Antifungal Therapy of *Aspergillus* Invasive Otitis Externa: Efficacy of Voriconazole and Review

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Invasive otitis externa (IOE) due to *Aspergillus* is a rare, potentially life-threatening, invasive fungal infection affecting immunocompromised patients. The invasive process may lead to skull base osteomyelitis with progressive cranial nerve palsies and can result in irreversible hearing and neurological impairment. We report two cases of *Aspergillus* IOE treated with voriconazole alone and a literature review of antifungal therapy of *Aspergillus* IOE. Twenty-five patients, including the two described in the present report, were analyzed. Eighteen patients were treated with amphotericin B, and nine of them received itraconazole as an additional agent. Three patients received initial therapy with itraconazole, and one patient was treated with both voriconazole and caspofungin therapy. The two patients in the present report received voriconazole therapy alone with good clinical and biological tolerance despite prolonged treatment. The last patient did not receive antifungal therapy, as the diagnosis was made postmortem. Eighteen patients underwent an initial extensive surgical debridement. The majority of the patients had a favorable outcome. 17 patients experienced a complete recovery, and 6 showed a partial improvement. Both of the patients reported on here had favorable outcomes, and no aggressive surgical debridement was required. Although voriconazole has been shown to be effective for the treatment of invasive aspergillosis, its precise role in the management of *Aspergillus* IOE had not been documented. These observations demonstrate that voriconazole could be an effective and well-tolerated therapeutic option for the management of *Aspergillus* IOE.

Invasive otitis externa (IOE) is a particular entity among ear infections (6). Its main feature is its spreading from the external auditory canal to adjacent anatomical structures including soft tissues, cartilage, and bone. The invasive process can lead to skull base osteomyelitis, progressive cranial nerve palsies, and even death if IOE is not recognized and treated early. Invasive external otitis typically occurs in elderly diabetic patients, and *Pseudomonas aeruginosa* is the most common causative microbe (11, 35).

Fungal pathogens, mostly *Aspergillus* spp., are a rare cause of IOE (5). As for other localizations of invasive aspergillosis, *Aspergillus* IOE occurs in immunocompromised patients, usually with profound and long-lasting neutropenia or under long-term steroid therapy (21, as well as in patients with uncontrollable diabetes mellitus (14).

The treatment of *Aspergillus* sp. IOE classically includes extensive surgical debridement and intensive long-term antifungal therapy including amphotericin B and/or itraconazole. Despite this management, this pathology is associated with substantial morbidity and mortality, mostly due to late diagnosis and patient comorbidities (2, 37). Treatment failure could also be a result of suboptimal therapeutic management as a consequence of antifungal agent toxicity. In particular, the side effects of amphotericin B, especially renal failure, may require interruption of antifungal agents or a decrease in dosage.

Voriconazole might become a therapeutic option for the management of *Aspergillus* IOE. This broad-spectrum azole exhibits high anti-*Aspergillus* activity and good long-term tolerance. We report herein the first two cases of *Aspergillus* sp. IOE successfully treated with voriconazole alone and provide a literature review of *Aspergillus* sp. IOE.

**CASE REPORTS**

**Case 1.** A 48-year-old man with a history of relapsing polychondritis was diagnosed with right external otitis characterized by acute ear pain and a foreign-body sensation. Immunosuppressive therapy consisted of oral methotrexate (12.5 mg/week) and prednisone (10 mg/day). He was initially given oral amoxicillin-clavulanic acid, but as his pain increased, he was switched to oral ofloxacin.

Two weeks after the initial diagnosis, he was admitted to our hospital because of a failure to improve. The patient noticed severe ear pain and relative hearing loss on the right side. Physical examination revealed an erythematous and edematous right ear canal with discharge and a tympanic membrane perforation. Magnetic resonance imaging showed soft-tissue filling of the right mastoid air cells and the middle ear and thickening of the roof of the right external ear canal.

A biopsy specimen from the external ear canal revealed nonspecific chronic inflammation with associated calcium oxide crystal deposition. Mycological microscopy examination

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of the discharge showed acute-angle branching septate fungal hyphae, and culture yielded *Aspergillus niger*. Gram staining did not reveal any other microorganism, and bacterial culture was negative. The patient was treated with oral voriconazole (200 mg orally twice a day [b.i.d.]), and no extensive surgical debridement had to be performed. A computed tomography (CT) scan of the petrous temporal bone performed 2 months following treatment initiation demonstrated progressive pneumatization of the mastoid bone. After 3 months on voriconazole therapy, the patient had fully recovered, with normal clinical and otoscopic examinations and no more hearing loss. The patient showed good clinical and biological tolerance of long-term antifungal therapy. He received a total of 5 months of subsequent voriconazole therapy without a relapse after a 1-year follow-up.

