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Perforation of the Aortic Sinus After Closure of Atrial Septal Defects With the Atriasept Occluder

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Percutaneous atrial septal defect closure is routinely performed nowadays because of the ease of implantation as well as the low complication rate. The Atriasept ASD occluder is a low profile, double disc device; over the years several modifications have been made. We report two cases of aortic sinus perforation by the Atriasept ASD occluder (model 2007). Two asymptomatic patients, in whom the device was implanted, were noticed to have metal projecting into the aorta. Real-time fluoroscopy showed fractures of the outer metal ring with abnormal movement of one of the struts of the device. One patient is being conservatively managed and in the other the device was surgically removed due to the presence of a second ASD, which needed closure. Transesophageal echocardiography and fluoroscopy may be necessary to identify this potentially life-threatening complication of this device. © 2009 Wiley-Liss, Inc.

Key words: atrial septal defect; percutaneous intervention; aortic perforation; pericardial transverse sinus

INTRODUCTION

Percutaneous closure of ostium secundum atrial septal defects (ASD) has gained popularity because of the success and low incidence of complications following the procedure. Various devices are now available on the market, allowing the clinician to select the most appropriate device for a given ASD. The Atriasept ASD occluder (version 2007, Cardia Eagan, MN) is a double umbrella device with left and right-sided nitinol struts (arms) and two polyfluoroethylene discs (Fig. 1) and is available in different sizes. A circular wire was added to the left-sided struts to prevent prolapse of the struts through the ASD during deployment. The Atriasept has the advantages of low profile, conformity to the atrial septum, self-centering, and retrieve ability. Initial studies showed good closure rates and virtually no complications in small and medium-sized ASDs and patent foramen ovale [1–4].

We report two nonfatal cases of perforation of the aortic sinus by a strut of the left atrial disc.

CASE REPORTS

Case 1

A 14-year-old female was diagnosed by transthoracic echocardiography (TTE) to have right heart dilation due to an ostium secundum ASD. Intraprocedural transesophageal echocardiography (TEE) identified two ASDs; the largest ASD was closed with a 20-mm Atriasept occlusion device (2007). The second smaller ASD was left untouched at that stage.

One year later, a significant shunt persisted and she was taken back to the catheterization laboratory. Intraprocedural TEE showed abnormal movement of structures at the left atrial aspect of the device (fractured circular wire), with protrusion of a strut through the atrial limbus into the noncoronary aortic sinus (Fig. 2). The aortic valve did not touch the strut throughout the cardiac cycle. The pericardium was free of effusion—the strut had passed from the atrium into the aorta below the pericardial fold of the transverse sinus. Real-time fluoroscopy clearly showed that one left-sided arm moved out of synchronization with the rest of the device—moving anterosuperiorly in systole whilst the rest of the device moved inferoposteriorly. Also, three segments of the thin circumferential wire

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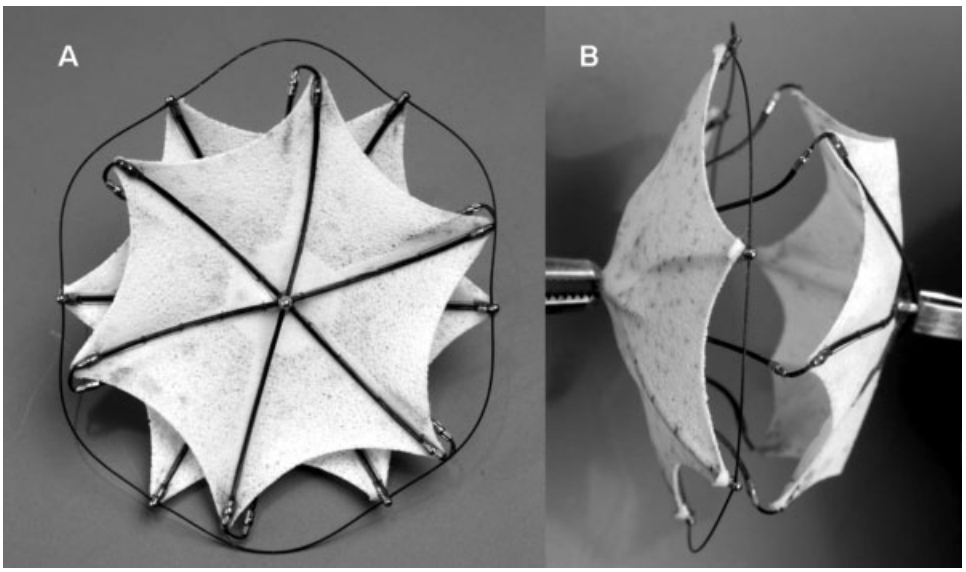

