Echocardiographic Evaluation of Porcine Bioprosthetic Valve Degeneration

M. Alam

J. B. Lakier

S. Goldstein

Follow this and additional works at: https://scholarlycommons.henryford.com/hfhmedjournal

Part of the Life Sciences Commons, Medical Specialties Commons, and the Public Health Commons

Recommended Citation
Available at: https://scholarlycommons.henryford.com/hfhmedjournal/vol30/iss3/5

This Article is brought to you for free and open access by Henry Ford Health System Scholarly Commons. It has been accepted for inclusion in Henry Ford Hospital Medical Journal by an authorized editor of Henry Ford Health System Scholarly Commons.
Echocardiographic Evaluation of Porcine Bioprosthetic Valve Degeneration

M. Alam, MD,* J. B. Lakier, MD,* and S. Goldstein, MD*

Spontaneous cusp degeneration is one of the most common long-term complications associated with porcine bioprosthetic valves (1-6). Recognition of its occurrence is essential for appropriate management to be instituted. In this report we have reviewed our echocardiographic experience with porcine bioprosthetic valve degeneration (7-8).

Materials and Methods

We reviewed all M-mode and two-dimension (2-D) echocardiographic studies of bioprosthetic porcine valves performed in our laboratory in the last four years (311 clinically normal and 35 degenerative valves). Of the 35 degenerative valves, 20 were implanted in the mitral and 15 in the aortic position. Clinical, hemodynamic, and angiographic findings in these 35 patients are summarized in Table I. In all instances, the diagnosis was confirmed by gross anatomic examination of the valve obtained during surgery or autopsy. All M-mode and 2-D echocardiographic studies were performed with commercially available instruments (Smith-Kline and Advanced Technological Laboratory). Studies were usually performed from the left parasternal approach with patients in the left lateral position. The valve cusps were distinguished from the highly echo reflective stents by their opening and closing motion. In all instances, the valve cusps were enlarged once they were identified and scanned slowly for abnormal motion or flutter. Cusp thickness was measured from the enlarged segment of the valve at the maximal point during systole for mitral valves and during diastole for aortic valves.

Results

Normally functioning valves

Figures 1 and 2 illustrate M-mode echocardiograms of normally functioning porcine aortic and mitral valves. Note the thin cusp echoes (C) with multiple echoes from the stents. In all but 14 instances, the systolic mitral and diastolic aortic cusp thickness of 311 normally functioning valves measured less than 3 mm.

Degenerating valves

Echocardiographic features of these valves depend on whether they are regurgitant (with torn cusps) or stenotic (with thickened, rigid, and calcified cusps).

Regurgitant valves

One or more of three features was present in 26 of 30 (87%) regurgitant valves.

Fig. 1

M-mode echocardiogram of a normal bioprosthetic aortic valve enlarged to show the thin cusps (C) with prominent stent echoes. AR = aortic root; C = cusps; EKG = electrocardiogram; LA = left atrium; St = stent. RVOT = right ventricular outflow tract.
Echocardiography of Valve Degeneration

TABLE I
Clinical, Hemodynamic, Angiographic, Echocardiographic, and Gross Anatomic Features of Porcine Bioprosthetic Valve Degeneration

<table>
<thead>
<tr>
<th>Valve Function</th>
<th>Mean Age</th>
<th>Presentation</th>
<th>M-Mode, 2-D Echo</th>
<th>Gross Pathology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regurgitant (30)</td>
<td>53</td>
<td>Class III dyspnea or congestive heart failure (26); Asymptomatic (4)</td>
<td>Thickened 22, Flutter 19, Flail 9, Others Diastolic mitral flutter (10)</td>
<td>Thickened 22, Torn 30</td>
</tr>
<tr>
<td>Stenotic (5)</td>
<td>46</td>
<td>Class III dyspnea or congestive heart failure (5); Syncope, angina (1)</td>
<td>Thickened 5, &lt;5 mm mitral diastolic slope (1)</td>
<td>5, 0</td>
</tr>
</tbody>
</table>

