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First National Series of Adolescent and Adult Congenital Heart Surgery in Benin: A Sub-Saharan Perspective

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Abstract | **Original Research Article**

Background: Medical advances have enabled most children with congenital heart disease (CHD) to reach adulthood in industrialized countries. In Sub-Saharan Africa, limited access to cardiac surgery delays this transition. We report the preliminary outcomes of the national congenital heart surgery program in Benin for adolescents and adults. The aim of the study was to assess the initial results of adolescent and adult CHD surgeries performed in Benin. ***Methods:*** This prospective study included all adolescents and adults who underwent surgery for congenital heart disease at CNHU-HKM between March 2021 and April 2025. Collected data included sociodemographic, diagnostic, therapeutic, and outcome variables. ***Results:*** Twenty-eight patients were operated on. The median age was 25.5 years [IQR: 19–39.5], with a female predominance (67.9%). Dyspnea was the most frequent presenting symptom (64.3%). Non-cyanotic CHDs predominated (92.9%). Twenty-four patients underwent open-heart surgery, and four underwent repair of aortic coarctation. The mean cardiopulmonary bypass and aortic clamping durations were 71.3±42.8 and 51.0±37.7 minutes, respectively. Septal surgeries were the most common procedures (75%). The overall postoperative complication rate was 25%. Two deaths (7.1%) were recorded within 30 days. The average hospital stay was 16.7 ± 3.6 days. ***Conclusion:*** Initial outcomes demonstrate the feasibility of a congenital heart surgery program for adolescents and adults in Benin. Expanding surgical volume, optimizing management of complex cases, and ensuring long-term follow-up remain essential for sustaining these achievements.

Keywords: Adult congenital heart disease, Adolescent, Congenital heart surgery, Short-term outcomes, Sub-Saharan Africa.

BACKGROUND

Congenital heart disease (CHD) affects approximately 17.9 per 1,000 live births worldwide [1]. In high-income countries, medical and surgical advances now allow the vast majority of children with CHD to reach adulthood [2,3]. This demographic shift has generated a growing demand for specialized care among adults living with CHD.

In Sub-Saharan Africa, the situation remains starkly different: late diagnoses, inadequate infrastructure, and limited surgical capacity mean that less than 3% of the 500,000 children born annually with CHD undergo corrective surgery [4,5]. In Benin, the hospital prevalence is estimated at 3 per thousand, but only 25% of operable cases are treated—mostly through NGOs—with a refusal rate approaching 25% [6].

To address this gap, a national cardiac surgery program was established in Benin, with a priority focus on adolescents and adults. This pilot phase is intended as a springboard for the future development of a self-sufficient pediatric cardiac surgery system. This study reports on the initial outcomes from the first cohort operated on under this program.

MATERIALS AND METHODS

Study design and setting:

This was a prospective, observational study conducted at the Hubert Koutoukou Maga National and

University Hospital Center (CNHU-HKM) in Cotonou, Benin, from March 2021 to April 2025.

Study population:

The study included all patients over 10 years of age, weighing more than 30 kg, diagnosed with CHD, and with a surgical indication validated during a multidisciplinary case conference.The age threshold of 10 years was chosen in accordance with the World Health Organization's definition of adolescence [7], and the weight limit was set at 30 kg for safety and perfusion team expertise considerations. No eligible patient was excluded.

Data collection:

Collected variables included sociodemographic, diagnostic, therapeutic, and outcome data. Early mortality was defined as any death occurring within 30 days post-surgery.

Statistical analysis:

Qualitative variables were expressed as counts and percentages, while quantitative variables were reported as means ± standard deviation or medians [interquartile range], depending on the Shapiro–Wilk normality test.

Ethical approval :

The study received institutional approval from the administrative authorities of the National University Hospital Center Hubert Koutoukou Maga (CNHU-HKM) in Cotonou. Informed written consent was obtained from all adult patients or legal guardians for minors. The research was conducted in accordance with the ethical principles of the Declaration of Helsinki.

RESULTS

Preoperative Data

A total of 28 patients were included, representing 18.1% of all cardiac surgeries performed during the study period. The median age was 25.5 years [IQR: 19–39.5], ranging from 12 to 59 years. Females predominated (67.9%). Dyspnea was the main presenting symptom (64.3%). None of the patients had undergone prior cardiac surgery.

Cardiomegaly was observed in 75% of cases, with a mean cardiothoracic index of 0.58 ± 0.07. Atrial fibrillation was present in 7.1%. Non-cyanotic CHDs accounted for 92.9% of cases, dominated by isolated atrial septal defects (ASD) (42.9%). Two patients (7.1%) had cyanotic CHD. Associated valvular lesions included mitral regurgitation (7.1%) and aortic regurgitation (7.1%). Eight patients (28.6%) had functional tricuspid regurgitation.

The mean preoperative left ventricular ejection fraction (LVEF) was 60.1 ± 7.3%. Surgical risk classification using RACHS-1 showed Level 1 in 57.1% of patients, Level 2 in 32.1%, and Level 3 in 10.7%.

