

The Impact of Electrolytes in Pathogenesis of Simple Febrile Convulsions

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Abstract

Febrile convulsion is one of the most common seizure disturbances in children with an approximate rate of 2%–5%, febrile seizures (FSs) occur between the age of 6 and 60 months with a 38°C or higher temperature, and they do not result from central nervous system infection or any metabolic imbalance, and these seizures occur when a history of prior FSs is absent. In this study, 150 children whose ages ranged between 6 and 60 months were divided into three groups: Group A included 50 children with febrile convulsions, Group B included 50 children having fever without convulsion, and Group C included 50 healthy children with nonfebrile convulsions. In the present study, the serum sodium and potassium were significantly lower in cases of febrile convulsion than the control groups, whereas no significant changes were shown in the levels of ionic calcium in the cases of febrile convulsion when compared with the control groups. These findings revealed that there is a correlation between differences of serum sodium and potassium in simple febrile convulsion.

Keywords: Convulsions, febrile convulsions, fever, potassium and calcium, sodium

INTRODUCTION

Febrile seizure (FS) is a highly common neurological problem during childhood. About 2%–5% of children are estimated to undergo at least one seizure during a febrile illness before the age of 5 years, accounting for 30% of all seizures among children. Seizure is associated with fever although there is no evidence of intracranial infection or a definite cause for it.^[1,2]

The mechanisms underlying FS have multifactorial etiology, complicated by the fact that the pathogenesis of FS is unknown in most cases; FS represents the point between a low seizure threshold and genetic components. Many important elements have important roles in redox reactions, in connective tissue or cell membranes, in stabilization of biological molecules, and in the control of biological processes by facilitating the binding of molecules to receptor sites on cell membranes.^[3] While disturbance in serum electrolytes is considered as a pathogenetic theory of FS, it has not been confirmed as yet, low levels of some elements such as iron and sodium (Na⁺) in the blood play roles in repeated occurrence of FS.^[4]

Sodium is the major cation of extracellular fluid and plays a key role of monovalent cation, and it is best represented

vital blood which is associated with metabolic and enzymatic processes as cell activator, it is mainly associated with cell membrane function, and it occurs in the formation and transmission of action potentials in acetylcholinergic synaptic transmission.^[5] Potassium is the major intracellular cation. Hypokalemia or hyperkalemia can rarely cause symptoms in the central nervous system (CNS) in contrast to other electrolyte abnormalities. The exact effects of changes in the extracellular potassium is mainly on the cardiovascular and nervous systems, and severe potassium abnormality may, therefore, provoke fatal arrhythmias or muscle paralysis before the appearance of CNS symptoms.^[6,7]

The most abundant mineral element in the human body is calcium. The term ionized calcium, although widely used, is a misnomer because all calcium in plasma or serum is ionized, irrespective of whether or not it is free or is associated with protein or small anions by ionic binding. Free (ionic) calcium

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is the biologically active part of blood calcium; PTH and 1,25 (OH)₂D tightly regulate calcium, and thus it is observed as the best indicator of calcium status.^[8] Calcium has key roles in many important physiologic functions including muscle contraction, hormone secretion, glycogen metabolism, and cell division.^[9] Calcium stabilizes the plasma membranes and influences permeability and excitability.^[10]

MATERIALS AND METHODS

Subjects

This study was carried out in Babylon Teaching Hospital for Gynecology and Pediatrics, Hilla City, Babylon Province. The Patients of study sample attended the outpatient clinic, emergency room. All samples were collected from August 2016 to February 2017. The laboratory workup for diagnosis was done in the hospital laboratory. While the biochemical tests under the study were performed at the Laboratory of the Department of Clinical Biochemistry, College of Medicine, University of Babylon. The study included 150 children, 50 of them were patients diagnosed with simple febrile convulsion and the other 100 (fifty with fever and other fifty were healthy group).

