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[The relationship between serum electrolyte and febrile seizure]

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Dedication

To the greatest & strongest woman I've ever seen

the woman who takes care of me more than i do..

my idol & highest example....

the woman who taught me to be strong and who also taught me to let everything to ALLAH & ALLAH will always choose the best for me ...

the flower of my life and my reason to live

to my mother " the woman I've never seen better than".

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My amazing sister and gentle brother who helped me and supported me in everything.

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LIST OF ABBREVIATIONS

Symbols	Meanings
NIH	National institutes of health.
F.S	Febrile seizure.
ILAE	International League Against Epilepsy
AAP	American academy of pediatrics.
GEFS+	Generalized epilepsy with febrile seizure plus.
SFS	Simple febrile seizure.
CFS	Complex febrile seizure.
PFS	Prolonged febrile seizure.
FSE	Febrile status epilepticus.
F.C	Febrile convulsion.
$S.Na^{+}$	Serum sodium.
$S.K^{+}$	Serum potassium.
$S.Ca^{+}$	Serum calcium.
EEG	Electroencephalogram.
CSF	Cerebrospinal fluid.

Abstract

Background:

febrile seizures as a seizure occurring in febrile children between the ages of 6 and 60 months who do not have an intracranial infection, metabolic disturbance, or history of afebrile seizures, The mechanism of seizure activity is altered in hyponatremia, due to deficiency of sodium ion, more calcium ion influx, and generation of repetitive action potential which will cause repetitive seizure initiation.

Aim of study:

To assess the effect of serum electrolyte (Na^+ ,k^+ , Ca^+) in children with febrile convulsion.

Patient and methods:

A case-control study was conducted from 1st of October 2017 till 31th of January 2018 and involved 60 children aged 6 months to 6 years, divided into 30 cases with febrile convulsion and the other 30 were normal children (control). Cases and control were collected from pediatric floor and pediatric emergency unit in Al-Imamain Al-Kadhimin teaching hospital. The information taking from the case sheets.

Results:

We found serum electrolyte disturbance Na^+ is decreased (66.7%) ,K^+ is increased (16.7%) and Ca^+ is decreased (6.7%) respectively . most common age group affected <2 y (36.6%). Complex seizure associated with (Na+, K^+, Ca^+). Family history and status epilepticus more common in complex group (26.6%).

Conclusion:

There is significant association between serum electrolyte (Na^+, K^+, Ca^+) level and febrile convulsion.

Introduction

Definitions:

There are three chronological definitions currently used to characterize FS. The first definition was published in 1980by the National Institutes of Health (NIH). It defined FS as an abnormal, sudden, excessive electrical discharge of neurons (gray matter) that propagates down the neuronal processes (white matter) to affect an end organ in a clinically measurable fashion, occurring in infancy or childhood, usually between 3months and 5 years of age, and is associated with fever but lacks evidence of intracranial infection or defined cause [1]. The second definition was published by ILAE in 1993 and had the same concept, but it expanded the inclusion age group to young infants apart from neonates and excluded children with symptomatic febrile convulsions [2]. More recently, the American Academy of Pediatrics (AAP) has announced a standard definition of febrile seizures as a seizure occurring in febrile children between the ages of 6 and 60 months who do not have an intracranial infection, metabolic disturbance, or history afebrile seizures [3].

Epidemiology:

Simple FS have an age range classically described as 6 to 60 months. The peak incidence is usually in the second year of life. FS are prevalent in up to 5% of children, with the overall incidence estimated to be 460/100,000 in the age group of 0 – 4 years [4]. Most FS are simple; however, up to 30% might have some complex features [5]. The risk of recurrence of FS is related to various factors, including younger age group, prolonged seizure duration, degree of fever, and positive personal and family history of FS, In fact, a positive family history of FS in first-degree relatives is observed in up to 40% of patients [6]. Gender distribution has been studied in the literature. One previous study found a mild male predominance [7], but this has not been supported by other literature reviews. Seasonal variation with regard to seizure incidence has not yet been fully understood. Studies have shown that FS tend to occur more in the winter months and are more common in the evening [8].The underlying pathophysiological explanations for these observations remain obscure [9,10].