**Case 2.** A 40-year-old diabetic woman was admitted to our hospital in 2006 with a 4-month history of left-side otalgia and otorrhea. She had a history of insulin-dependent diabetes complicated by blindness (secondary to diabetic retinopathy and bilateral endophthalmitis) and end-stage nephropathy. She had undergone renal transplantation 1 year earlier, and chronic allograft rejection had led to chronic renal failure (creatinine clearance, 40 ml/min). Her immunosuppressive therapy consisted of prednisone (10 mg/day), mycophenolate mofetil (500 mg three times a day) and tacrolimus (0.5 mg b.i.d.).

Initially, a diagnosis of otitis externa was made. She was treated with two successive courses of oral antibiotic therapy and topical ofloxacin, with partial improvement. Four months after the first evaluation, she was admitted because of worsening pain. On clinical examination, the left external ear canal was markedly painful, congested, and filled with black necrotic tissue debris. A CT scan of the temporal bone demonstrated left-side mastoiditis and a soft-tissue mass filling the external auditory canal was markedly painful, congested, and filled with black necrotic tissue debris. A CT scan of the temporal bone demonstrated left-side mastoiditis and a soft-tissue mass filling the external auditory canal (Fig. 1). Gallium scintigraphy showed high uptake in the left external ear canal and in the occipital region and homolateral skull base. A biopsy of the external ear canal revealed chronic inflammation and fungal hyphae within necrotic granulation tissue; the culture yielded *A. niger*. Voriconazole therapy was initiated, first at 200 mg orally b.i.d. and then at 300 mg b.i.d. to obtain a trough concentration of more than 1 mg/liter (22). *Antipseudomonas* intravenous antibiotics initiated upon admission (ceftazidime and ciprofloxacin) were discontinued.

Because of hearing loss due to a left tympanic membrane perforation, the patient underwent a left tympanoplasty with a mastoidectomy 2 months after voriconazole initiation. Surgical specimen cultures were negative for fungi and bacteria. Histology only disclosed nonspecific inflammation without hyphae, thereby verifying complete sterilization.

After an 8-month course of oral voriconazole, the patient experienced complete resolution of her otalgia and a clinical examination was normal except for moderate left-ear hearing loss. The follow-up CT scan had also improved (Fig. 2), with a normal auditory canal. Voriconazole was continued for a further 4 months. In total, the patient received 12 months of voriconazole therapy with good clinical and biological tolerance, except for moderate liver cholestasis. She had experienced no relapse within 10 months after antifungal therapy discontinuation.
FIG. 1. Axial CT scans of the temporal bone (image B was obtained inferior to image A) show soft tissue (*) filling the left external auditory canal and abnormal soft-tissue attenuation (arrowheads) in the left inferior mastoid air cells (compare with the opposite side).
ery, and 6 had a partial response to treatment. The last two died of invasive aspergillosis (17, 34); one of them did not receive any antifungal therapy because the diagnosis was postmortem, and the other had received a reduced dosage of amphotericin B because of acute renal failure. Five patients with initial clinical improvement died of other causes generally related to their underlying conditions (8, 27, 32, 38).

**DISCUSSION**

Invasive aspergillosis in immunocompromised hosts is characterized by a wide spectrum of clinical presentations, ranging from local to disseminated infections (36). *Aspergillus* is an uncommon cause of IOE. The first case was described in 1985 in a 68-year-old man with relapsing acute myelogenous leukemia (30). Since then, only 24 additional cases have been reported in the English-language literature, including our 2 cases.

During IOE, invasion is related to the spread of *Aspergillus* from the external auditory canal. The fungal infection slowly invades adjacent soft tissues and the mastoid air cells. Diagnosis is often delayed because *Aspergillus* is very rarely involved in IOE, compared with *P. aeruginosa* (5). As a result, if not recognized early, the infection can lead to extensive skull base osteomyelitis (40), with multiple cranial nerve palsies and sometimes a fatal outcome.

