Echocardiographic diagnosis of a ruptured aneurysm of the sinus of Valsalva: operation without catheterisation in seven patients

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Abstract

A ruptured aneurysm of the sinus of Valsalva was diagnosed by Doppler, colour, and cross sectional echocardiography in a consecutive series of seven patients. The diagnoses were confirmed at operation without cardiac catheterisation. Examination by pulsed and continuous Doppler echocardiography showed continuous turbulence in six patients with aneurysms rupturing into the right ventricular outflow tract and in the patient with rupture of an aneurysm of the non-coronary sinus into the right atrium. Colour Doppler echocardiography showed turbulent flow across the defects in all seven patients. A ventricular septal defect with aortic regurgitation was detected in one patient and an associated ventricular septal defect in another.

Doppler, colour, and cross sectional echocardiography were useful non-invasive techniques for diagnosing a ruptured aneurysm of the sinus of Valsalva without the need for cardiac catheterisation.

A ruptured aneurysm of a sinus of Valsalva is relatively rare. It occurs as an isolated defect or with other cardiac anomalies.1,3 The reported incidence in oriental countries is higher than in Western countries.2,4 Before cross sectional colour Doppler echocardiography became available ruptured aneurysms of the sinus of Valsalva were difficult to diagnose. The auscultatory findings may resemble those in various other diseases such as coronary arteriovenous fistula, persistent ductus arteriosus, aortic regurgitation, or ventricular septal defect associated with aortic regurgitation.

We assessed the feasibility of diagnosing ruptured aneurysms of the sinus of Valsalva in seven patients with cross sectional colour Doppler echocardiography without the use of cardiac catheterisation.

Results

CROSS SECTIONAL ECHOCARDIOGRAPHY

According to the criteria of cross sectional echocardiography alone all seven patients had aneurysmal sacs. In six of them aneurysm affected the right sinus of Valsalva. The aneurysms were of different sizes, but they all protruded anteriorly, caudally, and to the left (fig 1). However, rupture of the aneurysm often could not be established by cross sectional echocardiography alone. In the only patient in whom the aneurysm affected the non-coronary sinus of Valsalva (patient 5, table) it protruded into the right atrium (fig 2).

COLOUR DOPPLER ECHOCARDIOGRAPHY

Both pulsed and continuous Doppler echocardiography showed continuous turbulence in the right ventricle in all six patients with rupture into the right ventricular outflow tract (fig 1); in the patient with ruptured aneurysm of the non-coronary sinus the turbulence was detected in the right atrium (fig 2). An associated ventricular septal defect was suspected in two patients (1 and 2) in whom continuous Doppler echocardiography showed high velocity prominent systolic flow at the level of the subpulmonary ventricular septum just below the aneurysm of the right sinus of Valsalva in the parasternal long axis view (fig 1). At operation a subpulmonary ventricular septal defect was seen in these two patients; however, continuous Doppler echocardiography did not detect an associated ventricular...
septal defect in another patient (patient 6). Colour flow mapping showed turbulence across the ruptured aneurysm in every patient (figs 1 and 2). Colour Doppler echocardiography showed evidence of associated aortic regurgitation in patient 1; this was confirmed at operation.

Discussion
DOPPLER AND CROSS SECTIONAL ECHOCARDIOGRAPHIC FEATURES OF A RUPTURED ANEURYSM OF THE SINUS OF VALLSALVA

Like the patients reported by Chiang et al, all six aneurysms of the right sinus protruded anteriorly, caudally, and to the left. This unique protrusion pattern caused blood to flow caudally into the right ventricle across the aneurysm in a parasternal long axis view and anteriorly and leftward in a short axis view (fig 1). Both pulsed and continuous Doppler echocardiography showed continuous high velocity turbulence in the right ventricular outflow tract in all patients with a ruptured aneurysm of the right sinus; in the patient with a ruptured aneurysm of the non-coronary sinus turbulence was detected in the right atrium. The high systolic velocity detected in the subpulmonary region by continuous Doppler echocardiography was strongly suggestive of an associated ventricular septal defect, which was confirmed at operation in two patients. In one patient a ventricular septal defect was not detected by Doppler echocardiography because part of the aneurysm overlay the ventricular septal defect or the jet of ventricular septal defect was not parallel to the echo beam. The surgeon always looked for the associated ventricular septal defect in these patients at operation because such an association is common in oriental countries.
Echocardiographic diagnosis of a ruptured aneurysm of the sinus of Valsalva

In all seven patients we detected a continuous turbulent flow by Doppler echocardiography in the chambers with which the ruptured sinus of Valsalva communicated and we saw the mosaic pattern of turbulent colour flow across the ruptured aneurysm. The congenital origin of the disease was confirmed at operation in all seven patients.

In earlier studies contrast echocardiography was useful in aiding diagnosis of a ruptured aneurysm of the sinus of Valsalva. We found that the Doppler colour flow technique was probably better than contrast echocardiography in showing the turbulence of blood flow across the site of rupture into the communicating cardiac chamber. We know of no reports of the use of transoesophageal echocardiography in this disorder. In theory transoesophageal echocardiography should be useful for the examination of aneurysms of the sinus of Valsalva, particularly when they have ruptured into left and right atria.

