Unusual complications of bacterial endocarditis

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Four patients are described who developed unusual complications of bacterial endocarditis, in addition to aortic regurgitation: one patient with ventricular septal defect and three patients with mycotic aneurysm of the mitral-aortic intervalvular fibrosa.

The definitive diagnosis of these unusual manifestations of bacterial endocarditis can only be established by cardiac catheterization and with left cineventriculography and/or aortography. Treatment should consist of vigorous and appropriate antimicrobial therapy, measures to combat the congestive heart failure, and surgical correction of the lesions, preferably after the infection has been eradicated. In patients in whom the cardiac decompensation is a real threat to life, however, surgical correction should be performed after antimicrobial therapy has been administered for as long a period as possible.

Bacterial endocarditis may produce destruction of valve cusps or leaflets, chordae tendineae, or papillary muscles. When endocarditis extends from the aortic valve leaflets into the aortic ring, it may produce a sinus of Valsalva aneurysm or a fistula between the sinus of Valsalva and a cardiac chamber. In very rare patients, bacterial endocarditis may result in the development of penetrating abscess or aneurysm of the left ventricular wall or the production of a ventricular septal defect (Layman and January, 1967; Pirani, 1943). This type of cardiac aneurysm is much less common than the usual variety which occurs as the result of myocardial infarction of the anterior wall or apex of the left ventricle (Hurst and Logue, 1966; Schlichter, Hellerstein, and Katz, 1954).

The purpose of this communication is to describe 4 patients with unusual complications of bacterial endocarditis: 1 patient with a ventricular septal defect secondary to bacterial endocarditis of the aortic valve, 2 patients with mycotic aneurysms of the heart, and 1 with a penetrating abscess of the left ventricular outflow tract.

Case reports

Case 1 A 44-year-old man with chronic alcoholism was admitted in 1967 to Grady Memorial Hospital following a recent drinking bout: he was confused and febrile. He had no previous history

of heart disease and a chest x-ray 5 months before admission was normal.

His temperature was 40°C orally, and his blood pressure was 140/90 mmHg, with a pulse rate of 114 beats a minute. Admission examination of the heart and the electrocardiogram was normal. His cerebrospinal fluid contained 2,600 white cells/mm³ and the Gram stain, fluorescent antibody studies, and subsequent cultures were positive for *D. pneumoniae*. He was given 30 million units of aqueous penicillin daily intravenously. The diastolic aortic murmur of aortic regurgitation, which was first heard faintly on the second hospital day, progressively increased in intensity and by the sixth hospital day he developed severe pulmonary oedema for which he received digitalis, diuretics, and sodium restriction. On the 17th hospital day, a grade 4/6 continuous murmur at the upper left sternal border was discovered.

On the 19th hospital day, cardiac catheterization was performed. A left-to-right shunt was detected at the level of the right ventricle with a pulmonary to systemic flow ratio of 2.9:1. An ascending cine-aortogram revealed massive aortic regurgitation. In addition, a jet of contrast material flowed from the aorta to the right ventricle through a high ventricular septal defect (Fig. 1).

The patient's congestive heart failure did not respond to vigorous medical management and it was felt that surgical correction of the lesion was necessary. Before the operation, he had received intravenous aqueous penicillin for 21 days and had been afebrile for 13 days.

At operation the heart was enlarged and its surface was covered with petechial haemorrhages. The left coronary cusp was avulsed close to the commissure between the left and the right coronary cusp and there was a 2 cm fenestration

in the right coronary cusp (Fig. 2). The aortic valve was excised, revealing a 5 cm diameter defect in the upper membranous ventricular septum. Granulation tissue was present on the margins of the ventricular septal defect but not on the aortic valve leaflets. The ventricular septal defect was closed with interrupted sutures using a Teflon felt patch, and the aortic valve was replaced with a No. 10 Starr-Edwards ball valve prosthesis (Fig. 2). Since the heart was found to be in complete heart block after defibrillation, a bipolar pacing electrode was sutured to the wall of the left ventricular myocardium and connected to an external pacemaker.

