The Role of Three-Dimensional Transesophageal Echocardiography in Better Understanding the Mechanism of Percutaneous Atrial Septal Device Failure

Angele Azevedo Alves Mattoso, MD, Túlio César Azevedo Alves, MD, Larissa Espíndola, MD, Ricardo José Costa Mattoso, MD, Joana Senna Trinção de Oliveira, MD, Laila Machado Pinheiro, MD, and Nilzo Augusto Mendes Ribeiro, MD, Salvador, Brazil

INTRODUCTION

Transcatheter device occlusion has become the first choice for secundum atrial septal defect closure in case of feasible morphology. Serious complications were observed in ≤1% of patients, such as device embolization, vascular trauma, device-related thrombosis, recurrent thromboembolic events, atrial arrhythmias, and cardiac erosion or perforation. In this report we demonstrate the additional value of three-dimensional (3D) transesophageal echocardiography (TEE) in understanding the underlying pathology involved in septal occluder failure, providing real and anatomic images that are unique to 3D TEE by en face views.

CASE PRESENTATION

A 43-year-old woman was admitted to our clinic with progressive dyspnea. Medical history revealed that the patient had undergone percutaneous atrial septal defect closure using an Ultrasept device (Cardia, Eagan, MN) approximately 4 years previously at another hospital (Figure 1A). Transthoracic echocardiography showed severe right atrial (50 mL/m²) and right ventricular (43 mm mid-diameter) enlargement (Figure 1B) and a left-to-right shunt through the device on color Doppler. The two-dimensional TEE demonstrated a well-seated atrial septal device. Color Doppler showed multiple large left-to-right shunts through the device (Figure 2, Video 1). Three-dimensional TEE by en face views of the device from the right atrial perspective and left atrial perspective showed the remarkable and peculiar shape of the daisy device with the polyvinyl alcohol (PVA) membrane completely disintegrated, causing multiple and severe defects, without any image of arm fracture or endocarditis (Figures 3A-3D, Video 2). Three-dimensional color Doppler TEE showed multiple shunts across the well-seated device (Figure 3E).

From Proalívio Day Hospital, Salvador, Brazil.

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The patient underwent surgical removal of the faulty device. On an intraoperative view, it was confirmed that the device was correctly implanted, the nitinol frame was intact, and the PVA membrane was completely disintegrated (Figure 3F). The device was extracted from the septum, and a patch was successfully placed. The patient had an uneventful postoperative recovery. Analysis of the explanted device did not show evidence of infection, and culture remained sterile.

DISCUSSION

Transcatheter closure is a widespread technique used to treat secundum atrial septal defect. It is important to be aware of the available devices and the possible complications inherent to each one, in order to understand the mechanisms involved in their failure. In this case we present a patient with an Ultrasept occluder. The Ultrasept occluder is composed of a PVA “sail-like” membrane covering a nitinol frame on its flower-like rounded disks (daisy device). The disintegration of the PVA membrane is rare, and it usually requires surgical intervention. These devices have shown multiple PVA membrane perforations between 1 and 16 weeks after implantation. In this case, two-dimensional TEE demonstrated a well-seated atrial septal device, and the color Doppler image showed multiple large shunts through the device. However, it was possible to infer only a probable diagnosis of perforations in the membrane of the device. As shown, 3D TEE by unique 3D en face views allowed...
direct and real visualization of the device,\textsuperscript{3,4} which is important in order to understand the mechanisms involved in the septal occluder failure. En face views from the right atrial and left atrial perspectives showed direct anatomic visualization of this late complication related to this type of device, showing a membrane completely disintegrated with multiple severe shunts through the device. In addition, 3D TEE provided the peculiar flower-like image of this daisy device.

**CONCLUSION**

In this case, we demonstrate the additional value of 3D TEE over two-dimensional TEE for more accurate understanding of the underlying mechanisms involved in the rare cause of septal occluder failure reported. This was possibly because 3D TEE provides direct and real visualization of the cardiac structures, mainly in the en face views.

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**Figure 1** (A) Fluoroscopy showing the atrial septal defect occluder (Ultrasept) during the transcatheter closure 4 years previously. (B) Transthoracic echocardiography showing severe right ventricular enlargement. LV, Left ventricle; RV, right ventricle.

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**Figure 2** (A) Two-dimensional TEE demonstrating a well-seated atrial septal device (red arrow). (B) Color Doppler showing multiple large left-to-right shunts through the device (orange arrows). IVC, Inferior vena cava; LA, left atrium; RA, right atrium; SVC, superior vena cava.
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