**CLINICAL PROGRESS**

**Diagnosis of Diffuse Myocardial Fibrosis**

*By C. Sidney Burwell, M.D., and Eugene D. Robin, M.D.*

Sixty-eight patients with constrictive pericarditis were studied by this laboratory in a 30-year period. During this time 14 patients were encountered whose findings suggested constrictive pericarditis but who showed an abnormal myocardium at operation or autopsy. Two of these patients had both constrictive pericarditis and myocardial fibrosis, each of the other 12 had a normal pericardium. The hemodynamic aspects of diffuse myocardial fibrosis as exemplified in 10 of these patients have been described by Robin and Burwell.1,2

The purpose of this paper is to describe the course and manifestations of diffuse myocardial fibrosis in these 14 patients, to discuss the diagnosis of this disorder, and to consider the differentiation of myocardial fibrosis from constrictive pericarditis. The fact that constrictive pericarditis is to some degree remedial by surgery makes this differentiation of high importance.

Myocardial fibrosis is defined as a diffuse replacement or invasion of the myocardium by fibrous connective tissue to such an extent that there is interference with the action of the heart. It may be expected that the nature, location, and extent of such fibrosis will influence its manifestations in a given patient.

Such fibrosis can result from a number of causes. Probably the most frequent cause is coronary artery disease, but many other diseases involving the myocardium diffusely can also result in myocardial fibrosis. Some such causes are listed in Table 1. Diversity of cause is also true of constrictive pericarditis; a number of etiologic agents produce inflammation of the pericardium that may result in the ultimate development of restrictive disease of the heart.

We present now brief summaries of the course and manifestations of diffuse myocardial fibrosis in our 14 patients. Ten of these patients were studied by right heart catheterization and the results were published in detail.1 In the present paper only general statements are made about this aspect of the diagnostic observations.

**Case Reports**

1. W.I., PBBH 7A331. This patient was a 38-year-old streetcar conductor who entered the hospital because of severe and disabling dyspnea. At the onset of his disability 5 years earlier he was treated at another hospital for what was called "influenza and pneumonia" and was given digitalis. Shortly after his discharge, shortness of breath and swelling of the abdomen recurred. From this time he was severely incapacitated in spite of continued administration of digitalis, restriction of sodium in the diet, and weekly injections of diuretics. At no time did he have chest pain suggesting coronary artery insufficiency.

On physical examination he looked pinched and thin. The neck veins were distended and pulsating. Venous pressure was 320 mm. of water. The arterial blood pressure was 115/80; cardiac enlargement was evident; cardiac rhythm was regular; no murmurs were audible but the pulmonic second
sound was accentuated. Over the bases of the lungs there were persistent rales. The liver was enlarged, and the physical signs of ascites were present. Pitting edema of the lower extremities was observed.

The electrocardiogram was interpreted as indicating right axis deviation. The vital capacity was 1,800 ml and the circulation time (Decholin) was 35 seconds. X-ray examination showed a large heart without evidence of calcification. The excursions of the cardiac border as observed under the fluoroscope were interpreted as abnormally small.

Cardiac catheterization showed a low cardiac output per minute and per beat and a "plateau of pressures" at the level of approximately 40 mm. Hg. This plateau extended from the "pulmonary capillaries" to the peripheral veins. Pressure tracings from the right atrium showed an "M" form and from the right ventricle a diastolic "dip."

Because constrictive pericarditis was considered a real possibility, a thoracotomy was performed. This revealed a pericardium of normal appearance. Eight months later, the patient died and post-mortem examination showed gross occlusion of all 3 main coronary arteries by atherosclerosis. There was evidence of multiple myocardial infarctions, both old and recent. Microscopic study revealed extensive, diffuse myocardial fibrosis and a normal pericardium.

