Research Paper

Neuro-Cognitive Functioning and Depression among Epileptic Children

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ABSTRACT

Epilepsy leads to neurocognitive impairment and might lead to various psychological co-morbidities. The aim of the study was to bring out the relationship between one of such co-morbidities- Depression and Neurocognitive functioning among epileptic children (8-15 years). Only epileptic children with normal IQ were included in the study (N=74) among which 49 are male and 25 are female. Center for Epidemiological studies Depression Scale for Children (CES-DC) was used to assess depression and NIMHANS Neuropsychological Child Battery was used to evaluate the cognitive function which emphasize on executive functions. Each test included under the battery assesses a known specific function and has well established constructive validity. The statistical analysis was done using Pearson product moment correlation, Step wise Regression and ANOVA. Results indicated that there is significant positive relationship between Depression and logical memory, focused attention, divided attention and visuo-spatial abilities. There is negative relationship between depression and new learning, susceptibility for interference, recognition and immediate memory span. There is 80% of effect of depression on the performance of logical memory test. The future studies could bring out more information related to this association.

Epilepsy is condition with multiple seizures; it is caused due to disturbance in nerve cell activity in the brain. Depression is a serious mental illness, it negatively affects the way in

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which the individual think and act. Excessive cognitive distortion is a key factor in depression and has negative implication on cognitive functions[1].

Cognitive functions are mental processes that allow us to carry out any task. This ability enables the individual to have an active role in the processes of receiving, choosing, transforming, storing, processing and retrieval of information, allowing the subject to navigate the world around[2]. Problem in these areas or functions leads to cognitive impairment. The reason for impairment could be structural damages (due to Epilepsy) and other behavioral issues like substance abuse, side effects of drugs and so on.

Epileptic population has cognitive impairment in general. Epileptic seizures can effect cognitive functioning depending on the area of occurrence and how fast it spreads to other regions of the brain based on its underlying causes the effect of seizures on cognitive comorbidity can be a result of medications, type and frequency of seizure, cognitive inflexibility and structural damages[3].

Cognitive impairments in epileptic children is commonly noticed in areas of attention, concentration and memory, this might also pave way to psychological illness like anxiety, pain syndrome, sleep disturbance. Studies show these children have higher vulnerability to develop ADHD, conduct disorder and particularly depression[4]. There is evidence which shows network disruptions in area of frontal regions which could be the cause of cognitive impairment; there is increased activity in affective network which reasons out for depression. The epileptic seizure network hyper synchronizes with cognitive networks that might result in pathogenesis of depression[5].

But there are only few studies that show association between depression and cognitive functions in epileptic children. The focus of this study is to delineate the relationship between depression and cognitive functioning in epileptic children.

MATERIALS

Raven's Progressive Matrices was used to assess IQ for screening patients.

Center for Epidemiological studies Depression Scale for Children (CES-DC) [28,29] Depression was assessed using 20 items scale that has statements about symptoms that had occurred in past one week, with four response options that refer to frequency of the symptoms.

NIMHANS neuropsychological child/Adult battery [30,31] was used which includes Color trial (CT) [30] is conducted in two trails 1 and 2 which assess focused attention and divided attention respectively, Finger tapping (FT) left and right hand [30] which assess fine motor abilities and motor speed, it allows to know about the efficiency of brain whether it is able to integrate various functions which contribute to the movement. Phonemic fluency (PF)[31] and animal name fluency (AF) [31]assess phonetic and categorical fluency, Passage memory test (LMT) [30] assess logical memory immediate and delayed recall, Auditory- Verbal Learning training (AVLT) [30] assess immediate memory span, new learning, susceptibility for interference and recognition. Memory for design test (MFDT) [30] assesses visuospatial ability and visuospatial memory. Digit vigilance (DV) assesses attention during rapid visual tracking; Digit symbol substitution test (DSST) [31] assesses processing speed, working memory, visuospatial processing and attention.

Inclusion criteria

School going epileptic children aged 8-15 years (49 males and 25 females) with normal IQ was included in the study.

Exclusion criteria

Epileptic children with impaired IQ and aged below 8 years or above 15 years and with other neurological conditions were not included in the study.

Sample

The study included N= 74 children (49 males and 25 females) through purposive random sampling who had prior epileptic seizures. The study included school going epileptic children (4th to 10th Std.) with normal IQ aged 8 – 15 years.

Objectives

1. To study the relationship between depression and neuro-cognitive functions in epileptic children.
2. To identify the neuro-cognitive function that is highly predicted by depression among epileptic children.

