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 acetilocolinergic 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.\(^9\) Calcium has key roles in many important physiologic functions including muscle contraction, hormone secretion, glycogen metabolism, and cell division.\(^{10}\) 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

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**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      | Simple febrile convulsion    | 50 | 4.23±0.42   | <0.05*  |
| (mol/l)        | Fever without convulsion     | 50 | 4.64±0.77   |         |
| Sodium         | Simple febrile convulsion    | 50 | 137.21±3.44 | <0.05*  |
| (mol/l)        | Fever without convulsion     | 50 | 138.46±3.99 |         |
| Ionic calcium  | Simple febrile convulsion    | 50 | 1.09±0.12   | 0.656   |
| (mol/l)        | Fever without convulsion     | 50 | 1.08±0.12   |         |

*\(P<0.05\) was significant. SD: Standard deviation.
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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

Results were found no significant difference in the mean serum sodium between the study group and controls, Al-Rubae et al., 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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