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Original Article

Electrocardiografic Changes in Seizure Disorder

M. Borzoee*, SM. Rafiei

Abstract

Background: Seizure disorders are common in infants and children. Cardiac dysrhythmias may manifest clinically as seizure disorders which, if missed, may cause serious consequences.

Objective: To investigate the electrocardiogram, conduction and rhythm disturbances in a group of patients in pediatric age group clinically presenting as various types of seizures

Methods: We studied electrocardiograms of 273 infants and children aged 5 months to 16 years who presented with febrile and afebrile seizures. Of these, 155 (56.8%) were male and 118 (43.2%) were female (M/F= 1.3). Most of the patients (n=230, 84.2%) presented with generalized tonic-colonic seizures. Beside neurological evaluation, a thorough cardiac investigation including auscultation, electrocardiogram, and when indicated, echocardiography, exercise tolerance test, and 24-hour heart monitoring, was performed on all of these patients.

Results: Out of 273 patients, 32 (11.7%) showed either prolonged corrected QT (QTc), or other dysrhythmias. In 6 patients, the 24-hour ambulatory heart monitoring also revealed abnormalities (mostly dysrhythmias). In 9 of the above patients, the anti-arrhythmic management was instituted, depending on the results of cardiac evaluation. Precipitation of "seizure" episodes by exercise and emotional upset predicated the presence of an underlying cardiac rhythm disturbance.

Conclusion: In evaluation of refractory seizure disorders in children, particularly those provoked by emotional upset, one should bear in mind the cardiac sources of seizure.
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Keywords • Epilepsy • arrhythmia • long QT syndrome.

Introduction

Seizure disorders (SD) are common among pediatric patients.[1] Some cardiac dysrhythmias may mimic SD.[2] Cardiac abnormalities, mostly cardiac rhythm disturbances, may be detected during a seizure episode. These may clinically mimic a seizure event and cause serious consequences.[3] Prolonged QT syndrome (LQTS) is considered a rare but potentially malignant condition which may clinically present as SD.[3,4] LQT, or, to be more precise, long QT corrected for the heart rate (LQTC), may present in either acquired or genetic forms.[5,6] These are the most common types of ECG abnormalities masquerading as SD.

Department of Pediatrics, Shiraz University of Medical Sciences, Shiraz, Iran

Correspondence: M. Borzoee, M.D., Department of Pediatrics, Shiraz University of Medical Sciences, Shiraz, Iran
Tel/Fax: +98-711-6265024
E-mail: borzoee@sums.ac.ir

Table 1: Demographics and variables in patients with seizure disorder

Parameters	Case	Control	OD (95%CI) Ratio	p value
Age	5 m – 16 y	3 m – 18 y	–	0.3
Sex male/female ratio	1.3/ 1	1.2/ 1	–	0.639
Normal ECG/total	241/273	232/234	15.4 (3.55, 94.02)	<0.001
Seizure				
Generalized Tonic colonic	231/273	2/234	63.8 (14.8, 386.1)	<0.001
Refractory Seizure (Group A / Group B)	21/32	12/241	36.4 (13.1, 104.2)	<0.001

M= month, y=year, CI = Confidence interval

SD is the sole clinical presentation in 10% of patients with LQTS.[5] In LQTS, malfunction of ion channels impairs ventricular repolarization and triggers a characteristic ventricular tachyarrhythmia.[6] Exercise tolerance test (ETT)[7] and 24-hour ECG monitoring [8] are recommended if seizures are difficult to control with anti-convulsant drugs. Complex partial seizures have also been reported to have transient cardiac arrhythmia as their underlying cause.[9] Conversely, kindled seizures may elevate blood pressure and induce cardiac arrhythmias.[10] Cardiac alterations may occur during about half of the seizure activities.[10] T wave humps, involving left precordial and limb leads, suggest the presence of the LQST trait.[11]

This study was conducted in our neurology and cardiology unit to determine the prevalence of seizure disorders with cardiac origin in children.

