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Tailored Callosotomy in Third Ventricle Colloid Cyst Resection via Anterior Interhemispheric Transcallosal Approach

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■ BACKGROUND: **The colloid cyst represents a relatively uncommon intracranial lesion. It garners significant attention from neurosurgeons due to its benign nature, deep-seated location, and promising prognosis when identified early and surgically removed. A variety of surgical methods are used to treat these cysts, each with their strengths and weaknesses. The aim of this study is to introduce and assess a precise microsurgical technique for managing colloid cysts using the anterior interhemispheric transcallosal approach.**

■ METHODS: **The research involved a retrospective analysis of 14 cases between 2021 and 2023 treated with the anterior interhemispheric transcallosal approach by 2 experienced skull base surgeons. The evaluation encompassed demographic, clinical, radiological, histological, and surgical data. Additionally, the colloid cyst risk score was used to assess the risk of obstructive hydrocephalus. The procedure incorporated neuronavigation and ultrasound to determine the precise entry point and to plan the trajectory.**

■ RESULTS: **The minimally invasive microsurgical technique was effectively employed in all 14 cases, with no reported postoperative complications. Postsurgery magnetic resonance imaging scans confirmed complete cyst removal, with an average callosotomy measurement of 5.4 $\pm$ 2.5 mm. Importantly, none of the patients experienced disconnection syndrome associated with callosotomy.**

■ CONCLUSIONS: **The adapted microsurgical approach via the anterior interhemispheric transcallosal method emerges as a secure and efficient way to address colloid cysts. It ensures comprehensive cyst removal while minimizing complications, boasting advantages such as reduced invasiveness, enhanced visibility, and minimal tissue disturbance, thereby confirming its role in colloid cyst surgical interventions.**

INTRODUCTION

Colloid cysts located within the third ventricle (TV) are considered rare, constituting approximately 1% of all brain tumors.[1-5] The reported incidence stands at around 3.2 cases per 1 million individuals annually.[6] Colloid cysts are commonly located at the frontal and central region of the TV, close to a crucial structure called the foramen of Monro. This

Key words
- Anterior interhemispheric transcallosal approach
- Callosotomy
- Colloid cysts
- Microsurgical approach
- Minimally invasive surgery

Abbreviations and Acronyms
CCRS: Colloid cyst risk score
CC: Corpus callosum
CG: Cingulate gyrus
CSF: Cerebrospinal fluid
CT: Computed tomography
FLAIR: Fluid-attenuated inversion recovery
GTR: Gross total resection
LV: Lateral ventricle
MR: Magnetic resonance
TV: Third ventricle

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placement is significant because these cysts, when they obstruct the foramen of Monro, can interfere with the regular flow of cerebrospinal fluid (CSF) within the brain, potentially resulting in a condition termed hydrocephalus.[7] Hydrocephalus involves an abnormal accumulation of CSF within the brain, leading to increased pressure inside the skull. It may be communicating or obstructive. Colloid cysts cause obstructive hydrocephalus. Clinical findings occur with increased intracranial pressure and ventricular enlargement is observed with Evans index on cranial imaging. This heightened pressure can compress brain tissue and thereby trigger a range of neurological symptoms.[8] Because a colloid cyst can induce hydrocephalus and subsequent neurological symptoms, surgical intervention is frequently necessary to extract it and address the associated manifestations effectively.[9]

Several standard surgical approaches are employed for removing colloid cysts from the TV. These encompass methods such as transcortical transventricular, interhemispheric transcallosal, and endoscopic approaches. Each method offers its own set of advantages and limitations in addressing these cysts.[1,8-14] There is currently no unanimous agreement about the most effective surgical procedure for colloid cysts, underscoring the importance of considering multiple factors. The core goals of surgery remain consistent: complete cyst removal without remnants, management of hydrocephalus if present, prevention of complications, and minimal manipulation of brain tissue and blood vessels. The selection of a surgical approach often hinges on the individual patient's individual condition and the expertise of the surgeon.

The purpose of our study is to delineate our specific microsurgical technique employing the anterior interhemispheric transcallosal approach, through the presentation of outcomes from 14 patients who underwent this procedure. Our findings aim to contribute to a comprehensive understanding of effective strategies for managing colloid cysts, while elucidating the nuances and potential advantages of our chosen approach (**Figure 1**).

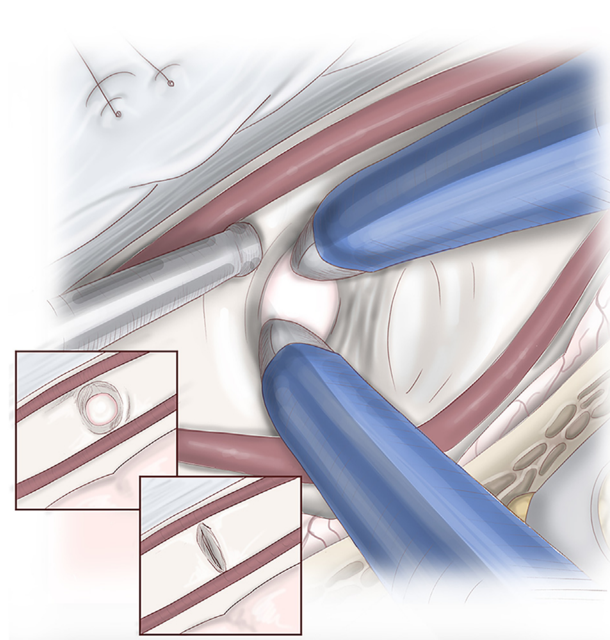

Figure 1. Illustration of the callosotomy. The corpus callosum and bilateral pericallosal arteries are identified. The small inset shows callosal fibers post early postoperative cyst excision and their subsequent shrinking during follow-up.

MATERIALS AND METHODS

Patient Selection and Variables

After permission was obtained from the local ethics committee, data were extracted from 2 hospitals (Kartal Dr. Lütfi Kırdar City Hospital and Bakırköy Mahzar Osman Mental and Neurological Diseases Hospital) using a retrospective design. All patients consented to the procedure and the patient in the figures consented to the publication of his/her image.

Patient demographics included age and sex. The extracted radiological data included lesion location, lesion volume and diameter in all 3 spatial planes, computed tomography (CT) features, and magnetic resonance (MR) features of T1-weighted, T2-weighted, and fluid-attenuated inversion recovery (FLAIR) sequences. Hydrocephalus was also assessed in the radiological data, for example, by Evans ratio measurements, hydrocephalus was considered if the Evans ratio was more than 30%.[15] Periventricular lucency was also examined. We used the colloid cyst risk score (CCRS), which combines clinical and radiological data, on basis of previous studies.[16] The CCRS covered the range 0–5 points, one point each if present: 1) headache, 2) lesion diameter >7 mm, 3) lesion located in risk zone, 4) patient age <65 years, and 5) hyperintensity on FLAIR imaging.[16] The anterior part of the third ventricle was classified as zone 1, the middle as zone 2, and the posterior as zone 3.[16] Zones 1 and 3 were considered risk zones. CCRS scores of 4 and 5 are considered high risk for progression to acute hydrocephalus.[16] Therefore, patients with a score of 4 and 5 were at higher risk of developing hydrocephalus, so these patients were operated on even in the absence of hydrocephalus.[17] Preoperative neurological status and Karnofsky Performance Scale were also assessed.

