

Concurrent language disorders in children with idiopathic epilepsy

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Objectives

The relationship between language and epilepsy remains complex. Language disorder and epilepsy can be concomitant but unrelated phenomena. They can also be separate consequences of the same underlying brain pathology. Epilepsy can also be the direct cause of the language disorder. The aim of this study was to study concurrent language disorders in children with idiopathic epilepsy.

Study design

This cross-sectional study was conducted on 50 children attending the Neurology Clinic at Alexandria University Children Hospital at El-Shatby with the diagnosis of idiopathic epilepsy. Their ages ranged from 3 to 6 years, and 29 were male and 21 were female. These children were divided into two groups: group 1 included 25 cases with idiopathic generalized epilepsy, and group 2 included 25 cases with idiopathic focal epilepsy. All cases were subjected to thorough history taking, assessment of epilepsy severity using the National Hospital Seizure Severity Scale, and comprehensive neurological examination. They were also subjected to digital electroencephalographic recording. The studied cases had undergone psychometric assessment using the Stanford–Binet Test and language assessment using the Comprehensive Arabic Language Test.

The study was approved by the Ethics Committee at the Faculty of Medicine, Alexandria University. Consent was taken from all cases to participate in the study.

Results

Thirty-two (64%) children with idiopathic epilepsy presented with developmental language disorders. As regards the observed disorders, 30 (93.7%) cases presented with phonological disorder, 29 (90.6%) presented with semantic disorders, 29 (90.6%) presented with syntax disorders, 20 (62.5%) presented with morphological disorders, and 28 (87.5%) cases presented with pragmatic disorders. Male sex, age (54.48 ± 9 months), and uncontrolled epilepsy demonstrated to have a higher risk for developmental language disorders.

Conclusion

Male sex, age, and uncontrolled epilepsy are risk factors.

Keywords:

developmental language disorders, epilepsy, risk factor

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Introduction

There are many potential causes of language disorders, because language is a complex behavior influenced by genetic, biological, perceptual, cognitive, linguistic, and environmental factors. Of them, the role of epilepsy in neuropsychological impairments and alterations related to the language development, which recent studies have identified, has been highlighted [1].

Speech and language can be affected in all epileptic conditions when brain areas associated with speech and language processing are involved, mostly those of the dominant hemisphere and particularly in Broca's and Wernicke's areas, the area around the Sylvian fissure and the Rolandic area [2].

Children with epilepsy are particularly vulnerable to language disorders and therefore to educational problems and emotional maladjustments [3]. Seizure types, electroencephalographic (EEG) findings, age at onset, severity, chronicity, anatomical location, etiology, and treatment, each of these parameters may have a specific influence on language [4].

The aim of this study was to verify developmental language disorders (DLDs) occurrences in preschool children with idiopathic epilepsy who attended the

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Neurology Clinic at Alexandria University Children Hospital at El-Shatby.

Patients and methods

A cross-sectional study was conducted on 50 preschool-aged children with a definite diagnosis of idiopathic epilepsy. These patients were subjected to evaluation of language development after taking written consent from the parents or caregivers. The study was approved by the Ethics Committee at the Faculty of Medicine, Alexandria University.

The study was carried out in the Neurology Clinic at Alexandria University Children Hospital at El-Shatby and the Unit of Phoniatics, Department of Otorhinolaryngology (Alexandria University Main Hospital), Egypt.

The selection criteria of cases were as follows:

Inclusion criteria

Inclusion criteria were as follows:

- (1) Definite diagnosis of epilepsy, according to the definition of International League Against Epilepsy (ILAE) [5].
- (2) Age from 3 to 6 years.
- (3) Normal neurological examination.

Exclusion criteria

Exclusion criteria were as follows:

- (1) Presence of associated pediatric neuropathologies.
- (2) Other causes of DLD (e.g. hearing impairment, autism spectrum disorder, environmental deprivation, and mental retardation).

Procedures

Patients were selected. The demographic data were obtained and the following variables were analyzed: sex, age, age at first seizure, types of seizure, treatment regimen, controlled or not, complaint of DLD symptoms, and family history of epilepsy or DLDs.

- (1) Assessment of seizure severity was carried out using the National Hospital Seizure Severity Scale (NHS3) [6].
- (2) Digital EEG recording was carried out for all cases. Twenty-minute EEG recording was performed. Sleep recording using chloral hydrate (50 mg/kg) was carried out for some cases.

