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Case Report

Diagnosis and management of cerebral sparganosis: An uncommon parasitic infection of the brain [☆]

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ABSTRACT

Cerebral sparganosis is a rare parasitic infection that can be difficult to diagnose due to similarities in clinical and imaging features with more common parasitic infections, such as neurocysticercosis, and other neurologic conditions. We present a case of a 61-year-old female with a verified case of cerebral sparganosis. We also review the current literature regarding the sparganosis infection process, imaging features, and unique therapeutic options. With awareness of the risk factors for cerebral sparganosis and consideration for this diagnosis when the response to therapy for other organisms appears suboptimal, the time to accurate diagnosis may be reduced, and treatment outcomes improved.

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Introduction

Cerebral sparganosis is a rare human parasitic infection that can lead to various debilitating neurologic symptoms. However, establishing a diagnosis of sparganosis can be challenging due to significant overlap of clinical and imaging features with other neurologic conditions, including more common parasitic infections. Here, we present a case of verified cerebral sparganosis, review the current literature surrounding this uncommon parasitic infection, and highlight

similarities and differences between cerebral sparganosis and a more prevalent parasitic mimic, neurocysticercosis.

Case report

A 61-year-old female initially presented to an outside facility with complaints of intermittent headache, dizziness, and nausea, worsening over the prior year. A non-contrast CT examination of the head was performed, revealing an area of right-sided periventricular nodular calcification and

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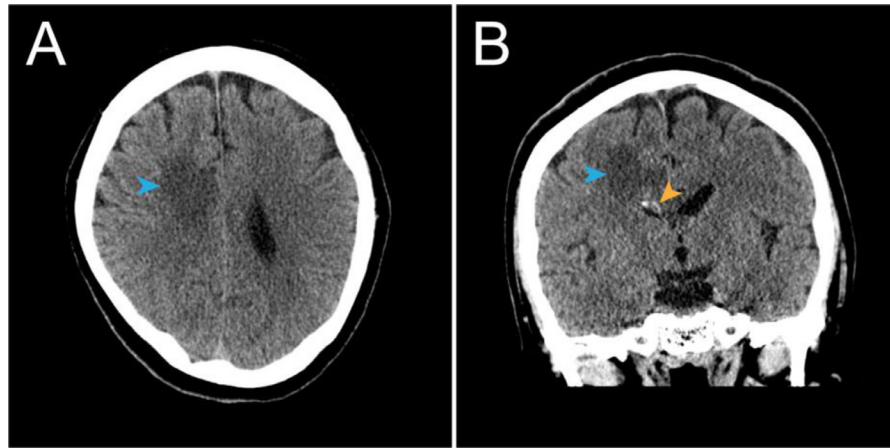


Fig. 1 – Imaging at initial presentation. Axial (A) and coronal (B) non-contrast head CT images show nodular calcifications at the margin of the body of the right lateral ventricle (orange arrowhead) and hypoattenuation suggestive of edema extending into the subcortical white matter of the adjacent cingulate gyrus and right frontal lobe (light blue arrowhead). (Color version of the figure is available online.)

adjacent frontal lobe white matter edema, which produced a mild local mass effect as evidenced by partial effacement of the right lateral ventricle (Fig. 1). The patient underwent contrast-enhanced MR imaging of the brain 2 months later that showed a heterogeneously enhancing, nodular, periventricular mass with reduced diffusivity, and perilesional edema (Fig. 2). Punctate foci of enhancement were also identified along the left side of the splenium of the corpus callosum, distinct from the dominant lesion. An area of cortical thinning and underlying gliosis was also noted in the left precuneus, presumed to be incidental and related to a prior insult. She was referred to our institution for workup of a presumed malignancy, with provided differential considerations including multicentric glial neoplasm, CNS lymphoma, and metastases.

Additional clinical workup and whole body 18F-FDG PET-CT were performed but no primary malignancy was identified. However, the PET-CT did reveal nonspecific radiotracer uptake in a 2 cm subcutaneous soft tissue density nodule along the medial aspect of the left thigh (Fig. 3). By this time, 5 months had elapsed since her initial presentation with no clear progression of clinical symptoms despite the lack of any targeted therapeutic intervention. Thus, a consensus multidisciplinary decision was reached to defer brain biopsy in favor of close interval imaging follow-up.

