

Endoscopic Versus Microsurgical Resection of Third Ventricle Colloid Cysts

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ABSTRACT: Objective: Endoscopic resection of colloid cysts has been performed as an alternative to microsurgical resection and stereotactic aspiration since 1982. To date, there are limited published studies comparing these procedures. In this study, we present the largest series of endoscopic resections published to date and compare outcomes to a cohort of microsurgical resections performed at the same institution. **Methods:** A retrospective chart review was conducted for all patients in the Calgary Health Region undergoing resection of a colloid cyst between 1991 and 2004. Comparison was made between patients treated with endoscopic resection versus microsurgical resection. **Results:** Twenty-five endoscopic and nine microsurgical procedures were performed. Complete resection was achieved in 24 of 25 procedures in the Endoscopic group, compared with all 9 procedures in the Microsurgical group. Patients in the Endoscopic group had a reduced operative time (mean 104 minutes versus 217 minutes) and reduced length of stay (3.8 days versus 8.4 days) compared to the Microsurgical group. One patient in the Endoscopic group had a complication (hemiparesis/pulmonary embolus). By contrast, 3 patients in the Microsurgical group had complications (seizure, ventriculitis/bone flap infection, and transient memory deficit). There was one recurrence in each group which both occurred at 5 years follow-up. The mean length of follow-up is 38 months in the Endoscopic group and 33 months in the Microsurgical group. **Conclusion:** Endoscopic resection of colloid cysts can be performed with significantly lower risk of complication than microsurgical resection and with equivalent surgical success. Operative time and length of hospital stay are both significantly reduced with endoscopic resection.

RÉSUMÉ: Résection endoscopique versus microchirurgicale des kystes colloïdes du troisième ventricule. Objectif : La résection endoscopique des kystes colloïdes comme alternative à la résection microchirurgicale et à l'aspiration stéréotaxique est réalisée depuis 1982. À ce jour, peu d'études comparant ces interventions ont été publiées. Dans cette étude, nous présentons la plus grande série de résections endoscopiques publiée à ce jour et nous comparons les résultats à ceux d'une cohorte de patients ayant subi une résection microchirurgicale dans la même institution. **Méthodes :** Nous avons procédé à une révision des dossiers de tous les patients qui ont subi une résection d'un kyste colloïde entre 1991 et 2004 dans la région sanitaire de Calgary. Nous avons comparé les patients traités par résection endoscopique à ceux traités par résection microchirurgicale. **Résultats :** Vingt-cinq interventions endoscopiques et neuf interventions microchirurgicales ont été pratiquées. La résection a été complète dans 24 des 25 interventions du groupe traité par endoscopie et dans les 9 interventions pratiquées par microchirurgie. Le temps opératoire était plus court chez les patients traités par endoscopie, soit une durée moyenne de 104 minutes versus 217 minutes pour le groupe traité par microchirurgie, et le séjour hospitalier était plus court, soit 3,8 jours par rapport à 8,4 jours, pour le groupe traité par microchirurgie. Un patient du groupe traité par endoscopie a subi une complication (hémiparésie/embolie pulmonaire). Trois patients du groupe traité par microchirurgie ont subi des complications (crise convulsive, ventriculite/infection du volet osseux et perte de mémoire transitoire). Il y a eu une récurrence dans chaque groupe, toutes deux découvertes au cours du suivi, 5 ans après la chirurgie. La durée moyenne du suivi était de 38 mois pour le groupe traité par endoscopie et de 33 mois pour le groupe traité par microchirurgie. **Conclusion :** La résection endoscopique de kystes colloïdes comporte significativement moins de risques de complications que la résection microchirurgicale et donne des résultats équivalents. Le temps opératoire et la durée d'hospitalisation sont significativement plus courts pour la résection endoscopique.

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Colloid cysts of the third ventricle represent about 0.5-2 percent of intracranial tumors.^{1,2} Although uncommon, they are an important clinical entity because of their ability to cause cerebrospinal fluid (CSF) obstruction and sudden death.³⁻¹⁹ In one population-based study, one third of patients with symptomatic colloid cysts presented with acute neurological deterioration, underscoring the need for their treatment.⁹

There has been some debate over the optimal management of colloid cysts over the past few decades. Management options include CSF diversion procedures (e.g. ventriculo-peritoneal

shunt), stereotactic aspiration, microsurgical resection, and endoscopic resection. Microsurgical resection has been deemed

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the gold standard for many years because of its success at accomplishing a complete resection. However, microsurgical resection is associated with significant morbidity and prolonged post-operative hospital stays.^{2,20-28} More recently, some authors have reported less invasive microsurgical techniques with endoscopic assistance,²² neuronavigation²⁹ and approaches through cylindrical retractors using stereotactic frames.^{30,31}

Although potentially less invasive, stereotactic aspiration is associated with recurrence rates of 30-80%³²⁻³⁴ with recurrences occurring as early as two months in half of these.³³

Endoscopic resection of third ventricle colloid cysts was first described in 1982.³⁵ Since that time, there have been several small case series reporting successful endoscopic resections of colloid cysts.³⁶⁻⁴⁹ To date, there have been two reports comparing endoscopic to microsurgical resection.^{24,28} These studies demonstrated shorter operative times and length of hospitalization in the endoscopic groups. These reports also showed a trend toward reduced morbidity and reduced risk of treatment complications for patients treated with an endoscopic approach. However, these were relatively small series and long-term follow-up is ongoing. To effectively evaluate the efficacy of new surgical treatment techniques for patients with colloid cysts, larger series of endoscopically treated patients are needed for comparison to the conventional standard of microsurgical resection.

In this manuscript, we report the largest published experience to date of patients who underwent endoscopic removal of their colloid cysts. An additional goal of this review is to present this large patient experience in the context of a non-randomized cohort of patients treated by microsurgical resection during the same time period, at the same institution.

