

Is Cranial Imaging Necessary in Children with First-Time Focal Seizures?

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Received: 07.03.2023

Accepted: 05.07.2023

ABSTRACT

Objective: Seizures in children represent a common cause of admission to the emergency department. This study aimed to determine clinically significant intracranial abnormalities in children presenting to the pediatric emergency department with first-time focal seizures.

Methods: Patients aged 1 month-18 years, who presented to the pediatric emergency department with first-time focal seizures between 2009 and 2019, were retrospectively screened. Patients with a history of trauma, cases in which focal neurological signs could not be assessed, and patients with pre-existing structural brain or neurological abnormalities, and metabolic disorders were excluded from the study. Cranial computed tomography findings were re-evaluated by a pediatric radiologist. The fourth and fifth-level according to the classification of the International League Against Epilepsy were interpreted as urgent intracranial pathologies requiring medical or surgical intervention. The univariate analysis was performed using the chi-square test for categorical data and the Mann-Whitney U test for continuous data.

Results: The mean age of the 121 patients was 46.8±44.4 months, and 52.5% were male. Clinically significant emergency intracranial pathologies were detected in the neuroimaging of eight patients. Intracranial masses, bleeding, and hematomas were the most common pathologies. The presence of focal neurologic findings and an age below six months were clinically determined as predictors of an urgent intracranial pathology.

Conclusion: We found the rate of urgent cranial pathologies to be 6.6% in patients presenting to the emergency department following the first focal seizure. Children younger than six months with focal neurological signs should be evaluated for emergency neuroimaging.

Keywords: Children, computed tomography, emergency department, focal seizure

1. INTRODUCTION

Seizure is a very common condition among children, accounting for 4-10% of all pediatric neurological disorders (1). Approximately 10% of children have a seizure once in their lifetime (2). Most of these seizures are short-term, and more than 50% are focal seizures in children younger than two years (3,4). Most children with seizures present to emergency services, and the decision on whether neuroimaging is necessary in these patients varies according to the clinician. Studies have reported that the rate of large structural lesions in pediatric patients with new-onset seizures is between 0% and 21% (5-8). In the literature, the importance of neuroimaging for pediatric patients presenting with afebrile seizures remains a controversial issue (6). The American Academy of Neurology (AAN), the Child Neurological Society, and the American Epilepsy Society (AES) have also published guidelines on neuroimaging for the evaluation of a child with a non-febrile seizure. These guidelines indicate immediate neuroimaging for children with persistent postictal neurological deficits and those who do not return to their baseline neurological status within a few hours (9). Clinicians should decide whether to

perform emergency neuroimaging in selected cases based on medical history and physical examination findings to identify urgent intracranial pathologies. However, during this process, unnecessary neuroimaging and radiation exposure, risks associated with sedation, and side effects of contrast media should also be considered (9,10).

This study aimed to investigate the frequency of abnormal neuroimaging and to identify clinical variables that could predict clinically significant intracranial abnormalities in children who were evaluated by computed tomography and presented to the pediatric emergency department for the first time with focal seizures.

2. METHODS

For data collection, approval was obtained from the Clinical Research Ethics Committee of Keçiören Training and Research Hospital (2012-KAEK-15/2070), and official permission was received from the Medical Specialization Education Board of Health Sciences University Dr Sami Ulus Maternity and Child Health and Diseases Training and Research Hospital.

2.1. Population

The study was conducted in a tertiary pediatric emergency department between January 2009 and December 2019. Patients aged 1 month-18 years, who presented to the pediatric emergency department following the first focal seizure, were retrospectively screened using the computer registry system of the hospital.

2.2. Data Collection

All children that had a seizure with focal symptoms for the first time and underwent neuroimaging (Cranial Computed Tomography) within 24 hours of the seizure at the emergency department were included in the study. Excluded from the study were patients with a history of trauma, cases in which focal neurological symptoms could not be evaluated (e.g., intubated patients and those with pre-existing hemiparesis), patients with pre-existing structural brain or neurological abnormalities (e.g., tumor, stroke, hydrocephaly, arterio-venous malformation, and presence of ventriculoperitoneal shunt), those aged <1 month or >18 years, and those with metabolic disorders (e.g., hypoglycemia and hyponatremia).

