International Journal of Surgery Case Reports 96 (2022) 107294

Contents lists available at ScienceDirect

International Journal of Surgery Case Reports

journal homepage: www.elsevier.com/locate/ijscr

Case report

Successful aortic root enlargement procedure in low resource setting: Two rare cases

Lyndon Darwin, Oky Revianto Sediono Pribadi *

Department of Thoracic, Cardiac, and Vascular Surgery, Faculty of Medicine, Universitas Airlangga – Dr. Soetomo General Academic Hospital, Surabaya, Indonesia

ARTICLE INFO

Keywords:
Aortic root enlargement
Patient-prosthesis mismatch
Surgical aortic valve replacement

ABSTRACT

Background: Small aortic root is an unexpected incident during surgical aortic valve replacement in which the prosthesis valve size does not match the case being treated.
Case presentation: Two patient-prosthesis mismatches with aortic valve problems underwent surgical aortic valve replacement. Based on calculating the body surface area (BSA) and effective orifice area (iEOA), the selection of prosthesis valve size was determined. When minor aortic root surgery was performed, it was discovered that the procedure of aortic root enlargement had to be conducted. The surgery went smoothly, but both patients had different outputs. The first patient was dead, while the second patient had a better quality of life.
Discussion: Every surgical aortic valve replacement preparation of aortic root enlargement procedure needs to be prepared for the worst-case scenario.
Conclusion: Aortic root enlargement procedure must be anticipated in aortic valve replacement, especially for the patients with small aortic roots, both isolated and with concomitant valve procedure.

1. Introduction

Aortic valve disease was reported in 241,303 people aged 18 years, and the number of cases has increased threefold in the US in the last 5 years [1]. Management of aortic valve disease is surgical aortic valve replacement to reduce pressure and volume overload on the left ventricle, relieve symptoms, and improve survival [2,3]. Some patients need small-sized prosthetic valves, commonly known as patient-prosthesis mismatch. Patient-prosthesis mismatch can be prevented by calculating the body surface area (BSA) of the patient planned for surgery. Minimum indexed effective orifice area (iEOA) can be obtained by multiplying BSA by 0.85 cm^2/m^2 [4]. The appropriate prosthesis, according to iEOA, may not always fit in the annulus due to the small aortic root. The patient with aortic valve stenosis with a small aortic root will influence the outcome and may also lead to patient-prosthesis mismatch [5]. Aortic root enlargement is one of the options available for small aortic roots [6,7]. Based on the description above, we were interested in reporting the success of two cases of aortic root enlargement procedures in low resource settings based on surgical case report (SCARE) 2020 guidelines [8].

2. Case presentation

2.1. Case 1

A 56-year-old female was diagnosed with severe aortic stenosis, moderate aortic regurgitation, and mild mitral regurgitation. She had a body surface area of 1.52 m^2, and for such body surface area, the appropriate prosthesis valve size would be a minimum of 19. Preoperative transthoracic echocardiography showed mild mitral regurgitation, severe aortic stenosis (AVA Planimetry 0.6 cm^2; AV Vmax 6.61 m/s; AVA mean PG 4.79 m/s), moderate aortic regurgitation (AR PHT 481 ms; AR Sdec 2.5 m/s^2), mild pulmonary regurgitation, typical chamber dimension and normal systolic function (EF by Teich 63 %). No dilatation of the aortic root with a diameter of the aortic annulus was 1.7 cm. Operative findings showed a tricuspid aortic valve with heavy calcification until the aortic annulus. Due to the small aortic root, even the number 16 prosthesis aortic valve was unable to be implanted. Manougian procedure was then performed, enabling number 16 aortic valve prosthesis to be placed using pericardium-lined Dacron patch with 12-Pledget suture (Fig. 1). Cross clamp time was 117 min, and total CPB time was 149 + 27 min. Postoperative hemodynamic support was 1 mg/

