

Cognitive, Language, and Visuomotor Abilities of Very Low Birthweight Infants at Corrected Age of Two Years

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Objective: To assess the prevalence and predictors of language and visuomotor delay in very low birthweight (≤ 1250 grams) children at corrected age (CA) of 2 years.

Design: Prospective observational.

Setting: Neonatal follow-up clinic of a level III center.

Participants: Children with birthweight ≤ 1250 grams and discharged alive ($n=164$) from April 2012 to April 2013 were followed up till 2 years CA ($n=126$).

Methods: Development, neurological status, and language/visuomotor cognitive skills were assessed by Cognitive Adaptive Test/Clinical Linguistic and Auditory Milestone Scale (CAT/CLAMS). Development Quotient *DQ) was calculated.

Main Outcome: Prevalence and predictors for the language and visuomotor delay.

Results: At 2 years ($n=123$ CAT, 126 CLAMS), 30 (24%) children had below average DQ (<90) and 93 (74%) average and above average DQ (≥ 90) in full scale CAT/CLAMS test. Small for gestation infants ($n=86$) have higher risk of below average DQ ($P=0.036$). Gestational age and socioeconomic status have a positive correlation with language development at 9 months and 2 years, respectively.

Conclusions: In VLBW (birth weight ≤ 1250 g) infants, the prevalence of language/visuomotor delay is high. Small for gestational age infants are at higher risk for language and visuomotor development delay at 2 years corrected age.

Keywords: *Clinical Linguistic and Auditory Milestone Scale, Cognitive Adaptive Test, Language delay, Very low birth weight, Visuomotor delay.*

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Development is a complex, multidimensional, structured process, and aberration in it is associated with a delay and disability in later life. It is important to perform the developmental assessment of all children for early identification of the delays and timely institution of interventions to prevent adverse consequences [1]. Very low birth weight (VLBW) infants and neonatal intensive care unit (NICU) graduates have significant morbidities in neonatal period, which increase their risk of developmental delays in childhood [2,3]. The developmental delay may involve either all the five domains of development (language, grossmotor, visuomotor, adaptive and social) or a particular domain. Multiple screening as well as diagnostic tools exist to identify the delay/dissociation in the development process [4,5].

The Bayley Scales of Infant Development (BSID) is a frequently used scale to evaluate the neurodevelopment in children; however, it requires expertise, training and is time-consuming which makes it difficult to use in general practice [4,6]. The Cognitive Adaptive Test/Clinical Linguistic and Auditory Milestone Scale (CAT/CLAMS) was designed for cognitive, language and visuomotor

development assessment by pediatricians in general practice. It takes 10-20 minutes and has good correlation with BSID in normal as well as high-risk children [7,8].

Accompanying Editorial in Print Issue

We aimed to evaluate the prevalence and predictors for delayed language and visuomotor development in babies with birthweight ≤ 1250 g at a corrected age of two years using CAT/CLAMS tool.

METHODS

This prospective cohort study was conducted in the neonatal follow-up clinic of a tertiary center from April 2012 to April 2015. All babies born from April 16, 2012 to April 15, 2013, with a birthweight of ≤ 1250 grams were enrolled after taking written informed consent from the parents and followed up till 2 years corrected age (CA) for language and visuomotor assessment. The study was approved by the institute research ethics committee.

All cases were followed at neonatal follow-up clinic at CA of 40 weeks, 3 months, 6 months, 9 months, 12 months, 18 months, and 2 years. During these visits, anthropometry,

neurological examination [9] and development assessment [6] were done by a neonatologist. Brainstem evoked response audiometry (BERA) was performed in all children at CA of 3 months. At 9 months and 2 years CA, their language and visuomotor development skills were assessed by the Capute scale - Cognitive Adaptive Test/ Clinical Linguistic and Auditory Milestone Scale (CAT/CLAMS) by a trained clinical psychologist. The developmental quotient (DQ) scores were calculated in each domain by dividing the age equivalent score for the given scale by the chronological age and multiplying by 100 to express as a percentage. Full-scale CAT/CLAMS DQ (FS DQ) was calculated by averaging the CAT and CLAMS development quotients. The CAT/CLAMS/FS DQ was further categorized as follows: <70, delayed; 70-79, borderline; 80-89, below average; 90-109, average and ≥ 110 , above average. To simplify the analysis, these categories were further divided into below average if $DQ < 90$, and average and above if $DQ \geq 90$.

