Morbidity and Mortality of Pediatric Cardiac Surgery: About 84 Cases Operated at the Cardio-Pediatric Center Cuomo: Retrospective Study over 9 Months

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Abstract: The general objective of this study was to evaluate the results of pediatric cardiac surgery over 9 months at the Cuomo cardio-pediatric center in Fann, Senegal. The specific objective was to assess morbidity and mortality over the same period after heart surgery in children. Our study focuses on 84 children with congenital or acquired heart disease. This is a retrospective single-center study that took place over a period of 9 months in 2017. An Excel sheet has been prepared to collect antecedents, clinical signs, paraclinical signs, as well as the operative protocol and the postoperative follow-up of the patients. A statistical analysis of the data was performed with the Stata software and the Excel spreadsheet. We found a male predominance with a sex ratio M/F of 1.1. We found dyspnea on 89.3% children and 94% had a heart murmur. The average of left ventricle ejection fraction (LVEF) was 66%. Congenital heart disease (58.3%) is represented by cyanogenic heart disease (15.5%), left-right shunts (33.3%) and obstructive malformations (9.5%). Acquired heart disease (41.7%) is represented by rheumatic heart disease (40.5%) and chronic constrictive pericarditis (1.2%). There was a complication in 46.4% of cases in intensive care and 4.8% of cases in hospital. Overall mortality was 2.4% with an operative mortality of 1.2% and a late mortality of 1.2%. Mitral disease was found only in the MORBIMORTALITY group (14.9% of cases) and this difference was significant (p=0.014). Among the procedures performed, there was more mitral surgery in the UNCOMPLICATED group (83.3% vs 30%). Whereas in the MORBIMORTALITY group there was more mitral valve replacement (70% vs 16.7%), this difference was significant (p=0.003). The average total length of hospital stay was 19 days. The length of stay in intensive care unit was longer in the MORBIMORTALITY group (5 vs 3 days, p=0.0027) and the duration of hospitalization (18 vs 11 days, p=0, 0004). At 3 months postoperative clinical improvement was noted in 85.7% of patients and there was no mortality. Surgery improves the quality of life for children who have congenital and acquired heart disease. This surgery is practicable in Senegal with satisfactory results. A better knowledge of the characteristics of patients with a complication or deceased can allow a better management in our center.

Keywords: Congenital Heart Disease, Rheumatic Heart Disease, Heart Surgery, Morbidity, Mortality

1. Introduction

Surgery in congenital heart diseases helps to reverse their pathophysiological consequences; It is either palliative or corrective, anatomical or not, allowing development of the child. The complexity of this surgery and the fragility of children means that it has to be performed in specialized centers with a specially dedicated team. The management of valvular heart disease is above all medical but may require surgery (repair or replacement of a valve) [1]. Nonetheless it still has many relevant complications of the underlying heart condition and Cardiopulmonary Bypass (CPB). Mortality from this surgery has dropped sharply since its inception. Mortality is determined by age, the existence of cardiac or extracardiac comorbidities and the impact of valvulopathy on the myocardium [2]. A careful preoperative evaluation and a rigorous perioperative therapeutic strategy are imperative for the prevention, early detection and/or cost-effective management of these complications [2]. The objective of this study was evaluate congenital and acquired pediatric heart disease surgeries over 9 months at the cardio-pediatric center of Cuomo in Dakar (Senegal), to study short and medium-term morbidity and mortality in the center and to formulate recommendations for better care of children in pediatric cardiac surgery in Senegal.

2. Materials and Methods

Our study involved 84 children with congenital or acquired heart disease who underwent open heart surgery aged 15 or less at the time of the study. It is a monocentric, longitudinal, retrospective, descriptive and analytical study. It took place over a period of 9 months (January 2017 to September 2017) at the cardio-pediatric center of Cuomo located at the level of the thoracic and cardiovascular surgery clinic of the National University Hospital Center of Fann in Dakar (Senegal). An Excel file was established to collect the history, clinical signs, paraclinical signs, as well as the operating protocol and postoperative monitoring of patients. A statistical analysis of the data was carried out with the Stata software and the Excel spreadsheet. Statistical analyzes were performed with Stata software (version 13; StataCorp, College Station, Texas, USA), considering a 5% risk of bilateral first-class error. The population is described by associated numbers and percentages for the categorical variables, and by the mean (± standard deviation) or the median [interquartile range] for the quantitative variables, with regard to their statistical distribution (normality studied by the test of Shapiro-Wilk). The comparisons between independent groups (morbi-mortality yes/no) concerning quantitative parameters, were carried out by the Student's t test or by the Mann-Whitney test if the t-test conditions were not respected (normality, homoscedasticity studied by the Fisher-Snedecor test). The comparisons between groups concerning qualitative parameters were made using the Chi2 test or by the exact Fisher test.

