Abscesses of the Valve Rings of the Heart, a Frequent but Not Well Recognized Complication of Acute Bacterial Endocarditis

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Abscesses of the valve rings of the heart were encountered at autopsy in 86 per cent of patients with acute bacterial endocarditis who had received antibiotic therapy. The abscesses, which appeared to arise from mycotic aneurysms in the valve rings, represented in most instances the only persistent focus of acute inflammation. They may account in part for the unsatisfactory results in the treatment of acute bacterial endocarditis, and their frequent occurrence suggests a relationship to antibiotic therapy.

SINCE 1947 we have encountered 12 cases of acute bacterial endocarditis in which single or multiple abscesses of the valve rings of the heart were present. Abscesses were found in 86 per cent of all cases of acute bacterial endocarditis which came to autopsy during this period. The lesions, although of appreciable size, were not conspicuous on routine examination of the heart; in fact, they were easily overlooked if not specifically sought. We believe that the abscesses represent a not well recognized complication of acute bacterial endocarditis. We have failed to find similar lesions in 11 cases of subacute bacterial endocarditis during the same period. The valve ring abscesses may be of clinical significance and their frequent occurrence might be related to therapy with antibiotics.

METHOD

We first noted abscesses in a case of acute bacterial endocarditis which at autopsy showed marked involvement of the aortic valve together with a single mass of vegetation on the anterior mitral cusp. The gross appearance of the vegetation was not unusual, considering that the patient had received extensive penicillin therapy, but it was noted that the vegetations of the anterior mitral cusp arose directly over the valve ring and did not involve the free edge of this valve. Close inspection and palpation of the valve ring suggested an ill-defined swelling which could also be felt to involve the ring of the adjacent aortic leaflet. Upon incision a cavity was found which exuded purulent material and which was partially filled with laminated blood clot. Abscesses were specifically sought in all subsequent cases of acute and subacute bacterial endocarditis and the following method of dissection was evolved.

The heart was opened in the usual manner and the vegetations cultured. All postmortem clots were removed and the valve rings were carefully inspected. In the later cases areas suspicious of abscess were aspirated and the contents cultured. All four valves were then photographed. Following the usual examination of the heart, the entire heart skeleton was dissected in one block. This specimen included all valves, as well as a strip of myocardium and mural endocardium of both atria and ventricles adjacent to the valve ring.

The entire specimen was then fixed in Zenker’s fluid with 5 per cent glacial acetic acid. After fixation, the valves, valve rings and adjacent myocardium were sectioned at 2 to 3 mm. intervals. In this manner, any grossly recognizable lesion involving the valve rings was visualized in its entire extent and could be photographed.
Multiple blocks were taken from each valve ring. All blocks included the valve, valve ring and adjacent myocardium. Many, often subserial, sections were cut and stained with hematoxylin and phloxine, phloxine-methylene blue, Wilder's modification of the reticulum stain, Weigert's elastic tissue stain, Gram stain and occasionally, Mallory's aniline blue stain. In addition, multiple sections representing all four chambers of the heart were examined.

The other organs were dissected in appropriate manner and examined both grossly and histologically.

**Autopsy Findings**

The description to follow represents a summary of the autopsy findings of all 12 patients. The findings with which we are chiefly concerned were similar in all cases, and for this reason it is felt that a single case report suffices for illustration.

M. J., a 59 year old white woman, was hospitalized on Feb. 4, 1949. She had been in fairly good health until three weeks before admission when she developed a persistent nonproductive cough. One day later she experienced the first of many severe chills. Her family stated that she had been feverish throughout her illness. Two days before admission she became irrational.

It was thought that the patient had had valvular heart disease for many years, but no history of acute rheumatic fever could be obtained. She had experienced numerous syncope attacks during early adult life. Orthopnea and exertional dyspnea had been present during the two years before admission.

**Physical Examination.** The temperature was 104.6 F., the pulse rate 108 and the respiratory rate 22 per minute. The blood pressure was 96/64. The patient appeared acutely ill and was irrational. The neck veins were moderately distended. Moist rales were heard over both lung bases. The apex impulse of the heart was located 11.5 cm. to the left in the fifth intercostal space. The cardiac rhythm was regular. A harsh third heart sound was audible along the entire left border of the heart; no diastolic murmurs were heard. There was a minimal pitting edema of the lower extremities.

