Clinical Investigation

Surgery for Aortic Root Abscess:

A 15-Year Experience

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Aortic root abscess is the most severe sequela of infective endocarditis, and its surgical management is a complicated procedure because of the high risk of morbidity and death.

Twenty-seven patients were included in this 15-year retrospective study: 21 (77.8%) with native- and 6 (22.2%) with prosthetic-valve endocarditis. The surgical reconstruction of the aortic root consisted of aortic valve replacement in 19 patients (70.4%) with (11) or without (8) a pericardial patch, or total aortic root replacement in 7 patients (25.9%); 5 of the 27 (18.5%) underwent the modified Bentall procedure with the flanged conduit. Only one patient (3.7%) underwent subaortic pericardial patch reconstruction without valve replacement. A total of 7 patients (25.9%) underwent reoperation: 6 with prior valve surgery, and 1 with prior isolated sinus of Valsalva repair. The mean follow-up period was 6.8 ± 3.7 years.

There were 6 (22.2%) in-hospital deaths, 3 (11.1%) of which were perioperative, among patients who underwent emergent surgery. Five patients (23.8%) died during follow-up, and the overall survival rates at 1, 5, and 10 years were 70.3% ± 5.8%, 62.9% ± 6.4%, and 59.2% ± 7.2%, respectively. Two of 21 patients (9.5%) underwent reoperation because of paravalvular leakage and early recurrence of infection during follow-up.

After complete resection of the perianular abscess, replacement of the aortic root can be implemented for reconstruction of the aortic root, with or without left ventricular outflow tract injuries. Replacing the aortic root with a flanged composite graft might provide the best anatomic fit. ***(Tex Heart Inst J 2016;43(1):20-8)***

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Aortic root abscess, a severe form of infective endocarditis (IE) of the aortic valve and adjacent tissues, continues to challenge cardiovascular surgeons. In clinical presentation, uncontrolled aortic root abscess can manifest itself as a burrowing abscess, a cardiac fistula or a rupture into a cardiac chamber, a pseudoaneurysm, or an arrhythmia leading to hemodynamic instability. Early and extensive surgical reconstruction of major aortic root abscess can be essential, because antibiosis alone is usually inadequate to arrest the destructive effect of the abscess. Any delay in surgery can promote the risk of devastating damage to surrounding tissue.

A large, multicenter, international study[1] showed that 22% of patients with aortic valve IE had perianular abscess, which developed at a higher rate in association with prosthetic valves than with native valves (40% vs 19%); moreover, coagulase-negative staphylococcal infections had a higher rate of sequelae development than did infections with other microorganisms. Echocardiographic diagnosis of the paravalvular abscess should warn physicians to refer a patient for early surgical intervention. The surgical treatment usually involves extensive débridement of the infected and necrotic tissues around the aortic root, reconstruction of the aortic root by patching or plicating the resected area, and aortic valve replacement (AVR) with a prosthesis. Radical débridement leads to total aortic root replacement (ARR) by means of a biological or prosthetic composite graft.

The aim of this study was to review our 15-year surgical experience in patients with extensive aortic valve endocarditis complicated by aortic root abscess. Surgical approaches were compared to show which approach (AVR or ARR) yields better results. This study also raises the matter of how the flanged technique lends confidence to the surgeon who is faced with an extensive perianular abscess that necessitates urgent surgery.

Patients and Methods

This retrospective analysis was performed in compliance with our human-studies guidelines and was approved by our institutional review and ethical review boards.

We studied the surgical data of 27 patients who, from December 1998 through December 2013, had undergone aortic root surgery to resolve aortic root abscess (Table I). In-hospital clinical and blood analyses were obtained, together with records of follow-up visits. The preoperative clinical status of the patients was evaluated in accordance with the modified Duke criteria for IE.[2] Because an echocardiographic evaluation was the major imaging technique for all patients, we confirmed the standard transthoracic echocardiographic study by means of transesophageal echocardiography, and we diagnosed destructive aortic valve endocarditis upon the observation of a vegetation or a paravalvular abscess formation.[3] This study included only patients with aortic valve endocarditis and associated extensive perianular abscess.

The timing for surgical intervention depends on the anatomic condition and extravalvular extension of tissue destruction due to infectious and inflammatory processes. Despite advances in pharmacology that have led to better antibiotic therapy, mortality and morbidity rates have remained high because of perianular sequelae. The situation is also worse in the presence of infected prosthetic valves. In this study, life-saving surgery is defined as "urgent" when performed within 24 hours ("emergent" means such surgery performed immediately after the diagnosis of potentially fatal sequelae). "Early" surgery indicates surgical intervention within 48 hours after the diagnosis of aortic root abscess or 48 hours after the referral of patients to our department from another center. "Elective" surgery is defined as surgery performed within days of hospitalization.

TABLE I. Clinical Characteristics of 27 Patients with Aortic Root Abscess

Variable	Value
Age (range), yr	37.3 ± 13.2 (17–62)
Male	20 (74.1)
Electrocardiographic findings	
Sinus rhythm	22 (81.5)
Atrial fibrillation	2 (7.4)
Complete heart block	3 (11.1)
Associated disease	
Hypertension	3 (11.1)
Behçet disease	2 (7.4)
Hydatid cyst	1 (3.7)
New York Heart Association functional class	
I	2 (7.4)
II	5 (18.5)
III	5 (18.5)
IV	15 (55.6)
Urgent surgery*	4 (14.8)
Emergent surgery**	3 (11.1)
Septic shock	3 (11.1)

*Performed within 24 hours
**Performed immediately after diagnosis of potentially fatal sequelae

Data are presented as mean ± SD or as number and percentage.