The Capute Scale (CAT /CLAMS) is a development assessment tool to quantitatively measure receptive and expressive language skills along with nonverbal problem-solving skills in infants from 0 to 36 months of age [8,10]. CLAMS is for language assessment and it relies mostly on parental history in the first 18 months of life and thereafter on a combination of parental history and observation skills of the examiner, whereas CAT deals with visuomotor problem-solving skills and requires direct observation of a child performing a specific task during the assessment. In contrast to other commonly used screening tools which give pass/fail results, this is a quantitative assessment tool that determines the degree as well as the type of the developmental delay. This tool has got importance due to its objective nature and quick administration even by trainee residents/fellows.

The primary outcome measure was to estimate the prevalence of cognitive and language delay and secondary outcome measure was to identify the risk factors for the delay in VLBW (birthweight ≤ 1250 g) children at 2 years corrected age.

Statistical analyses: The basic demographics were expressed as percentages for categorical variables, mean (SD) for normally distributed continuous variables on the Shapiro-Wilk test and as median (1st, 3rd quartile) for skewed distributed continuous variables. Categorical variables were compared between groups by chi-square test or Fisher exact test as applicable. The Pearson correlation coefficient (including Biserial correlation if applicable) was used to assess correlation among groups with normally distributed continuous variables. SPSS version 20 software was used for analysis.

RESULTS

A total of 341 babies with birth weight ≤ 1250 g were enrolled of whom 202 were admitted in NICU – 164 (48%) were discharged alive, 11 (3.2%) died in NICU and 27 (8%) left against medical advice. The remaining 139 (41%) had died in delivery room either due to resuscitation failure at birth, non-receipt of optimal care due to inadequate infrastructure, extreme prematurity or other reasons. Of the 164 discharged infants, 126 (85%) were assessed at 2 years, 16 infants had died (10%) and 22 were lost to follow up (13%). The demographic details and baseline characteristics of the discharged infants are shown in **Table I**. The outcome at 9 months and 2 years corrected age respectively, are shown in **Table II**. **Table III** presents the predictors for abnormal language development at 2 years. Small for gestational age status is associated with below average ($DQ < 90$) language and visuomotor development [OR

TABLE I Baseline Demographic Characteristics of The Participants (N=164)

Characteristics	Value
*Gestation (wks)	30.7 (2.8)
*Birthweight (g)	1051 (147)
#Male	74 (39.8)
#Appropriate for gestational age	78 (47.6)
#Small for gestational age	86 (52.4)
#Rural residence	74 (45.1)
#Maternal education (n=120)	
Illiterate	4 (3.3)
Primary school certificate	7 (5.8)
Middle school certificate	19 (15.8)
High school certificate	33 (27.5)
Intermediate	14 (11.7)
Graduate/Postgraduate	39 (32.5)
Professional/Honors	4 (3.3)
#Socioeconomic status (Kuppuswamy's scale)	
Upper	30 (18.3)
Upper middle	42 (25.6)
Lower middle	54 (32.9)
Upper lower	30 (18.3)
Lower	8 (4.9)
#Absent/Reduced end diastolic flow on antenatal Doppler	
#Intraventricular hemorrhage	49 (29.9)
Grade I/II	43 (26.2)
Grade III/IV	6 (3.7)

Values are expressed as *Mean (SD) or #n (%), PCA: Post conceptional age.

