Fungal Infections of the Heart: Analysis of 51 Autopsy Cases

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The clinical setting, predisposing factors and consequences of fungal involvement of the heart were examined in all patients with this condition who underwent autopsy at The Johns Hopkins Hospital from 1889 through 1977. The 51 patients with cardiac fungal infection were all observed since 1954; they ranged in age from 2 weeks to 80 years; 29 were male. Fungal endocarditis was present in 13 patients, myocarditis in 31, pericarditis in 4 and pancarditis in 3. In only one instance was cardiac fungal infection diagnosed during life. The infecting organisms were Candida in 34 patients, Aspergillus in 13, Cryptococcus in 3 and combined Candida and Aspergillus in 1. The conditions appearing to predispose to fungal infection were abdominal surgery in 20 patients, thoracic surgery in 7 and treatment with corticosteroids, antineoplastic agents or antibiotic drugs, alone or in combination, in 43 cases. Endocarditis was most commonly associated with central venous catheters or prosthetic valve surgery and was often caused by Aspergillus. Myocarditis and pancarditis usually occurred in a setting of gastrointestinal surgery, intense antibiotic therapy and systemic candidiasis. Death could be attributed to fungal infection in 36 patients and specifically to cardiac involvement in 8. Endocarditis was diagnosed once during life. Cardiac fungal infection, especially myocarditis, may be difficult to recognize clinically. It is associated with extensive therapeutic interventions and may in itself produce a fatal outcome.

Cardiac infection by fungi was rarely reported in the past. In 1915 Hurley[1] described a patient with Blastomyces dermatitidis in the right atrium. In the first completely documented case of candidal endocarditis, reported in 1940,[2] the patient was a heroin addict. A patient with postvalvulotomy endocarditis due to Candida albicans was described in 1956.[3] Aspergillar mural endocarditis in a child was described in 1947.[4] Aspergillar valve endocarditis was first reported in 1950 in a patient with rheumatic heart disease who received large doses of penicillin for a leg wound.[5] Systemic fungal infections have since been identified with increasing frequency. Cardiac involvement may be difficult to diagnose clinically, is frequently fatal and may first be discovered at autopsy. In this study we systematically examined the clinical setting, predisposing conditions, pathologic findings and consequences of endocarditis, myocarditis and pericarditis in 51 patients with postmortem examination.

Case Material

The cases of all patients who underwent autopsy patients at The Johns Hopkins Hospital from 1889 through 1977 were reviewed for histologically confirmed fungal infection of the heart. There were 51 patients with such confirmation; the first identified case occurred in 1954. Among these patients the incidence, clinical setting, signs contributing to early diagnosis, the consequences and pathologic features of cardiac fungal infection were studied. The clinical records, autopsy reports, histologic sections, surgical pathology material and the available preserved hearts of all patients were examined.

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Patients were included in the study only if their heart demonstrated unequivocal morphologic evidence of fungal organisms in cardiac tissue. Because identification of organisms was made on morphologic grounds (Fig. 1), the mention of Candida, Aspergillus or Cryptococcus in this study must be understood as "organisms morphologically consistent with" one of these genera. However, histologic identification was confirmed with premortem cultures from 24 patients and with postmortem cultures from 8 other patients.

Results

The 51 patients formed three distinct clinicopathologic groups (Table I). Thirteen patients had fungal endocarditis, occurring usually in a setting of previous cardiac surgery or prolonged maintenance of an infected central venous catheter. Thirty-four patients had fungal myocarditis, usually associated with abdominal surgery or with prolonged administration of multiple antibiotic drugs. Included in this group are three patients with pancarditis with involvement of all three layers of the heart that arose from a hematogenous dissemination comparable with that producing the myocarditis only. Only four patients had fungal pericarditis which was associated with cytotoxic therapy, corticosteroids, leukemia and pericardiectomy, respectively.

Endocarditis (Fig. 2 and 3): *Clinical features:* Among the 13 patients with fungal endocarditis, the initial clinical manifestations were fever in 13, leukocytosis with a "left shift" in 8 and a new murmur with a palpable spleen in 3. Roth spots, Osler nodes and splinter hemorrhages were not described. Four patients

