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Surgical Repair of Ventricular Septal Defects at Soavinandriana Hospital: First Case Series

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Abstract

Introduction: Surgical closure of ventricular septal defects (VSDs) has been feasible in Madagascar since 2024. This study aimed to report the results of a series of VSD surgeries performed at Soavinandriana Hospital. **Materials and methods:** This retrospective study reports on the first series of nine surgical repairs of ventricular septal defects (VSD) performed at Soavinandriana Hospital in Madagascar between 2024 and 2025. The authors analyze patient demographics, clinical presentation, echocardiography results, surgical techniques involving cardiopulmonary bypass time, and immediate postoperative outcomes. **Results:** Nine children who underwent surgical repair of VSD are reported in this study, including six boys (66%) and three girls (33%). The average age was 11.89 years. The mean weight was 28.22 kg. The main symptoms were a cardiac murmur (88%), recurrent lung infections (66%), and failure to thrive (66%). Echocardiography revealed seven perimembranous VSDs (77%), two infundibular VSDs (22%), and 8 VSD type IIa (88%). The VSDs were large in 88% of cases, with a mean diameter of 12.11 mm. One patient had a VSD associated with pulmonary hypertension (11%). All VSD repairs were performed using conventional surgery and cardiopulmonary bypass (CPB). The VSDs were most commonly closed using a pericardial heterologous patch (88%). The mean CPB time was 111.22 minutes. The mean aortic

cross-clamping time was 58.89 minutes. The postoperative success rate was 100%. **Conclusion:** The study concludes that surgical closure of large VSDs is feasible in this setting, reporting a 100% success rate in the initial cohort.

Keywords

Ventricular Septal Defects, Congenital Heart Disease, Surgery, Pediatrics

1. Introduction

Ventricular septal defects (VSDs) are the most common type of congenital heart disease (CHD) in Antananarivo, accounting for around 17% of all cases [1]. Access to surgical repair of VSD remains challenging for the Malagasy population because most families cannot afford the cost of surgery abroad. However, surgical closure of VSD is now possible in Madagascar with the support of the Chain of Hope organisation. The first VSD surgical repair was performed in 2024 at Soavinandriana Hospital. Nowadays, CHD surgery is performed irregularly every three months with the help of French missionaries. Few studies from sub-Saharan Africa have published experiences of VSD surgical repair [2]. This study aimed to report the first series of cases of VSD repair performed at Soavinandriana Hospital.

2. Patients and Methods

Soavinandriana Hospital (Cenhosoa) is a military hospital in Antananarivo, Madagascar. Cenhosoa is now the only hospital in Madagascar to perform open heart surgery on children. Since 2024, surgical repair of an isolated ventricular septal defect (VSD) has been performed periodically at Cenhosoa. This retrospective, descriptive study looks at cases of VSD repair in children and young adults at the Cardiac Surgery Unit of Cenhosoa from 1 May 2024 to 31 October 2025. This study reports on all VSD repair surgeries performed on Malagasy children since the first case at Cenhosoa. This study included all children and young adults weighing at least 15 kg who underwent surgical repair for an isolated symptomatic ventricular septal defect (VSD). Demographic data, symptoms, imaging diagnosis results, surgical procedures, outcomes, and hospital stays were analysed. The postoperative success criteria included the survival of the patient after surgery and complete closure of the defects, confirmed by echocardiography. The data were collected, analysed, and managed using KoboToolbox® software.

3. Results

Nine patients who underwent surgical repair of VSD were reported in this study, including 6 boys (66%) and 3 girls (33%). The average age was 11.89 ± 5.71 years old, ranging from 5 to 25 years old (**Table 1**). There was a male predominance (66%) with a sex ratio of 2. The mean weight was 28.22 ± 11.62 kg, ranging from 15 to 54 kg. The average height was 115.44 ± 30.61 cm, ranging from 56 to 150

cm. All VSD cases were symptomatic, with the main symptoms being cardiac murmur (88%), recurrent lung infections (66%), and failure to thrive (66%). Chest X-ray showed cardiomegaly (88%) and increased pulmonary vascularity (100%). Echocardiography showed 7 perimembranous VSD (77%), 2 infundibular VSD (22%), and 8 VSD type IIa (88%) (Table 2). The sizes of the defects were very large (≥10 mm) in 66% and large (6 to 9 mm) in 33% of cases. The mean diameter of ventricular defects was 12.11 mm (ranging from 7 to 20 mm). One patient had VSD associated with pulmonary hypertension (PH) (11%).

Table 1. Demographic data and symptomatology.

