

Characterization of ECG Pattern in Children Attending Pediatric Arrhythmia Clinic In Sohag University Hospital: A prospective hospital-based study

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Abstract

Background: arrhythmia" refers to any change from the normal sequence of electrical impulses. Cardiac arrhythmias have been classified into tachycardia and bradycardia. Pediatric arrhythmias account for approximately 55 per 100,000 patients evaluated in pediatric emergency departments. Sinus tachycardia is by far the most commonly reported arrhythmia, followed by supraventricular tachycardia (SVT) which represents about 13%, and bradycardia accounting for about 6% of all cases

Objective: To characterize patients attending pediatric arrhythmia outpatient clinic as regards the presence of cardiac rhythm abnormalities, the pattern of cardiac rhythm abnormalities and the impact of diagnosis and treatment on patient morbidity.

Methods: This prospective observational study was conducted on 500 pediatric patients from October 2016 to September 2017 in the Pediatric arrhythmia outpatient Clinics of the Pediatric Department. All patients in this study were subjected to complete clinical history including the cause of the referral, complete clinical examinations and twelve leads ECG. The following investigations were requested when indicated and its results were included in the study: Serum electrolyte, Echocardiography, Holter cardiac rhythm monitoring and Electrophysiological studies (EPS), and finally data was analyzed by SPSS software.

Keywords: Pediatric cardiac arrhythmia, Characterization of ECG Pattern of cardiac arrhythmia, management of pediatric cardiac arrhythmia

Introduction:

The expression "arrhythmia" refers to any change from the normal sequence of electrical impulses. Cardiac arrhythmias have been classified into tachycardia and bradycardia. Mechanisms of tachyarrhythmias can be enhanced automaticity with triggered foci or enhanced conduction with the presence of reentrant circuits. Similarly, bradycardia can result from suppressed automaticity or suppressed conduction, where normal conduction is delayed or arrhythmic drugs, acid/base, and electrolyte imbalance are also frequent etiologies of rhythm issues [8].

blocked. The four main types of arrhythmia are premature (extra) beats, supraventricular arrhythmias, ventricular arrhythmias and bradyarrhythmia [8]

There are many reasons for arrhythmias. Increased end-diastolic pressures resulting in a trial or ventricular stretch, valvular dysfunction, tumors, multiple surgeries, scarring and ischemia, all play a significant role in arrhythmia generation. Cardiac swelling, pro-

Arrhythmias can lead to myocardial dysfunction, heart failure, cardiac arrest, intracardiac clot formation, seizures, syncope, and acquired cardiomyopathy.

About 5% of the emergency hospital admissions in the pediatric population are attributed to symptomatic arrhythmias [13] Pediatric arrhythmias represents roughly approximately 55 per 100,000 patients evaluated in pediatric emergency departments. Sinus tachycardia is by far the most commonly reported arrhythmia, followed by supraventricular tachycardia (SVT) which represents about 13%, and bradycardia accounting for about 6% of all cases [8]

The indications of ECG in children include chest pain, suspected arrhythmias, changes in rhythm (eg atrial fibrillation to sinus rhythm, new bundle branch block), post-cardiac arrest/resuscitation, post syncopal episodes, ST/T wave changes consistent with metabolic and electrolyte disturbances, preoperative assessment, post-insertion of pacemaker (permanent or temporary), routine requirements and assessment of medications known to cause cardiac arrhythmia [4].

Material and methods:

This prospective observational study was conducted on 500 pediatric patients from October 2016 to September 2017 in the Pediatric arrhythmia outpatient Clinics of the Pediatric Department. Written informed consent was obtained from the caregivers of every study subject. The study was approved by Sohag medical faculty ethical committee.

All patients in this study were subjected to complete clinical history including the cause of the referral, complete clinical examinations, twelve leads ECG (Fukuda Denshi CardiMax ECG, model

FCP-7101, (Japan) with a 25 mm/s paper speed, gain 10 mm/mV. The cooperative patients did not need sedation, while non-cooperative patients needed to be sedated by oral chloral hydrate (25mg/kg) before electrodes connection, the device composed of standard bipolar leads I, II, III. Augmented leads aVR, aVF, aVL, and slandered unipolar pericardial leads V1 to V6.

The right-sided leads V3R or V4R have been recorded for evaluation of right ventricular hypertrophy resulting in 13 leads ECG which. A longer record of a single lead (usually lead II) was obtained to analyze the rhythm more precisely. In a patient known to have dextrocardia, the standard pericardial leads were positioned over the right chest in a mirror image manner. Neonatal electrodes were obtained by trimming the adult-sized electrodes. Cleaning the neonatal skin with alcohol was applied to lower the high skin impedance associated with vernix [3]. ECG electrodes were placed following the well-known universal standards for 12 ECG electrodes placement [2].

The children were referred for, whenever indicated, echocardiography to exclude cardiac causes of abnormal ECG, Holter cardiac rhythm monitoring in children with highly suspected cardiac rhythm abnormality in spite of normal 12 lead ECG and in children with paroxysmal cardiac arrhythmia to characterize the frequency & severity of their condition and lastly, electrophysiological studies (EPS) to find the site of arrhythmia's origin within the cardiac tissue.

