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Cognitive outcomes in Children who present with a first unprovoked seizure

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Abstract

Purpose—To determine the long-term cognitive and educational outcomes in children prospectively identified at the time of a first unprovoked seizure.

Methods—A cohort of children with a first unprovoked seizure was enrolled and followed for a mean of 15 years. Cognitive function and educational outcomes were determined 10 or more years after the first seizure via standardized neuropsychological tests, school records and structured interviews. Children with symptomatic etiology were excluded from the analysis. When available, siblings of study subjects were recruited as normal controls. Primary educational outcome was defined as enrollment into special education services or grade repetition.

Results—28% (43/153) of children with a single seizure and 40% (42/105) of children with epilepsy received special education service or repeated a grade (p=0.05). There was a statistically significant trend in which the children with more seizures tended to require special education or repeat a grade more often (28% in single seizure group vs. 34% in 2–9 seizure group vs. 64% in ≥ 10 seizure group; p=0.004). Of 163 subjects who completed neuropsychological tests, children with single seizures tended to score higher than children with epilepsy on WRAT reading (p=0.08), TONI-II (p=0.02), and WISC/WAIS (p=0.07). There was no statistically significant difference between children with a single seizure and sibling controls.

Conclusion—The results suggest that children with a single seizure represent a group that is distinctly different from children with epilepsy and are more similar to sibling controls. In contrast, even children with very mild epilepsy have significantly worse educational outcomes.

Keywords

Cognition; Education; Neuropsychology; Children; Epilepsy; Seizure

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We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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INTRODUCTION

Childhood seizures are very common, with estimated rate of unprovoked seizure in 2% and epilepsy in 1% of all children by age 16 (Berg 1995, Hauser, et al. 1993, Hauser & Kurland 1975). While the prognosis for remission of seizures is generally favorable, published data indicate a long-term adverse impact of childhood epilepsy on education, employment and marriage (Brorson & Wranne 1987, Camfield, et al. 1993, Jalava & Sillanpaa 1997, Jalava, et al. 1997, Kokkonen, et al. 1997, Mitchell, et al. 1991, Sillanpaa, et al. 1998). While the reasons for the poor educational outcomes are not entirely clear, the association between epilepsy and cognitive co-morbidity has been well described (Berg, et al. 2004, Besag 2006, Elger, et al. 2004, Engelberts, et al. 2002, Espie, et al. 1997, Hermann, et al. 2007, Hermann, et al. 2008). Cognitive co-morbidities can be present in children with newly diagnosed epilepsy, well-controlled epilepsy requiring antiepileptic drugs (AEDs), as well as in children who are in remission and no longer require AEDs (Austin, et al. 2002, Berg, et al. 2005, Wirrell, et al. 1997). It is not clear whether those co-morbidities are secondary to the frequency of seizures, their treatment with AEDs, social stigma or a co-morbid neurological disorder, as these factors are strongly interrelated (Berg, et al. 2007, Hessen, et al. 2006, Northcott, et al. 2005). It is less well documented in the literature whether children with a single unprovoked seizure have the same scope of issues described in children with epilepsy. A better understanding of the long term cognitive and educational outcomes of childhood onset seizures is important for designing early interventions to improve long term outcomes in children at risk. We report the results of the cognitive and educational outcomes of children with a first unprovoked seizure, obtained in a prospective study with more than 10 years of follow- up.