CLINICAL MATERIALS AND METHODS

Patient Population

A retrospective chart review was done for all patients admitted to the Foothills Medical Centre and the Alberta Children's Hospital (Calgary, Alberta) for resection of a colloid cyst between 1991 and 2004. These two hospitals are tertiary care centres providing care to patients in Southern Alberta and parts of South-Eastern British Columbia (population approximately 1.5 million at the time of this report), and are the only Neurosurgical centres for this region. Patients who presented for Neurosurgical consultations were treated either by microsurgical resection by the admitting surgeon or referred for endoscopic resection by one of two surgeons that perform neuroendoscopy on a regular basis. The choice of treatment was based on preferences of both the admitting surgeon and the patient, and therefore was not randomized.

Data was retrospectively collected from surgeon's operative reports, operating room datasheets, progress notes, discharge summaries, imaging reports (and diagnostic imaging studies when available), pathology reports, and follow-up clinic notes for all patients. Patient demographic data, symptoms on presentation, and radiographic studies were reviewed.

Technique of Endoscopic Resection

Endoscopic removal of all colloid cysts was accomplished utilizing a single burr hole and predominately with a flexible endoscope (Codman® Model #83-1340).

The ventricle was entered on the side determined to have a combination of the best trajectory and which Foramen of Munro has the largest amount of exposed colloid cyst as visualized by coronal MRI images (Figure 1). A standard pre-coronal site was selected for the skin incision with the burr hole centered 3.5-4.5 cm from the midline. Image-guidance is a useful adjunct to surgical planning. However, in this series, it was not routinely utilized because of the versatility for movement provided by the flexible endoscope within the enlarged ventricle. A 12.5 or 14.0 French introducer with peel-away sheath was used for ventricular access. The sheath was marked on the outside to identify the 5 cm distance as a reference point, and was not fixed in place. The capsule was opened with endoscopic monopolar cautery (Codman® ME-2) at low coagulation power settings. The contents were removed predominately in a piecemeal fashion using the endoscope tip as a suction port. This involved directing the tip of the endoscope through the hole in the capsule and performing short, controlled periods of aspiration by the surgical assistant with a syringe attached to the endoscope irrigation port by a short length (30 to 50 cm) of extension tubing. Contents appeared in the syringe, or were adherent to the end of the endoscope which was removed by sliding the

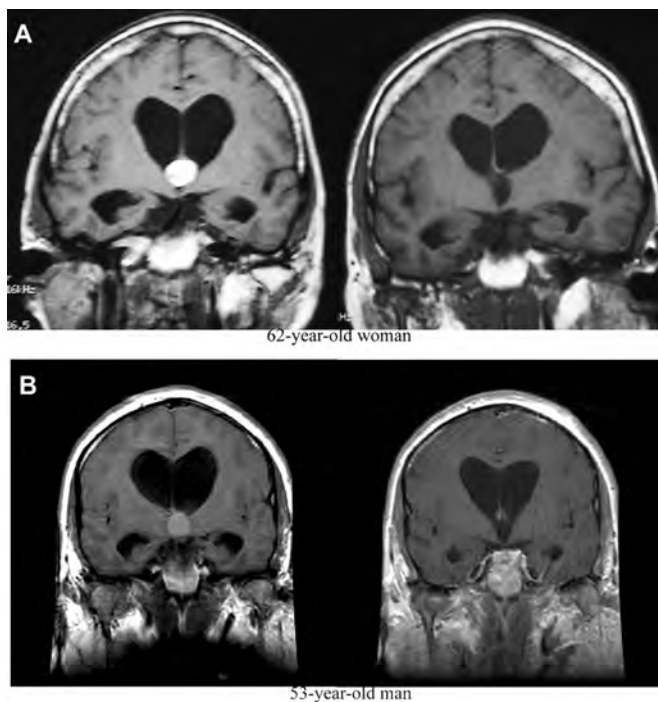


Figure 1: Pre-operative (left) and post-operative (right) coronal T1 weighted MR images of endoscopic resection of colloid cysts. The coronal images are used for pre-operative assessment of trajectory through Foramen of Munro to colloid cyst. When either a left or right trajectory provides adequate exposure to the cyst as in the case of this 62-year-old woman (A), then a right sided trajectory is chosen. The image on the right demonstrates a complete resection of the colloid cyst. In this case of a 53-year-old man (B), a left sided approach provided a better trajectory through an already enlarged Foramen of Munro.

endoscope out through the ventricular access sheath. The monopolar coagulator could also be utilized to help in removal of some of firmer cyst contents. The tip of the ME-2 was placed into the firmer cyst material followed by a short burst of coagulation; the cyst contents would stick to the tip and could be removed by sliding the endoscope out through the ventricular access sheath. Endoscopic grasping forceps were utilized less frequently, but could be of assistance with some types of cyst contents and with manipulation of the cyst capsule.

Total removal of the capsule was not performed in the majority of cases. However, residual capsule may contribute to cyst recurrence, therefore residual capsule was always extensively cauterized with the ME-2 prior to completion. The flexible scope greatly facilitated coagulation by allowing steering of the ME-2 tip to desired areas of the capsule.

With completion of the endoscopic part of the procedure, the scope and sheath were removed. A ventricular drain was not routinely utilized, unless the patient had one preoperatively. A small piece of Gelfoam® was placed into the small dural defect and was held in place with a small amount of Tisseel®. Standard wound closure was utilized.

