Original Article

Early Postoperative Arrhythmias after Paediatric Cardiac Surgery

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Abstract

Background: *The radical change in techniques in paediatric cardiac surgery has dramatically reduced the morbidity and mortality. The different varieties of arrhythmia that are frequently observed in postoperative period in our country are still not well documented.* ***Objectives:*** *To determine the incidence and risk factors of arrhythmia immediately after cardiac surgery in paediatric age group.* ***Materials and method:*** *It was a prospective study. A total of 100 paediatric patients (age <18 years) who underwent cardiac surgery at Dhaka Shishu Hospital between 2013 and 2016 were selected purposively* ***Results:*** *Out of 100 patients maximum 41% were from 13-72 months age group. The mean age was 49.73±37.17 months with range of 0.5-231 months, 58% patients were male and rest were female. Postoperatively 31% subjects were arrhythmic and of these the highest number of patients suffered from junctional ectopic tachycardia. Out of these 100 patients, 39% were diagnosed as VSD followed by TOF (35%). Among 31 arrhythmic patients 59.83%, 41.93% and 3.22% manifested onset of arrhythmia at 1st, 1st to 2nd and 2nd to 7th postoperative period respectively. In this study age, body weight, cyanosis, CPB time, postoperative acidosis, ventilation support days, hypertension on arrival in ICU as well as ICU stay days were recognized as significant risk factors (p <0.05).* ***Conclusion:*** *Proper and careful monitoring of younger patient with lower body weight undergoing corrective cardiac surgery with long cardiopulmonary bypass (CPB) time may reduce the episodes of post operative arrhythmia. These patients may require high inotropic support post operatively. So, medical prevention and early diagnosis as well as proper management may improve the operative outcome.*

Keywords: *Postoperative arrhythmia; paediatric cardiac surgery.*

Delta Med Col J. Jan 2018;6(1):22 – 28

Introduction

Now-a-days paediatric cardiac surgery has got a modern dimension with versatile logistic supports including ultramodern technologies, newer cardiac surgery technique, and newer drug use. Improvement of paediatric intensive care unit (PICU) facilities have increased the survival rates in complicated paediatric cardiac surgery.[1]

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Arrhythmia is one of the vital early complications of paediatric cardiac surgery. But unfortunately there is little information still now regarding the incidence and risk factors of this event that is not isolated to one type of disease or surgical technique.[2] Although transient and treatable in most cases, arrhythmia is a cause of substantial morbidity and mortality, especially when they occur in the early vulnerable period of unstable hemodynamics. In particular, junctional ectopic tachycardia (JET) remains a notorious arrhythmia that prolongs PICU stay and some leads to death.

The incidence of acute postoperative arrhythmias ranges from 7.3% to 48%.[3,4] There is no such a consensus in Bangladesh still now; though the paediatric cardiac surgery, as a discipline is not well flourished in multiple centers here. Dhaka Shishu Hospital, NICVD, National Heart Foundation, Ibrahim Cardiac Hospital & Research Institute are the four super specialized centres serving as a sole centre for this surgery.

There are multiple recognized factors that are responsible for early post operative arrhythmia. These are direct surgical injuries like myocardial incision, cannulation, sutures close to conduction system, and acute changes in intracardiac pressure caused by volume and pressure overload.[5] Besides cardiopulmonary bypass (CPB) with ischemia reperfusion and related cellular biochemical effects as well as medical interventions such as electrolyte shifts and catecholamine administration may affect in the stability of the cellular membrane and result in increased myocardial irritability and automaticity.[6]

High incidence of malnutrition in children, financial constraints of the parents, lack of awareness about signs and symptoms of heart disease and late presentation of the cases are some important factors affecting the outcome of paediatric cardiac surgery in developing countries.[7] Surgical type like Fontan or Senning type operations and total correction of tetralogy of Fallot are responsible for atrial and ventricular arrhythmia respectively.[8]

The main aim of this study was to determine the incidence and risk factors of arrhythmia immediately after cardiac surgery in paediatric age group.

Materials and method

It was a prospective observational study on paediatric patients (age <18 years) who underwent cardiac surgery at Dhaka Shishu Hospital, Dhaka, Bangladesh between 2013 and 2016. The study protocol was duly approved by the ethics committee of the institute and informed consent was obtained from the parents of all children. During this period total 136 paediatric patients were admitted for cardiac surgery. Out of them 100 subjects were included purposively for this study. Data including patient's age at the time of surgery, aortic cross clamp (ACC) time, ionized calcium and magnesium levels on arrival in PICU as well as other clinical, surgical, biochemical and sociodemographic profile were documented.

