ILLUSTRATIVE ECHOCARDIOGRAM

Ventricular Septal Defect Noted by Two-Dimensional Echocardiography*

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Echocardiography may play a major role in diagnosing and following-up the physiologic effects of ventricular septal defects (VSD). The following case illustrates the potential of echocardiography to provide information on cardiac anatomy and physiology in a patient with a VSD.

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CASE REPORT

A 66-year-old white woman sought medical attention for treatment of "a hole in the heart." She had an enlarged heart in childhood, but engaged in normal childhood activity despite easy fatigability. She was acyanotic and took no medications during childhood, had a normal pregnancy and delivery, and remained relatively asymptomatic until age 58, when she developed dyspnea on exertion. Noninvasive work-up suggested the diagnosis of VSD, and cardiac catheterization confirmed an isolated VSD with a pulmonary-to-systemic flow ratio of 2.1:1 and slightly elevated pulmonary pressures (60/15 mm Hg). She was placed on treatment with digoxin,

![Figure 1. Apical four-chamber views from preoperative two-dimensional echocardiogram showing dropout of interventricular/septal echoes (left panel). Peripheral venous D5W injection (middle panel) at first opacifies only right atrium and ventricle, with no right-to-left shunt and possible left-to-right shunt as indicated by negative contrast effect in the right ventricle. With a premature beat, contrast crosses the VSD and is present in the left ventricle (right panel). RV = right ventricle, LV = left ventricle, RA = right atrium, LA = left atrium. Shading in lower panels indicates peripherally injected ultrasound contrast.](image-url)
FIGURE 2. Apical four-chamber views from two-dimensional echocardiogram three months postoperatively. Upper panels show patch in place closing former VSD. No right-to-left shunting is seen on peripheral venous contrast injection (lower panel). LV = left ventricle, RV = right ventricle, LA = left atrium, RA = right atrium, P = surgical patch closing VSD.

furosemide and quinidine. Her dyspnea gradually increased over eight years to the point of limiting her to a bed-chair existence. She had experienced two episodes of syncope while walking in the prior three years, and presented to Stanford for further treatment.

Blood pressure was 150/100 mm Hg, pulse rate was 115/minute, and respirations were 20/minute. The precordium was active with a visible apex impulse to the left of the midclavicular line. There was a prominent apical impulse and systolic apical thrill. S\textsubscript{2} was normal. There was a grade 6/6 holosystolic murmur with maximal intensity at the apex and lower sternal edge. S\textsubscript{3} was widely split with P\textsubscript{2} louder than A\textsubscript{2}. An S\textsubscript{4} was present. There was no diastolic murmur.

Her electrocardiogram showed sinus rhythm with frequent atrial premature contractions and right bundle branch block. M-mode echocardiogram showed an enlarged left atrium and normal septal motion. Sector scan was performed using a wide angle phased array ultrasonograph with a 2.25 megahertz transducer (Varian V3000). It showed (Fig 1) lack of basal septal echoes suggesting a VSD. This was confirmed by right-to-left shunting of peripherally injected microbubbles through the apparent defect after a premature beat. Cardiac catheterization confirmed a VSD with a calculated shunt ratio Qp:Qs = 3.0:1, and a pulmonary resistance of 2.3 Wood units.

At surgery a 1.5 cm defect in the membranous interventricular septum was seen. It was repaired with a Teflon patch. Convalescence was satisfactory. At follow-up three months after surgery, she reported decrease in dyspnea with exercise and the absence of palpitations. Repeat sector examination showed the patch in the area of the former VSD, with no contrast seen crossing to the left heart after peripheral venous injection (Fig 2).

DISCUSSION

Echocardiographic features suggesting the diagnosis of VSD include lack of upper interventricular septal echoes, increased left ventricular and left atrial dimensions (with predominant left-to-right shunts), systolic fluttering of the tricuspid valve and imaging of peripherally injected contrast agents crossing into the left ventricle.\textsuperscript{1}

Dropout of the echoes in the upper ventricular septal area was a sign noted early in M-mode echocardiographic experience with VSDs. However, this sign proved to be neither sensitive nor specific.\textsuperscript{2} This is to be expected, since any echo beam must be smaller than the tissue defect in order to record a true discontinuity of the septum. Also, spurious echo dropout often can be caused by excessive medial angulation of the M-mode transducer giving reduced echo reflection from the septum.

Two-dimensional real-time echocardiographic techniques have allowed imaging of the ventricular septum from multiple transducer locations (left sternal border, apex, subxiphoid). Echo dropout in the septum seems more reliable with this method than with M-mode probably due to the multiple views available. The most specific way to diagnose a VSD using current real-time echocardiographic systems is to image peripherally injected contrast flowing from the right to left side of the septum. The site of a VSD may be definitely located using this technique, although multiple VSDs might be difficult to appreciate. Though a shunt can be documented by peripheral contrast M-mode echocardiography,\textsuperscript{5} its site can be best localized by two-dimensional equipment.

The major problem with peripheral contrast echocardiographic diagnosis of VSDs is that this technique only images right-to-left flow, whereas most VSDs have mainly left-to-right shunt until late in their course when pulmonary hypertension may develop. However, the presence of a small amount of bidirectional shunting in many VSDs may allow visualization of microbubbles on the left side as occurs in most ASDs.\textsuperscript{4,6} Even if this does not occur, a premature beat may alter hemodynamics sufficiently to cause some right-to-left shunting, as occurred in our patient. The timing within the cardiac cycle of contrast appearance in the left ventricle and degree of clearing with systole may provide additional information about hemodynamics.\textsuperscript{6} Echocardiographically-derived right ventricular systolic time...
intervals have also been reported to correlate with hemodynamics.\textsuperscript{7}

Future ultrasonic methods for diagnosing VSDs will probably include the use of pulsed Doppler. An early communication has claimed impressive sensitivity for this technique.\textsuperscript{8}

REFERENCES