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Surgical strategy to prevent moderate patient–prosthesis mismatch in infective endocarditis complicated by a narrow aortic root: a case report

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ABSTRACT

A 65-year-old male presented with fever, progressive dyspnea, bilateral lower-extremity edema, and new-onset angina. Transesophageal echocardiography and coronary computed tomography angiography revealed severe aortic and tricuspid regurgitation with large vegetations, moderate mitral regurgitation, a narrow aortic root, and critical stenoses of the left main and right coronary arteries. Blood cultures grew vancomycin-sensitive *Enterococcus faecalis*. The patient underwent urgent aortic and tricuspid valve replacement, mitral valve repair, and triple-vessel coronary artery bypass grafting. Because of the narrow aortic root, the Nicks procedure was performed to provide adequate prosthetic valve area and to prevent patient–prosthesis mismatch (PPM). This rare adult case emphasizes the importance of preoperative indexed effective orifice area (iEOA) calculations and highlights the role of Nicks, Manouguian, and Yang enlargement techniques in preventing PPM and managing complex left ventricular outflow tract pathology.

Keywords: Infective endocarditis, aortic root enlargement, patient–prosthesis mismatch, indexed effective orifice area, Nicks procedure

INTRODUCTION

Despite advancements in antimicrobial therapy, *Enterococcus faecalis* infective endocarditis remains a significant clinical challenge, with mortality rates between 20% and 40%, and surgical intervention required in approximately 40% of cases, distinguishing it from other endocarditis etiologies.[1] Surgical indications in infective endocarditis include severe valvular stenosis or regurgitation unresponsive to medical therapy, uncontrolled intracardiac abscess, pseudoaneurysm, fistula, rapidly enlarging vegetation, vegetation exceeding 10 mm with recurrent embolism, vegetation larger than 15 mm irrespective of embolic events, refractory pulmonary edema, or cardiogenic shock.[1] In prosthetic valve infective endocarditis, indications differ slightly, encompassing recurrent blood transfusions due to hemolysis from paravalvular leak (PVL), new or worsening New York Heart Association (NYHA) class III-IV heart failure symptoms, endocarditis-related PVL, elevated pulmonary artery pressures with left atrial dilation, and scenarios where medical management proves inadequate; rocking motion exceeding 15 degrees, indicative of annular dehiscence, necessitates urgent surgery to prevent hemodynamic collapse.[2] In patients with a small aortic annulus, the clinical benefits of aortic valve replacement depend on the prevention of PPM. This technique is useful for enabling the implantation of larger prosthetic valves to avoid such mismatch.[3] This report presents a rare adult case of infective endocarditis complicated by a narrow aortic root requiring complex multivalve intervention in which the Nicks procedure was performed to prevent PPM.

CASE

A 65-year-old male (172 cm, 75 kg) presented with fever, fatigue, bilateral leg edema, and exertional dyspnea (NYHA II–III). His past medical history included chronic obstructive pulmonary disease, hypertension, and atrial fibrillation. Laboratory evaluation confirmed elevated inflammatory markers, and blood cultures yielded vancomycin-sensitive *Enterococcus faecalis*. Transesophageal echocardiography showed an ejection fraction of 40-45%, a narrow aortic root, a 5x8 mm mobile vegetation on the aortic valve, a 19x10 mm vegetation on the tricuspid valve, and mild mitral valve destruction (**Figure 1A**). Coronary computed tomography (CT) angiography was performed due to acute chest pain and rising troponin levels. Critical stenoses were identified in both the left main coronary artery and proximal right coronary artery (**Figure 1B, C**). Given the severity of valvular destruction, large vegetations, multivessel coronary disease, and the patient's clinical deterioration, urgent surgery was scheduled.

Surgical Procedure

Following median sternotomy, arterial cannulation was achieved via the aorta, with venous cannulation through the superior and inferior vena cavae. Cardiopulmonary bypass (CPB) was initiated. After aortic cross-clamping, antegrade Del Nido cardioplegia induced cardiac arrest. To minimize embolization risk from vegetation, superior and inferior vena cava snares were tightened post-cross-clamping, and a vent cannula was placed in the right superior pulmonary vein;

