Tricuspid Valve Fluttering*

Echocardiographic Features of Ventricular Septal Defect

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M-mode echocardiographic features are presented in four patients with membranous ventricular septal defect. The most consistent echo findings in all the patients were the presence of fuzzy, fluttering echoes of the tricuspid valve during systole. More careful echocardiographic evaluation of the tricuspid valve in ventricular septal defect is therefore recommended.

Although M-mode echocardiographic features of ventricular septal defects have been reported, their specificity and sensitivity are limited. This is particularly true with small ventricular septal defects. In this report, we describe the echocardiographic features of four patients with membranous ventricular septal defects in whom fluttering of the tricuspid valve was the most consistent echocardiographic clue to the diagnosis. Recently, similar echocardiographic features of the tricuspid valve have been reported with ventricular septal defects, but were considered to be due to a different mechanism than what we propose. In that report, the fluttering was ascribed to an aneurysm of the membranous ventricular septum. Our observations suggest that echoes are secondary to the streaming of blood across the septal defect producing fluttering or turbulence about the septal leaflet of the tricuspid valve.

METHODS AND MATERIAL

Four patients with membranous ventricular septal defects had an M-mode echocardiogram performed (Smith Kline Ekoline 20-A instrument). A 2.25/MHz transducer was placed in the second to fifth left intercostal space with the patient positioned in the supine or 30° to 40° left lateral position. The tricuspid valve was visualized by angulating the transducer inferiorly and medially, the systolic segment of the tricuspid valve showing the fuzzy echoes was clearly visualized with more anterior and medial angulation of the transducer. The tracings were recorded on a recorder (Ekoline 21) at a paper speed of 50 and 100 mm/second. The echocardiographic studies were performed within two days of cardiac catheterization in all patients. Appropriate cardiac surgery was performed in three of the four patients within two weeks of the echocardiographic studies following which the echocardiograms were reported.

RESULTS

The clinical features of these patients are summarized in Table 1. Patient 1 had associated severe

<table>
<thead>
<tr>
<th>Case, Age (Years), Sex</th>
<th>Symptoms</th>
<th>Signs</th>
<th>Clinical Diagnosis</th>
<th>Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 14, M</td>
<td>Dyspnea on exertion</td>
<td>Left ventricular enlargement; continuous murmur at LLSB</td>
<td>VSD with severe AI</td>
<td>AVR, normal TV</td>
</tr>
<tr>
<td>2, 5, F</td>
<td>Dyspnea on mild exertion</td>
<td>No cyanosis; holosystolic and a diastolic blowing murmur at LLSB</td>
<td>Acyanotic tetralogy of Fallot; mild AI</td>
<td>Patch repair of large VSD and pulmonary infundibular resection; normal TV</td>
</tr>
<tr>
<td>3, 10, F</td>
<td>None</td>
<td>Systolic thrill; holosystolic murmur at LLSB</td>
<td>VSD</td>
<td>Repair of a 5 mm VSD; normal TV</td>
</tr>
<tr>
<td>4, 9, M</td>
<td>None</td>
<td>Systolic thrill; holosystolic murmur at LLSB</td>
<td>VSD</td>
<td>NP</td>
</tr>
</tbody>
</table>

AI = aortic insufficiency; AVR = aortic valve replacement; LLSB = lower left sternal border; TV = tricuspid valve; VSD = ventricular septal defect; NP = not performed
Table 2—Hemodynamic Features of Patients with Ventricular Septal Defect

<table>
<thead>
<tr>
<th>Case</th>
<th>Left-to-right Shunt (Liters per minute)</th>
<th>Qp/Qs</th>
<th>Pulmonary Arteriolar Resistance</th>
<th>Angiography</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.0</td>
<td>1.3:1</td>
<td>Normal</td>
<td>Aortic root = severe AI LV = faint opacification of RV through VSD</td>
</tr>
<tr>
<td>2</td>
<td>9.8</td>
<td>2.8:1</td>
<td>*NC</td>
<td>RV = severe pulmonary infundibular stenosis, normal pulmonary valve; LV = aortic over-riding; RV visualized through the VSD</td>
</tr>
<tr>
<td>3</td>
<td>5.4</td>
<td>2.1:1</td>
<td>Normal</td>
<td>Catheter traversed the VSD from RV; LV = RV opacification through the VSD</td>
</tr>
<tr>
<td>4</td>
<td>2.9</td>
<td>1.8:1</td>
<td>Normal</td>
<td>Catheter traversed the VSD from RV; LV = interventricular septal aneurysm created by adherence of septal leaflet of TV to VSD</td>
</tr>
</tbody>
</table>

AI = aortic insufficiency; LV = left ventricle; RV = right ventricle; VSD = ventricular septal defect; *NC = not calculated as pulmonary pressures could not be obtained (near systemic RV systolic pressures); TV = tricuspid valve; Qp/Qs = pulmonary-to-systemic flow ratio.