According to the literature review, treatment of *Aspergillus* IOE requires long-term antifungal therapy in association with appropriate management of the underlying condition, mostly diabetes mellitus. In addition, as in the management of *Aspergillus* osteomyelitis (43), prompt surgical debridement consisting of radical mastoidectomy is required in the majority of cases. Only three patients were exposed to hyperbaric oxygen therapy. This treatment is usually considered as an adjunctive therapy for refractory cases, although its efficacy remains debated (28, 31).

In the reviewed reports, the most commonly used antifungal agent was amphotericin B. This drug has been shown to be effective in the treatment of *Aspergillus* IOE, but its substantial toxicity profile must be taken into account, especially for patients with serious underlying comorbidities.

The two immunocompromised patients in the present report were successfully treated with long-term voriconazole therapy alone. Amphotericin B was not considered the optimal therapeutic option because the first patient had already received a potentially nephrotoxic agent (methotrexate) and the second suffered from chronic renal transplant rejection with severely impaired renal function. Both patients received long-term voriconazole therapy (5 and 12 months, respectively) with good clinical and biological tolerance, except for moderate liver cholestasis in the second patient. It is noteworthy that the initial voriconazole therapeutic plasma range was not optimal for the second patient whereas she received a standard dosage. This result may be explained by the high interindividual variability in voriconazole pharmacokinetics. In both cases, clinical and radiological improvement was observed after 2 months of voriconazole therapy and no initial aggressive surgical debridement was required. Of note, the surgery performed for local complications in case 2 did not demonstrate any evolutive infection when histological and mycological examinations were combined.

FIG. 2. Axial CT scan of the temporal bone. After therapy, the left external canal is air filled (arrowheads).
There is only one other reported case of *Aspergillus* IOE partly treated with voriconazole (23). A 77-year-old man with non-insulin-dependent diabetes mellitus was successfully treated with both voriconazole and caspofungin for *A. fumigatus* infection. She underwent a wide cortical mastoidectomy and was treated with intravenous voriconazole for 7 weeks with a successful outcome.

Voriconazole is currently considered the first-line therapeutic option for invasive aspergillosis (43), based on its high intrinsic anti-*Aspergillus* activity and its superiority against intravenous amphotericin B in a large randomized trial (18). In addition, this broad-spectrum azole is distributed throughout the body, including soft tissues and bone, where its good diffusion has been recently documented (9). Furthermore, long-term voriconazole therapy has been demonstrated to be effective in several patients with *Aspergillus* bone infections (26). This antifungal agent is well tolerated despite prolonged treatment and available intravenously and orally. However, the present report underlines the high pharmacokinetic interindividual variability of voriconazole due primarily to drug-drug interactions and the individual variability of voriconazole due primarily to drug-drug interactions.

