Prevalence and prediction of abnormal CT scan in pediatric patients presenting with a first seizure

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ABSTRACT

الأهداف: حساب معدل الإنتشار وعوامل التنبؤ بوجود نتائج أشعة مقطعية غير طبيعية بين الأطفال المصابين بالتشنج للمرة الأولى بقسم الطوارىء.

الطريقة: أجريت دراسة مقطعية على جميع الأطفال في سن 12 عام أو أقل من المصابين بحالة تشنج للمرة الأولى والذين تم تنويمهم في قسم الطوارىء بمدينة الملك عبدالعزيز الطبية للحرس الوطني، الرياض، المملكة العربية السعودية خلال الفترة من شهر يناير 2005م حتى شهر ديسمبر 2010م (العينة=124). تمت مراجعة جميع ملفات المرضى الذين كانت نتيجة تصوير الأعصاب لديهم غير طبيعية وتم جمع البيانات المتعلقة بخصائص المريض وخصائص التشنج ونتيجة تصوير الأعصاب. تم استخدام تحليل الإنحدار المنطقي لتحديد عوامل التنبؤ بالنتيجة غير الطبيعية للأشعة المقطعية وتم اعتبار القيمة الإحصائية أقل من 0.05 قيمة مهمة إحصائيا.

النتائج: وجدت النتيجة غير الطبيعية للأشعة المقطعية عند 53 مريضا من إجمالي 124 (42.7%). كانت هذه النتائج ذات ارتباط معنوي إحصائيا مع كل من: وجود إصابات الجهاز العصبي المركزي (χ^2=16.1, p<0.01) ، وتأخر تطور الطفل (Fisher exact test, p<0.01)، وحالة التشنج العام (χ^2=4.17, p=0.04)، ووجود علامات اكلينيكية موضعية عصبية جديدة (χ^2=21.70, p<0.01). إلا أنه بعد تطبيق تحليل الإنحدار المنطقي لضبط تأثير العوامل المربكة، وجد أن كلاً من تأخر تطور الطفل ([OR=4.79, p=0.01]) ووجود علامات اكلينيكية موضعية عصبية جديدة (OR=7.85, p=0.006) كانت هي المنبئات المعنوية إحصائياً للنتائج غير الطبيعية للأشعة المقطعية.

خاتمة: أظهرت هذه الدراسة انتشار كبير للنتائج غير الطبيعية للأشعة المقطعية للأطفال المصابين بالتشنج لأول مرة. وينصح بالأخذ بنتيجة الأشعة المقطعية عند التخطيط لعلاج هذه الفئة من الأطفال بعد إجراء البحوث المستقبلية في هذا الصدد.

Objectives: To estimate the prevalence of abnormal neuroimaging in children presenting to the emergency department (ED) with a new-onset seizure, and to identify the significant clinical predictors for an abnormal CT scan.

Methods: In this cross-sectional study, all children age 12 or younger, admitted to the ED at King Abdulaziz Medical City (KAMC) in Riyadh, Kingdom of Saudi Arabia, between January 2005 and December 2010, with a first seizure clinically suspected of neurological condition, and a CT scan before discharge from the ED (N=124), were identified through a chart review. The charts for all patients with abnormal neuroimaging were reviewed for patient characteristics, seizure characteristics, and neuroimaging results. A logistic regression analysis was used to identify the independent predictors of an abnormal CT scan. Statistical significance was calculated at a p-value of ≤0.05.

Results: Abnormal CT results were found in 53/124 patients (42.7%). These were significantly associated with the presence of a lesional CNS disorder (χ^2=16.1, p<0.01), developmental delays (Fisher exact test, p<0.01), generalized seizure (χ^2=4.17, p=0.04), and the presence of new focal neurological findings (χ^2= 21.70, p<0.01). However, after applying a logistic regression analysis to adjust for different confounders, only developmental delay (odds ratio [OR]=4.79, p=0.01) and focal neurological findings (OR=7.85, p=0.006) significantly predicted an abnormal CT scan.

