Tricuspid Valve Blood Cysts on Intracardiac Echocardiography

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INTRODUCTION

Valvular blood cysts are rare congenital growths that are most commonly solitary and found along the mitral valve. Although usually asymptomatic, these cysts can affect valvular integrity, causing symptoms and requiring intervention. It is imperative to choose an optimal imaging modality when interrogating cardiac masses to guide future therapies. We present a rather unusual case of multiple concurrent tricuspid valve (TV) blood cysts and the surprising utility of intracardiac echocardiography (ICE) in visualizing these structures.

CASE PRESENTATION

A 73-year-old man with type 2 diabetes mellitus, hypertension, hyperlipidemia, class 2 obesity (body mass index 32 kg/m^2), and obstructive sleep apnea presented to the emergency department with lightheadedness and presyncope. On evaluation, the patient was afebrile and nonhypoxic, with a blood pressure of 150/93 mm Hg and a heart rate of 104 beats/min. Cardiovascular examination revealed an irregularly irregular rate and rhythm and no cardiac murmurs. Electrocardiography confirmed atrial fibrillation with rapid ventricular response. Transthoracic echocardiography (TTE) yielded poor visualization of the right-sided valves but was otherwise interpreted as normal and without significant findings (Figure 1, Video 1). Rate-control medications were started, and the patient was discharged with a plan for outpatient follow-up.

The patient later presented for a planned electrophysiologic study with cryoablation pulmonary vein isolation; ICE was used throughout the procedure. In the home view, cystic-appearing structures of the TV were readily apparent. Slight rotation and anteflexion of the intracardiac echocardiographic probe improved visualization of the echo texture and motion of these lesions in relation to the TV. The septal leaflet was freely moving with an 11 × 10 mm, round, thin-walled lesion marked by a hyperechoic border and an echo-lucent core. The visualized nonseptal leaflet appeared fixed with a 12 × 8 mm lesion, characterized by a thin, hyperechoic border and heterogenous but predominantly hypoechoic content (Figure 2, Video 2). The procedure was otherwise completed without complication.

The appearance and composition of these lesions seemed most consistent with multiple blood cysts affecting the TV. To confirm these findings and investigate the hemodynamic significance of these lesions, transesophageal echocardiography (TEE) was pursued. The transesophageal midesophageal views were limited by probe-esophagus contact, and the tricuspid structures could not be redemonstrated well (Figure 3, Video 3). The TV was better visualized after advancing the transesophageal echocardiographic probe to the transgastric position at 90° (Figure 4, Video 4) and even more apparent with omniplane rotation to 124° (Figure 5, Video 5). TEE redemonstrated cystic lesions (each 1 cm in diameter and involving the anterior and posterior TV leaflets) with well-demarcated, hyperechoic borders and echo-lucent cores. Color flow Doppler interrogation of the TV revealed mild primary tricuspid regurgitation with otherwise preserved valvular integrity and right atrial chamber size (Figure 5, Video 6).

VIDEO HIGHLIGHTS

Video 1: Two-dimensional TTE, apical four-chamber view, demonstrates reduced image quality with poor acoustic transmission, grossly normal biventricular size and systolic function, normal mitral valve, and poorly visualized TV.

Video 2: Two-dimensional ICE, home view (catheter positioned within mid right atrium), demonstrates normal right heart dimensions and right ventricular systolic function. The septal leaflet of the TV and the nonseptal leaflet are fixed; there are at least two masses with hyperechoic, well-defined borders and echo-lucent cores.

Video 3: Two-dimensional TEE, midesophageal, four-chamber (0°), rightward rotated view, demonstrates normal right heart chamber size and right ventricular systolic function; the septal TV leaflet appears thick in systole but is not well visualized.

Video 4: Two-dimensional TEE, transgastric right ventricular inflow (90°) view, demonstrates abnormal cystic masses on the anterior and posterior TV leaflets (best seen in systole). The TV leaflets and associated masses move out of plane in diastole.

