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Evaluation and Management of Syncope in Pediatrics: A prospective Observational study at Sohag University Hospital

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ABSTRACT

Background: Syncope is defined as temporary loss of consciousness and postural tone resulting from an abrupt transient decrease in cerebral blood flow. It is characterized by rapid onset, short duration and spontaneous complete recovery.

Objective: Our study aimed to analyze the frequency of syncope due to cardiac, neurocardiogenic, neurologic, situational, psychiatric, and other causes and make a differential diagnosis of syncope types according to detailed medical history and further investigations with focus on cardiac cause as the most serious type of syncope.

Patients and Methods: 125 pediatric patients were recruited from Arrhythmia Clinic in our Cardiology Unit, Sohag University Hospital. They presented with a primary complaint of syncope aged from 1year to 18 years with a mean age of 6.49 ± 3.77 years.

Results: The most common diagnosis was neurocardiogenic syncope (n=76, 60.8%). Sixty-four cases (84.2%) had recurrent episodes. Epilepsy was found in Thirty-four cases (27.2%) and psychogenic pseudo-syncope affected one female child. There were fourteen cases (11.2%) with cardiac syncope: 8 patients with LQTS, one patient with CPVT, one patient with AVNRT, 2 patients with dilated cardiomyopathy, 1 patients with history of atrioventricular (AV) canal defect closure and one patient with cardiac mass. There was significant relationship between arrhythmia and cardiac syncope ($p < 0.001$). Exercise-induced syncopes were significantly associated with cardiac origins ($p < 0.001$). Positive ECG, Holter and echocardiographic findings were statistically significant for cardiac syncope ($P < 0.001$).

Conclusion: Syncope is a common pediatric complaint. Most cases seen were resulting from benign causes, with only a small percentage because of serious medical conditions. In addition, most syncopal episodes in the pediatric population were diagnosed clinically or with minimally invasive testing, emphasizing the importance of a detailed history and physical examination.

Keywords: Pediatric, cardiac, syncope.

INTRODUCTION

Syncope is defined as temporary loss of consciousness and postural tone resulting from an abrupt transient decrease in cerebral blood flow [(1)]. It is characterized by rapid onset, short duration and spontaneous complete recovery. It's a relatively frequent symptom in children and its evaluation is an important aspect in pediatric medical practice [(2)]. Syncope is caused by a wide array of etiologies that include abnormalities of the autonomic nervous system, as well as cardiac, neurologic, psychogenic and metabolic problems [(3)].

Whereas the vast majority of episodes of syncope are benign, a minority are caused by more serious or even life-threatening malignant cardiac condition prompting referral to pediatric cardiologists [(4, 5)].

Neurocardiogenic (vasovagal) syncope is most common and usually has a favourable prognosis [(6)]. More serious, but less frequent causes of syncope include hypertrophic cardiomyopathy and the so-called primary electrophysiological disorders, which can result in ventricular tachycardia (VT) and fibrillation [(7)]. The presence of structural heart disease increases the likelihood of a serious cause of syncope, such as malignant ventricular arrhythmias.

This study aimed to analyze the frequency of syncope due to cardiac, neurocardiogenic, neurologic, situational, psychiatric, and other causes and make a differential diagnosis of syncope types according to detailed medical history and further investigations with focus on cardiac cause as the most serious type of syncope.

PATIENTS AND METHODS

This prospective observational study was conducted from April 2019 to April 2020 at Pediatric Arrhythmia Clinic in Sohag University Hospital.

Inclusion criteria: Children aged from 1 year to 18 years presenting with syncope to the Pediatric Arrhythmia Clinic in our Cardiology Unit after clinical assessment by any pediatrician or from Emergency Unit in Sohag University Hospital.

Exclusion criteria: Previously diagnosed cardiac or neurologic disease, children with diabetes mellitus, material ingestion, trauma, chronic medication use and those with history of channelopathies or arrhythmia.