Systematic Literature Review

We performed a systematic review according to published guidelines for meta-analysis of observational studies in epidemiology.⁵⁰ Full MEDLINE and PUBMED searches were performed. The terms "colloid cyst" and "colloid cysts" were used as text words. Limits were placed on language and year of publication. We selected abstracts that were published in either English or French from 1980 to the present, describing case series of treatment for colloid cysts. When authors reported overlapping patient populations, only the more recent study was used. Studies were included if they described a case series for patients undergoing either stereotactic aspiration or microsurgical or endoscopic resection of colloid cysts. We did not contact the authors of the studies.

For all eligible publications, we tabulated the data found in Tables 4-6. Patient outcome was graded according to the scale by Nitta and Symon.⁵¹ In some studies, patient outcome data was not reported or could not be inferred from the available data. In these situations, statistical calculations were made solely from the case series in which the data was complete. Sensitivity analysis was performed for the extremes of possibilities from the given data when performing statistical analysis.

Statistical Analysis

Comparison of patient demographics, clinical data, and results for both treatment groups was performed using Fisher's exact test, Chi-squared test and two-tailed Student's t-test assuming unequal variances.

RESULTS

Patient Presentation

Thirty-two patients were identified. Twenty-five endoscopic resections were performed on 24 patients by two neurosurgeons. The senior author (MGH) performed the majority of these procedures and assisted in the remaining cases. Patient E1 had a second endoscopic resection for a recurrence five years after his first procedure (Table 1). Both procedures are presented.

Nine patients were treated by microsurgical resection by four neurosurgeons. All four neurosurgeons had several years experience with complex microsurgical technique. There was one recurrence in this group that was treated by endoscopic resection (patient M2/E11), five years after the first procedure.

The patients' demographic information and their symptoms at presentation are shown in Table 1. Comparison of presenting signs and symptoms, age, gender and cyst diameter between the endoscopic and microsurgical groups is shown in Table 2. Statistical analysis did not demonstrate any significant differences between the presenting characteristics of patients in the two groups.

Outcomes

Outcomes for patients in the two treatment groups are listed in Table 1. Completeness of resection is reported with respect to both cyst contents as well as treatment of the cyst capsule. The cyst capsule was completely removed in three cases, and partly removed in all other cases. In all but one case, the cyst capsule was coagulated as previously described. Complete removal of cyst contents was achieved in all nine procedures in the microsurgical group and in 24 of 25 procedures in the endoscopic group. The one patient with an incomplete endoscopic resection (E3) had predominately calcified cyst contents. The Foramen of Munro was effectively decompressed at surgery and her hydrocephalus relieved. Surprisingly, follow up MRI demonstrated significant shrinkage of the residual cyst contents nine months post-operatively (Figure 2).

Comparison of outcomes between the two groups is shown in Table 3. The average length of operative time was 104 minutes in the endoscopic group and 217 minutes in the microsurgical group ($p < 0.001$). Length of hospital stay was 3.8 days in the endoscopic group and 8.4 days in the microsurgical group ($p = 0.002$). There was one complication out of 25 procedures in the endoscopic group and three complications out of nine procedures in the microsurgical group ($p = 0.045$). Complications were classified as either minor or major, according to the criteria listed below Tables 4-6.

One patient in the endoscopic group had a major complication (patient E15). He suffered an injury to the internal capsule with subsequent hemiparesis and a pulmonary embolus which required three months of anticoagulant therapy. He was transferred to a rehabilitation unit on post-operative day (POD) 6 and was independent with a good recovery at three months follow-up.

In the microsurgical group, two patients had minor complications and one patient had a major complication. Patient M8 had a seizure on POD 5. She had a pre-existing seizure disorder, however had been seizure-free for several months prior to her procedure. She was discharged on POD 10, and was not seen in follow-up. Another patient (patient M3) had a transient memory deficit which resolved over several days. Patient M4 in the microsurgical group had a major complication. She had a CSF leak causing ventriculitis which was treated with intravenous antibiotics. This patient returned several months later with a bone flap infection which required removal of the infected bone flap and cranioplasty to repair the skull defect.

Patient outcome was graded according to the grading system introduced by Nitta and Symon.⁵¹ Outcomes were good (III) or

Table 1: Summary of patient demographics, clinical presentation, interventions, and outcome

