





# The Frequency of EEG Abnormalities in Children with Febrile Seizure

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## ABSTRACT

**Background & Objective:** Febrile seizures are one of the most common neurological disorders in children. The aim of this study was to investigate the extent of abnormal EEG reports and its association with other risk factors of febrile seizures.

**Materials & Methods:** In this prospective observational study, all patients with febrile seizure admitted into Mousavi Hospital in Zanjan, Iran, from April 2015 to March 2016 were enrolled. EEG was carried out for all patients and the clinical data were recorded in the prepared questionnaire. The statistical analysis was performed by using spss.16 software.

**Results:** One hundred seventy patients, 92 (54.1%) male and 78 (45.9%) female with the mean age of 28.57 months were evaluated. The EEG reports were normal in 140 (82.4%) cases and 30 (17.6%) cases had abnormal reports including 8 cases (26.6%) of spike & sharp electric discharge, 2 cases (6.6%) of slow activity and 20 cases (66.6%) of nonspecific changes. EEG abnormalities were significantly related with male sex ( $P = 0.020$ ), history of previous febrile convulsion ( $p < 0.001$ ), positive family history of epilepsy and febrile seizures ( $p < 0.001$ ) and complex type of febrile convulsion ( $p < 0.001$ ). Longer duration of seizure ( $p < 0.001$ ) and older age of patients ( $p < 0.033$ ) had significant relation with abnormal EEG.

**Conclusion:** Although EEG is not routinely performed in all patients with febrile seizure, it is recommended for male gender, age over 3 years, complex febrile seizure, previous history of seizure and family history of epilepsy or febrile seizures.

**Keywords:** Electroencephalography (EEG), Simple febrile convulsion, Complex Febrile seizure, Febrile convulsion (FC)



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## Introduction

Febrile seizure is one of the most common pediatric neurological conditions with a prevalence of 2-14% (1). The International League Against Epilepsy (ILAE) defined febrile convulsion as “a seizure occurring in childhood after one month of age, associated with a febrile illness not caused by an infection of the central nervous system, without previous neonatal seizures or a previous unprovoked seizure, and not meeting the criteria for other acute symptomatic seizures” (2). The risk factors for febrile convulsion are male sex (3), sudden rise in temperature, infection of the upper respiratory system, positive family history (4), preterm birth and brain injury at birth, vitamin deficiencies (5), and changes in serum and cerebrospinal fluid trace element levels (1, 6, 7). On the other hand, high income families have a reduced risk of febrile seizure (8).

Based on the duration of the seizure, the presence of focal neurological symptoms and its recurrence in 24 hours, febrile seizures are divided into two types, simple and complex (5). Simple FS is benign and self-limited,

and rarely causes status epilepticus (3). In the complex type, the seizure lasts longer than 15 minutes, or recurs in 24 hours, or there are focal neurological symptoms (9). Complex febrile seizures can be seen in 22.6% of patients and their incidence of epilepsy will be up to 12%. (10). In dealing with a child who had febrile seizure for the first time, the question is always whether it is possible for the seizure to recur or not. Several risk factors are known to affect the recurrence of febrile seizures, including the patient's age, the degree of fever at the time of seizures, family history of epilepsy or seizures, type of simple or complex seizures (11). One method of determining the likelihood of seizure recurrence is electroencephalography.

The EEG has been studied in many investigations in febrile seizure. Some studies reported that in more than 90% of cases, the EEG reports were normal (12) but it should be considered that pseudo-petit mal discharge (PPMD) pattern and abnormal EEG pattern are among the risk factors of febrile seizure. (13). A study concluded that

the positive predictive value of epileptiform discharges was low in complex febrile seizure but it was twice higher in recurrent febrile seizures and concluded that epilepsy is unlikely in patients with normal EEG. (14) Patients with abnormal discharge on electroencephalography are more likely to develop epilepsy.(10).On the other hand, in children with febrile seizure ,epileptiform alterations are not uncommon (9) and therefore EEG is recommended especially for recurrent complex febrile seizure patients.(10) As mentioned above it is very important for the family to predict the chance of recurrence that may be possible with performing EEG. However, it may not be cost effective to do EEG for all febrile seizure patients. Therefore, we need to know for which patients the EEG should be performed. The aim of this study was to investigate the extent of abnormal EEG reports and its association with other risk factors of recurrence in febrile seizures in order to identify the appropriate cases to perform EEG.

## Materials and Methods

In this study, 170 patients with febrile seizures admitted to the pediatric ward of Ayatollah Mousavi Hospital in Zanjan, were examined for a period of one year from April 2015. Inclusion criteria were defined as seizure occurring in children aged six months to five years, “with a febrile illness not caused by an infection of the central nervous system, without previous neonatal seizures or a previous unprovoked seizure, and not meeting the criteria for other acute symptomatic seizures”.Patients with CNS infection, *shigella* infection or refractory encephalopathy were not included in the study. Patients who had no access to the EEG, for any reason, were excluded from the study.

