Clinical Reasoning: A 12-Month-Old Male With Staring Episodes, Ataxia, and Right-Sided Weakness

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Abstract

Baylisascaris procyonis, or raccoon round worm, is a rare cause of eosinophilic meningoencephalitis with historically poor clinical outcomes. Symptoms of neural larval migrans begin approximately 2-4 weeks after ingestion with fatigue, nausea, fever, and lethargy, then rapidly progress to weakness, incoordination, ataxia, seizures, altered mental status, and finally coma. Only 31 other cases of central nervous system Baylisascaris neural larval migrans have been reported, with over 25% being lethal. Of the remaining cases, all but three were neurologically devastated largely due to delays in diagnosis and treatment. We present a case of an infant Baylisascaris neural larval migrans manifested as right hemiparesis, ataxia, and cortical blindness. Eosinophilia was missed at an outside hospital due to misidentification of eosinophils as monocytes on automated cell differential. Repeated testing of serum and CSF revealed marked eosinophilia consistent with eosinophilic meningoencephalitis, and serum antibody testing through the Centers of Disease Control confirmed Baylisascaris infection. Notably, this child had a remarkably positive outcome with near complete recovery of neurologic function after treatment with albendazole and steroids. While eosinophilic meningoencephalitis is rare, accounting for less than 3% of all lumbar punctures with pleocytosis, this case illustrates: A) the
importance of early disease recognition and treatment to improve patient outcomes and B) the fact that automated cell differentials may misidentify eosinophils as monocytes.

Section 1:

A 12-month-old full-term, previously healthy, and typically developing boy presented to a community hospital with new-onset focal motor seizure (right-sided shaking and unresponsiveness) with secondary generalization, in the setting of congestion and tactile fevers. The seizure self-resolved after 30 minutes. On arrival to an outside Emergency Department, he was lethargic, but had reportedly intact cranial nerves and symmetric localization to painful stimuli. A basic metabolic panel was unremarkable. His complete blood count (CBC) demonstrated a leukocytosis of 32,000 cells/µL (27% neutrophils, 48% lymphocytes, 1% bands). A non-contrast computed tomography of the head was normal. Lumbar puncture (LP) demonstrated 14 cerebrospinal fluid (CSF) red blood cells (RBC), 303 white blood cells (WBC; 30% neutrophils, 43% lymphocytes, and 27% monocytes), protein of 41 mg/dL, and glucose of 73 mg/dL. Nasopharyngeal swab testing for SARS-CoV-2 was negative. He was empirically treated with vancomycin and ceftriaxone given concern for bacterial meningitis until CSF cultures were negative at 48 hours. He remained afebrile, seizure free, and was discharged 2 days later with a reportedly normal neurologic examination and a presumptive diagnosis of viral meningitis.

Shortly after discharge, he developed new clusters of staring episodes lasting 1-2 minutes each and decreased use of his right arm. He was also reaching indiscriminately, as if trying to grasp objects that did not exist, and therefore presented to our institution 12 hours after initial discharge. He was afebrile without meningismus, alert, but irritable. Pupils were equal, round and reactive to light, but he did not fixate on faces, had no light aversion, and could not track. Facial movements were symmetric with crying, though he had no other vocalizations (baseline, babbling with single words). He had significant axial hypotonia requiring left truncal support to sit. Left upper extremity movements were at least antigravity with a raking grasp, prominent tremor, and dysmetria. Right upper extremity and bilateral lower extremity strength was grossly normal.
Sensation was normal. Deep tendon reflexes were 2+ except at bilateral ankles which were 4+ with 2-3 beats of clonus. Plantar responses were extensor bilaterally.

