EUROCYSTICERCOSIS (NCC) is the most common parasitic infestation of the human nervous system, with the parenchymal form being its most frequent mode of presentation.3,8,12,17,18,20,30–32 Cysticercus cellulosae is the encysted larva of the intestinal tapeworm Taenia solium. Parenchymal cysticercosis of the brain usually manifests with multiple lesions that include live cysticerci, granulomas, and calcific residues. Solitary cysts or granulomas are also frequently seen in the cerebral hemispheres and a solitary cerebral cysticercus granuloma is the most common form of NCC seen in patients in India.3 However, isolated solitary cysticercus granuloma of the brainstem is rare. We report on the clinical and radiological features and outcomes in four patients with solitary cysticercus granulomas of the brainstem.

Case Reports

The following cases are summarized in Table 1.

Case 1

This 32-year-old woman presented with a 6-month history of bifrontal headache and two transient episodes of inability to move her eyes to the right side, which had resolved within a few days.
ma. Because the patient was asymptomatic at the time of presentation, it was decided to follow her case clinically and radiologically. A CT scan obtained 6 months later showed a minimal decrease in the size of the lesion. At follow-up evaluation 3 years later, the patient remained asymptomatic, and she refused further examinations.

Case 2

This 21-year-old man presented with an 8-month history of double vision and headaches. The patient had experienced difficulty in reading and descending stairs and had episodic right-sided frontal headache. Three months earlier, the patient had begun an empirical course of antituberculous chemotherapy at an outside institution.

Examination. On ophthalmic examination, the patient’s visual acuity and fields appeared normal. His pupils were equal and reacted normally to light. Visual convergence was impaired by a retraction nystagmus and there was bilateral horizontal gaze–evoked nystagmus. The remainder of the neurological examination was normal. The results of analysis of CSF, including testing for acid-fast bacilli and fungal cultures, were negative.

Computerized tomography scanning revealed a contrast-enhancing lesion, smaller than 20 mm, in the dorsal midbrain on the right side, with mild dilation of the third and lateral ventricles. Magnetic resonance imaging demonstrated a lesion in the same location that appeared isointense with a hypointense center on T1-weighted images and hyperintense on T2-weighted images.

Case 3

This 36-year-old man presented with a 2-month history of paresthesias involving his right upper and lower limbs. He had experienced an episode of sudden onset of diplopia when looking to the left side, as well as headache and gait ataxia 2 months earlier that had resolved spontaneously.

Examination. At presentation, the patient exhibited no clinical evidence of neurological deficits. No studies of CSF were performed. The results of an ELISA for detection of cysticercal antibodies were negative.

Magnetic resonance imaging showed a contrast-enhancing lesion measuring less than 20 mm in the pons on the left side. The lesion appeared isointense on T1-weighted images and hyperintense on T2-weighted images.

Course of the Illness. Because of the sudden onset of the patient’s symptoms, the possibility of a hemorrhagic event in the pons was considered. However, the appearance on MR imaging was suggestive of a pontine granuloma. Carbamazepine was administered for the paresthesias and the patient was evaluated at regular intervals. Computed tomography scanning performed 3 months later appeared normal and MR imaging performed 6 months later demonstrated complete resolution of the granuloma. However, the patient continued to complain of right-sided paresthesias and, hence, carbamazepine therapy was continued. The paresthesias were persistent at follow-up evaluation 1.5 years later despite an increased dosage of carbamazepine.

Case 4

This 43-year-old man presented with a gradually progressive 1.5-month history of numbness and weakness in his right upper and lower limbs, diplopia when looking to the left side, and gait ataxia. He also had a headache lasting 15 days.

Examination. On examination, the patient exhibited a left-sided sixth nerve paresis and diminished sensations in the right half of his face and right upper and lower limbs.
He displayed a right-sided hemiparesis with Grade 4/5 strength. No CSF studies were performed.

Computerized tomography scanning revealed a contrast-enhancing 20-mm lesion in the pons. Magnetic resonance imaging demonstrated a 20-mm lesion in the pons located more toward the left side. The lesion was isointense on T1-weighted images and hyperintense on T2-weighted images, with surrounding edema. The lesion enhanced after gadolinium administration (Fig. 2 left).