Patients’ information including age and sex, type and duration of seizures, developmental status of the child, extent and duration of fever, previous history of febrile seizures, family history of febrile seizures or epilepsy,

reports of EEG, and paraclinical tests including hemoglobin, blood sugar, serum calcium, sodium, and potassium was entered in the relevant pre-prepared questionnaire.

The EEG was taken during sleep within 5-7 days after the seizure, using a NIHON KOHDEN CORPORATION (Japan) device. All electroencephalographs were reported by a pediatric neurologist who was aware of a brief history written in the ordering form .The EEG reports were divided into 4 categories: normal, sharp scattered waves, slow waves, and nonspecific changes. Non-specific changes mainly consisted of intermittent rhythmic theta activity.

Statistical analysis was performed using SPSS.16 software. Chi-square test was used to determine the relationship between qualitative variables and Mann-Whitney test was used to determine the relationship between quantitative and qualitative variables.

All patients’ information remained confidential. Results were published in groups and anonymously. This study was approved by the Ethics Committee of Zanjan University of Medical Sciences (Ethics ID: IR.ZUMS.REC.1394.94).

## Results

This study was performed in Mousavi Hospital in Zanjan, Iran, from April 2015 to March 2016. One hundred seventy patients hospitalized with diagnosis of febrile seizures, 78 females (45.9%) and 92 males (54.1%) were enrolled. The patients were from 6 to 66 months old (mean = 28.57months). The means of temperature, duration of fever and duration of seizures were 38.946 °c, 6.34 hours, and 4.02 minutes respectively. The demographic findings of patients are shown in [table1](#).

**Table1.** The demographic findings of patients

variable	Number of children(%)
<b>Sex</b>	
Boy	92(54.1)
Girl	78(45.9)
<b>Type of delivery</b>	
NVD	128(75.3)
C/S	42(24.7)
<b>Family history of febrile seizure</b>	
Positive	57(33.5)
Negative	113(66.5)
<b>Family history of epilepsy</b>	
Positive	21(12.4)
Negative	149(87.6)

variable	Number of children(%)
<b>Previous history of febrile seizure</b>	
Positive	42(24.7)
Negative	128(75.3)
<b>Type of seizure</b>	
Simple	140(82.4)
Complex	30(13.6)
<b>EEG results</b>	
Normal	140(82.4)
Abnormal	30(13.6)

For all patients, EEG was taken in the first week of hospitalization. EEG reports were normal in 140 cases (82.4%), but the abnormal reports were seen in 30 cases (17.6%) including 8 cases (26.6%) of spike & sharp electric discharge, 2 cases (6.6%) of slow activity and 20 cases (66.6%) of nonspecific changes.

Fifty percent of normal EEG reports were seen in boys and 50% in girls. However, out of 30 abnormal EEG reports, 22 (73.3%) reports were seen in males and this difference was significant ( $P = 0.020$ ). 104 (74.3%) patients with normal EEG and 24 (80%) patients with abnormal EEG had NVD delivery. There were no statistically significant difference between type of delivery and normal EEG reports ( $P$  value = 0.510)

A history of previous febrile seizure was positive in 18 patients (12.9%) with normal EEG and 24 patients (80%) with abnormal EEG and this difference was statistically significant ( $p < 0.001$ ). Also, family history of epilepsy was positive in 5.7% of patients with normal EEG and 43.3% of patients with abnormal EEG which was statistically significant ( $P$  value  $< 0.001$ ).

A family history of febrile seizure was positive in 27.1% of patients with normal EEG and 63.3% of patients with abnormal EEG. This difference was statistically significant ( $P$  value  $< 0.001$ ). There was also a significant difference between EEG findings with age and duration of seizures so that the mean age in the group with normal EEG report ( $27.25 \pm 14.7$  months) was significantly lower than in the group with abnormal EEG report ( $34.43 \pm 16.5$  months)  $p = 0.033$ . Also, the mean duration of seizures in the group with normal EEG report ( $3.44 \pm 2.0$  minutes) was significantly lower than in the group with abnormal EEG report ( $6.73 \pm 3.4$  minutes)  $p < 0.001$ .

A statistically significant relationship between the types of seizure (whether simple or complex) and the result of the EEG report was found. Thus, most patients with normal EEG had simple febrile seizures and most patients with abnormal EEG had complex febrile seizures.

[Table 2](#) shows the relation between EEG findings and study variables.

**Table 2. Relation of EEG findings and study variables**

Variable	Normal EEG	Abnormal EEG			P value
		Spike & sharp waves	Slow waves	Non specific	
<b>Sex</b>					
Boy	70 (50%)	15 (75%)	2 (100%)	5 (62.5%)	0.077
Girl	70 (50%)	5 (25%)	0 (0%)	3 (37.5%)	
<b>Delivery type</b>					
NVD	104 (74.3%)	16(80%)	1 (50%)	7 (87.5%)	0.673
Cesarean section	36 (25.7%)	4(20%)	1 (50%)	1 (12.5%)	
<b>Previous febrile seizure history</b>					
Negative	122 (87.1%)	5 (25%)	0 (0%)	1 (12.5%)	< 0.001
Positive	18 (12.9%)	15 (75%)	2 (100%)	7 (87.5%)	

