Infective Endocarditis in Patients with Ventricular Septal Defect

Endocardite infectieuse chez les patients porteurs d'une communication interventriculaire

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Summary

Introduction: Infective endocarditis (IE) is considered a rare complication in patients with ventricular septal defect (VSD), and current international guidelines classify VSDs as low-risk lesions not requiring antibiotic prophylaxis. However, IE in this population may lead to severe complications and life-threatening outcomes.

Methods: We report a retrospective case series of patients with VSD complicated by infective endocarditis, managed in a tertiary pediatric cardiology center between January 2021 and June 2025. Patient history, clinical, laboratory, and detailed echocardiographic data were collected. Therapeutic management and any potential complications were also documented.

Results: Twelve patients were included. The median age at diagnosis was 12 years (range: 1–68 years), with 42% of patients being adults. All VSDs were perimembranous, including one Gerbode-type defect, and the majority were restrictive. Streptococci were the most frequently isolated microorganisms. Echocardiography revealed vegetations predominantly involving the tricuspid valve, VSD margins, and pulmonary valve, with rare localizations including the pulmonary artery band. Pulmonary embolism occurred in 42% of cases, and pericardial effusion was observed in three patients, one complicated by tamponade. Surgical intervention was required in 58% of patients, mainly due to uncontrolled infection, large mobile vegetations with embolic events, or severe tricuspid regurgitation. Two patients died, highlighting the potential severity of this condition.

Conclusion: Infective endocarditis in patients with ventricular septal defect can result in serious and sometimes fatal outcomes. These findings suggest that the risk of IE in VSD patients may be underestimated and support the need for careful follow-up, strict preventive measures, and reconsideration of current prophylactic strategies.

Keywords

VSD, infective endocarditis, children, complications, localization.

Résumé

Introduction : L'endocardite infectieuse (EI) est considérée comme une complication rare chez les patients porteurs d'une communication interventriculaire (CIV), et les recommandations internationales actuelles classent les CIV parmi les lésions à bas risque ne nécessitant pas d'antibioprophylaxie. Cependant, l'EI dans cette population peut entraîner des complications sévères et mettre en jeu le pronostic vital.

Méthodes : Nous rapportons une série de cas rétrospective de patients porteurs d'une CIV compliquée d'endocardite infectieuse, pris en charge dans un centre tertiaire de cardiologie pédiatrique entre janvier 2021 et juin 2025. Les antécédents médicaux, les données cliniques, biologiques et échocardiographiques détaillées ont été recueillis. La prise en charge thérapeutique ainsi que les complications éventuelles ont également été documentées.

Résultats : Douze patients ont été inclus. L'âge médian au diagnostic était de 12 ans (extrêmes : 1–68 ans), avec 42 % de patients adultes. Toutes les CIV étaient de type périmembraneux, incluant une anomalie de type Gerbode. Les streptocoques étaient les microorganismes les plus fréquemment isolés. L'échocardiographie a révélé des végétations touchant principalement la valve tricuspide, les bords de la CIV et la valve pulmonaire. Une embolie pulmonaire est survenue dans 42 % des cas, et un épanchement péricardique a été observé chez trois patients, dont un compliqué de tamponnade. Une intervention chirurgicale a été requise chez 58 % des patients, principalement en raison d'une infection non contrôlée, de végétations volumineuses et mobiles associées à des événements emboliques, ou d'une insuffisance tricuspide sévère. Deux patients sont décédés, soulignant la gravité potentielle de cette affection.

Conclusion : L'endocardite infectieuse chez les patients porteurs d'une CIV peut avoir des conséquences graves et parfois fatales. Ces résultats suggèrent que le risque d'EI chez les patients porteurs d'une CIV pourrait être sous-estimé et soutiennent la nécessité d'un suivi attentif, de mesures préventives strictes et d'une réévaluation des stratégies prophylactiques actuelles.

Mots-clés

CIV, endocardite infectieuse, enfants, complications, localisation

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INTRODUCTION

Ventricular septal defects (VSDs) are the most prevalent congenital cardiac heart disease in children and the second most common heart defect in adults, after bicuspid aortic valves (1). It represents 30% of congenital cardiac malformations at birth, 20% during childhood, and 10% in adult life (2).

The long-term prognosis is generally favorable. While symptomatic cases or those associated with complications require closure, asymptomatic cases typically do not necessitate intervention. However, regular follow-up remains essential to promptly identify potential complications, particularly the long-term risk of infective endocarditis (IE) (4).