Methods of the study:

All patients in this study were subjected to the followings:

(A) Clinical history focusing on:

Full medical history: Significant systemic hypotension associated with paradoxical bradycardia is characteristic of the majority of pediatric patients. The upright position, such as prolonged period of standing or change in posture (orthostasis) can be the reason for most

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episodes. Commonly associated triggers for fainting in children can be also emotional or stress factors such as venipuncture, public speaking, pain and fear. Fatigue, hunger, concurrent illness and dehydration also can be the provocative factors for vasovagal syncope. Duration of loss of consciousness is short, no more than 1 to 2 minutes. It is accompanied by relatively rapid recovery or some patients may have a residual headache, nausea, giddiness and fatigue.

History suggesting cardiac syncope: Prior history of known structural heart disease, known arrhythmia, or suspected heart disease (recent fatigue, exercise intolerance) [(4)]**.** Little or no prodrome, prolonged loss of consciousness (longer than 5 min), exercise-induced syncope, chest pain or palpitations and event requiring cardiopulmonary resuscitation.

History suggesting non cardiac causes of syncope: e.g. migraine and seizures.

Family history of syncope, heart disease or sudden death.

(B) Thorough clinical examination: Blood Pressure measurement and complete cardiac examination **(**rate, rhythm and auscultated murmurs).

(C) Investigations:

1-12 leads ECG: 12 leads ECG was done to all infants & children using (FUKUDA DENSHI, CARDIMAX, model FCP 7101). 12 leads ECG record analyzed using specific centile tables for normal values of ECG waves & intervals according to age [(8)]**.**

2-Echocardiography: Echocardiography was done for all patients with Syncope to exclude structural heart abnormalities. Specially those of syncope of undetermined origin based on a detailed history, physical examination and ECG analysis. It was done also for all patients with suspected structural heart disease, e.g. abnormal cardiovascular examination, abnormal ECG, exercise induced syncope, in those with history of palpitations. Further investigations were done in cases of unexplained exercise-induced syncope by previous methods.

3- 24 hr ambulatory ECG monitoring Holter monitoring: We limited ambulatory ECG to patients with abnormal 12 lead ECG, which didn't explain the cause of syncope, frequent symptoms, positive family history and exercise-induced syncope.

Type of machine: Mortara 2016 American made H3+.

Software: Mortara Company American made.

Holter monitoring was applied to 50 children, minimum, mean, maximum heart rate, heart rate rhythms and corrected QT were evaluated. Positive contribution of Holter was identified as: **Diagnosis:** the type of arrhythmia causing syncope, establishing a new diagnosis / changing a current diagnosis / confirming a suspected diagnosis. **Management:** Introducing new therapy /withdrawal of current therapy / change of current dosage of therapy.

4- Tilt Table Test tilt:

Head up passive tilt testing (HUTT) had assisted us in our study in the diagnosis of vasovagal syncope. Head up tilt test (HUTT) was done in patients with recurrent unexplained exercise-induced syncope. Where cardiac syncope is either not suspected or had been excluded as the cause. The test involved testing the patient in the morning having fasted. After lying supine for 30 min, the patient is tilted to 60-80˚ for < 45 min (strapped in and with arm rest support), and asked to report any symptoms; BP and heart rate were recorded throughout. A test is positive (vasovagal syncope diagnosed) only if the patient's original presyncopal or syncopal symptoms were reproduced entirely, and accompanied by arterial hypotension (BP fall > 20mm Hg: vasodepressor response), bradycardia (HR fall >10% baseline: cardio-inhibitory response) or both. Haemodynamic changes without symptoms comprised a negative test.

5- **Stress ECG** was done in patients with syncope where the symptoms are associated with exertion. An echocardiogram was done first for all patients undergone exercise test to exclude left ventricular obstruction, e.g. aortic stenosis & HCM.

6- **EEG** was done for all patients with diagnosis of syncope are uncertain (convulsive syncope, long duration loss of consciousness, or sudden unexplained falls).