Operative variables included selected craniotomy side, craniotomy area, operative time, choice of surgical approach, intraoperative complications, and resection rate. Postoperative follow-up variables included early and late complications, length of hospital stay, and postoperative Karnofsky Performance Score. The length of the callosotomy was measured in sagittal sections on early postoperative and follow-up magnetic resonance imagings to demonstrate the impact of the procedure on the corpus callosum (CC).

Operative Technique

All surgeries were performed with patients in a supine oblique position; the opposite shoulder was elevated with a pillow to ensure that the head was parallel to the floor (**Figure 2**). Neuronavigation setup was installed, matched, and checked to minimize the accuracy and deviation margin. To optimize exposure, the operative side was positioned below, using gravity

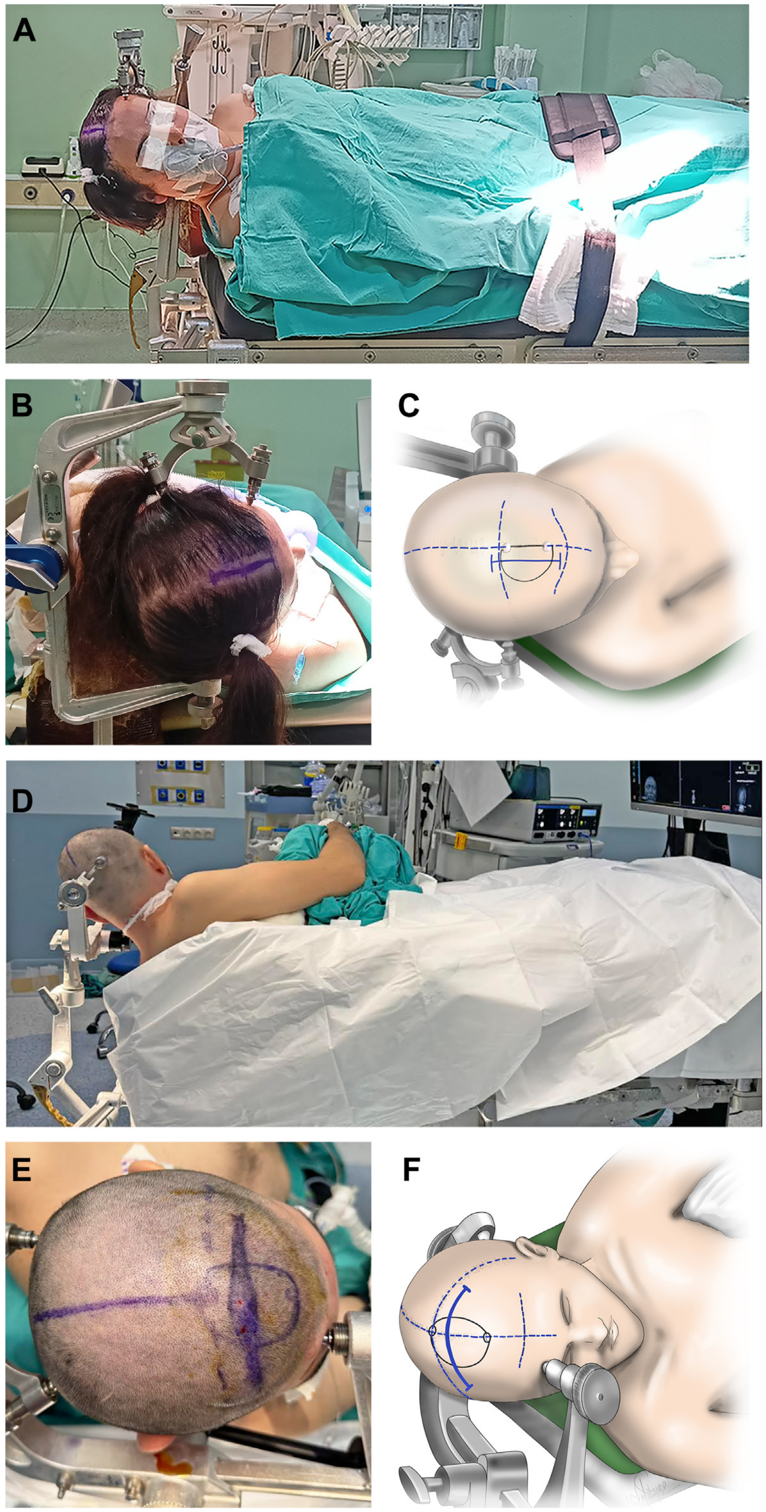

Figure 2. (**A**) Photograph of the patient's supine oblique position. The opposite shoulder was elevated with a pillow. (**B**) Photograph of the vertical linear incision site. (**C**) Illustration of the vertical linear incision site. (**D**) Photograph of the patient's supine oblique position. (**E**) Photograph of the transverse linear incision site. (**F**) Illustration of the transverse linear incision site.

without the need for retraction. If necessary, CSF could be drained to expand the exposure.

A frontoparietal incision was made in a golf club shape or a linear pattern (Figure 2). The craniotomy commenced approximately 0.5–1 cm anterior to the coronal suture and extended about 4–5 cm forward. Depending on the surgeon's preference, 2 or 3 burr holes could be made. It is advisable to open 2 burr holes along the midline over the superior sagittal suture; this allows for safe dissection of the sinus from the bone, minimizing the risk of sinus injury. Doppler control was implemented after the burr hole was created (Figure 3).

Before an incision was made in the dura, the entry point and trajectory were determined using neuronavigation and ultrasound (Figure 4A–C). The dura was then incised in a curved fashion, the base of the incision remaining over the sinus, and it was placed over the midline above the sinus (Figure 4D). The dura was then suspended with threads, providing dynamic retraction thanks to their weight.

