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Prosthetic valve endocarditis: surgical complexity, microbiological profile, and medium-term survival outcomes

Endocarditis valvular protésica: complejidad quirúrgica, perfil microbiológico y resultados de sobrevida a mediano plazo

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ABSTRACT

Introduction: prosthetic valve endocarditis is the most severe form of endocarditis. Due to its high complexity, it is imperative to analyze clinical experience and outcomes, as well as the local microbiological profile and survival rates using current surgical techniques. **Objective:** to evaluate the surgical management of prosthetic valve endocarditis and its clinical outcomes, incidence, microbiological profile, clinical characteristics, echocardiographic findings, surgical techniques employed, and short- and medium-term survival of patients operated on at our institution during the period from January 1, 2022, to December 31, 2024. **Material:** a retrospective, observational, and descriptive study. It included all patients undergoing cardiac surgery at the Hospital during the specified period (n = 655). Categorical variables are expressed as absolute frequencies and percentages. Survival was estimated using the Kaplan-Meier method. **Results:** incidence was 2.9%, with 19 cases of prosthetic endocarditis. Mechanical prosthetic valves were the most affected structure, with 84.2% of cases. Early endocarditis accounted for 52.6%, and late endocarditis for 47.4%. Risk factors identified included diabetes mellitus, advanced age, and a history of native valve endocarditis. Staphylococci were isolated in 73.6% of cases. Echocardiographic findings included

RESUMEN

Introducción: *la endocarditis de válvula protésica es la forma más grave de endocarditis. Por su alta complejidad es imperativo analizar la experiencia y los resultados clínicos, así como el perfil microbiológico local y tasas de sobrevida con las técnicas quirúrgicas actuales.* ***Objetivo:*** *evaluar el manejo quirúrgico de la endocarditis de válvula protésica y sus resultados clínicos, incidencia, perfil microbiológico, características clínicas, hallazgos ecocardiográficos, las técnicas quirúrgicas empleadas y sobrevida a corto y mediano plazo de los pacientes operados en nuestra institución durante el periodo 01 de enero 2022 al 31 de diciembre 2024.* ***Material:*** *estudio retrospectivo, observacional y descriptivo. Incluyó a todos los pacientes sometidos a cirugía cardíaca en el Hospital durante el periodo señalado (n = 655). Las variables categóricas se expresan en frecuencias absolutas y porcentajes. La sobrevida se estimó por Kaplan-Meier.* ***Resultados:*** *la incidencia fue del 2.9%, con 19 casos de endocarditis protésica. La prótesis mecánica fue la más afectada, con 84.2% de los casos. El 52.6% fueron endocarditis temprana y 47.4% tardía. Los factores de riesgo detectados fueron diabetes mellitus, edad avanzada y antecedente de endocarditis de válvula nativa. Se aisló estafilococos en 73.6%. Hubo hallazgos ecocardiográficos como dehiscencia de prótesis, abscesos y fístulas.*

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prosthesis dehiscence, abscesses, and fistulas. Mortality was 36.8%, and survival was 63.1%. **Conclusions:** prosthetic valve endocarditis treated surgically at our center represents one of the most lethal pathologies in cardiovascular surgery. Perivalvular invasion (dehiscence, abscesses, and fistulas) constitutes a primary surgical indication. The high survival rate validates the strategy of aggressive and early surgical intervention.

Keywords: cardiac surgical procedures, complications, bacterial endocarditis, endocarditis, prosthetic valve, heart valve prosthesis, infections, survival rate.

*La mortalidad fue 36.8% y sobrevida de 63.1%. **Conclusiones:** la endocarditis de válvula protésica tratada quirúrgicamente en nuestro centro representa una de las patologías más letales en cirugía cardiovascular. La invasión perivalvular (dehiscencia, abscesos y fístulas) son indicación quirúrgica primaria. La alta sobrevida valida la estrategia de intervención quirúrgica agresiva y temprana.*

***Palabras clave:** procedimientos quirúrgicos cardiacos, complicaciones, endocarditis bacteriana, endocarditis, válvula protésica, prótesis valvular cardiaca, infecciones, tasa de supervivencia.*