2. L.H. PBBH 7E92. This patient was a housewife aged 39 years who entered the hospital because of shortness of breath. She reported that 7 years before she had been admitted to another hospital because of rapid heart action. She was then told that one observer noted an apical diastolic murmur but that this observation was not confirmed by others. She remained generally in good health until 3 years before the present admission, when she developed shortness of breath, fatigue, and peripheral edema. In spite of digitalis, sodium restriction, and the frequent administration of mercurial diuretics, these disabilities persisted to such a degree that she was severely disabled for most of this period. At the time of her admission to the Peter Bent Brigham Hospital, she required abdominal paracentesis every fortnight.

On physical examination she had manifest edema and ascites. There was a medium-sized left pleural effusion and a small amount of fluid on the right. The heart was enlarged. A grade-I systolic murmur was heard at the apex and a faint diastolic gallop over the midprecordium. The liver edge was felt 5 cm. below the right costal margin. The vital capacity was 2500 ml; arterial pressure was 110/80; venous pressure was 200 to 250 mm. of water; and the circulation time was (Decholin) 27 seconds. X-ray showed an enlarged heart without evidence of calcification. On fluoroscopy, the amplitude of pulsation was diminished along all borders. An electrocardiogram showed right bundle-branch block. Cardiac catheterization showed moderately diminished cardiac output per minute and per beat; plateau of pressures from the "pulmonary capillaries" to the right atrium; low right ventricular pulse pressure, and pressure curves in the right atrium and right ventricle considered to be compatible with constrictive pericarditis. Thoracotomy was undertaken hopefully but direct vision showed a normal pericardium and a

### Table 1.—Some Causes of Myocardial Fibrosis

<table>
<thead>
<tr>
<th>Type of Fibrosis</th>
<th>Examples</th>
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<tbody>
<tr>
<td>Coronary artery disease a. acquired</td>
<td>b. congenital</td>
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<tr>
<td>Constrictive pericarditis associated with myocardial fibrosis</td>
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<td>Inflammatory a. rheumatic fever</td>
<td>b. diphtheria</td>
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<td>c. suppuration</td>
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<td>d. trichinosis</td>
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<td>e. virus infections</td>
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<td>f. Chagas disease</td>
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<td>g. toxoplasmosis</td>
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<td>h. Fiedler's myocarditis</td>
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<td>i. rickettsia</td>
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<td>j. miscellaneous</td>
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<td>Nutritional a. endomyocardial fibrosis</td>
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<td>Chemical a. chloroform</td>
<td>b. phosphorus</td>
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<tr>
<td></td>
<td>c. carbon monoxide</td>
</tr>
<tr>
<td></td>
<td>d. benzel</td>
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<td></td>
<td>e. miscellaneous</td>
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<tr>
<td>Systemic diseases a. amyloid</td>
<td>b. glycojen storage</td>
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<td></td>
<td>c. anemia</td>
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<td></td>
<td>d. hemochromatosis</td>
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<td>e. scleroderma</td>
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<td>f. sarcoidosis</td>
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<td>g. xanthomatosi</td>
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<td></td>
<td>h. myotonia atrophica</td>
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<td></td>
<td>i. Friedreich's ataxia</td>
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<td></td>
<td>j. progressive muscular dystrophy</td>
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<tr>
<td>Obscure a. congenital idiopathic hypertrophy</td>
<td>b. adult idiopathic hypertrophy</td>
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<tr>
<td></td>
<td>c. chronic fibroplastic myocarditis</td>
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<td></td>
<td>d. idiopathic right cardiac hypertrophy</td>
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<td></td>
<td>e. miscellaneous</td>
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myocardium that appeared to be irregularly mottled. The mottling seemed to be due both to subepicardial fat and to scarring in the myocardium. No obstruction was demonstrated in the inferior vena cava or in the left pulmonary vein. The conclusion was that the patient had myocardial fibrosis.

3. **R.C. PBBH 7F475.** This patient was a 37-year-old housewife who had good general health throughout most of her life. During a pregnancy 6 years before admission to this hospital, she was hospitalized because of pleuritic pain and, at this time, was found to have atrial fibrillation. Pain and arrhythmia disappeared after delivery; she regained her usual good health and continued to be well until about a year before admission. At this time she developed shortness of breath and fatigue. Both of these grew worse progressively and were eventually incapacitating.

