

investigation to address whether lipid-rich obstructive lesions should be treated differently for revascularization.

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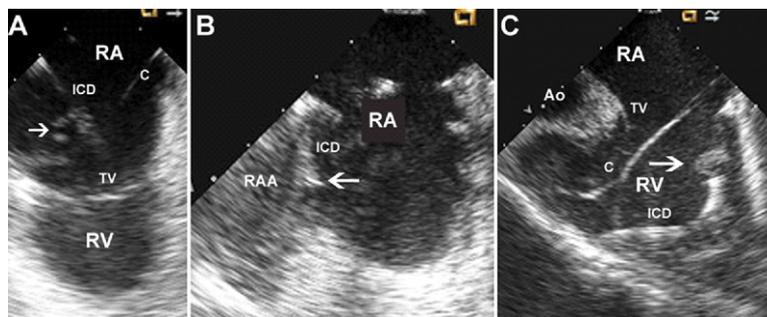
## Intracardiac Echocardiographic Detection of Mobile Echodensities Adherent to the Intracardiac Leads

We read with interest the report by Naqvi et al. (1) describing the utility of real-time 3-dimensional (3D) transesophageal echocardiography in suspected right-side endocarditis in 3 patients with pacemaker (PM) or implantable cardioverter-defibrillator (ICD) leads and biological tricuspid prostheses. Precise detection and delineation of loca-

tion of vegetation associated with intracardiac structure or leads in these patients may help therapeutic medical and surgical treatment decisions. Three-dimensional echocardiography has the potential to both complement existing 2-dimensional imaging modalities (trans-thoracic and transesophageal echocardiography) and enhance the ability to define the spatial location of the vegetation relative to a device lead or prosthetic valve and surrounding intracardiac structures, as indicated by Naqvi et al. (1). Although 3D echocardiography represents a rapidly evolving technology, it has definite limitations such as a relatively low spatiotemporal resolution, slow imaging acquisition rate, lack of standardized 3D views, and a steep learning curve in both understanding and appropriately integrating 3D images in a procedural environment (2,3).

In our experience with intracardiac echocardiography (ICE) in >2,000 ablation cases, it has also proved effective in real-time detection of mobile echodensities/thrombus adherent to the intracardiac PM or ICD (4). With the ICE transducer placed in the right atrium (RA) or right ventricle (RV), one can image the course of intracardiac leads from/in the RA (Fig. 1A) to the right atrial appendage (RAA) (Fig. 1B) and/or RV (Fig. 1C) and detect any mobile echodensity/thrombus attached to the intracardiac leads. In 86 consecutive patients with a PM or ICD who presented for atrial fibrillation or ventricular tachycardia ablation procedures, 26 of 86 patients (30%) had a mobile echodensity/thrombus (average length  $18 \pm 6$  mm and width  $4 \pm 2$  mm) attached to the intracardiac lead in the RA/RAA ( $n = 25$ ) and/or RV ( $n = 5$ ) identified with ICE.

ICE revealed mobile echodensities adherent to the intracardiac leads consistent with either thrombi, vegetation, or infected thrombi. The diagnosis of endocarditis related to PM/ICD lead infection should be suspected in the presence of fever, bacteremia, or pulmonary lesions consistent with a septic embolus. Compared with the 2 patients with recurrent infective endocarditis (fever, bacteremia, or perforation in the bioprosthetic tricuspid valve detected) presented by Naqvi et al. (1), our patients had no fever and were asymptomatic. We found an elevated pulmonary artery systolic pressure in the group who demonstrated a mobile echodensity/thrombus (5) compared with those with no echodensity/thrombus ( $n = 43$ ) detected. No differences were found in the patient characteristics (e.g., age, sex), type of ablation, left



**Figure 1. Intracardiac Echocardiographic Imaging of a Mobile Thrombus Attached to Intracardiac Leads**

Intracardiac echocardiographic images with the transducer placed in the right atrium (RA), showing the mobile thrombus (arrow) attached at the implantable cardioverter-defibrillator (ICD) lead in the RA (A), right atrial appendage (RAA) (B) or right ventricle (RV) (C). Ao = aortic root; C = ablation catheter; TV = tricuspid valve.

ventricular ejection fraction, history of myocardial infarction, heart failure, number of intracardiac leads, and warfarin therapy between the groups. The potential causal relationship between lead mobile echodensity/thrombus and elevated pulmonary artery systolic pressure and its clinical significance warrant further study, but our study results clearly validate a role for ICE in identifying a mobile versus fixed thrombus on device leads.

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#### REPLY

I thank Ren and Marchlinski for their interest in our study and sharing their experience with the detection of mobile echodensities on intracardiac leads during percutaneous ablative procedures with intracardiac echocardiography (ICE). The authors need to be congratulated for showing that ICE can detect the presence and location of mobile echodensities on right-sided leads; however, they did not describe whether differentiation of the location of echodensities on the implantable converter-defibrillator lead versus the right atrial or the right ventricular lead was possible in some or all of their patients. The severity and etiology of pulmonary hypertension in those with echodensities are not indicated, but could be related to pulmonary thromboemboli. Their patients did not have clinical evidence of or suspected endocarditis, and identification of echodensities or differentiation of the locations of these densities on various intracardiac leads likely did not lead to a change in

therapeutic decisions, unlike in our series. We agree with Ren et al. regarding the limitations of 3-dimensional (3D) echocardiography with respect to the learning curve; however, spatiotemporal resolution is constantly improving, acquisition times are short, and newer techniques allow 3D rendering in 1 instead of multiple cycles. Reconstruction after image acquisition remains a challenge and is a function of operator expertise. I also agree with the ability of ICE to delineate intracardiac leads and unexpected thrombi attached to them. This role is particularly important in visualizing left-sided catheters as well as details of mitral valve anatomy during percutaneous mitral valve procedures, thereby allowing the operator to manipulate the catheters accordingly, as our own experience suggests (1). ICE is more invasive than transesophageal echocardiography (TEE) and carries a higher risk of complications. Although 3D ICE is to be available soon, at present, it remains a monoplane 2D imaging technique, thus prone to nonvisualization of structures not in the ICE imaging plane and for incomplete visualization of structures due to limited manual manipulation of the single imaging plane. Limited spatial resolution, as seen in Figure 1, specifically panel B, by Ren et al., also remains a limitation. ICE carries a steep learning curve, the ICE catheter is expensive, and, at present, its use remains limited to guidance during percutaneous procedures such as device closures of atrial septal defects and patent foramen ovale and during ablative electrophysiology procedures as used by Ren et al. ICE is not routinely used as a diagnostic echocardiography procedure in patients with suspected endocarditis due to the limitations outlined here. It is to be noted that ours was a series of case reports and not a systematic study evaluating the ability of 3D TEE to detect the location of vegetations on the right-sided structures (2). Such a study is indicated to clarify the role of 3D TEE in assisting with therapeutic decision making in such patients.

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