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Case Report

Balamuthia amoebic encephalitis directly causing intracranial infection: A case report☆,☆☆

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ABSTRACT

Balamuthia amoebic encephalitis (BAE) is a rare and often fatal central nervous system (CNS) infection caused by Balamuthia mandrillaris, a free-living amoeba typically found in soil and water. This organism can invade the brain directly, bypassing other organs, making early diagnosis particularly challenging. Symptoms often do not appear as distinctive early warning signs, and many patients do not experience noticeable skin lesions or systemic symptoms before neurological manifestations emerge. Balamuthia can enter the body through various routes, including the respiratory tract, skin, or gastrointestinal tract, eventually crossing the blood-brain barrier and causing aggressive encephalitis. The early symptoms of BAE are nonspecific, and the disease has an extremely high mortality rate. This report presents a 35-year-old male patient who died from Balamuthia amoebic encephalitis. The patient had a history of prolonged exposure to underground mines and consumed raw beef a week before the onset of symptoms. The infection is believed to have entered through the respiratory tract or gastrointestinal route. Diagnosis was primarily based on pathological findings, and the patient did not receive effective treatment due to delayed diagnosis, ultimately passing away approximately 2 months after the onset of symptoms. This case emphasizes the rarity and fatal nature of BAE, particularly when neurological symptoms are the first sign of infection without preceding systemic or dermatological manifestations. The report highlights the importance of considering Balamuthia mandrillaris infection in patients presenting with unexplained encephalitis and brain abscess, especially with a potential history of exposure to amoeba-contaminated environments.

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Introduction

Balamuthia mandrillaris is a free-living amoeba found in soil and water that can cause Balamuthian amoebic encephalitis (BAE), a rare and fatal central nervous system (CNS) infection [1]. The amoeba was first isolated from the brain of a baboon that died of meningoencephalitis [2]. These amoebas usually enter the body through the skin, lungs, or gastrointestinal tract, ultimately crossing the blood-brain barrier and triggering amoebic encephalitis [3]. BAE is extremely rare, with approximately 300 cases reported globally [4]. Factors such as exposure to contaminated freshwater, soil, and immune suppression increase the risk of infection. Certain occupations, such as mining, plumbing, and agricultural work, also present a higher risk. The disease often begins insidiously, with nonspecific symptoms such as headache, fever, nausea, vomiting, seizures, confusion, vision loss, and speech difficulties [5]. Due to its rapid progression and high fatality rate, early diagnosis is crucial to improve patient outcomes [6].

Case reports

A 35-year-old male patient presented with a sudden onset of fever (38°C) on May 10, 2024, accompanied by abdominal pain, nausea, vomiting, and intermittent headache characterized by a pulsatile pain in the left eye socket and frontal region. The patient had not received any treatment, and there were no gastrointestinal symptoms such as diarrhea. On May 13, the patient developed right upper limb seizures with associated right-sided numbness, lasting for about 5 minutes before spontaneously resolving, with 5-6 episodes occurring daily. An MRI performed at a local hospital showed abnormal signals in the left parietal lobe, suggestive of a central nervous system infection. The patient was treated with anti-inflammatory medications, after which the seizures subsided, and his fever decreased to around 37°C. However, on May 15, the patient experienced progressive right-sided weakness, with difficulty using his right hand to hold chopsticks and walking difficulties in his right leg, accompanied by numbness in the right side of his body. On May 17, the patient was transferred to a higher-level hospital for further evaluation. MRI on May 22 revealed a round enhanced lesion in the left parietal lobe with associated edema, consistent with an infectious lesion. Despite treatment with antibiotics, corticosteroids, and medications to reduce intracranial pressure, the right-sided weakness persisted without significant improvement. Follow-up MRIs on June 4 and June 18 showed a reduction in the size of the lesion in the left parietal lobe (Fig. 1) but the appearance of multiple new lesions in the right parietal lobe (Fig. 2). On June 20, the patient developed left-sided numbness and weakness, unable to get out of bed, and had facial drooping. On June 24, due to worsening condition, the patient was transferred to our hospital's neurology department for further management.

