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RESEARCH ARTICLE

Evaluation of neuroimaging findings in children who admitted to pediatric emergency clinic with acute neurologic complaints

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ABSTRACT

Aim: Acute neurological complaints are one of the reasons why children present to pediatric emergency departments. Neuro-imaging techniques gain more importance in children since physical examination and anamnesis do not provide sufficient information due to insufficient cooperation. We aimed to determine the distribution of patients who applied to the pediatric emergency department with non-traumatic acute neurological complaints and underwent neu-roimaging, and the clinical benefit of neuroimaging in these patients.

Methods: The information and records of the patients who applied to the Konya City Hospital Pediatric Emergency Clinic between January 1 and October 1, 2022, due to acute neurological complaints and underwent neuroimaging were retrieved and analyzed retrospectively. Acute neurological complaints of the patients were classified according to the International Classifi-cation of Diseases-10 diagnostic coding.

Results: This study included 180 (50.5% male) patients. The median age of the patients was 120 (interquartile range: 45-180) months. Afebrile convulsion was the most common reason for admission in 69 patients (38.3%). Cranial computed tomography (CCT) was performed in all 180 patients. Of the patients, 68 (37.8%) only underwent CCT scan, while 90 (50%) had diffusion magnetic resonance imaging (MRI), 20 (11.1%) had brain+diffusion MRI, and 2 (1.1%) had brain+diffusion+spinal MRI. Neuroimaging abnormalities were statistically higher in patients with abnormal physical examination findings than in patients with normal physical examination findings ($p<0.001$).

Conclusion: Neuroimaging results are mostly normal even in the presence of symptoms such as seizures, headaches, and impaired consciousness. Therefore, neuroimaging should be planned by considering not only the acute neurological complaint on admission but also the physical examination findings.

Keywords: acute neurological complaints, neuroimaging, pediatric emergency

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INTRODUCTION

Emergency outpatient clinics have high patient admission rates and require urgent diagnosis and planning of treatment approaches based on the patient's physical, social, and psychological conditions (1). Acute neurological complaints such as seizures, acute changes in consciousness, headache, and acute neurological deficits are among the reasons why pediatric patients apply to pediatric emergency outpatient clinics (2). Initiating the necessary treatment to prevent or minimize acute brain damage in patients who apply to the pediatric emergency outpatient clinic with acute neurological complaints as soon as possible requires an accurate and rapid approach. The first thing to do is obtain a detailed medical history and perform a physical examination. However, laboratory tests and imaging techniques gain more importance in pediatric patients since physical examination and anamnesis do not provide sufficient information due to insufficient cooperation. Today, many imaging techniques, such as direct radiography, ultrasonography (USG), cranial computed tomography (CCT), and magnetic resonance imaging (MRI) are used in the evaluation of central nervous system (CNS) diseases. The patient's clinical picture, age, pre-diagnosis, and the physical conditions of the hospital are determinants in the decision of the imaging techniques (3,4). CCT is very successful in evaluating brain anatomy and pathology and is the first-line imaging technique in life-threatening conditions that require immediate intervention, such as brain tumors, head trauma, cerebral hemorrhage, and hydrocephalus. However, despite its clinical importance and widespread use, CCT contains high radiation, and the risk of radiation-induced malignancy may be higher in young children than in adults (5,6). Therefore, CCT should be used only when necessary. Besides brain CT, structural abnormalities, neuro-metabolic diseases, and tumors are also visualized using MRI. However, the use of MRI in urgent clinical evaluation is limited due to its high cost, long scan time, and the possible need for anesthetic sedation.

This study aimed to determine the distribution of patients who applied to the pediatric emergency outpatient clinic with non-traumatic acute neurological complaints and underwent neuroimaging (cranial MRI, spinal MRI, CCT, USG, etc.), according to indications, the frequency of emergency intervention (medical/surgical) due to abnormal clinical and radiological findings, and the clinical benefit of neuroimaging in these patients, as well as the frequency of excessive and unnecessary use.

MATERIAL AND METHOD

In this study, the information and records of the patients who applied to the Konya City Hospital Pediatric Emergency Outpatient Clinic between January 1 and October 1, 2022, due to non-traumatic acute neurological complaints and underwent neuroimaging were retrieved from the hospital automation system and analyzed retrospectively.

Acute neurological complaints of the patients were classified as syncope, acute altered consciousness, headache, seizure, and acute neurological deficit according to the International Classification of Diseases-10 (ICD 10) diagnostic coding. The age, gender, time of admission, complaint on admission, accompanying symptoms, previous diseases, physical examination findings, neuroimaging results reported by radiology, consultation reports of related branches, diagnoses, and surgical or medical treatments applied, were retrieved from the patient record system and files of the patients included in the study.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics Version 22.0 for Windows statistical software package (IBM Corp., Armonk, NY). Numbers and percentages were reported for discrete variables; continuous variables were expressed as mean and standard deviation for data with normal distribution and as the median and interquartile range (IQR) for non-normally distributed data. The chi-square (X2) test was used to compare nonparametric data; the Mann–Whitney U test was used to compare non-normally distributed continuous data and the independent samples t-test for normally distributed continuous data. The P value < 0.05 was considered statistically significant.

