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Valve-related factors and incidence of prosthetic valve endocarditis

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Abstract

Aim: The aim of the study was to present our experience and evaluate the valve-related factors and the incidence of prosthetic valve endocarditis.

Material and methods: This is a retrospective study. Between 2010 and 2018, 36 patients were re-operated on due to prosthetic valve endocarditis The valve-related factors (type, size and position of the prosthetic valve) were analysed.

Results: Thirty-six patients had prosthetic valve endocarditis. The overall hospital mortality was 16.67%. Early vs. late onset prosthetic valve endocarditis mortality was 23.08% vs. 13.04% respectively. The type, size or position of the prosthesis was not associated with prosthetic valve endocarditis. There was a statistically significant difference between occurrence of prosthetic infection between mitral repair and replacement both in mechanical and biological valve groups. The most common infective agent in the early onset group was Staphylococcus aureus, whereas in the late onset group it was Enterococcus faecalis. Out of 13 patients with early prosthetic valve endocarditis, 11 had infection in the perioperative period around primary operation.

Conclusions: Based on our experience, prosthetic valve endocarditis has a high mortality. Early onset prosthetic valve endocarditis is less common but has higher mortality compared to the late onset. Mitral valve repair was less prone to develop prosthetic valve endocarditis, and valve-related factors (type and size of the valve, valve position) did not have any influence on the incidence of prosthetic valve endocarditis.

Key words: prosthetic valve endocarditis, valve-related factors.

Introduction

Prosthetic valve endocarditis (PVE) is a life-threatening complication which accounts for 10–30% of all cases of infective endocarditis [1, 2]. PVE affects 1–6% of patients with prosthetic valve implants [3].

The diagnosis is based on clinical findings, laboratory tests, echocardiography and operative findings [4]. Patients with PVE undergoing valve reoperations show lower 30-day mortality and greater survival at follow-up compared with medical therapy [5]. Nevertheless, the in-hospital mortality is very high, ranging from 20% to 40% [3], with some sources reporting mortality as high as 80% [6].

Prosthetic valve endocarditis is usually defined as early or late based on the time period between the primary operation and onset of PVE. The most commonly reported threshold is 1 year. This definition is however arbitrary. It is more important to determine whether IE was acquired perioperatively and which microorganism is involved [3].

Some risk factors appear more frequently, such as a recent episode of infectious endocarditis, postoperative bloodstream infection and surgical wound infection [7]. However, others are not well defined in the literature and results between different series vary. For example, choice of prosthesis (mechanical vs. biological), position (mitral vs. aortic), concomitant coronary surgery, cardiopulmonary bypass time and many others show controversial results [2, 3, 8, 9].

Aim

The aim of this study was to present our experience and evaluate the valve-related factors and the incidence of PVE.

Material and methods

Patient selection

This retrospective study was conducted at the Clinic of Cardiac Surgery at the National Institute of Cardiovascular Diseases in Bratislava, and included patients who underwent cardiac surgery for prosthetic valve endocarditis at our clinic within the years 2010–2018. During that time 36 (0.86%) patients were operated on due to PVE from

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a total of 4165 valve procedures. Indications for surgery included severe hemodynamic impairment due to acute paravalvular insufficiency, prosthetic valve dysfunction due to vegetations, recurrent major embolism or large vegetations and abscess or perivalvular involvement.

Early PVE was defined as endocarditis of the prosthetic valve within a year after the primary operation. There were 13 patients with early and 23 with late onset PVE.

The patients' characteristics that were analysed were: gender, age, body mass index (BMI) and EuroSCORE II. Six (16.67%) patients were primarily operated for bacterial endocarditis and 23 (64%) patients had an infection during the perioperative period of the primary procedure. The following valve-related risk factors were analysed: type, size and position of the prosthetic valve. Patients who were treated conservatively, undiagnosed, contraindicated for operation or operated in different hospital were not included in the study. Informed consent and institutional review board permission were obtained to present these results.

Statistical analysis

After processing individual data we used Fisher's exact test to determine statistical significance. We preferred Fisher's test over the χ^2 test because some of the analysed groups of patients were relatively small and would cause the χ^2 test to be invalid. The probability randomness threshold was set for 0.01, meaning there is substantial evidence against the null hypothesis. Numerical variables were presented as mean with minimal, maximal and median values, and categorised variables were summarised by percentages. For the statistical analysis we used statistical analysis tools available at http://www.socscistatistics.com.

Results

In the period between 2010 and 2018 in our institution, 4165, aortic or mitral valvular procedures were performed and 36 (0.86%) patients patients had a reoperation due to PVE. There were 13 (36.1%) patients with early and 23 (63.9%) with late onset PVE .