Pt. no.	Year of surgery	Gender	Symptoms at admission	Hydro	Cyst diameter (mm)	Age (yrs)	Procedure	Cyst Contents	Removal of Capsule	Length of OR (h:mm)	Length of stay (days)	Complications	Outcome	LFU (mo)	MRI FU (mo)	Residual capsule (MRI)	Tumor recurrence
E1	1995	male	h/a, v, vis	biventricular	n/r	28	Endoscopic	gross-total	coagulated	2:31	2	none	Excellent (IV)	60.3	60.3	no	yes
E2	1995	female	g, m, inc, cog	biventricular	22	63	Endoscopic	gross-total	coagulated	3:27	4	none	Excellent (IV)	102.1	92.7	no	no
E3	1996	female	h/a, v, c	biventricular	15	63	Endoscopic	incomplete	partly removed	3:05	18	none	Poor (II)	99.6	8.6	yes	no
E4	1997	female	h/a, m, vis	unilateral	15	36	Endoscopic	gross-total	coagulated	1:06	2	none	Excellent (IV)	99.5	64.5	yes*	no
E5	1998	male	m, sz, loc	mild	15	63	Endoscopic	gross-total	removed	3:20	3	none	Excellent (IV)	68.5	63.7	no	no
E6	1998	male	h/a, v, sz, c	unilateral	15	35	Endoscopic	gross-total	coagulated	2:02	3	none	Good (III)	65.7	0.1	no	no
E7	1999	male	h/a, v, vis	biventricular	n/r	40	Endoscopic	gross-total	coagulated	2:03	2	none	Excellent (IV)	62.5	62.5	no	no
E8	1999	male	h/a, g, m, cog	biventricular	20	74	Endoscopic	gross-total	coagulated	1:42	4	none	Good (II)	37.9	36.4	no	no
E9	1999	female	h/a, d, g, m, p	biventricular	15	63	Endoscopic	gross-total	coagulated	1:15	3	none	Excellent (IV)	56.8	56.8	no	no
E10	1999	male	g, m, inc, cog, p	biventricular	10	49	Endoscopic	gross-total	coagulated	1:14	2	none	Good (III)	56.4	56.4	no	no
E11	2000	male	m, r	biventricular	10	27	Endoscopic	gross-total	coagulated	1:00	1	none	Excellent (IV)	52.2	50.2	yes*	no
E12	2001	male	r	no	15	33	Endoscopic	gross-total	coagulated	1:08	3	none	Excellent (IV)	48.3	47.3	no	no
E13	2001	male	h/a, sens	biventricular	17	62	Endoscopic	gross-total	coagulated	2:25	3	none	Good (III)	33.3	33.3	no	no
E14	2002	male	h/a, d	biventricular	5	29	Endoscopic	gross-total	removed	1:19	1	none	Excellent (IV)	30.3	12.5	no	no
E14	2002	male	h/a	biventricular	10	19	Endoscopic	gross-total	coagulated	1:34	3	Transient hemiparesis, pulmonary embolus	Excellent (IV)	19.5	17.5	no	no
E15	2003	male	h/a, c	biventricular	16	38	Endoscopic	gross-total	coagulated	1:44	6	Transient hemiparesis, pulmonary embolus	Good (III)			no	no
E16	2003	male	h/a, v	biventricular	11	28	Endoscopic	gross-total	coagulated	0:53	3	none	Excellent (IV)	15.1	10.8	no	no
E17	2003	male	h/a, vis, sens	mild	8	43	Endoscopic	gross-total	coagulated	0:58	1	none	Excellent (IV)	0.0	0.0	no	no
E18	2003	female	h/a, m, r	no	16	36	Endoscopic	gross-total	coagulated	1:15	1	none	Excellent (IV)	12.7	12.7	no	no
E19	2003	male	h/a, v, vis	no	6	15	Endoscopic	gross-total	removed	1:25	2	none	Excellent (IV)	15.4	15.4	no	no
E20	2003	male	m, loc, cog, p	mild	15	72	Endoscopic	gross-total	coagulated	2:33	15	none	Good (III)	14.9	14.9	no	no
E21	2003	female	sz, c, cog	unilateral	12	62	Endoscopic	gross-total	coagulated	0:59	5	none	Excellent (IV)	10.8	10.8	no	no
E22	2004	female	h/a, v, m, vis, sz, loc	biventricular	23	38	Endoscopic	gross-total	coagulated	1:39	3	none	Excellent (IV)	4.1	4.1	no	no
E23	2004	male	h/a	mild	8	58	Endoscopic	gross-total	coagulated	1:51	2	none	Excellent (IV)	0.6	0.1	no	no
E24	2004	male	h/a, g, m	biventricular	16	53	Endoscopic	gross-total	coagulated	0:46	3	seizure	Excellent (IV)	0.1	0.1	no	no
M1	1991	male	h/a, v, c	biventricular	11	26	Transcallosal	gross-total	removed	2:57	9	none	Excellent (IV)	148.4	148.4	no	no
M2	1994	male	h/a, vis, sens	biventricular	12	22	Transcallosal	gross-total	removed	4:37	8	none	Excellent (IV)	102.9	102.9	no	yes
M3	1998	male	h/a, v, m	biventricular	n/r	47	Transcallosal	gross-total	removed	4:10	8	Transient memory deficit	Good (III)	21.5	21.5	no	no
M4	1998	female	loc	biventricular	15	50	Transcallosal	gross-total	removed	3:46	13	Ventriculitis, CSF leak, bone flap infection	Excellent (IV)	10.3	5.6	no	no
M5	1999	female	none	unilateral	9	35	Transcallosal	gross-total	removed	3:48	3	None	Good (III)	0.1	0.0	no	no
M6	2000	male	h/a, v, g, sync	biventricular	20	40	Transcallosal	gross-total	removed	2:55	5	None	Excellent (IV)	4.2	0.1	yes*	no
M7	2002	male	h/a, c	biventricular	25	36	Transcallosal	gross-total	removed	3:58	10	None	Poor (II)	11.9	11.9	no	no
M8	2002	female	none	no	10	32	Transcallosal	gross-total	removed	3:35	10	seizure	Good (III)	0.3	0.1	no	no
M9	2003	male	h/a, v, m, sync	biventricular	9	46	Transcallosal	gross-total	removed	2:48	10	none	Excellent (IV)	0.5	0.5	no	no

Abbreviations: h/a=headache; v=vomiting; d=dizziness; g=gait disturbance; m=memory deficit; inc=incontinence; vis=visual symptoms; sync=syncope; sz=seizure; c=coma; loc=decreased level of consciousness; cog=cognitive deficits; p=personality changes; sens=sensory changes; r=recurrence; n/r=not recorded * indicates likely residual coagulated capsule with gross-total resection of cyst contents

Table 2: Comparison of demographic data and clinical presentation of Endoscopic and Microsurgical groups

