Transcatheter Intervention for Complex Ascending Aortic Pseudoaneurysm After Cardiac Surgery

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Background: Ascending aortic pseudoaneurysm (PsA) is an uncommon but surgically challenging problem with high morbidity and mortality. Herein we describe the efficacy and safety of the different approaches to transcatheter intervention for repair of ascending PsA and assess the selection of occluder devices using real-time 3-dimensional (RT 3D) color Doppler transesophageal echocardiography (TEE).

Methods and Results: Three patients with complex ascending PsA after cardiac or aortic root surgery were treated with transcatheter intervention due to high risk for redo surgery. Perioperative RT 3D-TEE combined with fluoroscopy was used for monitoring. All ascending PsA were successfully occluded with different devices using the transcatheter technique either with the transapical, transarterial approach, or transvenous combined with hybrid process depending on lesion anatomy.

Conclusions: Treatment of complex ascending PsA with transcatheter or combined hybrid intervention with cautious planning based on patient presentation and well-coordinated teamwork was successful. RT 3D color Doppler TEE provided precise information for the selection of appropriate occluder device, and also facilitated the procedure by guiding the catheter through difficult anatomy. (Circ J 2014; 78: 2215–2218)

Key Words: Aortic pseudoaneurysm; Cardiac surgery; Real-time 3-dimensional transesophageal echocardiography (RT 3D-TEE); Transcatheter combined hybrid intervention; Transcatheter intervention

 Ascending pseudoaneurysm (PsA) is a rare complication of aortic root and/or cardiac valve surgery and generally, surgical intervention is advised to avoid high cardiac output failure.\(^1\)\(^-\)\(^4\) Redo surgery, however, is often associated with high morbidity and mortality in such cases. Surgical management is always mandatory because of lethal complication. In recent years, endovascular treatment of aortic pathology with endoluminal graft has emerged as a minimally invasive alternative to open surgery repair.\(^6\)\(^-\)\(^7\) Despite these advances, endovascular graft therapy in aortic root or ascending PsA remains technically challenging due to short landing zones, which may cause coronary compromise. Two-dimensional transesophageal echocardiography (2D-TEE) with color flow and pulsed Doppler imaging has been shown to be useful in the diagnosis of suspected PsA.\(^8\) The neck of the PsA, however, has a complex geometry between the lesion and the surrounding native tissue. The dimension, location and length of the neck of the PsA viewed on conventional 2D-TEE alone might be inadequate, but 3D-TEE provides precise imaging of shape, size and length of the lesion neck during transcatheter repair.

Here we discuss 3 different forms of ascending PsA with complex anatomy following cardiac or aortic root surgery that were treated with transcatheter intervention with different approaches for repair. Transcatheter techniques were carried out under general anesthesia in the hybrid room, under fluoroscopy and RT 3D color Doppler TEE guidance.

Methods

TEE Perioperative 2D-TEE and RT 3D-TEE were carried out with a 5.5-MHz new matrix array X7-2t transducer and a commercially available Philips iE33 ultrasound system after induction of anesthesia and endotracheal intubation.\(^8\)\(^-\)\(^12\) RT 3D-TEE was performed at the end of a comprehensive 2D-TEE examination and used for the assessment of PsA lesions, guidance of the catheter intervention, device selection and positioning, post-repair examination of residual leak and identification of any additional aortic abnormality (ie, dissection, pericardial effu-
ascending aorta (Figure 1B) and a giant aneurysm with partial thrombus formation. On RT 3D-TEE the PsA neck diameter measured 12 mm and was positioned approximately 1.5 cm distal to the origin of the right coronary artery (Figure 1C), and en face neck view of the PsA showed the round-shaped neck with firm ring (Figure 1D). Therefore, transcatheter closure of the PsA opening with device occlusion was performed. Unfortunately, several attempts at guiding the catheter through the left subclavian artery approach failed to reach the PsA sac due to a tortuous aorta. The procedure was changed to a transapical approach and a guiding catheter was subsequently smoothly passed through the PsA sac (Figure 1E). A 14-mm Amplatzer atrial septal occluder (AGA Medical) was deployed without any identifiable residual leak (Figure 1F).