Video 5: Two-dimensional TEE, transgastric right ventricular inflow (124°) view, demonstrates the anterior and posterior TV leaflets with associated cystic masses with hyperechoic borders and echo-lucent cores that move with TV motion.

Video 6: Two-dimensional TEE, transgastric right ventricular inflow (124°) view with color flow Doppler, demonstrates the TV cystic masses with mild tricuspid regurgitation.

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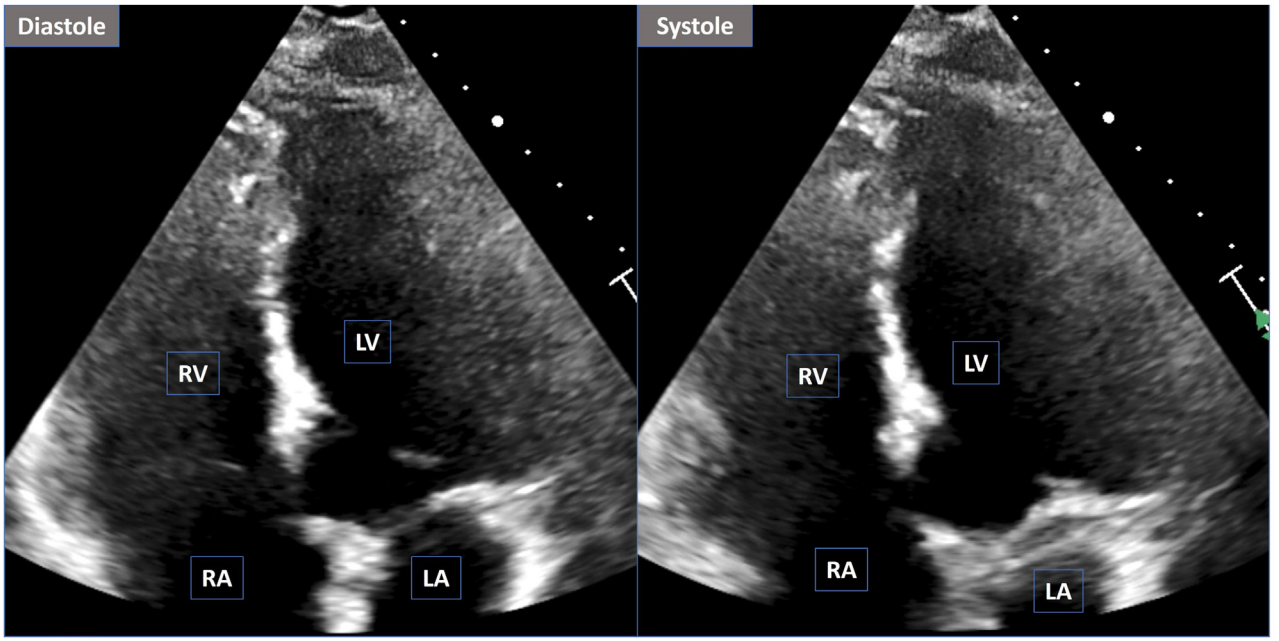

Figure 1 Two-dimensional TTE, apical four-chamber view in diastole (*left*) and systole (*right*), demonstrates reduced image quality with poor acoustic transmission, grossly normal biventricular size and systolic function, normal mitral valve, and poorly visualized TV. *LA*, Left atrium; *LV*, left ventricle; *RA*, right atrium; *RV*, right ventricle.

