Case Reports

Late Postoperative Prosthetic Pulmonary Valve Endocarditis

in a 13-Year-Old Girl with Repaired Tetralogy of Fallot

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Prosthetic pulmonary valve endocarditis has infrequently been described outside large cohort reviews, which have typically focused on infections of the left-sided heart valves. Hence, the pathogenesis, clinical presentation, and management principles of prosthetic pulmonary valve endocarditis have not been well differentiated from those of infected aortic and mitral valves. More patients with repaired tetralogy of Fallot are reaching adulthood and will need pulmonary valve implantation. Consequently, a focus on this infrequent but serious cardiac infection is needed, to learn what characteristics might distinguish it from infections of left-sided heart valves.

We report the case of a 13-year-old girl with repaired tetralogy of Fallot who presented with fever and nonspecific symptoms. The patient initially failed to meet the Duke criteria for endocarditis but was then found to have endocarditis of her prosthetic pulmonary valve. We explanted the valve and replaced it with a pulmonary homograft, after which the patient had no infectious sequelae. In addition to presenting the patient's case, we review the literature on surgically inserted prosthetic pulmonary valves and discuss the primary management concerns when those valves become infected with endocarditis.
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Key words: *Device removal; endocarditis, bacterial/diagnosis/etiology; heart defects, congenital/complications; heart valve prosthesis/adverse effects; prosthesis-related infections/diagnosis; pulmonary valve/surgery; reoperation; staphylococcal infections/diagnosis/surgery; time factors; treatment outcome*

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Most reported cases of prosthetic valve endocarditis are about adults with prosthetic aortic or mitral valve infections; reports of prosthetic pulmonary valve (PV) endocarditis are few. We present a case of late endocarditis of a surgically implanted prosthetic PV in a teenager who had undergone earlier repair of tetralogy of Fallot. In addition, we review the relevant medical literature and discuss the management of endocarditis occurring in surgically inserted prosthetic PVs.

Case Report

In October 2012, a 13-year-old girl presented at our institution with abdominal pain, malaise, myalgia, a rash, and a fever of 39.7 °C. At 3 months of age, she had undergone valve-sparing tetralogy of Fallot repair. At 12 years of age, because of increasing pulmonary insufficiency and right ventricular dilation and dysfunction, she had undergone the implantation of a 25-mm Mosaic® porcine tissue valve (Medtronic, Inc.; Minneapolis, Minn) in the pulmonic position. She had then thrived for more than a year, until the current presentation. Our initial findings included hypotension, a poor response to volume and inotropic support, a white blood cell count of $8.1 \times 10^3/\mu L$ with 85% neutrophils, a C-reactive protein level of 26 mg/dL, and no lactic acidosis.

The next day, the patient developed leukocytosis and thrombocytopenia, and a urine culture grew methicillin-sensitive *Staphylococcus aureus*. A single blood culture grew the same pathogen. A transthoracic echocardiogram showed qualitatively normal biventricular function, trivial PV regurgitation, and mild PV stenosis. A chest radiograph showed mild bilateral lower-lobe interstitial infiltrates.

The presumed toxic shock syndrome was treated with intravenous antibiotics (vancomycin, ceftriaxone, and clindamycin) and immunoglobulin. Despite multiple negative blood and urine cultures, the patient's fever persisted. A transesophageal echocardiogram (TEE) one week later revealed vegetation that involved all 3 leaflets of the prosthetic valve (Fig. 1); an undulating portion extended into the right ventricle and diminished that chamber's function. A computed tomogram of the chest confirmed the echocardiographic findings and revealed extensive bilateral septic pulmonary

emboli that the chest radiograph had not shown. The results of abdominal and pelvic computed tomography were normal.

We surgically removed the patient's prosthetic PV. The valve leaflets had multiple vegetations (Fig. 2), and the integrity of the valve was lost. Direct inspection of the right atrium and ventricle and videoscopic inspection of the branch pulmonary arteries yielded no other infectious foci. A 24-mm pulmonary homograft was implanted in the pulmonic position. Intraoperative TEE revealed a competent valve and good biventricular function.

Pathologic analysis of the vegetation and valve revealed a fibrinopurulent exudate and necrotic valve tissue consistent with endocarditis. Gram stains showed numerous gram-positive cocci but no growth in culture. The patient was discharged from the hospital 4 weeks postoperatively and had no infectious sequelae at her most recent follow-up examination (February 2015).

