Techniques

Modified Danielson Technique for Prosthetic Aortic Valve Endocarditis

and Aortoventricular Discontinuity

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Endocarditis is a devastating complication of prosthetic aortic valve replacement. The infective process can destroy aortic annulus tissue, making conventional surgical valve replacement difficult or impossible and causing aortoventricular discontinuity. Several treatment techniques have been proposed. One of these, the Danielson technique, involves translocating the aortic valve to the native ascending aorta, débriding the abscess cavity, closing the coronary ostia, and bypassing the coronary arteries with a Y anastomosis between 2 vein grafts. We describe our use of a modified Danielson technique in a 68-year-old man with advanced prosthetic valve endocarditis that was associated with aortic annulus destruction and aortoventricular discontinuity. This modified technique enables safer, more secure anchoring of a replacement valve, reduces the risks and concerns associated with bypass grafts, and successfully treats aortoventricular discontinuity.
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Endocarditis is a severe complication of prosthetic heart valve replacement that can be fatal if not promptly diagnosed and treated.[1] The infective process can destroy large areas of aortic annulus tissue, which reduces the amount of healthy tissue available for conventional sutured valve replacement and causes aortoventricular discontinuity. In 1974, Danielson and colleagues[2] introduced a surgical technique for treating this condition that involved translocating the aortic valve to the native ascending aorta, débriding the abscess cavity, closing the coronary ostia, and bypassing the coronary arteries with a Y anastomosis between 2 vein grafts. However, this technique leaves the patient dependent on a single source of coronary flow, the failure of which would put the patient at risk. Moreover, if the procedure has to be repeated, pericardial adhesions must be dissected from the entire left side of the heart before bypass grafting can be done.[2] These limitations can be overcome by modifying Danielson's technique, as we describe in the case of a 68-year-old man with advanced prosthetic valve endocarditis that was associated with aortic annulus destruction and aortoventricular discontinuity.

Case Report

A 68-year-old man was referred to our institution with fever (temperature, 37.5 °C) despite 2 months of antibiotic therapy, dyspnea at rest (New York Heart Association [NYHA] class III/IV), dizziness, syncope, and transient ischemic attack. The patient's antibiotic therapy for fever had consisted initially of amoxicillin alone and then in combination with vancomycin and gentamycin. Four years previously, the patient's aortic valve had been replaced with a 23-mm bileaflet mechanical prosthetic valve to treat severe bicuspid aortic valve stenosis.

At the current presentation, 2-dimensional transthoracic and transesophageal echocardiograms revealed a left ventricular ejection fraction (LVEF) of 0.40, a pulmonary artery systolic pressure (PASP) of 55 mmHg, and a perivalvular leak causing severe intraprosthetic aortic regurgitation with a mean pressure gradient of 30 mmHg (maximum, 50 mmHg) and a flow velocity of 3.5 m/s (Fig. 1). A suspected vegetation (2 × 1.5 cm) seemed to be the cause of regurgitation, and a periannular abscess was blocking the left leaflet of the prosthetic valve from tilting. The infective process did not appear to involve the native mitral valve. The aortic root was 42 mm in diameter; the ascending aorta was dilated to 47 mm in diameter. A computed tomogram confirmed the

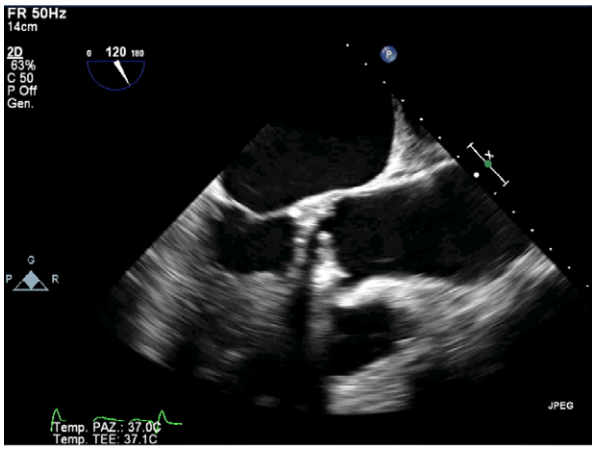

Fig. 1 *Preoperative 2-dimensional transesophageal echocardiogram (midesophageal 3-chamber view) shows a perivalvular leak causing severe intraprosthetic aortic regurgitation.*

