Diagnosis of left ventricular thrombi by two-dimensional echocardiography¹

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SUMMARY Sixteen patients had two-dimensional echocardiographic diagnosis of the presence or absence of left ventricular thrombi and anatomical, radiological, or clinical confirmation of the diagnosis. Eleven patients had positive diagnoses, which were confirmed in 10 and possibly incorrect in one. Five other records were reviewed because the patients had undergone aneurysmectomy after two-dimensional echocardiograms: three were true negative and two were false negative studies.

Early experience with M-mode echocardiography suggested that left ventricular thrombi were seldom recognised, though recent reports are more promising (Horgan *et al.*, 1976). There are few series using two-dimensional echocardiography (Ports *et al.*, 1978; DeMaria *et al.*, 1979). In patients with coronary artery disease, the cardiac apex is the site of most left ventricular thrombi (Jordan *et al.*, 1952; Hamby *et al.*, 1974). The recent use of apical and subxiphoid transducer positions for two-dimensional echocardiography has made the apex more accessible for diagnostic assessment. We report our experience in detecting left ventricular thrombi over the past 2½ years, using these techniques.

Subjects and methods

We reviewed the records of all patients who had an initial report written with the diagnostic impression of a 'possible' or 'probable' left ventricular mass suggesting thrombus by two-dimensional echocardiography from June 1976 to December 1978 and who had surgical, angiographic, or clinical confirmation of cardiac thrombi. In addition, records were reviewed to include patients who had undergone two-dimensional echocardiography before resection of left ventricular aneurysms during the last 18 months of the study period.

All patients were examined in the 30° left lateral decubitus position initially, but many were turned into more lateral positions for the apical views. Subxiphoid views were obtained with the patient supine and the knees flexed to attain good relaxation of abdominal muscles. For subxiphoid visualisation, some records were made during sustained or maximal inspiration. A commercially available two-dimensional phased array ultrasonograph (Varian V3000, Palo Alto, CA) was used with a 2.25 MHz fixed focus transducer (Anderson *et al.*, 1977). M-mode recordings were performed using a Smith-Kline Ekoline 20A ultrasonoscope and a 2.25 MHz or 3.50 MHz transducer with 5 cm beam collimation. Initial recordings were made from the left sternal border in long and short axis views as described by Kisslo *et al.* (1976). Apical and subxiphoid views were then performed with particular attention to the left ventricular apex (Chang *et al.*, 1975; Silverman and Schiller, 1978).

We used several criteria for two-dimensional echocardiographic diagnosis of left ventricular thrombi: (1) echocardiographic signs of a mass adjacent to the left ventricular wall, but distinct from the endocardial echo; (2) the texture of the echoes in the mass (frequently) different from the adjacent myocardium; (3) location of the abnormal echo usually near the cardiac apex; (4) asynergic motion of the adjacent ventricular myocardium; (5) imaging of the mass best from the apical or subxiphoid view; (6) occasional mobile projections from the mass into the ventricular lumen (but motion usually synchronous with the adjacent ventricular wall).

The illustrations of two-dimensional echocardi-

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grams in this article are Polaroid pictures of stop-action video tape single frame television images. These images are of significantly lower quality than the display in real time, since only one field of a two field video frame is portrayed. Thus, only one half of the information content on the video tape is displayed by this process, and there is some blurring by the optical system. The motion pattern in real time obviously cannot be appreciated from such pictures.

Results

Eleven patients were identified with a previously made prospective diagnosis of possible or probable left ventricular thrombus. Their clinical characteristics, echocardiographic findings, and method of diagnosis of left ventricular thrombus are listed in the Table. Seven of these patients had confirmation

Table Clinical, echocardiographic, and diagnostic findings

Case no.	Age/sex	Clinical diagnosis	Confirmation	M-mode
1	60 F	CAD, S/P MI	Cerebrovascular accident	Possible thrombus (reading influenced by 2D echo findings)
2	41 M	CAD, S/P MI	LV angio +	Negative for thrombus
3	48 M	CAD	LV angio +	Not done
4	70 M	CAD, S/P MI, endocarditis	LV angio +	Negative for thrombus
5	65 M	Aortic stenosis, heart failure	LV angio +, surgery +	Negative for thrombus
6	52 M	Renal failure, CAD	LV angio +	Negative for thrombus
7	66 F	CAD, S/P MI	LV angio +, surgery +	Negative for thrombus
8	45 M	CAD, S/P MI	Amaurosis fugax	Not done
9	56 M	CAD, S/P MI	LV angio +	Negative for thrombus
10	78 M	CAD, S/P MI	Multiple peripheral emboli	Negative for thrombus
11	30 M	CAD, S/P MI	LV angio +	Negative for thrombus

Abbreviations: CAD, coronary artery disease; S/P MI, status post-myocardial infarction; LV, left ventricular.

of these findings by surgery or left ventricular angiography. Three further patients had clinical settings suggestive of intracardiac thrombi: one had a stroke, one had multiple systemic emboli, and one had amaurosis fugax. The diagnosis of left ventricular thrombus was unconfirmed in one patient (case 6). He had a negative left ventricular angiogram four months after a positive two-dimensional echocardiogram suggesting left ventricular thrombus. This was regarded as a possible false-positive echocardiographic study.

