ECHOCARDIOGRAPHIC ABNORMALITIES OF THE MITRAL VALVE — A STUDY OF 72 CASES

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SYNOPSIS

First introduced in 1954, echocardiography is today one of the most useful investigations of the cardiovascular system. Echocardiography is particularly valuable as a diagnostic tool because it is completely non-invasive.

This paper describes an analysis of the abnormalities of the mitral echogram seen in 72 patients studied in the University Department of Medicine. These 72 patients comprise cases of rheumatic mitral valve disease, the prolapsing mitral valve syndrome, Starr-Edward prosthetic valve, calcified mitral annulus, infective endocarditis, chronic and acute aortic incompetence, hypertrophic cardiomyopathy and atrial myxoma. Echocardiographic illustration of each condition is presented and the salient echocardiographic findings are discussed.

INTRODUCTION

Echocardiography (EC) or the use of pulsed reflected ultrasound for the examination of the heart, was first started by Edler and Hertz in Sweden in 1954. Initially, this technique was slow in gaining popularity chiefly because the application of ultrasound to the diagnosis of cardiac disease came at a time when other methods such as cardiac catheterisation and angiography had already achieved considerable precision. However, in the past 5 years there has been a great resurgence of interest and an exponential growth in research and publications in the field of EC. Echocardiography is today in its adolescence. New diagnostic criteria for many pathologic conditions are concurrently under development. The sensitivity and specificity of this technique in the diagnosis of the various cardiac disorders which have hitherto been described are also being constantly re-appraised. Even in its adolescence, it is clear that EC has become one of the most important investigations available today for the evaluation of cardiovascular disorders.

Echocardiography was first started in this department in February 1976. So far, we have performed 213 consecutive

examinations in 200 patients using standard techniques for M-Mode echocardiography, employing a Picker Echoview 80C machine, 2.25 mega Hertz focussed transducer and a Honeywell Strip-chart recorder. The spectrum of cases studied included patients suffering from acquired valvular heart disease, congenital heart disease, cardiomyopathy, pericardial effusion, coronary and hypertensive heart disease, aortic aneurysm, prosthetic and biological artificial valves, and atrial myxoma.

Echoes from the mitral valve (MV) are extremely important for the following reasons: (1) They are the easiest to record and recognise. (2) They serve as landmarks in the search for other structures. (3) They have great diagnostic value in many pathologic conditions. (4) Historically, the first clinical application of EC was for the diagnosis of mitral stenosis (MS).

PATIENTS & MATERIALS

Abnormalities of the mitral echogram (ME) were seen in 72 out of the 200 patients and their analysis form the basis of this communication. Group 1, numbering 61 patients, consists of those with structural abnormalities of their mitral valves. Group II, numbering 11 patients, consists of those whose mitral valves are morphologically normal (Table I).

Twenty-five patients with pure rheumatic MS showed the classical changes of a reduced E-F slope of the anterior leaflet and paradoxical anterior movement of the posterior leaflet of the MV. In 2 patients, repeat examination showed a considerable increase in the E-F slope of the anterior leaflet after mitral valvotomy. Nine patients with mixed rheumatic MS and mitral incompetence (MI) and 5 patients with pure rheumatic MI all showed changes in their ME which are similar to those seen in pure MS. A mid-systolic prolapse (MSP) was seen in 8 patients and a pan-systolic prolapse (PSP) in 10 patients due to the prolapsing mitral valve syndrome. Normal functioning Starr-Edward prosthetic mitral valves were recorded in 2 patients. Heavy calcification of the mitral annulus and changes consistent with infective endocarditis were seen in 1 patient each. Fluttering of the MV leaflets were demonstrated in 4 patients with isolated chronic aortic incompetence (AI) and in 1 patient with calcific AS and AI. Premature systolic closure of the MV occurred in 1 patient with severe acute AI. Systolic anterior motion (SAM) of the anterior leaflet of the MV was seen in 2 cases of hypertrophic cardiomyopathy. Left atrial myxoma was detected in 1 patient. Two cases of MI secondary to severe myocardial dysfunction showed very small diastolic excursions of their MV leaflets.

