ventricle and one in the lateral ventricle adjacent to the right foramen of Monro.

Presenting symptoms included headache (70%); nausea, vomiting, and dizziness (30%); neuropsychological deficits (i.e., memory disturbance, symptomatic transitory psychotic syndrome, disturbance of concentration, and reduced mental load capacity) (30%); paresthesia (25%); hemiparesis (10%); loss of consciousness (5%); impaired vision, fatigue, and seizure (10%); and tremor, gait disturbance, and anxiety (5%) (Table 1). The duration of symptoms ranged from sudden onset to a couple of days to almost 8 years. In our series, 2 patients (Table 1, patients 1 and 11) required emergency treatment because of acute neurologic deterioration. After external ventricular drainage, these patients recovered immediately and underwent endoscopic resection after 2 and 3 days, respectively. Analyzing these 2 patients, both showed warning symptoms such as headache, dizziness, and fatigue for a few days and approximately 1 year respectively.

Endoscopic colloid cyst resection was performed in 19 patients. In a patient with a small cyst and absence of hydrocephalus, only endoscopic plexus coagulation and widening of the ipsilateral foramen of Monro were performed. Cyst evacuation was impossible because the cyst was completely covered by the fornices. However, a good communication between lateral and third ventricle could be obtained (Figure 1). In all other cases, the cysts were evacuated entirely. Total cyst resection was achieved in 16 cases. In 3 patients, small remnants of cyst capsule had to be left behind, because of strong adherence to the tela choroidea at the roof of the third ventricle (Figures 2–4). All remnants were cauterized thoroughly to devascularize the capsule. A bimanual technique was used for the final 4 patients of the series and since then for all our patients. One procedure had to be converted to open microsurgery. The cyst was large and cyst content aspiration was impossible. Because the piecemeal removal of the solid content was ineffective and prolonged operative time was expected, we switched to a microsurgical technique using the endoscope track as the surgical corridor.

Histologic examination was performed in all patients except one and colloid cyst was confirmed.

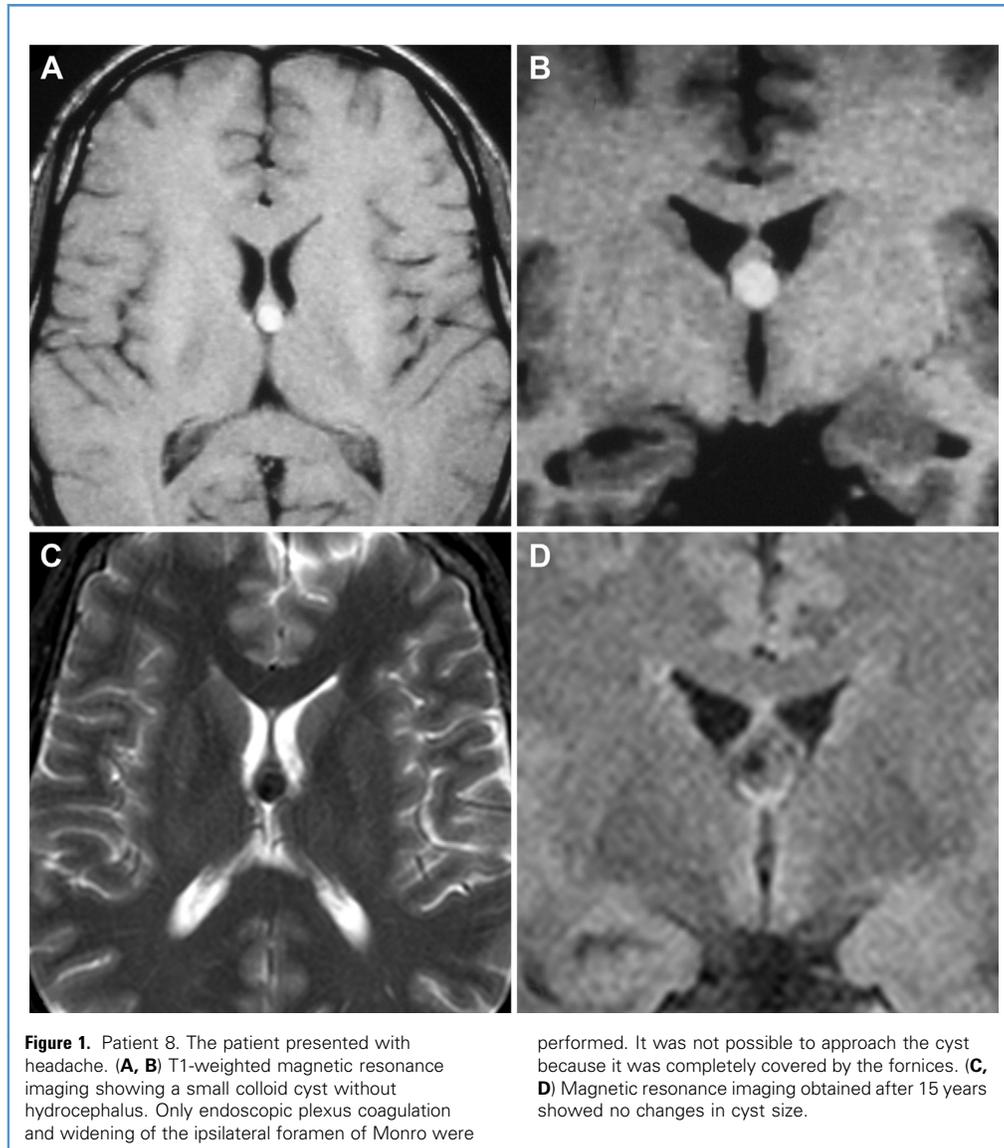
Two patients died during the follow-up period (8 and 21 years after the endoscopic procedure) because of problems not related to the cyst. One patient was lost to follow-up. The mean follow-up period was 188 months (16 years; range, 81–275 months).

