Constrictive Pericarditis
Masquerading as Mitral Stenosis

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The five patients presented were considered to have mitral stenosis because of a history of dyspnea on exertion or paroxysmal atrial fibrillation, the presence of a loud first heart sound with an "opening snap," a loud pulmonary component of the second heart sound, electrocardiographic evidence of right axis deviation and left atrial enlargement or radiological evidence of cardiomegaly, especially left atrial and right ventricular enlargement. The correct diagnosis of constrictive pericarditis was made by cardiac catheterization and confirmed at surgery. The echocardiogram was found to be very helpful in the differential diagnosis. The demonstration of normal motion of the anterior mitral leaflet ruled out the presence of mitral stenosis.

INTRODUCTION

Constrictive pericarditis is encountered frequently. Occasionally, it may mimic mitral stenosis. White emphasized this in a classic paper, but today several textbooks of cardiology do not list constrictive pericarditis in the differential diagnosis of mitral stenosis. This report presents five cases of constrictive pericarditis, which were misdiagnosed at one time or another, as mitral stenosis. The differential diagnosis of the two conditions will be discussed with particular emphasis on the use of the reflected ultrasound technique.

CASE REPORTS

CASE 1
A 25-year-old housewife developed progressive dyspnea and lightheadedness on exertion four months prior to admission and ankle edema three months later. Mitral stenosis was diagnosed because of a history of shortness of breath on exertion and the presence of a loud first sound, an opening snap, and a short presystolic murmur (described by the admitting physician, but not confirmed in the hospital).

Results of physical examination on admission were: blood pressure was 100/80; pulse, regular, 80/min. Neck veins were distended at 45° with prominent A and V waves. Heart was not enlarged. Apex moved outward during diastole and inward in systole. S1 loud. S2 physiologically split with pulmonic component slightly accentuated. An early diastolic sound was present. Liver was barely palpable, nontender. There was ankle edema. Chest x-ray film showed left atrial enlargement with pericardial calcification. Electrocardiogram showed diffuse ST-segment depression and T-wave inversion. The phonocardiogram confirmed auscultatory findings described above. A2 to diastolic sound, 0.10 sec. Supine apex cardiogram indicated systolic retraction followed by outward motion during diastole, synchronous with early diastolic sound. An echocardiogram of the anterior mitral leaflet showed normal motion. Cardiac catheterization results: PVC, (13) a = 17, v = 15; PA, 28/14 (19); RV, 29/13; RA, (12) a = 14, v = 13; ascending aorta. 94/58 (70); LV, 96/13; cardiac index, 2.1 liter/min/M². The ventricular pressure curves showed an early diastolic dip followed by a plateau. The PVC and RA pressure curves showed the "W" or "M" configuration.

The patient underwent pericardiectomy with marked relief of symptoms. A follow-up phonocardiogram showed a soft S1 at the apex, 0.17 sec. from A2.

CASE 2
A 57-year-old physician developed paroxysms of atrial fibrillation five years prior to admission. Eleven months prior to admission, the patient developed ankle edema and mild dyspnea on exertion. The edema worsened, and swelling of the abdomen occurred. The diagnosis of mitral stenosis was considered because of the loud first sound and the diastolic sound, thought to be an opening snap, a right ventricular heave felt by some observers and the electro-
cardiogram which showed right axis deviation and atrial fibrillation.

Results of physical examination on admission were blood pressure of 130/80; pulse, regular, 84/min. Neck veins were distended at 45° with prominent A-V waves. The heart was enlarged to 1 cm lateral to the midclavicular line with a ventricular heave. S₁, loud. S₂, physiologically split with P₂ greater than A₂. A diastolic sound was heard. The liver was palpable 3 to 4 cm and tender. Moderate ascites were present as was edema of legs up to the knees. The electrocardiogram showed sinus rhythm, right axis deviation, diffuse nonspecific ST-T changes, and borderline low voltage in the limb leads. The chest x-ray indicated slight cardiac enlargement with rounding of the apex. The phonocardiogram showed S₁ accentuated; A₂-diastolic sound, 0.095 sec. Echocardiogram showed normal mitral valve motion. Results of catheterization were: PVC, (16); PA, 23/16 (19); RV, 25/15; RA, (13); ascending aorta, 110/70; LV, 110/16; cardiac index, 2.7 liter/min/M². The right and left ventricular diastolic pressure curves: early dip and rapid rise, followed by plateau. Left and right atrial pressure curves: "W" configuration.