TABLE I

Abnormalities of Mitral Echogram	
Group I (61 patients)	**Nos.**
Rheumatic MS	25
Mixed rheumatic MS & MI	9
Rheumatic MI	5
Mid-systolic prolapse	8
Pan-systolic prolapse	10
Prosthetic Starr Edward Valves	2
Calcified Mitral Annulus	1
Infective Endocarditis	1
Group II (11 patients)	
Diastolic fluttering of MV	5
Premature systolic closure MV	1
Systolic anterior motion of MV	2
Left atrial myxoma	1
MI due to severe myocardial dysfunction	2

RESULTS

The mean value for the E-F slope in patients with pure rheumatic MS, MS & MI and pure rheumatic MI is 20, 19 and 36 mm/sec respectively. All these are less than the normal value of 80-150 mm/sec. The mean E-F slope for patients with MSP and PSP is 148 and 160 mm (Table II). Since the majority of the patients with MS have not undergone haemodynamic evaluation no attempt is made in this study to correlate between the E-F slope and the degree of stenosis.

The mean mitral valve diastolic excursion defined as the distance between the D and E points in all these 5 groups of patients is within normal limits. Table III shows that the mean E-F slope in patients with MS and MS & MI is siginificantly less than those

TABLE II

	EF Slope (mm/sec)	DE (mm)
MS	Mean = 20 SE ± 3	Mean = 20 SE ± 1
MS MI	mean = 19 SE ± 5	Mean = 23 SE ± 2
MI	Mean = 36 SE ± 4	Mean = 25 SE ± 1
MSP	Mean = 148 SE ± 8	Mean = 27 SE ± 1
PSP	Mean = 160 SE ± 14	Mean = 25 SE ± 2

TABLE III

	EF Slope	DE
MS vs MS MI	NS	NS
MS vs MI	p <0.05	p <0.05
MS MI vs MI	p <0.05	NS
MI vs MSP	p <0.001	NS
MI vs PSP	p <0.001	NS
MSP vs PSP	NS	NS

with pure MI. Even more striking is the difference between the E-F slope between patients with rheumatic MI and those with prolapsing mitral valve, the latter being considerably greater.

ECHOCARDIOGRAPHIC ILLUSTRATIONS AND DISCUSSION

Mitral Stenosis

EC is an excellent tool for the diagnosis of MS. Initially, and until recent years, it was believed that the E-F slope is a good index of the severity of the lesion. However, we now know that this is not so. The EC is extremely useful for the diagnosis or exclusion of MS, but is a poor judge of its severity (Cope et al, 1975). However, in an individual patient, an increase in the E-F slope after operation indicates a successful valvotomy and a subsequent decrease in this slope suggests a re-stenosis. Furthermore, the ME is useful for evaluation of calcification and mobility of the MV, both of which are important factors when considering whether a valvotomy or a valve replacement should be done.

Fig. 1 is an EC recorded from a patient with critical mitral stenosis. It shows a reduced E-F slope of 25 mm/sec, and paradoxical anterior movement of the posterior leaflet. The valve excursion is within normal limits, measuring 25 mm and single thin echoes are recorded from both the leaflets. All these findings indicate a pliable and non-calcified MV which will be eminently suitable for valvotomy. At operation, the MV orifice was found to be only 0.8 cm^2 and it was dilated to 3.75 cm^2. Two weeks after valvotomy, there was a significant increase in diastolic slope which now measures 50 mm/sec.

In marked contrast, Fig. 2 belongs to a patient with MS due to a heavily calcified, nonmobile MV, as exemplified by a very poor valve excursion of only 10 mm, and thick conglomerulation of echoes. Incidentally a normal tricuspid valve is also seen.

