JACC: CASE REPORTS VOL. 29, 2024

EDITORIAL COMMENT

Intracardiac Echocardiography

The Front-Row View to Structural Heart Interventions

Jonathan Curio, MD, Maria Isabel Körber, MD

Interventional echocardiography, as a new distinct skill and specialty within clinical echocardiography, has become a cornerstone of current structural heart interventions.[1] Whereas transthoracic echocardiography (TTE) is useful for the initial diagnosis and assessment of structural heart diseases, transesophageal echocardiography (TEE) is the gold standard for exact quantification and grading of these diseases, for evaluation of the technical feasibility of different potential transcatheter approaches, and finally, for periprocedural guidance, thereby crucially supplementing fluoroscopic imaging.

Nevertheless, although it enables technically advanced and finely nuanced interventions, TEE faces some notable potential limitations. Far-field TEE imaging remains a technical challenge, and this issue may limit its applicability when intervening in structures anatomically distant from the esophagus, especially the tricuspid valve. The presence of cardiac implants (surgical valves, already implanted transcatheter devices, or cardiac implantable electronic devices), the delivery system of the device itself or anatomical variants such as esophageal strictures may cause shadowing or can hamper image quality. Finally, use of TEE usually necessitates general anesthesia during the procedure, and prolonged TEE use may carry the risk of relevant esophageal injury.[2]

Intracardiac echocardiography (ICE) has emerged as a relevant new tool with the potential to overcome several of these TEE limitations while maintaining high levels of imaging quality, with 3-dimensional ICE and real-time multiplanar reconstruction available with the latest iterations of devices. There is an ongoing effort to optimize resolution further, and, currently, 3 devices are commercially available (VeriSight Pro, Philips; Acuson AcuNav Volume, Siemens Healthineers; NuVision, Biosense Webster). The access profile of the single-use catheters ranges from 9-F to 12.5-F. After venous access, the probe may be placed according to the specific intervention, either in the right atrium or, after transseptal puncture (itself potentially guided by ICE), in the left atrium for left-sided interventions. Indeed, this shift of periprocedural imaging modality from TEE to ICE, leaving the probe in the sterile area and potentially in the hands of the operator, requires adoption of the catheterization laboratory setup, as well as a division of tasks between the interventionalist and the interventional imager, wherein the imager, for example, may manage the echocardiography machine in a nonsterile environment.

In this issue of *JACC: Case Reports*, Gregório et al[3] report on an ICE-guided endomyocardial biopsy in a patient with a complex right atrial mass, a case highlighting another potential field of application for this novel imaging modality. Gregório et al[3] share the case of an 80-year-old woman with a history of B-cell non-Hodgkin lymphoma who had significant dyspnea on exertion and lower limb edema. TTE showed an extracardiac mass, 65 mm × 22 mm, that was invading the right atrium. Cardiac computed tomography findings were suggestive of mural thrombus, whereas cardiac magnetic resonance showed characteristics typical of malignancy. Thus, thrombus and primary or metastatic malignant disease were considered as differential diagnoses, the latter most likely given the patient's history. To enable a definite diagnosis to initiate timely treatment, the decision was made to perform an endomyocardial biopsy, thereby allowing for histopathologic examination. Given the high-risk profile and the anatomical inability to perform a full

From the Department of Cardiology, Heart Center Cologne, Faculty of Medicine and University Hospital, University of Cologne, Cologne, Germany.

The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2024.102724

resection, the decision was made to perform this biopsy by the percutaneous route.

Initially, imaging guidance was with TTE and fluoroscopy, but this approach proved insufficient to delineate the mass and guide the bioptome properly. Thus, additional guidance using ICE was established. This technique enabled precise positioning of the guide catheter and the bioptome, as well as adequate description of the interaction between the catheter and the mass, thereby facilitating collection of several samples. The histopathologic diagnosis revealed the presence of diffuse large B-cell lymphoma, in accord with the leading differential diagnosis of recurrent malignant disease. This timely diagnosis allowed for prompt initiation of proper oncologic treatment.