Patients (No.)	Age (years)	Gender	Weight (kg)	Height (cm)	Existence of symptoms
1	13	M	28	137	Yes
2	10	M	31	80	Yes
3	12	M	54	145	Yes
4	9	M	21	127	Yes
5	15	M	30	156	Yes
6	10	F	15	115	Yes
7	8	F	17	110	Yes
8	5	M	24	119	Yes
9	25	F	34	150	Yes

Table 2. Echocardiography results.

Patients (No.)	Location of VSD	VSD type	Diameter (mm)	Size	Pulmonary Hypertension
1	Infundibular	IIa	7	Large	No
2	Perimembranous	IIa	15	Very large	No
3	Infundibular	IIa	8	Large	No
4	Perimembranous	IIb	10	Very large	Yes
5	Perimembranous	IIa	20	Very large	No
6	Perimembranous	IIa	20	Very large	No
7	Perimembranous	IIa	10	Very large	No
8	Perimembranous	IIa	10	Very large	No
9	Perimembranous	IIa	9	Very large	No

All VSD were closed by conventional surgery using cardiopulmonary bypass (CPB) and normothermic blood cardioplegia. The surgical procedures were performed by sternotomy followed by closure of VSD with pericardial or dacron patches. (Figures 1-4) Most VSD were closed using pericardial heterologous patch (88%). The mean CPB time was 111.22 minutes (ranging from 80 to 168 min)

(Table 3). The mean aortic cross-clamping time was 58.89 minutes (ranging from 37 to 102 min). The mean operative time was 257.67 ± 54.51 min. The average length of hospital stay was 11.44 ± 1.94 days (ranging from 9 to 14 days). No death was registered among the 9 VSD repairs. The postoperative success rate was 100%.

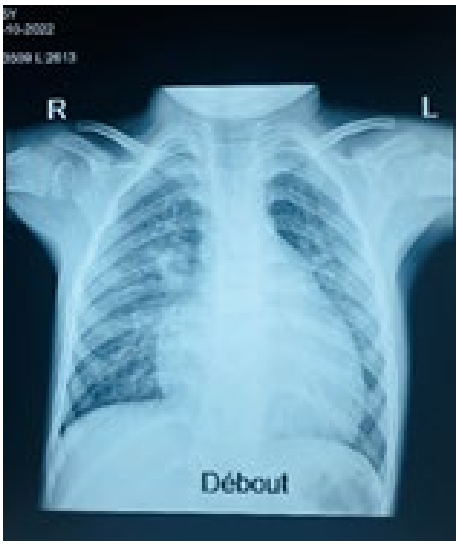

Figure 1. Chest radiography with cardiomegaly and increased pulmonary vascularity.

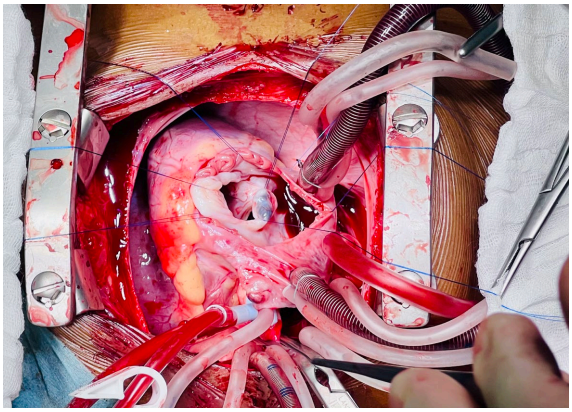

Figure 2. Perimembranous VSD exposure during surgical repair.

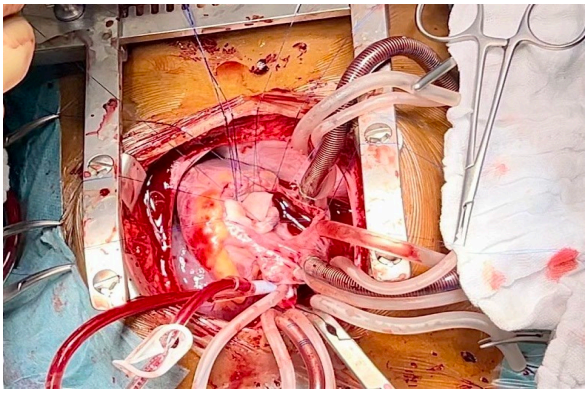

Figure 3. Perimembranous VSD closure using a heterologous pericardial patch.