The EEG results were classified as follows:

- (a) Normal [EEG did not confirm the presence of epileptiform activity (EPFA)].
- (b) Generalized EPFA.
- (c) Focal EPFA, which was further classified as follows:
 - (i) Temporal EPFA (left temporal, right temporal, right posterior temporal, and bitemporal).
 - (ii) Other focal EPFAs.

It was conducted at the Department of Pediatrics (Alexandria University Children Hospital) in a quiet EEG specialized room.

- (3) All patients were also subjected to psychometric assessment using the fourth revision of the Stanford–Binet scales [7] and language assessment was carried out using the Comprehensive Arabic Language Test (CALT) [8], which included the following:
 - (a) Test of phonology included 71 words in which each Arabic phoneme is assessed in different positions. It also encompasses correct articulation of the corresponding picture.
 - (b) Test of semantics included 214 items in which the child recognizes and names different semantic groups (e.g. body parts, clothes, vegetables, and animals) and also other concepts (e.g. direction, quantity, time, and matching).
 - (c) Test of morphology included 56 questions covering different morphological structures (e.g. personal pronouns, plurals, verb tense, negation, and derivation).
 - (d) Test of syntax covering both the receptive syntactic ability (repeating 10 sentences, following eight directives and answering seven questions) and the expressive syntactic ability (describing 10 actions, sequencing four events).
 - (e) Test of pragmatics included 42 questions denoting different speech acts (e.g. requesting, regulating, informing, expressing, and organizing devices).

The CALT was constructed by the members of the Department of Phoniatics at Alexandria Main University Hospital to form a detailed comprehensive assessment battery for Arabic language and test its reliability and validity to use it in the early detection of subtle changes in the various components of language in cases of language-impaired children. It was carried out on 540 children, which included 320 normal children who were divided into 13 groups, each group consisting of about 20 normal children with age interval between

the groups of 4 months, and 220 children having delayed language development. They were divided into subgroups according to the etiological categorization of delayed language development. Their ages ranged from 2 to 6 years. Both groups (control and cases) were age and sex matched.

Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package, version 20.0 (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.).

Qualitative data were described using number and percent. Quantitative data were described using minimum and maximum, mean and SD, and median.

Comparison between different groups as regards categorical variables was tested using the χ^2 -test. When more than 20% of the cells have expected count less than 5, correction for χ^2 was conducted using Fisher's exact test or Monte Carlo correction.

For normally distributed data, comparison between two groups was made using the independent *t*-test. For abnormally distributed data, comparison between the two groups was made using the Mann–Whitney test.

Univariate and multivariate logistic regression was assessed. Significance of the obtained results was judged at the 5% level [9,10].

Results

Table 1 shows that the majority of epileptic children (both focal and generalized) were male. As regards age, there was no significant statistical difference between the two groups.

Table 2 shows that in most of the epileptic children (both focal and generalized) first seizure was experienced at an age older than 2 years. Forty (80%) idiopathic epileptic children (focal and generalized) were on monotherapy, whereas only 10 (20%) cases were on double therapy, polytherapy,

Table 1 Comparison between the studied groups (focal and generalized epilepsy) according to age and sex of the cases

	Focal (<i>n</i> =25) [<i>N</i> (%)]	Generalized (<i>n</i> =25) [<i>N</i> (%)]	Test of significance	<i>P</i>
Sex				
Male	15 (60.0)	14 (56.0)	$\chi^2=0.082$	0.774
Female	10 (40.0)	11 (44.0)		
Age (years)				
Minimum–maximum	3.0–5.83	3.0–6.0	<i>t</i> =1.031	0.308
Mean±SD	4.36±0.83	4.12±0.96		
Median	4.75	4.08		

Table 2 Comparison between the studied groups (focal and generalized epilepsy) according to epilepsy characteristics

	Focal (<i>n</i> =25) [<i>N</i> (%)]	Generalized (<i>n</i> =25) [<i>N</i> (%)]	Test of significance	<i>P</i>
Age of first seizure (years)				
<2	7 (28.0)	8 (32.0)	$\chi^2=0.095$	0.758
≥2	18 (72.0)	17 (68.0)		
Treatment				
Monotherapy	20 (80.0)	20 (80.0)	$\chi^2=7.000$	MC0.082
Double therapy	1 (4.0)	3 (12.0)		
Polytherapy	4 (16.0)	0 (0.0)		
Not on treatment	0 (0.0)	2 (8.0)		
Controlled or not ^a				
Controlled	12 (48.0)	14 (56.0)	$\chi^2=0.321$	0.571
Not controlled	13 (52.0)	11 (44.0)		
Family history of epilepsy				
Negative	13 (52.0)	15 (60.0)	$\chi^2=0.325$	0.569
Positive	12 (48.0)	10 (40.0)		
National Hospital Seizure Severity Scale				
Minimum–maximum	3.0–17.0	7.0–21.0	<i>Z</i> =2.925*	0.003*
Mean±SD	8.56±4.99	13.20±4.10		
Median	9.0	13.0		

MC, Monte Carlo test; Z, Z for Mann–Whitney test. ^aControlled: months or years seizure free (6 months). *Statistically significant at *P*≤0.0.

or not on treatment. The NHS3 was significantly lower in focal epilepsy as compared with the generalized epilepsy.

