

## EDITOR'S CHOICE

# Complication avoidance in transcallosal transforaminal approach to colloid cysts of the anterior third ventricle: An analysis of 80 cases

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## ABSTRACT

**Object:** The objective of the present study is to analyze the complications and their avoidance in a series of 80 patients operated by transcallosal transforaminal approach to colloid cysts of the anterior third ventricle.

**Materials and Methods:** The surgical outcome and complications of 80 patients operated by transcallosal transforaminal approach for colloid cysts in the anterior third ventricle was analyzed. A detailed pre- and post-operative neurological assessment was done in all patients. Neurocognitive assessment of corpus callosal function was done in the last 22 cases. CT scan of the brain was done in all patients, before and after surgery.

**Results:** All patients underwent transcallosal transforaminal approach. Total excision of the lesion was achieved in 79 patients and subtotal in one. The complications encountered were postoperative seizures in six, acute hydrocephalus in four, venous cortical infarct in four, transient hemiparesis in four, transient memory impairment, especially for immediate recall in nine, mutism in one, subdural hematoma in one, meningitis in three, and tension pneumocephalus in one patient. There were two mortalities. There was no incidence of postoperative disconnection syndrome.

**Conclusion:** Colloid cyst is surgically curable. With good knowledge of the regional anatomy and meticulous microsurgical techniques, there is a low mortality and minimum morbidity, when compared to the natural history of the disease. With increasing experience, most of the complications are avoidable. The limited anterior callosotomy does not result in disconnection syndromes.

**Key words:** Anterior third ventricle, colloid cyst, complications, disconnection syndrome, transcallosal, transforaminal

## Introduction

In 1858, Wallmann published the first description of a colloid cyst, found on autopsy.<sup>[1]</sup> Since then, these lesions have garnered a great deal of attention and controversy over the years, as they are benign, found in young and middle-aged

adults with an excellent chance of surgical cure, or they can be devastating, and even fatal, if not recognized and treated on time. Colloid cysts are uncommon brain tumors, accounting only for 0.2 to 2.0 percent of all brain tumors. In 1921, Dandy was the first neurosurgeon who successfully removed a colloid cyst from the third ventricle through a posterior transcallosal approach.<sup>[2]</sup> The anterior transcallosal approach was suggested by George Ehni.<sup>[3]</sup> Over the years, there has been various proposals regarding the origin of these lesions.<sup>[4-8]</sup>

## Materials and Methods

We analyzed the surgical outcome and complications of 80 patients operated by the transcallosal transforaminal approach for a colloid cyst in the anterior third ventricle. This is a retrospective study from 1988 to 1999, and a prospective study from 2000 to 2011. The neurological status of the patient, before and after the surgery, and the complications were analyzed. Neurocognitive assessment was carried out in the last 22 cases, preoperatively and postoperatively on the

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sixth postoperative day and on follow up. A battery of bedside clinical tests was performed to assess the interhemispheric somatosensory and motor transfer of information and the memory function. Each patient underwent a Mini Mental Scale Examination (MMSE) and specific tasks defined for assessing corpus callosal function namely; volitional saccades, transfer functions, stereognosis, and coin sorting tasks. Also, 22 patients with other intracranial lesions were also analyzed as a control group. CT scan of the brain was done in all patients pre- and postoperatively.

## Results

### Demographics

There were 35 females, and 45 male patients.

### Clinical features

The duration of symptoms ranged from 15 days to 8 years [Table 1]. The commonest mode of presentation was headache in 72 patients, with 54 of these patients having associated papilledema. Nine patients presented with decreased sensorium, six with seizures (generalized or focal), and six with drop attacks. Episodic loss of consciousness was seen in seven patients, probably due to the development of acute hydrocephalus, which was relieved with a change in posture, cranial nerve abnormalities in eight, and spastic hemiparesis in three patients.

Neurocognitive assessment was done in the last 22 patients, which included the MMSE and specific tasks defined for assessing corpus callosal function. Twenty-two subjects who suffered from other neurological illnesses were also subjected to aforementioned tests and served as controls. Fifteen patients who underwent transcallosal surgery were found to have deficits in the above tasks as compared with five patients who served as controls. Results showed that nine patients had all four tasks impaired, two had three tasks impaired, two had two tasks impaired, and two had one task impaired. Stereognosis/tactile anomia and cross replication of finger positions (transfer functions) were the most commonly affected tasks, especially in the left hand. Decreased memory, especially immediate recall, was transiently impaired in nine patients compared with preoperatively. MMSE score range was between 27 and 30 in these patients. Preoperative mean MMSE was 28.32, and postoperative mean MMSE was 28.14. Hydrocephalus was present in 17 patients. The preoperative mean MMSE in patients with hydrocephalus was 28.3, and 28.26 in patients without hydrocephalus. Postoperatively, mean MMSE was 28.12 and 28.02, respectively, concluding that hydrocephalus did not affect the cognitive outcome.