**Laboratory Data.** The urine specific gravity was 1.016 and there was 1 plus albuminuria. The urinary sediment was not abnormal. A serologic test for syphilis was negative. The red blood cell count was 3.5 million per cu. mm. and the blood hemoglobin concentration was 8.8 Gm. per 100 cc. The erythrocyte sedimentation rate was 85 mm. in one hour (Westergren). The white blood cell count was 8750 per cu. mm., later rising to 20,150. The blood nonprotein nitrogen concentration on admission was 38 mg. per 100 cc., but later rose to 148. Lumbar punctures done on two occasions revealed normal findings. Electrocardiograms showed left bundle branch block and later during her illness auricular fibrillation.

Seven blood cultures drawn at the time of admission grew pneumococcus type 32. These organisms grew in 0.01 unit but not 0.02 unit per cc. of penicillin. Four blood cultures taken on the eighth day of penicillin treatment were sterile.

**Hospital Course.** The patient was given 100,000 units of aqueous penicillin intramuscularly every three hours for 12 days, receiving a total of 0.7 million units. Her temperature remained elevated varying between 99 and 101 F. On the third hospital day she was digitalized and then maintained on digitoxin. On the sixth day it was noted that the systolic murmur heard at the time of admission was now barely audible, while a loud high pitched diastolic murmur was present over the primary and secondary aortic areas.

The patient showed little response to therapy and died on the thirteenth day of hospitalization. Signs of congestive heart failure were minimal at the time of death.

**Gross Pathologic Findings.** The heart weighed 550 Gm. and the pericardium was covered by a fibrinous exudate. The valve measurements were: tricuspid 12.1 cm., pulmonic 8.3 cm., mitral 9.8 cm., aortic 7.3 cm. The left ventricle measured 2 cm. in thickness and the right 0.6 cm.

The left atrium contained an unattached aneurysm of the aortic valve measuring 2 by 1 cm. The annulus of the anterior mitral cusp showed a glistening, red and friable vegetation, 1.8 by 1.5 cm. (fig. 1C). Several nodular areas of calcification measuring 3 to 4 mm. were located on the ventricular surface of the annulus of the posterior cusp.

The left leaflet of the aortic valve was covered with innumerable minute, shiny, friable, yellow-gray vegetations involving the ventricular surface, part of the free edge and the sinus of Valsalva (fig. 1A). The free edge of this leaflet was rolled. An oblique 1.5 cm. tear extended from the commissure connecting this and the posterior leaflet, into the valve as far as the annulus. Just beneath this leaflet was an ulceration, 2.0 by 1.2 cm., covered by reddish-brown soft tissue. On cut surface the ulceration led into a cavity, 1.3 by 0.7 cm., containing soft reddish brown material (fig. 2A). The cavity extended upward behind the root of the aorta, where it appeared to involve the myocardium of the left atrium and downward into the annulus of the anterior mitral cusp.

The right aortic leaflet was also covered by many shiny yellowish-gray vegetations ranging from 1 to 4 mm. in size (fig. 1A). They involved the ventricular surface and the sinus of Valsalva, but spared the thickened free edge. In the center of the leaflet near its left side was an out-pouching, 6 by 2 mm.
Just below the leaflet was an ulceration, 3.5 by 1.2 cm., containing soft grayish-red material. The fundus of the sinus of Valsalva showed an 8 mm. cone shaped retraction with a 2 mm. central opening. Cut surface showed a cavity which measured 1.7 cm. and contained soft grayish-red material (fig. 1A). The cavity extended upward for a short distance behind the root of the aorta and involved the commissure between the right and posterior aortic leaflets. It also extended into the annulus of the right and left leaflets of the pulmonic valve.

The two cavities located respectively behind the right and left aortic leaflet did not communicate with each other.

The posterior aortic leaflet including its sinus of Valsalva was almost completely calcified, but revealed no vegetations (fig. 1A).