Abbreviations:
IE = infective endocarditis
PVE = prosthetic valve endocarditis

Infective endocarditis (IE) is a cardiovascular pathology with significant morbidity and mortality. Within its clinical spectrum, prosthetic valve endocarditis (PVE) represents the most severe and challenging form of the disease, constituting a major public health problem in the context of valvular heart surgery.[1-3]

PVE occurs in 1 to 6% of patients with a valvular implant, with an annual incidence of 0.3 to 1.2% per patient-year. In various international registries (such as the Euro Heart Survey and the ICE-PCS study), PVE is responsible for 20 to 30% of all cases of infective endocarditis. PVE is classified as early or late based on the time elapsed since the valve replacement surgery, being defined as less than or equal to 12 months for early PVE and greater than 12 months for late PVE. This distinction is crucial due to significant differences in microbiological profiles and pathogenesis.[3-6]

The etiological profile of PVE varies according to temporality. Early PVE, which develops in the perioperative period, is associated with nosocomial infections and is primarily caused by Staphylococcus aureus, *Staphylococcus epidermidis*, or Gram-negative pathogens and fungi. These microorganisms have a high affinity for implanted surfaces and are capable of producing an antibiotic-resistant biofilm; coagulase-negative staphylococci susceptible to novobiocin are particularly frequent. Conversely, late PVE tends to mimic the pattern of native valve endocarditis, with a predominance of streptococcal infections. Additional risk factors include the type of prosthesis used, postoperative infections affecting the sternum or urinary tract, and performing the initial valve replacement surgery during active endocarditis.[1,2,7-9]

The treatment of PVE requires a multidisciplinary approach, where surgery is considered the best therapeutic option for complicated cases. The main indications for surgical re-intervention include severe congestive heart failure, the presence of large vegetations (> 10 mm) with embolism risk, periprosthetic dehiscence, the formation of perivalvular abscesses or fistulas, and persistent sepsis despite effective antibiotic treatment. Surgical options range from simple valve replacement to complex reconstruction of the aortic root with allografts, especially in the presence of extensive periannular involvement.[2,5,6,10-13]

Despite technical advances, PVE is associated with high morbidity and a mortality rate of 20 to 40%. Poor prognostic factors include advanced age, diabetes mellitus, staphylococcal or fungal infections, multi-valve involvement, and hemodynamic instability. It has been established that the most significant risk factor for infection recurrence and mortality is denying surgery when a clear indication exists.[2,3,6,11]

MATERIAL

A retrospective, observational, and descriptive study was conducted. The population included all patients undergoing cardiac surgery at our institution during the period from January 1, 2022, to December 31, 2024 (n = 655). The specific sample for data analysis consisted of 19 patients diagnosed with prosthetic valve endocarditis (PVE) who underwent surgical management during the 2022 to 2024 period.

Patients of any age and sex with a diagnosis of PVE by modified Duke criteria (2023) and patients undergoing cardiac surgical re-intervention for PVE were included. Patients with NVE and incomplete medical records were excluded.

Categorical variables (e.g., pathogen, affected valve) are expressed as absolute frequencies and percentages (proportions). Continuous variables (e.g., age, vegetation size) are expressed as medians. The incidence and frequency of PVE were estimated relative to the total number of cardiac surgeries. The Kaplan-Meier method was used for survival analysis.

RESULTS

Findings were obtained from the retrospective analysis of the cohort of 19 patients undergoing surgery for PVE between 2022 and 2024.

PVE had an incidence of 2.9% of total cardiac surgeries and represented 32.2% of all infective endocarditis cases operated

on at the hospital. The mean age of the cohort was 51.8 years. 68.4% (n = 13) of the patients were men. The majority of PVE cases developed on mechanical prostheses (84.2%, n = 16), while only 15.8% (n = 3) were observed on previously placed bioprosthesis. 52.6% of patients presented with early PVE and 47.4% with late PVE *(Table 1)*.

