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Third-Ventricular Neurocysticercosis: Hydraulic Maneuvers Facilitating Endoscopic Resection

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Abstract

Neurocysticercosis, infection of the central nervous system with the larval cysts of the pork tapeworm, *Taenia solium*, is the most common parasitic disease of the central nervous system. The disease is a major global cause of acquired epilepsy and may also manifest as intracranial hypertension due to mass effect from large cysts, or to cerebrospinal fluid flow obstruction by intraventricular cysts or inflammation of the subarachnoid space. While the condition is endemic in several regions of the world and has been appreciated as a public health problem in such regions for several decades, its emergence in the United States in areas far from the Mexican border is a more recent phenomenon. We present a case of surgically corrected acute hydrocephalus in a recent Haitian emigrant child due to a third-ventricular neurocysticercal cyst complex, and describe the endoscope-assisted en bloc removal of the complex, together with hydraulic maneuvers facilitating removal of the intact cyst.

Keywords

Endoscopy; Hydrocephalus; Neurocysticercosis

Introduction

Neurocysticercosis, infection of the central nervous system with the larval cysts of the pork tapeworm, *Taenia solium*, is the most common parasitic disease of the central nervous system [14] and the most common cause of cystic lesions in the central nervous system [13].

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The disease is a major global cause of acquired epilepsy [14], and may also manifest as intracranial hypertension due to mass effect from large cysts [23], or to cerebrospinal fluid flow obstruction by intraventricular cysts or inflammation of the subarachnoid space [5]. Neurocysticercosis is endemic in several regions of the world, including parts of India and Latin America, where intermediate host animals, particularly pigs, have frequent contact with humans and human feces, usually as a result of poor or absent sewage systems, and are thus able to perpetuate a state of tapeworm infestation [13,21,9]. Although the disease has been appreciated as a public health problem in such regions for several decades [13], its emergence in the United States in areas far from the Mexican border is a more recent phenomenon, attributable to migration from endemic areas, as well as tourism and travel to and from such areas [27,22,31,19,11,8]. The prevalence of cysticercosis in Haiti was formally established [26] not long before the 2010 earthquake, and as disaster relief efforts have led to increased international travel to Haiti as well as emigration from the country, cysticercosis cases of Haitian origin are now being observed at treatment centers far from Haiti.

We present a case of acute hydrocephalus in a recent Haitian emigrant child due to a third-ventricular neurocysticercal cyst complex, and describe the endoscope-assisted en bloc removal of the complex.

Case Report

History and Examination

A 15-year-old right-handed Haitian boy, recently immigrated to Massachusetts after being displaced by the 2010 earthquake in Haiti, presented after experiencing two days of severe headaches. He had previously been healthy and had no significant medical history. On the morning of admission, he had presented to a community hospital after two episodes of emesis; CT imaging demonstrated acute hydrocephalus with enlargement of the lateral and third ventricles and periventricular edema (Figure 1), and the patient was transferred to our institution. On admission to the Emergency Department he was found to be lethargic and bradycardic, and family members confirmed he appeared confused, with an abnormally depressed level of consciousness.

Operations

On the day of admission the patient underwent emergent placement of an external ventricular drain through a right frontal burr hole. The intracranial pressure was 30 cm H₂O, and the cerebrospinal fluid was clear and microbiologically benign. Following the procedure, the mental status of the patient improved but did not return to its baseline; he subsequently became sleepy, arousing when stimulated but quickly returning to sleep, and engaging minimally in conversation.

MRI of the head obtained following drain placement (Figure 2) demonstrated decompression of the right lateral ventricle with enlargement of the left lateral ventricle and bowing of the septum pellucidum from left to right, as well as a third-ventricular mass oriented anteriorly toward the foramen of Monro and extending posteriorly with an unusual

shape, and with a signal different from that of CSF. Also noted was a posterior interhemispheric mass that had been seen previously on CT, with signal characteristics similar but not identical to those of CSF.

One day after the ventriculostomy, the patient underwent a second operation, this time through a left frontal burr hole, for endoscopic resection of the third-ventricular mass. Endoscopic inspection of the left lateral ventricle revealed that the lesion was cystic, appeared to fill the third ventricle, and protruded through the foramen of Monro (Figure 3). Gentle massaging of the mass with the endoscope tip confirmed that the cyst was mobile.

The patient was placed in the Trendelenburg position, and cerebrospinal fluid was released through the ventriculostomy, generating a pressure gradient across the foramen of Monro. The cyst was carried rostrally with the resulting fluid flow, from the third ventricle toward the roof of the left lateral ventricle. This hydraulic maneuver, together with gentle manipulation, delivered the entire mass into the left lateral ventricle.