When she entered the hospital she had an obviously enlarged heart, well marked venous distention, fluid in both pleural cavities, and a "questionable" diastolic murmur. X-ray examination showed cardiac enlargement and also demonstrated pulmonary vascular congestion and an enlarged pulmonary artery. No calcification in relation to the heart was seen. An electrocardiogram showed atrial fibrillation, small QRS complexes, and abnormal but nonspecific T-wave changes. The venous pressure was 200 mm. of water and remained elevated in spite of careful treatment and progressive loss of weight.

Cardiac catheterization showed low cardiac output, low stroke volume, and low right ventricular pulse pressure. She had the familiar plateau of pressure from peripheral veins to "pulmonary capillaries." The atrial pressure tracing showed the so-called "M" form and the right ventricular tracing showed a diastolic "dip." These findings, in the presence of intractable cardiac failure, suggested constrictive pericarditis as a hopeful possibility. An exploratory thoracotomy was carried out. When a normal pericardium was found, it was decided to examine the mitral orifice for a possible source of this patient's disability. The mitral valve was of normal size. Examination of a specimen of the left atrium taken at the same time showed focal thickening of the endocardium, but no clear evidence of rheumatic activity.

She continued to exhibit intractable and progressive congestive failure and in 1957 reentered the hospital. At this time, she was severely dyspneic and orthopneic. Physical examination revealed a pulse rate of 76 and a blood pressure of 100/60. There was no pulsus paradoxus. Cyanosis was noted and massive anasarca was present. The vital capacity was 700 ml. and the venous pressure was 320 mm. of water. Despite intensive therapy, the patient remained in severe congestive heart failure and died. Postmortem examination revealed extensive focal myocardial fibrosis.

4. **G.S. PBBH.** This 39-year-old man was admitted to the hospital because of progressive dyspnea of 2 years' duration. He had been entirely well until 2 years before admission, when he developed exertional dyspnea, orthopnea, and a nonproductive cough. He was admitted to another hospital where he was found to be in congestive failure, although the cause of his failure was not apparent. He was treated with digitalis, diuretics, and a low-salt diet. Despite these measures he continued to have progressive symptoms.

Physical examination revealed a chronically ill white man. There were neck vein distention, generalized cardiomegaly, pulsus alternans, a diastolic gallop, and hepatomegaly. An electrocardiogram showed sinus tachycardia, numerous ventricular premature beats, and intraventricular block. Venous pressure was 204 mm. of water. A chest film showed an enlarged, globular heart with prominent hilar vessels suggesting pulmonary congestion. Right-sided cardiac catheterization revealed a low cardiac output. No pressure plateau was present; the "pulmonary capillary" pressure measured 39 mm. Hg while the right atrial pressure was 16 mm. Hg. A diagnosis of probable myocardial disease was made. Several weeks after discharge the patient died. Postmortem examination showed extensive fibrinoid degeneration of the left atrium and left ventricle. There was also widespread myocardial fibrosis in many areas of the left ventricle.

5. **N.L. PBBH 7E569.** This patient entered the hospital in 1954 at the age of 15. He exhibited severe congestive heart failure with extensive peripheral edema and persistent ascites. He had been disabled for a number of years. At the age of 7, he developed a streptococcal pharyngitis which was treated with sulfonamide. After this illness, he continued to suffer from persistent fatigue and a chest film was reported to show cardiac enlargement. In 1948, when studied at the Children's Medical Center, he showed obvious and persistent heart failure. In 1950, 4 years before his final admission, cardiac catheterization showed a low cardiac output per minute and per beat and a right ventricular diastolic "dip." Venous pressure at this time was 218 mm. of water. This patient did not have a plateau of pressures and the right ventricular pulse pressure was 26 mm. Several aspects of the general picture failed to support the diagnosis of constrictive pericarditis, but this diagnosis was not considered to be ruled out and an exploratory thoracotomy was per-
formed. A normal pericardium was found. The epicardium appeared to contain fat but no more specific evidence of myocardial disease could be obtained by inspection. After the operation, the patient followed a slowly progressive, deteriorating course. He developed atrial fibrillation. The size of the liver and spleen increased. Ascites recurred and edema was persistent. Venous pressure remained high throughout the course of his disease. Eventually, this patient developed multiple peripheral arterial emboli and died in circulatory shock. At postmortem examination diffuse myocardial fibrosis was found.

