Endocardial fibroelastosis with predominant involvement of left atrium

Possibility of diagnosis by non-invasive methods

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SUMMARY Endocardial fibroelastosis with predominant involvement of the left atrium is rare but of clinical importance. This study shows how the diagnosis can be made using a combination of non-invasive methods, including phonocardiogram, apexcardiogram, pulse tracings, echocardiogram, and computer analysis of echocardiographic recordings.

Three cases are reported where fibroelastosis of the left atrium was diagnosed from the non-invasive findings of enlargement and isolated standstill of the left atrium. In all cases, necropsy verified the diagnosis.

Endocardial fibroelastosis is a well-known entity of unknown aetiology.¹⁻³ Several studies have shown that the main site is the left side of the heart; that is, the left ventricle, or the left ventricle and the left atrium combined.⁴⁻⁶ Predominant involvement of the left atrium seems to be rare.

Case reports

CASE 1

A girl had a congenital complete heart block and a systolic murmur noted soon after birth but no cardiac symptoms. At the age of 2 years, she had an acute left-sided hemiplegia. A cerebral embolus was suspected, and she was treated for a time with dicoumarol. All symptoms disappeared spontaneously. At the age of 5 the heart murmur was systo-diastolic and chest x-ray film showed an enlarged heart particularly the left atrium and the left ventricle. Cardiac catheterisation was performed. It confirmed the diagnosis of persistent ductus arteriosus. Catheterisation showed left-to-right shunting at the pulmonary arterial level. The Table shows the pressure measurements. Angiocardiography was not done. Soon afterwards, she was operated on, with ligation of the ductus. Four days after operation, she developed a right sided hemiplegia, right sided facial paresis, and aphasia. The symptoms subsided slowly. During the following

years, she had no cardiac symptoms. At age 14, a new incident arose with left sided hemiparesis. These symptoms disappeared completely. Suspicion of myxoma or thrombus formation in the left atrium inspired further non-invasive and invasive investigations. The non-invasive studies are reported below. Cardiac catheterisation with angiography showed enlargement of the left atrium and the left ventricle, but no signs of thrombus. When the left atrial angiogram was re-evaluated, no contractions of the left atrium could be detected. Pulmonary capillary wedge and pulmonary arterial pressures were moderately increased (Table). One month later, she died suddenly. Necropsy showed a dilated and hypertrophic heart with fibroelastosis of the left atrium and thickening of the edges of the mitral leaflets. The left atrial appendage was small with fresh thrombi. There was also slight fibrosis of the endocardium of the left ventricle. There was a large defect in the temporal lobe, probably the result of a previous infarction.

The non-invasive methods used for studying this patient consisted of phonocardiography from five standard areas; apexcardiography; pulse tracings from the carotid artery, the jugular vein, and the liver; and echocardiography. All tracings, except the echocardiograms, were made with a 7-channel ink-recorder (Mingograph 81, Elema Schönander) at a paper speed of 100 mm/s. The phonocardiograms were recorded with an acceleration microphone (EMT

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Table Pressure measurements at cardiac catheterisation

Case No	Age (y)	Pressures (mmHg)					
		Right atrium (mean)	Right ventricle (syst/diast)	Pulmonary artery (syst/diast)	Pulmonary capillary wedge (mean)	Left ventricle (syst/diast)	Aorta (syst/diast)
1	5	2	45/5–12	65/22	18	—	150/70
	14	2	45/4	43/14	18	—	—
2	2	13	58/12–18	57/35	35	97/25–45	100/75

25C) fixed to the thoracic wall with adhesive tape. The apexcardiogram and the pulse tracings were done with a special hand-held funnel-shaped pick-up connected to a crystal transducer (EMT 510C) with a 35 cm latex tube. The technical properties are described elsewhere⁷. The echocardiograms were registered with a commercially available ultrasonoscope (Hewlett-Packard, 72 14 A, Diagnostic Sounder) with a 1 MHz transducer. The resolution of this old system was not comparable with later generations of ultrasonoscopes and did not allow a sufficiently accurate recording of the left ventricular dimension.