Dissection between the hemispheres was initiated carefully, cortical veins that drain into SSS being preserved. If necessary, the durotomy should be minimized or these veins should be carefully mobilized by dissecting the arachnoid sleeve. If the necessary exposure is not provided to enter the interhemispheric fissure, freeing the veins by dissecting them from the arachnoid plane or making a new incision parallel to the veins on the dura will help to enter the interhemispheric region without sacrificing them. The veins in the entry area should be checked with MR venography in the preoperative period and craniotomy and dura incision should be planned accordingly. There is a risk of venous infarction due to sacrification of a venous structure and may have catastrophic consequences. The cortical arachnoid membrane is opened for CSF drainage allowing gravity to pull the hemisphere away from

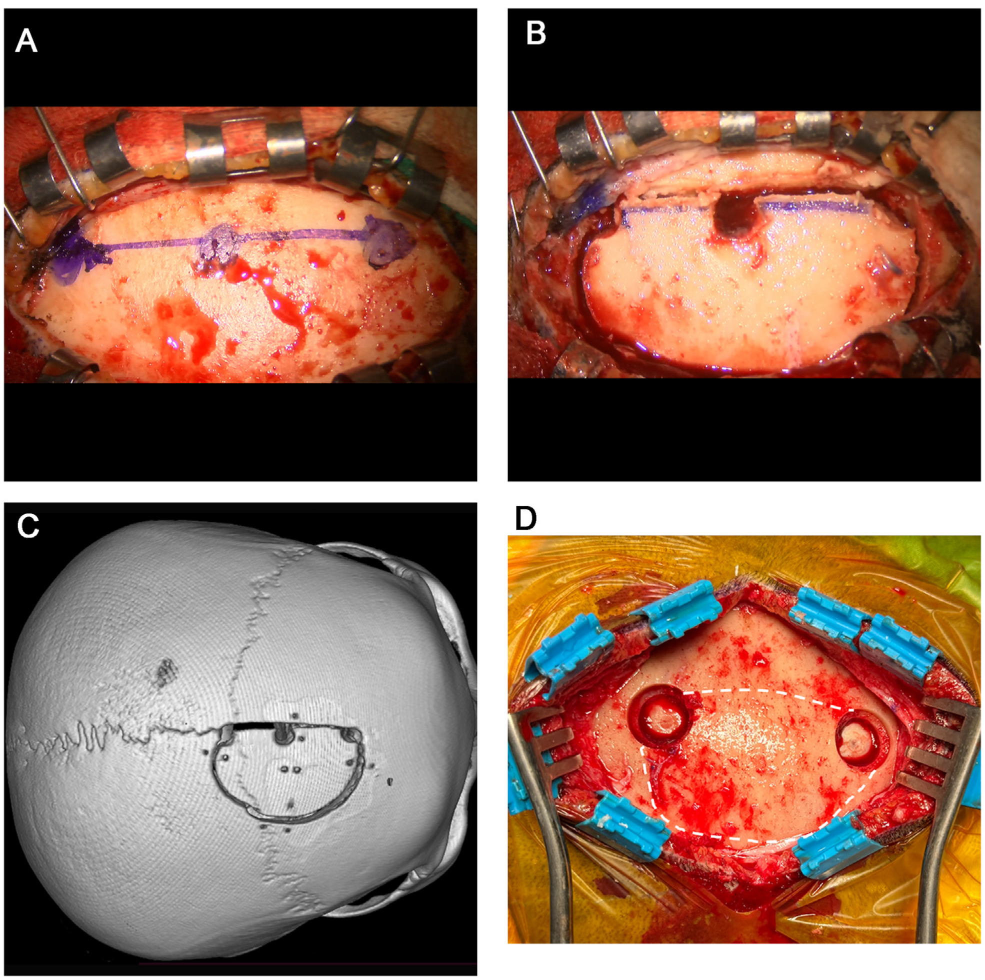

Figure 3. The intraoperative views: (**A**) Superior sagittal sinus identified using neuronavigation. (**B**) Craniotomy performed through 3 burr holes. (**C**) CT 3D reconstruction of postoperative craniotomy. (**D**) Burr hole and craniotomy placement in the vertical incision pattern. CT, computed tomography; 3D, 3-dimensional.