Table 3 shows EEG results of the studied sample (focal and generalized epilepsy). The EEG of six (12%) cases in the studied sample did not confirm the presence of EPFA, whereas 44 (88%) cases had different EPFAs (all cases in the focal epilepsy group and 19 cases in the generalized epilepsy group).

Table 4 shows EEG results of the studied sample (focal epilepsy only). Fifteen (60%) cases in the focal epilepsy group had temporal EPFA, whereas 10 (40%) cases had other abnormal focal activities.

Table 5 shows that the majority of epileptic children, especially the focal type had DLDs, although it did not reach statistical significance on comparing the two studied groups (focal and generalized epilepsy). Two cases of focal epilepsy had primary stuttering, which is a speech disorder, and this was not noticed in generalized epilepsy.

As regards the observed disorders, 30 (93.7%) of 32 cases with DLDs presented with phonological disorder, 26 (81.3%) cases presented with semantic disorder, 25 (78.1%) presented with a syntax disorder, 20 (62.5%) presented with morphological disorder, and 30 (93.7%) presented with pragmatic disorder according to CALT (Table 6).

Table 3 Distribution of the studied sample (focal and generalized) according to electroencephalographic results

EEG	N (%)
No epileptiform activity	6 (12.0)
Epileptiform activities	44 (88.0)
Focal	25 (57.0)
Generalized	19 (43.0)

EEG, electroencephalography.

Table 5 Comparison between the studied groups according to the Comprehensive Arabic Language Test results

CALT (final language score)	Focal (n=25) [N (%)]	Generalized (n=25) [N (%)]	χ^2	P
Within normal range	8 (32.0)	10 (40.0)	0.347	0.556
DLD	17 (68.0)	15 (60.0)		

CALT, Comprehensive Arabic Language Test; DLD, developmental language disorder.

Table 6 Descriptive study of Comprehensive Arabic Language Test domains (phonology, semantics, syntax, morphology, and pragmatics) of epileptic children who had developmental language disorder

	Phonology [N (%)] ^a	Semantics [N (%)] ^a	Syntax [N (%)] ^a	Morphology [N (%)] ^a	Pragmatics [N (%)] ^a
Epileptic children with DLD [32 (64%)]	30 (93.7)	26 (81.3)	25 (78.1)	20 (62.5)	30 (93.7)

DLD, developmental language disorder. ^aThe figures are not mutually exclusive.

Table 7 shows the distribution of the presence or absence of DLDs related to variables such as sex, age, age at first seizure, type of seizure, treatment regimen, controlled or not, complaint of DLD symptoms, EEG results (the focal epilepsy group only), National Hospital Seizure Severity Scale (NHS3), and intelligence quotient. It was statistically significant on comparing epileptic patients with normal language development and those with DLD as regards age and control of seizures. Other variables were statistically nonsignificant.

Table 8 demonstrates the assessment of possible risk factors for DLD in epileptic children using logistic regression. It was found that older age (54.48±9 months), uncontrolled epilepsy, and male sex were statistically significant risk factors for DLDs. Moreover, focal epilepsy could be predictive for DLDs.

Discussion

Few previous studies have addressed the question of whether children with idiopathic epilepsy might run the risk of developing language disorders.

In this cross-sectional study, although it is common that parents do not complain about language disorders, it is necessary to call attention to a significant occurrence of language disorders in preschool children with epilepsy.

According to CALT, 32 (64%) studied cases, focal and generalized epilepsy, had DLDs, whereas

Table 4 Distribution of studied sample (focal epilepsy only) according to electroencephalography

EEG	N (%)
Temporal lobe epileptiform activity	15 (60.0)
Others	10 (40.0)

EEG, electroencephalographic.