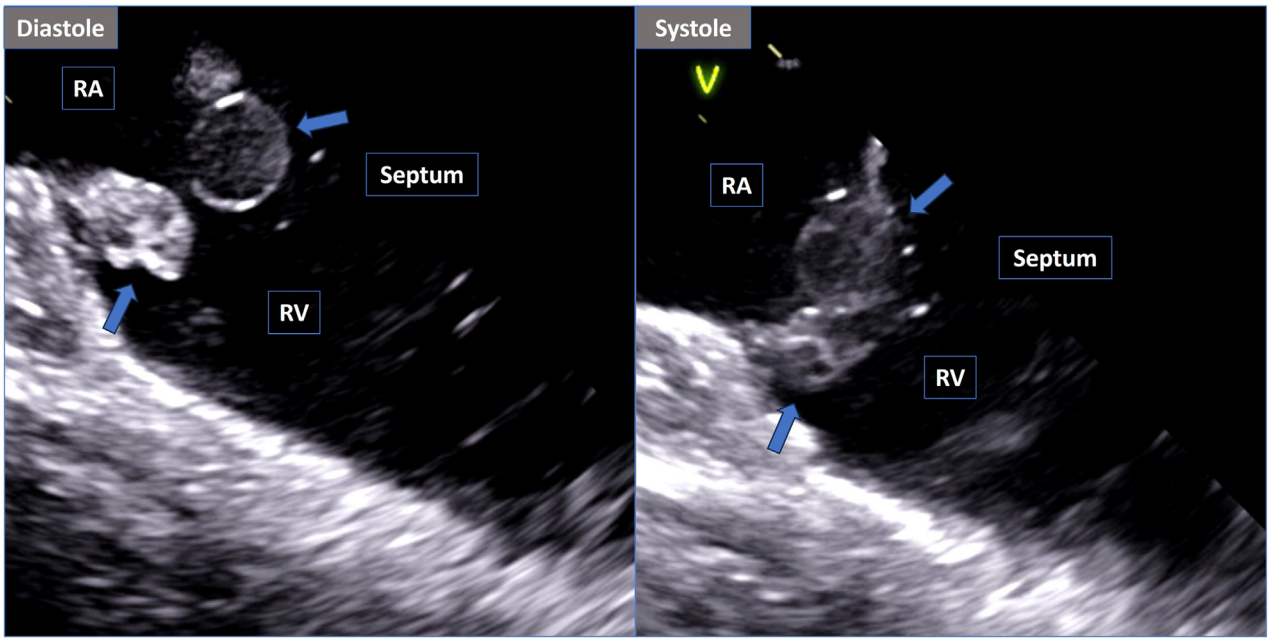

Figure 2 Two-dimensional ICE, home view (catheter positioned within mid right atrium [RA]) in diastole (*left*) and systole (*right*), demonstrates grossly normal right heart dimensions and right ventricular systolic function; there are at least two TV masses (*arrows*; maximal diameter 12 mm) with hyperechoic, well-defined borders and echo-lucent cores. *RV*, Right ventricle.

On review of TEE, it was felt that the complete cardiac involvement of these lesions had not been elucidated. As such, cardiac computed tomography (CCT) was pursued, which noted several well-circumscribed, homogenous, and hypoattenuated TV masses, the largest measuring 12 mm in diameter (Figure 6). Finer positioning and leaflet characterization, however, were limited. On follow-up, the patient remains asymptomatic from this finding, and no further intervention has been pursued.

DISCUSSION

Blood cysts are thin-walled, blood-filled intracardiac structures that are anomalous congenital growths rarely persisting into adulthood.[1] They are usually incidental findings and most commonly solitary growths along atrioventricular valves, typically mitral.[2] Although they are usually benign, there have been cases reported of blood