Ethical considerations:

Children were included after informed consent was obtained from their parents. The study was approved by the Scientific Ethics Committee of the Faculty of Medicine, Sohag University.This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Walk test. Qualitative data were represented as frequencies and relative percentages. Chi square test ($\chi 2$) to calculate difference between two or more groups of qualitative variables. Quantitative data were expressed as mean ± SD (Standard deviation). Independent samples t-test was used to compare between two independent groups of normally distributed variables (parametric data). P value ≤ 0.05 was considered significant.

RESULTS

The study was conducted on 125 patients with syncope. Age of the studied patients ranged from one year to 18 years. Mean age of studied cases was 6.49 ± 3.77 years while the median age was 6 (3 – 9.5) years. 65 (52%) of cases were males and 60 (48%) were females (Table 1).

Table (1): Distribution of the studied patients according to gender and age (N. =125)

Characteristics	Summary statistics
Gender	
Female	**60 (48%)**
Male	**65 (52%)**
Age (months)	
Mean± S.D.	**6.49 ± 3.77**
Median (IQ range)	**6 (3 – 9.5)**

Exercise was a statistically significant predisposing factor for neurocardiogenic and cardiac syncope, 17 patients (22.4%) with vasovagal syncope experienced syncope related to exercise and 13 (92.9%) patients with cardiac syncope experienced syncope related to exercise (Table 2).

Table (2): Relation between predisposing factors and final syncope types (N. =125)

	Types of syncope				P-value
	Cardiac (n= 14)	Epilepsy (n= 34)	Neurocardiogen-ic (n= 76)	Pseudosyncope (n= 1)	
Exercise					
No	**1 (7.1%)**	**32 (94.1%)**	**59 (77.6%)**	**1 (100%)**	**<0.001**
Yes	**13(92.9%)**	**2 (5.9%)**	**17 (22.4%)**	**0 (0.0%)**	
Crying					
No	**14 (100%)**	**31 (91.2%)**	**52 (68.4%)**	**1 (100%)**	**0.008**
Yes	**0 (0.0%)**	**3 (8.8%)**	**24 (31.6%)**	**0 (0.0%)**	
Fear and anxiety					
No	**14 (100%)**	**24 (70.6%)**	**63 (82.9%)**	**1 (100%)**	0.102
Yes	**0 (0.0%)**	**10 (29.4%)**	**13 (17.1%)**	**0 (0.0%)**	
Standing					
No	**14 (100%)**	**34 (100%)**	**64 (84.2%)**	**1 (100%)**	**0.036**
Yes	**0 (0.0%)**	**0 (0.0%)**	**12 (15.8%)**	**0 (0.0%)**	
Pain					
No	**14 (100%)**	**34 (100%)**	**71 (93.4%)**	**1 (100%)**	0.34
Yes	**0 (0.0%)**	**0 (0.0%)**	**5 (6.6%)**	**0 (0.0%)**	
At rest					
No	**13 (92.9%)**	**15 (44.1%)**	**72 (94.7%)**	**0 (0.0%)**	**<0.001**
Yes	**1 (7.1%)**	**19 (55.9%)**	**4 (5.3%)**	**1 (100%)**	
Anemia					
No	**14 (100%)**	**34 (100%)**	**75 (98.7%)**	**1 (100%)**	0.885
Yes	**0 (0.0%)**	**0 (0.0%)**	**1 (1.3%)**	**0 (0.0%)**	

