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Diagnosis of atrial thrombi by ultrasound

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ABSTRACT Left atrial thrombi were shown by two-dimensional echocardiography in three patients with mitral valve disease and neurological symptoms. In two patients the atrial thrombi had probably been the source of a previous cerebrovascular embolus. In the third, two-dimensional echocardiography detected the development of a recent ball-valve thrombus in the left atrial cavity, which caused intermittent obstruction and syncope. Echocardiographic findings were correlated with anatomical and histological data in all three patients. The spatial orientation provided by the multiple imaging planes of two-dimensional echocardiography permitted correct estimates of the size and position of the thrombus, and this mode was superior to the standard M-mode technique for non-invasive imaging of thrombus. Despite limitations of technique and resolution, the information provided by ultrasound can be extremely helpful in the management of patients. Ultrasonic screening (particularly the two-dimensional mode) is to be recommended in patients with neurological symptoms and clinical evidence of cardiac disease or arrhythmia.

The range of cardiac conditions that may predispose to embolism is extensive; early recognition of these may in some cases lead to appropriate treatment and so avert disastrous neurological complications. The purpose of this paper is to show the value of ultrasound and in particular of two-dimensional echocardiography in the diagnosis of atrial thrombi.

Methods

Echocardiography We performed conventional M-mode echocardiography using standard equipment with strip-chart recording of the ultrasonic data. The cross-sectional two-dimensional echocardiography studies were performed with a mechanical sector scanner (Smith-Kline Instruments Eko-sector I) having a scanner probe containing a transducer mechanically driven through 30° sector at 30 cycles (60 frames) a second. Gain settings and reject control were optimised to avoid misinterpretation of structures. Cross-sectional images were recorded on videotape; the images were then available for analysis in real-time, slow-motion, or single-frame format. In the static pictures there was, however, loss of visual integration that normally occurs during dynamic recordings. The standard two-dimensional echocardiography was performed on several cross-sectional imaging planes through the heart, from all available acoustic windows, including the parasternal, subcostal, and apical transducer positions.

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Histological methods Tissue from the three patients reported in detail in this paper was available for histopathological study. Areas were selected from suitable sites, processed, and paraffin embedded; 5-μm thick sections were then cut and stained with haematoxylin and eosin, Miller's elastic van Gieson, and, where appropriate, Martius scarlet blue stains.

Case studies

Case 1 A 36-year-old man with intermittent atrial arrhythmias and progressive dyspnoea from non-rheumatic mitral regurgitation suffered transient blindness of his left eye, which he described as a "curtain" crossing the visual field. Grey-white material, thought to be emboli, was seen in the retinal vessels by ophthalmoscopy shortly after this episode of amaurosis fugax. The computed tomography scan was normal and there was no evidence of arterial occlusion on angiography. No abnormalities were detected in the mitral valve region or in the atrium by routine M-mode echocardiography; two-dimensional echocardiography, however, showed the presence of a slightly mobile, echo-dense mass about 2 cm in diameter in the posterior wall of the atrium (fig 1); in addition, there were echoes suggestive of thrombus formation near the posterior leaflet of the mitral valve. Three months later the patient underwent cardiac surgery and the presence of a thrombus (2 × 1 cm) in the atrium and in the area of attachment of the valve was confirmed. The mitral valve was repaired by excision of part of the prolaps-

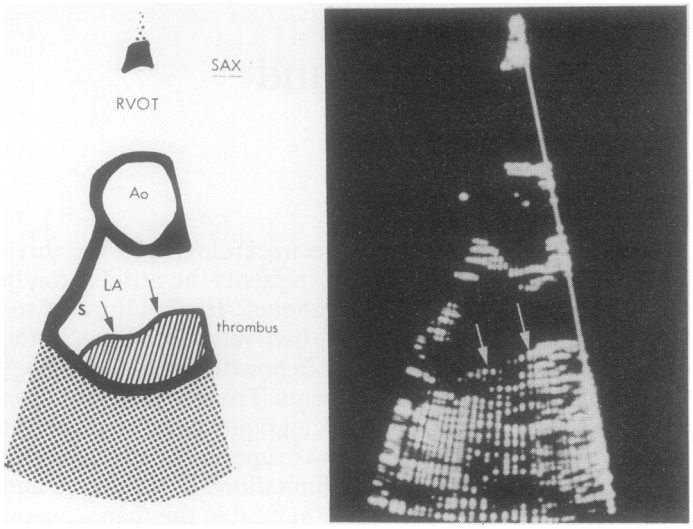

Fig 1 *Cross-sectional short-axis plane (SAX) in which the wedge-shaped ultrasonic beam is orientated from the patient's left shoulder to the right iliac crest. This plane of the ultrasonic beam traverses the base of the heart; the right ventricular outflow tract (RVOT), aorta (Ao), left atrium (LA), and interatrial septum (S) can be visualised. An echo-dense mass suggestive of thrombus is seen in the posterior wall of the left atrium (arrows).*

ing area and by anuloplasty of the posteromedial commissure. Histologically the thrombus had areas of organisation at the base, although other sections were more recent.

