

Original article

Early Postoperative Arrhythmias after Cardiac Surgery in Children at the Shisong Cardiac Center, Cameroon

Arrhythmies postopératoires précoces chez l'enfant après chirurgie cardiaque au Centre Cardiaque de Shisong, Cameroun

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ABSTRACT

OBJECTIVE. The objectives of this study were to determine the frequency and characteristics of early postoperative arrhythmias, factors associated with their occurrence, and their treatment in children after cardiac surgery.

METHODOLOGY. This was a retrospective and analytic study in children operated at the Cardiac Center Shisong (Cameroon) between January 2010 and December 2013. Information on demographic, pre-operative, surgical and post-operative characteristics was extracted from each patient's medical record. Arrhythmias were classified as sinus bradycardia, sinus tachycardia, atrial flutter, etc...

RESULTS. A total of 150 children were recruited. The most common arrhythmias were supra-ventricular tachycardia (35.3%), sinus bradycardia (19.6%) and junctional ectopic tachycardia (15.7%). Arrhythmias appeared mainly in the first 24 hours postoperative (57.4%). Amiodarone was the most commonly used antiarrhythmic drug. After a multivariate logistic regression analysis, weight between 5 and 9 kg ($p < 0.001$) and open heart surgery ($p < 0.01$) were the factors that remained significantly associated with arrhythmias.

CONCLUSION. Early postoperative arrhythmias are common after pediatric cardiac surgery and the most common is supra-ventricular tachycardia. Children with weight ranging between 5 and 9 kg and those who undergo an open heart surgery are at risk of developing arrhythmias.

KEYWORDS. Arrhythmias, Cardiac Surgery, Early Postoperative period, Pediatrics, Cameroon

RÉSUMÉ

OBJECTIFS. Les objectifs de cette étude étaient de déterminer la fréquence et les caractéristiques des arythmies postopératoires précoces, les facteurs liés à leur fréquence, et leur traitement chez les enfants après une chirurgie cardiaque.

MÉTHODOLOGIE. Nous avons réalisé une étude rétrospective, analytique chez les enfants opérés au Centre de chirurgie cardiaque de Shisong (Cameroun) entre Janvier 2010 et Décembre 2013. Les informations démographiques, les caractéristiques pré et post-opératoires des patients, la chirurgie réalisée ont été obtenues à partir du dossier médical de chaque patient. Les arythmies ont été classées en bradycardie sinusale, tachycardie sinusale, flutter auriculaire,...

RÉSULTATS. Un total de 150 enfants ont été recrutés. Les arythmies les plus fréquentes étaient la tachycardie supra-ventriculaire (35,3%), bradycardie sinusale (19,6%) et la tachycardie ectopique jonctionnelle (15,7%). Les arythmies sont apparues principalement dans les 24 premières heures post-opératoires (57,4%). L'amiodarone était l'antiarythmique le plus utilisé. Après une régression logistique multivariée, le poids entre 5 et 9 kg ($p < 0,001$) et la chirurgie à cœur ouvert ($p < 0,01$) ont été les facteurs qui restaient significativement associés à des arythmies.

CONCLUSION. Les arythmies postopératoires précoces sont fréquentes après une chirurgie cardiaque pédiatrique et la tachycardies supra-ventriculaire est la plus retrouvée. Les patients ayant un poids compris entre 5 et 9 kg et qui ont subi une chirurgie à cœur ouvert sont le plus à risque de développer une arythmie en post opératoire.

MOTS-CLÉS. arythmies, chirurgie cardiaque, période post-opératoire précoce, pédiatrie, Cameroun

INTRODUCTION

The Postoperative arrhythmias are a frequent complication after cardiac surgery in both adults and children. The majority of studies were conducted in adult populations [1]. Although in the immediate and early postoperative period, arrhythmias are transient and reversible, they can cause substantial morbidity and mortality during such a vulnerable phase of hemodynamic instability. They are caused both by mechanical irritation of the conduction tissue and humoral factors [2].

