NEURODEVELOPMENTAL OUTCOME UPTO 1 YEAR OF AGE AMONG TERM ASPHYXIATED BABIES

Medicine

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ABSTRACT

Worldwide, perinatal asphyxia is a major cause of death and of acquired brain damage in newborn infants. The prognosis depends on the severity of the asphyxia. Perinatal asphyxia and resulting HIE is one of the most common identifiable causes of CP and poor neurologic outcome in full-term newborns. This highlights the paramount importance of a well-designed follow-upprogramme to monitor the general health and neurodevelopmental outcome.

This study was conducted to evaluate the term asphyxiated infants for long-term morbidities like developmental delays, visual and hearing impairments and other ongoing illness. 107 term asphyxiated neonates were evaluated by serial neurological examination for the neurodevelopmental outcome. The stage of encephalopathy was assessed by using Sarnat and Sarnat clinical staging. DDST II scale was used for the developmental assessment and was followed up to 12 months to assess the neurodevelopmental outcome. The developmental delays at 12 months of age confound by DASII scale.

At the end of 3 months of age in gross motor domain 28 infants, in fine domain17 infants, in language and social 10 infants were affected. At end of 6 months of age in gross motor domain 16 infants, in fine domain13 infants, in language and social 8 infants were affected were affected. At end of 9 months of age in gross motor domain 19 infants, in fine domain18 infants, in language 11 infants,and in social 17 infants were affected. At end of 12 months of age in gross motor domain 17 infants, in fine domain13 infants, in language 11 infants,and in social 13 infants were affected. Overall HIE III study subjects have the worst neurological outcome with a greater incidence of delays seen in gross motor, fine motor, personal and language domains. Irrespective of HIE staging gross motor domain was affected more than the other developmental domains. The social domain was the least affected of all developmental domain.

The results of the developmental delay were comparable to many of the previous studies except the hearing abnormalities as evident by the BERA results. Further, follow up studies could be helpful to substantiate the results achieved in our study.

KEYWORDS

INTRODUCTION

According to World Health Organization,130 million infants were born each year worldwide. 4 million die in the first 28 days of life. Among these four to nine million cases of newborn asphyxia occurs each year[1]. Of thesebirth, asphyxia accounted for 23% of neonatal deaths worldwide[2]. The incidence of birth asphyxia is 36.6/1000 live birth infants in an Indian study[3]. In spite of substantial advances in monitoring technology, obstetric care and knowledge of fetal and neonatal pathologies, asphyxia remains a serious condition causing significant mortality and long-term morbidity[4]. Perinatal asphyxia has resulted in clinical presentations such as seizure, cerebral palsy, mental retardation, speech, hearing, visual and learning disabilities[5].

As the survival rate of asphyxiated infants continues to improve, the total number of infants with unique follow up needs will continue to grow. Numerous studies have shown that despite significant improvement in neonatal mortality, the incidence of chronic morbidities and adverse outcomes have not declined much[6]. This highlights the paramount importance of a well-designed follow-upprogramme to monitor the general health and neurodevelopmental outcome after discharge from Neonatal Intensive Care Units. Hence the study was conducted to follow up neurodevelopmental outcome till 1 year of age among term asphyxiated babies.

For term asphyxiated infants, growth monitoring, neurologic examination,and developmental assessment should be done at each visit. Ophthalmologic examination, hearing assessment, referral for physiotherapy, investigations like USG brain, CT scan, MRI of brain and EEG should be done as per individual need. Those cases, who exhibit neurodevelopmental delays in the Denver Developmental Scale Test (DDST),should be subjected to the confirmatory test like Developmental Assessment Scale for Indian Infants (DASII).

Hence, this study was conducted with the following objectives:
1) To evaluate the term asphyxiated infants for long-term morbidities.

2) To evaluate developmental delays, visual and hearing impairments and other ongoing illness.
3) Starting appropriate early interventions to reduce the incidence of developmentaldelays, administering early therapy for other problems (growth failure, tone abnormalities, visual and hearing problems, seizure disorder, etc) thereby reducing further morbidity and improving the quality of life of the high-risk infants.

MATERIALAND METHODS

107 patients Asphyxiated term newborn infants who were admitted in NICU/SNCU/NHDU from January 2016 to July 2017 at Department of pediatric medicine DR.B.C.ROY Post graduate institute of pediatric sciences, 111, Narkeldanga Main road, Kolkata, West Bengal, India.

Inclusion criteria-
Term asphyxiated newborns admitted within 24 hours after birth.

Exclusion criteria-
- Preterm infants.
- Children with major congenital abnormalities.
- Parents who are not willing to follow up.
- Perinatal infection.
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The term infants were identified as having perinatal asphyxia when at leastthree of the following criteria are fulfilled(3):
1. pH ≤ 7.2 (whether metabolic or mixed) determined by blood gas analysis within the first hour of the birth.
2. Apgar score: <4 at one minute and/or <7 at five minutes.
3. Requirement of more than one minute of positive pressure ventilation before sustained respiration occurred.
4. Fetal heart rate abnormalities (Fetal bradycardia <100 beats/minute or fetal tachycardia>160 beats/minute) and/or presence of meconium-stained amniotic fluid.

Complete obstetric history was obtained and examination of the babies

was performed at the time of admission. The neonatal clinical course was followed up prospectively and data were recorded on pre-designed proforma.

Informed written parental consent was obtained for all infants before entry in the the study, which was approved by the ethical committee.