Intraoperative Data

Four patients with aortic coarctation underwent resection with Dacron graft interposition via left posterolateral thoracotomy (Figure 1). Twenty-four patients underwent median sternotomy with aorto-bicaval cardiopulmonary bypass (CPB). Normothermic blood cardioplegia was used in all cases. The mean CPB and aortic cross-clamp times were 71.3 ± 42.8 and 51.0 ± 37.7 minutes, respectively. Complete curative procedures were performed in all patients. Septal surgeries were the most common (75%), followed by aortic (25%), tricuspid (25%), and pulmonary surgeries (17.9%). Mean postoperative LVEF was 54.4 ± 7.1%.

Table I: Preoperative Characteristics of Adolescents and Adults with Congenital Heart Surgery in Benin (N=28)

	Values
Gender	
Female, n (%)	19 (67.9)
Male, n (%)	9 (32.1)
Age (in years), median [IQR], (range)	25.5 [IQR: 19–39.5] (12-59)
Symptoms / Initial presentation	
Dyspnea	18 (64.3)
NYHA Stage II (9)	
NYHA Stage III (6)	
NYHA Stage IV (3)	
Palpitations, n (%)	9 (32.1)
Syncope, n (%)	5 (17.9)
Chest pain	4 (14.3)
Hypertension	4 (14.3)
Digital clubbing	2 (7.1)
Left Ventricular Ejection Fraction, mean ± SD (range)	60.1±7.32% (45-70)
Type of congenital heart disease	
Atrial septal defect (ASD), n (%)	12 (42.9)
ostium secundum (10)	

sinus venosus (1) ostium primum (1)	
Aortic coarctation, n (%)	4 (14.3)
Laubry–Pezzi syndrome, n (%)	2 (7.1)
Ventricular septal defect (VSD) + Pulmonary valve stenosis, n (%)	2 (7.1)
ASD (ostium secundum) + Cor triatriatum, n (%)	1 (3.6)
ASD (ostium secundum) + Patent ductus arteriosus (PDA), n (%)	1 (3.6)
Pulmonary stenosis, n (%)	1 (3.6)
Pulmonary stenosis + Patent foramen ovale (PFO), n (%)	1 (3.6)
Pulmonary stenosis + ASD, n (%)	1 (3.6)
Partial atrioventricular septal defect (AVSD), n (%)	1 (3.6)
Ventricular septal defect (VSD), n (%)	1 (3.6)

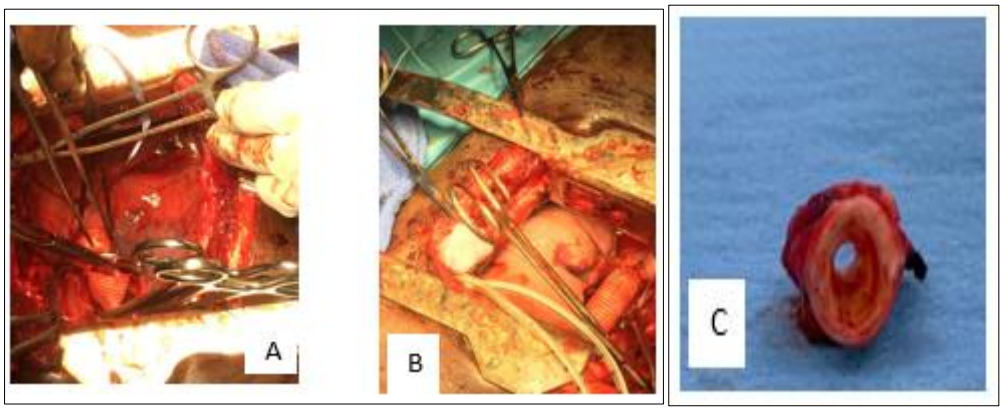

Figure 1. Intraoperative view of aortic coarctation repair.
A: Distal anastomosis of the Dacron graft to the aorta
B: Interposed Dacron graft
C: Resected coarctation segment

Postoperative Outcomes

Two deaths (7.1%) occurred within 30 days postoperatively. The causes were multiorgan failure on postoperative day 1 in a 12-year-old patient with a ventricular septal defect (VSD) and severe tricuspid regurgitation, and sudden deterioration on day 2 in a patient with ASD and mitral valve repair. The overall 30-day postoperative complication rate was 25%, including complete atrioventricular block (10.7%), respiratory complications (10.7%), pericardial tamponade (7.1%), and acute kidney injury (3.6%)—none requiring dialysis. Three patients (10.7%) required reoperation for bleeding. The average hospital stay was 16.7 ± 3.6 days (range: 14–22 days).