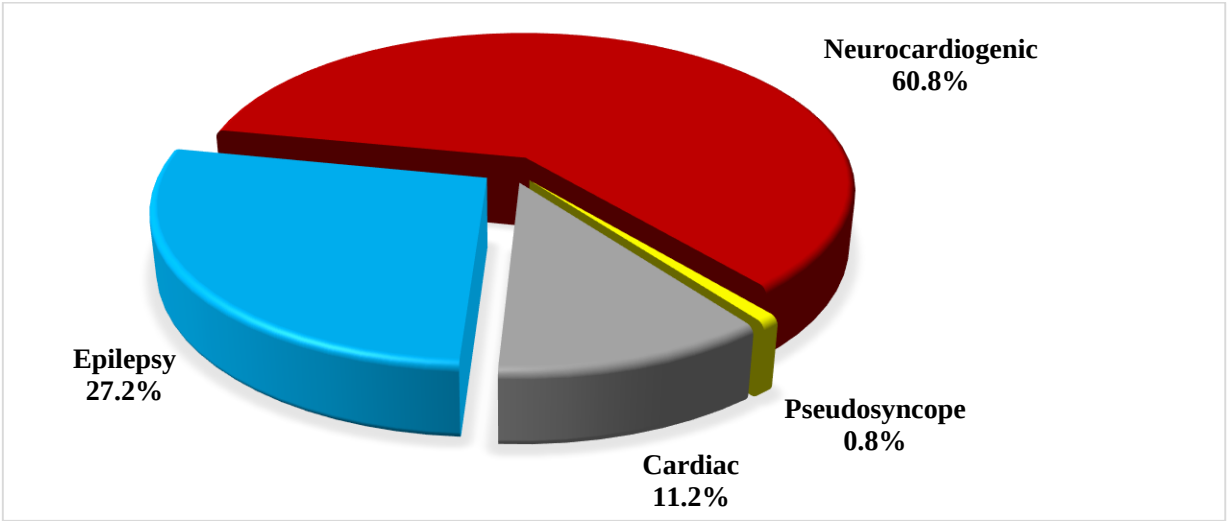

Figure (1): distribution of the studied patients according to final type of syncope (N. =125)

There was a statistically significant difference between QTc interval in cardiac syncope and other types of syncope. Patients with cardiac syncope had longer QTc duration than other types of syncope (Table 3).

Table (3): Relation between QTc and final syncope types (N. =125)

	Types of syncope				P-value
	Cardiac (n= 14)	Epilepsy (n= 34)	Neurocardiogenic (n= 76)	Pseudosyncope (n= 1)	
QTc Mean ± S.D.	**489.33 ± 78.35**	**394.63 ± 28.89**	**399.48 ± 26.17**	**426 ± NA**	**0.005**

Positive echocardiographic findings were statistically significant for cardiac syncope (Table 4).

Table (4): Relation between Echo findings and final syncope types (N. =125)

	Types of syncope				
	Cardiac (n= 14)	Epilepsy (n= 34)	Neurocardiogenic (n= 76)	Pseudo-syncope (n= 1)	p-value P
Echo					
Dilated	**2 (14.3%)**	**0 (0.0%)**	**0 (0.0%)**	**0 (0.0%)**	
cardiomyopathy	**1 (7.1%)**	**0 (0.0%)**	**0 (0.0%)**	**0 (0.0%)**	**< 0.001**
Cardiac mass	**1 (7.1%)**	**0 (0.0%)**	**1 (1.3%)**	**0 (0.0%)**	
Operated ASD, VSD	**9 (64.3%)**	**34 (100%)**	**75 (98.7%)**	**1 (100%)**	
Normal					

Positive Holter findings were statistically significant for cardiac syncope (Table 5).

Table (5): Relation between Holter findings and final syncope types (N. =50)

	Types of syncope			
	Cardiac (n= 5)	Epilepsy (n= 6)	Neurocardiogenic (n= 39)	P-value p-
Holter ECG				
Atrial and/or junctional ectopics	**0 (0.0%)**	**1 (16.7%)**	**4 (10.3%)**	
Frequent ventricular ectopics, ventricular tachycardia	**4 (80.0%)**	**0 (0.0%)**	**0 (0.0%)**	**< 0.001**
Sinus bradycardia	**1 (20.0%)**	**0 (0.0%)**	**0 (0.0%)**	
Sinus tachycardia	**0 (0.0%)**	**1 (16.7%)**	**1 (2.6%)**	
Unifocal Ventricular ectopics	**0 (0.0%)**	**0 (0.0%)**	**4 (10.3%)**	
Normal	**0 (0.0%)**	**4 (66.7%)**	**30 (76.9%)**	