Preoperative symptoms were completely relieved in 16 patients and improved in 2 patients. None of the patients had permanent

Table 1. Patient Demographics, Clinical Presentation, Cyst Size, Surgical Approach, Extent of Resection, Complications, Follow-Up Period, Recurrence, and Outcome

Patient Number	Age (years), Sex	Year of Surgery	Symptoms at Admission	Hydrocephalus	Cyst Size (mm)	Surgical Approach	Extent of Resection	Complications	Follow-Up (Months)	Recurrence	Outcome
1	31, F	2000	h/a, n/v, m	Biventricular	12 × 12 × 13	L	STR	DVT	198	Yes	Excellent
2	46, F	2008	sens	Biventricular	11 × 10 × 10	R	GTR	No	108	No	Good
3	37, M	2002	h/a, m, f, d	Biventricular	—	L	GTR	No	178	No	Excellent
4	59, F	1999	a, t, r, g	Biventricular	14 × 19	R	GTR	STPS	143	No	Excellent
5	49, F	2008	hemi, sens, STPS	Biventricular	20 × 17 × 17	R	GTR	No	Lost for follow-up	Lost for follow-up	—
6	41, M	2004	h/a, STPS	Biventricular	19 × 20 × 16	R	GTR	No	157	No	Good
7	45, M	2007	h/a, g	Biventricular	5 × 7 × 6	R	GTR	MLS	115	No	Excellent
8	22, M	1997	MLS	No	10 × 8	R	Plexus coagulation and widening of foramen of Monro	No	238	No	Excellent
9	41, F	1996	h/a, m, g, sens	Biventricular	15 × 18 × 19	R	GTR	No	247	No	Excellent
10	37, M	1997	h/a, n/v, f, d	Unilateral	15 × 17	R	GTR	Vertical gaze palsy, STPS	246	No	Excellent
11	61, F	1994	sz, loss of consciousness, d	Biventricular	10 × 8 × 10	R	GTR	STPS	81*	No	—
12	14, M	1997	h/a, n/v, neuropsychological deficits	Unilateral	10 × 12 × 14	L	GTR	No	244	No	Excellent
13	36, M	1995	h/a	Biventricular	9 × 12	R	GTR	No	264	No	Excellent
14	28, F	1994	h/a, n/v, vis	Biventricular	10 × 14	R	GTR	No	275	No	Excellent
15	59, M	1996	h/a, d, vis	Unilateral	12 × 14	R	GTR	No	163	No	Excellent
16	30, M	1993	sz, n/v, d	Biventricular	10 × 11 × 12	R	STR	No	244*	Yes	Excellent
17	32, M	2008	h/a, d	Unilateral	15 × 11 × 9	L	GTR	No	105	No	Excellent
18	24, F	2003	h/a, hemi, sens	Biventricular	11 × 12	R	STR	No	167	No	Excellent
19	49, F	2004	sens	Biventricular	12 × 12	R	GTR	No	155	No	Excellent
20	45, F	1997	h/a, n/v	Biventricular	11 × 12	R	GTR	No	244	No	Excellent