Surgical Procedure

Twenty of the 27 patients (the AVR group) received a prosthetic valve replacement or subaortic patch repair, and the other 7 (the ARR group) received a biological or prosthetic composite graft replacement. Perioperative antibiotic doses were tailored to each patient by infectious-disease specialists.

The standard median sternotomy was used in all patients. Arterial cannulation was performed via the ascending aorta (in primary operations and in some reoperations) or via the right subclavian or femoral artery (in some reoperations). The venous cannulation was established in accordance with the accompanying cardiac procedures as unicaval or bicaval via the right atrium. The left ventricle (LV) was vented via the right superior pulmonary vein. All operations were performed with patients under cardiopulmonary bypass (CPB) in moderate or deep hypothermia. After cross-clamping, cardiac arrest and myocardial protection were achieved by antegrade or retrograde (or both) administration of isothermic blood cardioplegic solution. After the standard aortotomy was performed, we delicately investigated the perianular aortic abscess and its surroundings. The infected valve and all foreign materials were excised in preparation for the extensive débridement of infected and necrotic tissues in the abscess cavity. This destruction of surrounding structures necessarily affected our subsequent approach to surgical reconstruction.

When a localized abscess was not larger than a single aortic cusp, we reconstructed the aortic anulus by plicating the defect between pledgeted mattress sutures placed just below the native aortic anulus and the sewing ring of the prosthetic stented valve during AVR (n=8; 29.6%).

When a circular abscess was larger than one aortic cusp without aortoventricular dehiscence, the defect on the aortic anulus was reconstructed with use of a pericardial patch, and pledgeted sutures were placed on this patch during AVR (n=11; 40.8%).

When an aortoventricular dehiscence (discontinuity between the aorta and the LV of more than half the aortic circumference, after resection of all infected tissues) developed, an extended ARR had to be applied. In that event, we resected the aortic root and all infected tissues around the aortic anulus, which of course disturbed the continuity between the aortic and mitral anuli. After resecting the aortic anulus, only the LV outflow tract (LVOT) was left to us for the implantation of a prosthetic composite graft (n=5; 18.5%) or a xenograft (n=2; 7.4%) between the LV and the ascending aorta.

Our modified Bentall procedure (using a flanged composite graft) was the preferred approach for reconstruction of the destroyed aortic anulus.[4] A larger (3-cm) segment of the proximal end of the tubular graft was averted outward to create the flange of the graft; then we affixed a mechanical valve to the graft with continuous 4-0 polypropylene suture and subsequently reshaped the last averted part of the graft into its original form. This proximal part of the flanged conduit was implanted in a circular manner with 2-0 interrupted sutures supported by large Teflon pledgets placed subanularly on healthy tissue at the native LVOT (on the membranous septum at the right fibrous trigone, on the mitral anulus, or on the base of the anterior leaflet, deep on the myocardium) (Fig. 1A). Both ends of the sutures were passed through the proximal free end of the flanged portion of the conduit in order to use that part as a strip between knots and the myocardial aortic wall (Fig. 1B). Both left and right coronary buttons were anastomosed, and the distal anastomosis of the graft was performed, in that order. In one patient, the iatrogenic subaortic ventricular septal defect (VSD) was closed with a tongue-like extension of this flanged graft (Fig. 1C). Only one patient (3.7%), because of pseudoaneurysm formation, underwent subaortic pericardial patch reconstruction without AVR or ARR.

Statistical Analysis

The study was designed to evaluate early-mortality (perioperative, 30-day, and hospital) and late-mortality rates, the long-term survival rate after discharge from the hospital, and early and late morbidity. Perioperative death indicated death after surgery, whereas 30-day death indicated death within the first 30 days, and hospital death showed all deaths during hospitalization before discharge. The late-mortality rate indicated death during long-term follow-up evaluation after discharge from the hospital. The overall mortality rate showed all deaths together. Data were presented as mean ± SD for continuous variables and as number and percentage for categorical variables. Differences between groups were evaluated by means of the χ^2 test for categorical variables and the *t* test for continuous variables. Analysis with regard to actuarial survival was performed by the Kaplan-Meier method with use of SPSS software version 16.0 (IBM Corporation; Armonk, NY). Results were presented as mean ± SE. A *P* value ≤0.05 was considered statistically significant for all comparisons.

Results

Distribution of Extended Endocarditis and Microorganisms

The mean follow-up period was 6.8 ± 3.7 years. All patients had extended and complicated NVE (21 patients; 77.8%) or PVE (6 patients; 22.2%). Several causes were observed: the spread of active infection (21 patients; 77.8%), previous patch repair of sinus of Valsalva (1 patient; 3.7%), intravenous drug usage (3 patients; 11.1%), and previous pacemaker implantation (2 patients; 7.4%).

Native aortic valve endocarditis developed in 8 patients with bicuspid aortic valve (38.1%), in 3 patients with severe aortic regurgitation (14.3%), in 3 patients with normal valve (14.3%), in 2 patients with degenerative aortic stenosis (9.5%), and in 5 patients with multivalvular disease (23.8%).

