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Original Research Article

Neurodevelopmental outcomes in newborns with birth asphyxia with special reference to hearing and visual impairment

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ABSTRACT

Background: Birth asphyxia, the commonest cause of neonatal hospital admission with involvement of majority of an infant's organs but brain impairment is particularly worrisome. Early, severe neurologic dysfunction indicates significant hypoxic-ischemic insult and is the best predictor of neurologic sequelae. The survivors suffer from hypoxic–ischemic brain injury affecting vulnerable areas of the brain leading to neurodevelopmental sequelae including problems with sensory-motor, auditory and language processing.
Methods: This prospective cohort study conducted at Neonatal Section of JNMCH, AMU, Aligarh included 150 asphyxiated newborns fulfilling inclusion criteria. The discharged newborns were followed at 6,10 and 14 weeks and 6 months for neurological assessment using HINES along with screening assessment of visual and hearing. The findings noted compared with different Stages of HIE.
Results: Among a total of 150 eligible asphyxiated newborn enrolled in the study, 91 babies were discharged. 89% of the Stage I HIE discharged infant had HINES score of more than 70 at 6 months whereas score of more than 65 was seen in 96%, 81% and 35% in the three advancing stages of HIE respectively. All babies in stage I, 77% of stage II and 50% of stage III babies had normal ophthalmological examination. All babies with stage III had an abnormal hearing.
Conclusions: Majority of asphyxiated newborn of Stage I and II were having good hospital as well as neurodevelopment and visual outcome but the Stage III babies had high mortality and adverse neurological, ophthalmic and hearing sequalae in the survivors.

Keyword: Birth asphyxia, HINES score, CP

INTRODUCTION

Birth Apshyxia results in 23% of neonatal deaths and 10% of all under 5 deaths in children globally.[1] It is one of three leading causes of perinatal and neonatal mortality and morbidity especially in developing countries. In addition, it is an important preventable cerebral injury occurring in neonatal periods.[2] Cerebral palsy, mental retardation, and epilepsy are some of the frequent sequelae. Other persistent long-term issues include Intellectual disability and attention deficit hyperactivity disorder (ADHD), autism, and schizophrenia.[3]

One million children who survive birth asphyxia around the world have been identified to have permanent neurodevelopmental conditions such cerebral palsy, mental retardation, and learning difficulties.[4] In India the reported incidence varies from 2 to 16.2%.[5] with the reported case fatality rates ranging from 38.5 to 74%. The frequency of asphyxia is higher in preterm infants than in full-term infants and is inversely related to gestational age and birth weight.[6]

The likelihood of long-term consequences varies with HIE severity. Infants who survive severe HIE can experience

substantial complications in up to 80% of cases, moderately severe disability in 10-20% of cases, and normal development in up to 10% of cases. Infants who survive moderately severe HIE may experience substantial long-term problems in 30-50% of cases, and modest neurological morbidities in 10-20% of cases.

Objectives

Objectives of current study were to determine the neurodevelopmental outcome of asphyxiated new-borns with special reference to visual and hearing impairment and to assess the neurological outcome at discharge and follow up using hammersmith infant neurological examination (HINE).

Gaps in knowledge

There are number of studies on the neurological development in birth asphyxiated patient but the study regarding the subject is lacking and moreover here the methods used were more objective in assessment and therefore interpretations.

METHODS

Study design, location and duration

Current study was a prospective cohort study conducted at neonatology section of department of pediatrics in collaboration with Department of Gynaecology and Obstetrics, JNMC, AMU, Aligarh from December 2020 to October 2022.

Study population

All new-borns with birth asphyxia fulfilling the inclusion criteria and admitted in the Neonatal Division of department of Pediatrics, Jawaharlal Nehru Medical College and Hospital, NICU (Neonatal Intensive Care Unit), JNMCH, AMU, Aligarh were included in the study.

Inclusion criteria

Inclusion criteria were; Term (37-41 week 5 days gestational age) and late preterm (34-36 week 5 days gestational age) newborns. Newborns satisfying the American Academy of Pediatrics/American College of Obstetrician criteria of Birth Asphyxia. (At least two out of four criteria).[7] Profound metabolic acidosis or mixed acidemia (pH <7.0). Persistence of Apgar score 0-3 for longer than 5 minutes. Neonatal neurologic sequelae (seizure, coma, hypotonia) and Multiple Organ involvement (kidney, lungs, liver, heart, intestine).

Exclusion criteria

Exclusion criteria were; Early preterm (<34-week gestational age) and Babies with an antenatally diagnosed significant congenital malformation or clinically suspected TORCH infection.

