Screening TEE for Transcatheter Tricuspid Valve Repair

A review of the key images required for transcatheter tricuspid valve repair screening and a successful procedure.

BY RICHARD Y. BAE, MD

Tricuspid regurgitation (TR) is a highly prevalent disease and is associated with severe morbidity and mortality.[1,2] Treatment options have typically been limited to diuretic therapy because isolated tricuspid valve surgery carries a high in-hospital mortality rate.[3,4] The transcatheter edge-to-edge tricuspid valve repair (TTVR) technique with the TriClip tricuspid valve repair system (Abbott) is one of the few transcatheter techniques under development that is being evaluated in prospective clinical trials. Early feasibility data support the TriClip system as safe and effective in reducing TR severity.[5]

Screening for TTVR typically involves a multimodality approach that includes transthoracic echocardiography, transesophageal echocardiography (TEE), and, occasionally, cardiac CT. Together, these modalities assess TR severity, tricuspid valve anatomy, and right ventricular (RV) size and function. TEE is the principal imaging technique for intraprocedural guidance and, therefore, is critical during screening to demonstrate that key views can be adequately obtained and visualized for a successful procedure. Screening TEE images need to confirm TR severity, location along the commissures, mechanism, and anatomic features predictive of procedural success (including leaflet length, gap widths, leaflet tethering, and pacemaker interaction with leaflets, if present). Unfortunately, imaging of the tricuspid valve can be challenging because it is typically in the far-field from the esophageal position, the leaflets are thin, and there are often issues with acoustic shadowing obscuring visualization of part of the valve (eg, a lipomatous atrial septum, atrial septal defect closure devices, mitral or aortic valve calcium, prosthetic material).

This article describes the key TEE images for TTVR screening. These same views will also be used intraprocedurally for navigation and clip deployment.

FOUR-CHAMBER VIEW

The four-chamber view is typically obtained at a transducer angle of 0° to 25° (Figure 1A). From this view, both the RV and left ventricular (LV) size and function can be assessed. The septal leaflet is readily identified, attached to the interventricular septum. The lateral leaflet is typically the anterior leaflet, but it can be the posterior leaflet if the probe tip is extended or advanced further into the esophagus. The probe can be manipulated to visualize TR between the leaflets. Both leaflets should be visualized throughout the cardiac cycle because this view is occasionally used intraprocedurally to assess clip grasping. Adjustments to the right-left flexion wheel can help optimize the images. Leaflet length and assessment of any tethering or prolapse can also be evaluated. If present, the RV pacemaker wire should be carefully examined as it crosses the valve to evaluate for any leaflet impingement. A zoomed color-flow image of TR can then be obtained to measure vena contracta and, with baseline shift, proximal isovelocity surface area (PISA) diameters. Continuous-wave Doppler should also be obtained through the TR jet to capture systolic and diastolic flow. This tracing can be used for PISA, estimated RV systolic pressure, and to exclude any significant tricuspid stenosis.

RV INFLOW/OUTFLOW AND COMMISSURAL VIEW

The RV inflow/outflow and commissural view is typically obtained between 60° and 90° (Figure 1B). The aortic valve is seen in the short axis, and the RV inflow and outflow are visualized. In this view, the individual tricuspid valve leaflets are not distinctly seen; rather, it is a commissural view with the septal-anterior commissure toward the right side of the valve (closer to the aortic valve) and the posterior-septal commissure toward the left side (further away from the aortic valve). The angle should be adjusted to show the widest extent of TR coming through the valve, and the location of the regurgitation (ie, anterior, posterior, both) should be demonstrated. PISA, vena contracta, and continuous-wave Doppler should be captured as previously described.

This view is analogous to the commissural view for transcatheter mitral valve repair. Instead of localizing the medial-to-lateral location and width of the regurgitation between the anterior and posterior leaflets of the mitral valve, the anterior-to-posterior location and width of the regurgitation are demonstrated with respect to the septal-anterior and septal-posterior commissures. Similar to the mitral commissural view, an X-plane cursor can be directed through the valve to show the orthogonal image to the right. If the cursor is directed through the tricuspid valve closer to the aortic valve, the orthogonal view will show the septal and anterior leaflets—a potential grasping view at that location (Figure 1C). During the procedure, the clip can be advanced where the cursor is directed, and the clip arms should be visualized when open in the orthogonal view. Similarly, if the cursor is directed toward the left (further from the aortic valve), the orthogonal view will show the septal and posterior leaflets at that location. Multiple image clips should be obtained with and without color as the cursor is swept across the tricuspid valve. It is important to see the tricuspid leaflets throughout the cardiac cycle, especially in the regions where TR is located because these will be potential grasping views during the procedure.