	Endoscopic group (n=25)	Microsurgical group (n=9)	p-value
<i>Characteristic</i>			
Age at surgery (years)	45.1 +/- 17.0	37.1 +/- 9.6	0.100
range	15-74	22-50	
Male:Female	18.7	6:3	0.308
<i>Presentation</i>			
Headache (n)	18	6	0.308
Vomiting (n)	5	4	0.128
Seizure/Syncope (n)	4	2	0.339
Coma (n)	4	2	0.339
Asymptomatic (n)	1	2	0.150
Hydrocephalus (n)	22	8	0.446
Cyst diameter (mm)	13.5 +/- 4.7	13.9 +/- 5.8	0.939
range	5-23	9-25	

excellent (IV) in all but one patient from each group. Patient E3 in the endoscopic group presented in a moribund state with massive hydrocephalus, having been in coma for several hours prior to reaching the Neurosurgical Centre. She improved only marginally after insertion of ventricular drains, and had a very slow convalescence after resection. She remains severely disabled with loss of most of her short-term memory capacity, all felt to be due to the prolonged pre-operative elevation in her intracranial pressure. Patient M7 in the microsurgical group had increased intracranial pressure and early transtentorial

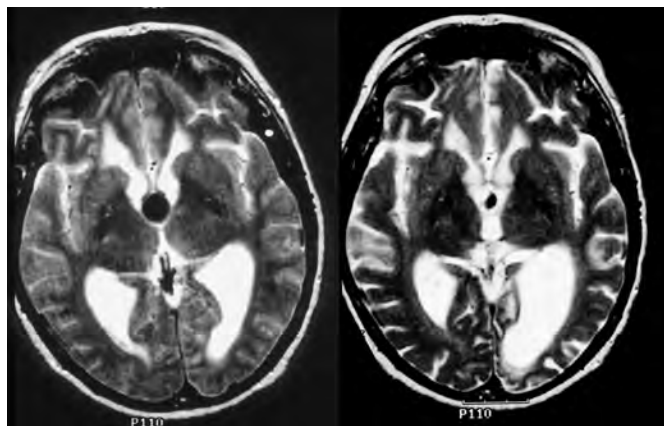


Figure 2: Post-operative (left) and 9 month follow-up (right) axial T2 weighted MR images of patient E3. Predominantly calcified cyst contents resulted in an incomplete resection of her colloid cyst (left). Follow-up image at 9 months (right) demonstrated a reduction in size of cyst contents.

Table 3: Comparison of outcomes of Endoscopic and Microsurgical groups

	Endoscopic group (n=25)	Microsurgical group (n=9)	p-value
Resection of cyst contents	24/25 (96%)	9/9 (100%)	0.735
Resection of capsule	3/25 (12%)	9/9 (100%)	<0.001
Length of OR (minutes)	104 +/- 47	217 +/- 37	<0.001
range	46-207	168-277	
Length of stay (days)	3.8 +/- 4.0	8.4 +/- 3.0	0.002
range	1-18	3-13	
Recurrence	1/25 (4%)	1/9 (11%)	0.401
Length of follow-up (months)	38.5	33.4	
range	0-102.1	0.1-148	
Outcome			0.755
IV	18 (72%)	5 (56%)	
III	6 (24%)	3 (33%)	
II	1 (4%)	1 (11%)	
I	0 (0%)	0 (0%)	
Complications	1/26 (4%)	3/9 (33%)	0.045

herniation. Despite urgent resection, he sustained a posterior cerebral artery infarction, and a permanent loss of short-term memory.

Systematic Literature Review for Resection of Colloid Cysts

Tables 4, 5, and 6 summarize the published case series for resection of colloid cysts since 1980. This data was obtained by a systematic search of the medical literature. All publications that described case series in which the colloid cysts were treated by either microsurgical or endoscopic resection or by stereotactic aspiration were selected for further review. Case series describing only biopsies of colloid cysts were excluded. Patients that were treated by microsurgical resection using an approach other than transcallosal or transcortical-transventricular were not included. This search was limited to journal articles published in either English or French. The remaining foreign language publications were reports of less than five cases, or their data had been overlapped by publications in English. These criteria captured greater than 95% of published cases. We therefore felt that their omission here would not alter our findings. When there were overlapping case series from separate publications, only the most recent case series was included.

Systematic Review of Endoscopic Resection of Colloid Cysts

A systematic review of the literature yielded several case series describing institutional experience with endoscopic resection. These studies, including the current study, are summarized in Table 4. A review of 157 of these patients reveals an 87% success rate at complete resection of cyst contents. Of the 157 patients in these series all but two (98.7%) had definitive treatment of their symptoms and did not require further

Table 4: Literature review of endoscopic resections of colloid cysts

Authors	Year	n	Success*	Outcome				Complications			Shunt dependant	Residual capsule	Recurrence
				Excellent IV	Good III	Poor II	Dead I	Major†	Minor‡				
Grondin et al	2005	25	24 (96%)	18	6	1	0	1	0	0	1	1 at 60 months	
Tirakotai et al(49)	2004	22	22 (100%)	20	2	0	0	0	2	1	20	1 at 72 months	
Sgaramella et al(52)	2003	1	1 (100%)	1	0	0	0	0	0	0	1	none	
Schroeder and Gaab(41)	2002	12	11 (92%)	12	0	0	0	0	1	0	1	1 at 93 months	
Jho et al(46)	2002	2	2 (100%)	2	0	0	0	0	0	0	0	none	
Kehler et al(24)	2001	10	9 (90%)	9	1	0	0	1	1	0	1	1 at 22 months	
Rodziewicz et al(36)	2000	12	11 (92%)	7	4	1	0	0	1	1	1	none at mean 40 months	
Longatti et al(45)	2000	9	6 (67%)	7	1	1	0	1	1	1	3	none at mean 27 months	
Horvath et al(44)	2000	4	3 (75%)	4	0	0	0	0	0	0	1	none	
Decq et al(38)	2000	22	14 (64%)	12-19	2-9	1	0			0	8	1 at 44 months	
King et al(43)	1999	14	12 (86%)	13	1	0	0	1	1	0	3	none at mean 24.5 months	
Abdou and Cohen(37)	1998	13	10 (77%)	11	2	0	0	0	1	0	3	none at mean 48 months	
Deinsberger et al(42)	1994	4	4 (100%)	3	1	0	0	0	1	0	0	none at mean 12 months	
Lewis et al(28)	1994	7	7 (100%)	6	1	0	0	1	0	0	0	none reported**	
Total		157	136 (87%)	125-132 (80-84%)	21-28 (13-18%)	4 (2.5%)	0 (0%)	5 (3.2%)	8 (5.1%)	3 (1.9%)	43 (27%)	5 (3.3%)	

