

Hypoxic Ischemic Encephalopathy— Developmental Outcome at 12 Years

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This study was done to determine the mental and motor development and developmental psychopathology problems at 12 years of age, among term babies with hypoxic ischemic encephalopathy (HIE) at birth. 48 children with HIE at birth were assessed at 12 years of age, to find out the developmental status. Among 41 children, who had grade I HIE at birth, 15 (36%) had normal intelligence and only 4 (9.8%) had mental retardation. Among the rest of 7 babies who had grade 2 and 3 HIE, 2 children had mental retardation, 3 had borderline IQ and 2 had low average IQ. Hyperkinesia (23%) and somatic disorders (17%) were the commonest developmental psychopathology problems among all the three grades of HIE together. There was also an increased incidence of visual abnormality, cerebral palsy and various psychopathology problems in children who had grade 2 and 3 HIE.

Key words: Developmental outcome, Hypoxic Ischemic Encephalopathy (HIE), Psychopathology problems.

Perinatal hypoxia has been recognized as a possible cause of mental and physical handicaps in childhood for more than 100 years. Hypoxic ischemic encephalopathy (HIE) is the most important consequence of perinatal hypoxia(1). Perinatal hypoxia including birth asphyxia leading to HIE has immediate and long-term consequences to the baby. Perinatal hypoxia remains a major cause of acute perinatal brain injury, leading ultimately to neurologic dysfunction, which manifests as cerebral palsy, mental retardation, and epilepsy(2). Between 8-17% of all cerebral palsy is associated with adverse perinatal events suggestive of asphyxia(3). Sequelae include motor problems, subnormal mental development including speech and language delay, seizures, poor hearing or deafness, and poor vision. Perinatal brain damage has been reported to account for 57.5% of all neonatal deaths, 30% of admissions to a special care nursery, and 12.5% of mental retardation, epilepsy and cerebral palsy at the age of 14 years(4).

Neural damage affects the cognitive development of the individual impairing the ability to learn, talk, read, calculate, memorize, conceptualize, organize, pay attention, interact socially and behave appropriately. Some problems that appear more slowly are more difficult to detect, and may not be obvious until preschool or school age. They may present as poor coordination, scholastic backwardness, specific learning disability, very short attention span, behavioural problems, hyperactivity, etc. The present study assessed the developmental outcome at 12 years of age for babies who had HIE due to birth asphyxia.

METHODS

We included 48 children with various grades of HIE at birth, who reported for assessment of developmental status at 12 years of age at Child Development Centre (CDC). The following tools were used in this study, to measure the developmental outcome;

- (i) Malin's Intelligence Scale for Indian Children (MISIC) for measuring intelligence quotient and also for deriving verbal IQ, performance IQ and full scale IQ(5).
- (ii) The Indian adaptation of Vineland Social Maturity Scale (VSMS) to measure the social quotient (SQ) of the children(6).
- (iii) Developmental Psychopathology Checklist (DPCL) for children, to measure developmental and psychopathology problems using cut off scores as per interpretation and instructions of the checklist (7).
- (iv) Pure tone audiometry to find out hearing integrity.
- (v) Snellen chart for vision assessment.
- (vi) Clinical assessment was adopted to detect motor delay (cerebral palsy).

A consultant child psychologist administered the psychological tests. All children were examined in detail by a consultant pediatrician. The data quality was checked and analysis was done using SPSS to assess the consistency, relationships and differences among various parameters.

RESULTS

Among 48 children who reported for follow up at 12 years, 41(85.4%) children had Grade 1 HIE, 5 (10.4%) had Grade 2 HIE and 2 children (4.2%) had Grade 3 HIE. Since the number of cases in Grade 2 and 3 HIE were less, these two groups were pooled together for statistical analysis.

Among the total respondents, 45.8% children were born to mothers with high-risk pregnancy. Majority of children (60.4%) were delivered by cesarean section or vacuum suction. There was a history of fetal distress in the antenatal period in 29.2% children. All babies were born at full term and 79.2% babies had weight appropriate for gestational age. 18.8% were born as small for gestational age and only one child (2%) was born large for gestational age. Malin's Intelligence Scale for Indian Children (MISIC) could be administered in 46 children since two children (one child each in Grade

TABLE I MISIC SCORE (MEAN ±SD) AT 12 YEARS OF AGE IN CHILDREN WITH HYPOXIC ISCHEMIC ENCEPHALOPATHY

MISIC sub tests	MISIC Score (Mean ±SD)		P value
	Grade 1 HIE (n=41)	Grade 2 and 3 HIE (n=5)	
Information	87.61±16.58	78.83±11.81	0.11
Comprehension	104.59±25.35	77.00±6.16	0.01
Arithmetic	83.20±13.93	78.67±3.14	0.22
Similarities	92.17±25.33	68.33±6.02	0.01
Vocabulary	84.32±15.00	68.33±3.61	0.01
Digital span	84.29±20.79	71.33±8.87	0.07
Verbal IQ	89.36±15.75	73.75±4.86	0.01
Picture completion	79.41±16.21	71.17±2.71	0.11
Block design	81.00±20.38	67.83±6.62	0.06
Object assembly	59.61±18.37	49.67±24.73	0.12
Coding	90.17±17.19	85.83±9.20	0.28
Mazes	107.93±27.50	76.70±26.68	0.01
Performance IQ	83.63±13.27	70.24±7.06	0.09
Full Scale IQ	86.52±13.79	71.98±10.98	0.01