Case 2 A 46-year-old woman with chronic rheumatic carditis, atrial fibrillation, moderately severe mitral stenosis, progressive exertional dyspnoea, and intermittent episodes of dizziness, giddiness, and syncope required emergency hospital admission. The sudden exacerbation of symptoms was precipitated by a respiratory infection. M-mode echocardiography documented mitral stenosis and non-specific echoes were seen in the left atrium. Two-dimensional echocardiography showed a large mass with an acoustically dense exterior situated in the left atrial cavity, not attached to the atrial septum. Intermittently it occluded the mitral valve orifice, suggesting a ball-valve thrombus (fig 2). Despite intensive treatment the patient died suddenly five hours after admission from a combination of intractable heart failure and septicaemia while preparations were being undertaken for emergency cardiac surgery. At necropsy the atrial thrombus, loosely attached to the left atrial wall and measuring 4·5 cm in diameter, was identified. Superficially lines of Zahn were seen. Histologically it was shown to contain red blood cells and platelet-fibrin columnation typical of early thrombi. There was no evidence of infection or organisation of the thrombus, and the

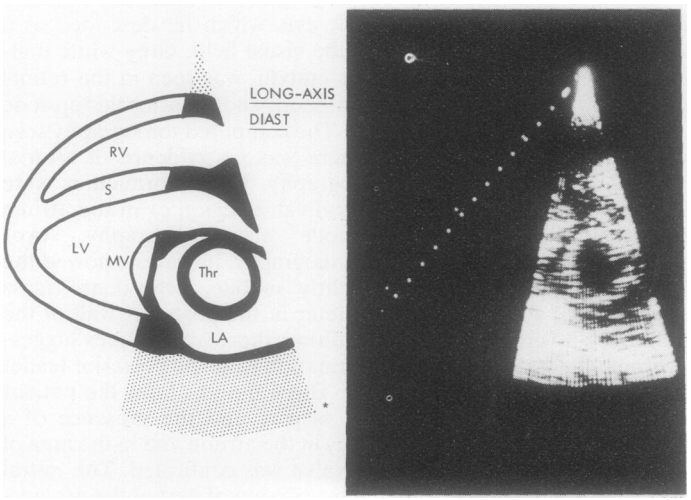

Fig 2 *Ball-valve left atrial thrombus: Conventional long-axis view of the heart. The fan of the ultrasonic beam traverses a plane from the aortic valve to the apex of the left ventricle (LV)—see diagram. By convention the long-axis tomogram is presented with the patient on his back, with the head to the right. The ball-valve thrombus (Thr) intermittently occluded the mitral orifice (MV), particularly during diastole (DIAST). Chordal thickening due to rheumatic mitral stenosis is also present. S = interventricular septum.*

cellular elements showed no features of degeneration. The thrombus was therefore relatively recent, probably of less than 48 hours' duration. The chordae tendineae were shortened and thickened and the effective mitral valve orifice measured 2 cm^2. No pathological changes in blood vessels or central nervous system were observed.

Case 3 A 54-year-old woman with rheumatic carditis, mitral stenosis, and increasingly severe exertional dyspnoea was referred for cardiac surgery. She had developed a right-sided hemiparesis two years before admission. Despite the absence of atrial arrhythmias, neurological investigations at that time suggested that the cerebral infarction was most likely embolic, and anticoagulant treatment was initiated. Physical and radiological signs on admission were those of moderately calcific mitral stenosis in sinus rhythm. The standard M-mode echocardiogram showed an enlarged left atrial cavity, mitral cusp thickening, and anterior movement of the posterior leaflet, consistent with mitral stenosis; no atrial echoes were seen behind the posterior wall of the aorta. The two-dimensional echocardiography study (fig 3) documented the presence of an intracavitary mass measuring about 3·5 cm contiguous with the posterior wall of the atrium. The findings were confirmed at surgery; the grossly distorted mitral valve was excised and replaced by a prosthetic device. A large thrombus 3·8 cm in diameter showing various stages of organisation was carefully dissected from the posterior atrial wall, and the left atrial appendage was ligated. Macroscopically the mitral valve leaflets were moderately thickened, and the chordae were shortened and of greater than normal width. Histologically the valve leaflets showed changes of an acquired nature, consistent with chronic rheumatic heart disease. The atrial thrombus had histological features of organisation, with fibroblasts, endothelial sprouts, capillaries, and areas of calcification.

Discussion

The role of M-mode echocardiography in the detection of cardiac masses is well established.[1 2] Recent developments in two-dimensional echocardiography techniques permits direct visualisation of nearly all areas of the heart and the simultaneous study of its chambers.[3 4] Two-dimensional echocardiography displays spatial characteristics of the image by rapidly steering the ultrasound beam back and forth through a given field of view, and these images have added new and more precise data to those obtained by M-mode echocardiography. Because these images anatomically resemble the heart, two-dimensional echocardiography is capable of visualising the cardiac masses rather than giving indirect evidence, as does the conventional M-mode technique. The potential for spurious echoes to appear within the heart in M-mode recordings is also well recognised; in the two-dimensional echocardiography studies, in which views are obtained from various locations around the thorax, the margin for error is reduced as spurious echoes are seen in only a single view, whereas intracardiac masses could be consistently visualised.