Etiology and Pathophysiology:

Signal pathway studies have only delivered theories in regard to why and how certain children develop FS. In the past, the most prevalent theory attributed a direct effect of hyperthermia on compensatory hyperventilation. This was assumed to cause mild brain alkalosis, resulting in increased neuronal excitability and the subsequent development of clinical seizures [9].This theory, however, has not explained why some children are more prone to develop such phenomena than others. Currently we know that there is a large role of genetic susceptibility based on a large group of gene variants. This genetic makeup has likely resulted in neurodevelopmental vulnerability, with alterations in sodium channel expression, hypothalamic dysregulation, and both cortical and hippocampal excitability,Environmental triggers, including nonfever causes, are then probably involved through neurotropicity and metabolic dysregulatory pathways [10].

Genetics:

FS can be seen in multiple family members and there is evidence of genetic and environmental causes. There is a variable inheritance pattern, with no single accepted mechanism. A positive family history of FS can be found in 25–40% of cases when a child present with a FS [11–13]. The number of FS a child has affects the risk of a sibling experiencing a FS [14]. Significantly higher concordance rates are seen for FS in monozygotic twins as compared to dizygotic twins in multiple twin registries [15].

The phenotype of FS plus may account for children without a specific epilepsy syndrome who have FS and then developed generalized epilepsy [16]. These patients or family members have a have a history of FS, often complex and frequently occur beyond 5 years of age. Epilepsy with variable seizure types develop later in childhood or adulthood. A variety of mutations including SCN1A, SCN1B, and GABGR2 have been demonstrated in these families[17]. The proposed genetic syndrome that is called generalized epilepsy with febrile seizures plus (GEFS+) is a spectrum of clinical epilepsy phenotypes, with the most severe phenotype of myoclonic-astatic epilepsy [16].

RISK FACTORS:

The two most consistently identified risk factors for developing febrile seizures are the height of the temperature and a positive family history in first-degree relatives [18, 19, 20].

Higher temperatures are associated with a higher likelihood of having a febrile seizure [19, 20]. The risk for febrile seizures increases with the number of relatives who have a history of febrile seizures [18, 21]. Sibling studies identify a risk of 10% to 45% [18,22] .Other identified risk factors are a neonatal nursery stay of greater than 28 days, developmental delay, and day care attendance [23,24,25].

CHARACTERISTICS AND CLASSIFICATION:

Febrile seizures are classified as simple or complex based on duration, physical characteristics, and recurrence patterns. A self-limited, short (< 15 minutes), generalized, tonic-clonic seizure that does not recur within the same illness and is not associated with post-ictal pathology is classified as a simple febrile seizure (SFS). Febrile seizures that do not meet all criteria for SFS are classified as complex febrile seizures (CFS). A prolonged febrile seizure (PFS) is a complex seizure that lasts longer than 15 minutes, and a febrile seizure that continues longer than 30 minutes is classified as febrile status epilepticus (FSE) [26]. FSE accounts for 5% to 9% of all febrile seizures [27, 28] and 25% of all episodes of status epilepticus occurring in children [18, 29]. In the second year of life, two-thirds of all cases of status epilepticus are FSE ,FSE is considered a medical emergency[30].

Electrolytes and febrile seizure:

The mechanism by which febrile seizures predispose to later epilepsy is much less clear. Prolonged febrile convulsions in early infancy may precede a variety of different seizures but are particularly common in children who develop intractable seizures of temporal lobe origin. Prolonged febrile seizures in childhood are known to have adverse physiologic consequences, including increased cerebral metabolic demand and systemic changes such as hypoxia, hypoglycemia, and arterial hypotension. Genetic factors appear to play a role when epilepsy develops after febrile seizures. Temporal lobe seizures are more likely to begin early but remit permanently if a first-degree relative had a febrile seizure [31]. A single gene is held responsible because the siblings of the patients with temporal lobe and febrile seizures have a similar incidence

of febrile seizures alone. Collectively, children with complex febrile seizures can be said to have a small but identifiable risk for later epilepsy, based on genetic, developmental and acquired factors. If these children develop persistent temporal lobe seizures, they are likely to continue to experience seizures in later life, Seizure activity can begin in a very discrete region of cortex and then spread to neighboring regions, there is a seizure initiation phase and a seizure propagation phase [32]. Initiation phase is characterized by two concurrent events in an aggregate of neurons [32].

1. High-frequency bursts of action potentials and
2. Hypersynchronization.

The bursting activity is caused by a relatively long-lasting depolarization of the neuronal membrane due to the influx of extracellular calcium, which leads to the opening of voltage-dependent sodium channels which leads to an influx of sodium [33].