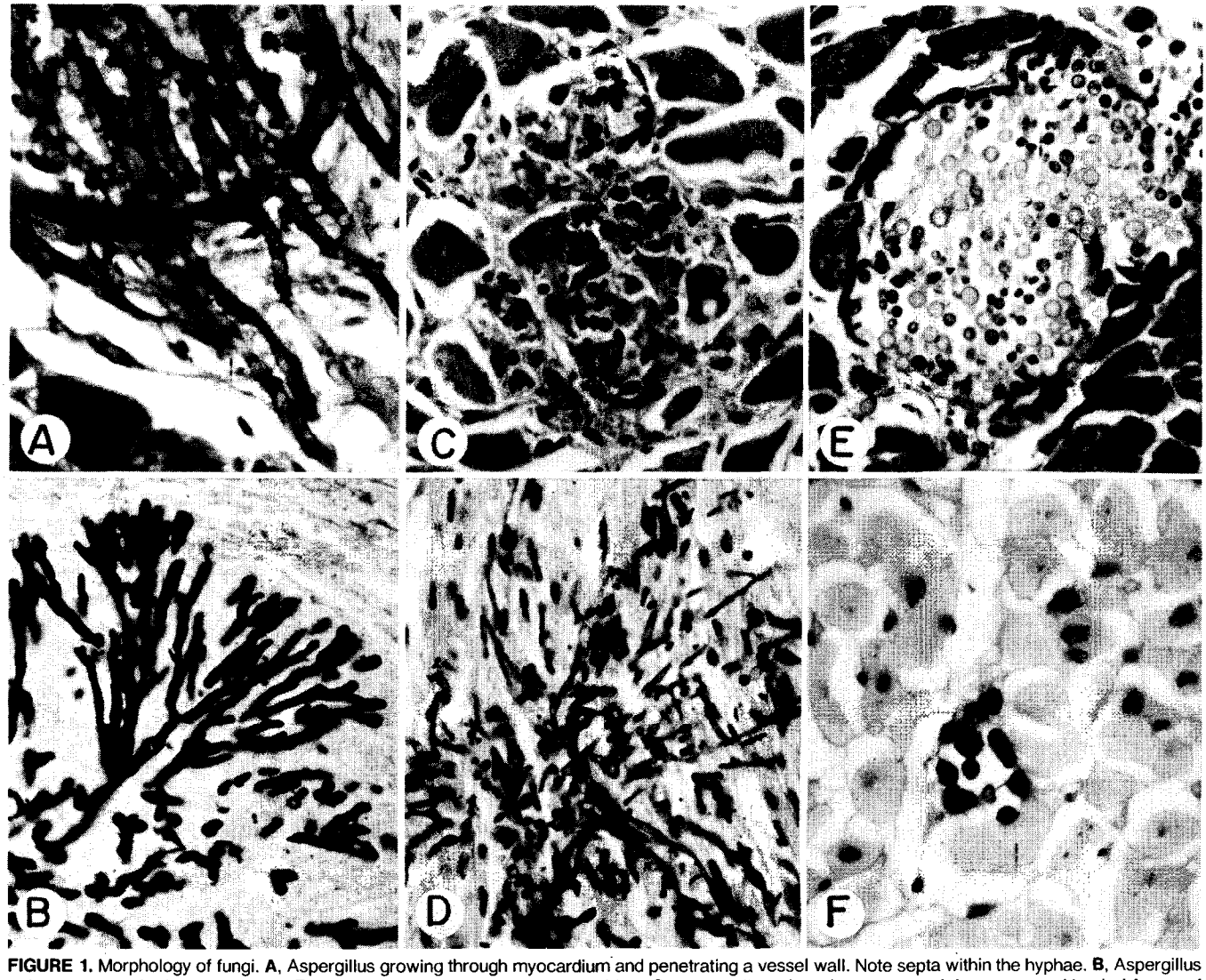

FIGURE 1. Morphology of fungi. **A**, Aspergillus growing through myocardium and penetrating a vessel wall. Note septa within the hyphae. **B**, Aspergillus colony growing in the epicardium. The organisms show extensive branching. **C**, myocardial microabscess containing spore and hyphal forms of Candida. The fungi may be difficult to distinguish from the inflammatory cells. **D**, Candida growing in the myocardium of a patient who had received immunosuppressive therapy. The inflammatory cell response is slight but the muscle cells invaded by organisms are necrotic. **E**, cryptococcal organisms producing a small focus of myocardial destruction apparently by mechanically pushing the muscle cells aside. There is very little inflammatory cell reaction. **F**, Cryptococcus blastospores showing the characteristic positive reaction to mucicarmine. (Hematoxylin-eosin [**A, C, E**], methenamine silver [**B**], periodic acid-Schiff stain [**D**] and mucicarmine stain [**F**]; all ×500, reduced by 6 percent.)

(31 percent) had clinically evident systemic embolism as an early sign of fungal endocarditis. Three had abrupt onset of neurologic changes: hemiparesis in two and oculomotor palsy in the third. The fourth patient presented with sudden femoral and mesenteric arterial occlusion by Candida-laden emboli 3 months after hospital discharge after implantation of a prosthetic aortic valve. Septic emboli arose from vegetations on the prosthetic valve. Femoral arterial embolectomy established the diagnosis of candidal embolus and led to valve resection. Cardiac fungal infection was diagnosed during life only in this patient.

Five (38 percent) of the 13 with fungal endocarditis underwent thoracic surgery compared with only 1 (3 percent) of the 34 patients with myocarditis. Similarly, only 2 patients (15 percent) with endocarditis underwent abdominal surgery in contrast to 16 patients (47 percent) with myocarditis. Candidal thrombosis of central venous catheters was observed in three patients (23 percent). After removal of the infected catheters, candidemia continued, with persistence of fungi in endocardial thrombi. Mitral commissurotomy for rheumatic valve disease in one patient was complicated by candidal endocarditis, valve obstruction by vegetations, and pulmonary edema. Clinically occult mycotic emboli occluded major arteries.

Pathology: Prosthetic valve implantation in three patients, mycotic thrombosis of central venous catheters in four, old bacterial endocarditis in one patient and rheumatic mitral stenosis in another were the major endocardial lesions preceding fungal endocarditis. Fungal vegetations complicated prosthetic valves in three ways: (1) obstruction causing intractable pulmonary edema, (2) multiple emboli, and (3) rupture of the aortic root. Fungal thrombosis of central catheters ranged from right atrial mural endocarditis to massive obstruction of tricuspid and pulmonic valve orifices by continuous Candida-laden thrombus.[6] Among the remaining four patients with fungal endocarditis, there was no identifiable predisposing endocardial lesion. Instead these patients had fungal mural endocarditis and systemic mycosis.