Repeat MR imaging was performed at months 6 and 7 (Figs. 4A and B) and demonstrated a gradual increase in the size of the dominant lesion, which produced a slight bulging of the right cingulate gyrus across the midline. Ultrasound-guided core needle biopsy of the left thigh lesion was also performed at month 7, and it was reported to contain fragments of cysticercosis with associated mixed inflammation. Infectious disease consultation was sought, and further workup revealed that the patient had no relevant animal exposures, travel history, or known consumption of undercooked meats. She was born, and raised in southeast Asia but had been living in the United States for 3 decades. Serum cysticercosis antibody (IgG) titers were negative; however, given the pathologic findings, she was treated for presumed

neurocysticercosis with a 14-day course of oral albendazole (800 mg/day), and praziquantel (50 mg/kg/day) along with a dexamethasone taper.

At a clinic visit 6 months following the aforementioned treatment, the patient reported unchanged symptoms of headache and dizziness and new soft tissue nodules, now on the right thigh. Brain MRI (Fig. 4C) showed a minimal decrease in the size of the dominant enhancing lesion. Given that the lack of response to treatment and negative prior serology were discordant with the presumptive diagnosis of cysticercosis, an excisional biopsy of the new right thigh nodules was performed. During the biopsy, the proceduralist noted that a 1.5 cm motile, white worm extended from the dermal-subcutaneous junction of the specimen. Microscopically, the specimen was found to be morphologically consistent with sparganum. The sample was sent to the Centers for Disease Control and Prevention for verification before a diagnosis of cerebral sparganosis was subsequently established.

Given that a recent study had found similar efficacy between surgical therapy and long-term high-dose praziquantel for cerebral sparganosis [1], the latter option was elected to avoid surgical morbidity. The patient received cycles of oral praziquantel (50 mg/kg/day) for 10 days, repeated monthly for 8 months. MR imaging obtained to monitor treatment showed a gradual decrease in size of the enhancing lesions, with the eventual resolution of all enhancing disease following the last cycle (Figs. 4D-F). Clinically, her headaches improved in severity and frequency, but her dizziness remained unchanged during the treatment course. Therefore, she was referred to pursue further neurologic workup for possible unrelated causes of this symptom.

Discussion

Sparganosis is a rare human parasitic infection caused by the larvae of the plerocercoid tapeworm of the genus *Spirometra* [2,3]. Several thousand cases of cerebral sparganosis are

