

ORIGINAL ARTICLE

Prevalence of positive findings of brain computed tomography scans in pediatric population

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Abstract

Objectives

Computed tomography (CT) scans are used more frequently in medical centers, increasing unnecessary requests for it as a first-line evaluation. This study aimed to investigate the rate and prevalence of abnormal findings in a brain CT scan in children at the Children's Hospital of Tabriz, Iran.

Materials & Methods

This study was a cross-sectional descriptive-analytical study that included all children under 15 years old undergoing a brain CT scan at the Children's Hospital of Tabriz, Iran. All patients who fulfilled the inclusion criteria and were referred to the Children's Hospital of Tabriz during the spring of 2018 entered the study. Age, gender, patient history, and clinical findings were examined. In the next step, the results of each patient's CT scan were evaluated.

Results

In this study, 108 patients were studied with a median age of 18.0 months. CT scan results were normal in seventy-four cases (68.5%), hydrocephalus was seen in 15 (13.9%), and benign infantile hydrocephalus was seen in eight (7.4%). The study revealed a statistically significant relationship between patient history and CT scan results ($p=0.017$). A statistically significant relationship was observed between the clinical findings and CT scan results ($p=0.042$).

Conclusion

Brain CT scans have more abnormal findings in patients with positive clinical findings. Although a CT scan is a highly sensitive and specific

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modality in diagnosing central nervous system (CNS) abnormalities, its value depends on the underlying medical history and physical exam.

Keywords: Brain CT –Scan; Children; Neuroradiology

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Introduction

Brain Computed Tomography (CT) has been a useful diagnostic method in all patients suspected of a central nervous system (CNS) pathology ⁽¹⁾. However, it delivers high doses of radiation, almost equal to the radiation imposed by 100 conventional chest X-rays ⁽²⁾, which is considered carcinogenic ^(3,4). Additionally, more than 40% of the collective radiation dose in diagnostic radiology is from CT scans alone ⁽⁵⁾, with 4% involving children less than 15 years old ⁽⁴⁾. CT scans are used more frequently throughout medical centers ⁽⁶⁾. Unfortunately, various scans report non-specific clinical findings ⁽⁷⁾. Considering that early diagnosis of almost all diseases leads to better treatment and prognosis, choosing the right diagnostic method is extremely critical in reducing physical and psychological expenses for patients and their families ⁽⁸⁾. Several studies have evaluated the diagnostic role of brain CT scans in pathologies of CNS. However, few have chosen youngsters as their population of interest. Since children are ten times more sensitive to radiation than middle-aged

adults (9), pediatricians are spreading the word against unnecessary CT scans. Therefore, this study aimed to investigate the prevalence of brain CT scans with abnormal findings in children and compare its results with patient history and clinical examination, searching for the necessity of brain CT scans in patients referred to the radiologic wards.

Materials & Methods

Study design

This cross-sectional descriptive-analytical study included all children under 15 years old who underwent a brain CT scan at the Children's Hospital of Tabriz during the spring of 2018. Inclusion criteria were: 1) All patients referred for a brain CT scan, 2) All patients with a complete record of medical history and physical examination. The exclusion criterion was defined as any patient with a known CNS abnormality. This study was done after the approval of the ethics committee by IR.TBZMED.REC.1398.561 code. Informed consent was obtained from parents or legal guardians.

Descriptive data of the participants were recorded. CT scan results were evaluated by a radiologist unaware of the final diagnosis. The relationship between medical history, physical examination, and CT scan results was analyzed.

Statistical analysis

Data were analyzed using SPSS software version 26. The normality of data was examined using the Kolmogorov- Simonov (K.S) test. The authors used the Chi-square test to analyze qualitative data; if not suitable, Fisher's exact test was used. A P-value less than 0.05 was considered significant.

Results

This retrospective observational study involved 108 patients with the demographic data shown in Table 1.

The patients' most common chief complaint (around 43%) was a seizure. Dyspnea or respiratory distress and vomiting were the second and third most common complaints. Most of those presented with these three symptoms showed no abnormality on brain CT scans. Only all patients with an established history of CNS abnormality (shunt malfunction and myelomeningocele) and one patient demonstrating gait abnormality had abnormal imaging findings. Else ways, among other symptoms, the percentage of positive and negative image findings were almost the same.

Screening for clinical findings revealed that the majority (around 61%) showed no signs of CNS abnormality. Secondly, fever and then loss of consciousness were most commonly seen. Among those patients with abnormal physical exams, 42.9% demonstrated abnormal image findings, but only 24.2% of those with normal physical exams had abnormal image findings.

The brain CT scans were normal in seventy-four cases (68.5%). Fifteen cases (13.9%) had hydrocephalus, and eight (7.4%) had benign infantile hydrocephalus. The other abnormal findings of brain CT scan were parenchymal loss or brain swelling (four patients), acute encephalitis or ischemia (three patients), arachnoid cyst (one child), intracranial hemorrhage (one child), cystic brain lesions (one child) and cavum septum pellucidum or cavum vergae (one child).

As shown in Table 2, the relation between the chief complaints and the physical examination findings with brain CT scan results are statistically significant (p value= 0.017 and p value=0.042, respectively).