6. F.O'C. PBBH 9D138. This patient was a physician of 56 years whose history differed from the previous patients. He entered the hospital because of cardiac failure, which had begun only 6 months before admission, and which had followed a severe respiratory infection with fever and prostration. After some 6 weeks of this infection, he experienced severe fatigue and developed atrial fibrillation, edema, and ascites. These symptoms increased in severity in spite of skillful management with digitalis, diuretics, and sodium restriction. At the time of admission, he looked ill and tired. He was dyspneic and orthopneic. The heart was enlarged. A diastolic gallop rhythm was heard but there were no murmurs. Peripherical blood pressure was 106/70. There were fluid collections in both pleural cavities and the abdomen and marked pitting edema of the legs. Venous pressure was 320 mm. water and circulation time (Deeholin) was 38 seconds. X-rays of the heart confirmed the enlargement observed on physical examination. Fluoroscopic examination showed a beat of poor amplitude. No caleification was observed. An electrocardiogram showed small QRS complexes and nonspecific T-wave changes.

Cardiac catheterization showed a greatly reduced cardiac output per minute and per beat, but did not show a pressure plateau. A right ventricular diastolic dip was observed and there was a relatively high right ventricular pulse pressure (41 mm.). The observations made by way of the cardiac catheter were thus considered to be against the probability of constrictive pericarditis, although the onset of his illness in association with an infection, the rapid development of intractable failure, and the absence of hypertension and valvular disease were consistent with the possibility of constriction. A thoracotomy was carried out as the only decisive diagnostic measure. At this operation, a normal pericardium was seen. The appearance of the myocardial surface was considered by the surgeon to be consistent with a diagnosis of myocardial fibrosis. Postoperatively, the patient continued to do poorly and died approximately 2 years after operation. Postmortem examination was not made.

7. W.Wa. PBBH. This 58-year-old white plumber was admitted because of progressive heart failure of 8 years' duration. No accurate date could be established for the onset of his illness but it had started shortly after he received therapy for a staphylococci infection of his left arm associated with blood stream invasion. Over the course of the next 8 years, he developed dyspnea, anasarca, and hepatomegaly. Physical examination showed a pulse rate of 62 and grossly irregular rhythm. Blood pressure was 115/75. There was marked neck vein distention. The heart was enlarged to the anterior axillary line. There were no significant murmurs. The venous pressure was 310 mm. of water and the circulation time was 61 seconds. Chest x-ray revealed a 13 per cent enlargement of the heart. An electrocardiogram showed atrial fibrillation and findings consistent with an old anterosetal myocardial infarct. Cardiac catheterization showed a stroke volume of 93 ml., a pulmonary capillary pressure that was 10 mm. Hg higher than his right atrial pressure, and a right ventricular pulse pressure that averaged 30 mm. Hg. All of these findings seemed somewhat against a diagnosis of constrictive pericarditis, but exploratory thoracotomy was performed. It showed a normal pericardium and a fibrotic myocardium. The patient was discharged home to be managed medically. No data are available as to his subsequent course.