Myocarditis (Fig. 4): *Clinical features:* Thirty-one of the 34 patients had pathologically defined fungal myocarditis without endocardial or pericardial involvement. Unlike patients with fungal endocarditis, those with myocarditis had no embolic events. The earliest clinical sign of fungal myocarditis was a positive blood culture. The most frequently associated therapeutic intervention related to fungal myocarditis was gastrointestinal surgery, which was performed in 47 percent of these patients compared with only 2 of 13 patients (15 percent) with fungal endocarditis. Other therapeutic interventions related to myocarditis were prolonged antibiotic therapy, administration of multiple antibiotic drugs and corticosteroids. More than 70 percent received a prolonged course of antibiotic therapy. Antibiotic agents typically were instituted for gram-negative bacteremia. Among 11 patients with either bacterial peritonitis or local intraabdominal abscess, 10 had fungal myocarditis.

Pathology: Myocardial abscesses ranged from microabscesses containing few organisms to grossly confluent regions of necrotic myocardium, inflammatory cells and invasive fungi. The abscesses were grossly visible at autopsy in 10 (29 percent) of the 34 hearts, principally as white to hemorrhagic well circumscribed defects in the myocardium ranging from 1 to 5 mm in diameter.

The intensity of inflammatory response varied inversely with the number of fungal organisms present in the myocardial lesions. The paucity or absence of

TABLE I

Clinical Features of 51 Patients With Cardiac Fungal Infection

	Endocarditis	Myocarditis/ Pancarditis	Pericarditis	Total
Patients (n)	13	34	4	51
Mean age (yr)	42	41	50	41
Age range	6 wk–69 yr	11 days–80 yr	6 wk–72 yr	11 days–80 yr
Male/Female ratio	7:6	20:14	2:2	29:22
Thoracic surgery (n)	5 (38%)	1 (3%)	1 (25%)	7 (14%)
Open heart surgery (n)	4 (31%)	1 (3%)	. . .	5 (10%)
Abdominal surgery (n)	2 (15%)	16 (47%)	. . .	18 (35%)
Prolonged antibiotic therapy (>10 days)	6 (46%)	24 (71%)	2 (50%)	32 (63%)
Multiple antibiotic drugs (≥3)	5 (38%)	19 (56%)	2 (50%)	26 (51%)
Prolonged placement of intravenous catheter (n)	10 (77%)	30 (88%)	4 (100%)	44 (86%)
Corticosteroids (n)	5 (38%)	19 (56%)	2 (50%)	26 (51%)
Cytoxic agents (n)	2 (15%)	7 (21%)	2 (50%)	11 (22%)
Leukemia (n)	2 (15%)	5 (15%)	2 (50%)	9 (18%)
Lymphoma (n)	—	1 (3%)	—	1 (2%)
Carcinoma (n)	1 (8%)	6 (18%)	—	7 (14%)
Prematurity (n)	1 (8%)	1 (3%)	—	2 (4%)
Sepsis (n)				
Gram-negative bacteria	2 (15%)	17 (50%)	1 (25%)	20 (39%)
Staphylococcus aureus	1 (8%)	—	—	1 (2%)
Pneumonia (n)				
Gram-negative bacteria	1 (8%)	7 (21%)	—	8 (16%)
Staphylococcus aureus	1 (8%)	—	—	1 (2%)

n = number of patients.

polymorphonuclear leukocytes and the simultaneous unchecked proliferation of organisms was related to clinical use of immunosuppressive agents, whereas an intense focal myocardial necrosis with many polymorphonuclear leukocytes and scarcity of organisms appeared in those patients who did not receive cytotoxic agents (Fig. 4, C and D).

Pancarditis: Three of the 34 patients with myocarditis had fungal pancarditis: coincident involvement of endocardium, myocardium and pericardium. Abdominal surgery, gram-negative sepsis and use of multiple antibiotic agents or immunosuppressive therapy for leukemia were the clinical settings of fungal pancarditis. There were no predisposing endocardial or pericardial defects in the patients with pancarditis. All 3 hearts were infected with aspergillar thromboemboli. Aspergillus occluded and invaded the myocardial vessels.

There were two patterns of lesions in pancarditis. The more destructive type was a transmural erosion through contiguous regions of endocardium, myocardium and pericardium. The second type was a diffuse embolic pancarditis; endocardial and pericardial lesions consisted of smaller but more widespread nodular fungal vegetations that were often contiguous with underlying myocardial abscesses.

Pericarditis (Fig. 5): Only 4 of the 51 patients had isolated pericarditis. Underlying conditions included pericardiectomy, leukemia, cytotoxic therapy, prolonged and multiple antibiotic therapy, corticosteroids and DiGeorge's syndrome. The severity ranged from the subclinical to an unremitting aspergillar pericarditis progressing through a friction rub, diffuse S-T segment elevation, pulsus paradoxus, hypotension and death. A 1 liter fibrinous and purulent pericardial effusion was