Non-invasive diagnostic findings

Fig. 1 and 2 show the diagnostic findings in case 1. Phonocardiogram from the apex (Fig. 1A) showed a very faint but repeatedly observed diastolic extra sound followed by a short and weak diastolic filling murmur. Each P wave (congenital heart block) was followed by an atrial sound. The apexcardiogram showed small irregularities during the rapid filling period and no A waves despite the clear atrial sound (Fig. 1A). The jugular venous tracings showed large A waves after each P wave (Fig. 1C).

The echocardiogram disclosed a thin mobile anterior tricuspid leaflet (Fig. 2A). When recorded together with the electrocardiogram (not shown here) typical closing movements could be seen after each P wave. The mitral valve, however (Fig. 2B), was thickened as seen when compared with the thickness of the tricuspid valve (Fig. 2A) and showed no undulations or A waves in diastole. As the atrial frequency was about 70/min and the ventricular frequency 35 to 40/min, at least one atrial contraction could be expected during each diastole. About 20 beats were recorded without any signs of an atrial contraction. The left atrium (Fig. 2C) was considered normal, but according to criteria adopted later, it should be considered slightly enlarged. The combination of an absence of A waves in the apexcardiogram and mitral echocardiogram, but good contractions of the right atrium with clear A waves in the jugular venous tracing and of the tricuspid leaflets, led to the diagnosis of isolated standstill of the

left atrium. The atrial sound seen in Fig. 1A was therefore considered right-sided. In addition, the mitral echocardiogram showed slightly thickened echoes which could explain the rudimentary opening sound and early diastolic murmur and the irregularities of the apex curve. Each of these findings was unimpressive, but together they indicated mitral valve abnormality of non-rheumatic origin, as the echoes were not typical for mitral stenosis. Left atrial fibroelastosis could explain both this mitral valve abnormality and isolated standstill of the left atrium.

CASE 2

This boy was first seen at the age of 2 years when slight cyanosis was noted. He had a faint systolic ejection murmur, an accentuated single second heart sound, and a third heart sound. He also had impressive hepatomegaly. Chest x-ray film showed enlargement of the heart mainly of its left atrium. Electrocardiogram showed signs of left atrial enlargement and right ventricular hypertrophy. The results of the non-invasive studies are reported below. Cardiac catheterisation and angiography showed low oxygen saturation values on the right side, pulmonary hypertension, and raised diastolic pressures both in the left and the right ventricle (Table). There were no signs of shunting. Angiography showed a greatly enlarged left atrium with little variations of volume with systole and diastole. The left ventricle was of normal volume and with normal variations. There were signs of mitral regurgitation.

The patient was treated with digitalis and frusemide. Clinically he remained stable for about a year with slight cyanosis and dyspnoea on exertion. He died at the age of 3 years in acute pulmonary oedema.

The necropsy showed an enlarged heart with slight hypertrophy of the myocardium of both ventricles and dilatation of both atria. The endocardium of the left atrium was greatly thickened by fibroelastosis. There were also patches of thickened endocardium in the right atrium and slightly increased thickness of the endocardium in the ventricles.

This patient was followed with repeated echo-

Fig. 1 Case 1. (A) Phonocardiogram (PCG) from apex left side. Note a very unimpressive diastolic extra sound, marked OS (opening snap), followed by a short, weak filling murmur. See text. From above, electrocardiogram lead II. Phonocardiogram: 25 Hz, 50 Hz, 100 Hz, 200 Hz, and 400 Hz, 100 mm/s. (B) Apexcardiogram together with phonocardiogram from the third left interspace. Note the slight irregularities of the rapid filling phase. No A waves after the P waves can be seen. 100 mm/s. (C) Jugular venous tracing. Note the distinct A wave after each P wave in the electrocardiogram 50 mm/s.

cardiographic examinations using an Echo-cardiovisor Ultrasonoscope (Organon-Teknika) with a fiberoptic recorder and a 4.5 MHz unfocused transducer. Standard techniques were used for the echocardiographic examinations.^{8,9} Left ventricular function was studied as previously described¹⁰ using the shortening fraction of the left ventricular internal diameter (Δ LVID) and systolic time intervals. Systolic time intervals for both the left and right side were measured from high speed recordings of the echoes from the aortic and the pulmonary leaflets. The measurements used were the right and the left pre-ejection period (RPEP, LPEP) and the right and the left ventricular ejection time (RVET, LVET). The quotients RPEP/RVET and LPEP/LVET were calculated and LVET was corrected for heart rate and expressed as a percentage of normal, LVET%.¹⁰