Methodology
Term asphyxiated newborns admitted to Dr. B C Roy Post Graduate Institute ofPediatric Sciences formed our study population.After the neonatestabilized from their critical condition, were screened for the inclusion and exclusion criteria. 107 neonates were selected through simple randomization after meeting the inclusion and exclusion criteria and willingness of the parents to participate in the study.

At the time of admission complete obstetric history was obtained and examination of the babies was performed. Length and the head circumference were measured and recorded.Birth weight was recorded from the natal records.

The neonatal clinical course was followed up prospectively till the date of discharge. Parents were advised to follow up at predetermined time intervals.

Neonates were prospectively followed up at 3 months,6 months,9months and 12 months of age.

On each follow-up all the study subjects underwent neurodevelopmental screening with DDST II in 4 domains of developmentnamely gross motor, fine motor/adaptive, language and personal social and the performance of study subjects was recorded. Weight, head circumference and length were measured and recorded.

Those study subjects who were found to be neurodevelopmental delayed in the Denver Developmental Screening Test (DDST) were subjected to the confirmatory test (at 1 year of age)-Developmental Assessment Scale for Indian Infants (DASII) and the performance of the study subjects was recorded.

Statistical Analysis:
For statistical analysis data were entered into a Microsoft excel spreadsheet and then analyzed by SPSS 24.0. andGraphPad Prism version 5. Two-sample t-tests for a difference in mean involved independent samples or unpaired samples. Paired t-tests were a form of blocking and had greater power than unpaired tests. One-way analysis of variance (one-way ANOVA) was a technique used to compare means of three or more samples for numerical data (using the F distribution). Unpaired proportions were compared by Chi-square test or Fischer's exact test, as appropriate. p-value ≤ 0.05 was considered for statistically significant.

RESULT AND ANALYSIS
We found that among 107 asphyxiated termnewborns, 44 (41.1%) were female and 63 (58.9%) were male. It was found that birth asphyxia using sarnat and sarnat staging and out of 107 asphyxiated termnewborns, 44 (41.1%) were in stage I, 48(44.9%) were in stage II and 15 (14%) were in stage III. We found that in our study out of 107 asphyxiated term newborns, in stage I 19(43.2%) were delivered by LSCS and 25(56.8%) were delivered by NVD; in stage II 18(37.5%) were delivered by LSCS and 30(62.5%) were delivered by NVD; in stage III 4(26.7%) were delivered by LSCS and 11(73.3%) were delivered by NVD. It was found that in stage I 13(29.5%) were <3SD; in stage II 3(6.3%) were < 3SD and in stage III 3(20%) were < 3SD. We found that in stage I 6(13.6%) were <3SD; in stage II 1(2.1%) were < 3SDand in stage III 3(20%) were< 3SD. It was found that in stage I 3(6.8%) were <3SD; in stage II 3(6.2%) were < 3SD; in stage III 6(40%) were < 3SD. We found that in stage I 6(13.6%) were <3SD; in stage II 12(25%) were < 3SD; in stage III 4(26.7%) were< 3SD. It was found that in stage I 4(33.3%) were <3SD; in stage II 4(33.3%) were < 3SD; in stage III 4(33.3%) were < 3SD. It was found that in stage I 4(9.1%) were <3SD; in stage II 2(4.2%) were < 3SD; in stage III 8(53.3%) were < 3SD. We found that in stage I 2(4.5%) were <3SD; in stage II 10(20.8%) were < 3SD; in stage III 7(46.7%) were < 3SD. It was found that in stage I 3(6.8%) were <3SD; in stage II 2(4.2%) were < 3SD; in stage III 5(33.3%) were < 3SD. We found that in stage I 2(4.5%) were <3SD; in stage II 2(4.2%) were < 3SD; in stage III 8(53.3%) were < 3SD. It was found that in stage I 2(4.5%) were <3SD; in stage II 0(0%) were < 3SD; in stage III 9(60%) were < 3SD. It was

found that in stage I 2(4.5%) were <3SD; in stage II 1(2.1%) were < 3SD; in stage III 6(40%) were < 3SD. We found that in stage I 2(4.5%) were <3SD; in stage II 2(4.2%) were < 3SD; in stage III 8(53.3%) were < 3SD. We found that in stage I 2(4.5%) were <3SD; in stage II 0(0%) were < 3SD; in stage III 8(53.3%) were < 3SD. It was found that stage I 2(4.5%) were <3SD; in stage II 0(0%) were < 3SD; in stage III 7(46.7%) were < 3SD We found that in stage I 2(4.5%) were <3SD; in stage II 2(4.2%) were < 3SD; in stage III 7(46.7%) were <3SD. We found that in HIE I 2(4.5%) were abnormal &42(95.5%) were normal. In HIE II 17(35.4%) were abnormal &31(64.4%) were normal. In HIE III 11(73.3%) were abnormal& 4(26.7%) were normal. It was found that in HIE I 2(4.5%) were abnormal &42(95.5%) were normal. In HIE II 18(37.5%) were abnormal &30(62.5%) were normal. In HIE III 12(80%) were abnormal& 3(20%) were normal. We found that in HIE I 8(18.2%) were abnormal; In HIE II 12(25%) were abnormal; In HIE III 6(40%) were abnormal. It was found that in HIE I 1(2.3%) were abnormal; In HIE II 17(35.4%) were abnormal; In HIE III 10(66.7%) were abnormal. We found that in HIE I 2(4.5%) were abnormal; In HIE II 24(50%) were abnormal; In HIE III 12(80%) were abnormal. It was found that the mean value of weight at birth in HIE I, HIE II and HIE III were 2.56kg,2.67kg and 2.66kg respectively. We found that the mean value of length at birth in HIE I, HIE II and HIE III were 46 cm,46.3 cm and 45.7 cm respectively. It was found that the mean value of head circumference at birth in HIE I, HIE II and HIE III were 32.9 cm, 32.8 cm,and 32.1 cm respectively. It was found that the mean value of weight at 3 months in HIE I, HIE II and HIE III were 4.91kg, 4.89 kg,and 4.51 kg respectively. It was found that the mean value of length at 3 months in HIE I, HIE II and HIE III were 55.8 cm, 56.4 cm,and 55 cm respectively. We found that the mean value of head circumference at 3 months in HIE I, HIE II and HIE III were 38.1cm, 38.2 cm and 35.8 cm respectively. We found that the mean value of weight at 6 months in HIE I, HIE II and HIE III were 6.7kg, 6.58 kg and 5.71 kg respectively. It was found that the mean value of length at 6 months in HIE I, HIE II and HIE III were 64.1 cm, 64.6 cm,and 60.9 cm respectively. We found that the mean value of head circumference at 6 months in HIE I, HIE II and HIE III were 41.6cm, 41.5 cm and 38.6 cm respectively. It was found that the mean value of weight at 12 months in HIE I, HIE II and HIE III were 8.96kg, 8.99 kg,and 7.27 kg respectively. We found that the mean value of length at 12 months in HIE I, HIE II and HIE III were 73.7 cm, 74.1 cm,and 68.8 cm respectively. It was found that the mean value of head circumference at 12 months in HIE I, HIE II and HIE III were 45.6cm, 45.67 cm and 42.3 cm respectively.