F, female; h/a, headache; n/v, nausea and vomiting; m, memory deficits; L, left; STR, subtotal resection; DVT, deep vein thrombosis; sens, sensory changes; R, right; GTR, gross total resection; M, male; f, fatigue; d, dizziness; a, anxiety; t, tremor; r, rigor; g, gait disorder; STPS, symptomatic transitory psychotic syndrome; hemi, hemiparesis; MLS, meningitislike symptoms; sz, seizure; vis, impaired vision.
*Patient died during follow up.



neurologic deficits. In 14 patients, MRI showed no cyst recurrence. In the patient with plexus coagulation, the cyst did not change (Figure 1C and D). In the patients with subtotal resection, cyst remnants were seen first on 3-month follow-up MRI (Figures 3C and D and 4C and D) and during later follow-up MRI (Figure 2). Cyst progression was seen in 2 patients (Figures 2E–H and 3E and F) after 8.8 and 7.8 years and stable cyst size in 1 patient (Figure 4E–H). No cyst remnant or recurrence caused any symptoms or required surgical treatment.

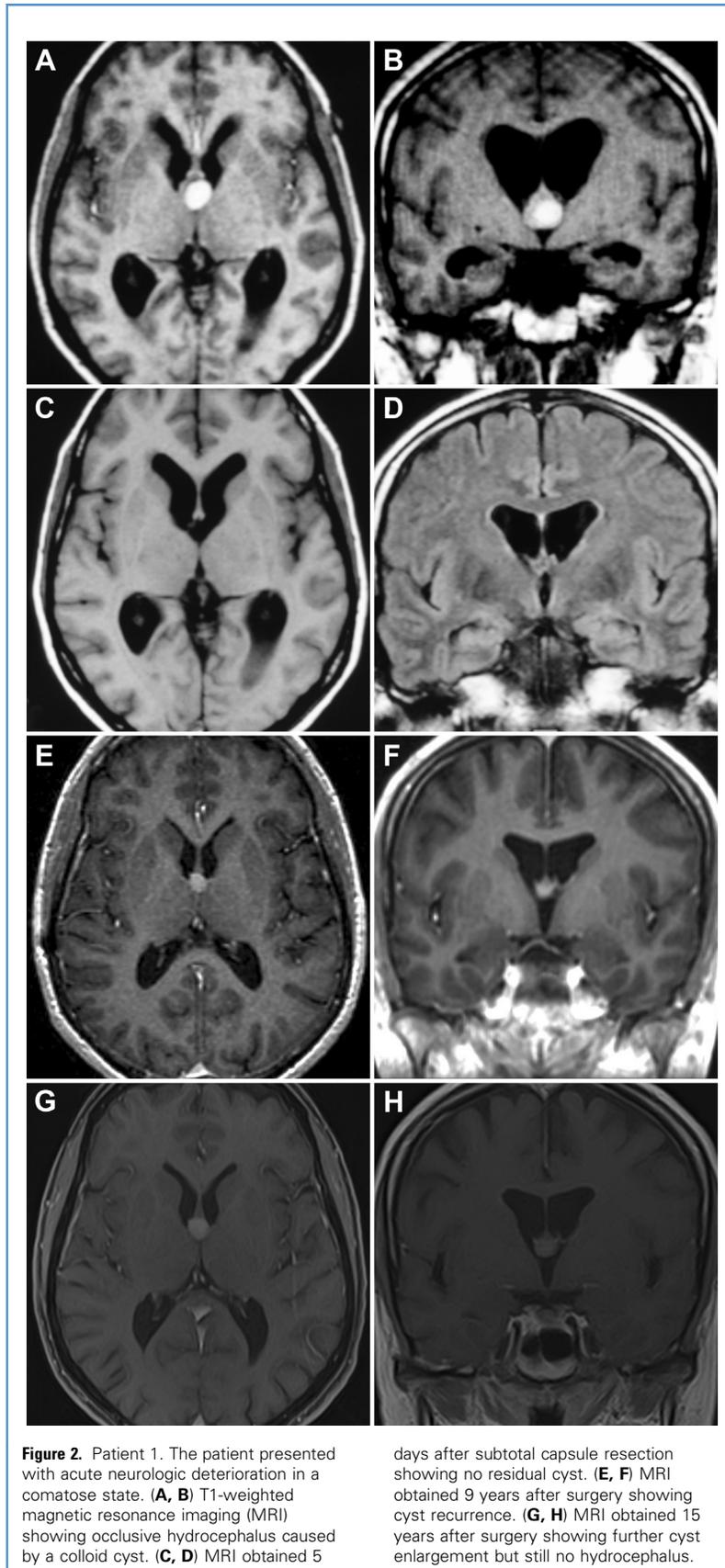
Intraoperative Asymptomatic Complications