IE represents a critical turning point in the clinical course of the VSD. It is a severe complication associated with significant morbidity and mortality which makes it crucial to prevent its occurrence. However, European and American guidelines classify VSDs as relatively low-risk for IE and therefore do not recommend antibiotic prophylaxis. Instead, they advocate for non-specific preventive measures (5-6).

This study included patients with VSD complicated by IE, with the aim of characterizing the clinical, microbiological, and echocardiographic features of this condition.

METHODS

This retrospective study included patients diagnosed with ventricular septal defect (VSD) complicated by infective endocarditis (IE) and hospitalized in our Pediatric Cardiology department between January 2021 and June 2025.

Inclusion criteria were:

- All age groups were included.
- Patients with main diagnosis of VSD isolated or associated with simple cardiac lesions.
- Patients who met the modified Duke criteria for definite infective endocarditis (6).

Non-inclusion criteria was:

Patients with associated complex congenital heart defects (e.g., tetralogy of Fallot, pulmonary atresia with VSD, or double outlet right ventricle).

Exclusion criteria were :

- Patients lost to follow-up.
- Patients whose medical records lacked essential clinical or diagnostic data.

For each patient, clinical, paraclinical, therapeutic, and outcome-related parameters were systematically assessed. We investigated medical history, pathological conditions and the presence of any genetic syndrome.

Clinical assessment included evaluation of body temperature, signs of heart failure, dermatological and osteoarticular findings, and any indicators of complications or possible entry points for infection.

The paraclinical investigations studied were mainly the inflammatory assessment (C reactive protein and white blood count), hemoglobin level and the blood cultures.

Echocardiography was a key examination. Type of VSD was recorded (peri-membranous VSD, muscular, inlet, or outlet VSDs). Hemodynamic assessment of the VSD relied on the analysis of shunt direction and velocity across the defect, estimation of pulmonary artery pressure, and the possible presence of right ventricular outflow tract obstruction. Detailed evaluation of the vegetations was done including site, number and size (small <10mm, moderate 10-20mm, and large >20mm).

Transesophageal echocardiography was done only if needed.

Thoraco-abdominopelvic and cerebral CT scan was performed, with brain MRI conducted when necessary, to screen for complications.

Therapeutic management was studied including the treatment of the portal of entry when identified, antibiotic therapy and the cardiac surgery mainly its indication, type and time of surgery.

Short and medium terms outcomes were evaluated based on hospital records and follow-up.

Statistical analysis was performed using SPSS-25 statistical software. Continuous variables are described as medians and interquartile ranges (IQRs), categorial variables as counts and frequencies.

RESULTS

Twelve patients met the inclusion criteria and were enrolled during the study period. A male predominance was observed, with 67% (n=8) of patients being male and 33% (n=4) female, yielding a sex ratio of 2.

The median age was 12 years at the time of the diagnosis of IE. Minimum age was one year and maximum was 68 years. Only one patient was under the age of two and 5 patients (42%) over the age of 18 years old.

Four patients were diagnosed with Down syndrome (33%), and one presented with a polymalformative syndrome (Facial dysmorphism, short stature and triventricular cerebral ventriculomegaly).

All patients had a previously diagnosed ventricular septal defect (VSD), all of which were peri-membranous. One patient presented with a Gerbode-type VSD, characterized by a left ventricle-to-right atrium shunt. The VSDs were predominantly restrictive (91%). One patient, was diagnosed with infective endocarditis at the age of five, had undergone surgical intervention at one month of age, due to the presence of a large VSD associated with aortic coarctation. The procedure included aortic arch repair and pulmonary artery banding.

Within our population, one patient had moderate infundibular stenosis, and two had a non-obstructive subaortic diaphragm.

Mild aortic regurgitation secondary to Laubry–Pezzi syndrome, defined by the prolapse of an aortic valve cusp into the adjacent VSD secondary to the Venturi effect, was observed in two patients. One of them was identified as high risk for infective endocarditis (IE), with a history of aortic valve IE at 31 years of age treated conservatively with antibiotics. The patient declined surgical repair, and a recurrence affecting the pulmonary valve was observed seven years later.

Demographic features and medical history are summarized in Table 1.

