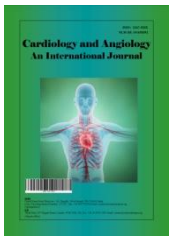

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Clinical Characteristics of Cardiac Arrhythmias in Pediatric Age Group

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: The Symptomatic manifestation of pediatric arrhythmias varies according to the age. Patients with disturbances in cardiac rhythm have several complaints, but also could be totally asymptomatic. This study aimed to assess clinical characteristics of Tachy and Brady arrhythmia in neonates, infant, children and adolescents of various age groups.
Methods: This cross-sectional study included 253 patients of pediatric age below 18 years old presented with different types of tachyarrhythmia or bradyarrhythmia. All patients were subjected to clinical general examination of patient, vital data collection, local cardiac examination, 12 leads electrocardiography, ambulatory ECG Holter monitoring, exercise ECG stress testing if indicated and transthoracic echocardiography.
Results: There was a significant relation between age of presentation of the study patients and classification of arrhythmia ($P < 0.001$). Palpitations was the most common presentations of arrhythmia in our study patients (32%) followed by dyspnea in 17.8 % of the patients. 20.6 % of the study patients with arrhythmias were asymptomatic. Congenital heart anomalies were in 43 % of the patients.
Conclusion: Pediatric arrhythmia can be totally asymptomatic and discovered accidentally. Congenital cardiac anomalies and cardiac arrhythmias are closely correlated. Holter monitoring and exercise ECG testing can help in diagnosing pediatric arrhythmia. Untreated or persistent arrhythmia causes LV myopathy and dilatation. Antiarrhythmic drugs can have their harmful effect on the growing child.

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Keywords: Cardiac arrhythmias; pediatric arrhythmia; congenital heart diseases; inherited rhythm disorders.

1. INTRODUCTION

It is not uncommon for Children of different age groups to develop cardiac arrhythmias. If they are not detected early and controlled effectively, these arrhythmias may cause morbidity and mortality among these children. The arrhythmias are caused by either congenital or inherited abnormalities of the specialized conduction system and myocardial tissues or in response to hemodynamic influences of congenital heart diseases on chamber dimensions, muscle mass and metabolism of myocardial tissue [1].

The symptomatic manifestation of pediatric arrhythmias varies according to the age. Cases with disorders in cardiac rhythm can have various complaints, but symptoms such as palpitations, syncope, pre syncope or dyspnoea commonly cause them to seek a physician's help [2].

Various investigations have revealed a varying relationship pattern between arrhythmias and underlying heart disease. Interestingly, Physical assessment and cardiac anatomy of children with severe arrhythmias may be entirely normal [2].

The fundamental principles of rhythm disruptions in toddlers and adults are identical. Progressive ECG changes in anatomy, physiology and accepted heart rate occurring between birth and adolescence, cause only some characteristics which vary from the normal adult pattern and differ in accordance the age of the child [3].

As example in pediatric cases, a diagnosis of bradycardia differs than in adults and according to the age. In general, bradycardia is described as a heart rate of less than 100 bpm in children up to 3 years old, less than 60 bpm in cases 3 to 9 years old, less than 50 bpm in cases 9 to 16 years old, and less than 40 bpm for cases older than 16 years. During sleep, these cutoffs are decreased by 15% to 20 % [4].

Tachycardia is described as a sequence of 3 or more non sinus beats at a rate which is more than 25% of the sinus rate at baseline.

The increased awareness combined with the advances in recent technological advances has caused an increase in the number of infants and children being diagnosed with cardiac rhythm disturbances [5].

Studying clinical features of different cardiac arrhythmias in pediatric age will help in proper diagnosis and management.

This work aimed to evaluate clinical characteristics of Tachy and Brady arrhythmia in neonates, infant, children and adolescents of various age groups.

2. METHODOLOGY

This cross-sectional study was included 253 patients of pediatric age below 18 years old presented with different types of tachyarrhythmia or bradyarrhythmia to cardiology department Tanta university hospitals from October 2018 to October 2020.

2.1 Inclusion Criteria

Patient age below 18 years old (WHO and UNICEF definition of childhood age). Presented to our hospitals with tachyarrhythmia or bradyarrhythmia.

2.2 Exclusion Criteria

Patients with physiological tachyarrhythmia or bradyarrhythmia (sinus tachycardia or sinus bradycardia or respiratory sinus arrhythmia), secondary causes of arrhythmia as fever or electrolyte disturbances...etc, and critically ill cases with poor general condition.

2.3 Methods

All patients were subjected to history taking, clinical general examination of patient, vital data collection, local cardiac examination, 12 leads electrocardiography, ambulatory ECG Holter monitoring, exercise ECG stress testing and transthoracic echocardiography.