Upon admission, the patient was alert but had slurred speech, limited eye movements, horizontal nystagmus, and left-sided facial drooping. The left-sided limbs showed reduced sensation, diminished reflexes, and muscle strength of grade 2, unable to perform coordination tests. Right-sided limb strength was also grade 2, with normal proprioceptive reflexes. The Babinski sign was positive bilaterally.

The patient was started on anti-infective and symptomatic treatments, including measures to reduce intracranial pressure. MRI showed multiple round abnormal signals in both parietal lobes, with new lesions in the right pontine and brainstem regions (Fig. 3). Compared to previous images, both the number and size of the lesions had increased. Diffusion-weighted imaging (DWI) showed restricted diffusion in some lesions, while enhanced scans revealed multiple nodular and ring-enhancing lesions within the brain parenchyma.

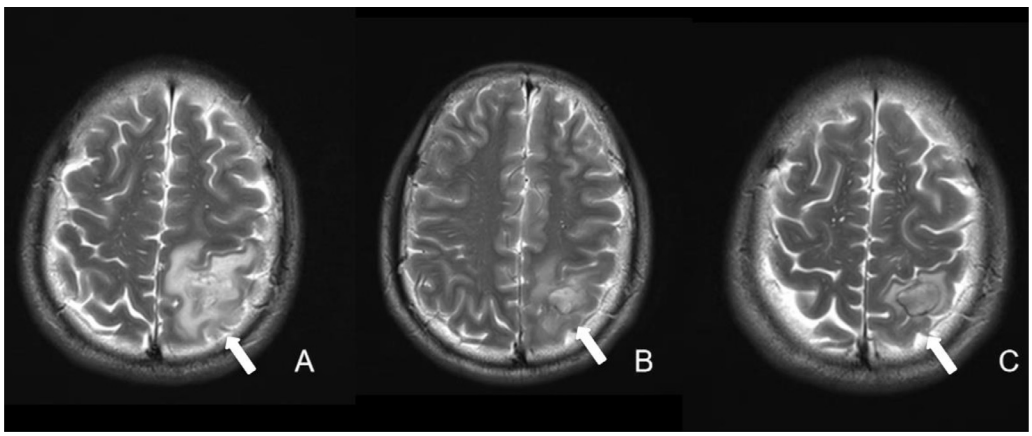

Fig. 1 – T2-weighted MRI images of the brain acquired on May 22 (A), June 4 (B), and June 18 (C). The extent of the lesion in the left parietal lobe (white arrows) is progressively decreasing. Multiple new foci have appeared in the right parietal lobe.

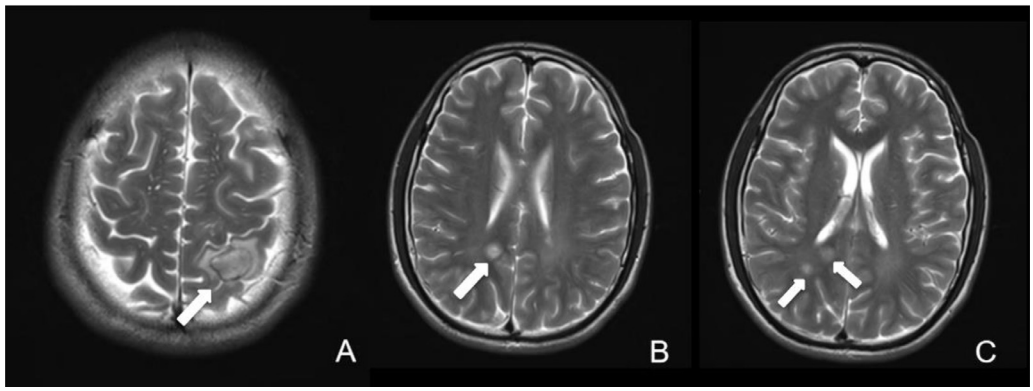

Fig. 2 – T2-weighted MRI images of the brain acquired on June 18. Multiple roundish hyperintense T2 signals are evident in the right parietal lobe (A), adjacent to the posterior horn of the right lateral ventricle (B) and within the right midbrain (C), which have newly emerged compared to the prior examination conducted on June 4th.

The central area of the left parietal lesion showed no significant enhancement, but a surrounding edema band was visible.

