Editorial

Coronary Artery Occlusion as a Complication of Transcatheter Aortic Valve Implantation

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See article by Toeg et al., pages 611.e1–611.e3 of this issue.

Transcatheter aortic valve implantation (TAVI) has now been accepted as the treatment of choice for symptomatic native aortic valve stenosis in patients who cannot undergo conventional open heart aortic valve replacement.1 The use of the transcatheter valve procedure has been increasing dramatically in Europe for the treatment of symptomatic aortic stenosis patients since it was approved for commercial use in 2007-2008. Although the transcatheter procedure is technically simpler and less invasive than conventional aortic valve replacement, it is still associated with considerable intraoperative and 30-day complications. The SAPIEN Aortic Bioprosthesis European Outcome (SOURCE) Registry2 showed 5.5% major intraoperative complications, including conversion to conventional aortic valve replacement, significant paravalvular leak (>2), valve embolization, and coronary artery obstruction, and 20.8% 30-day major complications, including stroke, acute renal failure requiring dialysis, pacemaker implantation, and major vascular complication. In the Placement of Aortic Transcatheter Valve (PARTNER) trial, arm A (high-risk patients), the 30-day major complication, including stroke, acute renal failure, pacemaker implantation, major bleeding, and major vascular complication, was 32.9%.3 With continuing optimization of the device and procedure, complications such as vascular complications, valve embolizations, and major bleeding are decreasing. Coronary artery obstruction is one of the life-threatening complications with TAVI. The reported incidence of coronary artery obstruction is < 1%.2,4-6 Coronary artery obstruction was a fatal complication in the early era of TAVI. With cumulative understanding and management experience, this complication has decreased and has become more manageable, but it is still associated with high mortality and morbidity.

Either the left coronary2,4-6 or right coronary ostium7 can be obstructed, although the left is much more common than the right. This is because the right coronary ostium is usually situated at a greater distance from the aortic annulus relative to the left coronary ostium in most patients. The most common cause of the complication is the displacement of a bulky, calcified native aortic cusp over a coronary ostium. In the extreme case, a part of the displaced native aortic valve could enter the left main coronary artery (LMCA), causing LMCA occlusion, as reported by Toeg et al. in this issue of the Canadian Journal of Cardiology.8 Toeg et al. reported that a large piece of the left aortic cusp was displaced into the LMCA while remaining attached to the annulus. In their case, the portion of the cusp was sandwiched between the stent and the wall of the LMCA, which could also happen during LMCA stenting. Complete obstruction to coronary flow by the prosthetic stent itself appears to be rare as the outflow end of the frame in current transcatheter valves is not covered by fabric. Other potential and extremely rare causes of coronary artery obstruction could be large debris from calcification of the native aortic valve or aortic root, clots, a large amount of air, or even aortic dissection. Svensson reported a case with embolic material into the left coronary territory without a leaflet blocking the LMCA after transapical placement of an aortic valve.9

Risks for the complication include (1) bulky calcification located near the edge of the left or right coronary cusp, (2) the LMCA ostium situated close to the aortic annulus—particularly when the distance between the ostium and the annulus is less than 10 mm or the distance between the ostium and the annulus is less than the height of the calcified left coronary cusp, (3) small or narrow sinus of Valsalva (a ratio of the sinus of Valsalva and annulus dimensions ≤ 1.0), and (4) signs of coronary artery obstruction during aortic balloon valvuloplasty. Echocardiography, aortography, and computed tomography angiography with 3-dimensional reconstruction have been used to assess these risk factors during patient selection. Although computed tomography angiography is the best imaging modality for the assessment, conventional aortic root—ascending aortography is a great initial screening tool. When imaging assessments suggest potential risk for the complication, aortic balloon valvuloplasty with injection of contrast to the aortic root could be helpful in determining the risk of coronary artery obstruction, al-

See page 535 for disclosure information.
though it could also be misleading. Presently, no definite criteria exist to exclude patients from TAVI based on the risk for coronary artery obstruction. Generally speaking, in the presence of these predisposing factors, the best way to avoid this life-threatening complication is to cancel stent valve implantation. If one plans to perform TAVI in a patient in whom concern for LMCA occlusion is high, it may be useful to place a wire in the left anterior descending coronary artery through a guiding catheter at the time of valve deployment, allowing quick access to the LMCA for angioplasty and stent.

Clinical presentations of coronary artery obstruction include progressive or acute onset hypotension, ventricular fibrillation, ST changes, or cardiac arrest without other obvious precipitants, such as massive hemorrhage, valve embolization, and severe aortic valve malfunction. Transesophageal echocardiography demonstrates worsening of left ventricular function and new wall motion abnormalities. Although delayed clinical presentation following coronary artery obstruction has been reported, the majority of patients who suffer coronary artery obstruction present with rapid hemodynamic deterioration immediately after deployment of a transcatheter valve. Therefore, immediate and appropriate action is critical to resolve this situation. In principle, if a patient is not immediately responding to resuscitation, immediate establishment of femorofemoral bypass is critical to promptly stabilize hemodynamics prior to further determination of causes of the event. Aortic and coronary angiography should then be performed to confirm the obstruction of a coronary ostium, and stenting of the left main is an effective and safe option for managing this complication (Fig. 1). If the stent fails, coronary bypass surgery is an option, but at present it carries an excessively high risk of operative mortality and morbidity in a patient previously deemed nonoperable or high risk.

The TAVI technique is complex and is associated with some major intraoperative complications, requiring both interventional and surgical knowledge and skills. Cardiologists bring their expertise in wiring and fluoroscopic imaging, while surgeons provide their knowledge of 3-dimensional anatomy of the heart and aorta and skills in open cardiovascular approaches. Coronary artery occlusion is one of these TAVI-related complications that requires cardiac surgeons to establish emergent cardiopulmonary bypass and interventional cardiologists to perform emergent LMCA or right coronary artery stent. In addition, cardiac anaesthesiologists, perfusionists, and operating room or catheter lab nurses are important to optimize procedures. A good team approach for TAVI leads to improved outcomes. In this issue of the Canadian Journal of Cardiology, Toeg et al. again demonstrated that an experienced TAVI team in a prepared environment could resolve an unstable, complicated, and stressful situation through on-site multidisciplinary expertise (cardiac surgeon, interventional cardiologist, anaesthetist, perfusionist, and operating room or catheterization laboratory nursing staff).

**Disclosures**

Jian Ye is a consultant to Edwards Lifesciences.
References