* Success defined as complete aspiration of contents. Some residual capsule may remain. ** Cases not included in calculation of percentage or statistical analysis. † Major complications: hemiparesis, pulmonary embolus, bacterial meningitis, ventriculitis, bone flap infection, intracerebral hemorrhage, intraventricular hemorrhage, chronic seizure disorder, permanent neurological deficit, death ‡ Minor complications: CSF leak, wound infection, aseptic meningitis, stitch granuloma, isolated seizure, subdural effusion, transient neurological deficit (except hemiparesis)

treatment. Good or excellent outcomes were achieved in 153 of 157 patients (97.5%). Of these, excellent outcomes were achieved in 125-132 patients (80-84%, data not exact), and good outcomes in 21-28 patients (13-18%). Four patients (2.5%) had poor outcomes. There were no deaths. Thirteen patients had complications (8.3%). Of these, 5 (3.2%) were considered major complications, and 8 (5.1%) were considered minor complications. The distinction of major and minor complications is detailed at the bottom of Tables 4, 5, and 6. There were a total of 5 recurrences (3.3%) at 12 to 93 months follow-up. There were three patients (1.9%) who were shunt dependant after their endoscopic procedure.

Systematic Review of Microsurgical Resection of Colloid Cysts

A systematic review of the literature since 1980 yielded 24 case series (Table 5). The majority of these procedures were performed through either a transcortical-tranventricular approach or through a transcallosal approach. A total of 719 patients were identified in these reports, including the current

series. Data regarding their procedure, outcome and complications is available for most of these patients, but incompletely reported in many of the publications. Complete resection was achieved in 96% (531 patients) of 551 patients where this was either reported or could be inferred from the manuscript. The complete resection rate in individual series ranged from 67% to 100%. Outcome data was available on 676 patients. Good or excellent outcomes occurred in 615 (91%) patients. Poor outcomes occurred in 41 patients (6.1%) and there were 20 deaths (3.0%). Nineteen deaths were as a result of peri-operative mortality and one was delayed. There were 199 (32%) patients with complications of the 618 patients for whom data was provided. The incidence of major and minor complications were 101 (16.3%) and 98 (15.9%) respectively. There were two recurrences in 15 of 25 studies where the patients were followed (accounting for 355 of 719 patients). Forty-six patients (6.4%) were shunt dependant post-operatively.

Table 5: Literature review of microsurgical resections of colloid cysts

Authors	Year	n	TF	TC	Success*	Outcome				Complications		Shunt dependant	Residual capsule	Recurrence
						Excellent IV	Good III	Poor II	Dead I	Major †	Minor ‡			
Grondin et al	2005	9	3	6	9 (100%)	5	3	1	0	1	2	0	1	1 at 64 months
Bartas and Karadereler(31) ⁶	2004	16	16	0	16 (100%)	16	0	0	0	1	1	0	0	none at 42 months
Pamir et al(53) ⁵⁶	2004	19	0	19	19 (100%)	17	2	0	0	0	2	1	0	none at mean 62 months
Solaroglu et al(54) ⁵⁶	2004	26	26	0	not reported**	26 good or excellent	←	0	0	2	1	not reported**	not reported**	none at mean 41 months
Gonzalez-Martinez et al(22) ²⁵	2003	11	11	0	10 (91%)	10	1	0	0	1	7	not reported**	1	none at mean 36.5 months
Desai et al(21) ¹⁸	2002	92	30	62	90 (97%)	77 good or excellent	←	11	5	27	20	2	3	1 of 80 followed for mean 42 months
Paleologos et al(55) ⁵⁵	2001	7	0	7	7 (100%)	6	0	1	0	0	2	not reported**	0	none at mean 12.8 months
Kehler et al(24) ³⁵	2001	10	9	1	8 (80%)	5	4	0	1	2	3	not reported**	2	none
Jeffrey and Besser(2) ³³	2001	38	4	34	37 (97%)	14	5	3		10	14	not reported**	1	none of 22 patients followed-up for mean of 70 months
Dulou et al(29) ²⁰	2000	4	4	0	not reported**	3	1	0	0	1	0	0	not reported**	not reported**
Lejeune et al(56) ⁴²	2000	110	77	33	not reported**	98 good or excellent	←	9	3	19	7	27	not reported**	not reported**
Mathieson et al(27) ⁴⁶	1997	24	2	22	22 (92%)	20	2	1	1	4	6	not reported**	2	none
Hernesniemi and Leivo(23) ²⁹	1996	32	1	31	32 (100%)	29	1	2	0	2	3	1	0	none at mean 52 months
Kondziolka and Lunsford(25) ³⁰	1996	20	20	0	20 (100%)	20	0	0	0	1	1	1	5	none at mean 52 months
Gokalp et al(57) ²⁴	1996	28	25	3	not reported**	21	4	2	1	2	0	2	not reported**	not reported**
Cabbell and Ross(58)d	1996	18	18	0	17 (94%)	15	3	0	0	2	3	3	1	not reported**
Lewis et al(28) ⁴⁴	1994	8	0	8	8 (100%)	6	2	0	0	1	4	1	0	not reported**
Cetinalp et al(59) ¹²	1994	13	9	4	13 (100%)	9	0	1	3	not reported**	not reported**	not reported**	not reported**	not reported**
Misra et al(60) ⁴⁹	1993	43	0	43	43 (100%)	38	4	1	0	not reported**	not reported**	not reported**	0	none at 1-65 months
Symon et al(61) ⁶⁹	1990	18	0	18	18 (100%)	18	0	0	0	0	0	not reported**	0	not reported**
Camacho et al(20) ¹¹	1989	49	47	2	49 (100%)	46 good or excellent	←	2	0	5	5	not reported**	0	none at 1-140 months
Abernathy et al(62) ⁴	1989	12	12	0	12 (100%)	8	4	0	0	0	3	not reported**	0	none at mean 19 months
Fritsch(63) ²²	1988	18	18	0	12 (67%)	12	6	0	0	not reported**	not reported**	6	not reported**	not reported**
Nitta and Symon(51) ⁵³	1985	36	36	0	36 (100%)	25	9	2	0	1	1	not reported**	0	not reported**
Antunes et al(64) ⁴	1980	31	23	8	27 (87%)	15	5	5	6	12	0	3	4	not reported**
		719	418	301	531 (96%)	360-528 (53-78%)	87-255 (13-38%)	41 (6.1%)	20 (3.0%)	101 (16.3%)	98 (15.9%)	46 (6.4%)	21 (4.2%)	2 (0.6%)