2.3.1 A 12 leads electrocardiography (ECG)

Standard 12 lead ECG was performed with Mortara ELI230 12 channel ECG machine in supine position at a rate of 25 mm/s and a calibration of 1 mV/cm=10 mm for all patients at baseline or at rest and during arrhythmia.

2.3.2 An ambulatory ECG holter monitoring

24 or 48-hour Holter monitoring was done to selected patients of our study population when

indicated. It was recorded and analyzed using a 3 channel Mortara recorder and software H3.

It was indicated in cases with:

- Symptoms of arrhythmia as palpitations or unexplained syncope with no documented tachy or brady arrhythmias during resting ECG.
- In children with bradycardias as complete heart block, a decision needs to be made about their demand for pacing. A lot of symptoms for pacing as stated by the AHA could be deduced from 24-hour monitoring. Among these include the existence of long pauses, the minimum heart rate recorded during the day and the presence of non-benign arrhythmias.
- Assessment of cases with frequent ventricular or atrial ectopics on antiarrhythmic treatment [6].

2.3.3 An exercise ECG stress testing

Exercise ECG Testing was performed also in selected patients of our study using GE treadmill stress ECG machine with cases exercising utilizing a multistage incremental protocol. The standard and common use Bruce protocol was applied in all treadmill testing, with the speed and elevation of the treadmill increasing every 3 min. During testing, cases were encouraged to maximally exercise if possible.

It was indicated in:

- Patients with bradycardia to assess the chronotropic response to exercise.
- Assessment of the rhythm through exercise in cases with suspicion of exercise-induced arrhythmia or when this arrhythmia was diagnosed from exercise.
- Cases with asymptomatic WPW pattern in the ECG for risk stratifications [7].

2.3.4 Transthoracic echocardiography

The echocardiographic examination was done with the case being either supine or on left lateral position. Electrodes were placed to the case's shoulders and to the right lower thorax so that the echocardiographic windows are freely accessible. If needed in small infants, Oral chloral hydrate was used to sedate the children in a dose of 50-100 mg/Kg body weight (total dose not to exceed 1.5 gm). They felt asleep within 15-20 minutes after receiving the choral hydrate.

Echocardiographic examination was performed using Vivid E9, General Electric Corporation. With either a 3.5 or 5 Mhz phased array transducer for all patients.

Full transthoracic echocardiography study was done to examine: Using 2D images, colour doppler, TDI, M mode, PW and CW doppler: The situs, AV and VA concordance, great vessel relation and abnormalities. Inter atrial and interventricular septae. State of cardiac valves, venous connections, and any intra cardiac shunts. Size and function of left ventricle, ejection fraction and fraction shortening. Size and function of right ventricle. Left and right atrial dimensions. Aortic root dimensions and arch of the Aorta examination. Pulmonary artery and its branches and presence or absence of PDA.

2.3.5 Statistical analysis of the data

SPSS v21 was used to perform statistical analysis (IBM Inc., Chicago, IL, USA). The same group's quantitative data were given as mean and standard deviation (SD) and compared using the paired Student's t-test. Chi-square test results for qualitative variables were provided as frequency and percentage (%) [8]. Multiple risk factors were evaluated using multivariate analysis (Binary Logistic regression) [9]. A two-tailed P value 0.05 was deemed statistically significant.

3. RESULTS

Table 1 shows age, sex, prenatal history, or mother related health problem, family history of similar conditions and different presentations of the study patients.

There was a significant relation between age of presentation of the study cases and classification of arrhythmia (tachyarrhythmia and bradyarrhythmia) ($P < 0.001$). There was a significant relation between type of tachyarrhythmia in the study cases (ventricular and supraventricular) and age of presentation with more ventricular arrhythmia prevalent in older children ($P = 0.007$). There was not significantly relation

between age of presentation and bradycardia type Table 2.

Table 3 shows arrythmias presentation, type of tachyarrhythmia and bradyarrhythmia in the study cases.

Table 4 shows Heart structure, and other comorbidities present in the study cases.

Table 5 shows treatments applied, recurrence and complications in the study cases.

