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IMAGING VIGNETTE

3D Echocardiography for Traumatic Tricuspid Regurgitation

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THE TRICUSPID VALVE (TV) IS A COMPLEX STRUCTURE. Unlike mitral and aortic valves, simultaneous visualization of the 3 TV leaflets cannot be achieved with 2-dimensional echocardiography (2DE) due to valve orientation with reference to the imaging planes. No 2D echo plane is parallel to the tricuspid valve. Therefore, there is no short-axis view for the tricuspid valve on 2DE. Three-dimensional echocardiography (3DE) supplements 2DE with detailed images of TV morphology. Tricuspid regurgitation (TR) secondary to blunt chest trauma is rare. 3DE provides a "surgeon view" of the valve to aid surgical planning. While functional TR secondary to right ventricular dilation is most common cause of TR, valve injury from device-lead or catheter placement/removal is increasing in incidence. 2DE is unable to completely visualize the intracardiac course of a lead or catheter as it usually does not lie in a single imaging plane. 3DE has the ability to define 3D spatial relationship of the TV with nearby intracardiac devices in real time. This report illustrates the diagnostic capability of 3DE in providing incremental anatomic information of the TV and its relation to adjacent structures and/or devices for prevention and management of traumatic TR (Figs. 1 to 4).

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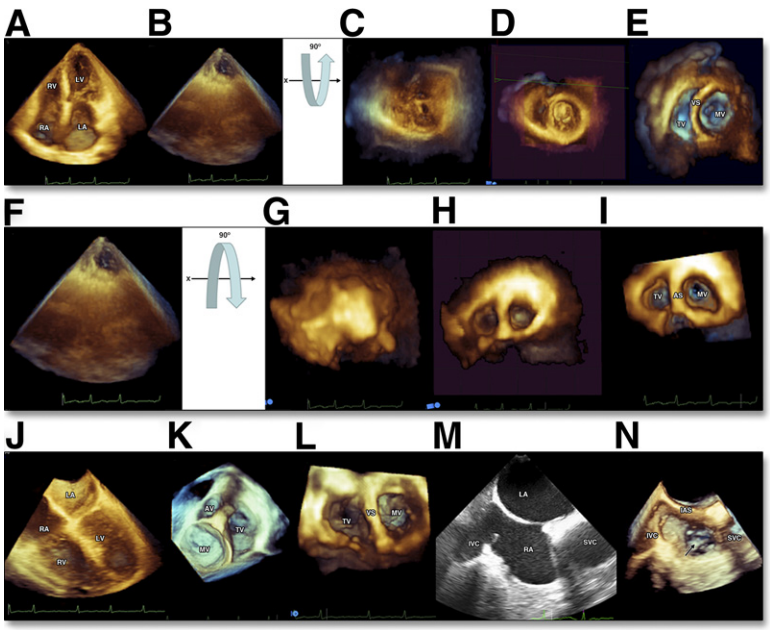

Figure 1. Normal Tricuspid Valve on 3D Echocardiography

On transthoracic echocardiography (TTE), standard 3-dimensional echocardiography (3DE) full-volume datasets can be obtained from the apical windows **(A and B)**. **(C)** The image is then rotated 90° around the x axis such that the apex moves towards the imager. Cropping from the apex towards the base **(D)** will display the en face view of the TV from the ventricular side **(E)**. When the image volume is rotated around the x axis for 90° such that the apex rotates away from the imager **(F, G)**, cropping from the atrial roof towards the apex **(H)** will display the TV from the atrial ('surgical') perspective **(I)**. The TV can be imaged in a similar way by real time (RT) 3D-TEE using four-chamber view at mid-esophageal level **(J)** to display the TV from the atrial view **(K)** and from the ventricular view **(L)**. The TV can also be imaged using the bicaval view at the mid-oesophageal level on RT3D-TEE. First with 2D-TEE, the standard bicaval view is obtained **(M)**. Switching on the live 3D imaging mode at the bicaval view immediately reveal the TV **(arrow)** en face from the right atrial perspective **(N)**. AS = atrial septum; AV = aortic valve; IAS = inter-atrial septum; IVC = inferior vena cava; LA = left atrium; LV = left ventricle; MV = mitral valve; RA = right atrium; RV = right ventricle; SVC = superior vena cava; TV = tricuspid valve; VS = ventricular septum.

