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Transventricular endoscopic approach to the anterior interhemispheric fissure for neurocysticercosis: illustrative cases

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BACKGROUND Neurocysticercosis (NCC) is a global public health problem. It is a complex disease to manage and a cause of great morbidity and mortality in affected patients. Conventional surgical approaches have been used for many years, but currently, minimally invasive approaches are being used with good results. The authors present a case of NCC in the anterior interhemispheric fissure that was treated with a transventricular endoscopic approach.

OBSERVATIONS A 32-year-old male patient was admitted for persistent moderate headache and dizziness. Gadolinium-enhanced magnetic resonance imaging (MRI) showed multiple parenchymal, ventricular, and subarachnoid cystic lesions, especially in the anterior interhemispheric space. A transventricular endoscopic approach was selected and applied. There were no complications during surgery. Pathological analysis confirmed the diagnosis of NCC. Control MRI demonstrated the absence of cysts in the anterior interhemispheric space.

LESSONS Minimally invasive approaches are an excellent alternative for patients with NCC, especially if a patient requires more than one surgery.

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KEYWORDS neurocysticercosis; endoscopic approach; anterior interhemispheric fissure

Neurocysticercosis (NCC) is the most common parasitic infection of the central nervous system (CNS), caused by the larval form of *Taenia solium*.[1,2] In the CNS, it manifests as a subacute and/or chronic pleomorphic disease and can affect parenchyma, ventricles, and subarachnoid space. The clinical presentation depends on the number, location, and stage of development of the cysticerci as well as the host's immune response.[3–5] Due to the increased migration of people from endemic regions, NCC has become a major health problem worldwide.[6–9] Treatment includes antiparasitic drugs (praziquantel and albendazole) and surgery. Many patients require more than one neurosurgical procedure[10–12] prior to medical treatment. Conventional (e.g., pterional, suboccipital, bifrontal) and minimally invasive approaches are used.[13,14] In this case, we used a transventricular endoscopic approach to reach the anterior interhemispheric fissure (AIF) in a patient with multiple NCC localizations.

Illustrative Case

A 32-year-old male patient with no significant medical history was admitted to the emergency service of the National Institute of Neurological Sciences, a neurological referral center in Lima, Peru, with persistent headache of moderate intensity and dizziness that did not resolve with treatment. On neurological examination, he was disoriented to space and time without other neurological signs. Serum immunoblot for cysticercosis was strongly positive. Magnetic resonance imaging (MRI) (Fig. 1A) using a fast imaging steady-state acquisition sequence showed multiple parenchymal, ventricular, and subarachnoid (anterior interhemispheric fissure) cystic images without perilesional edema, with collapse of the frontal horns of both ventricles due to the effect of the cyst mass. In the gadolinium-enhanced T1 sequence (Fig. 1B) in AIF, multiple cysts near the anterior communicating vascular complex were seen. After

ABBREVIATIONS AIF = anterior interhemispheric fissure; CNS = central nervous system; CSF = cerebrospinal fluid; ETV = endoscopic third ventriculostomy; MRI = magnetic resonance imaging; NCC = neurocysticercosis.

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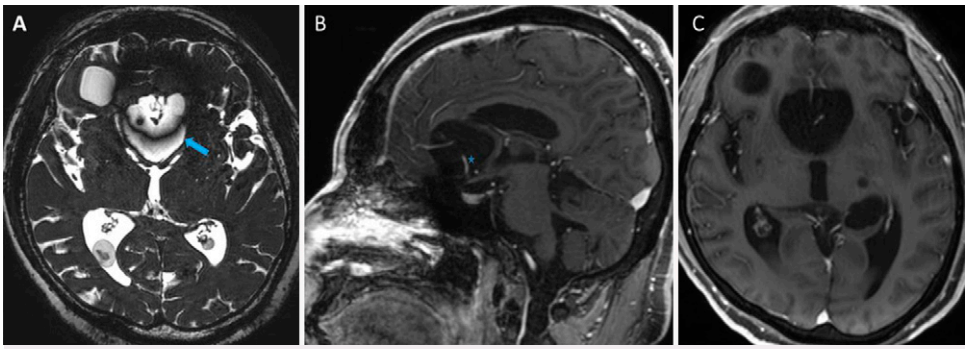

