

Cognitive Deficits in HIV Infected Children

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ABSTRACT

Background and Objectives: Children infected with HIV are at risk for significant neurological and neuropsychological problems. This study is aimed at identifying cognitive deficits in HIV-infected children and to compare them with equal number of normal controls. **Materials and Methods:** Twenty children with HIV infection who are currently on antiretroviral therapy were recruited. They were assessed for their intelligence using Malin's Intelligence Scale for Indian Children and also evaluated for their cognitive abilities with a comprehensive neuropsychological battery. They were matched with equal number of normal controls. **Results:** HIV-infected children have shown substantial impairments in the domains of attention, language, verbal learning and memory, visuospatial functions, fine motor performance, and executive functions. **Conclusion:** HIV-infected children have average intelligence, but they performed poorly on several neuropsychological measures.

Key words: Cognitive deficits, HIV infection, neuropsychological testing

INTRODUCTION

HIV is a fatal, sexually transmitted, or blood-borne disease affecting the health, cognitive abilities, and general well-being of the individuals including children and adolescents in particular. Children infected with HIV are at risk for significant neurological and neuropsychological problems. Neurological and cognitive deficits have been documented in up to 80% of HIV-infected children.^[1] Development delays and neurologic complications, such as encephalopathy, have been identified in children who are infected with HIV since the earliest descriptions of the disease.^[2,3]

HIV infects a variety of cell types in the brain leading to damage of the central nervous system (CNS).^[4] Neuropsychological tests serve as indirect measures

to assess CNS functioning along with the more direct measures such as computed tomography and magnetic resonance imaging scans. Studies of HIV-infected children have reported that cognitive deficits are observed in the areas of language and motor skills,^[5,6] verbal and memory functioning,^[7] visual-spatial integrative ability,^[8,9] and executive functions.^[10]

The recent development of highly active antiretroviral therapy (ART) has dramatically prolonged the survival of HIV-infected children. As HIV disease has moved from being a fatal to a chronic illness, cognitive, neurologic, and behavioral functioning of HIV-infected children has become a major concern. To date, not much studies of neuropsychological functioning of HIV-infected children who receive ART has been done in India.

MATERIALS AND METHODS

Participants

The sample for the present study comprised of 20 HIV-infected children who are inmates of a home exclusively for HIV-infected children in Chennai. The home which is run by a NGO is a special center, where they take care of HIV-infected children who belonged to low socioeconomic background. Majority of the parents

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of these children are alive and 80% of them visit their children once in 3 months. There were 30 inmates in the home. After obtaining prior permission for the home authorities, all the parents and the local guardians of the inmates were contacted and the written informed consent was obtained from them after explaining the purpose of the study. All the children in the HIV-infected group were assessed individually for their intelligence using Malin's Intelligence scale for Indian Children (II). The inclusion criteria were (a) Diagnosis of HIV infection made by the physician, which was confirmed with laboratory tests for HIV, (b) children who are receiving ART, (c) children up to 12 years of age of both sexes, (d) children with HIV infection through maternal transmission, and (e) children with an intelligence quotient (IQ) of 90 and above. The exclusion criteria were Children with a history of severe developmental disorder (e.g., autism) or significant psychiatric disorder or comorbid medical disorder not related to HIV. Out of 30, 20 HIV-infected children who fulfilled the inclusion and exclusion criteria were included in the study group.

Children with an IQ of 90 and above were only included in the study, because HIV infection affects the brain development in young children and causing intellectual deterioration. The children with HIV infection were matched with equal number of normal controls through purposive sampling. The subjects of the control group were selected from the schools in Chennai after obtaining permission from the school authorities and the written informed consent was obtained from the parents after the purpose of the study was explained to them. The children in the control group who had history of medical, psychiatric, or neurological disorders such as epilepsy that would affect the brain were excluded. They were also assessed for their intelligence individually after the class hours. Those who have obtained an IQ of 90 and above were included in the control group.

Procedure

All the children in both the groups were evaluated for their cognitive functions using a comprehensive neuropsychological battery.^[11] The battery includes nine neuropsychological tests, which measures nine neuropsychological domains namely attention, language, visual memory, verbal learning and memory, visuo-perceptual functions, visuospatial functions, visuomotor functions, fine motor performance, and executive functions. Each domain consists of one test only. These tests have been used by various authors^[12,13] for assessing various neuropsychological functions and found to be sensitive. The tests were administered according to standard procedure given in the manual in two sessions over a period of 2 consecutive days. The duration of each session was 2 h. The tests selected for assessing the cognitive functions are as follows:

- I. Attention
Digit span (MISIC)
- II. Language Vocabulary (MISIC)
- III. Visual memory
Benton Visual Retention Test
- IV. Verbal learning and memory
Rey Auditory Verbal Learning Test
- V. Visuo-perceptual functions
Picture completion (MISIC)
- VI. Visuospatial functions
Block design (MISIC)
- VII. Visuomotor functions
Object assembly (MISIC)
- VIII. Fine motor performance Coding (MISIC)
- IX. Executive functions
Trail making test (Part-B).

RESULTS

The sociodemographic characteristics of the participants are presented in Table 1. A total of 45% were in the age group of 8-9 years, while 55% were in the age group of 10-12 years in both HIV-infected and HIV-unexposed groups. Girls were 60% and boys were 40% in both the groups. In terms of educational level, 90% versus 60% in primary and 10% versus 40% were studying in secondary school. Regarding the status of HIV+, 85% of both father and mother were infected with HIV. All the HIV-infected children were under the care of home authorities, whereas all the children in the HIV-unexposed group were under the care of their parents. Parental education, age, and family income were lower in children with HIV infection than those in the control group and the details are presented in Table 2. Clinical status of HIV-infected children: All the children are taking ART for 2 years with a good adherence and they are nutritionally adequate at the time of induction into the study.

