

# Left Atrial Enlargement by Echocardiography: An Early Sign of Hypertensive Heart Disease

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Left atrial abnormality on the electrocardiogram (ECG) has been considered an early sign of hypertensive heart disease. In order to determine if echocardiographic left atrial enlargement is an early sign of hypertensive heart disease, we evaluated 12 normal and 20 hypertensive patients for echocardiographic left atrial enlargement. All patients had sinus rhythm, normal left ventricular volumes and function, no valvular disease, and no echocardiographic or ECG left ventricular hypertrophy. No patient met ECG criteria for left atrial abnormality. The mean left atrial dimension was  $3.25 \pm 0.2$  cm in normal individuals versus  $4.12 \pm 0.2$  cm in the hypertensive patients ( $p < 0.02$ ). The left atrial index was also higher in the hypertensive group,  $2.13 \pm 0.38$  versus  $1.81 \pm 0.12$  cm/m<sup>2</sup> ( $p < 0.04$ ). Left atrial to aortic root dimension ratio was significantly higher in the hypertensive group,  $1.39 \pm 0.3$  versus  $1.16 \pm 0.10$  ( $p < 0.02$ ). We conclude that echocardiographic left atrial enlargement may be an early sign of hypertensive heart disease in patients with no other apparent cause of left atrial enlargement.

**Key words:** Left atrial enlargement; hypertension; echocardiography

Systemic hypertension often leads to left ventricular hypertrophy, congestive heart failure, and death<sup>1</sup>. In some patients, concentric left ventricular hypertrophy can occur early in the course of mild to moderate hypertension<sup>3</sup>. Other patients may present with left ventricular dilatation, asymmetric septal hypertrophy, or eccentric left ventricular hypertrophy<sup>2</sup>. Frohlich et al<sup>4</sup> have suggested that electrocardiographic (ECG) evidence of a left atrial abnormality is an early sign of hypertensive heart disease. We have observed echocardiographic left atrial enlargement as the only abnormality in patients with systemic hypertension in the absence of definite left ventricular hypertrophy by ECG or echocardiographic criteria. Dunn et al.<sup>5</sup> have suggested that left atrial enlargement may be an earlier sign of hypertensive heart disease than left ventricular hypertrophy and/or dilatation. We conducted this study to determine whether echocardiographic left atrial enlargement is an early sign of hypertensive heart disease in the absence of ECG or echocardiographic evidence of left ventricular hypertrophy.

## Methods

The study population consisted of 12 control normotensive individuals and 20 hypertensive patients who met the following criteria: sinus rhythm with the absence of ECG evidence of myocardial infarction, no history suggestive of ischemic heart disease, no systolic global or regional left ventricular dysfunction by echocardiography, normal left ventricular end-diastolic and end-systolic left ventricular dimensions, clinically & echocardiographically no evidence of mitral or aortic valve disease, no left atrial abnormality by ECG criteria<sup>6</sup> and no left ventricular hypertrophy when Romhilt Estes' ECG criteria<sup>6</sup> or the echocardiographic criteria of end-diastolic left ventricular

posterior wall thickness  $> 1.2$  cm were used<sup>7</sup>.

The normotensive individuals had blood pressures that never exceeded 140/90 mm Hg on multiple visits. The hypertensive patients had blood pressure consistently  $> 140/90$  mm Hg on at least several visits for five to six years. These patients had been taking various antihypertensive medications but compliance was uncertain. The mean duration of clinically documented hypertension was 4.8 years (range 4.0 to 7.8 years). Eight of 12 normotensive and 13 of 20 hypertensive patients were male.

Echocardiographic study including M-mode and two-dimensional, was done for all patients by standard techniques. The aortic root and left atrial dimensions were measured with the leading edge technique.<sup>7</sup> The aortic root dimension was measured at end-diastole at the level of aortic valve. The left atrial dimension was measured at its largest diameter and the exact location of the posterior atrial wall was confirmed by two-dimensional echocardiography. The normal values for left atrial size, left atrial index, and left atrial-to-aortic root dimension ratio are 4.0 cm, 2.0 cm/m<sup>2</sup> and 1.17, respectively<sup>7,8</sup>.

Left ventricular cavity dimensions and thickness of interventricular septum and posterior left ventricular wall were measured from two-dimensional echocardiographic-guided M-mode recordings at the level of chordae tendineae according to American Society of Echocardiography (ASE) recommendations<sup>9,10,11,12</sup>. The end-diastolic point was measured at the peak of R wave on simultaneous ECG recording.

The values for echocardiographic variables were listed as mean  $\pm$  1 standard deviation. The control values were compared to hypertensive patients values by means of an unpaired Student's t test.

## Results

Clinical and echocardiographic characteristics of two groups are listed in Table 1. There was no difference in age, end-diastolic or end-systolic dimensions, fractional shortening or ejection fraction. The hypertensive group had a significantly higher mean arterial pressure at  $105 \pm 8$  mm Hg compared to  $93 \pm 7$  mm Hg for the normotensive group.