Table 1. Age, sex, prenatal history, or mother related health problem, family history of similar conditions, different presentations of the study patients (n = 253)

	N=253
Age of presentation	
< one month	9(3.6%)
1-12 months	56(22.1%)
> one year	188(74.3%)
Gender	
Males	114(45.1%)
Females	139(54.9%)
Prenatal history or mother related health problem	6(2.4%)
Family history of similar conditions	27(10.6%)
Different presentations	
Accidentally discovered by the doctor	40(15.8%)
Mother's observation	12(4.7%)
Palpitations	81(32.0%)
Dyspnea	45(17.8%)
HF symptoms	18(7.1%)
Syncope	15(5.9%)
Dizziness	12(4.7%)
Easy fatiguability	12(4.7%)
Feeding difficulty	6(2.4%)
Engorged neck veins	3(1.2%)
Cyanosis	3(1.2%)
Tachypnea	3(1.2%)
Asymptomatic "discovered by mother or doctor"	52(20.6%)
jjjbhSymptomatic	201(79.4%)

Data are presented frequency (%)

Table 2. Association between arrhythmia classification and age of presentation, between tachyarrhythmia and age of presentation and between bradyarrhythmia and age of presentation (n = 253)

Age of presentation	Tachyarrhythmia	Bradyarrhythmia	P
< one month	4(2.0%)	5(9.1%)	
1-12 months	36(18.2%)	20(36.4%)	<0.001*
> one year	158(79.8%)	30(54.5%)	
Tachyarrhythmia	**Supraventricular**	**Ventricular**	
< one month	4(2.4%)	0(0.0%)	
1-12 months	36(21.8%)	0(0.0%)	0.007*
> one year	125(75.8%)	33(100.0%)	
bradyarrhythmia	**Sinus node disease**	**AV node disease**	
< one month	0(0.0%)	5(10.6%)	
1-12 months	3(37.5%)	17(36.2%)	0.618
> one year	5(62.5%)	25(53.2%)	

*Data are presented frequency (%), *: Statistically Significant*

Table 3. Arrythmias presentation, type of tachyarrhythmia and bradyarrhythmia in the study patients

Classification of the arrhythmia	**N=253**
Tachyarrhythmia	198(78.3%)
Bradyarrhythmia	55(21.7%)
Tachyarrhythmia	**N=198**
Supraventricular	165(83.3%)
Ventricular	33(16.7%)
Bradyarrhythmia	**N=55**
Sinus node disease	8(14.5%)
AV node disease	47(85.5%)
Type of tachyarrhythmia	
AVNRT	81(40.9%)
AVRT	45(22.7%)
atrial tachycardia	28(14.1 %)
PVCs	18(9.1%)
NSVT	8(4.0%)
VT	7(3.5%)
AF	6(3.0%)
PACS	3(1.5%)
Atrial flutter	2(1.0%)
Bradyarrhythmia	
CHB	47(85.5%)
Junctional rhythm	2(3.6%)
Sinus arrest	3(5.5%)
Sinus pause	3(5.5%)

Data are presented frequency (%)

Table 4. Heart structure and other comorbidities present in the study patients

	N=253
Structure of the heart	
Normal	143(56.5%)
Abnormal (congenital heart disease)	110(43.5%)
Structure abnormality	
LV dilatation and/or myopathy	36(14.2%)
Post cardiac surgery	20(7.9%)
ASD	13(5.1%)
L-TGA	13(5.1%)
Ebestein anomaly	5(1.97%)
Dilated aortic root	5(1.97%)
Dilated right side of the heart	4(1.58%)
PDA	3(1.18%)
HCM	3(1.18%)
DORV	2(0.79%)
PFO	2(0.79%)
Bicuspid aorta	2(0.79%)
Rhabdomyoma	2(0.79%)
Other comorbidities	
Non	236(93.2%)
Thalassemia major	6(2.4%)
Skeletal Muscular dystrophies	5(1.9%)
Hypothyroidism	3(1.18%)
Diabetic	3(1.18%)

Data are presented frequency (%)

Table 5. Treatments applied, recurrence and complications in the study patients

Treatments	N=253
Medical	103(40.7%)
Ablation	81(32.0%)
Permanent pacemaker	44(17.4%)
Follow up	22(8.7%)
ICD insertion	3(1.2%)
Recurrence	41(16.2%)
Complications	
LV myopathy	19(7.5%)
LV dilated dimensions	7(2.7%)
Cardiac arrest	3(1.2%)
Thyroid dysfunction due to amiodarone	3(1.2%)
Left atrial dilatation	2(0.79%)
Mitral incompetence	2(0.79%)

Data are presented frequency (%)

4. DISCUSSION

Cardiac arrhythmias are a leading cause of child morbidity and a rare cause of baby death. The majority present to a neonatologist or a pediatrician prior to being sent to a paediatric cardiologist [3].

In the current study the patients presented with many different symptoms and some cases were asymptomatic (20.6 % of total study population). Palpitations were the most frequent symptom in 32 % of the study population. 1.2% of the cases presented with atypical chest pain. Also 1.2% of the cases had cyanosis. 4.7% of cases complained of dizziness. 17.8% of the cases presented with dyspnea. 4.7% of the cases came with easy fatigability. 1.2% cases showed engorged neck veins. 2.4% of the patients had feeding difficulties. 7.1% of the patients had heart failure symptoms. Syncope occurred in 5.9 % of the patients. 1.2% of the patients presented with tachypnea.

