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Emergency brain imaging findings in children with first afebril convulsion

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Abstract

Convulsion is the most common neurological disease seen in childhood and constitutes 4-10% of all neurological diseases and 2% of the admissions to child emergency rooms. While the primary purpose of performing emergency neuroimaging in a child presenting with the first afebrile convulsion is to investigate intracranial pathologies that may require urgent intervention. The cranial imaging to be performed for this purpose are transfontanellar ultrasonography, computed tomography, and magnetic resonance imaging. We aimed to evaluate the necessity, the contribution to diagnosis, and the effect of treatment of magnetic resonance imaging that was performed in the emergency rooms. Patients who were admitted to the pediatric emergency room for a one-year complaint of their first afebrile convulsion and performed brain magnetic resonance imaging in the pediatric emergency room within the first 24 hours of hospital admission were evaluated retrospectively. A statistically significant correlation was found between the abnormal magnetic resonance imaging and abnormal physical examination of the patients ($p<0.001$). By the brain magnetic resonance imaging findings acute changes were made in the treatment of 7 cases (1.3%) There was no statistically significant relationship between the magnetic resonance imaging abnormality and emergency seizures. We determined that it would be more appropriate to perform magnetic resonance imaging in outpatient clinics in cases where transportation can be provided early, in cases above 6 years of age without risk factors, and have a normal examination. Nonetheless, higher magnetic resonance imaging rates lead to lower computed tomography rates and ıts beneficial for pediatric patients in limiting radiation and providing definitive structural imaging for seizures.

Keywords: Convulsion, emergency imaging, children, MRI

Introduction

Convulsion is a temporary symptom and findings that results from abnormal sudden neuronal discharge in the brain. The diagnosis is based on a clinical basis. It is the most common neurological disease seen in childhood and constitutes 4-10% (under 2 years this rate may increase up to 5%) of all neurological diseases and 2% of the admissions to child emergency rooms (ER) [1,2]. It is also the most common neurological emergency in children that cause high anxiety in families. While the primary purpose of performing emergency neuroimaging in a child presenting with the first afebrile convulsion is to investigate intracranial pathologies that may require urgent intervention, secondly neuroimaging may be used to predict seizure recurrence and assist with the diagnosis of epilepsy [3,4]. The cranial imaging to be performed for this purpose are transfontanellar ultrasonography (USG), computed tomography (CT), and magnetic resonance imaging (MRI). Transfontanellar ultrasonography (USG) can be performed in infants with open fontanelle and it can detect hypoxic-ischemic damage, vascular anomaly, or brain anomalies. Computed tomography (CT) is usually the first choice because it is easy to access and easy to use in pediatric patients. Its sensitivity is approximately 30% in determining the etiology, it may be useful in detecting intracerebral hemorrhage, abscess, major vascular malformation, calcification, and ventriculomegaly however its sensitivity is low in small tumors, minor vascular malformations, cortical anomalies, and evaluation of the myelination. Therefore it should not be the first choice in determining the etiology of convulsion. However, the risk of radiation exposure in infants and young children should be considered when using CT, which is thought to potentially cause 122 cancers per 100.000 children scanned [5]. Magnetic resonance imaging (MRI) is the preferred imaging modality because it is more sensitive than CT in cortical dysplasia, mesial temporal sclerosis, vascular malformation, and

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cerebral dysgenesis [1-6]. The American Academy of Neurology (AAN) suggests emergent neuroimaging in child patients that are aged <6 months, that have their first convulsions, focal seizure, hydrocephalus, new cerebrospinal shunt surgery, neuro-cutaneous disease, persistent altered mental status or new head trauma history [7-9].

Numerous studies have been conducted on the necessity and contribution of neuroimaging performed in the ER and how much it has changed emergency treatment [6-16]. The patients were evaluated who undergo cranial MRI in the ER after the first afebrile convulsion. We aimed to evaluate the necessity, the contribution to diagnosis, and the effect on the treatment of MRIs that were performed in the ERs.