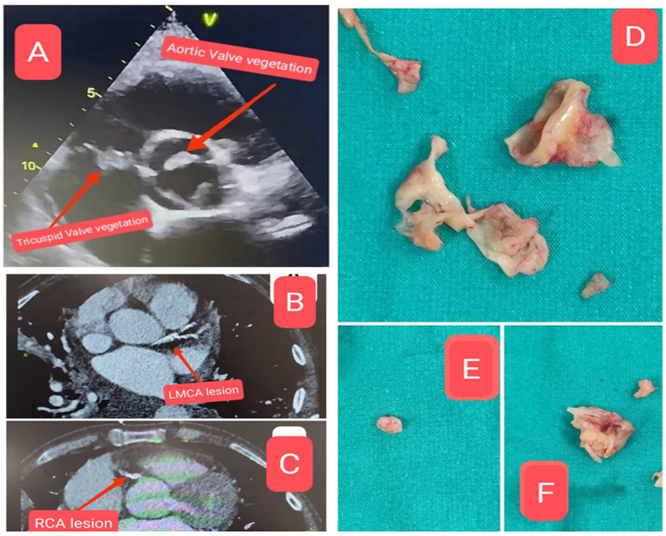

Figure 1. Preoperative echocardiographic and coronary computed tomography angiographic findings, and intraoperative images of the resected aortic, mitral, and tricuspid valves with vegetations.
A) Echocardiographic images demonstrating vegetations on the aortic and tricuspid valves.
B) Coronary computed tomography angiographic view showing an atherosclerotic lesion causing stenosis in the left main coronary artery.
C) Coronary computed tomography angiographic view showing an atherosclerotic lesion causing stenosis in the right coronary artery.
D) Intraoperative image of the resected aortic valve and vegetations.
E) Image of the resected mitral valve and associated vegetation.
F) Image of the resected tricuspid valve and vegetations.

cardiac manipulation was avoided prior to clamping. Distal anastomoses for left anterior descending (LAD), circumflex (CX), and right coronary artery (RCA) were completed using saphenous vein grafts. The mitral valve was accessed via a transseptal approach, with destruction at the anterolateral commissure repaired using pledgeted sutures. The tricuspid valve and its vegetation were excised, followed by biological valve replacement (Epic, No. 33, USA). The aortic valve and vegetation were then excised, with biological valve replacement (Epic, No. 23, USA) (**Figure 1D, F**).

Because intraoperative sizing revealed a 21-mm aortic annulus—insufficient to accommodate the required prosthesis without generating PPM—the Nicks procedure was performed. The aortotomy was extended through the midpoint of the non-coronary sinus into the aortomitral curtain. A bovine pericardial patch was used to enlarge the root, enabling safe implantation of the larger prosthetic valve. Proximal coronary anastomoses were completed, the cross-clamp was removed, and the patient was weaned off CPB uneventfully. Postoperative recovery was stable. After completing a six-week parenteral antibiotic course, the patient was discharged without complications.

DISCUSSION

In cases involving intracardiac space-occupying lesions—such as tumors, abscesses, hematomas, or vegetations resulting from infective endocarditis—we employ a 'no-touch' surgical strategy prior to aortic cross-clamping to minimize the risk of intraoperative embolization.[4] In patients at risk for PPM, posterior aortic root enlargement can be achieved using the Nicks, Manouguian, or Yang procedures, whereas a more extensive enlargement—albeit with increased operative risk—can be accomplished through the anterior enlargement technique known as the Konno–Rastan procedure (**Figure 2A**). The Nicks procedure involves an incision from the midpoint of the non-coronary sinus through the aortic annulus into the aortomitral fibrous curtain, typically without extending to the mitral anterior leaflet, followed by patch repair using pericardium or Dacron to enlarge the annulus, allowing implantation of a one-size larger prosthetic valve (**Figure 2B**).[5] In this case, the procedure facilitated larger valve replacement, prevented PPM, and created space for future transcatheter aortic valve implantation (valve-in-valve) procedures.[5] The Manouguian technique involves extending the incision from the commissure between the noncoronary and left coronary cusps toward the anterior leaflet of the mitral valve. In addition, the technique requires opening the roof of the left atrium. Although it provides greater enlargement of the aortic root, this procedure carries a risk of inducing mitral regurgitation. This procedure typically permits implantation of a prosthetic valve that is two to three sizes larger. In the Yang procedure, the incision begins at the commissure between the noncoronary and left coronary cusps and is extended toward the aortomitral curtain in an inverted 'Y' configuration. The resulting defect is repaired using a rectangular patch. This technique does not cause mitral regurgitation and allows implantation of larger prosthetic valves compared with the Manouguian technique; however, because it does not enlarge the basal ring of the aortic root, it is not preferred in cases of subvalvular stenosis. Although the Yang procedure facilitates the implantation of larger prostheses, it may make closure of the aortotomy more challenging. Furthermore, reconstruction of the aortic annulus with a rectangular patch may rotate or distort the left coronary ostium, thereby increasing the risk of coronary obstruction. Finally, deformation of the prosthetic valve during implantation may predispose it to structural deterioration and result in turbulent periprosthetic flow. This procedure generally allows implantation of a prosthetic valve that is three to five sizes larger.[5] Hemodynamic turbulence generated by a deformed prosthetic aortic valve may, over time, contribute to the formation of an acquired discrete subaortic membrane.[6] The Konno–Rastan procedure (anterior aortoventriculoplasty) can achieve a 40-50% enlargement of the aortic root. This procedure is an effective method for relieving subvalvular, valvular, or supravalvular left ventricular outflow tract obstruction. However, due to the complexity of the surrounding anatomical structures, the technique is technically demanding. Reported complications include septal artery injury, iatrogenic damage to the pulmonary valve, prosthetic valve dysfunction, infective endocarditis, complete atrioventricular block requiring permanent pacemaker implantation, RCA injury, and prolonged CPB times.