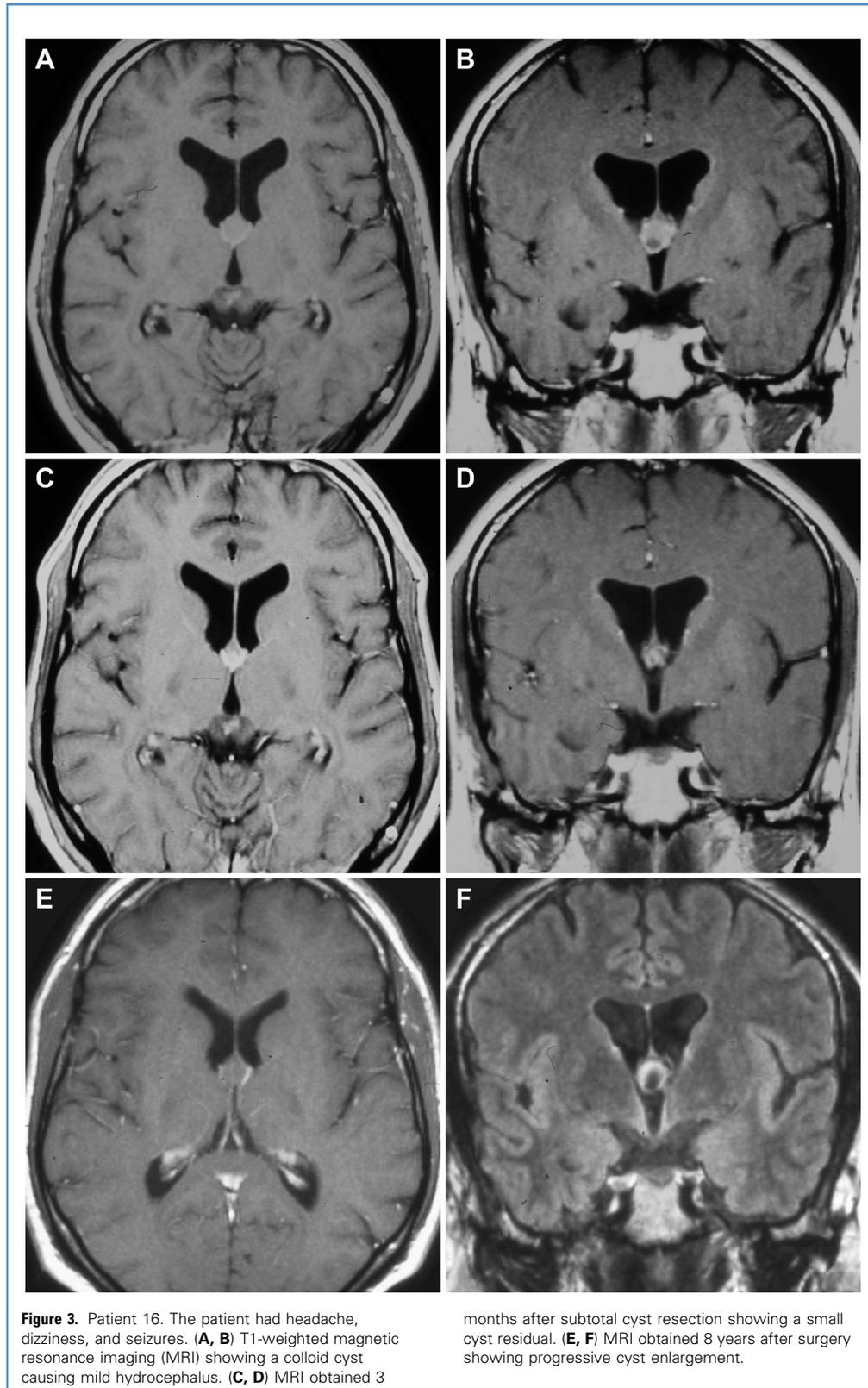
Two major and 5 minor venous hemorrhages occurred but were controlled endoscopically with the aid of continuous irrigation and bipolar coagulation. In the 2 major hemorrhages, the dry-field technique was applied, comprising aspiration of CSF from the