Regarding identified risk factors potentially associated with the development of PVE, eight patients had diabetes mellitus, six were of advanced age, and one patient had chronic renal failure. Seven patients had a history of prior surgery for native valve endocarditis, suggesting a highly susceptible population. The most common precursor infections were pneumonia (n = 3), wound infection (n = 2), and periodontal infection (n = 2). Clinically, fever was present in 16 patients, and NYHA functional class III was the most common, at 84.2%. Six patients presented with an ischemic cerebrovascular event, the origin of which was determined to be vegetation embolism. Four patients with PVE arrived in septic shock.

Regarding microbiological etiology results, staphylococci were the predominant pathogens, constituting 73.6% of cases (n = 14). Seven patients grew *Staphylococcus aureus* in blood cultures, seven grew *Staphylococcus epidermidis*, and five grew *Enterococcus faecalis*.

Regarding echocardiographic findings, all patients underwent transesophageal echocardiography to confirm the diagnosis. The aortic valve was the most affected (n = 10, 52.6%), followed by combined aortic and mitral involvement (n = 4). Vegetations were detected in 84.2% of patients (n = 16), and the average vegetation size was 12 mm. All patients presented some degree of prosthetic dysfunction. Perivalvular findings, indicative of uncontrolled local infection, were common and severe: prosthesis dehiscence and paravalvular leak (n = 10), abscesses (n = 7), and intercavitary fistulas (n = 6), with the most frequent being between the aorta and the right atrium. Other findings like pannus (n = 4) and thrombus (n = 3) were less common. The average left ventricular ejection fraction was found to be decreased to 45%, associated with the fact that the vast majority of patients were in NYHA functional class II-III at diagnosis.

Table 1: Results by category (N = 19).

Characteristics	n (%)
Demographics	
Male	13 (68.4)
Female	6 (31.6)
Type of prosthesis	
Mechanical	16 (84.2)
Bioprosthetic	3 (15.8)
Pathogen	
Staphylococcus aureus	7 (36.8)
Staphylococcus epidermidis	7 (36.8)
Enterococcus faecalis	5 (26.3)
Type of prosthetic valve endocarditis	
Early	10 (52.6)
Late	9 (47.4)
Location	
Aortic (isolated)	10 (52.6)
Aortic and mitral	4 (21.0)
Aortic and tricuspid	1 (5.3)
Mitral (isolated)	3 (15.8)
Tricuspid (isolated)	1 (5.3)

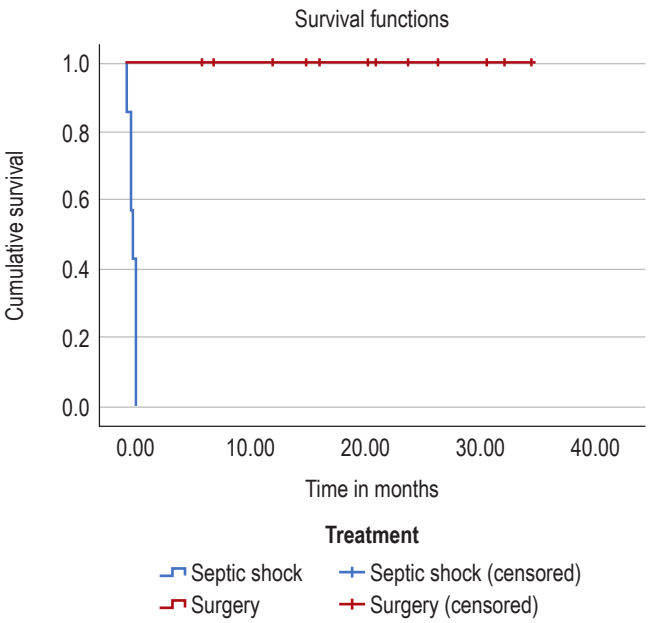

Figure 1: Survival analysis. An abrupt drop in the curve (light blue) is evident in patients who arrived in septic shock, whose survival did not exceed six days. The red curve represents patients who underwent surgery and whose hemodynamic status was not severely compromised, evidencing notable medium-term survival.

Thirty-day hospital mortality was high. Seven patients died: two died in the ward and five patients in the immediate postoperative period (i.e., in less than 30 days), representing a hospital mortality of 36.8%. Survival analysis (Kaplan-Meier) showed an abrupt drop in the curve in the first six days, stabilizing thereafter. The estimated cumulative survival probability at medium term (until the end of follow-up) was 63.1% *(Fig. 1)*.

