**Candida albicans** Sternal Wound Infections: A Chronic and Recurrent Complication of Median Sternotomy

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Eleven patients developed deep sternal wound infections due to *Candida albicans* after undergoing coronary artery bypass grafting (CABG) and were assessed. Six had sternal osteomyelitis, 1 had osteomyelitis and mediastinitis, and 4 had deep wound infections that probably involved bone. Seven patients experienced onset of infection within 28 days of CABG, but 4 experienced onset 48–150 days after CABG. Infections were characterized by a chronic, indolent course requiring prolonged treatment with an antifungal agent. Delay in initiating antifungal therapy was common. All patients were treated with fluconazole, and 1 also received amphotericin B. Six patients underwent incision and drainage, with or without wire removal, and 3 underwent sternectomy with placement of a muscle flap. Of 10 patients for whom follow-up data were available, 7 were cured after initial therapy (median duration of treatment, 6 months), and 3 experienced a relapse and required a second course of fluconazole.

Sternal wound infections are an important complication of median sternotomy after coronary artery bypass grafting (CABG) or prosthetic valve placement [1–5]. Most of these infections are due to staphylococci, but gram-negative bacilli, *Mycoplasma*, and fungi also have been reported to cause sternal wound infections. These infections range from simple infections that are superficial to the sternum to life-threatening mediastinitis. *Candida* species are an uncommon cause of sternal wound infections [1, 4–9]. Mediastinitis due to *Candida* is a rare but serious complication that usually occurs in the first few days to weeks after the surgical procedure and is associated with a mortality rate of >50% [10, 11]. Deep sternal wound infections that do not involve the mediastinal structures are infrequently attributed to *Candida* species [6–9]. We report on a series of 11 patients who developed deep sternal wound infections due to *Candida albicans*. These infections were characterized by a chronic, indolent, and recurrent course. Clinical manifestations and response to therapy are described, and the difficulties of establishing this diagnosis are discussed.

**PATIENTS AND METHODS**

**Patients.** The patients included in this article were identified by the Infectious Diseases Consultation Service or were seen in the Infectious Diseases Clinic at the Veterans Affairs (VA) Ann Arbor Healthcare System (Ann Arbor, MI). Two patients were also part of a prospective surveillance study of sternal wound infections among patients undergoing median sternotomy. That study was approved by the Human Studies Subcommittee and the Research and Development Committee of the VA Ann Arbor Healthcare System and was carried out in accordance with the revised Helsinki Declaration of 1983.

**Definition of infection.** A patient was determined...
to have a deep *Candida* sternal wound infection only when all of the following criteria were met: (1) isolation of *Candida* species from purulent drainage or tissue; (2) presence of ≥2 clinical signs of inflammation, including erythema, warmth, swelling, purulent drainage, tenderness, or pain; (3) absence of other microorganisms or failure of the signs and symptoms to clear with treatment directed against other organisms; and (4) clinical response to antifungal agents. Superficial wound infections and abscesses around suture sites or chest tube drainage sites were specifically excluded. A diagnosis of mediastinitis was made if operative findings showed mediastinal involvement and *Candida* species were isolated from mediastinal tissues. A diagnosis of osteomyelitis was made when changes in bone were documented by CT scan or were noted at the time of sternal resection or removal of wires. Patients whose cultures yielded *Candida* at presentation and continued to yield *Candida* on subsequent samplings and who had mediastinitis or osteomyelitis were classified as having definite deep *Candida* sternal wound infection; all others were classified as having probable deep *Candida* sternal wound infection.

**RESULTS**

**Demographic characteristics and underlying illnesses of patients.** The mean age of patients who developed deep *Candida* sternal wound infection was 65.5 ± 7.7 years (range, 48–75 years; table 1). Ten (91%) of 11 patients were men. All patients had undergone CABG; for 2 patients, this was the second such operation. Five patients (45%) had diabetes mellitus, and 5 patients (45%) had chronic obstructive pulmonary disease, 1 of whom required oxygen administration at home. All but 1 patient had smoked tobacco in the past, and 1 patient was still a smoker at the time of surgery. Eight (73%) of the 11 patients were considered to be obese (body mass index ≥27).

**Clinical manifestations of infection.** Seven patients had definite deep *Candida* sternal wound infections, 6 had sternal osteomyelitis, and 1 had both sternal osteomyelitis and mediastinitis. The remaining 4 patients had probable deep *Candida* sternal wound infections; their infections likely involved bone, but this was not definitively documented. Patients presented with symptoms a median of 22 days (range, 9–150 days) after surgery. Seven patients had symptoms and signs early in the postoperative period (range, 9–27 days after CABG); the remaining 4 patients developed symptoms 48–150 days after CABG.