3. Result

Our study consisted of 44 boys and 40 girls (sex ratio M/F=1.1). The average age was 9 years [range 4 months - 15 years]. The peak frequency was between 10 years and 15 years [120 to 180 months]. The distribution of patients by age group is illustrated in Figure 1.
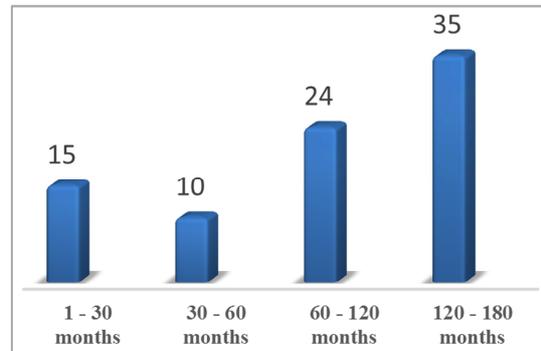

Figure 1. Distribution of patients by age group.

Congenital heart diseases were the most frequent pathologies in our study, 49 patients (58.3%) of all operated heart diseases. Acquired heart disease affected 35 patients (41.7% of our study population). Congenital heart disease was represented by cyanogenic congenital heart disease (13 patients, 26.5%) and non-cyanogenic congenital heart disease mainly left-right shunts (28 patients, 57.2%) and obstructive malformations (8 patients, 16.3%), see Figure 2.
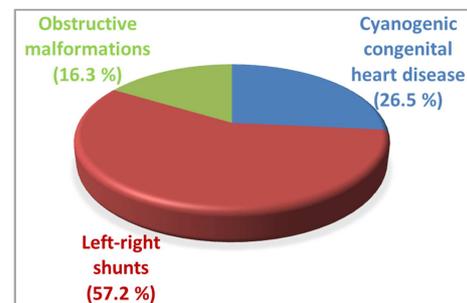

Figure 2. Distribution of congenital heart disease.

Congenital cyanogenic heart disease (n=13) corresponded to 15.5% of the cases in our study and 26.5% of all congenital heart disease. All of the cyanogenic congenital heart diseases were Tetralogies of Fallot (T4F). Non-cyanogenic congenital heart disease (n=36) represented the majority of the cases in our study (42.9%), or 73.5% of congenital heart disease. They were:

1. Left-right shunts (n=28, one third (33.3%) of the heart diseases operated in our series, more than half of the congenital heart diseases (57.1%) and 80% of the non-cyanogenic congenital heart diseases). We found:
   a) Patent of the ductal arteriosus (PDA) in 12 patients.
   b) Atrial septal defect (ASD) in 4 patients.
   c) Ventricular septal defect (VSD) in 3 patients.
   d) A VSD associated with an ASD in 2 patients, including 1 associated with ectasia of the ascending

aorta.
  e) A VSD associated with aortic regurgitation (Laubry-Pezzy Syndrome) in 2 patients
  f) An ASD in the context of an anomalous pulmonary venous connection (APVC) in 2 patients.
  g) An ASD associated with a PDA in 1 patient.
  h) An ASD associated with a pulmonary stenosis on a Banding of the pulmonary artery in 1 patient.
  i) An atrioventricular canal in 2 patients.
2. Obstructive malformations (n=8, or 9.5% of the cases in our study and 16.3% of congenital heart diseases and 22.2% of non-cyanogenic congenital heart diseases).

We found:
  a) 4 cases of right mid-ventricular stenosis (including 3 associated with a VSD).
  b) 3 cases of sub-aortic diaphragm (1 associated with congenital mitral stenosis; the other 2 associated with VSD, one of the 2 also presents with pulmonary valve stenosis).
  c) 1 case of infundibular stenosis associated with a VSD.

Acquired heart disease (n=35) represented 41.7% of the cases in our study and 97.1% of acquired heart disease (Table 1).

Table 1. Distribution of acquired heart disease.

Acquired heart disease (n=35)		
Pure mitral regurgitation	3 cases	8.5%
Mitral regurgitation (MR) + Tricuspid regurgitation	13 cases	34.2%
Mitral disease + Tricuspid regurgitation	4 cases	11.4%
Pure aortic regurgitation	3 cases	8.6%
Mitral regurgitation + Aortic regurgitation	2 cases	5.7%
Mitral regurgitation + Tricuspid insufficiency + Aortic regurgitation	7 cases	20%
Mitral disease + Aortic regurgitation	1 case	2.9%
Aortic disease + Mitral stenosis + Tricuspid regurgitation	1 case	2.9%
Chronic constrictive pericarditis	1 case	2.8%

Mitral valve disease was found in 31 patients (91.2% of acquired valve disease), aortic valve disease in 15 patients (44.1% of acquired valve disease) and tricuspid valve disease in 25 patients (73.5% of acquired valve disease). Tricuspid valve disease was always associated with another valve disease (mitral and/or aortic). There was only 1 case of chronic constrictive pericarditis corresponding to 1.2% of the cases in our study and 2.8% of the acquired heart diseases. In the medical and surgical history, in children with acquired valvulopathy there was recurrent angina in 19 patients (55.9%), polyarthralgia in 21 patients (61.7%), at least one cardiac decompensation episode in 20 patients (58.8%). In patients with congenital heart disease we found a history of cardiac surgery in 3 patients (6.1%): 1 left modified Blalock, 1 right modified Blalock and 1 Banding of the pulmonary artery; a notion of parental consanguinity was found in 23 patients (46.9%). No antenatal diagnosis had been made. There were at least 3 antenatal consultations in 79 patients (94%) and all had had a prenatal ultrasound (94%) during pregnancy. All pregnancies were carried to term. The socio-economic level was considered low in 51 patients (60.7%). Clinically, dyspnea was the most common sign seen before admission (75 patients, 89.3%). Among them, 59 patients (70.23%) had dyspnea at least at stage 2 of the NYHA (New York Heart Association) and dyspnea at feeding was found in 16 infants (19.04%) all suffering from congenital heart disease. Other symptoms included palpitations in 10 patients (11.9%), recurrent bronchitis in 17 patients (20.2%), precordialgia in 11 patients (13.1%) and cough in 12 patients (14.3%). The physical examination found a good general condition in 76 patients (90.5%), stunted growth in 8 patients (9.5%, all had a congenital heart disease), a heart murmur in 79 patients and signs of peripheral cardiac congestion preoperatively in 8 patients. Among patients with congenital