For over a decade now, publications have focused on arrhythmias after cardiac surgery in the pediatric population. These are mainly from developed countries [1,3–6]. In Africa, cardiac surgery is not part of routine clinical practice and as such studies related to the subject are scarce [7,8]. Authors reported the frequency of post operative arrhythmias as from 8,8% to up to 79,1% after open heart surgery [6].

The aims of this study were to determine the frequency and characteristics of early postoperative arrhythmias after pediatric cardiac surgery in the Central African region, and its associated factors. It would be a contribution to the knowledge of the magnitude of this poorly documented disease in our communities.

MATERIAL AND METHODS

It was a retrospective and analytic study on patients operated upon for congenital and acquired heart diseases at the St Elizabeth General Hospital Cardiac Center Shisong (Cameroon) between January 2010 and December 2013. Patients included were aged 18 years at most and had a complete medical file. The exclusion criteria were death in early postoperative period without experiencing an arrhythmia; arrhythmia documented preoperatively; antiarrhythmic therapy before surgery and admission to intensive care unit [ICU] on cardiac stimulation. Data were collected from medical files including ICU surveillance data sheets and standard electrocardiogram tracings. The surgeries were performed by different teams.

Data collected included: demographics (age, gender), anthropometric (weight, height), type of heart disease operated upon (congenital, acquired), type of surgical procedure, per-operative parameters (cardiopulmonary bypass time, aortic crossclamp time) and postoperative data (use of inotropic agents, duration of mechanical ventilation, ICU and hospital stay). For each case of arrhythmia, the onset, the type and the treatment modality were recorded. The Aristotle Basic Score (Aristotle Institute, Denver; available at <http://www.aristotleinstitute.org/>) was used to score each surgery indicated for congenital heart disease, excluding all reinterventions.

Patients were monitored using bedside monitors in the ICU, and standard electrocardiogram tracings in both the ICU and postoperative wards. The standard

electrocardiogram tracings were analyzed by the same cardiologist. Arrhythmia was defined as any rhythm different from normal sinus rhythm, the extreme values being adapted according to the normal ranges used after cardiac surgery [9].

Arrhythmias were classified as sinus bradycardia sinus tachycardia, atrial fibrillation, atrial flutter, supraventricular tachycardia, junctional ectopic tachycardia, Second and third degree atrioventricular blocks, ventricular tachycardia, ventricular fibrillation and atrial extrasystoles or ventricular extrasystoles.

Sinus bradycardia was defined as a sinus rhythm with a rate too low for a particular age and hemodynamic condition or a junctional escape rhythm in the absence of atrioventricular block or junctional ectopic tachycardia. Sinus tachycardia was an abnormally accelerated sinus rhythm without an identified physiological etiology (anemia, stress). The supra-ventricular tachycardia was defined as a narrow QRS complex tachycardia with atrioventricular conduction of 1:1 and a reentry mechanism [10]. Junctional ectopic tachycardia was defined as a narrow QRS complex tachycardia with a rate between 170 and 230 beats per minute and atrioventricular dissociation [11].

The early postoperative period was defined as the interval between the exit from the operating room until 30 days after surgery during the same hospitalization [12]. The postoperative evolution for each patient was studied until his discharge from the hospital.

For this study, high doses of inotropic agents was said to be administered in the ICU when dose was greater than 0.5 mcg / kg / min for epinephrine and norepinephrine, 10 mcg / kg / min for dopamine and dobutamine, 0,75 mcg / kg / min for milrinone and 10 mcg / kg / min for enoximone.

The nutritional status of the patients was evaluated by the 2007 Weight-for-age World Health Organization curves when aged <5 years and body mass index for ages ≥ 5 years [13].

Data were analyzed with the International Business Machine® with the Statistical Package for the Social Sciences software 19.0. Quantitative variables were expressed as mean \pm standard deviation and categorical variables as proportions. The comparison between groups (arrhythmic versus non-arrhythmic) was made using the Student t test and Chi-square test for quantitative and qualitative variables respectively. The difference between the groups was considered statistically significant for p values less than 0.05. Secondly, the variables found to be significantly associated with arrhythmias on univariate analysis were entered into a logistic regression model to determine the predictive factors.