**Questions for Consideration:**

1. What is the differential diagnosis?
2. What are the next steps in diagnostic evaluation?

**Section 2:**
In a child with new abnormal movements concerning for seizure and progressive multifocal neurologic deficits, the differential diagnosis is broad. The lymphocyte predominant pleocytosis, normal CSF glucose, and negative CSF cultures raise concern for viral meningoencephalitis. Enteroviruses, herpes simplex virus, and human herpesvirus 6 comprise the most common causes of viral meningoencephalitis in children. Rarer entities include arboviruses, varicella zoster virus, measles, mumps, and others. Rickettsial infections can cause encephalitis but generally present with systemic symptoms like fever or headache and laboratory abnormalities such as thrombocytopenia or hyponatremia. Neuroinflammatory/autoimmune conditions, including acute disseminated encephalomyelitis, anti-myelin oligodendrocyte glycoprotein encephalitis, neuromyelitis optica-spectrum disorders, other autoimmune encephalitides, and certain vasculitides can present similarly. Acute flaccid myelitis can present with motor deficits but would not cause seizures or impact vision. Metabolic disorders or an accidental ingestion were less likely given normal electrolytes and lactate. Trauma was unlikely with a normal head CT.

A broad diagnostic evaluation was pursued. Repeat CBC showed down-trending leukocytosis of 16,200 cells/µL (16% neutrophils, 33% lymphocytes, 44% eosinophils; absolute eosinophil count of 6960). Comprehensive metabolic panel was normal. Repeat LP revealed 50 CSF RBC, 189 WBC (69% eosinophils), protein 38 mg/dL, and glucose 49 mg/dL. Video electroencephalogram monitoring demonstrated hemispheric asymmetry with slower frequencies, absent organization, and higher voltages in the left hemisphere. There were rare left temporal sharp waves but no seizures and no electrographic correlate to staring episodes. Magnetic
resonance imaging (MRI) of the brain with and without gadolinium demonstrated multifocal supratentorial and infratentorial areas of T2/FLAIR hyperintensity (Figure 1). Complete spinal MRI was normal. Ophthalmology was consulted and noted evidence of cortical visual impairment but an otherwise normal retinal and ocular examination.

Questions for consideration:

3. How does this information change the differential diagnosis?

4. What is the significance of the new eosinophilia on LP and CBC?

Section 3:

The differential diagnosis for serum eosinophilia is broad, including neoplasm, allergy and immunologic disorders, primary eosinophilic disorders, and infections. The neuroimaging and CSF findings in this case are suggestive of a meningoencephalitis. Eosinophilic meningoencephalitis, defined by >10 eosinophils/µL and/or eosinophils accounting for >10% of CSF WBC, is a rare entity accounting for <3% of all CSF samples from patients with pleocytosis. The differential diagnosis for causative organisms is limited, primarily including *Angiostrongylus cantonensis*, *Baylisascaris procyonis*, and *Gnathostoma spinigerum*. Less commonly, other helminthic infections (e.g. toxocariasis, echinococcosis, others), Rickettsial disease, fungal infection (coccidiomycosis, cryptococcosis), and viral infections may also cause eosinophilic meningoencephalitis.

Non-infectious causes of eosinophilic meningoencephalitis include primary hypereosinophilic syndromes, autoimmune disorders (e.g. Churg-Strauss disorder), oncologic processes involving the central nervous system (CNS), drug reactions (e.g. non-steroidal anti-inflammatory drugs, certain antibiotics), or the presence of a ventriculoperitoneal shunt, none of which were suggested by this child’s neuroimaging or clinical course.

Importantly, automated differentials can misclassify eosinophils as monocytes. This is likely why no eosinophils were seen on initial CBC and CSF studies. Therefore, it is important to obtain a manual differential
with Wright-Giemsa stain confirming automated differentials when there is clinical suspicion of an eosinophilic process.

**Question for consideration:**

5. What are your next steps in management?

### Section 4:

Given suspicion for parasitic meningoencephalitis, this child was treated with a 10-day course of corticosteroids (methylprednisolone 20mg/kg/day for 3 days, followed by prednisolone 2mg/kg/day for 7 days) and albendazole (40mg/kg/day divided twice daily) with improvement in coordination and vision. He had no further seizures. His eosinophilia was improved at discharge 5 days later, with an absolute eosinophil count of 1630 cells/µL. *Baylisascaris procyonis* testing (IgG ELISA) performed at the Centers for Disease Control and Prevention (CDC) was positive in the serum, but negative in CSF. Other diagnostic testing, including genetic testing for hypereosinophilic syndromes, stool ova and parasites, and CSF metagenomic sequencing, was negative.