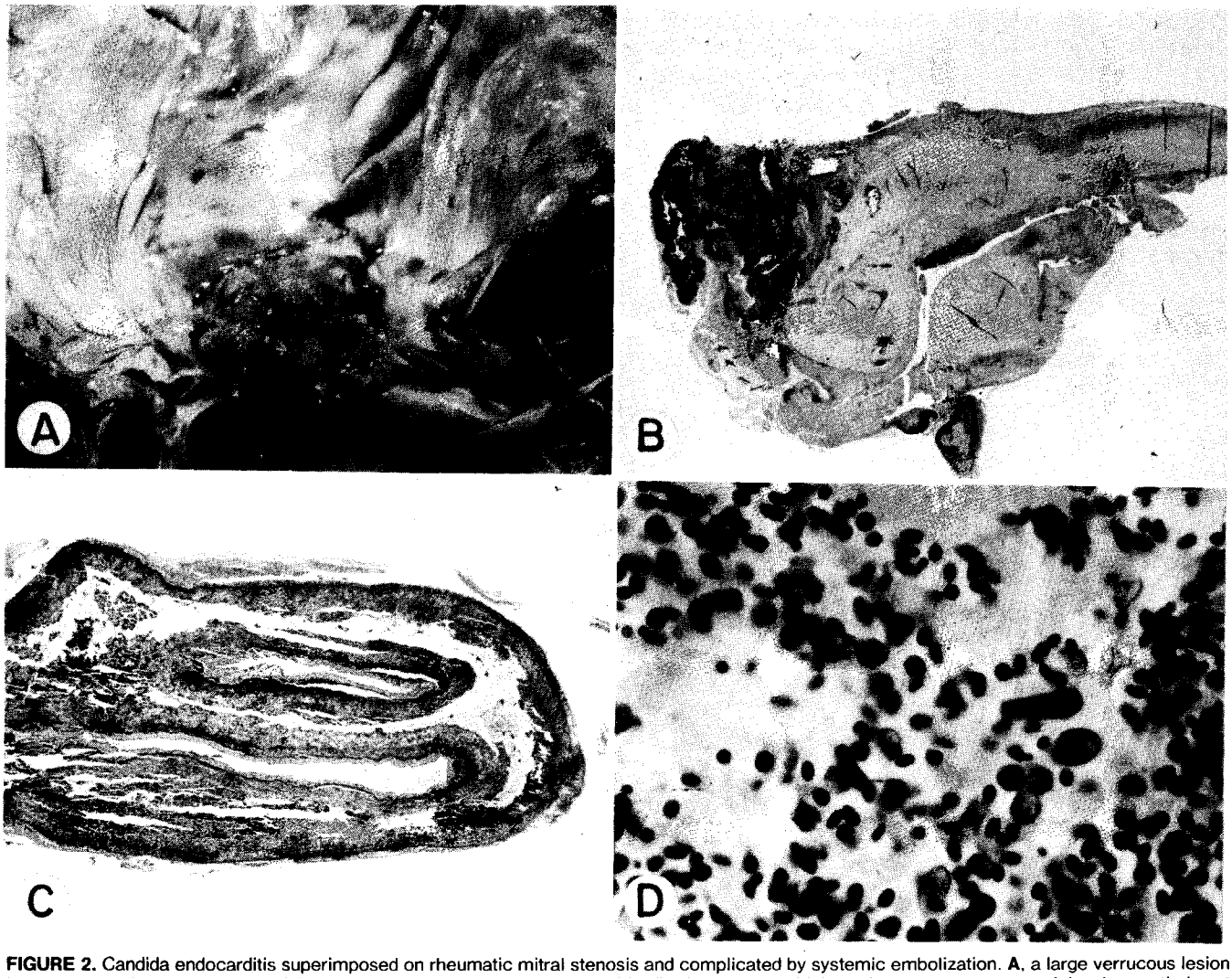

FIGURE 2. Candida endocarditis superimposed on rheumatic mitral stenosis and complicated by systemic embolization. **A**, a large verrucous lesion is present on the atrial aspect of the anterior mitral leaflet. **B**, the mitral leaflet is markedly thickened as a consequence of the rheumatic heart disease. The large mass of fungi stains darkly in the superimposed endocarditic lesion. **C**, embolus surgically removed from the internal iliac artery; the clot consists mainly of fungi and resembles the material still present on the mitral valve. **D**, candidal organisms present in the embolus. (Periodic acid-Schiff stain × 5 [**B**], ×10 [**C**] and ×500 [**D**].)

found at postmortem examination in one of the four patients.

Pathologic lesions ranged from insignificant visceral pericardial nodules to a purulent and fibrinous pericarditis.

Organisms: Candida was the most frequently observed organism in each of the three major clinicopathologic groups. When species were determined, at least 15 cardiac infections were due to Candida albicans and 2 to Candida tropicalis. Aspergillus was the second most frequent fungus to involve the heart. Aspergillus caused approximately 50 percent of all cases of endocarditis, whereas Candida caused 71 percent of cases of myocarditis. Cryptococcus caused myocarditis in 3 cases.

Diagnosis: Definitive premortem diagnosis of cardiac fungal infection was established in only one patient. A diagnosis of systemic mycosis leading to antifungal therapy was established in 22 percent. Positive blood cultures were documented in 42 percent. The earliest identification of Candida was established by blood culture in 10 patients (20 percent). Nine other patients (18 percent) had positive cultures of urine, peritoneal fluid, intravenous catheters, wounds, cerebrospinal fluid or emboli 1 to 3 weeks before cultures of blood were positive. Aspergillus was never cultured from blood during life, whereas Candida was cultured from 54 percent of patients with candidal cardiac infections.

Autopsy evidence revealed the following as apparent sources of infection (Table II): prosthetic valves, central venous catheters and mitral commissurotomy in patients with fungal endocarditis. Fungal pneumonitis, esophagitis, enterocolitis and urinary tract infections were apparent sources of infection in patients with myocarditis with or without pancarditis.

Treatment: Amphotericin B was administered to 11 patients (22 percent), two of whom also received 5-fluorocytosine. Impaired renal function prompted discontinuation of amphotericin B in 4 of the 11 patients. Only one patient underwent resection of an infected valve.

Causes of death: The nonfungal associated diseases of 15 patients (29 percent) immediately contributed to their death (Table III). These included bacterial sepsis, profuse gastrointestinal hemorrhage and acute renal failure with terminal arrhythmias. A total of 36 patients died with fungal infection as the principal factor contributing to their death; 8 of these died as the result of direct cardiac fungal involvement.