Fig. 1A (top left). Acute bacterial endocarditis of aortic valve. The left leaflet (at right) is partly destroyed and covered by vegetations extending to the commissure, into the sinus of Valsalva and to the ventricular aspect of the anterior mitral cusp. The opening at the base of the valve leads into the abscess shown in figure 2A. The posterior leaflet (center) is thickened. The free edge of the right leaflet (shown on the left) although thickened, is uninvolved by vegetations which cover the remainder of this structure and extend to the interventricular septum.

B (top right). Aortic valve with syphilitic aortitis and valvulitis. Multiple crater-like openings on mural endocardium beneath posterior leaflet (left) represent points of rupture of underlying valve ring abscess associated with acute bacterial endocarditis of mitral valve. The left leaflet (right) shows near its base a ruptured valvular aneurysm. Note that the free edge of both leaflets shows no vegetations.

C (bottom left). Anterior mitral cusp with healing vegetation attached to valve ring. The vegetation is secondary to an abscess involving the aortic and mitral ring shown in figure 2A. Note that remainder of valve is grossly normal.

D (bottom right). Atypically located healing vegetations on commissure between left and right pulmonic valve leaflets. The vegetations overlie an abscess extending from the aortic and the pulmonic ring shown in figure 2B. The abscess is associated with acute bacterial endocarditis of the aortic valve. Note that the vegetations arise from the sinuses of Valsalva and the mural endocardium beneath the commissure but do not involve the leaflets.

The pulmonic valve showed three separate yellowish-brown vegetations (fig. 1D). One measured 8 by 9 mm. and arose from the mural endocardium just beneath the commissure between the right and left leaflets. The others arose from the same commissure in the sinus of Valsalva of the right leaflet, measured about 5 by 3 mm. each, and did not
involve the valve leaflet. The remaining portions of the pulmonic valve were not remarkable. Cut surfaces showed that the vegetations overlay the above described cavity behind the root of the aorta (fig. 2B).

The tricuspid valve and the remaining portions of the mural endocardium were not remarkable.

The myocardium displayed multiple minute scars and the papillary muscles and trabeculae of the left ventricle showed indistinct zigzag yellow lines. The coronary arteries revealed diffuse atheromatous plaques without gross occlusion.

The aorta showed some atherosclerosis, but the coronary orifices were only slightly encroached upon. Small old and recent infarcts were present in the lungs, spleen, kidneys and in the right cerebellar hemisphere. Additional gross findings were chronic passive congestion of the liver, a pedunculated polyp measuring 4 by 2 cm. in the sigmoid, obliteration of the appendix, and fibrous adhesions around the cecum and in the right pleura.

Cultures taken at autopsy yielded gamma streptococci and Pseudomonas aeruginosa from the heart blood, coagulase negative Staphylococcus aureus from the spleen and no growth from the lung.

Histologic Findings. All aortic leaflets showed extensive old fibrosis and focal calcification. The right and left leaflets showed many areas of necrosis and were covered on both surfaces by vegetations. The necrotic areas and the vegetations showed generally advanced repair with endothelialization and organization (fig. 3). The mitral valve revealed old fibrosis with minimal focal calcification. Areas of necrosis of the valve and vegetations were seen on the anterior cusp. The latter were present on the ventricular surface where they represented an extension of the lesion of the left aortic leaflet. Another mass of vegetations was present on the atrial surface at the base of the cusp. The necrotic areas and vegetations also revealed advanced repair.

The cavities located behind the right and left aortic leaflets were similar in appearance. They involved the loose areolar tissue between the roots of the aorta and pulmonic artery and extended into the adventitia of both vessels (fig. 6). The commissure between the right and left pulmonic leaflets and the annulus of the anterior mitral cusp as well as the myocardium of the left atrium, the interventricular septum and the muscle of the conus arteriosus of the mitral ventricle were also involved (fig. 4). The vegetations on the atrial aspect of the anterior mitral cusp marked the points where the cavities approached the surface or had actually perforated. The cavities contained some laminated old blood clot as well as necrotic material, fibrin and degenerating neutrophilic polymorphonuclear leukocytes. The walls consisted of granulation tissue with subacute and chronic inflammatory cell infiltration (fig. 7). Several small and medium sized arteries displayed thrombosis (fig. 8), and revealed marked fibrosis of the adventitia and media without atheromatous changes in the intima.