Table 1. Demographic Features and medical history

	Frequency	Percentage (%)
Gender		
Male	8	67
Female	4	33
Age		
< 2 years	1	8
2-10 years	5	42
11 - 18 years	1	8
> 18 years	5	42
Down Syndrome	4	33
Type of VSD		
Peri-membranous (PM)	11	91
PM + Gerbode-type	1	8
Characteristic of VSD		
Restricted	11	91
Large	1	8
Complications		
Laubry-Pezzi	2	17
Infundibular stenosis	1	8
Subaortic diaphragm	2	17
Surgical history		
Pulmonary banding + Aortic arch repair	1	8
Previous episode of IE	1	1

IE: Infective endocarditis; PM: peri- membranous; VSD: Ventricular septal defect

Fever was observed in 83% of cases (n = 10). It was prolonged low-grade fever often followed a fluctuating course, resulting in a delayed and insidious clinical presentation.

In the remaining two patients (17%), the diagnosis was suspected due to weight loss and anorexia. Among adult patients, symptoms of heart failure were noted in two cases (17%) and was effectively managed with medical treatment.

A potential portal of entry was identified or suspected in 50% of cases (n = 6), with a dental origin in 33% (n = 4) and a dermal origin in 17% (n = 2).

Biological assessment revealed elevated C-reactive protein (CRP) levels in all patients, with a mean value of 79 ± 31 mg/L. Leukocytosis was observed in 5 patients (42%), while one patient presented with leukopenia. Inflammatory anemia was noted in all cases. Two patients (17%) required blood transfusion due to severe, poorly tolerated anemia, with hemoglobin levels of 4.8 g/dL and 5.3 g/dL respectively.

Blood cultures were performed for all patients (Table2). They were positive in 83% of the cases (n=10). Streptococcus was the most commonly isolated pathogen, identified in 42% of the patients. Staphylococcus was found in 17%. They remained negative in 2 cases (17%), who were self-medicated with antibiotics.

Table 2. Blood culture in our study population

Blood culture	Type	Frequency (%)
Streptococcus		5 (42)
	Streptococcus Anginosus	1 (8)
	Streptococcus Sanguinis	1 (8)
	Streptococcus Oralis	1 (8)
	Streptococcus Mitis	1 (8)
	Streptococcus Gallolyticus	1 (8)
Staphylococcus		2 (17)
	Staph. Hémolyticus	1 (8)
	Staph. Hominis	1 (8)
Gram-negative bacilli		3 (25)
	Klebsiella Pneumonia	1 (8)
	Klebsiella Oxyttoca	1 (8)
	Achromobacter xylosoxidans	1 (8)
Negative blood culture	-	2 (17)

All our patients underwent transthoracic echocardiography, and none required complementary transesophageal echocardiography. The mean size of vegetation was 12.6 ± 6.87 with a minimum size of 3 mm and a maximum size of 30 mm.

Isolated tricuspid valve vegetations was documented in 5 patients (42%). One patient had an isolated pulmonary valve vegetation (8%).

Vegetations on the margins of the VSD floating in the right

ventricle were documented in five patients (42%). Two cases were isolated and for another two it was associated with additional vegetations on the septal leaflet on the tricuspid valve, in a patient with Laubry-Pezzi syndrome and a patient with Gerbode defect, respectively. In the fifth patient, vegetations involved both the tricuspid and pulmonary valves and extending into the pulmonary trunk and its main branches. (Figures 1 and 2).

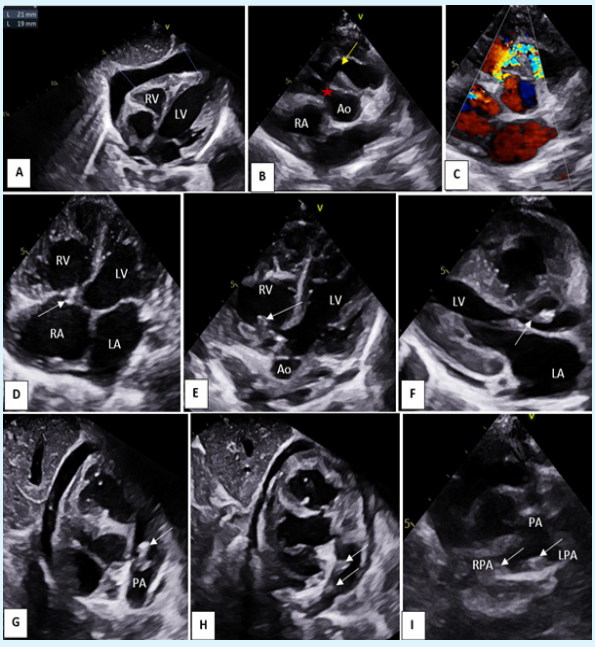

Figure 1. Echocardiographic findings of a perimembranous VSD complicated by infective endocarditis and pericardial effusion;

A: Subcostal view: moderate pericardial effusion (21 mm) along the right-sided chambers.