TABLE II Language And Visuomotor Development At 9 Month and 2 Years Corrected Age

<i>Outcome Parameter</i>	<i>9 mo (n=83)</i>	<i>2 yrs</i>
<i>Cognitive Adaptive Test</i>		<i>(n=123)*</i>
#Composite Score	101 (9)	95.3 (10.7)
Delay (<70)	1 (1.2)	5 (4.1)
Borderline (70-79)	2 (2.4)	3 (2.4)
Low Average (80-89)	3 (3.6)	21 (17.1)
Average (90-109)	59 (71.1)	84 (68.3)
Above Average (110 or more)	18 (21.7)	10 (8.1)
<i>Clinical Linguistic and Auditory Milestone Scale</i>		<i>(n=126)</i>
#Composite score	98.5(11.1)	94.9 (15.7)
Delay (<70)	2 (2.4)	9 (7.1)
Borderline (70-79)	3 (3.6)	9 (7.1)
Low Average (80-89)	9 (10.8)	21 (16.7)
Average (90-109)	50 (60.2)	68 (54.0)
Above Average (110 or more)	19 (22.9)	19 (15.1)
<i>Full scale Developmental Quotient</i>		<i>(n=123)</i>
#Composite score	99.7(9)	95.0 (11.6)
Delay (<70)	1 (1.2)	5 (4.1)
Borderline (70-79)	2 (2.4)	6 (4.9)
Low Average (80-89)	7 (8.4)	19(15.4)
Average (90-109)	62 (74.7)	85 (69.1)
Above Average (110 or more)	11 (13.3)	8 (6.5)

*3children were not cooperative for cognitive adaptive test; Figures expressed as n (%); #expressed as Mean (SD).

(95% CI) = 2.5 (1.1-5.8), $P=0.036$] (1.1-5.8). DQ's correlation with other variables was also performed. Gestational age had a weak but significant ($P<0.01$) positive correlation with CLAMS ($r=0.38$) and full-scale DQ ($r=0.33$) at 9 months; however, it was not significant at 2 years. A weak, but a significant positive correlation (using Biserial correlation) was also observed between higher socioeconomic status (score > 15 on Kuppuswamy scale) and CLAMS and full scale DQ score at 2 years ($r=0.21$ and 0.21 , respectively, $P<0.01$). Importantly, CAT score and CLAMS score at 2 years have moderate but significant positive correlation ($r=0.53$, $P<0.01$) with each other suggesting the development of one domain is closely related to another. CAT score at 9 months had weak, but the significant ($P<0.01$) positive correlation with CAT DQ ($r=0.28$) and full-scale CAT/CLAMS DQ ($r=0.28$) score at 2 years. Language and visuomotor skill development (full scale DQ) at 9 months had a strong positive correlation with full scale CAT/CLAMS DQ at 2 years ($P<0.01$). Overall, 9 months assessment correlates well with language/visuomotor development at 2 years.

DISCUSSION

In the present study about one-fourth of the children had below average language and visuomotor development skills (composite DQ <90). SGA status was strongly associated with below average visuomotor and language development at 2 years. Higher gestational age and higher socioeconomic status positively correlate with better language development. Similarly, language and/or visuomotor development at 9 months had a significant positive correlation with the language and visuomotor skills at 2 years corrected age.

The observations on Language delay are in concordance with the previous studies [11-13]. A recent cross-sectional study from Indonesia among toddlers in community settings using CAT/CLAMS full-scale DQ scores found that 16 % babies had suspect/delay in cognitive development [14]. The higher prevalence noted in the present study is likely due to differences in the study population. Previous studies have shown conflicting results on association of language development and gender [11, 15,16]. However, no gender difference in language development was noted in the present study.

We found a significant correlation between socioeconomic status and language development, consistent with previous studies [17-19]. Just as in previous studies, the present study also noted that SGA babies had poor composite language and visuomotor outcome as compared to the appropriate for gestational age (AGA) babies [20,21]. This may be related to an insult to the neural architecture in the frontal lobe leading to the volume reduction of the frontal lobe.