8. W.I. PBBH 8F182. This patient was a 44-year-old farmer. He entered because of persistent and progressive heart failure of 10 years' duration. Physical examination showed a pulse rate of 72, and blood pressure of 100/64. The patient lay flat in bed without discomfort. The neck veins were distended. The heart was enlarged to the midaxillary line. The cardiac rhythm was grossly irregular. There were no significant murmurs. The signs of ascites were noted and the liver was palpable 5 cm. beneath the right costal margin. There was well-marked pitting edema of the ankles. The venous pressure was 280 mm. of water and the circulation time was 55 seconds. The chest x-ray showed generalized cardiac enlargement. The electrocardiogram showed atrial fibrillation and left bundle-branch block. At cardia catheheterization his pulmonary artery mean pressure exceeded his right atrial pressure by 11 mm. Hg. The marked cardiomegaly and the left bundle-branch block pointed to myocardial rather than to pericardial disease. In the faint hope that a surgically remediable lesion might be found, thoracotomy was performed but the pericardium was normal. The coronary arteries were calcified and in addition to fairly
diffuse fibrosis, there was a single scar (about 8 by 4 cm.) on the anterior surface of the right ventricle. The patient was discharged with a diagnosis of myocardial fibrosis secondary to coronary artery disease. No data are available as to his subsequent course.

9. W. Wo. _PBBH._ This 54-year-old white male engineer was admitted to the hospital because of a 4-year history of dyspnea, orthopnea, and peripheral edema. On physical examination he was an obese, chronically ill man. The arterial blood pressure was 135/85. There was a pulsus paradoxis of 15 mm. Hg. There were moist rales at both bases. The heart was moderately enlarged. There was normal sinus rhythm and a presystolic gallop, but no murmurs. There were hepatomegaly and severe pitting edema of the extremities. The venous pressure was 260 mm. of water, and the circulation time was 25 seconds. X-ray of the heart revealed a 15 per cent enlargement involving all chambers. There was no intracardiac calcification. The cardiac beat was diminished along all borders. The electrocardiogram was compatible with old posterior and anterior myocardial infarctions. Cardiac catheterization showed a low cardiac output. No plateau of pressures was present, the pulmonary capillary pressure exceeding the right atrial pressure by 10 mm. Hg.

Favoring a possible diagnosis of constrictive pericarditis were the relatively small heart and the presence of pulsus paradoxis. The electrocardiographic evidence of old myocardial infarctions and the lack of pericardial calcification favored myocardial disease. Although the weight of evidence favored myocardial fibrosis, this diagnosis was by no means certain. Therefore, an exploratory thoracotomy was performed. It revealed a normal pericardium. The myocardium was streaked with dense bands of fibrous tissue. The patient was discharged with a diagnosis of myocardial fibrosis.

The following 3 patients illustrate the clinical pattern of myocardial fibrosis. Cardiac catheterization was not performed in these patients but in each instance the diagnosis was confirmed by autopsy.

10. _P.M. NEDH._ This patient was a 13-year-old white boy who had been well until 6 months before admission, when swelling of the abdomen was noted. Shortly thereafter, he developed a sense of fatigue and was admitted to the New England Deaconess Hospital. On physical examination he appeared thin and chronically ill. The neck veins were distended. The left border of the heart extended to the anterior axillary line. The blood pressure was 100/80 mm. Hg, and a pulsus paradoxus was reported. There were ascites but no peripheral edema. A presumptive diagnosis of constrictive pericarditis was made. Because of the worsening course of the patient, exploratory thoracotomy was undertaken promptly. During the induction of anesthesia the patient died. Postmortem examination revealed a normal pericardium. There was considerable fibrosis of the myocardium involving both ventricles.

11. _H.W. PBBH 51117._ This 60-year-old white housewife developed easy fatigability and dyspnea 6 years before the present admission. She was admitted to another hospital where she was found to be in congestive failure. She was treated with a low-salt diet, digitalization, and diuretics. Despite these measures, her congestive failure progressed. At this time, she was admitted to the Peter Bent Brigham Hospital.

Physical examination showed a chronically ill woman. There was visible venous distention, and moist inspiratory rales were present at both lung bases. The heart was enlarged to the anterior axillary line. There were frequent premature beats, both ventricular and atrial. There was a presystolic gallop at the apex. The liver was felt 4 cm. beneath the costal margin. There was minimal ankle edema. A venous pressure of 320 mm. of water and a circulation time of 45 seconds were recorded. Chest x-ray showed diffuse enlargement of the heart. An electrocardiogram indicated left bundle-branch block. Despite intensive therapy this patient continued to do poorly and approximately 1 year after her discharge from the hospital she died. Postmortem examination showed evidence of an old myocarditis with replacement of large segments of the myocardium by fibrous tissue.