DISCUSSION

Syncope is a common event in the children that leads to frequent visits to pediatricians and emergency departments. For every patient, an initial goal is to determine if an uncommon but serious form of cardiac disease is present. All patients underwent an initial evaluation, which included detailed medical history, physical examination, 12-lead electrocardiogram and echocardiography. Other targeted specific tests were carried out according to suspected underlying cause such as 24-hour Holter monitoring, exercise stress ECG testing, EEG and head tilt testing. Data systematically collected regarding medical history included family history of syncope, cardiac disease or sudden death, previous episodes of fainting, prodromes, associated symptoms (such as palpitations or chest pain) and triggers (effort, stress, pain, etc.). After assessment, patients were classified into four diagnostic categories, NCS, cardiac syncope, neurological disorder and psychogenic pseudosyncope (PPS). A diagnosis of PPS was made after the exclusion of other causes, and was confirmed by the psychologist after clinical evaluation.

In our study there were 7 patients with long QT syndrome (LQTS) and deaf had family history of the same condition and 4 patients of them had family history of sudden death.

In our study, the most common syncope was NCS (n-76, 60.8%). 39 patients were males (51.3%) and 37were females (48.7%) with a mean age of 6.84 ± 4.03 years; 64 patients of them (84.2%) had recurrent episodes. This is consistent with **Mathieu *et al.* [9] study** where NCS was detected in 69 patients (70.4%) but in contrast to our study, with a significant female preponderance (59.4%; *P* = 0.02) and a mean age of 12.3 ± 3.0 years; 59 patients (85.5%) had recurrent episodes and eight patients (11.6%) presented by only presyncopal symptoms. **Li *et al.* [10]** found that 595(67%) patients were diagnosed to have NCS, of them 271 were males (45.5%) and 324 females (54.5%) and the mean age was 12.3 ± 2.9 years.

The present work diagnosed a cardiac cause for syncope in 11.2% of children who presented to our tertiary referral center in the form of arrhythmia, 8 patients were diagnosed by ECG to have LQTS, one

patient with cathecholaminergic polymorphic ventricular tachycardia (CPVT) who had an abnormal ECG but was diagnosed by Holter ECG and his diagnosis was confirmed by exercise ECG testing, one patient with atrioventricular nodal reentrant tachycardia (AVNRT) was diagnosed during the attack by ECG, the remaining 4 patients included 2 patients with dilated cardiomyopathy, one patient with atrioventricular (AV) canal defect closure and one patient with cardiac mass all of them were diagnosed by echocardiography. This is somewhat similar to that reported by **Hegazy *et al.*** [11] 11.5% of them 5.5% had arrhythmia, **Driscoll *et al.*** [12] (10%). Lower contribution of cardiac causes to pediatric syncope were reported by **Mathieu *et al.*** [9] (5.1%), **Ikize *et al.*** [13] (4.2%)**, Steinberg and Knilans** [14] (3.9%), **Massin *et al.*** [3] (2%) and **Ritter *et al.*** [15] (4.6%), and much higher percentages were reported by **Kilic *et al.*** [2] (30.5%), **Wolff *et al.*** [16] (28%).

Zavala *et al.* [17] documented that 4% of patients had cardiac syncope. Arrhythmias were identified in 16.9% of cardiac subjects, Long QT interval accounted for 3.38%, whereas dilated cardiomyopathy and hypertrophic cardiomyopathy accounted for less than 2% of cardiac cases in aggregate. The most common pathology confused with syncope is seizures. Both clearly involve loss of consciousness, and other findings classically associated with seizures can occur with true syncopal episodes.