Total 150 newborns (late preterm and term), who experienced asphyxia upon delivery were enrolled in the study. Maternal profile and risk factors as well as intrapartum complications were also documented. The distinct newborn parameter at birth, the findings on detailed clinical examination as well as reports of investigations were documented. The neurological examination included a detailed assessment in the form of Sarnat and Sarnat system for Hypoxic Ischemic Encephalopathy. The newborns who survived and discharged went through baseline neurological, hearing as well as ophthalmological assessment. For the late neurological outcomes, neurological examination was done using Hammersmith Infant Neurological Examination (HINE), subsequent hearing assessment via OAE and BERA and visual evaluation up to 6 months of age during their follow up in the well-baby clinic and high-risk clinic.

Statistical analysis

Continuous data was summarized as mean and standard deviation and categorial data was expressed as frequencies and percentages. Statistical analysis was done by using latest version of SPSS (Statistical package for social science). Chi square test and ANNOVA was used to calculate between two groups, p value of less than 0.05 was considered significant.

RESULTS

Out of 150 (111 term and 39 late preterm) cases taken under study, 56 (37.4%) were stage I HIE, 29 (19.3%) were Stage II HIE and 65 (43.3%) were of HIE Stage III. 74 (49%) were male cases and 76 (51%) were female cases.

Table 1: Distribution of HIE in study population.

Stage of HIE	N (%)
I	56 (37.3)
II	29 (19.3)
III	65 (43.3)

The bag and mask technique were used for revive the babies in 82.7% (N=124), however in 22 (15%) babies invasive breathing with endotracheal tube placement was necessary, and 4 (3%) of the babies undergone chest compressions and concurrent medication use. The majority of neonates with asphyxia had normal birth weights with mean weight of 2.59±0.88. Mean Gestational Age found to be 37.4±3.4 weeks. Most of them delivered by lower section caesarean section with 72% (N=108) of deliveries had MSAF stained amniotic fluid. Majority babies had APGAR score of less than 5. The mean pH found in initial post-natal hour was 7.06±0.28 with the range of 6.80-7.40. The average lactates found were

11.1±5.7 (mmol/l) ranging from 2.60 mmol/l to more than 15mmol/l.

Table 2: Demographic variable in study population.

Variables		N (%)
Gender	Male	74 (49)
	Female	76 (51)
Birth weight	Low birth weight (Lbw)	58 (38.7)
	Normal birth weight	92 (61.3)
Gestational age	Term	111 (74)
	Late preterm	39 (26)
Mode of delivery	Normal Delivery	62 (41.3)
	Lower section caesarean section(LSCS)	88 (58.7)
Amniotic fluid	Clear Amniotic Fluid	42 (28)
	Meconium stained	108(72)
Malpresentation		11 (7.3)
Cord prolapse		5 (3.3)
PROM		53 (35.3)
PIH		53 (35.3)
Maternal anemia		124 (82.7)
ANC visit	Booked	60 (40.0)
	Emergency	65 (43.3)
	Registered	25 (16.7)
Maternal age (years)	≤ 20	6 (4)
	21 -30	129 (86)
	More Than 30	15 (10)

Out of 56 new-borns in stage 1 HIE, 55(98.2%) were discharged and only 1 (1.8%) expired. While stage 2 HIE was seen in 29 cases and 27 (93.1%) cases in this group were discharged with mortality of only 2(6.9%) neonates. Among 65 cases with HIE stage 3, there was high mortality rate as observed in 57 (87.7%) cases. Only 8 (12.3%) of them were discharged. Therefore, a total of 90 babies were discharged from the hospital in which the expiry was predominantly seen in babies with Stage III HIE. During follow up, a HINES score of more than 65 was seen in 96%, 81% and 35% in the three advancing stages of HIE respectively.

Table 3: Hospital outcome of birth asphyxiated newborns.

Hospital outcome	Discharged N (%)	Expired N (%)
HIE I	55 (98)	1 (2)
HIE II	27 (93)	2 (7)
HIE III	8 (12)	57 (88)

All Stage 1 HIE cases (54) had normal vision on follow up. 6 (23.1%) out of 26 cases in HIE stage 2 showed vision abnormality while 20 (76.9%) were having normal vision. Among HIE stage 3 cases 4(50%) had abnormal vision and 4 (50%) had normal vision. Therefore, all babies in stage 1 had normal ophthalmological examination while two-third of stage 2 and half of stage 3 babies had a normal assessment. Hearing assessment was normal in all 54 cases in stage 1 HIE. Among 26 stage 2 HIE cases 25 (96.2%) showed normal hearing while 1 (3.8%) had abnormal hearing. Hearing abnormality was found in all cases of HIE stage 3 hence all babies with stage 3 had an abnormal hearing screening.