Cerebrospinal fluid (CSF) analysis revealed an elevated total cell count and white blood cell count, with reduced glucose levels and elevated protein concentrations. Immunological tests showed increased levels of IgG, IgA, and IgM. No bacterial or fungal organisms were detected on CSF smear.

Given the MRI findings, the patient underwent stereotactic brain biopsy, and histopathology from tissue obtained 12 days postsurgery revealed extensive tissue necrosis with mixed inflammatory cell infiltration. Pus and tissue were sent for culture and next-generation sequencing (NGS). NGS results indicated the presence of Balamuthia mandrillaris genomic sequences with 89 reads. This confirmed the diagnosis of Balamuthia amoebic encephalitis. The patient was transferred to the infectious diseases department for further management but unfortunately passed away on July 9, 2024.

Discussion

Balamuthia infections can manifest through various clinical presentations, including skin lesions, respiratory infections, and CNS involvement [7]. The infection typically enters the body via inhalation of contaminated soil particles, skin abrasions, or ingestion of contaminated food, eventually crossing the blood-brain barrier and causing encephalitis [7]. Studies have shown that individuals who work with soil, such as miners and agricultural workers, are at an increased risk [8]. In this case, the patient's prolonged exposure to underground mines is a plausible source of infection, as Balamuthia is commonly found in soil, which could have facilitated the amoeba's entry through minor skin abrasions or inhalation of dust particles. Additionally, the patient's consumption of raw beef one week before the onset of symptoms raises the possibility of gastrointestinal transmission, although this route remains speculative.

The early signs of BAE include non-specific respiratory symptoms, such as nasal congestion, flu-like symptoms, and low-grade fever. As the disease progresses, symptoms become more severe, including persistent throbbing headaches, nausea, vomiting, fever, confusion, and neurological deficits, such as limb weakness, seizures, and ataxia. In the final stages, patients may develop respiratory and circulatory failure, ultimately leading to death [9]. Although skin lesions are a prominent feature in some cases [10], they were absent in this patient, who instead presented with direct central nervous system involvement.

BAE imaging typically shows single or multiple foci at the cortical-medullary junction and around the ventricles, with surrounding brain edema. Commonly affected areas include the mesencephalon, thalamus, and brainstem, often near cerebrospinal fluid spaces such as ventricular walls and subarachnoid space. Some lesions may exhibit ring-shaped enhancement on T1-weighted images, aiding early diagnosis [11].

Early diagnosis of BAE is challenging due to non-specific initial symptoms, frequent negative pathogen detection in CSF and other tests, and limited clinician awareness. Prompt diagnosis and anti-amoebic treatment are critical to prevent permanent neurological damage and improve outcomes [12]. Preventive measures include avoiding contaminated water and raw food, promptly treating skin injuries, and wearing protective gear in high-risk environments.

