Comparison of Transesophageal to Transthoracic Color Doppler Echocardiography in the Identification of Intracardiac Mycotic Aneurysms in Infective Endocarditis

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We report on cases of mycotic aneurysms in a group of 14 patients with infective endocarditis, all of whom were evaluated with transthoracic (TTE) and transesophageal (TEE) color Doppler echocardiography. Four mycotic aneurysms were found, one each in the left ventricular outflow tract, the right coronary sinus of Valsalva, the anterior mitral leaflet, and the atrial septum. With TTE, only three of four cases of mycotic aneurysms could be detected. Utilizing TEE, however, all were detected and their connections with the heart chambers or great vessels could be readily and clearly depicted, especially those in the atrial septum and mitral leaflet. We are of the opinion that TEE is superior to TTE in the identification and detailed analysis of mycotic aneurysms complicating infective endocarditis. In addition, we feel that echocardiography may help evaluate the progress of the disease, the location and direction of infection, and the extent of involvement of the mycotic aneurysms, providing useful information for guiding surgical intervention. (ECHOCARDIOGRAPHY, Volume 8, November 1991)

mycotic aneurysm, transesophageal echocardiography

A number of life-threatening complications may develop in the course of infective endocarditis, such as disruption of the valves and their supporting structures, formation of aneurysm and fistulas, and development of myocardial abscesses. Some of these may be associated with rapid or progressive congestive heart failure, which often necessitates early surgical intervention. Transthoracic M-mode and two-dimensional echocardiography (TTE) are well-established techniques for diagnosing infective endocarditis and its complications. The introduction of transesophageal color Doppler echocardiography (TEE) has recently provided a new acoustic window to the heart. In this method, the transducer is close to the heart and the sound beam is not hampered by the chest wall and lung. This allows high quality images with excellent resolution of certain cardiovascular structures. Previous studies have shown that TEE is superior to TTE in detecting vegetations in suspected infective endocarditis, especially in the early stage.[1-3] TEE has also been used for the detailed analysis of ring abscess and mycotic aneurysm.[4,5] In this article, we describe our experience in the identification of mycotic aneurysm complicating infective endocarditis in four patients using TTE and TEE, and evaluate the methods' relative superiority.

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Methods

From April 1988 to April 1990, TTE and TEE were performed in 14 patients with infective endocarditis. Criteria for the clinical diagnosis of infective endocarditis were: fever, anemia, leukocytosis, a new cardiac murmur, bacter-

emia, or positive histologic findings for specimen obtained during valve replacement. In these 14 patients, a total of 18 valves were diseased, 17 native and one prosthetic. In four of 14 patients, endocarditis complicated with mycotic aneurysm was detected by TEE. This diagnosis was made when an abnormal echo-free recess containing color Doppler signals indicating blood flow was seen in the endocardium, septum, valvular leaflet, or in the wall of a great vessel. All echocardiographic examinations were performed using a Hewlett-Packard Model 500K or Model 1000L color Doppler machine (Hewlett-Packard, San Diego, CA, USA). A 2.5- or 3.5-MHz transducer was used for TTE and a 5.0-MHz transducer was used for TEE. All TEE were carried out with conscious patients placed in the left lateral decubitus position. Topical anesthesia and an intravenous drying agent were given as premedication before esophageal intubation. The examination was usually completed in 10 to 15 minutes. No complications occurred.

Report of Cases

Case 1

A 45-year-old man was hospitalized because of chills, fever, and progressive shortness of breath for 2 weeks. He was known to have had aortic regurgitation for 1 year. On admission, a grade 3/6 diastolic blowing murmur and a systolic ejection murmur were heard over the aortic region. Blood culture was positive for *Staphylococcus aureus*. Chest X ray showed cardiomegaly with signs of pulmonary congestion.

With TTE in the parasternal long-axis view, the aortic leaflets were found to be calcified. An echolucent sac was present between the posterior aortic wall and the left atrium. The color flow study demonstrated the filling of the aneurysmal sac from the left ventricle during systole. Severe aortic regurgitation and mild mitral regurgitation were also noted and the left ventricle was dilated.