The first 14 postoperative hours were complicated by the low cardiac output syndrome that gradually responded to careful expansion of blood volume, the use of ventricular pacing, digoxin, and the infusion of dopamine. The complete heart block persisted for 4 days, when he developed intermittent AV conduction that became persistent on the 8th postoperative day. He was begun on bishydroxycoumarin on the 9th postoperative day. He was continued on 30 million units of aqueous penicillin intravenously and 4 g nafcillin daily for three weeks after operation, and was discharged from the hospital on the 28th postoperative and 50th hospital day.

After discharge, the patient returned to his heavy consumption of alcohol but remained asymptomatic regarding his cardiovascular system. Two and a half years later, the patient was brought to the emergency clinic after a *grand mal* seizure with a severe laceration of his tongue. Immediately after local infiltration of his tongue with 2 per cent lignocaine, the patient had a cardiac arrest and resuscitation efforts were unsuccessful. At necropsy an exact anatomical cause of death could not be found. The heart weighed 330 g and the prosthetic valve was well seated, with the valve ring completely endothelialized and no ball variance. There was scarring of the upper ventricular septum at the site of septal closure and the Teflon patch was smoothly and completely endothelialized. There was early aspiration pneumonia in the lungs thought to be caused by blood from the laceration of the tongue. Permission for brain examination was not granted. He was thought to have probably died from hypoxia and cardiac arrhythmia secondary to aspiration of blood. Whether or not lignocaine can be incriminated is speculative.

- **Case 2** A 54-year-old woman had acute rheumatic fever at 6 years of age. In 1944, at the age of 29, she was admitted to the Cincinnati General Hospital with a left hemiparesis and was found to have *Streptococcus viridans* endocarditis and aortic regurgitation. She was successfully treated with sulphonamides with resolution of her hemiparesis.
- In 1947 she came to Grady Memorial Hospital with a history of exertional dyspnoea and paroxysmal nocturnal dyspnoea, physical findings of moderate aortic regurgitation with a blood pressure of 120/30 mmHg, and an electrocardiogram compatible with left ventricular hypertrophy. She was treated with digitalis and intermittent

FIG. 1 (Case 1.) Cine-aortogram showing aortic regurgitation and ascending aorta to right ventricle shunt. AO = aorta; RV = right ventricle; VS = interventricular septum; LV = left ventricle.

injections of mercurial diuretics with a good clinical response. For the next 18 years she did well, with episodes of congestive heart failure occurring only when she discontinued her medications. From 1967 until December 1968, however, she had progressive symptoms of exertional dyspnoea, paroxysmal nocturnal dyspnoea, and angina pectoris. In October 1968 she underwent cardiac catheterization, ascending cine-aortography, and biplane aortography that revealed massive aortic regurgitation and what was thought to be an aneurysm of the posterior sinus of Valsalva (Fig. 3).

In December 1968 she was operated upon. When the pericardium was opened, a pulsating mass between the ascending aorta and right atrium was seen (Fig. 4), but the sinuses of Valsalva appeared normal. Aortotomy was performed and the non-coronary cusp was found partially absent with the remaining cusps partially calcified. Beneath the aortic annulus in the area of

FIG. 2 (Case 1.) Left, and top right: schematic demonstration of the fenestration of the right coronary cusp and of the interventricular septal defect. Bottom right: schematic demonstration of the technique used for the repair of the lesions.

the mitral-aortic intervalvular fibrosa, a 5 mm stoma was identified that communicated with a pulsating mass between the ascending aorta and right atrium. The aortic valve was resected, the opening of the old mycotic aneurysm was closed, and a No. 10 Starr-Edwards ball valve prosthesis was sutured into the aortic valve area. The external wall of the aneurysm was enforced with a Teflon felt patch, even though it decreased in size and no longer pulsated after the closure of its stoma. Her postoperative course was relatively uneventful and when last seen 15 months after operation, she was symptomatically improved, her heart size had decreased, and she was receiving digitalis and bishydroxycoumarin.

Case 3 A 29-year-old woman was admitted to Grady Memorial Hospital in February 1969 with fever, anaemia, heart murmurs, and congestive heart failure.