All surgeries were performed by the same surgical team. In PICU, an attempt was made to record a 12 lead electrocardiogram (ECG), but if bandages or tubes did not allow placement of all chest leads, a 6 lead (limb leads) ECG was recorded. A minimum of 18 hours of ICU stay was considered mandatory to allow for assessment of early postoperative arrhythmias.

In this study, an arrhythmia was defined as an alteration in the heart rate or rhythm that necessitated an intervention, such as a change in medication, using of temporary pacing wires, or electrical cardioversion/defibrilliaction. This allowed inclusion of all types of supraventricular tachycardia (SVT) and ventricular tachycardia (VT), as well as disorders of atrioventricular (AV) conduction. Here, junctional ectopic tachycardia (JET) was defined as a narrow complex tachycardia, with AV dissociation or retrograde atrial capture, which was at least 20% faster than underlying sinus rate.

All recorded arrhythmias were analyzed by a paediatric cardiologist who achieved expertise in paediatric arrhythmias. Direct recordings from the temporary atrial pacing wires were made to

confirm the diagnosis in necessary cases. Sinus arrhythmia is a notorious confounding factor here for detection of arrhythmia. Hence ECG were done in all neonates who sustained a heart rate of >200 bpm, infants and children with heart rate of >180 bpm and those found to have a heart rate that is not appropriate for existing clinical setting.

Statistical analysis

Statistical analysis was done with Statistical Package for Social Science (SPSS, Inc, Chicago, IL, USA) version 23. Data were expressed in frequencies and mean±SD where applicable. The independent sample t test was done to draw comparisons between patients having arrhythmia and patients without arrhythmia. A p-value <0.05 was considered as statistically significant.

Results

Table I shows that out of 100 patients the highest 41% patients were from 13-72 months age group followed by 36% from 6-12 months age group. Mean age of the respondents was 49.73±37.17 months (age range: 0.5-231 months).

Table I: Age distribution of the respondents (n=100)

Age (months)	Frequency (%)
<6	1
6 – 12	36
13 – 72	41
73 – 144	5
>144	17
Mean age (in months)	49.73±37.17
Age range (in months)	0.5 – 231

Table II shows the distribution of basic sociodemographic characteristics and sex distribution. Out of 100 paediatric patients 58% were male and 42% were female. The female to male ratio was 1:1.38. The economic status shows that the household income <10,000 BDT per month were categorized as poor income status whereas 10,000-30,000 and >30,000 BDT per month household income were classified as middle income and affluent class respectively. As Dhaka Shishu Hospital is a government patronized hospital in Bangladesh; here middle income people gathered mostly, maximum 63% patients were from middle income group followed by 35% from the affluent class. As it is an expensive treatment system, mostly the minimum treatment cost is also beyond reach of poor people. Here 2% patients were from low income category and these 2 patients' treatment costs were contributed by different generous rich people of society.

Table II: Distribution of sociodemographic characteristics

Variables (N=100)	Frequency
Sex	
Male	58
Female	42
Economic status of parents	
Poor income (<10,000 BDT/month)	2
Middle income (10,000-30,000 BDT/month)	63
Affluent class (>30,000 BDT/month)	35
Area of residence	
Urban	71
Rural	29

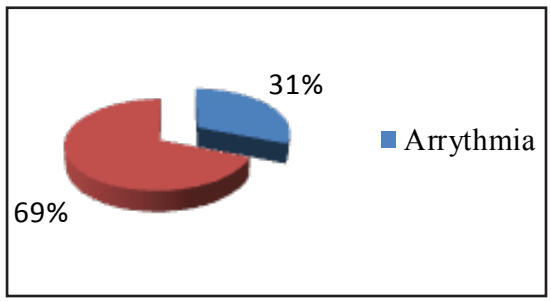

Fig 1: Distribution of arrhythmia among respondents (N=100)

Figure 1 shows that out of 100 paediatric patients only 31% children experienced arrhythmia in early post operative period whereas rest 69% did not; though some of them experienced other complications which is beyond scope of this study.

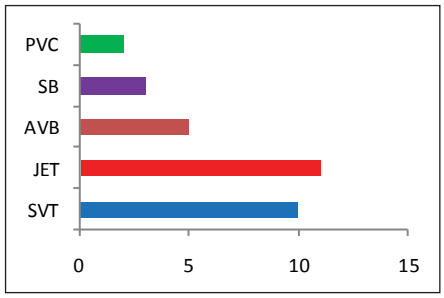

Fig 2: Distribution of different types of arrhythmia (n=31)

Figure 2 shows that out of 31 postoperative arrhythmic patients occurrence of junctional ectopic tachycardia (JET) was the highest (11), followed by supraventricular tachycardia (SVT) being 10.