Focal manifestations were defined as any recorded transient impairment of motor function, such as eye deviation, head deviation, and isolated limb twitching. The presence of Todd's paralysis following a generalized seizure was accepted as a focal symptom. Age, gender, seizure characteristics, neurological examination findings, and radiological results were evaluated.

Table 1. Classification of neuroimaging results (11)

Abnormality	Definition	Examples
(1) Non-specific	Lesions not requiring immediate intervention that may be responsible for seizure	Periventricular leukomalacia, generalized cerebral atrophy
(2) Static-remote	Non-progressive lesions of the central nervous system that occurred remotely in time	Porencephaly, other malformations of cortical development
(3) Focal	Focal lesions responsible for the seizure but not requiring immediate intervention	Focal cortical dysplasia, mesial temporal sclerosis
(4) Sub-acute or chronic	Process responsible for the seizure that does not require immediate intervention but has important therapeutic or prognostic implications	Brain tumor or mass, adrenoleukodystrophy
(5) Emergent	Acute process requiring immediate, urgent intervention	Ischemic stroke, cerebral hemorrhage, hydrocephalus, encephalitis, meningitis, metabolic cytopathy, cerebral edema, acute cerebral herniation, skull fracture with bleed, new hypoxic injury

The cranial Computed Tomography (CT) findings were screened from the radiological reports over the computer system. The findings were re-evaluated by a single pediatric radiologist who was

blinded to the patient's clinical history and results. Neuroimaging findings were evaluated according to the International League Against Epilepsy (ILAE) imaging guideline on new-onset epilepsies published in 2009 (11) (Table 1). According to this classification, the fourth and fifth-level seizures were interpreted as urgent intracranial pathologies requiring medical or surgical intervention.

2.3. Statistical Analysis

The Statistical Package for the Social Sciences for Windows version 23.0 software package was used for data analysis. The demographic and clinical data of the cases were expressed as mean and standard deviation using descriptive statistics, and frequency data were presented as numbers and percentages. The univariate analysis was performed using the chi-square test for the analysis of categorical data and the Mann-Whitney U test for continuous data. Statistical significance was calculated with a p-value of < .05. The radiological results were recorded as "normal brain CT" (normal and Class I – III findings) or "abnormal brain CT" (Class IV – V findings).

3. RESULTS

During the study period, cranial CT was performed in 121 patients who presented to the pediatric emergency department with febrile and afebrile focal seizures. The mean age of the patients was 46.8 ± 44.4 months, and 64 (52.5%) were male. Most patients (45.5%) were younger than 24 months. The patients' demographic characteristics are given in Table 2, and significant emergency neuroimaging findings are in Table 3. Clinically significant emergency intracranial pathologies were detected in the neuroimaging of eight patients. The characteristics of patients with and without clinically urgent intracranial pathologies are in Table 4. The risk of CT abnormalities was found to be significantly higher in patients with focal neurological findings ($p < .05$).

Table 2. Demographic characteristics of the patients presenting with focal seizures

Demographic data n (%)	
Age (mean \pm SD), month	46.8 \pm 44.4
1-12 months	39 (32.2)
13-60 months	42 (34.7)
61-132 months	32 (26.4)
133-215 months	8 (6.6)
Gender	
Female	57 (47.1)
Male	64 (52.9)
Seizure type	
Febrile seizure	59 (48.8)
Afebrile seizure	62 (51.2)
Seizure duration	
<5 minutes	34 (28.1)
5-15 minutes	46 (38)
\geq 15 minutes	41 (33.9)
Seizure recurrence (two or more)	
Present	77 (63.6)
Absent	44 (36.4)
Neurological examination findings	
Normal	115 (95)
Focal signs	6 (5)
The prolonged state of impaired consciousness	
Absent	109 (90.1)
Present	12 (9.9)