Fig. 3 is an EC of a 16 year old girl with severe

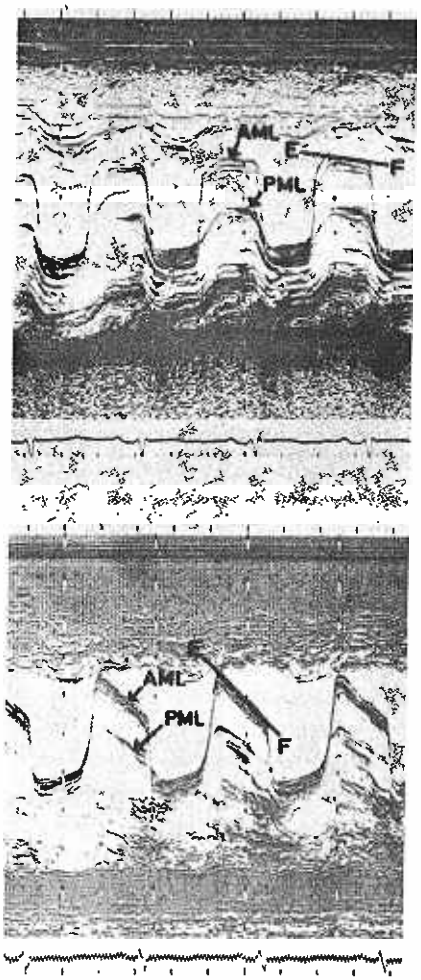

Fig. 1 Top panel — Echocardiogram of a patient with severe mitral stenosis before mitral valvotomy.
aml = anterior leaflet of mitral valve.
pml = posterior leaflet of mitral valve.
Bottom panel — After mitral valvotomy (see text)

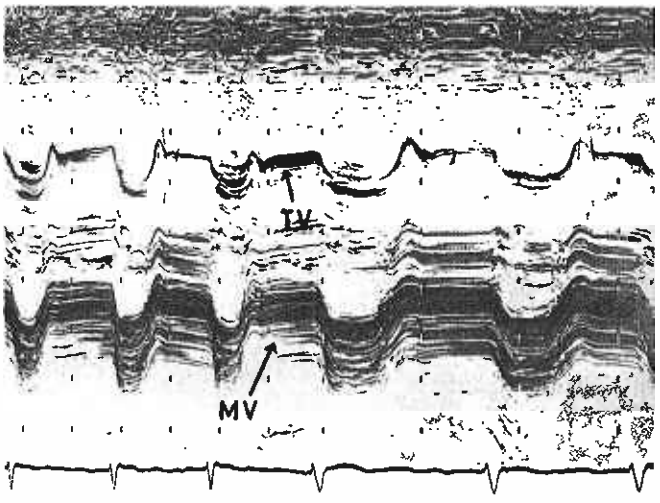

Fig. 2 Echocardiogram of a patient with severely calcified mitral valve.
MV = Mitral Valve.
TV = Tricuspid valve.
(see text).

rheumatic MI. It is not possible, looking at this EC to predict whether this patient has MS, MS and MI, or MI. It is clear that the ME is not useful for the diagnosis of rheumatic MI. Unlike MI due to other causes such as a prolapsing mitral valve or ruptured chordae tendinae, where the E-F slope is frequently increased, the E-F slope in rheumatic MI is usually less than the normal value as is shown in our present study.

Prolapsing Mitral Valve Syndrome

EC more than any other investigation, has been responsible for the explosion of interest and knowledge as well as for the current confusion in the prolapsing mitral valve syndrome. This is a fascinating condition which is commonly encountered all over the world, including Singapore. The EC findings are either a MSP as shown by the arrows in Fig. 4, or a PSP (fig. 5) (Popp et al, 1974). The arrows in Fig. 5 indicate the onset of ventricular systole and it is obvious that there is marked PSP of both the anterior as well as the posterior leaflets of the MV. It has been estimated that about 90% of subjects showing the characteristic auscultatory findings of mitral valve prolapse, will show these typical EC findings. However, careful attention to technique is absolutely essential as false negative results may be produced by inadequate scanning of the MV and false positive findings may be due to over-angulation of the transducer if it is placed too high.

Aortic Incompetence

The major EC diagnostic feature of AI lies not in the aortic valve (AV) but in the MV and also in the finding of a hyperdynamic left ventricle (LV). Fluttering of the MV leaflets is a specific sign of AI (Fig. 6). The presence of this abnormality is dependent more on the direction of the incompetent jet rather than the severity of the AI. In a patient with AI and an apical diastolic murmur, normal movements of the MV leaflets as seen in this EC excludes MS, and indicates that this murmur is Austin Flint in nature.