Prosthetic-valve endocarditis developed in 6 patients who had undergone either a mechanical AVR (4 patients) or a mechanical double-valve replacement (DVR)

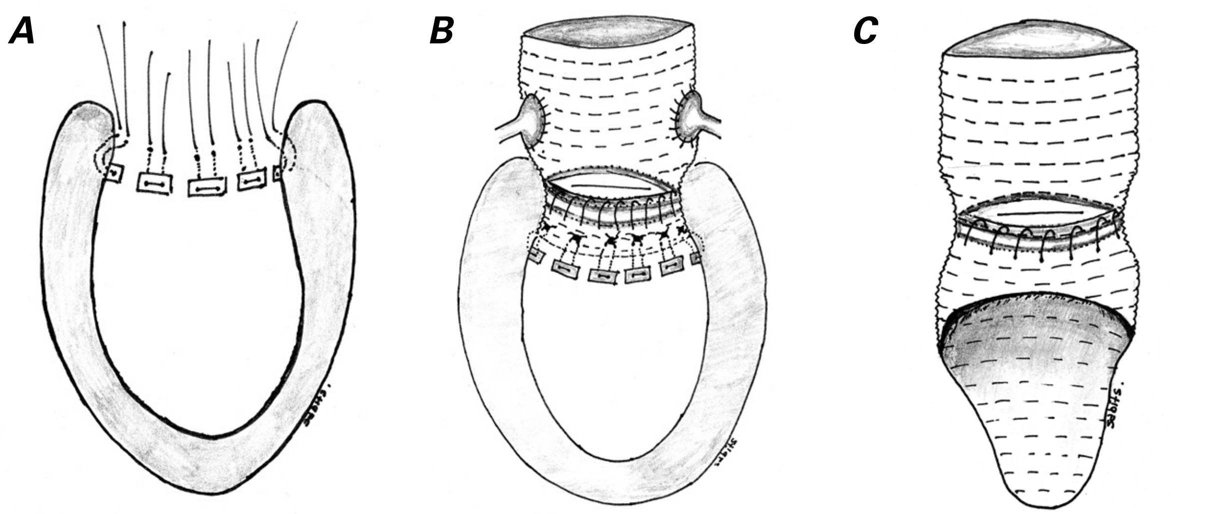

Fig. 1 *Drawings show **A**) the placement of pledgeted mattress sutures at the healthy and strong tissue below the aortic anulus, **B**) the result of the modified Bentall procedure, with the flanged composite graft, and **C**) the preparation of the flanged part of the composite graft that was used to repair a subaortic ventricular septal defect in 1 patient.*

TABLE II. Relationship between Microorganism and Endocarditis Type in Overall Mortality Rate

	NVE (n=21)		**PVE** (n=6)		
Microorganism	**n** (%)	**Deaths**	**n** (%)	**Deaths**	**Total Deaths, n** (%)
Staphylococcus aureus	6 (28.6)	1	2 (33.3)	2	3/8 (37.5)
Staphylococcus epidermidis	1 (4.8)	1	1 (16.7)	1	2/2 (100)
Streptococcus spp.	4 (19)	1	0	0	1/4 (25)
Enterococcus faecalis	2 (9.5)	0	1 (16.7)	1	1/3 (33.3)
Candida sake	1 (4.8)	1	0	0	1/1 (100)
None (culture-negative endocarditis)	7 (33.3)	3	2 (33.3)	0	3/9 (33.3)
Total	21	7	6	4	11/27 (40.7)

NVE = native-valve endocarditis; PVE = prosthetic-valve endocarditis

(2 patients) in their previous operations. Four of those patients (3 with AVR and 1 with DVR) were evaluated as "persistent" and "early recurrent" for this study. There were 7 repeat operations (25.9%): 6 patients with PVE and one patient with NVE because of perianular abscess that developed 6 months after patch repair of the right coronary sinus of Valsalva. In this cohort, the common microorganisms were *Staphylococcus* spp. (37.1%), *Streptococcus* spp. (14.8%), *Enterococcus faecalis* (11.1%), and *Candida sake* (3.7%). Nine patients (33.3%; an equal percentage in each group) had so-called "culture-negative endocarditis," because no microorganism was cultured either from the blood or from surgical specimens. Table II lists the relationships between identified microorganisms and the type of IE in decedents.

Operative Data

Table III lists all surgical interventions with associated cardiac procedures, and Table IV lists the abscess location and its closure technique. The surgical reconstruction of the aortic root consisted of a radical resection of all infected tissues, the reconstruction of the aortic anulus with a pericardial patch (11 patients) or by direct plication (8 patients), and AVR with a bioprosthesis (2; 7.4%) or a mechanical prosthesis (17; 62.9%) in 19 patients. Four of them received mechanical DVR; another underwent a concomitant Nicks posterior aortic-root enlargement and a septal myectomy because of a small aortic anulus and LVOT obstruction. Aortoventricular dehiscence—caused either by circular abscess formation or by the radical resection of all infected tissues—was found in 7 patients (25.9%), all of whom received a total ARR with a xenograft or a prosthetic composite graft. In the first 2 patients, we used xenograft material (in 1 patient, for the replacement of the ascending aorta); however, in the last 5 patients, we preferred our specific modified Bentall procedure with the flanged composite graft, because of its several advantages. In addition, 1 of the 5 patients received an ARR with mitral valve replacement (MVR), and another received an ARR with simultaneous VSD closure. In this series, ARR was performed in 4 patients with NVE (4/21; 19.1%) (1 xenograft and 3 flanged composite grafts) and in 3 patients with PVE (3/6; 50%) (1 xenograft and 2 flanged composite grafts). Only one patient (3.7%) underwent subaortic pericardial patch reconstruction (without AVR or ARR), to compensate for the damage caused by pseudoaneurysm formation.

