Early Postoperative Arrhythmia after Cardiac Surgery for Congenital Heart Diseases

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Abstract

Objective- Early post-operative arrhythmias are a known complication of cardiac surgery; however, there is a paucity of data specific to pediatric heart surgery. The purpose of this study was to evaluate the occurrence rate and type of early post-operative arrhythmias in children.

Methods- Data were collected in a prospective observation of pediatric patients undergoing cardiac surgery between December 2001 and December 2005. All consecutive patients undergoing well-defined surgical procedures were prospectively evaluated for the occurrence rate and type of early post-operative arrhythmias that occurred in the ICU and during the post-operative hospital stay by means of continuous electrocardiographic monitoring in the intensive care unit and use of 24-hour Holter monitors. All the operations were performed by one surgeon throughout the study period. The procedures were performed with cardiopulmonary bypass (CPB) and moderate hypothermia (28-32º C) using anterograde crystalloid cardioplegia for myocardial protection. To determine the relationship between the age of the patients and the degree of post-operative arrhythmia, the patients were divided into 17 age groups.

Results- Arrhythmias occurred in 231 of the 658 patients (35.01%). The most common types of arrhythmia were junctional rhythm (47), premature atrial contractions (PACs) (40), bradycardia (39), and premature ventricular contractions (PVCs) (28). The total correction operations for the tetralogy of Fallot (TOF), atrial septal defect (ASD) repair, and ventricular septal defect (VSD) repair were the procedures in which the most post-operative arrhythmias occurred. The occurrence rate of arrhythmias was higher in the infants (202-57 arrhythmia 30.69%) and in TOF (205-102 arrhythmia 46%). Post-operative atrioventricular (AV) block was observed in 18 (7%) patients, 10 of whom had a complete AV block (4%), comprising 4 VSD repairs, 4 TOF repairs, and 2 complete AV canal repairs, and 5 and 3 had second- and first- degree AV blocks, respectively. During the whole study period, 48 (21%) patients died because of a post-operative arrhythmia. The total number of deaths was 97 (15%).

Conclusion- Approximately 1/3 of all the patients experienced cardiac arrhythmia during the early post-operative period after open heart surgery for congenital heart disease, and a higher occurrence rate of arrhythmias was found in the infants and cyanotic children. Junctional arrhythmia, PACs, bradycardia, and PVCs were the most frequent arrhythmias ***(Iranian Heart Journal 2008; 9 (3):53 -58).***

Key words: congenital heart disease ■ junctional tachycardia ■ post-operative arrhythmia ■ cardiac surgery

Post-operative arrhythmia is a major cause of morbidity and mortality after cardiac surgery for congenital heart disease. Cardiopulmonary bypass (CPB), intraoperative injury to the conduction system and myocardium, post-operative

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metabolic abnormalities, electrolyte disturbances, and increased adrenergic tone in response to the stress of the surgery or inotropic agents are also known factors associated with an increased risk of arrhythmia in the immediate post-operative period.[1]

However, there is a dearth of data on the occurrence rate and clinical consequences of arrhythmias in the early post-operative period after cardiac surgery for congenital heart disease.[2]

We decided to perform a retrospective study to evaluate the occurrence rate and type of early post-operative arrhythmias that occurred in the ICU and during the post-operative hospital stay in children less than 16 years old.

Methods

During the period from December 2001 to December 2005, nearly 658 patients had open heart operations at the cardiac surgery ward at our center. The cases were studied in a retrospective method with reference to the patients' file in the archives of the hospital. All of the recorded arrhythmias were extracted and studied. The age limit of the study was 16 years old, and patients between 1 day old to 16 years old were studied (Table I). Pre-operatively and before hospital discharge, a 12-lead ECG was routinely obtained. In case of arrhythmias in the post-operative course, the patients also had a 24-hr Holter recording before discharge.

All the patients had standard 12-lead ECG at the time of reception and the following changes of ECG band compared with the first band were studied, and the cases without new changes were omitted from the list of post-operative arrhythmias.

The list of all the patients is presented in Table II. Each file recorded items such as the particulars of the patient, type of disease, type of performed operation, and the age of the patient. In case of the patients with arrhythmias, in addition to the foregoing mentioned data, the type of arrhythmia and the treatment duration were recorded.

To study the degree of the relationship between arrhythmia and the type of disease, the method of operation was taken as the main criterion.

In order to do a more comprehensive study, all of the arrhythmia cases that resulted in death are presented separately in Table III. In our study, all of the observed arrhythmias and also the ones that did not result in hemodynamic disorders (such as bundle branch blockage [BBB] and premature atrial contractions [PAC]) are also presented in Table IV.