1) Abnormal cusp flutter: Presence of diastolic aortic and systolic mitral valve fluttering by M-mode study was diagnostic of a regurgitant valve (Figs. 3 and 4). This finding was observed in 19 of 30 (63%) regurgitant mitral and aortic valves but in none of the 311 normally functioning valves. On gross examination, all of these valves had a tear in one or more cusps. We believe that cusp flutter results from vibration as regurgitant blood flows across the torn cusps. Diastolic mitral flutter was observed with or without systolic flutter in five cases but was not present in ten degenerating valves as well as in normal porcine mitral valves in the presence of aortic insufficiency, atrial fibrillation, and once for unknown reasons.

2) Flail valve motion was observed in 9 of 30 (30%) regurgitant valves by M-mode and 9 of 20 (45%) by 2-D study. Protrusion of an aortic valve cusp into the left ventricular outflow tract during diastole and of a mitral valve cusp into the left atrium during systole characterized this finding (Figs. 3 and 4). Flail valve motion was more easily identified when the valves were thickened.

3) Thickened valve cusps: Diastolic aortic and systolic mitral cusp thickness of 3 mm or more was found in 22 of 30 (73%) regurgitant valves (Figs. 3 and 4).

Stenotic valves
One or more of the following features was observed in all five stenotic valves.
1) Thickened valve cusps measuring 3 mm or more were observed in all five stenotic valves resulting from cusp degeneration (Fig. 5). 2) The two stenotic valves in the aortic position (Fig. 5) had reduced systolic valve cusps of 3 and 6 mm (normal: less than 10 mm). 3) Reduced mitral diastolic stent slope less than 5 mm was observed in one of three stenotic mitral valves as well as in eight normally functioning mitral valves in the presence of reduced left ventricular compliance.

Discussion
Gross pathologic examination of severely degenerating bioprosthetic porcine valves usually reveals thickened calcified cusps with or without tearing (9). The presence of cusp flutter as revealed by M-mode echocardiography reflects torn cusps and results from vibration of unsupported cusp margins. Since the tear may be localized to a single cusp, slow scanning of the entire valve is crucial to demonstrate this sometimes subtle finding. While the presence of flutter when the valve is in the

Fig. 2
M-mode echocardiogram of a normal porcine mitral valve. Note the thin cusps (C) during systole with only the anterior cusp demonstrated during diastole (arrow). C = cusps; EKG = electrocardiogram; RV = right ventricle; LV = left ventricle; S = ventricular septum; St = stent.
Fig. 3

M-mode echocardiogram of thickened, regurgitant, and flail porcine aortic valve in the left ventricular outflow tract (LVOT). Note the thickened cusps (C) with diastolic flutter (arrow). LVOT = left ventricular outflow tract; RVOT = right ventricular outflow tract.

Fig. 4

M-mode and 2-D echocardiogram of a thickened, regurgitant, and flail porcine mitral valve. The thickened cusps (C) are prolapsing in the left atrium during systole (arrow); AV = aortic valve.
M-mode echocardiogram of a stenotic aortic valve. The thickened cusp (C) has a systolic opening smaller than 10 mm (arrow). The closed position is specific for regurgitant valves, it is not frequently found. The presence of diastolic flutter is, however, not a specific finding for regurgitant mitral valves. Echocardiographically measured cusp thickness of 3 mm or more, in the absence of infective endocarditis and thrombi, correlates with thickening and calcification observed on gross examination. Of the 14 normally functioning porcine valves with 3 mm or more cusp thickness, six have developed severe clinical valve degeneration that required surgery. In these 14 patients, the increased cusp thickness is apparently a subclinical manifestation of early valve degeneration. Increased cusp thickness is not specific for degenerating valves because valve vegetations, thrombi, stent reverberation with normal valves, as well as the use of increased gain settings, may produce an identical echocardiographic picture. However, infective endocarditis is usually easily differentiated from valve degeneration, and thrombus formation is relatively rare with tissue valves (1). Use of proper gain control and the techniques outlined in the methodology section minimize false positive studies caused by technical factors.

References