TEE was then performed. In the left ventricular outflow view,[6] a large septated aneurysmal cavity extending from the lateral wall to the interventricular septum, involving the whole posterior aspect of the left ventricular outflow tract (LVOT), was observed (Fig. 1A). The color flow study demonstrated multiple jets of blood filling the different aneurysmal sacs during ventricular systole (Fig. 1B). No communication was seen with the aortic root. The patient received surgical treatment because of progressive congestive heart failure. Surgical findings showed calcification and vegetation over the bicuspid aortic valve, and a mycotic aneurysm over the medial, posterior, and lateral aspect of the LVOT with multiple intimal perforations noted.

Case 2

A 38-year-old woman had intermittent chills and fever for 2 months and dyspnea on moderate exertion for 2 days. On admission, a grade 3/6 pansystolic murmur was heard at the apex and a grade 3/6 to-and-fro murmur was heard at the region of aortic area. Chest X ray revealed cardiomegaly with signs of pulmonary congestion. No bacteria were isolated from the blood culture. TTE demonstrated a flail right coronary cusp with a large shaggy echogenic mass attached. The left ventricle was dilated. The color flow study showed a continuous left-to-right shunt from the aortic root into the right ventricle through a small protruding aneurysm at the right coronary sinus of Valsalva, along with moderate-to-severe aortic regurgitation and mild mitral regurgitation. TEE was then performed, and the ruptured aneurysm could be clearly demonstrated from the basal short-axis view of the aortic root (Fig. 2). Small vegetations (2 to 5 mm) were also found on the other two aortic cusps and on both mitral leaflets. The patient was operated on because of progressive congestive heart failure and the above TEE findings were confirmed.

Case 3

A 37-year-old man was hospitalized with a history of intermittent chills and fever for 6 months and dyspnea on exertion for 2 months. On physical examination, a grade 4/6 to-and-fro murmur at the aortic area and a grade 2/6 pansystolic murmur at the apex were heard. Blood cultures were negative. TTE was per-

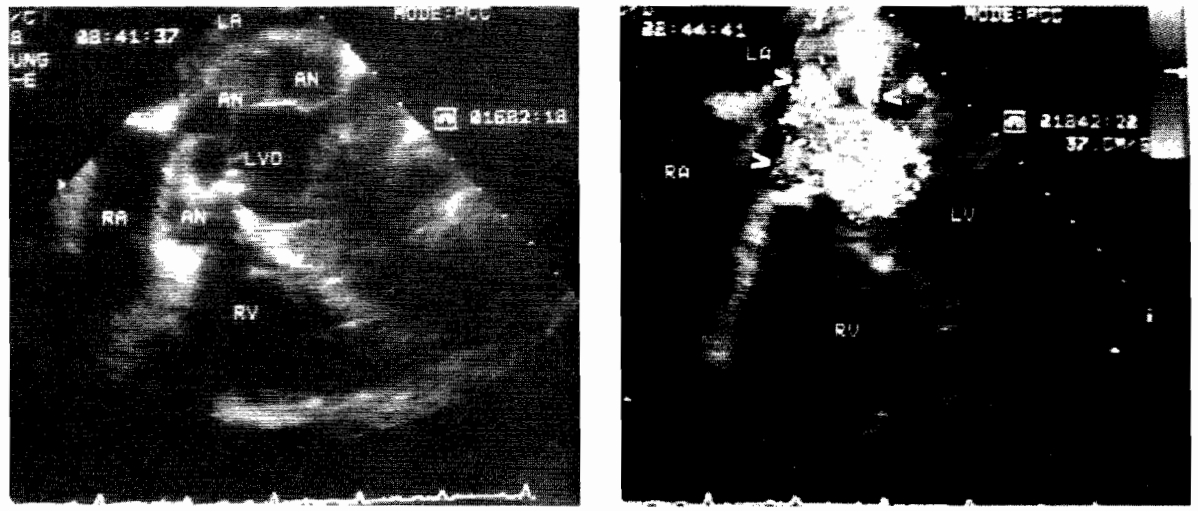

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Figure 1. *Transesophageal echocardiogram, left ventricular outflow view. (A) Shows the extensive mycotic aneurysm (AN) involving the medial, posterior, and lateral wall of the left ventricular outflow (LVO) tract. There are septa inside the aneurysm. (B) Color flow study showing three different jets of blood (arrows) during ventricular systole suggesting the presence of multiple perforated holes. LA = left atrium; LV = left ventricle; RA = right atrium; RV = right ventricle.*