Conclusion: This study demonstrates a high prevalence of abnormalities identified on the CT scans of children who presented with their first apparent seizure. An emergency CT may be considered in children presenting with their first seizure.

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Guidelines for obtaining emergent neuroimaging in adult patients presenting with seizures are present in the literature. With findings of a 34-45% prevalence of abnormal neuroimaging findings across studies of adults with new-onset seizures, recommendations include either urgent or emergent neuroimaging in these cases.[1] Seizures are common reasons for pediatric admissions to the Emergency Department (ED). A practice parameter recently published by the American Academy of Neurology states that an emergency CT may be considered in children with a first seizure.[2] However, there was insufficient evidence to recommend routine neuroimaging in children with new-onset afebrile seizures.[3] Reviewed in these practice parameters, 4 class III studies[4-7] documented a prevalence of abnormal neuroimaging ranging from 0-21%.

Based on these studies, an emergency CT in children with a first seizure is described as possibly useful for the acute management of the patient (class III). The American Academy of Neurology recommended that an emergency CT be considered in children with a first seizure (Level C).[8] This study aimed to: 1) estimate the prevalence of abnormal neuroimaging in children presenting to the ED with a new-onset seizure and, 2) to identify the significant clinical predictors for abnormal CT scans.

Methods.

Study setting. This cross-sectional study was conducted in King Abdulaziz Medical City (KAMC), Riyadh, Saudi Arabia, which is a multi-entity tertiary hospital that provides care to over 500,000 patients annually, and has more than 1000 beds with an increasing capacity. It was originally built for the medical services of the Saudi National Guard. However, it now serves all Saudi nationals who are in need of tertiary care. The KAMC strives to attain the highest clinical research standards to ensure the safety of its patients.

Study subjects. Patient charts were examined to identify all pediatric patients aged 12 or younger who had their first seizure of suspected neurological condition - based on clinical judgment, admitted to the ED at KAMC between January 2005 and December 2010, and for whom CT scans were carried out before their discharge from the ED (N=124). Patients with known tumors, a craniotomy history, hydrocephalus, bleeding disorders or an open skull fracture, and patients with seizures lasting 30 minutes or more were excluded.

Data collection. The following information was obtained from the hospital charts: age at seizure onset, gender, recent and past medical history, history of developmental delay, known toxic ingestion, history of head trauma, neurological examination results at the time of presentation, seizure type, seizure duration, and the result of investigations performed in the ED, including laboratory tests and CT scans.

The seizure types evaluated in this study included partial (simple or complex partial or partial with secondary generalization) and generalized tonic-clonic seizures. Children with an established diagnosis of epilepsy were excluded. All seizure types were defined according to the guidelines of the International League Against Epilepsy (ILAE).[9] The clinical data abstracted from the charts included temperature, altered mental status, focal neurological signs, and medical or surgical interventions. Final CT reports were categorized as either normal, clinically insignificant, or medically significantly abnormal. Medically significant abnormalities were those that resulted in a change in patient management (for example, tumor, or stroke).

Clinically insignificant findings were those considered to be incidental to the patient's seizure (for example, asymmetry of the ventricles, or a small increase in the external fluid space). Surgically significantly abnormal findings were those that resulted in an immediate surgical intervention. The charts of all patients with abnormal neuroimaging were reviewed.

The study protocol (Application No RS2005/031) received ethical approval from the Institutional Review Board of the National Guard Health Affairs, Riyadh, Saudi Arabia.

Statistical analysis. Data were analyzed using Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA) software (version 17.0). Frequencies (%) and 95% confidence intervals (CI) were calculated for CT scan abnormalities. The following tests were applied as appropriate: Pearson's chi-square test, the chi-square test for linear trends, and Fisher's exact test. A logistic regression analysis was used to identify the independent predictors of an abnormal CT scan. Statistical significance was calculated at a p-value of ≤0.05.

Disclosure. This study was approved (Application No RS2005/031) and supported by the Research Committee of the King Abdullah International Medical Research Center (KAIMRC), King Saud Bin Abdulaziz University for the Health Sciences, National Guard Health Affairs, Riyadh, Saudi Arabia. The authors declare no conflicting interests, support or funding from any drug company.