FIG. 1. Preoperative gadolinium-enhanced MRI. **A:** Axial fast imaging steady-state acquisition (FIESTA) sequence showing cystic images in the AIF space (*light blue arrow*), with the frontal horns of both lateral ventricles collapsed due to mass effect of the cysts. **B:** Sagittal image showing the anterior vascular complex (*light blue asterisk*) surrounded by cysts in the subcallosal AIF space that displace the anterior wall of the lateral and third ventricle. **C:** Axial image showing anterior communicating vascular complex surrounded by cysts.

discussing the case, considering that cysts in the subarachnoid space are usually not adherent to the surrounding structures (greatly decreasing the risks of complications), and considering that this patient was a candidate for more than one surgical procedure prior to starting antiparasitic treatment, a minimally invasive endoscopic approach was chosen.

Surgery

We used a Storz device for ventricular endoscopy, approaching through the right Kocher's point with a trephine, in the same projection as for an endoscopic third ventriculostomy (ETV) once in the right lateral ventricle the thalamus-striate vein, choroid plexus, and the protrusion at the floor of the lateral ventricle produced by the NCC cysts in the AIF (Fig. 2), which was fenestrated with bipolar coagulation up to the AIF (Fig. 2). From here, some cysts began to appear and were removed with a Nelaton #8 probe, which allowed us to extract a greater volume of cysts than endoscopic biopsy forceps. The procedure was repeated with very slight traction and rotation to detach the cysts from the brain parenchyma and arteries. As expected, we did not find resistance to extracting the cysts. Still, much caution is advised because a lesion in the principal arteries or performant branches could be a catastrophic complication. Finally, in the AIF, the entire anterior communicating complex was identified (Fig. 2F), and all cysts were removed. There were no

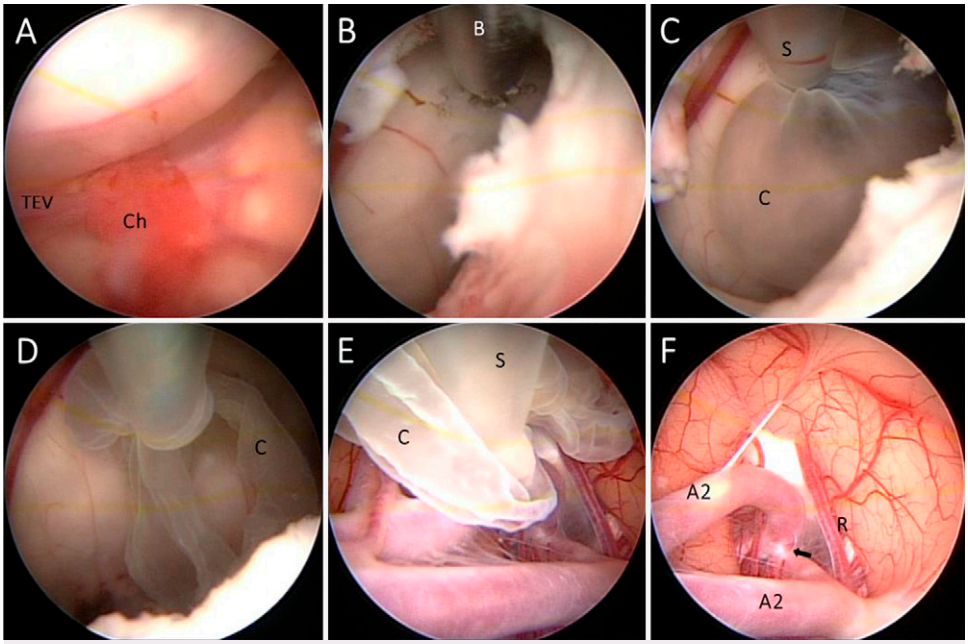

FIG. 2. Intraoperative images. **A:** Initial view of the right lateral ventricle showing the thalamo-striate vein (TEV) and choroid plexus (Ch). **B:** Fenestration of the floor of the lateral ventricle with bipolar. **C and D:** Extraction of NCC cysts protruding into the lateral ventricle with a Nelaton #8 probe. **E:** Extraction of NCC cysts from the AIF. **F:** Final view of the AIF in which the entire anterior communicating vascular complex can be seen. *Black arrow* indicates anterior communicating artery. A2 = anterior cerebral artery segment A2; C = NCC cysts; R = Heubner's recurrent artery; S = Nelaton catheter #8.

