Superiority of Transesophageal Echocardiography in Detecting Cardiac Source of Embolism in Patients With Cerebral Ischemia of Uncertain Etiology

ANTHONY C. PEARSON, MD, FACC,† ARTHUR J. LABOVITZ, MD, FACC,* SATYARARAYAN TATINENI, MD,‡ CAMILO R. GOMEZ, MD‡

St. Louis, Missouri

The diagnostic yield of transesophageal and transthoracic echocardiography for identifying a cardiac source of embolism was compared in 79 patients presenting with unexplained stroke or transient ischemic attack. There were 35 men and 44 women with a mean age of 59 years (range 17 to 84); 52% had clinical cardiac disease. Both transthoracic and transesophageal echocardiograms were performed using Doppler color flow and contrast imaging.

Transesophageal echocardiography identified a potential cardiac source of embolism in 57% of the overall study group compared with only 15% by transthoracic echocardiography (p < 0.0005). Compared with transthoracic echocardiography, transesophageal echocardiography more frequently identified atrial septal aneurysm associated with a patent foramen ovale (9 versus 1 of 79 patients, p < 0.005), left atrial thrombus or tumor (6 versus 0 of 79 patients, p < 0.05) and left atrial spontaneous contrast (13 versus 0 of 79 patients, p < 0.0005). All cases of left atrial thrombus or spontaneous contrast were identified in patients with clinically identified cardiac disease.

Approximately one-sixth of all cerebral infarcts are due to cerebral embolism of cardiac origin (1). Despite this, the standard surface two-dimensional echocardiographic examination of patients with embolic stroke is usually unRewarding in identifying potential cardiac embolic sources (2-4). Transesophageal echocardiography has recently emerged as a very promising tool for identifying cardiac sources of embolism. Recent studies have demonstrated that transesophageal echocardiography is much more sensitive than transthoracic echocardiography in detecting left atrial thrombus, especially in the left atrial appendage (5), and atrial septal defect (6), two potential causes of cardiogenic embolism.

This study was designed to evaluate the utility of transesophageal echocardiography in patients presenting with unexplained stroke and compare the diagnostic yield of transesophageal and transthoracic echocardiography in this group of patients.

Methods

Study group. Between September 1988 and August 1989, all patients admitted to the stroke service of our institution with the diagnosis of cerebral infarction or transient ischemic attack of uncertain etiology were prospectively enrolled in the study. The study group consisted of 35 men and 44 women with a mean age of 59 years (range 17 to 84). Fifty-two percent had clinical cardiac disease and 48% were free of clinically identifiable cardiovascular disease as assessed by history, physical examination, electrocardiogram and chest roentgenogram. Atrial fibrillation was present in 14%, coronary artery disease in 18% and valvular disease in 20% of the study group.

Echocardiographic examinations. All patients underwent both transthoracic and transesophageal imaging with contrast administration and Doppler color flow imaging. All studies were recorded on 1/2 inch 0.27 cm VHS videotape for subsequent playback and analysis. Transthoracic echocardiography was performed within 3 days (usually 24 h after

From the "Department of Internal Medicine, Division of Cardiology and Department of Neurology, St. Louis University Medical Center, St. Louis, Missouri.

Manuscript received April 10, 1990; revised manuscript received July 11, 1990, accepted July 14, 1990.

†Current address and address for reprints: Anthony C. Pearson, MD, Associate Professor of Medicine, Division of Cardiology, The Ohio State University, 6th Floor Means Hall, 1654 Upham Drive, Columbus, Ohio 43210.

©1991 by the American College of Cardiology.
transesophageal echocardiography) using several commercially available ultrasound systems with 2.5 to 3.5 MHz imaging transducers. Standard views including parasternal long- and short-axis, apical two and four chamber and subcostal four chamber views were obtained in all patients.

Transesophageal echocardiography was performed with the patient in the fasting state using small amounts of intravenous sedation and topical pharyngeal anesthesia. All studies were performed using the Hewlett Packard 5 MHz transesophageal echocardiographic probe mounted on the end of a 100 cm flexible gastroscope. Standard views were recorded in all patients.

Contrast imaging was performed during both surface and transesophageal echocardiography. Saline solution (10 ml) was mixed with a small amount of air and agitated by vigorous passage between two 12 ml syringes through a three-way stopcock. Three injections of agitated saline solution were then performed through an 18 gauge catheter in the antecubital vein during normal respiration, a series of coughs and the Valsalva maneuver. The transthoracic echocardiogram was read by an independent experienced reader blinded to the results of transesophageal echocardiography. The transesophageal echocardiogram was read by a second independent experienced reader blinded to the results of transesophageal echocardiography.

