Fatal *Acanthamoeba* Encephalitis in a Patient With a Total Artificial Heart (Syncardia) Device

Susanna K. Tan,[1] Kiran Gajurel,[1] Christie Tung,[2] Gregory Albers,[2] Stan Deresinski,[1] Jose G. Montoya,[1] Ahmad Y. Sheikh,[3] Dipanjan Banerjee,[4] and Richard Ha[3]

[1]Department of Medicine, Division of Infectious Diseases and Geographic Medicine, Stanford University School of Medicine; [2]Department of Neurology & Neurological Sciences, Stanford University School of Medicine; [3]Department of Cardiothoracic Surgery, Stanford University School of Medicine; and [4]Department of Medicine, Division of Cardiovascular Medicine, Stanford University School of Medicine, California

***Acanthamoeba* encephalitis is an uncommon but often fatal infection complication. Here we report the first case of *Acanthamoeba* encephalitis in a patient with a Total Artificial Heart device.**

Keywords. *Acanthamoeba*; encephalitis; total artificial heart; heart failure.

A 60-year old man with a history of nonischemic cardiomyopathy with severe left ventricular systolic dysfunction (NYHA class 4), chronic kidney disease, and obstructive sleep apnea presented with worsening dyspnea on exertion and fluid retention. In preparation for planned implantation of a Syncardia total artificial heart device as a bridge to cardiac transplantation, he underwent several dental extractions 2–3 weeks prior to admission. He formerly lived on a 5-acre property in rural Northern California and regularly drank well water, prior to relocating closer to our institution 1 month prior to the device placement.

On hospital day 14, he received the total artificial heart device without operative difficulty. Two days later, he developed flaccid paralysis of the left upper extremity. His left pupil was fixed and dilated at 5 mm, and he remained obtunded despite removal of sedation. Computerized tomography (CT) of the head showed a right medial temporal lobe hypodensity without enhancement in an atypical location for ischemia, raising the possibility of an infection (Fig. 1). The patient was empirically started on acyclovir for possible herpes simplex virus encephalitis and broad spectrum antibiotics for possible bacterial infection. A repeat CT of the head on postoperative day 4 revealed increased brain edema with 8-mm leftward midline shift and uncal herniation. Lumbar puncture for cerebrospinal fluid analysis and magnetic resonance imaging could not be obtained due to herniation and presence of the total artificial heart device, respectively. The patient developed loss of brainstem reflexes despite maximal medical management with hypertonic saline, mannitol, and steroids. The patient's wife refused further invasive procedures including decompressive hemicraniectomy and brain biopsy, and he was transitioned to comfort care and died 5 days after device placement.

Autopsy revealed a $6 \times 6 \times 5$ cm area of necrosis and hemorrhage (Fig. 2) of the brain parenchyma with numerous amoebic trophozoites (20–22 μm with a single nucleus and a prominent nucleolus) and double walled cysts (Fig. 3). Gram, AFB, GMS, and PAS-d stains did not reveal bacterial, mycobacterial, or fungal organisms. Morphologic analysis, immunoperoxidase staining, and molecular analysis by multiplex real-time polymerase chain reaction (PCR) of 18S ribosomal RNA (rRNA) of brain tissue performed by the Centers for Disease Control and Prevention (CDC) confirmed *Acanthamoeba* species belonging to morphology Group 1 [1]. A review of over 6 slides of lung, 12 from the heart and device, 2 from skin, 3 from gastrointestinal tract, and 1 from remaining organs, did not reveal any trophozoites or cysts by histology. Four tissue blocks from heart and lungs were sent to the CDC and were negative for *Acanthamoeba* by immunohistochemistry. PCR of these tissue blocks was not performed. The total artificial heart device had been returned to the manufacturer and was unavailable to us for analysis.

DISCUSSION

Acanthamoeba spp. are free-living amoebae that are ubiquitous in the environment, found in soil and freshwater, brackish, and marine water. They have been isolated from showerheads, sink drains, humidifiers, cooling systems, and dental irrigation equipment [2, 3]. *Acanthamoeba* cysts or trophozoites can enter the body through the eyes, sinonasal, skin, or respiratory tracts with subsequent hematogenous spread and invasion into the central nervous system through the blood-brain barrier [4]. *Acanthamoebae* are classified into 3 main groups based on morphology and size. Group 2 cause the majority of reported

Received 24 May 2014; accepted 13 June 2014.