DESCRIPTION OF FINDINGS AND SURGICAL TECHNIQUE

The surgical indication was based on the presence of vegetations and prosthetic valve dysfunction leading to clinically significant heart failure. The hemodynamic status was evaluated and considered, particularly for the four patients who arrived in septic shock; they were given support with

vasopressors and broad-spectrum antibiotic coverage prior to surgical resolution, to achieve minimum hemodynamic stability before surgery to tolerate the surgical event. However, echocardiographic findings suggestive of uncontrolled local infection, such as abscesses, prosthetic dehiscence, and fistulas, ratified the need for emergent surgery as the first line of treatment. It is important to note that all patients, from readmission and suspicion of PVE, received prophylactic antibiotic coverage with vancomycin until culture results and respective antibiograms were available.

As a preventive measure for surgery, the availability of femoral cannulas and vascular grafts was guaranteed for eventual peripheral cannulation if necessary. In this cohort, all patients were approached via median sternotomy, and femoral cannulation was performed in only two of them.

One of the most significant challenges in cardiac reoperation is successfully releasing adhesions and adequately exposing the heart and great vessels to achieve good vascular control *(Fig. 2)*. The risk of bleeding, myocardial wall rupture, dissection, and vascular catastrophe is very high in a reoperation, particularly during the release of adhesions.

Among the surgical findings, all patients had grade III and IV adhesions according to the Zulhke classification. In two patients who experienced greater hemodynamic deterioration, ventricular fibrillation occurred during opening and adhesion release. Upon attempting to free tissue for electrical cardioversion, dehiscence of the previous aortorrhaphy occurred, necessitating femoral cannulation; however, despite vascular control, the ventricular fibrillation was refractory, and the tissue was not viable for repair due to poor quality, resulting in death.

Once exposure is achieved, it is important to manipulate the heart as little as possible to avoid embolization of vegetations attached to the valvular prostheses. Once in cardiac arrest, the affected prosthesis was identified, and as a first step, visible vegetations were extracted, followed by annular release of the prosthesis, preserving the greatest amount of fibrous tissue if possible, while simultaneously resecting infected, necrotic, or dehiscent tissue.

In all patients, the previous prosthetic valve was extracted and replaced with a new one *(Fig. 3) (Fig. 4)*.

Before placing sutures for the new prosthesis, the residual tissue in the annulus must be evaluated, and ventricular cavities explored as appropriate to avoid leaving residual thrombi or vegetations. In cases where abscesses were present, they were drained, tissue was cleaned, and the area was plicated with a pericardial patch, which aided in anchoring the sutures of the new valve *(Fig. 3)*.

There were situations where abscesses existed in the mitral-aortic continuity and the aortic root, as well as fistulas towards atrial cavities *(Fig. 4)*. In the case of fistulas, the defect is similarly repaired with a pericardial patch, isolating the cavities *(Fig. 3)*. In our case series, there was no need to perform surgery for resection and repair of the mitral-aortic continuity (Commando procedure), under the precept of maintaining the greatest amount of viable tissue and avoiding being more invasive with the myocardium.

One of the surgical decisions made concerns the depth of sutures in an already weakened annulus. Within our experience, each case and each annulus is individualized; however, in mitral replacements, greater care is taken not to injure the circumflex artery. Regarding rhythm disorders, principally atrioventricular blocks that could be generated, the risk and benefit of placing a definitive epicardial pacemaker versus not being able to reseat a new prosthesis in the patient are weighed. Therefore, if viable, the greatest amount of healthy tissue must be taken to anchor the new prosthesis. In our cohort, four patients presented complete AV block requiring placement of an epicardial pacemaker.

Finally, one of the variables also evaluated was the cardiopulmonary bypass time and aortic cross-clamp time. The mean CPB time was 210 minutes, and the aortic cross-clamp time was 130 minutes. The hospitalization time for patients who survived ranged between 42 to 50 days, associated with compliance with antibiotic therapy.

