FOCAL INFECTION AS A FACTOR IN HEART DISEASE*

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All possible etiologic factors in cardiac failure warrant thorough consideration since heart disease is today by far the most frequent cause of death. Clark[1] states that in the year 1928 the number of deaths from heart disease in certain states having an aggregate population of 25,000,000 was 228 per 100,000 persons as compared with 106 from kidney disease, 105 from cancer and 100 from pneumonia. He adds that the number of deaths from heart disease in the registration area of the United States doubled during the eight year period from 1917 to 1925, while the population increased by only one-third.

Many deaths from heart disease are due primarily to valvular disease resulting for the most part from activity of the virus of rheumatic fever. In other cases, death results from vascular syphilis or is the end result of arterial hypertension. A very large proportion of the deaths from heart disease result, however, from chronic changes in the myocardium which we group under the term chronic myocarditis, or chronic myocardial degeneration, often ascribed to senescent changes. Impairment of the blood supply secondary to coronary artery disease is an important factor in the development of the myocardial changes. Often, however, the cause is not apparent. I wish to emphasize one possible factor, namely, chronic focal infection, which is often overlooked or its importance underestimated.

Rheumatic infections of the heart valves and heart muscle are focal in origin in the sense that they usually metastasize from infection in the nasopharynx. These infections occur typically at an early age although their effects may be apparent only late in life. The proper care of tonsil and dental infection has seemingly definitely decreased the incidence of rheumatic fever and consesequently of rheumatic heart disease. It is not, however, the virus of rheumatism which I wish to discuss and emphasize but other infections of focal origin, largely streptococcic in type.

All students of heart disease are aware of the effect of infection

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on the heart muscle. It may be accepted as axiomatic that in every acute infection a certain degree of myocardial degeneration takes place. Recovery from this change may be complete but often the acute disturbance in the heart muscle is followed by fibrosis or scar tissue formation in the myocardium. It is probably for this reason that chronic fibrous myocarditis is the heart lesion most commonly observed. The acute myocarditis seen so often in diphtheria and the characteristic carditis of rheumatic fever and chorea are known to everyone. Other types of infection might be mentioned in which manifest acute involvement of the myocardium is frequently seen. These types are easily recognized. The slow chronic poisoning from a focus of infection is less spectacular and not so easily recognized but is equally disastrous in its end results.

Under the head of focal infection I do not include the infections of rheumatic fever as these are not due to a chronic focal infection in the commonly accepted use of the term although they usually arise in nasopharyngeal lymphoid tissue. Rheumatic infections occur usually before the age of 30. It is after this period that chronic septic foci are much more common and most disastrous. Few of us escape them. Dental infection increases at this period, tonsil infection may continue, and infections in the gall bladder, the sinuses, the cervix, the prostate, and the appendix may develop. From such areas, absorption of bacteria and their toxins may go on for a long period, often for years, with constant damage to the heart.

A chronic focal infection is practically always due to the nonhemolytic streptococcus. Such an infection does not cause the primary valvular disease which is typical of the rheumatic virus, but may give rise to bacterial infections of valves already damaged by the rheumatic virus. Typically and most frequently, however, focal infections cause chronic myocardial disease, which is characterized by degeneration of muscle fibers and replacement by fibrous tissue. The action is essentially the same as that occurring in the case of various acute infections. The action is slower and more prolonged but the final result is much the same. In chronic joint disease we appreciate the effect of long continued absorption from a chronic focus of infection but often forget that the myocardium may be similarly affected over a long period of time resulting in a chronic fibrosis. The marked effect of such infection is often brought to light by the added element of some other acute infection such as influenza, which removes the final margin of safety.

Further proof concerning the relation of septic foci to heart disease may be adduced experimentally by:

(1) The results of injection of animals with bacteria from septic foci; (2) attempts in selected cases to reproduce in animals

the heart lesion from which the patient suffers by the injection of bacteria recovered from foci in the patient; and (3) therapeutic results obtained by the removal of foci from patients suffering from heart disease presumably of focal origin.