NEURO-DEVELOPMENTAL ASSESSMENT AT 3 MONTHS OF AGE Gross Motor
HIE-I: 33(75%) were found to be in 'PASSED' category; 5(11.4%) were in FAILED category; 4(9.1%) were in 'CAUTION' category.

HIE-II: 29(69.4%) were found to be in 'PASSED' category; 9(18.8%) were in FAILED category; 10(20.8%) were in 'CAUTION' category.

HIE-III: No subject was found to be in 'PASSED' category; 14(93.3%) were in FAILED category; 1(6.7%) subject was not available for follow up.

Fine motor
HIE-I: 35(79.5%) were found to be in 'PASSED' category ; 2(4.5%) were in FAILED category; 4(9.1%) were in 'CAUTION' category;1(2.3%) was in 'ADVANCE' category;2(4.5%) were not available for follow up.

HIE-II: 42(66.7%) were found to be in 'PASSED' category ; 3(6.3%) were in FAILED category; 13(27.1%) were in 'CAUTION' category.

HIE-III: No subject was found to be in 'PASSED' category ; 12(80%) were in FAILED category; 2(13.3%) were in 'CAUTION' category; 1(6.7%) was not available for study.

Language
HIE-I: 39(88.6%) were found to be in 'PASSED' category ; 2(4.5%) were in FAILED category; 1(2.3%) were in 'CAUTION' category;2(4.5%) were not available for follow up.

HIE-II: 42(87.5%) were found to be in 'PASSED' category ; 6(12.5%) were in 'CAUTION' category.

HIE-III: 1(6.7%) were found to be in 'PASSED' category ; 8(53.3%) were in FAILED category; 4(26.7%) were in 'CAUTION'

category;1(2.3%) was in 'ADVANCE' category;1(6.7%) were not available for follow up.

PERSONAL
HIE-I: 38(86.4%) were found to be in 'PASSED' category ; 2(4.5%) were in FAILED category; 2(4.5%) were in 'CAUTION' category;1(2.3%) was in 'ADVANCE' category;2(4.5%) were not available for follow up.

HIE-II: 45(93.8%) were found to be in 'PASSED' category; 1(2.1%) were in FAILED category; 2(4.2%) were in 'CAUTION' category.

HIE-III: 2(13.3%) were found to be in 'PASSED' category; 7(46.7%) were in FAILED category; 5(33.3%) were in 'CAUTION' category; 1(6.7%) was not available for study.

NEURO-DEVELOPMENTAL ASSESSMENT AT 6 MONTHS OF AGE
Gross Motor
HIE-I: 32(72.7%) were found to be in 'PASSED' category; 2(4.5%) were in FAILED category; 3(6.8%) were in 'CAUTION' category; 2(4.5%) were in advance category; 5(11.4%) subject was not available for follow up.

HIE-II: 23(47.9%) were found to be in 'PASSED' category; 2(4.2%) were in FAILED category; 20(41.7%) were in 'CAUTION' category. 1(2.1%) were in advance category; 2(4.2%) subject was not available for follow up.

HIE-III: No subject was found to be in 'PASSED' category; 12(80%) were in FAILED category; 1(6.7%) were in 'CAUTION' category; 2(13.3%) subject was not available for follow up.

Fine motor
HIE-I: 34(77.3%) were found to be in 'PASSED' category; 2(4.5%) were in FAILED category; 1(2.3%) were in 'CAUTION' category; 2(4.5%) was in 'ADVANCE' category;5(11.4%) were not available for follow up.

HIE-II: 18(37.5%) were found to be in 'PASSED' category; 1(2.1%) were in FAILED category; 27(56.3%) were in 'CAUTION' category; 2(4.2%) subject was not available for follow up.

HIE-III: 2(13.3%) were found to be in 'PASSED' category; 10(66.7%) were in FAILED category; 1(6.7%) were in 'CAUTION' category; 2(13.3%) was not available for study.