formed and revealed a large vegetation attached to the noncoronary cusp of the aortic valve, which moved into the LVOT during diastole. A shaggy mass was also noted on the anterior mitral leaflet and a small echolucent area was seen inside this mass during ventricular systole, suggestive of abscess formation. The left ventricle was hypokinetic. The color Doppler study showed moderate-to-severe aortic regurgitation and mild mitral regurgitation. The

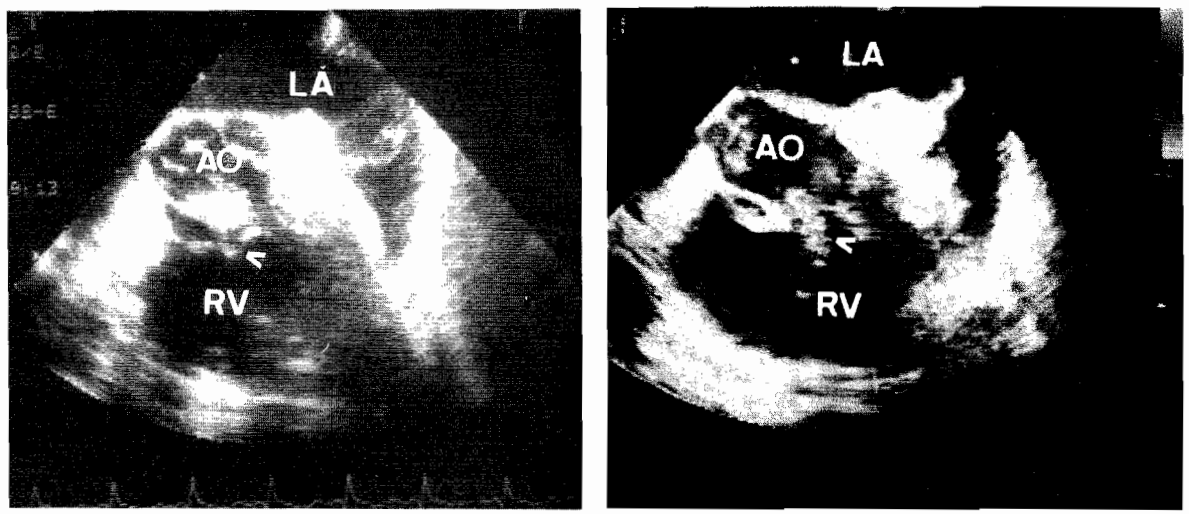

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Figure 2. *Transesophageal echocardiogram, basal short-axis view of the aortic root. (A) Shows vegetation on the aortic leaflets and the small mycotic aneurysm (arrow) at the right sinus of Valsalva. (B) Color flow study showing blood flow through the rupture aneurysm into the right ventricle (RV). AO = aorta; LA = left atrium.*

