Evaluation of patients for potential compression of anomalous coronaries coursing behind the aortic root before device closure of secundum atrial septal defects

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ABSTRACT
Coronary arteries coursing behind the aortic root may get compressed when nitinol septal occluders are used to close an atrial septal defect. Hence, echocardiographic recognition of a retroaortic linear vessel is important during preinterventional evaluation. While the left circumflex arising from the right coronary artery is the most common cause, a similar finding is sometimes observed in a single left or right coronary artery and rarely with small sinus nodal branches from the left circumflex artery. Complex three-dimensional relations between the defect and the aortic root may be understood only after a postdeployment selective coronary angiography. Two patients with anomalous retroaortic left circumflex from the right coronary artery underwent uneventful device closure with clearly documented separation between the edges of the occluder and the anomalous vessel. Follow-up imaging and exercise testing confirmed the safety of the intervention. A selective postdeployment and postrelease coronary angiography are mandatory in every patient with retroaortic coronaries.

Keywords: Anomalous circumflex artery, contraindication, device closure, echocardiography, extrinsic coronary compression, myocardial ischemia

INTRODUCTION
Device closure of atrial septal defect (ASD) is a preferred alternative to surgery. Barring very large defects, deficient margins, and coexisting anomalies that need surgery, there are very few contraindications. Anomalous retroaortic course of the coronary artery may pose a risk of compression when an occluder device flares around the aortic margin of the defect. After the introduction of the nitinol atrial septal occluders in 1998, the potential for coronary compression due to its abnormal course was recognized 5 years later.[1] Reports of this anomaly nearly excluded all such patients from interventions.[2,3] However, a blanket exclusion may not be justifiable as the orientation and flaring of the occluder around the aortic root may differ in patients depending on the location of the retroaortic coronary course and margins of the defect.[4] We report two patients with anomalous retroaortic left circumflex coronary artery, where device closure of ASD had an uneventful outcome, as the vessel was not located in the plane of the occluder device.
CASE REPORTS

Case 1

A 32-year-old female with effort dyspnea, pulmonary outflow systolic murmur, and wide split second sound was diagnosed to have a large 22 mm secundum ASD with adequate rims including the retroaortic margin. Electrocardiogram showed sinus rhythm, rSR' pattern in lead V1, and frequently isolated monomorphic ventricular ectopic, suggestive of origin from the right ventricular outflow. Chest X-ray showed cardiothoracic ratio of 60%, dilated main pulmonary artery segment, and pulmonary plethora. A 28 mm Cera septal occluder (Lifetech Scientific, Shenzhen, PRC) was deployed across the defect. Prerelease transthoracic echocardiogram showed a stable device position without any residual flows. There was a previously unrecognized linear vascular structure coursing behind the aortic root, suggestive of an anomalous coronary artery. After obtaining arterial access, coronary angiogram confirmed the retroaortic
course of the anomalous left circumflex from the right coronary artery, but the vessel appeared separated from the device in an angiogram done in the right anterior oblique projection [Figure 1 and Video 1]. Coronary flows were normal with no evidence of compression. After affirming that the patient remained asymptomatic without any new electrocardiographic changes, the device was released. Follow-up echocardiography confirmed separation of coronary from the device and normal segmental strain [Figure 2]. A multislice computed tomographic study later again confirmed a separation of the occluder from the anomalous vessel [Figure 3].

Case 2

A 25-year-old asymptomatic male was diagnosed to have secundum ASD during a routine annual clinical examination in a well-health clinic. Cardiovascular examination showed cardiomegaly, outflow systolic murmur, and wide split-second sound. Chest X-ray and electrocardiogram were consistent with left-to-right pretricuspid shunt. Echocardiogram showed a 30 mm secundum ASD with adequate rims including retroaortic margin. The defect was closed with a 34 mm Amplatzer septal occluder (Abbott Medical, Plymouth, MN). After confirming a stable device position and lack of residual flows, the device was released. Postrelease transthoracic echocardiogram showed a retroaortic linear vascular channel. Coronary angiogram showed anomalous left circumflex origin from the right coronary artery with a retroaortic course; however, there was no extrinsic compression from the occluder [Figure 4]. On a right anterior oblique projection, there was a separation between the coronary artery and the occluder. There were no fresh electrocardiographic changes. Exercise stress electrocardiography done twice after the procedure at a 4-year interval did not show any evidence of ischemia.