No microorganisms were identified in any of the lesions. The tricuspid valve and the remaining portions of the pulmonic valve showed nothing of note.

The myocardium revealed hypertrophy of the muscle fibers, some fatty metamorphosis and multiple small areas of old and recent scarring. A few foci of recent acute necrosis of muscle fibers showing infiltration by neutrophilic polymorphonuclear leukocytes were present. A small vessel near a recent scar showed occlusion by amorphous material similar to that composing the valvular vegetations. The pericardium revealed an organizing fibrous pericarditis. No Aschoff bodies were encountered. The aorta showed some atheromatous plaques but there was no evidence of syphilis.

Additional histologic findings were multiple old and recent infarcts in the lungs, spleen, pancreas, kidneys and cerebellum. There was some chronic passive congestion of all organs with foci of central hemorrhage and necrosis in the liver. The bone marrow showed secondary hyperplasia. The lesion in the right sigmoid was an adenomatous poly. Anatomic Diagnosis. Acute bacterial endocarditis, healing, of aortic, mitral and pulmonic valves with mycotic aneurysm of right aortic leaflet; two abscesses of aortic annulus fibrosus with involvement of mitral and pulmonic valve rings, extension into the root of the aorta and pulmonic artery, interventricular septum and left atrium and with rupture into the left and right ventricle and into the sinus of Valsalva of the right aortic and right pulmonic leaflet; fibrosis and calcification of mitral and aortic valves with calcification of mitral and aortic annulus fibrosus; unattached thrombus, left atrium; embolic myocarditis, old and recent; fatty metamorphosis of myocardium; atherosclerosis of coronary arteries; cardiac hypertrophy (550 Gm.); fibrous pericarditis, healing; multiple infarcts, old and recent, of lung, spleen, pancreas, kidneys and cerebellum; pulmonary edema; chronic passive congestion of viscera; central hemorrhage and necrosis of liver; generalized atherosclerosis, mild; adenomatous polyp of sigmoid; scarred, obliterated appendix; peritoneal and right pleural adhesions, fibrous.

Morphologic Observations

Gross Findings. Endocarditis involved most commonly the aortic valve, while the mitral, tricuspid and pulmonic valves were involved in decreasing frequency (table 1). Involvement of two valves was encountered in 3 instances, involvement of three valves in one.

The endocarditis always showed at least one valve the typical appearance of acute bacterial endocarditis, modified by antibiotic
therapy (fig. 1A). In the case of aortic valve involvement, which was the most common occurrence, the leaflets showed a varying but generally extensive degree of ulceration and perforation with smooth and rounded edges. In many instances, small aneurysmal outpouchings were present. The vegetations were bulky mottled grayish-yellow and -red masses which, on close inspection, revealed endothelialization. The vegetations, however, did not only involve the line of closure of the leaflets proper. They had often spread to the commissures, the fundus of the sinus of Valsalva and to the mural endocardium at or adjacent to the attachment of the valve to the valve ring. (figs. 1C and 1D). In instances of combined mitral and aortic valve involvement, the mitral vegetation spared the line of closure, but arose near or at the valve base in the region of the valve ring. In the single instance of pulmonic and mitral valve vegetations associated with ulcerative endocarditis of the aortic valve, the pulmonic valve vegetation arose from a commissure and extended into the adjacent sinuses of Valsalva. Vegetations also arose from the mural endocardium of the right ventricle where it joined the involved pulmonic valve commissure (fig. 1D).

The atypical location of some vegetations suggested that they had formed secondarily...

With aortic valve endocarditis the vegetations sometimes extended to the ventricular aspect of the anterior mitral cusp. Single or multiple crater-like openings ranging from 1 to 5 mm. in size were frequently found. They were located at the junction of mural and valvular endocardium (fig. 1B), on the commissures of the semilunar valves, or in the fundus of the sinus of Valsalva. Postmortem blood clots or vegetations often masked these openings. A probe should be inserted into the openings to a depth of a few mm. to 1 to 2 cm. In several instances, the endocarditis involved more than one valve, as occurred in the case reported in detail. Here, the endocarditis of the aortic valve presented the picture as described but vegetations were also present on the mitral and pulmonic valves to an expanding lesion in the underlying tissues. This impression was confirmed by further gross and histologic studies.