At 4-week follow-up, the child had a subtle residual left-hand preference but otherwise normal neurologic examination. At 3-month follow-up, neuro-ophthalmology noted normalized vision for age. At 4-month follow-up, neurology noted mild delays in ambulation (not walking at 16 months of age). A repeat CBC showed rising eosinophilia, with absolute eosinophil count of 1970 cells/µL. Repeat MRI brain with and without gadolinium demonstrated interval worsening of multifocal areas of symmetric non-enhancing FLAIR signal abnormality throughout the supratentorial white matter (Figure 2). Given concern for disease progression, he was readmitted for evaluation and treatment. Lumbar puncture was notable for CSF WBC 15 (47% eosinophils) and RBC 2880. He was treated with albendazole for 28 days and methylprednisolone 20 mg/kg/day for 5 days, followed by a 5-week prednisone taper, which he tolerated well. Serial evaluations, most recently 21 months after initial presentation (33-months-of-age), demonstrated stable neuroimaging and normalized eosinophil...
counts. Examination at that time was notable for subtle right hemiparesis, trace right-sided hypertonia with positive right Babinski, and independent ambulation with mildly wide-based gait. Despite subtle gross motor and speech delays, his global development is progressing.

Discussion

Baylisascaris procyonis is an intestinal round worm that infects raccoons in the United States, though regional prevalence varies. Humans become infected by ingesting eggs, which can survive for years in the soil of raccoon latrines. Infection risk is highest in young children who are prone to pica or geophagia. Clinical symptoms correlate with the volume of embryonated eggs ingested, and can present as ocular larval migrans (unilateral retinitis with photophobia and vision loss) and/or neural larval migrans. With neural larval migrans, symptomatic onset occurs within 2-4 weeks of ingestion, starting with fatigue, nausea, fever, and lethargy, then progressing to weakness, incoordination, ataxia, seizures, altered mental status, and later coma\textsuperscript{3,4}.

Characteristic neuroimaging findings of CNS Baylisascaris infection include T2 prolongation in the deep white matter\textsuperscript{5} as larval migration tracks cause necrosis, with secondary inflammation caused by eosinophil degranulation and release of neurotoxic proteins, including IL-5\textsuperscript{6}. Baylisascaris procyonis should be suspected in patients with CSF eosinophilia and white matter lesions on MRI. The diagnosis is confirmed with serum and CSF antibody testing through the CDC. Discordant serum and CSF testing is rare, though two other cases have been reported.\textsuperscript{7} Morphologic identification via brain biopsy is unlikely to yield sufficient sample for detection.

Treatment involves antihelminthic agents like albendazole with concurrent corticosteroids to prevent toxicity secondary to cytokine release from parasite death\textsuperscript{8}. The appropriate duration of treatment has not been established. Baylisascariasis is highly morbid. Tissue damage begins prior to symptomatic onset, so there is a lag in symptom onset from exposure, and diagnosis is often delayed. Of the 31 documented cases with CNS involvement to-date, five caused death, and nearly all remaining patients had profound neuro-cognitive deficits\textsuperscript{6,8–13}. Only three prior cases have been described without neurologic devastation: one child with mild paraparesis and moderate speech delay\textsuperscript{14} and two children with full neurologic recovery\textsuperscript{7,15}. This case represents
a fourth child with remarkable recovery from what has historically been a devastating disease. Each child was promptly treated with corticosteroids and high dose albendazole, suggesting that early recognition and treatment are imperative to improving patient outcomes.

**Figure 1: Neuroimaging findings at presentation.** MRI brain demonstrating multifocal areas of T2/FLAIR signal intensity (white arrows) involving the (A) right greater than left frontal lobe and bilateral parietal lobes, (B) left greater than right thalamus, (C) bilateral temporal lobes and left occipital lobe as well as the splenium of the corpus callosum (not shown), and (D) the cerebellum.

**Figure 2: Interval progression of symmetric, non-enhancing FLAIR signal abnormality (white arrows) involving the bilateral deep, periventricular, and subcortical white matter (A-C) as well as medial cerebellar hemispheres (D)**
### Appendix 1: Authors

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References:


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