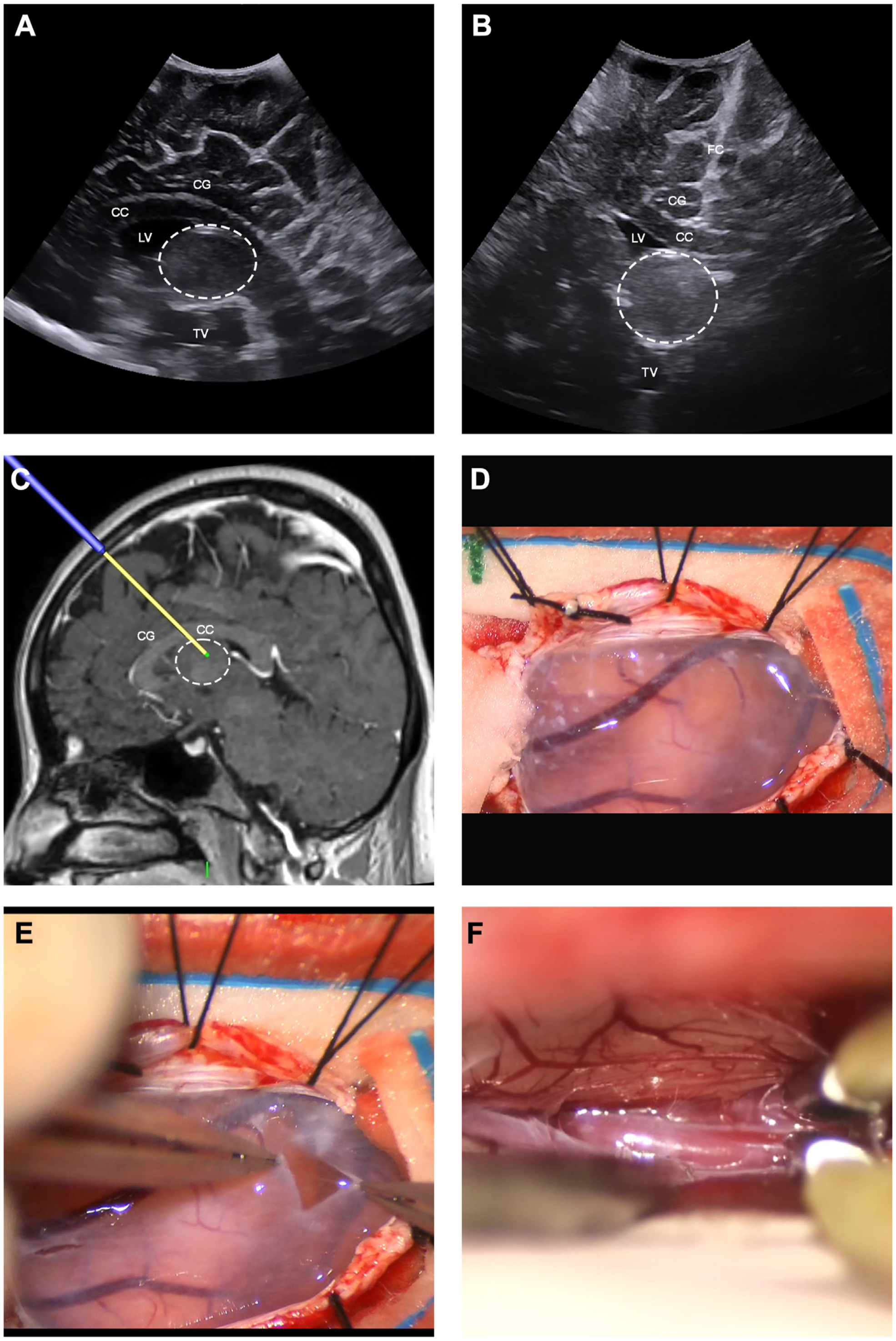

Figure 4. The intraoperative view. (**A**) An ultrasound image (sagittal view) shows the lesion. (**B**) An ultrasound image (coronal view) shows the lesion. (**C**) A neuronavigation image shows the entry point and trajectory. (**D**) The dura is opened and showed the parenchyma. (**E**) The arachnoid membrane is opened for CSF drainage. (**F**) The pericallosal arteries are visualized. Abbreviations: CC, corpus callosum; CG, cingulate gyrus; FC, falx cerebri; LV, lateral ventricle; TV, third ventricle; CSF, cerebrospinal fluid.

the falx and open the interhemispheric fissure without using a retractor (Figure 4E–F). The arachnoid dissection was carried out meticulously, taking care to identify vascular structures in the interhemispheric space. The bright white structure of the CC and the pericallosal arteries on it needed to be visible before the dissection was cautiously continued. The pericallosal arteries must be carefully identified and dissected laterally. In case of injury, side-to-side anastomosis may be required if repair is feasible.[18-20] Rarely, there may be anastomosis between the pericallosal arteries; care should be taken during dissection. If these anastamoses cannot be dissected without damage, both pericallosal arteries can be dissected to one side to protect these anastamoses and callosotomy can be performed in this way. The anterior cerebral arteries divide into pericallosal and callosomarginal arteries at A2, anterior to the CC. The callosomarginal arteries course over the cingulate gyrus (CG), which may herniate contralaterally. In such cases, the callosomarginal arteries may be mistaken for the pericallosal arteries, and the CG may be confused with the CC, risking resection of the CG. This risk underscores the importance of careful anatomical identification, particularly for less experienced surgeons.

Callosotomy was performed between the 2 pericallosal arteries, guided by neuronavigation and ultrasound and dissection of the commissural fibers following their course (Figure 5A–F). With the help of neuronavigation, the location of the callosotomy and the entry point and orientation were determined accordingly, the foramen of Monro was targeted, and the entry point was determined by defining the lesion, septum pellucidum, lateral ventricles (LVs), and foramen of Monro using ultrasound with the help of a cottonoid.[21] Since neuronavigation is based on preoperative imaging, it may be misleading with CSF drainage and resection, but ultrasound is less misleading because it provides real-time images. Care was taken during this procedure to avoid injuring the pericallosal arteries. Callosotomy should be performed parallel to the callosal fibers, so that as little fibers damage as possible is done. After callosotomy, the LV is reached and CSF inflow is observed. Confirmation of the foramen of Monro, along with recognition of the septum pellucidum, thalamostriate vein, anterior caudate vein, and choroid plexus, verified entry into the correct ventricle. These critical structures are septum pellucidum and foramen of Monro in the midline, thalamostrite vein and anterior caudate vein in the lateral side, and septal vein in the midline. Identification of these structures is valuable both for their preservation and for the reliability of our location. Particularly, the thalamostriate vein and anterior caudate vein come from deep structures and nuclei and sacrifice is not recommended. The choroid plexus extends to the foramen of Monro in the midline and may cause bleeding during dissection and can be coagulated with bipolar if bleeding occurs. During dissection of the cyst, the internal cerebral veins, especially posterior and inferior to the cyst, may be adherent to the cyst wall and should not be removed without dissecting the cyst. The internal cerebral veins run in the velum interpositum and drain into the venous system of the galen vein. In case of damage, infarction extending from the third ventricle to the hypothalamus may occur and this may cause persistent electrolyte disturbance, endocrine hormonal disorder, and seizures.

The cyst wall was carefully dissected from surrounding structures; special attention was given to the choroid plexus and veins. The internal cerebral vein is not always visible in the inferoposterior area and should be approached with caution. After excision was completed, a third ventriculostomy could be performed by opening the tuber cinereum to prevent the collapse of the foramen of Monro or the development of hydrocephalus due to granulation tissue (Figure 6A–B).

RESULTS

The total number of patients was 14, with an equal distribution from each author (A. G. and B. O.). The mean age of the patients was 40.5 ± 13.8 years. Two were in their second decade, 1 in their third, 2 in their fourth, 4 in their fifth, and 6 in their sixth. Most patients (64%) were in their fifth or sixth decade at diagnosis. There were 8 female patients (57%).

The mean diameter of the colloid cysts was 15.1 ± 3.8 mm, and their mean volume was 1.61 ± 1.07 cm^3. The majority (9 cases, 64%) exhibited hyperdense features on the CT scan. Isodense features were present in the remaining 5 cases (36%). FLAIR imaging revealed hyperintense features in 10 cases (71%). Hydrocephalus was present in 11 cases (79%); 5 of this exhibited periventricular lucency. The mean Evans ratio was 0.37 ± 0.08. One patient had a ratio of 0.5 or more, 4 had ratios between 0.4 and 0.5, and 6 had ratios between 0.3 and 0.4. Nine patients scored 5 points on the CCRS, while 5 scored 4 points (Table 1).

All patients were operated on via the anterior transcallosal approach using the minimally invasive surgical technique described above. A right-sided craniotomy approach was preferred in all cases. The mean craniotomy area was 23.4 ± 6.7 cm^2. The mean operative time was 216 ± 31 minutes. The total resection rate was 100% according to postoperative imaging (Figure 7). There was no evidence of recurrence in any of the patients during the follow-up period. No intraoperative complications were observed in any patient. During the early postoperative period, a clinically asymptomatic periventricular mild diffusion defect was observed in 1 patient. No late complications were observed during the follow-up period. The mean length of stay in hospital was 4.8 ± 1.1 days. The mean postoperative callosotomy length was 8.2 ± 1.8 mm in postoperative MR imagings. This length decreased to 5.4 ± 2.5 mm after follow-up. All patients had a Karnofsky Performance Score of 100 at the end of the follow-up period. The mean follow-up was 15.1 ± 9.8 months (Tables 2 and 3).