DISCUSSION

Our findings confirm the significant burden that PVE imposes on surgical practice. The incidence of 2.9% represents a high result, exceeding the upper limit of the reported incidence range (0.3 to 1.2%) per patient-year. In our center, PVE constituted 32.2% of all operated endocarditis cases, which is higher than the 20-30% generally reported in large registries such as the Euro Heart Survey and the ICE-PCS study. This high proportion could reflect a cohort with

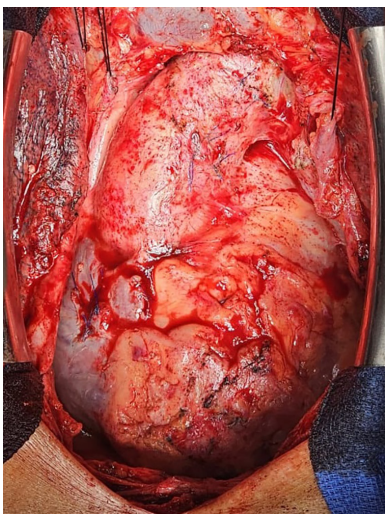

Figure 2:

Heart and great vessels exposed following adhesion release.

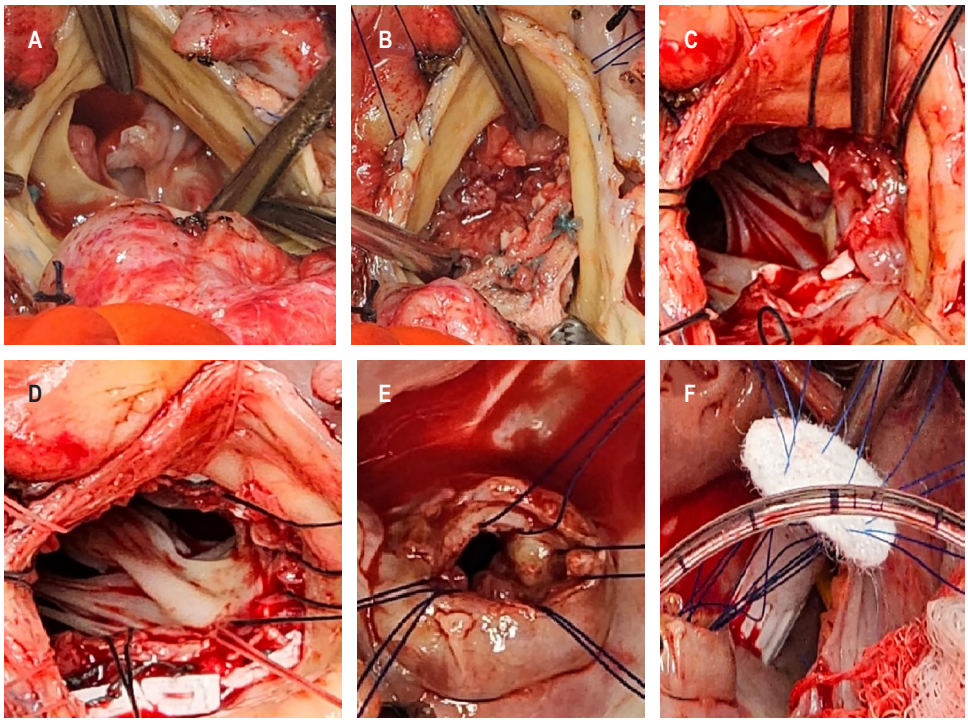

Figure 3:

A) Prosthetic valve endocarditis of a biological valve prosthesis in the aortic position; severe obstruction is evident. **B)** Prosthesis with dehiscence; extraction begins while preserving fibrous annular tissue. **C)** Residual aortic ring following valve prosthesis resection. Exploration of the left ventricle is performed to ensure no residual vegetations remain. **D)** The residual ring is cleaned of necrotic and infected tissue. At tear sites, it is plicated with a pericardial patch to reinforce the ring. Wide and loose sutures are placed to grasp the maximum amount of healthy ring. These sutures may pass through the previously placed pericardial patch for reinforcement. **E)** Fistula to the right atrium. Necrotic tissue is resected. **F)** Politetrafluoroetileno (PTFE) patch is placed for fistula closure.