The presence of the following lesions was noted: 1) left atrial or ventricular thrombus or tumor associated with a patent foramen ovale (defined as the passage of two or more microbubbles into the left atrium within three cardiac cycles of contrast opacification of the right atrium in the absence of a visual defect in the atrial septum); 2) atrial septal defect (defined as a break in the continuity of the atrial septum accompanied by Doppler color flow evidence of left to right shunting and contrast echocardiographic evidence of right to left shunting); 3) mitral valve prolapse (defined from the transthoracic echocardiogram as a score >3 using our previous reported criteria (7) and from the transesophageal echocardiogram as >3 mm bowing of the leaflets beyond the mitral annulus plane in the four chamber view); 4) left atrial spontaneous contrast (defined as dynamic swirling intracavitary echoes); and 5) atrial septal aneurysm (defined according to criteria published (8) for surface echocardiograms as demonstrated in Fig. 1).

Statistical methods. Comparison of the relative prevalence of each potential cardiac source of embolism was made by chi-square analysis. A p value <0.05 was considered significant.

Results

Atrial septal aneurysm and patent foramen ovale (Fig. 2). The prevalence of the predefined potential cardiac sources of embolism as diagnosed by transthoracic echocardiography and transesophageal echocardiography is demonstrated in Table 1. By transthoracic echocardiography, one isolated atrial septal aneurysm and one atrial septal aneurysm associated with a patent foramen ovale were identified. Transesophageal echocardiography identified four isolated atrial septal aneurysms and nine atrial septal aneurysms associated with a patent foramen ovale (p < 0.005 versus transthoracic echocardiography). Two of these atrial septal aneurysms with right to left shunting also demonstrated small (8 and 10 mm, respectively) defects in the atrial
Table 1. Cardiac Sources of Embolism by Echocardiography in 79 Patients With Transient Ischemic Attack or Stroke

<table>
<thead>
<tr>
<th></th>
<th>Transesophageal</th>
<th>Transthoracic</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrial septal aneurysm</td>
<td>4 (5%)</td>
<td>1 (4%)</td>
<td>NS</td>
</tr>
<tr>
<td>Patent foramen ovale</td>
<td>4 (5%)</td>
<td>3 (6%)</td>
<td>NS</td>
</tr>
<tr>
<td>ASA with PFO</td>
<td>9 (11%)</td>
<td>1 (10%)</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>Left atrial thrombus</td>
<td>6 (8%)</td>
<td>0 (0%)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Left atrial spontaneous contrast</td>
<td>13 (16%)</td>
<td>0 (0%)</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>Patent foramen ovale</td>
<td>2 (3%)</td>
<td>4 (6%)</td>
<td>NS</td>
</tr>
<tr>
<td>Mitral valve prolapse</td>
<td>5 (6%)</td>
<td>3 (6%)</td>
<td>NS</td>
</tr>
<tr>
<td>Noncontributory</td>
<td>34 (43%)</td>
<td>63 (67%)</td>
<td>&lt;0.0005</td>
</tr>
</tbody>
</table>

ASA = atrial septal aneurysm; PFO = patent foramen ovale.

Left atrial thrombus (Fig. 3 and 4). Transthoracic echocardiography identified no atrial masses, whereas transesophageal echocardiography identified left atrial thrombus in five patients and a left atrial myxoma in one (<0.05). Four of the atrial thrombi identified by transesophageal echocardiography were in the left atrial appendage. Spontaneous contrast in the left atrium was noted in three patients by transesophageal echocardiography and in none by transthoracic echocardiography; 9 of these 13 patients were in atrial fibrillation. The clinical characteristics of the patients with left atrial thrombus are listed in Table 2. All these patients had either atrial fibrillation or mitral valve disease, or both.

Mitra1 valve prolapse was identified in five patients by transesophageal echocardiography and in three patients by transthoracic echocardiography (<0.05). Left ventricular apical thrombus was identified in two patients by transesophageal echocardiography and in four patients by transthoracic echocardiography (<0.05).

