



Case Report

Surgical management of intraventricular neurocysticercosis: Two cases treated through transcallosal interhemispheric approach

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ABSTRACT

Background: Cysticercosis, caused by the larval stage of *Taenia solium*, is a prevalent parasitic infection affecting the central nervous system, primarily in low-income countries. Surgical intervention becomes necessary when cysticercosis manifests within the ventricular system, with endoscopic techniques increasingly preferred over traditional microsurgical methods due to lower risks and morbidity. However, the microsurgical transcallosal approach, although effective, is infrequently used due to its associated high morbidity.

Case Description: We present two cases of multiple intraventricular neurocysticercosis treated through an open microsurgical technique using a transcallosal interhemispheric approach. Patient 1, a 56-year-old male, presented with severe headaches persisting for 6 months, while Patient 2, a 54-year-old male, experienced a sudden decrease in consciousness. Both patients exhibited typical magnetic resonance imaging characteristics indicative of intraventricular neurocysticercosis, leading to the decision for surgical resection.

Conclusion: Despite the transcallosal approach's decreased popularity due to associated risks, we achieved relatively good outcomes with minimal morbidity in both cases. Our experience highlights the importance of considering microsurgical approaches, particularly in facilities lacking endoscopic instrumentation, for the effective management of intraventricular neurocysticercosis. Compliance with postoperative medical therapy remains crucial to prevent recurrence.

Keywords: Hydrocephalus, Infection, Neurocysticercosis, Neurosurgery, Transcallosal

INTRODUCTION

Cysticercosis is the most prevalent parasitic infection affecting the central nervous system (CNS), primarily found in low-income countries.^[7,18,20,22] It is caused by *Cysticercus cellulosae*, the larval stage of the pork tapeworm, *Taenia solium*.^[7,18] Surgical intervention typically becomes necessary when cysticercosis manifests within the ventricular system. However, traditional microsurgical methods have largely been phased out due to their associated high risks and morbidity in favor of minimally invasive techniques such as endoscopic surgery.^[2,15,21] Among these, the transcallosal approach, a microsurgical method, has become infrequently used in the contemporary treatment of intraventricular neurocysticercosis due to its high morbidity.^[15,18,21] Nonetheless, this approach can be performed with minimal morbidity, provided that the surgeons are well-versed in avoiding known pitfalls.

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This case report details the treatment of two patients with multiple intraventricular neurocysticercosis using a microsurgical technique through a transcallosal interhemispheric approach. We provide a comprehensive account of the clinical history, examination, operative procedure, histopathological findings, postoperative care, and discussion, including insights from previous studies and literature.

CASE DESCRIPTION

History

A 56-year-old male, Patient 1, presented to the emergency department with severe headaches persisting for the past 6 months. He described the headache as a heavy load pressing on his head, occurring intermittently up to 4 times a day, with each episode lasting approximately 1 h. The headaches had worsened over the past 2 weeks despite taking pain medication, which provided only temporary relief. In addition, the patient occasionally spoke incoherently during these headache episodes. No other associated symptoms, such as seizures, nausea, vomiting, weakness in the extremities, or sensory complaints were reported. The patient stated consuming medium-rare pork meat roughly 4 times a week. He had a history of hydrocephalus treated in 2001 with the insertion of a ventriculoperitoneal (VP) shunt at the right Kocher point.

Patient 2, a 54-year-old male, arrived at the emergency department due to a sudden decrease in consciousness 12 hours before admission. Following the onset, he became drowsy and began speaking incoherently. The day before these symptoms developed, he experienced a high fever, which subsided after taking over-the-counter medication such as paracetamol. In addition, he had a history of chronic headaches for the past year, which had intensified over the past week. Similar to Patient 1, there were no other associated symptoms such as seizures, nausea, vomiting, weakness in the extremities, or sensory complaints. This patient consumed pork meat almost daily. He had a history of hydrocephalus treated in 2017 with the insertion of a VP shunt at the right Kocher point.