DISCUSSION

The demographic data reported in our study do not differ from those reported in the general literature, except for gender. The mean age of the patients included in our study was 40.5 years and most of them (64%) were aged 30–50 years. This resembles previous studies. In a meta-analysis by Sheikh et al. reviewing 1278 patients comparing endoscopic with microscopic resection, the mean age was 40.5 years in the endoscopic group and 40 years in the microscopic group.[8] The male-to-female ratio in our study was 0.75:1, but in the aforementioned meta-analysis it was 1.4:1 in the endoscopic group and 1.3:1 in the microscopic group.[8] It was 1.5:1 in another meta-analysis that reviewed 301 patients and compared

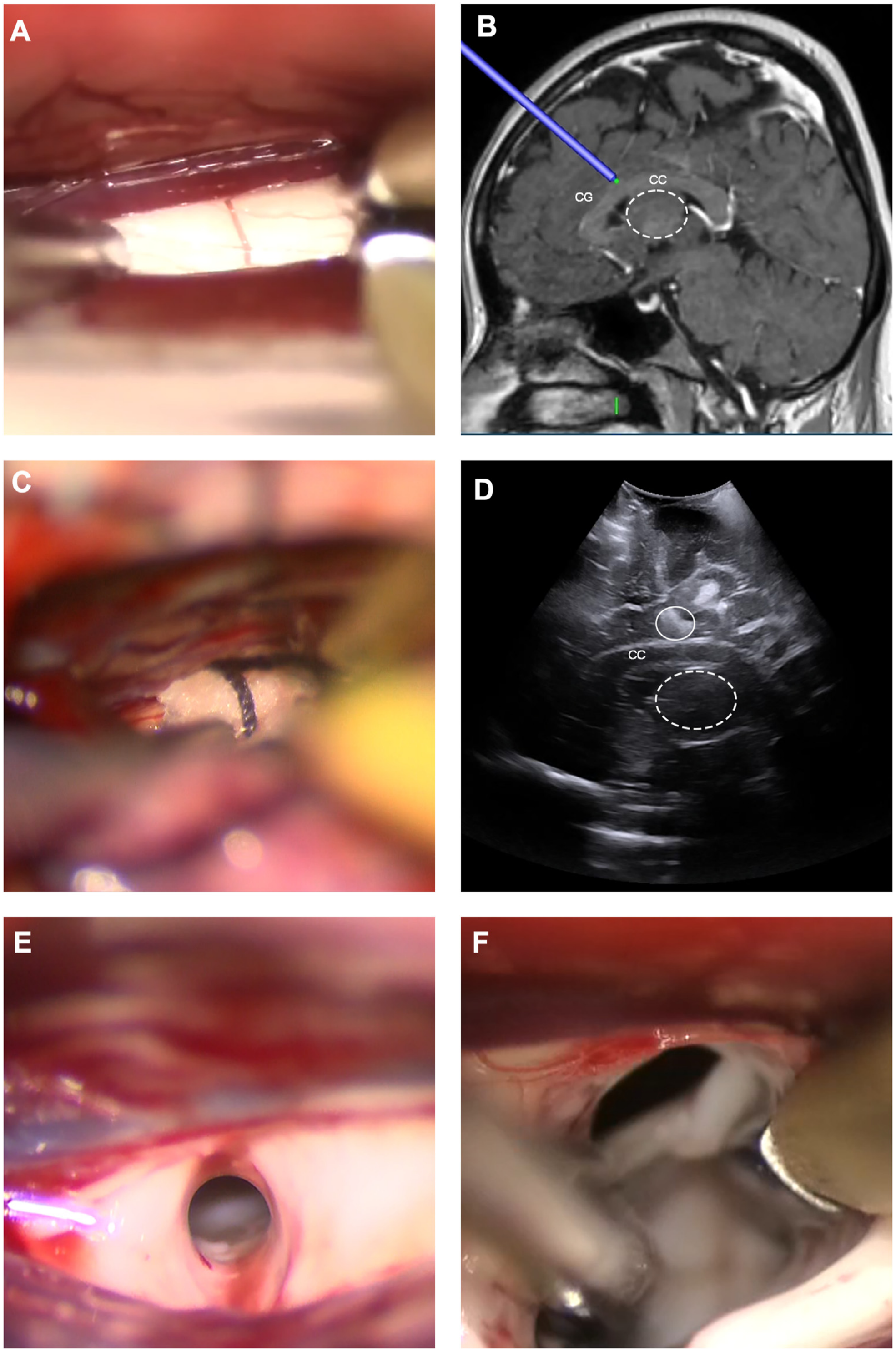

Figure 5. The intraoperative view. (**A**) The corpus callosum is observed. (**B**) A neuronavigation image shows the entry point of the corpus callosum. (**C**) A cottonoid is placed in the corpus callosum to facilitate ultrasonographic confirmation of the correct trajectory. (**D**) An ultrasonographic image shows the cottonoid placed in the corpus callosum. (**E**) The callosotomy is performed. (**F**) Septum pellucidum and lateral ventricle is visualized.

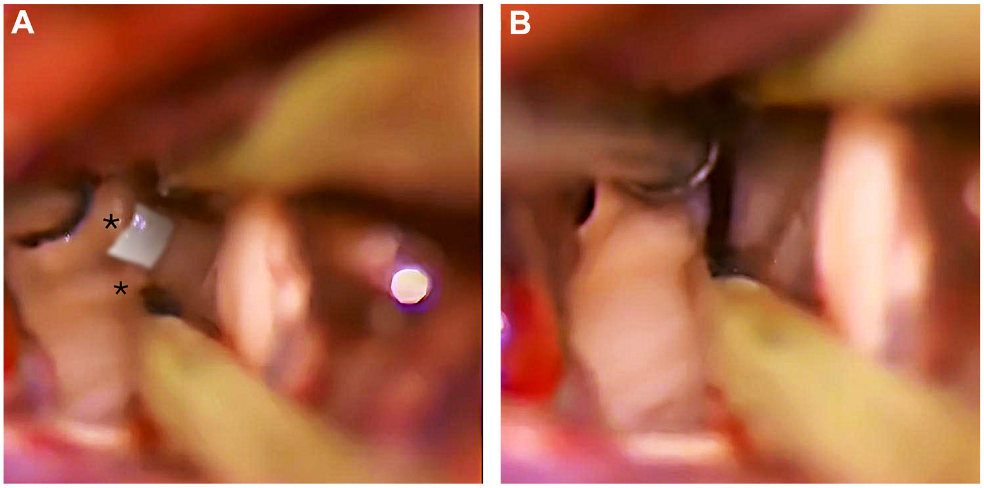

Figure 6. The intraoperative view of third ventricle. (**A**) The mammillary bodies (asteriks) and tuber cinereum (white-colored line) are identified. (**B**) The floor of the third ventricle is opened.

procedures (transcortical vs. transcallosal vs. endoscopic) for colloid cysts.[22]

The characteristics of the cysts in our cases were also similar to previous literature. The mean cyst length in our study was 15.1 mm. In the meta-analysis by Sheikh et al., it was 13.2 mm in the microsurgery and 14.3 mm in the endoscopy pool.[8] The mean cyst length was 14.7 mm in the endoscopic resection group and 14.2 mm in the microsurgical resection group in a recent comparative meta-analysis involving a total of 3143 patients.[23]

As mentioned above, colloid cysts are associated with hydrocephalus/ventriculomegaly because they are often located in the anterior part of the TV. In our study, hydrocephalus was present in 79% of the patients. In the meta-analysis of 301 patients comparing 3 approaches, the corresponding rate was 73%,[22] although it varied among the groups.[22] The transcortical microsurgical (82.6%) and endoscopic (82.8%) groups had a higher prevalence of preoperative hydrocephalus than the transcallosal microsurgical approach (52.2%).[22] A likely explanation for this difference is that the endoscopic and transcortical approaches are applicable when the ventricles are enlarged, whereas the transcallosal approach is indicated for ventriculomegaly or normal ventricles.