Discussion

Fungal infections of the heart, heretofore considered uncommon, have occurred with increasing frequency during the last two decades.[7–10] In our hospital the incidence has increased from 1 case per 1,000 autopsies in the period from 1954 to 1961 to 4 cases per 1,000 from 1962 through 1977. Endocarditis, myocarditis and pericarditis may result from involvement of the heart by fungus; they are virtually always associated with multiple therapeutic interventions. Fungal endocarditis was especially related to cardiac surgery and preexisting valvular heart disease. Fungal myocarditis was most

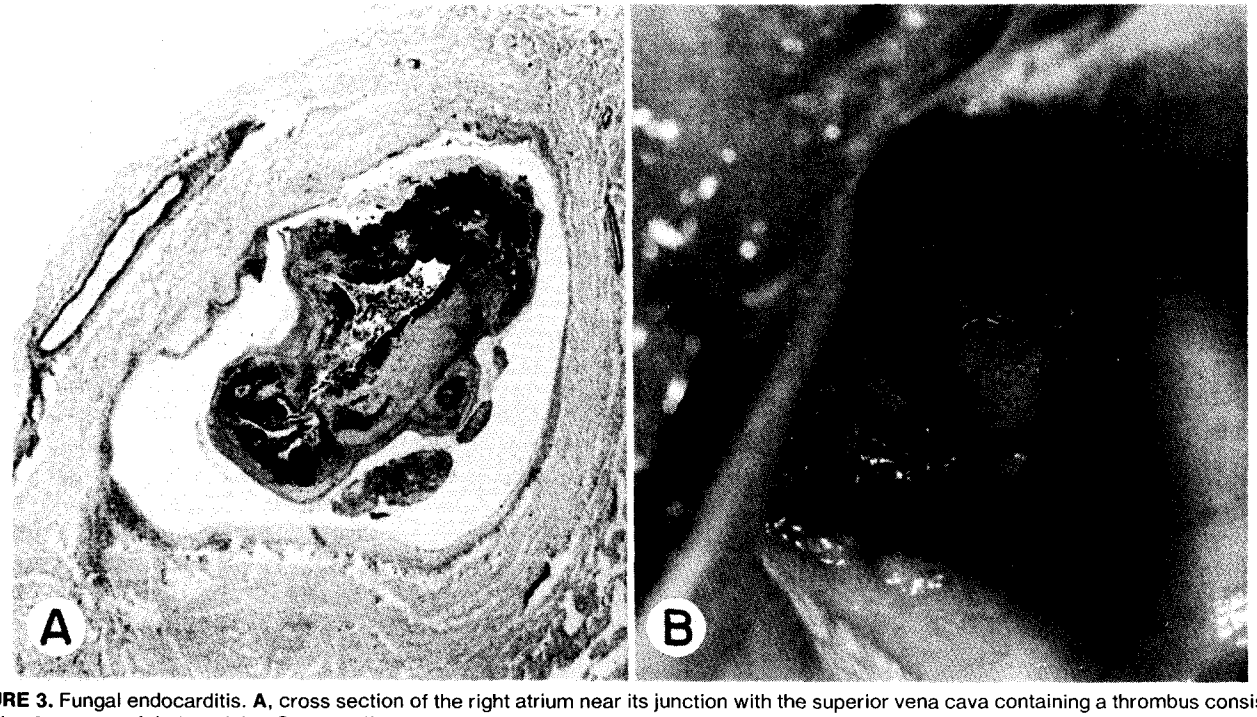

FIGURE 3. Fungal endocarditis. **A**, cross section of the right atrium near its junction with the superior vena cava containing a thrombus consisting largely of masses of dark-staining Candida. The central venous catheter, which had been in place during life, has been removed from the center of the thrombus (periodic acid-Schiff stain ×15). **B**, aspergillar endocarditis on a prosthetic aortic valve viewed from the aortic aspect. The valve had been in place for 3 weeks and death occurred from rupture of the aortotomy site, which was also infected by Aspergillus.

frequently associated with gastrointestinal surgery, prolonged multiple antibiotic therapy and corticosteroid therapy. Pancarditis developed as a progression of myocarditis to involve endocardium and pericardium. Pericarditis occurred infrequently and was related to pericardiotomy, immunosuppression therapy and treatment with multiple antibiotic drugs.

Endocarditis

Clinical manifestations: The classic manifestations of bacterial endocarditis often were not seen in fungal endocarditis. Fever, anemia and leukocytosis occurred in 50 percent of patients and a new murmur developed in less than 25 percent. Osler nodes, Roth spots or splinter hemorrhages were not described in our patients whereas an earlier study[7] reported their frequent appearance. Absence of these signs should not reduce suspicion of fungal infection in the patient at risk.