Table III shows distribution of preoperative diagnoses. It was proclaimed in this table that maximum 11 (35.48%) patients out of 31 arrhythmic cases had the preoperative diagnosis tetralogy of Fallot's (TOF) and subsequently 8(25.80%) patients were found to have ventricular and atrial septal defect.

Table III: Distribution & comparison of arrhythmic & non arrhythmic subjects along with preoperative diagnosis (N=100)

Diagnosis (N=100)	Types of arrhythmia					Total arrhythmias (n=31)	Total non-arrhythmias (n=69)	p-value
	SVT N=10)	JET (n=11)	AVB (n=5)	SB (n=3)	PVC (n=2)			
TOF (n=35)	4	7	-	-	-	11	24	
VSD + ASD (n=11)	4	-	2	2	-	8	3	
AVCD (n=9)	-	2	3	-	-	5	4	>0.05^{NS}
VSD (n=39)	2	-	-	-	1	3	36	
ASD (n=6)	-	2	-	1	1	4	2	

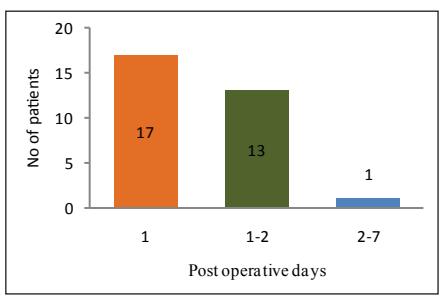

Fig 3: Distribution of patients according to onset of arrhythmia (n=31)

Figure 3 shows that out of 31 arrhythmic patients 17(54.83%), 13(41.93%) and 1(3.22%) manifested onset of arrhythmia at 1st, 1st to 2nd and 2nd to 7th postoperative period respectively.

Table IV shows that all the potential risk factors showed statistically significant difference in creating post operative arrhythmia except aortic cross clamp (ACC) time, electrolyte disturbances, ventilation support days and ICU stay days.

Table IV: Distribution of potential risk factors for arrhythmias and perioperative details in paediatric cardiac surgery (n=100)

Parameters	Arrhythmia cases (n=31)	Non-arrhythmia cases (n=69)	p-value
Age (month)	13.16±3.31	47.57±7.69	<0.05
Body weight (kg)	8.73±1.79	12.79±9.17	<0.05
Cyanosis (%)	16 (51.61%)	21 (30.43%)	<0.05
CPB time (min)	105.43±50.17	46.73±18.75)	<0.05
ACC time (min)	49.73±21.35	46.73±17.77	>0.05^{NS}
Post-operative acidosis (%)	8 (25.80%)	2 (2.89%)	<0.01
Electrolyte disturbances (%)	1 (3.22%)	3 (4.34%)	>0.05^{NS}
High inotropic support (high dose) on leaving operating room (%)	10 (32.25%)	2 (2.89%)	<0.01
Ventilation supports days	4±1.7	1±0.7	<0.01
Anemia (%)	9 (29.03%)	4 (5.79%)	>0.05^{NS}
Hypotension on arrival in ICU (%)	11 (35.48%)	5 (7.24%)	<0.01
ICU stay days	7±2	3±2	<0.05

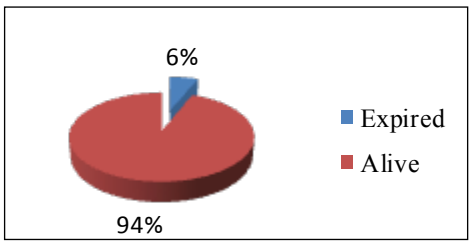

Fig 4: Distribution of outcome of surgery (n=100)

Figure 4 shows that out of 100 patients 6% expired and 94% remained alive. Of these 6 expired patients 5 (83.33%) experienced early post operative arrhythmia.

