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Infective Endocarditis Complicated by Paravalvular Abscess: A Surgical Challenge. An 11-Year Single Center Experience

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ABSTRACT

Aim: To evaluate the impact of paravalvular abscess in the surgical management and outcome of infective endocarditis.

Methods: Retrospective review of 35 patients with paravalvular abscess due to active endocarditis operated on at 1 institution from September 1996–August 2007. Patients' mean age was 59.4 ± 12.1 years; 80% were men. 31 patients suffered from native- and 4 from prosthetic valve endocarditis. In 23 cases the affected valve was the aortic, in 7 cases the mitral, in 4 cases both (mitral and aortic), and in 1 patient the tricuspid; no abscess presence was noticed by pulmonal annuluses. Surgical procedures included radical lesion-resection as well as reconstruction of the annulus with pericardial patches. Most of the patients were preoperatively in New York Heart Association (NYHA)-class III-IV. Follow-up was 100% complete with a maximum of 11.25 years.

Results: Early mortality (30 days) was 11.4% (n = 4). The 11-year overall survival rate was 68.7 ± 9% (76.1% for aortic valve patients and 26.9% for mitral valve patients ($P = .15$). With regard to the type of prosthetic devices, the survival rates at 11.25 years were 74.2% for mechanical, 80% for biological, and 45.6% for other/reconstructive ($P = .6$). There were no episodes of recurrent endocarditis; hence freedom of recurrent endocarditis at 11 years was 100%. Causative microorganisms were approximately 30% *Staphylococci*, and MRSA seems to induce more frequent destructive lesions like paravalvular abscess.

Conclusions: Considering the severity of the onset, a radical surgical treatment delivers acceptable long-term results by acceptable operative mortality. The choice of the prosthetic device seems not to be influential in long-term survival and morbidity.

INTRODUCTION

The presence of paravalvular abscess still remains a challenge for the surgical treatment of native and prosthetic valve endocarditis. In several studies, the presence of paravalvular abscess was identified as an idependent early mortality risk factor, and the reoperation rate in these patients was significantly increased [Mills 1982; Mullany 1989]. The optimal management of paravalvular abscess is unclear, however, because up to 30% of the cases are diagnosed during surgery or at autopsy [Choussat 1999]. Depending on the extent of the infection and of the abscess cavities, several operative techniques have been proposed in order to solve the associated technical problems. Particularly, concerning the choice of prosthetic devices, several groups advocate the use of homograft valves in the aortic position [Knosalla 2000], whereas others prefer the use of mechanical replacement devices [Bauernschmitt 1996]. In order to contibute to the discussion and to evaluate the impact of the presence of paravalvular abscess in the surgical treatment and outcome of infective endocarditis, we retrospectively reviewed all cases operated on at our institution because of infective endocarditis with paravalvular abscess.

MATERIALS AND METHODS

From September 1996 through August 2007, 35 consecutive patients with infective endocarditis complicated by

Table 1. Demographics of the Study Population*

Variable	Patients, n	%
Sex (male/female)	27/8	77.1/22.9
Previous cardiac surgery	7	20
Prosthetic Valve Endocarditis	4	11.4
Preoperative NYHA class III/IV	10/18	80
Septic/cardiogenic shock	9	25.7
Arterial embolization	7	20
Preoperative AV-block	3	8.6
Associated diseases		
Diabetes mellitus	10	28.5
Hypertension	14	40
Hypercholesterinemia	6	17.1
Renal insufficiency	15	42.8

*Patients' ages ranged from 28 to 85 years (mean, 59.41). Mean preoperative serum-creatinin was 1.5 mg/dL. NYHA indicates New York Heart Association; AV, atrioventricular.

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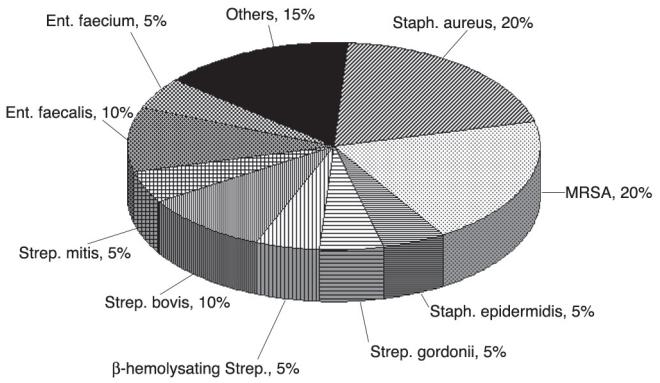

Figure 1. Causative microorganisms.

paravalvular abscess, out of 112 patients with acute infective endocarditis, underwent surgical treatment at our department.