TABLE III. Surgical Procedures in the 27 Patients

Surgical Procedures	**Value**
Aortic valve replacement	**19 (70.4)**
Isolated (4 reoperations)	14 (51.9)
+ MVR	3 (11.1)
+ MVR, Nick's enlargement, and septal myectomy	1 (3.7)
+ Kay mitral annuloplasty	1 (3.7)
Aortic root replacement	**7 (25.9)**
Xenograft	2 (7.4)
Isolated	1 (3.7)
+ Ascending aorta replacement (2nd operation)	1 (3.7)
Flanged composite graft for modified Bentall procedure	5 (18.5)
Isolated (1 reoperation)	3 (11.1)
+ MVR	1 (3.7)
+ VSD closure (2nd operation)	1 (3.7)
Subanular repair	**1 (3.7)**

MVR = mitral valve replacement; VSD = ventricular septal defect

Data are presented as number and percentage.

There were 7 patients with previous aortic root surgery: 4 had PVE after the mechanical AVR in their first operations (3 of them underwent repeat AVR, and 1 was given a xenograft with the ascending aorta replacement); 2 patients had PVE after DVR (one underwent total ARR associated with iatrogenic VSD repair and the other repeat AVR); and the 7th patient had NVE after a pericardial patch repair of the right sinus of Valsalva aneurysm in his first operation (the aortic valve was replaced in the current operation, but he underwent reoperation for DVR). These current 2nd open cardiac surgical procedures (reoperations) required longer mean operative times than did the primary operation: the mean aortic cross-clamp time was 168.3 ± 91.5 versus 101.6 ± 44.9 min (P=0.067); the mean CPB time was 256.3 ± 41.2 versus 136.3 ± 54.9 min (P=0.045); and the mean operative duration was 329.7 ± 26.9 versus 194.3 ± 46.9 min (P=0.032).

Early surgical intervention had been planned for all patients, but 4 patients (14.8%) underwent urgent surgery (3 had emergent surgery; 11.1%) because of cardiogenic and septic shock (functional class IV). Early surgery was performed in 20 patients (74.1%), and elective surgery in 3 patients (11.1%). The mean CPB and cross-clamp times were significantly longer in the ARR group than in the AVR group (Table V). The mean duration of intensive-care-unit stay was 7.2 ± 9.1 days (median, 3 d; range, 1–37 d) and the mean duration of hospital stay was 31.8 ± 24.1 days (median, 26 d; range, 7–98 d).

Mortality and Survival Rates

The overall mortality rate for this 27-patient cohort was 40.7% (11 deaths), whereas it was 66.6% (4/6 patients) for PVE (75% [3/4] for AVR, 50% [1/2] for ARR) and 33.3% (7/21 patients) for NVE (41.2% [7/17] for AVR and 0% [0/4] for ARR) (P=0.16). The hospital mortality rate was higher in the AVR group; similarly, late death was observed only in this group (Table V). On the other hand, hospital death in the ARR group was observed in only 1 of 3 patients with PVE (33.3%), but not in any patient with NVE (0/4). The overall late-mortality rate (during follow-up after hospital discharge) was 23.8% (5/21), which was observed only in the AVR group; the causes were congestive heart failure (with or without renal failure), sepsis, or unknown reasons. In the AVR group, the in-hospital and late-mortality rates were 23.5% (4/17) and 30.8% (4/13) for mechanical (P=0.34) and 50% (1/2) and 100% (1/1) for bioprosthetic prostheses (P=0.2). The overall mortality rate did not vary by abscess location (Table VI). The 1-, 5-, and 10-year survival rates were 70.3% ± 5.8%, 62.9% ± 6.4%, and 59.2% ± 7.2%, respectively (Fig. 2).

The hospital mortality rate for the entire cohort was 22.2% (6/27): perioperative death occurred in 3 patients in the AVR group (11.1%) who died immediately after surgical intervention (postoperative 1st, 2nd, and 5th days) because of intractable low cardiac output syndrome (LCOS). They were taken to emergency surgery because of septic shock; only one of them had PVE, which developed after DVR (9.5% vs 16.7%; P=0.66). The identified microorganisms in the patients who died perioperatively were *Candida sake*,

TABLE IV. Abscess Locations and Surgical Treatments

Abscess Location and Intraoperative Findings	No.	Closure Technique	No.
NCC involved	7	Plication with valve replacement	1
Anular level	4	Pericardial patch and valve replacement	4
Fistula to LA	2	Total root replacement	2
Fistula to RA	1		
Below NCC (leaning to aortic mitral continuity)	4	Plication with valve replacement	1
		Pericardial patch and valve replacement	2
		Total root replacement	1
Between NCC and LCC	7	Plication with valve replacement	2
Anular level	5	Pericardial patch and valve replacement	3
Commissural level	1	Total root replacement	1
Subaortic level	1	Pericardial patch without valve replacement	1
LCC involved	2	Plication with valve replacement	1
		Total root replacement	1
Between RCC and LCC	3	Plication with valve replacement	3
RCC involved	1	Pericardial patch and valve replacement	1
Between RCC and NCC	3	Pericardial patch and valve replacement	1
Anular level	1	Total root replacement	2
NCC sinus rupture	1		
Leaning to interventricular septum	1		