Results. A total of 124 children with new-onset seizure were included in this study (74 boys and 50 girls), of whom 25.3% were febrile, and 74.7% were afebrile. Patient age ranged from one month to 12 years (mean 3.5 years) at the time of presentation to the ED. The median age of the patients with their first seizure was 4 years. A CT scan was obtained for all patients.

Normal CT results were reported in 71 patients (57.3%), and abnormal CT results were shown in 53/124 patients (42.7%), However, only 23.4% of scans were medically and/or surgically significant. Clinically insignificant CT results were reported in 24 patients (19.3%), clinically significant neuroimaging abnormalities of medical significance were reported in 16 patients (12.9%), and an abnormal CT with surgical significance was reported in 13 patients (10.5%). Three of these (2.4%) had abnormal CT results that required immediate surgical intervention.

A univariate analysis demonstrated that abnormal CT scans were significantly associated with the presence of a lesional CNS disorder, developmental delays, generalized seizure, and the presence of new focal findings (**Table 1**). However, after applying a logistic regression analysis to adjust for different confounders,

Table 1 - Distribution of the study sample according to the frequency (%) of abnormal CT scans and some demographic and clinical characteristics.

Characteristics	Abnormal CT n (%)		Odds ratio (95% CI)	Statistical significance
Age				χ2LT, df1=2.13, ns
<1 month	2/6	(33.3)	1*	
1-6 months	15/29	(51.7)	2.14 (0.34-13.59)	
>6-12 months	6/11	(54.5)	2.40 (0.30-19.04)	
1-<5 years	14/22	(63.6)	3.50 (0.52-23.56)	
5-12 years	16/56	(28.6)	0.80 (0.13-4.81)	
Gender				χ2=1.686, *p*=0.19
Male	29/76	(38.2)	1*	
Female	24/48	(50.0)	1.62 (0.78-3.37)	
Chronic disease				χ2, df3=32.3,
CNS	23/33	(69.7)	8.28 (3.24-21.14)	*p*=0.0000004
Lesional	7/7	(100.0)	25.20 (2.87-221.10)	
Others	8/15	(53.3)	4.11 (1.28-13.18)	
None	15/69	(21.7)	1*	
Developmental delay				FET (*p*<0.01)#
Global	18/23	(78.3)	8.36 (2.82-24.74)	
Motor	7/8	(87.5)	16.25 (1.91-138.3)	
None	28/93	(30.1)	1*	
Head trauma				FET (*p*=0.56), ns
Yes	4/13	(30.8)	0.56 (0.16-1.94)	
No	49/111	(44.1)	1*	
Temperature				FET (*p*=0.68), ns
≥38ºC	14/32	(43.8)	1.06 (0.47-2.38)	
<37ºC	39/92	(42.4)	1*	
Type of seizure				χ2=4.17, *p*=0.04
Partial	30/84	(35.7)	1*	
Generalized	23/40	(57.5)	2.44 (1.13-5.26)	
Duration of seizure (min)				χ2, df2=0.15, *p*=0.93
<5	17/42	(40.5)	1*	
5-30	23/53	(36.5)	1.13 (0.50-2.56)	
>30	13/29	(68.4)	1.20 (0.46-3.11)	
Physical findings				χ2, df2=20.87,
New focal finding	18/21	(85.7)	13.75 (3.70-51.11)	*p*<0.00003
Low consciousness	11/24	(45.8)	1.94 (0.76-4.94)	
None	24/79	(30.4)	1*	
Chemical				FET (*p*=0.40), ns
Abnormal	1/6	(16.7)	0.25 (0.03-2.24)	
Normal	52/118	(44.1)	1*	

CI - confidence interval, χ2LT - chi-square test for linear trend, FET - Fisher's exact test, ns - statistically not significant, #global and motor developmental delays were added together when applying the FET, *reference category, df - degrees of freedom

Table 2 - Logistic regression analysis for an abnormal CT with independent variables.

