Localization of Aortic Valve Vegetations by Echocardiography

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SUMMARY Nine patients with anatomically documented vegetations on one or more cusps of the aortic valve had echocardiograms in which abnormal echoes were associated with the aortic leaflet echoes. The motion of the abnormal echoes during systole correlated well with the anatomic location of vegetations: a vegetation on the right coronary cusp moved anteriorly with systole while a vegetation on the noncoronary cusp moved posteriorly during systole. Our data, although inconclusive, suggest that echoes from a vegetation on the left coronary cusp maintain a mid-aortic position throughout the cardiac cycle.

The echocardiographic appearance of vegetations is not specific, but in the setting of septicemia, dense mobile echoes in the region of the aortic valve are strongly suggestive of vegetation. A normal echocardiographic appearance of the aortic valve does not exclude the possibility that vegetation is present, especially if the growth is less than 5 mm in size.

THE ECHOCARDIOGRAPHIC APPEARANCE of the aortic valve was described by Gramiak and Shah in 1968. Since then, the aortic valve echo has been shown to be useful in the identification of a variety of pathologic states of the valve and surrounding structures, including valvular aortic stenosis, congenitally bicuspid valve, ruptured aortic cusp, membranous subvalvular stenosis, supravalvular aortic stenosis, sinus of Valsalva aneurysm, and sinus of Valsalva fistula.

Dillon et al. first described the echocardiographic appearance of vegetations on the aortic valve in patients with infective endocarditis. Recently, we saw nine patients with endocarditis involving the aortic valve in whom vegetations were demonstrated by echocardiography and subsequently confirmed anatomically; the echocardiographic appearance of the vegetations and the anatomic correlations are reported herein.

Materials and Methods

Pertinent clinical information of the patient group is presented in table 1. All patients were men 25 to 79 years of age, with a mean age of 39 years. None had a history of prior cardiac disease. Endocarditis was clinically suspected in all. Six of the patients were users of illicit intravenous drugs at the time of or within a month of onset of symptoms.

Studies were performed using either a Unirad Series 100 echocardiograph with Polaroid film or interfaced with an Electronics for Medicine DR8 recorder or a Picker E.V. 10 echocardiograph with Polaroid film or interfaced with a Honeywell 1856 or Tektronics strip chart recorder. In each case, the valve root and its surrounding structures were imaged from as many different locations on the chest as possible using a 1.3 cm focused 2.25 megaHertz transducer. The interval between the last echo and the time of anatomic confirmation varied from 0 to 11 days, with an average of five days.

Results

In each patient, the aortic valve was abnormal on echocardiogram with multiple dense echoes overlying the image of one or more leaflets. The abnormal echoes associated with the leaflet moving anteriorly with systole were predicted to indicate vegetations attached to the right coronary cusp and the dense echoes moving posteriorly with systole were thought to represent attachment to the noncoronary cusp. The left coronary cusp, rarely visible on an echocardiogram, is thought to appear as a systolic continuation of the echo from the coapted leaflets; therefore, it was expected that a vegetation attached to the left coronary cusp would remain in the middle of the aortic lumen throughout diastole and systole. Table 2 shows the echocardiographic and anatomic findings. Of the nine patients, seven had anatomically normal tricuspid aortic valves. Two had forms of congenitally bicuspid valves. Three patients had separate vegetations on more than one cusp. Of the six patients with single vegetations, four had vegetations attached to a single cusp, which in two was the anterior cusp of a bicuspid valve. Two patients had overlap of a single vegetation onto a second cusp.

Location of the vegetations predicted from the echocardiograms generally agreed with the anatomic findings. In the two patients (1 and 2) with anatomically normal valves and isolated right coronary cusp lesions, abnormal echoes moved anteriorly with systole (fig. 1). In the two patients (3 and 4) in whom a single vegetation was attached to two cusps, the vegetation appeared by echocardiogram to move with the cusp of predominant attachment (fig. 2). In one patient (9), in whom a right cusp vegetation was predicted, a bicuspid valve was found and the vegetation was attached to the anterior cusp. In the second patient (8) with a bicuspid valve, echoes filled the aortic lumen during systole and a cusp of attachment could not be predicted (fig. 3A); the vegetation was found to be localized to the junction of congenitally fused, right and left cusps (fig. 3B). It is uncertain which, if any, of the systolic echoes can be attributed to the calcified vegetation in the presence of calcification. In one patient (5) with multiple vegetations, the echocardiogram correctly predicted a large (15 mm) vegetation attached to the right coronary cusp but failed to detect the 4 to 5 mm lesions found at surgery on the remaining two cusps, whereas the echocardiogram of another patient (7) suggested abnor-

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malities of all three cusps (fig. 4). In a third patient (6) some transducer locations showed a normal-appearing valve (fig. 5, lower left), but a sweep from mitral ring to aortic root revealed a cloud of echoes (fig. 5, upper panel), which on detailed examination suggested the presence of vegetation on each of the three leaflets (fig. 5, lower right); the autopsy specimen is shown in figure 6.