LA = left atrium; LCC = left coronary cusp; NCC = noncoronary cusp; RA = right atrium; RCC = right coronary cusp

TABLE V. Comparison of Operative Variables between the Groups

Variable	**Overall** (N=27)*	**AVR** (n=20)*	**ARR** (n=7)	*P* Value
CPB time (min)	159.1 ± 66.6 (61–295)	136.3 ± 49.9 (61–227)	250 ± 43.3 (88–295)	<0.001
ACC time (min)	117.9 ± 55.4 (46–234)	98.9 ± 38.9 (46–180)	193.6 ± 47.2 (123–234)	0.004
ICU stay (d)	7.2 ± 9.1 (1–37)	4.8 ± 7.9 (1–37)	14.8 ± 8.8 (3–26)	0.019
Hospital stay (d)	31.8 ± 24.1 (7–98)	26.4 ± 17.6 (7–79)	53.3 ± 29.9 (20–98)	0.04
Deaths	11/27 (40.7)	10/20 (50)	1/7 (14.3)	0.098
Hospital	6/27 (22.2)	5/20 (25)	1/7 (14.3)	0.539
Late	5/21 (23.8)	5/15 (33.3)	0	0.111
Morbidity (late)				
IE recurrence	2/21 (9.5)	2/15 (13.3)	0	0.348
Reoperation	2/21 (9.5)	2/15 (13.3)	0	0.348
Tamponade	1/21 (4.8)	1/15 (6.7)	0	0.512
Renal failure	1/21 (4.8)	1/15 (6.7)	0	0.512
GI bleeding	1/21 (4.8)	1/15 (6.7)	0	0.512

ACC = aortic cross-clamp; ARR = aortic root replacement; AVR = aortic valve replacement; CPB = cardiopulmonary bypass; GI = gastrointestinal; ICU = intensive care unit; IE = infective endocarditis

*The patient with subaortic pericardial patch repair was included in this group.

Data are presented as mean ± SD (range) or as number and percentage. *P* <0.05 was considered statistically significant.

TABLE VI. Overall Mortality Rates in the Subgroups

Variable	Deaths
Septic shock	3/3 (100)
NYHA functional class	
<IV	4/12 (33.3)
IV	7/15 (46.7)
Surgical procedure	
AVR	8/15 (53.3)
Mechanical prosthesis	6/13 (46.2)
Biological prosthesis	2/2 (100)
DVR (mechanic prosthesis)	1/4 (25)
ARR	1/7 (14.3)
Flanged composite graft	1/5 (20)
Xenograft	0
Without valve replacement	1/1 (100)
Main location of abscess	
Noncoronary sinus	7/19 (36.8)
Intervalvular fibrous body	1/2 (50)
Interventricular septum	1/2 (50)
Anterior mitral anulus	2/4 (50)

ARR = aortic root replacement; AVR = aortic valve replacement; DVR = double valve replacement; NYHA = New York Heart Association

Data are presented as number and percentage.

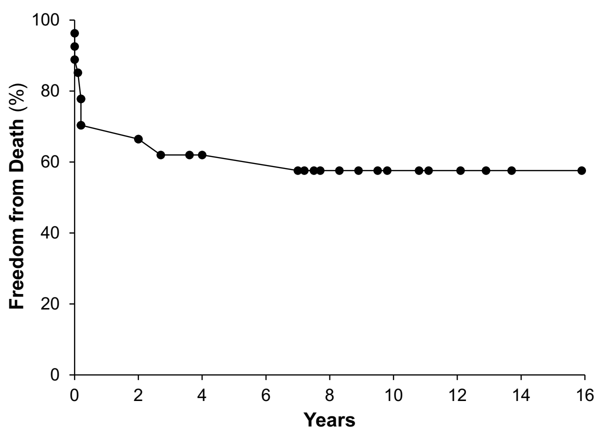

Fig. 2 *Graph shows freedom from death among patients with aortic root abscess.*

methicillin-sensitive coagulase-negative *Staphylococcus*, and methicillin-resistant *Staphylococcus aureus*. The 30-day mortality rate was 3.7%. This was attributable to the death of 1 patient of cardiac tamponade and LCOS on the 20th postoperative day; this patient had PVE caused by methicillin-resistant *S. aureus*, after undergoing ARR with a flanged composite graft in an attempt to repair iatrogenic VSD 5 days after DVR. Hospital death caused by sepsis or tamponade was observed in 2 patients (7.4%), on postoperative days 37 and 79. The identified microorganisms in these patients were *Enterococcus faecalis* and methicillin-sensitive *Staphylococcus epidermidis*.

Morbidity

The most prevalent early sequela was LCOS, and inotropic support was used in 19 patients (70.4%). Six of them were given inotropic therapy longer than 2 days, and 3 of them (11.1%) also received intra-aortic balloon pump support, but those 3 died of intractable LCOS. Transient atrioventricular block occurred in 4 patients postoperatively; however, a permanent pacemaker was implanted in only one.