Variables	B	SE	*P*-value	OR	95% CI
Chronic disease	7.12	0.52	0.17	2.04	0.74-5.63
Developmental delay	1.60	0.63	0.01*	4.79	1.44-17.4
Physical examination			0.021*		
Focal findings	2.06	0.75	0.006*	7.85	1.82-33.81
Decreased consciousness	0.48	0.54	0.376	1.62	0.57-4.62
Type of seizure	-0.42	0.48	0.38	0.66	0.26-1.69
Constant	-1.10	0.48	0.022	0.33	

*statistically significant, $\chi 2$ model = 39.74, $p<0.001$, B - beta coefficient, SE - standard error, OR - odds ratio, CI - confidence interval

the presence of a developmental delay and focal findings were the only significant predictors of an abnormal CT scan (**Table 2**).

Discussion. Few studies have evaluated whether acute management for a pediatric emergency patient presenting with a first seizure will change based on the results of neuroimaging. The incidence of abnormal neuroimaging in existing studies ranged between 0-21%.[4-7] In the present study, abnormal CT results were found in 42.7% of all patients. Of those, 54.7% were clinically significant, constituting approximately 21% of all patients. This finding demonstrates a high prevalence of abnormalities identified by CT scans compared to previous studies. However, the scans with medical and/or surgical significance were only 23.4%. Maytel et al[5] found that 21% of 66 children observed in the ED with new-onset seizures had abnormal neuroimaging findings, although the authors did not differentiate between clinically significant and insignificant findings. Garvey et al[6] reviewed 99 children with new-onset seizures, excluding those with underlying neurological disorders; 17% had complex febrile seizures, and 19% had abnormal neuroimaging findings. The findings of the present study are most similar to those from Mathur et al,[10] who found that 32% of all children with a first unprovoked seizure had an abnormal CT scan result.

In the present study, only 3 patients (2.4%) required intervention, compared to 7% in Garvey et al's study.[6] This finding was in concordance with the finding of the 4 class III studies cited above, for which acute management was a necessity for 3-8% of the patients. The frequent CT abnormalities that resulted in a change in acute management in these studies were the following: cerebral hemorrhage, tumors, cysticercosis, and obstructive hydrocephalus.[4-7] In the present study, CT abnormalities included cerebral hemorrhage, hydrocephalus, and tumors.

Children with febrile seizures have a low reported risk for neuroimaging abnormalities;[11] the prevalence of abnormal neuroimaging in children with febrile seizure varies between 17-71%.[4-7] In the present study, abnormal CT results were identified in 44% of febrile, and 41% of afebrile patients, showing no significant differences.

The use of routine neuroimaging in children with a new-onset afebrile seizure is controversial. Khodapanahandeh and Hadizadeh[12] recommended CT or MRI for children who present with focal seizures or abnormal neurologic findings, or are less than 2 years old. In the present study, based on univariate analyses, abnormal CT scans were significantly associated with the presence of a lesional CNS disorder, developmental delays, the type of seizure, and the presence of new focal findings. However, after applying a logistic regression analysis to adjust for different confounders, the presence of a developmental delay and focal neurological findings were the only significant predictors of an abnormal CT scan.

The present study has some limitations. First, the sample size is small, however, this study was applied upon only those with first seizure clinically suspected of a neurological condition. Second, the patients had both afebrile and febrile seizures, potentially complicating any suggested comparisons with the findings of other studies that evaluated patients with afebrile seizures only. Third, the cross-sectional study design is insufficient to detect a causal association between CT scan abnormalities and clinical findings.

Aside from these limitations, this study demonstrates a high incidence of abnormalities identified on the CT scans of children with new-onset seizures. The study showed that a developmental delay and focal findings significantly predicted an abnormal CT scan. We can also conclude that emergency CT in children with their first seizure may be useful for acute patient

management. However, large, well-defined, prospective studies are needed to further evaluate the potential predictive factors for a treatable CNS abnormality after a first seizure.

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