

Traumatic rupture of the tricuspid valve and multi-modality imaging

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Introduction: Motor vehicle accident (MVA) account for most cases of traumatic rupture of the tricuspid valve. Valve rupture during an MVA is generated by an abrupt deceleration coupled with an increase in right-side cardiac pressures (Valsalva maneuver and thorax compression).

Case: A 39-year-old asymptomatic man was referred for an echocardiogram due to the presence of a systolic murmur. He had no prior significant medical history, except for a remote MVA 3 years ago. Real-time 3D echocardiography (RT3DE) showed a tear in the body of the anterior leaflet and not at the cord, as was suggested by two-dimensional transthoracic echocardiography (2D-TTE). Based on these findings, the mechanism was considered anterior leaflet rupture of the tricuspid valve, secondary to chest blunt trauma. The anterior leaflet was repaired using two polytetrafluoroethylene sutures, and tricuspid annuloplasty with an Edwards ring was performed.

Conclusions: Multimodality imaging helps to determine timing of surgery in asymptomatic traumatic tricuspid rupture. The combination of echocardiography and magnetic resonance imaging provide information of volumetric data and contractility of the right ventricle (RV) during follow-up. RT3DE gives information relevant to the morphological and functional characterization of the valve, allowing the planning of appropriate surgical procedure.

Keywords: Traumatic rupture of the tricuspid valve; three-dimensional transthoracic echocardiography; cardiac magnetic resonance

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Introduction

Motor vehicle accident (MVA) account for most cases of traumatic rupture of the tricuspid valve. Valve rupture during an MVA is generated by an abrupt deceleration coupled with an increase in right-side cardiac pressures (Valsalva maneuver and thorax compression) (1). The most frequent rupture site is the tendinous cords, followed by the anterior papillary muscle and tear or detachment of the anterior leaflet (1,2). During the acute phase of an MVA, life-threatening lesions to the head, thorax, or abdomen are of most clinical relevance. Thus, accurate cardiac diagnosis early after MVA may be limited, especially when dealing with discrete or moderate valve lesions. Diagnosis of tricuspid valve rupture is usually delayed, due to its mild

clinical course. Echocardiography plays an important role in the diagnosis, follow-up, and surgical indication in patients with tricuspid valve rupture (2,3).

Case report

A 39-year-old asymptomatic man was referred for an echocardiogram due to the presence of a systolic murmur. He had no prior significant medical history, except for a remote MVA 3 years ago.

His vital signs were heart rate 70/min, and blood pressure 120/70 mmHg. His jugular venous pressure was not elevated, had no peripheral edema or hepatomegaly, but a holosystolic murmur was heard at the fourth left parasternal border. A chest X-ray demonstrated normal