Discussion

With the advancement of surgical techniques, logistic supports, immense improvement in early results of paediatric cardiac surgery has been observed. But though arrhythmia still remains a

striking factor for early morbidity and mortality.[9] The overall incidence of arrhythmia after paediatric cardiac surgery according to our study was 31% which was almost nearer to the results of Chelo et al. in June, 2015 from Cameroon.[10] Kamel et al.[11] found 27.2% new cases in their study whereas Yildrim et al.[4] reported only 8.8% arrhythmia in their study. They found such a lower result which may be due to the fact that they considered only sustained arrhythmia (≥30 seconds duration, recurrent and/or affecting the hemodynamic status). Arrhythmia is common after corrective surgery (29.4%) rather than palliative surgery (13.3%).[11] But it is true that arrhythmia incidence is more in complex cardiac surgeries. In the study of Valsangiacomo et al. the incidence of arrhythmia were 48% and such a big figure of incidence was explained by performance of more complex surgical procedures.[2] In this study, the incidence rate is not quite low which may be explained by the fact that this study included all kinds of abnormal rhythm with or without hemodynamic effects.

Jacobs et al.[12] categorized arrhythmia as early and late onset where the early onset was defined as presence of arrhythmias during the first 48 hours post operatively. In this study, we have got 31% early onset arrhythmia. These early onset arrhythmias were expected in previous study due to the swelling of the myocardium, unstable hemodynamic status, high dose of inotropes administration and metabolic disturbances.[12]

Junctional ectopic tahycardia (JET) and supraventricular tachycardia (SVT) were found common in corrective surgery in this study especially in tetralogy of Fallot 7/35 (20%) and 4/35 (11.43%) respectively. Some previous studies supported our findings.[13] This could be explained by direct trauma, or infiltrative hemorrhage of the bundle of His secondary to increasing traction through the right atrium for resection of right ventricular outflow tract obstruction. But Valsangiacomo et al.[2] found different findings in their study. According to their study the most common types of arrhythmia were sinus bradycardia, second and third degree AV block and SVT. This could be related with the difference in complex surgical interventions between different studies.

Various risk factors for arrhythmia described in the literature include younger age at surgery, prolonged CPB time, longer aortic cross clamp time, cyanosis, deep hypothermic circulatory arrest and type of surgery.[4] This study revealed that younger age, low body weight, cyanosis, CPB time all create statistically significant ($p=<0.05$) impact in producing early post operative arrhythmia. But like previous studies, this study denied to agree ACC time as a significant risk factor for early onset post operative arrhythmia. This was supported by the report of Talwar et al.[14] The younger age and low body weight can be explained by the fact that complex surgical interventions if more frequent at an early age, cause the biggest impact in favor of arrhythmia as the sensitivity to electrolyte and acid base disorder is higher early in life.[15] Besides, the longer CPB time causes changes in the micro and macro equilibrium. The arrhythmias might have been increased because of the alterations in the myocardial conduction pathways. Furthermore CPB with ischemia-reperfusion and the related cellular biochemical effects as well as medical interventions such as electrolyte shifts and catecholamine administration may affect the stability of the cellular membrane and results in an increased myocardial irritability and automaticity.[16,17] This could be explained by the fact that inotropic support, hypotension and acidosis may affect the cellular membrane. As a result, myocardial irritability and automaticity may happen.[15]

Delaney et al.[5] reported that electrolyte disturbances show no statistical significance in causing arrhythmia and their report support our study results. Interestingly, it was not supported by Batra et al.[18] who reported that low magnesium level was responsible for appearance of JET.

Rekawek et al.[19] reported that development of early post operative arrhythmia is associated with a prolonged post operative cardiac ICU stay, and longer ventilation time. Immer and colleagues[20]

hypothesized the degree of myocardial damage and the risk of arrhythmia by measuring troponin levels. In this study, the mean serum creatinine kinase MB was not significantly higher in arrhythmia (data not shown) which suggests good myocardial protection. A possible reason could be the use of del Nido cardioplegia[21] that contains mannitol as a free radical scavenger. It has a very high concentration of magnesium, preventing intracellular calcium accumulation. This effect is likely how magnesium improves ventricular recovery in hypothermic cardioplegia solutions when coupled with a calcium level.[22] The advantages of del Nido cardioplegia have been described in paediatric as well as adult patients.[23]

The need for higher dose on inotropes and hypotension were 15 out of 31 patients for each (35.48%) and the presence of acidosis in 16 out of 31 patients (51.61%) showed statistical significance when compared to non arrhythmic patients that was supported by the report of Rosales et al.[24] These factors are also internally related to a higher hospital mortality.[24]

Conclusion

Prevention of early onset post surgical arrhythmia usually ensures the long term survival of patients. Proper and careful monitoring of younger patient with lower body weight undergoing corrective cardiac surgery with long CPB time may reduce the episodes of post operative arrhythmia. These patients may require high inotropic support post operatively. So, medical prevention and early diagnosis as well as proper management may improve the operative outcome. Here the first 48 hours are the critical time. All preparations must have to tackle JET and SVT; as these are the commonest episodes.

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