Late sequelae were observed only in the AVR group. Cardiac tamponade with and without multiorgan failure occurred in 2 patients, and both of them died. Other morbidities were acute renal failure requiring dialysis (1 patient), sepsis (1), and upper gastrointestinal system bleeding (1). There were 2 patients with recurrent endocarditis in the AVR group: one died of sepsis and the other lived. Valve-related reoperations during follow-up were performed in 2 AVR patients: one, with a periprosthetic leak that had developed one year after surgery, underwent dehiscence repair and lived; the other, who had undergone sinus of Valsalva aneurysm repair in his first operation and AVR in his 2nd, underwent repeat AVR and MVR because of late recurrence of periprosthetic abscess formation. He died. There were no late sequelae, such as bleeding or tamponade, valve- or graft-related sequelae (paravalvular leakage, thrombosis, or pseudoaneurysm), recurrences, or persistence of PVE in the ARR survivors.

Discussion

In this study, we have reported our 15-year surgical experience in treating extensive aortic valve endocarditis with aortic root abscess; and we also have compared AVR with ARR in regard to early and late outcomes, to show whether radical surgery with the flanged technique makes reconstruction of the aortic root anatomy more complicated. Despite the significantly longer operation times in the ARR group, ARR was less amenable to early and late adverse events. The hospital mortality rate was higher in the AVR group than in the ARR group (25% vs 14.3%; $P=0.54$), late death was observed only in the AVR group (5 pts), and the overall mortality rate did not differ significantly between mechanical and bioprosthetic valves (43.5% vs 25%; $P=0.51$).

We could not show any statistically significant differences between groups because of the low number of patients. However, these meaningful differences show us that implantation of prostheses on healthy and strong tissues "after extirpation of all infected tissues, radical débridement of all necrotic tissues, and, if necessary, fearless replacement of the aortic root"[5] are more important than the type of prosthesis, to maintain a better sequela-free survival. This finding was reported by David and colleagues,[5] who concluded that the choice of a certain type of prosthesis or conduit was not a substitute for this surgical strategy.

The complexity of the surgical treatment in patients with aortic root abscess ranges from partial resection of the aortic anulus and surrounding tissues to radical removal of the base of the heart—including the entire aortic root, the intervalvular fibrous body, and part of the interventricular septum. If homografts can be used, the trend shifts toward ARR as the preferable surgical approach to reconstruct the aortic root in patients with aortic root abscess.[6] Surgical treatment of aortic root abscess is an interventional initiative in which the appropriate homograft insertion is possible. In the real world, the major limitation for homografts is the mismatch between availability and need; and in Turkey we cannot use any aortic homograft because of the scarcity of production.[7] The other limitation is structural failure of homografts, and also of bioprostheses, in long-term follow-up evaluations. At the beginning of this study, we used only 2 xenografts, but then we joined others in favoring prosthetic materials, despite recommendations to the contrary in the literature.[8,9] We think that the flanged composite graft is the best option for ARR—perfectly suited (like homografts and xenografts) to repair complex aortic root defects and (unlike homografts and xenografts) to prevent late reoperation for structural deterioration.

The main indication for a flanged composite graft is the presence, in patients with perianular abscess, of a destroyed aortic anulus with impaired surrounding tissues, in which case simple AVR becomes impossible and total ARR is inevitable. We think that total ARR with a flanged composite graft is ideal for reconstruction of the aortic root, because that flanged graft is easier to handle and the subprosthetic part of the synthetic graft can be used, especially in the absence of homografts, to patch all kinds of defects created by resection of the abscess. This prosthesis can be prepared, shaped, and implanted very easily; and, unlike homografts, it can be produced in different sizes, without limitation. The modified Bentall technique with the flanged composite graft is more applicable and advantageous than other aortic root prostheses. The first advantage lies in the surgeon's ability to tailor the flanged portion in accordance with the remaining aortic anulus: in standard aortic root pathologic conditions, we leave a short skirt below the prosthetic valve to suture the tubular graft at the aortic anulus continuously; in the destroyed aortic anulus (with or without LVOT defects), we usually leave the flanged portion longer than usual, in order to place the graft more deeply in the LVOT. The 2nd advantage is that any kind of subanular defects can be repaired (as in our patient with iatrogenic VSD) by tailoring the flanged part as a tongue for the closure of LVOT defects without using a patch. The 3rd advantage is the easier anastomosis of the flanged portion to the anulus, when the aortic anulus is intact and healthy, or to the subanular LVOT tissues, when the aortic anulus is destroyed and aortoventricular discontinuity occurs—in which case we place all pledgeted sutures deeply in the healthy and strong myocardium. The 4th advantage is the quicker and safer implantation of composite graft (than is possible in conventional modified Bentall procedures). The 5th advantage is the avoidance of patient–prosthesis mismatch by virtue of the largest prosthetic valve available, with or without aortic root enlargement. The 6th advantage is the maintenance of the flexibility and dynamic function of the LVOT and the surrounding tissues. The 7th advantage is the expediency of the widest graft size in creating pseudosinuses, in order to simplify the direct anastomosis of coronary ostia on the graft—with no tension or kinking, especially in reoperations.