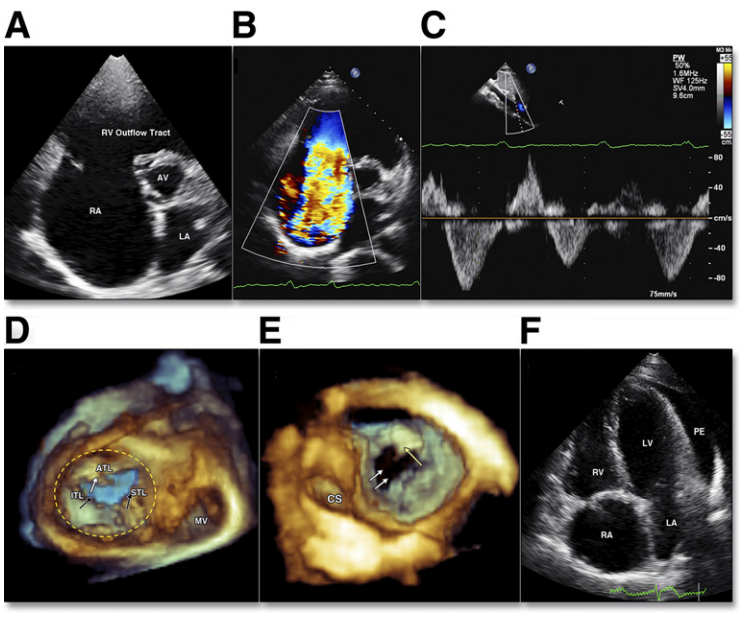

Figure 2. Traumatic Tricuspid Regurgitation Secondary to Blunt Chest Trauma

A 40-year-old man presented with palpitation. A loud systolic murmur was noted with jugular distention. He had a history of blunt chest trauma 20 years ago when he was involved in a road traffic accident while carrying out duty as a policeman. Two-dimensional echocardiography (2DE) transthoracic echocardiography (TTE) showed that the right ventricle is severely dilated **(A)** and presence of severe tricuspid regurgitation **(B)** with late systolic flow reversal in hepatic veins **(C)**. RT3DE clearly demonstrated the anatomy of the 3 TV leaflets and hence useful for surgical planning in this case. **(D)** RT3D-TTE view of TV from the ventricular aspect showed the anterior leaflet is flail due to rupture chordae (white arrow), while both the inferior and septal leaflets **(black arrows)** are restricted in motion due to annular dilation and RV remodeling. **(E)** The flail anterior leaflet **(yellow arrow)** with a large coaptation defect **(white arrows)** can be clearly seen from the RA aspect on RT3DE TTE. After reviewing the 3DE images, the patient underwent TV replacement instead of TV repair in view of the complex pathology associated with the flail leaflet, fibrosis, and significant tethering. The patient's symptoms resolved after surgery, and the RV decreased in size with significantly improved RV function **(F)**. There is a small amount of pericardial effusion which subsequently resolved on follow up echo. See Online Videos 1, 2, and 3. Abbreviations as in Figure 1.

