Echocardiographic Evaluation of Morphological and Hemodynamic Significance of Giant Left Atrium
An Important Lesson

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In this issue of Circulation, Minagoe et al. describe an interesting Doppler echocardiographic observation that blood flow velocity in the inferior vena cava (IVC) entrance into the right atrium is increased especially during inspiration in patients with a giant left atrium (GLA) and mitral stenosis. The increase in velocity was caused by the narrowed IVC orifice at its junction with the right atrium resulting from bulging of the atrial septum in these patients with GLA. Compared with the patients with lone atrial fibrillation or mitral stenosis without GLA, they had a smaller IVC orifice and higher flow velocity in the absence of severe tricuspid regurgitation. Two-dimensional and Doppler echocardiographic measurements were made from a right parasternal longitudinal plane, and pulsed-wave Doppler velocities in the IVC were recorded simultaneously with a respiratory tracing. In these patients with GLA, hepatomegaly by palpation was more frequent, and the authors concluded that a localized obstruction at the IVC orifice by GLA resulted in systemic venous congestion.

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Definition of Giant Left Atrium

A case of "extreme dilatation of the left auricle" in a 40-year-old woman was described by Owen and Fenton in 1901. The patient had suffered from rheumatic fever and presented with urgent dyspnea. On examination, the entire right side of the chest at the back was dull, which was thought to reflect the presence of pleural effusion. Urgent paracentesis, however, produced pure blood. Postmortem examination showed that the pericardial sac occupied the entire thoracic cavity with extreme dilatation of the left atrium, which had been tapped. Since this case report, various diagnostic criteria of GLA were proposed with advances in imaging modalities to debate its clinical significance.3-7 To describe the clinical features of the patients with "extreme left atrial enlargement," De Sanctis et al. reviewed 10 patients whose left atrium either "touched the right chest wall or extended within one centimeter of it on posteroanterior chest x-ray." All of their patients had some degree of heart failure and hepatomegaly. Compression of adjacent structures (lung, trachea, bronchi, aorta, and esophagus) was common. The cardiothoracic ratio (CTR) was greater than 88% in each patient. Others used a CTR of ≥0.7 to define giant left atrium.5,6 However, the left atrial size is difficult to be measured accurately from a chest x-ray. Since the initial clinical application of echocardiography in the 1960s, it became the imaging technique of choice to determine the cardiac chamber size, including the left atrium, in everyday cardiology practice.5,9 When Piccoli et al. measured the left atrial dimension by echocardiography from the parasternal long-axis view in 40 patients with a CTR >0.7, it ranged from 7 to 12 cm.

Therefore, echocardiographic evidence of massive left atrial enlargement (i.e., anteroposterior diameter >8 cm) has been combined with GLA to define GLA in another study. More recently, computed tomography was used to determine the left atrial dimension and volume in a patient with GLA. There are no established diagnostic criteria for GLA, however, and an empirical definition of left atrial dimension of ≥65 mm on two-dimensional echocardiography parasternal long-axis view was used in this study. Compared with the previous criteria of GLA, the present study includes patients with smaller left atrial size.

Echocardiographic Evaluation of the GLA

Morbidity of GLA comes from compression of intracardiac and adjacent extracardiac structures. In 28-40% of patients with GLA who underwent mitral valve replacement, the atrial septum was found to be anteriorly displaced narrowing the IVC-atrial junction along with small and compressed right atrium5 as described in Minagoe’s present study. A two-dimensional echocardiographic study demonstrated that the posterobasal wall of the left ventricle may be bent inward (toward the ventricular septum) by inferior extension of the left atrial dilatation.11 When the bending is significant, the motion of the bending segment of the posterobasal wall may become akinetic. Hemodynamic effects of the intracardiac compression by GLA, however, has not been evaluated until the present study using Doppler echocardiography.
Application of the Doppler technique has made echocardiography not only a noninvasive imaging tool but also a hemodynamic modality. By measuring velocities of blood flow in the heart and vessels, Doppler echocardiography allows reliable measurement of pressure gradients across the stenotic orifice, intracardiac pressures, stroke volume, valve area, and diastolic filling profiles. Normal velocity profiles of cardiac valves, great arteries, and central veins are well established. A significant variation from the normal values indicates an abnormality in flow status or cross-sectional area of the valve or vessel lumen. At a relatively constant flow, flow velocity is inversely proportional to cross-sectional area. If the cross-sectional area is fixed, flow velocity is proportional to flow. Therefore, blood flow velocity increases when area decreases, flow increases, or both. Valvular stenosis or vascular narrowing such as coarctation is therefore diagnosed by increased Doppler velocities, and their severities are estimated by the degree of velocity increase and area calculation by estimating flow from an orifice with known area and Doppler velocities (such as left ventricular outflow tract). In the patients with GLA, the peak IVC orifice flow velocities were increased, indicating small orifice size, increased flow, or both. When there was no severe tricuspid regurgitation, increased velocity was related primarily to the compressed IVC orifice size. When there was severe tricuspid regurgitation, the increased velocity was related to both higher flow through the IVC orifice and relative compression of the IVC by the atrial septum. Doppler echocardiography also allows recording of the direction of blood flow. When hepatomegaly is caused by severe tricuspid regurgitation or constrictive pericarditis, pulsed-wave Doppler in the hepatic vein shows significant systolic and diastolic reversal flow velocities, respectively. If the liver is congested by IVC obstruction, I would have expected significant flow reversals in the hepatic vein as severe tricuspid regurgitation or constrictive pericarditis. The authors, however, did not find any significant differences in the hepatic vein velocities among different groups, but they measured only antegrade flow velocities, and no reversal flow velocity in the hepatic vein was mentioned.

What Have We Learned From the Present Study?

Minagoe and colleagues should be congratulated for their attempt to investigate morphological and hemodynamic consequences of the GLA using two-dimensional Doppler echocardiography. It is clear that blood flow velocities in the IVC orifice were increased because of compression of the atrial septum toward the right atrium by the GLA. Its clinical significance is less clear, however, because the change in mean velocity was modest (from 70.2 to 93.4 cm/sec with corresponding pressure gradient from 2 to 3.5 mm Hg), and there was no objective evidence of a systemic venous congestion in patients with GLA except for the increased incidence of hepatomegaly by palpation. Further documentation of more objective measures of systemic venous congestion would strengthen the authors’ observation.

The most important lesson from this study should be the understanding that complete structural, functional, and hemodynamic evaluation of the cardiovascular system can be obtained by comprehensive two-dimensional, Doppler, and color flow echocardiographic examination. To produce the optimal result, all available ultrasound windows need to be explored, including the transesophageal approach. The authors were the first group to introduce the right parasternal window to optimize the visualization of the atrial septum and IVC orifice. Simultaneous recording of respiration and Doppler velocities as performed in the present study allows better appreciation of the respiratory effects on the cardiovascular system under normal and abnormal conditions.

With this versatile diagnostic tool, we are now in a better position to characterize morphological and hemodynamic significances of not only GLA but also all other cardiovascular pathologies noninvasively.

References


KEY WORDS • left atrium, giant • Editorial Comments
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Circulation. 1992;86:328-330
doi: 10.1161/01.CIR.86.1.328

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