A cerebral embolus is a much-dreaded complica-

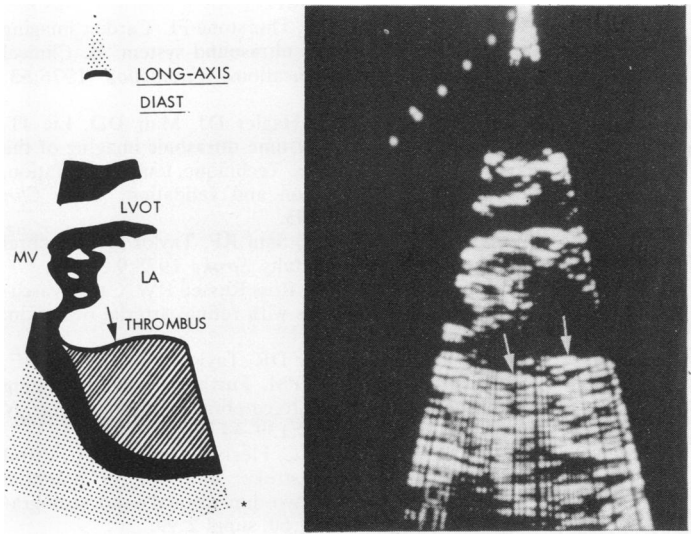

Fig 3 *Atrial thrombus and mitral stenosis. Conventional long-axis view of the heart (see diagram in fig 2), diastolic frame. There are noticeable chordae and mitral valve thickening. A fairly large (3·5 cm) thrombus is seen adherent to the posterior wall of the atrium (arrows).*

tion of cardiac disease as it often occurs unexpectedly in patients whose symptoms are few and whose prognosis is otherwise good. Emboli from within the heart are well recognised as a frequent cause of stroke; this appears particularly relevant in young adults, where embolisation of thrombotic material from the heart is a relatively frequent cause of neurological symptoms.[5 6]

Cerebral ischaemic lesions in young patients with mitral valve prolapse can result from thromboembolism;[7] two-dimensional echocardiography has showed the presence of thrombi in the atrium and attached to prolapsing valves in some of these patients presenting with transient ischaemic attacks or stroke,[8] as in the youngest patient we report (case 1). In patients with rheumatic heart disease two-dimensional echocardiography can detect the development of a ball-valve thrombus in the left atrial cavity, as in our second patient, which can cause fluctuating changes in the degree of obstruction, sometimes with syncope or sudden death. The detection of atrial thrombus also provides useful clinical information for the management of patients with mitral stenosis such as patient 3. Anticoagulation is urgently indicated on detection of atrial mural thrombi in these patients, even in the presence of sinus rhythm. These patients are also unsuitable candidates for a closed mitral valvotomy.

A correlation between ultrasound and the morphological and histological findings was possible in the patients reported here. Although relatively recent thrombi can be detected, some degree of organisation is probably required for their accurate identification. We would emphasise that the thrombi visualised were all relatively large (more than 2 cm in diameter); the sensitivity of ultrasound in relation to clot size is unknown, but many small thrombi are likely to remain undetected, particularly the shallow thrombi in close contact with the atrial wall. The visualisation of the atrial appendage is technically very difficult; as over half the thrombi in patients with mitral stenosis are localised to the atrial appendage,[9] ultrasound can be expected to be an imperfect method for their detection.

False-positive diagnoses of atrial thrombi can be minimised if consideration is given to the technical limitations of ultrasound. Inappropiate gain-attenuation settings and the acoustical similarity of small thrombi to the surrounding blood or atrial wall hinder the sensitivity of this method; intracavitary echoes that simulate thrombi can also be produced by the axial and lateral resolution problems inherent in the two-dimensional echocardiography technique.

Despite isolated reports,[10 11] standard M-mode echocardiography is usually inadequate for detecting atrial thrombi. Because it records larger portions of the atrium and permits the visualisation of dynamic movement of the mass, two-dimensional echocardiography facilitates the interpretation of vague M-mode findings. It can show the formation of potentially embolic thrombus which is secondary to abnormalities of atrial size, rhythm, or wall surface properties that occur alone or in combination with mitral valve disease. We have recently reviewed our experience with cardiac ultrasound in patients presenting with cerebral ischaemia.[12] It appears that in selected patients with either clinical evidence of cardiac disease or an arrhythmia who have experienced one or more episodes of cerebral or retinal ischaemia the presence of an intracardiac mass is not uncommon, and ultrasonic screening should aid clinical management in such cases. In patients with neurological symptoms without clinical manifestations of heart disease, however, this technique failed to provide evidence of underlying cardiac disease.

Despite some of the limitations discussed, ultrasound (particularly in the two-dimensional mode) is a useful technique in the non-invasive imaging of left atrial masses. Visualisation of atrial thrombus can provide important clinical information and may help to define patients at risk from embolisation.

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