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Osteomyelitis of the Sternum Caused by *Apophysomyces elegans*

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***Apophysomyces elegans*, a member of the family *Mucoraceae*, was found to infect the chest wall and sternum of an immunocompetent man following minor trauma. As in previous cases, amphotericin B therapy alone was inadequate. Extensive surgical debridement was required in order to eradicate the infection.**

Apophysomyces elegans, a saprophytic fungus of the class *Zygomycota* and the order *Mucorales*, is a rare human pathogen. Misra et al. first isolated the fungus in 1979 from soil samples collected in a mango orchard in northern India (8). In the United States, *A. elegans* was first reported in 1982 when it colonized a patient's respiratory tract (2). Since then, there have been nine reports of zygomycosis caused by *A. elegans* (1, 3–5, 7, 9, 12–14). We describe a case of severe posttraumatic soft tissue infection with extension into the sternum in a patient without apparent underlying disease.

While trimming a tree, a healthy 70-year-old man was struck in the midchest area by the cut end of a large limb. He was wearing a shirt, and he noted no break in the skin. Two months later he developed high fever, dyspnea, and right pleuritic chest pain. After several emergency room visits, the symptoms persisted. He was admitted to a Florida hospital and had a normal chest radiograph, but he received broad-spectrum antibiotics for presumed bacterial pneumonia. Over several days, an indurated mass developed on his anterior chest wall. Biopsies and cultures of the mass revealed a zygomycete fungus. Despite a prolonged course of amphotericin B and multiple surgical debridements over the next 3 months, infection persisted, and he was transferred to our facility. He underwent sternectomy up to the manubrium with removal of the lower ribs bilaterally. Debridement was carried back to healthy, bleeding bone. An omental flap and skin grafts were required to close his extensive incisions. The patient received an additional gram of amphotericin B following surgery. Four months later he remained afebrile, with no evidence of recurrent disease.

Pathologic examination of the surgical specimens showed extensive scarring with chronic inflammation and areas of foreign body reaction. There were acute inflammatory exudates as well as aggregates of amorphous material containing numerous nonseptate fungal hyphae with right-angle branching. Similar fungal elements and amorphous material packed the marrow space of the sternum.

Cultures obtained from an excised rib segment grew a mold with white to yellowish white, floccose colonies and had erect aerial mycelia that approached the upper lid of the petri dish. Routine efforts to induce sporulation failed. The fungal culture was referred to the Fungus Reference Laboratory of the Division of Bacterial and Mycotic Diseases at the Centers for Disease Control and Prevention. Both this organism and isolates from the referring hospital were identified as *A. elegans*.

Microscopic examination of the isolate showed hyaline, broad, sparsely septate, nonsporulating hyphae measuring 3.5 to 8.0 μm in diameter. The isolate grew well at 37°C as well as at temperatures as high as 43°C. It was subcultured on Sabouraud dextrose (2%) agar plates and was incubated for 7 days in the dark at 25°C. Agar blocks permeated with mycelial growth were transferred aseptically to a plate containing 20 ml of sterile distilled water supplemented with 0.2 ml of 10% filter-sterilized yeast extract solution. The plate was incubated in the dark at 37°C. After 7 days of incubation, growth seen as a thin film over the surface of the water was mounted in lactophenol cotton blue stain and examined microscopically (10). Numerous sporangia typical of *A. elegans* were observed (Fig. 1). The bell- or funnel-shaped apophyses distinguish *A. elegans* from other members of the *Mucoraceae*. One other pathogen, *Absidia corymbifera*, produces funnel-shaped apophyses. *A. elegans* is easily distinguished from *A. corymbifera* by its dark brown, pronounced campanulate or funnel-shaped apophyses and darkly pigmented, thick-walled zones of sporangiophores with narrow lumens. In addition, sporangiophores of *A. elegans* are supported by a foot cell similar to foot cells produced by *Aspergillus* species. The identity of the present isolate was confirmed by the exoantigen test (6). The isolate was deposited in the Centers for Disease Control and Prevention's fungus culture collection under accession number CDC B-5049.