* Corresponding author: Oky Revianto Sediono Pribadi, Department of Thoracic, Cardiac, and Vascular Surgery, Faculty of Medicine, Universitas Airlangga – Dr. Soetomo General Academic Hospital, Jl. Mayjend Prof. Dr. Moestopo No. 6-8, Airlangga, Gubeng, Surabaya, East Java 60286, Indonesia.
E-mail address: okyreviantosedionopribadio@gmail.com (O.R.S. Pribadi).

https://doi.org/10.1016/j.ijscr.2022.107294
Received 21 April 2022; Received in revised form 7 June 2022; Accepted 7 June 2022
Available online 10 June 2022

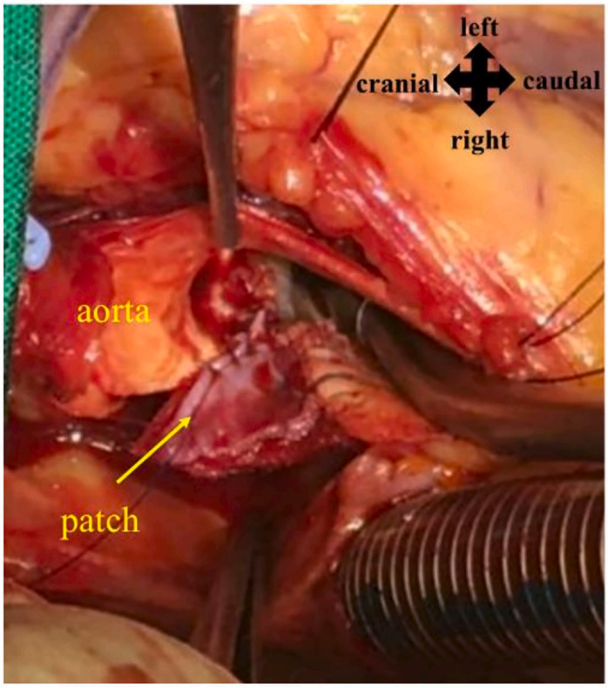

Fig. 1. Aortic root enlargement using Teflon and pericardium patch.

h of NTG and 100 nanogram/kg/min. Evaluation of transesophageal echocardiography showed good and functional mechanical prosthesis with a pressure gradient of 10.50 mmHg, peak velocity 2.1 cm/s, and DVI 0.33 without valvular or paravalvular leakage, and normal LV systolic function (EF by Teich 60 %). The postoperative course was eventful, but unfortunately, the patient died caused by sepsis-related to ventilator-associated pneumonia.

2.2. Case 2

A 30-year-old female was diagnosed with severe mitral stenosis, moderate mitral regurgitation, severe aortic stenosis, moderate aortic regurgitation, and moderate pulmonary hypertension. The patient had a body surface area of 1.55 m^2, and according to the appropriate iEOA, prosthesis aortic valve number 21 should be placed to avoid patient-prosthesis mismatch. Pre-operative transthoracic echocardiography showed severe mitral stenosis (planimetry 0.47 cm^2), moderate mitral regurgitation with restrictive PML, severe aortic stenosis (AVA 4.0 cm^2), moderate MR with malcoaptation NCC, LCC, RCC, moderate TR, with LA, RA, RV dilatation, and normal LV systolic function (EF by Teich 63.5 %). The operative finding showed a tight aortic annulus with the fibrous band from RCC to the sub-annular part of the aorta. The cusps were thickened. There was also calcification of AML and PML. Mitral valve replacement was performed using mechanical mitral valve size 25 with a 12-Pledget suture.

In contrast, aortic root enlargement used a Dacron patch to allow mechanical aortic valve size 16 placed with a 14-Pledget suture (Fig. 2a and b). Cross clamp time was 176 min and 210 min of CPB time. The postoperative course was uneventful, and the patient was discharged on postoperative day 5. A summary of these cases is shown in Table 1.