The echocardiograms of the left ventricle and the mitral leaflet were also analysed by computer as previously described¹⁰ using the method of Gibson and Brown.¹¹

Non-invasive diagnostic findings

In case 2, the most impressive echocardiographic finding was the enormously dilated left atrium with hardly any movement of the posterior aortic wall with systole (Fig. 3). The LAD/AOD ratio was 2.5 to 3,

Fig. 2 Case 1. (A) The echocardiogram of the anterior tricuspid leaflet shows undulations caused by the contractions of the right atrium. (B) Echocardiogram from the mitral anterior leaflet indicates a thickened valve and absence of A-waves. (C) The left atrium seems normal or possibly slightly enlarged in comparison with the aortic root. Normal aortic leaflets.

Fig. 3 Case 2. Echocardiogram of the aortic root (Ao) and the left atrium (LA). The left atrium is extremely enlarged and varies very little in size during the cardiac cycle.

compared with the upper normal limit of 1.35.¹⁰ The size of the left ventricle was normal (Fig. 4), as was the thickness of the septum and the left ventricular posterior wall. The right ventricle was slightly enlarged. The echo from the tricuspid leaflet was normal. The echo from the anterior mitral leaflet showed on the first examinations a rapid opening and early diastolic closure rate and a small A wave indicating atrial systole. On later examinations, the A wave had disappeared, and the echo from the anterior

mitral leaflet remained flat during the later part of diastole. The left ventricular echocardiogram showed a rapid increase in left ventricular dimension at the beginning of diastole but then little further increase during the later part of the diastole. Δ LVID was normal. The computer analysis of the echocardiograms showed normal or slightly increased values for peak normalised lengthening rate of the left ventricular internal dimension and normal early diastolic closure rate for the anterior mitral leaflet.

Fig. 4 Case 2. Echocardiographic M-mode scan from the left ventricle (LV) to the aorta (Ao) and left atrium (LA). The left ventricle is of normal size while the left atrium is extremely dilated. RV, right ventricle; IVS, interventricular septum.

The computer print-out of the left ventricular instantaneous dimension showed a pathological pattern with all the dimension changes taking place during systole and the early part of diastole, whereas the dimension remained constant during the later part of diastole and throughout atrial systole (Fig. 5).

The systolic time intervals showed a decreased LVET% that remained around 85 throughout the observation period (lower normal limit 92¹⁰). LPEP/LVET was normal. The quotient RPEP/RVET increased to around 0.45 (upper normal limit 0.30).¹² There was no A wave on the echo from the pulmonary leaflet.

The echocardiographic findings remained unchanged during the year the patient was observed, except for the disappearance of the A wave on the echo from the anterior mitral leaflet.

Fig. 5 Computer print-outs of the left ventricular instantaneous dimension in a normal child (A) and in case 2 (B). In panel B the dimension remains constant during the later part of diastole.

CASE 3

This girl developed signs of cardiac decompensation at the age of 14 months after a short period of fatigue. She had no cardiac murmur but enlargement of the left atrium on x-ray film. She died suddenly in cardiac standstill one week after admission.

The necropsy showed isolated fibroelastosis of the left atrium which was also severely dilated; the rest of the heart was normal.

The non-invasive studies on this patient were made in a similar manner to those in case 2. She was also examined with two-dimensional echocardiography.

Non-invasive diagnostic findings

Echocardiography, including two-dimensional examination, showed an enormously enlarged left atrium (LAD/AOD ratio 2.6). The posterior wall of the aortic root moved very little, indicating decreased volume changes of the left atrium. The anterior mitral valve echo showed, however, a small A wave, indicating some atrial activity. This resembles that seen in case 2 on the earliest echocardiographic recordings. The left ventricle was of normal size and had normal volume variations.

Discussion

Fibroelastosis of the heart usually leads to one of two conditions.^{2 13 14} In the congestive type, the left ventricle is dilated with decreased contractility and impairment of the emptying of the ventricle. In the restrictive type, the size of the ventricle is normal or small, and there is impairment of the filling. In both cases, the left atrium is enlarged, the enlargement being more pronounced in the restricted type. In restrictive cardiomyopathy there is usually a severe degree of left ventricular hypertrophy.