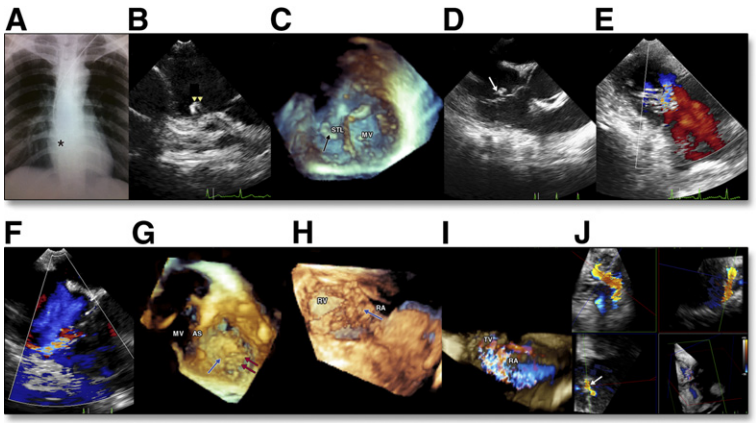

Figure 3. Iatrogenic Trauma of TV During Central Venous Catheter Placement

A 27-year-old woman with end-stage renal failure requiring hemodialysis underwent jugular venous catheter placement. After gaining access to the right internal jugular vein, a J-tipped guidewire was introduced for guiding venous catheter insertion using Seldinger technique. During the procedure, however, the guidewire was noted to be "stuck" and could not be withdrawn from the venous system. A chest radiograph **(A)** showed that the guidewire tip is located at the tricuspid region **(asterisk)**. On 2D-TTE parasternal view, the J-shaped guidewire tip **(yellow arrowheads)** has passed across the tricuspid annulus, lying within the right ventricular inflow region **(B)**. **(C)** RT3D-TTE from the RV perspective clearly demonstrated that the guidewire is entrapped in the RV with its J-tip **(arrow)** "hooking" around the tricuspid orifice **(dashed line)** closely adjacent to the septal leaflet, with apparent entanglement with the associated chordae tendinae. **(D)** After extraction of the guidewire, a flail TV leaflet can be seen on 2D-TEE **(arrow)**, in association with a new, eccentric jet of tricuspid regurgitation, the severity of which is difficult to assess by color-Doppler TTE, transgastric **(E)** or mid esophageal views of TEE **(F)** owing to eccentric course of the jet. RT3D-TEE of TV from RA aspect at mid-esophageal **(G)** and transgastric level **(H)** demonstrated a flail septal leaflet **(blue arrow)** with ruptured chordae **(red arrows)**. **(I)** 3D color-Doppler revealed the entire tricuspid regurgitant jet within the RA, suggestive of severe tricuspid regurgitation. **(J)** While vena contracta of the TR jet was difficult to assess on 2D planes due to jet eccentricity, using multiplanar reconstruction of the jet on the 3D color-Doppler dataset, the vena contracta area **(arrow)** could be measured (which is 0.67 cm^2). See Online Videos 4, 5, 6, 7, 8, 9, 10, and 11. Abbreviations as in Figure 1.

Figure 4. Pacemaker Lead-Related Tricuspid Regurgitation

A 70-year-old woman with a history of pacemaker implantation 6 years ago presented with progressive ankle edema and ascites a year after replacement of the ventricular pacing lead due to lead failure. The old lead was not removed. Chest radiography **(A)** showed cardiomegaly and presence of 2 RV pacemaker leads **(arrow)**. **(B and C)** 2D TTE revealed severe tricuspid regurgitation with dilated RV and RA. Only a short portion of the pacemaker leads **(arrows)** can be visualized on a 2D plane, and the relationship between the leads and TV leaflets are poorly defined. RT3D-TTE using parasternal RV inflow view **(D)** demonstrated clearly the entire course of the pacemaker leads in the RA and across the TV orifice **(asterisk)**. **(E)** From the ventricular perspective of an apically obtained 3D view, the 2 pacemaker leads, one old and one new **(arrowheads)**, can be visualized impinging on the inferior (ITL) and septal tricuspid leaflets (STL), contributing to the severe tricuspid regurgitation. See Online Videos 12, 13, and 14. Abbreviations as in Figure 1.

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