RESULTS

A total of 150 patients were included. Their ages ranged from 2 months to 18 years (mean 6.5 ± 5.7 years). The sex ratio was 1.17, showing a slight male predominance. Congenital and acquired heart diseases were respectively the surgical indications for 72% (108 patients) and 27.3% (41 patients) of the population. One patient had both congenital and acquired as indications for surgery.

Among the 150 patients, at least one episode of arrhythmia was found in 47 patients (31.3%). Of these 47 patients, two respectively presented 2 types

(junctional ectopic tachycardia and atrioventricular blocks III) and 4 types (sinus tachycardia, supraventricular tachycardia, ventricular tachycardia and ventricular fibrillation) of arrhythmias, giving a total of 51 episodes of arrhythmia. Of the 133 patients with open heart surgery, 46 (34.6%) had arrhythmias while only 01 (5.9%) of the 17 patients with closed heart surgery had an arrhythmia. The arrhythmic population (30 boys and 17 girls) was aged 64.7 months on average. Arrhythmias were associated with three postoperative deaths.

TABLE 1: TYPES OF ARRHYTHMIAS CLASSED DEPENDING ON THE TYPE OF CARDIAC SURGERY

Types of arrhythmias	Indication		Total (%)
	Congenital heart Disease (n/n')	Acquired heart disease (n/n')	
SVT	AVSD repair (02/08)	Mitral valve and tricuspid valve replacement (01/02)	18 (35.3)
	VSD closure (07/32)	Mitral valve plasty (01/07)	
	ASD and VSD closure (02/05)		
	Repair of TOF (04/29)		
	Pulmonary conduit replacement (01/03)		
SB	AVSD repair (01/08)	Mitral valve replacement and tricuspid valve plasty(02/10)	10 (19.6)
	VSD closure (04/32)	Mitral and tricuspid valve plasty (01/01)	
	Repair of TOF (01/29)	Aortic valve replacement and mitral valve plasty(01/04)	
JET	AVSD repair (02/08)	Mitral valve replacement and tricuspid valve plasty (02/10)	08 (15.7)
	Repair of TOF (01/29)		
	RVOT repair (01/02)		
	Pulmonary artery banding (01/02)		
	Valvuloplasty, Ebstein's anomaly (01/01)		
ST	VSD closure (02/32)		03 (5.9)
	Pulmonary conduit replacement (01/03)		
AVB III	Closure VSD + Mitral and tricuspid valve plasty (01/01)		03 (5.9)
	Repair of TOF (01/29)		
	ASD closure (01/03)		
VT	VSD closure (01/32)		03 (5.9)
	Pulmonary conduit replacement (01/03)		
	RVOT repair (01/02)		
AVB II	AVSD repair (01/08)	Mitral and tricuspid valve replacement (01/02)	02(3.9)
AF	Repair of TOF (01/29)	Mitral valve replacement (01/03)	02(3.9)
VF	Pulmonary conduit replacement (01/03)		01(2.0)
VES	VSD closure (01)		01(2.0)

AF : atrial fibrillation; ASD : atrial septal defect; AVB:atrioventricular block; AVSD : atrioventricular septal defect; JET(junctional ectopic tachycardia);RVOT : right ventricular outflow tract; SB :sinus bradycardia; ST: sinus tachycardia; SVT: supra-ventricular tachycardia; TOF : Tetralogie of Fallot VES : ventricular extrasystoles; VF:ventricular fibrillation; VSD :Ventricular septal defect VT: ventricular tachycardia; n : number of episodes of arrhythmia per surgical intervention; n' : number of surgical interventions depending on the indication.

Types and characteristics of arrhythmias

The most represented arrhythmias were supra-ventricular tachycardia (35.3%), sinus bradycardia (19.6%) and junctional ectopic tachycardia (15.7%) (Table 1). Of the 47 patients, 57.4% developed arrhythmia in the first 24 hours following surgery. The

most observed arrhythmias in patients having received high doses of inotropic agents were Junctional ectopic tachycardia (06/21) and supraventricular tachycardia (06/21).