The patient underwent pericardiectomy with rapid relief of symptoms.

Case 3

A 41-year-old man, unemployed, noticed increasing shortness of breath five years prior to admission. Treatment with digitalis and diuretics resulted in improvement until one year before admission, when again dyspnea became apparent and edema of the legs appeared. He deteriorated despite intensive medical treatment. The diagnosis of mitral stenosis was based on the longstanding shortness of breath, loud S₁, with a loud sound in diastole. taken to be an opening snap and an electrocardiogram which showed right axis deviation and left atrial enlargement.

Results of physical examination on admission were: blood pressure of 100/70, pulse regular, 100/min. The neck veins were distended up to the angle of the jaw at 45°. There were decreased breath sounds over both lower lung fields. Heart was enlarged to 2 cm lateral of the midclavicular line with a ventricular heave. S₁ loud. S₂ normally split. A sound was heard in diastole. The liver was markedly enlarged and nontender. There was edema of the legs and ascites. The electrocardiogram showed sinus rhythm, rate 75/min, right axis deviation, "P" wave notched in I, II, AVF, and from V2 through V6; diffuse ST-segment depression and T-wave flattening. Chest x-ray indicated a moderately enlarged heart without apparent selective enlargement of any chambers; bilateral pleural effusion. Results of the phonocardiogram were A₂-diastolic sound, 0.10 sec and early systolic murmur at low left sternal border. The echocardiogram showed normal motion of anterior mitral leaflet. Results of cardiac catheterization were: PVC, (12), a = 15, v = 13; PA, 27/12 (18); RV, 26/15; RA, (12) a = 15, v = 13; ascending aorta, 84/64 (74); LV, 84/16; cardiac index, 1.7 liter/min/M².

At thoracotomy a thick pericardium was found, and pericardiectomy performed.

Case 4

A 43-year-old white man, a rewinder, was admitted four days after the onset of squeezing precordial pain. One of the patient's sisters had had tuberculosis. Mitral stenosis was suspected because of a loud first sound, followed by an "opening snap" and the electrocardiogram showed left atrial enlargement.

The physical examination on admission revealed a blood pressure of 130/80, pulse, regular, 80/min. The neck veins were distended with prominent "a" and "v" waves at 45°. Heart size was normal. Systolic retraction and diastolic expansion was palpable at the apex; S₁, accentuated. S₂, normally split. A loud diastolic sound was heard over the precordium. The lungs were clear. The liver was slightly...
enlarged and nontender. There was no edema of the legs. The electrocardiogram showed sinus rhythm, 72/min.; PR
interval, 0.22 sec.; ST-segment depressed and T-wave inverted in V1 through V4; P-wave, notched in I, II, V5, V6,
and biphasic in V1 with a predominant negative opponent.
The phonocardiogram indicated $A_2$-diastolic sound, 0.10
sec. Chest x-ray showed the heart of normal size; pericardial
calcification. Echocardiogram showed normal motion of the
anterior mitral leaflet. Results of catheterization: PVC, (14);
PA, 20/9 (14); RV, 20/13; RA, (10), $a = 13$; ascending
aorta, 90/60 (74); LV, 90/14; cardiac index, 2.7 liter/min/ 
M$^2$. The ventricular diastolic pressure curves had an early
dip, followed by a plateau. The Valsalva maneuver elicited
a "square wave" type of response. Selective coronary arter-
ography demonstrated a sudden narrowing of the lumen
of the left anterior descending artery in the proximal one
third of its course.

Pericardiectomy was performed. A spur of calcified peri-
cardium was found to partially compress the left anterior
descending artery, accounting for the abnormalities seen
on cine coronary arteriography.

