Accurate Localization of Ruptured Sinus of Valsalva Aneurysm by Real-time Two-dimensional Doppler Flow Imaging

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The surgical approach to the repair of a ruptured sinus of Valsalva aneurysm can depend on the cardiac chamber into which rupture occurs. This report details the color flow Doppler images in two patients who developed a right sinus of Valsalva aneurysm to right atrial fistula owing to bacterial endocarditis. In both cases, the color flow Doppler image was superior to contrast aortography in identifying the chamber into which rupture had occurred. The early experience with real-time two-dimensional Doppler flow imaging suggests that this noninvasive technique is valuable in the management of ruptured sinus of Valsalva aneurysms. (Chest 1988; 94:462-65)

Aneurysms of the sinus of Valsalva are most commonly congenital but also can be acquired in association with trauma, bacterial endocarditis, syphilis, or tuberculosis.1,2 Rupture is the most frequent complication, although right or left ventricular outflow tract obstruction, coronary insufficiency, acute myocardial infarction, and conduction abnormalities have been described.3-7 Because the right coronary cusp is the most common site of aneurysmal dilatation,8 rupture usually occurs into the right ventricle or right atrium.1,7,8 Since the surgical approach to the repair of ruptured sinus of Valsalva aneurysms can vary according to the chamber into which the aneurysm ruptures,8-11 the preoperative localization of the fistula assumes great importance and is generally accomplished using contrast aortography.

This report describes two cases of ruptured sinus of Valsalva aneurysm from the right coronary sinus into the right atrium that were diagnosed preoperatively by two-dimensional echocardiography and color flow Doppler imaging. In both cases the color flow Doppler image localized the fistula between the aorta and the right atrium more precisely than biplane contrast aortography.

Case Reports

Case 1

A 28-year-old male intravenous (IV) drug abuser was initially hospitalized with fever, chills, malaise, weight loss, and congestive heart failure. Echocardiographic and Doppler studies demonstrated aortic insufficiency, aortic valvular vegetations, and a dilated, hypercontractile left ventricle. Blood cultures were positive for α-hemolytic Streptococcus. The patient underwent aortic valve replacement with a Hancock porcine prosthesis because of progressive heart failure. Early in the postoperative stage, a murmur of aortic insufficiency was heard, and progressive congestive heart failure developed over the next several weeks despite medical therapy including IV penicillin. The patient was evaluated for possible reoperation one month after surgery because of refractory left ventricular failure.

On examination, his temperature was 37.2°C; pulse, 110 beats/min; respiratory rate, 22 breaths/min; and systemic blood pressure, 110/55 mm Hg. Carotid arteries were bounding. There was prominent jugular venous distention, with a large V wave and a palpable venous thrill. The lung fields were clear on auscultation. A left parasternal lift was felt, and the apical impulse was hyperdynamic, enlarged, and laterally displaced. Cardiac auscultation revealed normal first and second heart sounds. A continuous murmur was heard along the right sternal border, and a holosystolic murmur was noted at the apex. The liver was enlarged and pulsatile. There was no peripheral edema or cutaneous embolic stigma.

Two-dimensional echocardiography demonstrated a mildly dilated left ventricle with flattening of the interventricular septum but normal overall systolic function. In the parasternal short-axis view, an echo-free space surrounding the prosthetic valve was demonstrated along the anterior and septal aspects of the aorta (Fig 1,A). Aortic, mitral, and tricuspid regurgitation were identified by spectral Doppler examination. Doppler color flow imaging revealed a turbulent jet originating from the echo-free space around the prosthetic valve and extending into the right atrium (Fig 1,B).

The patient underwent cardiac catheterization, during which a significant step-up in oxygen saturation was found at the level of the mid-right atrium. Biplane aortography revealed 3+ aortic insufficiency with a dilated sinus of Valsalva. Contrast material was noted to pass from the aorta to the right-sided chambers near the tricuspid valve. It was unclear, however, whether this represented a fistula between the aorta and the right atrium or between the aorta and

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the right ventricle in the presence of tricuspid regurgitation (Fig 1, C).

The patient underwent open heart surgery for aortic valve replacement and correction of the left-to-right shunt. The right atrium was opened, and an aortic-to-right-atrial fistula was demonstrated. This defect was corrected with the use of a Dacron patch on the aorta. The patient recovered well and was discharged in stable condition without echocardiographic or Doppler evidence of a recurrent fistula.

**CASE 2**

A 41-year-old man with end-stage renal disease who was maintained on long-term hemodialysis, presented initially with fever and chills. Blood cultures were positive for *Staphylococcus aureus*. Treatment with vancomycin, administered during hemodialysis, resulted in resolution of his symptoms. Several follow-up blood cultures were sterile. An echocardiogram and contrast aortogram obtained at another hospital demonstrated an aneurysm of the right sinus of Valsalva and 2+ to 3+ aortic insufficiency. No angiographic evidence of a fistula between the aorta and the right heart was found. The patient presented to our Medical Center two months later because of increasing dyspnea.

On examination, the patient had an oral temperature of 38.3°C, pulse, 84 beats/min; respiratory rate, 18 breaths/min; and blood pressure, 140/40 mm Hg. The peripheral pulses were of "waterhammer" quality. There was an arteriovenous fistula in the right arm for vascular access. There was prominent jugular venous distention, with a systolic thrill palpable at the base of the neck. The lungs were clear to auscultation. Cardiac auscultation revealed first and second heart sounds of normal intensity. A three-component friction rub was heard along the left sternal border. A prominent to-and-fro continuous murmur was heard along the right sternal border. Third and fourth heart sounds were not heard. There was mild hepatomegaly. No peripheral edema or cutaneous embolic stigmas were found.