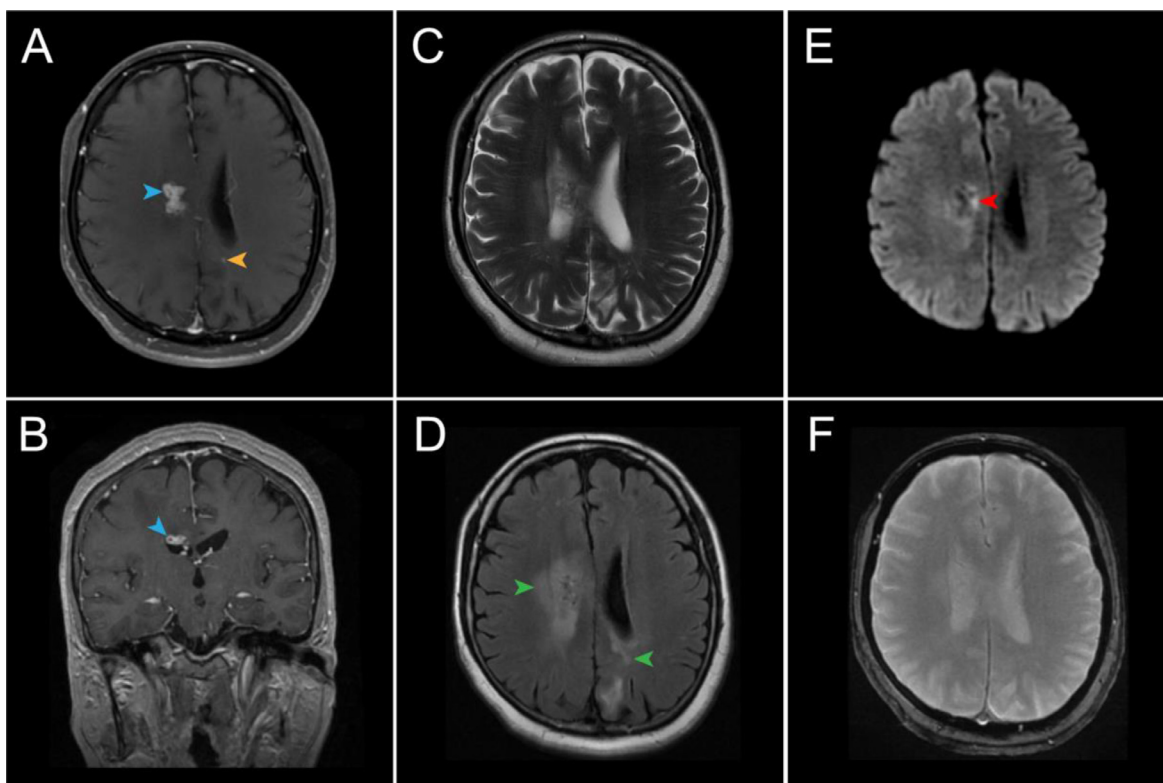


Fig. 2 – Initial MR imaging including axial post-contrast T1-weighted (A), coronal post-contrast T1-weighted (B), axial T2-weighted (C), axial FLAIR (D), axial diffusion-weighted trace (E), and T2*-weighted (F) images. An irregularly shaped enhancing lesion is seen bordering the body of the right lateral ventricle (light blue arrowhead), and another punctate focus of enhancement is seen along the left side of the splenium (orange arrowhead). The lesions are surrounded by T2 and/or FLAIR signal changes consistent with vasogenic edema (green arrowheads), and the larger lesion exhibits patchy areas of reduced diffusivity (red arrowhead). (Color version of the figure is available online.)

estimated to occur around the world annually, and more than 1600 cases of sparganosis have been documented worldwide, primarily in East and Southeast Asian countries [4,5]. The parasite lifecycle is characterized by 2 intermediate host stages that harbor larval or asexual forms of the parasite and a definitive host for the sexually-reproducing adult stage. The first intermediate hosts are copepods, a type of crustacean in which infective procercooids for second intermediate hosts can develop. Snakes, fish, frogs, birds, and mammals are second intermediate hosts. Humans serve as only second intermediate hosts, while dogs and cats serve as definitive hosts [6]. Transmission occurs when immature *Spirometra* reside in the host intestine and lay eggs, which are shed in the feces before subsequently hatching in water. The larvae are then consumed by copepods, and the cycle continues when they are consumed by second intermediate or definitive hosts [7]. Humans are primarily infected after drinking water contaminated with infected copepods, eating raw or undercooked frogs or snakes, or using the flesh of an infected host as a poultice for open wounds [4,8].

The ribbon-shaped motile worm enters the abdominal cavity by passing through the alimentary canal before further migrating into the diaphragm and mediastinum to reach the neck. The parasite subsequently passes through the foramen magnum to invade the CNS into the brain parenchyma as

well as the subarachnoid space, or the spinal cord [2,7]. Cerebral sparganosis can lead to various clinical manifestations, including most commonly headache, seizure, sensory disturbances, or hemiparesis, with an onset varying from months to multiple decades [3,9]. The parasite has also been found to invade ocular structures, subcutaneous tissue, and open wounds and more rarely in the pleural or abdominal cavity, liver, ears, lungs, breasts, scrotum, and testicles [10–16]. The primary tissue infected is immediately surrounded by inflammatory changes, but migratory lesions, also known as “wandering lesions,” “tunnel signs,” or “string-knots signs,” are areas of granulomatous inflammation along migration tracks that are particularly suggestive of the infection [3].