Language
HIE-I: 31(70.5%) were found to be in 'PASSED' category; No subjects were in FAILED category; 12(25%) were in 'CAUTION' category; 5(11.4%) were not available for follow up.

HIE-II: 34(70.8%) were found to be in 'PASSED' category; 12(25%) were in 'CAUTION' category; 2(4.2%) were not available for follow up.

HIE-III: 2(13.3%) were found to be in 'PASSED' category; 8(53.3%) were in FAILED category; 3(20%) were in 'CAUTION' category; 2(13.3%) were not available for follow up.

PERSONAL
HIE-I: 35(79.5%) were found to be in 'PASSED' category; No subject was in FAILED category; 2(4.5%) were in 'CAUTION' category; 3(6.8%) was in 'ADVANCE' category; 5(11.4%) were not available for follow up.

HIE-II: 32(66.7%) were found to be in 'PASSED' category; No subject was in FAILED category; 2(13.3%) were not available for follow up.

HIE-III: 3(20%) were found to be in 'PASSED' category; 8(53.3%) were in FAILED category; 2(13.3%) were in 'CAUTION' category; 2(13.3%) was not available for study.

NEURO-DEVELOPMENTAL ASSESSMENT AT 9 MONTHS OF AGE
Gross Motor
HIE-I: 35(79.5%) were found to be in 'PASSED' category; 2(4.5%) were in FAILED category; No subject was in 'CAUTION' category;

2(4.5%) were in advance category; 5(11.4%) subject was not available for follow up.

HIE-II: 30(62.5%) were found to be in 'PASSED' category; 5(10.4%) were in FAILED category; 11(22.9%) were in 'CAUTION' category; 2(4.2%) subject was not available for follow up.

HIE-III: No subject was found to be in 'PASSED' category; 12(80%) were in FAILED category; 1(6.7%) were in 'CAUTION' category; 2(13.3%) subject was not available for follow up.

Fine motor
HIE-I: 37(84.1%) were found to be in 'PASSED' category; 2(4.5%) were in FAILED category; No subject was in 'CAUTION' category; No subject was in 'ADVANCE' category;5(11.4%) were not available for follow up.

HIE-II: 29(60.4%) were found to be in 'PASSED' category; 4(8.3%) were in FAILED category; 13(27.1%) were in 'CAUTION' category; 2(4.2%) subject was not available for follow up.

HIE-III: 3(20%) were found to be in 'PASSED' category; 10(66.7%) were in FAILED category; 2(13.3%) was not available for study.

Language
HIE-I: 36(81.8%) were found to be in 'PASSED' category; 2(4.5%) were in 'FAILED' category; 1(2.3%) were in 'ADVANCE' category; 5(11.4%) were not available for follow up.

HIE-II: 32(66.7%) were found to be in 'PASSED' category; 14(29.2%) were in 'CAUTION' category; 2(4.2%) were not available for follow up.

HIE-III: 2(13.3%) were found to be in 'PASSED' category; 9(60%) were in FAILED category; 2(13.3%) were in 'CAUTION' category; 2(13.3%) were not available for follow up.

PERSONAL
HIE-I: 37(84.1%) were found to be in 'PASSED' category; 2(4.5%) in FAILED category; 5(11.4%) were not available for follow up.

HIE-II: 42(87.5%) were found to be in 'PASSED' category; 4(8.3%) were in 'CAUTION' category; 2(13.3%) were not available for follow up.

HIE-III: 4(26.7%) were found to be in 'PASSED' category; 9(60%) were in FAILED category; 2(13.3%) was not available for study.

NEURO-DEVELOPMENTAL ASSESSMENT AT 12 MONTHS OF AGE
Gross Motor
HIE-I: 36(81.8%) were found to be in 'PASSED' category; 2(4.5%) were in FAILED category; No subject was in 'CAUTION' category; 1(2.3%) were in advance category; 5(11.4%) subject was not available for follow up.

HIE-II: 28(58.3%) were found to be in 'PASSED' category; 3(6.3%) were in FAILED category; 14(29.2%) were in 'CAUTION' category; 2(4.2%) subject was not available for follow up;1(2.1%) were in advance group.

HIE-III: 1(6.7%) were found to be in 'PASSED' category; 12(80%) were in FAILED category; 1(6.7%) were in 'CAUTION' category; 2(13.3%) subject was not available for follow up.

Fine motor
HIE-I: 37(84.1%) were found to be in 'PASSED' category; 2(4.5%) were in FAILED category; No subject was in 'CAUTION' category; No subject was in 'ADVANCE' category; 5(11.4%) were not available for follow up.

HIE-II: 26(54.2%) were found to be in 'PASSED' category; 1(2.1%) were in FAILED category; 19(39.6%) were in 'CAUTION' category; 2(4.2%) subject was not available for follow up.

HIE-III: 3(20%) were found to be in 'PASSED' category; 10(66.7%) were in FAILED category; 2(13.3%) was not available for study.

Language
HIE-I: 37(84.1%) were found to be in 'PASSED' category; 2(4.5%) were in 'FAILED' category; 5(11.4%) were not available for follow up.

HIE-II: 33(68.8%) were found to be in 'PASSED' category; 1111111122(4.2%) were in FAILED category 11(22.9%) were in 'CAUTION' category; 2(4.2%) were not available for follow up.

HIE-III: 4(26.7%) were found to be in 'PASSED' category; 9(60%) were in FAILED category; 2(13.3%) were not available for follow up.

PERSONAL
HIE-I: 37(84.1%) were found to be in 'PASSED' category; 2(4.5%) in FAILED category; 5(11.4%) were not available for follow up.

