RESEARCH ARTICLE

Clinico-radiologic evaluation of new onset seizures in children presenting to a tertiary care hospital; a descriptive cross-sectional study

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Abstract

Objective: To determine the clinical and radiological spectrum of new onset seizures in children, and to determine outcomes in such cases.

Method: The cross-sectional study was conducted at the Paediatric Department of Medical Teaching Institute Lady Reading Hospital Peshawar, Pakistan, from November 1, 2023. to April 30, 2024, and comprised children aged from one month to 15 years presenting with new onset seizures regardless of aetiology. Data was collected using a semi-structured questionnaire. Data was analysed using SPSS 27.

Results: Of the 156 patients with mean age 1.91±1.025 years, 99(63.5%) were boys and 57(36.5%) were girls. Fever was present in 129(82.7%) children at presentation, while 27(17.3%) presented with status epilepticus. Multivariable logistic regression showed that focal neurological deficit was a significant predictor of poor outcome (p<0.02; odds ratio: 2.98, 95% confidence interval: 1.178-7.57).

Conclusion: Among several predictors of poor outcome in children with new onset seizures, focal neurological deficit was the most significant.

Key Words: Seizures, Paediatric, Neuroimaging, Meningitis, Hydrocephalus, Infarct.
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Introduction

Seizure is an abnormal neuronal activity in the brain, eventually causing abnormal changes in patients' awareness, behaviour and movement.[1,2] Seizures cause significant morbidity and mortality in childhood, and constitute a common complaint in children presenting to the emergency department (ED).[3,4]

Seizures in children account for 1% of all ED visits with a wide range of medical conditions having varied aetiologies.[1,2] The presentation varies from children having simple febrile fits to more aggressive status epilepticus, which itself carries significant morbidity and mortality.[5,6] Seizures are more prevalent in children aged <3 years with a total prevalence of 4-10% in children aged up to 16 years for both febrile and afebrile seizures.[1,2,7] Seizures in children pose a diagnostic challenge in terms of determining their aetiology, type and complexity. Generalised seizures constitute the most common seizure type. Main subtypes of generalised seizures are tonic, clonic, atonic, myoclonic and absence seizures.[8-10]

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Seizures can happen with high-grade fever as simple or complex febrile convulsions, or without fever.[11] Seizures happening without fever may be due to genetic or metabolic causes, traumatic brain injury, infections, electrolyte derangements, congenital brain malformations and certain cardiac conditions and their complications. Central nervous system (CNS) infections remain the leading cause of seizures in the developing world.[8,12]

Children presenting with seizures should be evaluated by haematological workup, metabolic studies, cerebrospinal fluid (CSF) rolling eye movements (R/E) and electroencephalogram (EEG).[12] Neuroimaging is performed in children to determine underlying brain pathology necessitating immediate management.[7] Brain imaging includes ultrasonography (USG), computed tomography (CT) and magnetic resonance imaging (MRI), and functional neuro-imaging comprises functional MRI (f-MRI), positron emission tomography (PET), single photon emission computed tomography (SPECT) AND magnetic resonance spectroscopy (MRS).[13] CT is easily available, less sensitive to patient motion, does not generally require sedation, and is cost effective compared to MRI. This makes it an important screening tool.[3] MRI is especially useful in identifying the surgically remediable lesions, identifying, and assisting in predicting medical refractoriness.[14]

A few studies have been done about new onset seizures

in South Asia, including a study in India about the clinical and aetiological spectrum,[15] one in Karachi that dealt with predictors of abnormal imaging and EEG, and another one in Pakistan about the outcomes of new onset seizures in adults.[8,16]

The current study was planned to determine the clinical and radiological spectrum of new onset seizures in children, and to determine outcomes in such cases.

Patients and Methods

The cross-sectional study was conducted at the Paediatric Department of Medical Teaching Institute Lady Reading Hospital Peshawar, Pakistan, from November 1, 2023. to April 30, 2024, and comprised children aged from one month to 15 years presenting with new onset seizures regardless of aetiology. Children having metabolic disorders, seizure disorder and those having cerebral palsy were excluded. Written, informed consent was obtained from all the parents.

After approval from the institutional ethics review board, the sample size was calculated using OpenEpi software[17] formula for proportion. By using seizure prevalence as 10%1,2,7 with 95% confidence interval (CI), 5% margin of error and design effect.[1] The sample size was inflated to cover for a non-response rate of 10%. The sample was raised using consecutive sampling technique from among patients presenting to the ED with new onset seizures.