Although due to the retrospective nature of the study some cases of post-operative arrhythmia may not have been recorded, a great deal of time was dedicated to the study of all the files to avoid statistical errors. If necessary, a more comprehensive study of all the files was performed. As it will be explained in the concluding section more clearly, the relationship between post-operative arrhythmia and the method of operation was determined and the operative methods with more risks of post-operative arrhythmia were specified. At the end, attempts were made to compare the obtained results with those of some other scientific centers of the world so as to have a more comprehensive study.

In addition, to study the occurrence of arrhythmia, the duration of hospitalization of the patients in the ICU and post-ICU wards was taken into consideration. The routine method was that all the patients, after being moved from the operating room, were hospitalized in ICU wards. All of the patients had 24-hour monitoring and after stabilization, they were moved to post-ICU wards, where they had 24-hour monitoring based on their conditions if necessary before they were moved from this ward.

All the operations were performed by one surgeon throughout the study period.

The procedures were performed with CPB in moderate hypothermia (28-32º) using anterograde crystalloid cardioplegia for myocardial protection.

Results

Of the 658 patients studied, 359 (55%) were female and 299 (45%) were male. In the patients with arrhythmia, 74 (57%) were female and 56 (43%) were male (Fig. 1).

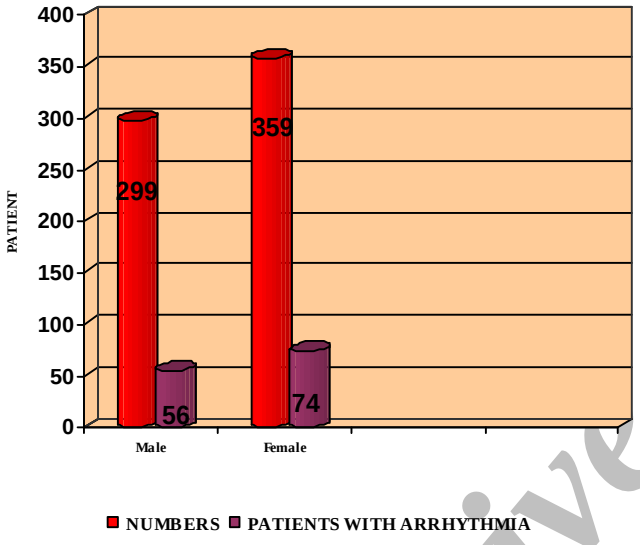

Fig. 1. Distribution of patients in terms of gender

To determine the relationship between the age of the patients and the degree of post-operative arrhythmia, the patients were divided into 17 age groups (Table I).

Table I. Age-arrhythmia relation

Age (yr)	Number (n)	Percent (%)	Patients with arrhythmia (n)	Percent (%)
0-1	202	31	57	25
1	82	12	25	11
2	42	6	15	6
3	37	6	25	11
4	54	8	16	7
5	34	5	23	10
6	46	7	16	7
7	32	5	7	3
8	20	3	5	2
9	19	3	6	3
10	10	2	2	1
11	15	2	5	2
12	19	3	10	4
13	16	2	8	3
14	14	2	5	2
15	7	1	2	1
16	9	1	4	2

The patients fell into age group 0-1 (30.69%), 1 year (12.46%), and 4 years (8.20%), respectively. The relationship between the age of the patients and the occurrence of post-operative arrhythmia is shown in Table I.

Table II shows the various forms of arrhythmias observed with their occurrence rate in the study population. On the whole, 16 types of arrhythmias were recorded. In order to have a more clear classification, all the junctional arrhythmias were placed in one group, the left and right branch blocks in the BBB group, and the AV blocks in a separate group. The classification included 47 cases of junctional, 40 cases of PAC, and 39 cases of bradycardia arrhythmias.

Table II. Types of incidence of relevant arrhythmias

	Leading to death	Not leading to death	
All patients	97 (15%)	561 (85%)	658
All patients with arrhythmia	48 (21%)	183 (79%)	231

As Table III depicts, the total correction surgical operations for the tetralogy of Fallot (T/C Fallot), ASD repair, and VSD repair were the cases in which the most post-operative arrhythmias occurred. In Table III, all the surgical operations with post-operative arrhythmias are presented and the number of them is specified.

Of all the 658 patients, 231 (35.01%) had arrhythmias during the immediate post-operative period. The occurrence rate of arrhythmias was higher in the infants (202, 57 arrhythmias, 30.69%) and in TOF (205, 102 arrhythmias, 46%).

Post-operative AV block was observed in 18 (7%) patients: 10 cases were complete AV block (4%) and 5 and 3 were second- and first- degree AV blocks, respectively.