HIE-II: 39(81.3%) were found to be in 'PASSED' category; 7(14.6%) were in 'CAUTION' category; 2(13.3%) were not available for follow up.

HIE-III: 4(26.7%) were found to be in 'PASSED' category; 9(60%) were in FAILED category; 2(13.3%) was not available for study.

DISCUSSION
This study was an attempt to evaluate the neurodevelopmental outcome of the term neonates with the perinatal asphyxia. Neonates were prospectively followed up at 3months, 6months, 9months, 12 months of age for neurodevelopmental assessment with Denver Developmental Screening Test (DDST II).

107 asphyxiated term newborns were enrolled in our study. However, 4 babies were lost to follow-up and 5 babies died during the study period. Total 98 infants were followed upto 1 year of age in thehigh-risk clinic during the period of January 2016 to July 2017.

We differentiated all the study subjects into three groups according to Sarnat and Sarnat staging of HIE. Out of 150 asphyxiated term newborns, 44 (41.1%) were stage I, 48 (44.9%) stage II and 15 (14%) stage III.

Out of 107 study subjects, 66(61.7%) were delivered by NVD and 41(38.3%) were delivered by LSCS. Female study subjects were 44 (41.9%) in number and 63 (58.9%) were male.

According to the performance of the study subjects in the DDST II they were categorized into 4 groups namely pass, fail, caution, and advance. Analysis of developmental delay using DDST II as follows,
1)   If the baby fails even in one domain, we will consider that the baby has a developmental delay. And/or
2)   If thebaby has caution in two domains, we will consider that baby also asdevelopmentally delayed.

In fine motor we found that the number of patients in fail and caution category in HIE 1, HIE 2 AND HIE 3 were respectively 2(4.5%)&4(9.1%);3(6.3%)&13(27.1%);12(80%)&2(13.3%).

These study subjects were regularly followed up till 1 year of age. At the end of 1 year of age the results showed in fail and caution category in HIE 1, HIE 2 and HIE 3 were respectively 2(4.5%)& no study subject was in caution category; 1(2.1)&19(39.6%);10(66.7%)& no study subject was in caution category.

In gross motor at 3 months we found that the number of patients in fail and caution category in HIE 1, HIE 2 AND HIE 3 were respectively 5(11.4%)&4(9.1%);9(18.8%)&10(20.8%); 14(93.3%)&no study subject was in caution category. These study subjects were regularly followed up till 1 year of age. At the end of 1 year of age the results showed in in fail and caution category in HIE 1, HIE 2 AND HIE 3 were respectively 2(4.5%)&no study subject was in caution category;3(6.3%)&14(29.2%);12(80%)%and no study subject was in caution category.

In language we found that the number of patients in fail and caution category in HIE 1, HIE 2 AND HIE 3 were respectively 2(4.5%) & 1(2.3%);no study subject was in fail category &6(12.5%); 8(53.3%) &5(33.3%).These study subjects were regularly followed up till 1 year of age. At the end of 1 year of age the results showed fail and caution category in HIE 1, HIE 2 AND HIE 3 were respectively 2(4.5%)&no study subject was in cautio category;2(4.2%)&11(22.9%);9(60%)&no

study subject was in caution category.

In personal we found that the number of patients in fail and caution category in HIE 1, HIE 2 AND HIE 3 were respectively 2(4.5%)&2(4.5%); 1(2.1%)&2(4.2%); 7(46.6%)&5(33.3%).These study subjects were regularly followed up till 1 year of age. At the end of 1 year of age the results showed in in fail and caution category in HIE 1, HIE 2 AND HIE 3 were respectively 2(4.5%)&no study subject was in caution category;no study subject was in fail category&7(14.6%);9(60%)&no study subject was in caution category.

At the end of 1 year of age 32(32.6%) out of 98 study subjects were found to be developmentally delayed. The incidence of developmental delay is higher in the HIE III stage study subjects than HIE II and HIE I stages.

The results obtained in this study echoed with the findings of the study conducted by Thoker et al.[7].The incidence of developmental delay in our study (32.6%) and the study by Thoker et al. (31.2%) was similar. Both the studies showed higher rates of developmental delays in HIE III than HIE II and HIE I stages.

Yin-Hsuan La et al.[8] showedslightly lesser incidence of developmental delays in their retrospective hospital-based analysis. 55(23.7%) out of 232 enrolled infants showed neurodevelopmental impairments. However, inclusion, criteria of the study subjects were not limited to neonates with perinatal asphyxia and subjects with epileptic disorders were also included. Hence the comparison between the two studies fraught with difficulties.

The incidence of mild, moderate and severe neurodevelopment handicaps were 23.3%, 20%, and 16.6% respectively in the study conducted by Begum et al.[9] The overall incidence of neurodevelopmental delay in this study was 59.9% which is significantly higher compared to our study. However, there was no grading of the degree of birth asphyxia, the study subjects included both preterm and term and the follow up of the study subjects extended up to two years of age.

The study design employed in our study was similar to the study conducted by Adhikari and Rao[10].In HIE II study subjects, the incidence of fine motor, gross motor and language delays in this study (18.2%, 29.4%,and 19.2% respectively) were higher compared to our study (2.1%, 6.3%,and 4.2% respectively). The variation between the results might have been due to the fact neurodevelopmental assessment was done up to two years of age in this study by Adhikari and Rao.

The study by S. Samatha and P. P. Maiya[11] showed comparable results with regard to neurodevelopmental outcome at one year of age the incidence of normal development in HIE I, HIE II and HIE III were 94.6%, 62.2%,and 23% respectively. These results were similar to those obtained in our study (95.1%, 58.1% and 14% normal development in HIE I, HIE II and HIE III respectively).