Treatment

Regarding management, treatment was done in 37 (78.7%) of the 51 episodes of arrhythmia. Treatment modalities are shown in Table 2. Several therapeutic methods were used for 8 patients. Correction of electrolyte imbalance was done in 15 patients and amiodarone administered to 10 patients.

TABLE II: ARRHYTHMIAS THERAPIES

Therapy	Effectifs (%)
Medication	19 (51)
Cardiac pacing	9 (24)
Cardiac pacing and medication	7 (19)
Electric cardioversion	1 (3)
Electric cardioversion and medication	1 (3)
TOTAL (%)	37 (100)

All the atrioventricular blocks, except for one third degree block which occurred after closure of ventricular septal defect combined with mitral and tricuspid valvuloplasty, were transient. It persisted until the 12th day following the surgery and finally, a permanent pacemaker was placed.

Analysis of risk factors

Factors statistically associated with arrhythmias after univariate analysis were weight ($p < 0.05$), open heart surgery ($p < 0.05$), high doses of inotropic agents postoperatively ($p < 0.001$), prolonged duration of mechanical ventilation ($p < 0.001$), ICU stay ($p < 0.001$) and hospitalization stay ($p < 0.01$). Multivariate logistic regression analysis was then

done, including only the above variables found to be significantly associated to arrhythmias on univariate analysis. On this level only weight between 5 and 9 kg (Odds Ratio= 5.5 ; Confident Interval = 95% ; $p < 0,001$) and heart surgery with cardiopulmonary bypass (Odds Ratio = 21.3 ; Confident Interval = 95% ; $p = 0.008$) were significantly associated with the development of arrhythmias.

DISCUSSION

This study focused on arrhythmias in early postoperative surgery of congenital and acquired heart disease in children. Surgical procedures were not carried out by the same team, introducing bias on the variables linked to the surgery (surgical procedures, cardiopulmonary bypass time, aortic crossclamp time). This could result in a decrease in the quality of the results when compared to studies guaranteeing standardized surgical procedures or a single competent surgical team carrying out the surgeries [1,14].

The evolution of the patients was observed until discharge from the hospital which occurred before the 30th postoperative day. As such this could reduce the actual incidence of early postoperative arrhythmias. However, our results are comparable to those from several studies found in the literature, in which the authors also considered shorter periods of follow-up [3,4,7]. Nevertheless, this retrospective study conducted over a 3 year period in a referral center for heart surgery could be taken as an adequate reflection on early postoperative arrhythmias in this region of Africa.

Table III: factors potentially associated with early postoperative cardiac arrhythmias

Parameters	Arrhythmic (n=47)	Non-arythmic (n=103)	P value
Age (months) ^a	64.7 ± 67.5	83.8 ± 68.3	0.112
Body weight (kg) ^a	16.9 ± 12.8	22.2 ± 15.7	0.048*
Nutritionnal status ^b			0.132
Poor nutritionnal status	17	25	
Good nutritionnal status	30	78	
Preoperative oxygen saturation ^a	93.3 ± 6.0	94.3 ± 6.1	0.383
Cardiopathy ^b †			0.291
Congenital heart disease	36	72	
Acquired heart disease	10	31	
Aristotle Basic Score ^a	6.7 ± 1.6	6.1 ± 1.9	0.071
Type of surgery ^b			0.016*
Open heart surgery	46	87	
Closed heart surgery	01	16	
Cardiopulmonary bypass time ^a (min)	108.5 ± 46.8	113.8 ± 61.6	0.612
Aortic cross-clamp time ^a (min)	61.2 ± 32.6	70 ± 48.1	0.249
Inotropic support ^b			< 0.001*
High dose	21	18	
None/ Low to moderate dose	26	85	
IPPV time ^a (hours)	31.8 ± 43.5	12.9 ± 16.7	< 0.001*
ICU stay ^a (days)	4.5 ± 3.2	2.6 ± 1.2	< 0.001*
Hospitalisation stay ^a (days)	12.7 ± 4.1	10.6 ± 2.9	0.003*

* $p < 0.05$; ^aStudent t test ; ^bChi-square test; † The patient operated upon for congenital and acquired heart disease was not considered; IPPV : Intermittent positive pressure ventilation ; ICU : Intensive care unit.