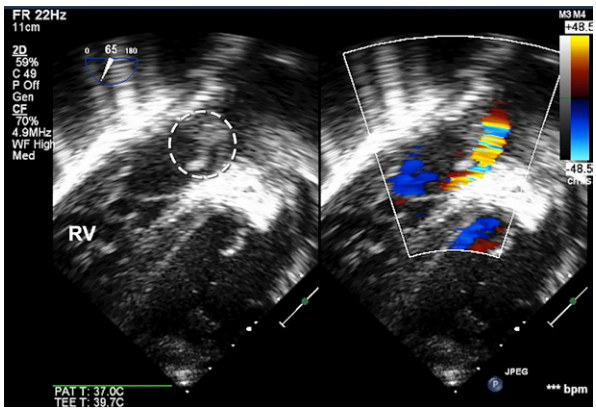

Fig. 1 *Two-dimensional transesophageal echocardiogram (transgastric view toward the right ventricular outflow tract) shows vegetation (encircled) on the prosthetic pulmonary valve, as does color-flow Doppler mode at right.*

RV = right ventricle

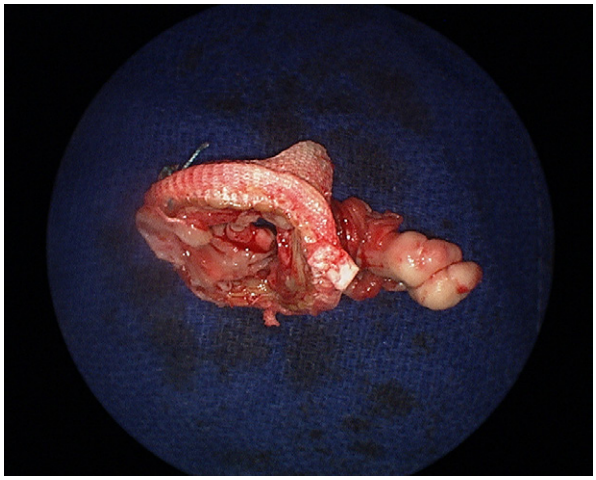

Fig. 2 *Photograph shows the explanted bioprosthetic pulmonary valve with adherent vegetation.*

Discussion

We searched the medical literature and identified only 50 previous instances of endocarditis of a surgically implanted prosthetic PV, all reported since 1986 (Table I).[1-10] We found one multicenter review,[3] some single-center reviews,[1,2,4,7-9] and 3 case reports.[5,6,10] Infections of percutaneously placed PVs are of recent interest[11-18] but are beyond the scope of this report.

Specific information is sparse in regard to the prevalence and characteristics of endocarditis of surgically placed prosthetic PVs. In a multicenter review, Wang and colleagues[3] identified 556 cases of prosthetic valve endocarditis. Of these, 31 (6%) were PV endocarditis. The most prevalent pathogens in the entire cohort were *S. aureus* (23% of cases) and coagulase-negative staphylococcus (17%). The total in-hospital mortality rate was 23%, and 49% of all patients underwent surgery.

The above review[3] did not stratify data by valve position, so it is uncertain how the clinical characteristics and presentation, pathogen identification, and patient outcomes differed for each position. The other reports of prosthetic PV endocarditis[1,2,4-10] contain similarly scant information. Consequently, the existing data might not enable a complete comparison of the characteristics and management of left-sided prosthetic valve endocarditis with those of prosthetic PV endocarditis. The primary concerns are to identify the risk factors, make the diagnosis, and determine the need for surgical intervention.

Widely cited risk factors for endocarditis include recent dental procedures, cardiac surgery, intravenous drug use, the use of intravenous catheters, and skin trauma or infection. Our patient's prior cardiac surgery was her sole risk factor. We suspected a genitourinary origin of the infection, given that urine and blood cultures grew the same pathogen.

The clinical diagnosis of prosthetic valve endocarditis is guided by the modified Duke criteria.[19] Our patient fulfilled one major criterion (endocardial involvement) and 4 minor criteria (predisposition, fever, vascular phenomena, and microbiological evidence). However, the initial lack of apparent vascular phenomena and the absence of echocardiographic evidence of myocardial involvement precluded early diagnosis.