Material and Methods

Patients who were admitted to the pediatric ER for one year, due to their first afebrile convulsion and performed brain MRI in the pediatric ER within the first 24 hours of hospital admission were evaluated retrospectively. MRI was performed in patients who did not require sedation or for the confirmation of the lesion in CT because it is more sensitive in detecting the convulsion etiology and it does not contain radiation.

The patients between 1 month and 18 years old who had undergone their first afebrile convulsion without trauma, infection, chronic illness, recognized drug use, evidence of a previous febrile/afebrile convulsion, an electrolyte imbalance such as hypoglycemia, hypocalcemia, etc. were included the study.

Demographic data, neurological examination, convulsion semiology, and duration, past medical history of the patients were recorded. The convulsion semiology was taken from the patient's relatives who had neurology outpatient clinic administrations. The convulsion duration was classified as emergency seizures as continuing at the time of admission to the ER or recurrence in ER. Those who were diagnosed with status epilepticus were not included in the study because they were followed up in the inpatient clinics after the emergency treatment and MRIs were performed in these clinics. The emergency MRI/CTs were interpreted by a usual radiologist.

MRI examınations at both primary sites were performed on a 1.5 Tesla Siemens Aera scanner The protocol consisted of the following scanning sequences; sagittal T1 weighted spin echo, slice thickness =1.0mm, axial T2 weighted fast spin echo, coronal oblique fast fluid-attenuated inversion recovery (FLAIR), axial diffusion-weighted single-shot spin echo echoplanar. Continuous variables were expressed as mean ± standard deviation, and categorical variables were expressed as frequency and percentage. Two independent categorical variables were evaluated with the chi-square statistics. The statistical significance level was determined as $p<0.05$. The study was approved by the hospital's institutional review board. The ethics committee approved by the Sadi Konuk Research and Education Hospital ethics committee as number 2019-14-12.

Results

A total of 534 patients including 353 males (66%), and 181 females (34%) were included in the study. The mean age of the patients was 7.8±5 years (1 month-18 year). The number of cases under the age of 6 was 92 (17.2%). There were abnormal neurological examination findings in 41 cases (7.7%), and the majority of those with abnormal physical examination were younger than 6 years (78.0%).

The abnormal neurological examination findings were as follows: Psychomotor retardation (80.4), prolongation of postictal confusion (9.7%), hemiparesis (2.4%), unilateral 6th cranial nerve paresis (2.4%), nausea-vomiting (2.4%) and aphasia (2.4%) Table 1. MRI abnormalities were detected in 24 (4.5%) of the patients with an abnormal neurological examination. Moyamoya disease in the case with hemiparesis, tumor in 1 case with nausea and vomiting, hydrocephalus in the case with 6th cranial nerve paresis, medial cerebral artery (MCA) infarction in the case with aphasia, diffusion restriction- cytotoxic edema compatible with the neurometabolic disease in 2 cases with prolonged confusion, periventricular leukomalacia in 7 cases, cerebral atrophy in 3 cases, encephalomalacia in 3 cases, gliosis in 2 cases, cerebral dysgenesis in 2 cases and abnormal myelination in 1 case were detected in MRG (Table 1).

Table 1. Demographic features and results (MRI: Magnetic resonance imaging)