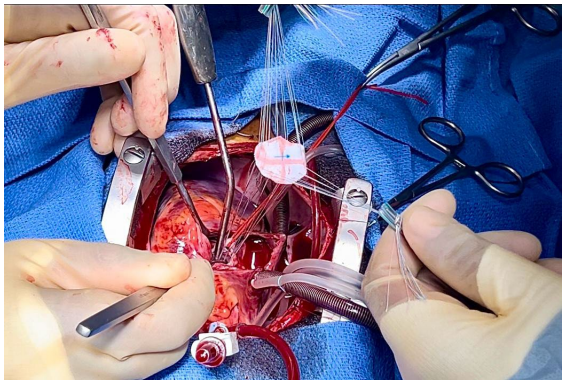

Figure 4. Perimembranous VSD closure using a dacron patch.

Table 3. Surgical procedures and hospital stay.

Patients (No.)	Surgical procedures	CPB time (min)	Cross-clamp time (min)	Operative time (min)	Hospital stay (day)
1	Heterologous pericardial patch	104	51	250	13
2	Heterologous pericardial patch	99	59	270	14
3	Heterologous pericardial patch	168	102	347	11
4	Heterologous pericardial patch	103	59	270	11
5	Dacron patch	156	90	337	12
6	Heterologous pericardial patch	102	37	210	9
7	Heterologous pericardial patch	80	45	200	9
8	Heterologous pericardial patch	104	45	205	10
9	Heterologous pericardial patch	85	42	230	14

4. Discussion

Cardiac surgery for CHD remains a significant public health issue in Sub-Saharan African countries. Access to congenital cardiac surgery in Africa is limited, with capacity accounting for less than 5% of annual CHD cases [3]. The difficulties in accessing cardiac surgery are usually related to the poverty of the majority of the population. However, the practice of congenital cardiac surgery is growing in developing countries thanks to partnerships with more advanced countries. Most African hospitals have started performing congenital cardiac surgery in partnership with European NGOs, such as Chain of Hope at Soavinandriana Hospital in Antananarivo. This study reports the first case series of VSD repair performed at

the Cardiac Surgery Unit of Soavinandriana Hospital.

The average age of patients who underwent surgical repair of VSD was 11 years. Our results are similar to those of other Sub-Saharan African studies, such as the studies of Tamatey MN *et al.* [2] and Yangni-Angate KH *et al.* [4], in which the average age of patients undergoing surgical repair of VSD was 10 and 9 years, respectively. However, VSD repair is usually performed at an earlier stage in more advanced countries, as shown in the studies of Aydemir NA *et al.* [5] and Shetty V *et al.* [6], in which the average age was 5 and 23 months, respectively. The older age of our patients could be explained by delayed diagnosis of VSD and long waiting times for surgery. Our study found a male predominance twice that of females (66%). Some studies have also shown a male predominance in populations of patients who underwent surgical repair of VSD, such as the studies of Tamatey MN *et al.* (58%) [2] and Yangni-Angate KH *et al.* (60%) [4]. The average weight of patients who underwent surgical repair of VSD differed according to the cardiac surgery team's experience. In our study, the mean weight of patients was 28 kg. However, our study showed an average weight that was much higher than in the studies of Scully B *et al.* (7 kg) [7] and Aydemir NA *et al.* (5 kg) [5]. The choice of weight for surgical repair of VSD depends on the experience of the cardiac surgery team. The effect of body weight on infants undergoing VSD closure has been published by different researchers. Caution is warranted for infants with a body weight below 4.5 kg [8]. Most studies in Sub-Saharan Africa showed a predominance of symptomatic ventricular septal defects (VSD) in patients who underwent surgical repair. In our study, VSD was symptomatic in eight patients (88%). Similar results were found by other authors, such as Bah MB *et al.* [9] and Yangni-Angate KH *et al.* [4], who also observed a predominance of symptomatic VSD. In our study, the main symptoms were a cardiac murmur (88%), recurrent lung infections (66%), and failure to thrive (66%). Bah MB *et al.*'s study showed similar results, with the most common clinical signs being systolic murmur (90%) and growth retardation (51.76%) [9]. The predominance of symptomatic VSD could be explained by a lack of systematic newborn screening, resulting in under-discovery of asymptomatic VSD.