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Table 1. Demographic and Clinical Characteristics of the Participants

Age median (q1, q3)	18 months (3.4, 42.0)
Min	1 day
Max	12 years
Gender N (%)	
Male	65 (60.2)
Female	43 (39.8)
Patient History N (%)	
Dyspnea or respiratory distress	23 (21.3)
Seizure	47 (43.5)
Agitation	9 (8.3)
CSF shunt malfunction	2 (1.9)
Vomiting	10 (9.3)
Gait abnormality	1 (0.9)
Lethargy	2 (1.9)
Fever	4 (3.7)
Myelomeningocele	2 (1.9)
Other	8 (7.4)
Physical Examination N (%)	
Normal	66 (61.1)
DTR abnormality	2 (1.9)
High body temperature	22 (20.4)
Head circumference abnormality	4 (3.7)
Muscle tonicity	2 (1.9)
Cervical stiffness	4 (3.7)
Lumbosacral tumor with CSF leak	2 (1.9)
Primitive reflex abnormality	1 (0.9)
CT Scan Results N (%)	
Normal	74 (68.5)
Hydrocephalus	15 (13.9)
Arachnoid cyst	1 (0.9)
Parenchymal loss and brain swelling	4 (3.7)
Acute encephalitis and ischemia	3 (2.8)
Intracranial Hemorrhage	1 (0.9)
Cystic lesions	1 (0.9)
Benign infantile hydrocephalus	8 (7.4)
Cavum Verga & Cavum Septum Pellucidum	1 (0.9)
CT: Computed Tomography, CSF: Cerebro-Spinal Fluid, DTR: Deep Tendon Reflex	

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Table 2. Comparison Between Patient History, Physical Exam and CT Scan Results

	Normal CT scan N (%)	Abnormal CT scan N (%)	p value
Patient History			
Dyspnea or respiratory distress	16 (69.6)	7 (30.4)	.017*
Seizure	32 (68.1)	15 (31.9)	
Agitation	5 (55.6)	4 (44.4)	
CSF shunt malfunction	0	2 (100)	
Vomiting	9 (90)	1 (10)	
Gait abnormality	0	1 (100)	
Lethargy	2 (100)	0	
Fever	2 (50)	2 (50)	
Myelomeningocele	0	2 (100)	
Other	8 (100)	0	
Physical Exam			
Normal	50 (75.8)	16 (24.2)	.042*
Abnormal	24 (57.1)	18 (42.9)	

CT: Computed Tomography, CSF: Cerebro-Spinal Fluid

Discussion

The study showed that children with abnormal clinical examination findings have a higher incidence of abnormal findings in brain CT scans (42.9%). However, 24.2% of children with normal clinical examinations have abnormal brain CT scans. Incidences of abnormal brain CT scans among children with previously established CNS disease were significantly higher than in patients with other chief complaints. There was a significant statistical relationship between the chief complaint and clinical findings with the probability of abnormal brain CT scan findings (P value= 0.017). Rai et al. investigated 500 patients with the chief complaint of headache in Central India and observed parenchymal damage in twenty-nine cases (5.8%). The headache in other cases (94.2%) were due to problems such as sinusitis and otitis

media (10), which is consistent with this study's results.

The most common finding in Fallahi et al. study was brain atrophy in 21% of participants and intracranial hemorrhage in 5% of them(11). On the other hand, Haghighi et al. found arachnoid cysts as the most common finding and congenital brain retardation as the least common finding (12). In another study that followed patients with a history of epilepsy, brain atrophy was the most common finding. Structural dysgenesis, intracranial calcification, and hydrocephalus were also seen (13). In other similar studies, such as those reviewed by Bennimahadeo et al. and Talebian et al., brain atrophy and brain lesions were the most common abnormal findings (14,15). This study, with normal CT scans in 68.5% of cases, showed inconsistency with others, which could be due to

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the difference between the population of interest in some studies (Presence of prior history of epilepsy in the study by Fallah et al. (13)). However, the main reason is the unnecessary use of CT scan in our tertiary center.

In a study by Talebian et al., all patients with an abnormal neurological examination had abnormal CT scans (Sensitivity = 100%), and all patients with normal physical exams had normal CT scans (Sensitivity = 100%), indicating the significance of a thorough and accurate physical exam before ordering radiologic exams ⁽¹⁵⁾. This study showed a statistically significant relationship between clinical history and the CT scan results (P-value = 0.017) and between clinical findings and CT scan results (P-value = 0.042), which shows the importance of accurate history taking and clinical physical examination in approaching an accurate diagnosis and avoiding the unnecessary imaging.

Limitation & Recommendations

The biggest limitation of the present study was the low statistical population. The authors believe increasing the number of participants in similar studies will reduce possible statistical errors. The authors recommend similar prospective studies in the future besides serial CT scans and create conditions for the completion of the clinical course of the disease and the possible increase of pathological findings. CT scans can further help to understand the relationship between patients' clinical findings and CT scan images (As a more accessible modality compared to other modalities with similar applications).

In Conclusion

Although a brain CT scan is one of the most common imaging modalities in diagnosing CNS abnormalities, this study showed that its sensitivity

and specificity depend mainly on clinical examination and history taking. Considering the inaccuracy of chief complaints in children, a precise neurological and clinical examination is of much more importance in diagnosing and managing such patients.

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Author's Contribution

Amirreza Jahanshahi: Study Design, Proposal Writing, Imaging Analysis and Reporting

Shahram Sadeghvand: Study Design, Proposal Writing, Patients Clinical Examination

Mohammad Khalafi: Statistical Analysis, Manuscript Writing

Alireza Jafarzadeh: Proposal Writing, Data Collection

Armin Zarrintan: Study Design, Statistical Analysis, Imaging Analysis and Reporting, Manuscript Writing

Conflict of Interest

The authors declare no conflict of interest.

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