TF = transfrontal; TC = transcallosal * Success defined as complete aspiration of contents. Some residual capsule may remain. ** Cases not included in calculation of percentage or statistical analysis. † Major complications: hemiparesis, pulmonary embolus, bacterial meningitis, ventriculitis, bone flap infection, intracerebral hemorrhage, intraventricular hemorrhage, chronic seizure disorder, permanent neurological deficit, death ‡ Minor complications: CSF leak, wound infection, aseptic meningitis, stitch granuloma, isolated seizure, subdural effusion, transient neurological deficit (except hemiparesis)

Systematic Review of Stereotactic Aspiration of Colloid Cysts

The published series on stereotactic aspiration are shown in Table 6. These account for 129 different patients from 11 published series. Symptomatic improvement was achieved in 82 patients (64%). The remaining patients with failed aspirations were subsequently treated by a different procedure; therefore relevant outcome data is only available in 52 patients. Of 52 patients treated by aspiration alone, where data is available, there were 51 excellent outcomes and 1 good outcome. There were no poor outcomes and no deaths. There were 5 major (3.9%) and 8 minor (6.2%) complications attributable to stereotactic aspiration. There were 16 symptomatic recurrences from 71 previously adequately treated patients (23%). Two patients were shunt dependant (1.6%).

DISCUSSION

The goal of this manuscript was to compare endoscopic versus microsurgical resection of colloid cysts. This was achieved by comparing the outcomes of patients treated by both modalities at a single institution between 1994 and 2004. This data was also compared in the context of the majority of published reports from 1980 to the present.

COMPARISON OF ENDOSCOPIC VERSUS MICROSURGICAL RESECTION: CURRENT SERIES

Our series represents the largest experience of endoscopic resection of colloid cysts published to date. The endoscopic group is compared to a group of patients treated by microsurgical resection at the same institution. There were no significant differences in clinical presentation between the two groups. The most significant findings of this study were reduced morbidity, operating time, and length of hospitalization in the endoscopic group. It was noted that the length of hospital stay in the microsurgical group was unusually high (mean 8.4 days). This may be artificially elevated for a number of reasons. However, these findings are consistent with those of Lewis et al.²⁸ In their study, they established not only reduced operative times and length of stay in the endoscopically treated group, but also a more rapid return to work.

The main limitation of the current study is that it is a retrospective comparison of small, non-randomized groups of patients. Despite this limitation, some reliable information may be compared between groups, thus allowing modest conclusions to be made.

Another limitation of the current study is that the data was collected over an 11-year-period. Therefore any differences in outcomes may reflect changes in practice patterns rather than actual differences between the two surgical procedures. We

Table 6: Literature review of stereotactic aspirations of colloid cysts

Authors	Year	n	Success*	Outcome				Complications		Shunt dependant	Residual	Recurrence
				Excellent IV not reported**	Good III not reported**	Poor II not reported**	Dead I not reported**	Major†	Minor‡			
Blond et al(65)	2000	33	11	not reported**	not reported**	not reported**	not reported**	5	4	0	29	22
Kumar et al(66)	1998	5	5	5	0	0	0	0	0	2	3	1 at 75 months
Kondziolka and Lunsford(32)	1994	25	13	not reported**	not reported**	not reported**	not reported**	0	0	0	19	1
Mathieson et al(33)	1993	16	8	not reported**	not reported**	not reported**	not reported**	0	0	0	15	13
Peragut et al(67)	1990	8	5	5	0	0	0	0	0	0	not reported**	not reported**
Couldwell and Appuzzo(68)	1990	2	2	2	0	0	0	0	0	0	not reported**	not reported**
Musulino et al(69)	1989	11	9	10	1	0	0	0	4	0	5	1
Pappada et al(70)	1988	2	2	2	0	0	0	0	0	0	not reported**	none at 12 months
Mohadjer et al(71)	1987	12	12	12	0	0	0	0	0	0	not reported**	not reported**
Heikkinen and Heikkinen(72)	1987	5	5	5	0	0	0	0	0	0	not reported**	none at mean 30 months
Donauer et al(73)	1986	10	10	10	0	0	0	0	0	0	not reported**	none at 1 to 48 months
		129	82 (64%)	46 (98%)	1 (2%)	0	0	5 (3.9%)	8 (6.2%)	2 (1.6%)	74 (82%)	38 (36%)

* Success defined as significant reduction in size to alleviate symptoms. ** Cases not included in calculation of percentage or statistical analysis.