The study population consisted of a total of 25 (69.44%) men and 11 (30.56%) women. The median age was 59.5 (34–81) years, BMI 28.5 (22.2–37.04) kg/m^2 and EuroSCORE II 11% (4–22.56). Twenty (55.56%) of these patients had infection in the perioperative period of the primary operation and 6 (16.67%) patients were primarily operated for bacterial endocarditis. Eleven patients had a bloodstream infection, 3 patients sternal wound infection, 3 patients postoperative pneumonia, 2 patients urinary tract infection, and 1 patient sternal wound infection and postoperative pneumonia. From the 6 patients who were primarily operated on for bacterial endocarditis, 2 had a positive postoperative prosthetic valve culture and 2 had a positive perioperative blood culture.

Biological vs. mechanical prosthesis

There was no statistically significant difference in the incidence of PVE in patients after aortic valve replacement, mitral valve replacement or Bentall procedure. In the aortic valve position the incidence for mechanical valves was 1.31% and 0.81% for biological valves (p = 0.2198), in the mitral valve position 1.35% for mechanical valve and 3.38% for biological valve (p = 0.4475), in the Bentall group 9.09% for mechanical composite graft and 0% for biological composite graft (p = 0.4475) (Table I).

Valve size

There was no statistically significant difference in the incidence of PVE between different valves sizes in aortic position both in the mechanical and biological valve group (p = 0.5879 and p = 0.9230 respectively) (Tables I, II).

Mitral repair vs. replacement

There was a statistically significant difference between occurrence of prosthetic infection between mitral repair and replacement both in mechanical (repair 0.095%, replacement 1.35%, p = 0.0416) and biological valve groups (repair 0.095%, replacement 3.38%, p = 0.0001).

Prosthesis position

There was no statistically significant difference between aortic and mitral position of mechanical valves (1.31% and 1.35% respectively, p = 1). In the biological group there was a statistically significant lower rate of PVE in aortic position compared to mitral (0.81% vs. 3.38%, p = 0.0128) (Table III).

Microbial agents

The most common microbial agent was *Enterococcus faecalis* (25%), followed by coagulase-negative staphylococci (22.22%) and *Staphylococcus aureus* (22.22%). Viridans streptococci were present in 5.56%. There was one

Table I. Results and incidence of prosthetic valve endocarditis overall

Procedure	Endocarditis	Total	Incidence (%)
AVR mechanical	12	916	1.31004367
AVR biological	15	1859	0.80688542
MVR mechanical	2	148	1.35135135
MVR biological	5	148	3.37837838
MVP	1	1053	0.09496676
Mechanical Bentall	2	22	9.09090909
Biological Bentall	0	19	0
Overall	36	4165	0.86

AVR – aortic valve replacement, MVR – mitral valve replacement, MVP – mitral valve repair.

Table II. Results and incidence of prosthetic valve endocarditis dependant on biological valve size (p = 0.9230)

Prosthesis size	Endocarditis	Total	Incidence (%)
19	1	151	0.66225166
21	3	477	0.62893082
23	7	622	1.12540193
25	3	340	0.88235294
27	1	140	0.71428571

Table III. Results and incidence of prosthetic valve endocarditis dependant on mechanical valve size (p = 0.5879)

Prosthesis size	Endocarditis	Total	Incidence (%)
19	2	67	2.98507463
21	1	153	0.65359477
23	4	252	1.58730159
25	1	157	0.63694268
27	1	94	1.06382979

case caused by *Pseudomonas aeruginosa* (2.78%), one case by *Morganella morganii* (2.78%) and one by oxacillin-resistant *Staphylococcus lentis* (2.78%). In 4 (11.11%) cases the haemocultures and peroperative swabs taken from the prosthesis were negative and in 4 (11.11%) cases the pathogen was not stated (information was acquired retrospectively from patient documentation).

In the early onset group the most common infective agent was *Staphylococcus aureus* (30.77%), followed by *Enterococcus faecalis* (23.08%) and coagulase-negative staphylococci (15.38%). In the late onset group the most common infective agent was *Enterococcus faecalis* (26.09%) and coagulase-negative staphylococci (26.09%), followed by *Staphylococcus aureus* (17.39%).

Out of 13 patients with early PVE 11 (84.62%) had an infection during the perioperative period of the primary operation (Table IV).

Mortality

The overall hospital mortality was 16.67% (6 patients). In the group with early onset of PVE the mortality was however almost double compared to late onset (23.08% vs. 13.04%).

Discussion

In our study the incidence of PVE was 0.86%, where 36.1% of the patients had early onset and 63.9% had late onset PVE. The incidence of PVE in the aortic position (29 patients, 80.56%) was higher than in the mitral position (7 patients, 19.44%). Our results show that the incidence of PVE is similar to that reported by other studies [1, 2, 6–9].

