Value and limitations of two-dimensional echocardiography for the detection of left main coronary artery disease[1]

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To evaluate the sensitivity and specificity of two-dimensional echocardiography for the detection of left main coronary artery disease, echocardiograms were obtained of 47 patients (38 men and 9 women) with the use of a Hewlett-Packard phase array system. Coronary arteriograms were also obtained. Three false-positive results compared with 28 true-positive cases resulted in a specificity of 90% for two-dimensional echocardiography; 3 patients had normal echocardiograms in the presence of significant angiographic lumen narrowing. Since 9 patients had left main trunk disease, sensitivity was 67%. Our findings suggest that two-dimensional echocardiography is somewhat limited in permitting visualization of left main coronary artery disease.

Index terms: Coronary disease • Heart, ultrasound studies
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Several studies suggest that two-dimensional echocardiography can be used as an alternative method for the detection of left main coronary artery stenosis.[1–10] Some investigators, however, have questioned the value of this technique for the diagnosis of coronary artery disease.[11,12] We evaluated two-dimensional echocardiography in clinical practice for the detection of left main coronary artery disease.

Material and methods

During a one-month period, 47 patients referred to the Cleveland Clinic with a diagnosis of coronary artery disease were studied with two-dimensional echocardiography and coronary arteriography. Both studies were done within 12

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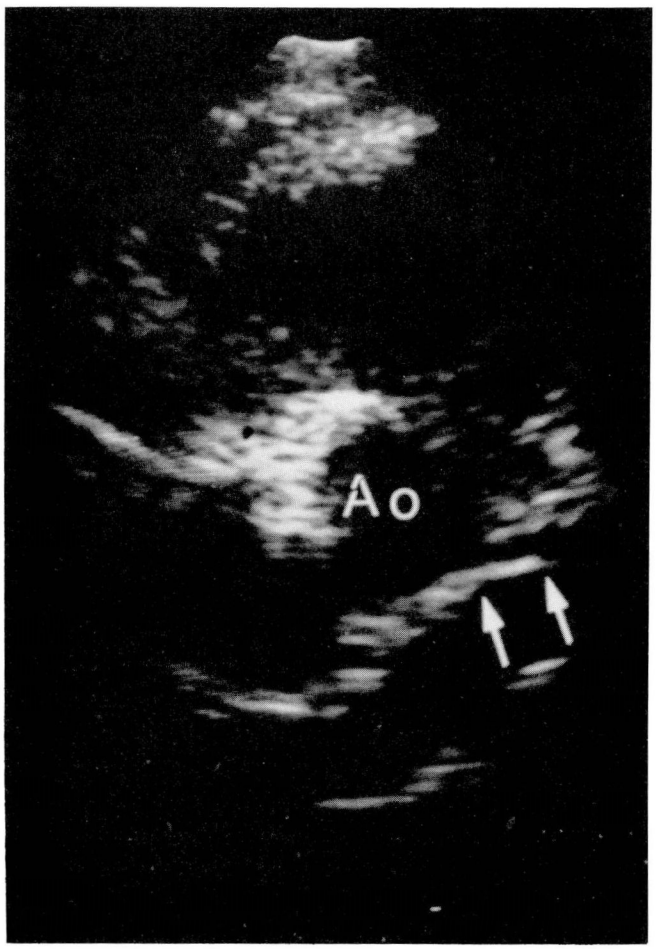


Fig. 1. Short axis left parasternal view at the level of the aorta in a patient with normal left main coronary artery. The arrows point to this vessel; the ostium and the walls of the artery are clearly seen and show no abnormalities.

Fig. 2. Short axis left parasternal view at the level of the aorta in a patient with an ostial lesion in the left main trunk. Notice that the walls of the vessel have increased reflectivity and the lumen is narrowed at the origin.

hours of each other. The angiographic results were unknown to the investigators performing or reviewing the two-dimensional echocardiograms. There were 38 men and 9 women. All the echocardiograms were performed with a Hewlett-Packard phase array system and each study was recorded on a ½-inch video recorder for subsequent frame-by-frame analysis. The left parasternal and apical windows were used to study the left main trunk. This vessel was recognized by its origin in the left coronary sinus, visualization of its ostium, and by the characteristic appearance of the vessel walls, which are seen as two parallel lines perpendicular to the left lateral wall of the aorta (*Fig. 1*).