Transesophageal versus transthoracic echocardiography. In 57% of the study group, a potential cardiac source of embolism was identified by transesophageal echocardiography compared with only 15% by transthoracic echocardiography (<0.0005). In the 38 patients with no clinical cardiac disease (Table 3), potential cardiac sources of embolism were identified in 39% by transesophageal echocardiography compared with only 15% by transthoracic echocardiography (<0.0005). Transesophageal echocardiography was superior to transthoracic echocardiography in detecting isolated atrial septal aneurysm (<0.05) and atrial septal aneurysm with a patent foramen ovale (<0.05). Transesophageal echocardiography detected atrial septal aneurysm or patent foramen ovale, or both, in 31% of this group compared with 11% for transthoracic echocardiography (<0.0005). There were no cases of left atrial or apical spontaneous contrast in the left atrium was noted in 13 patients by transesophageal echocardiography and in none by transthoracic echocardiography; 7 of these 13 patients were in atrial fibrillation. The clinical characteristics of the patients with left atrial thrombus are listed in Table 2. All these patients had either atrial fibrillation or mitral valve disease, or both.

Mitra1 valve prolapse was identified in five patients by transesophageal echocardiography and in three patients by transthoracic echocardiography (<0.05). Left ventricular apical thrombus was identified in two patients by transesophageal echocardiography and in four patients by transthoracic echocardiography (<0.05).

Transesophageal versus transthoracic echocardiography. In 57% of the study group, a potential cardiac source of embolism was identified by transesophageal echocardiography compared with only 15% by transthoracic echocardiography (<0.0005). In the 38 patients with no clinical cardiac disease (Table 3), potential cardiac sources of embolism were identified in 39% by transesophageal echocardiography compared with only 15% by transthoracic echocardiography (<0.0005). Transesophageal echocardiography was superior to transthoracic echocardiography in detecting isolated atrial septal aneurysm (<0.05) and atrial septal aneurysm with a patent foramen ovale (<0.05). Transesophageal echocardiography detected atrial septal aneurysm or patent foramen ovale, or both, in 31% of this group compared with 11% for transthoracic echocardiography (<0.0005). There were no cases of left atrial or apical spontaneous contrast in the left atrium was noted in 13 patients by transesophageal echocardiography and in none by transthoracic echocardiography; 7 of these 13 patients were in atrial fibrillation. The clinical characteristics of the patients with left atrial thrombus are listed in Table 2. All these patients had either atrial fibrillation or mitral valve disease, or both.

Mitra1 valve prolapse was identified in five patients by transesophageal echocardiography and in three patients by transthoracic echocardiography (<0.05). Left ventricular apical thrombus was identified in two patients by transesophageal echocardiography and in four patients by transthoracic echocardiography (<0.05).

Transesophageal versus transthoracic echocardiography. In 57% of the study group, a potential cardiac source of embolism was identified by transesophageal echocardiography compared with only 15% by transthoracic echocardiography (<0.0005). In the 38 patients with no clinical cardiac disease (Table 3), potential cardiac sources of embolism were identified in 39% by transesophageal echocardiography compared with only 15% by transthoracic echocardiography (<0.0005). Transesophageal echocardiography was superior to transthoracic echocardiography in detecting isolated atrial septal aneurysm (<0.05) and atrial septal aneurysm with a patent foramen ovale (<0.05). Transesophageal echocardiography detected atrial septal aneurysm or patent foramen ovale, or both, in 31% of this group compared with 11% for transthoracic echocardiography (<0.0005). There were no cases of left atrial or apical spontaneous contrast in the left atrium was noted in 13 patients by transesophageal echocardiography and in none by transthoracic echocardiography; 7 of these 13 patients were in atrial fibrillation. The clinical characteristics of the patients with left atrial thrombus are listed in Table 2. All these patients had either atrial fibrillation or mitral valve disease, or both.

Mitra1 valve prolapse was identified in five patients by transesophageal echocardiography and in three patients by transthoracic echocardiography (<0.05). Left ventricular apical thrombus was identified in two patients by transesophageal echocardiography and in four patients by transthoracic echocardiography (<0.05).