One of the main issues for IE is whether the valve is native or prosthetic, which affects the patient's prognosis.[5,6,10] The virulence of the microorganism and the resistance of the host cause paravalvular abscess, cardiac fistulas, and severe destruction of the native aortic valve. Infection of a mechanical valve is usually located in its sewing ring and extends into surrounding structures. The microbiology of the IE depends on whether the valve is native or prosthetic. Native-valve endocarditis causing perianular abscess involves the aortic valve more often than the mitral valve.[11] Similarly, the extension of infection to surrounding tissues—causing paravalvular abscess—occurs relatively more often in PVE, despite the prevalence of NVE over PVE.[1] Aortic valve IE can be also an independent predictor of paravalvular abscess.[12] David and colleagues[13] reported that the early and late outcomes of PVE were worse than those of NVE, because PVE's frequent association with paravalvular abscess made the surgical reconstruction more complex. It is important for cardiovascular surgeons to be aware that these complicated reconstructive procedures have higher mortality and morbidity rates than does simple valve replacement for active IE. The operative mortality (19.7% vs 11.6%) and 10-year survival rates (52% ± 7% vs 62% ± 6%; for all groups 57% ± 5%) in patients with aortic root abscess are worse for PVE than for NVE.[5] We found that the overall mortality rates in our cohort showed relations similar to those reported in the literature, but the rates were higher: 66.7% for PVE and 33.3% for NVE. On the other hand, patients who underwent ARR for NVE or PVE had better survival rates—without serious sequelae such as recurrence of PVE, pseudoaneurysm, paraprosthetic leaks, valve degeneration, or reoperation. These results suggest that ARR, in application to patients with aortic root abscess, has lower operative mortality rates and better sequela-free survival rates. Preoperative identification of microorganisms from blood cultures or surgical specimens is essential to create medical antibiotherapy individually, via a multidisciplinary approach involving specialists in infectious disease, cardiology, and cardiac surgery. The most prevalent microorganisms are *S. aureus* in NVE and *S. epidermidis* in PVE abscess.[5] A large prospective study carried out by several clinics showed that staphylococci were responsible for IE in major risk groups like intravenous-drug users and patients with intracardiac devices in place.[14] We were able to document only 18 of 27 patients as culture positive, and 8 of those died. Nine culture-negative patients were diagnosed in other hospitals, and their antibiotherapies were already started; they were sent to our department for aortic root surgery because of the sequelae of IE. Although most of the microbiological results of our study were consistent with other clinical study findings, the lack of information can be cited as a limitation of our cohort.

The operative mortality rate for the surgical treatment of aortic root abscess varies from 3.9% to 25%.[1,3,5,7,15,16] Early intervention for IE with extended sequelae is known to have better outcomes and for this reason leads surgeons to early operation if life-threatening sequelae do not develop.[17] Most urgent surgical series have high mortality rates, ranging from 55% to 77%.[4,5] However, emergent surgery has a higher mortality rate than does elective surgery (14.3% vs 9.3%).[6] In spite of 88.9% of patients' undergoing surgical interventions within the first 48 hours, our series had more early (delayed-urgent) surgery than urgent surgery (74.1% vs 14.8%). The perioperative mortality rate was 75% (3/4) for urgent surgery and 15% (3/20) for early surgery, but we did not observe any operative death in the 3 elective cases.

Our strategy is to undertake aortic root surgery after stabilizing the patient's infection, hemodynamics, and general status. Although a detailed preoperative investigation can take time, the uncovered details help the surgeon to develop plans for this complicated and challenging procedure. In our study, we used transesophageal echocardiography to locate abscesses in proximity to the aortic valve and surrounding anatomic structures, and this revealed that most of the abscesses arose from the noncoronary sinus of the aortic root, like the others.[5,9] This explains why we usually prefer early (delayed-urgent) surgery.

Comparing our survival rates with published long-term survival rates for patients with aortic root abscess is difficult, because most studies are not confined to aortic valve endocarditis in association with perianular extension. Moon and colleagues[18] reported that 10-year survival rates were better for patients with NVE than for patients with PVE (54% vs 41%), but they did not find any difference in accordance with the type of valve implanted. When Klieverik and colleagues[19] compared their AVR outcomes for active endocarditis in 138 patients (106 allografts and 32 mechanical prostheses), they found no survival benefit for an allograft over a mechanical valve replacement (59% vs 66%). Musci and associates[20] reported that the 1-, 5-, and 10-year survival rates for patients with PVE associated with perianular abscess were 57.8 ± 3.3%, 43.9 ± 3.5% and 27.3 ± 4%, respectively; they also found that sepsis was the main reason for multiorgan failure. Jassar and coauthors[8] reported similar results with 3 different ARR procedures: the 1- and 5-year survival rates were 67% ± 7% and 58% ± 9% for patients with mechanical composite grafts, 65% ± 7% and 62% ± 7% for patients with biological valve-conduits, and 61% ± 8% and 58% ± 9% for patients with homografts (P=0.48), respectively. They concluded that, as their graft selection evolved with time, mechanical prostheses became the most frequent choice for root replacement in reoperation. In our study, mean 1-, 5-, and 10-year survival rates were 70.3% ± 5.8%, 62.9% ± 6.4%, and 59.2% ± 7.2%, respectively. Our long-term results seemed better with ARR than with AVR, and better after NVE than after PVE. Despite early morbidities that developed similarly in both groups in our study, the ARR group was free from late sequelae. It is of special interest that we did not see any prosthetic graft- or valve-related late sequelae in this group. This observation shifted our preference, in patients with destructive aortic root abscess, to the use of a flanged composite graft in ARR procedures.