Echocardiography with Doppler and colour flow mapping can be used to accurately evaluate the anatomy and haemodynamics of VSDs [10]. More researchers have published studies on the prevalence of perimembranous VSD in patients who have undergone VSD closures. In our study, VSDs were most commonly located in the perimembranous septum (77%). Other African studies have also shown the predominance of perimembranous VSD, for example, the study by Bah MB *et al.* (70%) [9] and the case series by Kalezi ZE *et al.* (66%) [11]. Additionally, Yangni-Angate KH *et al.*'s study produced a similar result, with 76% of VSDs being perimembranous [4]. Large VSDs, either with or without pulmonary hypertension, require surgical or interventional closure of the defect. Our study found a predominance of VSD type IIa (88%). Aydemir NA *et al.* found a similar result, with a predominance of type IIa (50%), followed by type IIb (40%) [5]. However,

the study by Bah MB *et al.* showed a high rate of VSD type IIb (44%) [9].

The size of the defect in VSD repair varies in the literature. A large defect usually requires surgical or interventional closure. The mean diameter of VSD closures reported in studies from Sub-Saharan Africa is often larger than in more developed countries. Our study showed a mean diameter of 12.11 mm. However, this result is higher than in the studies of Mirzaaghayan *et al.* [12] and Hu *et al.* [13], in which the mean diameter was 9.85 mm and 6.81 mm, respectively. Some studies on percutaneous VSD closures have shown a much lower mean diameter than our result, such as the studies by Wang S *et al.* (4 mm) [14] and Jiang-Shan H *et al.* (3.5 mm) [15]. Due to the lack of systematic screening for CHD in infants, small and moderate asymptomatic VSDs are usually under-discovered in the Sub-Saharan African population.

Pulmonary hypertension (PH) is one of the most common complications associated with a left-to-right shunt, which is related to the presence of a ventricular septal defect (VSD). Our study identified one case of PH (11%) among nine patients who underwent VSD repair. However, some authors have published higher rates of PH in patients who have undergone surgical treatment for VSD, such as Walia *et al.* (76%) [16] and Akagi *et al.* (29%) [17]. The risk of PH depends on the size of the defect. The absence of systematic screening increases the risk of PH in Malagasy children with CHD.

During the surgical mission, the operations were performed with direct hands-on assistance from the visiting team. Due to a lack of experience, the surgeries were practiced independently by the local team. All VSDs were repaired using conventional surgery. The choice of patch used to close the VSDs depended on the availability of patches. In our study, a high proportion of heterologous pericardial patches were used (88%). However, Yangni-Angate *et al.*'s study showed a high rate of autologous or synthetic patches (96%) being used to close VSDs [4]. Otherwise, the study by Josephraj *et al.* found a predominance of Gore-Tex patches (41%), followed by glutaraldehyde-treated autologous pericardial patches (36%) [18].

The length of time that cardiopulmonary bypass (CPB) is required depends essentially on the experience of the cardiac surgery team. In our study, the mean CPB time was 111 minutes. Some authors found shorter mean CPB times than in our study, such as Bata AK *et al.* (71 minutes) [19] and Aydemir NA *et al.* (71 minutes) [5]. However, Zhou K *et al.*'s study showed a CPB time similar to that in our study (112 minutes) in patients who underwent total thoracoscopic repair of VSD [20]. The mean aortic cross-clamping time was 58 minutes. This is longer than in the study by Bata *et al.* (51 minutes) [19], but shorter than in the study by Lee *et al.* (64 minutes) [21]. The long CPB and aortic cross-clamping times in our study could be explained by the team at Cenhosoa's lack of experience in congenital cardiac surgery. The Cenhosoa team had less experience in congenital cardiac surgery than teams at other centres.

The length of surgery essentially depends on the surgeon's experience. In our

study, the mean operative time was 257 minutes. This is longer than the mean operative times reported in the studies of Banday *et al.* (206 minutes) [22] and Yosi *et al.* (157 minutes) [23]. The longer surgery times in our study could be explained by the inexperience of the Malagasy surgeons who performed the surgeries. They performed the surgery alongside French missionary surgeons. During the open heart surgery mission, all French missionaries shared their experience with the Malagasy team.

The results of surgical repair of VSD varied according to the study. No deaths were recorded in our study. However, Yangni-Angate *et al.*'s study showed a hospital mortality rate of 4%. The average length of hospital stay in our study was 11 days. However, Aydemir NA *et al.*'s study showed an average hospital length of stay that was shorter than our result (8 days) [5]. In addition, Banday MJ *et al.*'s study showed an even shorter mean length of stay than our result (five days) [22].

4. Conclusion

This case series presented the initial experience of surgically closing VSDs at Soavinandriana Hospital. Most of the VSDs were very large and symptomatic. CPB and cross-clamp times were long due to the Malagasy team's lack of experience. However, the results of VSD repair were satisfactory in this first series of cases.

Ethical Approval

The study is exempt from ethical approval at our institution.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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