In acute AI, several additional characteristic EC findings are seen as is shown in this 22 year old man who had a flail aortic leaflet secondary to SBE. First there is early systolic closure of the MV (Fig. 7). This is an ominous sign, auguring an extremely poor prognosis if surgery is delayed. In this same man, vibrations of the AV are seen in diastole (Fig. 8). A scan from the aorta to the LV reveals that these diastolic vibrations persist up to the level of the LV outflow tract as indicated by the oblique arrows (Fig. 9). We believe that these vibrations

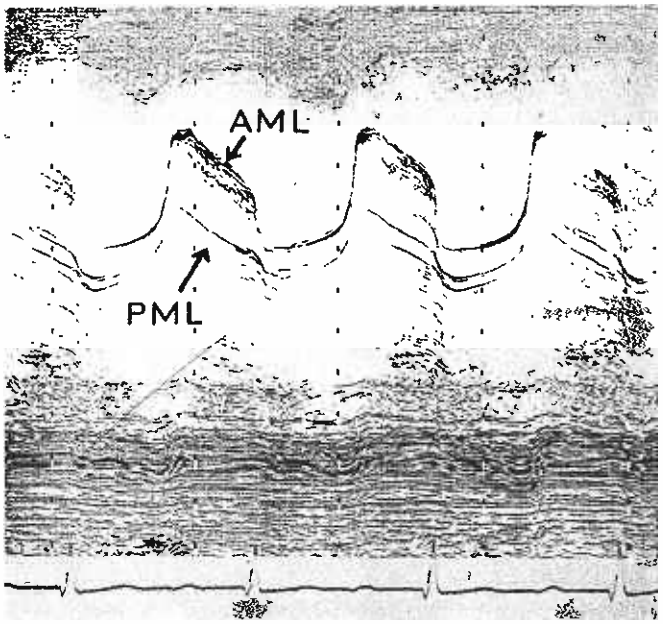

Fig. 3 Echocardiogram of a patient with severe Rheumatic mitral incompetence. (See text).

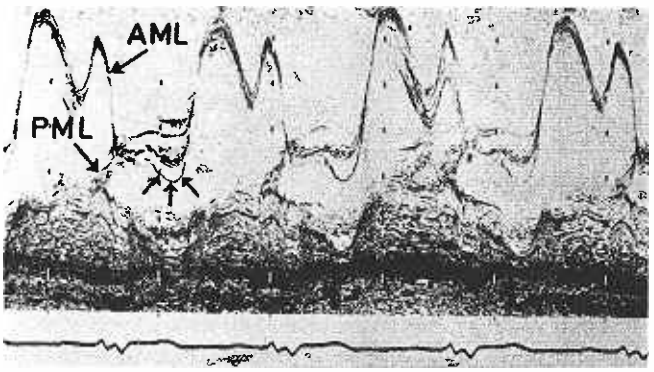

Fig. 4 Echocardiogram of a patient with the prolapsing mitral valve syndrome. AML = Anterior leaflet of mitral valve. PML = Posterior leaflet of mitral valve. The 3 arrows illustrate the mid systolic prolapse of the mitral valve. (See text).

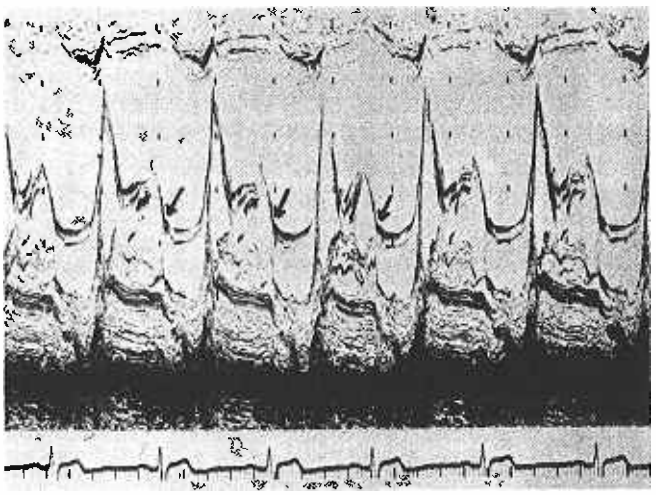

Fig. 5 Echocardiogram of a patient with the prolapsing mitral valve syndrome. Arrows indicate the beginning of systole. There is obvious pansystolic prolapse of both mitral valve leaflets. (See text).