Table 7 The distribution of the presence or absence of developmental language disorders related to variables such as sex, age, age at first seizure, type of seizure, treatment regimen, controlled or not, complaint of developmental language disorder symptoms, electroencephalographic results (focal epilepsy group only), NHS3, and intelligence quotient

	Normal language development (<i>n</i> =18) [<i>N</i> (%)]	DLD (<i>n</i> =32) [<i>N</i> (%)]	Test of significance	<i>P</i>
Sex				
Male	8 (44.4)	21 (65.6)	$\chi^2=2.122$	0.145
Female	10 (55.6)	11 (34.4)		
Age (mean±SD) (years)	3.41±0.75	4.54±0.75	<i>t</i> =5.103*	<0.001*
Age of first seizure (years)				
<2	5 (27.8)	10 (31.3)	$\chi^2=0.066$	0.797
≥2	13 (72.2)	22 (68.8)		
Type of epilepsy				
Focal	8 (44.4)	17 (53.1)	$\chi^2=0.347$	0.556
Generalized	10 (55.6)	15 (46.9)		
Treatment				
Monotherapy	16 (88.9)	24 (75.0)	$\chi^2=3.993$	MC0.396
Double therapy	2 (11.1)	2 (6.3)		
Polytherapy	0 (0.0)	4 (12.5)		
Not on treatment	0 (0.0)	2 (6.3)		
Controlled or not				
Controlled	14 (77.8)	12 (37.5)	$\chi^2=7.488^*$	0.006*
Not controlled	4 (22.2)	20 (62.5)		
EEG (focal epilepsy only)				
Temporal lobe epileptiform activity	3 (37.5)	12 (70.6)	$\chi^2=2.482$	FE0.194
Others	5 (62.5)	5 (29.4)		
DLD symptoms				
No	17 (94.4)	23 (71.9)	$\chi^2=3.668$	FE0.073
Yes	1 (5.6)	9 (28.1)		
NHS3 (mean±SD)	10.06±4.87	11.34±5.23	<i>Z</i> =0.833	0.405
General IQ (mean±SD)	86.22±10.33	82.47±9.16	<i>t</i> =1.329	0.190
Verbal IQ (mean±SD)	89.61±15.38	86.31±11.93	<i>t</i> =0.787	0.438
Abstract IQ (mean±SD)	84.06±5.65	83.34±8.95	<i>t</i> =0.344	0.732

DLD, developmental language disorder; EEG, electroencephalography; FE, Fisher's exact test; IQ, intelligence quotient; MC, Monte Carlo test; Z, Z for Mann–Whitney test.

Table 8 Logistic regression for age, treatment control, sex, and type of epilepsy

	<i>B</i>	SE	<i>P</i>	OR	95% CI	
					LL	UL
Age (months)	0.133	0.044	0.002*	1.142	1.048	1.244
Controlled or not	−2.058	0.857	0.016*	0.128	0.024	0.685
Sex (male, female)	−1.830	0.899	0.042*	0.160	0.028	0.935
Type (focal, generalized)	0.113	0.793	0.887	1.120	0.237	5.296

B, unstandardized coefficient; CI, confidence interval; LL, lower limit for 95% CI; OR, odds ratio; SE, standard error of the unstandardized coefficient; UL, upper limit for 95% CI. *Statistically significant at $P \leq 0.05$.

18 (36%) cases had normal language development. These results highlighted the fact that DLDs are common in children with idiopathic epilepsy. It can be attributed to the fact that there was a disruption of cerebral networks subserving language functions due to abundant EPFA [11].

In agreement with the current study, Revista [12] had found that 18 (60%) children with epilepsy presented with DLDs and 12 (40%) presented with normal language development.

As regards the observed disorders, 30 (93.7%) cases presented with phonological disorders, 26 (81.3%) cases presented with semantic disorders, 25 (78.1%) cases presented with syntax disorders, 20 (62.5%) presented with morphological disorders, and 30 (93.7%) presented with pragmatic disorders. As regards the phonological domain, the cause may be that the parents are more concerned about the epilepsy itself and try to solve the problem by always treating the child as a baby. Thus, parents deprive children of having a social life and, whenever

they talk to them, infantilize the speech, reinforcing the model of omissions and phoneme changes, which are characteristics of a child's speech in this period. As regards the pragmatic domain, some epileptic children had a poor memory of the story, may be due to minor absence seizures, and a more detailed analysis of the story was difficult to perform [13].

Similarly, Caplan *et al.* [14,15] found more problems in all language areas in children with epilepsy than in the matched control group, including pragmatic difficulties.

Some differences in the results from the present study were detected by Selassie [16] as regards language domains. As regards the pragmatic domain, only 15% were reported to have difficulty. It may be attributed to the type of measure used and may not reveal the true ability to construct a narrative.