In studying some problems in dental focal infection I injected 1500 rabbits intravenously with bacteria from periapical infection. The organisms were principally nonhemolytic streptococci. Each

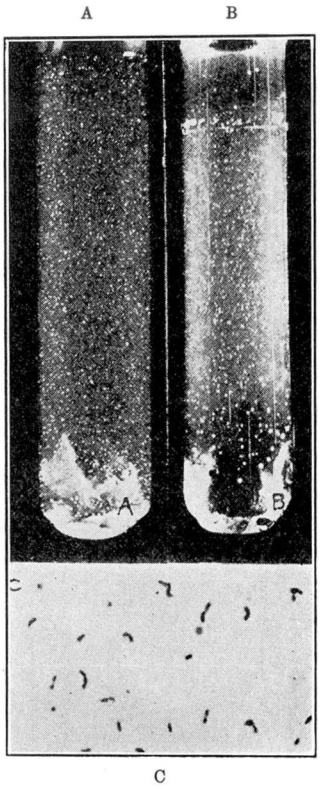

Fig. 1.— (A) Culture from periapical dental infection in glucose-brain agar. Note the uniform growth of colonies throughout the tube; (B) Culture similarly made in which the organism present will grow only under partial oxygen tension as shown by the absence of growth at the top of the tube; (C) Photomicrograph of characteristic nonhemolytic diplococcus from dental infection.

animal received 5 c.c. of a 24-hour broth culture and was autopsied in from three to six days. The organisms were grown under partial oxygen tension (Fig. 1), a point most important in preserving pathogenicity during the period intervening between removal of the bacteria from the body and the injection of it into the experimental animal. All gross lesions observed at the routine autopsy

TABLE 1

Localization of bacteria Isolated From Dental Infection

Number of Animals	*Number of Patients*	*Percentage of Animals Showing Lesions In:*							
		Joint	*Kidney*	*Muscle*	*Endo-cardium*	*Myo-cardium*	*Brain*	*Eye*	*Stomach and Duodenum*
1500	501	58	30	21	18	10	4	14	16

were tabulated (Table 1). In this series, 18 per cent showed gross endocardial lesions and 10 per cent showed lesions in the myo-

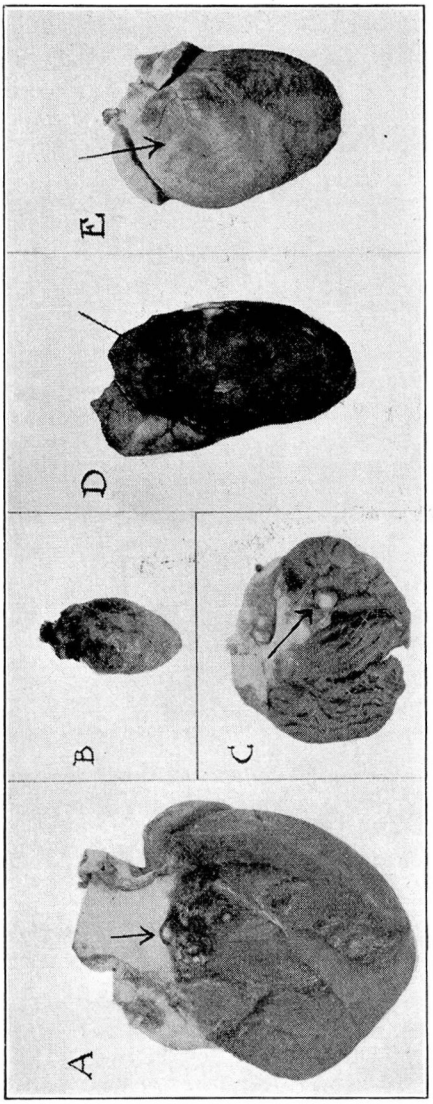

Fig. 2.— Heart lesions in the rabbit produced by the intravenous injection of bacteria from periapical dental infection. (A) vegetations on aortic valve; (B) pericarditis; (C) large vegetation on mitral valve; (D) multiple hemorrhages in right auricle; (E) massive necrosis of wall of right ventricle.

cardium. The lesions recorded are only those which are visible to the naked eye (Fig. 2). If microscopic studies had been made the incidence of lesions in the myocardium would certainly have been much higher. The myocardial lesions observed were hemorrhage, sometimes limited to the right auricle, areas of necrosis of the heart

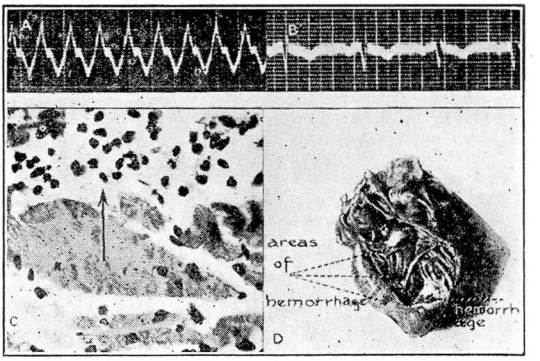

Fig. 3.— (A) Electrocardiogram of patient (Case 1) taken during an attack of paroxysmal tachycardia; (B) electrocardiogram of same patient taken one month after the attack; (C) photomicrograph of patient's heart muscle obtained at autopsy. Note the area of polymorphonuclear infiltration; (D) heart of rabbit injected with streptococcus from an abscess around a partially erupted third molar tooth of the patient.

muscle, and occasionally small abscesses. It seems apparent from such results that the organisms in chronic septic foci are well able to produce disease of the myocardium and heart valves.