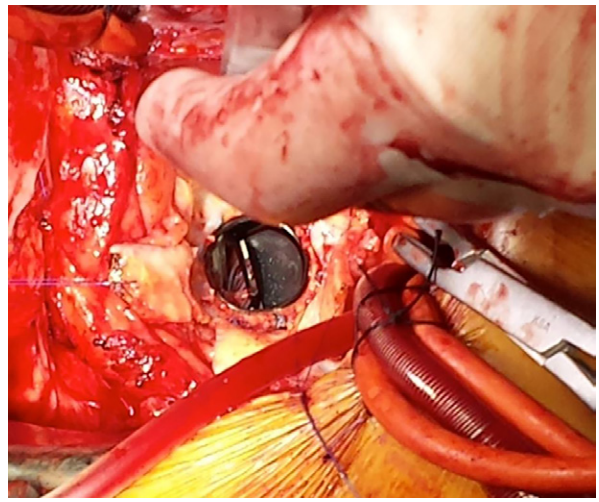

Fig. 2 *Intraoperative photograph shows the prosthetic aortic valve with half of its circumference dehiscent and vegetation blocking the tilting movement of the left leaflet.*

echocardiographic findings and showed no evidence of ischemia secondary to embolization. Blood culture results were negative for infection. Because of the patient's persistent fever, evidence of vegetation with periannular abscess, and prosthetic valve dysfunction, he was scheduled for emergency surgery.

Technique

The sternum was reopened. Pericardial adhesions on the left ventricle were dissected only to the extent needed to perform the planned repair. The left ventricle was vented through the right superior pulmonary vein. Cardiopulmonary bypass (CPB) was initiated after bicaval cannulation. The aorta was cross-clamped, and the previous aortotomy site was reopened. Cardiac arrest was achieved by selective antegrade administration of cold blood cardioplegia through self-inflatable cannulae in the coronary ostia. The cannulae enabled administration of cardioplegia independently of other surgical maneuvers. On inspection, half of the valve's circumference was dehiscent and involved the commissure between the left and right coronary sinuses. The tilting movement of the valve's left leaflet was blocked by a vegetation (2 × 1.5 cm) (Fig. 2), confirming the cause of the regurgitation we had seen on the preoperative transesophageal echocardiogram. The aortic annulus had been destroyed by the infective process, resulting in discontinuity between the left ventricular outflow tract (LVOT) and aorta.

The dilated ascending aorta was resected, and the prosthetic valve was removed. Infected and necrotic tissue were débrided from the annulus and aortic root. The native coronary ostia were detached, as buttons, from the aortic wall. A 26-mm Dacron graft sized to the LVOT was folded inward, as for the elephant trunk technique (Fig. 3A). It was then positioned in the LVOT below the aortic annulus, and attached to the interventricular septum and intervalvular fibrous body and to the mitral valve annulus with 4 semicontinuous 3-0 Prolene sutures reinforced with Teflon felt (Fig. 3B). The folded section of the graft was then withdrawn and everted to create a rim onto which a 23-mm bioprosthetic aortic valve (Carpentier-Edwards Perimount Magna Ease; Edwards Lifesciences) was sewn with 3 semicontinuous 2-0 Prolene sutures (Fig. 3C). The graft was then straightened and trimmed, and a distal graft-to-graft anastomosis with the aortic remnant was created. Finally, the left coronary artery ostium was reimplanted into the graft above the prosthetic valve through an interposed 10-mm segment of Dacron graft; and the right coronary artery ostium, through an interposed short segment of autologous saphenous vein (Fig. 3D).

The aortic cross-clamp time was 158 minutes, and the CPB time was 258 minutes. Hemostasis was achieved more easily than expected because of the limited dissection of pericardial adhesions. However, because the procedure had lasted so long, the chest was packed and the sternum left open for 24 hours. The graft-to-graft anastomosis was sealed with biological glue. Six units of packed red blood cells and 4 units of fresh frozen plasma were transfused.