heart disease, there was Down's syndrome in 3 patients (3.6% of congenital heart disease) and cyanosis in 9 patients (10.7% of congenital heart disease). On the anterior chest X-ray, cardiomegaly was found in 73 patients (86.9%) with an average cardio-thoracic index of 0.62 [range 0.52 - 0.8]. Hypervascularization was found in 48 patients (57%), bulging of the left middle arch in 28 patients (33.3%) and a splitting of the right lower arch in 25 patients (29.7%). All patients had a regular sinus rhythm before surgery. We noted left ventricular hypertrophy in 41 patients (48.8%), left atrial hypertrophy in 22 patients (26.2%), right ventricular hypertrophy in 29 patients (34.5%), right atrial hypertrophy in 14 patients (16.66%), branch block in 7 patients (8.3%), and 2 patients (2.4%) had an atrioventricular block before surgery.

No echocardiographic diagnosis of congenital heart disease was made during pregnancy. The mean left ventricle ejection fraction (LVEF) was 66%. The other parameters of the cardiac ultrasound are reported in Table 2.

Table 2. Preoperative echocardiographic parameters.

	Average	Minimum	Maximum
LVEF (%)	66	51	84
Left Ventricle in diastole (mm)	44	20	81
Left Ventricle in systole (mm)	28	6	59
Diastolic Septum (mm)	7	4	17
Diastolic posterior wall (mm)	6	2	15
Left Atrium diameter (mm)	34	9	75
Left Atrium Surface (cm^2)	29	9	86
Right Ventricle (mm)	20	5,4	58

Among the congenital lesions, the preoperative cardiac ultrasound showed:
1. 13 cases of T4F: 12 in its regular form (one of which had already benefited of a permeable Blalock) and 1 in

its irregular shape.

2. 12 cases of PDA: average diameter of 6 mm [2.5 - 10 mm].

3. 9 cases of ASD (7 ostium secundum and 2 sinus venosus). In 3 cases there was an associated abnormal pulmonary venous return (2 partial and 1 total). There was a small arterial canal in 1 case, 1 case of sub-aortic VSD with stenosis of the pulmonary branches and small isthmus without coarctation, 1 case right coronary from left aortic sinus of valsalva, 1 case of left superior vena cava, 1 case of persistence of foramen oval (PFO), 1 case of pulmonary stenosis and 1 case of pulmonary arterial hypertension. The mean size of the septal defect was 17.5 mm [12 - 30 mm].

4. 3 cases of PFO: 1 associated with ostium secundum ASD, 1 with perimembranous VSD and 1 with PDA.

5. 6 cases of VSD: 5 perimembranous and 1 sub-aortic. There was an association of VSD with an ASD in 1 case and a VSD with an ASD type ostium secundum associated with pulmonary artery stenosis on pulmonary artery Banding in 1 case. The average size of the septal defect was 12 mm [7.7 - 17 mm]. The average trans-ventricular gradient was 28.3 mmHg [3 - 92 mmHg].

6. 2 cases of Laubry-Pezzy syndrome were found with moderate aortic regurgitation in the 2 patients. Both was associated with VSD (1 type perimembranous and 1 type infundibular). The average size of the septal defect was 6.5 mm [4 - 9 mm].

7. 2 cases of atrioventricular canal were found with ASD type ostium primum in all 2 cases and, VSD in 1 case.

8. 3 cases of sub-aortic diaphragm were found with an average maximum gradient between the Left Ventricle (LV) and the aorta of 59 mmHg [38 - 80 mmHg]. One patient had infundibular VSD associated with pulmonary valve stenosis. In the other case, we had a moderately severe congenital mitral stenosis and in 1 case an aortic stenosis.

9. 3 cases of severe right mid-ventricular stenosis. The 2 cases were associated with VSD and the other with mitral regurgitation.