The length of the left main trunk visualized with echocardiography was measured in millimeters with the instrument's computer as the distance from the ostium to the point where one or both of the vessel walls could not be imaged.

The echocardiographic abnormalities considered necessary to establish the presence of left main trunk disease included strong echo reflections within the vessel lumen and/or localized hyper-reflectivity in the walls of the artery (*Fig. 2*). The video tape recordings were analyzed frame-by-frame by two independent investigators. In case of disagreement, a consensus decision was made. When an obstruction was believed to be present, an approximation of the degree of narrowing was made by visual inspection.

Coronary arteriography was performed by the Sones technique with multiple oblique projections. Special attention was given to the spatial orientation of the left main trunk. Left main

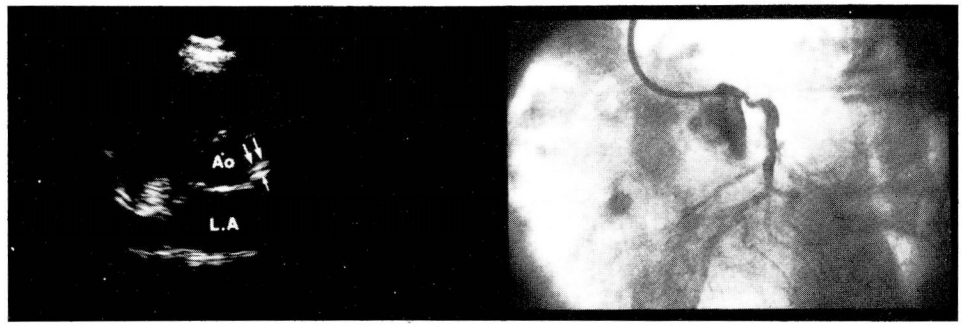


Fig. 3. Short axis left parasternal echocardiographic view and left anterior oblique projection of a left coronary arteriogram, demonstrating a proximal 80% obstruction in the left main trunk. The arrows in the echocardiogram point to a thickened and narrow left main coronary artery.

trunk disease was determined as a 50% or more luminal narrowing. By this criteria, 35 patients (74%) had no left main trunk lesions, 9 patients (19%) had at least 50% stenosis in the left main coronary artery, and 3 patients (6%) had absent left main trunk with the left anterior descending and circumflex arteries originating from different ostia.

The sensitivity and specificity of two-dimensional echocardiography to detect left main coronary disease were calculated by standard statistical methods.[13]

Results

The left main trunk was visualized by two-dimensional echocardiography in 40 (85%) of the 47 patients. In 1 of the 7 patients in whom the left main trunk was not visualized, the left anterior descending and the circumflex arteries had different ostia. Another patient had marked calcification of the aortic root. In the other 5 patients, there was no clear definition of the echocardiographic structures at the level of the left main coronary artery. There were only 3 cases in which the left main trunk could only be visualized from the apical window. Two-dimensional echocardiography did not afford recognition of the separate origin of the left anterior descending artery and the circumflex artery in any of the 3 cases in which this was proved by angiography.

The anatomic spatial orientation of the left main trunk was analyzed in detail from multiple angiographic projections in the patients in whom no echocardiographic visualization of this vessel was possible and was compared with that of 10 randomly selected patients in whom the left main trunk was clearly delineated by echocardiography.

Echocardiography did not afford visualization of the left main trunk when it originated in the posterosuperior aspect of the left coronary sinus and the initial segment of the vessel had a cephalic angulation. In contrast, good echocardiographic visualization of the left main trunk was possible when the ostium was in the anterior aspect of the sinus of Valsalva and the orientation of the initial segment of the vessel was horizontal rather than cephalic.

The median length of the left main trunk visualized by two-dimensional echocardiography was 1.2 ± 0.2 cm (range, 0.8–1.8 cm).

In 6 patients, there was echocardiographic and angiographic agreement regarding the presence of left main trunk disease (*Fig. 3*). *Table 1* demonstrates fair correlation regarding the magnitude of obstruction in the patients studied by these methods.