Correspondence: Susanna K. Tan, MD, Stanford University, Stanford, CA (susietan@stanford.edu).

Open Forum Infectious Diseases

DOI: 10.1093/ofid/ofu057

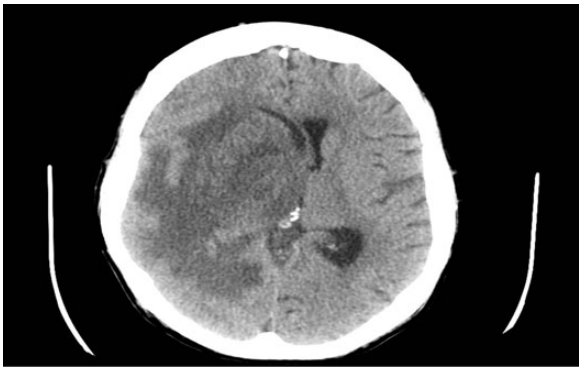

Fig. 1. CT head with and without contrast showing an ill-defined hypodensity at the right medial temporal lobe causing mass effect and uncal herniation with surrounding vasogenic edema. Abbreviation: CT, computerized tomography.

human infections of *Acanthamoeba* keratitis and encephalitis [5]. Group 1 and 3 *Acanthamoebas* have also been implicated in human infections, although less frequently reported [6]. The clinical course of *Acanthamoeba* encephalitis can be fulminant, with rapid progression to death with onset of neurologic symptoms.

Although *Acanthamoeba* encephalitis is believed to primarily affect immunocompromised hosts such as transplant recipients, it has also been reported to occur in immunocompetant patients [7, 8]. A review of 18 cases in the literature since 2002 noted 83% (15/18) were males, and 61% (11/18) had identifiable underlying immunosuppressive conditions [9]. The incubation period is not known but is postulated to be >10 days and can span several weeks to months [7, 10]. Other than end-stage heart failure, our patient did not have a recognized underlying immunocompromised state. Possible portals of entry

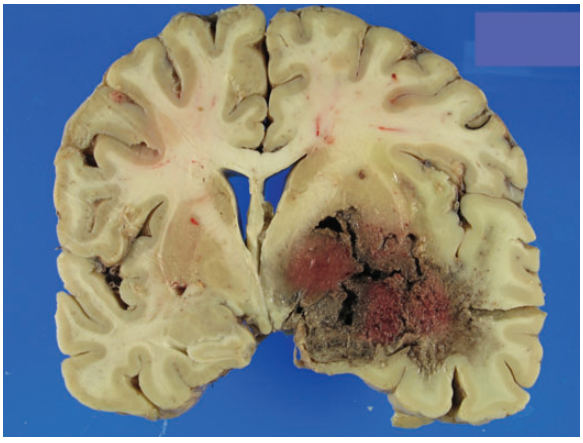

Fig. 2. Coronal section of cerebrum displaying a 6 × 6 × 5 cm area of gelatinous necrosis and hemorrhage involving globus pallidus, putamen, and a portion of the lateral internal capsule with extension into the temporal lobe.

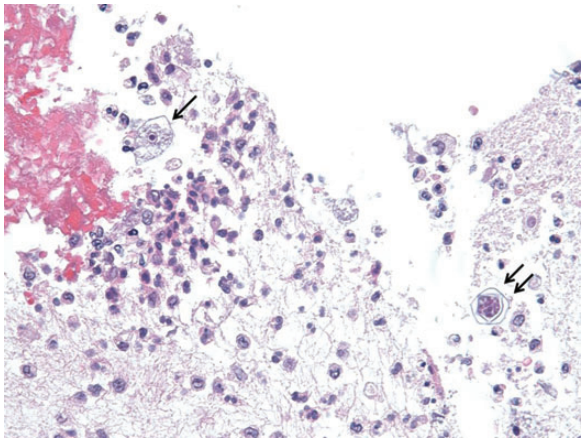

Fig. 3. H&E stain of brain tissue at 40× magnification showing an amoebic trophozoite with a single nucleus and a prominent nucleolus (*single arrow*) and a cyst form with stellate double-layered walls which were PASd- and GMS-stain positive (*double arrow*).