The results of animal inoculation with organisms recovered from chronic foci in patients suffering from heart disease of probable focal origin are best illustrated by case reports. The following are typical examples:

Case I

Acute Myocarditis

A medical student, twenty-four years of age, stated that he had had several acute attacks of rapid heart beginning at the age of twelve years. There was no history of coincident infection at the onset. At the age of eighteen an attack occurred while the patient had an abscessed tooth. In May, 1925, he had an attack lasting several hours during which electrocardiograms were taken. These showed the tachycardia to be of a ventricular type (Fig. 3, A). For several weeks before this attack he had had an infection around a partially erupted third molar tooth. A second electrocardiogram

taken in June, 1925, showed a normal heart rate but evidence of myocardial disease (Fig. 3, B).

At this time the third molar tooth was removed, revealing a pocket of pus from which a pure culture of a streptococcus was obtained. Two rabbits were injected with this culture. One died forty-eight hours later. At autopsy numerous areas of hemorrhage were found in the heart muscle (Fig. 3, D). The other animal was killed and at autopsy a smaller number of hemorrhages were found in the heart muscle.

In October, 1925, the patient died during another attack. At autopsy the heart showed no gross lesions. Sections, however, showed areas of acute infection in the heart muscle (Fig. 3, C).

Case 2

Acute Auricular Fibrillation

A banker, sixty-five years of age, had been having attacks of acute auricular fibrillation for only a short period of time. He had otherwise been in excellent health. The general physical examination was negative except for the heart condition. He had had some indefinite gastric symptoms. There was no hypertension. The dental radiographs showed three pulpless teeth only one of which showed radiographic evidence of infection. All three teeth were extracted. Only two, the upper right and left second biscuspids (Fig. 4, A) were cultured. Both showed a profuse growth of streptococci.

Two animals were injected with 5 c.c. each of the broth culture of the streptococcus recovered from the upper right second bicuspid. One animal was killed five days later. The examination showed a large vegetation on the tricuspid valve (Fig. 4, B) and hemorrhages in the myocardium. There were also hemorrhages in the first part of the duodenum, a few cortical kidney abscesses, purulent fluid in the large joints, and some areas of necrosis in the muscle. The second rabbit was killed six days after injection. There were vegetations on the tricuspid valve and in the right auricle (Fig. 4, C). The joints showed very slight involvement. There was one small abscess in the medulla of one kidney and some necrosis in the muscle.

Two rabbits were also injected with the diplococcus recovered from the upper left second bicuspid. In one, hemorrhages were seen in the papillary muscle of the left ventricle (Fig. 4, D), vegetations and hemorrhages in the endocardium of the right auricle, and some infection around the joints. The other animal showed vegeta-

tions on the heart valves and some small focal lesions in the myocardium. A few lesions were also found in the kidney medulla and there was involvement of the joints and muscles.

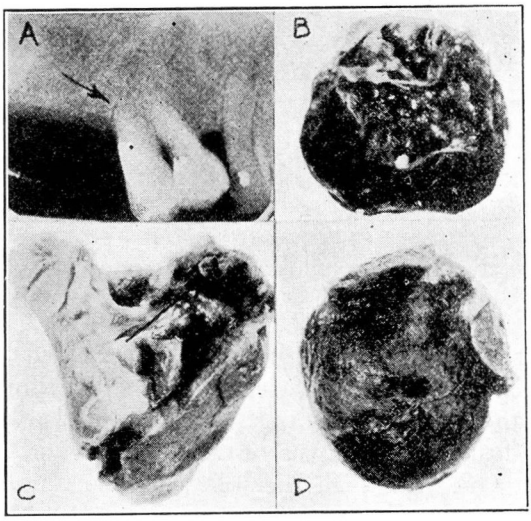

Fig. 4.— (A) X-ray negative of pulpless tooth of patient (Case 2) which showed a profuse growth of streptococci on culture; (B) vegetations on tricuspid valve of rabbit injected with culture; (C) heart of another rabbit similarly injected showing multiple vegetations and hemorrhages in the wall of the auricle; (D) hemorrhage in myocardium.