Three patients were classified as having left main trunk disease by echocardiography when angiographically the vessel was normal (*Fig. 4*). These three false-positive results when compared with the 28 true-positive cases give a specificity of 90% of two-dimensional echocardiography in the detection of left main trunk disease. Three patients had normal echocardiographic images of the left main trunk in the presence of significant angiographic lumen narrowing (*Fig. 5*). Since

Table 1. Quantification of left main trunk lesion

Patient no.	Angiography	Echocardiogram
22	70%	60%
23	80%	90%
27	80%	80%
36	50%	60%
39	50%	50%
30	80%	80%

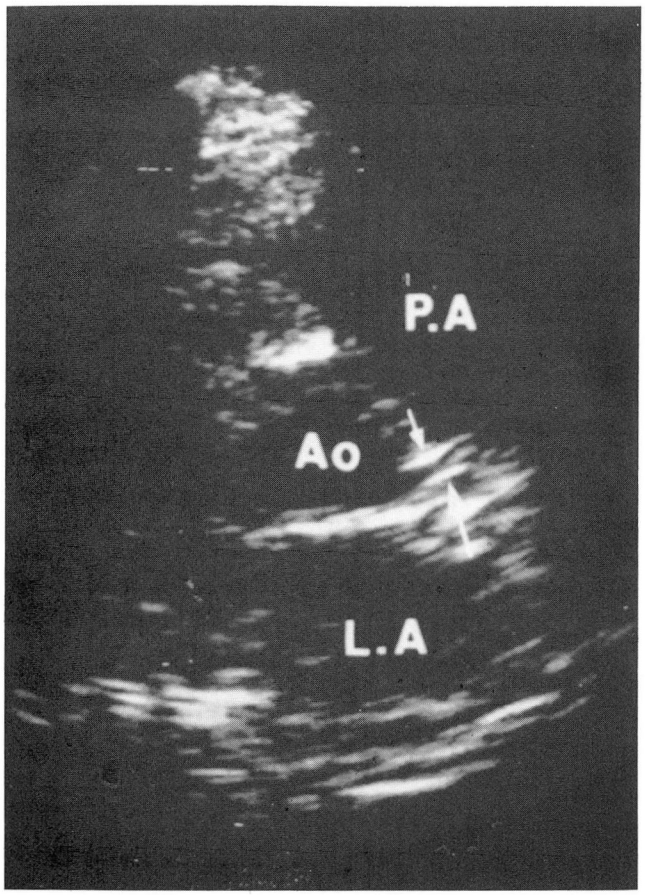


Fig. 4. Short axis left parasternal view in a patient with a false-positive two-dimensional echocardiogram for left main trunk disease. The arrows point to the apparent vessel walls encroaching into the lumen. Angiographically, the arteries appear to be normal.

there were 9 patients with left main trunk disease, sensitivity was 67% (*Table 2*). In the 3 patients with false-negative results, the angiographic lesions of the left main trunk were close to the bifurcation.

Discussion

Echocardiographic visualization of the left main coronary artery has been reported by several investigators. The percentage of patients in whom this has been possible has varied from 60% to 99%. We were able to visualize the left main trunk in 85% of our patients. Our evaluation of the angiographic spatial orientation of the main trunk in relation to the two-dimensional ability to visualize this vessel showed that the arteries that arise from the anterior aspect of the left coronary sinus and then have a horizontal course are the easiest to image. Arteries originating in the posterior aspect of the coronary sinus that have a cephalic course are more difficult to visualize with echocardiography. This anatomic variation probably explains the wide range of visualization percentages previously reported.

Also important in evaluating the left main trunk by echocardiography is the length of the vessel that can be visualized. The average length we visualized was 1.2 ± 0.2 cm, which implies that lesions situated more than 1.2 cm from the ostium are more difficult to detect. Conversely, ostial lesions or lesions in the origin of the left main artery are more easily detected.

The motion of the root of the aorta during the cardiac cycle produces simultaneous motion of the left main coronary artery. This moves the vessel in and out of the echocardiographic sector plane and it may be transected in an oblique way, producing in some instances the appearance of pseudo-obstructions (*Fig. 4*).

Changes in gain setting can also result in error. With a low gain setting, a lesion in the artery may not be apparent (*Fig. 6*) and an excessive gain setting may produce localized areas of increased echodensity simulating an obstructive lesion.