Data was collected using a predesigned semi-structured questionnaire that was adapted from existing literature.[12,18,19] Blood (2-3ml) was taken in ethylenediaminetetraacetic acid (EDTA) tubes for complete blood count (CBC). Lumbar puncture was performed where indicated in stable patients. EEG was performed where indicated in children with seizures except where bedside EEG could not be performed in critical patients due to lack of that facility. Blood pressure (BP) was checked for every subject. When required, the subjects underwent Magnetic Resonance Imaging (Magnetic Power 1.5 Tesla, Toshiba Canon Japan). Routine imaging protocols of MRI brain including diffusion-weighted imaging (DWI), was used. MRI reports were evaluated and cross-checked by a consultant radiologist. Likewise, when required, the subjects underwent CT brain (Toshiba Canon Aquilion Prime 160 slices Japan) in supine position. Thin 1mm axial sections were taken, with reformatted images for detailed assessment. Intravenous (IV) contrast was administered where needed after confirmation of good renal function. Uncooperative patients were sedated.

Outcome of seizures was defined as good when the patient was discharged without any physical disability. The outcome was taken as bad when children died, or were discharged with physical disability or weakness.

Data was analysed using SPSS 27. Descriptive analysis was conducted for both scale and categorical variables, determining the frequencies and percentages. Binary logistic regression was applied for the outcome. Good outcome was coded as 1 and bad outcome was coded as 0. $P<0.05$ was taken as significant.

Results

Of the 156 patients with mean age 1.91±1.025 years, 99(63.5%) were boys and 57(36.5%) were girls. Fever was present in 129(82.7%) children at presentation, while 27(17.3%) presented with status epilepticus (Table 1). Headache, neck stiffness in children aged >10 years, fever and tonic-clonic seizures were among the significant findings (Table 2). On CT, infection was found in 44(28.21%) patients (Table 3), while MRI found infection in 30(19.23%) patients (Table 4).

Table-1: Descriptive characteristics of the patients (n=156).

Variable		Frequency	Percentage	Variable		Frequency	Percentage
Birth Asphyxia history	Yes	15	9.60%	CSF	Not done	72	46.20%
	No	141	90.40%		Normal	29	18.60%
Family History of fits	Yes	14	9%		Viral	17	10.90%
	No	142	91%		Bacterial	29	18.60%
Headache	Yes	45	28.80%		Tuberculous	6	3.80%
	No	111	71.20%		Antimeasles antibodies positive	2	1.30%
Neck stiffness	Yes	55	35.30%		Traumatic	1	0.60%
	No	101	64.70%	EEG	Not done	133	85.30%
Upper motor neuron signs	Yes	97	62.20%		Normal	4	2.60%
	No	59	37.80%		Abnormal	5	3.20%

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Nature of fits	Tonic	34	21.80%		Burst suppression pattern	7	4.50%
	Clonic	2	1.30%		Encephalopathic pattern	4	2.60%
	Atonic	2	1.30%		Focal abnormality	1	0.60%
	Myoclonic	8	5.10%		Centrotemporal spikes	1	0.60%
	Tonic-clonic	110	70.50%		Myoclonic seizures	1	0.60%
Status epilepticus	Yes	27	17.30%	Outcome	Alive without complications	95	60.90%
	No	129	82.70%		Alive with complications	51	32.70%
Fever	Yes	129	82.70%		Dead	10	6.40%
	No	27	17.30%	Blood pressure	Normal	150	96.20%
Developmental history	Normal	119	76.30%		High	6	3.80%
	Regression	20	12.80%	TLC count	Normal	67	42.90%
	Delayed	17	10.90%		High	88	56.40%

CSF: Cerebrospinal fluid, EEG: Electroencephalogram, TLC: Total leucocyte count.

Table 2: Association of Age categories with Clinical Presentation in children with new onset seizures.

