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ORIGINAL ARTICLES

Perioperative Management of Congenital Atrial and Ventricular Septal Defects: A Five-Year Single-Center Review

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Abstract

Introduction: Atrial septal defect (ASD) and ventricular septal defect (VSD) are the most prevalent congenital heart defects in children. Optimized perioperative management remains crucial to minimizing operative risk and preventing postoperative complications, underscoring our collective responsibility to improve patient outcomes.

Materials and Methods: This five-year retrospective review at our tertiary cardiac surgery centre (January 2020 – June 2024) reflects our collective effort to analyse clinical data from pediatric patients undergoing surgical correction for isolated septal defects, to inform clinical practice.

Results: A total of 170 paediatric patients underwent surgical correction during the study period. The cohort included 82 patients (48.2%) diagnosed with ASD and 88 patients (51.8%) with VSD. The broad age range of patients enabled a meaningful evaluation of age-related clinical differences and perioperative outcomes.

Conclusion: This review confirms that ASD and VSD are the most common congenital heart diseases requiring surgical intervention in the pediatric population. Sharing our clinical experience aims to support your efforts in timely surgical correction, guided by accurate clinical and echocardiographic assessment, to prevent disease progression and improve long-term outcomes.

Keywords: atrial septal defect, ventricular septal defect, pediatric cardiac surgery.

Introduction

Congenital heart disease (CHD) remains the leading cause of congenital malformations worldwide, accounting for significant morbidity during childhood and beyond [1]. Among CHDs, ASD and VSD comprise nearly 40% of all diagnosed defects [2]. Although many small defects may close spontaneously, moderate to large defects frequently require surgical intervention to prevent pulmonary hypertension, heart failure, and arrhythmias [3].

In recent years, attention has shifted from purely surgical success toward perioperative optimization, including anesthesia, cardiopulmonary bypass (CPB) management, and postoperative intensive care [4].

This study presents a five-year single-center European experience, emphasizing perioperative and anesthetic considerations.

Anatomical Classification and Pathophysiology

ASDs are primarily classified into: Ostium secundum (≈70%), ostium primum, and sinus venosus defects.

VSDs are most frequently: Perimembranous, muscular, outlet (supracristal).

Both lesions cause left-to-right shunting, leading to pulmonary overcirculation, increased right ventricular preload, and progressive pulmonary vascular remodeling if left untreated [5, 6].

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Materials and Methods

A retrospective cohort study was conducted, including 170 pediatric patients undergoing surgical correction of ASD or VSD from January 2020 to June 2025.

Inclusion criteria: Isolated ASD or VSD, elective surgical repair, and age <18 years.

Exclusion criteria: Complex CHD, previous cardiac surgery, concomitant major extracardiac anomalies.

Data Collection

Collected variables included: demographics (age, gender, weight); preoperative echocardiography; pulmonary artery pressure estimates; surgical technique and CPB duration; anesthetic approach; and postoperative outcomes (ventilation time, ICU stay, complications).

Results

Patients with ASD were significantly older at the time of surgery compared with those with VSD. The mean age at intervention for ASD was 6.2 ± 2.1 years, whereas VSD patients underwent surgery at a mean age of 1.8 ± 0.9 years, reflecting earlier symptom onset and hemodynamic burden in VSD [1, 2].

This age discrepancy is consistent with the natural history of these defects, where VSDs often present with early congestive heart failure, failure to thrive, or recurrent respiratory infections [3].

A female predominance was observed in the ASD group (61%), whereas VSD patients showed a male predominance (56%), consistent with gender distributions reported in previous population-based studies and European registries. [4, 5].

At the time of surgical referral, ASD patients were more often asymptomatic or mildly symptomatic, with exercise intolerance or recurrent respiratory infections as the most common complaints.

VSD patients frequently presented with signs of volume overload, including tachypnea, poor weight gain, feeding difficulties, and recurrent lower respiratory tract infections.