Gregório et al[3] ought to be congratulated for the skilled execution of the procedure in this very challenging case, with the results of the histopathologic examination, which formed the basis of a timely final diagnosis, being highly relevant for the clinical course of the patient. Furthermore, Gregório et al[3] highlight the versatile possible applications of ICE by exemplifying its use during structural intervention in a complex cardiac mass. This case shows how ICE can potentially play a general role in structural interventions, beyond more standardized procedures such as transcatheter edge-to-edge repair of (predominantly) the tricuspid valve or (also) the mitral valve, patent foramen ovale or atrial septal defect closure, left atrial appendage occlusion, or emerging technologies such as transcatheter mitral or tricuspid valve replacement.

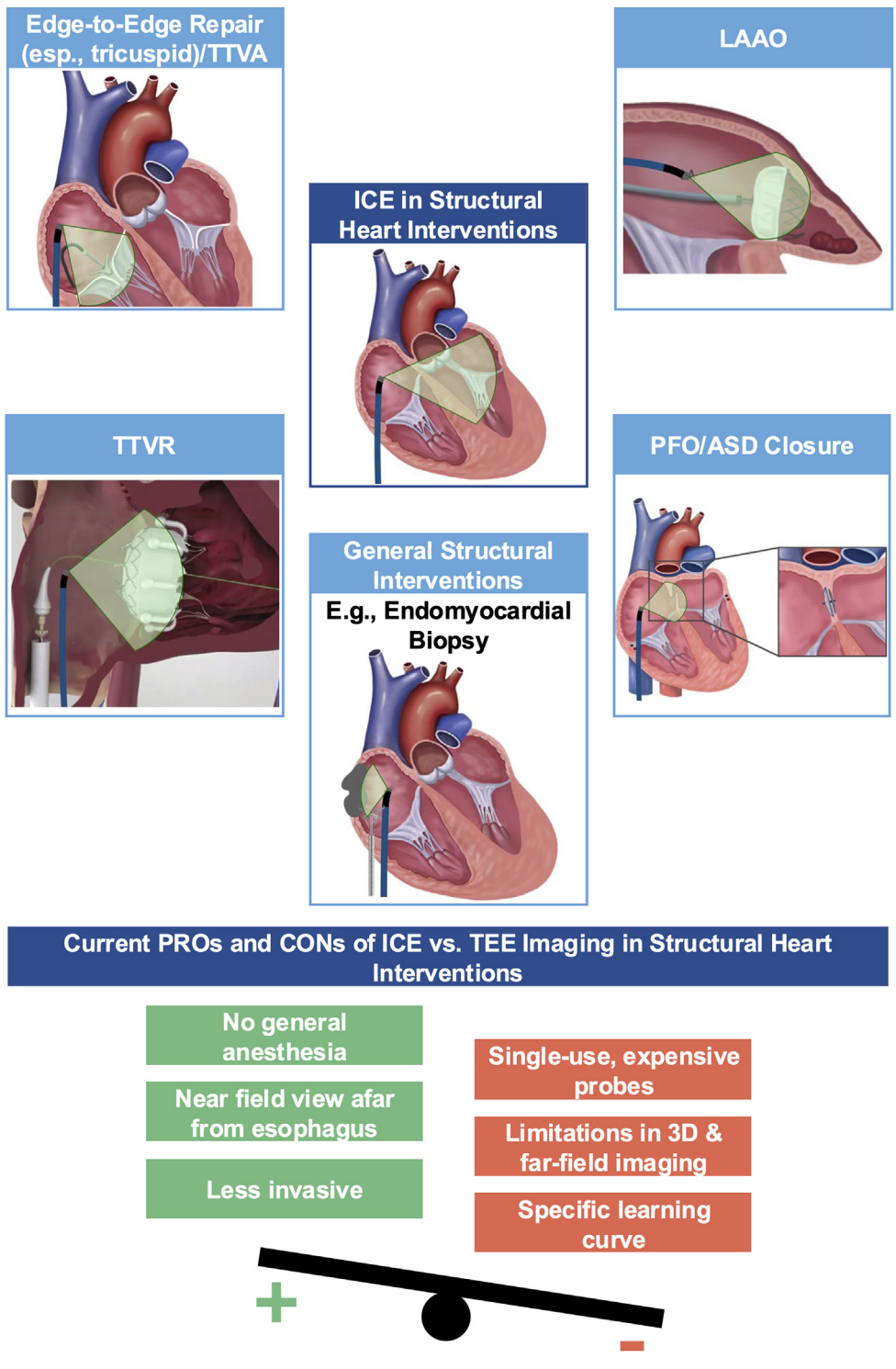
Of note, the operator of the present case is stated to be highly experienced with endomyocardial biopsies and especially also with the use of ICE, on the basis of other structural interventions such as left atrial appendage occlusion. The distinct maneuvering of the catheter and the handling of the connected console to acquire the best images require a certain skill set with a notable learning curve, which limits broader application of ICE. The location of the mass in the right atrium rendered it ideal for the use of ICE. This technique can most easily and effectively be used in the atria (especially in the right atrium, not needing additional transseptal puncture as for the left), whereas entering the ventricles for close-up imaging of structures or devices can prove more challenging. Apart from transfemoral access for the ICE probe, given its profile, also a transjugular approach, allowing for other degrees of flexibility and a straight-on appreciation of structures in the right atrium or the tricuspid valve can be considered. However, ICE use was limited in the present case given the potentially interfering leads of an implanted cardiac electronic device.