Transesophageal versus transthoracic echocardiography. In 57% of the study group, a potential cardiac source of embolism was identified by transesophageal echocardiography compared with only 15% by transthoracic echocardiography (<0.0005). In the 38 patients with no clinical cardiac disease (Table 3), potential cardiac sources of embolism were identified in 39% by transesophageal echocardiography compared with only 15% by transthoracic echocardiography (<0.0005). Transesophageal echocardiography was superior to transthoracic echocardiography in detecting isolated atrial septal aneurysm (<0.05) and atrial septal aneurysm with a patent foramen ovale (<0.05). Transesophageal echocardiography detected atrial septal aneurysm or patent foramen ovale, or both, in 31% of this group compared with 11% for transthoracic echocardiography (<0.0005). There were no cases of left atrial or apical spontaneous contrast in the left atrium was noted in 13 patients by transesophageal echocardiography and in none by transthoracic echocardiography; 7 of these 13 patients were in atrial fibrillation. The clinical characteristics of the patients with left atrial thrombus are listed in Table 2. All these patients had either atrial fibrillation or mitral valve disease, or both.

Mitra1 valve prolapse was identified in five patients by transesophageal echocardiography and in three patients by transthoracic echocardiography (<0.05). Left ventricular apical thrombus was identified in two patients by transesophageal echocardiography and in four patients by transthoracic echocardiography (<0.05).
thrombus in the group of patients with no clinical cardiac disease. Mitral valve prolapse was diagnosed in three patients by both transthoracic and transesophageal echocardiography.

**Discussion**

Previous studies with transthoracic echocardiography. Although cardiac embolism to the brain may be responsible for ≤20% of ischemic strokes, the search for cardiac sources of embolism is typically unrewarding in young patients with ischemic stroke, the cause remains undefined in ≤35% of cases. Despite the well-documented sensitivity of surface echocardiography in detecting most types of intracardiac masses (9), several investigators have demonstrated a low yield of the surface examination even in patients with presumed embolic stroke. Lovett et al. (3) studied 138 patients with focal cerebral ischemia in whom a cardiac mechanism was suspected. Intracardiac thrombus was detected in only nine patients (6.5%), all of whom had clinical cardiac disease or atrial fibrillation, or both. With the exception of one possible intracardiac thrombus, studies in the 55 patients without clinical cardiac disease were noncontributory. In three patients, unsuspected mitral valve prolapse was identified. No cases of atrial septal aneurysm or patent foramen ovale were identified; however, contrast studies were not routine in this study.

Recent studies of transesophageal versus transthoracic echocardiography. The present study confirms the limited utility of transthoracic echocardiography in detecting cardiac sources of embolism. Only 15% of the entire study group and 19% of the patients with no clinical cardiac disease had such sources identified by transthoracic echocardiography. In contrast, transesophageal echocardiography diagnosed potential embolic sources in 57% of the total group and 39% of the group without clinical cardiac disease. Transesophageal echocardiography appears superior to transthoracic echocardiography in detecting atrial septal aneurysm, patent foramen ovale, left atrial thrombus and left atrial spontaneous contrast. All four of these lesions are related to either the left atrium or atrial septum, two structures that are best visualized by transesophageal echocardiography as a result of their posterior location.

**Left atrial thrombus.** The strong association between atrial fibrillation and rheumatic mitral valve disease and stroke is thought to be due to atrial thrombus formation secondary to stasis followed by embolization (10). Transthoracic echocardiography demonstrates a sensitivity of only 23% to 59% for detection of left atrial thrombus and is particularly insensitive to left atrial appendage thrombus (11-12). Recent studies (5) indicate that transesophageal echocardiography is extremely accurate in the diagnosis of left atrial thrombus and much more sensitive than transthoracic echocardiography, especially for left atrial appendage thrombus. The present study confirms the superiority of transesophageal echocardiography for detection of left atrial appendage thrombus. Left atrial thrombus was found only in patients with clinical cardiac disease. In patients without either atrial fibrillation or mitral valve disease, the yield of transesophageal echocardiography for thrombus appears very low.

**Left atrial spontaneous contrast.** Left atrial spontaneous contrast is a fascinating echocardiographic phenomenon initially described (13) with transthoracic echocardiography in an enlarged aneurysmal left ventricle. These rare "smoke-like" echoes are experimentally (14) and clinically (15) related to low flow states. With higher frequency 5 MHz transesophageal echocardiography, left atrial spontaneous contrast is frequently noted in the left atrium of patients with mitral valve disease or atrial fibrillation. Daniel et al. (16) found that patients with left atrial spontaneous contrast had a significantly more frequent history of arterial embolization and a significantly increased incidence of left atrial thrombus than did patients without this phenomenon. In our laboratory (17), we have found left atrial spontaneous contrast to be present with much greater frequency in patients with cerebral ischemia (52% versus 23%, p < 0.05). For these reasons, left atrial spontaneous contrast has been cited as a risk factor for arterial embolism.