Preoperative echocardiography showed elevated pulmonary artery pressures in 18% of ASD patients and 32% of VSD patients, indicating a more aggressive pulmonary vascular response in early life among VSD patients [6].

In the *ASD group,* Ostium secundum defects were the most common. Right atrial and right ventricular dilation were present in most patients, with preserved ventricular systolic function. In the *VSD group,* Perimembranous defects were the most common. A significant proportion showed left ventricular volume overload and borderline elevation of pulmonary vascular resistance.

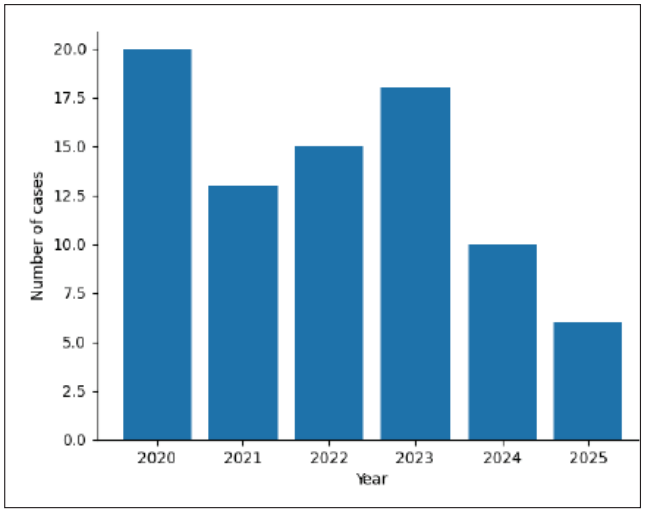
These findings influenced both the timing of surgery and perioperative anesthetic planning, particularly regarding pulmonary vasodilator readiness and ventilation strategies [7].

All patients underwent successful surgical closure with standard techniques under cardiopulmonary bypass. There was no intraoperative mortality. Mean cardiopulmonary bypass (CPB) time was 42 ± 11 minutes for ASD repairs and 58 ± 14 minutes for VSD repairs.

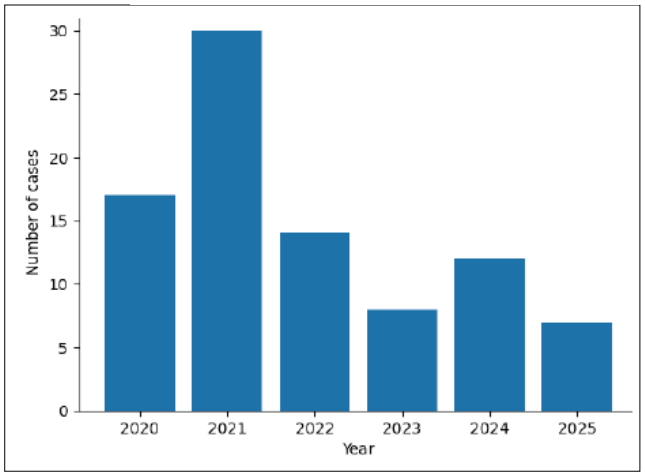
The longer CPB and aortic cross-clamp times in patients with VSD reflect increased anatomical complexity and proximity to the conduction system [8].

Balanced general anesthesia was used in all cases, with careful avoidance of factors that increase pulmonary vascular resistance, such as hypoxia, hypercapnia, and acidosis.