The incidence of abnormal neurological outcome was 14% in neonates with perinatal asphyxia in the study conducted by Nazeer et al.[12]these results were lesser compared to our study. There was no grading of the degree of birth asphyxia, term and preterm study subjects were not differentiated, and follow up was done only up to 6 months of age preventing legible comparison with the result of our study.

The results of this study are also comparableto the results obtained by Carli et al. who studied neuro developmental outcome at 1 year of age in the newborn with moderate hypoxic-ischemic encephalopathy. In the latter, 31% of the study subjects showed developmental delay[13].

In a study by Dixon et al. 25% and 62% of the neonates with moderate and severe encephalopathy respectively showed developmental delay. The variation of the neurodevelopmental outcome seen between the moderate and severe encephalopathy is similar to the results obtained in our study. However, the incidence of bad neurological outcome is comparably higher in both the groups in our study where 41% of HIE 2 and 84% of HIE 3 showed neurodevelopmental delay at 1 year of age[14].

At the end of 1year, we found that 28(26.2%) study subjects having abnormal BERA among 98 study subjects.

In a study on birth asphyxiated term neonates at 3 months of age by Misra et al.[15] 43.3% neonates showed some abnormality in BERA waveform. The variation between the results of the two studies might have been due to the difference between the age of the neonates at which BERA was assessed.

In a study on high-risk neonates by Maqbool et al.[16] 62.5% of neonates had a persistent abnormal BERA. The incidence of the abnormal BERA was higher when compared to our study. This might have been due to the exclusion of high-risk neonates other than birth asphyxia in our study.

CONCLUSION

Overall HIE III study subjects have the worst neurological outcome with a greater incidence of delays seen in gross motor, fine motor, personal and language domains. Irrespective of HIE staging gross motor domain was affected more than the other developmental domains. The social domain was the least affected of all developmental domain. The results of the developmental delay were comparable to many of the previous studies except the hearing abnormalities as evident by the BERA results. Further, follow up studies could be helpful to substantiate the results achieved in our study.

Table: Association of DDSTII(3MON)FINE MOTOR and DDSTII(3MON)GROSS MOTOR in three groups.

		I	II	III	TOTAL	Chi-square value	p-value
DDSTII(3MON)FINE MOTOR	**ADVANCE** Row % Col %	1 100.0 2.3	0 0.0 0.0	0 0.0 0.0	1 100.0 0.9	65.1373	<0.00001
	CAUTION Row % Col %	4 21.1 9.1	13 68.4 27.1	2 10.5 13.3	19 100.0 17.8		
	FAIL Row % Col %	2 11.8 4.5	3 17.6 6.3	12 70.6 80.0	17 100.0 15.9		
	NA Row % Col %	2 66.7 4.5	0 0.0 0.0	1 33.3 6.7	3 100.0 2.8		
	PASS Row % Col %	35 52.2 79.5	32 47.8 66.7	0 0.0 0.0	67 100.0 62.6		
	TOTAL Row % Col %	44 41.1 100.0	48 44.9 100.0	15 14.0 100.0	107 100.0 100.0		
DDSTII(3MON)GROSS MOTOR	**CAUTION** Row % Col %	4 28.6 9.1	10 71.4 20.8	0 0.0 0.0	14 100.0 13.1	48.8266	<0.00001
	FAIL Row % Col %	5 17.9 11.4	9 32.1 18.8	14 50.0 93.3	28 100.0 26.2		
	NA Row % Col %	2 66.7 4.5	0 0.0 0.0	1 33.3 6.7	3 100.0 2.8		
	PASS Row % Col %	33 53.2 75.0	29 46.8 60.4	0 0.0 0.0	62 100.0 57.9		
	TOTAL Row % Col %	44 41.1 100.0	48 44.9 100.0	15 14.0 100.0	107 100.0 100.0		

Table: Association of DDSTII(3MON)LANGUAGE and DDSTII(3MON)PERSONAL in three groups.

		I	II	III	TOTAL	Chi-square value	p-value
DDSTII(3MON)LANGUAGE	**`ADVANCE** Row % Col %	0 0.0 0.0	0 0.0 0.0	1 100.0 6.7	1 100.0 0.9	63.4204	<0.00001
	CAUTION Row % Col %	1 9.1 2.3	6 54.5 12.5	4 36.4 26.7	11 100.0 10.3		
	FAIL Row % Col %	2 20.0 4.5	0 0.0 0.0	8 80.0 53.3	10 100.0 9.3		
	NA Row % Col %	2 66.7 4.5	0 0.0 0.0	1 33.3 6.7	3 100.0 2.8		
	PASS Row % Col %	39 47.6 88.6	42 51.2 87.5	1 1.2 6.7	82 100.0 76.6		
	TOTAL Row % Col %	44 41.1 100.0	48 44.9 100.0	15 14.0 100.0	107 100.0 100.0		
DDSTII(3MON)PERSONAL	**CAUTION** Row % Col %	2 22.2 4.5	2 22.2 4.2	5 55.6 33.3	9 100.0 8.4	51.4101	<0.00001
	FAIL Row % Col %	2 20.0 4.5	1 10.0 2.1	7 70.0 46.7	10 100.0 9.3		

		I	II	III	TOTAL		
NA Row % Col %		2 66.7 4.5	0 0.0 0.0	1 33.3 6.7	3 100.0 2.8		
PASS Row % Col %		38 44.7 86.4	45 52.9 93.8	2 2.4 13.3	85 100.0 79.4		
TOTAL Row % Col %		44 41.1 100.0	48 44.9 100.0	15 14.0 100.0	107 100.0 100.0		

Table: Association of DDSTII(6MON)FINE MOTOR and DDSTII(6MON)GROSS MOTOR in three groups.