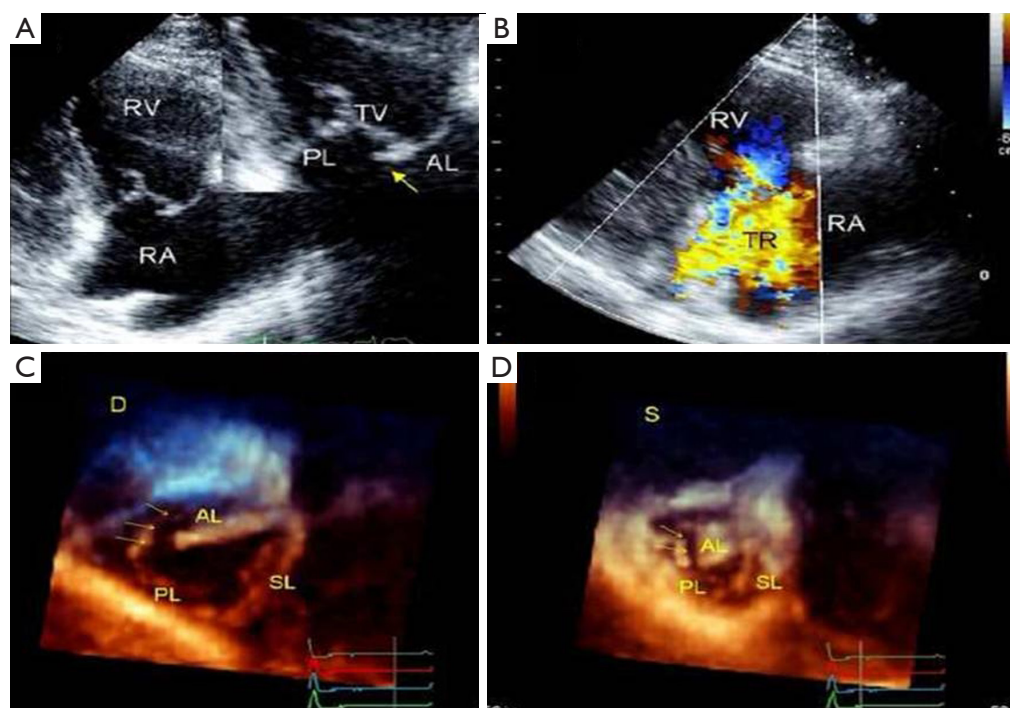


Figure 1 TTE. (A) Left: longitudinal view of the RV during systole. Note the linear structure in the mid-portion of the tricuspid anterior leaflet (arrow) consistent with cord rupture. Nevertheless, it is interesting to note that central coaptation is not lost; (B) right side: color Doppler image showing severe TR; (C) left: post-processed full volume image. Tricuspid valve is viewed from the RV (diastole). Note a tear in the body of the anterior leaflet (arrow) and not at the chord, as was suggested by 2D-TTE. The tear is observed from the free border to the annulus; (D) right: post-processed full volume image. Tricuspid valve is viewed from the RV (systole) tricuspid valve is closed and folded. Note the persistence of a linear image indicative of an anterior leaflet rupture (arrow). Data acquisition was performed by two experienced sonographers using an $\times 3$ matrix transducer connected to an RT-3DE system (IE33, Philips Medical Systems). Harmonic RT3DE imaging was performed in the same setting with the fully sampled matrix array transducer ($\times 4$, 2 to 4 MHz) that uses 3,000 elements to obtain a pyramidal volume data set from a single window. 2D-TTE, two-dimensional transthoracic echocardiography; RT3DE, real-time 3D echocardiography; RA, right atrium; RV, right ventricle; TR, tricuspid regurgitation.



Figure 2 TTE. Two-dimensional echocardiography. Four chamber view for see right ventricle (RV) (4). Available online: <http://www.asvide.com/articles/310>

cardiac silhouette. The electrocardiogram showed sinus rhythm. Two-dimensional transthoracic echocardiography (2D-TTE) revealed severe tricuspid regurgitation (TR) and a moderately dilated right ventricle (RV) with apparent normal systolic function (*Figure 1, Figure 1A*) (*Figures 2-5*). The precise mechanism for this valve dysfunction was not clearly defined; it appeared to be secondary of a cord rupture in the mid-portion of the tricuspid anterior leaflet. The right atrium was dilated with moderately increased intra-atrial pressure. The left ventricle and remaining valves were normal. For detailed assessment of the tricuspid valve and its surrounding structures, three-dimensional echocardiography was used.

Real-time 3D echocardiography (RT3DE) showed a tear



Figure 3 TTE. Long view of right ventricle with color Doppler showing severe tricuspid regurgitation (TR). The regurgitation jet is directed towards posterior wall of the atrium (5). Available online: <http://www.asvide.com/articles/311>



Figure 4 TTE. Four chamber view with color Doppler showing severe TR. In this view it is not easy to identify which valve leaflet is involved to the regurgitation mechanisms (6). TR, tricuspid regurgitation. Available online: <http://www.asvide.com/articles/312>



Figure 5 TTE. Two-dimensional echocardiography. Long view of right ventricle. A linear image is observed on the atrial surface of the anterior leaflet (7). Available online: <http://www.asvide.com/articles/313>



Figure 6 TTE RT3DE. Post-processed full volume image. Tricuspid valve is viewed from the RA. Tricuspid valve is closed and folded. Note the persistence of a linear image indicative of an anterior leaflet rupture (8). RT3DE, real-time 3D echocardiography; RA, right atrium. Available online: <http://www.asvide.com/articles/314>



Figure 7 TTE RT3DE. Post-processed full volume image. Tricuspid valve is viewed from the RV. Note a tear in the body of the anterior leaflet. The tear is observed from the free border to the annulus (9). RT3DE, real-time 3D echocardiography; RV, right ventricle. Available online: <http://www.asvide.com/articles/315>

in the body of the anterior leaflet and not at the cord, as was suggested by 2D-TTE (*Figure 1C*). Based on these findings, the mechanism was considered anterior leaflet rupture of the tricuspid valve, secondary to chest blunt trauma. Nevertheless, it is interesting to note that central coaptation is not lost, this probably acted to preserve some residual tricuspid valve function and the patient was not in clinical RV failure (*Figures 6, 7*).

We recommended early surgical intervention to prevent RV failure.