Table 3. Characteristics of the patients with abnormal brain CT findings

	Age	Gender	Number of seizures	Fever >38°C	Seizure recurrence within 24 hours	Focal neurological sign	The prolonged state of impaired consciousness	CT finding
1	169 months	Female	<5 min	Absent	Absent	Present	Absent	Intracranial mass
2	9 months	Male	10 min	Absent	Present	Present	Present	Epidural hematoma
3	55 months	Male	5 min	Absent	Present	Absent	Absent	Intracranial mass
4	4 months	Female	10 min	Absent	Present	Absent	Absent	Subdural hemorrhage
5	2 months	Male	<5 min	Absent	Present	Present	Absent	Subdural hematoma
6	66 months	Male	10 min	Absent	Absent	Absent	Absent	Intracranial cystic mass
7	37 months	Female	>15 min	Present	Present	Absent	Absent	Cerebral edema (meningoencephalitis)
8	3 months	Male	<5 min	Present	Present	Absent	Absent	Subarachnoid hemorrhage

CT: Computed Tomography

Table 4. Characteristics of the patients with and without clinically urgent intracranial pathologies

	Clinically urgent intracranial pathology present (n = 8)	Clinically urgent intracranial pathology absent (n = 113)	p-value	OR
Age	43.13 ± 56.75	47.1 ± 43.71	.317	
<24months ≥24 months	4 4	51 62	1.000	1.216
Gender (F/M)	3/5	53/60	1.000	1.132
Fever (≥38°C) Present Absent	2 6	57 56	.274	.327
Seizure recurrence within 24 hours (two or more)	6	71	.709	.563
Seizure duration <15 min ≥15 min	7 1	73 40	.263	3.83
Focal neurological sign	3	3	.004	22.00
Todd's paralysis	0	3	1.000	1.073
Prolonged state of impaired consciousness	1	11	.578	.75

OR: Odds Ratio

4. DISCUSSION

In this study, the data of 121 patients younger than 18 years, who had focal seizures for the first time, were retrospectively analyzed, and their demographic, clinical, and neuroimaging results were evaluated.

Despite the availability of relevant guidelines, there are still differences of opinion among physicians concerning which patients should undergo emergency cranial CT in clinical practice. Studies have concluded that routine emergency cranial CT is unnecessary in patients presenting with new-onset afebrile seizures, and the decision should be made based on the clinical history and neurological examination findings of each case (4,7,10).

In studies evaluating the neuroimaging findings of patients with seizures, it has been reported that prolonged seizure, focal seizure, and the presence of abnormal brain fog are risk factors for CT abnormalities (6,12,13). In the study conducted by Sharma et al. (7), evaluating patients presenting to the emergency department following the first afebrile seizure, clinically significant findings were found in 8% of patients on cranial CT. The authors determined that the presence of

focal seizures and age below 33 months were risk factors that indicated the necessity of cranial CT (7). In another study, the presence of multiple seizures and age lower than 24 months were reported to predict abnormal CT results (14).

There are only limited studies involving the evaluation of risk factors for CT abnormalities in pediatric patients presenting to the emergency department with focal seizures. In our study, clinically urgent intracranial pathologies were detected in eight (6.6%) patients on CT. In a previous study, Aprahamian et al. (15) detected the rate of urgent intracranial pathologies as 4.1% among patients presenting with focal seizures (infarction, bleeding, and thrombosis). The authors stated that the presence of focal seizures, Todd's paralysis, and age below 18 months predicted abnormal clinically urgent pathologies in neuroimaging, but the presence of multiple seizures was not one of the predictive factors (15).

Studies have reported that the younger age group is at a higher risk of having intracranial abnormalities in neuroimaging (7,12,16). In contrast, there are also researchers demonstrating that such abnormalities are not associated

with age (13,17). In our study evaluating focal seizures, when the results were compared between the children younger and older than 24 months old, no significant significance was found in terms of CT abnormalities ($p = 1.000$). However, emergency cranial CT was required in those younger than six months old [$p = .032$, odds ratio (OR): 6.93].