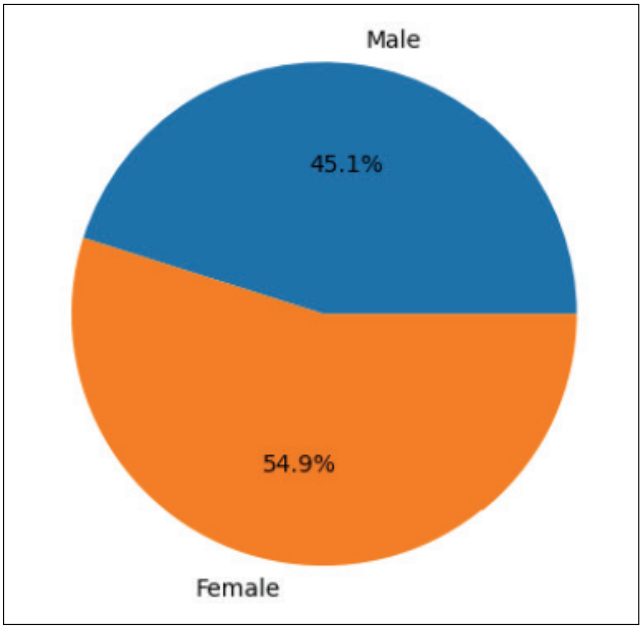
Postoperative recovery was favorable in both groups: the median duration of mechanical ventilation was 6 hours, and most patients were extubated on the first postoperative day. Median ICU stay ranged from 24 to 48 hours, depending on age and preoperative pulmonary pressures. The total hospital length of stay was shorter among patients with ASD.



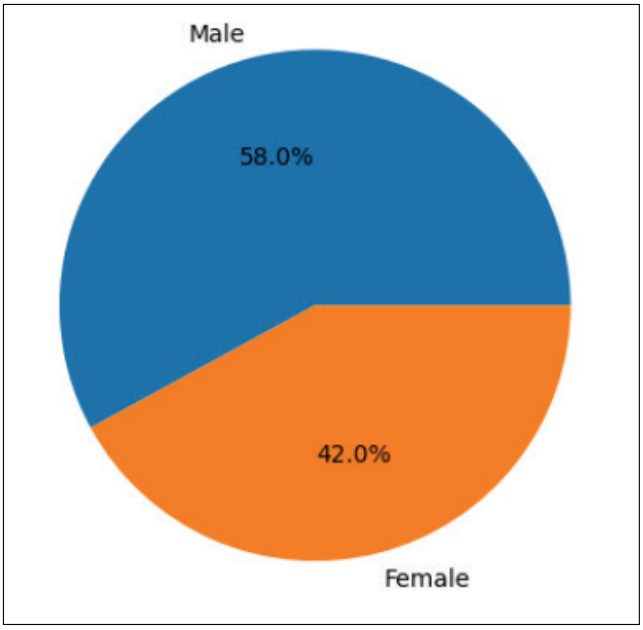
Graphic 1. Annual distribution of ASD cases.



Graphic 2. Annual distribution of VSD cases



Graphic 3. Gender distribution in ASD



Graphic 4. Gender distribution in VSD

Early postoperative complications were uncommon: Transient supraventricular arrhythmias occurred in 6% of patients and resolved with conservative management. Pulmonary hypertensive episodes were documented in 4% of cases, predominantly among VSD patients with preoperative pulmonary hypertension. No cases of permanent atrioventricular block, residual shunt requiring reintervention, or early reoperation were observed.

Importantly, there was no early postoperative mortality, underscoring the safety of current perioperative protocols [9].

Discussion

This review integrates current evidence on the perioperative management of atrial and ventricular septal defects with a five-year single-center clinical experience. The findings of our retrospective analysis confirm that ASD and VSD remain among the most frequently corrected congenital heart defects in pediatric cardiac surgery, with distinct differences in clinical presentation, timing of intervention, and perioperative course.

In our cohort, ASD was more frequently diagnosed and surgically corrected in female patients, whereas VSD showed a male predominance.

This gender distribution aligns with previously published European and international data and may reflect underlying genetic and developmental factors that influence septal formation.

Furthermore, the mean age at surgical intervention was significantly higher in patients with ASD than in those with VSD. This difference can be explained by the often insidious clinical course of ASD, which allows for delayed presentation, in contrast to VSD, where symptoms of pulmonary overcirculation and heart failure typically necessitate earlier intervention [1, 2].