The limitations of our study are that we had a low follow up rate at 9 months, hence, could not compare the outcomes between 9 and 24 months. Also, we assessed by using only one measure of language development and not by formal speech assessment scale. Multiple measures may have provided more accurate results. The strength of our study is its prospective nature, large sample size, detailed structured assessment with a validated tool, hearing assessment (BERA) for all subjects and good follow up (85%) till 2 years.

In conclusion, a quarter of VLBW (birth weight ≤ 1250 grams) children had below average DQ for language and visuomotor development. Higher gestation and socioeconomic status have a positive correlation with language development. We recommend that the structured language assessment, as well as speech stimulation, should be a part of the routine follow up in high-risk clinics.

What is Already Known?

- Language and visuomotor delay is a common problem in very low birth weight infants.
- There are several social, environmental, and biological risk factors for language and visuomotor delay.

What This Study Adds?

- One –fourth of VLBW (birth weight ≤ 1250 g) infants have composite language and visuomotor delay.
- Small for gestational age infants are at higher risk of language and visuomotor delay.

TABLE III Predictors of Language and Visuomotor Development at 2 Years Corrected Age

Parameter	Category	#CAT DQ		P	CLAMS DQ		P	FSDQ		P
		Below Average (DQ <90) (n=29)	Average and above (DQ \geq 90) (n=94)		Below Average (DQ <90) (n=39)	Average and above (DQ \geq 90) (n=84)		Below Average (DQ <90) (n=30)	Average and above (DQ \geq 90) (n=93)	
Gestation (wks)	<28	8 (24.2)	25 (75.8)	0.9	12 (27.3)	22 (72.7)	0.5	11 (33.3)	22 (66.7)	0.1
Birth Weight (gms)	< 1000	9 (21.4)	33 (78.6)	0.8	10 (23.2)	33 (66.8)	0.2	9 (21.4)	33 (78.6)	0.6
Sex	Female	15 (24.2)	47 (75.8)	1	23 (35.4)	42 (64.6)	0.3	16 (25.8)	46 (74.2)	0.8
Maternal Education	Less than Graduate	19 (27.1)	51 (72.9)	0.2	27 (28.1)	44 (71.9)	0.055	20 (28.6)	50 (71.4)	0.2
Father's Education	Less than Graduate	20 (26.0)	57 (74.0)	0.5	28 (35.4)	51 (64.6)	0.1	20 (26.0)	57 (74.0)	0.6
Residence	Rural	13 (25.5)	38 (74.5)	0.8	19 (35.9)	34 (64.1)	0.3	12 (23.5)	39 (76.5)	1
*SES	Lower (Score < 15)	22 (23.2)	73 (76.8)	0.8	29 (29.6)	69 (70.4)	0.5	23 (24.2)	72 (75.8)	0.9
SGA	Yes	13 (24.5)	40 (75.5)	0.8	19 (35.2)	35 (64.5)	0.3	18 (34.0)	35 (66.0)	0.036
IVH	Yes	11 (30.6)	25 (69.4)	0.2	12 (32.4)	25 (67.6)	0.8	12 (33.3)	24 (66.7)	0.1
BERA	Abnormal	4 (50.0)	4 (50.0)	0.08	4 (50.0)	4 (50.0)	0.2	2 (25.0)	6 (75.0)	1

CAT: Cognitive Adaptive Test; CLAMS: Clinical Linguistic and Auditory Milestone Scale; FS: Full scale CAT/CLAMS; DQ: Development quotient; IVH: Intraventricular hemorrhage; SGA: Small for gestational age; BERA: Brainstem evoked response audiometry; SES: Socioeconomic status; #CAT could not be performed in 3 cases; $p < 0.05$ considered significant; *Modified Kuppuswamy's socioeconomic status scale.

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questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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