In early childhood, the patient had multiple episodes of tonsillitis and at the age of 17 she was first told that she had a heart murmur. In 1963,

during her third pregnancy, she was seen at Grady Memorial Hospital and the clinical diagnosis of mitral stenosis was made. She had mild exertional dyspnoea and orthopnoea, and her chest x-ray was typical of mitral stenosis (Fig. 5A). In the interval, between 1963 and 1967, she had four more pregnancies relatively free of cardiac symptoms. In December 1968 she had the onset of fever and chills together with pounding headaches, dyspnoea on exertion, orthopnoea, paroxysmal nocturnal dyspnoea at rest, and severe weakness.

On admission, she had an oral temperature of 40°C, blood pressure 140/0 mmHg, and pulse rate 110 a minute. She had pale mucous membranes without petechiae haemorrhages; dental caries; a haemorrhagic bulbus on the heel of her right foot; bounding peripheral pulses and pulmonary rales. Her cardiac apex was in the 5th left intercostal space near the left anterior axillary line and the whole anterior thorax was hyperdynamic. There was a grade 3/6 holosystolic murmur in the 1st and 2nd interspaces bilaterally, a grade 4/6 diastolic decrescendo murmur along the left

sternal border, and a grade 3/6 mid-diastolic rumble with presystolic accentuation at the apex. The liver and spleen were not enlarged. Admission haematocrit was 20 per cent, WBC 9000 with a normal differential. Chest x-ray showed increased heart size since 1963 (Fig. 5B). There was no growth in multiple blood cultures. Because of the strong suspicion that she had bacterial endocarditis, she was placed on 8 g cephalothin and 1 g streptomycin per day. Cephalothin was used because of alleged penicillin allergy. Shortly after the institution of antibiotic therapy, she developed acute renal failure, which remitted spontaneously after 7 days. Her anaemia was treated with oral iron and multiple blood transfusions and she was placed on digitalis and diuretics for control of her heart failure. Because her fever persisted, despite cephalothin and streptomycin, she was desensitized to penicillin and placed on 10 million units of aqueous penicillin intravenously daily for 30 days. She remained febrile during the administration of the penicillin but became afebrile after it was discontinued. In spite of intensive medical therapy, the patient's clinical picture continued to deteriorate and surgical repair of her valvular lesions seemed mandatory. In preparation for operation in April 1969, she underwent a right and left heart catheterization and cineangiography, which showed massive aortic and mitral regurgitation, together with a subvalvular aneurysm in the left ventricular outflow tract (Fig. 6).

On 22 May 1969, the patient was operated upon. After the pericardium was opened, a pulsatile mass protruding between the ascending aorta and right atrium was seen. After routine cannulation, left atriotomy and aortotomy incisions were made and both the aortic and mitral valves were exposed. The mitral valve was heavily calcified, stenotic, and regurgitant. The left and non-coronary aortic cusps were completely destroyed, apparently from the previous endocarditis. Just beneath the non-coronary cusp there was a 3 mm orifice in the mitral-aortic intervalvular fibrosa that communicated with the pulsatile mass between the ascending aorta and right atrium. The orifice was closed, the mitral valve was replaced with medium-sized disc Beall valve and the aortic with No. 9 Starr-Edwards ball valve prosthesis.

Her immediate postoperative course was uneventful and she had obvious improvement in her symptoms of congestive heart failure. The prosthetic valve sounds were distinct and her heart size slightly decreased (Fig. 5C). On the sixth postoperative day she was begun on oral anticoagulants. Four weeks after operation she developed signs and symptoms of classic post-cardiotomy syndrome. She was placed on prednisone, 40 mg a day, with rapid defervescence of her symptoms. Four days after the prednisone, she developed a sudden massive cerebral haemorrhage, at which time her prothrombin time was greater than 2 minutes, whereas it had been in the range of 18 to 20 seconds before the catastrophe. She rapidly went into coma and died two days later on the 36th postoperative day.

FIG. 3 (Case 2.) Retrograde ascending aortogram showing aortic regurgitation and aneurysm of the mitral-aortic intervalvular fibrosa. AO = aorta; LV = left ventricle; AN = aneurysm.

Necropsy examination revealed an enlarged heart with left ventricular and left atrial enlargement. The prosthetic valves were well seated, completely endothelialized, and free from evidence of thrombi. The old mycotic aneurysm was completely obliterated with fibrous tissue, and cultures from it showed no growth. The brain was oedematous with massive haemorrhagic destruction of the right temporal lobe and right hemisphere. No mycotic or berry aneurysm was identified in the brain.