The gross recognition of abscesses in the valve rings proved difficult unless certain findings were noted. Upon inspection or palpation, even the largest abscess, which measured 5 cm. in diameter, revealed itself only as a slight and ill-defined swelling. Sometimes a slight bluish discoloration of the overlying endocardium could be noted. The already described crater-like openings (fig. 1B) and the atypically located vegetations (figs. 1C and 1D) were a definite indication of the presence of an abscess. It must be stressed, however, that occasionally abscesses up to 1 cm. in diameter were present which had neither ruptured nor produced vege-

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tation and were revealed only when the specimen was sectioned as described.

Upon sectioning, the abscesses were found to range from 3 mm. to 5 cm. in diameter (fig. 2). They tended to follow the course of the valve rings, but in the region of the aortic ring, often spread upward between the root of the aorta and the myocardium of the left atrium. Occasionally they extended for a short distance into the anterior mitral cusp. The outer layers of the aorta and particularly the myocardium of the left atrium were often involved. The lesions were quite well defined and upon sectioning exuded variable amounts of soft reddish-gray or brown material. In many instances, they were partly filled by firm laminated blood clot. The abscesses were multiple in 6 cases. In one case, as many as seven apparently separate lesions were noted. In all but one instance the valve cusp or leaflet adjacent to an abscess showed endocarditis (fig. 9).

**Histologic Findings.** The histologic findings of the valve involved by endocarditis did not differ from the already described picture of this infection when treated by antibiotics (fig. 3). In all but 2 instances, the valves showed advanced repair with formation of abundant vascular granulation tissue. The remaining necrotic valve tissue and other necrotic material were partially or completely surrounded and penetrated by granulation tissue. Bacteria could not be demonstrated in the vegetations and endothelialization had occurred. The various stages in the formation of valvular aneu-

**Fig. 2.** Cross sections of valve ring abscess associated with acute bacterial endocarditis of aortic valve. (Drawings made from gross photographs.) A. Large ring abscess beneath left aortic leaflet extending upwards between root of aorta and left atrium and downwards into mitral ring. Note cross section of vegetation on atrial aspect of anterior mitral cusp (compare with fig. 1C.) B. Large ring abscess beneath left aortic leaflet extending behind aortic root into commissure between left and right pulmonic valve leaflets. The vegetations arise from this commissure and correspond to those shown in figure 1D. Note ulceration of sinus of Valsalva of aortic leaflet.

**Fig. 3.** Healing acute bacterial endocarditis of aortic valve. Granulation tissue is penetrating into the necrotic material of the vegetation. There is no acute inflammatory cell infiltration. Phloxine-methylene blue, X 210.

rysms as described by Saphir were seen. In 2 patients with staphylococcal infection, the inflammatory process was acute and masses of microorganisms were present. In one of these (case 9) no significant repair could be found while in the other (case 8), healing was slight.

All abscesses involved at least one of the valve rings. In many instances, the extension of the lesions along the heart skeleton, with involvement of the rings of different valves could be clearly demonstrated (figs. 4, 5 and 6).

The unruptured abscesses showed a core of necrotic material with purulent exudate sur-
rounded by granulation tissue. In some areas the granulation tissue displayed acute inflammatory cell infiltration, while more peripheral areas appeared older, showing organization (fig. 7). In many instances, old laminated blood clot formed part of the contents (fig. 5). Occasional structures resembling microorganisms surrounding tissues were carefully studied. Occasionally remnants of fragmented and degenerating elastic tissue fibers were found in the abscess wall. In several instances, medium sized arteries near the lesions were occluded, and contained necrotic material similar to that seen in the older portions of the abscesses (fig. 8). Newly formed connective tissue distorted the

![Image](https://example.com/image1.png)