### Radiology

All 80 patients underwent plain and contrast CT scan of the brain. In 62 patients, the lesion was hyperdense to brain and of these, 41 were contrast enhancing. In eight patients, the lesion

was hypodense, and in 10 patients the lesion was isodense to brain. Sixty-seven patients had hydrocephalus.

### Surgical treatment

All patients under the cover of anticonvulsants underwent a right frontoparietal midline craniotomy, anterior transcallosal transforaminal approach, and excision of the lesion. In 69 patients, the lesion was located at the foramen of Munro and was occluding it, and in 11 patients it was situated posterior to the foramen of Munro. In both of the above locations, it was possible to excise the cyst through the same approach, the transforaminal entry into the third ventricle. The foramen is never made wider by incision of brain tissue. Total excision of the lesion was achieved in 79 patients and in one patient, only subtotal excision of the lesion could be achieved as it was densely adherent to the wall of the third ventricle. In two patients, there was injury to a branch of pericallosal artery and in one patient a cortical vein draining into the superior sagittal sinus got torn during dissection.

### Complications

Postoperative seizures were seen in six patients, due to one of these complications: Right frontal lobe venous infarct, frontal horn pneumocephalus, acute hydrocephalus, and brain retraction edema [Table 2]. This can be avoided by

**Table 1: Clinical features**

Symptoms	No. of patients	Signs	No. of patients
Head ache	72	Papilledema	54
Vomiting	54	Memory disturbance	8
Visual disturbance	33	Cranial nerve paresis	8
Seizures	6	Motor deficit	3
Cognitive and memory	15	Sensory deficit	1
Gait abnormality	13		
Decrease level of consciousness	9		
Drop attacks	6		
Giddiness	8		
Urinary incontinence	2		
Weakness of one side limbs	3		
Extrapyramidal symptoms	1		

**Table 2: Complications**

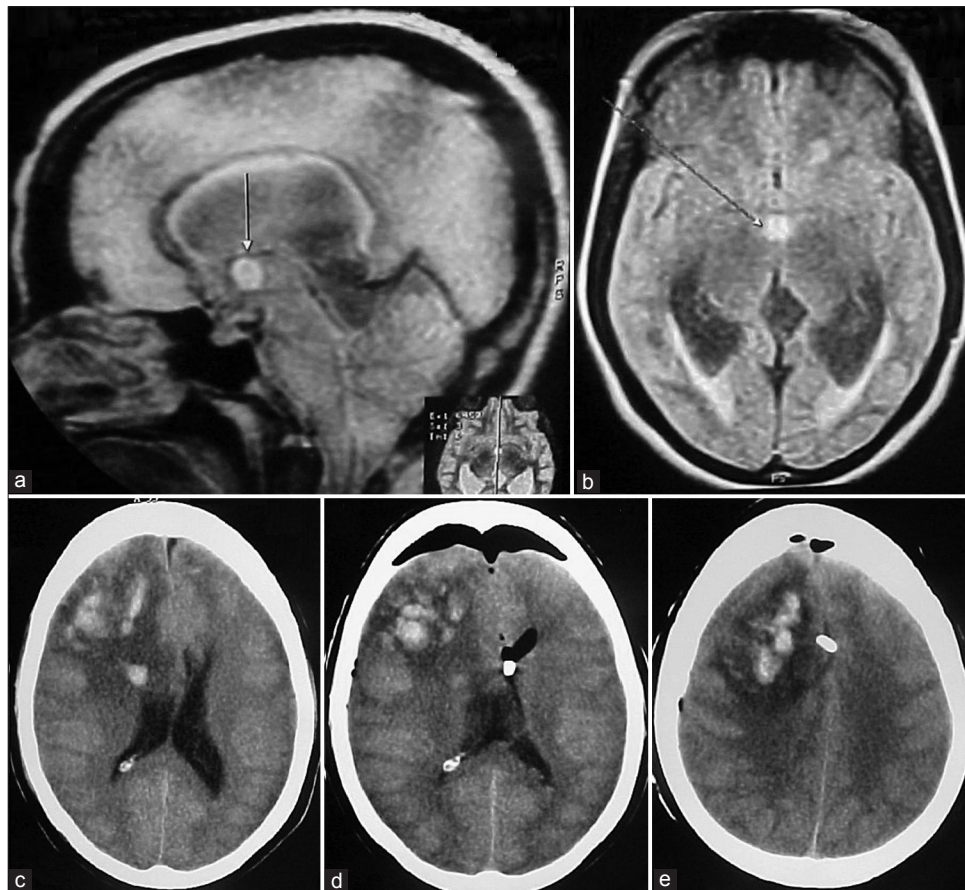
Transient memory loss	9
Seizures	6
Acute hydrocephalus	4
Transient hemiparesis	4
Venous cortical infarct	4
Subdural hematoma	1
Tension pneumocephalus	1
Mutism	1
Meningitis	3
Mortality	2