Procedure

Informed consent was obtained from patient's parents or guardian. The patients were referred by neurologist and data was collected from Bangalore Neuro-Centre. The patients were given clear instructions before administering the tests. Raven's Progressive Matrices was used to screen patients with normal and high IQ and only they were included for further assessment. The Center for Epidemiological studies Depression Scale for Children (CESDC) was used to assesses depression. The NIMHANS neuropsychological child battery was administered to the patients which includes Color trial (CT-1 & 2), Phonemic fluency (PF), Animal fluency (AF), Audio-Verbal Learning Training (AVLT), Memory for design test (MFDT), Finger tapping (FT), Logical Memory Test (LMT), Digit Vigilance Test (DV) and Digit Symbol Substitution Test (DSST). The results are discussed below.

RESULT AND DISCUSSION

Table -1 – Shows mean and standard deviation of the variables among epileptic children.

Sl.No	N= 74	Mean	Std. Deviation
1.	Age	11.77	2.26
2.	CESDC	28.97	7.48
3.	DV (Time Seconds)	1200.83	251.20
4.	AVLT(Learning)	32.68	6.24
5.	AVLT (Immediate Recall)	5.86	1.54
6.	AVLT (Delayed Recall)	5.51	1.73
7.	CT-1 (Time Seconds)	94.35	37.71
8.	CT-2 (Time Seconds)	144.32	62.82
9.	LMT (Immediate Recall)	8.251	2.07
10.	LMT (Delayed Recall)	6.670	1.62
11.	DSST (Time Seconds)	278.08	70.60
12.	MFDT (Delayed Recall)	8.80	3.26
13.	MFDT (Learning)	21.03	4.088
14.	AF	7.67	2.31
15.	PF	5.82	1.75
16.	FT (Right)	27.59	3.26
17.	FR (Left)	24.60	3.82

Table 1- Shows Mean and Standard deviation of depression scale and neuro-cognitive variables. The average age of the patients included are 11.7 years and the mean of CESD score ($\overline{X}$=28.9) indicates depression among the patients. The average of tests with time in seconds indicates good performance in that particular test with decrease in seconds.

Table -2 – Shows the correlation between depression and neuro-cognitive test among epileptic children.

Sl. No	Tests	Correlation coefficient
1	CT-1 (Time Seconds)	0.59**
2	CT- 2 (Time Seconds)	0.71**
3	DSST (Time Seconds)	0.47**
4	DV (Time Seconds)	-0.41**
5	MFDT (Learning)	0.45**
6	MFDT (Delayed recall)	0.07
7	AVLT (Learning)	-0.26*
8	AVLT (Immediate Recall)	-0.60**
9	AVLT (Delayed Recall)	-0.45**
10	LMT (Immediate Recall)	0.72**
11	LMT (Delayed Recall)	0.80**
12	PF	0.03
13	AF	0.02
14	FT (Right)	-0.09
15	FT (Left)	-0.12

Significant level at 0.01 level**; Significance level at 0.05 level*
Note: Abbreviations of the tests are given in procedure.

Table 2 – Shows there is a significant positive relationship ($p < 0.01$) between Depression and Color Trail Test I &II, Digit- Symbol Substitution Test, Memory For Design Test (total) and Logical memory (immediate and delayed recall) . There is significant negative relationship between depression and Digit Vigilance, Auditory- Verbal Learning Test total ($p \geq 0.05$), Auditory- Verbal Learning Test (immediate and delayed recall).

Table-3 & 4 Shows the regression of neuro-cognitive tests with depression.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1. LMT(DR)	0.80	0.64	0.64	4.48
2. LMT(DR), AVLT(IR)	0.85	0.72	0.71	3.99
3. LMT(DR), AVLT(IR), CT-1 (Time Seconds)	0.86	0.75	0.74	3.78
4. LMT(DR), AVLT(IR), CT-1(Time Seconds), LMT(IR)	0.88	0.78	0.76	3.60