The anterior leaflet was repair using two

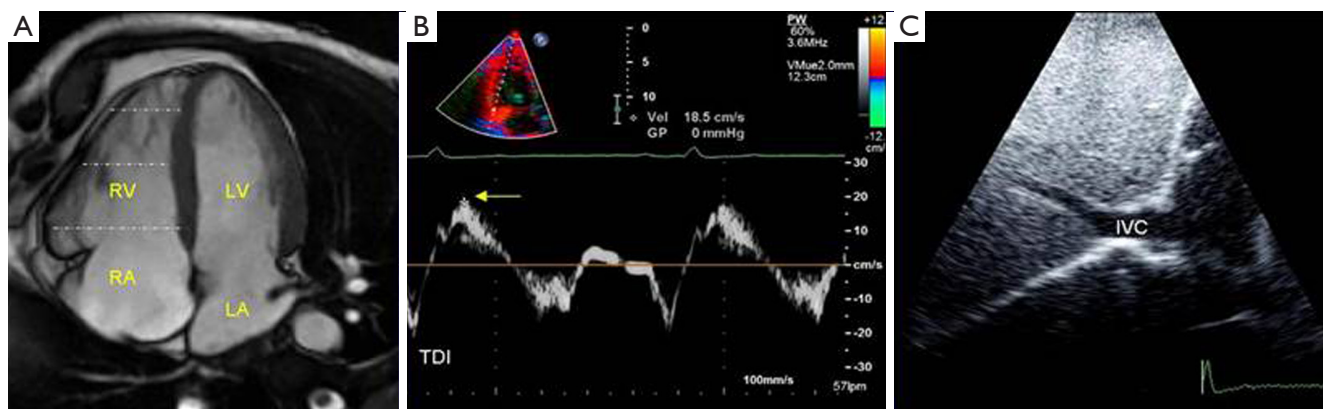


Figure 8 (A) Cardiac magnetic resonance: balanced steady-state free precession sequence (CINE). Four-chamber views during diastole showing the RV diameters at different levels. The volumes of the RV were 237 mL volume of end diastole and 130 mL for volume of end systole. The ejection fraction calculated for the RV was 45%; (B) tissue Doppler image. RV function by tissue Doppler imaging was normal (tricuspid annular systolic velocity >12 cm/s); (C) two-dimensional image of the inferior vena cava with normal inspiratory collapse suggest normal right-side cardiac and venous pressures despite volume overload. LV, left ventricle; RV, right ventricle; LA, left atrium; RA, right atrium; TDI, tissue Doppler image; IVC, inferior vena cava.

polytetrafluoroethylene sutures, and tricuspid annuloplasty with an Edwards MC ring was performed. Post-operative 2D-TTE demonstrated no residual TR and good leaflet apposition. His recovery was uncomplicated and he was discharged 6 days post-operative.

RT3DE was very useful in the evaluation of spatial abnormalities of the tricuspid valve and helps in making a decision for surgical intervention.

Discussion

MVA are a major cause of traumatic tricuspid insufficiency (10-12). In the acute phase of blunt chest trauma, TR may often go undetected because the associated injuries of other organs tend to obscure the cardiac involvement (13). Therefore, the frequency of traumatic tricuspid insufficiency is probably underestimated (10). However, because TR with flail leaflets is a serious and progressive disease (14), the early diagnosis of this disorder is very important. According to previous reports in the literature, if the TR is severe, the prognosis is poor even in asymptomatic patients.

Enlargement of the RV in the presence of TR is also predictive of a poor outcome (14). Surgical intervention should be considered in such patients because it entails low operative mortality and provides symptomatic improvement (15-17).

Knowledge of RV diameter and function in addition to data regarding the systemic venous circulation is of interest

prior to tricuspid valve surgery (18-20). For the assessment of the RV, contractility parameters obtained with tissue Doppler or 2D-strain echocardiography, plus high quality volumetric and diameters data obtained with cardiac magnetic resonance provide an excellent combination for preoperative evaluation (Figure 8).

RT3DE emerges as a novel useful imaging tool, offering a detailed anatomic and functional assessment of the tricuspid valve (21,22).

RT3DE can be used to provide fast and noninvasive evaluation of tricuspid valve function that is more spatial and anatomically realistic compared with conventional echocardiography (21-23).

Conclusions

Multimodality imaging may help to determine the time of surgery in asymptomatic traumatic tricuspid rupture. The combination of echocardiography and magnetic resonance imaging provide information of volumetric data and contractility of the RV during follow-up.

RT3DE gives information relevant to the morphological and functional characterization of the valve, allowing the planning of appropriate surgical procedure.

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