minimal retraction of the frontal lobe and sacrifice of bridging veins. If a vein needs to be sacrificed, then retractor should not be applied on the area of drainage. Seizures can also be prevented by the use of preoperative anticonvulsants. Acute hydrocephalus occurred in four patients and all underwent a CSF diversion procedure. This may occur due to block in the CSF pathways due to incomplete excision of the lesion or a blood clot blocking the aqueduct. If such situations are anticipated, an external ventricular drain (EVD) can be kept within the lateral ventricle. Postoperatively, the EVD can be kept closed and if there is deterioration in sensorium, it can be opened. Venous cortical infarct was seen in four patients [Figure 1]. This can be prevented by avoiding sacrifice of the bridging veins and prolonged excessive retraction of the frontal lobe. Transient hemiparesis occurred in four patients, due to retraction edema [Figure 2], venous infarct, and prolonged pericallosal artery retraction. Transient memory impairment occurred in nine patients within the first 72 hours after surgery, which completely resolved by the 7<sup>th</sup> postoperative day in seven patients. Mutism occurred in one patient. These can occur due to excess handling of the fornix, especially on the left side, and walls of the third ventricle and will recover in time. The opening in the callosum must be less than 2.5

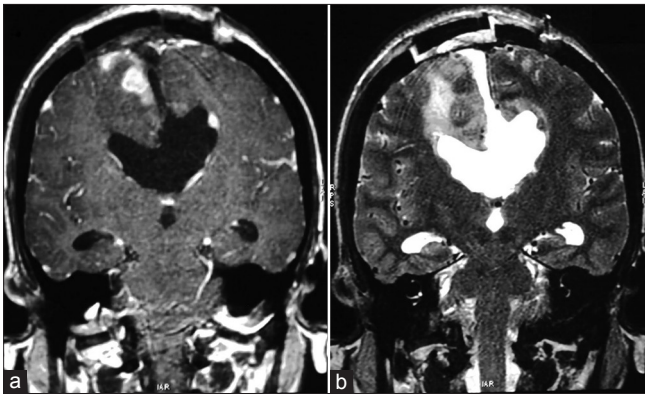
centimeters to avoid disconnection syndromes. One patient had subdural hematoma which required evacuation. This was seen in a patient with gross hydrocephalus and can be avoided by initially making a small opening in the corpus callosum and letting out CSF slowly. The brain may bulge during surgery and, if no other cause is obvious, acute SDH must be considered. Meningitis occurred in three patients. Tension pneumocephalus occurred in one patient [Figure 3], and the postoperative recovery was delayed. A plain X-ray of the skull lateral view will clinch the diagnosis and a frontal burr hole with tapping of the air will help relieve the pneumocephalus. Two patients died in the postoperative period due to basal ganglia hemorrhagic infarct following vascular injury [Table 2]. Majority of the above complications occurred during the initial years.

### Follow up

A total of 74 patients (92.5%) were followed up from the period of one month to six years with a mean follow up period of 1.18 years. Six patients did not return for follow up. Seventy patients had no deficits on follow up. One patient had shunt infection at one month follow-up which required removal of the shunt tube. One patient had generalized tonic clonic



**Figure 1:** Preoperative MRI of the Brain sagittal, (a) and axial, (b) showing colloid cyst in the anterior third ventricular region. Postoperative CT scan of the brain, (c-e) showing venous infarct in the right frontal lobe causing mass effect. Ventricular catheter of the external ventricular drainage is seen to be in the ventricle



**Figure 2:** Postoperative MRI of the brain (a) T1, and (b) T2, coronal after a transcallosal approach for a colloid cyst showing retraction edema of right frontal cortex

seizures at six-month follow-up. One patient had residual hemiparesis. Three patients had impaired recent memory at 3-month, one-year, and 5-year follow-up. None of the patients had a disconnection syndrome.

## Discussion

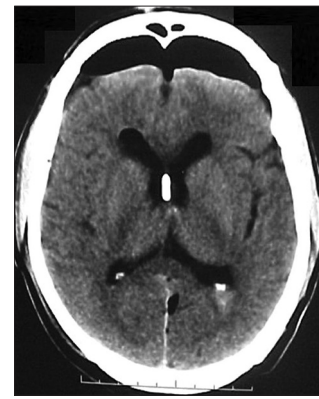
Colloid cysts have always provoked interest in neurosurgeons because of their controversial origin, benign histology, dramatic clinical presentations, and the variety of possible treatment options.