RESULTS

A total of 269 patients who applied to the Pediatric Emergency Department of our hospital between January 1 and October 1, 2022, with acute neurological complaints and underwent neuroimaging were identified. Of these patients, 89 were excluded due to the lack of information in the patient record system and suspected trauma history. The present study included 180 patients, 91 of whom were male (50.5%). The median age of the patients was 120 (interquartile range: 45-180) months.

Afebrile convulsion was the most common reason for admission to the emergency department in 69 patients (38.3%). This was followed by headache in 36 (20%) patients and febrile convulsions in 34 (18.9%) patients (Table 1). Of the patients, 154 (85.6%) applied to the emergency outpatient clinic outside working hours.

Abnormal physical examination findings were recorded in 36 patients (20%). These findings were confusion in 25 patients (13.9%), speech disorder + limb weakness in four patients (2.2%), peripheral facial paralysis in three patients (1.7%), double vision in two patients (1.1%), neck stiffness in one patient (0.6%), limb weakness in one patient (0.6%), and ataxic gait + speech disorder in one patient (0.6%). Neuroimaging results were abnormal in 13 (36%) of 36 patients with pathological physical examination findings, whereas neuroimaging results were abnormal in only three (2%) of 144 patients with normal physical examination findings. Neuroimaging abnormality was statistically higher in patients with abnormal physical examination findings than in patients with normal physical examination findings ($p<0.001$).

Table 1. Characteristics of patients.

Age (month)	
Median (interquartil range)	120 (45-180)
Sex, n(%)	
Male	91 (%50.5)
Female	89 (%49.5)
Acute neurological complaints, n(%)	
Afebrile seizure	69 (%38.3)
Headache	36 (%20)
Febrile seizure	34 (%18.9)
Acute change in consciousness	32 (%17.8)
Acute neurological sequelae	9 (%5)
Physical examination findings, n(%)	
Normal	144 (%80)
Abnormal	36 (%20)

CCT was performed in all 180 patients. Of these patients,68 (37.8%) underwent CCT scan only, while 90 (50%) had diffusion MRI, 20 (11.1%) had brain+diffusion MRI, and two (1.1%) had brain + diffusion + spinal MRI.

Analysis of patients' imaging results according to their complaints on admission

Neuroimaging results of patients presenting with afebrile convulsions

A CCT scan was requested for all 69 patients, and 7 (10.1%) of them displayed abnormal findings. Of the seven patients, three had ventriculoperitoneal shunt dysfunction, two had hydrocephalus, one had Dandy-Walker malformation, and one had cerebral atrophy. Diffusion MRI was performed in 44 (63.7%) of these patients, diffusion + brain MRI was performed in 10 (14.5%) patients, and abnormalities were detected in nine of them. Seven of the nine patients were patients who previously had abnormalities on the CCT scan. The other two patients had normal CCT, one had posterior reversible encephalopathy syndrome (PRES) on brain and/or diffusion MRI, and the other had an arteriovenous malformation. Three patients with ventriculoperitoneal shunt dysfunction underwent emergency surgery.

Neuroimaging results of patients presenting with headache

CCT was performed in all 36 patients and abnormal findings were observed in one (2.8%) patient. This patient had an intracranial mass. Eleven of the patients had diffusion MRI, and two of them had brain+diffusion MRI. Abnormalities were detected in two of these patients. One of the patients was the patient with a CCT showing abnormality. The other patient had a

normal CCT, exhibited an increase in the amount of CSF around the optic nerve on brain+diffusion MRI, and was later diagnosed with idiopathic intracranial hypertension. The patient with an intracranial mass underwent emergency surgery.

Neuroimaging results of patients presenting with complicated febrile convulsions:

All 34 patients underwent CCT and 16 patients underwent CCT+diffusion MRI. None of the patients exhibited abnormal findings.

Neuroimaging results of patients presenting with acute altered consciousness

Of the 32 patients who were diagnosed with syncope by history and physical examination, all underwent CCT, 16 had CCT+diffusion MRI, and 2 had CCT+diffusion MRI+brain MRI. None of the patients had abnormal findings. All eight patients who presented with acute altered consciousness without syncope underwent CCT. Bleeding was detected in one patient. CCT+diffusion MRI was performed in six patients, and acute ischemia was detected on the diffusion MRI in one of these patients. CCT+diffusion MRI+brain MRI were performed in two patients, and demyelinating plaques were detected on the brain MRI in one of the patients.