In Clausen et al. [5] study the Presenting complaints were Palpitations 65.2 % (similar to our study it was the most frequent symptom), Chest pain in 20.0 %, Lethargy in 18.7%, Respiratory distress in 14.1%, Dizziness 5.8 % (less frequent opposed to current study), Syncope 2.5 % ,Chest tightness 2.5 %, Seizure in 0.4 %, Other miscellaneous symptoms in 22.8% of their patients.

In concordance with our study Saygi, et al. [10] had 73 % of their study population with palpitations, 21% with chest pain and the rest of the patients presented with syncope.

The current study showed 198 cases with tachyarrhythmia (78.3%) 165 cases were supraventricular (83.3%) and 33 cases were ventricular (16.7%). Bradyarrhythmia was in 55 cases 8 of which were sinus node disease (14.5%) and 47 AV nodal disease (85.5%).

Christian James Turner and Christopher Wren [11] in their population based study of epidemiology of pediatric arrhythmia in England found only 8.6 % of their patients to have bradycardia.

As in our investigation, Marwan Refaat et al. [12] conducted a study of arrhythmia in neonates and babies in a tertiary care institution in Lebanon. They found that 91.1% of the study patients had different forms of tachyarrhythmias and only 8.89% out of their patients had Bradyarrhythmias.

In the current study AV block was the more common pediatric bradycardia (47 patients with AV nodal disease Vs 8 patients with sinus node disease). Also, Marwan Refaat et al. [12] found AV blocks to be a more common bradycardia than sinus node dysfunction.

In the current study AVNRT was the highest pediatric arrhythmia to be encountered in our study patients (40.9%) while Christian James Turner and Christopher Wren [11] in their study AVRT was in 66.6 % of the study patients.

This was opposed to what Sarala Premkumar et al. [2] found where ventricular ectopics were the most prevalent form of arrhythmia noted accounting for 30% of children.

Wolf Parkinson White syndrome was found in 41 cases of our study population (about 16.5 %), Gilljam et al. [13] described experience of accessory pathway-mediated neonatal supraventricular tachycardia, also from a single center. They discovered that 34% of their study patients had evidence of ventricular pre-excitation.

In the current study 143 patient showed normal structure of the heart during 2D echocardiography (56.5%). While 110 case had congenital heart disease (43.5%). This was not the case with Clausen et al. [5] who found only 12.9 % of their patients to have had structural heart disease.

In our current study 40.7 % of cases had medical treatment for arrhythmia and the rest had interventional ways of treatment. In 2008, Massin et al. [14] study found The treatment decision was based on the frequency and severity of symptoms, as well as the impact of arrhythmia on quality of life. Medical intervention was recommended for infants and children, while ablation operations were suggested for adolescents.

In the current study 16.2% of cases had recurrence of arrhythmia after 1st episode treatment while in a similar study done by Tia A. Tortoriello et al. [15] approximately 60% of children in their study developed their initial arrhythmia episode by 1 year of age. Even though the arrhythmia resolved in the majority of these individuals within one year, around thirty percent of them experienced a recurrence.

In the current study 7.5% of our study patients had LV myopathy as a complication of their arrhythmia (tachycardia induced myopathy) while Bahram Kakavand et al. [16] follow up study of 28 child with frequent ventricular ectopy in the pediatric who had complete records and follow-up visits 17.5% of their study population developed LV dysfunction. The cases with LV dysfunction had a significantly higher VPB burden ($p = 0.0016$).

In the current study three cases developed thyroid dysfunction after treatment with amiodarone.

Brett Barrett et al. 2019 study explores a pediatric and young-adult population in an effort to explain the natural history of amiodarone-induced thyroid dysfunction in a large cohort of cases at a single pediatric referral hospital. They realized that 33% (63/190) of cases developed thyroid dysfunction while on treatment with amiodarone.

5. CONCLUSION

Pediatric arrhythmia could be totally asymptomatic and noticed unexpectedly. Congenital cardiac anomalies and cardiac arrhythmias are closely correlated. Holter monitoring and exercise ECG testing can help in diagnosing pediatric arrhythmia. Untreated or persistent arrhythmia causes LV myopathy and dilatation. Antiarrhythmic drugs could have their harmful effect on the growing child.

DISCLAIMER

Some part of this manuscript was previously presented and published in the conference: 15TH PASCAR Congress in association with Kenya Cardiac Society on 22nd - 25th November 2021 in Mombasa, Kenya. Web Link of the proceeding:
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CONSENT AND ETHICAL APPROVAL

The study was done after approval from the Ethical Committee Tanta University Hospitals, Egypt. An informed written consent was obtained from all participants parents.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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