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Review Article

Demographic Information, Cardiac Findings and Factors Related to Childhood Syncope: A Cross-Sectional Study

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Abstract

Introduction: Due to the association of syncope and some serious cardiovascular disorders in children, evaluation of relevant findings and determination of its common and uncommon findings can lead to early diagnosis and especially better management of these patients.

Methods: In this cross-sectional study, data including syncope episode numbers, leading factors, aura presence, complete medical history, clinical data, Cardiopulmonary findings and 12-lead electrocardiography (ECG) information were recorded. If there is a positive ECG or clinical result, 2D Doppler echocardiography was performed for patients and the results were recorded.

Results: Among the included patients [n=100], the average number of syncope episodes at the time of study was 4 syncope episodes. The most common cause of syncope in children studied was syncope following exercise [33%]. The most common aura was palpitation with a frequency of 29%. In the studied children, abnormal ECG was observed in 11 children [11%]. Abnormalities included prolonged QTc in 4 cases, ventricular hypertrophy based on high voltage in 2 cases, atrial enlargement in 2 cases, abnormal axis in 1 case, complete heart block in 1 case, and supraventricular tachycardia in 1 case.

Conclusion: The appropriate history and clinical examination along with ECG is of great value in the diagnosis of syncope with cardiovascular causes in children. It was also observed in this study that the main defaults of cardiac syncope include early syncope with common periods, abnormal ECGs, and higher sitting and standing blood pressure differences.

Keywords: cardiogenic syncope; vasovagal syncope; children; mortality

Abbreviations

2D: 2 dimensiona3456784567812345671

ECG: Electrocardiography

NMS: Neurally mediated syncope

PDA: Patent ductus arteriosus

WPW: Wolff-Parkinson-White

Introduction

Various causes can lead to a transient decrease in consciousness, which can be traumatic or non-traumatic. Non-traumatic causes of transient decrease in consciousness include syncope, seizures, and metabolic disorders. Syncope is a common problem in children and is defined as a sudden loss of consciousness and inability to maintain postural tone, which is usually due to the dysfunction and a decrease in diffuse, temporary, and sudden cerebral blood flow (Gupta et al., 2020; Takatsuki et al., 2019). This condition usually resolves on its own and does not leave brain sequels. The event usually begins with a series of pre-existing symptoms such as nausea, epigastric pain, lightheadedness, and paleness that lasts from a few seconds to two minutes, which can be the same or vary in different episodes (Fadnis et al., 2019). The minimum blood flow required for normal brain activity is estimated at about 60 ml per minute for every 100 grams of brain tissue. Syncope occurs following cerebral

hypo-perfusion in a very short span of time (about 12 seconds) (Shen et al., 2009). Syncope is divided into three main groups: Neurally mediated syncope (NMS), cardiovascular syncope and non-cardiovascular syncope. NMS or vasovagal syncope is the most common cause of syncope in young patients (Wolff, 1997). The mechanism of this type of syncope seems to be related to increased beta-adrenergic sensitivity of baroreceptors in the arteries and mechanoreceptors in the left ventricle after changes in body tone, circulating volume, or direct release of catecholamines from the related brain regions (Hueston & Hebbar, 2003).The incidence of syncope at all ages has been reported to be about 3% of total life expectancy. Syncope is more common in females and is most common between the ages of 15 and 19 (Gourishankar et al., 2020). According to the literature, the incidence of syncope under the age of 18 is about 15%. Some studies have also reported a higher prevalence of syncope in adults, most of whom have had at least one seizure before the age of 18 (Bilici et al., 2019). In general, 3 to 5% of referrals to emergency departments are related to syncope cases, which is associated with 40% of hospitalizations for an average duration of 5.5 days. In addition, morbidity, including 35% of recurrences, 29% of physical injuries and 4.7% of major trauma have been reported in syncope patients (Brignole et al., 2006; Ohanisian et al., 2019). One of the main parts in the clinical examination of children with syncope is cardiovascular examination, first step of which is electrocardiography (ECG). ECG examination should be performed on QT interval and T-wave morphology to diagnose long QT syndrome; Voltage should also be recorded in leads to detect the possibility of ventricular hypertrophy, obstructive cardiac lesions or cardiomyopathies, existence of Wolff-Parkinson-White (WPW), bradycardia or conduction disorders (Das & Chan, 2020; Tanel & Walsh, 1997). In cases prone to arrhythmias, 24-hour monitoring should be performed to detect VT, supraventricular tachycardia, bradycardia, WPW, and heart blocks (Brignole et al., 1992). Due to the causes of syncope and its association with some serious cardiovascular disorders in children, evaluation of relevant findings and determination of its common and uncommon findings can lead to early diagnosis and especially better management of these patients. Therefore, the aim of the present study was to assess cardiac findings in patients referring to a pediatric clinic with syncope.