Among the acquired valvular diseases, there was regurgitation in 32 patients (38%), including 27 severe, 3 moderate, 2 minimal. Mitral stenosis was found in 8 patients (9.5%), including 3 severe. Mitral disease (combining severe mitral stenosis and severe mitral regurgitation) was found in 7 cases (8.33%). Aortic valve lesions were dominated by aortic regurgitation in 28 patients (33.3%), including 9 severe. Aortic stenosis in 1 case (1.2%) and aortic disease (combining severe aortic stenosis and severe aortic regurgitation) in 1 case (1.2%). Tricuspid regurgitation was found in 32 patients (38%), it was severe in 6 patients. The average systemic pulmonary artery pressure was 59 mmHg [24 - 98 mmHg]. The distribution of acquired heart disease in the preoperative trans-thoracic ultrasound is illustrated in Figure 3.
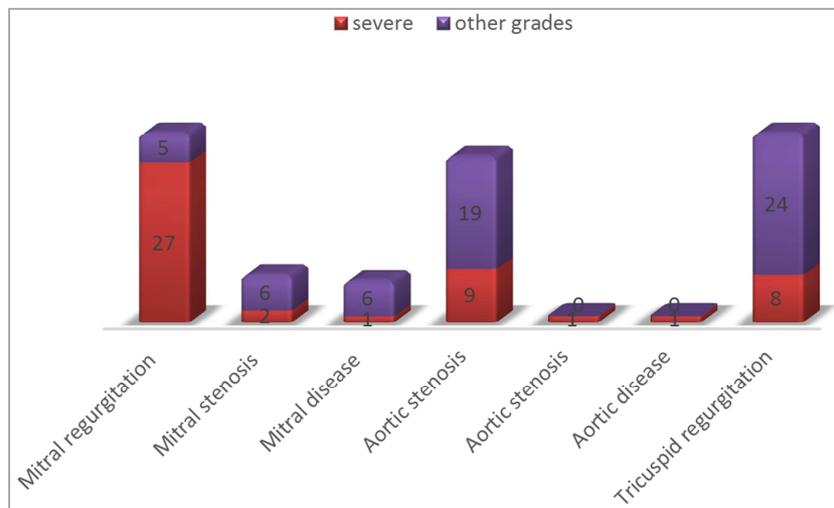

Figure 3. Distribution of acquired heart disease according to preoperative cardiac ultrasound.

Laboratory results showed an average hemoglobin level was 13 g/dl [23.4 - 8.1 g/dl], with an average rate of 12.4 g/dl for acquired heart disease and 13.4 g/dl for congenital heart disease. All serologies of anti streptolysin O, HIV and hepatitis B and C were normal. There were no ORL and stomatology infectious found. Preoperative treatment was initiated in 61 patients (72.6%). This treatment was based on a diuretic in 52 patients (62%), sometimes associated with potassium in 11 patients (13.1%), beta-blockers in 5 patients (6%), converting enzyme inhibitors in 26 patients (31%), antibiotics in 33 patients (39.3%), Iron in 11 patients (13.1%), anti-anginal agents in 4 patients (4.8%). The other treatments (in 8 patients, 9.5%) were composed of digitalis (3 patients), anticoagulants (2 patients), bronchodilators (2 patients), corticoids (1 patient), vitamins (1 patient).

- Surgically, the approach was a median sternotomy in 73 cases (87%) and a posterolateral thoracotomy in 11 cases (13%). Open heart surgery was performed in 70 cases (83.3%) and closed heart surgery in 14 cases (16.7%). Cardioplegia was blood in 68 patients (97.1%) and

crystalloid in 2 patients (2.9%). The cardioplegia was cold in 65 patients (92.8%), normothermic in 3 patients (4.3%) and hot in 2 patients (2.9%). Cardioplegia was performed anterograde in all cases. Left discharge was placed in 61 patients (87.1%). In the operating room we found compliance with preoperative echocardiographic diagnoses in 78 patients (93%). There was no compliance in 6 patients:

1. Absence of pulmonary valve stenosis but muscular and fibrous hypertrophies in the mid-ventricles in 1 patient.
2. VSD under aortic and vegetations in tricuspid valve versus VSD + Mid-ventricular stenosis + sub-aortic diaphragm + Endocarditis in 1 patient.
3. PFO versus partial atrioventricular canal + PFO in 1 patient.
4. Absence of infundibular stenosis in 1 patient.
5. Absence of T4F but infundibular VSD + mid-ventricular stenosis in 1 patient.
6. Different VSD size in 1 patient.

The operating procedures consisted of:

1. An aortic valve replacement in 10 patients (11.9%), all the valves were mechanical.
2. An aortic repair performed in 5 patients (6%).
3. Mitral valve replacement in 16 patients (19%), it was mechanical in 13 cases and biological in 3 cases.
4. A mitral repair performed in 16 cases (19%).
5. A tricuspid repair performed in 24 patients (28.5%).
6. Pericardial decortication performed in 1 case (1.2%).
7. A T4F treatment in 11 patients (13% of procedures performed) including a complete treatment in 10 patients and palliative surgery in 1 patient.
8. A PDA closure performed in 11 patients (13%), including 8 per suture-section and 3 per ligature.
9. An ASD closure performed in 9 patients (10.7%), with an autologous or heterologous patch.
10. Closure of VSD performed in 13 patients (15.5%), with an autologous or heterologous patch.
11. A full course of atrioventricular canal performed in 2 patients (2.4%).
12. A resection of the sub-aortic diaphragm performed in 3 patients (3.6%).
13. A mid-ventricular stenosis treatment performed in 7 patients (8.3%).
14. An APVC treatment in 3 patients (3.6%).
15. The other gestures are pulmonary artery enlargement (1 case), modified Blalock-Taussig (1 case) and 1 case of pulmonary artery Banding.