Embolic manifestations were important clinical features in one third of the patients with endocarditis: acute onset of a central neurologic deficit (hemiparesis, oculomotor palsy, for example), a fungus-laden macu-

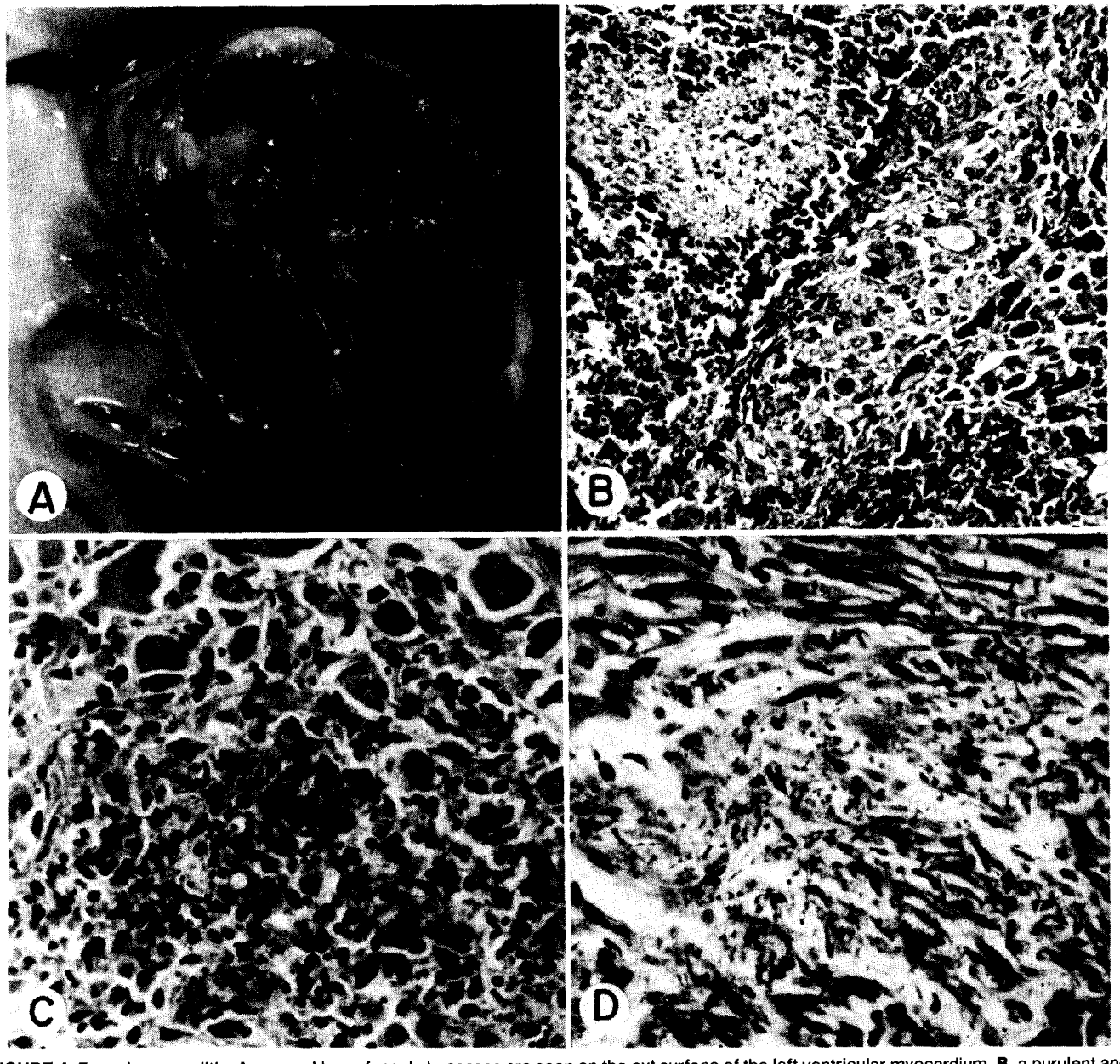

FIGURE 4. Fungal myocarditis. **A**, several large fungal abscesses are seen on the cut surface of the left ventricular myocardium. **B**, a purulent and granulomatous myocardial abscess which appears to have been present for at least 10 to 14 days. A clump of Candida is present at the upper left. **C**, a typical Candida microabscess with an admixture of organisms and acute inflammatory cells. **D**, focus of myocardial Candida infection in a patient with severe leukopenia. Spores and hyphae are growing in and destroying cardiac muscle cells. There is almost no inflammatory cell response. (Hematoxylin-eosin ×250 [**B**], ×500 [**C**] and ×125 [**D**].)

TABLE II

Apparent Sources of Infectious Organisms in 51 Patients

	Endocarditis	Myocarditis/ Pancarditis	Pericarditis	Total
Patients (n)	13	34	4	51
Prosthetic valve (n)	3 (23%)	1 (3%)	...	4 (8%)
Central venous catheter (n)	4 (31%)	1 (3%)	...	5 (10%)
Mitral commissurotomy (n)	1 (8%)	...	...	1 (2%)
Pericardiotomy (n)	...	...	1 (25%)	1 (2%)
Fungal pneumonitis (n)	2 (15%)	6 (18%)	1 (25%)	9 (17%)
Hematogenous (n)	3 (23%)	15 (44%)	2 (50%)	20 (39%)
Esophagitis (n)	...	6 (17%)	...	6 (12%)
Enterocolitis (n)	...	2 (6%)	...	2 (4%)
Other (cystitis, wound infections) (n)	...	3 (9%)	...	3 (6%)

n = number of patients.

lopapular rash in nonintertrigenous regions, abrupt major arterial occlusion and fungal endophthalmitis. Among four patients whose eyes were examined postmortem, three had fungal chorioretinitis that would have been ophthalmologically visible during life. The typical discrete retinal lesion described elsewhere[11,12] may be diagnosed early in the course of endocarditis before the onset of more catastrophic events.