LONG-AXIS VIEW—INTENT-TO-CLIP VIEW

The long-axis view is obtained at 140° to 180° and is similar to the orthogonal view obtained from the commissural view (Figure 1D). This view is frequently used for grasping during the procedure (and thus is often referred to as the intent-to-clip view); therefore, visualization of both of the leaflets throughout the cardiac cycle is important. Leaflet length and assessment of any tethering or prolapse can also be evaluated. As with the other views, PISA, vena contracta, and continuous-wave Doppler should be captured.

THREE-DIMENSIONAL IMAGES

Three-dimensional (3D) imaging of the tricuspid valve should be obtained with the highest frame rates possible, with and without color (Figure 1E). Even in atrial fibrillation, the systolic time interval remains relatively constant, and with retrospective capture, images

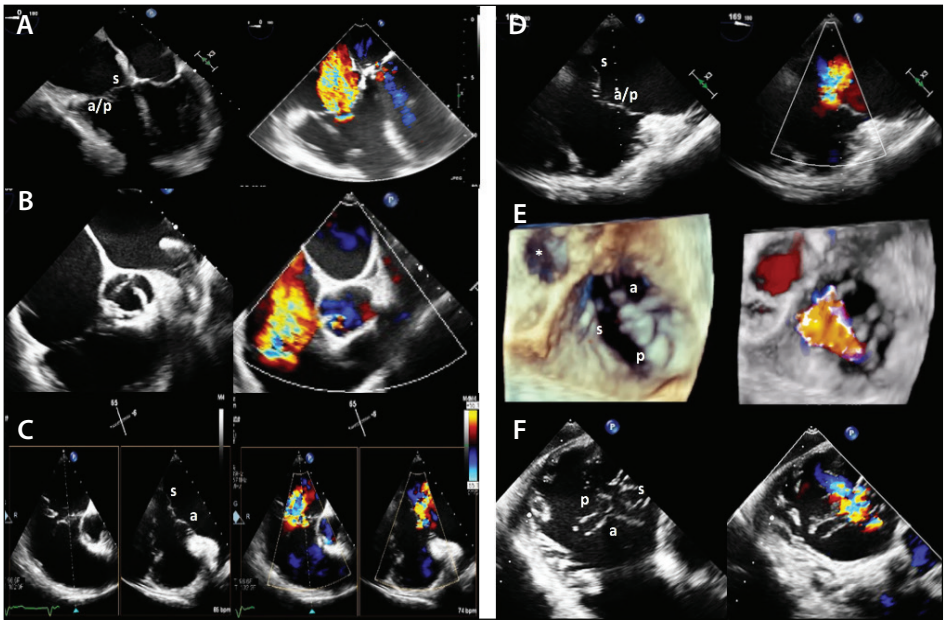

Figure 1. Four-chamber view showing the septal (s) and anterior (a) or posterior (p) leaflets. Two-dimensional and color flow images (A). RV inflow/outflow (commissural) view (B). X-plane view with cursor directed anteriorly on commissural view yielding long axis view of septal (s) and anterior (a) leaflets on orthogonal image (C). Long-axis view showing septal (s) and anterior (a) or posterior (p) leaflets (D). Three-dimensional image of the tricuspid valve viewed from right atrium showing all three leaflets. Aortic valve (*) is included for spatial reference (E). Transgastric short-axis view showing all three leaflets and the commissures (F).

can be selected with minimal stitch artifacts with multiple-beat capture. The images can be obtained from any starting view, but the commissural view is often useful to ensure that part of the aortic valve is included in the image for orientation purposes.

These images can be used to assess leaflet gaps and 3D vena contracta and during the procedure for clip arm alignment in the right atrium. If the image quality is sufficient, multiplanar reconstruction images can be obtained from the 3D images during the procedure to assess leaflet insertion.

DEEP ESOPHAGEAL WINDOW

Occasionally, a lipomatous atrial septum, atrial septal defect closure device, mitral or aortic calcium, or prosthetic material can cause shadowing of the tricuspid leaflets (particularly the septal leaflet) on midesophageal views. If this is the case and the leaflets are not optimally visualized, images should be obtained from the deep esophageal position just above the gastroesophageal junction. From this position, the atrial septum and septal mitral annulus are taken out of the field of view, and the leaflets are often better visualized. Four-chamber, RV inflow-outflow/commissural, long-axis, and 3D views can be repeated from this window if needed.