In case 1, the suspicion of fibroelastosis of the left atrium was based on the combination of left atrial standstill and thickening of the mitral valve. Even if the findings in the phonocardiogram and apex-cardiogram were unimpressive, they occurred in repeated recordings and therefore reinforced the echocardiographic impression of a thickened mitral valve, which was confirmed at necropsy. The left ventricle, however, could not be evaluated as the echo equipment used at that time (1972) did not allow recordings of the septal and posterior wall endocardium. Indirect signs of changed distensibility of the left ventricle (pathological A wave and atrial heart sound) could not be recorded because of the atrial standstill, and neither was there any sign of a pathological third heart sound.

The most impressive finding in cases 2 and 3 was the enlarged left atrium. Left atrial enlargement can be the result of cardiac failure, large left-to-right

shunts, mitral valve disease, cor triatriatum, aneurysm of the left atrium or the left atrial appendage, and dilatation secondary to disease in the left ventricle.^{2 15-20} X-ray and clinical findings could exclude shunt and cardiac failure as the reason for left atrial enlargement in cases 2 and 3. Echocardiography excluded mitral stenosis as the reason for left atrial dilatation, and the echo from the anterior mitral leaflet also gave a clue to the malfunction of the left atrium with its lack of A wave in case 2. The echo from the posterior aortic wall showed very little movement with systole in both cases. Strunk *et al.*²¹ showed an excellent correlation between the movement of the posterior aortic wall echocardiogram and the volume changes in the left atrium. The echocardiographic findings in these patients thus indicated an enlarged left atrium with little systole-diastole volume variations; this was confirmed by the angiographic examination in case 2.

The filling pattern of the left ventricle in case 2, shown especially on the computer print-outs of the left ventricular dimension changes (Fig. 5), with impaired filling of the ventricle, could be compatible with restrictive cardiomyopathy and also with constrictive pericarditis. Restrictive cardiomyopathy would be expected to show increased wall thickness; this was not found. In addition the LPEP/LVET quotient was normal, and several workers have shown this to be raised in cases of restrictive cardiomyopathy.^{22 23} In constrictive pericarditis, LPEP/LVET is normal, as in our patient. His LVET% was slightly shortened. This was also noted in some patients with constrictive pericarditis and small stroke index.²⁴ Constrictive pericarditis would not explain the lack of left atrial activity shown both on the mitral echo and by the posterior aortic wall echo. A primary disease of the left atrium, such as fibroelastosis, thus seemed most likely, as it would explain both the filling pattern of the left ventricle, the enlarged, non-contracting left atrium, and the signs of pulmonary hypertension (high RPEP/RVET ratio, lack of A wave on the pulmonary leaflet echo tracing). Idiopathic aneurysmal dilatation of the left atrium^{18 20} could give rise to a similar dilatation of the atrium, but then presumably with preserved atrial activity. Another differential diagnosis that M-mode echocardiography could not totally exclude was a membrane in the left atrium. It is not always possible to visualise the membrane by echocardiography.¹⁷ The findings at cardiac catheterisation, however, made the diagnosis unlikely.

In case 2, echocardiography and necropsy showed that the disease was mainly sited in the left atrium, but there was probably also some impairment of the left ventricular myocardium, which would account for the extremely high diastolic pressure. The low

LVET% could also be an indication of decreased myocardial contractility.

The experience gained from these three patients illustrates that detailed analysis of left atrial function can be made by non-invasive methods. The characteristic findings in fibroelastosis of the left atrium seem to be an enlarged left atrium with absent or diminished volume variations during the cardiac cycle and signs of diminished or absent ventricular filling during atrial systole.

Poor atrial function and atrial dilatation increase the risk of formation of thrombi in the left atrium. Anticoagulant treatment can be valuable in these cases. As an alternative to such treatment extirpation of the left atrial appendage can be considered.^{15 16} So far, a treatment for the basic disorder of the heart is not known. As anticoagulant treatment or surgery can diminish the risk of atrial thrombosis, however, it is of clear clinical importance to establish the diagnosis.

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We regret the late appearance of the Journal but we hope to be back on schedule before the end of the year. The delays are the result of a change in typesetting techniques.