Table 4: Follow up outcomes of asphyxiated newborns.

HINES Score	Stage of HIE	<65	65-70	>70
	HIE I	3 (5)	0	52 (95)
	HIE II	8 (12)	2 (25)	17 (63)
	HIE III	6 (75)	2 (25)	0
Visual impairment	HIE I	0		
	HIE II	6 (23.1)		
	HIE III	4 (50)		
Hearing impairment	HIE I	0		
	HIE II	1 (3.8)		
	HIE III	8 (100)		

DISCUSSION

The advanced stage of HIE were associated with adverse short-term outcome as well as long term neurological sequalae. The results are in conformity to study by Thornberg and Mohan et al and several other authors who similarly reported that the cases of severe asphyxia had high mortality have reported increased risk of mortality in different clinical setting.[8-11] A study by an Australian group has reported less mortality among babies with neonatal encephalopathy. However, the authors had a smaller number of asphyxiated babies in the study group. The reason for high mortality in our centre may due to the fact that ours is a tertiary care centre where many mothers are referred late from the distant peripheral hospitals and the babies thereby bear the brunt of asphyxia insult. We used the HINES system of classification for the assessment of neurological status which has a good predictive power for motor outcome in both preterm and term born infants.[12,16] We classified HINE score in three categories namely Less than 65, 65 to 70, and more than 70. Our results have confirmed the previous observations by Romeo et al[14]who study the optimality score and concluded that infants with sub-optimal scores <67 were always associated with motor impairment. Previous researches reported cut-off scores similar to those of our study that infants with a global score <56 and < 65 had a high probability to develop CP at 3 months and 12 months respectively.[17,18] Considering the different types of CP, the HINE scores could be used to identify only infants with severe CP, the sensitivity is very low.[19]

We describe visual outcome among cases in different stages of HIE. Our findings were similar to those describe by Salati et al who reported 63.1% cases with visual impairment in visual acuity, ocular motility and fundus finding.[20] Azzopardi et al reported 10% visual impairment not corrected by glasses or blindness reported by

questionnaire.[21] However, they have employed subjective tools for visual assessment. Similar degree of vision impairment in different form is evident in many previous studies.[20,22-24] Our results support the correlation between neonatal HIE and later visual impairment. However, variability in diagnosing, treating and measuring the severity of HIE and lack of robust and validated visual function tests often hinder the studies on visual impairment in very young children.

Our finding on hearing was consistent with the recent study by Aziza et al where a clear correlation between the degree of hearing impairment in infants and the degree of CNS involvement is reported.[25] The degree of impairment of the auditory analyser increased parallel with the degree of severity of asphyxia. Hamed et al found significant association of permanent hearing loss with patient of HIE who had PPHN.[26] Similar finding was quoted study of Fitzgerald et al.[27] The study by Michniewicz et al[27] of the 49 infants who returned for follow-up assessment, 4 (8.2%) were diagnosed with sensorineural bilateral hearing impairment. The prevalence of hearing impairment in our study was low as compared to other studies. The reason for this difference is that these studies were done at earlier ages. It has been found that in dynamic studies, peripheral hearing impairment in newborns with asphyxia is transient in nature and can normalizes by 6 months of life.[25]

Limitations

Our study was conducted in the tertiary care centre were most of the mothers were referred due to one of more labour complications. This major reason had caused significant contribution in the frequency of this birth complications. Also, our study was to follow the survivors of birth asphyxia for up to 6 months. Although we can predict the forthcoming neurological impairment at this early age, there is need for further monitoring of these child for better correlation of the neurodevelopment outcomes. We had only few survivors of severely asphyxiated babies on which study findings were documented. Last but not least, in the era of advanced imaging modality, these cases must be subjected to MRI scans that would not just disclose the real scenario of brain involvement, but also help in framing prognosis of the suffered child.

CONCLUSION

From current study, it is interfered that birth asphyxia is preventable cause of neonatal morbidity and mortality. There are multiple causes for this terrible birth complication which should be addressed to prevent its feared sequalae. The more advance the severity of Birth asphyxia, the more is the catastrophic consequences. Most of the asphyxiated babies of mild and moderate degree had favourable hospital as well as follow up outcomes. But it was found that severe birth asphyxia was associated with high mortality and those who survived had poorer neurodevelopmental, vision and hearing problems. These consequences when occurs not just hamper the child's life but made it difficult for the parents in handling them. Therefore, identifying these neurologically impaired children at an early stage with regular and timely monitoring by HINES score and basic hearing and vision evaluation tools could significantly reshape the adverse neurological sequalae by early interventions.

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