Another issue highlighted in the literature is the length of hospital stay depending on the treatment used. The mean length of hospital stay in our study was 4.8 days. In the 2022 meta-analysis by Sayehmiri et al., this duration was 4.7 days in the endoscopy group and 7.8 days in the microsurgery group.[23] The modified, minimally invasive microsurgical approach is likely to have a lower risk of complications and a shorter recovery time, which could explain the shorter length of stay in our study.

Differences in the definition of gross total resection (GTR) have been reported in the literature.[7] In our study, GTR was considered to be the removal of the cyst contents and the entire cyst wall. In contrast, some publications consider GTR to be removal of the cyst contents and part of the wall and coagulation of the remaining wall.[7,24-26] This difference probably explains why 2 previous meta-analyses gave different results. Sayehmiri et al. reported a total resection rate of 91.3% in the endoscopic group and 98.2% in the microscopic group.[23] In contrast, Sheikh et al. defined GTR as complete removal of cyst contents and cyst wall with no observable portion of wall left intraoperatively, as in the present study. They reported GTR of 58.2% in the endoscopic group and 96.8% in the microsurgical group.[8] The mean operative time in our study was 216 minutes, which is slightly longer than the microsurgical group (mean 194 minutes) in the meta-analysis by Sayehmiri et al.[23] Therefore, it appears that our meticulous dissection does not increase the operative time significantly.

Neurosurgeons have long been highly interested in colloid cysts, which are predominantly found in the anterior two thirds of the TV. In about 80% of cases, they result in enlargement of the foramen of Monro. This prominence underscores the clinical significance of their location and their potential effect on the flow of CSF.[27] Lesions in the posterior and superior areas of the TV do not usually manifest directly at the foramen of Monro. Instead, they often occlude and displace this foramen. Patients affected by colloid cysts often seek medical attention after experiencing acute hydrocephalus, highlighting the potential effect of these cysts on the normal flow of CSF and the subsequent onset of symptoms.[28] The widespread use of CT and magnetic resonance imaging for assessing patients with headaches has led to more diagnoses of colloid cysts even before hydrocephalus develops. There has also been a noticeable rise in the discovery of incidental or asymptomatic colloid cysts. This increase has sparked innovations in treatment.

Despite these advances, a consensus on the optimal surgical management of colloid cysts remains elusive. Many medical experts advise against using shunting as the sole long-term treatment for symptomatic lesions because it fails to address the

Table 1. Radiological and Clinical Features of the Patients

			Radiological Features												Colloid Cyst Risk Scoring					
			Diameter (mm)																	
Patient Number	Age	Gender	Ax	Sag	Cor	Volume (cm^3)	CT	T1W MRI	T2W MRI	FLAIR	HC	PVL	Evans Ratio	Preoperative Karnosfky Score	H&A	>7 mm Diameter	Zone	Age <65	FLAIR Hiper	Total
#1	48	F	11	11	9	0.56	Hyper	Iso	Iso	Hyper	+	-	0.39	100	+	+	1	+	+	5
#2	18	F	13	14	14	1.31	Iso	Iso	Iso	Iso	+	+	0.41	100	+	+	1	+	-	4
#3	14	F	9	10	9	0.42	Hyper	Hyper	Iso	Hyper	-	-	0.25	100	-	+	1	+	+	4
#4	50	M	16	17	17	2.45	Iso	Hyper	Hyper	Hyper	+	+	0.5	100	+	+	1	+	+	5
#5	54	F	11	12	12	0.80	Hyper	Iso	Hypo	Hyper	+	-	0.33	100	+	+	1	+	-	5
#6	53	F	16	16	19	2.63	Iso	Hyper	Iso	Hyper	+	+	0.38	100	+	+	1	+	+	5
#7	53	M	15	18	16	2.24	Hyper	Hypo	Hypo	Hyper	+	-	0.43	100	+	+	1	+	+	5
#8	56	M	17	19	18	2.88	Hyper	Hypo	Hypo	Hyper	+	+	0.47	100	+	+	1	+	+	5
#9	45	F	9	13	10	0.63	Hyper	Hypo	Hypo	Hyper	-	-	0.22	100	+	+	1	+	+	5
#10	41	F	9	10	9	0.41	Hyper	Hypo	Hypo	Iso	+	+	0.33	100	+	+	1	+	-	4
#11	46	M	11	11	9	0.56	Hyper	Hypo	Hypo	Iso	+	-	0.34	100	+	+	1	+	-	4
#12	30	F	17	21	17	3.22	Iso	Hyper	Hyper	Hyper	-	-	0.27	100	+	+	1	+	+	5
#13	30	M	11	10	16	0.91	Hyper	Iso	Hypo	Hypo	+	-	0.39	100	+	+	1	+	-	4
#14	29	M	20	17	17	2.92	Iso	Iso	Iso	Hyper	+	-	0.47	100	+	+	1	+	+	5

Ax, axial; Sag, sagittal; Cor, coronal; CT, computed tomography; T1W, T1-weighted; MRI, magnetic resonance imaging; T2W, T2-weighted; HC, hydrocephalus; PVL, periventricular lucency; H&A, headache; F, female; M, male; FLAIR, fluid-attenuated inversion recovery.