In the case of hyponatremia due to deficiency of sodium ion, more calcium ion influx, and generation of repetitive action potential which will cause repetitive seizure initiation.Fever plays an important role in causing disturbances in fluid and electrolyte imbalance. Hyponatremia has been thought to enhance the susceptibility to seizures associated with febrile illness in childhood. Sodium levels are lower in those children with complicated convulsions in comparison with those having simple convulsions. the sodium concentrations are lowest in children with repeated seizures compared with children having simple or other complicated types of febrile seizures such as focal seizures. Seizures lasting longer than 15 min during febrile convulsions have been studied serum potassium levels showed no significant differences between patient groups. However, calcium levels and osmolarity significantly lower than control groups. The electrolytic modification of overall hyponatremia is probably due to the syndrome of inappropriate antidiuretic hormone may have a role in short-term relapses of febrile convulsions. Hypernatremia has been documented in some children with high fever, without seizures, it may be that Hyponatremia in predisposed subjects lowers the threshold of neuromuscular excitability [34, 35, 36, 37].

Aim of study

To assess the effect of serum electrolyte disturbance (Na+ ,k+ , Ca+) in children with febrile convulsion.

Patient and Methods

A case-control study was conducted from 1st of October 2017 till 31th of January 2018 and involved 60 children aged 6 months to 6 years, divided into 30 cases with febrile convulsion and the other 30 were normal children (control). Cases and control were collected from pediatric floor and pediatric emergency unit in Al-Imamain Al-Kadhimin teaching hospital.

History was taken from parents involving information about gender, first or recurrence, type FC it's simple or complex, have status epileptics or not, family history, FC remit (spontaneously or only with intervention), response to treatment, investigation (brain image, EEG, CSF) , according to type of seizure we divided to two groups simple and complex groups. serum electrolyte normal limits ($S.Na^{+}$ = 135-150mEq/L , $S.K^{+}$ = 3.6-5.5mmol/L,$S.Ca^{+}$= 9-11mg/L), according to kit from (ABBOTT) company in (America).

Exclusion Criteria:

- Children with signs of meningitis.
- Children with developmental delay.
- Children with neurologic disorders.

Statistical analysis:

The IBM SPSS software program version 24, was used for all computerized statistical analysis. The results were expressed as frequencies and percentages. Variables were compared by using Chi-square X^2 tests. *P*-value equal or less than 0.05 was considered to be statistically significant and > 0.001 was highly significant.

Results

Among cases group, there were 14 boys (23.3%) and 16 girls (26.3%). The male to female ratio was 1:1.14.

Acording to serum electrolyte results in patient group shows the $S.Na^{+}$ is significant decreased (66.7%) (0%) F.C and control, while in $S.K^{+}$ is increased (16.7%) (0%) and $S.Ca^{+}$ is decreased (6.7%) (0%) respectively between patient with F.C and control group, as shown in table (1).

Table(1):Relationship between Serum Electrolytes Level and patient and F.C group.

S. Electrolytes Level		Type of Patient		Total	*P-Value*
		Child with F.C *freq. (%)*	Normal Child *freq. (%)*		
Na+ Value	Normal	10 (33.3%)	30 (100%)	40 (66.7%)	*<0.001*
	Decreased	20 (66.7%)	0 (0%)	20 (33.3%)	
K+ Value	Normal	25 (83.3%)	30 (100%)	55 (91.7%)	*0.020*
	Increased	5 (16.7%)	0 (0%)	5 (8.3%)	
Ca + value	Normal	28 (93.3%)	30 (100%)	58 (96.7%)	*0.150*
	Decreased	2 (6.7%)	0 (0%)	2 (3.3%)	
Total		30 (100%)	30 (100%)	60 (100%)	*1.000*
**P-value if less than 0.05 significant or less than 0.001 highly significant*					

According to the relationship between age of children and type of febrile seizure. The study shows the common age in F.S is less than 2 years 11(36.6%), as shown in table (2).

Table (2): Relationship between Age of child and type of seizure

Child Age (in months)	Type of Seizures		Total NO (%)
	Simple NO (%)	Complex NO (%)	
<1y	2 (6.7%)	5 (16.6%)	7 (23.3%)
1y to < 2y	5 (16.7%)	6 (20%)	11 (36.6%)
2y to <3y	0 (0%)	5 (16.6%)	5 (16.7%)
3y to <4y	2 (6.7%)	0 (0%)	2 (6.7%)
4y to 5y	2 (6.7%)	3 (10%)	5 (16.7%)
Total	11 (36.7%)	19 (63.6%)	30 (100%)

serum electrolyte disturbance assessment we fond Na^+ was more common in patient with complex F.S than simple F.S (46.7%) , (20%) respectively while $S.K^+$ (16.7%) , (0%) respectively and Ca^+ (6.7%),(0%) respectively between complex and simple in type.