B: Parasternal short-axis view, perimembranous VSD (asterisk) and infundibular stenosis (yellow arrow).

C: Parasternal short-axis color Doppler, left-to-right shunt across VSD and flow acceleration at the infundibulum.

D: Apical four-chamber view, tricuspid valve vegetation (white arrow).

E: Apical five-chamber view, large vegetation on VSD margin in the RV (white arrow).

F: Parasternal long-axis view, vegetation on VSD margin prolapsing into LVOT (white arrow).

G: Subcostal view, vegetation on pulmonary valve (white arrow).

H: Subcostal view, vegetations on main and right pulmonary arteries (white arrows).

I: High parasternal short-axis view, vegetations at pulmonary bifurcation and right pulmonary artery (white arrows).

Ao: aorta, LA: left atrium, LPA: left pulmonary artery, LV: left ventricle, LVOT: left ventricle outflow tract, PA: pulmonary artery, RA: right atrium, RPA: right pulmonary artery, RV: right ventricle, VSD: ventricular septal defect

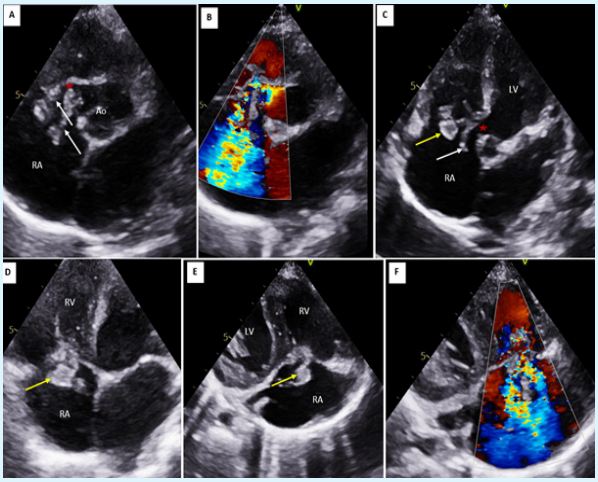

Figure 2. Echocardiographic finfings of a Gerbode defect complicated by infective endocarditis.

A: Parasternal short-axis view showing the Gerbode defect (asterisk) with vegetations on its margins (white arrows).

B: Color Doppler parasternal short-axis view demonstrating left ventricle–to–right atrium shunt through the VSD.

C: Apical five-chamber view demonstrating the Gerbode defect (asterisk), a vegetation on its margin (white arrow), and a tricuspid valve vegetation (yellow arrow).

D, E: Apical four-chamber and modified parasternal long-axis views showing tricuspid valve vegetations (yellow arrow).

F: Modified parasternal long-axis view showing severe tricuspid regurgitation.

Ao: aorta, LV: left ventricle, RA: right atrium, RV: right ventricle, VSD: ventricular septal defect

An unusual location of the vegetation on the pulmonary artery band was identified in a patient.

Pericardial effusion was detected in three patients (25%), all of whom had Down syndrome. In two cases, the isolated pathogen was Streptococcus, while in the third case, the pathogen was decapitated. The effusion was complicated with tamponade requiring pericardiocentesis in a patient.

A thoraco-abdominopelvic and brain computed tomography (CT) scan was performed in the majority of patients (83%). It was not conducted in two cases: in one patient, due to a known allergy to contrast agents, although no clinical signs of embolic events were observed. The second patient died within a few days of hospitalization due to a sudden, severe episode of massive hemoptysis, most likely caused by a mycotic pulmonary artery aneurysm, before the CT scan could be performed.

Pulmonary embolism was observed in five patients (42%). Mild respiratory symptoms were observed in these patients. Blood cultures were positive for Streptococci in three cases,

while one patient had negative cultures, due to prior antibiotic therapy. Transthoracic echocardiography revealed variable locations of the vegetations, including the margins of the VSD, the tricuspid valve, both the tricuspid valve and VSD margins, as well as the site of the pulmonary banding and pulmonary valve with subsequent extension of the vegetations into the pulmonary trunk and its branches. Vegetations were of moderate and large size.

Echocardiographic findings are detailed in Table 3.