**Fig. 4.** Abscess of aortic valve ring (A) extending upwards between aortic root and wall of the left atrium (B). Extension of the abscess to the surface of the sinus of Valsalva has produced ulceration covered by vegetation (C). Another vegetation (D) overlies the atrial aspect of the mitral ring and on serial sections was shown to have formed secondarily to an extension of the abscess (compare with fig. 2A). Phloxine-methylene blue, × 6.5.

were seen within polymorphonuclear leukocytes of the acute inflammatory cell exudate. Colonies of microorganisms were not encountered except in two instances of recent staphylococcal infection. The periphery of the lesions showed fibrosis with some chronic inflammation. Hemosiderin deposits were an almost constant finding in the surrounding tissue.

The blood vessels in the abscess walls and

![Image](https://example.com/image2.png)

**Fig. 5.** Abscess involving both aortic and mitral rings partly filled with laminated thrombus. The abscess has ruptured through mural endocardium beneath aortic leaflet (left center). Phloxine-methylene blue, × 6.5.

walls of these vessels, and extended into the thrombus.

The grossly described crater-like openings in the endocardium were seen to represent points of rupture of the abscesses (figs. 4 and 5). The core and the outer layers of the wall of the ruptured lesions were similar to those already described.

The extension of the abscesses occurred by spread of the acute inflammatory process and could often be followed to the surface of one of the heart chambers or to a sinus of Valsalva.
Vegetations formed when the underlying inflammatory process approached the endothelial surface (fig. 4). Various stages in the formation of vegetation could be observed from minute histologic thrombi to bulky masses, but their degree of repair was similar to that noted in the primarily infected valves.

Other Findings. The heart weights varied from 240 to 790 Gm., with an average of 498 Gm.

The valves not involved by endocarditis appeared grossly and histologically normal. Calcification of the aortic valve annulus, with some involvement of the leaflets, was present in 2 cases. Calcification of the mitral valve annulus was noted in 3 instances. Embolic myocarditis was an almost constant finding, and showed advanced healing. In one patient with staphylococcal endocarditis (case 12) a 3 mm. abscess was present in the tip of the right papillary muscle of the left ventricle. Morphologic evidence of syphilitic aortitis was found in 6 patients (table 1).

A wide variety of peripheral embolic complications was encountered, which did not differ from those commonly found in this disease. In most instances, these showed advanced healing. In 2 patients with staphylococcal endocarditis, embolic brain abscesses appeared to be of clinical significance and in one the brain showed multiple areas of infarction. A fortunate cut revealed that an area of infarction was associated with a classic mycotic aneurysm of a cerebral vessel.

In all patients but one who entered the hospital with pneumonia, meningitis or both, these infections showed advanced or complete healing at autopsy.

Clinical Findings

Some of the clinical data are summarized in table 1.
Our patients varied in age from 28 to 78 years. There were 8 men and 4 women.

The duration of acute illness before hospitalization varied from one day to five weeks but in most instances was about three weeks. All patients were acutely ill when admitted, and usually a history had to be obtained from the family. All had had an acute febrile illness, and classic symptoms of pneumonia or meningitis were elicited in several instances. The past history of one patient revealed lobar pneumonia six months prior to his present illness. He had received penicillin therapy at that time. Another patient had had a criminal abortion eight days before admission.

The past history of 7 patients indicated organic heart disease, and 6 of these had experienced symptoms of congestive heart failure. In 3 of the 7 patients syphilitic aortic insufficiency had been previously diagnosed, and syphilitic aortitis was found at autopsy in 2 others. The history of a further patient suggested longstanding rheumatic heart disease.

Seven patients had previously received antisyphilitic therapy or had positive serologic tests for syphilis at the time of admission. At autopsy 6 of these were found to have morphologic evidence of syphilitic aortitis. The seventh gave a history of antisyphilitic therapy and had a strongly positive serologic test, but no evidence of the disease could be found at postmortem examination.

Eight patients were irrational or comatose when first seen in the hospital. Six had clinical and laboratory findings of pneumonia. A diagnosis of meningitis was established in 6 patients, and an additional patient was found to have meningitis at autopsy. Both pneumonia and meningitis were present in 4 patients.