CASE 5
A 50-year-old housewife noted mild dyspnea on ex-
ertion and ankle edema two years prior to admission. The
symptoms were progressive, and she was admitted to
another hospital with marked edema of the legs and short-
ness of breath and treated with digitalis and diuretics with
some improvement. Immediately before admission here, the
symptoms worsened. She developed orthopnea and palpi-
tations. There was a history of rheumatic fever and rheuma-
toid arthritis. Mitral stenosis was suspected because of an
abnormal chest x-ray picture (see below) and a combination
of loud $S_1$ and an "opening snap."

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**Figure 2.** Simultaneous pressures in the right ventricle are shown. The early diastolic dip in the ventricular pressure curves is clearly seen followed by a plateau. Notice that the end diastolic pressure is elevated, and in the case of the right ventricle is higher than 50 percent of the systolic pressure. The pressure curves of the two ventricles are exactly the same during diastole.

**Figure 3.** Simultaneous pressure of the left ventricle and then a pullback pressure from the right ventricle into the right atrium. Again the configuration of the diastolic portion of the curves of the two ventricles is quite characteristic of constrictive pericarditis. The right atrial pressure curve is typically of "M" or "W" configuration.
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Physical examination on admission gave these results: blood pressure 115/70, pulse, regular, 80/min. The neck veins were moderately distended at 45°. Lungs were clear. Heart was slightly enlarged to 2 cm lateral to the midclavicular line in the fifth left intercostal space. Apical impulse increased with parasternal lift; $S_2$ normally split with $P_2$ greater than $A_2$. A diastolic sound was present. Liver was slightly tender and palpable 2 fingerbreadths below the costal margin. There was edema of the lower legs. Joint changes of rheumatoid arthritis and subcutaneous nodules were present. Chest x-ray showed heart, top normal size with mild but definite left atrial enlargement and

![Figure 4. Pullback from the right ventricle into the right atria is shown. The early diastolic dip followed by the plateau in the right ventricular pressure curve is quite prominent. The right atrial pressure curve shows the typical "M" or "W" configuration.](image)

![Figure 5. Phonocardiograms and echocardiograms of patient No. 3 are shown. Notice the pericardial knock located 10 sec. from the second sound. In the lower left corner of the figure we can see the mitral echocardiogram showing normal pattern of motion of the anterior mitral leaflet. In the lower right corner of the figure there is a carotid pulse of the patient which is not quite pure due to the prominent neck vein pulsation present in this patient.](image)
CONSTRICTIVE PERICARDITIS

FIGURE 6. Multichannel phonocardiograms, echocardiogram, and carotid pulse of patient No. 4 are shown. Prominent pericardial knock is clearly depicted with separation from the second sound of .10 sec. In the lower left corner of the figure the normal pattern mitral valve motion as shown by the reflected ultrasound technique is demonstrated. The carotid pulse is not pure due to prominent neck vein pulsation present in the patient. Suggestion of right ventricular enlargement. The pulmonary vasculature was normal. The electrocardiogram showed sinus rhythm, 65/min, diffuse nonspecific ST-T wave changes; PR interval, 0.20 sec. Phonocardiogram indicated S1 accentuated; a loud diastolic sound was present 0.11 sec. from A2. Echocardiogram showed normal motion of the anterior mitral leaflet. Results of catheterization were: LA, (16), a = 18, v = 22; PA, 35/19 (30); RV, 34/19; RA, (15) a = 20, v = 17; ascending aorta, 114/70 (90); I.V. 114/20; cardiac index, 2.6 liter/min/M2.

Atrial pressure curves were of "M" configuration. Ventricular pressure curves were dip-plateau pattern. Valsalva maneuver: "square wave" response.

The patient underwent pericardiectomy. The pericardium was thick, and blood clots were seen in the pericardial space.

DISCUSSION

In a classic paper, describing his experience with 15 cases of constrictive pericarditis, White considered mitral stenosis the condition most likely

FIGURE 7. Low frequency phonocardiograms, electrocardiograms, apex cardiograms, and echocardiograms of the patient No. 1 are shown in this figure. The apex cardiogram shows a systolic retraction followed by a diastolic outward motion of the chest wall. The pericardial knock is synchronous with the diastolic outward motion of the chest wall. In the right lower corner of the figure, this mitral echocardiogram of the patient showing a normal pattern of motion of the anterior mitral leaflet. S1 is the first sound, A2 and P2 are aortic component and pulmonic component of the second sound. "K," pericardial knock. ECG, electrocardiogram.
to be confused with constrictive pericarditis. Since then, this diagnostic pitfall has not been properly emphasized. We have presented five patients who were thought to have "silent mitral stenosis" (mitral stenosis without a diastolic murmur) and subsequently were proved by cardiac catheterization and surgery to have constrictive pericarditis. In a differential diagnosis, the following points in the history, physical examination, and laboratory tests need emphasis.