Examples of two-dimensional echocardiographic images interpreted as showing left ventricular thrombi are shown in Fig. 1-4. The gross specimen of the large apical thrombus imaged in Fig. 4 is

Fig. 1 Apical four-chamber (above) and apical long axis (below) two-dimensional echocardiographic images (left) from case 3. The stippled circle in the diagrams (right) indicates the abnormal mass of echoes thought to represent a thrombus. AO, aorta; LA, left atrium; LV, left ventricle; RA, right atrium; RV, right ventricle.

Fig. 2 Apical four-chamber view (above) and apical long axis view (below) of a left ventricular thrombus (shaded area in diagram at right) in case 4. LV, left ventricle; LA, left atrium; RV, right ventricle, RA, right atrium.

Fig. 3 Serial long axis views in case 1 showing disappearance of left ventricular thrombus: (a) May 1977, showing thrombus (arrow) as shaded in panel d. (b) March 1978, with smaller mass of echoes (arrow). (c) December 1978, no further abnormal echoes in area of arrow. LV, left ventricle; P, papillary muscle; AO, aorta; LA, left atrium. (Note: Panel c appears different from a and b because of the altered method of video recording of original images.)

Fig. 4 Long axis (above) and short axis (below) images of 2D echocardiogram from case 7. Shaded areas in diagrams at right represent thrombus, dense white areas indicate myocardium underlying the thrombus. LV, left ventricle; LA, left atrium; AO, aorta.

shown in Fig. 5, after successful removal at aneurysmectomy. The specimen is sliced in a plane similar to the ultrasonic plane of imaging. The M-mode echocardiogram in this patient (Fig. 6) did not suggest left ventricular thrombus.

Four patients had serial two-dimensional echocardiograms over a period of several months. In case 1 a mass in an apical aneurysm was unchanged two months after initial study, much smaller at 10 months, and gone at 19 months (Fig. 3). Initial study in case 3 showed two separate apical masses, and over the follow-up period of 10 months the larger one gradually resolved and the smaller remained constant.

Separately, we reviewed records of all patients undergoing left ventricular aneurysmectomy or aneurysm plication during the period from June 1977 to December 1978. Of the 54 patients in this category, six had preoperative two-dimensional echocardiographic studies. One of these had a positive preoperative two-dimensional echocardiogram and is included in the Table (case 7). Three patients had negative two-dimensional echocardiograms confirmed by lack of thrombus at surgery. Two patients had false-negative preoperative two-dimensional echocardiograms. One of these was a 30-year-old man with a traumatic apical aneurysm caused by a knife wound. Apical anatomy was distorted as a result of the initial trauma and two subsequent cardiac operations. On current review of the echocardiogram, echoes possibly representing the apical thrombus were found to be present. Another false-negative study was recorded on a 66-year-old man with an apical aneurysm. Very limited apical and no subxiphoid views were recorded; on review, echoes suggesting apical thrombus were seen in the apical view.

Fig. 5 Gross specimen of left ventricular thrombus imaged in Fig. 4. Thrombus is sectioned in a plane similar to the upper panel of Fig. 4.

Discussion

Contrast left ventriculography is the primary tool for diagnosis of mural thrombi but its specificity and sensitivity for this diagnosis are poorly defined in the published reports (Hamby *et al.*, 1974). Thus, it is

difficult to assess the accuracy of echocardiographic methods for recognition of mural thrombi unless they are compared with direct pathological examination. In our small series of prospective interpretations two-dimensional echocardiographic findings correctly suggested the diagnosis in 10 of 11

Fig. 6 M-mode echocardiographic sweep from the left ventricular outflow track (LVOT) to the left ventricular body (LV) in case 7. The large thrombus seen in Fig. 4 and 5 cannot be recognised from this M-mode study.

positive readings. The usual lack of findings to suggest a mural mass on M-mode records underlines the advantage of the two-dimensional method. We consider the findings in case 6 to have been a possible false-positive since a negative angiogram was found four months after the echocardiogram. Unfortunately, an echocardiogram was not done at the time of the angiogram, and we have assumed the angiogram accurate for this purpose. There was no clinical evidence of embolism between the two studies. A left ventricular thrombus might dissolve during this period. We followed four patients serially (cases 1, 3, 8, 11) for periods from two to 19 months and in two of these cases, with stable masses on the one- and two-month follow-up studies, apparent reduction in size was noted at nine- and 10-month follow-up, respectively; by 19 months the latter patient had no detectable residual mass. This type of information on the natural history of such lesions, available from echocardiography, is desirable for the best management of such patients.

Our experience with false negative and false positive diagnoses of ventricular masses makes us interpret the findings in each new case with considerable conservatism. Several 'artefacts' may simulate the appearance of intracavitary masses. Strong echo reflectors within the image plane may be spuriously displayed within the cavity because of imperfect beam width (Roelandt *et al.*, 1976). Similarly, strong reflectors either in front of, or behind, the primary imaging plane may be spuriously displayed and suggest a mural mass. The transducer related fixed artefact, most prominent in phased array systems, may cause confusion with an apical mass when apical views are used. In addition, dense highly reflective myocardial scar may produce multiple trailing echoes or reverberations that may mimic a mural mass in any one view, but these artefacts have no consistent pattern of location within the heart with various transducer locations.

This phenomenon is seen commonly within the aorta and left atrium resulting from reverberations trailing from the strong aortic wall echoes.

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