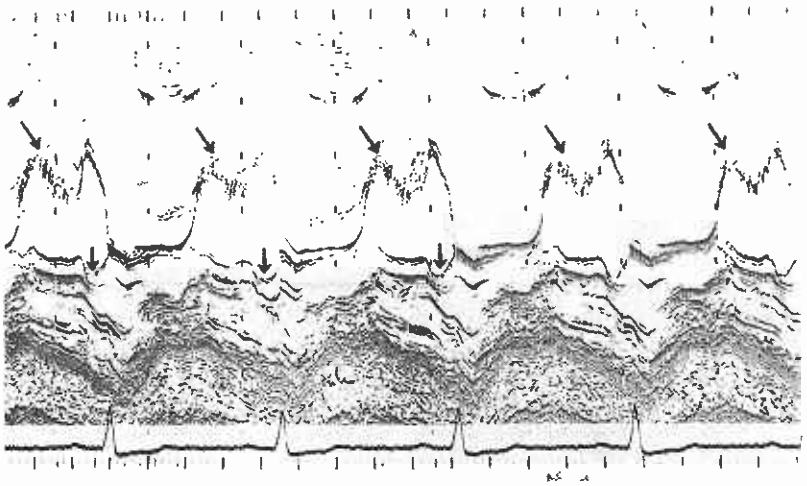

Fig. 6 Echocardiogram of a patient with severe aortic incompetence. Fine diastolic fluttering of the anterior leaflet (oblique arrows) and the posterior leaflet (vertical arrows) of the mitral valve is recorded. (See text).

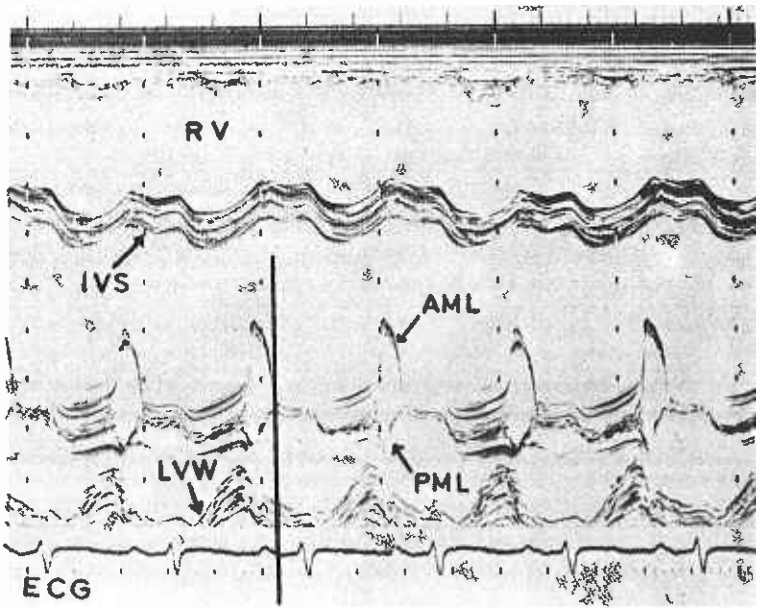

Fig. 7 Premature systolic closure of the mitral valve in severe acute aortic incompetence, due to SBE.
RV = Right ventricular cavity.
IVS = Interventricular septum.
LVW = Posterior wall of the left ventricle.
AML = Anterior leaflet of mitral valve.
PML = Posterior leaflet of mitral valve.

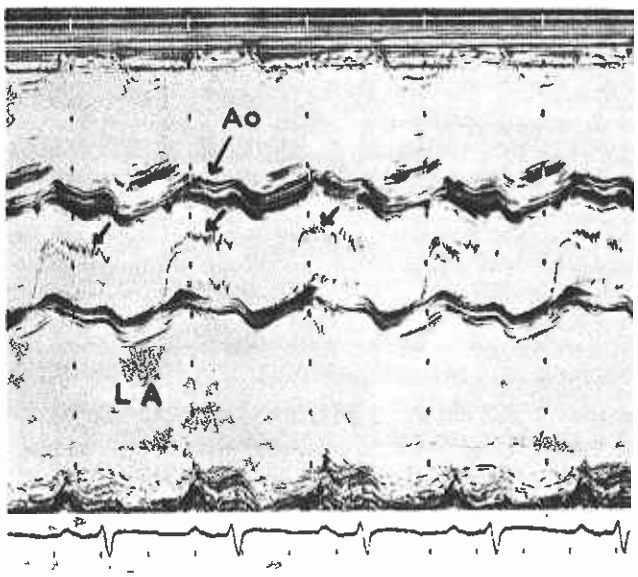

Fig. 8 Diastolic vibrations of the aortic valve due to flail aortic valve cusp (Oblique arrows). Ao = Aorta, LA = Left atrium. (See text).