Fever was present in only 5 patients, 4 of whom had sternal wound infection during the immediate post-CABG period. All patients had erythema, sternal pain, tenderness, and drainage. Pain often preceded drainage by days to weeks; in 1 patient, drainage occurred 4 months after the onset of pain. The drainage was initially serosanguineous in 3 patients but eventually became purulent. In the remaining 8 patients, initial drainage was described as “copious thick yellow-green purulent material.” Warmth was described in 57% of the patients and swelling in 62%. Only 2 patients had sternal instability. In all patients, a sterile swab placed into the wound was noted to probe to bone.

**Laboratory and imaging studies.** WBC counts were mildly elevated (12,700–14,800 cells/μL) in only 2 patients. Westergren sedimentation rates were elevated in 5 of the 8 patients for whom this test was performed (mean rate, 83 ± 34 mm/h).

Routine chest radiographs were not helpful in defining infection. CT scans were performed for 7 patients. The most common abnormality seen on CT scan, which was present in all 7 of these patients, was soft-tissue stranding anterior, posterior, or inferior to the sternum; no patient had definite collections of fluid or abscesses noted. Four of the 7 also had sclerotic or destructive changes of the sternum (n = 3) or an adjacent rib (n = 1). Only 2 patients underwent technetium bone scan; both demonstrated increased uptake of isotope on the delayed images. One of these patients also had a technetium-labeled WBC scan that showed no uptake.

*C. albicans* was isolated from the initial culture performed on wound drainage samples or deep-tissue specimens in all 11 patients. *C. albicans* was grown repeatedly on multiple occasions in specimens from 6 patients, 5 of whom had definite infection, for 3 weeks to 10 months before an antifungal agent was administered. Five patients, 4 of whom were treated with an antifungal agent as soon as yeast was identified by culture, had only 1 culture that was positive for *C. albicans*. However, 2 of these patients later experienced relapse, and follow-up cultures again yielded *C. albicans* on several occasions. Three patients with probable *Candida* infection had concomitant isolation of bacteria: coagulase-negative staphylococci were isolated from specimens from all 3, *Enterococcus faecalis* was isolated from 1 of these 3 patients, and *Enterococcus faecium* was isolated from another. Three patients with definite *Candida* infection subsequently had a single positive culture for coagulase-negative staphylococci 4–6 weeks after initiation of antifungal therapy; this was felt to be a contaminant in all 3 cases.

**Treatment and outcomes.** All patients were treated with fluconazole, 400 mg daily, with the exception of 4 patients who had moderately severe renal insufficiency and who received 100–200 mg daily. In 1 patient, the dose was increased to 800 mg, because little improvement was seen when the dose was 400 mg, and therapy for 1 patient, who experienced nausea while receiving fluconazole, was changed to itraconazole. One patient who had both sternal osteomyelitis and mediastinitis initially received fluconazole and then was given a total of 500 mg of amphotericin B after mediastinal exploration. The median length of treatment with an antifungal agent for the initial
Table 1. Characteristics of 11 patients who had deep sternal wound infections due to *Candida albicans* after median sternotomy.