### Table 1. Characteristics and clinical courses of patients with IOE caused by *Aspergillus* species

<table>
<thead>
<tr>
<th>Reference</th>
<th>Age (yr)/ gender</th>
<th>Underlying disease</th>
<th><em>Aspergillus</em> species isolated</th>
<th>Treatment*</th>
<th>Adjuvant treatment*</th>
<th>Outcome</th>
<th>Response assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>68/M</td>
<td>AML</td>
<td><em>A. fumigatus</em></td>
<td>SD</td>
<td>Recovery</td>
<td>Clinical</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>85/M</td>
<td>None</td>
<td><em>A. fumigatus</em></td>
<td>SD</td>
<td>Relapse, improvement, unrelated death</td>
<td>Clinical</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>80/M</td>
<td>Myelodysplasia</td>
<td>Unspecified</td>
<td>SD</td>
<td>Improvement, unrelated death</td>
<td>Clinical</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>38/M</td>
<td>Chronic otitis externa</td>
<td><em>A. fumigatus</em></td>
<td>SD</td>
<td>Recovery</td>
<td>Clinical, histological</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>64/F</td>
<td>AML, diabetes mellitus</td>
<td>Unspecified</td>
<td>SD</td>
<td>Relapse, improvement, unrelated death</td>
<td>Clinical, histological, gallium scan</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>46/F</td>
<td>AML</td>
<td><em>A. flavus</em></td>
<td>SD</td>
<td>Recovery</td>
<td>Clinical, microbiological</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>42/M</td>
<td>AML</td>
<td><em>A. flavus</em></td>
<td>SD</td>
<td>Recovery</td>
<td>Clinical, microbiological</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>30/M</td>
<td>AIDS</td>
<td><em>A. fumigatus</em></td>
<td>SD</td>
<td>Improvement</td>
<td>Clinical</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>61/M</td>
<td>Diabetes mellitus</td>
<td><em>A. flavus</em></td>
<td>SD</td>
<td>Recovery</td>
<td>Clinical</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>67/F</td>
<td>Diabetes mellitus</td>
<td><em>A. flavus</em></td>
<td>SD, HBOT</td>
<td>Recovery</td>
<td>Clinical, CT scan</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>82/M</td>
<td>None</td>
<td><em>A. flavus</em></td>
<td>SD</td>
<td>Recovery</td>
<td>Clinical, gallium scan</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>20/M</td>
<td>ALL</td>
<td><em>A. flavus</em></td>
<td>SD</td>
<td>Death due to invasive aspergillosis</td>
<td>No response</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>41/M</td>
<td>AML</td>
<td><em>A. fumigatus</em></td>
<td>SD</td>
<td>Death</td>
<td>No response</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>65/M</td>
<td>Diabetes mellitus</td>
<td><em>A. fumigatus</em></td>
<td>SD</td>
<td>Recovery</td>
<td>Clinical, galium scan</td>
<td></td>
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<tr>
<td>45</td>
<td>18/M</td>
<td>AML</td>
<td><em>A. fumigatus</em></td>
<td>SD</td>
<td>Improvement, unrelated death</td>
<td>Clinical</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>27/F</td>
<td>AML</td>
<td><em>A. fumigatus</em></td>
<td>No</td>
<td>Relapse, improvement, death due to pneumonia</td>
<td>Clinical</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>41/M</td>
<td>AML</td>
<td><em>A. fumigatus</em></td>
<td>SD</td>
<td>Recovery</td>
<td>Clinical</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>36/M</td>
<td>AIDS</td>
<td><em>A. fumigatus</em></td>
<td>SD</td>
<td>Recovery</td>
<td>Clinical, CT scan</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>14/F</td>
<td>ALL</td>
<td><em>A. flavus, A. niger</em></td>
<td>SD</td>
<td>Recovery, unrelated death</td>
<td>Clinical</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>58/M</td>
<td>None</td>
<td><em>A. niger</em></td>
<td>None</td>
<td>Recovery</td>
<td>Clinical, gallium scan</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>7/M</td>
<td>Neuroblastoma</td>
<td><em>A. flavus</em></td>
<td>None</td>
<td>Recovery</td>
<td>Clinical, histological, CT scan</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>73/M</td>
<td>Diabetes mellitus</td>
<td><em>A. niger</em></td>
<td>None</td>
<td>Recovery</td>
<td>Clinical, CT scan</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>77/M</td>
<td>Diabetes mellitus</td>
<td><em>A. flavus</em></td>
<td>SD, HBOT</td>
<td>Recovery</td>
<td>Clinical, gallium scan</td>
<td></td>
</tr>
<tr>
<td>PR</td>
<td>48/M</td>
<td>Relapsing polychondritis</td>
<td><em>A. niger</em></td>
<td>None</td>
<td>Recovery</td>
<td>Clinical, CT scan</td>
<td></td>
</tr>
<tr>
<td>PR</td>
<td>40/F</td>
<td>Diabetes mellitus</td>
<td><em>A. niger</em></td>
<td>None</td>
<td>Recovery</td>
<td>Clinical, histological, CT scan</td>
<td></td>
</tr>
</tbody>
</table>

*PR, present report.

F, female; M, male.

a ALL, acute lymphoblastic leukemia; AML, acute myeloid leukemia.

b AmB, amphotericin B; Itz, itraconazole.

c PR, present report.

d HBOT, hyperbaric oxygen therapy; SD, surgical debridement.
interactions, liver dysfunction, or cytochrome CYP2C19 polymorphisms. Therapeutic drug monitoring of voriconazole is now recommended to improve its safety and efficacy, especially in immunocompromised patients (29, 39).

In conclusion, based on its favorable bone penetration, its tolerance, and its efficacy as demonstrated in these reported cases, voriconazole may be considered an attractive first-line therapeutic option for *Aspergillus* IOE.

REFERENCES