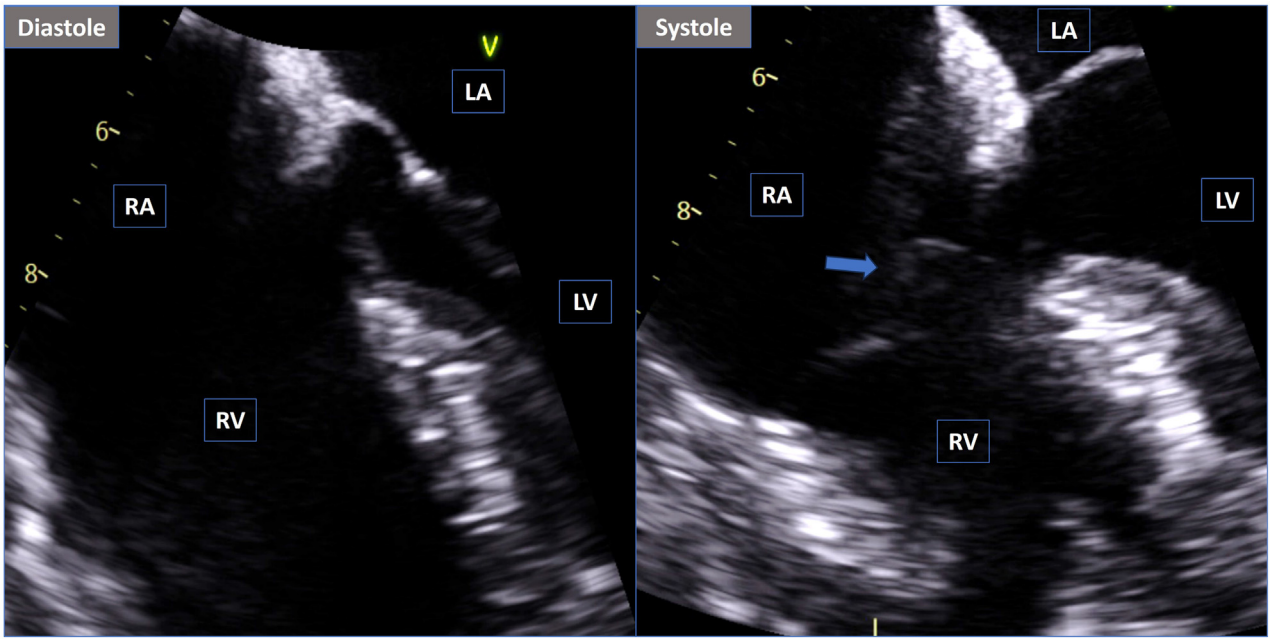

Figure 3 Two-dimensional TEE, midesophageal four-chamber (0°), rightward rotated, diastolic (*left*) and systolic (*right*) views, demonstrates normal right heart chamber sizes and right ventricular systolic function. The septal TV leaflet appears thick in systole (*arrow*) but is not well visualized. *LA*, Left atrium; *LV*, left ventricle; *RA*, right atrium; *RV*, right ventricle.