Table II: Intraoperative Data and Postoperative Outcomes of Adolescents and Adults Undergoing Congenital Heart Surgery in Benin (N=28)

	Values
Cardiopulmonary Bypass time, mean ± SD (range)	71.3±42.8 (17-192)
Cross clamping time, mean ± SD (range)	51.0±37.7 (8-156)
Surgery type	
Septal, n (%)	21 (75)
Aortic, n (%)	7 (25)
Tricuspid, n (%)	7 (25)
Pulmonary, n (%)	5 (17.9)
Mitral, n (%)	3 (10.7)
Surgical procedures performed	
Open-heart surgery	
ASD closure, n (%)	10 (35.7)
ASD closure + Cor triatriatum repair + Tricuspid valve repair, n (%)	2 (7.1)
ASD closure + Mitral valve repair, n (%)	2 (7.1)
ASD closure + Ductal ligation, n (%)	1 (3.6)
ASD closure + Mitral valve repair + Tricuspid valve repair, n (%)	1 (3.6)
Infundibular resection + RVOT enlargement + Patch augmentation, n (%)	1 (3.6)
Infundibular resection + RVOT enlargement + Patch augmentation + PFO closure, n (%)	1 (3.6)
Infundibular resection + RVOT enlargement + Patch augmentation + ASD closure, n (%)	1 (3.6)

Modified Bentall procedure + VSD closure + Intraventricular muscle resection + Tricuspid valve repair, n (%)	1 (3.6)
VSD closure + Bioprosthetic pulmonary valve replacement + Patch augmentation + Tricuspid valve repair, n (%)	1 (3.6)
Aortic valve replacement + VSD closure + Tricuspid valve repair, n (%)	1 (3.6)
VSD closure + RVOT enlargement + Bioprosthetic pulmonary valve replacement, n (%)	1 (3.6)
VSD closure + Tricuspid valve replacement, n (%)	1 (3.6)
Repair of aortic coarctation	
Resection of the coarcted segment + Interposition of a Dacron graft	4 (14.3)
Post-operative LVEF, mean ± SD (range)	54.4±7.1 (40-70)
Post-operative complications	
Third-Degree Atrioventricular Block, n (%)	3 (10.7)
Bleeding, n (%)	3 (10.7)
Pneumonia, n (%)	3 (10.7)
Cardiac Tamponade, n (%)	2 (7.1)
Acute Renal Failure, n (%)	1 (3.6)
Mortality at 30 Days	2 (7.1)
Length of hospital stay (in days), mean ± SD (range)	16.7+/-3.6 (14-22)

DISCUSSION

In high-income countries, nearly 95% of children with CHD now reach adulthood [8]. This has led to the emergence of a distinct population of adolescents and adults with CHD, requiring specialized care for residual lesions, reoperations, and late complications. Conversely, in resource-limited countries like those in Sub-Saharan Africa, access to such specialized care remains scarce. The lack of pediatric cardiac surgery programs leads to high early mortality, with an estimated survival rate of only 50% before age 17 in Benin [6]. This reality influences the pattern of CHD observed in adolescents and adults in these settings, often marked by the persistence of less complex lesions. In our cohort, left-to-right shunt lesions, especially isolated ASD, accounted for 42.9% of cases, aligning with other African studies that highlight the predominance of ASD, VSD, tetralogy of Fallot, and persistent ductus arteriosus [2]. In contrast, U.S. data show a predominance of right ventricular outflow tract anomalies (21%) due to wider surgical access and improved survival for complex defects [9]. The median age in our series (25.5 years) matches findings from similar studies, typically ranging from 25 to 39 years [2,3,9]. Female predominance, also reported in other African cohorts, may reflect the sex-neutral distribution of ASD [2]. None of our patients had undergone prior cardiac intervention, reflecting the delayed access to care in our context—a trend repeatedly documented across African series [2], whereas in high-income settings, up to 39% of adult CHD patients had previous surgical or interventional treatment [3]. Surgically, septal closures dominated the procedures, unlike Western series where right ventricular outflow tract repairs and arrhythmia treatments are more common [3,9]. Our observed 30-day mortality (7.1%) aligns with literature-reported rates ranging from 0.6% to 7.6% [2,3]. Both deceased patients had severe pulmonary hypertension, a known adverse prognostic factor. The 25% overall postoperative complication rate is consistent with published data, which vary from 9.6% to 50% depending on case complexity [2,3,9].

Study limitations

This study has several limitations. The small sample size limits statistical power and precludes multivariate analysis. Moreover, the 30-day follow-up period prevents assessment of late complications, such as arrhythmias, reinterventions, and quality of life. As an inaugural study in a national program, initial patient selection favored technically manageable and lower-risk cases. Future capacity building, expansion to complex pathologies, and long-term follow-up will be essential to comprehensively evaluate outcomes and improve adolescent and adult CHD care in Benin.

CONCLUSION

This prospective study highlights the feasibility and promising outcomes of congenital heart surgery for adolescents and adults in Benin. Non-cyanotic CHDs, particularly ASDs, were the most prevalent. Mortality and complication rates remained acceptable. Strengthening cardiac surgery programs, improving postoperative monitoring, and developing long-term follow-up systems are crucial to consolidating these results and improving access to specialized care in the region.

Competing interest: The author(s) declare that they have no competing interests.

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