Variable	Normal EEG	Abnormal EEG			P value
		Spike & sharp waves	Slow waves	Non specific	
<b>Family history of epilepsy</b>					
Negative	132 (94.3%)	14 (70%)	1 (50%)	2 (25%)	p < 0.001
Positive	8 (5.7%)	6 (30%)	1 (50%)	6 (75%)	
<b>Family history of febrile seizure</b>					
Negative	102 (72.9%)	8 (40%)	0 (0%)	3 (37.5%)	p = 0.001
Positive	38 (27.1%)	12 (60%)	2 (100%)	5 (62.5%)	
<b>Seizure type</b>					
Simple febrile seizure	130 (92.9%)	9 (45%)	0 (0%)	1 (12.5%)	p < 0.001
Complex febrile seizure	10 (7.1%)	11 (55%)	2 (100%)	7 (87.5%)	

According to [Table 1](#), the type of abnormal EEG findings have no statistically significant relationship with patients' gender (p value = 0.077) and the type of delivery (p value = 0.673).

There was also a statistically significant relationship between family history of epilepsy, the family history of febrile seizures, the type of seizure (simple or complex) with type of EEG findings (p value <0.001, p value = 0.001, p value <0.001 respectively).

## Discussion

In this study, 170 patients admitted into Mousavi Hospital from April 2015 to March 2016 were evaluated. Thirty (17.6%) patients had an abnormal EEG report and normal EEG was seen in 82.4% of cases which is different from the study of Shukla with 68% normal EEGs. (5) In the study of Joshi, 175 patients with complex febrile seizures, were evaluated and 39.43% showed abnormal ECG (15). In Maytal's study, 33 children were diagnosed with complex febrile seizures, 8.6% of whom had abnormal electroencephalography (16). In a study in Kermanshah, Iran, 111 patients with complex febrile convulsions were studied during 2 years. The electroencephalogram was abnormal in 37.8% of patients, epileptic waves were seen in 9% and 28.8% had nonspecific abnormal waves (17). The prevalence of abnormal EEG in different studies ranged from 2-86%, which depends on the time of performing electroencephalography and the presence of risk factors in different patients (18).

In the present study, a significant relationship was found between abnormal EEG report and male gender. This result is consistent with Nishiyama's study which showed that male sex is an independent risk factor for febrile seizure (OR: 1.21) (3). According to Hemmati's study, although abnormal EEGs were more common in girls (40%) compared to boys (34.15%), this difference was not statistically significant. These results are different from our results that showed abnormal reports

were more significantly seen in males. This difference may be due to different studied populations (17).

In our study, there was a significant relationship between abnormal EEG findings and older age. In the study of Joshi, age over three years and neurological impairment on examination were significantly associated with abnormal EEG (15). A study conducted for two years on 107 patients with febrile seizures in Tehran showed that older age increases the likelihood of an abnormal EEG (19). These results are consistent with our study.

We found a significant relationship between abnormal EEG findings and positive family history of febrile seizures and epilepsy, previous history of febrile seizures in the patient, complex febrile seizure and longer duration of seizures. These findings are consistent with the study of Khodapanahandeh in Tehran (19).

In Hemmati's study there was a significant relationship between abnormal EEG with family history of febrile seizures which is consistent with our study but unlike our study, he showed that family history of epilepsy was negative in individuals with abnormal EEG (17).

Our study showed abnormal EEG in 17.6% of reports; The most common (66.6%) was nonspecific changes followed by 26.6% for spike & sharp electric discharges and 6.6% for slow activity. The most common abnormal epileptiform discharges in Karimzadeh's study were 27.6% slow waves in the early EEG and 36% sharp waves in late EEG (20). The presence of specific changes in electroencephalography such as focal and pseudo petit mal discharges are helpful in predicting epilepsy and recurrent febrile seizure (13, 21).

In a study on 82 children aged 6-60 months with first febrile seizure, EEG abnormality was observed in 7.3% of patients with complex febrile convulsion and the study concluded that complex febrile convulsion is an important risk factor for epilepsy (22).

In a retrospective study in Poland on 103 FS children aged 5–55 months, the EEG was performed between the 3rd – 7th days. Abnormal EEG was reported in 29% of patients and a weak correlation was found between the EEG abnormalities and duration of seizures. EEG abnormalities were recorded in 37% of patients with recurrent FS, and in 27% of non-recurrent individuals. This study showed that abnormal EEG is involved in all types of FS but only in Complex FS an EEG exam is routinely recommended. (23). In this study in which EEG was performed at the same age and time of admission as our study, the frequency of abnormal EEG was higher than in our study, but similar to our results the abnormal EEG report was higher in complex febrile seizure.

## Conclusion

Febrile seizure is a benign condition in childhood for which EEG should not routinely be carried out. Due to the higher risk of abnormal EEG reports in patients with complex febrile seizures, developmental disorder and family history of epilepsy and febrile seizure and age over 3 years, this study recommends performing an electroencephalogram for patients with these risk factors.

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## Conflict of Interest

The authors declare that there is no conflict of interests.

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