All patients received penicillin therapy in the hospital. One died shortly following an initial administration of 50,000 units. The other patients received total doses ranging from 600,000 to 150 million units over periods from 3 to 27 days. In addition, sulfadiazine was given to 6 patients, aureomycin to 2 and streptomycin to 2. No reliable information is available concerning therapy before admission. A subsiding meningitis and pneumonia encountered in the patient dying within three hours after admission suggest that he had received previous antibiotic therapy.

Nine of the 12 patients remained febrile up to the time of death. Three of the 9 patients showed no clinical evidence of congestive heart failure, 4 had minimal findings and 2 were in moderately severe failure. Two of the 12 became afebrile, one on the fourth, the other on the sixth day of therapy. Both, however, died of severe progressive heart failure. The last patient died with a massive encephalomalacia, possibly embolic in origin.

![Fig. 8. Occluded blood vessel at periphery of valve ring abscess. Phloxine-methylene blue, × 400.](image)

**Bacteriologic Findings**

The causative organism in 9 patients was pneumococcus and in 3 *Staphylococcus aureus* (coagulase positive in 2, coagulase negative in one) (table 1). Multiple blood cultures were positive in all patients on admission and in 6 the organism was also recovered from the spinal fluid. Blood cultures were repeated during treatment in 5 patients. The cultures of 3 patients with pneumococcal infection yielded no growth. The cultures of 2 patients with staphylococcal endocarditis continued to be positive.

During the early phases of this study we did
not appreciate the importance of thorough post-mortem bacteriologic study, and in most instances failed to obtain cultures from vegetations and valve ring abscesses. Cultures of vegetations were obtained from 6 patients. Pneumococcus was recovered from two, Staphylococcus aureus from three and one vegetation proved sterile. Valve ring abscesses were cultured in only 3 cases and all were positive. Staphylococcus aureus was grown from two and pneumococcus from the third. Cultures of heart blood and lung were taken at autopsy in all 12 cases. A positive blood culture was obtained in only one patient with pneumococcal endocarditis and in no instance was the pneumococcus recovered from lung. Staphylococcus aureus was grown from heart blood or lung in all 3 patients with this infection.

**Discussion**

Abscesses in the valve rings occurred in 12 of 14 cases of acute bacterial endocarditis which came to autopsy between 1947 and 1950. Similar lesions, although searched for, were not encountered in 11 cases of subacute bacterial endocarditis. The abscesses were often of appreciable size, but inconspicuous on routine examination of the heart. The presence of the lesions could be suspected from certain gross findings. Sometimes a swelling was noted in the region of the valve rings, occasionally associated with a bluish discoloration of the endocardium. Crater-like openings in the mural endocardium near the valve rings and in the sinuses of Valsalva, as well as on the commissures of the semilunar valves, were frequently encountered and found to represent points of rupture of underlying abscesses. The most striking finding was vegetations which arose near or at the valve ring. The free edge and line of closure of these valves were uninvolved. These atypically located vegetations had formed secondarily to the extension of the underlying abscess. In all but one instance the abscesses involved the ring of a valve cusp or leaflet which showed the typical picture of primary involvement by acute bacterial endocarditis. Here the vegetations always involved the free edge and line of closure of the valve. The abscesses were often multiple and sometimes extended from one valve ring to another (fig. 9).

On histologic examination, the abscesses consisted of a necrotic center surrounded by granulation tissue. Old laminated thrombi were often part of the core. All abscesses showed areas of acute and progressive inflammation, as well as repair. In some instances the tissue surrounding the abscesses revealed arteries occluded by organizing thrombi.

In all but 2 patients (cases 8 and 9) the valves, the vegetations, and the embolic lesions, in the myocardium as well as in other organs, showed subsidence of the acute inflammatory process and advanced repair. The valve ring abscesses appeared to be the only obvious foci of acute inflammation.