Left atrial dimension of most of normotensive individuals were below the normal upper limit of 4 cm. The mean left atrial dimension was  $3.25 \pm 0.2$  cm in normal individuals versus  $4.12 \pm 0.2$  cm in the hypertensive patients ( $p < 0.02$ ) (Table 2).

Left atrial index in most of normal individuals was below the upper limit of  $2 \text{ cm/m}^2$ . The mean left atrial index (left atrial dimension divided by body surface area) was significantly higher in the hypertensive group  $2.13 \pm 0.38$  as compared to  $1.81 \pm 0.12 \text{ cm/m}^2$  in the control normotensive individuals ( $p < 0.04$ ) (Table 2).

The ratio of left atrial to aortic root dimension was above the normal value of 1.17 in 17 of 20 hypertensive patients while it was below this limit in most of normal individuals. The mean left atrial to aortic root dimension ratio was significantly higher in the hypertensive group,  $1.39 \pm 0.3$  as compared to control normotensive individuals,  $1.16 \pm 0.10$  ( $p < 0.02$ ) (Table 2).

Table 1. Clinical and Echocardiographic Characteristics

	Age (Yr)	BSA ( $\text{m}^2$ )	MAP (mm Hg)	Ejection Fraction (%)	EDD (cm)	ESD (cm)
Control (n = 12) (Mean $\pm$ SD)	42 (30-65)	$1.72 \pm 0.21$	$93 \pm 7$	$65 \pm 7$	$4.6 \pm 0.7$	$3.1 \pm 0.5$
Hypertensive (n = 20) (Mean $\pm$ SD)	46 (34-68)	$1.75 \pm 0.19$	$105 \pm 8$	$69 \pm 8$	$4.8 \pm 0.8$	$3.0 \pm 0.7$
P-value	NS	NS	$< 0.01$	NS	NS	NS

BSA = body surface area; MAP = mean arterial pressure; EDD = end diastolic dimension; ESD = end systolic dimension; SD = 1 standard deviation.

Table 2. Left Atrial Measurements

	Left Atrial Dimension (cm)	Left Atrial Index ( $\text{cm} / \text{m}^2$ )	Ratio of Left Atrial to Aortic Dimension
Control (n = 12) (Mean $\pm$ SD)	$3.25 \pm 0.2$	$1.81 \pm 0.12$	$1.16 \pm 0.10$
Hypertensive (n = 20) (Mean $\pm$ SD)	$4.12 \pm 0.2$	$2.13 \pm 0.38$	$1.39 \pm 0.30$
P-Value	$< 0.02$	$< 0.04$	$< 0.02$

## Discussion

ECG evidence of left atrial enlargement has been shown to occur in hypertensive patients. Frohlich et al.<sup>4</sup> compared 25 normotensive patients to 97 untreated hypertensive patients to determine the presence of left ventricular dysfunction and left atrial enlargement by ECG criteria. It was found that ECG left atrial abnormality was related to initial hemodynamic evidence of left ventricular dysfunction, as measured by left ventricular ejection rate and left ventricular stroke work. Josephson et al.<sup>13</sup> have shown that left atrial enlargement by ECG does not necessarily correlate with echocardiographic left atrial enlargement and may be a manifestation of a conduction delay due to other causes.

Savage et al.<sup>3</sup> studied 234 hypertensive patients by echocardiography. They excluded the presence of coronary artery disease on the basis of a negative history and the absence of ECG evidence of myocardial infarction. They found 15% to have increased left atrial dimensions and concluded that left atrial enlargement did not appear to be an early sign of cardiac involvement; however, they did

not study left atrial enlargement in relation to left ventricular hypertrophy and whether they occur independently.

Our results demonstrate that echocardiographically demonstrated left atrial enlargement in patients with hypertension and no other cardiovascular disease occurs in the absence of ECG left atrial abnormality and ECG or echocardiographic manifestations of left ventricular hypertrophy. Of the three methods used to determine left atrial enlargement echocardiographically, the left atrial-to-aortic root dimension ratio provided the best separation between the normotensive and hypertensive subjects. However, with all three methods, there is overlap of hypertensive patients with normal subjects. Nevertheless, few of normal subjects had abnormal values and none of the 12 normotensive subjects had left atrial enlargement when all three methods were used.

The cause of early left atrial enlargement is unknown, but other studies have suggested that abnormal left ventricular compliance may be an early sign in hypertensive patients. Dreslinski et al.<sup>14</sup> demonstrated

reduced left atrial emptying index as assessed by M-mode echocardiography in hypertensive patients without ECG evidence of left atrial or ventricular enlargement. Inouye et al.<sup>15</sup> noted abnormal radionuclide angiographic measures of diastolic left ventricular filling in patients with mild to moderate hypertension, but there was a correlation between these measures and echocardiographic left atrial dimension and left ventricular mass.

In conclusion, our data demonstrate that echocardiographic left atrial enlargement in the absence of evidence for left ventricular hypertrophy can occur in patients with systemic hypertension. This finding may represent an early manifestation of hypertensive heart disease. Patients with ECG evidence of left atrial abnormality should have an echocardiogram to correlate that this aberration is due to left atrial enlargement rather than due to atrial conduction abnormalities.

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