Members of the family *Mucoraceae* are ubiquitous fungi but rarely cause disease except in patients with host defenses impaired by diabetes mellitus, abnormal neutrophil function, or trauma (11). Our patient is the 10th reported patient with an infection due to *A. elegans*, and his is the first case involving the soft tissue of the chest wall and the second case of osteomyelitis from contiguous spread. In the nine previous reports of *A. elegans* infection, one patient had diabetes mellitus (13) and the others were apparently immunocompetent. In seven patients, invasive soft tissue infections complicated burns or wounds contaminated by soil (1, 3, 7, 9, 12, 14). The eighth patient developed an infection involving the kidney and bladder followed by hematogenous osteomyelitis, with no apparent source of the fungus (5). In a recently reported case from India, *A. elegans* caused fatal necrotizing fasciitis of the abdominal wall in an immunocompetent patient who underwent inguinal herniorrhaphy (4). Thus, the limited experience with *A. elegans* suggests that direct inoculation is a more important predisposing factor than immunocompromise. In all previous

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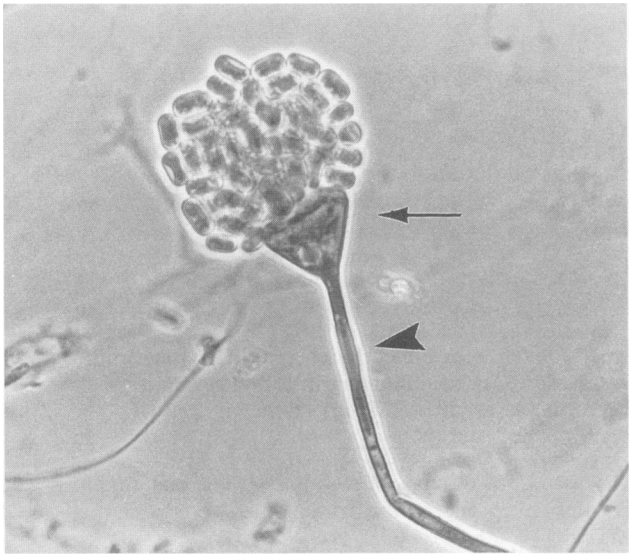

FIG. 1. Dark, thick-walled sporangiophore (arrowhead), campanulate apophysis (thin arrow), and oblong, hyaline, smooth, one-celled sporangiospores of *A. elegans* (CDC B-5049). Magnification, ×560.

reports involving trauma, soft tissue infection followed shortly after obvious disruption of the skin. This case was unusual in that the presumed initial trauma did not grossly abrade the skin and preceded the development of symptoms by 2 months. The diagnosis of *A. elegans* infection is often delayed. In tissue, the fungus appears similar to other zygomycetes. It grows well on routine mycological media but fails to sporulate by routine procedures. To induce sporulation, a nutritionally deficient medium and an incubation temperature of 37 rather than 25°C is necessary, and a procedure under these conditions is not performed in most hospital laboratories.

Although there are no published in vitro data on the activity of antifungal agents against *A. elegans*, amphotericin B is the treatment of choice for zygomycotic infections and has been used in other cases of *A. elegans*. However, amphotericin B alone is usually not sufficient to control infection caused by the members of the order *Mucorales*. Extensive surgical debridement, often including amputation of limbs, is required. Of the seven previously reported patients with *A. elegans* infections for whom the clinical outcome was recorded, three required amputation, one required nephrectomy, two had extensive soft tissue and bone debridement, and the seventh eventually died despite amphotericin B and extensive abdominal wall debridement.

In our patient, the clinical presentation of fevers and chest pain preceding development of the chest wall mass was confusing. However, the subsequent course was typical for zygomycosis. Progression of the chest wall infection despite therapy with more than 1 g of amphotericin B necessitated a radical surgical approach that left a flail chest and considerable functional deficit.

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