## Clinical features

Dandy's series included 31 autopsy cases, confirming the belief in sudden death as a common initial presentation of colloid cyst.<sup>[9]</sup> Ryder *et al.*<sup>[10]</sup> analyzed 56 cases of colloid cysts having suffered sudden death and postulated that the reflex effects involving the cardiovascular centers near the third ventricle might have contributed to the sudden death. The symptoms produced by colloid cysts of the third ventricle are primarily those of increased intracranial pressure and are non-localizing.<sup>[8,11-13]</sup> In our series, the duration of symptoms ranged from 15 days to 8 years. Seventy patients had complaints of headache, with 54 patients having features of raised intracranial pressure. None of these patients had true localizing signs or symptoms. Kelly stated that these symptoms were not specific for colloid cyst, as any midline mass may present similarly. However, they are a strong indication of a colloid cyst.<sup>[12]</sup>

## Radiology

On CT brain, these lesions can be clearly identified as round homogenous masses in the anterior third ventricle, in the region of the foramen of Munro. We analyzed three parameters; density of the cyst, enhancement of the cyst, and the presence of hydrocephalus. In our series, in 62 patients, the lesion was hyperdense to brain, and in 41 there was contrast enhancement. The 41 enhancing lesions were soft viscous and 21 non-enhancing were thick semisolid colloid. In



**Figure 3:** Postoperative CT scan of the brain of a patient operated for colloid cyst showing frontal pneumocephalus. Ventricular catheter of the external ventricular drainage is seen to be in the ventricle

eight patients, the lesion was hypodense, and in 10 patients the lesion was isodense to brain. In all these patients, there was soft, viscous colloid material, which could be aspirated. Kondziolka and Lunsford<sup>[14,15]</sup> reviewed 122 cases in the literature and they related the density directly to the viscosity of the cystic contents. They found that hyperdense cysts were unlikely to be aspirated successfully.

## Surgical management

All patients underwent a right frontoparietal midline craniotomy and anterior transcallosal transforaminal approach. Apuzzo *et al.*<sup>[16]</sup> studied the distribution of parasagittal venous complex in the region of the coronal sulcus in 100 angiograms. 70% of these venous tributaries entered the superior sagittal sinus within the sector 2 cm posterior to the coronal suture, whereas 30% were in the anterior 2 cm region. He stressed the importance of proper planning of the dural flap and by mobilizing rather than sacrificing the cortical veins.<sup>[17]</sup> The corpus callosum is incised in the midline between the pericallosal arteries for a length for 1.5 to 2.5 cm in the sagittal plane in the anterior corpus callosum. There is preference to open the corpus callosum between the two pericallosal arteries or depending on the local anatomy of the arteries and the disposition of their branches, the dissection is carried out by displacing both to either side depending on the curvature of the arteries.<sup>[18]</sup> An incision of up to 2.5 cm in the anterior body of the corpus callosum is adequate for the exposure of the ventricular system and does not cause any disconnection syndromes.<sup>[9,11,16,19-31]</sup> However, larger incisions in the corpus callosum involving the anterior and mid corpus callosum have been reported to result in impairment of interhemispheric transfer of information.

In majority of the cases, the lesion is found bulging at the foramen of Munro and can be excised by the transforaminal approach. The foramen of Munro is never made wider by incision of the brain tissue.<sup>[32]</sup>

### Complications: Transient memory loss

Transient memory loss is probably due to forniceal manipulation during surgery and is not an unusual postoperative complication.<sup>[16,24,33-35]</sup> Little and MacCarty reported no incidence of memory loss or personality changes following division of the anterior column of the fornix in patients with colloid cysts.<sup>[36]</sup> Memory deficits probably arise from direct and transmitted injury to deep midline and paramedian structures such as the basal forebrain nuclei, thalamic nuclei, septal nuclei, and inferior thalamic peduncle.<sup>[37-40]</sup> Some studies find little influence of one forniceal injury on recent memory if the contralateral fornix is intact.<sup>[41]</sup> The potential importance of the septal nuclei in memory function is underscored by the frequency of the amnesia in a patient who sustain rupture of the anterior communicating artery and subsequent damage to this region [Figure 4]. Hernesniemi and Leivo<sup>[32]</sup> have found that the far lateral corpus callosal incision has been especially valuable in avoiding memory disturbances. Jeeves *et al.*<sup>[42]</sup> found after careful testing that there is impairment in the transfer of the tactile data. However, Bogen<sup>[43]</sup> found that interhemispheric transfer of information is preserved as long as the splenium remained intact. Following forniceal lesion, it is observed that the remote memory is intact while there is loss of memory for recent events.<sup>[40,44]</sup> Woolsey and Nelson have discussed about sectioning of the fornix bilaterally for the treatment of epilepsy without any incidence of memory loss.<sup>[41]</sup>

### Postoperative mutism

This occurred in one patient where one of the large cortical veins draining into the superior sagittal sinus and a large vein in close proximity to the lesion got injured. Nakasu *et al.* stated that a partial callosotomy alone was not responsible for postoperative mutism. Instead, impairment of adjacent

structures such as cingulate gyrus, trauma to the wall of the anterior III ventricle and floor of the lateral ventricle, and damage to the dominant supplementary motor cortex may lead to postoperative mutism.<sup>[45]</sup> Bellotti *et al.* reported postoperative transient mutism as their most frequent complication following a transcallosal procedure.<sup>[46]</sup>