Pulmonary overcirculation was a prominent finding in both groups, present in 75% of ASD cases and in all VSD cases. These results highlight the hemodynamic burden of left-to-right shunting and underscore the importance of timely surgical correction before irreversible pulmonary vascular disease develops. The absence of advanced pulmonary hypertension in most of our patients suggests that intervention was appropriately timed, in accordance with current European recommendations [3, 4].

From a surgical perspective, the predominance of direct suture closure in ASD cases and the universal use of autologous pericardial patch repair in VSD cases reflect contemporary standard practice. The low incidence of postoperative complications in both groups supports the effectiveness of structured perioperative management, including optimized anesthetic strategies, cardiopulmonary bypass techniques, and targeted postoperative pharmacological therapy [5].

Postoperative outcomes in our series were favorable, with a very low complication rate and minimal mortality. The absence of mortality in ASD patients and the single fatal outcome in the VSD group align with outcomes reported in large European registries. These findings underscore the critical role of perioperative monitoring, early recognition of complications, and multidisciplinary postoperative care in achieving optimal results [6].

Overall, this five-year experience reinforces the concept that early diagnosis, appropriate patient selection, and individualized perioperative management are key determinants of successful surgical correction of ASD and VSD. The integration of institutional data with contemporary literature strengthens the evidence supporting current surgical and perioperative strategies in pediatric congenital heart disease [7].

A gradual decline in the number of surgically treated cases was observed during the later years of the study period. This trend should not be interpreted as a true reduction in the incidence of congenital septal defects but rather as the result of several contributing factors [8].

First, a sustained decline in overall birth rates has been reported in recent years across many European countries, including our region. Because atrial and ventricular septal defects are congenital, a reduction in live births is expected to result in fewer affected children, even if the incidence per 1,000 live births remains unchanged.

Second, advances in prenatal screening and fetal echocardiography have enabled earlier detection of congenital heart defects. In some cases, this has led to alternative prenatal counseling and management strategies, potentially reducing the number of children who require postnatal surgical correction, particularly for complex defects associated with chromosomal abnormalities [9].

Third, evolving clinical practice has favored a more conservative approach for smaller or hemodynamically insignificant septal defects, especially in ASD. Improved outpatient follow-up and delayed or avoided surgical intervention in selected patients may have further contributed to the observed reduction in surgical volume. *Finally,* external factors, including healthcare system constraints during the COVID-19 pandemic, may have influenced referral patterns and the timing of elective pediatric cardiac surgery, particularly during the early years of the study period.

Taken together, these factors suggest that the observed decrease in surgical case numbers reflects broader demographic, diagnostic, and healthcare-related trends rather than a true decline in disease burden (10).

Conclusions

This review, supported by five years of single-center clinical experience, demonstrates that atrial and ventricular septal defects remain among the most common congenital heart diseases in the pediatric population that require surgical correction. Our findings confirm that timely surgical intervention, guided by appropriate clinical and echocardiographic assessment, prevents progression of pulmonary overcirculation and irreversible pulmonary vascular disease.

The results highlight distinct clinical patterns between ASD and VSD, particularly in age at intervention and symptom severity, underscoring the need for individualized perioperative strategies. Structured perioperative management, including meticulous preoperative evaluation, standardized intraoperative techniques, and targeted postoperative care, was associated with low complication rates and excellent early outcomes.

Overall, our experience supports current European recommendations advocating early diagnosis and optimized perioperative management to ensure favorable surgical results and improved long- term prognosis in children with septal defects.

Abbreviations

CHD - Congenital Heart Disease; ASD - Atrial Septal Defect; VSD - Ventricular Septal Defect; CPB - Cardiopulmonary Bypass; ICU – Intensive Care Unit; CPB - Cardiopulmonary Bypas;

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