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Two-Dimensional Echocardiographic Imaging of Left Atrial Appendage Thrombi

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The utility of two-dimensional echocardiography in the diagnosis of left atrial thrombi is well documented. One major limitation of this technique, however, has been the failure to successfully image left atrial appendage thrombi. This report discusses the presumptive diagnosis in three patients of pathologically confirmed left atrial appendage thrombi using a modified short-axis parasternal two-dimensional echocardiographic view.

The utility of two-dimensional echocardiography in the diagnosis of left atrial thrombi is well documented (1–10). One major limitation of this diagnostic modality, however, has been the failure to successfully image left atrial appendage thrombi (3,8,9). Indeed, we are unaware of any reported cases of two-dimensional echocardiographic detection of left atrial appendage thrombi with subsequent pathologic confirmation. The detection of left atrial appendage thrombi is of clinical significance because it could potentially affect decisions concerning medical therapy with systemic anticoagulation or the surgical approach to the left atrium for mitral valve replacement. In this report, we describe three cases of presumptively diagnosed left atrial appendage thrombi with pathologic confirmation. The use of a modified parasternal short-axis two-dimensional echocardiographic view for imaging left atrial appendage thrombi is discussed.

Methods

Routine two-dimensional echocardiograms were performed with a mechanical ultrasonoscope (model Mark III, Advanced Technology Laboratories) utilizing standard imaging techniques (11). In addition, a modified short-axis parasternal two-dimensional echocardiographic view at the aortic valve level was used to image the left atrial appendage. To obtain this view, the transducer was first oriented for the standard parasternal short-axis view at the aortic valve level. The plane of the beam was then angulated superiorly with lateral tilting of the transducer, so that the pulmonary and aortic valves, but not the tricuspid, were imaged (Fig. 1 and 2). The positioning of the transducer in a high intercostal space was sometimes helpful for optimal imaging of the left atrial appendage in patients with a dilated left atrium. In one patient, the left atrial appendage thrombus was best seen with the sector plane tangential to the aortic valve, so that aortic and pulmonary valve leaflets were not imaged (Fig. 3). The left atrial appendage was best visualized during late ventricular systole when the left atrium was maximally distended.

Echocardiographic images were recorded on videotape and illustrations were obtained from photographs of stop action, single frame scan images displayed on a Tektronix model 634 high resolution video monitor. The diagnostic criterion for a presumptive left atrial appendage thrombus was a well defined echo-dense mass within the appendage, completely or partially surrounded by an echo-free area.

Reports

Case 1: mitral stenosis, new atrial fibrillation and heart failure. A 37 year old man with rheumatic heart disease was admitted to the hospital on July 1, 1981 with increasing dyspnea, orthopnea and new atrial fibrillation with a rapid ventricular rate.

A two-dimensional echocardiogram showed left atrial enlargement, mitral stenosis and a left atrial appendage mass interpreted as a thrombus (Fig. 1). After medical treatment,

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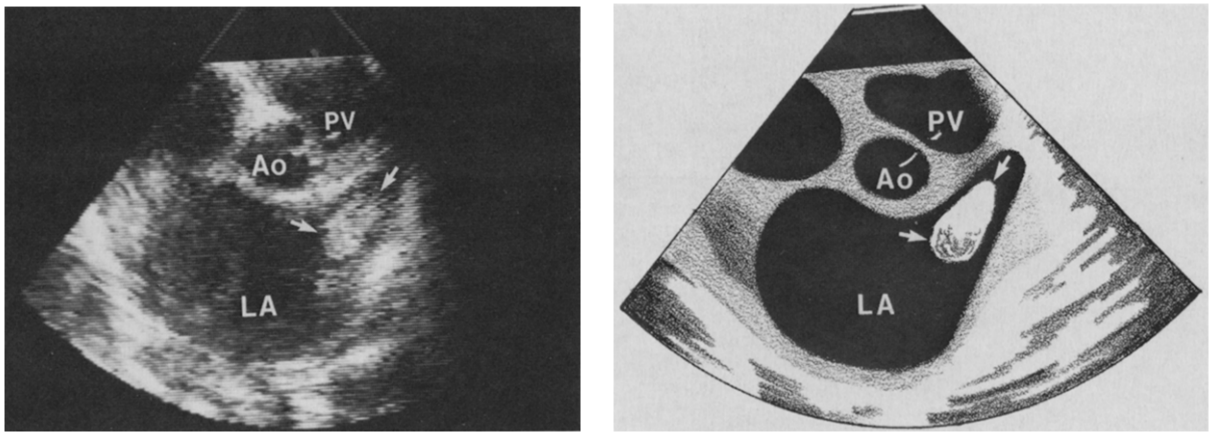


Figure 1. Case 1. Two-dimensional echocardiogram, modified parasternal short-axis view at aortic valve level (**left**) and diagram (**right**). The aortic (Ao) and pulmonary valves (PV) are imaged. A left atrial (LA) appendage thrombus is identified (**arrows**).