Acute major arterial occlusion—a characteristic of fungal endocarditis[8,13]—may occur abruptly long after hospital discharge. One patient presented with mycotic femoral and mesenteric arterial emboli 3 months after

TABLE III

Factors Immediately Contributing to Death in 51 Patients With Fungal Infections of the Heart

Fungal infection	36 (71%)
Systemic mycosis	28 (55%)
Cardiac fungal infection	8 (16%)
Valve obstruction	3 (6%)
Mycotic embolization	3 (6%)
Aortic rupture	1 (2%)
Myocardial failure	1 (2%)
Associated diseases	15 (29%)
Gram-negative sepsis	7 (14%)
Gastrointestinal hemorrhage	4 (8%)
Acute renal failure	4 (8%)

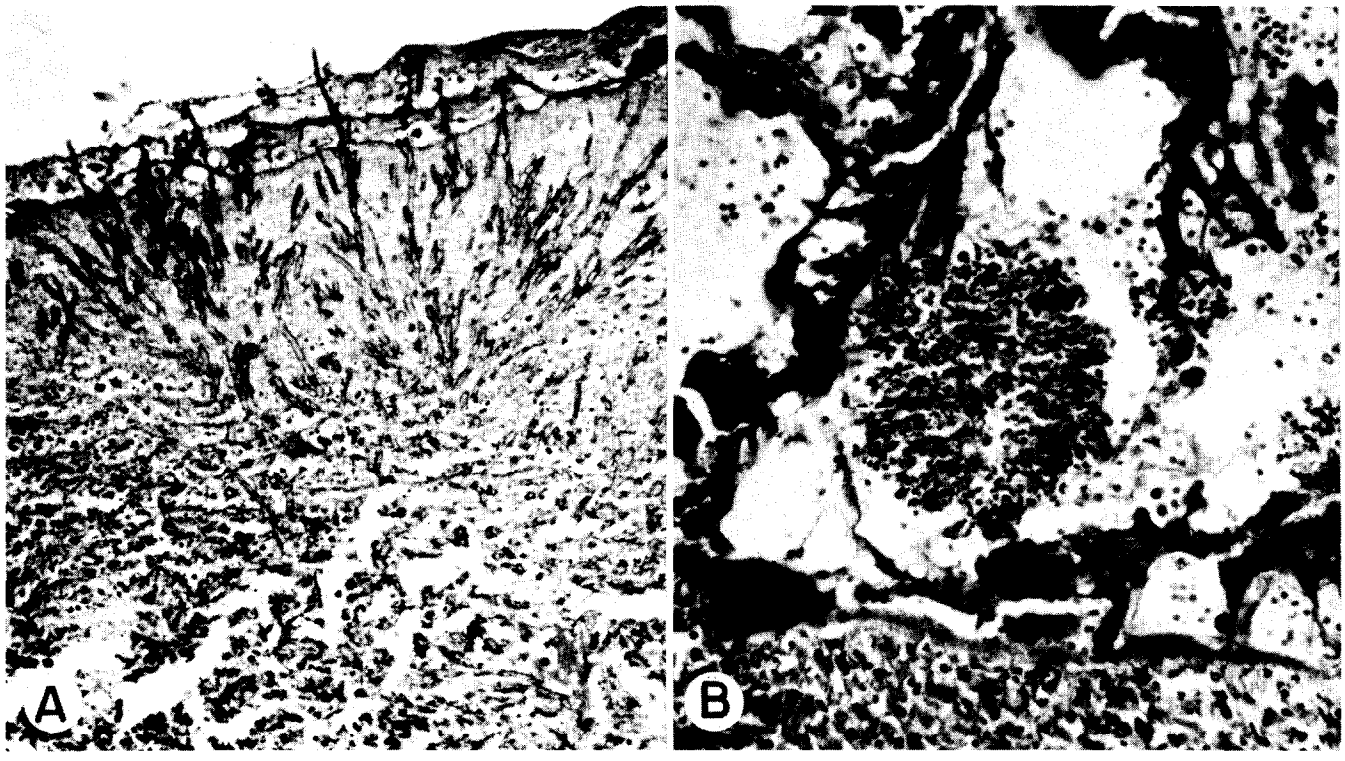

FIGURE 5. A, aspergillar pericarditis in a patient who had undergone immunosuppressive therapy. **B,** colonies of Candida albicans growing in a fibrinopurulent pericarditis. The infection developed after pericardiotomy in an infant with DiGeorge syndrome. (Hematoxylin-eosin ×250 [**A** and **B**].)

hospital discharge after prosthetic valve implantation. Fungal endocarditis occurred in settings ranging from one of positive fungal blood cultures, embolic phenomena, murmurs and intractable congestive cardiac failure to one of an indolent infection in which the patient succumbed to an undetected disseminated mycosis.

Fungal blood cultures in aspergillar endocarditis are virtually always negative regardless of extent of dissemination and size of vegetations.[14,15] Candida, however, is frequently cultured during a candidal endocarditis, although the diagnostic significance of candidemia has been disputed[16,17] as representing colonization and not invasive mycosis. A positive admission blood culture for Candida albicans in a woman with fever, rheumatic mitral disease, mitral commissurotomy and congestive heart failure was dismissed as a contaminant: Candidal vegetations compromising the mitral valve were discovered after death (Fig. 2). This patient and four similar patients who died with systemic candidiasis document the hazard of dismissing a positive fungal blood culture.

An important sign of candidal endocarditis is persistence of Candida in blood cultures after removal of a central venous catheter that has an infected tip. The source of persistent dissemination may be a Candida-laden thrombus adherent to the endocardium.[18] The data on hospital-acquired fungemia have recently been reviewed.[19]

Diagnosis: Diagnostic methods that identify fungal endocarditis earlier in the clinical course are necessary. In our series, cultures of urine, wounds, skin lesions and cerebrospinal fluid often grew Candida earlier than did blood cultures. Only one third of patients with endocarditis had positive blood cultures. Aspergillus was never cultured from blood.