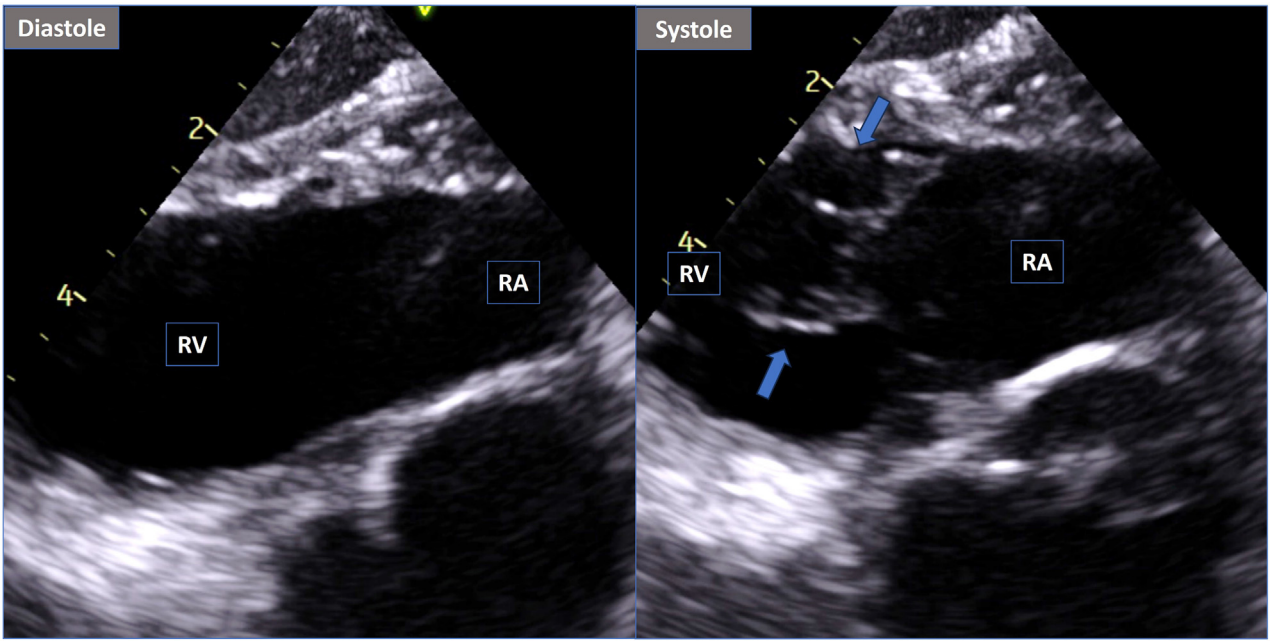

Figure 4 Two-dimensional TEE, transgastric right ventricular inflow (90°) diastolic (*left*) and systolic (*right*) views, demonstrates the abnormal cystic masses (*arrows*) on the anterior and posterior valve leaflets (best seen in systole). The TV leaflets and associated masses move out of plane in diastole. *RA*, Right atrium; *RV*, right ventricle.

cysts leading to symptoms and severe complications warranting surgical removal.[2]

In identifying and treating cardiac masses, adequate visualization and characterization are imperative. Imaging options continue to grow in number and complexity, and understanding their individual utilities helps direct use. Both TTE and TEE are usually initial measures in assessing the size, morphology, and hemodynamic significance of intracardiac structures given their widespread availability, affordability, and lack of radiation use. As such, they are generally accepted as sufficient imaging modalities for mitral blood cysts.[3] The imaging quality of TTE, however, can be impeded by poor acoustic windows related to lung pathology, body habitus, and difficult patient