According to literature, iEOA is defined as the ratio of effective orifice area (EOA) to body surface area (BSA). Guidelines recommend a target iEOA greater than 0.85 cm^2/m^2 to avoid PPM, with moderate PPM occurring at 0.65–0.85 cm^2/m^2 and severe PPM at ≤0.65 cm^2/m^2.[7] To prevent PPM:

- Calculate target EOA by multiplying target iEOA (0.85 cm^2/m^2) by BSA;
- Select prosthesis from published model-specific EOA tables;

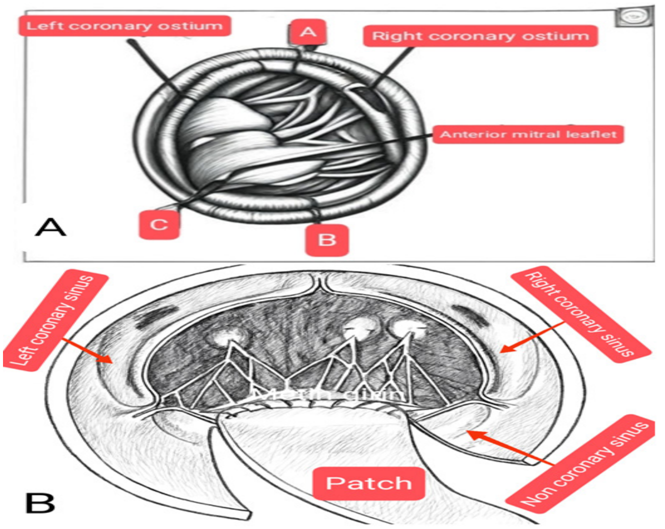

Figure 2. Surgical anatomy of the aortic root after leaflet excision and schematic illustration of the patch placement technique used in the Nicks procedure.
2A. Point A: In the Konno–Rastan procedure, the incision extends through the right coronary cusp, across the aortic annulus, and into the interventricular septum.
Point B: In the Nicks procedure, the incision is made through the midpoint of the non-coronary cusp and extended toward the aortomitral fibrosa.
Point C: When the incision is extended from the commissure between the non-coronary and left coronary cusps toward the anterior mitral leaflet, it represents the Manouguian technique; If the incision is extended in an inverted Y configuration that undermines both cusps, it corresponds to the starting point of the Yang procedure.
2B. Schematic illustration of patch placement along the incision performed through the midpoint of the non-coronary cusp during the Nicks procedure.

- Compare prosthesis EOA to target—if prosthesis EOA ≥ target, proceed; if < target, opt for larger valve or root enlargement;
- Compare intraoperative annulus diameter to prosthesis—if equivalent, implant; if 2-3 mm smaller, consider Nicks for one-size enlargement; if 4-6 mm smaller, Yang or Manouguian for 1.5-2 sizes; If it is at least 6-8 mm smaller, consider a Konno-Rastan procedure or aortic root replacement;
- Re-measure post-enlargement annulus with sizers before implantation. Some valve designs provide larger EOA values for the same labeled valve size, and tables presenting published EOA data are available in the literature.

In the presented case, BSA was approximately 1.89 m^2. To avert PPM, the target EOA for the prosthetic valve was ≥1.61 cm^2 (0.85 $cm^2/m^2 \times 1.89\ m^2 \approx 1.61\ cm^2$). Based on manufacturer-specific EOA tables, this required a minimum 23-mm prosthesis. Intraoperative annulus measured 21 mm with sizers. The 2-3 mm discrepancy between target and actual size prompted Nicks procedure for one-size enlargement. Postoperative echocardiographic follow-up confirmed that the cardiac valves were functional and that no PPM had developed at the aortic valve.

To our knowledge, this is one of the very few reported adult cases of multivalvular infective endocarditis combined with critical left main and right coronary artery disease in which an iEOA–guided algorithm was prospectively applied to determine the need for posterior aortic root enlargement.

CONCLUSION

This case underscores the importance of meticulous preoperative evaluation—including iEOA-guided planning—in the management of complex infective endocarditis with a narrow aortic root. It also highlights the critical role of surgical strategy in patients with a narrow aortic root who are predisposed to developing PPM. Aortic root enlargement remains an essential tool in the surgical armamentarium for selected high-risk patients requiring aortic valve replacement.

ETHICAL DECLARATIONS

Informed Consent

Written informed consent was obtained from the patient(s) included in this report. Signed consent forms are retained by the authors and are available upon request.

Peer Review Process

This report underwent external peer review.

Conflict of Interest

The authors declare no conflicts of interest.

Financial Disclosure

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Author Contributions

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