Echocardiography may reveal an exophytic valve vegetation of fungal endocarditis, allowing for prompt medical and surgical therapy.[20,21] Vegetations on mitral and aortic valves in fungal endocarditis have been echocardiographically diagnosed and followed by early therapeutic initiatives.[20,22]

Serologic determinations of precipitin antibodies against the cytoplasmic constituents and cell wall of candidal organisms may facilitate early diagnosis of active infection.[23] Murray et al.,[24] in a prospective study, identified by serologic determinations six patients who had candidal endocarditis after cardiac surgery. Precipitin antibodies are most rapidly diagnosed by immunoelectrophoresis. Efficacy of antifungal therapy corresponds to declining titers. However, immunosuppressive therapy or a disease that severely compromises the immune response may prevent an appreciable precipitin antibody response.[25] Diagnosis of systemic candidiasis may be improved with crossed immunoelectrophoresis.[26]

Aspergillar versus candidal endocarditis: The large incidence of aspergillar endocarditis among our patients is an unusual finding in contrast with that in previous series of cases of fungal endocarditis.[8,27] Candida is most commonly responsible for fungal endocarditis in narcotic addicts,[10,28] who may constitute a large proportion of the patients studied. There were no narcotic addicts among our patients.

Fungal infections have been responsible for 13 to 20 percent of all opportunistic endocarditis following open cardiac surgery.[29] Whereas Candida is the most frequent cause of fungal endocarditis after open heart surgery,[23,30] Aspergillus and Candida were equally present in our patients with open heart surgery. Environmental factors play a role. Aerosolized aspergilli from contaminated operating room ventilating systems were identified as a source of postoperative aspergillar endocarditis in another study.[31] The higher proportion of aspergillar endocarditis is also ascribed to patients who had mural endocarditis.[32] These patients were severely debilitated or had received immunosuppressive therapy and were without predisposing endocardial lesions. Aspergillar pneumonia was a probable portal of entry.

Thus, there are two populations at risk for fungal endocarditis: those patients just described, who are debilitated but without an initial endocardial lesion, and those patients whose endocardium has been damaged. Patients with an altered immune defense and aspergillosis are at risk for endocarditis even without an antecedent lesion. Similar involvement of the endocardium has been described in cancer patients with cardiac candidiasis.[33,34]

Aspergillus was more invasive than Candida in our series. Aspergillus endocarditis involved contiguous myocardium more frequently than did candidal endocarditis. Aspergillus eroded through the aorta in a patient with an infected prosthetic aortic valve. It caused transmural erosion of the mitral valve ring and produced each of the three cases of pancarditis. The invasiveness and myocardial necrosis adjacent to mycelia may be due in part to the organism's elaboration of oxalic acid, which is toxic to tissue.[35]

Myocarditis

The importance of myocarditis has been emphasized only recently.[36,37] Among patients with disseminated candidiasis, the frequency of myocarditis may exceed 60 percent.[36,38] Franklin et al.[36] described new conduction disturbances, supraventricular arrhythmias and QRS changes in the electrocardiogram. These changes are not specific for fungal myocarditis.[39] Candidal myocarditis has caused complete heart block at the His bundle.[40] Myocarditis may progress to involve the endocardium or pericardium.

Several patients in our large series of myocarditis had extensive confluent abscesses even though myocarditis is said not to be diffuse[37] and of little clinical significance.[33] Two patients with widespread confluent candidal myocarditis had a relentless course of intractable congestive heart failure without other apparent cause. Myocarditis often occurs in the setting of fungal sepsis and may be very difficult to diagnose before death.[41]

The predisposing clinical setting in myocarditis of abdominal surgery, intensive antibiotic therapy and

corticosteroid therapy contrasts with that of thoracic surgery, valve disease and infected central venous catheters in endocarditis. Candida was the overwhelming cause of myocarditis, whereas Aspergillus was an important cause of endocarditis and serious complications. Myocarditis did not cause the embolic complications or new murmurs of endocarditis. Contiguous myocardial abscesses extended into the pericardial space as the principal mechanism for pericarditis in this series.

Pericarditis

The pericardial space was infected either by erosion of a contiguous myocardial abscess or by direct contamination during or after thoracotomy. The infrequency of fungal pericarditis within a series of cardiac mycoses has been observed.[33,36,41] Lesions ranged from small pericardial nodules to widespread purulent pericarditis. Postthoracotomy purulent pericarditis, whose cause is usually bacterial, has presented with increased frequency.[42] Severe fungal pericarditis may occur with no history of thoracic surgery (Table I). Aspergillar pericarditis resulted in fatal cardiac tamponade in a pancytopenic woman. Signs of pericarditis in the immune-compromised patient may be due to underlying cardiac fungal infection.

Treatment

Therapeutic results of cardiac fungal infection remain dismal. Patients undergoing treatment for fungal endocarditis have had a survival rate of less than 20 percent.[8] Early diagnosis is difficult but crucial to successful treatment. Delay or failure in establishing the diagnosis, embolization causing extracardiac foci of infection, invasion of myocardium,[32] poor penetration of amphotericin B into vegetations[43] and severity of underlying disease[37] contribute to the bleak prognosis. Early surgical intervention,[44–46] especially in patients with prosthetic valves,[47,48] and concomitant medical therapy[45,49] are advocated for fungal endocarditis. The toxicity and administration of amphotericin B have been well reviewed.[37,50,51] Synergism between amphotericin B and 5-fluorocytosine has been demonstrated; this combination is recommended in serious candidal infections.[37] Treatment of the underlying disease is imperative. A minimal follow-up period of 2 years in successfully treated patients is strongly encouraged.[52]

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