This delay in diagnosis underscores the importance of maintaining strong suspicion of endocarditis in a patient who has a prosthetic valve but who initially fails to meet the Duke criteria. Blood cultures and TEE are more often negative for endocarditis in prosthetic valves than in native valves.[20] If blood cultures are negative and the initial echocardiogram shows normal results, additional imaging should be performed. We think that the early use of TEE is essential when suspicion persists.

TABLE I. Reports Identifying Prosthetic Pulmonary Valve Endocarditis

Reference	Article Type (study period)	Relevance	Prosthetic PVE Instances Cited (n)	Infectious Organism
Ilbawi MN, et al.[1] (1986)	Single-center review (20 yr)	49 pts who underwent porcine valve insertion	1	Not specified
Alexiou C, et al.[2] (2000)	Single-center review (23 yr)	118 pts with native or prosthetic valve endocarditis	2	Not specified
Wang A, et al.[3] (2007)	Multicenter, observational prospective study (5 yr)	556 cases of prosthetic valve endocarditis	31	Not specified
Hill EE, et al.[4] (2008)	Single-center review (6 yr)	80 pts with prosthetic valve endocarditis	1	Not specified
Fiore AC, et al.[5] (2008)	Case series (11 yr)	82 pts who received a bioprosthetic valve or homograft in pulmonic position	2	1 "staphylococcal" and 1 unidentified
Irving CA, et al.[6] (2010)	Case report	Bioprosthetic PVR responded to antibiotics without surgery	1	MRSA
Lee C, et al.[7] (2011)	Single-center review (11 yr)	181 pts who underwent bioprosthetic PVR	7	Not specified
Vohra HA, et al.[8] (2012)	Single-center review (11 yr)	37 pts who underwent bioprosthetic PVR	1	Not specified
Johnson JA, et al.[9] (2012)	Single-center review (60 yr)	97 pts with native or prosthetic valve endocarditis	3	Not specified
Jung J, et al.[10] (2013)	Case report	Describes construction of valved graft with use of a tissue valve and an artificial graft	1	MSSA
Current case	Case report	Porcine bioprosthesis surgically replaced with pulmonary homograft	1	MSSA, then gram-positive cocci

MRSA = methicillin-resistant *Staphylococcus aureus*; MSSA = methicillin-sensitive *Staphylococcus aureus*; pts = patients; PVE = pulmonary valve endocarditis; PVR = pulmonary valve replacement

If TEE is nondiagnostic, other methods are computed tomography, magnetic resonance imaging, and intracardiac echocardiography.

The decision to proceed with medical management is dictated by the causative organism. *Staphylococcus aureus* is identified most frequently in prosthetic valve endocarditis,[21] and it is also the most virulent: mortality rates as high as 75% have been reported.[22] The American Heart Association and the European Society for Cardiology currently recommend an extended course of triple antibiotic therapy, including rifampin, for *S. aureus* prosthetic valve endocarditis.[20,21]

In our patient, only the first of many blood cultures was positive. Stains revealed numerous gram-positive cocci; however, a culture of the vegetation exhibited no growth. We suspect that the freely circulating planktonic state of *S. aureus* cleared quickly during the antibiotic therapy, but that the pathogen persisted on the valve in a biofilm state. Bacteria in the adherent biofilm state express different genes from those of the planktonic state, and this difference in biological state perhaps makes biofilm bacteria particularly resistant to antibiotics and laboratory culture techniques.[23]

Prosthetic valve endocarditis has been successfully treated with antibiotics alone.[6,24] However, the addition of surgical treatment is thought to improve outcomes, particularly when endocarditis is associated with *S. aureus*, congestive heart failure, prosthetic dehiscence, valve dysfunction, intracardiac abscess formation, or persistent bacteremia.[25,26] Our patient's incomplete response to intravenous antibiotics, along with the follow-up echocardiogram that confirmed the endocarditis and showed pulmonary emboli, prompted our explantation of the infected valve.

Prosthetic PV endocarditis will most likely be reported more often as more patients with repaired tetralogy of Fallot need prosthetic PV implantation. To better distinguish the pathogenesis, clinical presentation, and best management principles of prosthetic PV endocarditis from those of left-sided prosthetic valve endocarditis, continued specific reporting and analysis are needed.

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