		I	II	III	TOTAL	Chi-square value	p-value
DDSTII(6MON)FINE MOTOR	**ADVANCE** Row % Col %	2 100.0 4.5	0 0.0 0.0	0 0.0 0.0	2 100.0 1.9	86.9001	<0.00001
	CAUTION Row % Col %	1 3.4 2.3	27 93.1 56.3	1 3.4 6.7	29 100.0 27.1		
	FAIL Row % Col %	2 15.4 4.5	1 7.7 2.1	10 76.9 66.7	13 100.0 12.1		
	NA Row % Col %	5 55.6 11.4	2 22.2 4.2	2 22.2 13.3	9 100.0 8.4		
	PASS Row % Col %	34 63.0 77.3	18 33.3 37.5	2 3.7 13.3	54 100.0 50.5		
	TOTAL Row % Col %	44 41.1 100.0	48 44.9 100.0	15 14.0 100.0	107 100.0 100.0		
DDSTII(6MON)GROSS MOTOR	**ADVANCE** Row % Col %	2 66.7 4.5	1 33.3 2.1	0 0.0 0.0	3 100.0 2.8	78.3454	<0.00001
	CAUTION Row % Col %	3 12.5 6.8	20 83.3 41.7	1 4.2 6.7	24 100.0 22.4		
	FAIL Row % Col %	2 12.5 4.5	2 12.5 4.2	12 75.0 80.0	16 100.0 15.0		
	NA Row % Col %	5 55.6 11.4	2 22.2 4.2	2 22.2 13.3	9 100.0 8.4		
	PASS Row % Col %	32 58.2 72.7	23 41.8 47.9	0 0.0 0.0	55 100.0 51.4		
	TOTAL Row % Col %	44 41.1 100.0	48 44.9 100.0	15 14.0 100.0	107 100.0 100.0		

Table: Association of DDSTII(6MON)LANGUAGE and DDSTII(6MON)PERSONAL in three groups.

		I	II	III	TOTAL	Chi-square value	p-value
DDSTII(6MON) LANGUAGE	**ADVANCE** Row % Col %	6 100.0 13.6	0 0.0 0.0	0 0.0 0.0	6 100.0 5.6	72.5723	<0.00001
	CAUTION Row % Col %	2 11.8 4.5	12 70.6 25.0	3 17.6 20.0	17 100.0 15.9		
	FAIL Row % Col %	0 0.0 0.0	0 0.0 0.0	8 100.0 53.3	8 100.0 7.5		
	NA Row % Col %	5 55.6 11.4	2 22.2 4.2	2 22.2 13.3	9 100.0 8.4		
	PASS Row % Col %	31 46.3 70.5	34 50.7 70.8	2 3.0 13.3	67 100.0 62.6		
	TOTAL Row % Col %	44 41.1 100.0	48 44.9 100.0	15 14.0 100.0	107 100.0 100.0		
DDSTII(6MON) PERSONAL	**ADVANCE** Row % Col %	3 100.0 6.8	0 0.0 0.0	0 0.0 0.0	3 100.0 2.8	69.4313	<0.00001

CAUTION Row % Col %	2 11.1 4.5	14 77.8 29.2	2 11.1 13.3	18 100.0 16.8	
FAIL Row % Col %	0 0.0 0.0	0 0.0 0.0	8 100.0 53.3	8 100.0 7.5	
NA Row % Col %	5 55.6 11.4	2 22.2 4.2	2 22.2 13.3	9 100.0 8.4	
PASS Row % Col %	34 49.3 77.3	32 46.4 66.7	3 4.3 20.0	69 100.0 64.5	
TOTAL Row % Col %	44 41.1 100.0	48 44.9 100.0	15 14.0 100.0	107 100.0 100.0	

Table: Association of DDSTII(9MON)FINE MOTOR and DDSTII(9M0N)GROSS MOTOR

		I	II	III	TOTAL	Chi-square value	p-value
DDSTII(9MON)FINE MOTOR	**CAUTION** Row % Col %	0 0.0 0.0	13 100.0 27.1	0 0.0 0.0	13 100.0 12.1	56.6649	<0.00001
	FAIL Row % Col %	2 12.5 4.5	4 25.0 8.3	10 62.5 66.7	16 100.0 15.0		
	NA Row % Col %	5 55.6 11.4	2 22.2 4.2	2 22.2 13.3	9 100.0 8.4		
	PASS Row % Col %	37 53.6 84.1	29 42.0 60.4	3 4.3 20.0	69 100.0 64.5		
	TOTAL Row % Col %	44 41.1 100.0	48 44.9 100.0	15 14.0 100.0	107 100.0 100.0		
DDSTII(9M0N)GROSS MOTOR	**ADVANCE** Row % Col %	2 100.0 4.5	0 0.0 0.0	0 0.0 0.0	2 100.0 1.9	66.0557	<0.00001
	CAUTION Row % Col %	0 0.0 0.0	11 91.7 22.9	1 8.3 6.7	12 100.0 11.2		
	FAIL Row % Col %	2 10.5 4.5	5 26.3 10.4	12 63.2 80.0	19 100.0 17.8		
	NA Row % Col %	5 55.6 11.4	2 22.2 4.2	2 22.2 13.3	9 100.0 8.4		
	PASS Row % Col %	35 53.8 79.5	30 46.2 62.5	0 0.0 0.0	65 100.0 60.7		
	TOTAL Row % Col %	44 41.1 100.0	48 44.9 100.0	15 14.0 100.0	107 100.0 100.0		

Table: Association of DDSTII(9M0N)LANGUAGE and DDSTII(9M0N)PERSONAL in three groups.