In our study, the presence of infection in the postoperative period of the primary operation was associated with an increased incidence of PVE, where 11 patients with early PVE had such infection. The most closely related infection, as in our study, was primary bloodstream infections, which is considered a causal factor for PVE, together with the direct contamination of the prosthesis that may occur during the surgical procedure [8, 10–13]. Other authors, like us have found the presence of surgical wound infection and fever in the postoperative period as a risk factor [9, 14, 15].

In our study, we found no statistically significant difference in the incidence of PVE between the use of mechanical or biologic prosthetic valves. Flynn *et al.* [16] found, in a meta-analysis of surgical outcomes comparing mechanical valve replacement and bioprosthetic valve replacement in infective endocarditis, no significant difference in risk of recurrent endocarditis between mechanical and biological valves. They recommend that the decision of which type of valve prosthesis should be implanted be based on patient age, co-morbidities and preferences. Moreover, the European Society of Cardiology guidelines for the management of infective endocarditis state that PVE affects biological and mechanical valves equally [3]. The current AATS guidelines [17] for surgical treatment of endocarditis state that for patients requiring valve replacement, there is little evidence that risk of recurrent infection is different between mechanical and tissue prostheses. They recommend that the choice of replacement valves should be based on the usual criteria. However, in recent registry studies from Sweden and Denmark when comparing incidence of endocarditis following valve replacement of non-infected pathologies, bioprostheses were associated with higher risk of endocarditis than mechanical prostheses [2, 18].

An alternative, especially useful in the aortic position in infective endocarditis with significant disruption of the annulus, is the homograft. Several works appear to indicate that homografts may be more resistant to infection than either biological or mechanical prostheses [19, 20]. However, others have shown no difference in the rates of re-infection [21].

Concerning the valve size, in our study, there was no statistically significant difference in the incidence of PVE between different valve sizes in the aortic position both in the mechanical and biological valve group. In the published literature, there are no data on the association between

Table IV. Infective agents

Infective agent	Total		Early		Late	
	N	%	*N*	%	*N*	%
Negative swabs	4	11.11	0	0.00	4	17.39
Not stated	4	11.11	1	7.69	3	13.04
Staphylococcus aureus	8	22.22	4	30.77	4	17.39
Enterococcus faecalis	9	25.00	3	23.08	6	26.09
Coagulase-negative staphylococci	8	22.22	2	15.38	6	26.10
Streptococcus viridans	2	5.56	0	0.00	2	8.69
Staphylococcus lentis oxacillin resistant	1	2.78	1	7.69	0	0.00
Pseudomonas aeruginosa	1	2.78	0	0.00	1	4.35

the valve size of the prosthetic valve and the incidence of PVE.

A purported advantage of mitral valve repair over replacement is greater freedom from valve-related morbidity, including endocarditis. In our study a statistically significant difference was found between occurrence of prosthetic infection between mitral repair and replacement both in the mechanical and the biological valve group. This finding is similar to data published by other authors, who reported ten-year freedom from endocarditis after mitral valve repair 95% to 99% [22–24].

In our study, we identified a higher incidence of PVE in biological valves in the mitral position than in the aortic position. Concerning the mechanical valves there was no difference. The low number of patients with PVE after mitral valve replacement may contribute to this finding. In contrast, data from other authors showed no difference in the incidence of PVE according the valve position, or reported that the aortic position is more prone to infection [5–8, 25].

The most common microbial agent reported in our study was *Enterococcus faecalis*, followed by coagulase-negative staphylococci and *Staphylococcus aureus*. In the early onset group the most common infective agent was *Staphylococcus aureus*, whereas in the late group the most common agent was *Enterococcus faecalis*. Moreover, infection with *S. aureus* is the leading cause of PVE in most epidemiologic studies and represents a high-risk subgroup in this population [25, 26]. On the other hand, other authors reported *S. epidermidis* as the most frequent causative microorganism [7, 27].

Overall mortality in our study was 16.67%, which is comparable with data from other studies. A meta-analysis by Mihos *et al.* [5] and a multicentre analysis from Germany [25] reported 30-day mortality of 25% and 19.6% respectively. The mortality in patients in our study with early PVE was almost twice as high (13.04% vs. 23.08%) compared with late PVE. Higher mortality in early than in late PVE was also reported by Tugtekin *et al.* [6].

There are some limitations in our study that should be considered when interpreting the results. It is a single centre retrospective study, with a small cohort of patients. The small number of patients in the cohort may influence the results.

Conclusions

Based on our experience, PVE has a high mortality. Early onset PVE is less common but has higher mortality compared to the late onset. Mitral valve repair was less prone to develop PVE, and valve-related factors (type and size of the valve, valve position) did not have any influence on the incidence of PVE.

Disclosure

The authors report no conflict of interest.

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