DISCUSSION

Adverse cardiac events are known to occur in certain coronary anomalies. The coronary abnormality of relevance in device closure of ASD or a patent oval foramen is anomalous retroaortic course of the coronary artery hugging the aortic root, seen as a linear vascular shadow behind the aortic sinus. The left circumflex artery originating from the right aortic sinus with retroaortic course is the most common coronary anomaly found in 0.6% of routine coronary angiograms or autopsy. An single coronary artery is an extremely rare anomaly where the left main coronary artery originating from a single right coronary artery or a right coronary artery originating from a single left coronary artery sometimes follows a retroaortic course. The periaortic flaring of the occluder may lead to compression in these coronary anomalies. An oversized device with splayed discs could potentially compress a retroaortic coronary artery, whereas a softer device may prevent it.

This potential problem was first recognized in a predischarge surveillance transeosophageal echocardiography in a patient after the closure of a patent foramen ovale for a transient ischemic attack using a septal occluder device, leading to exercise testing that showed myocardial ischemia on stress. As it was unrecognized before the procedure, selective coronary angiography was not done. Compression of the anomalous left circumflex by the occluder was recognized on magnetic resonance imaging through the artifacts created by the device. However, device closure was not attempted in another institution for a similar anatomy after its recognition on a preprocedural coronary angiography. When the left main coronary artery anomalously arising from a single right coronary artery entered behind the aortic root, the large coronary trunk carried a higher chance of compression as documented in two cases. However, the chances of compression may be less for a smaller retroaortic left circumflex artery from the right coronary artery, which is one of the commonly observed coronary anomalies. Successful device closures were reported in two patients with anomalous retroaortic circumflex coronary artery, showing its feasibility.

While recognizing that the possibility of coronary compression in each case was related to the relative size of the defect and device, adequacy of the aortic separating margin and a three-dimensional relation between the defect location versus the plane of the coronary artery, a small word of caution could be added due to uncertainties of aortic dilatation and changes in its orientation as well as remodeling of the right heart. It is intuitive to suspect an interaction between the coronary and the device if a relatively large coronary crosses behind the aortic root when a large oversized device is deployed in a defect near the sinuses with a deficient retroaortic margin. Without a postdeployment coronary angiography, the complex relationship between the device and the coronary could not be precisely predicted in most patients. In addition, a postrelease coronary angiography was also mandatory to verify any changes in orientation of the device after release from the delivery cable. We demonstrated a significant separation between the device and the coronary in the right anterior oblique projections of selective coronary angiography even though an overlap was observed in other projections.
Regarding somatic growth in young children undergoing device closure, the growth of the remainder of the atrial septum around the device with advancing age should maintain a stable distance from a coronary artery.

Awareness of this coronary anomaly led to echocardiographic identification of linear vascular shadows behind the aortic root in patients with ASD. Compression of a small retroaortic sinus nodal artery branch arising from the left circumflex artery and coursing behind the aortic root was avoided by the use of a softer wire mesh occluder in a patient with ASD who was previously treated for pulmonary atresia with an intact ventricular septum through repeated balloon pulmonary valvotomies.[10]

CONCLUSIONS

Echocardiographic recognition of retroaortic linear vessels as anomalous coronaries is vital during preinterventional evaluation of ASD. While anomalous left circumflex from the right coronary artery is the most common cause of a retroaortic course, it can be observed in a single right or left coronary artery too. A large anomalous left coronary artery is more likely to be compressed, but small vessels such as circumflex or right coronary artery and smaller branches such as sinus nodal artery may not always be compressed by occluders. The potential for coronary compression can only be identified on postdeployment selective coronary angiography in the right anterior oblique projection, as the complex three-dimensional anatomical relation between the defect and the coronary cannot be predicted based on echocardiography alone. Adequacy of a retroaortic rim, especially near the aortic root is important to prevent an interaction. It is mandatory to repeat a postrelease coronary angiography to confirm the separation of the device from the coronary artery.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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