The mean aortic clamping time was 76 min [31 - 144 min], with an average of 89 min for surgery of acquired lesions and 63 minutes for surgery of congenital lesions. The mean CPB time was 106 min [58 - 191 min], with an average of 115 min for surgery of acquired lesions and 96 minutes for surgery of congenital lesions. As an intraoperative incident, we had 1 case of a PDA wound during the placement of clips and 1 case of resumption of a mitral repair with placement of a ring having resulted in mitral stenosis (average gradient at 8 mmHg) which required recovery for mitral repair without ring. The average length of the total stay was 19 days (± 15.9 days [range 6 - 128 days]), 22 days for acquired pathologies and 16 days for congenital. The average length of stay in intensive care was 4 days (± 1.4 days [range 1 - 39 days]), 4.3 days for acquired pathologies and 3.9 days for congenitals. The mean time to remove chest drains was 1.8 days (± 0.56 days [range 1 - 4 days]). The withdrawal time for amines was 1.9 days (± 1.7 days [range 24 - 9 days]). The average length of stay in hospital was 14.8 days (± 11.8 days [range 4 - 89 days]), 18 days for acquired pathologies and 12.6 days for congenitals.

Morbidity in intensive care was 46.4% (39 patients):

1. Hemodynamic complications in 13 patients (15.5%). These were Right Ventricular dysfunction in 6 patients, Left Ventricular dysfunction in 1 patient and bi-ventricular dysfunction in 2 patients, right heart failure in 3 patients and a stenosing aortic prosthesis in 1 patient.
2. Infectious complications in 12 patients (14.3%), with pneumonia in 5 patients, a nosocomial infectious syndrome found in 4 patients, 1 case of infection of the operating site, 1 case of sternitis and 1 case of sepsis klebsiella pneumonia.
3. Pericardial effusion was found in 5 patients (6%) and pleural effusion in 2 patients (2.4%).
4. Rhythm and conduction disorders were 8 in number (9.5%), at the rate of 5 auriculo-ventricular bloc (2 complete including 1 fitted), 1 case of atrial flutter, 1 case of complete right bundle branch block and 1 persistent tachycardia.
5. Neurological complications were found in 2 patients (2.4%) including 1 agitation associated with a spatio-temporal disorientation which were regressive and 1 transient ischemic attack.
6. Biological complications were found in 4 patients (4.8%): 2 cases of anemia, 1 case of hemolytic syndrome and 1 case of hyperkalemia.
7. The other complications (in 7 patients, or 8.33%) consisted of 1 case of postoperative bleeding requiring surgical re-operation, 1 case of early thrombosis of a Blalock-Taussig shunt after six days, 2 cases of HTAP, 2 cases of residual VSD and 1 case of gluteal deep bedsores.

There were 4 cases of complications in hospitalization (4.8%): 1 alteration of the LVEF to 32%, 1 heart failure, 1 bronchopneumopathy, 1 mediastinitis with septic shock. The overall mortality was 2.4%. Operative mortality was 1.2% (1 patient having benefited from a mitral valve replacement associated with an aortic repair having had an irreducible ventricular fibrillation with cardiac arrest, then pronounced death after 45 minutes of resuscitation) and late mortality of 1.2% (1 patient having benefited from a complete cure of T4F complicated by a residual VSD by release of overlock with a residual gradient on the pulmonary way which required a surgical resumption and secondarily of a dilation of the pulmonary valve in percutaneous, had presented neurological disorders with the type of dystonia with opisthotonos).

Morbidity and mortality analysis: in the postoperative operations, we compared the clinical and paraclinical data of patients who died or had a morbidity (MORBIMORTALITY group, 47 patients, 56%) with those of patients whose surgical suites were simple (UNCOMPLICATED group, 37 patients, 44%). The parameters of the two groups are highlighted in Table 3:

Table 3. *Comparison of the parameters between the MORBIMORTALITY and UNCOMPLICATED groups.*

	Morbimortality (%) Group	Uncomplicated (%) Group	P-value
Number of Patients (%)	47 (56%)	37 (44%)	-
Age	8.6 year	7.9 year	0.56
Dyspnea ≥ Stage 3 + Dyspnea at feeding (%)	22 (46.8%)	13 (35%)	0.7
Average LVEF	66%	66%	0.95
Average Left Atrium diameter	36 mm	32 mm	0.20
Severe mitral regurgitation (%)	17 (36%)	11 (29.7%)	0.48
Severe mitral stenosis (%)	3 (6.4%)	0 (0%)	0.28
Mitrale disease (%)	7 (14.9%)	0 (0%)	0.014*
Severe Aortic regurgitation (%)	5 (10.6%)	4 (10.8%)	0.61
Severe Aortic stenosis (%)	2 (4.2%)	1 (2.7%)	0.70
Aortic disease (%)	1 (2.13%)	0 (0%)	0.37
Significant Tricuspid Insufficiency (%)	6 (12.7%)	2 (5.4%)	0.54
Average systemic pulmonary artery pressure [extremes]	59 mmHg [24 - 110]	53 mmHg [10 - 89]	0.28
Pulmonary Insufficiency ≥ moderate (%)	7 (14.9%)	2 (5.4%)	0.078
PDA (%)	4 (8.51%)	8 (21.62%)	0.08
Mitral repair (%)	6 (30%)	10 (83.3%)	0.003*
Mitral valve replacement (%)	14 (70%)	2 (16.7%)	0.003*
Average aortic clamping time	78 min [43 - 144]	73 min [31 - 140]	0.45
Average CPB time	109 min [64 - 197]	101 min [55 - 168]	0.36
Average length of stay in intensive care	5 days [2 - 39]	3 days [1 - 9]	0.0027*
Average length of the total stay	18 days [6 - 89]	11 days [4 - 40]	0.0004*