Methods

In this cross-sectional study, sample size was set at 100 patients based on the etiology variable of syncope (syncope after physical activity) with a prevalence of 27.6% based on the study of Hegazy et al. (Roncon et al., 2018), and considering 90% alpha power and 5% error. Children who had referred to a clinic of a referral children's hospital with at least one case of syncope were examined to enter the study. Inclusion criteria were: 1) Existence of at least one syncope episode based on its definition as sudden and complete loss of consciousness, 2) Consent to participate in the study, 3) Absence of underlying congenital heart diseases or seizures. Patients with maternal retardation and metabolic disorders were excluded from the study. Syncope-related factors containing the number of syncope events, factors leading to syncope (including prolonged standing, hyperventilation, psychological stress, exercise and long-term hunger), Any aura before syncope (including confusion, palpitation, decreased vision, nausea, sweating, and paleness), Medications and family history (including syncope, sudden death, and cardiovascular disease) were recorded for all the patients. Clinical examination information of the patient including heart rate, systolic and diastolic blood pressure in the supine and sitting position (after standing for 10 minutes) and Cardiopulmonary findings were recorded as well by a cardiologist who was blinded to the rest of patient records. Also, 12-lead ECG was performed for patients and information including heart rate, cardiac axis, P wave height, QRS length and QTc were recorded. In case of positive ECG or clinical findings, 2D Doppler echocardiography was performed for patients by a specialist who was blinded to the rest of patient records and the results were recorded. The data obtained in the present study were analyzed by SPSS statistical analysis software version 18. Demographic information was analyzed by descriptive statistical methods and the results were presented as mean±standard deviation and frequency (percentage) by appropriate graphs and tables. Quantitative variables were compared by Student's t test and qualitative variables were compared by Chi-Square test. A p-value of less than 0.05 was considered as significant.

Results

demographic findings

In this cross-sectional study, 100 children who referred to a clinic of referral children's hospital with at least one episode of syncope were studied. The mean age of the children was 8.54±2.70 years ranging from 2.5 to 16 years. The average number of syncope episodes was 4 episodes with a range between 1 and 12 episodes. In terms of gender distribution, 44 patients [44%] were boys and 56 [56%] were girls.

Syncope related factors

In a review of the clinical records of the patients, 70 children [70%] had experienced syncope for the first time, while 30 children [30%] had at least one history of syncope and were chronically ill. The family history of syncope was positive in 7 children [7%]. In addition, none of the children studied had a family history of cardiovascular diseases or sudden death. The most common cause of syncope in children was exercise-related syncope, which accounted for 33% [33%]. Examination of the early clinical signs of syncope (aura) in the studied children showed that the most common symptom was palpitation, which had a frequency of 29%. The frequency of early clinical signs of syncope in children is shown in Table 1. Also, in 38% of patients no clinical symptoms were reported at the time of syncope. The frequency of leading causes and early clinical signs of syncope in children are summarized in Table [1].

Table [1]. Frequency of leading causes, early clinical signs, and blood pressure differences in children with syncope.