Nonetheless, besides economic considerations, there remain various technical disadvantages of ICE such as a lack of biplane imaging and limited 3-dimensional capabilities and image resolution. Furthermore, far-field resolution, especially in patients with severely dilated atria, is sometimes limited.

In general, there seems to be great potential for the implementation of ICE during catheter-based structural heart interventions (**Figure 1**). The ability to perform ICE using only conscious sedation makes the procedure less invasive and less stressful for the patient, when compared with TEE imaging, which in the reported case would have required general anesthesia. The currently expensive single-use probes are expected to improve further in the near future, thus enabling TEE-like views, with comparable degrees of flexibility and similar technical modes of image procession. All these improvements point to the possibility of a near-field view also for structures that are anatomically distant from the esophagus. Even so, adequate training and standardization of techniques and views are needed, as for the whole new and ever emerging field of interventional imaging.[4,5]

In conclusion, Gregório et al[3] with their case give a great example of the versatile applicability of ICE in structural heart interventions. Although still in its infancy, this technique, with additional iterations of technology and standardized teachable imaging protocols, may play a key role in further advancing the field, thereby potentially enabling a front-row view to all variations of structural interventions.

FIGURE 1 The Emerging Role of ICE in Structural Heart Interventions



ASD = atrial septal defect; esp. = especially; ICE = intracardiac echocardiography; LAAO = left atrial appendage occlusion; PFO = patent foramen ovale; TEE = transesophageal echocardiography; TTVA = transcatheter tricuspid valve annuloplasty; TTVR = transcatheter tricuspid valve replacement; 3D = 3-dimensional.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

Dr Curio has received research grant support from Boston Scientific; and has received travel support from LaraLab GmbH. Dr Körber has received travel support and lecture fees from JenaValve, Edwards Lifesciences, and Abbott.

ADDRESS FOR CORRESPONDENCE: Dr Jonathan Curio, Department of Cardiology, University Heart Center Cologne, Kerpener Strasse 62, 50937 Cologne, Germany. E-mail: jonathan.curio@uk-koeln.de.

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KEY WORDS interventional imaging, intracardiac imaging, novel imaging technologies, structural heart interventions, transcatheter tricuspid interventions