### Hydrocephalus

Of the 67 patients who had hydrocephalus, a preoperative right ventriculoperitoneal shunt was done in 16 patients, to reduce intracranial pressure as retracting a tense brain may cause retraction injury and edema. Postoperative hydrocephalus was seen in four patients. Three patients required a right ventriculoperitoneal shunt and one patient underwent revision of the preoperative shunt. Hydrocephalus secondary to obstruction of the foramen of Munro by colloid cyst is common. Despite complete removal of the cyst, there may be enough edema at the foramen of Munro and aqueductal stenosis which can result in acute hydrocephalus to warrant shunt placement.<sup>[47]</sup> Hall and Lunsford observed that hydrocephalus persisted even after complete removal of the colloid cyst.<sup>[48]</sup> Desai *et al.*<sup>[24]</sup> in the last 10 years excised the colloid cyst directly without prior shunt procedure and follow-up CT scan showed complete resolution of the hydrocephalus. Fenestration of the septum pellucidum was done in all 80 patients to communicate both the lateral ventricles should unilateral hydrocephalus develop. Also, the contralateral ventricle can be entered and the opposite side foramen of Munro can be inspected for any residual blood clots.

### Subdural hematoma

Subdural hematoma causing mass effect, and requiring evacuation, occurred in one patient. This patient had preoperative hydrocephalus and no CSF diversion procedure

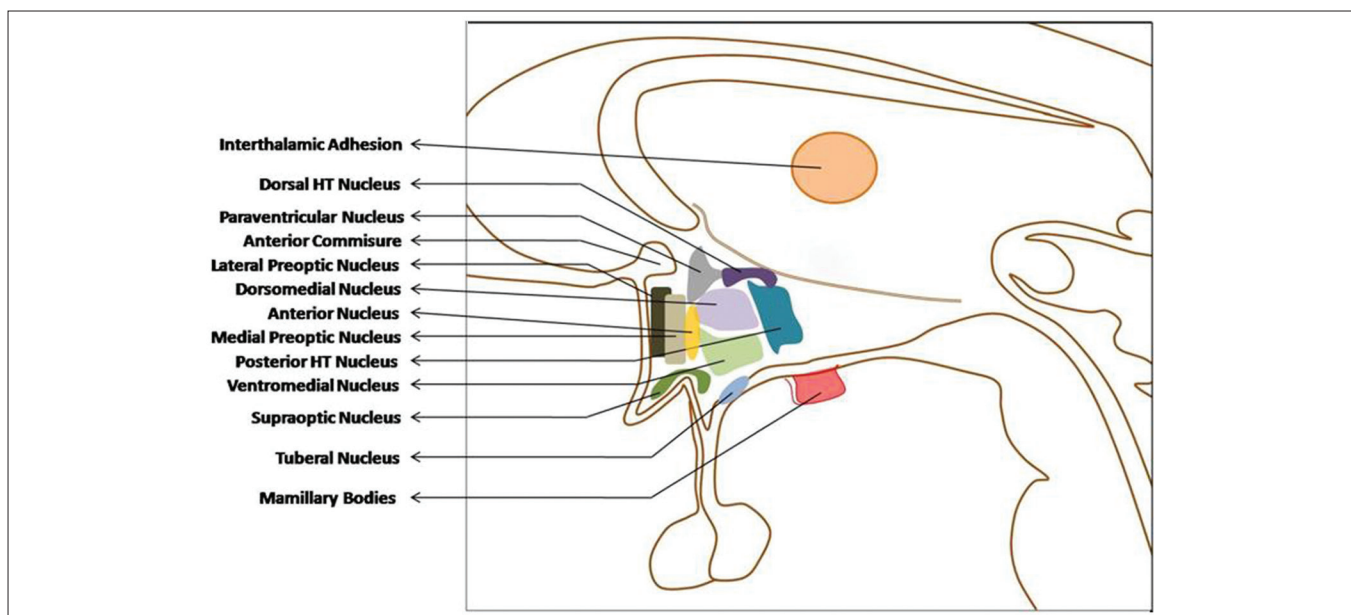


Figure 4: Hypothalamic and other nuclei around the third ventricle and foramen of Munro

was done. The cause may have been a rapid drainage of CSF intraoperatively. Hernesniemi and Leivo<sup>[32]</sup> also reported one patient who developed a chronic subdural hematoma in the postoperative period.

### Seizures

Six patients developed seizures in the postoperative period due to right frontal lobe venous infarct, right frontal horn pneumocephalus, acute hydrocephalus, and retraction edema. It is for this reason we routinely give anticonvulsants because of the frontal lobe retraction during surgery. Some neurosurgeons do not give anticonvulsants to patients undergoing transcallosal approach, as the cortical incision is avoided, thereby minimizing the risk of seizures. The incidence of postoperative seizures via the transcortical transventricular approach is 11%.<sup>[11,37]</sup> McKissock and Little<sup>[36]</sup> reported 12 to 13% of postoperative seizures via the transcortical approach; Villani *et al.*<sup>[29]</sup> reported 28%; and Desai *et al.*<sup>[24]</sup> reported 26.6%.