Variable	Category	Age category				
		<5yrs	5-10yrs	>10yrs	P-value	Chi-square
Birth Asphyxia	Yes	60%	26.7%	13.3%	0.158	3.7
	No	36.90%	29.10%	34.00%		
Family history of fits	Yes	35.70%	14.30%	50.00%	0.256	2.7
	No	39.40%	30.30%	30.3%		
Headache	Yes	6.70%	26.70%	66.70%	<0.001	40.7
	No	52.30%	29.70%	18.00%		
Neck Stiffness	Yes	9.10%	38.20%	52.70%	<0.001	33.4
	No	55.40%	23.80%	20.80%		
Upper Motor Neuron Signs	Yes	26.80%	27.80%	45.40%	<0.001	24.1
	No	59.30%	30.50%	10.20%		
Nature of fits	Tonic	64.70%	20.60%	14.70%	<0.001	36
	Clonic	0%	0%	100%		
	Tonic-clonic	33.60%	34.50%	31.80%		
	Myoclonic	0%	0%	100%		
	Atonic	100%	0%	0%		
Status Epilepticus	Yes	33.30%	29.60%	37.00%	0.76	0.538
	No	40.30%	28.70%	31.00%		
Developmental History	Normal	39.50%	29.40%	31.10%	0.05	9.1
	Delayed	58.80%	29.40%	11.80%		
	Regression	20.00%	25%	55%		
Fever	Yes	31.80%	31%	37.2%	<0.001	17.6
	No	74.10%	18.50%	7.40%		
Focal Neurological Deficits	Yes	25.00%	40.60%	34.40%	0.13	4
	No	42.70%	25.80%	31.50%		
CSF fluid	Not done	45.80%	36.10%	18.10%	0.024	23.4

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normal	27.60%	20.70%	51.70%
Viral	35.30%	29.40%	35.30%
bacterial	44.80%	17.20%	37.90%
tuberculous	0%	50%	50%
Antimeasles antibodies	0%	0%	100%

CSF: Cerebrospinal fluid.

Table-3: CT brain findings.

CT Brain findings	Frequency	Percentage (%)
Normal	23	14.74
Not done	46	29.49
Infection	44	28.21
Infarction	14	8.97
Hydrocephalus	22	14.10
Others	7	4.49
Total	156	100

CT: Computed tomograpgy.

Table-4: MRI brain findings.

MRI Brain findings	Frequency	Percentage (%)
Not done	93	59.62
Normal	5	3.21
Atrophy	2	1.28
Infection	30	19.23
Hydrocephalus	2	1.28
Infarction	8	5.13
Others	16	10.26
Total	156	100

MRI: Magnetic resonance imaging

Table-5: Clinical predictors of outcome.

Variable	Category	Outcome		P-value	Variable	Category	Outcome		P-value
		Good	Bad				Good	Bad	
Gender	Male	58.9%	70.5%	0.17	Focal Neurological deficit	Yes	12.6%	32.8%	0
	Female	41.1%	29.5%			No	87.4%	67.2%	
Birth Asphyxia	Yes	8.40%	11.5%	0.58	TLC count	Normal	36.8%	52.5%	0.06
	No	91.6%	88.5%			High	63.2%	45.9%	
Family Hx of fits	Yes	9.5%	8.2%	1		Low	0.00%	1.6%	
	No	90.5%	91.8%		CSF	not done	46.3%	45.9%	0.03
Nature of fits	Tonic	24.2%	18%	0.04		Normal	13.7%	26.2%	
	Clonic	1.1%	1.6%			Viral	12.6%	8.2%	
	Atonic	2.1%	0.00%			Bacterial	24.2%	9.8%	
	Myoclonic	1.1%	11.5%			Tuberculous	2.1%	6.6%	
	Tonic-Clonic	71.6%	68.9%			Antimeasles antibodies	0.00%	3.3%	
Status Epilepticus	Yes	14.7%	21.3%	0.39	EEG	not done	89.5%	78.7%	0.09
	No	85.3%	78.7%			Normal	3.2%	1.6%	
Fever	Yes	82.1%	83.6%	1		Abnormal	2.1%	4.9%	
	No	17.9%	16.4%			Burst supression pattern	1.10%	9.8%	
Developmental Hx	Normal	87.4%	59%	<0.001		Encephalopathic pattern	3.20%	1.6%	
	Regression	4.2%	26.2%			focal abnormality	0.00%	1.6%	
	delayed	8.4%	14.8%			centrotemporal spikes	1.1%	0.00%	
						myoclonic seizures	0.00%	1.60%	

CSF: Cerebrospinal fluid, EEG: Electroencephalogram, TLC: Total leucocyte count, Hx: History.

Table-6: Multivariable logistic regression analysis related to patients outcomes.