Case 3

Acute Myocarditis and Phlebitis

A physician, sixty years of age, had had a phlebitis of the left femoral vein in 1904 following an acute alveolar abscess. Following this there were frequent flare-ups of the dental infection without further signs of systemic disease. In 1914 he began to have anginal attacks which continued up to 1916. These attacks were entirely relieved by the removal of an infected tooth. In March, 1923, the root of the bicuspid tooth became infected, and following this the patient had a recurrence of the phlebitis and anginal attacks. In June, 1923, nonhemolytic streptococcus was recovered from the blood. The patient became progressively worse, myocardial insufficiency developed, and death ensued. At autopsy multiple infarcts were found in the heart muscle.

After the extraction of the bicuspid root, the infection of which had initiated the present illness, cultures were made from the socket and two rabbits were injected. The culture showed only a green-

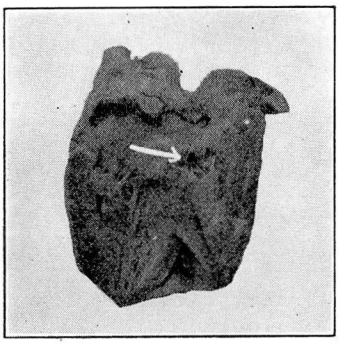

Fig. 5.— Vegetation on heart valves of rabbit injected with cultures in Case 3. This heart also showed necrosis of heart muscle.

producing streptococcus. The rabbits at autopsy showed only endocardial vegetations and infarcts of the myocardium. The upper right second and third molars were extracted in July, 1923. A profuse growth of streptococci was obtained from both. Two rabbits were injected. One was dead the following morning. The autopsy revealed only multiple hemorrhages at the base of the valves. The second rabbit was dead forty-eight hours after injection. The examination showed only vegetations of the heart valve (Fig. 5).

The tendency of bacteria recovered from active dental infection in patients suffering from heart disease of focal origin, to cause valvular and myocardial lesions in the experimental animal is striking and adds evidence of a causal relation of the septic foci to the systemic lesion. The results in a group of patients with heart and vascular disease so studied are shown in Table 2.

TABLE 2

Localization of Bacteria From Dental Infection in Heart and Vascular Disease

Group	*Number of Animals*	*Number of Patients*	*Percentage of Animals Showing Lesions In:*							
			Joint	*Kidney*	*Muscle*	*Endocardium*	*Myocardium*	*Brain*	*Eye*	*Stomach and Duodenum*
I*	1210	405	60	32	22	17	9	5	14	14
II†	40	10	60	25	22	63	50	2	8	14

*Group I. Animals inoculated with dental cultures from patients not known to be suffering from heart or vascular disease.
†Group II. Animals inoculated with cultures from teeth of patients suffering from heart or vascular disease.

Little evidence concerning the causal relation of a chronic focus to the heart affection is obtained from the results of removal of septic foci. In acute cases there may be a striking therapeutic

result. All too often no evident good results are obtained from the removal of the focus because the heart lesion has developed over a long period of time with permanent damage which may not be undone. Here the most to be hoped for is the prevention of the extension of the injury.

The important lesson to be learned from a study such as this is the realization on the part of the clinician of the potential danger to the heart of chronic septic foci. If this is kept in mind the importance of removal of focal infection early instead of late is apparent. There seems to be no doubt that the judicious removal of septic foci will do much to lessen the incidence of heart disease especially of the myocardium. In patients in whom the heart valves are already damaged by the rheumatic virus the removal of foci of infection should lessen also the incidence of subacute bacterial endocarditis. Early removal of chronic foci cannot be stressed too strongly in all diseases of focal origin. Too often the late removal is disappointing and the importance of chronic foci is underestimated because the systemic disease, although of focal origin, is beyond repair. Systemic disease of focal origin should be cured before it develops.

Summary

Chronic infection in teeth, tonsils, gall bladder, genito-urinary tract, and sinuses is an important factor in the causation of disturbances of the myocardium and in secondary infections of the heart valves.

Organisms recovered from chronic foci of infection caused heart lesions in a large percentage of rabbits injected intravenously.

Bacteria obtained from chronic foci in patients with heart disease due to focal infection produced heart lesions in a very high proportion of rabbits injected intravenously.

The therapeutic results of late removal of chronic foci are disappointing because the lesion caused by the focus is so often permanent.

The early removal of chronic foci should lessen the incidence of heart disease.

Reference

1 Clark, T.: Heart Disease: A public health problem, Pub. Health Rep., 44:2463-2467, 1929.