Table(3):Relationship between Serum Electrolytes and Type of febrile Seizure.

S. Electrolytes Level		Type of Seizure		Total NO (%)	*P-Value*
		Simple *freq. (%)*	Complex *freq. (%)*		
Na+ Value	Normal	5 (16.7%)	5 (16.7%)	10 (33.3%)	*0.284*
	Decreased	6 (20%)	14 (46.7%)	20 (66.7%)	
K+ Value	Normal	11 (36.7%)	14 (46.7%)	25 (83.3%)	*0.062*
	Increased	0 (0%)	5 (16.7%)	5 (16.7%)	
Ca + value	Normal	11 (36.7%)	17 (56.6%)	28 (93.3%)	*0.265*
	Decreased	0 (0%)	2 (6.7%)	2 (6.7%)	
Total		11 (36.7%)	19 (63.3%)	30 (100%)	*0.144*

Status epileptics seen more common in complex group than simple (26.6%) (3.3%) respectively, as shown in table (4).

Table(4): Relationship between status epileptics and type of febrile seizure.

Status epileptics	type of seizures		*p- value*
	Simple NO (%)	Complex NO (%)	
Yes	1 (3.3%)	8 (26.6%)	*0.057*
No	10 (33.3%)	11 (36.7%)	
Total	11 (36.7%)	19 (63.3%)	

**P-value* if less than 0.05 significant

Family history was positive in patient with complex F.C 8(26.6%) than simple F.C 3(10%), as shown in table (5).

Table (5): Relationship between family history and type of febrile seizure.

Family history	type of seizures		*p-value*
	Simple NO (%)	complex NO (%)	
Yes	3 (10%)	8 (26.6%)	*<0.417*
No	8 (26.7%)	11 (36.6%)	
Total	11 (36.7%)	19 (63.3%)	

Treatment is indicated in complex F.S simple F.S (50%),(6.7%)respectively.

Discussion

Regarding to male to female ratio 1:1.14 was almost equal which not agreed with KULANDAIVEL M [38] due to our sample small in size.

There is significant disturbance in serum electrolyte (Na^+, K^+, Ca^+) which agree with HUGEN CA study (52%) [37].

The current study shows common age was < 2 years (36.6%) which agree KULANDAIVEL M study [38].

According to type of febrile convulsion the study shows S.Na^+ decreased complex convulsion (46.7%) than simple convulsion (20%) which agree with the KULANDAIVEL M study was (92.4%) ,(32.8%) respectively [38].
While S.K^+ was increased with complex convulsion (16.7%) which disagree with study HUGEN CA due to our sample different in mass and short period of study, and S.Ca^+ was decreased with complex convulsion (6.5%) and p value was not significant which disagree with the study of USHA KIRAN, et al study was p value significant (p=*0.0001*) [39] due to our sample small in size.

Regarding to relationship between status epileptics and type of febrile convulsion we see the complex type mostly affected (26.6%) which this agree with NISHIYAMA M, et al Study [41].

Family history positive in the complex seizure than in simple (26.6%) which agree with SHRESTHA D, et al study (40%)[6].

Specific anticonvulsant treatment use for complex F.C (50%) which agree with PATEL AD, et al study [40].

Conclusion

1. There is significant association between serum electrolyte (Na^+, K^+, Ca^+) level and febrile convulsion.

2. Positive family history and Status epileptics see more common in children with complex febrile seizure.

Recommendation

1. Specific anticonvulsant treatment is indicted to the complex febrile seizure specially who have positive family history and statues epilpticus.

2. Long follow-up with patient with febrile convulsion include growth and development and school preforms if theirs affected of F.C.

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Questioners

Age (months)			
Gender	male	female	
Febrile seizure	1st	recurrence	
Type	simple	complex	
Status epileptics	yes	no	
Family history	yes	no	
Febrile seizure remit	spontaneously	Only with intervention	
Response to tretmen	Without antipyretic	with antiPyritic only	with Anticonvulsants
Investigation :			
Brain image			
EEG			
CSF			
ELECTROLYTE :			
Sodium:			
Potassium:			
Chloride:			
Calcium:			