Physical examination findings

Clinical examination of patients showed that the average heart rate of patients was 107.03±17.49 beats/min with a range between 67 and 158. The mean systolic blood pressure of patients in the sitting and at standing positions were 101.3± 12.4 mmHg with a range between 74 to 144 mm Hg, and 105.7±13.4 mmHg with a range of 77 to 145 mm Hg, respectively. The mean diastolic blood pressure of patients in the sitting and standing positions were 66.4±10.5 mmHg with a range between 40 to 99 mm Hg, and 64.3±9.4 mmHg with a range of 44 to 90 mm Hg, respectively. 19 patients [19%] had murmur on clinical examination. The frequency of differences between systolic and diastolic blood pressure compared to two standing and sitting positions after waiting for 10 minutes ware shown in Table [1].

ECG findings

Abnormal ECG was observed in 11 patients [11%]; while the frequency of abnormalities was as follows: Prolonged QTc in 4 cases, ventricular hypertrophy based on high voltage in 2 cases, atrial enlargement in 2 cases, abnormal axis in 1 case, complete heart block in 1 case, and supraventricular tachycardia in 1 case. The ECG findings of all the patients are summarized in Table 2. Also, a comparison of clinical examination findings based on syncope-related factors as well as heart rate and blood pressure based on ECG results is shown in Table 3. All of the patients with chronic syncope had normal ECG; while 15.7% of patients with acute syncope had abnormal ECG findings, which was

significantly different [P=0.003]. The results also showed that patients with abnormal ECG results had significantly higher diastolic blood pressure at sitting, lower orthostatic systolic pressure, and lower orthostatic diastolic pressure.

Echocardiography

A total of 24 patients underwent echocardiography, of which 4 cases [16.7%] had abnormal results. Abnormalities included one case of dilated cardiomyopathy, one case of hypertrophic cardiomyopathy, one case of mitral prolapse, and one case of mitral valve regurgitation. In two of these patients, the ECG result was normal, which included one case of mitral prolapse and one case of mitral valve regurgitation. There was a significant relationship between abnormal ECG results and abnormal echocardiographic results [p=0.001].