After 3 months post-operative clinical improvement was noted in 78 living patients (85.7%), 4 patients (4.8%) were lost to follow-up. The doppler echocardiography objectified:

1. A residual infundibular stenosis in 4 cases, a residual VSD in one case and a Blalock which remained partially permeable after its ligation by 2 clips during a complete cure for T4F.
2. A complete closure of the arterial canal in all cases of persistence of the arterial canal.
3. After atrioventricular canal surgery, the persistence of a residual ASD of 5 mm in 1 case and a moderate mitral regurgitation in 1 case.
4. Grade 2/4 of aortic regurgitation with moderate dilation of the left ventricle was found after the repair of Laubry-Pezzy syndrome.
5. After the mid-ventricular stenosis surgery, there was a case of residual mid-ventricular stenosis with a mean right ventricle-pulmonary artery gradient at 20 mmHg.
6. After repair of the rheumatic valve disease, we found an average mitral leak in 5 cases, a moderate leak in 4 cases, and a minimal leak in 2 cases. There was also a case of mitral stenosis.
7. After the valve replacement surgery, the mitral prosthesis was moderately leaky in 1 case.
8. During aortic repair, average aortic regurgitation was found in 1 case, and moderate insufficiency in 3 cases.
9. After the pericardial decortication, the Doppler echocardiography showed a refractive pericardial residue, especially with regard to the left ventricle, without any sign of compression.

4. Discussion

In our study of 84 patients, there were more children with congenital heart disease compared to acquired heart disease, 49 patients (58%) versus 35 patients (42%) respectively. The overall distribution by sex is roughly equal in all statistics (Table 4). Overall it is around 50% for both sexes with a slight male predominance. This is the case in our study with 52.4% male.

Table 4. *Global distribution of heart disease by sex in the literature.*

Authors	Country	Year of study	Number	male (%)	female (%)
Touré [3]	Niger	-	123	53.71	46.29
Martinez [4]	Spain	1989-1998	428	48.1	51.9
Beye [5]	Senegal	2006 - 2007	19	63.16	36.84
Our study	Senegal	2017	84	52.4	47.6

Generally speaking, the average age differs according to recruitment. Ab M'pemba [6] in his study found an average age of patients of 6.3 years with extremes from 9 months to 15 years, close to our series with an average age of 8.33 years and extremes ranging from 4 months to 15 years. Beye in Dakar (from June 2006 to June 2007) during the missions which involved 19 patients also found an average age of 93.36 months (7.73 years) with extremes ranging from 6 months to 19 years old [5]. The peak frequency between 10 and 15 years may be due to delay in diagnosis (delay in

consultation and absence of ultrasound).

4.1. The Distribution of Heart Disease

4.1.1. Congenital Heart Disease

In Senegal congenital heart diseases represent 1% of cardiovascular pathologies [7]. In Tunisia, according to a study carried out at the pediatrics department of Bizerte hospital (January 1994 to December 2003), the annual incidence of congenital heart diseases has been estimated at 2.5 per 1000 [8]. In Congo, the incidence of congenital heart disease in the Pediatrics department of the Brazzaville University Hospital during the period 1989-2001 was 5 per 1000 [6]. The incidence of congenital heart disease in industrialized countries is between 5.2 and 12.5 per 1,000 live births. The range is wide because the estimate of the incidence depends on many factors, such as the inclusion criteria, the means of diagnosis, the size of the population, the duration of the follow-up, etc. [4]. Parental inbreeding was found in 23 children with congenital heart disease (46.9%). There is a high frequency of congenital heart disease in communities with a higher inbreeding rate. This high rate is estimated at 30.5% by Hammami [8]. Congenital heart defects are represented by congenital cyanogenic heart diseases (26.5%) and congenital non-cyanogenic heart diseases which are represented mainly by left-right shunts (57.2%) and obstructive malformations (16.3%). Cyanogenic congenital heart diseases were represented only by Tetralogies of Fallot (15.5% of the cases in our study and 26.5% of congenital heart diseases). Non-cyanogenic congenital heart disease represented the majority of the cases in our study (42.9%), or 73.5% of congenital heart disease. They were mainly left-right shunts and obstructive malformations. Left-right shunts represented one-third (33.3%) of the heart diseases operated in our study, more than half of the congenital heart diseases (57.1%) and 80% of the non-cyanogenic congenital heart diseases. The distribution of congenital non-cyanogenic heart disease with left-right shunt according to the literature is illustrated by Table 5.

Table 5. Global distribution of congenital non-cyanogenic heart disease with left-right shunt according to the literature.