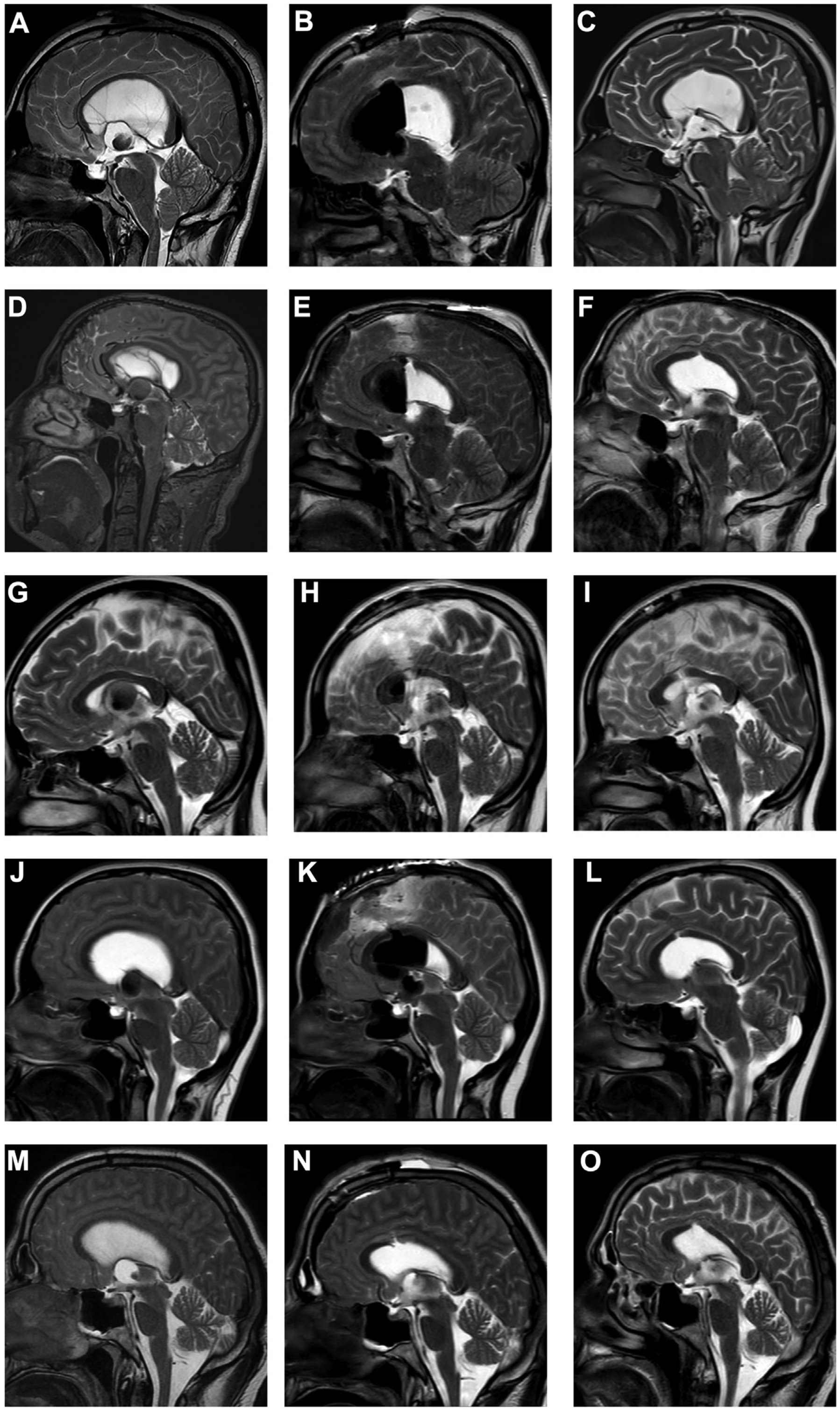

Figure 7. Magnetic resonance images of some demonstrated patients were selected and presented to demonstrate early postoperative callosotomy and late postoperative callosotomy. (**A**–**D**–**G**–**J**–**M**) Preoperative sagittal T2-weighted MRI image of the patients. (**B**–**E**–**H**–**K**–**N**) Early postoperative period sagittal T2-weighted MRI image. (**C**–**F**–**I**–**L**–**O**) Late postoperative period sagittal T2-weighted MRI image. MRI, magnetic resonance imaging.

Table 2. Perioperative Measurements and Postoperative Follow-Up Results of the Patients

Patient Number	Craniotomy Side	Craniotomy Area (cm^2)	Operation Time (minutes)	Surgical Approach	Resection Rate	Complications			SAH (day)	Callosotomy Length (mm)		Postoperative Karnofsky Score	Follow-Up (months)
						Intraoperative	Early	Late		Postoperative	Post Follow-Up		
#1	R	29.3	180	Anterior transcallosal	GTR	None	None	None	4	6.6	3.9	100	46
#2	R	17.6	230	Anterior transcallosal	GTR	None	None	None	5	6.7	4.2	100	34
#3	R	23.4	240	Anterior transcallosal	GTR	None	None	None	4	10.6		100	33
#4	R	13.6	280	Anterior transcallosal	GTR	None	None	None	3	6.1	4.8	100	33
#5	R	33.6	240	Anterior transcallosal	GTR	None	None	None	6	10.1	8.7	100	27
#6	R	35.5	240	Anterior transcallosal	GTR	None	None	None	7	10.2	8.9	100	24
#7	R	22.0	190	Anterior transcallosal	GTR	None	None	None	5	8.0	3.0	100	22
#8	R	-	180	Anterior transcallosal	GTR	None	None	None	5	8.0		100	22
#9	R	24.5	200	Anterior transcallosal	GTR	None	None	None	5	7.2	6.5	100	21
#10	R	28.7	210	Anterior transcallosal	GTR	None	None	None	3	9.2	9.2	100	21
#11	R	19.8	210	Anterior transcallosal	GTR	None	None	None	4	6.1	4.5	100	18
#12	R	16.5	210	Anterior transcallosal	GTR	None	None	None	6	7.3	3.3	100	19
#13	R	20.1	170	Anterior transcallosal	GTR	None	None	None	5	6.9	3.0	100	11
#14	R	19.3	240	Anterior transcallosal	GTR	None	None	None	5	12.0	1.6	100	10

SAH, stay at hospital; GTR, gross total resection; R, right.

Table 3. Demographic Variables of the Patients

Demographic Variables	
Total patient	14
Age	40.5 ± 13.8
F/M ratio	8/6
Radiological variables	
Volume (mL)	1.61 ± 1.07
Ventriculomegaly	11/14
Evans ratio	0.37 ± 0.08
Clinic variables	
Karnosfky score	
Preoperative	100 ± 0
Postoperative	100 ± 0
Risk score	
4	5
5	9
Craniotomy area (cm^2)	23.4 ± 6.7
Operation time (minutes)	216 ± 31
Callosotomy length	
Postoperative	8.2 ± 1.8
Post follow-up	5.4 ± 2.5
SAH	4.8 ± 1
GTR	100%

F/M, female/male; SAH, stay at hospital; GTR, gross total resection.

underlying cause of the cyst.[29] Microsurgical techniques, particularly the transcortical and transcallosal approaches, have long served as the cornerstone of treatment for colloid cysts and they are still widely used. There have been significant advances in management of these cysts since the successful removal of one via the groundbreaking transcortical transventricular approach by Walter Dandy in 1921. This pivotal event paved the way for further developments in treatment.[30] Microsurgical resection of TV colloid cysts presents distinct advantages, notably low recurrence rates (less than 1.5%) and low reoperation rates (less than 0.4%). However, it requires a craniotomy, which is associated with a mortality rate of approximately 1.4% and complication rates as high as 16%. While effective in minimizing recurrence and reoperation, the procedure does entail certain risks and complexities that need to be considered carefully during treatment planning.[8]