Patients and Methods

From September 1999 to February 2001, all patients aged between 5 months and 16 years who were referred to the Pediatrics Neurology Clinic with a clear-cut history of at least one episode of seizure activity, were included in the study. All patients with dubious histories, and those in whom the history pointed clearly to a "seizure mimicker", like syncope or breath holding spells[2] were excluded from the study. Neurological assessment consisted of a thorough neurological examination and obtaining an inter-ictal EEG (Nihon-Coden, 10-channel EEG machine) that was analyzed visually (SMR). The first author (MB) did the cardiac evaluation including physical examination, and ECG (including long lead II strip) interpretation. In refractory seizures provoked by emotional upset or exercise, exercise tolerance test (ETT), echocardiography and 24-hour ambulatory ECG monitoring were performed. Every rhythm disturbance and conduction abnormality was carefully monitored. ECG analysis (including measurements) was repeated at two or more separate QRS complexes or strips, without any awareness of the neurological status of the patient. ECG analysis was also performed in 234 sex- and age-matched normal children who visited the Pediatrics Clinic for routine check-up. The ECG findings were then compared in the two groups.

Anti-epileptic therapy was started or continued in true cases of SD. When indicated by cardiac evaluation, anti-epileptic treatment was discontinued, and anti-arrhythmic drugs were started. The two sets of drugs were administered in combination when deemed necessary. In two cases, permanent cardiac pacemakers were implanted.

Statistical analyses including Student's *t* test (paired and unpaired) were performed on the data.

Results

Two-hundred and thirty (84.2%) out of 273 patients had generalized tonic-clonic seizure. The duration of seizure ranged between <1 yr in 256 (93.7%), and >1 yr in 17 (6.3%) patients.

Of one-hundred and sixty nine (61.9%) patients with normal cardiac evaluation, 72 (26.4%) had only sinus dysrhythmia, and 32 (11.7%) showed other ECG abnormalities (the high-risk group). The most common ECG abnormality was prolonged QTc. Fifteen patients had borderline QTc (420–460 ms) and five had significant QTc prolongation (≥470 ms).[5] Complete AV block (CAVB) and ventricular dysrhythmia were other significant abnormalities.

We compared the patients with abnormal ECG findings (group A) with those with seizures but normal ECG (group B) and with those of normal children (group C). There were no significant differences in sex and age between all groups. Both A and B groups received similar anticonvulsant therapy. Patients who were on carbamazepine had no significant ECG abnormalities than those receiving other anti-convulsant drugs. Patients in group A had a higher prevalence of refractoriness to anticonculvsants, and their seizure activities were more frequently preceded by emotional upset and stress as compared to group B ($p<0.001$). Mean±SD QTc was significantly ($p<0.001$) different among normal children (395±18 ms), patients with SD (408±21ms) and high-risk patients (group A) (447±53 ms) (Table 1).

Discussion

Prolonged and hazardous QTc, including T-wave hump and borderline QTc,[11] ventricular dysrhythmia and AV block are potentially treatable states. There was significant ECG abnormality in group A and B as compared to normal children. Abnormal ECG findings were more frequent in patients with refractory seizures and drop attacks and also seizure episodes precipitated by anxiety, emotional upset, or physical strain ($p<0.001$). Prolonged QT interval has been reported as a cause of sudden infant death syndrome,[12-14] and it was known for many years[14] to be a cause of convulsion.[1,5] LQTS is now considered to be a collection of genetically distinct arrhythmogenic cardiovascular disorders resulting from mutations in fundamental cardiac ion channels which orchestrate the action potential of the human heart.[5,6] In this study two patients were controlled by adding anti-arrhythmic agent to their anti-epileptic regimen.

The response to anti-arrhythmic management can also be diagnostic, but larger studies and more evaluation, including 72-hour ambulatory ECG monitoring,[15,16] ETT,[7] as well as echocardiography, may yield more conclusive data.

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