Course of the Illness. Because the patient had a history of progressive symptoms of brainstem dysfunction, it was decided to perform a biopsy. The preoperative diagnosis was that of a progressive lesion such as a tuberculoma or neoplasm. He underwent a CT-guided stereotactic biopsy of the lesion and the findings were reported to be consistent with that of cysticercosis (Fig. 2 right). The patient was given a course of albendazole (15 mg/kg per day in two divided doses) for 2 weeks along with steroid medications. On completing the course of albendazole, the patient presented with worsened symptoms. However, a repeated CT examination did not reveal any change in the size of the lesion and the steroid therapy was continued for 6 weeks.

The case was reviewed after 3 months and the patient was found to be asymptomatic. A CT scan revealed only a small enhancing dot in the pons.

Discussion

Cysticercosis can cause dysfunction of the brainstem by a number of mechanisms. Cysticercal cysts can occupy the subarachnoid cisterns around the brainstem, where they can produce arachnoiditis with subsequent hydrocephalus and vasculitis. Cranial neuropathies can develop from focal ischemia and local mass effect from progressive cystic enlargement.5-7,13 There are reports of brainstem involvement in disseminated cysticercosis2 and in mixed forms.16 However, to our knowledge, features of a solitary intraparenchymal cysticercosis of the brainstem have not been discussed in the literature.

Solitary cysticercus granuloma is a benign form of NCC. The granuloma forms around a dying parasite and is the third stage in the natural evolution of a parenchymal cysticercus cyst of the brain.10,15

Clinical Presentation

Although the onset of clinical symptoms and disease progression were not uniform in our patients, in three of four the brainstem dysfunction was fairly rapid in onset and was not progressive. The possible clinical diagnoses in our patients included hemorrhage, demyelination, inflammatory mass, and neoplasm.

Imaging Features of a Solitary Cysticercus Granuloma

Solitary cysticercus granulomas in the cerebral hemispheres have a characteristic appearance on CT scans. They appear as enhancing lesions that are typically less than 20 mm in size.21,26 Their appearance on MR imaging is less stereotypical.22 All granulomas enhance in response to gadolinium administration. They are also well visualized on T1-weighted images and commonly appear as hypointense rings with a hyperintense center. On T2-weighted images the granulomas are mostly isointense (not seen); in some cases they might have a isointense periphery with a hypointense center.22

In all of our patients’ CT studies, the brainstem lesions measured 20 mm or less and enhanced after injection of a contrast agent. The MR images were also suggestive of a solitary cysticercus granuloma.

The differential diagnosis of solitary ring-enhancing brainstem lesions includes tuberculoma, cysticercus granuloma, and pyogenic abscess. Isolated brainstem tuberculomas are also uncommon; they are generally larger (maximum diameter > 20 mm) with progressive symptoms of brainstem dysfunction.24 Cavernous angiomas can be readily differentiated from inflammatory granulomas on the basis of MR imaging.23,29 None of the other inflammatory pathological entities that can resemble a solitary cysticercus granuloma on CT or MR imaging resolve spontaneously except, probably, demyelinating plaques.

Natural History of a Solitary Cysticercus Granuloma

It is now well recognized that a solitary cysticercus...
granuloma resolves spontaneously over a variable period of time. Several researchers, including us, have documented this behavior.\textsuperscript{3,5,19} It is not surprising that a solitary cysticercus granuloma undergoes spontaneous resolution, considering the fact that the granuloma forms around a dying parasite and the process of involution of the parasite ultimately leads to its “disappearance” from CT or MR imaging. In some instances, a calcific residue is the end result of the involution process; this is seen on CT or MR images as a calcific speck.

**Diagnosis of a Solitary Brainstem Cysticercus Granuloma**

In a prospective study,\textsuperscript{25} we recently validated the diagnostic criteria for solitary cerebral cysticercus granuloma in patients presenting with seizures. These criteria had a sensitivity of 99.5% and a specificity of 98.9% when applied to patients presenting with seizures. The CT criteria included: 1) the presence of a solitary contrast-enhancing lesion; 2) a lesion measuring less than 20 mm in maximum dimension; and 3) presence or absence of edema, but no edema severe enough to produce a shift in midline structures. We applied these CT criteria for cerebral solitary cysticercus granuloma to the present four patients to aid in diagnosing a cysticercus granuloma. The clinical criteria described by us for a solitary cerebral cysticercus granuloma obviously could not have been applied to these patients because of differences in clinical presentation relating to the location of the lesion. However, we expect that whatever its location in the central nervous system, a solitary cysticercus granuloma will not lead to progressive symptoms because the granuloma is formed around a dying parasite and the patient’s symptoms are caused by the host’s immune response to the release of the parasite’s antigen during the involution process. The history of progressive symptoms in Case 4 led us to obtain a biopsy specimen of the lesion because we believed that this history was inconsistent with the presumptive diagnosis of a cysticercus granuloma. Resolution of the granuloma in one patient after albendazole therapy (Case 2) and spontaneous resolution in two patients (Cases 1 and 3) was evidence of the cysticercal cause of the granuloma (Table 1). Further histological evidence of the diagnosis of a cysticercus granuloma was available in one patient (Case 4).