Table III. Underlying cardiac defects of study patients and proportion of patients with post-operative arrhythmias

Type of arrhythmia	Number of patients	Percent
BBB	22	9%
Bradycardia	39	17%
Junctional arrhythmia	47	21%
Complete AV block	10	4%
Second-degree AV block	5	2%
First-degree AV block	3	1%
Ventricular tachycardia	5	2%
Sinus arrest	2	1%
SA block	1	17%
PAC	40	12%
PVC	28	6%
AF	13	4%
VF	10	0%
VT	5	2%
SVT	5	0%
SSS	1	2%

BBB, bundle branch blockage**; AV,** atrioventricular**; SA,** sinoatrial**; PAC,** premature atrial contraction**; PVC,** premature ventricular contractions**; AF,** atrial fibrillation**; VF,** ventricular fibrillation**; VT,** ventricular tachycardia**; SVT,** supraventricular tachycardia**; SSS,** sick sinus syndrome

A total of 47 (21%) children had accelerated junctional rhythm with ventricular rates slightly above the expected age–specific range. Bradycardia was present in 39 of the 658 children (17%). The majority of these children (368) had predominantly atrial surgery. All these patients required temporary pacing until sinus node recovery.

Five (2%) patients had episodes of supraventricular tachycardia (after 2 VSD and one tetralogy repair). Adenosine was used for acute termination in these 5 patients. No chronic treatment was given to the patients.

Ten (4%) patients had episodes of ventricular fibrillation and 5 (2%) patients had ventricular tachycardia requiring electrical cardioversion, followed by the infusion of lidocaine. They had no recurrence. Forty children had PAC (17%) and 28 had PVC (17%) without hemodynamic relevance and they were not treated. In some patients with premature ectopic beats, abnormal serum potassium levels were treated, and the arrhythmia disappeared in all the patients after correction.

All the patients were in sinus rhythm pre-operatively without relevant conduction disturbance. Post-operatively, 10 (4%) patients had complete AV block (4 VSD repairs, 4 TF repairs, and 2 complete AV canal repairs). They left hospital with a permanent pacemaker. Twenty-two (19%) children had BBB (12 TF repairs, 8 VSD repairs, 1 PS repair, and 1 ASD repair).

During the whole study period, 48 (21%) patients died because of a post-operative arrhythmia. Total deaths were 97 (15%).

Discussion

The main findings of the present study were that roughly 1/3 of the pediatric patients after open heart surgery were affected with arrhythmias in the immediate post-operative course. These were associated with a ½ total mortality rate, and permanent treatment with antiarrhythmic drugs was required in only a small minority of the patients.

The incidence and types of arrhythmia after cardiac surgery vary with age, the underlying lesion, the type of surgery, and local practice patterns.[1] The overall incidence of early post-operative arrhythmia has been reported to be as high as 48% in children.[2]

Several studies have shown that the risk factors for early post-operative arrhythmias are lower body weight, younger age, longer CPB time, higher surgical complexity, and residual defect.[1,2] There is also a high incidence (40-78%) of ventricular arrhythmia late after tetralogy of Fallot repair.[3,4]

Increasing evidence supports both early and late post-operative arrhythmias as important

predictors of morbidity and mortality in many forms of congenital heart conditions.[1]

It is well known that increasing complexity of surgery is associated with an increasing risk of arrhythmias in the post-operative course.[5]

In the following section, other performed studies on this case are reviewed and their results are compared with this study. In the studies done by Koumo and his colleagues on 100 patients in Zurich,[6] 64 arrhythmias in 48 patients were recorded which included sinus bradycardia with junctional rhythm in 46%, premature complexes in nearly 20%, supraventricular tachycardia in nearly 15%, AV block nearly in 11%, and junctional ectopic tachycardia in nearly 8%.

In another study done by Dalani and his colleagues on 129 patients,[7] only 17% post-operative arrhythmias were detected, among which junctional ectopic tachycardia (JET) in nearly 14 cases and complete AV blocks in nearly 5 cases were recorded as the highest cases. Zang performed a study on 64 children with congenital heart diseases in the military hospital of Shaniang between 1988 and 1989[8]; nearly 35.2% of them showed post-operative arrhythmias.

In the studies performed in Chicago on ASD patients with the average age of 23 months to 27 years[9], nearly 560 conduction disorders were recorded, which shows a percentage of nearly 52%, excluding the first-degree AV block cases.

In a study performed in Minnesota in 2004 on 297 children with congenital heart diseases[10], it was concluded that right BBB occurred in a large number of children with AV canal or VSD. In Bern, a study was performed on 310 children with congenital heart diseases[11], 83 (27%) of whom had post-operative arrhythmias. Finally it is concluded that although arrhythmia risk after the operation in children is very high, the risk of complications and mortality rate are low.

Conclusion

Approximately 1/3 of all the patients after open heart surgery for congenital heart disease experienced cardiac arrhythmia during the early post-operative period, and a higher occurrence rate of arrhythmias was found in the infants and cyanotic children. Junctional arrhythmia, PAC, bradycardia, and PVCs were the most frequent arrhythmias. Early post-operative arrhythmias often require immediate electrolyte correction and pharmacological and non-pharmacological interventions.

Conflict of Interest

No conflicts of interest have been claimed by the authors.

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