Table 3. Echocardiographic findings in our study population

	Frequency	Percentage (%)
Vegetation localization		
Isolated		
Pulmonary	1	8
Tricuspid	5	42
VSD margins	2	17
Pulmonary banding	1	8
Multiple		
Tricuspid + VSD margins	2	17
Tricuspid + pulmonary + VSD margins	1	8
Vegetation size		
< 10	4	33
10 -20	6	50
> 20	2	17
Severe valvular insufficiency		
Tricuspid	2	17
Pericardial effusion	3	25
5-10 mm	2	17
10-20 mm	0	0
>20 mm	1	8
Embolic localization		
Pulmonary	5	42

All patients were treated with intravenous antibiotics, adapted to the antibiogram, or with empirical therapy in cases of negative cultures. When the portal of entry was identified, it was systematically treated.

Surgery was performed in 7 patients (58%), with a mean interval of 5 ± 5.8 months from diagnosis. Three patients (25%) underwent surgery due to uncontrolled infection despite appropriate antibiotic therapy. Two patients (17%) had surgery due to large and mobile vegetations with pulmonary embolism confirmed on CT imaging. Another two patients (17%) required surgery for severe tricuspid regurgitation.

Closure of the VSD was realized in all of the seven surgeries. Tricuspid annuloplasty was realized for 33% of our cases (n=4). One patient needed tricuspid valve replacement due to major damage and extensive vegetecotomy.

The clinical course was favorable in most cases (83%). In our study two patients (17%) died.

The first was a 27-year-old patient with Down syndrome whose management was delayed due to late presentation. After a few days of intravenous antibiotic therapy, he developed an acute episode of massive haemoptysis, most likely caused by mycotic pulmonary artery aneurysm.

The second was a one-year-old infant with a polymalformative syndrome who underwent surgical intervention—VSD closure and tricuspid annuloplasty—following two months of antibiotic therapy but died during the postoperative period.

DISCUSSION

We described the clinical, paraclinical, and therapeutic management in a series of twelve patients presenting with VSD complicated by IE.

Epidemiology

IE is considered a rare complication in patients with VSD. However, estimating its true incidence remains challenging due to inclusion bias and the heterogeneity of study populations. The Swiss Evaluation Registry for Pediatric Infective Endocarditis (SERPIE) involved 69 patients diagnosed with definite or possible IE. In this registry, congenital heart disease was present in 84% of cases, and VSD identified as a predisposing factor in 8 patients (11.5%) (7).

Age is a well-recognized influential risk factor for the development of IE, and should therefore be carefully considered. In our study, the median age was 12 years with only one patient under the age of two, while 5 patients (42%) were over the age of 18 years. Previous data reported that the estimated risk of IE in patients with VSD is 20 to 30 times greater than the risk in the general population. The incidence of IE in adults varies between 1.45 and 8/1000 patient-years in children 0–18 years, an incidence of 0.24/1000 patient-years has been reported (8).

Patients with Down syndrome who have congenital heart lesions are at increased risk of developing IE (9). This increased risk has been attributed to the high incidence of periodontal disease in this population, as well as underlying immune system dysfunction (10-11). In our study, 33% of patients were diagnosed with Down syndrome. Although the relatively small sample size did not allow for analytical evaluation of statistical significance, this proportion appears notable and may warrant further investigation in larger cohorts.

Clinical study

The clinical presentation of IE in children is highly influenced by age (12). The 2015 American Heart Association (AHA) updated review on IE in childhood reported that the clinical presentation is generally indolent, with prolonged low-grade fever and a variety of somatic complaints, including fatigue, weakness, arthralgias, myalgias, weight loss, rigors, and diaphoresis (13). These findings are consistent with our study, in which insidious prolonged fever was reported in 83% of patients.

Due to this nonspecific symptomatology, diagnosis is often delayed. Hence, it is important to maintain heightened clinical suspicion in VSD patients.

Paraclinical study

The hemodynamic characteristics of VSDs—particularly perimembranous with the high-velocity, left-to-right shunting of blood contribute to endothelial injury and increased susceptibility to infection.

Gerbode-type VSDs are rare, accounting for approximately 0.08% of all congenital cardiac anomalies (14). In our study, one patient (8%) was identified with a Gerbode-type VSD. Although uncommon, left ventricle–to–right atrium (LV–RA) shunts associated with this type of VSD have been reported to significantly increase the risk of IE—estimated at 58 cases per 10,000 patient–years—compared to the risk associated with typical VSDs (15).