3. Discussion

The aortic root has a complex anatomy. It is a direct continuation of the left ventricular outflow tract. The aortic root components are the sinuses of Valsalva, the fibrous interleaflet triangles, and the valvar leaflets. In the aorta, several rings support it. They are sinotubular junction, crown-like ring, anatomic ventriculoatrial junction, and the virtual ring formed by joining basal attachments of valvar aortic leaflets [9].

A small aortic root is defined as an inner aortic sinotubular junction

Table 1
Comparison of aortic root enlargement procedure.

Variable	Case 1	Case 2
Sex	Female	Female
Age	56 years old	30 years old
Valvular pathology	Mixed aortic stenosis and regurgitation, mild mitral regurgitation	Mixed aortic stenosis and regurgitation, mixed mitral stenosis and regurgitation
Pre-operative aortic annulus diameter	17 mm	N/A
The pre-operative transaortic mean pressure gradient	91.91 mmHg	32.47 mmHg
Size of mechanical aortic valve placed	16	16
Aortic root enlargement technique	Manoguian	Manoguian
The post-operative aortic pressure gradient	10.5 mmHg	10.7 mmHg
Concomitant procedure	None	Mitral valve replacement
Cross clamp time	117 min	176 min
CPB time	149 + 27 min	210 min
Outcome	Deceased on POD 8 due to ventilator-associated pneumonia and sepsis	Discharged on POD 5

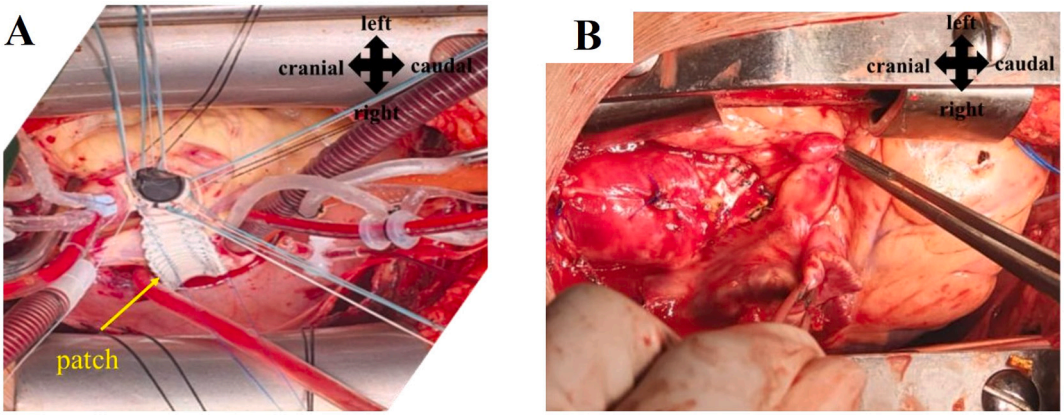

Fig. 2. Aortic root enlargement procedure using Teflon patch (a) and complete closure of the aortotomy with Teflon patch (b).

indexed for bodyweight <1.4 cm/m in women and <1.5 cm/m in men. Patients with aortic valve stenosis with small aortic roots will influence the outcome and lead to patient-prosthesis mismatch [5]. Patient-prosthesis mismatch will also lead to increased morbidity and mortality. To prevent patient-prosthesis mismatch, an appropriate valve prosthesis must be chosen according to a minimum effective orifice area of >0.85 cm^2/m^2. An aortic root enlargement procedure may be considered if the appropriate prosthesis ring size is larger than the aortic root [4].