METHODS

Cohort description

In the original prospective cohort study, 407 children and adolescents with a first unprovoked seizure were recruited and followed for a median of 15 years. These were identified at Montefiore Medical Center, Jacobi Medical Center, North Central Bronx Hospital, as well as the private practices of the authors between October 1983 and August1992. Eligibility criteria included children ranging from 1 month to 19 years of age, and presentation with a first unprovoked afebrile seizure. At the time of the initial visit, informed consent was obtained from the parent, as well as informed assent from the child whenever appropriate. For the purpose of this study, a child with a single seizure was classified by characteristic EEG features, imaging study, history and physical examination. Details of the inclusion and exclusion criteria for this cohort as well of the initial evaluation have been previously reported. (Shinnar, et al. 1996, Shinnar, et al. 1990, Shinnar, et al. 2001, Shinnar, et al. 2000, Shinnar, et al. 1999). The cohort consisted of 75 children with idiopathic etiology (neurologically normal children with presumed genetic epilepsies based on age of onset, seizure semiology and the characteristic EEG findings (Commission on Classification and Terminology 1989, Commission on Epidemiology and Prognosis 1993), 253 children with cryptogenic etiology (all cases not remote symptomatic or idiopathic), and 79 children with remote symptomatic etiology (children with static encephalopathy from birth and/or those that sustained a prior neurological insult, such as a stroke or significant head trauma). This study was conducted prior to the new proposed ILAE Classification scheme (Berg, et al. 2010) and therefore is based on the classification accepted at the time the study was conducted(Commission on Classification and Terminology 1981, Commission on Classification and Terminology 1989, Commission on Epidemiology and Prognosis 1993).

For this analysis, children with remote symptomatic etiology were excluded, as these children were known to be neurologically abnormal prior to the onset of seizure, and therefore expected to have worse cognitive and epilepsy outcomes. Of 407 subjects and 101 siblings from the original cohort, 328 subjects and 82 sibling controls met the inclusion criteria. The final cohort for this analysis consisted of 258 subjects and 78 sibling controls whose educational outcomes were obtained 10 or more years after initial entrance into the study. The study was approved by the Institutional Review Board of Montefiore Medical Center and the Albert Einstein College of Medicine. Informed consent and assent when applicable were obtained for all subjects.

Data Collection

Details including seizure characteristics, duration, number of seizures in 24 hours, and any treatment given were collected. Additional information regarding prior provoked seizures, prior neurological insults, birth history, and family history was also collected. Physical and neurological examinations were performed on all children. Electroencephalograms (EEGs) were scheduled on all cases. Neuroimaging studies (CT or MRI) were performed whenever clinically indicated. All cases had an MRI of the brain as part of the re-evaluation between 5 and 10 years after initial evaluation. Upon enrollment, subjects were followed by telephone interviews every 3 months for ascertainment of any seizure recurrence. In those children with a recurrence, records of any emergency medical care were reviewed, and the children were reevaluated. Recurrence was defined as an unprovoked seizure occurring more than 24 hours after the first seizure. Etiology and epilepsy syndrome were classified in all children at the time of initial evaluation and re-classified at the end of study in 2003 in accordance with International League against Epilepsy criteria(Commission on Classification and Terminology 1981, Commission on Classification and Terminology 1989, Commission on Epidemiology and Prognosis 1993). Etiology and epilepsy syndrome classification were stable in most of subjects (84%) over time, with a change in either localization only (n=13), etiology only (n = 20), both localization and etiology (n=22), or epilepsy syndrome within same category of localization and etiology (n=9). The classification from 2003 was used for this analysis, as it was the most accurate with all the available information including MRI results.

Neuropsychological testing

After 10 or more years following the first seizure, a structured interview was administered to all subjects in the cohort in order to assess educational history. In order to get a uniform measure of educational attainment and determine some of the possible causes of any adverse outcomes, standardized neuropsychological tests were administered to both subjects and sibling controls when available. In order to assess the impact of childhood seizures on educational outcomes, those subjects with one seizure were compared to those with two or more seizures. The following neuropsychological tests were administered based on age; Wide Range Achievement Test-3 (WRAT-3), Test of Non-Verbal Intelligence-II (TONI-II), Wechsler Intelligence Scale for Children-III (WISC-III) or Wechsler Adult Intelligence Scale-revised (WAIS-III) and Conners' Continuous Performance Test 2nd edition (CPT). The WRAT-3 provides objective information about level of educational attainment in reading, spelling, and mathematical computation, and was the primary outcome measure of the analysis. Given that there is considerable disparity in actual learning achievement from school district to school district, assessing educational achievement by tallying years of school completed (grade equivalents) has been shown to be markedly unreliable (Kaufman, et al. 1988, Reynolds & Wilson 1984). The reading recognition portion of the test has been shown to be more sensitive to actual ability than grade equivalents (Reynolds 1989). The TONI-II provides a measure of overall cognitive ability without requiring a language based response, and has demonstrated high reliability when administered to Spanish speaking