### Motor deficits

Four patients developed transient hemiparesis. Prolonged retraction may cause injury if the retractor is not periodically released. Excessive lateral retraction can result in frontal lobe swelling and medial retraction on the superior sagittal sinus can lead to sagittal sinus thrombosis.<sup>[28]</sup> Cerebral venous infarct secondary to a cortical vein occlusion causes serious neurological deficits and complication.<sup>[11,13,16,24,28,32,49,50]</sup> Apuzzo<sup>[19]</sup> stressed absolute preservation of the parasagittal cortical venous system whenever possible. He also recommended cerebral angiography before surgery to map out the cortical venous anatomy. Sugita *et al.*<sup>[17]</sup> have described the technique for preservation of bridging veins. Arterial injury may occur during lateral dissection, which may cause injury to small branches of the pericallosal arteries.<sup>[3]</sup> Also, when the cingulate gyrus of both sides are adherent and, it may be mistaken for the corpus callosum and on performing a callosotomy, cortical damage of the cingulate gyrus can occur; in addition, one may injure the callosomarginal artery during dissection causing contralateral lower extremity weakness. Woiciehowsky *et al.*<sup>[51]</sup> found variations in the course and branching pattern of the anterior cerebral artery, which may confuse the surgeon. The close relationship of the genu of the internal capsule to the foramen of Munro must be kept in mind when retracting the walls of the lateral ventricle.<sup>[52]</sup>

### Mortality

There were two postoperative deaths. Both patients developed basal ganglia hemorrhagic infarct with intraventricular bleed due to vascular injury. Laryne *et al.* have mentioned that there is no risk in coagulation of the thalamostriate vein.<sup>[26,53]</sup> Hirschs *et al.* have mentioned that coagulation of the thalamostriate vein could lead to severe neurological compromise.<sup>[54]</sup> We prefer not to coagulate the thalamostriate vein.

### Follow up

A total of 74 patients were followed up from the period of one month to six years with a mean follow up period of 1.18 years. Seventy patients had no deficits on follow up. One patient had residual hemiparesis, and three patients had impaired recent memory at 3-month, one-year, and 5-year follow-up. None of the patients had a disconnection syndrome.

### Natural History of Colloid Cyst

Sudden deterioration and death have been described in benign tumors of the third ventricle and foramen of Munro area, majority of these neoplasms being colloid cyst.<sup>[32,50,55]</sup> The proposed mechanism has been ventricular obstruction and acute hydrocephalus with brain herniation. Pollock and Huston<sup>[56]</sup> analysis comparing symptomatic and asymptomatic patients with colloid cyst found four factors associated with cyst-related symptoms. They are as follows: (1) Younger patient age, (2) Cyst size, (3) Ventricular dilatation, (4) Increased signal on T2-weighted MRI and concluded that patients with third ventricular colloid cysts become symptomatic when the tumor enlarges rapidly causing CSF obstruction, ventriculomegaly, and raised intracranial pressure. The patient with colloid cysts larger than 1.5 cm should be considered for surgical excision as these cysts are more likely to become symptomatic.<sup>[56]</sup> Also, MacDonald *et al.* stressed that younger patients are more likely to become symptomatic during their life time and thus require surgery.<sup>[57]</sup>

### Conclusion

The transcallosal transforaminal approach is a safe anatomical approach with minimal tissue destruction and the most direct path to excise third ventricular colloid cyst, without dependence on hydrocephalus. Total excision of the lesion is a permanent cure with low mortality and minimum morbidity and with increasing experience, most complications are avoidable and can be minimized. There are no major permanent deficits in memory or intellectual function due to the limited anterior callosotomy and forniceal handling and the approach does not result in disconnection syndromes, or behavioral abnormalities.

### References

1. Wallmann H. Eine Colloidcyste im dritten Hirnventrikel und ein Lipom im Plexus Choroideus. *Virchows Arch Pathol Anat* 1858;14:385-8.
2. Dandy WE. Diagnosis, localization and removal of tumours of the third ventricle. *Bull Johns Hopkins Hosp* 1922;33:188-9.
3. Ehni G. Interhemispheric and pericallosal (transcallosal) approach to the cingulate gyri, intraventricular shunt tubes, and certain deeply placed brain tumours. *Neurosurgery* 1984;14:99-110.
4. Hirano A, Ghatak NR. The fine structure of colloid cysts of the third ventricle. *J Neuropathol Exp Neurol* 1974;33:333-41.
5. Kappers JA. The development of the paraphysiscerebri in man with comments on its relationship to the intercolumnar tubercle and its significance for the origin of cystic tumors in the third ventricle. *J Comp Neurol* 1955;102:425-509.

