Transesophageal Echocardiography
New Window to Coronary Arteries and Coronary Blood Flow
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Transesophageal echocardiography (TEE) has opened a new window to the heart, as well as to the great vessels and coronary arteries. Not only the main stem but also the left circumflex, left anterior descending, and right coronary arteries can be visualized in longer lengths than by transthoracic echocardiography. The left main and left circumflex coronary arteries are nearly perpendicular to the echo beam, whereas the left anterior descending and right coronary arteries are nearly parallel to it. The success rate of visualizing coronary arteries has also increased with the increase in transducer frequencies. Varying success rates for visualizing the different parts of the coronary arteries by TEE have been reported in the literature. The left main coronary artery is visualized in 65% to 100% of cases, left anterior descending coronary artery in 54% to 100%, and the right coronary artery in 7% to 100%. Using TEE intraoperatively, Taams et al described a success rate of 100% for the detection of the left circumflex and left main coronary arteries. Information on sensitivity and specificity are not yet available.

Biplane TEE can produce a more reliable estimate of coronary lumen narrowing, particularly of the left main coronary artery. In the study by Yoshida et al, sensitivity was 91% and specificity 100% for detection of coronary luminal narrowing. Negative predictive accuracy was 100% and positive predictive accuracy 98%. These results demonstrate that multiple scan planes are advantageous compared with single plane transducers. Adjustment to the coronary artery position by transducers that can be rotated seem to be a prospective improvement to these applications in the future.

Pulsed Doppler and color Doppler echocardiography combined with TEE can be used to measure proximal coronary arterial blood flow velocity, as reported in this issue of Circulation by Iliceto et al. As with transthoracic echocardiography, the movement of the base of the heart can produce sampling problems. The sample volume may move in and out of the coronary lumen or may change its position in relation to the vessels, meaning that coronary blood flow velocity can only be measured during certain parts of the cardiac cycle, usually during diastole, a phase of maximum blood flow velocity. Measurement of coronary flow velocity during systole and...
diastole would be the exception. Moreover, respiration influences the position of the sample volume. These important limitations may be overcome by a new ultrasonic vessel tracking pulse Doppler system, which has been developed to stabilize the Doppler sample volume in relation to the vessel.24

The velocity measurement is dependent on the position of the sample volume in relation to the coronary luminal narrowing. The velocity is normal proximal to the stenosis, increased within the stenosis, and reduced distally. Thus, the anatomy of the artery has to be known to accurately measure coronary blood flow velocity. This can be done by two-dimensional transesophageal echocardiography or coronary angiography.

Even with severe coronary luminal narrowing, resting coronary blood flow velocity may be normal, but blood flow reserve is limited, as can be estimated from the ratio of maximal to baseline coronary blood flow velocities. For studies with intracoronary Doppler catheters25 or videodensitometry,26,27 vasodilating agents like intracoronarily injected papaverine — a short acting substance — or intravenously administered dipyridamol — a long acting substance — are used to induce maximal coronary blood flow. The difference can be used as an estimate of coronary blood flow reserve.

Iliceto et al23 have demonstrated that pulsed Doppler transesophageal echocardiography can be used to estimate coronary flow reserve. In patients with coronary artery disease and stenosis estimated to be \( \geq 75\% \), the ratio of maximal diastolic velocities before and after administration of dipyridamole was 3.22±0.96; the ratio of mean diastolic velocities before and after administration of dipyridamole was 3.04±0.88. These values cannot be regarded as “normal” values because, as Gould et al28 reported, already a stenosis area reduction of \( >60\% \) is required to reduce coronary flow reserve. In patients with coronary artery disease and stenosis \( \geq 75\% \), the corresponding ratios were 1.46±0.45 and 1.48±0.48.23 These results, used to calculate coronary flow reserve, demonstrate that coronary flow reserve is reduced in patients with significant coronary artery disease that has been diagnosed by other methods.28

One limitation of the method described by Iliceto et al23 is the exclusion of 30% of the patients because their TEE studies were of inadequate quality. Transesophageal echocardiography does, however, have the clear advantage of being less invasive, and with less complications, than heart catheterization,29 which is needed for quantitative lesion geometry and contrast appearance time.25–27 The method is, however, restricted to imaging of the left anterior descending coronary artery because the angle between the echo beam and either the left main coronary artery or the left circumflex coronary artery is, in most patients, more than 30° and often near 90°. For the right coronary artery, flow velocity measurements have not been reported. The right coronary artery is not in the near field of the high frequency transduc-
ers. Thus, imaging and Doppler measurements will be difficult to perform.

The safety of intravenous injection of dipyridamole needs to be considered. It has been demonstrated in 3,911 patients at 64 centers using the drug in thallium-201 myocardial scintigrams that chest pain occurred in 20% of the patients, headache and dizziness in 12%, and ST segment changes in 7.5%.30 However, the administration of aminophylline completely relieved the symptoms in 97% of these patients as was also seen in the study by Iliceto et al.23 There is a potential for increased risk of serious ischemic events in patients with histories of unstable angina. An increased risk of bronchospasm in these patients was also demonstrated by Ranhosky et al.30

In the future, studies using pulsed Doppler transesophageal echocardiography should include comparisons with other methods of measuring coronary blood flow reserve, like scintigraphy,30 coronary Doppler flow,25 and videodensitometry,26,27 to get an estimate of the accuracy of this new and promising seminvasive method.

**References**


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