**Differential Diagnosis**

A ruptured aneurysm of the sinus of Valsalva must be distinguished from the following conditions: persistent ductus arteriosus, coronary arteriovenous fistula, ventricular septal defect and aortic regurgitation. Our experience accords with that of Chiang et al who found that with right coronary arteriovenous fistula, as with ruptured sinuses, the dilatation lies above the aortic annulus and that the size of the aorta above the dilatation is normal. But, unlike an aneurysm of the sinus of Valsalva, the fistula is usually tubular rather than saccular and often protrudes in a cephalad direction and to the right (following the normal course of the right coronary artery). In contrast, a ruptured aneurysm of the sinus of Valsalva protrudes caudally and to the left. In patients with ruptured aneurysms of the sinus of Valsalva, but not in those with a coronary arteriovenous fistula, pulsed, continuous, and colour Doppler echocardiography will detect continuous turbulent flow at the right ventricular outflow tract. Ventricular aneurysms occur below the aortic annulus, whereas aneurysms of the sinus of Valsalva are always located above the aortic annulus. Doppler echocardiography will not show turbulent flow in the right ventricle in patients with ventricular septal aneurysm without rupture. In patients with a ductus arteriosus flow in the main pulmonary artery is turbulent and there should be no saccular aneurysm at the coronary sinuses. In aortic regurgitation flow in the left ventricular outflow tract is turbulent but only during diastole, whereas rupture of an aneurysm of the right sinus of Valsalva into the right ventricular outflow tract causes turbulence in the tract during both diastole and systole (fig 1). Aortic regurgitation should be sought at echocardiography because it is reported to be more common in patients with ruptured aneurysms of the sinus of Valsalva.

**Role of Cardiac Catheterisation**

The definitive diagnosis of ruptured aneurysm was confirmed at operation in all seven patients. Of 32 lesions, seven were confirmed by angiography and 25 were assessed by a combination of cardioangiography and transoesophageal echocardiography. We also performed right heart angiography in two patients. In the remaining 25 lesions no diagnosis was possible by angiography and transoesophageal echocardiography. The diagnosis of rupture was made from direct visualisation of the aneurysm in four patients and indirect visualisation of the aneurysm in two patients. In the remaining 10 patients angiography and transoesophageal echocardiography were not diagnostic of rupture.

**Comparison between echocardiographic diagnosis and operative findings in seven patients with ruptured aneurysm of the sinus of Valsalva**

<table>
<thead>
<tr>
<th>Case No</th>
<th>Age (yr)</th>
<th>Sex</th>
<th>Aneurysm ruptured into</th>
<th>Associated lesions</th>
<th>Operative findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32</td>
<td>M</td>
<td>RVOT</td>
<td>AR, VSD</td>
<td>Confirmed</td>
</tr>
<tr>
<td>2</td>
<td>31</td>
<td>M</td>
<td>RVOT</td>
<td>VSD</td>
<td>Confirmed</td>
</tr>
<tr>
<td>3</td>
<td>28</td>
<td>M</td>
<td>RVOT</td>
<td></td>
<td>Confirmed</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
<td>F</td>
<td>RVOT</td>
<td></td>
<td>Confirmed</td>
</tr>
<tr>
<td>5</td>
<td>37</td>
<td>M</td>
<td>RA</td>
<td></td>
<td>Confirmed</td>
</tr>
<tr>
<td>6</td>
<td>41</td>
<td>F</td>
<td>RVOT</td>
<td></td>
<td>Confirmed</td>
</tr>
<tr>
<td>7</td>
<td>35</td>
<td>M</td>
<td>RVOT</td>
<td></td>
<td>Confirmed</td>
</tr>
</tbody>
</table>

*Non-coronary sinus. AR, aortic regurgitation; RA, right atrium; RVOT, right ventricular outflow tract; VSD, ventricular septal defect.*
of the sinus of Valsalva by catheterisation depends not only on the presence of a step up in oxygen saturation in the right heart but also on the demonstration of filling of the right heart chambers by contrast medium from the ascending aorta. At catheterisation we missed a few cases of ruptured aneurysm of the sinus of Valsalva when contrast medium could not be adequately demonstrated in the right ventricle because of the rapid heart rate and high cardiac output in these patients. But turbulent flow can be detected by colour, M mode, and Doppler echocardiography despite rapid heart rate and high output state. We were able to avoid catheterisation before operation in patients with a ruptured aneurysm of the sinus of Valsalva after the condition was diagnosed by cross sectional and colour Doppler echocardiography.

LIMITATION
Combined cross sectional and colour Doppler echocardiography is unlikely to miss a ruptured aneurysm of the sinus of Valsalva. It may be more difficult to be certain whether there is also an associated ventricular septal defect. In an isolated ventricular septal defect the drop-out may not be detected by conventional cross sectional echocardiography alone. But Doppler and colour techniques always detected systolic turbulence in the right ventricle and Doppler showed continuous turbulence when there was a ruptured aneurysm of the sinus of Valsalva. A prominent systolic signal, however, should raise the suspicion of an associated ventricular septal defect. But the absence of such a finding does not exclude a ventricular septal defect.

A ruptured aneurysm of the sinus of Valsalva can be diagnosed precisely by careful non-invasive evaluation with colour Doppler and cross sectional echocardiography. Cardiac catheterisation before surgery can be avoided in these patients.