Recurrent Ventricular Fibrillation After Aortic Valve Replacement
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Abstract
We report a patient who developed several episodes of sustained ventricular fibrillation after chest closure following stentless aortic valve replacement. Myocardial ischemia was suspected. Transesophageal echocardiography (TEE) was invaluable in confirming the diagnosis in the setting of acute ventricular fibrillation and new left bundle branch block. Ischemia may be due to coronary artery spasm, air or particulate embolus, and reperfusion injury. Iatrogenic injury to coronary arteries is a known complication of aortic valve surgery, and was the likely source of the ischemia and resultant arrhythmia. Treatment of recurrent ventricular fibrillation after aortic valve replacement was with coronary artery bypass grafting. Once the coronary artery flow was restored, there were no further arrhythmias, and outcome was good.

INTRODUCTION
Because of the high risk of sudden death and diminished life expectancy, it is recommended that symptomatic patients with severe aortic stenosis (AS) undergo aortic valve replacement (AVR). The risk of death or serious complications from AVR for AS is between 1-5%, depending on age of the patient, degree of left ventricular dysfunction or dilatation, and co morbidities. We report a patient who developed several episodes of sustained ventricular fibrillation (VF) after chest closure, just prior to transfer from the operating room. The etiology and management of sustained VF after AVR is discussed.

CASE REPORT
A 58 year old woman with known AS and worsening dyspnea on exertion was scheduled to undergo stentless AVR. Her preoperative transthoracic echocardiography demonstrated severe AS with a valve area of 0.8 cm², peak gradient 53 mmHg, mean gradient 34 mmHg, a mildly dilated aortic root, mild left ventricular (LV) hypertrophy with no wall motion abnormalities and a LV ejection fraction of 60%. Preoperative coronary artery catheterization showed no coronary artery disease. Her past medical history was significant for hypertension and hypothyroidism; the patient’s medications included amiloride, levothyroxine, metoprolol, sertraline and simvastatin.

Induction, line placement, and initiation of cardiopulmonary bypass were all uneventful. Following the valve replacement portion of the procedure, the surgeon noted a dense plaque surrounding the left coronary ostia and that it had partially separated from the intima; the intimal flap was tacked down to the sinus of Valsalva with sutures, and tied externally, allowing easy passage several times with a 3mm coronary probe. After the patient was rewarmed and the heart was defibrillated, CPB was discontinued and heparin was reversed. Vasopressin, 2u/hour was infused for low systemic vascular resistance. Transesophageal echocardiogram (TEE) showed normal LV and right ventricular function and a properly functioning bioprosthetic aortic valve without valvular or perivalvular leak. There was no evidence of dynamic LV outflow tract obstruction. There were no regional wall motion abnormalities. Blood gas showed pH 7.36, PCO2 41 mmHg, PO2 91 mmHg, bicarbonate 20.8 mmol/L, base excess -2.1 mmol/L. Electrolytes were within normal limits, and hemoglobin was 9.6 g/dL. After satisfactory hemostasis was achieved, the chest was closed and preparation was made for transfer to the intensive care unit (ICU). Vital signs were stable, with a mean arterial pressure between 70-80 mmHg. Cardiac index was 2.5 l/min/m².
While preparing to transfer to the ICU bed, VF occurred suddenly with loss of the arterial and pulmonary artery pressure waveforms. All anesthetics were discontinued. Ventilation was with 100% oxygen. External cardiac massage was started, and the patient was defibrillated within 2 minutes using external electrode patches. Blood pressure was restored. There was a new left bundle branch block. Lidocaine, 100 mg and magnesium, 2 Gm were given. The TEE probe was reinserted. New LV systolic wall motion abnormalities were now evident. There was hypokinesis of the basal and mid septal and anteroseptal walls; the posterior and lateral walls were hyperdynamic. There was no evidence of aortic dissection or prosthetic valve dysfunction. Amiodarone 150 mg, IV was given. VF occurred several times over the next 15 minutes and was successfully defibrillated. Epinephrine and amiodarone infusions were initiated.

Concern was raised of compromised left coronary blood flow. The patient was heparinized and CPB was initiated to allow bypass grafting of the left anterior descending and circumflex coronary arteries. TEE exam performed following coronary artery bypass grafting (CABG) demonstrated preserved LV and RV wall motion, no evidence of further stunning, and competent bioprosthetic aortic valve. The patient was transferred to the ICU on epinephrine, 0.025 mcg/kg/min, vasopressin, 2 u/hour, and amiodarone, 1 mg/min. She was weaned from vasopressors, and her trachea was extubated 8 hours postoperatively. Right lower lobe pulmonary infiltrate was noted on postoperative day number 3, and was treated with antibiotics, diuresis and pulmonary toilet. Otherwise, recovery was uneventful and no neurologic deficit was noted. The patient was discharged home on postoperative day 6.