A) History

In mitral stenosis, the symptoms, of pulmonary venous congestion, dyspnea on exertion, orthopnea, pulmonary edema, hemoptysis, cough, etc. appear first; only late in the evolutionary pattern of the disease, do the symptoms and signs of right ventricular failure develop. In constrictive pericarditis the symptoms and signs of systemic venous congestion usually prompt the patients to seek medical attention. Symptoms of pulmonary congestion do exist in constrictive pericarditis but are not usually prominent. Still, Wood⁴ and Dalton and co-workers⁵ reported a high incidence of dyspnea on exertion in their series. Our patients No. 1 and No. 3 had dyspnea on exertion as chief complaints and they only developed ankle edema later in the course of their disease. Patient No. 5 had simultaneous onset of dyspnea on exertion and ankle edema. Patient No. 2 had several documented episodes of atrial fibrillation before the onset of ankle edema. This arrhythmia is seen frequently in both mitral stenosis and constrictive pericarditis.¹⁴⁻⁶

B) Physical Examination

Neck Vein Distention—Patients with mitral stenosis and right ventricular failure as well as patients with constrictive pericarditis will demonstrate neck vein distention. Diastolic collapse of the neck veins (Friedreich's sign) is frequently seen in constrictive pericarditis but is not pathognomonic.⁷ Three of our patients had this sign.

Figure 8. Multichannel phonocardiogram, electrocardiogram, echocardiogram, and carotid pulse of patient No. 5 are shown. There is a prominent pericardial knock 10 sec. from S₁. The indirect carotid pulse is impure again due to the presence of a neck vein pulsation. The echocardiogram in the left lower quadrant of the figure shows a normal pattern of motion of the mitral leaflet quite incompatible with mitral stenosis.
Apical Impulse—The study of the precardial motion is very fruitful. Patients with constrictive pericarditis may show what has been called a "diastolic heart beat," which is an outward motion of the apical precordium during early diastole, synchronous with the pericardial knock. We found this sign in two of our patients who also showed systolic retraction of the entire precordial area. The combination of Friedreich's sign, a diastolic heart beat with systolic retraction, and early diastolic sound is strongly in favor of constrictive pericarditis. This combination of signs was present in two of our patients. When mitral stenosis is accompanied by pulmonary hypertension and secondary tricuspid insufficiency, apical systolic retraction may be present. It is a localized phenomenon, however, and associated with a parasternal outward motion of the chest wall, due to right ventricular hypertrophy and dilatation with sudden retrograde filling of the right atrium. Obviously here a pansystolic murmur of tricuspid insufficiency will be heard. Our patients did not have significant murmurs.

First Heart Sound—In our five patients, a source of confusion was the presence of a loud first sound. The first sound in constrictive pericarditis is generally described as normal or soft. Our five patients prove that this is not always the case.

"Opening Snap"—All five patients had an early diastolic sound, a pericardial knock, easily mistaken for a late opening snap. The pericardial knock is usually separated from the aortic component of the second sound by an average of 0.10 sec. This time interval explains why occasionally a pericardial knock is mistaken for a ventricular gallop or an opening as in our five cases. The knock may be louder than the first and second sound and is sometimes snapping in quality. It is widely heard over the precordial area, closely resembling an opening snap. It is clinically impossible to distinguish a pericardial knock from a late opening snap.

Pulmonic Component Second Sound—Patients with mitral stenosis and right ventricular failure usually have auscultatory evidence of pulmonary hypertension. Three of our patients had accentuation of the pulmonic component of the second sound. It is to be remembered that the loudness of the pulmonic component of the second sound is not solely related to pressure within the pulmonary artery but also to body build. Also, accentuation of the pulmonic component of the second sound has been described in constrictive pericarditis.