The absence of residual foreign material in the third ventricle was confirmed by working around the mass with the endoscope; the open foramen of Monro was seen, and through it the tip of the ventricular catheter in the third ventricle. The mass was too large to remove through the working channel of the endoscope without rupturing the cyst, so a grasping forceps placed through the working channel was used to hold the mass while the endoscope was withdrawn. In this manner the cyst and endoscope were removed together through the entry port, resulting in a gross total resection of the lesion. The cyst was approximately 2 cm in diameter and brownish-green in color; it had a white area within it that appeared to represent a scolex (Figure 4). The wound was inspected endoscopically after the cyst was removed. There was no bleeding from the wound, and the foramen of Monro remained open.

Postoperative Course

The mental status of the patient improved dramatically in the postoperative period. His right-sided ventricular drain was weaned and then completely removed, and repeat MRI confirmed total resection of the third ventricular mass. The posterior interhemispheric mass remained unchanged (Figure 5).

Microscopic analysis of the cyst revealed a cysticercus with a folded and convoluted cyst wall (Figure 6). A neck with spiral canal was identified, leading to a protoscolex with an identifiable rostellum, hooklets, and sucker. The patient was found to be seropositive for *Taenia solium*. A diagnosis of neurocysticercosis was made, and the patient was treated with a four-week course of albendazole, following a short course dexamethasone during the first five postoperative days. The patient was discharged in good condition on the fourth postoperative day, without headache or focal neurologic deficit. On two-month postoperative follow-up was found to have returned to his previous state of good health. Specifically, he has had no headache, seizures, visual complaints, weakness, or memory trouble, and has returned to school in the appropriate grade.

It was subsequently confirmed that the patient had had extensive exposure to undercooked pork.

Follow-up magnetic resonance imaging obtained three months postoperatively demonstrated unchanged ventricular size, stable resolution of hydrocephalus, and no new cystic lesions. Additionally, there was near-complete resolution of the cysticercosis lesion within the left posterior parafalcine region: organized solid enhancement was apparent along the posterior interhemispheric fissure, likely reflecting the expected healing stage of the lesion (Figure 7).

Discussion

Contemporary diagnostic criteria for neurocysticercosis have been established [10], and the medical treatment of neurocysticercosis, including considerations relating to the use of antihelminthic [1] and cysticidal agents, steroids, and antiepileptic drugs, have been reviewed by a number of groups [12,13,28,21]. Neurosurgical indications and approaches have also been studied [20,7,24,30,15] and reviewed by several authors [25,29]. In the management of extraparenchymal, intraventricular neurocysticercosis, the indications for surgery include mass effect, cerebrospinal fluid obstruction, and fourth ventricular cysts (which may cause brainstem compression independent of ventricular patency). Acute hydrocephalus, as developed in the case presented here, requires emergent ventriculostomy followed by cyst resection [28,17]. Ventriculitis frequently complicates shunt placement in neurocysticercosis, and shunt malfunction rates are consequently high, exceeding 30%, with associated postoperative mortality exceeding 25% in retrospective studies [7,18]. Microsurgical excision of intraventricular cysts has been described [20,7]; however, endoscopic approaches to intraventricular cyst removal [3,4,2,6,25,15,30] are increasingly preferred, in part because the endoscopic approach has been demonstrated to facilitate safe excision while obviating the need for shunt placement (in some cases through internal cerebrospinal fluid diversion procedures at the time of cyst removal) [16,24].

A further consideration in the endoscopic removal of infectious cysts concerns the question of whether to collapse such cysts prior to removal, exposing the ventricular system to cyst fluid while facilitating cyst retrieval. Aspiration, lumbar drainage, and continuous irrigation have been described in conjunction with this approach in attempt to maintain patency of the ventricular system and avoid ventriculitis [16].

In the case reported here, a cyst 2 cm in diameter was retrieved intact following ventriculostomy and endoscopic exploration, as ventricular pressure gradients established by ventriculostomy with the patient in the Trendelenburg position facilitated delivery of the cyst with minimal endoscopic manipulation.

There is controversy associated with antiparasitic treatment of neurocysticercosis, as treatment can rarely exacerbate symptoms, and brain lesions often spontaneously resolve. When few (1–2) lesions are present, as in this case, studies suggest that antiparasitic treatment combined with steroids is of benefit in reducing seizure recurrence (antiparasitic treatment should be started after 3–5 days of steroid treatment). As such, the patient described here was treated for four weeks with oral albendazole (400 mg twice per day) following a course of dexamethasone.

Travel between endemic and nonendemic areas has increased the incidence of neurocysticercosis in regions previously unfamiliar with the condition. Intraventricular cysticercal lesions may mimic the presentation of other, more common intraventricular masses, including colloid cysts, and so intraventricular neurocysticercosis should be entertained in the differential diagnosis of acute hydrocephalus due to intraventricular masses.