12. _L.A. (Not hospitalized)._ This 64-year-old white man had suffered myocardial infarction 4 years before he was seen by us and after this had developed intractable cardiac failure. When seen, he was bedridden and troubled by weakness, shortness of breath, and anasarca. Physical examination showed a chronically ill, cachectic man. The pulse rate was 102 and the blood pressure 105/80 mm. Hg. There was marked distention of the neck veins. There were bilateral basilar dullness and numerous moist inspiratory rales in this area. There was marked carotid distal with distant heart sounds. A protodiastolic gallop was present at the apex. The liver was palpable 4 cm. beneath the right costal margin. Severe pitting edema of the extremities and sacrum was present. In spite of intensive cardiac therapy, the patient continued to do poorly and ultimately died. Postmortem examination revealed severe coronary atherosclerosis with narrowed coronary lumina but no complete occlusion. There was diffuse replacement of myocardium by fibrous connective tissue.
The 2 final patients are known to have had both myocardial fibrosis and constrictive pericarditis; therefore, they offer special and instructive diagnostic problems.

13. L.K. PBBH 5H602. This 48-year-old white merchant entered the hospital because of progressive congestive heart failure of 8 years' duration. Sixteen years before admission, he developed the first of many episodes of supraventricular paroxysmal tachycardia. These episodes were at first controlled by means of carotid sinus pressure but ultimately required the use of digitalis. Eight years before admission he began to suffer attacks of nocturnal dyspnea. Five years before admission he developed fever and pleuritic pain. Diagnostic studies did not identify any specific etiology but he was treated with penicillin, digitalis, cortisone, and Dicumarol. Three weeks before his final admission, he was found to have marked cardiomegaly, numerous ventricular premature beats, pleural effusion, hepatosplenomegaly, and ankle edema. The venous pressure was 250 mm. of water, and the circulation time was 45 seconds. Despite mercurial diuretics, he continued to accumulate fluid and was admitted to the hospital. One of his chief discomforts was persistent pain in the right upper quadrant.

On physical examination the blood pressure was 100/70 mm. Hg and the pulse rate was 72 with numerous ventricular premature beats. The neck veins were distended. There was evidence of a right-sided pleural effusion. There was marked enlargement of the heart. There were a faint apical diastolic gallop and a grade-I whistling systolic murmur that radiated to the left axilla. The liver was felt 14 cm. below the right costal margin and the spleen was felt 8 cm. below the left costal margin. There was minimal ankle edema. X-ray revealed diffuse enlargement of the heart involving all chambers. The electrocardiogram was consistent with an old anteroseptal myocardial infarct, and showed numerous ventricular premature beats of multifocal origin. The venous pressure was 255 mm. of water, and the circulation time was 40 seconds. Because of myocardial irritability, it was decided that cardiac catheterization should not be performed.

There was general agreement that a diagnosis of constrictive pericarditis was unlikely because of the extremely large heart. However, the possibility of this disease led to a decision to explore. At operation diffuse adhesions were found indicative of an old inflammatory process involving the anterior mediastinum. This process had produced both constrictive pericarditis and constrictive pleuritis. The pericardium was stripped with difficulty as the fibrotic process extended into the epicardial layer of the myocardium.

Following pericardiectomy, the patient did relatively well for approximately 12 days and for the first time in years was free of discomfort in the liver region. Then he was found dead in bed and the presumption was that he died of a ventricular arrhythmia. Postmortem examination was not performed, but the appearance of his myocardium at surgery made it clear that he had diffuse myocardial fibrosis.