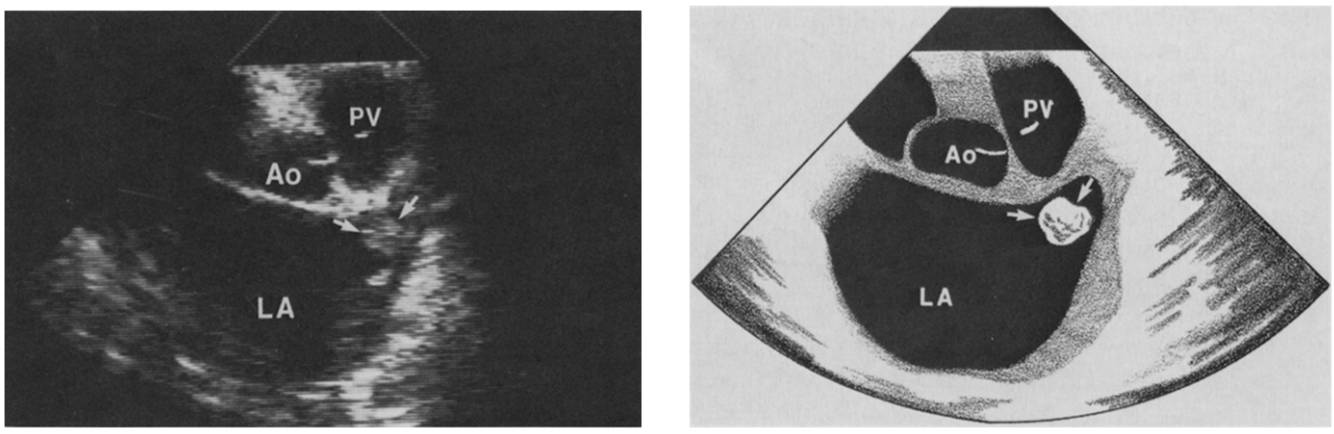
cardiac catheterization revealed moderately severe mitral stenosis with a calculated valve area of 0.8 cm^2, trace aortic insufficiency and 1^+ mitral regurgitation.

The patient underwent mitral valve replacement and at surgery, two areas of plaque-like organized atrial thrombus were found: one along the caudal wall of the left atrium between the right inferior pulmonary vein and mitral anulus, and the second in the left atrial appendage. These thrombi were surgically removed, and postoperative two-dimensional echocardiography revealed no recurrence of thrombus.

Case 2: mitral stenosis, atrial fibrillation, sepsis and peripheral embolism. A 34 year old woman with mitral stenosis was admitted to the hospital on October 11, 1982 with acute dyspnea and a 4 day history of fever. Two weeks before admission, her right foot suddenly became white and painful, but these findings resolved in several hours. Physical examination disclosed atrial fibrillation with a rapid ventricular rate of 180/min and a blood pressure of 94/80 mm Hg, a temperature of 38.9°C and diffuse inspiratory chest rales. A grade 3/6 systolic ejection murmur and a grade 2/6 diastolic rumble were heard at the apex; the pulmonary component of the second heart sound was accentuated. The right foot was cool with diminished pulses. The electrocardiogram showed atrial fibrillation with a rapid ventricular response and right ventricular hypertrophy. Pyuria was present on urinalysis; urine cultures and four sets of blood cultures were negative.

A two-dimensional echocardiogram revealed marked left atrial enlargement, and a thrombus in the posterior left atrium was imaged on the parasternal long-axis view. The modified short-axis view at aortic valve level (to visualize the left atrial appendage) demonstrated an enlarged left atrial appendage filled with thrombus (Fig. 2). The left atrial size was 72 mm on the M-mode echocardiogram and mitral stenosis was present, but no vegetations were imaged. Digoxin, verapamil, furosemide, heparin, penicillin, nafcillin and gentamicin were administered. The patient initially had relief of dyspnea, but remained febrile. One week after

Figure 2. Case 2. Two-dimensional echocardiogram, modified parasternal short-axis view at aortic valve level (**left**) and diagram (**right**). The aortic (Ao) and pulmonary valves (PV) are imaged. A left atrial appendage (LA) thrombus is present (**arrows**).