6. Shuangshoti S, Roberts MP, Netsky MG. Neuroepithelial (colloid) cysts: Pathogenesis and relation to choroid plexus and ependyma. *Arch Pathol* 1965;80:214-24.
7. Sjovall E. Ubereine Ependymcysteembryonalen Charakters (Paraphyse?) im dritten Hirnventrikel mit lipochromer Verande rungen mit auf treten von Halbondkorperchen. *Beitr Pathol Anat* 1910;47:248.
8. Yenerman MH, Bowerman CI, Haymaker W. Colloid cyst of the third ventricle: A clinical study of 54 cases in the light of previous publications. *Acta Neuroveg (Wien)* 1958;17:211-77.
9. Dandy WE. Benign tumours of the third ventricle of the brain: Diagnosis and treatment. Springfield, IL: Charles C Thomas; 1933.
10. Ryder JW, Kleinschmidt-DeMasters BK, Keller TS. Sudden deterioration and death in patients with benign tumour of the third ventricle area. *J Neurosurg* 1986;64:216-23.
11. Camacho A, Abernathy CD, Kelly PJ, Laws ER Jr. Colloid cyst: Experience with the management of 84 cases since the introduction of computed tomography. *Neurosurgery* 1989;24:693-700.
12. Kelly R. Colloid cysts of the third ventricle: Analysis of twenty-nine cases. *Brain* 1951;74:23-65.
13. Nitta M, Symon L. Colloid cysts of the third ventricle: A review of 36 cases. *Acta Neurochir (Wien)* 1985;86:99-104.
14. Kondziolka D, Lunsford LD. Stereotactic management of colloid cyst: Factors predicting success. *J Neurosurg* 1991;75:45-51.
15. Kondziolka D, Lunsford LD. Factors predicting successful stereotactic aspiration of colloid cysts. *Stereotact Funct Neurosurg* 1992;59:135-8.
16. Apuzzo ML, Chikovani OK, Gott PS, Teng EL, Zee CS, Giannotta SL, *et al.* Transcallosal, interforaminal approaches for lesions affecting the third ventricle: Surgical considerations and consequences. *Neurosurgery* 1982;10:547-54.
17. Sugita K, Kobayashi S, Yokoo A. Preservation of large bridging veins during brain retraction. *J Neurosurg* 1982;57:856-8.
18. Sridhar K. Surgical approach to the anterior third ventricle. In: Ramamurthi B, Tandon PN, editors. *Textbook of Neurosurgery II* ed. BI Churchill Livingstone; 1996. p. 94-945.
19. Apuzzo ML. Commentary. *Neurosurgery* 1990;26:542.
20. Apuzzo ML, Heifetz MD, Weiss MH, Kurze T. Neurosurgical endoscopy using the side viewing telescope. *J Neurosurg* 1977;46:398-400.
21. Bosch DA, Rahn T, Backlund EO. Treatment of colloid cysts of the third ventricle by stereotactic aspiration. *Surg Neurol* 1978;9:15-18.
22. Cabbell KL, Ross DA. Stereotactic microsurgical craniotomy for the treatment of third ventricle colloid cyst. *Neurosurgery* 1996;38:301-7.
23. Challa VR, Markesbery WR. Infratentorial neuroepithelial cyst (colloid cyst): Case report. *J Neurosurg* 1978;49:457-9.
24. Desai K, Nadkarni TD, Muzumdar DP, Goel AH. Surgical management of colloid cyst in the III ventricle. Study of 105 cases. *Surg Neurol* 2002;57:295-302.
25. Gazzaniga MS, Risse GL, Springer SP, Clark E, Wilson DH. Psychologic and neurologic consequences of partial and complete cerebral commissurotomy. *Neurology* 1975;25:10-5.
26. Lavayne MH, Patterson RH. Subchoroidal trans-velum interpositum approach to mid third ventricular tumours. *Neurosurgery* 1983;12:86-94.
27. Petrucci RJ, Buchheit WA, Woodruff GC, Karian JM, DeFilipp GJ. Transcallosal paraforaminal approach for third ventricle tumour: Neuropsychological consequences. *Neurosurgery* 1987;20:457-64.
28. Shucart WA, Stein BM. Transcallosal approach to the anterior ventricular system. *Neurosurgery* 1978;3:339-43.
29. Vallani R, Papagno C, Tomei G, Grimoldi N, Spagnoli D, Bello L. Transcallosal approach to tumors of the third ventricle. Surgical results and neuropsychological evaluation. *J Neurosurg Sci* 1997;41:41-50.
30. Winston KR, Cavazzuti V, Arkins T. Absence of neurological and behavioral abnormalities after anterior transcallosal operation for third ventricle lesion. *Neurosurgery* 1979;4:386-93.
31. Zaidel D, Sperry KW. Memory impairment after commissurotomy in man. *Brain* 1974;97:263-72.