Discussion

Syncope is a common occurrence in children and in some cases can cause concern in parents, teachers and companions. This phenomenon is one of the main reasons for frequent visits to pediatricians and emergency departments. Syncope occurs for many major reasons, including anatomical disorders of the nerves, heart, neurological, psychological, and metabolic problems (M. M. Massin et al., 2004). Most studies agree that syncope is a common problem in the community and requires long-term health and maintenance services. The initial incidence of syncope is 2.6 per 1,000 people per year. If the incidence of syncope is considered constant over time, it is equivalent to 6% in 10 years, or 42% in the lifetime of a 70-year-old. In general, investigating the causes of syncope is one of the diagnostic and therapeutic goals of these patients, which in some cases remains unknown and is costly. On the other hand, in the majority of patients with syncope, heart problems are also mentioned in the additional evaluations in most cases. In the present study, abnormal ECG and cardiovascular causes leading to syncope were observed in 11% of patients. The findings of our study are consistent with the study of Driscoll et al., Who reported a 10% prevalence of cardiac causes (Driscoll et al., 1997). However, there are other studies that have reported lower rates of cardiac syncope, including 4.5% (Ritter et al., 2000), 3.9% (Steinberg & Knilans, 2005) and 2% (M. M. Massin et al., 2004). On the other hand, in the study of Kilic et al., This rate was reported to be 30.5% (Kilic et al., 2002) and in the study of Wolff et al., 28% (Wolff, 1997). Of course, one of the things that should be considered in the evaluation of cardiac causes leading to syncope in studies is the type and center of sampling. The sampling hospital in the present study is a pediatric referral hospital in the center of the province, which seems to show a higher frequency compared to the emergency center in the incidence of cardiac causes leading to syncope. Another aspect is related to the definition of cardiac syncope. In the study by Ritter et al. (Ritter et al., 2000), patients with a diagnosis of minor valvular lesions, patent ductus arteriosus (PDA), septal disorders, and decreased left ventricular outflow were not considered as cardiac syncope, and only patients with cardiomyopathies and electrical heart disorders were considered. In contrast to the above study, in the present study, patients were studied from all aspects and the causes were extracted. The importance of accurate history and proper clinical examination for the assessment of syncope in children has been expressed by many researchers (Chen-Scarabelli & Scarabelli, 2004; M. Massin, 1998). However, in the present study, it was observed that the use of accurate history and clinical examination alone is not enough to determine cardiac syncope and more cases are needed, which is consistent with the results of the study by Ritter et al. (Ritter et al., 2000). Also, children cannot properly describe what happened in terms of the type of syncope, the duration of anesthesia, and his condition. In addition, many cases of syncope have occurred in schools and therefore detailed information is not provided to the physician. In the present study, only in 2 patients with abnormal ECG, murmur was observed and unlike previous studies in the present study, no relationship was observed between the presence of murmur and cardiac syncope [15]. In our study, it was observed that patients with abnormal ECG results had lower diastolic blood pressure at sitting time and had a higher difference between standing systolic and diastolic blood pressure than standing sitting. One of the most common causes of syncope in children is neurocardiogenic syncope and these people also have an abnormal response to orthostatic stress, which confirms the above finding in the present study (Johnsrude, 2000; M. M. Massin, 2003; M. M. Massin et al., 2004). One of the evaluation tools for patients with syncope to diagnose cardiogenic syncope is the use of ECG, which is easy to use and inexpensive, and is also available almost everywhere. Based on previous studies, this tool has a high diagnostic and prognostic value in syncope evaluation (Sun et al., 2004). In the present study, 11% of patients had abnormal ECG results, which was diagnostic in 2 patients who had abnormal echocardiographic findings. In fact, in the results obtained from ECG, the findings of patients' cardiac major are fully observed and it is suggested that in all patients and children with syncope, the first ECG evaluation be performed following the occurrence of syncope (Lerman-Sagie et al., 1994). Cardiac arrhythmias are one of the main and dangerous causes of syncope [5]. In the present study, some cases of arrhythmia were observed in some patients, which based on previous studies, the accurate evaluation of this issue can be well determined using a 24-hour Holter ECG. In a study by Kilic et al., It was reported that arrhythmias were responsible for 30.5% of syncope in children [19]. Summary of the findings of the present study shows that syncope in children in both sexes is almost the same, and does not depend on age. In this population, the most common cause of syncope was exercise and it was observed that hemodynamic regulation disorders are the main factor. Finally, it is suggested to conduct further studies on this subject with higher number of participants to reach more generalizability and choose in multi-center settings with 24-hour ECG holter monitoring to have a better overview above all the possible ECG abnormalities and overcome the limitations in this study.

Conclusion

According to the results obtained in this study, it can be concluded that the use of an appropriate history and clinical examination along with ECG is of great value in the diagnosis of syncope with cardiovascular causes in children. It is also best to have echocardiography for all patients who are suspected and have an abnormal ECG. It was also observed in this study that the main defaults of cardiac syncope include early syncope with common periods, abnormal ECG, and higher sitting and standing blood pressure differences.

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Not applicable.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

SS constructed the idea or hypothesis for research and manuscript. SR planned methodology to reach the conclusion. SS organized and supervised the course of the project or the article and taking the responsibility. AM took responsibility in execution of the experiments, patient follow-up, data management and reporting. PT and SR took responsibility in logical interpretation and presentation of the results. AM took responsibility in doing the literature review. SS and AM took the responsibility in the construction of the whole or body of the manuscript. SR reviewed the article before submission not only for spelling and grammar but also for its intellectual content.

Ethics approval

The present study with the code (IR.TBZMED.REC.1399.852) was approved by the ethics committee of Tabriz University of Medical Sciences. All patient information was strictly confidential. No additional costs were imposed on patients.

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