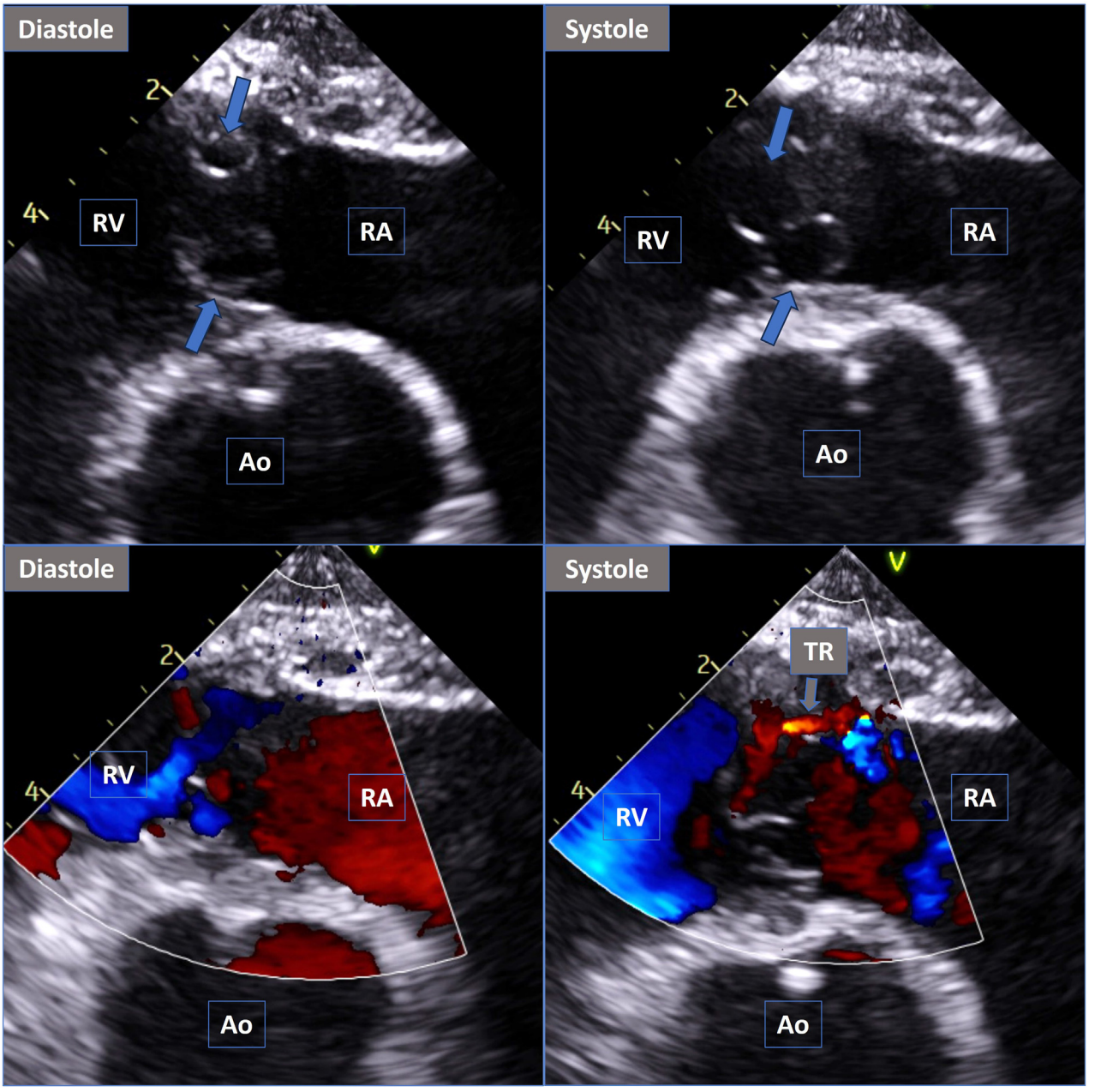

Figure 5 Two-dimensional TEE, transgastric right ventricular inflow (124°) diastolic (*left*) and systolic (*right*) views without (*top*) and with (*bottom*) color flow Doppler display, demonstrates the anterior and posterior TV leaflets with associated cystic masses with hyperechoic borders and echo-lucent cores (*blue arrows*) and mild primary tricuspid regurgitation. *Ao*, Aortic root; *RA*, right atrium; *RV*, right ventricle; *TR*, tricuspid regurgitant jet.

positioning. Although TEE is particularly helpful in characterizing atrial and valve lesions, image acquisition can be similarly challenged by esophageal pathology and cardiac positioning. Real-time three-dimensional TEE helps further analyze the characteristics and anatomic relationships of cardiac structures but is first dependent on adequate visualization of the structures in question.

Interestingly, the masses described in this case were not apparent on initial TTE but were seen on subsequent imaging (Figure 7). There have been several hypotheses previously raised regarding the development of intracardiac blood cysts. These include such lesions' arising from deformations during initial valve development or of the primitive pericardial mesothelium, blood cysts representing ectatic blood vessels within the valve, and cysts representing hematoma formation due to the occlusion of intravalvular end arteries. It seems less likely that this patient's blood cysts developed following initial imaging, as the first two hypotheses describe congenital or prolonged development processes, and the third hypothesis is usually driven by some insult (e.g., inflammation, anoxia, hemorrhage, surgical manipulation), which this patient did not sustain.[4]

There is merit to adjunct imaging in investigating and confirming the extent of cardiac pathology and its underlying nature to guide diagnosis and management of intracardiac masses. Regarding blood