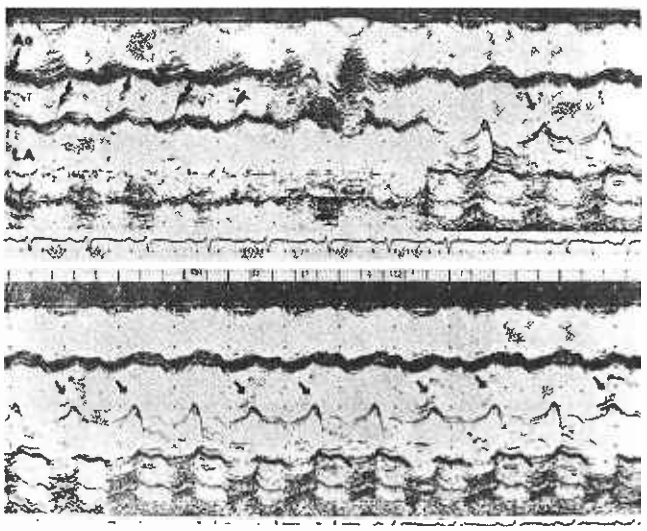

Fig. 9 Scan from aorta to left ventricular out-flow tract. Oblique arrows indicate flail valve cusp. Ao = Aorta. LA = Left atrium. (See text).

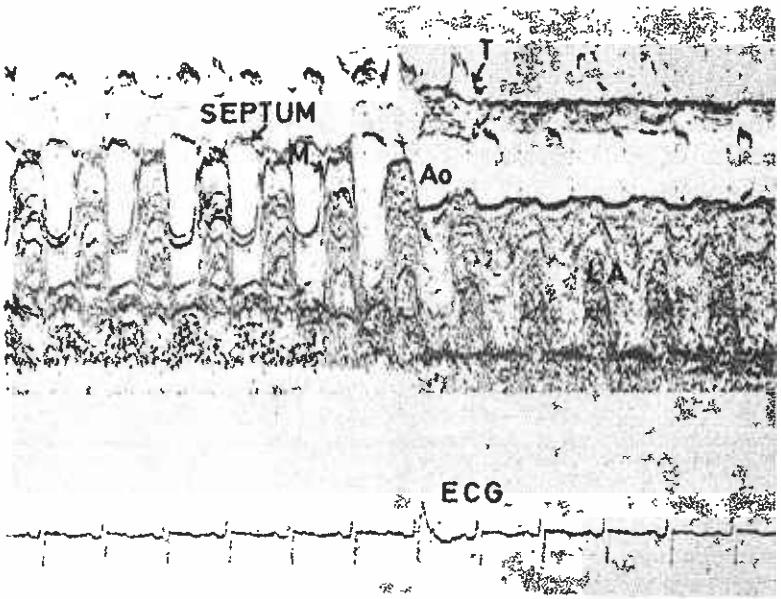

Fig. 10 Echocardiogram of patient with left atrial myxoma. M = Mitral valve. T = Tricuspid valve. Ao = Aorta. LA = Left atrium. (See text)