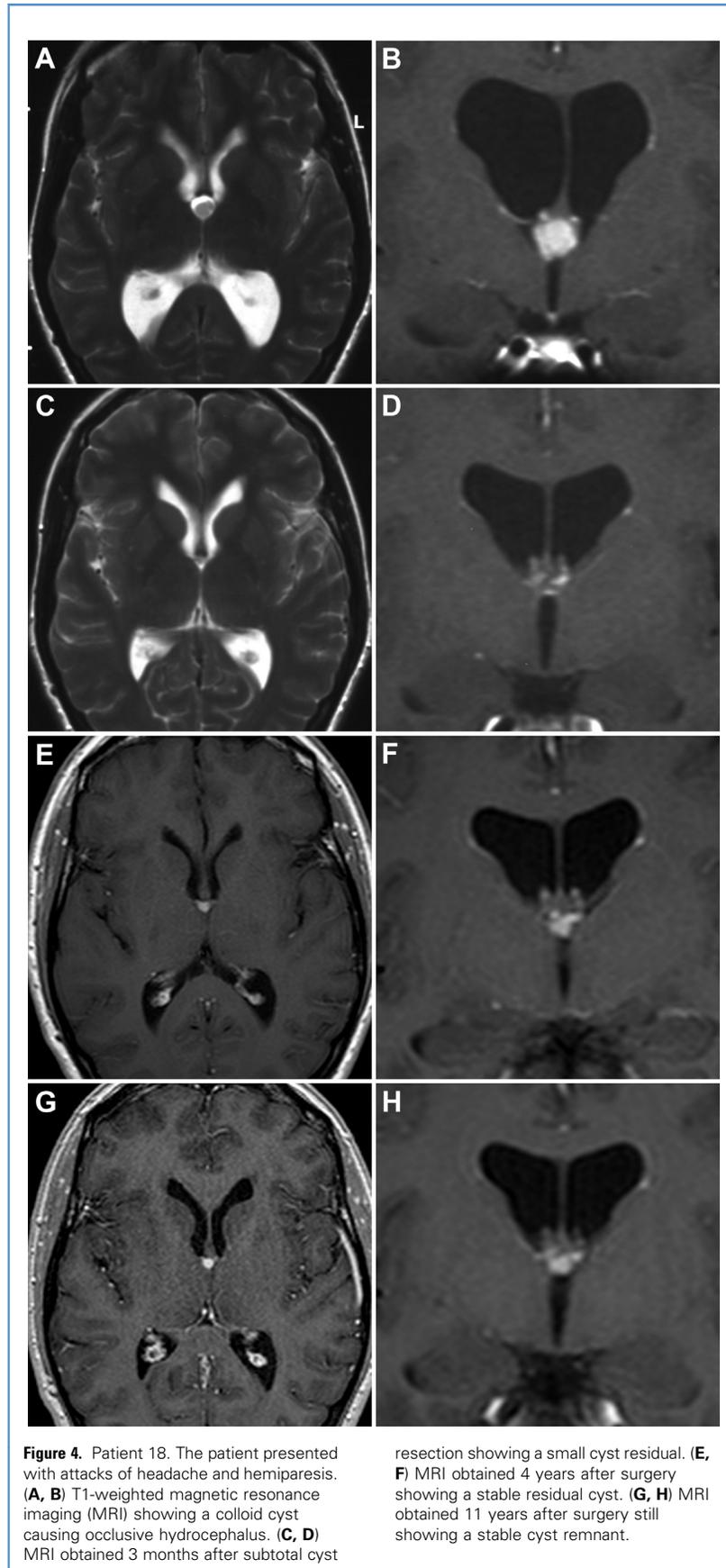
lateral ventricles to locate the source of bleeding. In both patients, the hemorrhage stopped spontaneously after CSF aspiration. During final endoscopic inspection after cyst resection, we observed superficial minor fornix contusion in 5 patients. In another patient, we found severe fornix atrophy caused by chronic hydrocephalus. In this patient, the right fornix had to be sacrificed to achieve total cyst resection. This patient presented with memory loss before surgery and memory did not deteriorate further after surgery.