Conclusion

Surgery for paravalvular abscess continues to be associated with high mortality and morbidity rates. After resection of all infected and necrotic tissue around the anulus, anular destruction can render difficult the implantation of a mechanical valve or a bioprosthesis. Similarly, homografts are inadequate to reconstruct the LVOT circumferentially in extensive aortoventricular dehiscence. The flanged composite graft is the best option for solving this life-threatening sequela and reconstructing the aortic root.

References

1. Anguera I, Miro JM, Cabell CH, Abrutyn E, Fowler VG Jr, Hoen B, et al. Clinical characteristics and outcome of aortic endocarditis with periannular abscess in the International Collaboration on Endocarditis Merged Database. Am J Cardiol 2005;96(7):976-81.
2. Li JS, Sexton DJ, Mick N, Nettles R, Fowler VG Jr, Ryan T, et al. Proposed modifications to the Duke criteria for the diagnosis of infective endocarditis. Clin Infect Dis 2000;30(4):633-8.
3. Murdoch DR, Corey GR, Hoen B, Miro JM, Fowler VG Jr, Bayer AS, et al. Clinical presentation, etiology, and outcome of infective endocarditis in the 21st century: the International Collaboration on Endocarditis-Prospective Cohort Study. Arch Intern Med 2009;169(5):463-73.
4. Kirali K, Mansuroglu D, Omeroglu SN, Erentug V, Mataraci I, Ipek G, et al. Five-year experience in aortic root replacement with the flanged composite graft. Ann Thorac Surg 2002;73(4):1130-7.
5. David TE, Regesta T, Gavra G, Armstrong S, Maganti MD. Surgical treatment of paravalvular abscess: long-term results. Eur J Cardiothorac Surg 2007;31(1):43-8.
6. Yankah AC, Pasic M, Klose H, Siniawski H, Weng Y, Hetzer R. Homograft reconstruction of the aortic root for endocarditis with periannular abscess: a 17-year study. Eur J Cardiothorac Surg 2005;28(1):69-75.
7. Guler M, Kirali K, Mansuroglu D, Tuncer A, Bozbuga N, Daglar B, et al. Aortic root replacement with homograft. Turk Kardiyol Dern Ars 2000;28(7):439-43.
8. Jassar AS, Bavaria JE, Szeto WY, Moeller PJ, Maniaci J, Milewski RK, et al. Graft selection for aortic root replacement in complex active endocarditis: does it matter? Ann Thorac Surg 2012;93(2):480-7.
9. Ramlawi B, White LE, Santora RJ, Reardon MJ. Recurrent prosthetic valve endocarditis with aortic-ventricular disruption: a surgical challenge. J Heart Valve Dis 2013;22(1):126-32.
10. Leontyev S, Borger MA, Modi P, Lehmann S, Seeburger J, Doenst T, Mohr FW. Surgical management of aortic root abscess: a 13-year experience in 172 patients with 100% follow-up. J Thorac Cardiovasc Surg 2012;143(2):332-7.
11. Kirali K, Guler M, Yakut N, Mansuroglu D, Omeroglu SN, Daglar B, et al. Combined medical and surgical treatment for active native valve infective endocarditis: ten-year experience. Turk Kardiyol Dern Ars 2001;29(9):543-8.
12. Graupner C, Vilacosta I, SanRoman J, Ronderos R, Sarria C, Fernandez C, et al. Periannular extension of infective endocarditis. J Am Coll Cardiol 2002;39(7):1204-11.
13. David TE, Gavra G, Feindel CM, Regesta T, Armstrong S, Maganti MD. Surgical treatment of active infective endocarditis: a continued challenge. J Thorac Cardiovasc Surg 2007;133(1):144-9.
14. Siniawski H, Grauhan O, Hofmann M, Pasic M, Weng Y, Yankah C, et al. Aortic root abscess and secondary infective mitral valve disease: results of surgical endocarditis treatment. Eur J Cardiothorac Surg 2005;27(3):434-40.
15. Lee S, Chang BC, Park HK. Surgical experience with infective endocarditis and aortic root abscess. Yonsei Med J 2014;55(5):1253-9.
16. Sabik JF, Lytle BW, Blackstone EH, Marullo AG, Pettersson GB, Cosgrove DM. Aortic root replacement with cryopreserved allograft for prosthetic valve endocarditis. Ann Thorac Surg 2002;74(3):650-9.
17. Knosalla C, Weng Y, Yankah AC, Siniawski H, Hofmeister J, Hammerschmidt R, et al. Surgical treatment of active infective aortic valve endocarditis with associated periannular abscess--11 year results. Eur Heart J 2000;21(6):490-7.
18. Moon MR, Miller DC, Moore KA, Oyer PE, Mitchell RS, Robbins RC, et al. Treatment of endocarditis with valve replacement: the question of tissue versus mechanical prosthesis. Ann Thorac Surg 2001;71(4):1164-71.
19. Klieverik LM, Yacoub MH, Edwards S, Bekkers JA, Roos-Hesselink JW, Kappetein AP, et al. Surgical treatment of active native aortic valve endocarditis with allografts and mechanical prostheses. Ann Thorac Surg 2009;88(6):1814-21.
20. Musci M, Hubler M, Amiri A, Stein J, Kosky S, Meyer R, et al. Surgical treatment for active infective prosthetic valve endocarditis: 22-year single-centre experience. Eur J Cardiothorac Surg 2010;38(5):528-38.