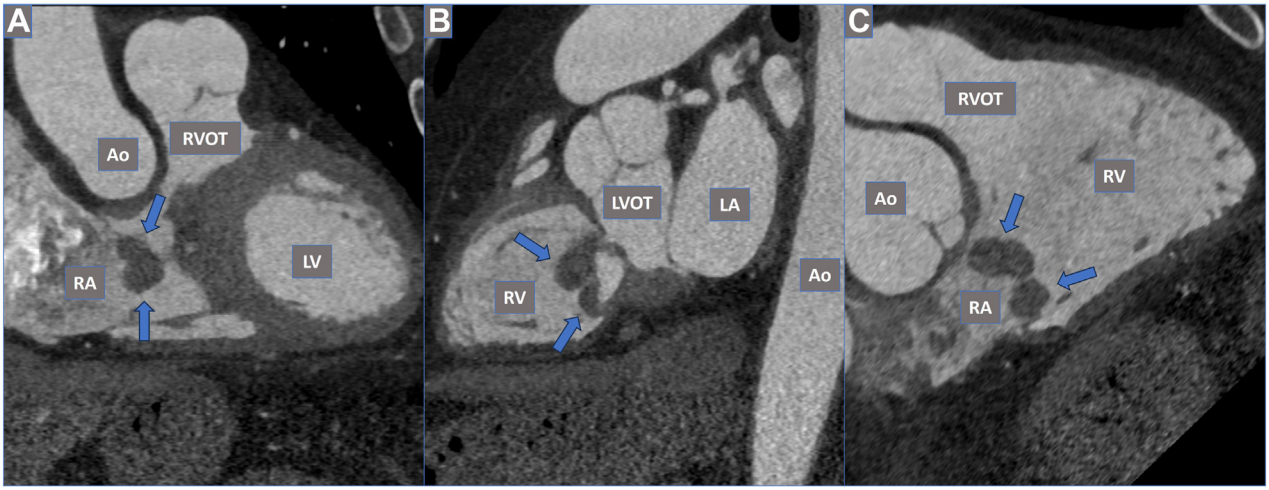

Figure 6 CCT, multiplanar reconstruction orthogonal views in **(A)** coronal, **(B)** sagittal, and **(C)** right anterior oblique displays, demonstrates multiple well-circumscribed, homogenous, and hypoattenuated TV masses (*arrows*; maximal diameter 12 mm). *Ao*, Aortic root; *LA*, left atrium; *LV*, left ventricle; *LVOT*, left ventricular outflow tract; *RA*, right atrium; *RV*, right ventricle; *RVOT*, right ventricular outflow tract.

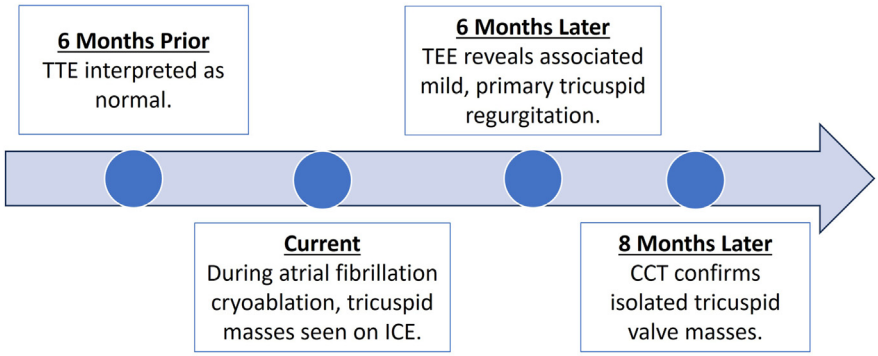

Figure 7 Timeline figure demonstrates clinically relevant cardiac imaging before, during, and after presentation.

cysts, cardiovascular magnetic resonance imaging (CMR) has gained traction given its ability to provide complete multiplanar reconstructions and give insight into histopathological characterization (using T1- and T2-weighted imaging, perfusion imaging, and examining early and late gadolinium enhancement) of these masses.[5] However, CMR is known to provide lower temporal resolution compared with echocardiography for mobile structures and is limited by long acquisition times, institution-dependent availability, and CMR-specific contraindications. One alternative to CMR is CCT, given its high spatial and temporal resolution, quick acquisition times, and greater access, but it does pose the risk of radiation exposure and contrast-induced kidney injury.[6] Nuclear imaging, such as positron emission tomography, reveals metabolic activity to help differentiate between benign and malignant masses but is again limited by availability and need for dietary preparation.[7]

In this case, TEE was performed and confirmed the hemodynamic significance and composition of the masses (on the basis of Doppler interrogation and echo texture seen), but complete cardiac characterization was needed to fully elucidate the extent of mass involvement. Although CMR was considered, given the lesions' valvular involvement and associated mobility, it was felt that CCT would be a preferable option for improved spatial resolution.