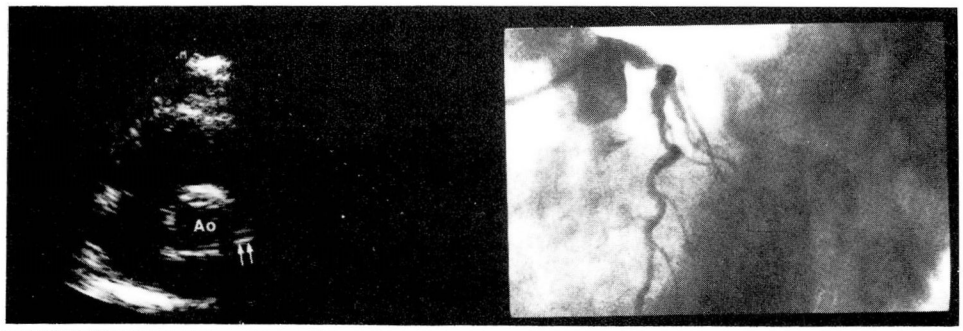
Since the prevalence of left main coronary artery disease is low, a highly sensitive and specific test is necessary for its detection. Echocardiography falls short of this. In our series, sensitivity was only 67%. However, the ability to exclude left main coronary artery disease by echocardiography was relatively high with a specificity of 90%. These results could support the use of echocardiography as a screening method to rule out left main coronary artery disease. Nevertheless, we agree with others that coronary arteriography remains the only viable method for the diagnosis of coronary artery obstructions. Its risk is low, even in patients with left main coronary artery disease, and the information it provides is far superior to any other current imaging modality.

Our findings suggest that although two-dimensional echocardiography permits visualization of

Table 2. Comparison of the angiographic and echocardiographic detection of left main trunk lesions

	Echocardiographic diagnosis	
	Lesions present	Lesions absent
Angiographic diagnosis		
Lesions present	6	3
Lesions absent	3	28

Sensitivity = 67%, specificity = 90%.



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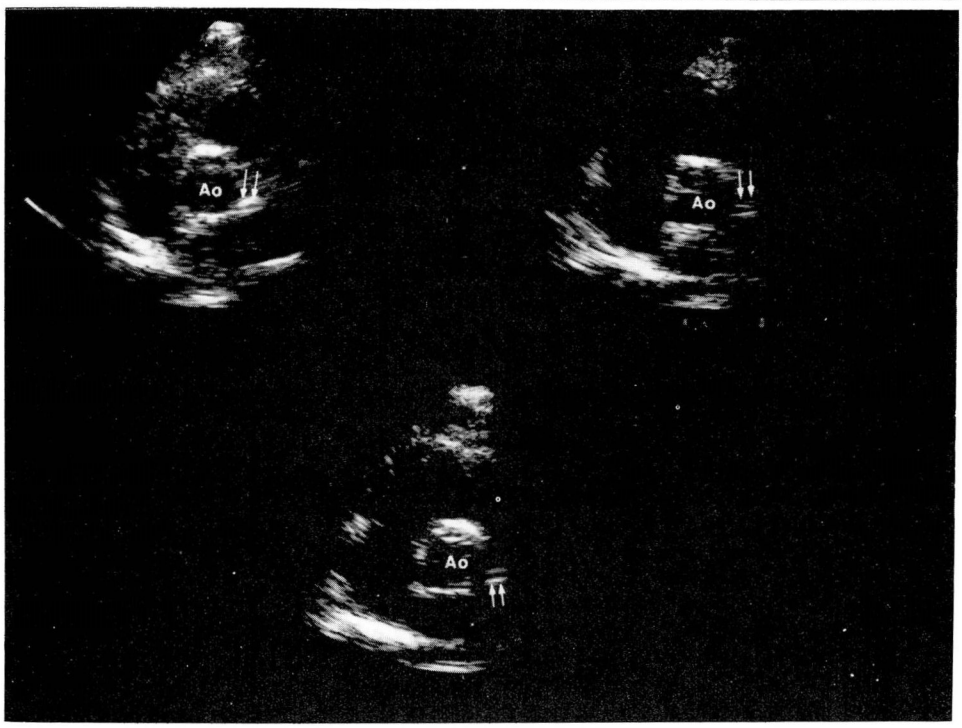

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Fig. 5. Two-dimensional echocardiogram and left anterior oblique hemiaxial projection coronary arteriogram, showing a severe left main trunk lesion just before its bifurcation. Note the normal appearance of the left main trunk in the two-dimensional echo (arrows).

Fig. 6. This echocardiogram demonstrates the effect of a different gain setting in the same patient. Only in the superior and left frames would we suspect the presence of disease. The inferior and right superior frames, which have a less gain setting, were interpreted as normal.

the left main trunk or parts of it, it does not promise to play an important role as an imaging technique to visualize left main trunk or other coronary artery stenosis.

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