The neuropsychological evaluation findings of the two groups are presented in Table 3. The *t*-test was used to find out the difference between the means. The *t*-test indicated significant group differences on the measures of attention, language, verbal learning and memory, visuomotor functions, fine motor performance, executive functions but not on visual memory, visuo-perceptual, and visuospatial functions. Comparison of scores for the two groups revealed that the HIV-infected group was more impaired on several neuropsychological measures than the control group.

DISCUSSION

Children with HIV infection are at high-risk for developing neurodevelopment and cognitive impairments.^[14] Several studies have demonstrated neurodevelopmental

Table 1: Sociodemographic variables of the participants

Variables	Group 1 (n (%))	Group 2 (n (%))
Age (years)		
8-9	9 (45)	9 (45)
10-12	11 (55)	11 (55)
Gender		
Boys	8 (40)	8 (40)
Girls	12 (60)	12 (60)
Education		
Primary	18 (90)	12 (60)
Secondary	2 (10)	8 (40)
Status of HIV+		
Both parents	-	-
Only mother	-	-
Only father	-	-

Table 2: Family characteristics of the two groups

Variables	Group 1	Group 2
Mean age (years)		
Father	30	33
Mother	26	28
Father's education (%)		
None	4 (20)	5 (25)
Primary	10 (50)	11 (55)
Secondary	6 (30)	4 (20)
Higher secondary and above	-	-
Mother's education (%)		
None	6 (30)	-
Primary	14 (70)	5 (25)
Secondary	-	12 (60)
Higher secondary and above	-	3 (15)
Income (in Rupees) (%)		
Upto 5000	15 (75)	3 (15)
5001 to 7000	5 (25)	10 (50)
7001 and above	-	7 (35)

Table 3: Neuropsychological test findings of the two groups

Cognitive domain	Group 1 (n=20)		Group 2 (n=20)		t
	Mean	SD	Mean	SD	
Attention	7.85	1.22	9.25	1.20	3.63**
Language	21.70	5.30	30.30	5.75	4.91**
Visual memory	6.60	1.14	7.30	1.41	1.71
Verbal learning and memory	44.05	0.36	50.95	0.62	2.07*
Visuoperceptual functions	8.35	2.09	8.75	2.13	0.59
Visuospatial functions	14.60	7.29	14.95	8.63	1.02
Visuomotor functions	8.60	3.15	11.30	4.23	2.29*
Fine motor performance	33.25	6.54	42.95	6.84	4.58**
Executive functions	2.50	1.73	1.25	0.91	2.86**

* $P < 0.05$, ** $P < 0.01$; SD – Standard deviation

impairment among HIV-infected children as early as in infancy,^[15,16] while other studies have demonstrated a neurocognitive deficit in HIV-infected preschool^[17,18] and school-aged children.^[19,20] Our study demonstrated that HIV-infected children have a mean IQ of 96 which was in the average range (the mean IQ of control

group was 103) and this finding is similar to other studies.^[21,22] However, they performed poorly on several neuropsychological measures such as attention,^[23] language,^[24] verbal learning and memory,^[25] visuomotor functions,^[26] fine motor performance,^[27] and executive functions^[19,28] when compared with control group.

The poor neurocognitive functions in HIV-infected children might be explained by the following reasons. First, HIV infection may have a direct effect on neurodevelopment during the first few years of life, which is the time of rapid brain development occurs or it may have an indirect effect through recurrent infections or opportunistic, leading to poorer general health. A Tanzanian study of HIV-infected infants reported that infants with *in utero* infection had higher risk of delayed mental functioning compared to infants who were diagnosed at a later stage of life.^[16] Another factor that might contribute to poor neurocognitive outcome may be due to low socioeconomic background of HIV-infected children which could lead to a variety of obstacles such as inadequate food and lack of time for cognitively stimulating activities may have negative impact on the neurocognitive development. Environmental factors such as low level of maternal education, changes in care givers, and poverty which are likely to affect HIV-infected children adversely. Many studies^[18,29,30] have observed that poverty and low socioeconomic status have been linked to poor outcomes on neurocognitive testing and similar findings are observed in the present study also.

Family structure and child rearing plays an important role in the neurodevelopment of the child. In our study, all the HIV-infected children are under the care of home authorities due to poverty in their families, while the normal controls lived with their parents. This finding is similar to a U. S. study, which reported that children living with their biological parents were less likely to manifest conduct or learning problems when compared to those living with others.^[31]

In our study, the cognitive functions among HIV-infected children were impaired despite they received the ART for 2 years with undetectable viral load and normal CD4 cell. This is similar to a South African study which reported that HIV-infected children with a median age of 5 years were not shown improvement in neurocognitive functions after 6 months of ART.^[18] Another study has also shown that neurocognitive functions do not improve with ART.^[24]

Implications of the study

This is the first study from this part of the country to assess the neurocognitive status of HIV-infected children. The findings in this study indicate that the

HIV-infected children experience difficulties with their daily living and social functioning when compared with peers of the same age without a chronic illness. There is a need for future research to develop strategies to improve neuropsychological functioning in this population.

Regarding the limitations, children who are living in the home were only studied. Vertically transmitted HIV-infected children were only studied leaving the other subtypes of HIV transmission. Results cannot be generalized because of small sample size.

CONCLUSION

Cognitive deficits have been observed in the domains of attention, language, verbal learning and memory, visuomotor functions, fine motor performance, and executive functions.

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