The patient's postoperative course was uneventful. A transesophageal echocardiogram obtained immediately postoperatively revealed an LVEF of 0.55, a reduced PASP of 35 mmHg, a mean pressure gradient of 4 mmHg across the composite graft, no LVOT obstruction, and trivial mitral regurgitation (Fig. 4). Findings from intraoperative microbiological culture analysis and pathologic examination of the excised infected prosthesis and tissue revealed that the patient's endocarditis was caused by a *Staphylococcus epidermidis* organism susceptible to linezolid. The patient was started on a 2-month regimen of linezolid (600 mg intravenously

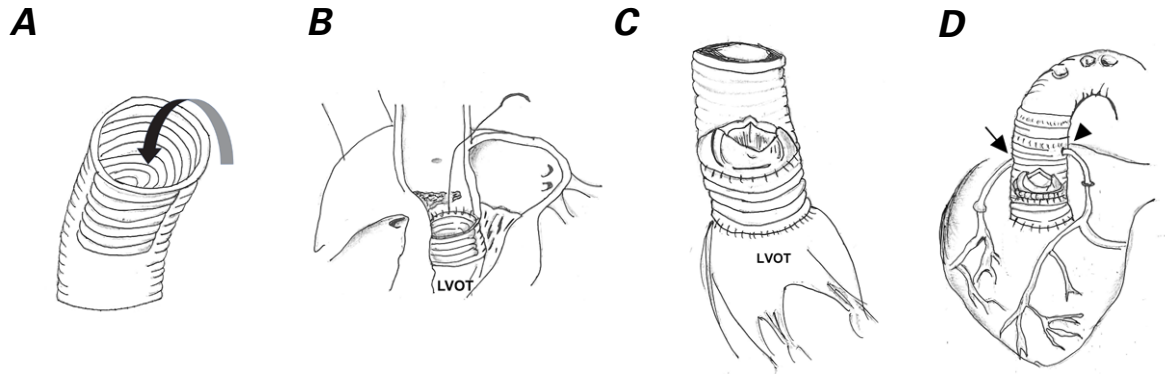

Fig. 3 *Surgical technique.* ***A****) A 26-mm Dacron graft was folded inward (curved arrow), as for the elephant trunk technique.* ***B****) The folded end of the graft was sutured below the annulus into the left ventricular outflow tract (LVOT), then withdrawn and everted.* ***C****) A 23-mm bioprosthetic aortic valve was sutured to the everted graft, which was then straightened and trimmed.* ***D****) A distal graft-to-graft anastomosis was created, after which the left coronary artery ostium was reimplanted into the graft above the valve through an interposed Dacron graft segment (arrowhead), and the right coronary artery ostium, through an interposed vein graft segment (arrow).*

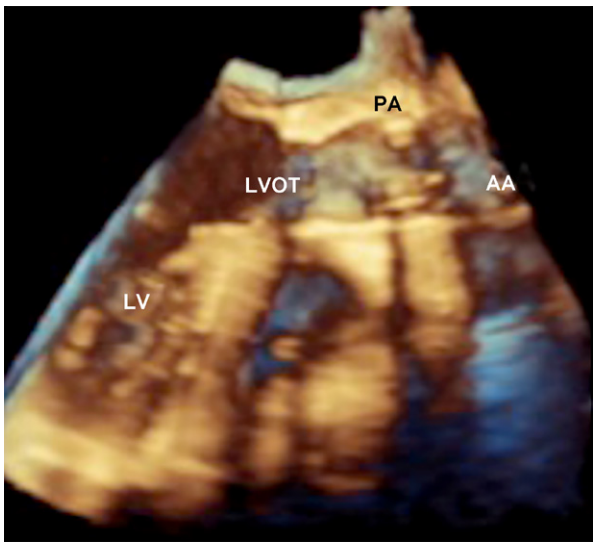

Fig. 4 *Postoperative 3-dimensional transesophageal echocardiogram (midesophageal 3-chamber view) shows the composite graft in place with no obstruction of the left ventricular outflow tract (LVOT).*