In contrast, cysticercosis is a more common parasitic infection of the larval stage of the pork tapeworm, *Taenia solium*. Annually, there are 50 million people worldwide who experience neurocysticercosis, causing around 50,000 deaths. The parasite is endemic in most low-income countries where pigs are raised, such as Latin American countries, sub-Saharan Africa, and large regions of Asia, including India, most of southeast Asia, and China [17,18]. Increasing immigration has led to the prevalence of neurocysticercosis increasing in countries where local transmission is low [19].

Cysticercosis has a 2-host life cycle involving pigs and humans. Both pigs and humans are intermediate hosts that

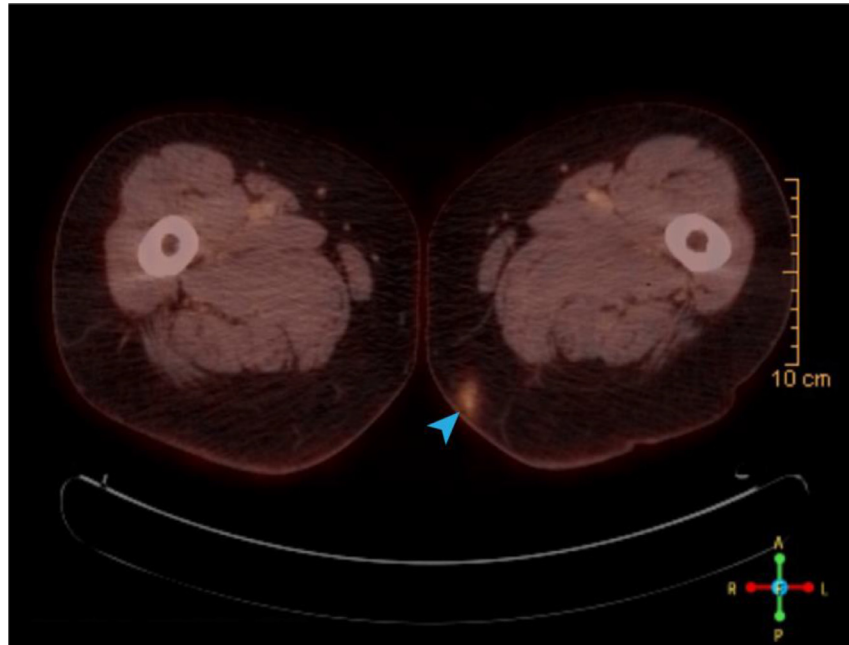


Fig. 3 – Axial fused ^{18}F -FDG PET-CT image at the level of the femoral diaphyses demonstrates a subcutaneous soft tissue nodule with radiotracer uptake along the medial margin of the left thigh (light blue arrowhead). No other abnormalities were identified to suggest a malignancy. (Color version of the figure is available online.)