Statistical analysis:

Statistical package for social sciences (IBM-SPSS, version 24 IBM 2016, Chicago, USA) was used for statistical

data analysis. The student t-test was used to compare the means between two groups, and one-way analysis of

variance (ANOVA) test was used to compare means of more than two groups. Mann Whitney test was used instead of the student t-test in case of non-parametric data. Pearson Chi-square was used to compare percentages of qualitative data, and Fisher's Exact Test was used for non-parametric data. P-value was considered significant if it was less than 0.05.

Results:

Our study included 500 cases of which 150 (30%) cases have arrhythmia, the median age of children with arrhythmia 6 years ranging from 15 days to 18 years 68 (45.33%) cases of them were females. 14 (9.33%) cases had a family history of CHD and or arrhythmia, 21(14.00%) with a history of cardiac catheterization and/or surgery. There were 350 cases that had normal ECG with a median age of 7 years ranging from one month to 14 years of which 33

(9.43%) cases had a family history of CHD and or arrhythmia, and 42 (12%) had a history of cardiac catheterization and or surgery.

The most common indication of referral in our study was clinically suspected abnormal rhythm in 97 cases (19.4%) of which 43 cases (8.6%) had an arrhythmia. The second indication was chest pain in 74 cases (14.8%) of which 11 cases (2.2%) have an arrhythmia. Fifty-seven cases were referred to due to a breath-holding spell of them 12 (2.4%) cases had an arrhythmia. Palpitation in 62 cases (12.4%) of the 9 cases (1.8%) had an arrhythmia. Tachycardia was encountered in 68 cases (13.6%) of the 27 cases (5.4%) had an arrhythmia. Children referred for Post-cardiac catheterization follow up were 59 cases (11.8%) of the 17 cases (3.4%) had an arrhythmia and there were 99 cases referred for other less common causes, (table 1).

Variable	No Arrhythmia N=350	Arrhythmia N=150	P-value
Suspected Arrhythmia Yes	54 (15.43%)	43 (28.66%)	<0.0001
Chest pain Yes	63 (18.00%)	11 (7.33%)	0.002
Breath-hold Yes	45 (12.86%)	12 (8.00%)	0.12
Palpitation Yes	53 (15.14%)	9 (6.00%)	0.004
Tachycardia Yes	41 (11.71%)	27 (18.00%)	0.06
Post cardiac cath. Yes	42 (12.00%)	17 (11.33%)	0.83

Table (1): Cause of referral for ECG in children with or without arrhythmia

ECG findings in patients with arrhythmia were sinus tachycardia in 28 (18.67%) cases, atrial ectopics in 11 (7.33%) cases, WPW in 10 (6.67%) cases, 1st degree heart block in 10

(6.67%) cases, junctional ectopics in 8 (5.33%) cases, complete heart block in 6 (4.00%) cases, lateral infarction in 6 (4.00%) cases, long QT syndrome in 5(3.33%) cases, complete RT bundle

branch block in 4(2.67%) cases, wandering atrial pacemaker in 3(2%) cases, junctional and atrial ectopics in 3(2%) cases, ventricular ectopics in 2 (1.33%) cases, 2nd degree heart block 2 in (1.33%) cases, sinus bradycardia 2(1.33%) cases, atrial fibrillation in 2 (1.33%) cases and atrial flutter in 1 (0.67%) case (table 3). Management of patients with arrhythmia was as follows: follow up in 82 (54.66%) cases, 17 (11.33%) cases referred for Holter, and anti-failure treatment in 14 (9.33) % cases. In cases of SVT, 9 (6%) cases were admitted in the hospital for Cordarone loading & maintenance. DC shock was used for cases resistant to medical treatment. Referral for pacemaker was done in 4 (2.67%) cases. Surgery was advised for the correction of PS & AS in 4 (2.67%) cases and excision of an atrial aneurysm in 1 (0.66%) case. Antifailure treatment &

Admission in hospital for inotropic support was carried out in 2 (1.33%) cases. One child only required ablation of the upper crista focus of atrium (table 4).

ECG finding	Number (%)
Sinus tachycardia	30 (20%)
WPW	10 (6.67%)
1 st -degree heart block	10 (6.67%)
Junctional ectopics	8 (5.33%)
Complete heart block	7(4.66%)
Lateral infarction	6 (4.00%)
Complete right bundle branch block	5 (3.33%)
Long QT	10 (6.66%)
Ventricular ectopics	2(4.66%)
Wandering atrial pacemaker	3 (2.00%)
Junctional & Atrial ectopics	4 (2.66%)
2 nd -degree heart block	2 (1.33%)
Sinus bradycardia	2 (1.33%)
Atrial fibrillation	2 (1.33%)
Atrial flutter	1 (0.67%)

Table (2): Distribution of causes of referral for ECG:

Management	Number (%)
Follow up	82 (54.66%)
Antifailure treatment	14 (9.33%)
For Holter	17 (11.33%)
Admitted in hospital for cordarone loading & maintenance	9 (6%)
Surgical correction of (AS , PS)	4 (2.67%)
Antivenome for scorpion & Lasix & prazosin	3 (2.00%)
CT Angio	4 (2.67%)
Referral for pacemaker	4(2.67%)
Admission in PICU & receive cordarone not improved &DC shock	2 (1.33%)
Admission in PICU received cordarone ,condition recur	3(2%)
Antiplatelet	2 (1.33%)
Management of hypertension	1 (0.66%)
Inderal	4 (2.67%)
Ablation of upper crista focus of atrium	1 (0.66%)
Antifailure treatment & Admission in hospital for inotropic support	2 (1.33%)
Correct of hypoglycemia	2(1.33%)
Surgical correction of atrial aneurysm	1 (0.66%)

Table (3): Management of patients with arrhythmia:

Discussion:

In our study, there were 500 cases of which 150 (30%) cases have an arrhythmia. The median age of children with arrhythmia was 6 years ranging from 15 days to 18 years. 350 cases had normal ECG, with a median age 7 years ranging from 1-month to 14 years. 68 (45.33%) cases of them were females.

The most common indication of referral in our study was clinically suspected abnormal rhythm in 97 cases (19.4%). The second indication was chest pain in 74 cases (14.8%), followed by tachycardia in 68 cases (13.6%) cases, then palpitation in 62 cases (12.4%).

Premkumar et al., 2016 [7] studied the characteristics of cardiac arrhythmia in pediatric patients with age from birth up to 12 years, 55% of cases were females in the tertiary care center in Chennai, India. In their study the most common indication of referral breathlessness, palpitation, chest pain, history of CHD, Syncope, history of toxins, drug ingestion, history of cardiac surgery. This difference in the distribution of the indications of referral between our study & their study may be due to the difference in their studied subjects as children attending the outpatient clinics in our study & inpatient in theirs.

ECG finding in patients with arrhythmia in our study is sinus tachycardia in 28 (18.67%) cases, atrial ectopics in 11 (7.33%) cases, WPW in 10 (6.67%) cases, 1st degree heart block in 10 (6.67%) cases, junctional ectopics in 8 (5.33%) cases, complete heart block in 6 (4.00%) cases, lateral infarction in 6 (4.00%) cases, long QT syndrome in 5 (3.33%) cases, complete RT bundle branch block in 4 (2.67%) cases, wandering atrial pacemaker in 3 (2%) cases, junctional and atrial ectopics 3 (2%) cases, ventricular ectopics 2

(1.33%) cases, 2nd degree heart block 2 (1.33%) cases, sinus bradycardia 2 (1.33%) cases, atrial fibrillation 2 (1.33%) cases, atrial flutter 1 (0.67%) case.

In contrast to our results, ventricular ectopics were the most common type of arrhythmia observed in the study of *Premkumar et al., 2016 [7]*, accounting for 30% of children. One child with Rheumatic Heart Disease (RHD) developed atrial fibrillation. In a Holter survey of 624 healthy children, *Martin et al., 1999 [5]*, found 12 children with ECG evidence of sinus node disease. The most common abnormality noticed was sinus arrest. The most common type of sinus node disease in the study of *Premkumar et al., 2016 [7]* was also sinus arrest.

Management of our patients with arrhythmia in this study was followed up in 82 (54.66%) cases; seventeen (11.33%) cases were referred for Holter. Antifailure treatment was initiated in 14 (9.33) % cases. Fourteen cases of previously diagnosed SVT were admitted with acute attacks, of the 9 cases had no recurrence. Five cases of admitted SVT cases had a recurrence after initiation of treatment All cases were discharged on B₁ blocker. Referral for pacemaker was done in 4 (2.67%) cases. Surgical correction of PS & AS was done in 4 (2.67%) cases and for an atrial aneurysm in 1 (0.66%) case. Ablation of upper crista focus of atrium in 1 (0.66%) case.

In contrast to our study, the study of *Perry and Garson, 1990 [6]* reported a recurrence rate of 78% in children aged >5 years at the time of the first episode. The presence or absence of structural heart disease did not influence the outcome. However, the presence of

WPW syndrome on the surface ECG did indicate a chance for recurrent episodes and even sudden death in symptomatic patients *Perry and Garson. 1990 [6]*.

Franklin et al. 1994 and Weindling et al. 1996 [1] [9] showed good results with digoxin or propranolol or a combination they recommended that propranolol could be used in patients with WPW syndrome. Amiodarone for Patients with myocardial dysfunction & therapy with any of the second-line drugs was to be planned in consultation with a Pediatric Cardiologist.

Conclusion: Cardiac arrhythmias in children can present at any age and the recognition requires a high index of suspicion. While the majority of children with arrhythmias have a structurally normal heart, diagnosis & proper management of pediatric cardiac arrhythmia have a major impact on the patient outcome.

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Conflict of Interest:

There is no conflict of interest to be declared.

Authors contributions:

All authors contributed to this project and article equally. All authors read and approved the final manuscript.

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