Physical examination

Patient 1

On physical examination, normal vital signs were noted, with a visual analog scale of 7 and a Karnofsky Performance Status (KPS) scale of 90. No abnormalities were detected on both physical and neurological examinations. Magnetic resonance imaging (MRI) in T1- and T2-weighted images revealed multiple loculated masses around the right lateral ventricle, third ventricle, and fourth ventricle [Figures 1a-d]. On the T2 sequence, multiple septae were observed inside the masses

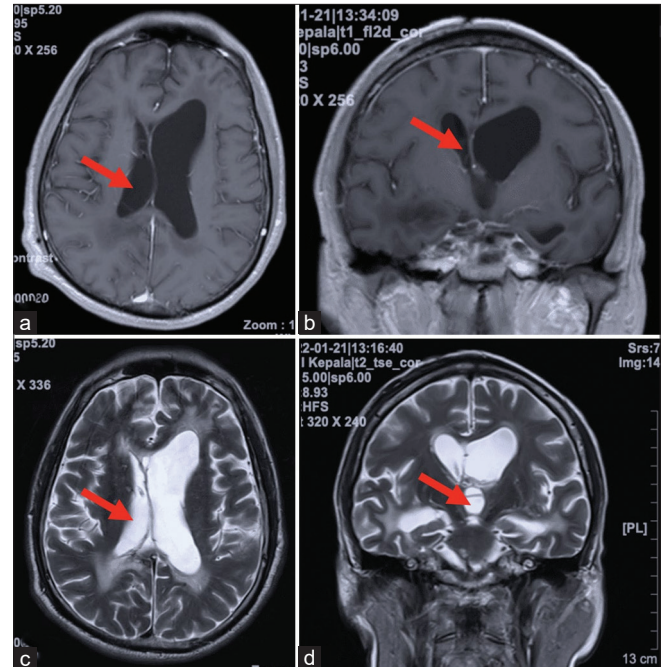


Figure 1: The magnetic resonance imaging depicts multiple loculated masses around the right lateral ventricle and third ventricle (red arrow). (a and b) Contrast-enhanced (a) axial and (b) coronal T1-weighted images. (c and d) (c) Axial and (d) coronal T2-weighted images revealing similar intensity between the mass and cerebrospinal fluid.

with a hyperintense feature, exhibiting the same intensity as cerebrospinal fluid (CSF). The masses displayed a thin layered wall and characteristic features resembling a cyst. In addition, dilation of both lateral, third, and fourth ventricles with periventricular edema suggestive of hydrocephalus was noted.

Patient 2

The patient's KPS scale was not recorded. During the physical examination, tachycardia was observed, with a heart rate of approximately 124 beats per minute, alongside an elevated body temperature of around 38.5°C. The patient's Glasgow coma scale (GCS) score was 12, with three for eye response, four for verbal response, and five for motor response. A positive meningeal sign was also noted. No other neurological abnormalities were identified in this patient. MRI in T1- and T2-weighted images revealed multiple masses concentrated around both sides of the lateral ventricle [Figures 2a-c]. On the T2 sequence, the masses exhibited a hyperintense feature, consistent with the intensity of CSF. These masses displayed a thin layered wall and characteristic features resembling a cyst. In addition, the masses were observed to obstruct both sides of the interventricular foramen, resulting in dilation of both lateral ventricles with periventricular edema suggestive of hydrocephalus.

Based on the history, physical examination, and MRI findings, both patients were suspected to have developed intraventricular neurocysticercosis. Therefore, a microsurgical procedure was decided to resect the mass and obtain a histopathological specimen to confirm the diagnosis. We did not perform resection on the cyst in the fourth ventricle area in both patients due to the small size of the cyst and the limitations of the surgical window for cyst resection. We did not administer medical therapy using albendazole to these patients before the surgical procedure because both patients exhibited signs of increased intracranial pressure, necessitating immediate management through microsurgical cyst resection.

Operative procedure

Both patients underwent the same surgical approach. The procedure was performed with the patients in the supine position, with the head elevated at 45°. A linear skin incision was made approximately along the coronal suture, perpendicular to the midline. Following the scalp incision, a craniotomy was executed, extending laterally by 4 cm to the right of the midline, with a total length of 5 cm, comprising 3 cm anteriorly and 2 cm posteriorly to the coronal suture. The final cut with the craniotome was made to connect the burr holes along the sinus (midline) to ensure rapid access to the sinus in case of inadvertent tearing. Bone drilling was performed with utmost caution to preserve the integrity of the superior sagittal sinus in the midline. On completion of the craniotomy, an interhemispheric approach was undertaken. Entry into the midline structures was achieved while meticulously preserving all bridging veins. On reaching the depth between the falx and medial gyrus, identification of the corpus callosum and both pericallosal arteries was conducted. A callosotomy of approximately 1.5 cm in length was performed. Following entry into the ventricle,

all masses were identified and resected [Figures 3a-e]. Samples of the mass wall were collected and forwarded to the pathology anatomy laboratory for further histopathological examination. On resection of the masses, the dural flap was meticulously closed using a water-tight technique, followed by the closure of the bone flap. The scalp was sutured layer by layer. The surgical procedures for both patients lasted approximately 5–6 hours.