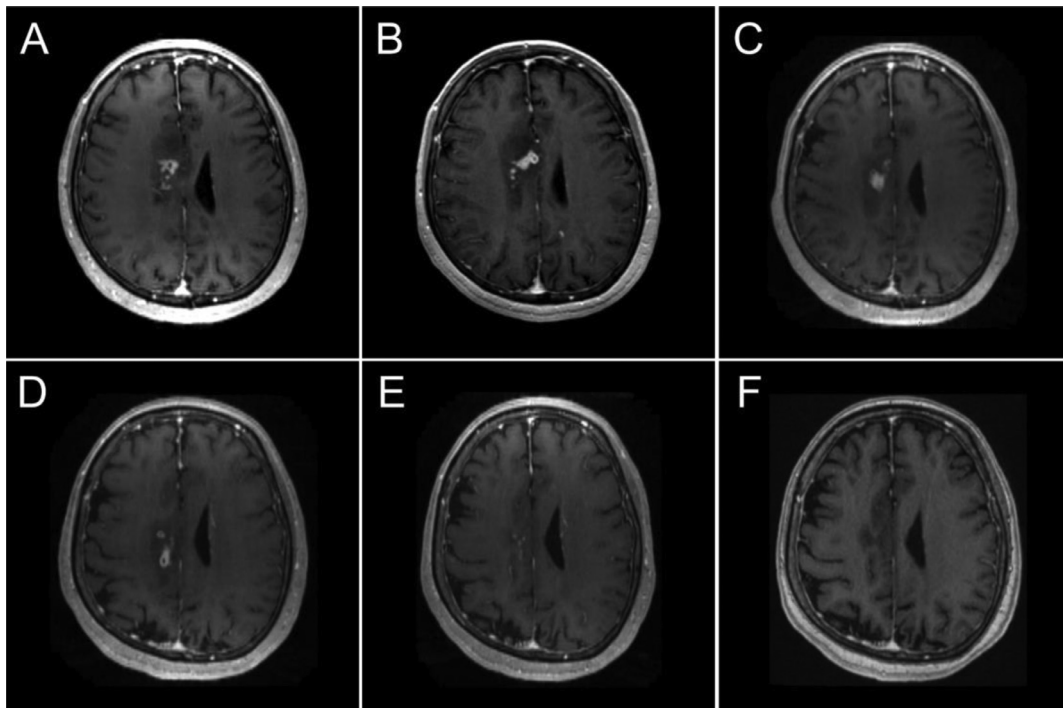


Fig. 4 – Disease progression and resolution. Axial post-contrast T1-weighted images demonstrate gradual enlargement of the right periventricular enhancing lesion during observational months 6 and 7 (A and B, respectively) following the initial presentation (cf Fig. 2.A). Following a standard course of therapy for presumed neurocysticercosis, the lesion was only minimally decreased in size (C). After the diagnosis of cerebral sparganosis was established and long-term praziquantel therapy was initiated, the enhancing lesion gradually resolved as seen following cycles 2, 4, and 8 (D, E, and F, respectively).

are capable of carrying the larval form, but humans are the only definitive host of the adult tapeworm [20]. Similar to sparganosis, transmission commonly occurs due to ingesting raw or undercooked pork or drinking contaminated water [19]. Cysts are able to attach to intestinal walls and cross the intestinal mucosa into the bloodstream, which carries it to peripheral tissue, including the brain, subarachnoid space, ventricles, and rarely the spinal cord, where they develop into cysticerci [21]. Cysticerci lead to various clinical symptoms, including seizures, focal neurologic deficits, intracranial hypertension, cognitive decline, headache, associate stroke, or involuntary movements, due to inflammation from cyst degeneration, their mass effect, and reduction of CSF circulation [20,22]. The parasite may also infect subcutaneous tissue, muscles, ocular structures, and more uncommonly, cardiac tissue [22,23].

CT and MR images are commonly utilized in the diagnosis of cerebral sparganosis. In both CT and MR images, irregular brain parenchyma lesions with peri-lesional edema and white matter injury, is seen in almost all cases [9,24,25]. Ipsilateral ventricular dilation is also a common finding; however, ventricular compression secondary to mass effect can also be seen in rare cases [9]. Other, less common features include focal cortical atrophy, small, punctate calcifications, and hemorrhage [9,24,26]. However, the hallmark finding of cerebral sparganosis is a tunnel sign, which can be seen primarily in MR postcontrast images. The peripherally-enhancing tunnel may be up to 6 cm in length, 0.5–1.5 cm in width, and columnar in shape. It appears hypointense on T1-weight images and slightly hyperintense or isointense on T2-weighted images. Another common feature seen in MR images, as in our case, is a conglomerated mass of bead-like lesions consisting of 3–6 foci that are 2–8 mm in diameter, with 1–2 mm wall thickness. Centrally, the lesions appear slightly hyperattenuating on unenhanced CT images, hypointense on T1-weighted images, hyperintense on T2-weighted images, and lack postcontrast enhancement. The lesion walls appear isoattenuating on non-enhanced CT images, hypointense on T1-weighted images, isointense or slightly hyperintense on T2-weighted images, and markedly enhanced post-contrast on both CT and MR images. Unfortunately, these findings are not always present. A review of 25 patients proved to have cerebral sparganosis indicated the tunnel sign was a hallmark finding in 10 of 25 patients while the bead-shaped enhancement was seen in 13 of 25 patients [9].