Case 4 A 17-year-old youth was admitted to Grady Memorial Hospital in September 1968, because of anaemia, fever, and splenomegaly occurring 6 months after operation for idiopathic subaortic stenosis.

Heart murmurs of aortic stenosis and regurgitation were first heard at the age of 6 months. The patient's early growth and development were normal. In March of 1962, at the age of 10, right and left heart catheterization showed a mean systolic gradient of 73 mmHg (peak systolic gradient = 94 mmHg) across the aortic valve. Left ventricular angiographic studies suggested aortic stenosis and mild aortic regurgitation with a normal ascending aorta and subvalvular area. The ascending aortic pulse was noted to be intermittently bisferiens. After the development of

anterior chest pain on exertion, he underwent a repeat right and left heart catheterization in December 1967. During the study, the mean systolic gradient across the aortic valve was 50 mmHg, with a peak systolic gradient varying from 29 to 124 mmHg. The LV aorta gradient did not increase after premature ventricular beats or after nitroglycerin administered to elicit evidence of idiopathic hypertrophic subaortic stenosis. The left ventricular end-diastolic pressure was raised to 17 mmHg compared with 5 mmHg in 1962. Aortography revealed mild dilatation of the ascending aorta, three aortic valve cusps, and mild aortic regurgitation.

In April 1968 he was operated upon; the three aortic valve leaflets were exposed under cardiopulmonary bypass and appeared to be normal. The aortic annulus was small, admitted only the operator's index finger, and hypertrophic muscular subaortic (subvalvular) stenosis of the left ventricular outflow tract was identified. After a right ventriculotomy, partial ventricular septectomy was performed and the septum was thinned to an estimated 3 mm. A systolic and diastolic thrill was palpated over the aorta. The patient's postoperative course was uneventful. His physical findings were unchanged from the preoperative state except for his aortic regurgitation murmur which became louder, and his electrocardiogram which showed right ventricular conduction delay.

In late April 1968 he had dental extractions for which he received intramuscular procaine penicillin before and for 3 days after the procedure.

In June 1968 he underwent postoperative cardiac catheterization which revealed a peak LV aorta systolic gradient of 92 mmHg on LV aorta pullback and 20 mmHg during simultaneous equisensitive LV and aorta readings.

He did well and continued asymptomatic until 17 July 1968, two months after dental work and one month after the postoperative cardiac catheterization, when he came to the outpatient clinic with complaints of fever, sore throat, and pain in his left thigh muscles. His blood pressure was 130/0 mmHg, the pulse rate was 88 a min, and the temperature was 38°C orally. The cardiac examination was unchanged. The only pertinent findings were a moderate hyperaemia of the pharynx and exudative tonsillitis. A splinter haemorrhage present on one fingernail was attributed to trauma. There were no Roth spots or petechiae haemorrhages. Four blood cultures and a throat culture were negative. It was decided to treat the patient with one million units of oral phenoxymethyl penicillin a day for 10 days. His haemogram was normal. He apparently felt well, but in September 1968 he returned to the clinic at which time he had a temperature of 38°C orally, a mild splenomegaly, and a haematocrit down to 32 per cent. He was admitted to the Medical Service. The patient's hospital course was very complicated and was characterized by persistent fever, negative blood cultures, electrocardiographic changes compatible with acute loss of inferior-posterior forces, multiple cardiac arrhythmias, and progressive biventricular heart failure with death on the 60th hospital day.

FIG. 4 (Case 2.) Photograph obtained at operation showing the aneurysm (AN) of the mitral-aortic intervalvular fibrosa presenting between the aorta (AO) and the superior vena cava (SVC). RA = right atrium; RV = right ventricle.

At necropsy the heart weight was 600 g, and there was extensive vegetative endocarditis of all aortic valve cusps. The aortic annulus was small. There was a small incisional aneurysm in the ascending aorta at the site of the previous aortotomy together with a penetrating abscess involving the mitral-aortic intervalvular fibrosa, the right sinus of Valsalva, and part of the base of the aortic valve (Fig. 7). There were gross and microscopical areas of myocardial necrosis on the posterior left ventricular wall and posterior interventricular septum, thought to be the result of several coronary artery occlusions by septic emboli. Blood cultures from the right ventricle taken at the time of necropsy, five hours after death, grew *Klebsiella* species. There was passive congestion of the lungs, liver, and spleen, and multiple splenic infarctions.