		I	II	III	TOTAL	Chi-square value	p-value
DDSTII (9M0N) LANGUAGE	**ADVANCE** Row % Col %	1 100.0 2.3	0 0.0 0.0	0 0.0 0.0	1 100.0 0.9	66.8907	<0.00001
	CAUTION Row % Col %	0 0.0 0.0	14 87.5 29.2	2 12.5 13.3	16 100.0 15.0		
	FAIL Row % Col %	2 18.2 4.5	0 0.0 0.0	9 81.8 60.0	11 100.0 10.3		
	NA Row % Col %	5 55.6 11.4	2 22.2 4.2	2 22.2 13.3	9 100.0 8.4		
	PASS Row % Col %	36 51.4 81.8	32 45.7 66.7	2 2.9 13.3	70 100.0 65.4		
	TOTAL Row % Col %	44 41.1 100.0	48 44.9 100.0	15 14.0 100.0	107 100.0 100.0		

DDSTII(9M0N)PERSONAL	CAUTION Row % Col %	0 0.0 0.0	4 100.0 8.3	0 0.0 0.0	4 100.0 3.7	55.1064	<0.00001
	FAIL Row % Col %	2 18.2 4.5	0 0.0 0.0	9 81.8 60.0	11 100.0 10.3		
	NA Row % Col %	5 55.6 11.4	2 22.2 4.2	2 22.2 13.3	9 100.0 8.4		
	PASS Row % Col %	37 44.6 84.1	42 50.6 87.5	4 4.8 26.7	83 100.0 77.6		
	TOTAL Row % Col %	44 41.1 100.0	48 44.9 100.0	15 14.0 100.0	107 100.0 100.0		

Table: Association of DDSTII(12MON)FINEMOTOR and DDSTII(12MON)GROSS MOTOR in three groups.

		I	II	III	TOTAL	Chi-square value	p-value
DDSTII(12MON)FINEMOTOR	CAUTION Row % Col %	0 0.0 0.0	19 100.0 39.6	0 0.0 0.0	19 100.0 17.8	76.3085	<0.00001
	FAIL Row % Col %	2 15.4 4.5	1 7.7 2.1	10 76.9 66.7	13 100.0 12.1		
	NA Row % Col %	5 55.6 11.4	2 22.2 4.2	2 22.2 13.3	9 100.0 8.4		
	PASS Row % Col %	37 56.1 84.1	26 39.4 54.2	3 4.5 20.0	66 100.0 61.7		
	TOTAL Row % Col %	44 41.1 100.0	48 44.9 100.0	15 14.0 100.0	107 100.0 100.0		
DDSTII(12MON)GROSS MOTOR	ADVANCE Row % Col %	1 50.0 2.3	1 50.0 2.1	0 0.0 0.0	2 100.0 1.9	75.1145	<0.00001
	CAUTION Row % Col %	0 0.0 0.0	14 100.0 29.2	0 0.0 0.0	14 100.0 13.1		
	FAIL Row % Col %	2 11.8 4.5	3 17.6 6.3	12 70.6 80.0	17 100.0 15.9		
	NA Row % Col %	5 55.6 11.4	2 22.2 4.2	2 22.2 13.3	9 100.0 8.4		
	PASS Row % Col %	36 55.4 81.8	28 43.1 58.3	1 1.5 6.7	65 100.0 60.7		
	TOTAL Row % Col %	44 41.1 100.0	48 44.9 100.0	15 14.0 100.0	107 100.0 100.0		

Table: Association of DDSTII(12MON)LANGUAGE and DDSTII(12MON)PERSONAL in three groups.

		I	II	III	TOTAL	Chi-square value	p-value
DDSTII(12MON)LANGUAGE	CAUTION Row % Col %	0 0.0 0.0	11 100.0 22.9	0 0.0 0.0	11 100.0 10.3	53.6532	<0.00001
	FAIL Row % Col %	2 15.4 4.5	2 15.4 4.2	9 69.2 60.0	13 100.0 12.1		
	NA Row % Col %	5 55.6 11.4	2 22.2 4.2	2 22.2 13.3	9 100.0 8.4		
	PASS Row % Col %	37 50.0 84.1	33 44.6 68.8	4 5.4 26.7	74 100.0 69.2		
	TOTAL Row % Col %	44 41.1 100.0	48 44.9 100.0	15 14.0 100.0	107 100.0 100.0		
DDSTII(12MON)PERSONAL	CAUTION Row % Col %	0 0.0 0.0	7 100.0 14.6	0 0.0 0.0	7 100.0 6.5	58.3551	<0.00001
	FAIL Row % Col %	2 18.2 4.5	0 0.0 0.0	9 81.8 60.0	11 100.0 10.3		

NA	5	2	2	9		
Row %	55.6	22.2	22.2	100.0		
Col %	11.4	4.2	13.3	8.4		
PASS	37	39	4	80		
Row %	46.3	48.8	5.0	100.0		
Col %	84.1	81.3	26.7	74.8		
TOTAL	44	48	15	107		
Row %	41.1	44.9	14.0	100.0		
Col %	100.0	100.0	100.0	100.0		

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