Fig. 1. Atriasept ASD occluder (2007) seen from right atrial side (A) and profile (B). A circular wire connects the left-sided struts to minimize prolapse of struts into the right atrium during deployment.

were fractured, two segments were missing and had embolized. Radiological screening to find the miniscule parts of the circumferential wire was unsuccessful. This patient was referred to surgery for device removal and closure of both ASDs. Due to the fact that the girl demanded an approach through thoracotomy, the surgeon was unable to inspect the aortic root. She made an uneventful recovery.

Case 2

The second patient was a 9.5-year-old male whose ASD was closed using a 16-mm Atriasept ASD occluder (2007). At routine control 1 year later, TTE showed a small echodense signal in one of the aortic sinuses in the long axial plane.

Due to our experience with the first patient, he was scheduled for a TEE and fluoroscopy. The TEE showed an identical perforation of the aortic sinus by a strut as well as numerous abnormal metal projections in the left atrium due to circular wire fractures. Real-time fluoroscopy once again showed the out-of-phase movement of one left atrial strut. Multislice computerized tomography confirmed projection of a left atrial strut into the noncoronary sinus of the aorta. The patient is asymptomatic and is currently being conservatively managed.

DISCUSSION

Percutaneous ASD closure has established itself as a routine intervention due to the effectiveness and safety of the procedure as well as the advantage of a short learning curve. Large numbers of devices from various companies are implanted worldwide. Complications have been described with all the "older" devices [5–8]. Although newer and better generations of devices are developed, they are also unlikely to be free of complications.

Our cases demonstrate perforations of the aortic sinus as a complication of the Atriasept (2007) atrial septal defect closure device. This may be a potentially life-threatening complication if it leads to cardiac tamponade.

Why did it occur with this device? Experience with percutaneous ASD occlusion has shown that the base of the aorta lies adjacent to the anterosuperior rim or limbus of the defect and in some cases makes up the only structure forming this border. Because of the positioning of the device against the interatrial septum, the anterosuperior aspect of the device then continuously comes into contact with the aorta during the cardiac cycle. The circumferential wire used in the Atriasept models in 2007 has seemingly inadequate strength and appears to fracture at the strut junction located along the periphery of the device. This frees the tip of the strut which then may penetrate into adjacent structures. The metal of the singular struts in those models appears sufficiently rigid to perforate; moreover, the left-sided nitinol struts are parabolic in shape (built-in metal memory), which adds an additional inward "pulling" force, further amplifying the effect of penetrating the septal tissues. If the atrial wall is perforated high on the aorta, and the pericardial transverse sinus is punctured before penetrating the aorta, tamponade may potentially ensue. In both patients the struts