Aortic insufficiency. Patient 2 had a ventricular septal defect associated with valvular and subvalvular pulmonary stenosis. Patients 3 and 4 had isolated ventricular septal defects. Cardiac catheterization and angiography were performed by conventional techniques, and the results are summarized in Table 2. A ventricular septal aneurysm was demonstrated by left ventricular angiography in only one of our patients (patient 4, Table 2). The most consistent findings on the M-mode echocardiogram were fuzzy

Figure 1. Composite of tricuspid valve complexes of all four patients before surgery. Note fuzzy fluttering echoes (arrow) and slight anterior motion of systolic segment of tricuspid valve (TV).
Case | Septal-aortic Discontinuity | Pulmonary Valve Flutter | Other Abnormalities | Systolic Tricuspid Valve Flutter | Preoperative | Postoperative |
--- | --- | --- | --- | --- | --- | --- |
1 | - | - | MV diastolic Flutter | + | - |
2 | + | + | Aortic overriding | + | - |
3 | - | - | - | + | - |
4 | - | - | - | + | NS |

(+) Present  
(−) Not present  
MV = mitral valve  
NS = No surgery

Fluttering echoes of the tricuspid valve during systole (Fig 1). A mild degree of systolic anterior motion of the tricuspid valve was also noted in all patients. The results of postoperative M-mode echocardiograms performed within four weeks of appropriate cardiac surgery in the three patients are summarized in Table 3. Systolic fluttering and the anterior motion of the tricuspid valve were no longer seen in the echocardiograms obtained after closure of the ventricular septal defect (Fig 2). The tricuspid valve, examined at the time of surgery, was normal and was free of vegetations or other masses.

**DISCUSSION**

The M-mode echocardiographic diagnosis of ventricular septal defect is usually difficult. The demonstration of echocardiographic septal-aortic discontinuity has been reported to be suggestive of a ventricular septal defect. Septal-aortic discontinuity,
however, is usually difficult to observe even when the septal defect is large, since the echo beam has to traverse the ventricular septal defect without hitting any part of the septum. As a result of this beam width problem, the majority of ventricular septal defects, particularly small defects, are not demonstrated. This was exemplified in three of our four patients who had sizeable ventricular septal defects. Septal-aortic discontinuity has also been reported in patients without ventricular septal defects due to malposition of the transducer. This further reduces the specificity of this echocardiographic feature.

Systolic fluttering of the pulmonary valve is another useful echocardiographic finding suggestive of subpulmonic ventricular septal defect. This finding, however, is also not specific and may be seen in normal patients as well as in patients with infundibular pulmonary stenosis. Systolic fluttering of the pulmonary valve was demonstrated in only one of our patients (patient 2) who also had severe infundibular pulmonary stenosis. Furthermore, technical difficulty in obtaining the systolic segment of the pulmonary valve reduces the usefulness of this echocardiographic feature. The presence of a dilated left ventricle and left atrium on the M-mode study may be useful in the diagnosis of ventricular septal defect. However, this feature is, again, not specific for ventricular septal defect and is usually not present in ventricular septal defects which do not result in a significant degree of left-to-right shunting.

Two-dimensional echocardiography has been shown to be of value in the diagnosis of ventricular septal defect due to greater spatial orientation; nonetheless, beam width remains a problem even with the two-dimensional echocardiographic study.

The systolic fluttering echos visualized on the tricuspid valve of our patients can best be explained on the basis of the tricuspid leaflets lying in the turbulent stream of blood flowing through a high ventricular septal defect. Similar systolic fluttering and anterior motion of the tricuspid valve has recently been reported in patients with ventricular septal aneurysms associated with ventricular septal defects. Since the septal leaflet of the tricuspid valve lies in close proximity to the membranous septum, it may form a part of the ventricular septal aneurysm. We believe, however, that the systolic tricuspid valve flutter, previously reported as arising from the ventricular septal aneurysms, probably results from the streaming effect of the left-to-right shunt through the ventricular septal defect impinging on the tricuspid valve leaflets. This is supported by the fact that only one of our four patients had a ventricular septal aneurysm associated with the ventricular septal defect.

The etiology of the systolic anterior motion of the tricuspid valve is not well understood. Although it has been previously reported with ventricular septal aneurysms, it has also been shown to occur from lateral resolution errors introduced by M-mode echo beam width. We believe that the systolic anterior motion of the tricuspid valve in our patients was probably due to a beam width problem exaggerated by marked anterior angulation of the transducer required for visualization of the tricuspid valve. The presence of a normal tricuspid valve in three of four patients at the time of surgery rules out vegetations or other organic disease of the tricuspid valve. Since most of the defects in the ventricular septum are situated in the membranous septum, it is conceivable that systolic fluttering of the tricuspid valve may be a more frequent finding if looked for. Since the fluttering is probably dependent on flow across the ventricular septal defect, the finding may be present even in small septal defects as in the case in our first patient.

In conclusion, we believe that the presence of fuzzy fluttering systolic echoes of the tricuspid valve is suggestive of a membranous ventricular septal defect and recommend careful evaluation of the tricuspid valve in patients in whom this diagnosis is made.

REFERENCES