Diastolic Rumble—White stated that the difficulty in distinguishing mitral stenosis from constrictive pericarditis originates in the failure to identify the apex of the heart and consequently to detect the diastolic murmur of mitral stenosis which often can only be heard in a narrow apical region. Today, the concept of silent mitral stenosis, that is, mitral stenosis without a diastolic murmur is widely accepted. Levine and Love thought that silent mitral stenosis could be present in 5 percent to 10 percent of the cases with mitral stenosis. In our experience mitral stenosis is silent in close to 5 percent of the cases.

Hepatomegaly, Edema, Ascites—Hepatomegaly is a consistent finding in constrictive pericarditis, abdominal swelling with or without ascites, has been reported to precede leg edema. Two of our patients had ascites and ankle edema. In both cases ankle edema appeared first.

C) Electrocardiogram

The electrocardiogram is another source of confusion since broad, notched "P" waves and right axis deviation may be seen in both conditions. The "P" wave was notched in two patients. Right axis deviation was seen in two patients. In one patient, both findings were present. Levine and Love suggested that a broad and notched "P" wave in the presence of right ventricular hypertrophy could be considered one of the criteria used to diagnose silent mitral stenosis. Atrial fibrillation is a common arrhythmia in both conditions and was seen in one of our patients.

D) Chest X-ray

Heart Size—In the past, it was thought that constrictive pericarditis is never associated with large hearts. It is now accepted that many cases of constrictive pericarditis present with cardiomegaly. Therefore, the heart size is not a good differential point between the two conditions. A mild degree of cardiomegaly was present in three of our patients.

Mitral Calcification—Calcification of the mitral leaflets, best evaluated by image intensification, is strong evidence in favor of rheumatic mitral stenosis. Calcification of the pericardium, if associated with signs of cardiac constriction, indicates constrictive pericarditis.

Left Atrial Enlargement—Enlargement of the left atrium is rather characteristic of mitral stenosis, but an apparent left atrial enlargement is occasionally seen in constrictive pericarditis as the left atrium escapes from the constricting pericardial sac. True enlargement of the left atrium has been reported by McKusick in constrictive pericarditis.

E) Echocardiogram

The study of the mitral valve motion by the reflected ultrasound technique is a standard proce-
dure in many clinics of this country and abroad. Its accuracy in detecting mitral stenosis parallels cardiac catheterization, with the advantage that it may be performed at the bedside and can be repeated at will (Fig 9).

In constrictive pericarditis, the mitral echocardiogram will show a normal pattern of motion, if the constrictive layer of calcium in the A-V groove does not interfere with the free motion of the mitral leaflets. Normal motion of the anterior mitral leaflet was observed in all five patients. Only twice have we found the patterns typical of mitral stenosis in patients with constrictive pericarditis: once in a patient in whom the two conditions coexisted and in another patient with constrictive pericarditis and a tight belt of calcium around the A-V groove. In this patient, the abnormal mitral valve motion was similar to that found in mitral stenosis. This patient had "extrinsic mitral stenosis."

F ) Cardiac Catheterization

We performed right and retrograde left heart catheterization in all our patients. The typical findings consisted of ventricular pressure curves, showing an early dip followed by a rapid rise of the pressure curves to a diastolic plateau, maintained until the next systole. All our patients showed the "M" or "W" configuration in the atrial pressure curves. Equalization of diastolic pressure in the four heart chambers was seen in all patients. The sudden halt of ventricular filling in early diastole, coinciding with the pericardial knock, was clearly seen in cine ventriculography. In none of our patients could we demonstrate a gradient across the mitral valve.

Conclusions

Five patients are presented with chronic constrictive pericarditis whose condition was misdiagnosed as mitral stenosis at the bedside. The echocardiogram was found to be extremely helpful for demonstrating normal mitral valve motion, thus excluding mitral valve stenosis. The confirmed diagnosis of constrictive pericarditis was later made by cardiac catheterization and cardiac surgery. Occasionally, these patients' symptoms may mimic mitral stenosis and a bedside echocardiogram is valuable for differentiating these conditions.

References

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