Pseudo seizures have also been reported in young subjects as a cause of transient loss of consciousness. It is the most common condition in the syncope mimics category. It may be difficult to distinguish these ‘pseudo’ episodes from true syncope. However, pseudosyncope/ pseudoseizures most often will occur several times a day and prolonged loss of consciousness, which almost never happens in the case of true syncope. In this study, 34 patients (27.2%) diagnosed to have epilepsy all of them were diagnosed by EEG and one 12 years old female patient was diagnosed to have pseudosyncope. In **Zavala *et al.*** [17], Neurological disorders accounted for 3.11% of syncopal cases while psychiatric etiologies accounted for 1.97% of patients with syncope. This is in contrast to **Mathieu *et al.*** [9] study where 2 patients only (2%) diagnosed to be epileptic and 20 patients (20.6%) were diagnosed to have psychogenic pseudosyncope (PPS).

In our study, we found that 13 (92.9%) patients with cardiac syncope experienced syncope related to exercise. There was statistically significant relationship between exercise-related episodes of syncope and cardiac syncope ($P < 0.001$). This agrees with **Mathieu *et al.*** [9] study who documented that exercise-related episodes were significantly associated with cardiac syncope ($P = 0.003$). Doing a 12 lead ECG as an initial step in the evaluation of syncope is extremely valuable in the diagnosis of a cardiac etiology [14]. It has diagnostic and prognostic value in the evaluation of syncope. A 12-lead ECG didn't miss any of the major cardiac abnormalities in our patient’ group and therefore we strongly recommend that an ECG to be used in evaluation of syncopal episode in children. In our study, the electrocardiogram was the most effective examination for detecting cardiac syncope, with particular attention paid to the QT interval, given that long QT syndrome is a major cause of cardiac syncope in children and adolescents [18].

According to ECG done in our study, Abnormal ECG was found in 23 patients (18.4 %) of them 14 patients were diagnosed to have cardiac syncope. In our study, there was statistically significant relationship between abnormalities found in ECG and cardiac syncope ($P < 0.001$).

There was a statistically significant difference between QTc interval in cardiac syncope and other types of syncope. Patients with cardiac syncope had longer QTc duration than other types of syncope. This is explained by the fact that 8 (57%) of 14 patients with cardiac syncope in this study has prolonged QTc syndrome.

In **Zavala *et al.*** [17] study, they found that of 4% of patients with cardiac syncope, Arrhythmias were identified in 16.9% of patients, long QT interval accounted for 3.38%, whereas dilated cardiomyopathy and hypertrophic cardiomyopathy accounted for less than 2% of cardiac cases in aggregate. **Redd *et al.*** [19] showed that ECG was abnormal in 9 patients, seven patients demonstrated prolonged QT interval and two revealed ventricular pre-excitation. This agrees with **Mathieu *et al.*** [9] who documented that five patients (5%) had cardiac syncope. Three of five patients revealed abnormalities in electrocardiography. two had complete atrioventricular block without structural heart disease and one patient had a type 1 long QT syndrome confirmed by genetic testing (pathogenic mutation of the KNCQ1 gene. **Hegazy *et al.*** [11] reported that cardiac syncope was detected in 11.5% of patients and arrhythmia was present in 5.5%.

Echocardiography was done for all patients in this study. As regard Echocardiographic examination, it reported dilated cardiomyopathy in 2 (1.6%) cases, multiple pedunculated masses from the posterior wall of the left ventricle in one (0.8%) case and operated ASD and VSD in 2 (1.6%) cases. All of them had cardiac syncope except of one patient with operated ASD and VSD who was diagnosed to have neurocardiogenic syncope. Positive echocardiographic findings were statistically significant for cardiac syncope ($P < 0.001$). Our study agrees with **Kilic *et al.*** [2] who recommended that echocardiography should be a part of the initial work up of pediatric syncope. **Steinberg *et al.*** [14] and **Ritter *et al.*** [15] recommended that echocardiography should only be done in patients with abnormal 12 lead ECG.

Holter ECG had contributed greatly in this work, it helped us in confirming certain diagnosis, negating another diagnosis and making new diagnosis. It also assisted us in management and follow up of high risk patients.