**DISCUSSION**

The operative mortality for AVR varies with the patient’s age and co-morbidities. In the Society of Thoracic Surgeons National Database, which contains tens of thousands of patients, the operative mortality is approximately 4% for isolated AVR and 7% for AVR combined with CABG. Excessive postoperative bleeding may require re-exploration of the mediastinum in 2-5% of patients; perioperative myocardial infarction occurs in 1-2% of patients, particularly if coronary artery disease is present.

Iatrogenic coronary artery ostial obstruction after AVR is a rare but life-threatening complication. Stenosis of the left main trunk and ostium of the right coronary artery after AVR was first described by Roberts and Morrow in 1967. Most often its clinical onset occurs 1-12 months after the procedure, and is thought to be linked to trauma to the coronary endothelium related to cannulation of the ostia during direct administration of cardioplegia for myocardial protection. Rarely, this complication may be due to a variable degree of direct obstruction of the coronary ostia by the prosthetic annular ring or stent secondary to poor valve-to-annular size matching, or unfavorable anatomy with a low coronary ostial origin. It is also possible that a coronary ostial lesion was missed during angiography. An aortic sinus
injection should be performed to look for ostial stenosis if either no arterial pressure is recorded when the catheter is engaged, or there is no reflux of contrast into the aortic sinus.

Earlier presentation of myocardial ischemia and VF is due to macro-injury of the ostia, but micro-injuries, combined with a genetic predisposition to atherosclerosis can lead to intimal thickening and fibrous proliferation. Turbulent flow around the prosthetic valve contributes to this pathophysiology. The incidence of coronary artery ostial stenosis following AVR has been estimated at 0.2-5%. Coronary ostia obstruction after AVR is associated with a high mortality rate if left untreated. The usual treatment is CABG (Table 1), but cases treated by percutaneous coronary intervention, balloon angioplasty, and catheter ablation have also been reported. If significant stenosis occurs several months after surgery, the clinical picture includes severe angina, ventricular arrhythmias, or heart failure.

VF can occur at any time during and after AVR. For this reason, the anesthesia and surgical team must remain vigilant and prepared to intervene, especially during periods of transfer from the operating room to the ICU. Monitoring may be an issue since transport monitoring systems do not have the same resolution or number of channels standard operating room monitors. The ability to rapidly perform diagnostic studies such as blood gases and TEE is obviously important. Aseptic conditions in the surgical suite must be maintained should the patient require another procedure such as CABG to treat the recurrent VF. At our institution, sterility is maintained until the patient has safely been transported to the ICU.

Other etiologies of recurrent VF must be sought and aggressively treated such as electrolyte abnormality, acidosis, hypoxia, and hypercarbia. Life threatening arrhythmias can also result should the pulmonary artery catheter be accidentally withdrawn into the right ventricle during transfer. (Table 2).

Table 2. Causes of Arrhythmias after AVR

<table>
<thead>
<tr>
<th>Myocardial Ischemia</th>
<th>Electrolyte abnormality</th>
<th>Acidosis</th>
<th>Hypoxia</th>
<th>Hypercarbia</th>
<th>Displacement of the pulmonary artery catheter</th>
</tr>
</thead>
</table>

Myocardial ischemia was suspected in our patient as there was no evidence of electrolyte abnormalities, difficulties with ventilation, or surgical bleeding. The pulmonary artery catheter position had not changed. TEE was invaluable in confirming new wall motion abnormalities in the setting of acute VF and new LBBB. Ischemia may be due to coronary artery spasm, air or particulate embolus, and reperfusion injury. For this case, iatrogenic injury to the coronary artery was felt to be the most likely source of coronary artery insufficiency, since the patient had normal coronaries at cardiac catheterization. Direct coronary injury (e.g., from pledgeted sutures) is a known complication of aortic valve surgery, and was the likely source of the ischemia and resultant arrhythmia (Table 3).

Table 3. Causes of myocardial ischemia after AVR in the immediate postoperative period

<table>
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<tr>
<th>Coronary artery spasm</th>
<th>Air embolus</th>
<th>Particulate embolus</th>
<th>Reperfusion injury</th>
<th>Direct coronary artery injury from suture or pledgets</th>
<th>Ostial obstruction from valve position or alignment</th>
<th>Proximal aortic dissection</th>
<th>Ostial rupture secondary to cannulation</th>
</tr>
</thead>
</table>

Treatment of recurrent VF after AVR was directed at the cause - CABG. Once the coronary artery flow was restored, there were no further arrhythmias, and outcome was good.

References
3. Cook DJ, Housmans PR, Rehfeldt KH. Valvular heart
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