Histopathological features

Both patients exhibited identical macroscopic and microscopic characteristics. The mass wall appeared white and thin and possessed a rubbery consistency. Microscopically, both specimens were characterized by a vesicular cyst wall and a reticular layer [Figures 4a-d]. The vesicular cyst wall consisted of three layers, arranged from outer to inner: the eosinophilic cuticular layer, a layer of smooth muscle fibers, and a cellular layer containing numerous small, uniform, and round nuclei. Within the reticular layer, excretory canaliculi containing fungal fibers were observed [Figures 4c and d]. Of significant note, both specimens contained larvae and some mummified dead larvae, consistent with the hallmark features of neurocysticercosis. Tissue specimens were stained with hematoxylin and eosin and examined at magnifications of $\times 100$ and $\times 400$.

Postoperative management

Both patients exhibited a favorable response to the surgical procedure postoperatively. Based on the histopathological results, the patients were diagnosed with intraventricular neurocysticercosis and prescribed cysticidal drugs such as albendazole for 30 days. Patient 1 was discharged on the 4th postoperative day and Patient 2 on the 5th postoperative day. Patient 2 regained consciousness with a discharge GCS of 15, and both patients experienced relief from symptoms of

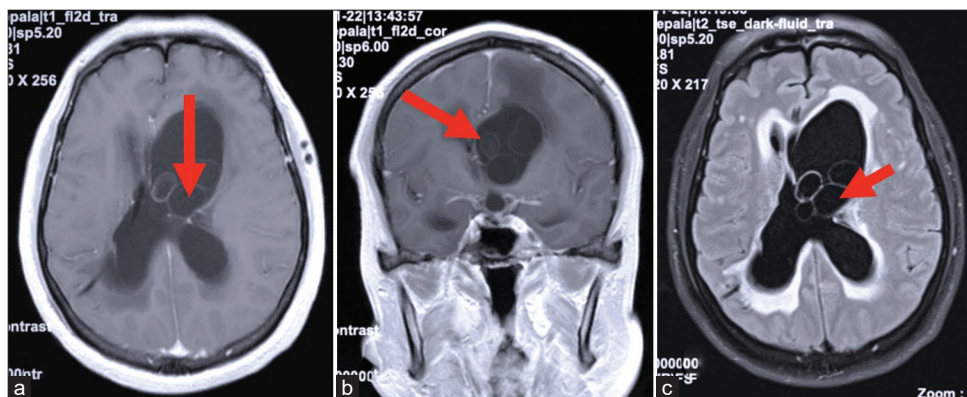


Figure 2: The magnetic resonance imaging reveals multiple masses located within both lateral ventricles (red arrow). (a and b) Contrast-enhanced (a) axial and (b) coronal T1-weighted images. (c) Fluid-attenuated inversion recovery image showing similar intensity between the mass and cerebrospinal fluid.