When we applied the diagnostic criteria for NCC proposed by Del Brutto, et al.,\textsuperscript{9} to our patients, Cases 1, 2, and 4 fulfilled a definitive diagnosis of NCC (Cases 1 and 4 had one absolute criterion each and Case 2 had one major, two minor, and one epidemiological criteria). Even Case 3 qualified for a probable diagnosis (one major, one minor, and one epidemiological criteria). Surprisingly, spontaneous resolution, which is a characteristic feature of a cysticercus granuloma, is not included in these diagnostic criteria. We believe it should be included as a minor criterion, in which instance Case 3 would shift over to the definitive diagnosis category.

Recently, there was a report\textsuperscript{11} of a solitary, small, enhancing brainstem lesion empirically treated as a tuberculous abscess, which we believe might have been a cysticercus granuloma. This underscores the importance of recognizing this entity and avoiding such empirical and potentially harmful therapy.

**Immunological Tests for Solitary Cysticercus Granuloma**

It would be ideal if a diagnosis of this essentially self-limiting entity could be made using noninvasive methods. Immunological tests appear attractive; however, both ELISA and enzyme-linked immunotransfer blot (EITB) display poor sensitivity in detecting anticysticercal antibodies in the serum and CSF of patients with a solitary cerebral cysticercus granuloma.\textsuperscript{1,4,33} In our experience, the sensitivity of ELISA in detecting anticysticercal antibodies in the serum of patients with a solitary cysticercus granuloma was 43.4% and the sensitivity of EITB ranged from 18 to 46.2%.\textsuperscript{27,28} Other authors have also reported poor results when using EITB in patients with a solitary lesion.\textsuperscript{33} Hence the negative ELISA findings in two of our patients have no relevance and cannot be used to rule out a diagnosis of cystercrosis.

**Stereotactic Biopsy of Brainstem Masses**

Stereotactic techniques provide a safe and reliable method of obtaining a histological diagnosis of brainstem masses.\textsuperscript{23} However, a definitive or etiological diagnosis of an inflammatory mass on a stereotactic biopsy sample is often elusive. In our experience, a definitive diagnosis of an inflammatory mass on a stereotactic biopsy specimen was possible in only approximately 56% of cases.\textsuperscript{23} In all instances, however, a diagnosis of inflammation ruled out a neoplastic process. We were fortunate to identify part of a cysticercus in the one patient in whom a biopsy was performed. This is extremely uncommon and stereotactic biopsies of solitary cerebral cysticercus granulomas in 10 patients only yielded a diagnosis of inflammation.\textsuperscript{3}

**Case Management**

Patients from regions where cystercrosis is endemic, who have no systemic disease, present with nonprogressive symptoms and signs of brainstem involvement, and display a solitary ring-enhancing mass in the brainstem...
measuring less than 20 mm on neuroimaging may be managed conservatively. Serological studies for cysterceral antibodies may be helpful if they prove to be positive. A trial of albendazole therapy might also lead to a definitive diagnosis if the granuloma resolves following such therapy. Close clinical and radiological monitoring is mandatory in patients who are being managed conservatively. Any clinical or radiological evidence of disease progression should lead to a stereotactic biopsy of the brainstem mass and appropriate management based on histological diagnosis.

The empirical use of antituberculose chemotherapy or stereotactic biopsy should be avoided at first presentation in patients with solitary granulomatous lesions of the brainstem who come from regions endemic for cystercerosis.

References

34. Vedantam Rajshekhar, M.Ch., Department of Neurological Sciences, Christian Medical College and Hospital, Vellore 632004, Tamil Nadu, India. email: vraj@neuro.cmc.ernet.in.

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Address correspondence to: Vedantam Rajshekhar, M.Ch., Department of Neurological Sciences, Christian Medical College and Hospital, Vellore 632004, Tamil Nadu, India. email: vraj@neuro.cmc.ernet.in.

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