include hematogenous spread from recent dental procedures or placement of the total artificial heart device, pulmonary dissemination from use of contaminated continuous positive pressures (CPAP) machine, and reactivation of prior latent infection. Although the role of contaminated positive pressure airway machines has yet to be implicated in the development of *Acanthamoeba* encephalitis, pulmonary dissemination has been reported [11]. Unfortunately, the patient visited numerous dental offices, which precluded further investigation by local public health officials, and the CPAP machine, distilled water used to humidify air for use with the CPAP machine, and total artificial heart device were disposed of prior to further testing. Absence of trophozoites or cysts in other organs including the lungs might suggest the CPAP machine as a less likely source of infection but does not exclude the possibility. The extent of brain parenchyma necrosis as seen on autopsy might suggest long-standing exposure to the organism, although the development of significant neurologic symptoms soon after placement of the device could imply a role of the procedure in accelerating the progression of disease. This case of fatal *Acanthamoeba* encephalitis in a patient with a newly placed total cardiac device highlights the need for further understanding of this organism and its pathogenesis.

Acknowledgements

The authors would like to acknowledge Dr Darren Salmi and Dr Hannes Vogel who performed the autopsy and provided the images to this case and Dr Carol Glaser for her contribution to the exposure investigation.

References

1. Qvarnstrom Y, Visvesvara GS, Sriram R, et al. Multiplex real-time PCR assay for simultaneous detection of *Acanthamoeba* spp., *Balamuthia mandrillaris*, and *Naegleria fowleri*. J Clin Microbiol. **2006**; 44:3589–95.

2. Marciano-Cabral F, Cabral G. *Acanthamoeba* spp. as agents of disease in humans. Clin Microbiol Rev. **2003**; 16:273–307.
3. Trabelsi H, Sellami A, Dendena F, et al. Free-living amoebae (FLA): morphological and molecular identification of *Acanthamoeba* in dental unit water. Parasite. **2010**; 17:67–70.
4. Khan NA. Acanthamoeba and the blood-brain barrier: the breakthrough. J Med Microbiol. **2008**; 57:1051–57.
5. Qvarnstrom Y, Nerad TA, Visvesvara GS. Characterization of a new pathogenic Acanthamoeba Species, A. byersi n. sp., isolated from a human with fatal amoebic encephalitis. J Eukaryot Microbiol. **2013**; 60:626–33.
6. Walochnik J, Haller-Schober E, Kolli H, et al. Discrimination between clinically relevant and nonrelevant *Acanthamoeba* strains isolated from contact lens-wearing keratitis patients in Austria. J Clin Microbiol. **2000**; 38:3932–6.
7. Visvesvara G, Moura H, Schuster F. Pathogenic and opportunistic free-living amoebae: *Acanthamoeba* spp., *Balamuthia mandrillaris*, *Naegleria fowleri* , and *Sappinia diploidea*. FEMS Immunol Med Microbiol. **2007**; 50:1–26.
8. Reddy R, Vijayasaradhi M, Uppin MS, et al. *Acanthamoeba* meningoencephalitis in an immunocompetent patient: An autopsy case report. Neuropathology. **2011**; 31:183–7.
9. Zamora A, Henderson H, Swiatlo E. *Acanthamoeba* encephalitis: A case report and review of therapy. Surg Neurol Int. **2014**; 5:68.
10. Martinez AJ. Free-living amebic meningoencephalitides: comparative study. Neurol Neurocir Psiquiatr. **1977**; 18:391–401.
11. Visvesvara GS, Mirra SS, Brandt FH, et al. Isolation of two strains of *Acanthamoeba castellanii* from human tissue and their pathogenicity and isoenzyme profiles. J Clin Microbiol. **1983**; 18:1405–12.