Postoperative Transient Morbidity/Complications

There was no mortality and permanent morbidity. Mild temporary complications such as meningitislike symptoms and symptomatic transitory psychotic syndrome occurred in 1 and 3 patients, respectively. One patient sustained vertical gaze palsy. All







complications resolved before discharge. Another patient had postoperative deep vein thrombosis and required anticoagulation medication (Table 1).

Neuropsychological Testing/Results

Fourteen patients participated in neuropsychological testing. Ten patients achieved average test results (PR, >16). Four patients scored borderline and abnormal test results (PR, <16). The group with average test results achieved a mean PR of 37.2, and the group with abnormal results achieved a mean PR of 6.3. The worst test results were obtained in verbal memory (PR, 19.4) and the best test results in figural memory (PR, 35.9). Patients with abnormal testing failed in all subtests equally. Because of the small number of patients, there was no chance of significant statistical evaluation. Interpretation of the test failures is complicated. Two patients did not seem to be motivated. The third patient was of advanced age (72 years) and had problems handling the computer. The fourth patient showed test results that were at the border of being abnormal. He was referred to a neuropsychological specialist but did not show up for further investigation. Neuropsychological follow-up results showed that most of the patients did not have major deficits in cognitive performance.

DISCUSSION

Although endoscopic colloid cyst removal has been established increasingly in the last 2 decades, there is still a debate about the optimal treatment of colloid cysts. Although endoscopic cyst resection is associated with a low complication rate and provides excellent short-term outcome, the resection is frequently not radical.^{10,15,20-25} Therefore, a higher rate of cyst recurrence has to be expected.^{16,26} Although endoscopic short-term follow-up studies have shown that cyst remnants usually do not cause clinical problems requiring surgical action, there is little information about the long-term course of cyst remnants.^{13,14,25} For that reason, we performed our long-term follow-up study. It clearly showed that incompletely resected colloid cysts may recur, even when most parts of the cyst have been resected. Simple coagulation of the cyst remnant, which has been recommended, obviously does not provide a cure.¹⁶ Therefore, our aim in endoscopic colloid cyst surgery is total resection of the cyst membrane.

Although older microsurgical series have been reported with a higher complication rate,^{27,28} newer series have shown excellent results with a high total resection rate and few complications.² Therefore, the endoscopic technique has to compete with the favorable results of the microsurgical series. Total cyst removal was achieved in most instances (mostly 100%).^{2,3,22,23,29} Therefore, we do not hesitate to convert to a microsurgical procedure if the endoscopic attempt of total cyst resection fails or the anatomic situation is unfavorable for endoscopic cyst removal.

Studies comparing microsurgical and endoscopic cyst removal have been reported.^{23,30} In the endoscopic group, significant reduction of operating time and postoperative stay were achieved. Kehler et al.²¹ presented a series of 20 patients. In the endoscopic group, fewer complications occurred and they were less severe. In the microsurgical group, total cyst removal was achieved in 80% of the patients, but in the endoscopic group, in only 30%. Cyst recurrence was observed only in the endoscopic group after 21

months. Outcome was better after endoscopy. Horn et al.²² presented the largest comparison showing similar results to the former investigators. Kehler et al. and Horn et al. all showed that after open surgery ventriculoperitoneal shunting was required more often (10% vs. 0%). Ventriculoperitoneal shunting bears additional morbidity predisposing for shunt malfunction and the risk of infection. All investigators who compared both techniques favored neuroendoscopic removal for colloid cysts.