MISIC – Malin's Intelligence Scale for Indian Children; IQ – Intelligence quotient

TABLE II ASSOCIATION BETWEEN IQ AND SEVERITY OF HIE

IQ level at 12 years	Grade 1 HIE n (%)	Grade 2 and 3 HIE n (%)	Total (%)
Below 69 (mentally retarded)	4 (9.8)	2 (28.6)	6 (12.5)
70-79 (borderline)	10 (24.4)	3 (42.9)	13 (27.1)
80-89 (low average)	12 (29.3)	2 (28.6)	14 (29.2)
90-109 (average and above)	15 (36.6)	–	15 (31.3)

Chi square= 5.01, d.f. =3, P>0.005

2 and 3 HIE) had very low intelligence and hence could not be assessed. The IQ of these children was assessed by Seguin Form Board (SFB) test. **Table I** shows the full scale IQ according to MISIC norms.

Table II demonstrates that children having average and above average IQ level are absent among children of Grade 2 and 3 HIE. The social quotient of children measured using Vineland Social

WHAT THIS STUDY ADDS?

- Children who had suffered from Grade 1 HIE at birth have a better prognosis as compared to those with grade 2 and 3 HIE with regard to full scale IQ and verbal IQ at 12 years of age.

Maturity Scale (VSMS) revealed that there was a decline in the social quotient of Grade 2 and 3 HIE group (mean 108.62, SD 24.6) as against (mean 115.94, SD 0.90) among Grade 1 HIE.

There was a statistically significant higher prevalence of developmental delay, developmental problems/disorders, learning disorder and somatic disorder among HIE Grade 2 and 3, but no statistically significant difference was observed for hyperkinesia, conduct disorder and emotional disorder. Obsessive compulsive neurosis and psychosis were not observed in both the groups. The observation that learning disorder was present only among 2.4% of Grade 1 HIE group as against 43% of Grade 2 and 3 HIE group is clinically important, because 85.4% of HIE in the study sample belonged to Grade 1. Multiple behavioral problems were observed in 6 (14.6%) children with HIE 1 as compared to 4 (57%) in children with HIE 2 and 3 ($P=0.001$). Hearing abnormalities were similar in two groups (HIE 1: 1/41 (2%); HIE 2 and 3: 1/7 (14%); $P=0.27$). Motor delay and visual problems were seen in 2 (29%) and 3 (43%) children in the HIE 2 and 3 group, respectively. When verbal IQ was considered as independent variable and performance IQ/full-scale IQ was considered as dependant variable, the correlation coefficient was significant ($P < 0.001$). Similarly, a strong correlation was observed between performance IQ and full scale IQ. On the contrary, social quotient (SQ) showed a strong negative correlation with behavior problems.

DISCUSSION

The results of this study showed that Grade 1 HIE had a good prognosis and Grade 2 & 3 had poor outcome on all parameters at 12 years of age. The findings of this study is in agreement with recent reports of late outcome of neonatal encephalopathy. In a study by Marlow, *et al.*(9), out of 65 children with neonatal encephalopathy evaluated at 7 years, disability was present in 6% of the moderate and

42% of the severe encephalopathy group. In particular, memory and attention/executive functions were impaired in the severe group. Despite relatively small differences in performance of the moderate group, special educational needs were identified more often in both encephalopathy groups, associated with lower achievement on national curriculum attainment targets(9).

Robertson, *et al.*(10) demonstrated that of 145 children with neonatal encephalopathy (56 mild, 84 moderate and 5 severe) tested for school performance at 8 years of age, the incidence of impairment, which included cerebral palsy, blindness, cognitive delay, convulsive disorder, and severe hearing loss, was 16%. Intellectual, visual-motor integration, and receptive vocabulary scores, as well as reading, spelling, and arithmetic grade levels for those with moderate or severe encephalopathy, were significantly below ($P < 0.01$) those in the mild encephalopathy or peer comparison groups. Nonimpaired survivors of moderate encephalopathy were more likely to be more than one grade level delayed than were children from the peer group (reading 35% vs 15%, spelling 18% vs 8%, arithmetic 20% vs 12%, respectively; $P < 0.01$). Thus, children who had moderate and severe neonatal encephalopathy are at risk for physical and mental impairment and reduced school performance. Children with mild encephalopathy had school performance scores similar to those of their peers(10). The limitation of the study was that there were only 5 children with Grade 2 & 3 HIE.

The observation that 1/3rd (31%) of children who had HIE in the neonatal period had normal IQ is a striking observation and supports the concept that birth asphyxia is not the only cause for mental retardation and cerebral palsy. The increased incidence of visual and motor disability and developmental psychopathology problems, especially

among children who had severe grades of HIE highlights the need for early intervention. The observation that the prognosis of babies who had HIE grade 1 is good can be utilised for counseling parents and offering them a positive outlook towards their child's neurodevelopmental outcome.

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