<table>
<thead>
<tr>
<th>Infection type,</th>
<th>Sex/age</th>
<th>Date of</th>
<th>Days to</th>
<th>CT scan</th>
<th>Antifungal</th>
<th>Surgical</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>patient no.</td>
<td>Patient no.</td>
<td>Surgery</td>
<td>onset of</td>
<td>results</td>
<td>therapy</td>
<td>intervention</td>
<td></td>
</tr>
<tr>
<td>Definite</td>
<td>1</td>
<td>F/75</td>
<td>4 Nov 1997</td>
<td>17</td>
<td>Not done</td>
<td>Flu (2)</td>
<td>Muscle flap</td>
</tr>
<tr>
<td>2</td>
<td>M/70</td>
<td>18 Nov 1997</td>
<td>22</td>
<td>Osteomyelitis</td>
<td>Flu (36)</td>
<td>I&amp;D</td>
<td>Relapsed 8 months after first course of therapy ended; re-treated; continues Flu therapy</td>
</tr>
<tr>
<td>3</td>
<td>M/73</td>
<td>12 Dec 1997</td>
<td>28</td>
<td>Osteomyelitis</td>
<td>Flu (24)</td>
<td>None</td>
<td>Cured</td>
</tr>
<tr>
<td>4</td>
<td>M/65</td>
<td>30 Dec 1997</td>
<td>128</td>
<td>Soft-tissue stranding</td>
<td>Flu (11)</td>
<td>I&amp;D; wire removal</td>
<td>Diedb</td>
</tr>
<tr>
<td>5</td>
<td>M/65</td>
<td>9 Feb 1998</td>
<td>75</td>
<td>Osteomyelitis</td>
<td>Flu (2); AmB (4)</td>
<td>I&amp;D; muscle flap</td>
<td>Cured</td>
</tr>
<tr>
<td>6</td>
<td>M/64</td>
<td>9 Jul 1998</td>
<td>22</td>
<td>Soft-tissue stranding</td>
<td>Flu (8)</td>
<td>I&amp;D; wire removal</td>
<td>Cured</td>
</tr>
<tr>
<td>7</td>
<td>M/64</td>
<td>3 Nov 1998</td>
<td>9</td>
<td></td>
<td></td>
<td>Muscle flap</td>
<td>Relapsed 7 months after first course of therapy ended; re-treated with Flu, then Itr for 12 months; cured</td>
</tr>
<tr>
<td>Probable</td>
<td>8</td>
<td>M/61</td>
<td>10 Dec 1997</td>
<td>150</td>
<td>Soft-tissue stranding</td>
<td>Flu (4)</td>
<td>None</td>
</tr>
<tr>
<td>9</td>
<td>M/61</td>
<td>31 Dec 1997</td>
<td>48</td>
<td>Not done</td>
<td>Flu (3)</td>
<td>I&amp;D</td>
<td>Lost to follow-up at 3 months</td>
</tr>
<tr>
<td>10</td>
<td>M/74</td>
<td>19 Mar 1998</td>
<td>13</td>
<td>Not done</td>
<td>Flu (2)</td>
<td>None</td>
<td>Dieda</td>
</tr>
<tr>
<td>11</td>
<td>M/48</td>
<td>30 Nov 1998</td>
<td>16</td>
<td>Not done</td>
<td>Flu (9)</td>
<td>I&amp;D</td>
<td>Cured</td>
</tr>
</tbody>
</table>

**NOTE.** AmB, amphotericin B; Flu, fluconazole; Itr, itraconazole; I&D, incision and drainage.

a Time between surgery and onset of symptoms.

b Patients died of causes other than *Candida* infection: one patient died as a result of chronic pulmonary disease, and the other died as a result of presumed sepsis 4 months after coronary artery bypass surgery.

episode of infection was 6 months (range, 2–36 months). Fluconazole was well tolerated, with no serious side effects.

The median delay in initiation of treatment with an antifungal agent after *C. albicans* was isolated was 5 weeks. Seven patients received empiric treatment for presumed bacterial infection for 2 weeks to 7 months before antifungal treatment was initiated, in spite of repeated isolation of *C. albicans* from sternal drainage in 5 of these 7 patients. The other 4 patients also received antibacterial agents either for organisms isolated at the same time as yeast or because the patient was seriously ill in the first 2 weeks after CABG.

Sternal resection with placement of a pectoralis or rectus muscle flap was performed for 3 patients 1–10 months after the initial onset of symptoms. Mediastinal tissue from the patient in whom the flap was placed after 10 months yielded *C. albicans*; antifungal therapy had not been initiated until 7 months after the initial isolation of *C. albicans* from the wound. Six patients underwent local incision and drainage, and 2 also had sternal wires removed. Three patients had no surgical drainage or debridement procedure performed.

For 10 patients, the total length of follow-up ranged from 11 to 51 months; 7 were cured with initial therapy, and 3 experienced relapse and needed a second course of antifungal therapy. One patient with probable infection was lost to follow-up after 3 months, and the long-term outcome for that patient is unknown. Three patients, 2 of whom had sternal resection and placement of a muscle flap, experienced relapse 5–8 months after fluconazole was discontinued and had recurrence of pain, erythema, and drainage that yielded only *C. albicans*; these patients had received fluconazole for 2, 3, and 36 months. All improved after reinitiation of antifungal therapy, and 2 were cured after 9 and 12 months of additional therapy. The third is receiving a lifelong fluconazole regimen. Two patients died, one of multiorgan failure and the other of advanced chronic obstructive pulmonary disease; in both, the fungal infection was no longer active and probably was cured.