Note: DR- Delayed recall; IR- Immediate recall

Table 4 – Shows the β- value and level of significance

Model		Unstandardized Coefficients		Standardized Coefficients	t
		B	Std. Error	β – value	
1	(Constant)	4.34	2.21		1.96*
	LMT (DR)	3.69	0.32	0.80	11.46**
2	(Constant)	17.37	3.54		4.90**
	LMT (DR)	3.05	0.32	0.66	9.51**
	AVLT (IR)	-1.49	0.33	-0.31	-4.42**
3	(Constant)	27.90	4.86		5.73**
	LMT (DR)	2.30	0.39	0.50	5.83**
	AVLT (IR)	-1.69	0.32	-0.35	-5.18**
	CT-1 (Time Seconds)	-0.04	0.01	0.23	2.99**
4	(Constant)	27.93	4.63		6.03**
	LMT (DR)	1.18	0.54	0.25	2.19*
	AVLT(IR)	-1.77	0.31	-0.36	-5.68**
	CT-1 (Time Seconds)	-0.05	0.01	0.25	3.37**
	LMT (IR)	1.00	0.34	0.27	2.87**

Significant level at 0.01 level**; Significance level at 0.05 level*
Note: DR- Delayed recall; IR- Immediate recall

The table -3 and 4 shows depression strongly predicts LMP DR (β = 0.80, p< 0.01), i.e. is about 80% of performance in LMPDR is determined by depression. Around 46% of performance in AVLT IR (β = -0.31, p < 0.01) is predicted by depression, the β – value shows that the performance decreases with increase in depression. The performance in CT-1 (β = 0.25, p< 0.01) and LMP IR (β = 0.27, p< 0.01), is predicted by depression around 18% and 15% respectively.

DISCUSSION

Results show that epileptic children with depression have performed better in tests related to focused attention, divided attention, mental speed, logical memory, visuospatial memory and ability. The better performance can be explained by the intelligent quotient obtained from Raven's Progressive Matrices. Increased activity and overall brain synchronization performance can be seen in the right hemisphere among depressed individuals and in general visuospatial activities are related with right hemisphere.[6] Moreover right hemisphere processes any information in the polysemantic context based on the simultaneous capture of the profuse natural relationships between elements of information and keeps wider representations active[7,8]. This might reason out the high performance in tests that involves visuospatial abilities and logical memory by epileptic children. Deficits in executive functions such set-shifting and response inhibition that are well established in adults are not found in epileptic children this could be due to task difference[9,10,11,12]. Even though detrimental effects in domains of attention, memory, learning and executive functions are related to depression by many studies[13] but neurological mechanisms might act as mediators in their disagreement.

Many earlier researches provide prominent evidence that depression and its related factors contribute to cognitive impairment among epileptic individuals[2]. Early onset of depression is associated with poor cognitive functioning [14, 15] and much heterogeneity can be seen in severity related factors. As mentioned earlier, the mean score in depression was higher which

indicates the severity level that can be associated with poor performance in AVLT (TOTAL), AVLT (IR & DR) and DV which assesses immediate memory span, susceptibility for interference, recognition, new learning, and attention during visual tracking. Neuro imaging and EEG findings during emotional or cognitive tasks and at rest are consistent with the reduced left prefrontal activity and hypoactivation of left hemisphere among depressed individuals [6,16].Left hemisphere processes focus word meanings to their core and any information in a unambiguous mono-semantic context [7,8]. There is significant impairment on verbal memory and short term retention capacity among depressed individuals when compared with healthy individuals [17].All of these could be linked with poor performance in the above mentioned tests. It is ambiguous whether these deficits are result of decreased devotion to task-related resources or increased attention to non-task-related information[18].

The other neurocognitive tests do not have any significant relationship with depression among epileptic children.

In general factors (severity, age of onset, type, medications, etc.) related to epilepsy and depression contributes to cognitive impairment. Attention, memory and executive functions are said to be impaired in depressed individuals but still ambiguity pertains regarding its association.

The present study among depressed epileptic children indicates deficits in areas like immediate memory span, susceptibility for interference, recognition, new learning, and attention during visual tracking; the individuals performed better in areas involving visuospatial abilities, set shifting, response inhibition and logical memory. Among these logical memory is predicted highest by depression. But many other factors like type of epilepsy, severity of depression, attention towards task related attention, proximate causes etc. might have an effect on these results. Further studies might be required to discern additional information regarding the association related to this domain.

LIMITATIONS

1. The results cannot be generalized to other age group.
2. The results indicate only about one neurological condition Epilepsy.
3. Other psychological comorbidities were not included in the study.

IMPLICATIONS

The study can be elaborated in future to entail different variables like severity of depression, EEG findings, and Neurochemical activities, types of seizures, gender differences, educational qualifications, different population, clinical conditions, and comparison with healthy adults to understand the association.

CONFLICT OF INTEREST

The authors peacefully declared there is no conflict of interest.

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