Intracardiac echocardiography using the AcuNav™ ultrasound catheter during percutaneous closure of multiple atrial septal defects

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Transesophageal echocardiography is routinely used in catheterization laboratories to guide the percutaneous closure of ostium secundum atrial septal defects. The patient is under general anesthesia, and the interatrial septum anatomy is usually well defined. Multiple atrial septal defects are, in some cases, a challenge for both the interventional echocardiographer and the interventional cardiologist, when trying to evaluate the anatomy of the defects, the strategy of closure and the correct choice of the device.

We describe the usefulness of a new phased-array ultrasound-tipped catheter for intracardiac echocardiography in a case of percutaneous closure of multiple ostium secundum atrial septal defects.

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Transesophageal echocardiography (TEE) is routinely used in catheterization laboratories to guide the percutaneous closure of secundum atrial septal defects (ASDs). The patient is under general anesthesia, and the interatrial septum anatomy is usually well defined at TEE. The release of the occluder device is monitored by means of fluoroscopy, as well as at TEE[1].

Multiple ASDs are, in some cases, a challenge for both the interventional echocardiographer and the interventional cardiologist, when trying to evaluate the number, size and position of the defects, the strategy of closure, and the choice of the type, size and number of devices.

Recent advances have made intracardiac ultrasound imaging by the invasive cardiologist a viable alternative. The AcuNav™ (Acuson-Siemens Co., Mountain View, CA, USA) is a new phased-array ultrasound-tipped catheter for intracardiac echocardiography (ICE). It is a 10F, 90 cm long catheter. The tip contains a 64-element vector phased-array transducer, which scans the longitudinal plane providing a 90° sector image with 12 cm tissue penetration, thus allowing for high-quality two-dimensional and color Doppler images as well as continuous and pulsed wave Doppler[2-4]. The catheter is interfaced with a Sequoia (Acuson-Siemens) echocardiography machine.

We report a case of a percutaneous closure of multiple ASDs, where ICE with the AcuNav™ catheter was helpful in defining the interatrial anatomy and in the choice of the device.

Case report

A 13-year-old female patient, weighing 50 kg, received a transthoracic echocardiography diagnosis of secundum ASD, eligible for percutaneous closure. As we were at the beginning of our experience with the new intracardiac phased-array ultrasound-tipped catheter, the procedure was performed under both ICE AcuNav™ and TEE guidance.

Informed consent was obtained from the parents before the procedure. The ASD closure protocol used was standard, with minor modifications. The patient was under general anesthesia and endotracheal intubation, and a TEE probe was interfaced with HP Sonos 5500 (Agilent Technology, Palo Alto, CA, USA), while the AcuNav™ catheter was inserted in the left femoral vein using an 11F standard sheath; the right femoral vein was used as a venous access for device delivery.

TEE showed two ASDs, respectively 6 and 4 mm in diameter; the interatrial septum in between measured 4 mm, and the total septum measured 38 mm. ICE yielded the same information (Fig. 1). We positioned a 24 mm occlusion balloon (AGA Medical Corp., Golden Valley, MN, USA) in the wider diameter defect in order to determine whether both defects could be closed by one device. The stretched diameter was 9 mm, but a shunt was still present in a different position from the second defect. At TEE examination, there was a residual shunt secondary to incomplete obliteration by the inflated balloon. Careful assessment with ICE raised the doubt that the shunt was through a third true interatrial communication (Fig. 2) localized in the anterior rim toward the aortic mound. Therefore, we positioned a pig tail catheter in the left atrium through the third defect, while the sizing balloon was inflated, a left atriogram was obtained, and the persistence of a left-to-right shunt was shown, confirming the existence of a true interatrial septal defect (Fig. 3). Thus, we decided to use a single device, a 33 mm CardioSeal STARFlex (NMT Medical, Boston, MA, USA), to cover all three defects. After deployment, color Doppler ICE confirmed that there were no residual shunts (Fig. 4).

At 6 months of follow-up the right chamber dimensions had decreased and the device was properly positioned without residual shunt and spoiling of the adjacent structures.