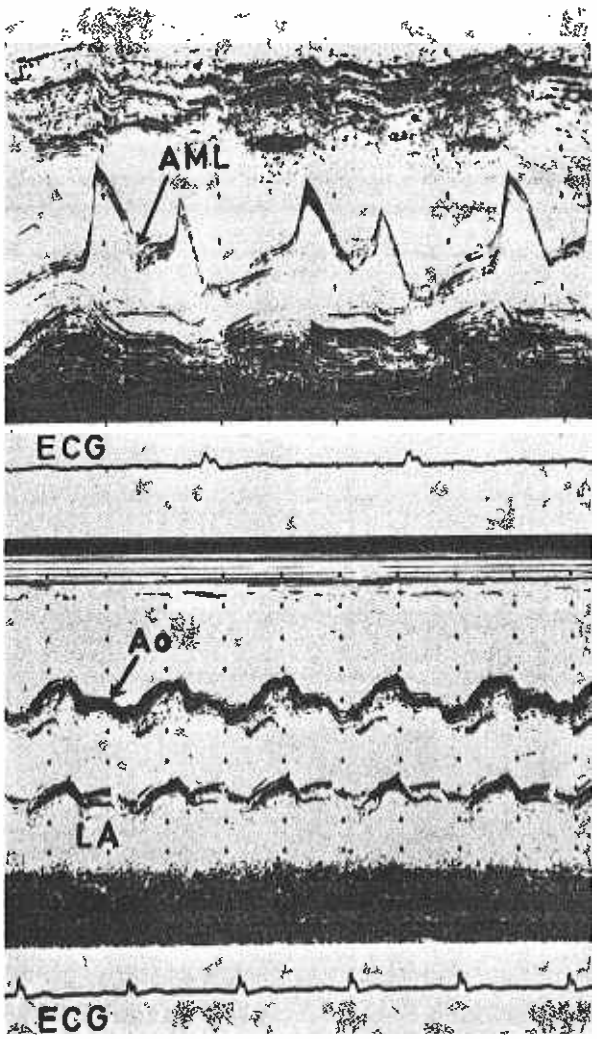

Fig. 11 Echocardiogram after removal of left atrial myxoma. Ao = Aorta. LA = Left Atrium. (See text).

represent the flail non-coronary cusp of the AV seen at necropsy in this case.

Atrial Myxoma

EC is an excellent tool for the diagnosis of myxoma of the atrium, and cases have been operated on without any other investigation. Fig. 10 shows classical EC findings of a left atrial myxoma. First, the anterior mitral leaflet shows a squarish pattern akin to that seen in MS. Second, clouds of echoes are seen behind this leaflet only in diastole due to the myxoma prolapsing through the valve. A scan from the MV to the aorta reveals a dilated left atrium (LA) filled with clouds of echoes which represent the tumour tissue. Several months after successful removal of the myxoma, the ME is normal and the LA is free of echoes (Fig. 11).

Hypertrophic Cardiomyopathy

EC has been found to be very useful in the diagnosis of hypertrophic cardiomyopathy (Henry et al, 1975) Fig. 12 which is an EC recorded from a 25 year old woman shows the relevant EC features: (1) Asymmetric septal hypertrophy. (2) Systolic anterior motion or SAM of the anterior leaflet of the MV resulting in LV outflow tract obstruction. (3) A reduction in the diastolic slope of the anterior mitral leaflet due to a decrease in LV compliance. In the presence of LV outflow tract obstruction the AV shows mid-systolic closure.

Each of these EC abnormalities when considered

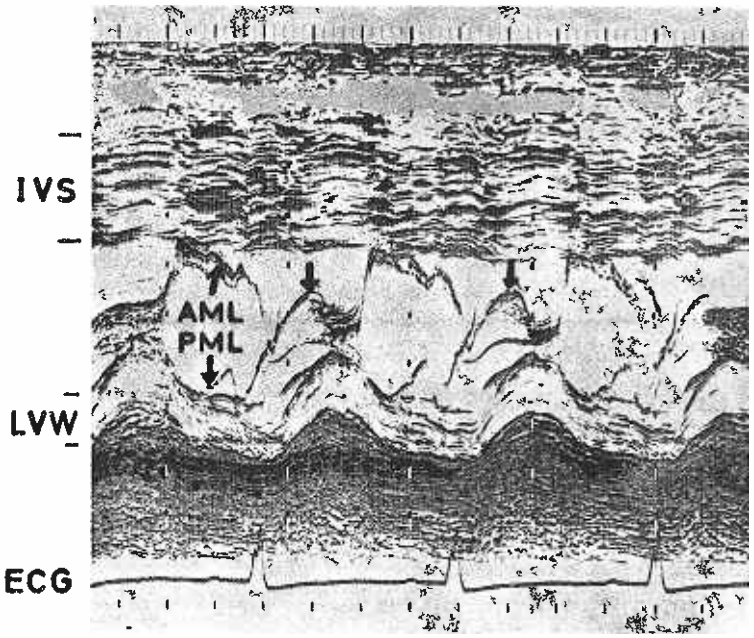

Fig. 12 Echocardiogram of patient with hypertrophic cardiomyopathy. Unlabelled vertical arrows indicate systolic anterior motion of the mitral valve. IVS = Interventricular septum. LVW = Posterior wall of the left ventricle. (See text).