The overall frequency of occurrence of postoperative arrhythmias after cardiac surgery was 31.3%. Our rate was higher than the 27.2% reported by Kamel et al. [8] and the 8.8% reported by Yildirim et al. [7] probably due to the fact that in these studies only sustained arrhythmias (≥ 30 seconds duration, recurrent and / or affecting the hemodynamic status) were considered. However, Grosse-Wortmann et al [6] found a rate of 79.1% after open heart surgery. This is the highest frequency in the literature. This result was explained by the use of the Holter electrocardiogram which is more sensitive in the detection of certain arrhythmias, especially extrasystoles when compared with the bedside monitor.

The frequency of occurrence of arrhythmias was 5.9% for closed heart surgeries and 34.6% for those with cardiopulmonary bypass. This lower frequency of arrhythmias after cardiac surgery with closed heart compared to that with cardiopulmonary bypass could be explained by direct injury to cardiac tissue from myocardial incision, cannulation, suture affecting atrioventricular conduction, and rapid change of intracardiac pressure caused by volume and pressure fluctuation [10]. Surgeries indicated for congenital heart disease caused many more arrhythmias than those indicated for acquired heart disease, though with no statistically significant difference. This could be explained by the complexity of surgical procedures used in congenital heart disease, which require the use of cardiopulmonary bypass and occur near the conduction tissues.

Arrhythmias appeared in 57.4% of cases within the first 24 hours following surgery. That could imply that specific factors inherent to the myocardium, cardiopulmonary bypass, the high dose of inotropic agents, low blood pressure, electrolyte disorders, acidosis and positive pressure ventilation play a part during this period [8].

Supraventricular tachycardia was the most common arrhythmia with a frequency of 35.3%. This is close to the 33.3% reported by Kamel et al [8]. and such a prevalence could be explained by right atrial cannulation for cardiopulmonary bypass and surgical approach through right atrium [6].

In this study, the average weight of arrhythmic patients was significantly lower than that of non-arrhythmic

patients. This is similar to that of Rękawek et al [4] and could be explained by the implementation of complex surgical procedures in younger patients who have smaller weights. Furthermore, sensitivity to electrolyte and acid-base disorders is greater in these patients [7].

Unlike other studies [1,4,14], prolonged cardiopulmonary bypass time was not significantly associated with the occurrence of postoperative arrhythmias. This difference could stem from the absence of use of highly complex surgical procedures (except repair atrioventricular canal), as previously demonstrated by Valsangiacomo et al [3] in their study. Among the treatment modalities, amiodarone was the antiarrhythmic drug administered most. This is probably due to its efficacy previously demonstrated in children in the postoperative period of cardiac surgery [15,16].

CONCLUSION

Early postoperative arrhythmias are a frequent complication after cardiac surgery. Supra-ventricular tachycardia is the most observed arrhythmia following cardiac surgery. Patients who have weights less than or equal to 9 kg and have undergone heart surgery with cardiopulmonary bypass are most at risk of developing such events. Nevertheless, such an occurrence of arrhythmias may depend on other variables that have not yet been explored.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper.

ETHICAL CONSIDERATIONS

This study was approved by the ethical committee of the Faculty of Medicine and Biomedical Sciences, Yaounde, Cameroon.

TABLE 4 : PREDICTIVE FACTORS OF EARLY POSTOPERATIVE CARDIAC ARRHYTHMIAS

Variables	Odds ratio	Confidence interval 95%	P value
Weight between 5 and 9 kg	5.5	[2.1 - 14.2]	< 0.001*
Open heart surgery	21.3	[2.2 - 202.5]	0.008*
High dose inotropic support	2.2	[0.8 - 5.9]	0.107
IPPV time > 10 heures	1.2	[0.5 - 3.0]	0.655
ICU stay > 3 jours	2.1	[0.8 - 6.0]	0.145
Hospitalisation stay > 10 jours	1.6	[0.6 - 4.1]	0.352

*p < 0.05 ; R2 de Nagelkerke : 33% ; Pouvoir prédictif : 81% ; N= 148 ; IPPV : Intermittent positive pressure ventilation

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