subjects (Brown, et al. 1990). Given that the study population was derived from a racially and ethnically diverse, predominantly inner city population, the TONI-II would provide an additional culture fair measure of intellectual ability. The WISC-III and the WAIS-III are the most widely used measure of intellectual functioning in the world (Lezak 1993). The WISC-III is designed for children from 6 to 16 years of age, and the WAIS-III is designed for individuals over the age of 16 years. Due to time constraints we administered 4 subscales of the WISC or WAIS (Similarities, vocabulary, Picture Completion and Block Design) which can yield estimates of overall IQ and became the basis for the now available WASI (Wechsler Abbreviated Scale of Intelligence) widely used in research settings. The mean score and standard deviation in WRAT-3 reading, TONI-II and WISC-III/WAIS-III full scale IQ are 100 +/− 15 and these tests have been validated in multiple populations (Brown, et al. 1990, Jastak & Jastak 1984, Jastak & Wilkinson 1984, Wechsler 1991, Wechsler 1997, Wilkinson 1993). The CPT is a computer-administered test designed to measure multiple aspects of attentional capacity including arousal, vigilance, speed of response, as well as commission/omission errors. The false positive and false negative rate of diagnosis of attention deficit and hyperactivity disorder (ADHD) by CPT is 10–15%, using the Overall Index cut-off point of 6. This was validated in a study of 3000 subjects (Connors 1994). Children with attentional problems typically perform poorly on tests requiring vigilance or sustained attention, and the CPT was used to check for presence of attentional problems that may be partly responsible for poor educational attainment (Masur & Shinnar 2000, Spreen, et al. 1995).

Sibling controls

Sibling controls for the included sample were recruited 10 or more years later whenever available, and used as normal controls with the same genetic and demographic background. An eligible sibling control was a sibling age matched within 5 years, and without a history of seizures, mental retardation, cerebral palsy, or other known prior neurological insult. If two or more siblings were eligible, the one closest in age was chosen. Paired analysis for siblings was not performed on final analysis, as sibling controls were available in only 24% of cases.

Analysis

The primary outcome was enrollment into special education services or grade repetition. The primary variable of interest was children with a single seizure, in comparison to children with epilepsy. Recurrent seizures were reported in 105/258 (41%) of children, thereby meeting the definition of epilepsy. Of these, 22 (9%) children had greater or equal to 10 seizures,. Although the total number of seizures was collected as a continuous variable, it was highly skewed to the left (less frequent seizures) and was therefore categorized into 3 groups (single seizure, 2–9 seizures, and ≥ 10 seizures). Descriptive analyses were performed on the following variables; age at the first seizure, age at interview, sex, primary language, number of seizures (1 versus 2–9 versus greater or equal to 10 seizures), history of status epilepticus, terminal remission, current and previous use of anti-epileptic medication, etiology (idiopathic versus cryptogenic), collapsed epilepsy syndrome, mother's educational level, WRAT-III reading score, TONI-2 score, WISC/WAIS IQ score and CPT index. Recurrence was defined as the occurrence of any unprovoked seizure more than 24 hours after the initial seizure(Commission on Epidemiology and Prognosis 1993). Terminal remission was defined as a child who is seizure free and off AEDs for at least five years as of the last follow-up. The mothers' educational level was categorized as "not completed high school", "completed high school: or "Bachelor's Degree and above". Primary analysis focused on the comparison between the subjects who had single seizures in contrast with subjects with epilepsy. The subjects with single seizures were also compared to the sibling control group. Pearson's Chi-square test and Fisher's exact test were used for categorical

variables. Student t-test or ANOVA were used for continuous variables. Kruskal-Wallis rank test was used to calculate p value instead of ANOVA for continuous variables when appropriate. Test for trends across ordered groups by Cuzick was used to assess the association between the number of seizures and outcomes. Logistic regression model on the outcome "received special education service or repeated grade" was used to investigate the relative contribution of the variables of interest. Variables in the model were chosen based on pre-determined criteria of $p<0.25$ in bivariate analysis and clinical relevance from the previous studies. The significance level was set as $p<0.05$. All analyses were undertaken with STATA for Windows (StataCorp 2007).