Neuroimaging results of patients presenting with acute neurological deficit

All nine patients underwent CCT+diffusion MRI, and five patients underwent CCT+diffusion MRI+brain MRI. Acute infarction was detected in one of the patients on diffusion MRI and brain MRI.

The rates of abnormalities in neuroimaging results according to the patients' complaints on admission are summarized in Figure 1.

DISCUSSION

In acute neurological conditions, the aim of the emergency services should be to make an accurate and rapid diagnosis, initiate treatment immediately, and ensure that neuronal loss or damage is as much as possible (3). The lack of cooperation in most children necessitates laboratory tests and neuroradiological imaging methods in addition to anamnesis and physical examination findings.

In our study, the most common complaint on admission was afebrile convulsion, which was seen in 38.3% of the patients. Epilepsy is a predisposition to recurrent seizures. Epilepsy is the occurrence of at least two seizures without a demonstrable cause and recurs for more than 24 hours, and reflex seizures are included in this definition (7). Emergency CCT imaging is recommended by the American Academy of Neurology in cases of prolonged post-ictal period or focal neurological deficit in children who have had a febrile seizure for the first time (8). A previous cohort study of 155 pediatric patients reported that CCT was performed in 46.5% of patients presenting with a first afebrile seizure. CCT results were normal in 87.5% of these patients. While clinically significant findings (left-sided intracranial calcification and encephalomalacia, subependymal nodules, and focal cerebral edema)

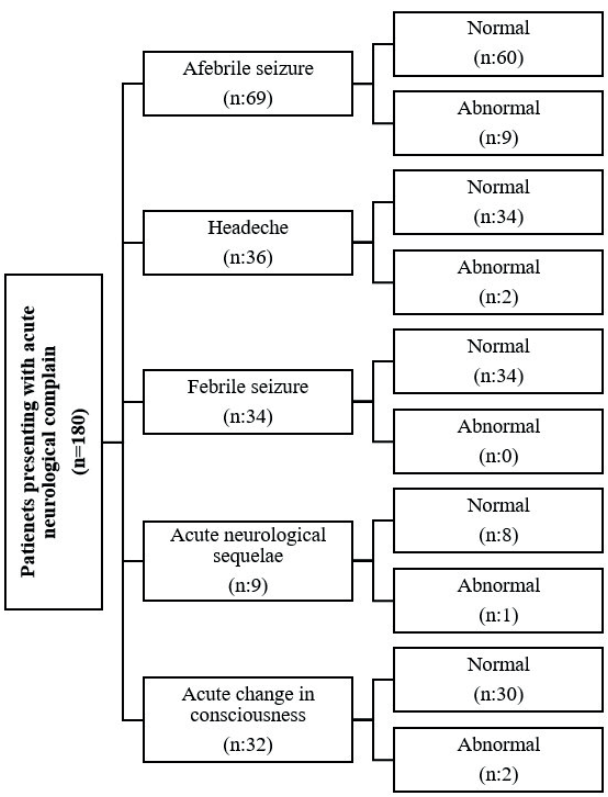

Figure 1. Neuroimaging results of patients presenting with acute neurological complaints.

were observed in three patients who had brain CT findings, nonspecific findings were reported in six patients (9). In our study, 38.3% of the patients who underwent neuroimaging presented with a first afebrile seizure. All patients underwent CCT, three had ventriculoperitoneal shunt dysfunction, two had hydrocephalus, one had Dandy-Walker malformation, and one had cerebral atrophy. Diffusion MRI was performed in 44 (63.7%) patients, and diffusion+brain MRI was performed in 10 (14.5%) patients. Anomaly was detected in nine of these patients. Seven of the nine patients were patients with CCT-identified abnormalities. The other two had normal CCT, one had posterior reversible encephalopathy syndrome (PRES) on brain and/or diffusion MRI, and the other had an arteriovenous malformation. None of the patients who presented with the complaint of seizures without any known central nervous system pathology required emergency surgical intervention. In these cases, a brain MRI may be more useful in elective conditions instead of a CCT.