Total number of the patients	**534**
Gender	353 (66%) male.181 (34%) female
The mean age	7.8±5 years
Brain MRI	475(89%) Normal
	59 (11%) Abnormal
Cases with abnormal neurological examination findings	41 (7.7%)
	Psychomotor retardation 80.4%
	Confusion 9.7%
	Hemiparesia 2.4%
	Cranial nerve palsy 2.4%
	Nause-vomiting 2.4%
	Aphasia 2.4%
Abnormal MRI+Abnormal neurological examination findings	24 (4.5%)
	Periventricular leucomalasia 29%
	Cerebral atrophy 12.5%
	Encephalomalasia 12.5%
	Neurometabolic disease 8%
	Gliosis 8%
	Disgenezis 8%
	Moyamoya disease 4%
	Tumor 4%
	Hydrocephalus 4%
	Stroke 4%
	Abnormal myelination 4%
Abnormal MRI+Normal neurological examination results	35 (6.5%)
	Periventricular leucomalasia 28.5%
	Gliosis 28.5%
	Disgenezis 11.5%
	Atrophy 8.5%
	Encephalomalasia 8.5%
	Tumor 6%
	Abnormal myelination 6%
	Hydrocephalus 3%
Normal MRI+Abnormal examination findings	17 (3%)
	Psychomotor retardation 88%
	Confusion 12%
Normal MRI+Normal examination	458 (86%)
Seizures	Generalized tonic-clonic 73%
	Generalized tonic 11%
	Focal seizures 15%
	Hypomotor 3%
Emergency seizure	71 (13%)
Emergency seizure+Abnormal MRI	11 (15%)

A statistically significant correlation was found between the abnormal MRI and abnormal physical examination of the patients (p<0.001). Physical examination of most of the patients with normal MRI was found to be normal (86%).

Brain MRI was normal in 89% of the patients (n=475) and abnormal in 11% (n=59). The pathological MRI findings included periventricular leukomalacia (n=17), gliosis (n=12), dysgenesis (n=6), cerebral atrophy (n=6), encephalomalacia (n=6), tumor (n=3), abnormal myelination (n=3), hydrocephalus (n=2), diffusion restriction compatible with hereditary metabolic disease (n=2) and arteriovenous pathology (n=2).

The number of cases with abnormal neurological examination and abnormal MRI was 24 (4.5%), whereas there were 17 (3%) cases with abnormal neurological examination findings with normal MRI. In the cases with normal neurological examination but abnormal MRI 35 (6.5)%; there were 10 patients with periventricular leukomalacia, 10 with gliosis, 4 with cerebral dysgenesis, 3 with cerebral-cerebellar atrophy, 3 with encephalomalacia, 2 with tumor, 2 with abnormal myelination and 1 with hydrocephalus. Neurological examination findings of those with normal MRI and abnormal neurological examination showed psychomotor retardation in 15 cases and prolonged postictal confusion in 2 cases. Following the brain MRI findings, acute changes were made in the treatment of 7 cases (1.3%) which included 2 vascular malformations, 3 tumors, and 2 neurometabolic diseases. Table 1

There was a history of generalized tonic-clonic seizures in 73% of the cases, whereas generalized tonic seizures were seen at 11%, focal seizures in 15%, and hypomotor seizure history in 3 cases. The number of patients whose seizures were continuing when admitted to the ER was 17 (3%) and 54 (10%) had recurrent seizures in the ER those who had continuing seizures despite treatment in the ER were accepted as status epilepticus and these cases were not included in the study. Abnormality in MRI was detected in 3 (4%) cases of patients who had seizures when they arrived at the ER and in 8 (11%) cases of patients who had recurrent seizures in the ER. There was no statistically significant relationship between the MRI abnormality with emergency seizures (p=0.182).

Discussion

Seizure accounts for 2% of all pediatric ER admissions [5]. Neuroimaging is required for detecting congenital structural anomalies such as cortical dysplasias, vascular malformations, or acquired structural anomalies such as neoplasm, infarction, traumatic injury, or acute detectable tissue changes like neurometabolic diseases, infectious or autoimmune encephalitis. In these situations, the importance of neuroimaging is critical in making a diagnosis, detecting complications, and guiding specific medical or surgical treatments [8-15].

Although the number of applications to ERs in our country is increasing day by day. In our study, we aimed to evaluate the choice, necessity, and effect of the imaging method in emergency conditions in children who applied to the ER with their first afebrile convulsions. For this purpose, we evaluated the results of MRI performed in the ER on children who applied to the ER with their first afebrile convulsion.