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References

1. Abba K, Ramaratnam S, Ranganathan LN. Anthelmintics for people with neurocysticercosis. Cochrane Database of Systematic Reviews. 2010
2. Anandh B, Mohanty A, Sampath S, Praharaj SS, Kolluri S. Endoscopic approach to intraventricular cysticercal lesions. Minimally Invasive Neurosurgery. 2001; 44(4):194–196. [PubMed: 11830776]
3. Bergsneider M. Endoscopic removal of cysticercal cysts within the fourth ventricle: Technical note. Journal of Neurosurgery. 1999; 91(2):340–345. [PubMed: 10433327]
4. Bergsneider M, Holly LT, Lee JH, King WA, Frazee JG. Endoscopic management of cysticercal cysts within the lateral and third ventricles. Journal of Neurosurgery. 2000; 92(1):14–23. [PubMed: 10616077]
5. Carabin H, Ndimubanzi PC, Budke CM, Nguyen H, Qian Y, Cowan LD, Stoner JA, Rainwater E, Dickey M. Clinical manifestations associated with neurocysticercosis: a systematic review. PLoS Neglected Tropical Diseases. 2011; 5(5):e1152. [PubMed: 21629722]
6. Colli BO, Carlotti CG, Assirati JA, Machado HR, Valença M, Amato MC. Surgical treatment of cerebral cysticercosis: long-term results and prognostic factors. Neurosurgical Focus. 2002; 12(6):e3. [PubMed: 15926782]
7. Colli BO, Martelli N, Assirati JA, Machado HR, de Vergueiro Forjaz S. Results of surgical treatment of neurocysticercosis in 69 cases. Journal of Neurosurgery. 1986; 65(3):309–315. [PubMed: 3734881]
8. Del Brutto OH. Neurocysticercosis Among International Travelers to Disease-Endemic Areas. Journal of Travel Medicine. 2012; 19(2):112–117. [PubMed: 22414036]
9. Del Brutto OH. Neurocysticercosis: A Review. The Scientific World Journal. 2012:159821.
10. Del Brutto OH, Rajshekhar V, White AC, Tsang VC, Nash TE, Takayanagui OM, Schantz PM, Evans CA, Flisser A, Correa D, Botero D, Allan JC, Sarti E, Gonzalez AE, Gilman RH, García HH. Proposed diagnostic criteria for neurocysticercosis. Neurology. 2001; 57(2):177–183. [PubMed: 11480424]
11. Figueroa JJ, Davis LE, Magalhaes A. Extraparenchymal neurocysticercosis in Albuquerque, New Mexico. Journal of Neuroimaging. 2011; 21(1):38–43. [PubMed: 20002970]
12. Friedland S, Martinez SM, Gonzalez AE, Allan JC, Flisser A, Correa D, Sarti E, Rajshekhar JV, Tsang VCW, Schantz PM, Takayanagui OM, White AC, Botero D, García HH, Evans CAW, Nash TE, Gilman RH, Del Brutto OH. Current Consensus Guidelines for Treatment of Neurocysticercosis. Clinical Microbiology Reviews. 2002; 15(4):747–756. [PubMed: 12364377]
13. García HH, Del Brutto OH. Neurocysticercosis: updated concepts about an old disease. Lancet Neurology. 2005; 4(10):653–661.
14. García HH, Evans CAW, Nash TE, Takayanagui OM, White AC, Botero D, Rajshekhar V, Tsang VCW, Schantz PM, Allan JC, Flisser A, Correa D, Sarti E, Friedland JS, Martinez SM, Gonzalez AE, Gilman RH, Del Brutto OH. Current Consensus Guidelines for Treatment of Neurocysticercosis. Clinical Microbiology Reviews. 2002; 15(4):747–756. [PubMed: 12364377]