PsA of Aortic Root to Right Atrial Communication

A 56-year-old man had undergone Bentall procedure for type A aortic dissection 6 years previously. He complained of chest pain in the recent 4 months. PsA with large shunt to the right atrium (RA) was diagnosed on computed tomography. Perioperative 3D-TEE, however, showed marked dilation of the aortic root and a PsA with a 10-mm fistula to the RA (Figure 2A). Based on these findings, the cardiac team chose a transcatheter intervention to repair the lesion. In order to prevent injury to the Bentall graft, a transfemoral venous approach was attempted (Figure 1B) that would affect planning. Using the 3D zoom modality, the entire PsA can be seen en face and the lesion orifices identified. The full volume modality allows the demonstration of Doppler color flow through the fistula or communication site.

Device Selection

The occluder device size was chosen to be 2 mm larger than the diameter of the defect measured on 3D-TEE. Amplatzer devices (AGA Medical, Golden Valley, MN, USA) including atrial septal defect, duct and muscular ventricular septal defect (VSD) occluders were used for deployment depending on lesion presentation.

Case Reports

Ascending PsA

A 58-year-old man underwent elective coronary artery bypass grafting for double-vessel coronary artery disease and aortic valve replacement (Edward perimount bovine 25-mm) 3 years previously. He had, however, suffered from chest tightness and exertion dyspnea in the recent 3 months. Chest X-ray showed a large mass at the right sternal region, and on computed tomography giant PsA (7.2×9.7 cm) with partial thrombosis arising from the ascending aorta (Figure 1A) was diagnosed. 2D-TEE showed marked dilation of the ascending aorta (Figure 1B) and a giant aneurysm with partial thrombus formation. On RT 3D-TEE the PsA neck diameter measured 12 mm and was positioned approximately 1.5 cm distal to the origin of the right coronary artery (Figure 1C), and en face neck view of the PsA showed the round-shaped neck with firm ring (Figure 1D). Therefore, transcatheter closure of the PsA opening with device occlusion was performed. Unfortunately, several attempts at guiding the catheter through the left subclavian artery approach failed to reach the PsA sac due to a tortuous aorta. The procedure was changed to a transapical approach and a guiding catheter was subsequently smoothly passed through the PsA sac (Figure 1E). A 14-mm Amplatzer atrial septal occluder (AGA Medical) was deployed without any identifiable residual leak (Figure 1F).
A 54-year-old woman presented with exertion dyspnea 5 months after undergoing aortic valve replacement. Fluoroscopy and aortic angiography showed PsA of the aortic root and fistula to LV (Figure 3A). RT 3D color Doppler TEE demonstrated that the aortic root PsA involved the right sinus of Valsalva. Attempted. A guiding catheter was therefore advanced through the right femoral vein, but it was unable to pass through the defect of the PsA. Therefore, sternotomy was decided upon to expose the RA, and the guiding and delivery catheter were able to carried by surgeon hand-assisted manipulation on the surface of the beating RA and then advanced through the defect to the aorta. A 12-mm Amplatzer PDA occluder was successfully deployed without leak (Figure 2B).

PsA of Aortic Root With Fistula to Left Ventricle (LV) A 54-year-old woman presented with exertion dyspnea 5 months after undergoing aortic valve replacement. Fluoroscopy and aortic angiography showed PsA of the aortic root and fistula to LV (Figure 3A). RT 3D color Doppler TEE demonstrated that the aortic root PsA involved the right sinus of Valsalva.

Figure 2. Transvenous method combined with hybrid approach for the closure of aortic root pseudoaneurysm (PsA) with a PDA occluder. (A) Real-time 3-dimensional (RT 3D) color Doppler transesophageal echocardiography (TEE) showing marked dilatation of aortic root and a 10-mm neck fistula (2 arrows) to RA. (B) RT 3D color Doppler showing deployment of 12-mm Amplatzer ductal occluder (D). B, Bentall graft; RA, right atrium.