The mean age of the patients was 7.8±5 years. The number of cases <6 years was relatively low because MRI has a sedation requirement. At the time of application; 41 cases (7.7%) had abnormal examination findings. The abnormal examination has been reported between 10-23% [8-16] and we found a lower rate in our study (7.7%), which may be associated with our higher average age. It has been reported in studies that the probability of detection of pathology increases as age decreases. Thirty-two (78%) were under the age of 6 years [8,16]. We detected abnormal examination findings that increased the risk of abnormality in MRI (p<0.001).

Generalized tonic-clonic seizures were seen mostly (73%). The results were similar to Muthuraja et al. study [17]. In studies conducted in childhood [5-16], the rate of generalized tonic-clonic seizures was found to be lower than in our study, this may be because the seizure semiology anamnesis was taken from relatives and the secondary generalizations with focal onset could not be evaluated. There was no absence or myoclonic seizure. There was no statistically significant relationship between the MRI abnormality and emergency seizures (p=0.182). Including the patients with status, epileptics could change this relationship.

Brain MRI was normal in 89% of the patients (n=475) and abnormal in 11% (n=59). In studies [6-12,18-25], the rate of abnormality detected when CT and MRI were used together was between 6.6-33%; whereas it increases up to 59% <2 years of age (9) and up to 47% [25] when only MRI was performed. In our study, this rate was found to be 11% and is consistent with the literature but lower than only MRI studies. Not including the status epilepticus cases in our study may have reduced the anomaly rate but we aim to evaluate the need and importance of MRI performed in the ERs. At the same time, non-significant anomalies such as ventricular enlargement, small arachnoid cysts, etc. which were mentioned in previous studies [18-25] were not included in our study and this also decreased the rate of anomalies. As in the studies by Shinnar and Mohammadim et al. [10,11] encephalomalacia, dysgenesis and gliosis were the most common anomalies. Mesial temporal sclerosis which was reported in a limited number of studies to be 5-7% [10,11] was not detected in our cases. Acute seizure presentation of demyelinating pathologies is rare and in our study, we did not detect any demyelinating pathology [26-28].

The treatment change was given between 1-8% following the findings of the emergency brain MRI [7-14] and in our study, we found this rate as 1.3%. Acute change in the treatment in 7 cases including 2 vascular malformations, 3 tumors, and 2 neurometabolic diseases were performed.

Children with seizures are more likely to undergo head CT at general ERs compared with pediatric ERs. Cain et al. determined that the frequency of emergency imaging is higher in general ERs and the low rate of positive findings supports the need for an evidence-based clinical decision tool for neuroimaging in the acute care setting [29]. Amagasa et al. recommended that; the clinician could determine the necessity of neuroimaging by seizure cluster, prolonged seizure, focal seizure, and abnormal neurological examination [30]. We detected abnormal examination findings is increased the risk of abnormality in MRI. The patients who have prolonged seizures or seizure clusters were followed up in the inpatient clinics after the emergency treatment and MRIs were performed in these clinics. We included the study cases whose

seizures ended with therapy in ER and we didn't find a statistically significant relationship between the MRI abnormality with these cases.

Conclusion

The presence of abnormal neurological examination was found to be the most important predictive factor for emergency neuroimaging in the patient who applied with the first afebrile convulsion. Neuroimaging is necessary in all of the cases who presented with afebrile convulsion because neurological examinations were normal in two patients with a brain tumor. When the facts such as the impossibility of MRI in the special protocols in emergency conditions, the fact that an experienced pediatric neuroradiologist can not evaluate the imaging, and considering the burden it will add to the ER workload. We determined that it would be more appropriate to perform MRG in outpatient clinics in cases where transportation can be provided early, in cases above 6 years of age without risk factors, and have a normal examination. Nonetheless, higher MRI rates lead to lower CT rates and ıts beneficial for pediatric patients in limiting radiation and providing definitive structural imaging for seizures.

Conflict of interests

The authors declare that there is no conflict of interest in the study.

Financial Disclosure

The authors declare that they have received no financial support for the study.

Ethical approval

Ethics approved by Bakırköy Sadi Konuk and Research Hospital Ethisc Committe ;number is :2019-14-12.

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