Real-time 3D transesophageal imaging has advanced significantly over the past several years. In our laboratory, we currently use real-time 3D transesophageal imaging in addition to multiplane 2D imaging in all of our transesophageal imaging. As the equipment and software continue to advance, new imaging modes and views become available.

Recently we started using a new view, which we named the 4V (4-valve) view. We found that it can be acquired in all patients undergoing a transesophageal imaging and provides a new perspective on cardiac anatomy (Figure 1 and online-only Supplemental Video).

The 4V view is most easily acquired from the midesophageal position, at a transducer angle of 0°. A 4-chamber view is the starting 2D view (Figure 2A). Once an adequate image is attained, the real-time full-volume mode is activated. At this point, an automatically cropped image is obtained, showing both ventricles and the posterior aspect of the atrioventricular valves. The lateral dimensions of this image are increased, such that both the mitral and tricuspid valves are completely included in the image (Figure 2C). Given that such a large data set is being acquired, the image frame rate drops significantly. If the patient is in a regular rhythm, changing to acquisition over a 2-beat gating can be helpful. However, this may create “stitching” artifacts that may be quite pronounced, especially in patients with irregular heart rhythm, degrading the image quality. Once the atrioventricular valves are visualized, the image is tilted forward slightly so the valves are visualized from the atrial perspective (Figure 2C). Finally, the cropping is reset such that the whole data set is visualized. This brings into view the anterior half of the image, showing the aortic and pulmonic valves (Figure 2D).

The obtained 4V view is a new way to look at the heart. It allows for true appreciation of the normal cardiac anatomy as well as insights into cardiac pathology. For example, imaging of atrial septal defect and defining the presence or absence of adequate rim around the defect to determine suitability for percutaneous closure is remarkably intuitive when using this technique (Figure 3A and 3B). It is also possible that this view might be useful in appreciation of other complex congenital pathologies (eg, transposition of the great vessels). The intervalvular fibrosa, that is, the area between the anterior mitral leaflet and the aortic valve (known also as the aortomitral curtain) is very well visualized with the 4V view, which is important in cases of endocarditis and suspected intracardiac abscess. The spatial relationships of the 4 valves become clear when observed on the 4V view, allowing for precise anatomic definition of focal pathologies such as site of mitral prosthesis dehiscence.

Although this view might be acquired by using other imaging modalities (eg, volume-rendered CT scanning), attaining it may require significant postprocessing with special off-line cropping. The echocardiographic 4V view can be obtained in real time, with only minimal manipulation of the image data (as shown in Figure 2).

Although our new 4V view appears to be very helpful and potentially instrumental for clear anatomic delineation of cardiac anatomy and pathology, it should be used in conjunction with other echocardiographic views (both 2D and 3D) for accurate and comprehensive diagnosis.

**Disclosures**

Dr Kronzon received honoraria from Phillips.

**Keywords:** real-time 3D echocardiography □ 3D transesophageal echocardiography

Figure 1. The 4-valve (4V) view. AV indicates aortic valve; MV, mitral valve; PV, pulmonic valve; and TV, tricuspid valve.
Figure 2. Obtaining the 4-valve (4V) view. A, Starting image: Midesophageal 4-chamber view at transducer angle of 0°. B, Automatically cropped full-volume image acquired from the midesophageal position at the 4-chamber view. C, Enlargement of the lateral dimension of the 3D data set and slight anterior tilt of the image. D, Cropping reset to bring the anterior half of the data set into view.

Figure 3. Four-valve (4V) view in atrial septal defect. A, Secundum atrial septal defect (ASD) as seen using the 4V view. Note the clear definition of the spatial relationship between the ASD and the aortic valve. B, Closure device in place, demonstrating occlusion of the ASD and the positioning of the device such that the aortic rim is caught in between the 2 plates of the device. AV indicates aortic valve; MV, mitral valve; PV, pulmonic valve; and TV, tricuspid valve.
The 4-Valve View
Michael Vitellas, Itzhak Kronzon, Cynthia Barnes and Gila Perk

doi: 10.1161/CIRCIMAGING.111.966416
Circulation: Cardiovascular Imaging is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2011 American Heart Association, Inc. All rights reserved.
Print ISSN: 1941-9651. Online ISSN: 1942-0080

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circimaging.ahajournals.org/content/4/5/594

Data Supplement (unedited) at:
http://circimaging.ahajournals.org/content/suppl/2011/09/21/4.5.594.DC1

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation: Cardiovascular Imaging can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation: Cardiovascular Imaging is online at:
http://circimaging.ahajournals.org//subscriptions/