Vegetations were most frequently observed on the septal leaflet of the tricuspid valve, along the margins of the VSD itself, or on the pulmonary valve, reflecting the areas most exposed to turbulent flow and jet lesions (16). These observations were in line with our results, where tricuspid involvement was observed in eight patients (64%).

In our study, we identified some very rare sites of IE, including the isolated pulmonary valve (1 patient), and the pulmonary band (1 patient), and one had IE affecting the tricuspid valve and the pulmonary valve extending into the pulmonary trunk and its main branches. These specific localizations have only been reported in a few cases in the literature (17).

The microbiologic findings in IE in congenital heart disease (CHD) patients are similar to those in the overall IE patient population (18). *Staphylococci* species are particularly pathologic and can adhere to damaged and even minimally abnormal endocardium. Streptococci species also commonly infect damaged endocardium and must be strongly considered in the CHD population when community-acquired IE is suspected (19).

As was found in our study, the most common microorganisms were *streptococci* (42%) and *staphylococci* (17%). Blood cultures were negative in 2 cases (17%) which can be explicated by the blind prescription of antibiotics that may delay the diagnosis and underestimate the causative germ.

Poor dental hygiene and dental procedures are the most common causal factors for IE. In our study 4 out of 12 episodes (33%) of IE were found to have causative oral microorganisms. These included Viridans group Streptococcus (*Strep. Oralis, Strep. Sanguinis, Strep. Mitis) and Streptococcus anginosus.*

As for antibiotic prophylaxis the American Heart Association (AHA) and the European society of cardiology (ESC) both considers VSDs to be relatively low risk and therefore does not recommend antibiotic prophylaxis against IE. Non-specific hygiene measures should be applied in all patients with adult congenital heart disease: good oral and cutaneous hygiene, and aseptic measures during healthcare and any invasive procedure (5-6).

Treatment and outcomes

The early course of IE may be marked by numerous complications, which can significantly contribute to its severity. According to literature data, the most common complications include valvular insufficiency, abscess formation, and septic pulmonary embolism (20).

In our study, pulmonary embolism was observed in four patients (33%), two patients had severe valvular regurgitation (16%). Cardiac tamponade and the rupture of mycotic pulmonary artery aneurysm were very rare complications, each occurring in a single patient within the study population. In fact, there is limited data available on the clinical characteristics and outcomes of these patients.

Effective treatment of infective endocarditis requires a multidisciplinary approach: Treatment of the portal of entry, appropriate antibiotic therapy to eliminate the infectious agent from the bloodstream and infected cardiac tissues, and surgery may be needed to manage the structural heart damage, improving patient outcomes and reducing mortality.

The European Society of Cardiology guidelines recommend surgery in patients with right-sided IE who are receiving appropriate antibiotic therapy if: 1) Right ventricular dysfunction secondary to acute severe tricuspid regurgitation non-responsive to diuretics 2) Persistent vegetation with respiratory insufficiency requiring ventilatory support after recurrent pulmonary emboli. 3) Large residual tricuspid vegetations (>20 mm) after recurrent septic pulmonary emboli. 4) Patients

with simultaneous involvement of left-heart structures. It also should be considered if persistent sepsis after at least 1 week of appropriate antibiotic therapy They also emphasize to repair the tricuspid instead of valve replacement, when possible. (6)

In our study tricuspid annuloplasty was realized for 33% of our cases. One patient needed tricuspid valve replacement due to major damage and extensive vegetecotomy.

VSD repair was realized for all patients, even though it is not strongly recommended in the international guidelines. In fact, the American Heart Association (AHA) (5) states that VSD closure after IE may be considered, whereas the European Society of Cardiology (ESC) (6) recommends that it should be considered, reflecting a stronger endorsement.

Right-sided IE is associated with better clinical outcomes compared with left-sided IE (20). When indicated, surgical treatment of right-sided IE can be performed with good early, mid-term, and long-term results (21).

CONCLUSION

Patients with unrepaired ventricular septal defects (VSDs) are at a higher risk of developing infective endocarditis (IE). However, current international guidelines classify VSDs as relatively low-risk and therefore do not recommend antibiotic prophylaxis for IE in these cases.

Our study demonstrates that IE in patients with VSD is not a rare complication and can lead to serious outcomes. Based on our findings, we propose that VSDs should be reconsidered for inclusion in antibiotic prophylaxis guidelines for IE.

This highlights the importance of careful monitoring and follow-up in these patients. It is essential for healthcare professionals to increase awareness and educate patients about the significance of dental hygiene and the potential risks of IE.

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