Authors	Year of study	Number	VSD%	ASD%	PDA%	atrioventricular canal%
Diakité [9]	2005 - 2006	51	35.29	31.13	1.96	15.86
Bosi [10]	1993	1445	39	7.5	3.8	5.4
Martinez [4]	1989 - 1998	428	39	13.5	5.4	4.2
Our study	2017	49/84	40,8	20,4	26.5	4

Obstructive malformations were found in 9.5% of patients in our study. Table 6 shows the distribution of congenital obstructive heart disease according to the literature.

Table 6. Global distribution of congenital obstructive heart disease according to the literature.

Authors	Year of study	Number	Pulmonary stenosis (%)	Aortic stenosis (%)	Aortic coarctation (%)
Bosi [10]	1993	1445	7.3	2.2	2.4
Martinez et al [4]	1989 - 1998	428	7.7	0.5	3.3
Our study	2017	84	8	6	0

4.1.2. Acquired Heart Disease

Acquired heart disease was found in 41.7% of the cases in our study represented mainly by valvular heart disease. Valvular heart disease represented 40.5% of the cases in our study and the majority of acquired heart disease (97.1%). Mitral valve disease was the most represented (91.2% of acquired valve disease), followed by tricuspid valve disease (73.5% of acquired valve disease) and aortic valve disease (44.1% of acquired valve disease). All mitral and/or aortic valve disease was rheumatic and all tricuspid insufficiencies were functional. Rheumatic valve disease is the primary etiology of childhood valve disease worldwide [11]. The incidence of these rheumatic valve diseases is estimated between 13 and 14 cases per 100.000 inhabitants per year [12]. This incidence is probably underestimated in Africa mainly because of the lack of data. Studies by Beaton have shown that cardiac ultrasound detects a significant number of clinically silent rheumatic heart disease cases estimated between 7.5 and 51.6 per 1.000 children [13]. A study from several centers in Africa showed that rheumatic heart disease is the most common cause of heart failure in children and young adults with a 6-month mortality rate of 17.8% and 70% of these patients die before the age of 26 [13].

4.2. Clinical and Paraclinical Data

4.2.1. Clinical Data

Preoperative dyspnea was the most common functional sign (89.3% of patients, with dyspnea at stage III of the NYHA classification, and dyspnea at feeding in 41.7% of patients). This result is identical to that of the Hammami study, which found dyspnea in 89% of the 79 cases of congenital heart disease [8]. Talwar et al in a study of 278 (aged 15 years or less) who received mitral valve repair for a rheumatic mitral lesion found dyspnea stage III or IV (NYHA) in 62% of patients [14]. Beye's team in Dakar (from June 2006 to June 2007) found dyspnea in 63.2% of cases as discovery circumstances for congenital heart disease [5]. In our series we found recurrent bronchitis in 20.2% of cases, which is close to Beye's series which finds recurrent bronchopneumopathies in 26.3% of cases [5]. A heart murmur was found in 94% of the cases. In the Hammami series, a heart murmur was found in 77.6% of the cases [8].

4.2.2. Paraclinical Data

The average cardio-thoracic index of 0.62 is close to that of the Ferratini series (0.67) for children of an average age of 16 years with rheumatic valve disease [15]. In our series, no echocardiographic diagnosis was made antenatal. In developing countries, the diagnosis of heart disease in children is made late, often after complications such as ventricular dysfunction, pulmonary obstruction, infective endocarditis, sometimes associated with sequelae. Despite a prenatal visit often performed during pregnancy, the diagnosis of heart disease was not made preoperatively, probably due to the absence of ultrasound performed before birth to diagnose a possible malformation. After birth, the delay in diagnosis is due to the absence of systematic echocardiography to demonstrate congenital or acquired lesions. In Nigeria only 33.6% of heart disease was diagnosed before the age of 1 year and 69% before the age of 5 years [16]. Regarding acquired heart disease, there was a predominance of mitral valve disease with mitral regurgitation in 38% of cases (32 patients, including 27 severe), mitral stenosis in 9.5% of cases (8 patients, including 3 severe). Mitral disease was found in 8.33% (7 cases). There was a predominance of mitral valvulopathy in other series in sub-Saharan Africa; In a study done in Nigeria, echocardiography showed 38% of mitral regurgitation, 27% of mitral disease [16]. In another Cameroonian series involving 262 patients with heart murmur 59.7% of patients had mitral regurgitation, 15.3% pure mitral stenosis and 13.7% mitral disease [17]. The average hemoglobin level (13 g/dl) is close to that of the S. A. Beye series (12.55 g/dl) [5].

4.3. Gestures and Immediate Operating Suites

4.3.1. Gestures

The mean CPB time (106 min, 96 minutes for congenital lesions) is close to Beye's series of congenital heart diseases (114 min). The mean aortic clamping time (76 min, 63 minutes for congenital lesions) is slightly longer than that of the Beye series (49.78 min) [5]. According to Jaggers et al, the duration of the extra-corporeal circulation determines the occurrence of complications in the postoperative period [18]. Hemofiltration according to Pouard et al would reduce the water-sodium overload, restore the hematocrit level, reduce dilution coagulopathy, improve ventilatory and hemodynamic functions and allow the elimination of mediators of inflammation [19].