Variable	Category	P-value	O. R	95% C.I.	
				Lower	Upper
Gender	Male	0.097	2.058	0.877	4.826
	Female	Reference	Reference		
Birth Asphyxia	yes	0.966	1.031	0.259	4.109
	No	Reference	Reference		
Nature of Fits	Tonic	0.67	0.815	0.317	2.091
	Clonic	0.403	3.466	0.188	63.892
	tonic-clonic	0.723	1.635	0.108	24.807
	Atonic	Reference	Reference		
Status Epilepticus	Yes	0.868	0.907	0.286	2.878
	No	Reference	Reference		
Developmental History	Regression	0.193	0.421	0.115	1.546
	Delayed	0.522	1.798	0.299	10.815
	Normal	Reference	Reference		
Focal Neurological deficit	Yes	0.021	2.987	1.178	7.573
	No	Reference	Reference		
CSF	normal	0.485	1.48	0.492	4.457
	viral	0.677	0.766	0.218	2.686
	bacterial	0.318	0.569	0.188	1.721
	tuberculous	0.288	2.861	0.412	19.861
	Not done	Reference	Reference		

CSF: Cerebrospinal fluid, OR: Odds ratio, CI: Confidence interval.

Tonic-clonic seizures, abnormal developmental history, focal neurological deficits, high total leucocyte count (YLC), CSF abnormality and EEG abnormality were associated with poor outcome (Table 5).

Multivariable logistic regression analysis showed that focal neurological deficit was a significant predictor of poor outcome (p=0.02; odds ratio: 2.98; 95%CI: 1.178-7.57) (Table 6).

Discussion

Seizure management in paediatric patients is challenging due to their diverse presentations. The underlying reasons for new onset seizures can vary widely, necessitating different levels of investigations, leading to discharge or admission to a paediatric intensive care unit (ICU).[4] Brain imaging is valuable in evaluating individuals experiencing new onset seizures as it aids in diagnosing treatable brain abnormalities amenable to surgery, and predicting the tendency to have recurrent seizures.[14]

The current study shows that infection (44%) remains the leading cause of new onset seizures in children. Existing literature shows that in children, acute symptomatic seizures account for 2.1% cases of seizures, and two-thirds of these are attributed to infectious factors.[1,20] Mani V et al. found that 8.8% children with new onset seizures had meningitis.[15]

In the current study, among the 23 patients who had normal CT brain, 7 underwent MRI brain; 3 had leukodystrophy/neurodegeneration, 2 had encephalitis, and 1 patient each had meningitis and infarct. MRI was found to have superiority in diagnosing leukodystrophy/neurodegeneration, subacute sclerosing panencephalitis (SSPE), Arnold-Chiari malformation and choroid fissure cyst.

Children with focal neurological deficits on CT and MRI mainly included cases with infection, infarction, hydrocephalus and leukodystrophy/neurodegeneration.

In a study, the average age of children presenting with new onset seizures was 7.2±4.9 years, and, of them, 48%

were girls. The study suggested replacing routine CT scans with MRI for children with new onset seizures in ED as it could reduce costs and enhance diagnostic efficacy.[21]

A study examined children who presented with status epilepticus due to new onset seizures, with 96% of them undergoing neuroimaging Longer seizure duration and older age were linked to urgent or emergent intracranial pathology.[22]

In the current study, CT brain abnormalities were detected in children aged <2 years and younger children up to 5 years of age. Similarly, a study observed a notably higher occurrence of abnormal imaging in infants aged <2 years compared to older children.[23] In the current study, children presenting with status epilepticus had abnormal imaging, which was similar to a and earlier study, which also noted that children presenting with focal seizures exhibited a higher frequency of imaging irregularities compared to those with generalised seizures.[23]

Future studies should focus on prospective cohort studies with extended follow-up periods to elucidate the natural history of new onset seizures, and evaluate the impact of early intervention strategies on disease progression and neurodevelopmental outcomes. Advanced neuroimaging techniques and biomarker analyses should be integrated to further enhance diagnostic accuracy.

Conclusion

Abnormal imaging, abnormal CSF picture, history of developmental delay or regression, presence of tonic-clonic seizures and focal neurological deficits were associated with poor outcome in children with new onset seizures. EEGs should be performed as they can be a guide towards patient outcome.

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RA, HP, NN, ZR, WR & MS: Concept, design, data acquisition, analysis, interpretation, drafting, revision, final approval and agreement to be accountable for all aspects of the work.