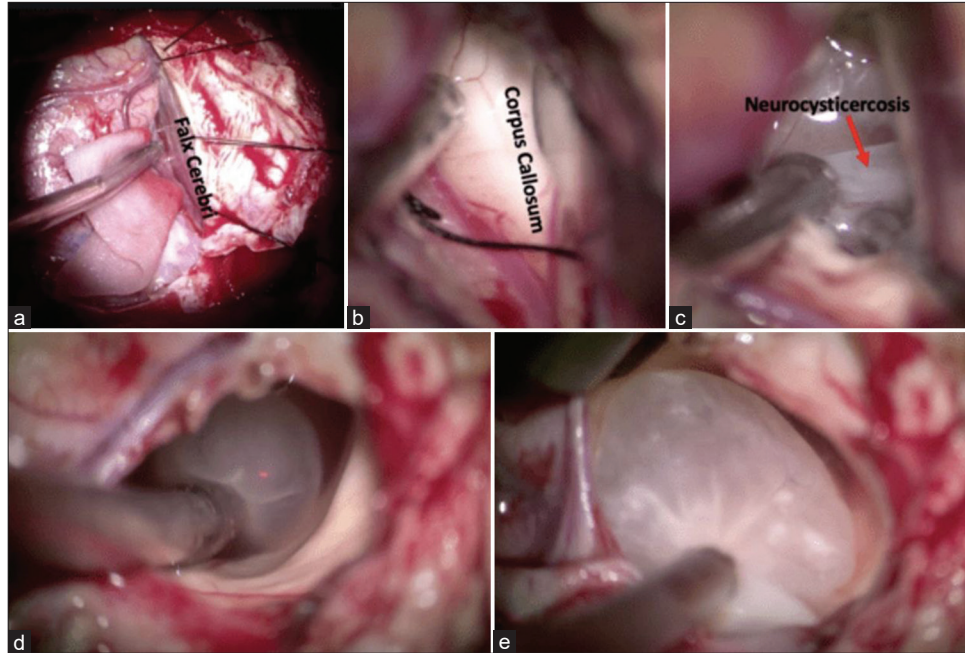


Figure 3: Intraoperative view. (a, b, c) Intraoperative features during the transcallosal interhemispheric approach in Patient 1. (d and e) Intraoperative features during the transcallosal interhemispheric approach in Patient 2.

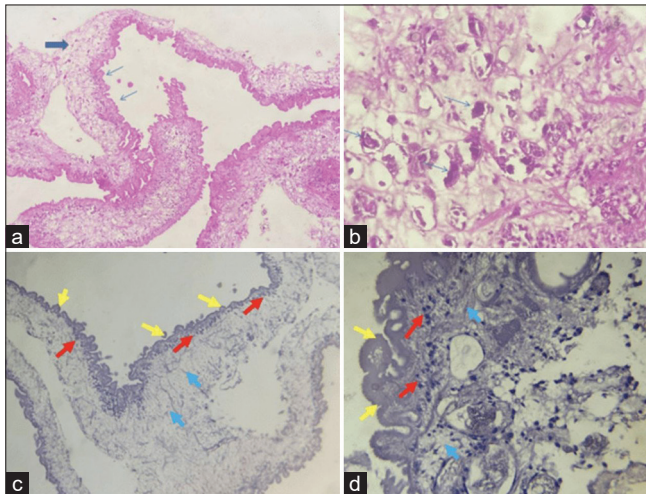


Figure 4: Histopathological features. (a) The microscopic appearance displays a vesicular cyst wall (thin arrow) and reticular layer (thick arrow). (b), The panel exhibits numerous mummified dead larvae (thin arrow). (c and d) The microscopic appearance illustrates the cellular layer (red arrow), reticular layer (blue arrow), and cuticular layer (yellow arrow) (Hematoxylin and eosin stain; x100 and x400 magnification).

headache. Patient 1 resided in a relatively remote area from our facility, making it impractical to conduct a repeat MRI, and follow-up could only be conducted through telephone. The patient remained in good condition without any limitations in performing daily activities. Patient 2 underwent a repeat MRI examination 1 year later, revealing recurrence

of cysts in the lateral ventricle area. The patient exhibited low compliance with cysticidal therapy. During follow-up, there was no worsening of neurological conditions, and the patient was able to carry out daily activities without assistance.

DISCUSSION

Cysticercosis is the most common parasitic infection affecting the CNS.^[7,20,22] It is predominantly found in low-income countries and is caused by the larval stage of the pork tapeworm, *T. solium*, known as *cysticercus cellulosae*.^[7,18] Clinical manifestations vary, with the most frequent symptoms including headache and seizures.^[7,18,19] In addition, the patient's clinical status may be influenced by head movements, a phenomenon known as Brun's syndrome. In this condition, movements of the head can alter the position of the cyst, leading to obstruction of CSF flow within the ventricular system and resulting in various neurological deficits.^[3,24]

The radiological pattern of MRI in patients with neurocysticercosis exhibits certain characteristic features.^[12,13,18,23] From the initial findings, a non-enhancing cystic structure with eccentric T1W1 hyperintensity (scolex) is observed, typically without any inflammatory response. These cysts can be located anywhere within the CNS structure, including intraparenchymal, ventricular, or subarachnoid spaces. Additional findings, such as calcification and hydrocephalus, may also be present.^[12] When developing intraventricularly, the cysts are primarily situated in the fourth ventricle, followed by the lateral and third ventricles.^[12,18] In

our cases, both patients exhibited similar MRI characteristics, such as a non-enhancing mass on T1 and a hyperintense feature with the same intensity as CSF on T2. These masses developed within the ventricular system, mainly around both lateral ventricles, obstructing the interventricular foramen. Consequently, both patients displayed signs of hydrocephalus.