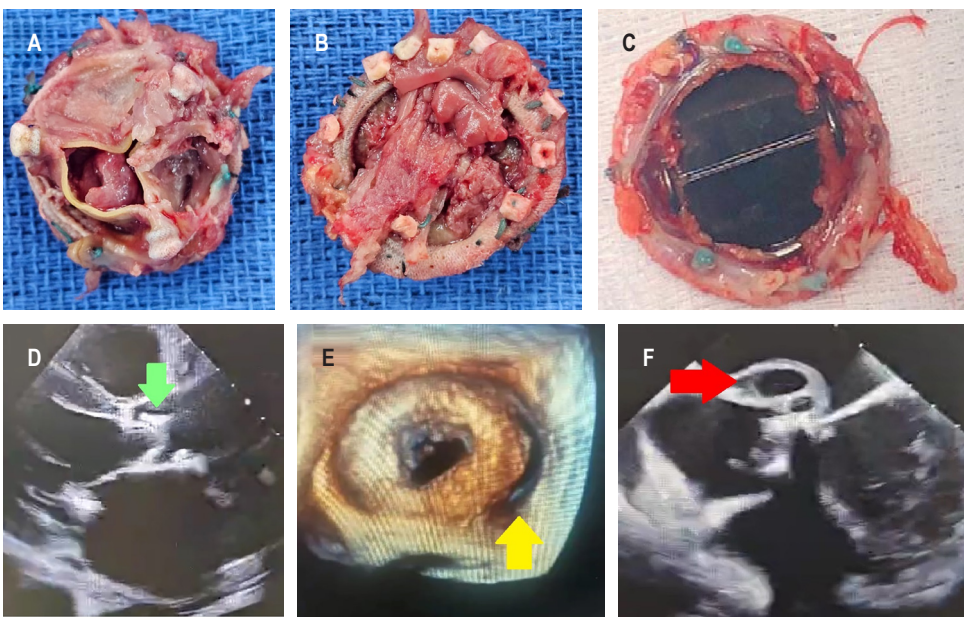

Figure 4:

A) Aortic surface. **B)** Ventricular surface of biological valve prosthesis with endocarditis. Abundant vegetations are observed obstructing and limiting opening. Fibrin tissue on leaflets and prosthesis cuff. **C)** Mechanical prosthesis with abundant pannus and vegetations limiting leaflet opening and closing. **D)** Vegetation attached to the arterial aspect of a mechanical prosthesis in the aortic position (green arrow). **E)** 3D transesophageal echocardiogram reconstruction of a biological mitral valve. Abundant pannus and prosthesis dehiscence with severe paravalvular leak are observed (yellow arrow). **F)** Abscess (red arrow) in the aortic root that caused a fistula towards the right atrium.

greater complexity or a more aggressive surgical policy at our center.[2,5,6,11,13]

Temporal classification revealed a slight predominance of Early PVE (52.6%). This form is invariably associated with a worse prognosis, as infections are nosocomial in origin, highly virulent, and develop on a myocardium still recovering from the initial surgery. Nevertheless, this result compels us to review and safeguard the correct execution of asepsis and antisepsis protocols followed within the institution. Regarding late PVE, there were cases where the presence of thrombi led to a higher risk of microbial seeding and development on the prostheses; during the review of medical records, incomplete adherence to anticoagulant treatment was evidenced. Another aspect identified in outpatient assessments, although not

evaluable in all patients due to incomplete follow-up notes, was neglect in home wound cleaning, as well as untreated dental infections. In particular, these were the patients who presented with septic shock upon admission and whose surgical findings were devastating. These findings suggest that sociocultural conditions may contribute to wound infection, poor clinical evolution, and consequently, a portal of entry for endocarditis development.[2,3,6,8,9,11]

The etiological profile of our cohort is consistent with the PVE pattern, especially early PVE. The predominance of staphylococci (73.6%), divided equally between *Staphylococcus aureus* (36.8%) and *Staphylococcus epidermidis* (36.8%), underscores the high burden of nosocomial pathogens. In the literature, coagulase-negative staphylococci *(S. epidermidis)* are the most frequent in early PVE due to their ability to form antibiotic-resistant biofilms on prosthetic material. The presence of *Enterococcus faecalis* in 26.3% of cases is another sign of the complexity of our cohort. While streptococci are more common in late PVE in some series, our results lean towards pathogens with high intrinsic or acquired resistance, explaining the high rate of antibiotic treatment failure associated with worse perioperative findings and greater cardiac tissue destruction.[3,5-9,12]