14. E.F. PBBH 6B132. This 44-year-old school teacher was observed at the Peter Bent Brigham Hospital for a period of 17 years. In 1937, he developed an acute tuberculous pericarditis. Five months after the acute phase of this illness, he showed the manifestations of constrictive pericarditis. The anterior half of his pericardium was resected but he continued in congestive heart failure. During the long period of observation, 3 more attempts to alleviate his failure by means of pericardial resection was made and all failed. He continued to show peripheral venous hypertension, a low cardiac output, pulmonary congestion, anasarca, and hepatosplenomegaly. He ultimately died of congestive failure, and postmortem examination revealed diffuse myocardial fibrosis. This myocardial fibrosis had resulted from the same process that had given rise to constrictive pericarditis and explained the progressive downhill course, which continued after relief of the pericardial constriction. In our experience, myocardial fibrosis and constrictive pericarditis are frequently seen in combination. The myocardial fibrosis is frequently a factor limiting the degree of relief obtained by surgery for constrictive pericarditis.

**Discussion**

Approximately 25 years ago chronic myocarditis or myocardosis was a popular and frequent diagnosis. It was defined as a lesion in which cardiac failure was associated with normal valves and pericardium while the heart muscle showed hypertrophy, alone or in combination with fibrous interstitial myocarditis. According to Cabot, it was the most frequent cause of failure seen in adult clinics. Subsequent work established that most of these patients had either hypertensive disease or coronary artery disease as a cause of their cardiac failure. The diagnosis of chronic myocardosis then received less and less attention until recent years, when the importance of diseases that specifically involve the myocar-
The anatomic situation was demonstrated in each patient by operation, postmortem examination, or both. In general, these patients with diffuse myocardial disease and without pericardial disease presented themselves with the manifestations of intractable heart failure. There was usually a definite onset in time. No patient in this group had clear evidence of valve disease; none had hypertension. The following phenomena were usually observed:

1. Elevated venous pressure
2. Congestive hepatic enlargement (with or without congestive splenomegaly)
3. Ascites
4. Peripheral edema
5. Enlargement of the heart
6. Distant heart sounds
7. A diastolic gallop rhythm
8. Diminished cardiac pulsations under the fluoroscope
9. Signs of peripheral congestion which were more impressive than those of pulmonary congestion
10. Electrocardiograms which showed low voltage and nonspecific T-wave changes
11. A disappointing response to treatment for congestive heart failure

These items are, in general, similar to those observed in patients with constrictive pericarditis. The elevated venous pressure of myocardial fibrosis is indistinguishable from that of constrictive pericarditis, and in both disorders the venous pressure remains high in spite of treatment. Phlebotomy or diuresis may lower it temporarily but it soon returns to its previous level.

Emphasis has been given by many authors to the absence of extreme cardiac enlargement in patients with constrictive pericarditis and this has sometimes been interpreted to mean that the heart in such patients is not enlarged. Actually, most patients with this disease do have cardiac enlargement. On the whole, however, the heart size is less than experience leads one to expect in a patient with the degree of congestion presented by these individuals. Therefore, a high degree of cardiac enlargement tends to tilt the scales in favor of myocardial fibrosis. It does not, however, prove the point, and one patient (no. 10), who had a very large heart and who was thought for this reason to have myocardial fibrosis, turned out at operation to have both constrictive pericarditis and myocardial fibrosis.

The electrocardiogram in these 2 conditions is likely to show a general similarity. If there is a characteristic pattern of infarction, this also tends to tip the scale toward myocardial rather than pericardial disease, but again, does not prove the point. The similarity in the electrocardiograms of patients with pericarditis and those with coronary disease is so marked as to constitute in our experience a demonstration that the electrocardiogram associated with coronary disease is not truly specific but simply points to an abnormality of the myocardium. No doubt coronary disease is the commonest cause of such abnormality but the tracing is nonspecific. Dr. Harold Levine, in analyzing 35 patients with proved constrictive pericarditis, reported that 4 showed preoperative electrocardiograms diagnostic of old myocardial infarction. Eight more had curves compatible with old myocardial infarction. He concluded that the diagnosis of constrictive pericarditis should not be surrendered simply because the electrocardiogram points to an old myocardial infarction.

One of the most characteristic findings in both these groups of patients is an intractable course resistant to treatment. In our experience, nothing about the course or the reaction to treatment can serve to differentiate one from another.