**Left atrial spontaneous contrast was found in the present study only in patients with clinical cardiac disease.** These patients were characterized by a history of atrial fibrillation, mitral valve disease or replacement, or both. This group of patients is at an increased thromboembolic risk. It has not been demonstrated in a prospective study what independent risk for thromboembolism left atrial spontaneous contrast adds to the underlying cardiac disease or what therapy may be appropriate when left atrial spontaneous contrast is found in the absence of left atrial thrombus.

**Patent foramen ovale.** Autopsy studies (18) demonstrate an overall prevalence of patent foramen ovale of 27%, with the percent decreasing with age from 34% during the first three decades of life to 25% during the fourth through eighth decades. Paradoxical embolism across a patent foramen ovale has long been implicated as a cause of stroke, and several studies using surface contrast echocardiography have demonstrated an increased prevalence of patent foramen ovale in
patients with stroke. Harvey et al. (19) studied 11 patients <50 years of age with unexplained stroke and no cardiac disease using surface contrast echocardiography during the Valsalva maneuver. They (19) observed right to left shunting during normal respiration in eight patients. Five of their six patients with contrast shunting underwent cardiac catheterization that documented a patent foramen ovale or atrial septal defect: four of these five eventually had surgery where a 5 to 10 mm patent foramen ovale in three and an 8 mm atrial septal defect in one were closed. Lechat et al. (20) studied the prevalence of patent foramen ovale in 60 adults <55 years of age with ischemic stroke and normal cardiac findings in comparison with a control group of 100 patients undergoing posterior fossa surgery. The prevalence of a patent foramen ovale was significantly higher in the patients with stroke (40%) than in the control group (10%, p < 0.001). The prevalence of a patent foramen ovale was particularly high (54%) in the 26 patients with no identifiable cause or risk factor for stroke (mitral valve prolapse, history of migraine or use of oral contraceptives).

In the current study, the prevalence of a patent foramen ovale by transthoracic echocardiography was considerably lower (5% overall and 8% in the subgroup with no clinical cardiac disease) than reported in these previous studies (18–20). This lower prevalence may be explained by differences in patient groups. There was no requirement for technical adequacy of the surface echocardiogram in the current study, whereas 14% of patients were excluded from the study of Lechat et al. (20) for this reason. In addition, the patients in the latter study were younger than our study patients (mean age 39 years compared with 57 years for the entire current study group and 52 years for the current subgroup without cardiac disease), and young patients with stroke are thought to have a higher yield of cardiogenic source of embolism. Finally, younger subjects have a higher prevalence of a patent foramen ovale and are usually easier to image echocardiographically than older subjects.

The diagnosis of a patent foramen ovale was significantly higher by transesophageal echocardiography than transthoracic echocardiography. This may be due to at least three technical factors: 1) superior visualization of the atria and atrial septum with transesophageal echocardiography because of the location of these structures in the "near field" and absence of chest wall acoustic interference; 2) absence of lung interference during Valsalva or cough maneuvers, thus allowing continuous imaging of right and left atria during such maneuvers; and 3) ability to confirm increased right atrial pressure and elevated right atrial/left atrial pressure gradient manifested by movement of the atrial septum toward the left atrium.

Atrial septal aneurysm. Atrial septal aneurysms involve the septum primum and arise from redundant valve tissue of the foramen ovale bulging through the fossa ovalis into either the right or left atrium (21). Originally described only at autopsy, with the widespread use of transthoracic echocardiography atrial septal aneurysm has been noted in ≤1% of routine studies. Recent studies (22,23) have described an association between atrial septal aneurysm and systemic embolic events. Gallet et al. (22) diagnosed 10 cases of atrial septal aneurysm by transthoracic echocardiography over a 3 year period. Three patients had mitral valve prolapse, three had atrial septal defect and two of the remaining four patients had a systemic embolic event. Belkin et al. (23) identified 36 patients over a 27 month period with atrial septal aneurysm by transthoracic echocardiography: 90% had interatrial shunting demonstrated by contrast studies and 22% had a definite or possible embolic event. Hanley et al. (8) observed a cerebrovascular event in 16 patients in a consecutive series of 80 patients with atrial septal aneurysm detected by transthoracic echocardiography.