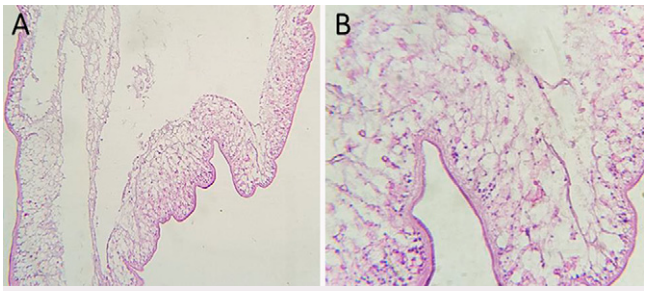

FIG. 3. Cysticercal membranes extracted by endoscopy. Typical double layer, eosinophilic membranes. Hematoxylin and eosin, original magnification ×10 (**A**) and ×40 (**B**).

complications during the procedure. The membranes were sent to pathology, which confirmed the diagnosis of NCC (Fig. 3). The patient was discharged without acute neurological signs, with continuous monitoring because of the risk of hydrocephalus that may develop because of cysts migrating in the ventricular space or the chronic inflammatory reaction characteristic of subarachnoid NCC. The patient was readmitted 2 weeks later due to hydrocephalus, which was treated with the installation of a ventriculoperitoneal shunt. MRI at 2 months showed no evidence of NCC cysts in AIF (Fig. 4). He received antiparasitic treatment with albendazole for 2 months. Currently, the patient is being followed up and has a modified Rankin score of 1.

Discussion

Observations

NCC is a complex disease. The extraparenchymal forms of NCC (ventricular and subarachnoid) are the ones that usually require neurosurgical treatment due to obstruction of the flow of cerebrospinal fluid (CSF), conditioning signs and symptoms of intracranial hypertension secondary to hydrocephalus in most cases, or mass effect and focal neurological signs, depending on the location of the lesions.[15] Neurological manifestations of NCC are extremely variable, from asymptomatic patients to extremely symptomatic patients with intracranial hypertension and a severe immunological-inflammatory reaction surrounding vascular and nervous structures.[15] Because the transfrontal transaqueductal approach for aqueductal stenosis was modified and adopted for ventricular NCC surgery soon after its description, we used these same principles to plan this surgery. Surgery for ventricular NCC currently uses conventional approaches,[16–18] endoscopy, and, recently, stereotactic surgery.[14] The main complications are hydrocephalus and infection (meningitis or ventriculitis),[14,19–21] and frequently patients require reintervention for these causes. There are no recorded intraoperative deaths. Perioperative mortality was 13%, mainly in relation to acute hydrocephalus in patients who had posterior fossa explorations.[22] Approaches with flexible and rigid endoscopes have been used for these procedures, both providing adequate management and preservation of the vascular-nervous tissue.[22–24]

For intraventricular lesions, the main differential diagnoses include colloid and ependymal cysts.[2] Cysts may be present in the lateral, third, or fourth ventricles, the latter location being the most common.[25] The most frequent location of extraparenchymal NCC is in the basal cisterns. Involvement of other spaces, as in our case in the anterior interhemispheric cistern, near the anterior communicating vascular complex, is less frequent. Contrast-enhanced neuroimaging studies allow assessment of the magnitude of the perilesional inflammatory reaction, information that is essential to plan surgery. In the ventricular and subarachnoid spaces, NCC cysts are most times free and not attached to the surrounding tissues; thus, no enhancement is seen. When contrast enhancement is observed in the cyst walls, it suggests that they are densely adhered to surrounding tissues, and resection attempts can cause local damage and bleeding leading to neurological morbidity and poor outcomes. In these cases, it is advisable to be cautious and, instead of resecting the lesions, install a CSF derivation and initiate antiparasitic treatment.[11,24,26]