RESULTS

Population characteristics

Of 328 subjects from the original cohort with a cryptogenic/idiopathic first seizure, 258 (79%) subjects and 78 sibling controls had sufficient cognitive outcome data to be included for this analysis. The median age of the 258 subjects at first seizure was 5.5 years (mean 6.6, s.d. 4.9, range 1 month to 19 years) with a median follow-up of 16.3 years (mean 16.1, s.d. 2.2, range 10.1 to 20.4 years). The median age at last follow up was 21.7 years (mean 22.7, s.d. 5.4, range (12.5 to 38.4 years). Of the 258, 57% were male, and English was a primary language in 93%. Maternal education was very variable with 32 (15%) mothers not completing a high school education, 124 (58%) graduating from high school and 59 (27%) with a Bachelor's Degree or above. Characteristics of seizures were shown on table 1. There was no difference in ethnicity ($p=0.21$) or mothers' educational level ($p=0.65$) between 180 subject without available siblings and 78 subjects with available siblings.

Educational outcome

Among children in this cohort, 43/153 (28%) children with a single seizure and 42/105 (40%) of children with epilepsy received special education services or repeated the grade ($p=0.05$). Among the sibling controls, 19/78 (24%) received special education services or repeated a grade. Educational outcomes were summarized on table 2. The epilepsy group as a whole had worse educational outcomes, when compared with sibling control ($p=0.03$) or single seizure group ($p=0.05$). Within the epilepsy group, children with ≥ 10 seizures received special education services or repeated grade more often than children with 2–9 seizures (14/22, 64% vs. 28/83, 34%). There was a statistically significant trend, in which the children with more seizures received special education or repeated grade more often ($p=0.004$).

Neuropsychological outcome

Standardized neuropsychological tests were completed in 162/258 (63%) subjects and 46/78 (59%) sibling controls. **Some subjects who have participated in the structured interview by phone, declined to come in for the full neuropsychological tests.** Compared to subjects who did not complete neuropsychological testing, the subjects who completed testing were significantly more likely to be receiving special education or required repeated a grade (38% vs. 25%, $p=0.03$). They were significantly more likely to have been placed on AED in past (34% vs. 6%, $p<0.001$). The mean age at the last follow up ($p=0.29$), total number of seizures ($p=0.59$), current use of AED ($p=0.24$), remission ($p=0.11$) and mothers' education level ($p=0.44$) were not statistically significantly different between the children who completed neuropsychological tests and those who did not. Table 2 shows the results of the neuropsychological test scores among the children with a single seizure, 2–9 seizures and ≥ 10 seizures. Among the children, 51 (31%) subjects were younger than 16 years of age (34 in single seizures, 12 in 2–9 seizures and 5 in ≥ 10 seizures). There were 9/43 (17%) children with 2–9 seizures and 8/16 (50%) children with ≥ 10 seizures, who were currently

on AED. Not surprising in a cryptogenic/idiopathic group with relatively mild epilepsy, only 3 children had IQ less than 70 (1 child in each group). Children with single seizures tended to score higher than children with epilepsy on WRAT reading (p=0.08), TONI-II (p=0.02), and WISC/WAIS (p=0.07). There was an inverse trend between the number of seizures and test scores in WRAT reading (z=0.04), TONI-2 (z=0.10), and WISC/WAIS (z=0.09) but not in CPT (z=0.62). There was no statistically significant difference in test scores between children with a single seizure versus controls.

The abbreviated versions of the WISC and WAIS did not allow for separate estimates of verbal and performance IQ. However, examining the vocabulary subscore of the WISC/WAIS, there was no difference among the groups. The TONI-2 which is an estimate of nonverbal intelligence, did show an effect as noted above (p=0.02). But the estimates of verbal IQ should be viewed with caution as based on only one subscale. We did separately examine the effect of age of onset on outcome and there was no difference in any outcome measure between subjects with age at first seizure ≤ 6 and those with age at first seizure >6, either in the overall group, those with a single seizure or those with epilepsy.