Data regarding demographics, preoperative clinical status, intra- and early postoperative course were prospectively collected. These data are part of a data registry of all cardiac surgical patients at our institution. Additional data concerning all pertinent information for this disease such as causative microorganism, intraoperative findings, and technical details of the performed surgical procedures were obtained by review of the hospital medical records. In 23 cases, the follow-up examinations after valve replacement, including clinical examination, lab control, and transthoracic echocardiography, were performed at our institution. The remaining follow-up data were gathered predominantly by mail and telephone contact either with the patients or relatives and/or their referring physicians according to a detailed questionnaire.

Patient Group

Our study group included 35 patients treated surgically because of infective endocarditis with associated paravalvular abscess. Follow-up was complete in 100% of patients. There were 27 men and 8 womn, aged 28 to 85 years (mean, 59.4 years). Thirty-one patients presented with native and 4 with prosthetic valve endocarditis. The infection affected the aortic valve in 23 cases, the mitral valve in 7 cases, both (mitral and aortic) in 4 cases, and the tricuspid valve in 1 case. The mean follow-up period was 3.6 years with a maximum of 11.25 years. Demographic and clinical characteristics of the study population are summarized in Table 1.

On preopeartive echocardiographic examination, an abscess was considered to be present when an irregular echodense or echo-lucent area of at least 2 mm in diameter was detected within the valvular annulus or periannular myocardium [Daniel 1991; Karalis 1992]. In our series the preoperative diagnosis of paravalvular abscess was made in 22 (62.8%) patients by transesophageal echocardiography (TEE).

Table 2. Intraoperative Findings and Surgical Procedures

Variable	n (%)
Abscess location	
Aortic valve	
Noncoronary sinus	8 (22.8)
Right coronary sinus	7 (20)
Left coronary sinus	6 (17.1)
Mitral valve	
Posterior mitral anulus	5 (14.2)
Anterior mitral anulus	4 (11.4)
Interventricular septum	2 (5.7)
Intervalvular fibrous body	4 (11.4)
Surgical procedures	
Aortic valve replacement (AVR)	22 (62.8)
Aortic valve inspection/repair	1 (2.8)
Mitral valve replacement (MVR)	7 (20)
AVR + MVR	1 (2.8)
AVR + mitral valve repair	1 (2.8)
AVR + tricuspid valve repair	1 (2.8)
Tricuspid valve replacement	1 (2.8)
Tricuspid valve inspection/repair	1 (2.8)
Concomitant procedures	
Coronary artery bypass grafting	1 (2.8)
Ascending aorta replacement	2 (5.6)
Congenital atrial septal defect closure	1 (2.8)
Paraanular abscess debridement	35 (100)
Anulus reconstruction	2 (2.8)

Intraoperatively, a paravalvular abscess was defined as a region of infective necrosis of the valve annulus and surrounding tissues containing purulent material, which required debridement before a device could be implanted.

Indications for surgery were the presence of abscess, cardiogenic and/or septic shock, congestive heart failure, persistent sepsis despite antibiotic therapy, vegetation larger than 1 cm, and central or peripheral arterial embolization.

The causative microorganism was identified in 23 patients (65.7%) preoperatively in blood cultures. *Staphylococci* were the most commonly detected microorganisms, as shown in Figure 1.

Operative Technique

All patients were operated on through median sternotomy with cardiopulmonary bypass (CPB) under moderate hypothermia (32°C-34°C). A cold hyperkalemic crystalloid solution (Brettschneider) was used for myocardial protection, and external cooling was established with a cold saline solution. The approach of the valve was performed by either a transverse aortotomy and/or classical left atriotomy. The