Discussion

With current echocardiographic technique, it is possible to image the aortic valve in most patients. There has been some disagreement over the identity of the anteriorly moving aortic leaflet echo, although most investigators now accept this to be the right coronary cusp. Our findings in two patients with isolated right coronary cusp vegetations strongly suggest that the cusp that moves anteriorly during systole is the right coronary cusp and that vegetation attached to this cusp will similarly move anteriorly with systole. In a recent report by Martinez et al., the echocardiogram of a large aortic valve vegetation is correlated with the postmortem specimen (their case No. 2). Abnormal echoes were present on the cusp moving anteriorly in systole. Although the authors suggested that the major vegetation was on the left coronary cusp, we believe that on the basis of mitral chordal insertions the photograph of the pathology is mislabeled and that the affected leaflet is in actuality the right coronary cusp. Chordae of the anterior leaflet of the mitral valve characteristically insert on the noncoronary cusp, sometimes overlapping onto the adjacent portion of the left coronary cusp, but virtually never insert onto the right coronary cusp.

Our results are consistent with the view that the cusp moving posteriorly during systole is the noncoronary cusp. In addition, we have seen a patient with a ruptured noncoronary aortic cusp in whom the echocardiogram demonstrated marked systolic vibrations of the posteriorly moving leaflet. In our case 4 (fig. 2), the echocardiogram showed dense echoes moving posteriorly with systole. At autopsy, a large vegetation was found attached predominantly to the noncoronary cusp.

The identification of the left coronary cusp by echocardiography is controversial. It has been suggested that midluminal echoes imaged during systole reflect from the left cusp. A vegetation localized to the left cusp would serve as a useful landmark for that cusp. We believe that the midluminal systolic echoes found in patients 6 (figs. 5 and 6) and 7 (fig. 4) may, in fact, reflect from the vegetations subsequently confirmed to be present on the left cusp in each patient. Both of these patients, however, had vegetations on the right coronary and noncoronary cusps as well. Unfortunately, we have not as yet studied a patient with a documented isolated left cusp vegetation.

The echocardiographic appearance of vegetations was varied in our patients, perhaps in part due to the multiplicity

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**Table 1. Pertinent Clinical Data for Nine Patients with Aortic Valve Vegetations**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (yr)</th>
<th>Duration of symptoms</th>
<th>Heroin abuse</th>
<th>Fever (&gt;90.6°F)</th>
<th>Murmur of AI</th>
<th>Petechiae</th>
<th>Leukocytosis WBC &gt;11,000/mm³</th>
<th>Organism(s)</th>
<th>Mode of documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>35 M</td>
<td>4 wk</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Serratia marcescens</td>
<td>Autopsy</td>
</tr>
<tr>
<td>2</td>
<td>25 M</td>
<td>3 wk</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Candida parapsilosis</td>
<td>Surgery</td>
</tr>
<tr>
<td>3</td>
<td>28 M</td>
<td>8 wk</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>Streptococcus viridans</td>
<td>Autopsy</td>
</tr>
<tr>
<td>4</td>
<td>32 M</td>
<td>4 d</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>Candida parapsilosis</td>
<td>Autopsy</td>
</tr>
<tr>
<td>5</td>
<td>47 M</td>
<td>3 wk</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>Staphylococcus aureus</td>
<td>Autopsy</td>
</tr>
<tr>
<td>6</td>
<td>31 M</td>
<td>10 d</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>Candida parapsilosis</td>
<td>Autopsy</td>
</tr>
<tr>
<td>7</td>
<td>25 M</td>
<td>7 d</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>Serratia marcescens</td>
<td>Autopsy</td>
</tr>
<tr>
<td>8</td>
<td>51 M</td>
<td>3 wk</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>None found</td>
<td>Autopsy</td>
</tr>
<tr>
<td>9</td>
<td>70 M</td>
<td>2 wk</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>Streptococcus viridans</td>
<td>Autopsy</td>
</tr>
</tbody>
</table>

**Abbreviations:** AI = aortic insufficiency; WBC = white blood cells.
of recording systems utilized. Several vegetations appeared as multiple dense parallel lines overlying a cusp echo. This was true of the four Candida vegetations in particular, an appearance consonant with that recently described by Gottlieb et al., in two patients similarly infected with Candida. In other cases, vegetations appeared as a cloud of fluffy echoes (fig. I) or simply as a marked increase in density of a mobile valve leaflet. In all cases, valves showed brisk opening during systole, as in the original description of aortic valve endocarditis by Dillon et al. In only one patient (8) was there calcification or pathologic thickening of valve cusps other than what was attributable to the inflammatory process itself.