**DISCUSSION**

Sternal wound infections are an uncommon but serious problem in patients undergoing CABG. Most large series of poststernotomy wound infections and mediastinitis note no cases or only a small proportion (<5%) of cases of sternal wound infection due to *Candida* species [1, 4, 5]. Two outbreaks of sternal wound infections due to *C. albicans* and *Candida tropicalis* have been reported, with a total of 23 cases [7, 8]. In both outbreaks, the source of the infection was thought to be a scrub nurse. Clinical details are scant, but it is apparent that these cases were not associated with systemic symptoms and had a chronic course. These findings contrast with those described for *Candida* mediastinitis, in which onset is more likely to be acute, systemic symptoms are present in approximately...
one-half of patients, and outcome is poor [10, 11]. However, even with mediastinitis, not all patients had systemic symptoms, and some presented as late as 100 days after sternotomy.

Most of our patients manifested a subacute-to-chronic course that did not improve until antifungal therapy was initiated. All of our patients initially received antibacterial agents, usually cephalaxin. The isolation of C. albicans, even on multiple occasions, was ascribed to contamination, and antifungal therapy was not begun for 2–28 weeks in 7 of the patients. This propensity to overlook the pathogenic potential of Candida species has been commented on by others and probably contributed to the chronic nature of our patients’ infections [10].

After these cases of Candida sternal wound infection occurred, we identified 16 patients with Pseudomonas aeruginosa sternal wound infections that occurred after CABG. PFGE confirmed that the source of the sternal wound infections that occurred after CABG. PFGE concurred, we identified 16 patients with C. albicans, even on multiple occasions. Repeated samples from the nurse’s nail yielded C. albicans, in addition to P. aeruginosa. She noted that she had had “this nail problem” for ~2 years, which encompasses the time in which the cases of Candida sternal wound infection occurred. This nurse was the scrub nurse for the operations on all of the patients with Candida sternal wound infection. It is possible that these 11 cases represent an outbreak. Six cases occurred within 2 months and the other 5 over the course of the next 11 months, and no cases were identified in the next 3 years after those 11 cases. The clustering of cases was not initially obvious because the patients presented at various stages of their illness, and the true nature of the infection did not become clear until infectious diseases consultation was obtained. Molecular confirmation linking C. albicans from the nurse’s nail to the organisms infecting our patients was not possible because the isolates from the patients were not available for genotyping.

The reported experience with treatment of Candida sternal osteomyelitis consists of only a few case reports [6, 9]. The largest experience with Candida osteomyelitis pertains to vertebral body infection [13–19], a situation that is not quite analogous to postsurgical sternal osteomyelitis. In the latter, the blood supply to the poststernotomy sternum has been disrupted, and frequently foreign material (bone wax, sternal wires) has been added; both of these factors make penetration of antimicrobial agents into the site of infection more difficult.

Because our patients’ symptoms were chronic, because none were seriously ill from the Candida sternal wound infection, and because most were older and had some degree of renal insufficiency, we elected to use fluconazole to treat these infections. One patient who also had mediastinitis was treated at another medical facility with amphotericin B. Fluconazole has been reported to successfully cure Candida osteomyelitis [9, 16–19]. However, many, but not all, of these reported patients were treated initially with an amphotericin B formulation, which raises the question of whether sequential therapy with a polyene and then an azole was required for a successful outcome or whether fluconazole alone was associated with success. In our patients, fluconazole monotherapy was initially deemed to be successful in 9 of 10 patients. However, 3 patients, 2 of whom underwent a relatively short course of therapy and both of whom had a muscle flap placed, experienced relapse and required further fluconazole therapy.

The role played by surgical resection of infected bone cannot be established from our experience, but resection is generally recommended for patients with deep sternal wound infections [20]. It is possible that more-aggressive surgical debridement early in the course of the infection might have allowed a shorter course of antifungal therapy to be effective. However, sternectomy with placement of a muscle flap did not ensure cure of the infection in the 3 patients who had this procedure performed, and 3 other patients, 2 of whom had probable disease, were cured without undergoing a surgical procedure.

The isolation of Candida species from purulent material obtained from a deep sternal wound that can be probed to bone should prompt further studies. Cultures should be repeated to verify the persistence of the yeast, and CT scans should be performed to assess bone involvement. We believe that antifungal therapy should be initiated if persistence of Candida from purulent material is documented, even if the CT scan shows only soft-tissue stranding and no obvious bone destruction. Our experience suggests that azole therapy is usually successful but must be provided for at least 6 months, and longer if CT scan reveals bone destruction. Early use of amphotericin B might shorten the treatment time and decrease the risk of relapse, but we have no personal experience that verifies this possible benefit and would be reluctant to use a polyene in an elderly patient who is at high risk for toxicity.

References