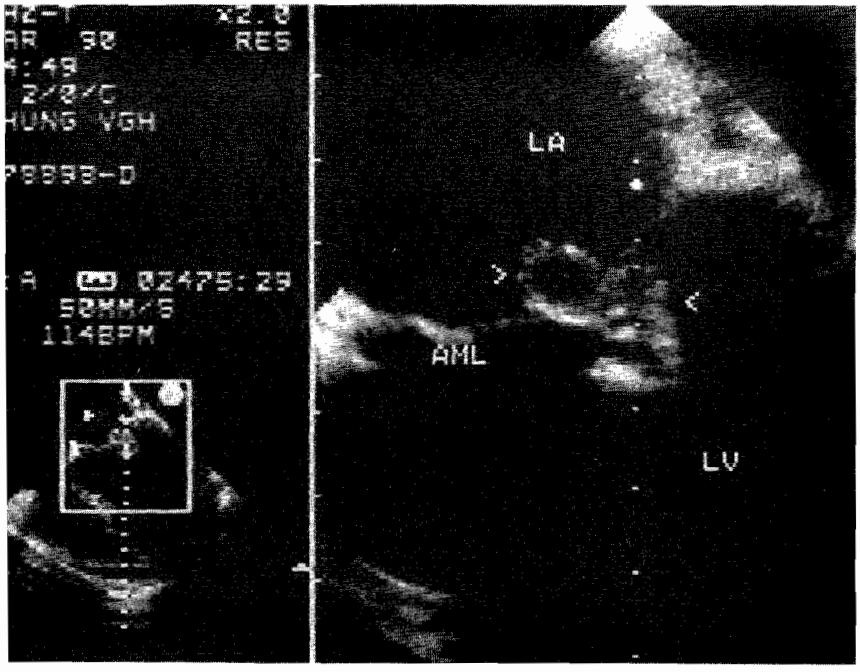

Figure 3. *Transesophageal echocardiogram, four-chamber view. A close-up view of the anterior mitral leaflet (AML) showing multiple diverticula (arrows) suggesting aneurysm formation. LA = left atrium; LV = left ventricle.*

mitral regurgitation had a late diastolic component. When TEE was performed, it showed vegetations on the left and noncoronary cusps of the aortic valve and multiple echolucent sacs on the anterior mitral leaflet (Fig. 3). Communication of these sacs with the left ventricular chamber was noted by color Doppler. This patient received surgical treatment because of progressive congestive heart failure, and mycotic aneurysm and vegetation on the anterior mitral leaflet were found.

Case 4

A 38-year-old man was hospitalized because of intermittent chills and fever for 4 months. On admission, a grade 3/6 pansystolic murmur with increased second heart sound was heard at the left sternal border. Janeway lesions and Osler nodes were present over both feet. Chest X ray showed cardiomegaly with diffuse interstitial change over both lungs. Group D streptococcus was isolated from blood culture. TTE revealed dilation of the aortic root and right heart chambers. Vegetations were seen on aortic and tricuspid valves. The color flow study suggested mild aortic regurgitation and severe tricuspid regurgitation. When TEE was performed, a 2 × 2 cm vegetation on the anterior tricuspid leaflet and a 2 × 5 cm vegetation on the right coronary cusp were seen. An aneurysm was found in the atrial septum (Fig. 4A). Color flow Doppler showed a right-to-left shunt during ventricular systole when the tricuspid regurgitant jet hit at the septum, suggesting rupture of the aneurysm into the left atrium (Fig. 4B). Surgical treatment was suggested because of episodes of pulmonary embolism and the presence of a ruptured atrial septal aneurysm but the patient refused.

Discussion

Intracardiac mycotic aneurysm may occur as a complication of infective endocarditis. The development of aneurysm is usually silent. They may, however, rupture, causing progressive