15. Goel RK, Ahmad FU, Vellimana AK, Suri A, Chandra PS, Kumar R, Sharma BS, Mahapatra AK. Endoscopic management of intraventricular neurocysticercosis. *Journal of Clinical Neuroscience*. 2008; 15(10):1096–1101. [PubMed: 18653345]
16. Husain M, Jha DK, Rastogi M, Husain N, Gupta RK. Neuro-endoscopic management of intraventricular neurocysticercosis (NCC). *Acta Neurochirurgica*. 2007; 149(4):341–346.
17. Kelesidis T, Tsiodras S. Extraparenchymal neurocysticercosis in the United States. *The American Journal of the Medical Sciences*. 2012; 344(1):79–82. [PubMed: 22222333]
18. Kelley R, Duong DH, Locke GE. Characteristics of ventricular shunt malfunctions among patients with neurocysticercosis. *Neurosurgery*. 2002; 50(4):757–761. [PubMed: 11904026]
19. Kraft R. Cysticercosis: an emerging parasitic disease. *American Family Physician*. 2007; 76(1):91–96. [PubMed: 17668846]
20. Madrazo I, García-Rentería JA, Sandoval M, López Vega FJ. Intraventricular cysticercosis. *Neurosurgery*. 1983; 12(2):148–152. [PubMed: 6601248]
21. Nash TE, Garcia HH. Diagnosis and treatment of neurocysticercosis. *Nature Reviews Neurology*. 2011; 7(10):584–594.
22. Ong S, Talan DA, Moran GJ, Mower W, Newdow M, Tsang VC, Pinner RW. Neurocysticercosis in radiographically imaged seizure patients in U.S. emergency departments. *Emerging Infectious Diseases*. 2002; 8(6):608–613. [PubMed: 12023918]
23. Proaño JV, Madrazo I, Avelar F, López-Félix B, Díaz G, Grijalva I. Medical treatment for neurocysticercosis characterized by giant subarachnoid cysts. *New England Journal of Medicine*. 2001; 345(12):879–885. [PubMed: 11565520]
24. Proaño JV, Torres-Corzo J, Rodríguez-Della Vecchia R, Guizar-Sahagun G, Rangel-Castilla L. Intraventricular and subarachnoid basal cisterns neurocysticercosis: a comparative study between traditional treatment versus neuroendoscopic surgery. *Child's Nervous System*. 2009; 25(11):1467–1475.
25. Psarros TG, Krumerman J, Coimbra C. Endoscopic management of supratentorial ventricular neurocysticercosis: case series and review of the literature. *Minimally Invasive Neurosurgery*. 2003; 46(6):331–334. [PubMed: 14968398]
26. Raccurt CP, Agnamey P, Boncy J, Henrys JH, Totet A. Seroprevalence of human *Taenia solium* cysticercosis in Haiti. *Journal of Helminthology*. 2009; 83(2):113–116. [PubMed: 19245737]
27. Schantz PM, Moore AC, Muñoz JL, Hartman BJ, Schaefer JA, Aron AM, Persaud D, Sarti E, Wilson M, Flisser A. Neurocysticercosis in an Orthodox Jewish community in New York City. *New England Journal of Medicine*. 1992; 327(10):692–695. [PubMed: 1495521]
28. Sinha S, Sharma BS. Neurocysticercosis: a review of current status and management. *Journal of Clinical Neuroscience*. 2009; 16(7):867–876. [PubMed: 19394828]
29. Sinha S, Sharma BS. Intraventricular neurocysticercosis: a review of current status and management issues. *British Journal of Neurosurgery*. 2012; 26(3):305–309. [PubMed: 22168964]
30. Suri A, Goel RK, Ahmad FU, Vellimana AK, Sharma BS, Mahapatra AK. Transventricular, transaqueductal scope-in-scope endoscopic excision of fourth ventricular neurocysticercosis: a series of 13 cases and a review. *Journal of Neurosurgery Pediatrics*. 2008; 1(1):35–39. [PubMed: 18352801]
31. Wallin MT, Kurtzke JF. Neurocysticercosis in the United States: review of an important emerging infection. *Neurology*. 2004; 63(9):1559–1564. [PubMed: 15534236]

Figure 1.

Non-contrast CT imaging of the head obtained on admission demonstrating (A) acute hydrocephalus with enlargement of the lateral and third ventricles, including the temporal horns, and periventricular edema; and (B) more rostrally, a left parasagittal fluid collection not connected to the ventricular system.

Figure 2.

Preoperative MR imaging (A, axial; B, coronal; C, sagittal) showing acute hydrocephalus, with dilation of the lateral ventricles and anterior third ventricle, and associated sulcal effacement. The pattern of ventricular enlargement is suggestive of obstruction in the region of the aqueduct and tectum. Also seen is a thin-walled, CSF-density, left parasagittal fluid collection, which is not connected to the ventricular system.

Figure 3.
Endoscopic view of the cyst, as seen from the right lateral ventricle, emerging from the right foramen of Monro.

Figure 4.
Gross view of intact cystic mass immediately after resection.

Figure 5. Postoperative MR images (A, axial; B, coronal; C, sagittal) showing resolution of hydrocephalus and a persistent parafalcine mass (A).

Figure 6. Microscopic views of a *Taenia solium* larva within the resected cyst (hematoxylin and eosin) at increasing magnification. Images (A, original magnification $\times 1$) and (B, original magnification $\times 4$) illustrate the protoscolex (head) of the larva. Images (C, original magnification $\times 10$) and (D, original magnification $\times 40$) demonstrate a rostellum (protuberance from the scolex) of hooklets (left), and sucker (right).

Figure 7.
Postoperative MR image taken three months postoperatively demonstrates resolution of the parafalcine mass.