The history of an original injury to either pericardium or myocardium may be significant. If there is a good history of acute pericarditis or a good history of myocardial infarction, one can start out with an etiology for constrictive pericarditis on the one hand
or myocardial fibrosis on the other. The weight one gives to this evidence depends on the thoroughness of the documentation.

Pulsus paradoxus may occur in both conditions but in our experience has been more frequent and more impressive in patients with constrictive pericarditis than in those with myocardial fibrosis.

Characteristic calcification involving the pericardium is present in about half of our patients with constrictive pericarditis. Its presence is, therefore, evidence in favor of this diagnosis. Since 50 per cent of our patients with constrictive pericarditis do not show calcification at all, its absence is not conclusive. Ten of our 14 patients underwent cardiac catheterization. One may say that the general pattern of intravascular pressures in these patients has certain similarities to the pattern observed in constrictive pericarditis. Each patient had a diminished cardiac output and a low stroke volume. The right ventricular pulse pressure varied from 8 to 45 mm.; in general this measurement tended to be below the normal level but was usually not reduced to the degree observed in constrictive pericarditis. The pressures in the pulmonary artery and the systolic pressure in the right ventricle tended to be higher in myocardial fibrosis than in constrictive pericarditis, but the levels overlapped. Most patients in whom satisfactory pressure tracings were obtained exhibited the so-called right ventricular "diastolic dip" and the right atrial "M."

In contrast to most patients with constrictive pericarditis, some of these patients did not have a plateau of pressures, i.e., the pulmonary capillary pressure exceeded the right atrial pressure by more than 5 mm. Hg. Patients with this finding who were examined post mortem were shown to have predominantly left ventricular fibrosis. Patients with fibrosis of both ventricles did show a plateau of pressures and the catheter findings were indistinguishable from those of patients with constrictive pericarditis.

The ingenious work of Isaacs and his co-workers on unilateral pericardial constriction showed that the absence of a pressure plateau does not necessarily rule out constrictive pericarditis. In our experience, however, the absence of a pressure plateau weights the scales on the side of myocardial constriction.

It is apparent that neither physical findings, course, nor catheterization measurements permit a specific differentiation between myocardial fibrosis and pericardial constriction. The similarities of the clinical and hemodynamic patterns of myocardial fibrosis and constrictive pericarditis have also been noted by Nye, Lovejoy, and Yu. The similarity of the manifestations of these 2 disorders indicates that the effect of fibrosis on the distensibility characteristics of the heart are similar whether the fibrosis is localized to the myocardium or the pericardium. Indeed, it is now known from the work of Clark, Ballentine and Blount that similar manifestations may occur in a patient with endocardial fibrosis. Since these disorders affect cardiac hemodynamics in an identical fashion, it is to be expected that their signs and symptoms should be virtually identical. In many patients this difficult differential diagnosis can only be resolved by direct inspection of the heart.

SUMMARY

Diffuse myocardial fibrosis is a disease of diverse etiology; the commonest cause is coronary artery disease. Physiologically, it produces a restriction of diastolic filling and thus resembles constrictive pericarditis and endocardial fibroelastosis. Clinically, it resembles constrictive pericarditis so closely that in many patients the differential diagnosis between these 2 disorders can be resolved only by thoracotomy and direct observation of the pericardium.

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**SUMMARIO IN INTERLINGUA**

Diffuse fibrosis myocardial es un morbo de diverse etiologias. Le causa le plus commun es morbo de arteria coronari. Physiologicamente illo produce un restriction del replenation diastolic e assi resimila pericarditis constrictive e fibroelastosis endocardial. Clinicamente illo resimila pericarditis constrictive si intimemente que le diagnose differential inter le 2 conditiones pote esser effectuate in multe casos solmente per thoracotomia e le observation directe del pericardio.

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**BEFORE LAENNEC**

Give me a calm and thankful heart
From every murmur free . . .

*From a hymn by Anne Steele, 1760*

Diagnosis of Diffuse Myocardial Fibrosis
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