TRANSGASTRIC IMAGES

The transgastric view is essential for screening as well as intraprocedural use. It also tends to be one of the more difficult images to obtain. The probe is advanced into the stomach and flexed to obtain a short-axis view of the mid-LV. It is then withdrawn until the tricuspid valve leaflets are visible. The angle is rotated anywhere between 0° and 60° to view all three commissures. Adjustments to right-left flexion can help optimize the view. Finally, probe flexion can be adjusted to focus on the leaflet tips, where the gaps between leaflets appear the smallest (Figure 1F). Properly identifying the gap width is essential because this variable is a key determinant of eligibility for TTVR and procedural success.

From this view, the location of TR along the commissures can be assessed, and the gap widths at those locations can be determined. This is instrumental for procedural planning (clip location, size, and number of clips). If an RV pacer lead is present, this view helps localize where the lead crosses the valve with respect to the commissures, whether there is excessive lead motion, and whether the lead is located close to the potential grasping locations. This view is also critical intraprocedurally for clip arm alignment and clip positioning, as well as for the assessment of leaflet insertion.

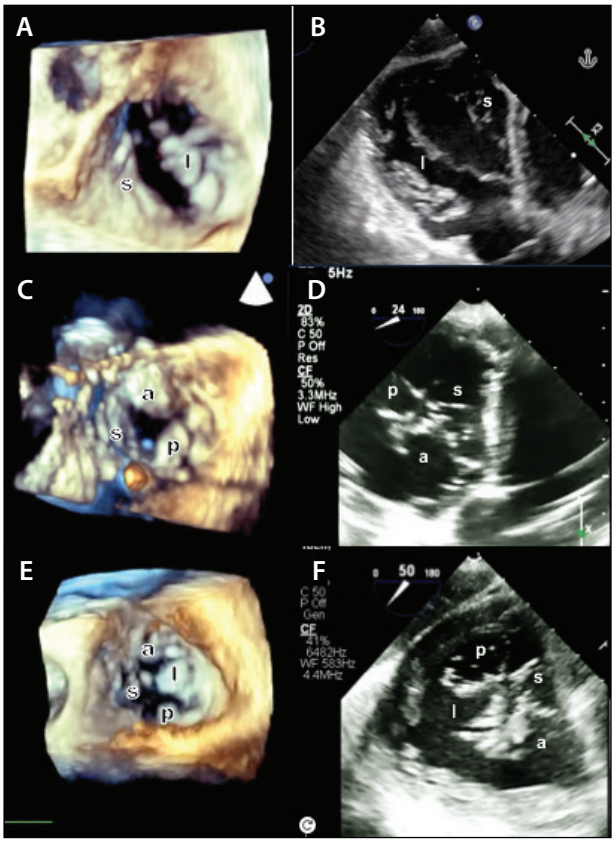

Figure 2. Anatomic variability in the number of tricuspid valve leaflets (septal leaflet [s], anterior leaflet [a], lateral leaflet [l], and posterior leaflet [p]). Three-dimensional view (A) and two-dimensional transgastric short-axis view (B) of a tricuspid valve with two leaflets. Tricuspid valve with three leaflets (C, D). Tricuspid valve with four leaflets (E, F).

SUPINE IMAGES

Screening TEEs are typically performed with the patient in the left lateral decubitus position. However, during TTVR, the patient is supine. Occasionally, this change in position can cause relative image deterioration as the heart shifts with the body supine. This is helpful to identify during screening, and we recommend obtaining limited images with the patient supine at the end of the screening exam. If image deterioration occurs, sometimes this can be mitigated by placing a towel or small pillow under the right shoulder while the patient is supine.

ANATOMIC VARIABILITY

The tricuspid valve is typically described as having three leaflets: septal, anterior, and posterior. However, anatomic variations are frequently encountered, and there can be two, three, four, or even more leaflets visualized. These variants are important to recognize during screening because they may alter the clipping strategy

(target locations and sizes of clips). These variants can occasionally be identified on 3D imaging but are generally easier to identify from the transgastric short-axis images given the higher spatial resolution (Figure 2).

CONCLUSION

TEE screening for TTVR can be challenging and requires several views that are not routinely obtained on standard studies obtained for other reasons. The transgastric short-axis view can be particularly challenging, but it is critical for procedural success. Additionally, imaging from the deep esophageal window can be extremely helpful when there is shadowing on the septal leaflet from the atrial septum, mitral/aortic calcium, or prosthetic material. The imager should practice obtaining all of these views on routine studies until they become second nature; this will facilitate the screening studies, reduce the number of studies that need to be repeated for missing views or poor image quality, and increase the likelihood of procedural success. ■

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Richard Y. Bae, MD
Director, Echocardiography Laboratory and Interventional Echocardiography
Minneapolis Heart Institute at Abbott Northwestern Hospital
Minneapolis, Minnesota
richard.bae@allina.com
Disclosures: Consultant to Abbott Vascular, Boston Scientific Corporation.