major surgical principle consisted of the radical excision of all infected tissue regardless of the extent of the infection. In all cases, the abscess cavity was irrigated and disinfected with a 2.5% povidone-iodine solution for at least 5 minutes. Subsequently, the abscess cavity was closed either by direct suture or by the prosthetic device sutures if the abscess cavity was localized in the valvular annulus. In 2 cases with an extraordinary extension of the abscess cavity into the periannular tissue, we performed an annular reconstruction with pericardial patch. A reconstructive or valve sparing procedure (n = 10, 28.6%) was performed when feasible, otherwise the affected valve was replaced by mechanical (n = 17, 48.6%) or biological prosthetic devices (n = 8, 22.8%). The left-sided valve prostheses were implanted using single, Teflon-coated sutures. In 2 patients the endocarditis affected the ascending aorta; thus concomitant replacement of the ascending aorta was performed. The intraoperative findings regarding the location and extent of the paravalvular abscess as well as the performed surgical procedures are listed in Table 2. Six patients (17.1%) presented postoperatively complete atrioventicular blockage. All patients were admitted to the intensive care unit and were treated with appropriate intravenous antibiotics for at least 6 weeks.

Statistical Methods

All continuous variables are presented as mean ± standard deviation (SD), and categorical variables are reported as frequencies unless otherwise stated.

Long-term survival estimates and the freedom of recurrent infection were calculated using the method of Kaplan-Meier, whereas univariate comparisons of survival data were tested using the Log-rank and the χ^2 test. Linearized rates, expressed as percentage per patient-year (%/py), were calculated by dividing the number of events by the total follow-up time in years and multiplying by 100.

A P value was considered statistically significant at $< .05$.

RESULTS

Mortality

Four patients died within 30 days after operation or prior hospital discharge, which resulted to an early mortality rate of 11.4%. The causes of death were in 2 cases cardiogenic and septic shock, in 1 patient intraoperative uncontrollable bleeding, and 1 patient died on the 18th postoperative day from intracerebral bleeding. Concerning the 2 patients who died of cardiogenic and septic shock, the first patient was a 56-year-old man, who had been admitted in cardiogenic/septic shock because of infective aortic valve endocarditis. The aortic valve had been replaced by a mechanical prosthesis after the closure of an annular abscess cavity and aortic annulus reconstruction. Intraoperative inspection of the mitral valve revealed jet lesions on the anterior mitral valve leaflet, which had been reconstructed after thorough debridement of the affected tissue. Although the preoperatively performed coronary angiography showed no evidence of coronary artery disease, the patient developed intraoperatively low cardiac output syndrome. Assuming an embolization into the coronary arteries, a bypass graft was performed as a last option. The patient did not recover, despite mechanical circulatory support (intraaortic balloon pump) and inotropic drug administration, and died during the operation. The second patient was a 55-year-old man, taken into the operation room in cardiogenic shock, anouric, with high doses of inotropes due to acute infective aortic valve endocarditis. The valve was replaced by a mechanical prosthesis. The patient survived the operation, but died on the first postoperative day because of cardiogenic shock with consequent multiple organ failure. Regarding the other 2 cases of early death, 1 patient was a 68-year-old woman, postaortic valve replacement and coronary artery bypass surgery, who developed prosthetic valve endocarditis. At redo surgery the aortic root and the ascending aorta were involved in the infection process. After closure of several abscess cavities, we performed aortic valve and ascending aorta replacement. While terminating extracorporeal circulation, uncontrollable bleeding resulted from a rupture of the friable tissue at the proximal aorta-graft anastomosis. The last case was a 70-year-old woman admitted in septic shock with acute renal failure and central embolization due to mitral valve endocarditis. The mitral valve was replaced by a mechanical prosthesis, and the patient survived the operation but died on the 18th postoperative day because of intracerebral bleeding due to the anticoagulation treatment.

Regarding the late mortality, 6 patients (17.1%) died during follow-up. One patient died because of a malignant disease, 2 because congestive heart failure, 1 because of sepsis with multiple organ failure, and in 2 cases of late mortality, the cause of death could not be detected and has been classified as death of an unknown cause, but were considered in the statistical analysis as cardiac related deaths. In all cases there was no clinical evidence of persistent or recurrent endocarditis. Overall late mortality and survival rates (including the early deaths) at 11.25 years were 5.05% per patient-year and 68.7 ± 9% per patient-year, respectively (76.1% for aortic valve patients and 26.9% for mitral valve patients ($P = .15$). With regard to the type of the prosthetic device used, the survival rate at 11.25 years was 74.2% for mechanical, 80% for biological, and 45.6% for other/reconstructive: 45.6% ($P = .6$) (Figure 2). The late mortality analysis concerning gender and preoperative clinical New York Heart Association (NYHA) class did not reveal any significant differences.