Treatment with cysticidal drugs such as albendazole may be recommended for patients with neurocysticercosis, both in parenchymal and intraventricular cases, as reported in several cases and literature.^[1,5,6,9] However, the use of medical therapy in cases of intraventricular neurocysticercosis remains unclear, both in terms of its utility and safety.^[9,17,25] A study conducted by Gongora-Rivera *et al.* showed that only six out of 14 patients treated with albendazole for 8 days demonstrated a reduction in cyst size within 6 months post-therapy.^[8] The recommended dosage of albendazole is 15 mg/kg/day, with some suggesting a treatment duration ranging from 3 to 30 days. In this case, we administered albendazole treatment for 30 days to achieve optimal results.

Most cases of intraventricular neurocysticercosis are managed surgically, involving either addressing the underlying hydrocephalus or directly excising the cyst.^[2,10,15,21] CSF diversion may be employed to manage hydrocephalus, but the tubing runs the risk of obstruction by granulomatous inflammatory debris. Various operative techniques exist for cyst resection, including microsurgery and endoscopic surgery.^[18] In contemporary neurosurgery, minimally invasive techniques like endoscopic procedures are favored.^[25] This approach is commonly chosen due to its minimally invasive nature, providing broad access to the operating surgeon for extensive cyst resection. However, in our cases, we opted for microsurgical cyst resection over endoscopic resection for several reasons. First, due to limitations in our facilities where endoscopic equipment is unavailable. Second, we chose microsurgical resection due to its high success rate in our institution, whether used in tumor cases or other intracranial lesions.

The choice of microsurgical approach depends on the cyst's location, which may necessitate a transcortical or transcallosal approach.^[2,15,21] The transcallosal approach, however, is less favored by many surgeons due to limited visualization and anatomical complexities.^[15] Challenges include preserving surrounding bridging cortical veins to prevent venous infarction and distinguishing between structures such as the cingulate gyrus and corpus callosum or the callosomarginal arteries and pericallosal arteries. To address these challenges, we differentiate the corpus callosum by its white structure, located beneath both pericallosal arteries and typically deeper than expected. Furthermore, this surgical procedure presents considerable challenges, chiefly because the incision in the corpus callosum area is confined to <2.5 cm, posing a risk of disconnection syndrome. In our cases, we limited the incision to 1.5 cm in both patients to mitigate this risk. Despite its

decreased popularity, we continue to utilize the transcallosal approach as the primary treatment for intraventricular cysts, particularly in facilities lacking endoscopic instrumentation. From our experience, this surgical approach has effectively excised all intraventricular cysts with minimal morbidity and no neurological deficits in both patients. Although the efficacy of medical treatment for intraventricular cysts remains uncertain, we supplemented both patients' treatment with cysticidal drugs postoperatively to aid in their recovery and eliminate any remaining larvae. Unfortunately, the second patient exhibited low compliance with therapy.

In the second patient, several factors contributed to why some cysts remained in the intraventricular cavity, despite our belief during intraoperative assessment that all cysts in the ventricles were well visualized and completely resected. First, although the patients were prescribed cysticidal drugs, they did not regularly consume the medication as prescribed, indicating low compliance with the medication. Second, neurocysticercosis can exhibit recurrence, particularly in cases of partial resection such as ours, where cysts in the fourth ventricle were not resected. This is supported by several studies showing recurrence rates ranging from 0% to 11.47%, with the highest average recurrence occurring in cases of partial resection (6.87%) compared to total resection (0.71%).^[4,11,14,16] Finally, the interval between the resection and the follow-up MRI scan was quite long, reaching 1 year. Based on all these factors, it can be understood why the recurrence of the cyst was found on the follow-up MRI scan.

CONCLUSION

Cysticercosis stands as the prevailing parasitic infection encountered within the CNS. Surgical intervention frequently proves necessary for the majority of cases of intraventricular neurocysticercosis, either to manage underlying hydrocephalus or to directly excise the cyst. The selection of a microsurgical approach hinges on the specific location of the cyst. Despite the transcallosal approach being seldom employed for treating patients with intraventricular neurocysticercosis due to its associated high morbidity, we could execute this procedure without significant morbidity in both cases.

Ethical approval

The Institutional Review Board approval is not required.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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