Cupping of the left atrial disc: a new echocardiographic pointer towards atrial septal defect-device mismatch

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Abstract

We report a case of percutaneous atrial septal defect closure (ASD) in which, despite careful device selection and successful shunt closure, a number of adverse echocardiographic features developed, necessitating surgical extraction of the device and patch closure of the defect. Lessons regarding case selection, device choice, appropriate follow-up and recognition of adverse echocardiographic features can be learned from this experience.

Keywords: Occlutech atrial septal defect device • Undersizing • Adverse features

INTRODUCTION

Transcatheter closure of secundum atrial septal defect (ASD) has gained wide acceptance due to excellent success rates and low risk [1–4]. There are, however, certain anatomical aspects, including defect size and position in the atrial septum that render some ASDs more difficult to close and more susceptible to complications. Advances in occlusion device technology mean that these difficulties and risks may be mitigated by the selection of a device that suits the anatomical substrate of a particular lesion best [1, 2]. These developments have the potential to broaden the population of patients with ASDs who can safely undergo catheter intervention and avoid surgery. With this comes the need to understand the limitations of current technology so that appropriate safety measures are put in place and further technological progress can be made.

Here, we report the case of a patient with an ASD that exhibited several technically challenging features. Careful device selection assisted successful deployment and shunt closure after an informed written consent was obtained. Despite this, a number of adverse clinical and echocardiographic features developed in the early post-procedure period, necessitating surgical extraction of the device and patch closure of the defect. Lessons regarding case selection, device choice and appropriate follow-up can be learned from this experience.

CASE REPORT

A 52-year old man born in Mozambique of Indian extraction, presented with a history of exertional chest discomfort and breathlessness. Nuclear perfusion imaging showed no evidence of myocardial ischaemia, but transthoracic echocardiography (TTE) demonstrated a large secundum ASD with left-to-right shunting and marked right ventricular volume overload. Transoesophageal echocardiography (TOE) confirmed on colour Doppler a large ASD with a maximum diameter of 36 mm (Fig. 1A) and the defect measured 39 mm, using stop flow balloon sizing. The inferior rim was adequate (9 mm) and the aortic rim was absent. In view of these anatomical features, a 40-mm Occlutech Figulla ASD Occluder (Occlutech, GmbH, Jena, Germany) was selected and successfully deployed, initially releasing the left atrial (LA) disc within the right upper pulmonary vein. The two discs splayed around the aortic root (Fig. 1B), as intended. The device conformed well to the other margins (Fig. 1C) and was stable on push–pull manoeuvre. Of note, however, the LA disc adopted a somewhat concave configuration and was indenting the posterior aspect of the aortic root (Fig. 1D) without affecting valve function.

TTE performed later the same day confirmed a stable device position, but 1 week after the procedure repeat, TTE demonstrated a small posterior pericardial effusion (maximum diameter: 1 cm, with no haemodynamic sequelae). Six weeks after the procedure, the patient’s breathlessness had improved, but TOE showed that the LA disc had adopted a deeper concave configuration and was indenting the posterior aspect of the proximal aortic root (Fig. 1D) without affecting valve function. The dislocation of the device towards the right atrium (RA) had moved the disc away from the septum. The small residual shunt between the device and the aorta persisted, as did the pericardial effusion. Concern was raised that the sharp anterior edge of the LA disc had the potential to cause aortic erosion and may already have eroded the roof of the left atrium. On the basis of these adverse findings, we elected to proceed to surgical extraction of the device. Nine weeks post-catheter procedure the patient had patch closure of the defect.
External inspection of the heart during surgery showed no evidence of injury to, or bruising of, the atrial wall or aortic root. Due to the marked device dislocation, the right atrial disc was projecting across the right atrium-inferior caval vein junction, making it difficult to cannulate the vein for cardiopulmonary bypass. Internal inspection after right atriotomy demonstrated that the device waist was relatively small for the size of the defect, and embolization was prevented only by the outer margin of the aortic aspect of the LA disc. The device had partially endothelialized, and was free of adherent clot. The discs of the explanted device did not flatten and maintained their concave configuration (Fig. 2A and B). The patient recovered from surgery uneventfully.

**COMMENT**

This patient had a large ASD, with the size being at the uppermost limit that permits closure with the currently available technology. Furthermore, because the aortic margin was absent, there were potential difficulties in aligning the device to the septum during deployment. The right upper pulmonary vein technique was therefore used, and an Occlutech Figulla ASD Occluder was selected. The ball and socket cable attachment of the Occlutech allows favourable angulation of the device, so that it hugs the aortic root even before release from the delivery cable. In our view, the alignment of the device to the septum as the right atrial disc is advanced out of the sheath makes it easier to avoid pulling the LA disc off the aortic root during deployment.

**Figure 1:** (A) TOE at 0°: Large secundum ASD measuring 36 mm on colour Doppler. (B) TOE at 32° demonstrating the two discs splayed around the aortic root. (C) TOE at 86° demonstrating a good position of the Occlutech ASD device in relation to the superior caval vein. (D) TOE demonstrating dislocation of the Occlutech ASD device towards the right atrium.

**Figure 2:** (A) Extracted 40 mm Occlutech ASD device with the RA disc on top. (B) Extracted 40 mm Occlutech ASD device facing the LA disc.
In retrospect, in this case, the waist of the device did not grip the defect margins adequately, allowing dislocation of device towards the right atrium. With only a 1-mm difference being present between stop flow balloon sizing and the maximum available device size, we recognized that undersizing was a potential issue, but were reassured that the device was stable immediately after deployment.

When an Occlutech device is outside the body, if the LA disc is held by its edge and pressure is applied to the middle of the disc, pushing it towards the RA disc, it is possible to produce a cup-shaped LA disc. We therefore speculated that, under normal circumstances, the stenting waist of the device anchors it within the septum, so that any displacement from the LA towards the RA is resisted by the stenting waist gripping the septal tissue. However, if the device is not large enough for the ASD, the stenting waist will not grip the septum, and any left-to-right displacing force will be applied directly to the LA disc. Therefore, as the device is effectively hanging on the rim of the LA disc, this pressure will tend to invert the LA disc and cause cupping.

The left-to-right displacing force may have been from the push-pull manoeuvre used by the operator to check the stability of the device or may have been a result of LA pressure being higher than the right atrial pressure.

We now interpret the ‘cupping’ of the LA disc and the presence of a residual shunt as indicators of an undersized device. As such, these may be helpful additional echocardiographic pointers towards device-defect mismatch.

Device dislocation and embolization are among the commonest major complications of percutaneous ASD closure. Other problems include atrial wall erosion with pericardial effusion and tamponade, aortic erosion, partial occlusion of vena cava, residual shunt, haemolysis and thrombus formation [1, 5].

The decision to operate was based on perceived risk that the LA disc had already eroded through the atrial wall or would erode into the aortic root. The question as to whether any harm would have resulted if the device was not removed cannot be known, but safety was paramount.

We would recommend implanting a larger device if it is available, as it is not a question of absolute size in our view, but of defect-device size mismatch. The largest current device manufactured by Occlutech has a stenting waist size of 48 mm.

**CONCLUSION**

Advances in device technology and the development of new delivery techniques have resulted in an increase in the number of ASDs that can be closed percutaneously. With this comes the need to understand the limitations of current technology so that appropriate safety measures can be put in place and remedial actions can be taken. The key to this is recognizing adverse echocardiographic features both at the time of device implantation and during follow-up.

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**REFERENCES**