Recurrent Endocarditis

In our series of patients with paravalvular abscess due to infective endocarditis, there were no events of recurrent endocarditis. Hence freedom from reoperation due to recurrent endocarditis at 11.25 years was 100%.

Early Postoperative Course

The intensive care unit (ICU) stay ranged from 1 to 7 days, with a mean of 3.1 days. Six patients (17.1%) developed complete aortic valve (AV)-block, which was treated with permanent pacemaker implantation approximately 4 to 8 days after surgery. In 3 cases the block was already present at preoperative admission, thus the AV-block was induced by the radical surgical excision only in 3 cases (8.6%). Regarding other major complications, 2 patients (5.7%) have been operated

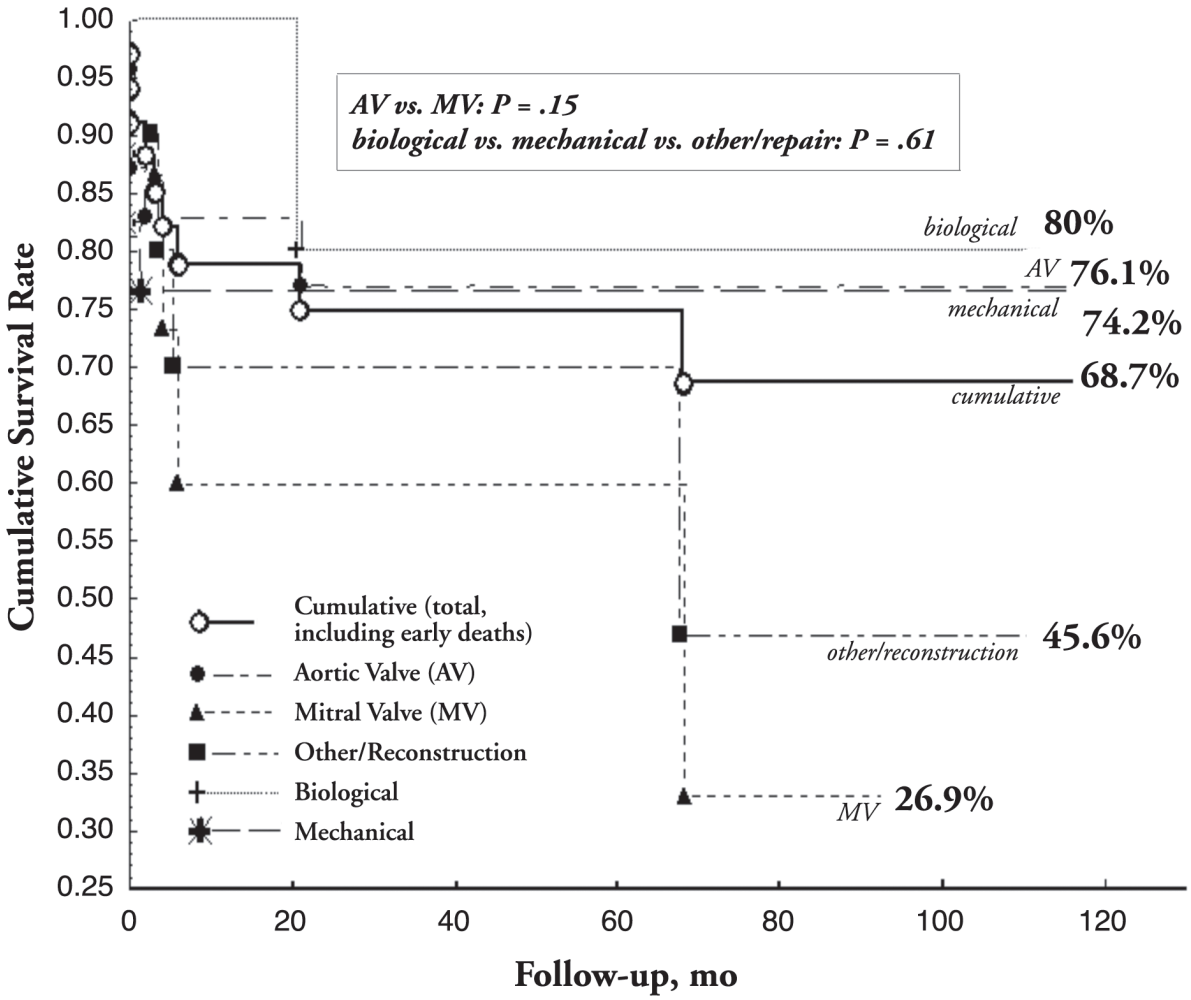

Figure 2. Cumulative survival function (Kaplan-Meier).

on again because of bleeding, and 1 patient developed postoperatively acute renal failure, which necessitated continuous hemodiafiltration.