Various differential considerations may have imaging features similar to cerebral sparganosis when no classic tunnel sign finding is present. With CT and MR imaging, the multiple stages of involution in neurocysticercosis can be seen in variable-sized lesions simultaneously, leading to a “starry night” presentation [27]. However, the colloidal vesicular stage, indicating degenerating cysticerci, demonstrates the most imaging overlap with sparganosis [28]. This stage is characterized by multiple ill-defined, peripherally-enhancing lesions accompanied by peri-lesional edema [27]. Smaller ventricles or hydrocephalus may also be present [29]. Additionally, calcified lesions are seen in 50% of patients with neurocysticercosis, most readily seen on CT scans [29]. Other differential diagnoses include calcifying brain tumors and other inflammatory granulomas. However, these conditions tend

to present with more well-defined, round nodules that commonly cause adjacent ventricular compression instead of the irregular lesions, and ventricular dilation frequently seen in cerebral sparganosis [8]. Furthermore, if cortical atrophy and degeneration of white matter are seen in imaging, a diagnosis of chronic cerebral ischemia may also need to be excluded [9].

Other methods can aid in confirming a diagnosis of cerebral sparganosis. Light microscopic analysis may demonstrate a carmine-stained motile worm with a transverse fold and depression at the scolex, a hallmark of the *Spirometra* larva. Molecular sequencing of the mitochondrial COX1 and 28S rRNA genes may also aid in confirming the diagnosis of cerebral sparganosis [30]. Additionally, enzyme-linked immunoassay analysis of serum, and CSF positive for anti-sparganosis antibodies can be performed for confirmation [1]. Eosinophilia is also a nonspecific marker of parasitic infection that may present, but it is uncommonly associated with cerebral sparganosis [31].

The standard treatment for cerebral sparganosis is the surgical removal of the sparganum from the infection site. This is generally performed using stereotactic aspiration surgeries and craniotomies, which commonly yield a resolution of symptoms and no relapse [32]. However, recent studies have indicated some patients responded well to long-term, high-dose praziquantel with efficacies and rates of adverse events, such as abdominal pain, diarrhea, dizziness, sleepiness, and headache, similar to that of surgical intervention [1,33]. Praziquantel is found to expose more surface antigens of the worm by damaging the parasite’s skin, resulting in epidermal erosion. The medication is also able to cause spastic paralysis in the parasite by dissolving smooth muscle bundles [34]. In a study consisting of 10 patients with cerebral sparganosis treated with multiple high-dose praziquantel treatments, 8 of 10 patients showed gradual improvements in clinical symptoms, including improvements in seizure frequency, neurologic deficits, and level of muscle power, generally within 9 months after the initial treatment. Motile lesions initially seen in MR imaging for all patients transformed into stable, chronic lesions by 3-month follow-up in 8 of 10 patients and were found to have disappeared completely in 2 of 10 patients after 10 and 25-months of follow-up. Of note, 6 of 10 patients experienced transient aggravation, but future follow-ups revealed clinical improvement [31].

Conclusion

Cerebral sparganosis is a rare parasitic infection that may be difficult to distinguish from other differential diagnoses, such as neurocysticercosis, due to similar imaging features. Our case report highlights the similarities and differences between cerebral sparganosis and neurocysticercosis, discusses methods to establish a diagnosis of cerebral sparganosis, and reports the current literature regarding pharmacologic treatment of cerebral sparganosis. With increasing awareness of the risk factors and characteristic features of this disease, the time to definitive diagnosis may be reduced, and patient outcomes may benefit.

Patient consent

During the clinical course, the patient signed conditions of admission, which at our institution include an agreement to undergo procedures and treatments including imaging examinations, an agreement to have trainees participate in patient care, and an agreement to have photographs, video, and other images used for training and education purposes. In addition, we have suppressed all personally-identifiable information from the report, including all 18 HIPAA identifiers.

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