Two mechanisms have been proposed for the association between atrial septal aneurysm and stroke. Several authors (21) have hypothesized that thrombus arising from the atrial septal aneurysm is responsible on the basis of frequent finding at autopsy of fibrin-thrombus tags on the convex surface of the aneurysm. However, none of the atrial septal aneurysms we visualized contained defects that resembled thrombus. The other mechanism involves paradoxic embolism across an associated patent foramen ovale or atrial septal defect. As in previous studies using transthoracic echocardiography, the present study confirms the strong association between atrial septal aneurysm and a patent foramen ovale or atrial septal defect.

Other cardiac lesions. In the current study, mitral valve prolapse was diagnosed by both echocardiographic methods at a similar rate (4% to 6% overall and 8% in patients without clinical cardiac disease). Mitral valve prolapse has been diagnosed in several studies (24) in >30% of young adults with otherwise unexplained stroke or transient ischemia attack. A cardioembolic mechanism for a cerebral event associated with mitral valve prolapse is supported by pathologic studies, case reports and case control analysis of risk factors (1). However, recent work by Levine et al. (25) suggests that mitral valve prolapse has been overdiagnosed by transthoracic echocardiography because of a saddle-shaped mitral annulus configuration that results in apparent leaflet displacement in the four chamber view in normal subjects. Because transesophageal echocardiography views the mitral valve from the four chamber equivalent plane, it may be equally susceptible to overdiagnosis of mitral valve prolapse.

In a preliminary report of the European Multicenter Study of Transesophageal Echocardiography in 479 cases of unexplained arterial embolism, Daniel et al. (26) reported finding mitral valve prolapse significantly more frequently by transesophageal echocardiography (n = 63) versus transthoracic echocardiography (n = 44). Zecht et al. (27) recently reported using transesophageal and transthoracic echocardiography in 40 young patients (mean age 35 years) with stroke. They diagnosed mitral valve prolapse by transesophageal echocardiography in 24 patients compared with 20 by transthoracic echocardiography. This prevalence was significantly higher than in the control group (17% by transesoph-
Atrial echocardiography. Until strict diagnostic criteria for mitral valve prolapse by transesophageal echocardiography have been established, we recommend caution in making this diagnosis by transesophageal echocardiography in the absence of corroborative transthoracic echocardiographic evidence.

Apical thrombus was diagnosed at an equivalent rate by both techniques. Transthoracic echocardiography has a well-documented (28) high sensitivity and specificity for detecting apical thrombi. The sensitivity of transesophageal echocardiography is not known, but may be limited because of the distance of the left ventricular apex from the transducer.

Limitations. The diagnosis of embolic stroke is notoriously difficult. Neurologic features such as abrupt onset or seizures are nonspecific. Neither computed tomographic scans nor cerebrospinal fluid examination can confirm the diagnosis. The mainstay of diagnosis remains "the presence of a potential cardioembolic source in the absence of cerebrovascular disease in a patient with non-lacunar stroke" (1). Even this criterion can be questioned because embolic strokes occasionally are lacunar and frequently occur coexistent with cardioid atherosclerotic disease. For these reasons, our study group may have included patients with noncardioembolic strokes. We believe the study group is, however, representative of those patients presenting to a tertiary care neurologic service with suspected embolic stroke and, therefore, the results should have widespread clinical application.

There was no independent confirmation of the lesions identified by transesophageal echocardiography. These data, therefore, do not determine the relative accuracy of the two techniques for any specific cardiac lesion. However, previous studies have established the high accuracy of transthoracic echocardiography for detecting left atrial thrombus. Several preliminary reports have also indicated transesophageal echocardiography to be superior to transthoracic echocardiography for identifying patent foramen ovale and atrial septal aneurysm.

Conclusions. In patients presenting with unexplained stroke, transesophageal echocardiography identifies potential cardiac sources of embolism in 57% of cases compared with 15% by transthoracic echocardiography. Even in patients with no clinical cardiac disease, the diagnostic yield of transesophageal echocardiography approaches 40%. In view of the high prevalence of patent foramen ovale in normal subjects, the clinical significance of this lesion must be decided on a case by case basis. However, the use of transesophageal echocardiography in patients with unexplained stroke, even in those with a normal transthoracic echocardiogram, should be recommended.

We acknowledge the superb assistance of Nancy Stallman, RN and Marianne Djiez, RN in the performance of these studies, and Margarite Richards in the preparation of the manuscript.

References