Clinical Status

At follow-up, 69% of survivors were in functional class I or II. All of them reported of a significant improvement in their clinical condition. Figure 3 depicts the comparison of the pre- and postoperative clinical status according to the NYHA classification.

Echocardiographic Data

Echocardiographic data evaluating the hemodynamic performance of the implanted prostheses were obtained in 92% (23/25) of hospital survivors. Transthoracic echocardiography showed that, in the mean 3.2 years after implantation, aortic valves had a mean effective orifice area (EOA) of 1.99 ± 0.78 cm^2, with peak and mean pressure gradients of 21.4 ± 5.5 mmHg and 11.5 ± 3.25 mmHg, respectively. The mean EOA of prostheses in the mitral position was 2.55 ± 0.4 cm^2, with peak and mean pressure gradients of 15.2 ± 3.1 mmHg and 4.9 ± 1.8 mmHg, respectively. Detailed echo data are depicted in Table 4.

DISCUSSION

Surgical treatment of acute infective valvular endocarditis is a necessary adjunct to medical therapy in many cases, and has been proposed in the early era of open heart surgery [Naqvi 2005]. In recent years, the incidence of paravalvular abscess due to active infective endocarditis increased [Wallace 1965]. It is essential to establish an early diagnosis of periannular abscess, often made by TEE [Daniel 1991], in order to prevent severe valvular annular destruction. In our series, the preoperative diagnosis of paravalvular abscess was established by TEE in 22 patients (62.8%). The remaining patients were admitted with the diagnosis of infective endocarditis established by transthoracic echocardiography (TTE), and the coexistance of paravalvular abscess was an intraoperative finding. The effectiveness of TTE compared to TEE regarding the detection of both native and prosthetic valve septic

Table 3. Operative and Follow-up Data

Intraoperative data	
Operating room times, min (mean ± SD)	
X clamping	84.3 ± 39.7
Cardiopulmonary bypass	114.5 ± 65.6
Operation	214.7 ± 105.4
Transfusion, units (range [mean])	
Red blood cells	0-11 (2.9)
Fresh frozen plasma	0-6 (0.9)
Thrombocytes	0-1 (0.03)
Status at end of operating room, n (%)	
Stable without isotropes	8 (22.8)
Low dose isotropes	15 (42.8)
High dose isotropes	8 (22.8)
Unstable (intraaortic balloon pump, Assist device)	2 (5.7)
Postoperative course	
Time in intensive care unit, d (range [mean])	1-7 (3.1)
Early complications, n (%)	
Low cardiac output syndrome	3 (8.6)
Rethoracotomy, bleeding	2 (5.7)
Renal failure	1 (2.8)
Aortic valve–block (pacemaker implantation)	6 (17.1)
Follow-up, n (%)	
Early mortality	4 (11.4)
Late mortality	6 (17.1)
Recurrent endocarditis	0 (0)

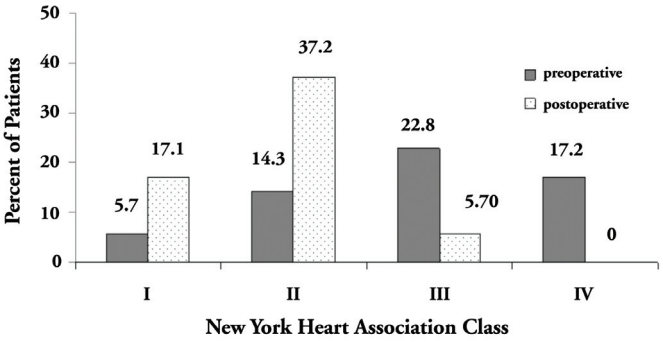

Figure 3. Clinical status.