Discussion

A ventricular septal defect due to bacterial endocarditis has rarely been reported and is usually the result of the intracardiac rupture of an abscess of the membranous interventricular septum (Gould, 1960). When this complication occurs, the symptoms of the associated valvular lesion(s) are usually accentuated, eventually resulting in uncontrollable congestive heart failure. The diagnosis of a ventricular septal defect due to the rupture of an abscess or of a mycotic aneurysm

is suspected when the typical systolic murmur of ventricular septal defect or continuous praecordial murmur appears (Symbas and Parr, 1968). The diagnosis is established by cardiac catheterization and left cineventriculography.

A penetrating abscess or a mycotic aneurysm of the left ventricle is a rare complication of bacterial endocarditis and mainly occurs at its base. It may either be the result of erosion of the myocardium from infection that started as ulcerative or subacute endocarditis or, rarely, the result of septic myocardial infarction, secondary to infected coronary embolus. An abscess and subsequently an aneurysm may also be formed in acute ulcerative endocarditis when the septic process spreads from the affected valve into the left ventricular wall (Pirani, 1943), or in subacute bacterial endocarditis when the ventricular endocardium is struck by a jet of regurgitant, infected blood (Chesler *et al.*, 1968). The abscess of the left ventricular wall may subsequently drain into the blood stream, resulting in an aneurysm, the wall of which consists of thickened epicardium, connective tissue, and perhaps organized blood and granulation tissue (Pirani, 1943). Uncommonly, the junctional zone between the aortic and mitral valve, the 'mitral-aortic intervalvular fibrosa' (Gross and Kugel, 1931), is the site of an abscess or mycotic aneurysm, which often presents as a pulsatile mass at the base of the heart between the aorta and left atrium (Chesler *et al.*, 1968) or between the aorta and right atrium. Usually it is associated with aortic regurgitation and is due to bacterial endocarditis. The abscess or the aneurysm may rupture in the pericardium (Chesler *et al.*, 1968; Pirani, 1943) and produce instantaneous death, it may remain clinically silent as in our two cases with the symptoms only from their basic valvular lesion(s), or it may serve as a focus of infection and a source of septic emboli as in Case 4. The presence of a left ventricular aneurysm or abscess involving the mitral-aortic intervalvular fibrosa is suspected when a communication is angiographically shown projecting between the ascending aorta and left or right atrium. This diagnosis, however, is difficult to differentiate from a sinus of Valsalva aneurysm.

The initial treatment of the left ventricular abscess and of ventricular septal defect due to bacterial endocarditis should consist of vigorous and appropriate antimicrobial therapy together with therapy of the congestive heart failure. Surgical correction of the lesion(s) is preferably performed after the infection has been eradicated or after the

FIG. 5 Chest radiographs of Case 3.

antimicrobial therapy has been administered for as long a period as possible. Antibiotic therapy is not necessary before repair of a chronic sterile mycotic aneurysm of the heart.

Surgical treatment should consist of replacement of the destroyed valve(s) and obliteration of the stoma of the abscess or aneurysm either with interrupted sutures through pericardium or Teflon pledgets, or with the use of pericardial or a Teflon patch, if necessary. Closure of the ventricular septal defect should be performed in a similar manner. Resection of the myocardial abscess or aneurysm should seldom be required, only when it compresses and impairs function of the adjacent cardiovascular structures. After

the obliteration of its stoma, the aneurysmal sac becomes organized and fibrosed with subsequent diminution of size.

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FIG. 6 (Case 3). Cine-aortogram showing aortic regurgitation and aneurysm of the mitral-aortic intervalvular fibrosa. AO = aorta; LV = left ventricle; AN = aneurysm.

FIG. 7 (Case 4). Photograph of the heart obtained at necropsy showing a mycotic aneurysm of the mitral-aortic intervalvular fibrosa and a small aneurysm of the old aortic suture line. AO = aorta; AVR = aortic valve ring; MVR = mitral valve ring; LV = left ventricle.