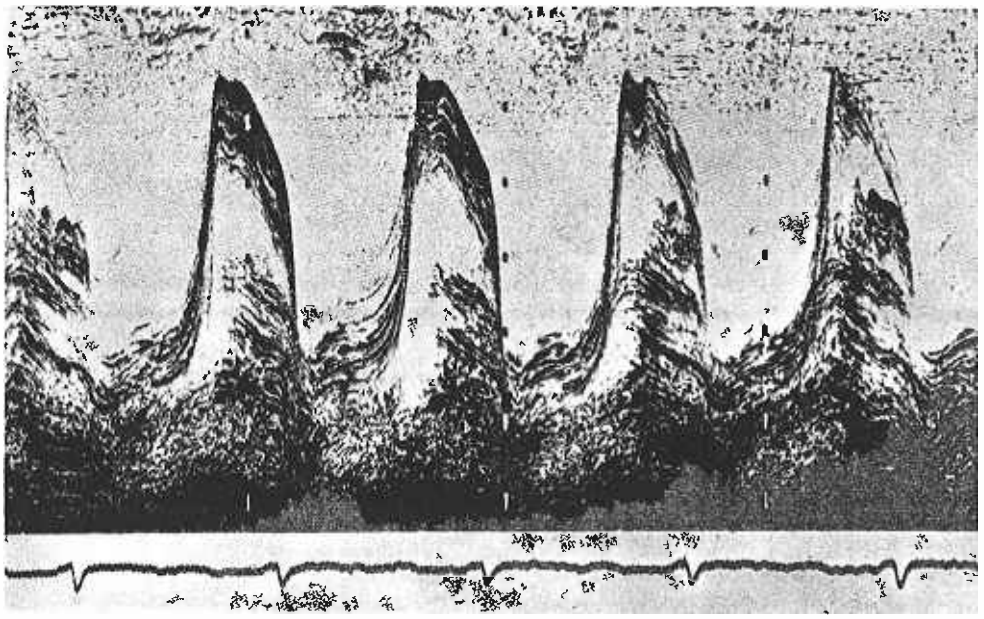

Fig. 13 Mitral echogram showing changes consistent with infective endocarditis. (See text).

individually is not diagnostic of hypertrophic cardiomyopathy, and can be found in several other conditions. However, if all these EC features are present, diagnosis of hypertrophic cardiomyopathy is not in doubt.

Infective Endocarditis

Fig. 13 is the EC of a 17 year old Chinese girl with known mitral incompetence who one day developed fulminating infective endocarditis. This tracing reveals a shaggy outline of the anterior mitral valve leaflet with multiple linear echoes posterior to this leaflet. These findings are consistent with infective endocarditis.

CONCLUSION

From all these examples, it is obvious that echocardiography is an excellent non-invasive tool for the evaluation of the cardiovascular system, and careful analysis of the ME will yield a wealth of information regarding the heart in patients with and without structural abnormalities of their mitral valves.

Echocardiography is particularly useful as a diagnostic tool for the following reasons:

1. It is completely non invasive and has no harmful effects on the patient whatsoever.
2. Because of its benign nature, echocardiography can be repeated at will — at yearly, monthly, weekly or even hourly intervals. Hence the progress of certain cardiac diseases such as chronic rheumatic valvular disease or pericardial effusion can be conveniently assessed by serial echocardiographic examinations.

3. It is a relatively cheap procedure compared to invasive procedures such as cardiac catheterization and angiography.
4. It can provide certain unique information e.g. fluttering of the mitral valve in aortic incompetence, which currently cannot be obtained by any other investigative techniques — invasive or non invasive.
5. At the present state of the art, echocardiography cannot replace cardiac catheterization and angiography but in some instances can shorten the invasive procedures by providing certain clues to the diagnosis before the catheterization procedure itself. In many other instances, it can make invasive cardiac procedures unnecessary by establishing a firm diagnosis of a condition e.g. mild mitral incompetence due to prolapsing mitral valve syndrome, which is non surgical in nature.

Echocardiography is also an invaluable research tool and has contributed significantly to the advancement of our understanding of the heart and circulation in health and in disease.

There is little doubt that with further developments such as those concerning 2 dimensional echo-cardiography, which are rapidly taking place, echocardiography will assume an even more important role in cardiology in the years to come.

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