Two-dimensional echocardiography revealed a dilated left ventricle, concentric left ventricular hypertrophy (end-diastolic posterior and septal wall thickness, 1.6 cm), and hyperdynamic systolic function (fractional shortening, 53 percent). A moderate-sized pericardial effusion was present. The aortic valve and aortic root were notably abnormal. A large aneurysm of the right sinus of Valsalva was protruding into the area of the atrioventricular groove (Fig 2, A). The aneurysm was noted to expand in size during diastole, with resultant distortion of the aortic valves. Spectral Doppler study showed aortic insufficiency. Also, a high-velocity diastolic jet was identified in the right side of the heart adjacent to the aneurysm. Doppler color flow imaging localized a turbulent jet originating in the aneurysm of the sinus of Valsalva and emptying into the right atrium immediately posterior to the tricuspid valve (Fig 2, B).

Biplane aortography was performed, revealing 3+ aortic insufficiency. The right sinus of Valsalva was markedly distorted and enlarged. Contrast material was seen to pass from the aneurysm into the right ventricle, predominantly during diastole, coinciding with the diastolic expansion of the aneurysm noted on echocardiography.

The patient underwent open heart surgery for aortic valve replacement and correction of the left-to-right shunt. A fistula from the right sinus of Valsalva aneurysm to the right atrium was identified through an aortotomy and confirmed by inspection of the right atrium. There was extensive necrosis in the area of the aneurysm. After debridement, Dacron pledgets were required to close a surgically induced ventricular septal defect and to repair the aorta. The patient’s postoperative course was uncomplicated. Follow-up echocardiography and Doppler studies confirmed successful repair of the aneurysm and fistulous tract.

**DISCUSSION**

When rupture of an aneurysm of the sinus of Valsalva

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**FIGURE 1.** Case 1. A (top), Two-dimensional echocardiography, parasternal short-axis view. Aneurysm of sinus of Valsalva (AN) visualized along anteroseptal aspect of aorta (AO). B (center). Color flow Doppler study in same view as Figure 1A: turbulent jet (large arrow) visualized originating from aneurysmal sinus of Valsalva and emptying into right atrium (RA) posterior to tricuspid valve (small arrows). C (bottom), Aortography, right anterior oblique view taken early during injection and before left ventricular opacification. Contrast material entered the right heart through the ruptured sinus aneurysm (curred arrows), but it was unclear whether the recipient chamber was the atrium or ventricle. The sinus of Valsalva aneurysm was opacified (open arrow). RV = right ventricle.
occurs, it is most commonly into the right heart, particularly the right ventricle. Other reported sites of rupture include left-sided chambers of the heart, the superior vena cava, the pericardium, and the thoracic wall. The cardiac chamber into which rupture occurs may be an important determinant of the surgical approach to repair the disorder. Indeed, Okada et al, Sanchez et al, and Bonfils-Roberts et al advocated an initial surgical approach through the chamber into which the fistula empties. Therefore, the precise localization of the fistula is useful preoperatively. The value of noninvasive methods, particularly Doppler color flow mapping, for localization of fistulous tracts has not yet been well studied.

Several M-mode echocardiographic features of ruptured sinus of Valsalva aneurysms have been described, including fluttering of the tricuspid valve, early closure of the anterior cusp of the aortic valve, premature pulmonic valve opening, and direct visualization of the aneurysm. However, these findings are nonspecific and cannot provide definitive evidence or localization of the rupture. Two-dimensional echocardiography can also be helpful in the diagnosis of ruptured sinus of Valsalva aneurysms. Although the aneurysm is often visualized, the site of rupture and chamber into which rupture occurs can be difficult to delineate.

Spectral Doppler echocardiography can detect a ruptured aneurysm by the presence of a high-velocity turbulent jet directed into the recipient chamber. However, the rupture often leads to right-sided volume overload, right ventricular failure, and significant tricuspid regurgitation. In the presence of high right ventricular pressures, tricuspid regurgitation produces high-velocity flow through the tricuspid valve during both systole and diastole, making localization of a turbulent jet through the ruptured aneurysm difficult.

Real-time two-dimensional Doppler echocardiographic flow mapping has recently been shown to be useful in the diagnosis of congenital heart disease and in the evaluation of native and prosthetic valve abnormalities. Fisher et al recently described a case of a ruptured para-aortic abscess leading to communication between the left ventricular outflow tract and the left atrium. The localization of the fistulous tract was well demonstrated by color flow Doppler imaging. In the cases described in this report, the rupture of the aneurysm occurred into the right atrium. This was well demonstrated by the presence on color flow Doppler imaging of a turbulent jet entering the right side of the heart, posterior to the septal leaflet of the tricuspid valve. In both cases, the localization of the site of rupture using spectral Doppler imaging alone was confounded by the presence of tricuspid regurgitation. At surgery, both patients had a fistula extending from the aneurysm of the right sinus of Valsalva to the right atrium just above the tricuspid valve, as predicted by color flow Doppler imaging. Contrast aortography, traditionally used to detect and localize such fistulas, was unable to localize precisely the level of the shunt in either patient. Reasons for the failure of contrast aortography to localize the fistula may include the close proximity of the shunt to the tricuspid valve and the associated tricuspid regurgitation. In addition, the predominance of diastolic flow through the fistula may have given an erroneous angiographic appearance of contrast directly entering the right ventricle.

REFERENCES


Accurate Localization of Ruptured Sinus of Valsalva Aneurysm (Chow et al)
3 Kiefaber RW, Takakin BS, Coffin LH, Gibson TC. Unruptured sinus of Valsalva aneurysm with right ventricular outflow obstruction diagnosed by two-dimensional and Doppler echocardiography. J Am Coll Cardiol 1986; 7:438-42

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