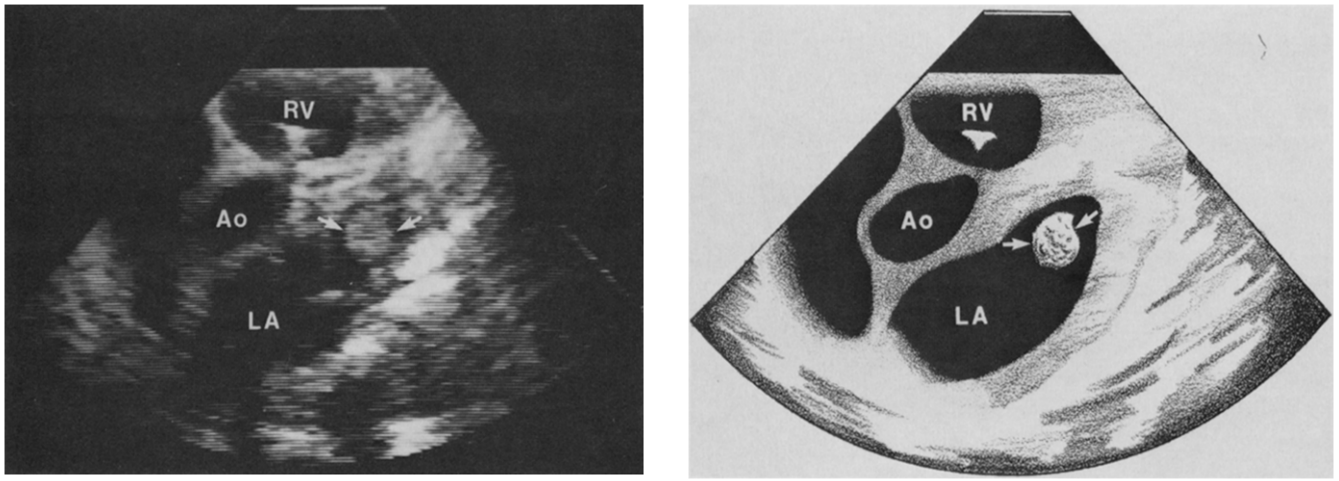


Figure 3. Case 3. Two-dimensional echocardiogram, modified parasternal short-axis view at aortic valve level with sector plane tangential to the aortic valve (Ao) (**left**) and diagram (**right**). A left atrial appendage (LA) thrombus is shown (**arrows**). A catheter is seen in the right ventricle (RV).

admission, she became severely dyspneic and a repeat two-dimensional echocardiogram showed a marked increase in the size of the left atrial thrombus.

An emergency open mitral valve commissurotomy was performed and a large organized thrombus (8 × 6.5 × 2 cm, 60 g) involving the left pulmonary vein, right inferior pulmonary vein, left atrial appendage and posterior leaflet of the mitral valve was removed. Culture of the thrombus grew out group D enterococci, Proteus mirabilis and Acinetobacter calcoaceticus. Postoperative ultrasonography revealed probable gall bladder sludge. The gall bladder was nonvisualized by technetium-99m cholescintigraphy. It was concluded that her polymicrobial sepsis with infected left atrial thrombus was of biliary tract origin. Postoperative echocardiographic studies on October 21 and 25, 1982 revealed no left atrial thrombi.

Case 3: atrial septal defect, atrial fibrillation and cerebral and pulmonary embolism. A 69 year old woman with a 3 day history of weakness and shortness of breath was found unconscious at home on July 31, 1979. On admission, physical examination revealed a cachectic, elderly comatose woman. Atrial fibrillation was present with a pulse of 150/min, a blood pressure of 110/65 mm Hg and a temperature of 38.3°C. There was jugular venous distension with a positive hepatojugular reflux and a pericardial friction rub. A flaccid right hemiparesis was noted.

A two-dimensional echocardiogram showed marked biatrial and right ventricular dilation, with a small left ventricle and paradoxical septal motion. Discontinuity of the interatrial septum was seen on the subcostal view, and a right to left shunt at the atrial level was demonstrated by contrast echocardiography (saline solution injection). A spherical mass imaged in the left atrial appendage was compatible with thrombus (Fig. 3).

The patient was treated with heparin, penicillin, gentamicin, digoxin and furosemide. Her hospital course was complicated by disseminated intravascular coagulation and respiratory failure. Serial two-dimensional echocardiograms on August 8 and 16, 1979 demonstrated decreasing size of the left atrial mass. The patient had a fatal cardiopulmonary arrest on August 19, 1979.

At autopsy, a secundum atrial septal defect was found and mural thrombi were present in both the right and left atrial appendages. Emboli were present in the left pulmonary artery and left middle cerebral artery. There was evidence of a recent myocardial infarct involving the septum.