Discussion

Closure of multiple ASDs is feasible, and different techniques have been described in the literature. Non-centering devices, or more often multiple occluder devices, are successfully used in the percutaneous closure of ASDs. It is important to define the correct anatomy

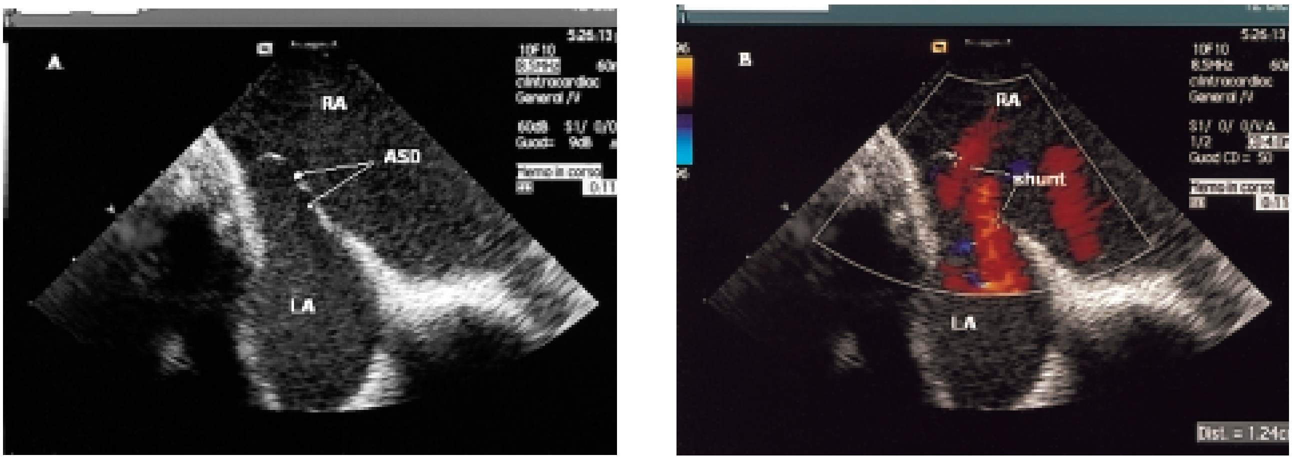

Figure 1. *Intracardiac echocardiography of the interatrial septum. The exit of the probe from the inferior vena cava may be seen at the left of the diagram. Two atrial septal defects (ASD) are shown in B-mode* (A)*; at color Doppler* (B) *it may be seen that the direction of flow through the shunt is from the left atrium (LA) to the right atrium (RA).*

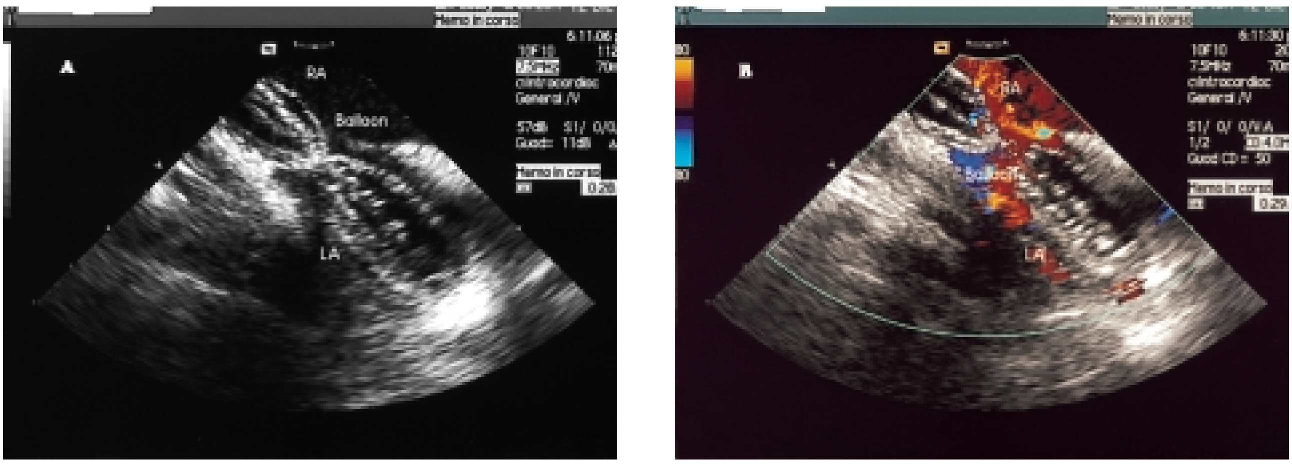

Figure 2. *Intracardiac echocardiography shows the inflated sizing balloon occluding the two adjacent defects* (A). *Color Doppler shows the persistence of a residual shunt originating from a third one* (B). *LA = left atrium; RA = right atrium.*

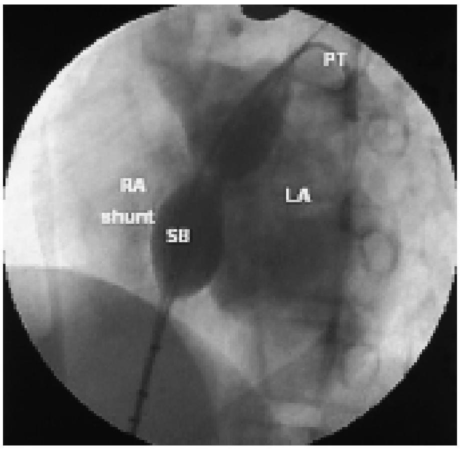

Figure 3. *Left atrial angiography, in the 50° left anterior oblique, 15° cranial projection. The pig tail (PT) is positioned in the left atrium (LA) through the patent atrial septal defect not occluded by the sizing balloon (SB). RA = right atrium.*