4.3.2. Immediate Operating Suites

The total average length of hospital stay was 19 days ± 15.9 days [range 6 days - 128 days]; It was longer (22 days) for acquired heart disease compared to congenital heart disease (16 days). Talwar in India finds (out of a series of 278 cases of children having undergone mitral valve surgery for rheumatic lesions) a much shorter average length of hospital stays of 5.8 days ± 1.7 days [range 4 days - 29 days] [19]. The average length of stay in intensive care was 4 days (96 hours) ± 1.4 days [range 1 day - 39 days]; It was slightly longer for acquired heart disease (4.3 days) compared to

congenital heart disease (3.9 days). In Beye's series, the average length of stay in intensive care was lower (72.68 hours with extremes of 37 to 117 hours) [5]. The average length of stay in hospital was 14.8 days ± 11.8 days [range 4 days - 89 days]; It was longer (18 days) for acquired heart disease compared to congenital heart disease (12.6 days). This lengthening of the length of stay in hospital (for acquired heart disease) can be explained by the need to balance the anticoagulant treatment in people with mechanical prostheses.

4.4. Morbidity and Mortality

4.4.1. Morbidity

In intensive care, a complication was found in 46.4% of patients. There was a predominance of hemodynamic complications (15.5% of cases) followed by infectious complications (15.6% of cases), with only one case of infection of the operating site and one case of sternitis (2.4%) whereas in the series by Pollock et al, infections of the operating wound were the most frequent [20].

4.4.2. Mortality

In our series the overall mortality was 2.4%. The operative mortality was 1.2% (1 patient having benefited from an valvular mitral replacement associated with an aortic plasty) and the late mortality of 1.2% (1 patient having benefited from a complete treatment of T4F complicated by a VSD residual by release of overlock with a residual gradient on the pulmonary route which required resumption). The series of 79 cases of Hammami congenital heart disease had shown a much higher mortality rate of 23.8% [8]. Two deaths are found in Beye's series (which involved 19 children with congenital heart disease, i.e. 10.5% mortality), 1 for lack of protection despite circulatory assistance by the pump and 1 in a table of cardiogenic shock by pericardial tamponade postoperatively [5]. In the series by Diouf et al concerning 21 cases of congenital heart disease, 4 cases of death were found, representing 19% mortality [21]. In Talwar's series (278 cases of repair surgery on the rheumatic mitral valve), there were 6 cases of early mortality (2.2%), 5 were due to persistent severe ventricular dysfunction and 1 case to a cerebral infarction [14].

4.4.3. Morbidity and Mortality Analysis

The comparative analysis between the 2 groups (MORBIMORTALITY and UNCOMPLICATED) made it possible to highlight some differences. The average age of patients in the MORBIMORTALITY group was slightly more advanced (8.6 years) compared to the UNCOMPLICATED group (7.9 years), but this difference was not significant (p=0.56). Preoperatively 46.8% of patients in the MORBIMORTALITY group had dyspnea at stage 3 or more, or dyspnea at feeding versus 35% in the UNCOMPLICATED group (p=0.7). There was no significant difference between the 2 groups (MORBIMORTALITY versus UNCOMPLICATED) for the LVEF (66% for both) preoperatively. There is no significant difference between the two groups regarding the

existence of severe Mitral regurgitation or severe Mitral stenosis. On the other hand, we find a mitral disease only in the MORBIMORTALITY group (14.9%) whereas there is none in the UNCOMPLICATED group, and this difference is significant (p=0.014). The systemic pulmonary artery pressure value was slightly higher in the MORBIMORTALITY group (59.2 mmHg) compared to the UNCOMPLICATED group (52.8 mmHg), p=0.28. Regarding congenital heart disease, there is more moderate to significant pulmonary regurgitation (14.9% vs 5.4%) in the MORBIMORTALITY group. There are more open hearts in the MORBIMORTALITY group (87%) compared to the UNCOMPLICATED group (78%), p=0.28. Among the gestures performed, there was much more mitral plasty in the UNCOMPLICATED group (83.3% vs 30%), while in the MORBIMORTALITY group there was much more mitral valve replacement (70% vs 16.7%); this difference was significant (p=0.003). For the other gestures performed there was no significant difference. The CPB and clamping times were close in the 2 groups. There was a significant difference between the 2 groups in terms of the length of stay in intensive care and the length of hospital stay. The length of stay in intensive care was longer in the MORBIMORTALITY group (5 vs 3 days, p=0.0027) as well as the duration of hospitalization (18 vs 11 days, p=0.0004).

5. Conclusion

Congenital and acquired heart disease in children is a public health problem in Senegal. Surgery improves the quality of life for these patients. This surgery is performed in Senegal with satisfactory results. Better knowledge of the characteristics of patients with a complication or who have died may allow better management. This would require:

1. Facilitate access to echocardiography for populations in order to have an early diagnosis and regular monitoring.
2. Equip structures dedicated to the care of cardiac heart diseases (congenital and acquired).
3. Train medical and paramedical staff to facilitate the diagnosis and adequate management of congenital heart disease and acquired valvular disease, in particular the management of complications.
4. Parents being informed about the need for regular monitoring for early detection of recurrences.

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