In the last 10 years, several investigators have reported results after endoscopic treatment of colloid cysts. In most series, only evacuation of the cyst content and partial resection of the wall with subsequent coagulation of the remnant were performed. Long-term results have only rarely been reported. Therefore, it is still unknown how high the recurrence rate of incompletely resected colloid cysts is. An Italian cooperative study with 61 patients, treated mostly with cyst content aspiration combined with capsule coagulation,²⁶ reported a total cyst resection rate of only 10%. Therefore, the recurrence rate added up to 11.4%. Even although recurrence was asymptomatic, the mean follow-up period was only 32 months. Levine et al.¹³ reported a long-term follow-up study of a 13-year period including 35 patients. When possible, entire cyst resection was performed and minimal cyst wall remnants were cauterized. Late cyst recurrence occurred in 2 patients after 4 and 6 years. Follow-up outcome was excellent in >90%, and only 3 patients noted minimal short-term memory loss without daily interference. Greenlee et al.¹⁴ reported similar results in their study. In 6 surgeries, conversion to microsurgery was necessary mostly because of strong forniceal adhesion. After a mean follow-up period of 7.3 years, only 1 recurrence occurred. Boogaarts et al.²⁵ presented a series of 90 patients with colloid cysts treated endoscopically. Total cyst removal was possible in 57.5%. Residual cyst was present in 34 patients, 6 of whom required repeated endoscopic surgery for symptomatic regrowth. Recurrent cysts were mainly seen within the first 2 years after surgery. Hoffman et al.¹⁶ compared the recurrence in patients with total endoscopic cyst resection versus those with coagulated cyst remnants. The recurrence rate was significantly higher in the group with cysts remnants.

In our series, total cyst resection was achieved in 80%. In 3 patients, only subtotal resection was accomplished because of firm adherence to the tela choroidea close to the internal cerebral veins. In these 3 patients, residual cyst remnants were seen on follow-up MRI. After 8.8 years, one of these patients experienced a late asymptomatic recurrence (Figure 2E–H), one remained stable in size (Figure 4E–H), and one showed slight increase of the residual after 7.8 years (Figure 3E and F). The third patient declined follow-up imaging, so cyst development remains open. Compared with other series, we saw very late recurrence of cyst remnants, but none of these patients has required repeated surgery.

Because cyst remnants, even after coagulation, can cause late cyst recurrence, we agree with Levine et al.¹³ and Teo⁷ that gross total resection should be the goal of endoscopic surgery in accordance with microsurgery. Although our cyst recurrence has remained asymptomatic, there is a significant risk of causing problems in the future. For this reason, we believe that total cyst resection should be the primary goal of treatment, but not

at the expense of neurologic deficits caused by neurovascular injuries such as fornix damage. We believe that with sophisticated endoscopic equipment and sharp dissection technique, gross total resection can be achieved safely.

In our series, 6 patients had neuropsychological disorders such as memory disturbance, impairment of concentration, limited mental load capacity, or symptomatic transitory psychotic syndrome before surgery (Table 1). One patient reported anxiety. Colloid cysts can cause these symptoms even although hydrocephalus is absent.^{1,31-34} It is supposed that the cyst itself applies pressure on adjacent ventricular structures that include memory functioning.³⁵ Lobosky et al.³⁵ reported 3 patients with disturbance in memory, emotion, and personality. Lajara-Nanson³⁶ and Upadhyaya and Sud³⁷ presented similar cases. Also, surgical treatment can contribute or even provoke postoperative amnesic syndrome and cognitive impairment. Anterograde and retrograde amnesia after fornix damage after colloid cyst removal has been reported in the literature several times.³⁸⁻⁴¹ Hodge and Carpenter⁴² stated that “bilateral fornix damage produces amnesia, and unilateral fornix damage produces selective impairment according to the side of the damage.”

In our neuropsychological study, 10 of 14 patients achieved average test results. Four patients scored borderline to abnormal test results. Five of the 6 patients who had neuropsychological disorders before surgery performed neuropsychological testing; 4 scored average results and 1 abnormal results. Our neuropsychological follow-up results showed that most of the patient did not

have major deficits in cognitive performance. However, because we have no preoperative neuropsychological data for comparison and patient numbers are small, we cannot evaluate whether the deficits were caused by the colloid cyst or the surgical procedure. A standardized psychometric assessment should be performed before surgery to assess the impact of the surgery.

CONCLUSIONS

Although short-term studies show excellent results after endoscopic colloid cyst removal, a significant cyst recurrence rate has to be expected when only partial resection of the cyst membrane is performed. Therefore, we advocate total endoscopic cyst resection as the first-line treatment. If this goal cannot be achieved and a significant remnant of cyst capsule would remain, we switch to endoscope-assisted microsurgery to provide total cyst removal and a cure for the patient. However, if there is a significant risk of causing permanent neurologic deficits as a result of an aggressive endoscopic or microscopic resection, the surgery should be terminated and a subtotal or near-total resection should be accepted. Even to date, there is no scientific evidence as to which treatment option is best.

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