complications has been investigated in multiple studies, which showed the superiority of TEE as an imaging diagnostic tool [Daniel 1991]. Despite the technical advantages of TEE over TTE, it is noteworthy that even TEE can underestimate the extent of infection and periannular destruction. Daniel et al [1991] reported on 44 patients with proven abscesses, 28.3% identified by the transthoracic and 87% by the transesophageal approach. The sensitivity in the diagnosis of abscesses using mono-, bi-, or multiplane TEE did not differ. Nevertheless, small and/or anterior annular aortic abscesses might be detected more easily with multiplane probes [Leung 1994]. Accordingly, the diagnosis remains difficult, especially if the abscesses are small in size and located on the anterior aortic wall and mitral annulus. This emphasizes that preoperative decision making should include all aspects of patient presentation along with information provided by imaging studies, rather than being based solely on imaging findings.

Endocarditis caused by microorganisms prone to form abscesses, such as *Staphylococcus aureus* or coagulase negative *Staphylococcus*, are best treated with early surgery. Additionally, it was shown that *Staphylococcus aureus* endocarditis was associated with higher mortality (20% versus 12%, P = .001) than in other bacterial endocarditis [Miro 2005; Hill 2006]. Infection by *Staphylococci* was identified by other investgators as an independent predictor of poor outcome, likely because of its virulence and ability to cause extensive abscesses, and consequently because of the complexity of the required reconstructive procedure [d'Udekem 1996]. In our study, 23 patients (65.7%) had positive blood cultures, and the most common offending microorgnisms were *Staphylococci* (predominantly *Staphylococcus aureus*) in 31.4% of cases, followed by *Streptococci* in 14.3% of cases. In 3 out of 4 early deaths, the offending microorganism was *Staphylococcus aureus* and caused in all cases extensive tissue defects, which complicated the required surgical procedure. Nevertheless, in the performed univariate mortality analysis, infection caused by *Staphylococci* could not be identified as an independent early mortality risk factor.

As mentioned before, the presence of paravalvular abscess complicates the surgical procedures and is associated with high morbidity and mortality. Difficulties and challenges of the surgical treatment arise from the radical exclusion of the abscess cavity from the circulation and the secure fixation of the prosthesis on a friable tissue. The reported early mortality rates in the literature vary from 4% to 31% [Lytle 2002; Naqvi 2005; Yankah 2005]. In our series the early mortality rate was 11.4% (4 patients). All of them were taken into the operation room under the condition of cardiogenic or septic shock and inotropic support. Two of the patients were additionally mechanically ventilated. This operative mortality, which is comparable to the above mentioned studies, is considerably lower than those reported in older series [Ivert 1984]. Advances made over the years in prompt diagnosis, better antimicrobial therapy, intensive care management, and surgical techniques contributed to this improvement.

Usually those patients are primarily treated by internists and are referred to the surgeon after medical treatment has failed. The indications for and timing of surgical intervention are still under debate among internists, and in order to reduce mortality and morbidity is necessary to accomplish a multidisciplinary approach to these patients, involving at least

Table 4. Echocardiographic Data*

Aortic Valve Replacement			
Prosthesis	P_{max}, mmHg (mean ± SD)	P_{mean}, mmHg (mean ± SD)	Effective Orifice Area, cm^2 (mean ± SD)
Sorin Bicarbon™ (Sorin Group, Modena, Italy)			
25 mm (n = 4)	20.8 ± 6.8	10.3 ± 3.1	2.4 ± 0.6
23 mm (n = 3)	22.1 ± 6.9	11 ± 3.9	2.1 ± 0.5
ATS Medical Inc. (Plymouth, Minnesota, USA)			
22 mm (n = 4)	21.9 ± 4.8	10.8 ± 4.2	2.1 ± 0.8
20 mm (n = 1)	22.8	11.1	1.8
Mosaic Medtronic (Minneapolis, Minnesota, USA)			
25 mm (n = 2)	18.7 ± 3.8	9.8 ± 1.9	2.2 ± 0.3
23 mm (n = 1)	20.1	12.3	1.9
21 mm (n =1)	22.7	14.8	1.7
Mitroflow Carbomedics Inc. (Sorin Group)			
23 mm (n = 1)	19.7	11.8	1.8
Carpentier-Edwards Perimount (Edwards Lifesciences, Irvine, California, USA)			
23 mm (n = 1)	23.5	12.2	1.8
Mitral Valve Replacement			
Prosthesis	P_{max}, mmHg (mean ± SD)	P_{mean}, mmHg (mean ± SD)	Effective Orifice Area, cm^2 (mean ± SD)
Sorin Bicarbon™ (Sorin Group)			
23 mm (n = 3)	16.9 ± 3.1	6.3 ± 1.9	2.2 ± 0.6
25 mm (n = 2)	15.8 ± 2.9	4.5 ± 1.8	2.7 ± 0.3
27 mm (n = 1)	12.7	3.9	2.7