Logistic regression model

Table 3 shows the result of bivariate analysis. Sex, the age at the first seizure, the age at last follow up, the number of seizures, attainment of terminal remission, current use of AED, Etiology, and mothers' education level. The mothers' education level was dichotomized as "not graduated from high school" and "graduated from high school". The logistic regression was performed focused on a subgroup of children with single seizure vs. children with epilepsy, using the variables in bivariate analysis. Attainment of terminal remission and current use of AEDs were removed from the model, as they were not independent from number of seizures. When adjusted for sex, age at first seizure, age at last follow-up and mothers' education level, patients with epilepsy were more frequently receiving special education services or repeating grades (p=0.04, OR 1.9; 95%CI: 1.0–3.5). The results of logistic regression comparing the children based on the number of seizures reported the Odds ratio for enrollment into special education or repeating grades increased from 1 in children with a single seizure, to 2.0 in children with 2–9 seizures and to 4.6 in children with ≥ 10 seizures.

DISCUSSION

In this prospective cohort of children identified at the time of their first unprovoked seizures with median follow up period of 15 years, over 50% of children had standardized neuropsychological testing. There was a statistically significant trend in which the children with more seizures tended to require special education or repeat a grade more often. The interpretation of this inverse trend needs caution, as this may simply indicate that the subjects with more seizures have more underlining brain dysfunction. Previous studies have reported lower cognitive test results in people with childhood onset epilepsy, with approximately 30% of children in these studies classified as mentally retarded (Ellenberg, et al. 1984, Murphy, et al. 1995). These studies focused solely on children with epilepsy, often skewed by the children with severe epilepsy, and it was difficult to separate impact of seizures from other variables. Our cohort provided a unique opportunity to assess the impact of seizures in childhood on educational and cognitive function, as a majority of the children are not taking AEDs at present and had only one seizure, or had mild epilepsy. This cohort also has the strong advantage of well screened epilepsy syndromes based on prospective long follow- up from the first seizure episode, as well as continuous EEG and MRI studies. The test results confirmed normal cognitive function in majority of children regardless of the total number of seizures, yet children with single seizures tended to score higher than children with epilepsy. The results suggest that the children with a single seizure represent a

group that is distinctly different from children with epilepsy. Austin et al (Austin, et al. 2002) prospectively studied behavioral problems in 224 children with new onset seizures (73% of them had recurrent seizures) and 159 siblings. The authors found statistically significant difference on CBCL Total and Internalizing Behavior Problems scores, with higher scores on children with epilepsy than in children with single seizures. Siblings had significantly lower Total and Internalizing Problems scores than both groups. Putting together with current study, this justify further that epilepsy should be defined as greater or equal to two seizures in view of cognitive co-morbidity.

The reasons for the difference between subjects who completed neuropsychological tests done and subjects who did not completed the tests are unclear. Those children with history of having been placed on AEDs might have been more motivated to continue in the study, and their parents might have worried more about the possibility of cognitive impairment. The overall mean scores of the neuropsychological tests in our subjects were lower than the general population, but were nevertheless generally consistent with available sibling controls. **The difference in each test score (WISC/WAIS IQ, TONI-II, WRAT reading) should not be interpreted as clinically meaningful based solely on the significance level ($p<0.05$) as all groups had normal scores.** Sibling controls were recruited as normal controls within the same genetic, socio-economic status and educational resources. Although we planned to perform matched-pair analysis between the subjects and their siblings, we decided against this strategy, as sibling controls were available in only 24% of cases and only 44 pairs of them completed the neuropsychological testing. The inclusion criteria for sibling control as having to be within 5 years difference from the subject might have decreased the eligibility of sibling controls. This age criterion was set to avoid the time effects, as demographics could change over 10 years. Nevertheless, we believe the sibling controls as a whole were still a valid representation of our study population, and there was no significant difference in mothers' educational level or ethnicity between the subjects with sibling pairs and those without sibling pairs. The children with epilepsy required special education service or repeated the grade more often than the sibling controls. In contrast, the educational outcomes and standardized neuropsychological tests results in children with single seizures were not significantly different from sibling controls. This indicates that one unprovoked seizure has little long term impact on educational or cognitive activities. They do not seem to have same educational and cognitive problems as those reported in children with epilepsy.