In 1949, Greenwood introduced the transcallosal approach, a significant development in surgical techniques for handling TV colloid cysts.[31] Over time, procedures such as stereotactic aspiration and endoscopic removal have become part of clinical practice for dealing with these lesions. Endoscopic removal in particular has gained traction in many medical settings, especially for TV colloid cysts. Neuroendoscopy has proven effective in draining cyst contents and treating the cyst wall through coagulation. However, we must acknowledge reservations about the endoscopic approach, primarily in view of documented instances of incomplete removal in the medical literature.[2,32]

In its early stages, the endoscopic approach was primarily restricted to cyst aspiration owing to limitations in technology and technique, leading to higher rates of cyst recurrence.[33] Recently, bolstered by increased expertise in the procedure and developments in technology, surgeons have been more successful in achieving GTR. This involves the complete removal of both the cyst content and its capsule, marking a significant advance in the effectiveness of the endoscopic approach.[34] Stereotactic or ventriculoscopic methods for aspirating isolated cysts can mitigate surgical risks, but they fall short in providing a comprehensive or lasting solution for these benign lesions owing to the high viscosity of the cyst contents. The aim of the transcortical transventricular approach, aided by stereotactic guidance, is to minimize potential cerebral injury, although it does entail the risk of postoperative seizures. However, this approach can pose challenges, especially in patients with smaller ventricles.

Alternative strategies for managing colloid cysts involve the anterior approach through the lamina terminalis and the posterior TV approach. The latter entails accessing the tela choroidea between the pineal gland and the vein of Galen through an infratentorial supracerebellar approach. Each of these approaches has its own set of considerations and potential advantages.[35]

The anterior transcallosal approach offers a direct and effective path to the LVs. Leveraging the natural opening provided by the foramen of Monro into the TV becomes particularly advantageous when the cyst has caused this opening to dilate. A key strength of the transcallosal transforaminal approach is the avoidance of cortical incisions and the use of natural dissection planes toward the anterior part of the TV. Furthermore, it provides multiple options for accessing the TV once entry into the LV is achieved. More posterior and superiorly located lesions in the third zone do not present in the foramen of Monro. Alternative potential access corridors are possible to reach the lesion. These include the interforniceal, subchoroidal, and suprachoroidal approach. All our patients underwent a transforaminal approach.[30] In the approach we have outlined, we maintain the patient's cranial orientation parallel to the horizontal plane, eliminating the need for retraction. The incision along the CC aligns with the direction of neural fibers, ensuring a maximum length of 2.5 cm.[36] Numerous studies indicate that an incision up to 2.5 cm in the anterior body of the CC provides sufficient exposure of the ventricular system without leading to disconnection syndromes.[37-40] In contrast, larger incisions spanning both the anterior and mid CC have been shown to disrupt interhemispheric information transfer. We did not need to enlarge the callosotomy, but simply changed the angle of the microscope and our working orientation to provide the necessary reachable space (**Figure 8**). Our meticulous approach ensures the preservation of neural connectivity. By combining specific patient positioning with our surgical technique, we achieve a minimally invasive incision that provides access to a substantial operative field. As a result, the callosotomy is significantly smaller at follow-up. We perform

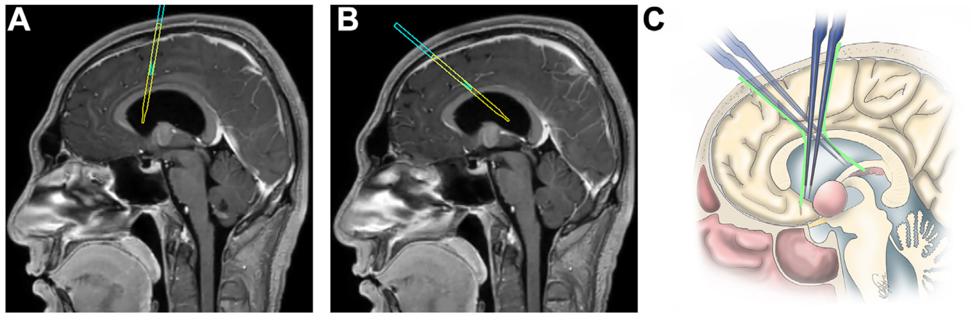

Figure 8. (**A**–**C**) Changing the angle of the microscope as indicated in the figure. It is suggested that surgeons should focus on changing the microscope angle before enlarging the callosotomy.

third ventriculostomy regardless of the presence of hydrocephalus. It is known that the possibility of shunting after resection is higher especially in patients who develop intraventricular hemorrhage during surgery and in cysts of large size. We applied a third ventriculostomy in every patient to prevent the development of hydrocephalus with microbleeds and granulation tissue even in the absence of a hemorrhage, and no patient developed hydrocephalus in the early or late period.[41] We reduce the risk of developing hydrocephalus in the follow-up of patients and reduce the need for shunting.

Before we initiate the surgical procedure, we use MR venography to delineate and plan the incision site precisely. A crucial advantage of this approach lies in its ability to achieve complete excision while safeguarding the integrity of cortical tissue and vascular structures. Meticulous planning ensures optimal outcomes by balancing effective cyst removal with the preservation of vital brain structures (Video 1).

Video available at www.sciencedirect.com

LIMITATIONS

A significant limitation of our study is its retrospective nature. Retrospective studies inherently carry the risks of selection bias, incomplete data, and the inability to control or standardize data collection methods. These limitations could affect the overall robustness of our findings and the validity of the conclusions. Our analysis was based on a relatively small number of patients, which could limit the generalizability of our results. Larger and more diverse datasets would provide a more comprehensive and reliable assessment of the predictive capabilities of this technique. Furthermore, considering that colloid cysts recur especially in the first 5 years, the follow-up period of this study may be considered early in terms of evaluating recurrences for now.

CONCLUSIONS

The modified microsurgical approach using the anterior interhemispheric transcallosal approach appears to be an effective and safe method for treating colloid cysts. The procedure demonstrated favorable surgical outcomes, with complete cyst removal and no postoperative complications. This approach offers the advantages of minimal invasiveness, optimal visualization, and reduced glial tissue incision, further establishing its viability in the management of colloid cysts in the TV.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Baris Ozoner: Writing – review & editing, Writing – original draft, Supervision, Conceptualization. **Muhammet Enes Gurses:** Writing – review & editing, Writing – original draft, Conceptualization. **Mehmet Ozturk:** Writing – review & editing, Writing – original draft, Visualization, Investigation, Data curation, Conceptualization. **Safa Arslan:** Writing – review & editing, Writing – original draft, Data curation. **Anil Ergen:** Writing – review & editing, Writing – original draft, Visualization, Validation, Investigation, Data curation. **Richard S. Tubbs:** Writing – review & editing, Writing – original draft, Conceptualization. **Pablo Gonzalez-Lopez:** Writing – review & editing, Writing – original draft, Conceptualization. **Sabino Luzzi:** Writing – review & editing, Writing – original draft. **Abuzer Gungor:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Conceptualization.

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