The echocardiographic appearance of aortic valve vegetations is not specific. Although acquired aortic stenosis usually produces significant restriction of valve excursion, this is not invariably true, and we have seen patients with significant valvular gradients whose valves retained good excursion on the echocardiogram. Congenitally bicuspid valves, as described by Nanda et al., similarly may mimic the echocardiographic appearance of vegetation.

An important question that our study does not answer is the size that a vegetation must be to be detectable on the echocardiogram. Seven of our nine patients were infected with organisms that characteristically produce bulky vegetations; i.e., Candida, Serratia, and Staphylococcus. Patients infected with these organisms are likely to come to surgery or autopsy. The echocardiogram in patient 5 permitted the visualization of a 15 mm vegetation, but 5 mm vegetations were not imaged. In addition, we have had several cases of clinical endocarditis believed, on the basis of murmurs, to involve the aortic valve in which the echocardiograms were repeatedly normal. All of these patients responded to medical therapy and thus anatomic correlations were not possible.

**Table 2. Anatomic and Echocardiographic Findings in Nine Patients with Aortic Valve Vegetations**

<table>
<thead>
<tr>
<th>Pt no.</th>
<th>Anatomy</th>
<th>Cusp involved*</th>
<th>Size of vegetation (maximum dimension in mm)</th>
<th>Abnormal cusp by echo*</th>
<th>Days between echo and documentation</th>
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<tbody>
<tr>
<td>1</td>
<td>Normal</td>
<td>R</td>
<td>30</td>
<td>R</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Normal</td>
<td>R</td>
<td>10</td>
<td>R</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Normal</td>
<td>R (L)</td>
<td>17</td>
<td>R</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Normal</td>
<td>N (L)</td>
<td>30</td>
<td>N</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>Normal</td>
<td>R</td>
<td>15</td>
<td>R</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>4-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>4-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Normal</td>
<td>R</td>
<td>6</td>
<td>R</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>18</td>
<td>L</td>
<td></td>
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<td></td>
<td></td>
<td>N</td>
<td>12</td>
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<td>Normal</td>
<td>R</td>
<td>8</td>
<td>R</td>
<td>7</td>
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<td>L</td>
<td>25</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>25</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Bicuspid</td>
<td>Ant</td>
<td>8</td>
<td>?</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>Bicuspid</td>
<td>Ant</td>
<td>26</td>
<td>R</td>
<td>7</td>
</tr>
</tbody>
</table>

Ant = anterior; R = right coronary; L = left coronary; N = noncoronary; multiple cusps involved indicate separate vegetations, whereas a cusp shown in parentheses indicates overlap of a single vegetation onto a second less affected cusp.
AORTIC VALVE ENDOCARDITIS/Hirschfeld and Schiller

**Figure 3** Left: Echocardiogram from patient 8 showing dense echoes that appear to occupy the entire aortic lumen during systole. At autopsy (right panel) an 8 mm vegetation was found localized to the junction of congenitally fused calcified right and left cusps. The specimen showed calcified bicuspid aortic valve. A tear is present in the noncoronary (posterior) cusp. AoAW = aortic anterior wall; AoPW = aortic posterior wall; C = dense echoes probably arising from calcified valve structures.

**Figure 4** Echocardiogram from patient 7 showing a short sweep from low (left) to mid-aortic (right) valve level. Dense posteriorly moving echoes are evident in the second systole and may represent noncoronary cusp vegetation (NC Veg). Dense echoes present anteriorly during systole are thought to reflect from a vegetation attached to the right coronary cusp (RC Veg). An isolated band of echoes occupies a mid-luminal position in systole and is hypothesized to represent a vegetation on the left coronary cusp (LC Veg). AoAW = aortic anterior wall.
FIGURE 5  Left) Echocardiogram from patient 6, showing normal-appearing aortic valve. Top panel) Echocardiogram from patient 6 showing sweep from mitral ring to aortic root. A cloud of echoes is evident low in the aortic outflow tract, probably representing a vegetation prolapsing below the plane of the aortic valve. Faint diastolic vibrations (Vib) may be secondary to ruptured noncoronary cusp (NC) (see fig. 6). Middle panel) Echocardiogram from patient 6 showing three views of the aortic valve from differing transducer angulations suggesting presence of vegetation (Veg) on each of the three aortic cusps. AoAW = aortic anterior wall; AoPW = aortic posterior wall; RC = right coronary cusp; NC = noncoronary cusp; AML = anterior mitral leaflet; IVS = interventricular septum; R = right, L = left.
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Acknowledgments

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References


Figure 6 Autopsy specimen from patient 6. Vegetations are present on each of the three cusps. Curved arrow points to a pedunculous 18 mm vegetation attached to the left coronary cusp. Straight arrow points to perforation of noncoronary cusp (NC). RC = right coronary cusp.
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