In addition to the unusual location and presentation of these blood cysts, this case was illuminating as to the clarity ICE can provide in visualizing intracardiac masses. The rapidly increasing utility of ICE has followed exponential advancements in transcatheter-based care and represents the concurrent advancement of cardiovascular imaging. Specifically, ICE's ability to provide high-resolution, real-time visualization of intracardiac structures has established its usefulness in procedures such as transseptal catheterization, atrial septal defect closure, left atrial appendage visualization, valve replacement, and ablation of atrial and ventricular arrhythmias.[8] As ICE continues to grow, Tang *et al.*[9] have described the utility of three-dimensional ICE in structural heart imaging and procedures. Although the necessity of femoral venous cannulation does have related risks, use of the imaging modality itself has been found to be uncomplicated and shown to improve procedural outcomes.[10]

Our institution follows a standard sequence of views using ICE during an electrophysiologic study such as that described by Enriquez *et al.*[8] The home view is obtained with the intracardiac echocardiography probe in the mid right atrium, providing imaging of the right atrium, TV, right ventricle, and short-axis view of the aortic valve. The catheter is rotated counterclockwise to view the

crista terminalis and subsequently clockwise to find the cavotricuspid isthmus between the eustachian ridge and TV. The aorta, right ventricular outflow tract, and pulmonary artery are seen with more clockwise rotation. Continued clockwise rotation brings the coronary sinus ostium into view and eventually the left atrial appendage, left atrium, mitral valve, and left ventricle into view. Slight manipulation here with advancement and withdrawal of the catheter will help visualize the entire interatrial septum. Continued clockwise rotation will sequentially bring the left then right pulmonary veins into frame before returning to the home view. The ICE catheter (with or without fluoroscopic guidance) can be gently advanced into the right ventricle to better visualize both right and left ventricular structures in finer detail. On the basis of the needs of the case, this sequence can be modified to further examine structures in question.

This unusual case of multiple blood cysts found along the TV highlights the clarity ICE can provide when visualizing intracardiac structures. With a standardized ICE diagnostic protocol, operators may safely and methodically interrogate static and mobile cardiac structures with standard and Doppler-augmented imaging. Although there exists an array of standard imaging modalities, it is interesting to consider ICE as an extra tool to circumnavigate certain limitations of these modalities on a case-by-case basis. Although we felt that our initial intracardiac echocardiographic examination was adequate in visualizing the nature and valvular association of these masses, we pursued complementary imaging with the aim of complete characterization given the unique nature of this case. Our subsequent imaging helped confirm our initial findings but was limited by various factors (e.g., esophagus-probe contact on TEE, clarifying the intermass and valvular relation of these cysts on CCT). As the utility of ICE grows with transcatheter procedural advances, this case raises the exciting prospect of future use in comprehensively visualizing and guiding treatment of intracardiac masses.

CONCLUSION

Valvular blood cysts are rare congenital growths that risk valvular integrity and may require intervention. Our case represents a rather rare presentation of multiple tricuspid blood cysts and highlights the utility of ICE in characterizing intracardiac structures to better guide their therapy.

ETHICS STATEMENT

The authors declare that the work described has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans.

CONSENT STATEMENT

The authors declare that since this was a non-interventional, retrospective, observational study utilizing de-identified data, informed consent was not required from the patient under an IRB exemption status.

FUNDING STATEMENT

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DISCLOSURE STATEMENT

The authors report no conflict of interest.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.case.2024.11.006.

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