† Major complications: hemiparesis, pulmonary embolus, bacterial meningitis, ventriculitis, bone flap infection, intracerebral hemorrhage, intraventricular hemorrhage, chronic seizure disorder, permanent neurological deficit, death. ‡ Minor complications: CSF leak, wound infection, aseptic meningitis, stitch granuloma, isolated seizure, subdural effusion, transient neurological deficit (except hemiparesis)

therefore felt it appropriate to survey the literature for the experience in other series of endoscopic and microsurgical resection.

Tables 4, 5, and 6 summarize most of the published case series for resection of colloid cysts since 1980. A total of 1005 individual cases were obtained from this search. We were most interested in comparing outcomes of patients treated by endoscopic resection to those treated by microsurgical resection. Table 7 compares the outcomes of all published series on both microsurgical and endoscopic resections, including our own data. We found that our data was consistent with previously published data. Notably, the incidences of major and minor complications in the microsurgically treated patients were elevated as compared to those in the published endoscopic series. The complications were more prevalent and more severe in the microsurgically treated patients. There was a combined complication rate of 32.2% in the microsurgical group and 8.3% in the endoscopic group ($p < 0.001$). This maintained statistical significance ($p < 0.001$) when classifying complications as major and minor.

There were also better reported outcomes for patients treated endoscopically than for those treated microsurgically. Patient outcomes were classified as excellent (IV), good (III), poor (II), or dead (I), according to the method used by Nitta and Symon.⁵¹ Endoscopically treated patients had a 97.5% favorable outcome; whereas microsurgically treated patients had a 91.0% favorable outcome ($p = 0.006$). Importantly, there was a 3.0% peri-operative mortality associated with microsurgical resection, compared to no deaths in the endoscopic group.

There were two features that were more favorable in the microsurgically treated patients. There was a significantly higher rate of gross-total resection in the microsurgical group compared

to the endoscopic group (96% vs. 87%, $p < 0.001$). Also, the reported recurrence rate was higher in the endoscopic group than in the microsurgical group (3.3% vs. 0.6%, $p = 0.006$).

Current data would estimate a recurrence rate of about 3-4% for endoscopically treated colloid cysts, with a mean time to recurrence of around five years. Intuitively, residual cyst capsule may account for the increased recurrence rate with endoscopic resection. This recurrence rate can likely be minimized by coagulation of the residual cyst capsule.

Interestingly, there was a higher prevalence of shunt-dependency seen in the microsurgical group ($p = 0.023$). The majority of these patients came from a national series from France, where 25% of patients were shunt-dependent. This may therefore reflect a practice pattern rather than a clinically important consequence of treatment.

There are a few notable limitations to the comparison of the above published case series. The first is that, like in our own series, all of the publications are retrospective, and therefore provide only limited reliable details.

The second limitation is that, like our own study, the data is collected over long periods of time, with endoscopic reports occurring more frequently in recent literature. Therefore, as in our own study, outcomes may represent evolving practice patterns rather than true differences between treatment modalities.

With recognition of the above limitations, cautious conclusions can be developed. It can be safely concluded that endoscopic resection is a successful definitive treatment option for third ventricle colloid cysts with success rates of approximately 87%. This success rate is comparable to, but lower than microsurgical resection for definitive treatment for patients with colloid cysts. There is a modest advantage for completeness of resection with microsurgical resection when

Table 7: Comparison of outcome for endoscopic vs. microsurgical resection of colloid cysts (all studies)

	Endoscopic	n	Microsurgical	n	p-value
gross-total resection	136 (87%)	157	531 (96%)	551	<0.001
complications	13 (8.3%)	157	199 (32.2%)	618	<0.001
major	5 (3.2%)		101 (16.3%)		<0.001
minor	8 (5.1%)		98 (15.9%)		
shunt-dependent	3 (1.9%)	157	46 (6.4%)	719	0.023
recurrence	5 (3.3%)	150	2 (0.6%)	355	0.003
follow-up (months)	37	150	43	355	
Outcome		157		676	<0.020
IV (excellent)	125-132 (80-84%)		360-528 (53-78%)		
III (good)	21-28 (13-18%)		87-255 (13-38%)		
II (poor)	4 (2.5%)		41 (6.1%)		
I (dead)	0 (0%)		20 (3.0%)		
Outcome		157		676	0.006
III or IV	153 (97.5%)		615 (91.0%)		
I or II	4 (2.5%)		61 (9.0%)		

compared with endoscopic resection (96% vs. 87%). This may be manifest by a need for more repeat endoscopic procedures being performed compared to microsurgical procedures.

It can also be safely concluded that the peri-operative morbidity and mortality is considerably higher with microsurgical resection. This was identified not only in our patient series, but also by a systematic review of the medical literature. This systematic review also documented a significant difference in good or excellent outcomes in favour of endoscopic resection. Therefore the increased need for repeat procedures in patients treated by endoscopic resection will likely be offset by a significantly reduced morbidity. If the above figures are accurate, it may be more favourable for a patient to undergo multiple endoscopic resections for a recurrent colloid cyst, than to accept the risk associated with one microsurgical resection.

Finally, the length of operative time and length of hospital stay are both low in patients undergoing endoscopic resection of their colloid cyst. Both are significantly reduced with endoscopic resection when compared with microsurgical resection, thereby reducing the burden of treatment to both the patient and to the health-care provider.

In summary, endoscopic resection is now becoming a well established treatment option for patients with colloid cysts of the third ventricle. It is less invasive than microsurgical resection, and is associated with less morbidity and mortality. Despite a lower success rate for complete resection, endoscopic resection appears to be associated with more favourable outcomes, and should be considered for primary treatment.

INVESTMENT/FINANCIAL DISCLOSURE

None of the authors of this study have any financial interest in the devices used for the treatment of colloid cysts.

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