32. Hernesniemi J, Leivo S. Management outcome in third ventricular colloid cyst in a defined population: A series of 40 patients treated mainly by transcallosal microsurgery. *Surg Neurol* 1996;45:2-14.
33. Berti A, Arienda C, Papagno C. A case of amnesia after excision of the septum pellucidum. *J Neurol Neurosurg Psychiatry* 1990;53:922-4.
34. Kwan E, Wolpert SM, Smith SP, Modic MT. Radiology of third ventricular lesions. In: Apuzzo ML, editor. *Surgery of the third ventricle*. 1<sup>st</sup> ed. Baltimore: Williams and Wilkins; 1987. p. 262-300.
35. Salzman M, Yamamoto I, Rhoton AL Jr, Pearce D. Microneurosurgery of the third ventricle. Part I Microsurgical anatomy. *Neurosurgery* 1981;8:334-56.
36. Little JR, MacCarty CS. Colloid cysts of the third ventricle. *J Neurosurg* 1974;39:230-5.
37. Antunes JL, Louis KM, Ganti SR. Colloid cysts of the third ventricle. *Neurosurgery* 1980;7:450-5.
38. Apuzzo ML. Surgery of masses affecting the third ventricular chamber: Techniques and strategies. *Clin Neurosurg* 1988;34:499-522.
39. Carmel PW. Tumours of the third ventricle. *Acta Neurochir (Wien)* 1985;75:136-46.
40. Hodges JR, Carpenter K. Anterograde amnesia with fornix damage following removal of III ventricle colloid cyst. *J Neurol Neurosurg Psychol* 1991;54:633-8.
41. Woolsey RM, Nelson JS. Asymptomatic destruction of the fornix in man. *Arch Neurol* 1975;32:566-8.
42. Jeeves MA, Simpson DA, Geffen G. Functional consequences of the transcallosal removal of intraventricular tumours. *J Neurol Neurosurg Psychol* 1979;42:134-42.
43. Bogen JE. Callosotomy without disconnection. *J Neurosurg* 1994;81:328-9.
44. Milner B, Sweet WH, Talland GA, Ervin FR. Loss of recent memory following section of the fornix. *Trans Am Neurol Assoc* 1959;84:76-82.
45. Nakasu Y, Isozumi T, Nioka H, Handa J. Mechanism of mutism following the transcallosal approach to the ventricle. *Acta Neurochir (Wien)* 1991;110:146-53.
46. Bellotti C, Pappada G, Sani R, Oliveri G, Stangalino C. The transcallosal approach for lesions affecting the lateral and third ventricle: Surgical consideration and results in a series of 42 cases. *Acta Neurochir (Wien)* 1991;111:103-7.
47. Apuzzo ML. The colloid cyst Surgery of the III ventricle. 2<sup>nd</sup> ed. Baltimore: William and Wilkins; 1998.
48. Hall WA, Lunsford LD. Changing concepts in the treatment of colloid cysts. *J Neurosurg* 1987;66:186-91.
49. Mishra BK, Rout D, Padamadan J, Radhakrishnan VV. Transcallosal approach to anterior and mid third ventricular tumours a review of 62 cases. *Ann Acad Med Singapore* 1993;22 Suppl 3:435-40.
50. Mathiesen T, Grane P, Lindgren L, Lindquist C. Third ventricle colloid cysts: A consecutive 12 yrs series. *J Neurosurg* 1997;86:5-12.
51. Woiciechowsky C, Vogel S, Lehmann R, Staudt J. Transcallosal removal of lesions affecting the third ventricle: An anatomic and clinical study. *Neurosurgery* 1995;36:117-22; discussion 122-3.
52. Timurnayak E, Rhoton AL Jr, Barry M. Microsurgical anatomy and operative approach to the lateral ventricles. *Neurosurgery* 1986;19:685-723.
53. Lavayne MH, Patterson RH. Subchoroidal trans-velum interpositum approach. In: Apuzzo ML, editor. *Surgery of the third ventricle*. 1<sup>st</sup> ed. Baltimore: Williams and Wilkins; 1987. p. 381-98.
54. Hirsch JF, Zouaoui A, Renier D, Pierre-Kahn A. A new surgical approach to the third ventricle interruption of the striothalamic vein. *Acta Neurochir (Wien)* 1979;47:135-47.
55. Chan RC, Thompson GB. Third ventricle colloid cysts presenting with acute neurological deterioration. *Surg Neurol* 1983;19:358-62.
56. Pollock BE, Huston J 3<sup>rd</sup>. Natural history of asymptomatic colloid cyst of the third ventricle. *J Neurosurg* 1999;91:364-9.
57. MacDonald RL, Humphreys RP, Rutka JT, Kestle JR. Colloid cysts in children. *Pediatr Neurosurg* 1994;20:169-77.

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