The aortic root enlargement procedure is one modality to overcome minor aortic root problems. Other options are supra-annular stented valve, stentless valve, root replacement, and Ross-Konno Procedure [6]. Several techniques have been developed since 1970 [10]. The Manouguian technique and Nicks technique can achieve posterior aortic root enlargement. Manouguian technique is achieved by extending the aortotomy incision further posteriorly and across the aortic annulus at the commissure between the left coronary sinus and the noncoronary sinus into the aortic-mitral continuity. Nicks's technique extends the aortotomy across the aortic annulus in the mid-portion into the fibrous subaortic curtain [11,12]. Besides Nicks and Manouguian techniques, there is the Konno-Rastan technique (anterior incision medial to the orifice of the right coronary artery), Vouhe technique (anterior incision through medial commissure of the aortic valve, and Nunez technique (incision into the posterior commissure and the interleaflet triangle below it) [13,14]. There are several techniques for the aortic root enlargement procedure, as shown in Table 2.

Preparation for aortic valve replacement must be planned carefully, as small aortic root may sometimes be tricky and lead to undesired patient-prosthesis mismatch and compromised outcome. Arterial cannulation is usually performed at the distal ascending aorta with venous drainage cannulated at the right atria appendage using the two-stage venous cannula. Cardioplegia may be delivered antegrade to immediately put the heart into asystole and later given via handheld cannula or retrogradely. Retrograde cardioplegia delivery gives the advantages of not compromising the surgical field of the aorta and may be continuously delivered cardioplegia solution. To prevent left ventricular distention hence increasing myocardial demand, venting of the heart may be placed in the aortic root and right superior pulmonary vein [15,16].

Options for managing small aortic annulus included trans-catheter aortic valve replacement, surgical aortic valve replacement, aortic root enlargement, and stentless or sutureless bioprosthesis. We consent about the possibility of the need for enlarging the aortic root to avoid patient-prosthesis mismatch. Additional risks of the procedure include longer duration of operation and cardiopulmonary bypass time; risk of injury to surrounding structure of aortic root (i.e., mitral valve, coronary arteries); also the risk of bleeding. Lifetime management of aortic stenosis must be carefully tailored and decided based on every patient. Aortic root enlargement provides a larger size to fit into the aortic annulus, therefore avoiding patient-prosthesis mismatch, which increases patient morbidity and mortality. Mild patient prosthesis mismatch is acceptable in some circumstances. However, prosthesis valve options may be limited, and a small aortic root may prevent the valve with acceptable iEOA from fitting into the aortic annulus [17–19].

Aortotomy may be performed transversely or obliquely. Oblique aortotomy is usually performed to anticipate the need for aortic enlargement. By performing an oblique incision, the surgeon may anticipate the need for aortic root enlargement by continuing the incision to the desired extent, depending on the techniques chosen.

4. Conclusion

Two cases in Indonesian people with heart problems for which aortic valve replacement have been performed according to the appropriate BSA and iEOA calculations. However, a small aortic root was found during the surgery. Aortic valve replacement in a patient with a small aortic root is challenging as it has been associated with a high risk of patient-prosthesis mismatch and increased postoperative morbidity and mortality. Aortic root enlargement procedure must be anticipated in aortic valve replacement, both isolated and concomitant.

Table 2
Differences between several surgical procedures of aortic root enlargement.

Techniques	Description
Nicks	Extending the aortotomy posteriorly through the noncoronary sinus across the aortic ring and inserting a patch to augment the annulus
Manougian	Extending incision through the commissure between LC sinus and NC sinus into the anterior mitral leaflet
Nunez	Aortic incision through posterior commissure into the interlealflet triangle
Bo Yang	Y incision at the aortomitral curtain and rectangular patch

Ethical approval

Not applicable.

Funding

None.

Author contribution

All authors contributed to data analysis, drafting and revising the paper, giving final approval of the version to be published, and agreeing to be accountable for all aspects of the work.

Guarantor

Oky Revianto Sediono Pribadi is the person in charge of the publication of our manuscript.

Research registration

Not applicable.

Consent

Written informed consent was obtained from the patient or guardian to publish this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Declaration of competing interest

Lyndon Darwin and Oky Revianto Sediono Pribadi declare that they have no conflict of interest.

Acknowledgement

We want to thank our editor “Fis Citra Ariyanto”.

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