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Original Research Article

Prospective Observational Assessment of Hearing Impairment in Newborns Admitted to A Neonatal Intensive Care Unit (NICU) Study

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Abstract

Introduction: Hearing is essential for humans to communicate with one another. Early diagnosis of hearing loss and intervention in neonates and infants can reduce developmental problems. The aim of the present study was to assess the prevalence of hearing impairment in newborns admitted to a neonatal intensive care unit (NICU) and analyze the associated risk factors.

Methods: Prospective observational study was conducted among neonates with birth asphyxia admitted to the NICU at RIMS, Ranchi, Jharkhand, India, from November 2020 to October 2021. Auditory function was examined by Otoacoustic emission (OAE) followed by auditory brainstem response (ABR) test and distortion product OAE (DPOAE). Statistical analysis, Chi-square test was used, and testing data was analyzed using the SPSS software version 22.

Results: Among the 100 neonates, most of the babies i.e., 14 (63.3%) had mild grade of hearing loss. Three babies (13.63%) had severe grade of hearing loss. The statistically significant risk factors for development of hearing impairment in babies with birth asphyxia were - Hypoxic ischemic encephalopathy (P=0.00817) and mechanical ventilation (P=0.0003).

Conclusion: Auditory function in neonates who are admitted to a NICU, especially those treated with oxygen or antibiotics and those born prematurely, should be assessed during their stay in Hospital. The importance of early diagnosis of hearing loss and intervention in these neonates and avoidance of any unnecessary oxygen or antibiotic therapy needs to be further promoted.

Keywords: Neonates, Birth asphyxia, NICU.

Introduction

Hearing is a vital part of a newborn's contact with his environment. The ability to communicate, acquire skills and perform academically is all greatly dependent on the ability to hear [1]. Hearing impairment is a hidden disability which is usually detected after 2 years of age [2]. OAE and ABR have been recommended as useful screening protocol in Newborn Hearing Screening [3]. OAE screening test is fast and easy test and can be conducted with or without sedation to newborn [4].

Consequences of perinatal asphyxia range from death to various degrees of neuro-developmental sensory or motor deficits. One of its well-known sequelae is sensorineural hearing impairment. Adequate oxygenation and perfusion are essential for inner ear function and studies showed that neonatal asphyxia can cause inner ear degeneration, disappearance of the outer and inner hair cells, and degeneration of the spiral and vestibular ganglion cells [5].

Recent advances in neonatal medicine have increased the survival rate of newborns, especially those admitted to neonatal intensive care units (NICUs). Due to problems such as prematurity, low APGAR scores, infection, and hyperbilirubinemia, and the risks associated with treatment strategies including mechanical ventilation, oxygen therapy, administration of antibiotics and other medications, infants in NICUs face various problems including hearing impairment. Significant hearing loss is the most common disorder at birth, occurring in 1 to 2 newborns per 1000 in the general population and 24% to 46% [6,7] of newborns who are admitted to a NICU.

The incidence of hearing impairment in neonates in Iran has been shown to 8% in high-risk neonates and 16% in neonates in intensive care [8].

Congenital or early childhood onset of deafness or severe-to-profound hearing impairment, as reported by the World Health Organization (WHO), is encountered in approximately 0.5–5 per 1,000 neonates and infants [9]. United States Preventive Services Task Force reported that the prevalence of neonatal hearing loss in the Neonatal Intensive Care Unit (NICU) is 10-20 times greater than the prevalence of hearing loss in a population of normal neonates [10].

Various studies have analyzed the cost of auditory screening in the neonatal period as well as the differences between the methods available [11]. The objective of the present study was to assess the prevalence of hearing impairment in newborns admitted to a NICU.

Materials and Methods

Prospective observational study was conducted among neonates with birth asphyxia admitted to the NICU at RIMS, Ranchi, Jharkhand, India, from November 2020 to October 2021

Inclusion Criteria:

Term neonates born with birth asphyxia defined as Apgar score of < 7 at 1 minute were included in the study as defined by WHO Southeast Asia, Neonatal Perinatal Mortality Database working definition of Birth Asphyxia [12].

Exclusion criteria:

Neonate with any congenital anomalies was excluded.

Data Collection:

Five components were used to assess the Apgar score– Heart rate, Respiration, Muscle tone, Reflex irritability and Color. Apgar score was performed at 1 minute, 5 minutes of birth and every 5 minutes for up to 20 minutes, if the 5-minute Apgar score was below 7.