As noted in this study, there were more occurrences of DLD in the male sex. This also holds true for several other developmental disorders. This is justified because boys have a slower development; therefore, they are more susceptible to environmental influences and also to other aspects - for instance, epilepsy, which happens more frequent in male children [17].

In agreement with the current study, Revista [12] observed that the male sex showed a risk of 2.03 (odd ratio=2.03) for DLDs.

In contrast, Selassie [16] had found the sex ratio was the opposite, with a predominance of girls and it was surprising. This might be attributed to the small number of boys in this study (only six boys).

As regards age, mean \pm SD of DLD was 4.54 \pm 0.75 years and 3.41 \pm 0.75 for normal language development, and it was statistically significant.

Another important variable that may interfere with the language development is the type of epilepsy presented by the child; 17 (68.0%) of 25 focal epilepsy cases had DLD, whereas 15 (60.0%) of 25 generalized epilepsy cases had DLD. This suggests that the focal nature of the seizure may cause effect in specific areas of the cerebral cortex related to the functions of language [18].

In agreement with the present study, Parkinson [18] and Cohen and Lenormand [19] found a high incidence of language disorder in children with focal epilepsies. Similarly, Revista [12] observed that children with focal epilepsy had a risk of 2.41 for DLD presence.

As regards the age at first seizure, this current study revealed that DLD occurred in 66.7% (10 cases) of selected cases who had their first seizure before the age of 2 years and in 62.8% (22 cases) of cases with their first seizure after the age of 2 years, but this was not statistically significant. This could it be attributed to the interpretation that early beginning of seizures, mainly before the age of 2 years, may interfere with brain development, and therefore in a short term have an impact on cognition by inhibiting the mitotic activity, affecting the myelination and reducing the number of cells.

In contrast, Revista [12] found that this aspect showed no association with DLD in this age. It could be argued that these results may be influenced by the small study samples.

According to treatment, it was noticed that DLD occurred in 60% of cases who were on monotherapy and in 80% of those on double, polytherapy, or not on treatment, although this did not reach the statistical significance. It highlights that polytherapy has a relatively severe impact on language when compared with the use of monotherapy, regardless of the type of antiepileptic medicine indicated; this may be attributed to the fact that those with more severe seizure activity received polytherapy. Moreover, negative side effects cannot be ruled out. In contrast, Revista [12] found a higher frequency of language disorders in his study sample with the use of monotherapy, but this aspect did not show significant difference.

Moreover, it was noticed that 83.3% (20 cases) of the selected cases that were not controlled on treatment had DLD. However, 46.2% (12 cases) of cases who were controlled on treatment had DLD, and this was statistically significant. Hence, uncontrolled epilepsy can be considered a risk factor for DLD. This is particularly important, as abundant EPFA may lead to disruption of cerebral networks subserving language functions and lead to permanent dysfunction during adulthood.

As regards EEG, 29 (65.9%) epileptic patients with abnormal EEG had DLD and 12 (80%) patients with temporal EPFA had DLD. This was expected, as focal seizures in areas subserving language and speech are expected to have consequences for language and speech. In particular, verbal memory is thought to be affected in temporal lobe epilepsy.

In agreement with this current study, Halász *et al.* [20] pointed out in their study that the epilepsy variables, which influenced language most, were the localization and the amount of EPFA. Moreover, Deonna and Roulet-Perez [2] found more obvious language dysfunctions in children with focal epilepsy, especially those with temporal lobe EPFA.

Finally, it was noticed in this study that the parents of 23 (71.9%) epileptic children who had DLD did not complain of DLD symptoms. It may be attributed to the fact that the concern of parents who have children with epilepsy, leads them, very often, to overprotect their kids and also to exclude the child from interacting with other children, which is the same concern that leads parents not to enroll kids for school or even take them away from school. They are afraid that something bad might happen to the little ones when they are performing their activities. Besides, parents are not aware of other comorbidities children may develop: language disorder, sleep disturbance, and hyperactivity. In this way, these behaviors may bring social and educational impairments to a child who already has an important neurological problem: epilepsy.

From this study, it is concluded that there is a higher frequency of DLD in preschool children with idiopathic epilepsy than in the control group. All language domains can be affected. Language can be affected in all types of epilepsy, but children with focal epilepsy, especially temporal lobe EPFA, have a greater risk. DLDs is common in male child with epilepsy. Moreover, it is common in uncontrolled epilepsy. Most of the parents of epileptic children who have DLDs do not complain of any language disorders symptoms. Hence, comprehensive neuropsychological and language assessment need to be factored into the initial evaluation and continued monitoring of children with new-onset epilepsy.

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Conflicts of interest

There are no conflicts of interest.

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