AA = ascending aorta; LV = left ventricle; PA = pulmonary artery

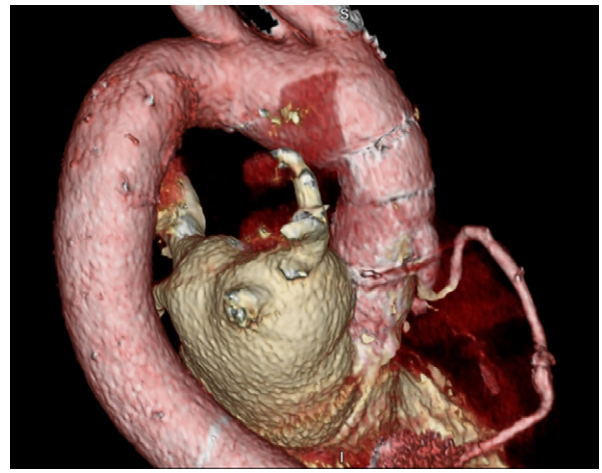

Fig. 5 *Three-dimensional computed tomographic angiogram obtained 4 months after discharge shows the 26-mm Dacron graft sutured to the left ventricular outflow tract and into which the 23-mm bioprosthetic aortic valve was translocated above the annulus; the reimplanted coronary arteries; and the distal graft-to-graft anastomosis.*

twice daily for one month, then 600 mg orally once daily, according to renal function, for one month) in combination with sulfamethoxazole-trimethoprim (1,000 mg orally twice daily). After completing the regimen, the patient was discharged home. Four months later, a computed tomographic angiogram showed patent reimplanted coronary buttons and no leakage at the distal graft-to-graft anastomosis site (Fig. 5). One year after discharge, the patient was in NYHA class I and showed no signs or symptoms of reinfection.

Discussion

Infective endocarditis is a potentially catastrophic complication of prosthetic aortic valve replacement. Operative mortality rates for affected patients range from 7.3% to 33%; those for patients with recurrent endocarditis range even higher, up to 60%.[1-3] Minimizing the risk of recurrent endocarditis requires a radical approach, but extensive débridement inevitably reduces the amount of healthy tissue available for conventional reconstruction and repair.[4,5]

Several techniques have been proposed to manage this complication. Aortic homograft repair is often the first choice, although it is associated with high early calcification rates and low homograft availability.[6] Pericardial patch repair, developed by the University of Toronto group,[6-8] can effectively treat destructive endocarditis. In the case of native valve endocarditis affecting the aortomitral curtain, the "commando" operation may be necessary. This technique involves using a patch to restore mitroaortic continuity and enable the placement

of 2 prostheses (one mitral and one atrial).[7,8] It differs from the Danielson technique in how the mitral valve is exposed and managed. In the commando operation, the surgical incision is extended from the ascending aorta into the left atrial roof to expose the aortic and mitral valves for replacement. In our modified Danielson technique, the uninfected mitral valve was left in situ and used to secure part of the Dacron graft in the LVOT.

Despite the disappointing short- and long-term results in the initial experience with the original Danielson technique,[2] results improved as experience with the technique grew. In one series of 21 patients,[9] the mortality rate was 14%. In another series of 12 patients,[10] there were no in-hospital deaths, and the actuarial 5-year survival rate was 75%. Finally, the Danielson technique has proved successful in LVOT reconstruction.[10-13]

Our modified Danielson technique differs from the original in several ways. It does not involve use of a Y anastomosis graft because it can place patients at risk for occlusive vein-graft disease, especially the younger ones.[14] It does not involve dissecting the pericardium away from the entire heart to create the distal coronary anastomoses.[7] It avoids having to reimplant the coronary ostia directly into the graft, a procedure that can be extremely demanding—if not dangerous—in patients whose coronary buttons are insufficiently mobile. Our technique for reattaching the coronary ostia to the graft avoids use of the Cabrol technique and the resulting "moustache,"[15] which may eventually kink. Instead, each coronary button is connected to an interposed vein or graft segment.[16] This creates a tension-free anastomosis and enables infusion of blood cardioplegia inside the graft to control the quality of the anastomosis with the coronary ostium. Using a folded graft creates 2 layers, which enables sutures to be firmly anchored. Finally, replacing the aortic root avoids the aneurysmal aortic dilatation that can occur after the classic Danielson technique.[2]

In conclusion, our modification of the Danielson technique for aortic valve translocation in a patient with infective prosthetic valve endocarditis enabled safer, more secure anchoring of a replacement bioprosthetic valve to healthy tissue, reduced the risks and concerns associated with bypass grafts, and successfully treated aortoventricular discontinuity.

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