*P_{max} indicates maximum pressure; SD, standard deviation; P_{mean}, mean pressure.

infectiologists, cardiologists, and cardiac surgeons [Moreillon 2004]. It is still not clear whether the presence of a perivalvular abscess is in itself an indication for surgery. The most established indications for surgical intervention in patients with infective endocarditis are significant heart failure due to valve insufficiency, resistant or fungal infection, multiple systemic emboli, and septal abscess with conduction disturbances [Croft 1983]. In some cases a conservative, nonoperative approach may be the treatment of choice, depending on the size and location of the abscess, and the virulence and the response to antimicrobial therapy of the causative organisms.

The Cox regression analysis of multiple variables did not reveal any independent predictors for early mortality in the present study, probably because of the small sample size. It is noteworthy that the early mortality rate in the group of endocarditis patients without associated paravalvular abscess (n = 77) was slightly higher, with 13%; the difference, however, was not statically significant.

The long-term survival, particularly for patients with native valve endocarditis, is satisfactory and in our series was approximately 69% at 11 years, comparable to that reported by other groups [Moon 2001]. With regard to the type of implanted prosthetic device (mechanical, biological, or reconstruction) there were no significant differences in long-term survival (Figure 2). In the present series there was no clinical evidence of persistent or recurrent endocarditis, thus the choice of the prosthetic device in these severe cases, since a reconstructive or a valve sparing procedure is not a treatment of first choice, still remains under debate. Homograft valves have, according to some authors [Knosalla 2000], theoretical advantages compared to mechanical or bioprosthetic valves, such as higher resistance to recurrent infection, flexibility, and additional periannular tissue. Other groups advocate, because of the 2 major homograft-drawbacks on one hand (limited availability and higher degeneration rate, leading to reoperation) and the comparable clinical results with prosthetic devices on the other, the use of mechanical or biological valves in patients with infective endocarditis [Hagl 2002; David 2007]. In our series we used predominantly mechanical (48%) and biological stented valves (23%). Approximately 43% of

the cases (15 patients) were operated on in an emergent or urgent setting, which made the availability of a homograft not feasible. In addition, the fact that patients with active infective endocarditis tend to be younger, confirmed by the relatively low mean age of 59 years in the present study-collective, supported our preference for mechanical prostheses, especially in younger patients. During follow-up there were no events of recurrent endocarditis, hence freedom from reoperation due to recurrent endocarditis at 11.25 years was 100%. This finding correlates with the suggestion of David et al [2007] that freedom of persistent or early recurrent endocarditis depends more on the recognition and ability of the surgeon to remove all infected tissues than on the type of prosthesis used. Data showing that the risk of recurrent valve infection with a biological or a mechanical prosthesis is highest early after surgery and then reaches a level of constant hazard, whereas the allograft valve has a low constant hazard level without early increased risk after surgery, are from studies performed in the early 1990s [McGriffin 1992]. It may be that the hazard for recurrent or persisting endocarditis of the mechanical or biological prosthetic valve will not have a flat line if the surgery were done in the era of radical excision. The fact is that up to date, there do not exist any controlled randomized trials comparing homograft and mechanical or biological valves for the surgical treatment of acute endocarditis.

Conclusions

Surgical treatment of acute infective endocarditis complicated by formation of paravalvular abscess remains challenging and is associated with high but acceptable mortality and morbidity. Despite this high operative mortality and morbidity, the long-term survival was satisfactory considering the severity of the onset and the complexity of the surgical procedures. Radical surgical resection of all infected tissue is the key point in order to achieve low rates of recurrent infections, and it must be performed even if the conductance system is thereby affected. The type of prosthetic device seems not to be influential in long-term survival and incidence of recurrent infection. In this study, we observed an increased rate of infections caused by *Staphylococci* and especially MRSA.

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