In studies conducted with patients with first-time afebrile seizures, the risk factors of intracranial abnormalities have been determined as long-term seizures, Todd's paralysis, and the presence of pathological neurological findings (11,18). In the current study, the risk of CT abnormalities was found to be significantly higher in the patients with focal neurological findings ($p = .004$; OR: 22.0). Todd's paralysis was not observed in any of the patients with CT abnormalities. The presence of multiple seizure was also not a predictive factor indicating the necessity of emergency cranial CT.

The American Academy of Neurology and the American Epilepsy Society recommend emergency neuroimaging in pediatric patients with first-time afebrile seizures in case of persistent postictal focal neurologic deficits or if the seizure does not return to baseline within a few hours (9). In our study, a nine-month-old male patient who presented to our emergency department following an afebrile focal seizure took a long time to return to the initial state after the seizure and had ongoing focal neurological findings. Among the remaining two patients with focal neurological findings, a subdural hematoma was present in a two-month-old male patient and an intracranial mass in a 169-month-old female patient.

In febrile seizures, children with focal and/or prolonged seizures have been reported to be more likely to have abnormal brain imaging findings. However, it has also been shown that most of these abnormalities do not affect the clinical management of patients (19). There are many studies demonstrating that complicated febrile seizures are less likely to have abnormal neuroimaging findings that require immediate medical or surgical intervention (20,21). Yücel et al. (22) evaluated the neuroimaging findings of children with complicated febrile seizures with postictal deficits and focal seizures and detected no emergency imaging findings in any of the patients. In another study conducted with children with complicated febrile seizures, emergency cranial CT findings were present in four cases with focal seizures or a prolonged state of impaired consciousness (23). In our study, CT findings requiring urgent treatment were detected in two patients with a fever, a three-month-old male patient with a subarachnoid hemorrhage and a 37-month-old female patient with cerebral edema due to meningoencephalitis and meningeal contrast enhancement.

Our study has important limitations. The first concerns the retrospective design and data being evaluated by screening patient files. Second, seizure characteristics may not have been adequately explained by parents, others witnessing the seizure and clinicians. Prospective multicenter studies with a large number of patients are needed to better define factors that may predict the need for emergency cranial CT in

patients presenting to the pediatric emergency department with focal seizures.

5. CONCLUSION

In this study, in which we evaluated patients who presented to the pediatric emergency department with first-time focal seizures and underwent cranial CT, we determined the rate of urgent intracranial pathologies as 6.6%. Emergency physicians should primarily exclude life-threatening intracranial pathologies that require immediate medical and surgical intervention in pediatric patients presenting with focal seizures. In our study, three infants younger than six months were seen presenting with focal seizures. Based on our data, similar to the literature, we recommend that emergency neuroimaging should be performed in children younger than six months who present with focal seizures and have focal neurological findings. Considering the negative consequences of unnecessary neuroimaging, such as radiation exposure, sedation, and cost, it is important to determine which children require this procedure by evaluating their medical history and physical examination findings.

Funding: The author(s) received no financial support for the research.

Conflicts of interest: The authors declare that they have no conflict of interest.

Ethics Committee Approval: This study was approved by Ethics Committee of Keçiören Trainin Hospital (approval date 2021 and number: KAEK-15/2070)

Peer-review: Externally peer-reviewed.

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Acquisition of data for the study: AT, BÖ, İB, AAÇ, AG, CDK

Analysis of data for the study: AT, EA, ASE, CDK, NT

Interpretation of data for the study: AT, EA, ASE, CDK, NT

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Final approval of the version to be published: AT, BÖ, İB, AAÇ, AG, ASE, CDK, NT

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How to cite this article: Tekeli A, Öztürk B, Bodur İ, Akça Çağlar A, Göktuğ A, Atasoy E, Ekşioğlu AS, Karacan CD, Tuğgun N. T1s Cranial Imaging Necessary in Children with First-Time Focal Seizures?. *Clin Exp Health Sci* 2024; 14: 183-187. DOI: 10.33808/clinexphealthsci.1261327