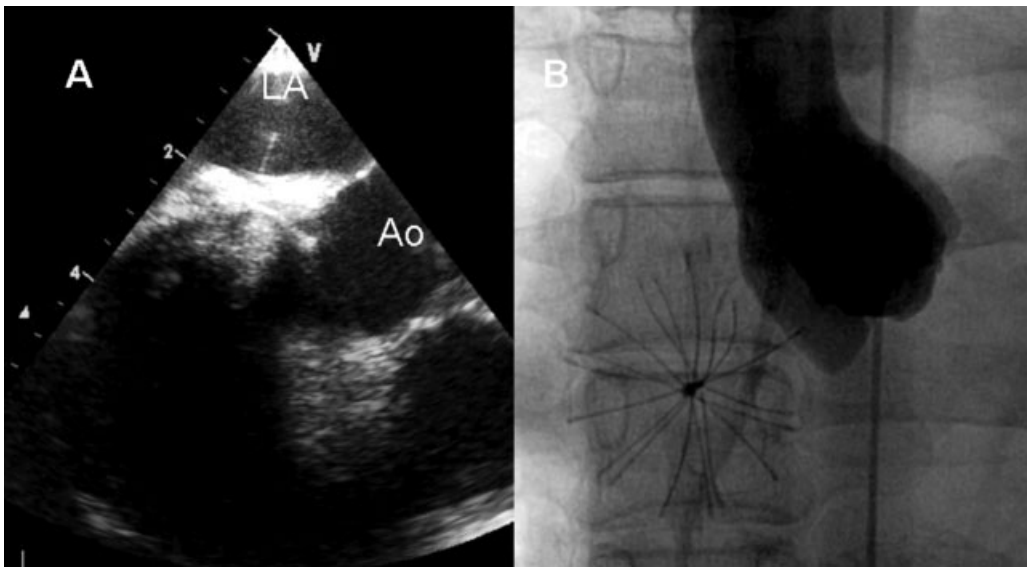

Fig. 2. A: TEE showing a strut perforating into the aortic sinus. A piece of fractured circular wire is visualized in the left atrium. B: Aortogram showing a strut perforating into the aortic sinus below the level of the pericardial transverse fold. The circular wire is missing in some segments. Ao, aorta; LA, left atrium.

remained within the tissue layers of the limbus in the roof of the left atrium as it pierced the aortic sinus, narrowly missing the open pericardial space. Subsequent to these events, we have been informed by colleagues that similar complications with this device have been experienced with both early and late tamponade occurring.

Both patients were asymptomatic and this complication was noticed by "chance." In patient 1 we opted for device removal and surgical closure due to the presence of a second ASD. In patient 2 the aortic strut now has probably exhausted its wall-penetrating stress with all the other struts lying on the atrial septum away from the atrial walls. The device is therefore very unlikely to cause further damage such as bleeding or tamponade. The patient and his parents as a result chose a conservative approach with close monitoring.

Complications arising from percutaneous ASD closure devices are uncommon, but both early and late complications may occur [9–13]. Most of the complications are minor and rarely need specific treatment. In total, the complication rate ranges between 4 and 12% for all devices, including periprocedural problems. These include malposition, embolism, allergy, headache, effusions, endocarditis, valve impingement, and arrhythmias. A rare, but potentially life-threatening complication has been reported with almost all types of septal occluders: erosion or perforation of the atrial wall and/or aorta with pericardial tamponade in 0.1–0.3% of cases [13–15]. This seems to occur more commonly in patients with deficient anterosuperior rim or with significant device oversizing. Complications resulting from device closure are probably unobserved, underreported, and unpublished, which may lead to underestimation of device-related problems. Therefore, it is important to report cases such as these and closely monitor them to gain insight into mechanisms of these rare and potentially dangerous problems.

On a practical note, after the TEE and radiological findings, we specifically repeated the TTE to detect this problem, but found it unreliable to confidently diagnose aortic perforation in patient 1. The implication therefore is that both real-time fluoroscopic screening and TEE should be used to diagnose this potentially lethal complication due to the Atriasept (2007) device.

CONCLUSION

Percutaneous closure of ASD is regarded as a routine procedure, but one should not forget that potentially lethal complications have been described in virtually all of the devices. Patients in whom these models of Atriasept devices have been used to close secundum ASDs should be closely monitored for fracture of the outer ring associated with perforation of adjacent cardiac structures. Detection may require TEE and/or fluoroscopy.

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