Discussion

Incidence of left atrial appendage thrombi in mitral valve disease. Left atrial thrombi are a common pathologic finding in rheumatic mitral valve disease (12–15). Presumably, other pathologic states (including rhythm disturbances) associated with stasis of blood in the left atrium can predispose to the development of thrombi. Nichols et al. (13) reported that 44 of 200 patients who had an open valve commissurotomy for mitral stenosis had left atrial thrombi. In an autopsy series of 51 cases of mitral stenosis with intracardiac thrombi, Jordan et al. (14) found thrombi in the left side of the heart in 42 patients, of which 48% were limited to the left atrial appendage. Thirty-two patients had pathologic evidence of systemic arterial embolization, and 13 of these patients had thrombi in the left side of the heart restricted to the left atrial appendage. Wallach et al. (15) found left atrial appendage thrombi in 20.3% of patients in an autopsy series of 296 patients with moderate or severe

rheumatic mitral valve disease. Left atrial appendage thrombi or clots in the body of the left atrium were seen in 35.8% of the patients. In 13% of their patients, left atrial appendage thrombi were unaccompanied by clots in the body of the left atrium. Thus, there is a significant occurrence of left atrial appendage thrombi in patients with rheumatic mitral valve disease.

Two-dimensional echocardiographic detection of left atrial appendage thrombi. *Previous studies.* Previous clinicopathologic studies of left atrial imaging by two-dimensional echocardiography have reported a uniform failure to detect left atrial appendage thrombi. Shrestha et al. (9) studied 293 patients with rheumatic heart disease who underwent mitral valve surgery. Left atrial thrombi were diagnosed by two-dimensional echocardiography in 33 patients and confirmed pathologically in 30. In 21 other patients, left atrial thrombi were present, but not detected echocardiographically, and in 11 of these patients, the thrombi were located solely in the left atrial appendage. Schweizer et al. (3) imaged 111 patients with significant mitral stenosis, of whom 92 had open heart surgery. Five patients had prospectively diagnosed thrombi in the body of the left atrium. Cardiovascular surgery identified an additional eight patients with left atrial thrombi not detected by two-dimensional echocardiography. Seven of these thrombi were located in the left atrial appendage, although four only filled the tip of the appendage and were "not larger than a pea." Baker and Martin (8) prospectively investigated 43 patients with rheumatic mitral valve disease. Eleven of the 43 had left atrial thrombi confirmed pathologically, but only six thrombi were detected by two-dimensional echocardiography. The five undetected thrombi were all located in the left atrial appendage. Finally, one of the three patients with left atrial thrombi reported by Perry et al. (6) had a probable left atrial appendage thrombus; however, there was no pathologic confirmation.

Present approach. We have demonstrated that left atrial appendage thrombi can be successfully imaged by two-dimensional echocardiography. Similar approaches to imaging of the left atrial appendage have been described by others (6,16). Dilation of the left atrial appendage and absence of effective atrial contraction due to atrial fibrillation, presumed prerequisites for thrombus formation, were present in all of our patients. The successful detection of appendage thrombi by echocardiography and the avoidance of false negative studies depend primarily on optimal imaging. The correct beam plane must be utilized to maximize the greatest tomographic area of left atrial appendage being imaged. Particular attention should be directed to analyzing images during late ventricular systole when the left atrial appendage is maximally distended. In addition, imaging is more satisfactory with an enhanced gray scale, using a minimal reject setting. Equally important is the avoidance of false positive echocardiographic studies. Correct identification of obliteration of the appendage during early ventricular diastole in patients with atrial fibrillation, or during atrial systole in patients with normal sinus rhythm, is important in avoiding the incorrect diagnosis of thrombi. It is also essential that echocardiographic images be analyzed during late ventricular systole when the left atrial appendage is maximally distended. Tangential imaging of the appendage wall may be problematic because of trabecular structures simulating thrombi. The latter pitfall can be avoided by requiring that left atrial appendage dilation be present and that the mass be separated from the wall of the appendage by a distinct echo-free area (Fig. 3).

Therapeutic implications. Left atrial cavity and appendage thrombi, with their attendant embolic complications, are a clinically significant problem. Decisions concerning therapeutic anticoagulation or possible surgical approaches to the left atrium may be affected by the echocardiographic detection of clots, including those limited to the left atrial appendage. The value of serial echocardiographic examination in clinical management was demonstrated by the changing size of the left atrial clots seen in Cases 2 and 3. In the former instance, failure of medical therapy was documented by two-dimensional echocardiography.

No attempt was made to prospectively or retrospectively evaluate patients for left atrial appendage thrombi at our institution. Thus, the diagnostic sensitivity and specificity of two-dimensional echocardiography for imaging left atrial appendage thrombi are unknown. The clinical utility of two-dimensional echocardiographic imaging of left atrial appendage thrombi remains uncertain, but warrants further prospective investigation.

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