We limited ambulatory ECG to patients with abnormal 12 lead ECG, which didn't explain the cause of syncope, frequent symptoms, positive family history and exercise induced syncope. In this study Holter ECG was done for 50 (40%) patients. As regards Holter findings; atrial and junctional ectopic were present in 5 (4%) cases, 4 with neurocardiogenic syncope and one with epilepsy. Frequent ventricular ectopic and ventricular tachycardia in 3 (2.4%) cases, all of them had cardiac syncope, one patient with CPVT, one patient with dilated cardiomyopathy and the last patient with cardiac mass in the left ventricle. Sinus tachycardia was recorded in 2 (1.6%) cases, one patient with neurocardiogenic syncope and the other patient with epilepsy. Infrequent ventricular ectopic in 4 (3.2%) cases, two patients with neurocardiogenic syncope, one patient with epilepsy and one patient with cardiogenic syncope who had operated atrioventricular (AV) canal defect. In this study, there was statistically significant relationship between sensitivity of Holter and accurate diagnosis of cardiac arrhythmia ($P < 0.001$). This agrees with **Massin *et al.*** [20] study who documented that Holter had a great value in diagnosis of 13 cases of cardiac syncope and provided information previously unknown from resting or exercise electrocardiogram. In contrast to our study, **Hegazy *et al.*** [11] study and **Li *et al.*** [10] study determined that Holter monitoring was not more powerful than standard electrocardiography and contributed no practical meaning to the etiologic analysis, as symptoms almost never occur in the short period while the monitor is worn.

Exercise ECG testing appeared important for patients who experienced syncope during or shortly after exertion. In the present work, exercise ECG test was done for 22 patients with unexplained exercise-induced syncope by ECG, echocardiography. It was normal in 21 patients with exercise-related syncope. One patient revealed catecholaminergic polymorphic ventricular tachycardia. He is a 12-year-old boy experienced repeated attacks of syncope during exercise. His ECG showed sinus bradycardia with 1st degree heart block, his Holter examination showed ventricular tachycardia and his diagnosis was confirmed by stress ECG findings. Similarly, **Mathieu *et al.*** [9] detected only one patient to have catecholaminergic polymorphic ventricular tachycardia after an LOC during exercise despite electrocardiography and echocardiography (including coronary anatomy) were normal. **Redd *et al.*** [19] found no patients with significant arrhythmias on exercise testing. Tilt-table testing is generally deemed unnecessary in children with normal physical examination, absence of abnormal laboratory findings, or supportive medical history characteristic of neurocardiogenic syncope [21].

In this study, head up tilt test (HUTT) was positive for vasovagal syncope in 21 patients with unexplained exercise-induced syncope (16.8% of patients with syncope). This is in contrast to **Zavala *et al.*** [17] study who documented that 2.08% only of patients with syncope had positive HUTT. **Gourishankar *et al.*** [22] documented that abnormal HUTT was found in in 112 patients with orthostatic intolerance (28%) (30% male and 70% female with a mean age of 15.6 years). This is also consistent with findings of **Massieu *et al.*** [9] study where HUTT was performed in 62 patients and was positive in 37 cases (59.6%).

CONCLUSION

Syncope is a common problem in pediatric medical practice. A consensus for diagnosis in a goal oriented approach is essential. A thorough history, physical examination and 12 lead ECG are highly sensitive primary lines of investigation to exclude cardiac causes of syncope in children. If an abnormality is diagnosed or suspected, then more sophisticated and time consuming investigations as transthoracic echocardiography, head up tilt test, EEG, Exercise test, 24 hour ambulatory ECG monitoring are warranted. We found that arrhythmia was the most common cause of cardiac syncope and long QT syndrome was the commonest etiology.

Clinicians should be aware of various treatments for common fainting and indications for referral. Training on diagnosing and treating arrhythmias and ECG changes should be strengthened in pediatric emergency services and ICUs.

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