In our study, another complaint that required neuroimaging was headache. The incidence of headache has increased significantly over the past 30 years (10). It is more common in girls and between the ages of 13-19 (11). The International Headache Society (IHS) classification system classifies headaches into two main groups, primary and secondary headache disorders. Primary headache has no underlying cause and is the most common headache in childhood. Headache that develops due to an underlying disease is defined as secondary headache. Although the use of neuroradiological imaging is not recommended for recurrent headaches in children with normal neurological examinations, it is often used to rule out intracranial pathologies and to alleviate the concerns of families (12). In our study, 20% of the patients who underwent neuroimaging had headache complaints. CCT was performed in all patients, and an abnormal finding (intracranial mass) was detected in only one patient (2.8%). Eleven of the patients had diffusion MRI, and two of them had Brain+Diffusion MRI. Abnormalities were detected in two of these patients. One of the patients had a CCT showing an abnormality. The other patient had a normal CCT, exhibited an increase in the amount of CSF around the optic nerve on brain+diffusion MRI, and was later diagnosed with idiopathic intracranial hypertension. In the literature, brainstem glioma was found in only one of 58 pediatric patients who applied to the pediatric emergency department and underwent CCT due to the possibility of secondary headache based on history and physical examination (13). Another study reported that 75.1% of pediatric patients admitted to the emergency department with the complaint of headache had normal brain MRI results. Among patients with abnormal findings, the most common symptoms were sinusitis 7.2%, pineal cyst 2.4%, arachnoid cyst 1.9%, and Chiari malformation (14). Our study and previous studies have shown that the majority of patients who applied to the pediatric emergency outpatient clinic with a complaint of headache and underwent neuroimaging had normal neuroimaging results. This highlights the need for guidelines on which patients presenting to the pediatric emergency outpatient clinic with a complaint of headache should undergo neuroimaging.

According to the International League Against Epilepsy (ILAE), the most common type of seizure in childhood and the most frequent cause of emergency admission is febrile seizure (7). It is a type of seizure accompanied by fever that occurs between the ages of 6 months and 6 years, without a known cause such as severe electrolyte-metabolic disorder, infection, trauma, or poisoning, and without a previous history of afebrile seizures. Of the febrile seizures, 20-30% are complicated febrile seizures, and neuroradiological imaging is decided in these patients after a detailed clinical evaluation (15). Generally, febrile seizures are not associated with intracranial pathologies (16). Although neuroimaging is not recommended in patients presenting with the first simple febrile seizure, there is no guideline for complicated febrile seizures (17). In our study, all patients who underwent neuroimaging due to complicated febrile seizures had normal findings, suggesting that neuroimaging is not essential in these patients.

Syncope is a common cause of altered consciousness. It is particularly common in children over 10 years of age and its incidence is almost twice as high in girls compared to boys (18). In our study, 24 (75%) of 32 patients presenting with acute altered consciousness were suspected to have syncope, but neuroimaging results of these patients were found to be normal.

Consistent with our study, the literature also shows that the CCT findings of the patients who presented to the emergency clinic and were diagnosed with syncope due to acute altered consciousness were indeed normal (19). While EEG is routinely recommended in cases of unexplained syncope in the literature, neuroimaging techniques are recommended only in cases with focal neurologic findings, a history of trauma, or suspected epilepsy (20). On the other hand, of the eight patients who were still unconscious when they were admitted to the emergency department, one had intracranial hemorrhage, one had acute ischemia and one had multiple demyelination plaques. The literature has shown that cranial MRI contributes to the treatment of more than three-quarters of children presenting to the pediatric emergency department with prolonged non-traumatic consciousness changes and may be preferred in acute non-traumatic coma (21).

Another group of patients in our study were those with acute neurological deficits. According to the neuroimaging results, the findings were consistent with acute infarction in one out of nine patients, and the other patients were evaluated as normal. The physical examination findings were found to be normal at the end of the 8-hour emergency follow-up period in all patients who had normal neuroimaging results.

Neuroimaging abnormality was statistically higher in patients with abnormal physical examination findings than in patients with normal physical examination findings. In light of these data, it is clear that neuroimaging contributes significantly to the diagnosis and treatment of patients with abnormal physical examination findings.

The weakness of our study is that there may be subjective findings and interpretations in the physical examinations due to the evaluation of the patients by different doctors. The strength of our study is that it was conducted in a tertiary health center with a rich diversity of patients.

In conclusion, CCT is the most frequently used examination method in the evaluation of acute neurological problems in our pediatric emergency department, followed by brain MRI. Neuroimaging results are mostly normal even in the presence of symptoms such as seizures, headaches, and impaired consciousness. Regardless of the cause, the fact that neuroimaging is normal in most patients suggests unnecessary and excessive use. Therefore, neuroimaging should be planned by considering not only the acute neurological complaint on admission but also the physical examination findings.

Ethical approval

This study has been approved by the University of Karatay (approval date 23/12/2022, number E-2022/008). We did not collect any data that could be used to identify patients. As this was a non-interventional retrospective study, informed consent forms were considered not necessary.

Author contribution

Concept: HÇ, İÖ, NB, HKÖ; Design: HÇ, İÖ, NB, HKÖ; Data Collection or Processing: HÇ, İÖ, NB, HKÖ; Analysis or Interpretation: HÇ, İÖ, NB, HKÖ; Literature Search: HÇ, İÖ, NB, HKÖ; Writing: HÇ, İÖ, NB, HKÖ. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

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