Figure 3. Transarterial closure of aortic root pseudoaneurysm (PsA) with a ventricular septal defect (VSD) occluder. (A) Aortic angiogram showing the ascending aorta PsA and a fistula (2 arrows) to left ventricle (LV). Larger arrow, prosthetic aortic valve (PAV). (B) Real-time 3-dimensional (RT 3D) color Doppler transesophageal echocardiography (TEE) showing a fistula (arrow) from the PsA to LV with a PsA neck diameter of 6 mm. (C) Aortic angiogram showing 8-mm muscular VSD occluder (small arrow) deployment. Larger arrow, PAV. (D) RT 3D color Doppler TEE showing exclusion of the aortic PsA with an Amplatzer muscular VSD occluder.
and a fistula to LV. On 3D color Doppler TEE the fistula neck was measured at 6 mm (Figure 3B). Therefore, an 8-mm muscular VSD occluder was successfully deployed without residual leak (Figures 3C, D). The postoperative recovery courses were uneventful in all cases.

Discussion

PsA is a rare but potentially fatal complication, with an incidence of 1% following aortic surgery. In the present 3 cases, 2 PsA developed due to aortic valve endocarditis, and 1 formed on the ascending aorta after surgical intervention at the aortic cannulation site. PsA due to surgical intervention generally results from a disruption of the aortic wall as a consequence of aortic procedures within a few months after cardiac operation. Hence, intraoperative events and perioperative infection demand careful attention if this devastating complication of cardiac surgery is to be prevented.

If aortic pathologies do develop, they can lead to significant morbidity and mortality given that redo surgery remains challenging. Treatment with transcatheter intervention is an alternative, but limitations remain. Stent-graft may not be an option in certain cases due to inadequate landing zone and close proximity to the great vessels. Coil embolization has been reported to treat narrow-neck PsA.

Although the transcatheter technique may be a novel alternative for repair, the anatomy of the ascending aorta may be distorted following cardiac surgery. Transcatheter techniques can be carried out via a transvenous, transarterial or transapical approach. In most ascending PsA, the site of aortic wall disruption leading to aneurysm formation is anteriorly located, giving rise to PsA that bulge anteriorly. In case 1, however, the aneurysm was located laterally, making it difficult to pass the guidewire through the neck of the PsA through the left subclavian artery. The transapical approach allowed more direct access to the lesion. In case 2, the patient with ascending PsA and fistula to the RA after Bentall operation required catheter delivery using the transfemoral venous approach to prevent Bentall graft damage by the delivery catheter. This case presented a challenge to pass the guidewire through the fistula from the RA to the aorta because of the severely angulated neck between the inferior venous cava and fistula, in addition to the retrograde blood flow from the aorta. In this patient, a transvenous approach combined with hybrid technique was selected. The RA was exposed by sternotomy so that the guide catheter could be directly manipulated and assisted by the surgeon to facilitate the passing of the guide catheter from the RA to the aorta. Therefore, transcatheter repair of PsA seems to be an attractive alternative for high-risk patients, but the complex variations in the aortic pathology and the presentation of disease still require a unique approach to each lesion.

Currently, transcatheter repair of PsA with Amplatzer occluder device is a novel technique that requires new equipment and advanced imaging. The 3 complex ascending PsAs were repaired by transcatheter or combined hybrid intervention with very careful planning of individualized approaches and close coordination between the different medical teams. Using the 3D zoom modality, the entire PsA was able to be seen en face and the lesion orifices identified. The full-volume modality allows the demonstration of Doppler color flow through the fistula or communication site. Perioperative RT 3D color Doppler TEE monitoring provides precise information and aid in determining the exact size and length of the neck of the PsA for appropriate device selection and for facilitating the procedure.

Conclusions

The present patients were successfully managed with transcatheter intervention with different Amplatzer occluder devices to repair complex ascending PsA. Perioperative RT 3D color Doppler TEE played an important role during the procedure. This single-center study was not randomized, the case number was small and the procedure was carried out only by experienced investigators, and the patient clinical courses were safe and feasible.

References