Echocardiographic findings evidence the destructive nature of the infection. Almost all patients had a vegetation attached to the prosthesis, and the average size of 12 mm is above the threshold of 10 mm considered a criterion for high embolic risk and an indication for surgery. A critical finding has been the high rate of perivalvular complications, such as dehiscence (52.6%), abscesses (36.8%), and intercavitary fistulas (31.6%). These complications are the result of local invasion by uncontrolled infection and are directly associated with the need for complex surgical procedures, such as annulus reconstruction or aortic root replacement. The predominant involvement of the aortic valve (73.6%) is especially concerning, as infection in this position tends to extend to the fibrous skeleton of the heart, complicating surgery and affecting prognosis.[3-6,10,11]

The analysis of perioperative findings demonstrated extensive tissue destruction secondary to infection. While an attempt was always made to be as conservative as possible, the removal of the greatest amount of infected tissue was guaranteed to prevent recurrence. All patients underwent prosthesis replacement, and in more severe cases of intercavitary fistulas, defects were repaired with bovine pericardial patches. One of the main complications in the perioperative period was conduction system blocks, which in some cases required definitive epicardial pacemaker placement. A common surgical finding in all patients was firm grade III and IV adhesions based on the Zulhke classification, which led to longer surgical times. In two cases of death, femoral cannulation had to be performed; however, the myocardial tissue was friable and of poor quality, not viable for repair. The cardiopulmonary bypass time was somewhat prolonged; however, the aortic cross-clamp time was shorter, reflecting the myocardial stunning that occurs following reoperation and extensive myocardial manipulation. Specifically, after aortic unclamping, we maintained the patient on circulatory assistance for a considerable time until achieving adequate myocardial contractility and tolerance to weaning from cardiopulmonary bypass.[1-3,5,6,12,13]

Our hospital mortality of 36.8% is at the upper end of the range reported in the literature (20-40%). In this context, it is important to mention its relationship with pre-existing risk factors in our cohort, such as cases of septic shock and cerebral embolism upon admission, which are predictors of poor outcomes. The Kaplan-Meier analysis offers a crucial perspective. The rapid drop in survival in the first six days confirms that mortality is dominated by the acute surgical phase and postoperative multi-organ failure. However, the subsequent stabilization of survival at 63.1% suggests that surgical intervention, although carrying a high initial risk, is effective in controlling the infection and its complications. This sustained survival highlights the clinical maxim that "denying surgery when an obvious indication exists is the most important risk factor for mortality." Patients who manage to overcome the perioperative phase benefit from the radical debridement that only surgery can offer.[1-3,5,6,10,11,13]

The results of this study reinforce the need for aggressive diagnostic evaluation (including TEE and cardiac CT, according to guidelines) and early surgical decision-making in the face of any sign of medical treatment failure or perivalvular complication. The high number of perivalvular complications in our series demands that surgical protocols emphasize radical debridement and the use of complex reconstruction techniques, such as the use of homografts or aortic root replacement, when the annulus is compromised.[2,3,6,11-14]

CONCLUSIONS

PVE treated surgically at our center during the 2022-2024 period reaffirms its status as one of the most lethal pathologies in cardiovascular surgery. The analysis demonstrated that our cohort of 19 patients presented high complexity, characterized by a predominance of early PVE (52.6%) and an etiology marked by highly virulent pathogens (staphylococci and enterococci in almost 100% of cases). Echocardiographic findings confirmed extensive perivalvular invasion (dehiscence, abscesses, and fistulas) in the majority of cases, which constituted the primary surgical indication.

Hospital mortality was high (36.8%), aligning with the upper ranges of international literature. However, the Kaplan-Meier survival analysis revealed that all mortality was concentrated in the immediate postoperative period

(first six days). Patients who overcame this critical phase presented robust medium-term survival (63.1%), validating the strategy of aggressive and early surgical intervention as the fundamental rescue treatment in the face of medical management failure and local infectious complications.

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