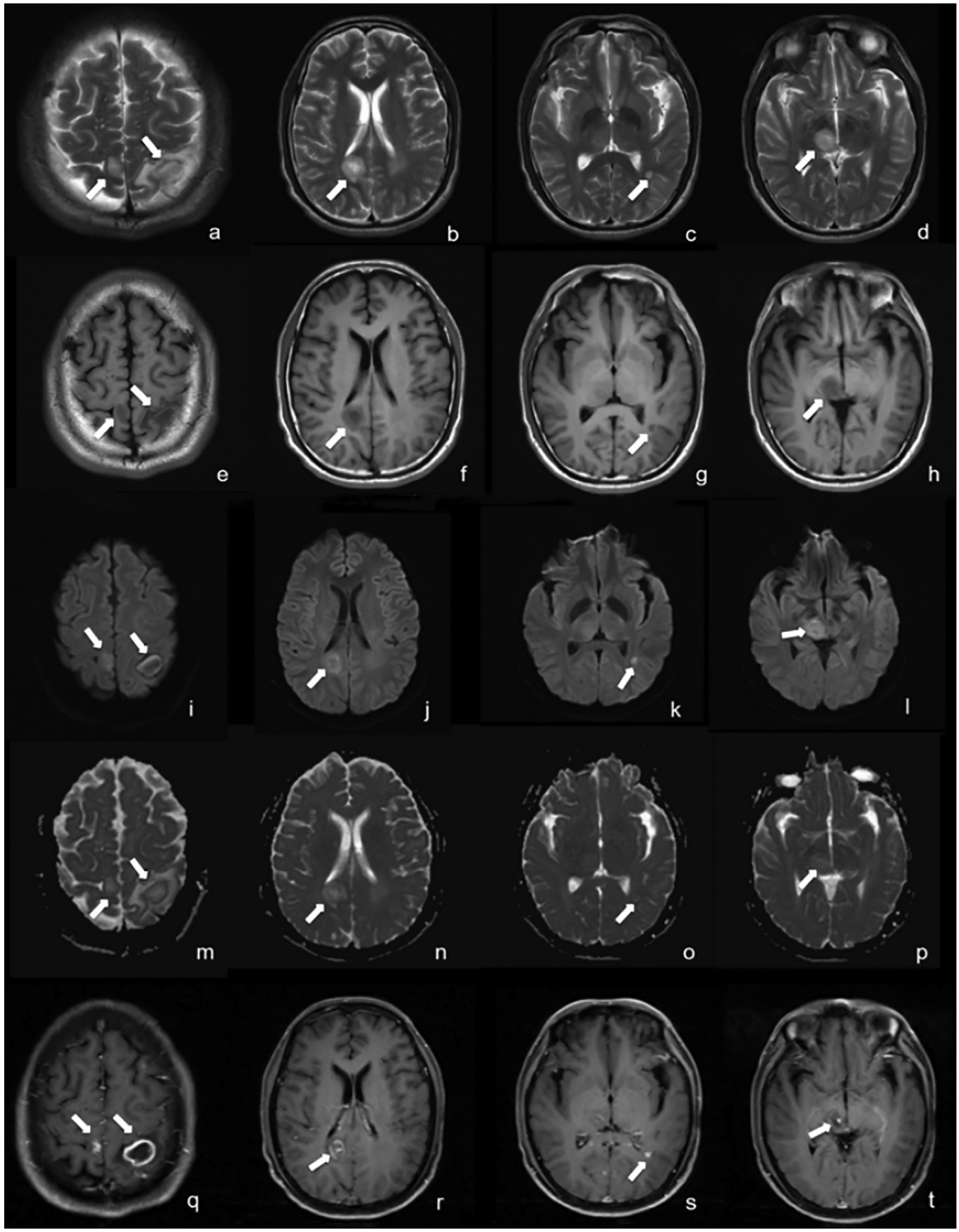

Fig. 3 – The brain MRI images on June 27 revealed multiple circular long T1 and long T2 abnormal signals in the bilateral parietal lobes (a, e), adjacent to the posterior horns of the lateral ventricles (b, c, f, g) and the right pons (d, h). The DWI sequence (i~l) demonstrated multiple nodular areas with restricted diffusion, presenting as high-signal intensities. Patchy long T1 and long T2 abnormal signals were detectable in the left parietal lobe, accompanied by a surrounding edema band. The DWI sequence presented a mixture of high and low signal intensities (h). Enhanced imaging revealed multiple nodular abnormal enhanced lesions within the brain parenchyma (q~t). The margin of the lesion in the left parietal lobe displayed ring-like enhancement, while no significant enhancement was noted at its center (q).

Conclusion

This case highlights the rarity and lethality of Balamuthia amoebic encephalitis, particularly when neurological symptoms are the first clinical manifestation without prior systemic or dermatological signs. The condition's rapid progression and high fatality rate necessitate early recognition and prompt diagnostic workup. Clinicians should consider Balamuthia mandrillaris infection when patients present with unexplained encephalitis and brain abscesses, especially if there is a history of exposure to amoeba-contaminated environments. Early use of molecular diagnostic tools, such as next-generation sequencing, can aid in confirming the diagnosis and initiating appropriate therapy to improve patient prognosis.

Patient consent

Written informed consent was obtained from the patient (or their legal guardian) for the publication of this case report, including any accompanying images and medical data. The patient was informed about the purpose of the publication and understood that personal identifying details will be kept anonymous and confidential. The patient has had the opportunity to ask questions and has agreed that their medical information may be shared for academic and scientific purposes.

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