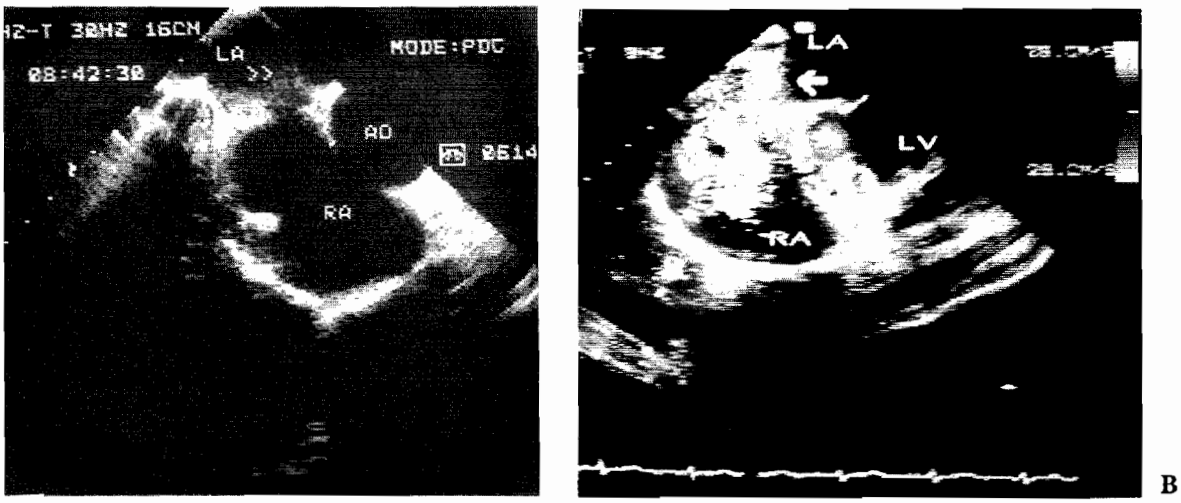

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Figure 4. *Transesophageal echocardiogram, basal short-axis view of aortic root. (A) Shows aneurysm (arrow) formation on the atrial septum. (B) Color flow study showing rupture of the aneurysm into the left atrium (LA) with right-to-left shunt during end-systole. AO = aorta; LV = left ventricle; RA = right atrium.*

heart failure or sudden death. They may be the locus of thrombi that may embolize, and may cause detachment of or damage to the cardiac valves. Accurate and early diagnosis is important for successful therapy because clinical evaluation alone cannot always differentiate patients at risk for this complication.

In the past decade, TTE has been used to evaluate patients with infective endocarditis. This procedure is useful in detecting valvular vegetation, identifying the leaflets involved, determining vegetation size and mobility, assessing the extent of leaflet damage, and identifying the anatomical distribution of the mycotic aneurysm.[7] However, TTE has certain limitations. Vegetations can only be detected when the mass reaches a diameter of at least 2 mm. In patients with chest wall deformities, lung disease, obesity, or prosthetic valves, evaluation by TTE is often technically difficult.

These limitations are now largely overcome by TEE. Because of its close proximity to the left atrium, it provides detailed anatomical information about the mitral valve and the atrial septum that is unavailable with TTE study. In these four cases, mycotic aneurysms were found to be situated at the LVOT, right coronary sinus of Valsalva, anterior mitral leaflet, and the atrial septum.

Using TTE, in only three of the four cases could mycotic aneurysms be detected. In case 1, color flow study was required in order to demonstrate that the aneurysm was filled from the left ventricle rather than from the aorta. In case 3, moreover, only a small echo-free area inside the shaggy mitral mass could be visualized during ventricular systole, which could not be differentiated from valvular abscess.

Utilizing TEE, however, all four cases of mycotic aneurysms could be clearly detected. In case 1, multiple aneurysmal sacs could be seen at the LVOT, and their connections with the left ventricle through multiple perforated holes were demonstrated by color flow study. In case 2, the small sinus of Valsalva aneurysm was also clearly shown by TEE color flow Doppler. Previously unnoticed small vegetations (2 to 5 mm in diameter) were also found on the other aortic and mitral leaflets. In case 3, multiple aneurysmal sacs were seen on the anterior mitral leaflet rather than the single echo-free space, suggestive of abscess displayed transthoracically. The atrial septal aneurysm in case 4 could be shown clearly. Color flow Doppler showed that it was situated at the site of impact of the tricuspid regurgitant jet and that a reverse shunt (right to left) was present during ventricular systole. From the above experience,

therefore, we are of the opinion that TEE is superior to TTE in the identification and detailed analysis of mycotic aneurysms complicating infective endocarditis.

The mechanism for intracardiac mycotic aneurysm formation is focal infection and weakness of the surface of the great vessel, valve leaflet, or the endocardium, resulting from direct extension or contact with the infected valve or from a jet lesion. In cases 1 and 2, the mycotic aneurysms were found near the infected aortic valve, suggesting that its formation might be due to direct extension or contact. In case 4, the most likely source of the atrial septal aneurysm was a jet lesion resulting from tricuspid regurgitation. The mechanisms of spreading of the infection inside the heart must be kept in mind during echocardiographic examination, for a careful search of the possible involved area may lead to the discovery of mycotic aneurysm. Thus, with the use of TEE, we may be better able to understand and evaluate the progress of the disease process, the relationship between the location of aneurysm and the diseased valve, and the extent of the mycotic aneurysm. This information may be useful in guiding surgical approach for the repair of these lesions.

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