Inclusion criteria

Children with simple FS from 6 to 60 months old with a single generalized seizure and one seizure attack during illness (24 h), seizure duration <15 min, generalized type, and normal growth were needed in the study.

Exclusion criteria

Children with a history of seizure, being younger than 6 months or older than 60 months, having a history of FS, vomiting and diarrhea, child with delayed development, failure to thrive, or acute meningitis were excluded from the study.

Blood sampling

From all participants, venous blood samples were taken using 5 ml disposable syringe. Five milliliters of blood was collected from each participant by venipuncture and put gently into clean and dry plain tubes. At 37°C and for 10–15 min, blood samples were left to dry and then centrifuged at 2000 × g for about 10–15 min, then sera were divided into five aliquots and stored at –20°C until analysis. The concentrations of serum sodium (Na), potassium (K), and ionic calcium (iCa) were measured in this study.

Methods

Measurement of serum sodium, potassium, and ionic calcium was done by fully automated instrument Ion Selective Electrode GE 300 Genius (Ireland) method.

RESULTS

The distribution of patient with simple febrile convulsion according to gender. There was equal percentage of male (50%) and female patients (50%).

Figure 1 shows the distribution of patient with simple febrile convulsion by age. It was divided according to month into

five categories where 6–12, 13–24, 25–36, 37–48, and 49–60. The number of persons was more in 13–24 ages and less in 37–48 ages.

Table 1 shows the mean differences of serum electrolytes including potassium, sodium, and ionic calcium between patients with simple febrile convulsion and patients with only fever without convulsion. There were significant differences between means of potassium and sodium in the study groups ($P < 0.05^*$), whereas there were no significant differences between means of ionic calcium in the study groups ($P = 0.656$).

Table 2 shows that the mean differences of serum electrolytes including potassium, sodium, and ionic calcium between patients with simple febrile convulsion and healthy participants. There were significant differences between means of potassium and sodium in the study groups ($P < 0.05^*$), while there were no significant differences between means of free calcium in the study groups ($P = 0.229$).

Table 3 shows the mean differences of serum electrolytes including potassium, sodium, and ionic calcium between patients with only fever and healthy persons. There were no significant differences between means of potassium, sodium, and ionic calcium in the study groups ($P = 0.408, 0.4, 0.189$, respectively).

DISCUSSION

Brain, among many other human tissues and organs, may be influenced by electrolyte disturbances; therefore, electrolytes

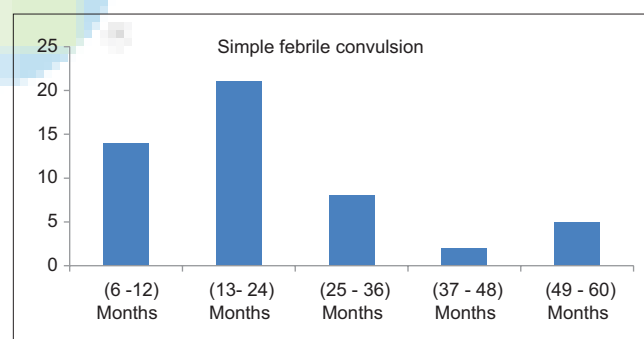


Figure 1: Distribution of patients with simple febrile convulsion according to age

Table 1: Mean differences of serum electrolytes between patients with simple febrile convulsion and patients with only fever without convulsion

Study variable	Group	n	Mean±SD	P
Potassium (mol/l)	Simple febrile convulsion	50	4.23±0.42	<0.05*
	Fever without convulsion	50	4.64±0.77	
Sodium (mol/l)	Simple febrile convulsion	50	137.21±3.44	<0.05*
	Fever without convulsion	50	138.46±3.99	
Ionic calcium (mol/l)	Simple febrile convulsion	50	1.09±0.12	0.656
	Fever without convulsion	50	1.08±0.12	

* $P \leq 0.05$ was significant. SD: Standard deviation

Table 2: Mean differences of serum electrolytes between patients with simple febrile convulsion and healthy participants