The basic principle for the treatment of NCC is to eliminate as many cysts as possible, thus resolving the obstruction or mass effect and allowing antiparasitic treatment to be started early, reducing the intensity of the immunological-inflammatory reaction caused by the destruction of large cyst masses. Many patients, after removing cysts resolving their obstructive effect, would still develop hydrocephalus and require a ventriculoperitoneal shunt system,[27] as with our case.

Exploration of the basal cisterns through ETV is a common procedure in ventricular endoscopic surgeries, which in the case of NCC aims to remove cysts from these spaces and allows careful exploration from the interpeduncular cistern to higher levels of the subarachnoid space of the cervical spine.[28,29] Exploration of the AIF for NCC has not been described. Proaño et al.[28] presented in 2009 a comparative study between conventional approaches and

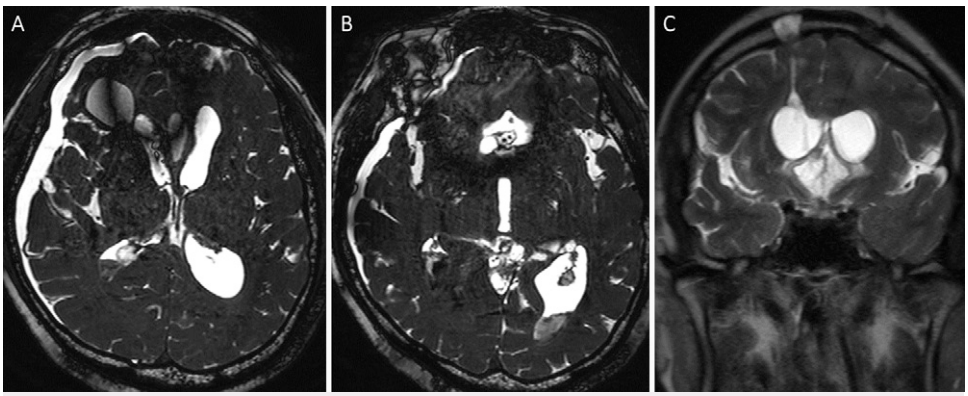

FIG. 4. Postoperative MRI. Axial FIESTA sequences (**A and B**) showing absence of NCC cysts in the AIF. Frontal horns of both lateral ventricles are now visible. Coronal T2-weighted MRI (**C**) showing dilated frontal horns, AIF free of cysts, and the path of the approach to the right lateral ventricle.

flexible cerebral endoscopy—so far the largest report on surgical treatment of NCC of basal and intraventricular cisterns. Functional results at 6 months of follow-up were significantly better for flexible endoscopy ($p = 0.003$).[28]

Lessons

Minimally invasive neurosurgical approaches are an excellent alternative for the management of tumoral and infectious pathology of the nervous system, as in our case. Confirmation that NCC cysts are not adhered to vascular and nerve structures is essential to plan and perform surgery with minimal risk of vascular injury, as discussed in the case presented. In patients with multiple massive NCC, there is frequently the need for more than one surgery, which makes it more imperative to use less invasive procedures and reduce potential adverse outcomes in the patients.

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Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: Lines-Aguilar, Vásquez, Romero. Acquisition of data: Lines-Aguilar, Caucha, Romero. Analysis and interpretation of data: Lines-Aguilar, Medina, Heredia, Romero. Drafting the article: Lines-Aguilar. Critically revising the article: Lines-Aguilar, Saavedra, García. Reviewed submitted version of manuscript: Lines-Aguilar, García. Approved the final version of the manuscript on behalf of all authors: Lines-Aguilar. Administrative/technical/material support: Lines-Aguilar, Apaza, Romero. Study supervision: Lines-Aguilar. Operating surgeon: Lines-Aguilar.

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