We were surprised at the frequency of valve ring abscesses in our cases of acute bacterial endocarditis. These lesions may have been overlooked by us in the past, or may represent a new aspect of acute bacterial endocarditis developing in association with more effective therapy. The incidence of these lesions cannot be determined from a review of the recent literature since they have not attracted attention. Careful study of autopsy protocols, however, included in reports on acute bacterial endocarditis revealed that similar lesions have occasionally been encountered. Of the standard textbooks of pathology, Karsner and Aschoff mention only the rare occurrence of abscesses in the myocardium following the extension of acute bacterial endocarditis. MacCallum describes cavities filled with infected thrombus in the sinuses of Valsalva which he called mycotic aneurysms. He noted perforations as well as extension into the walls of the atria and the interventricular septum. Ribbert describes the lesions in detail as a rare occurrence in acute bacterial endocarditis and states that they developed from a spread of the infection from the valves to the sinuses of Valsalva and the aortic root. His text figure 18 illustrates well their location and general histologic appearance. Except for these observations, the morphology and pathogenesis of the abscesses have apparently not been investigated. We
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have found no references to their possible clinical significance.

The pathogenesis of the valve ring abscesses remains uncertain, since despite extensive study, we have never encountered the early stage of the lesions. Their histologic appearance, with laminated thrombi in the center and occluded blood vessels in the adjacent tissue, suggests that they are mycotic aneurysms of the vessels in the valve ring. The peripheral vessels in acute bacterial endocarditis frequently show similar aneurysms which are the result of septic emboli.\(^5\)

If the valve ring lesions are mycotic aneurysms, increased vascularity of the valve ring, subsequent to syphilitic aortitis, rheumatic heart disease, or to atherosclerosis could represent a predisposing factor. It might therefore be significant that 6 of our patients had in close apposition to segments of the aortic ring.

Our study revealed no criteria for the clinical recognition of the valve ring abscesses. We feel, however, that the lesions may be of clinical significance. Several of our patients died with clinical evidence of persistent infection but without significant congestive heart failure. At autopsy the valvular and other lesions such as pneumonia and meningitis showed generally advanced healing while the valve ring abscesses

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**Fig. 9.** The drawing in the center shows the close anatomic relationships of the four valve rings as viewed from above after removal of the atria and the great vessels. The satellite drawings indicate the number and location of the valve ring abscesses (solid black) as well as the valves involved by endocarditis (shaded).
appeared to represent the only site of active inflammation. Despite vigorous administration of antibiotics, the therapeutic results in acute bacterial endocarditis have been unsatisfactory. This failure may in part be related to abscesses of the valve rings.

It is our impression that the valve ring lesions are actually more frequent now than in the past. Prior to modern therapy, most patients died early in the course of acute bacterial endocarditis with unchecked destruction of the valves and massive bacteremia. Antibiotics appear to control the infection on the valves as well as in other primary or metastatic sites, but may not penetrate the valve ring in therapeutic concentrations. The same factors which prior to antibiotic therapy prevented the healing of the valvular lesions may still obtain in the valve rings and account for the progression of infection in the valve ring abscesses.

SUMMARY

Single or multiple abscesses of the valve rings of the heart were encountered at autopsy in 12 patients with acute bacterial endocarditis who had received penicillin therapy. The abscesses measured from 1 to several centimeters in size and, because of the close anatomic relationships of the valve rings, frequently involved more than one of these structures. Rupture of the lesions either into the chambers of the heart or into the sinuses of Valsalva of the semilunar valves occurred in many instances.

The abscesses appeared to originate from mycotic aneurysms of vessels in the valve rings. Increased vascularity of these structures subsequent to syphilitic aortitis, rheumatic heart disease or atherosclerosis might represent a predisposing factor.

The valve ring abscesses were the only recognizable foci of persistent acute inflammation while the endocarditis and its peripheral embolic lesions as well as the associated pneumonia and meningitis generally showed advanced healing.

It is our impression that abscesses in the valve rings are encountered more frequently now than in the past. The unsatisfactory therapeutic results in acute bacterial endocarditis may be related to these lesions. Antibiotic agents control the infection on the valves as well as in the peripheral embolic and other associated lesions, but do not appear to penetrate the valve ring abscesses in sufficient concentration to prevent their progression.

REFERENCES

Abscesses of the Valve Rings of the Heart, a Frequent but Not Well Recognized Complication of Acute Bacterial Endocarditis
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