While the results of children with a single seizure in this study are valid, the results of children with epilepsy do not represent the spectrum of epilepsy of childhood onset. The educational and cognitive outcomes of childhood onset epilepsy as a whole are better represented in other cohorts, such as the Connecticut cohort and the Finnish cohort (Berg, et al. 1999, Sillanpaa, et al. 1998). The nature of the current study design which focused on a first unprovoked seizure, would exclude the children with myoclonic and/or absence seizures. Likewise, children with infantile spasms and Lennox-Gastaut syndrome were not eligible for inclusion into the original cohort. This limitation was unavoidable given the primary goal of studying the long-term effects of an isolated seizure or of a few seizures, as the above mentioned syndromes often involve seizures that occur in cluster or with great frequency. As a result, children with epilepsy in this cohort represent biologically mild epilepsy, which would have bias our result toward not finding a difference. We did not observe the significant difference in CPT index, the test to assess the ADHD symptoms between sibling controls, single seizure group and epilepsy group. ADHD has been reported in children with epilepsy as frequent co-morbidity (Hermann, et al. 2007). This could be related with the nature of the study design, which would exclude the children with absence epilepsy, in whom the ADHD is reported in 37% of children (Caplan, et al. 2008).

Despite these caveats, our study demonstrates definitive neurocognitive and educational differences when comparing children with one seizure to those having even mild epilepsy. The reason why children with epilepsy required special education service or repeated grade more often than the children with single seizures certainly cannot be explained by the neuropsychological test scores. Academic underachievement in children with epilepsy independent from the seizure control has been well reported (Fastenau, et al. 2008, Mitchell, et al. 1991, Williams, et al. 2001). Home environment, parental education, ADHD, age of seizure onset has been found to be associated with academic underachievement. In our study, home environment and parental education were controlled by sibling controls, and the age of seizure onset was not different when the children with single seizure and the children with epilepsy. Our finding may indicate the presence of factors, not measured in previous studies, such as labeling, stigma and parental expectation. **We were unable to obtain the information whether the school was informed about seizure disorder, which might have influenced the educational placement.** Our findings have potentially significant implications for the more comprehensive use of school assistive services early in the diagnosis of epilepsy, in hopes of preventing subsequent school failure.

Overall the study serves to both confirm the increasing data about cognitive and behavioral comorbidities in childhood onset epilepsy and to emphasize that children with a single unprovoked seizure do appear to be a population distinct from those with epilepsy as defined by two or more seizures with respect to their comorbidities as well as their seizure outcomes.

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Table 1

Seizure characteristics

	All eligible case	Structured interview done		neuropsychological tests done	
		Case (%)*	Case with sibling controls (%)*	Case (%)*	Case with sibling controls(%)*
N	328	258(79%)	78(24%)	162(49%)	44(13%)
Age at first seizure (median in year)	5.4	5.5	5.5	5.5	5.5
# of seizures					
Single	200	153(77%)	44 (22%)	94 (47%)	21 (11%)
2–9	106	83 (78%)	28 (26%)	52 (49%)	17 (16%)
≥10	22	22 (100%)	6 (27%)	16 (73%)	6 (27%)
Status epilepticus in past	46	40 (87%)	14 (30%)	25 (54%)	10 (22%)
Final seizure outcome					
≥ 5 year seizure free, off AEDs	284	233 (90%)	70 (25%)	142 (50%)	39 (14%)
≥ 5 year seizure free, on AEDs	26	13 (82%)	4(15%)	7 (27%)	3 (12%)
Currently on AEDs	26	24 (92%)	6 (23%)	17 (65%)	4 (15%)
Ever been on AEDs	63	60 (95%)	18 (29%)	54 (86%)	14 (22%)
Idiopathic etiology	75	62 (83%)	17 (23%)	41 (55%)	11 (15%)
Collapsed epilepsy syndrome**					
BECCT/BOE***	44	36(82%)	10(23%)	24 (55%)	5 (11%)
Primary generalized epilepsy	31	25 (81%)	7 (23%)	17 (55%)	6 (19%)
Other focal epilepsy	122	92 (75%)	30 (25%)	57 (47%)	17 (14%)
Undetermined focal and/or generalized	131	106(81%)	31 (24%)	64 (49%)	16 (12%)