Study variable	Group	n	Mean±SD	P
Potassium (mol/l)	Simple febrile convulsion	50	4.23±0.42	<0.05*
	Healthy person	50	4.59±0.84	
Sodium (mol/l)	Simple febrile convulsion	50	137.21±3.44	<0.05*
	Healthy person	50	139.02±3.36	
Ionic calcium (mol/l)	Simple febrile convulsion	50	1.09±0.12	0.229
	Healthy person	50	1.12±0.11	

*P≤0.05 was significant. SD: Standard deviation

Table 3: Mean differences of serum electrolytes between patients with only fever and healthy participants

Study variable	Group	n	Mean±SD	P
Potassium (mol/l)	Fever without convulsion	50	4.64±0.77	0.408
	Healthy person	50	4.59±0.84	
Sodium (mol/l)	Fever without convulsion	50	138.46±3.99	0.4
	Healthy person	50	139.02±3.36	
Ionic calcium (mol/l)	Fever without convulsion	50	1.08±0.12	0.189
	Healthy person	50	1.12±0.11	

P≤0.05 was significant. SD: Standard deviation

need to be immediately recognized as they may cause severe and life-threatening complications when neglected or not appropriately treated. The severity of acute neuronal derangement is reflected by the neurological manifestations, and therefore it requires emergency treatment.^[11] With rapidly progressive neurologic symptoms or seizures, acute and/or severe electrolyte imbalances can develop and may be the only presenting symptom. Seizures are often seen in patients with sodium disorders, especially, hypocalcemia, hyponatremia, and hypomagnesemia.^[12] The present study showed significant differences between low levels of means of potassium and sodium in a group of patients with febrile convulsion and fever without convulsion, with $P < 0.05^*$ and also there were significant differences between means of potassium and sodium in a group of patients with febrile convulsion and healthy person, with $P < 0.05^*$.

Functions of sodium include maintenance of fluid balance, regulation of BP, and normal functions of the nervous system. As physiology goes, sodium is the dominant extracellular cation, which determines the fluid movement. Whenever the level of sodium becomes low, it causes excess water to enter the cells. Extracellular hypo-osmolarity causes shift of fluid from intravascular space to intracellular space; most of the cells have the ability to expand, except for the neuronal cells, because brain is confined to a bony calvarium, where expansion is limited. Hence, this results in intracerebral edema which causes constant irritation of the neurons, ultimately resulting in seizures. As the sodium level goes down, seizure is more likely to be recurrent.^[13] In living organisms, the functions

of sodium and potassium are quite different. Animals, in particular, employ potassium and sodium differentially to generate electrical potentials in animal cells, especially in the nervous tissue. Depletion of potassium in animals, including humans, leads to different neurological dysfunctions.^[14,15] On the other hand, there were no significant differences in means of the results of ionic calcium in group of patients with febrile convulsion with other groups (fever without convulsion and healthy person). Hamed *et al.*^[16] reported no difference in the levels of Ca among the group of patients and the normal healthy group. Akbayram *et al.*, in their study, obtained that Ca and K concentrations in the FS group were lower than their levels in the control group,^[17] and Namakin *et al.*^[18] found a significant difference between the mean serum sodium of children with FS and controls. On the other hand, Nadkarni *et al.*^[19]

Results were found no significant difference in the mean serum sodium between the study group and controls, Al-Rubae *et al.*,^[20] in their study, showed that low levels of serum calcium and sodium were observed in FSs patients when compared to control group while no significant difference in potassium level between patient and control. However, there are some limitations in all above studies in that, in some studies, the electrolyte measurements are done by photometric method and that are less accuracy than electrolytes analyzer because the intervals' reference of electrolytes is very minutes, so it exposed to some errors in photometric method, also some studies done on small number of patients.

CONCLUSIONS

The study concluded that changes in sodium and potassium levels could have a role in the development of simple febrile convulsion.

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Conflicts of interest

There are no conflicts of interest.

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