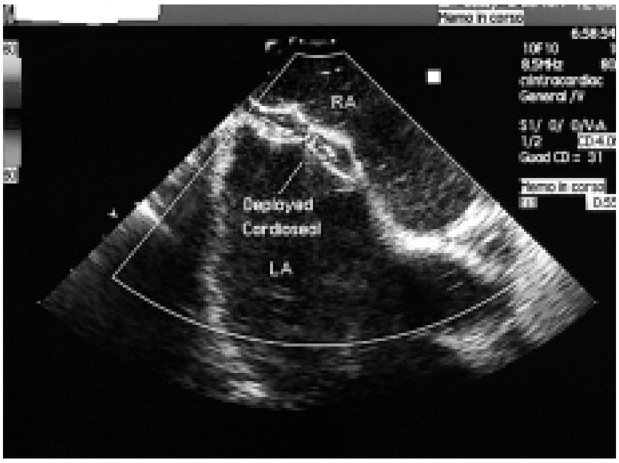

Figure 4. *Intracardiac echocardiography after correct deployment of the device: no residual shunts are evident. LA = left atrium; RA = right atrium.*

of the interatrial septum and the number and location of interatrial communications. Standard echocardiographic monitoring is performed with TEE[1]. The use of an intracardiac rotational mechanical ultra ICE™ catheter (Boston Scientific Corp.) has also been reported in the literature[5].

The use of AcuNav™ has been described in different interventional cardiology procedures: radiofrequency ablation[6], percutaneous mitral valvuloplasty[7], percutaneous atrioseptostomy[8], endomyocardial biopsy[8], ASD and patent foramen ovale closure[3,8-13].

In all these papers the feasibility and the accuracy of this phased-array ultrasound-tipped catheter, compared to TEE, has been validated. The complication rate is very low. The reported advantages include the avoidance of general anesthesia and endotracheal intubation in adolescent and adult populations, the reduction of the fluoroscopy and procedural times, and accurate imaging of the interatrial septum, of the adjacent structures and of the device[8-13]. An aneurysmal interatrial septum is difficult to identify when it prolapses into the right atrium[8]. The disadvantages include the large sheath diameter and the cost of the catheter[8-13].

Defining the correct anatomy of multiple ASDs is often a challenge for the cardiologist; the location, dimensions and spatial relationships of the ASDs, as well as the recognition of which hole is crossed by the delivery sheath, and whether the sizing balloon obliterates all the holes are sometimes difficult to define. The AcuNav™ catheter seems to be an ideal tool for this group of defects, thanks to the high-quality B-mode images and color Doppler assessment.

In our case, it proved useful in the recognition of a third interatrial communication which, at TEE and initial ICE assessment, seemed to be a residual shunt, secondary to an incomplete occlusion by the sizing balloon. We preferred to use the CardioSeal STARFlex device because, in comparison to the Amplatzer atrial septal occluder, it does not "stent" the defect, and was more likely to cover all three defects.

In this patient we used both TEE and ICE AcuNav™, because we were not acquainted with ICE imaging; after the first series of 3 patients, we are now routinely using only the ICE phased-array ultrasound-tipped catheter.

Even though we do not have any experience with the rotational mechanical ultra ICE™ catheter, the literature suggests that the main technical differences with the AcuNav™ catheter are the less user-friendly M-mode imaging and the lack of color Doppler and pulsed and continuous wave Doppler applications[14].

Our preliminary experience allows us to conclude that the performance of AcuNav™ is similar to that of traditional TEE, with more accurate imaging of the atrial septum with multiple fenestrations with high-quality color Doppler. The avoidance of general anesthesia and the reduced fluoroscopy and procedural times are the additional advantages we have observed and also reported in the literature[8-13]. The sheath size necessary for catheter introduction limits application in younger children. The catheter cost at the moment is high, so we optimize its use by choosing the ideal patient to monitor during an interventional procedure. Our policy is to use ICE in adults with a preference for those who have multiple ASDs or contraindications to general anesthesia; patients with an aneurysmal interatrial septum are still monitored with TEE.

The superiority of ICE AcuNav™ in monitoring percutaneous ASD and patent foramen ovale closure has been reported in a recent paper by Bartel et al.[13]; however, more experience is necessary. The phased-array ultrasound-tipped catheter, owing to its high-quality imaging and Doppler features, will play an important role in the future in both diagnostic and interventional fields.

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