* Divided by the number of eligible cases

** Child with a single seizure was classified based on the characteristic EEG features (Shinnaret al, 1998)

*** Benign childhood epilepsy with centro-temporal spikes/Benign childhood epilepsy with occipital spikes

Table 2

Standardized neuropsychological test scores and educational outcomes

Test	Siblings N=46	Subjects all N=164	P value	Siblings N=46	Single N=95	Epilepsy N=69	P value			Number of seizures			Z value for trend
							Siblings vs. Single	Siblings vs. Epilepsy	Single vs. Epilepsy	1 N=95	2–9 N=53	≥10 N=16	
Age at test	19+/−6	19+/−5	0.37	19+/−6	19+/−5	20+/−5	0.63	0.21	0.30	19+/−5	20+/−5	19+/−5	
WISC/WAIS IQ	94+/−14	95+/−13 (161)*	0.58	94+/−14	97+/−13	93+/−13(66)*	0.25	0.70	0.07	97+/−13	94+/−12 (51)*	92+/−16 (15)*	0.09
CPT Median	5.6	4.5(162)*	0.86	5.6	5.1(94)*	4.5(68)*	0.95	0.76	0.82	5.1(94)*	4.5	9.0 (15)*	0.65
Index≥6	43%	46%	0.79	43%	46%	46%	0.80	0.82	0.45	46%	42%	60%	0.62
TONI-II Mean	91+/−14	94+/−15 (163)*	0.22	91+/−14	96+/−15(94)*	91+/−14	0.05	0.98	0.02	96+/−15 (94)*	90+/−13	92+/−16	0.10
WRAT reading	92+/−16	93+/−16 (162)*	0.77	92+/−16	95+/−16(94)*	90+/−16(68)*	0.36	0.55	0.08	95+/−16 (94)*	92+/−15 (52)*	85+/−18	0.04
Received SE** or repeated the grade	19/78 (24%)	85/258 (33%)	0.15	19/78 (24%)	43/153 (28%)	42/105 (40%)	0.54	0.03	0.05	43/153 (28%)	28/83 (34%)	14/22 (64%)	0.004

*Number of subjects when it is different from the number on the first row

**Special education service

Epilepsia. Author manuscript; available in PMC 2011 December 1.

Table 3

Result of bivariate analysis for educational outcome

		Received special education service or repeated grade		P value
		Never (n=173)	Yes (n=85)	
Male Sex		95 (65%)	52 (35%)	0.34
Age of first seizure in years, median (mean)		5.9 (6.9 +/−5.1)	4.6 (6.2+/−4.5)	0.24
Age atlast interview in years, median (mean)		22.0 (23.2+/−5.5)	21.1 (21.9+/−4.9)	0.06
# of seizures	Single	110 (72%)	43 (28%)	0.004
	2–9	55 (66%)	28 (34%)	
	>=10	8 (36%)	14 (64%)	
Attained terminal remission*	Yes	160 (69%)	72 (31%)	0.05
	No	13 (50%)	13 (50%)	
Currently on AED	No	160 (68%)	75 (32%)	0.26
	Yes	13 (57%)	10 (43%)	
History of status epilepticus	No	149 (68%)	70 (32%)	0.43
	Yes	24 (62%)	15 (38%)	
Etiology	Cryptogenic	132 (67%)	65 (33%)	0.98
	Idiopathic	41 (67%)	20 (33%)	
Mother's education level	Not graduated HS**	19 (59%)	13 (41%)	0.26
	Graduated HS	78 (63%)	46 (37%)	
	BA*** and above	48 (81%)	11 (19%)	

*Seizure free for equal or greater than 5 years and off AEDs

**High school

***Bachelor's degree