Moderate birth asphyxia was defined as Apgar score between 4 to 6 at 1-minute of age severe birth asphyxia as Apgar score of 3 or less at 1-minute of age. A detailed history and clinical examination done and documented in preformed proforma. Newborns with birth asphyxia were screened by OAE -1 (First screening) by trained Audiologist in acoustically treated room before discharge. Results were interpreted as pass for normal hearing and ‘refer’ for who needed further evaluation. Follow up OAE-2 (Second screening) was done in ‘refer’ cases after 10 to 14 days.

ABR was done immediately for confirmation of hearing impairment in those cases with OAE-2 results as ‘refer’.

Those newborns showing hearing impairment by ABR was referred for further management to otorhinolaryngologist.

OAE Test procedure: OAE screening was done in an acoustically treated sound chamber in Department of Audiology only after removal of debris from external auditory canal and examination by an otorhinolaryngologist. OAE screening was carried out in order to avoid high referrals due to middle ear pathology. The screening was carried out using Biologic Natus AUDX Pro instrument. DPOAE screening was carried out at 5 kHz, 4 kHz, 3 kHz and 2 kHz for each ear separately. Clean and appropriate probe fit, minimum noise levels were ensured during the testing. 2 attempts of recording were done. Results were recorded as either 'pass' (normal functioning) or 'refer' (poor functioning).

Auditory Brainstem Response Testing procedure: Auditory brainstem responses were recorded in infants when a refer result is obtained in second stage of OAE screening. ABR was carried out using Biologic Natus Navigator PRO diagnostic instrument. Negative electrodes were placed in horizontal montage on the test ear mastoid, positive on non-test ear mastoid and ground electrode over forehead. Impedance is maintained at <5k ohms at all electrode sites. The following recording, stimulus and acquisition parameters were set before carrying out the test.

Classification of hearing loss: Clark's classification

- 10 to 15 dB - Normal hearing
- 16 to 25 dB - Minimal hearing loss
- 26 to 40 dB - Mild hearing loss
- 41 to 55 dB - Moderate hearing loss
- 50 to 70 dB - Moderately severe hearing loss
- 71 to 90 dB - Severe hearing loss
- >90 dB - Profound hearing loss

Statistical analysis:

Data was entered in and analyzed using the SPSS software version 22.0. Test result was considered significant if p value was less than 0.05.

Results:

During the study period, 1894 newborns were admitted in inborn RIMS, Ranchi. Jharkhand, India. Among them 504 babies were admitted for birth asphyxia out of which 371 were term babies who had birth asphyxia. One hundred term babies with birth asphyxia met the inclusion criteria.

Table 1 shows the baseline characteristics of 100 neonates with birth asphyxia.

As shown in table 2, in our study most of the babies i.e., 14 (63.3%) had mild grade of hearing loss. Three babies (13.63%) had severe grade of hearing loss.

The comparison of various risk factors associated with hearing loss in babies with birth asphyxia is shown in Table 3. In our study only 24.35% (19/78) babies with moderate birth asphyxia had hearing impairment as compared to 33.3% (6/18) babies with severe birth asphyxia had hearing impairment and the difference was statistically significant(P=0.00037). The statistically significant risk factors for development of hearing impairment in babies with birth asphyxia were - Hypoxic ischemic encephalopathy (P=0.00817) and mechanical ventilation (P=0.0003).

Table 4 shows multivariate analysis of various risk factors associated with development of hearing impairment in babies with birth asphyxia. HIE was found to be associated with development of hearing impairment in babies with birth asphyxia (P=0.005, OR-11.87, CI-1.89-50.21).

Table 1: Baseline Characteristics of Babies

Characteristic	Category		N	%Age	Mean ± SD
Gender	Male		52	52	-
	Female		48	48	-
Birth weight	<2.5 kg		31	31	2.05 ± 0.21
	>2.5kg		69	69	
Consanguinity	Consanguineous		43	43	-
	Non consanguineous		57	57	-
Mode of delivery	NVD		75	75	-
	LSCS		25	25	-
	Instrumental delivery		17	17	-
Meconium Aspiration Syndrome (MAS)	Yes		41	41	-
	No		59	59	-
Apgar at 1 minute	4 to 6 (moderate birth asphyxia)		87	87	-
	≤ 3 (severe birth asphyxia)		13	13	
HIE	HIE of any stage	Stage 1	19		-
		Stage 2	34		-
		Stage 3	8		-
		Total	61		-
	No HIE		67	67	-
Hyperbilirubinemia requiring	Phototherapy		27	27	-
	Exchange transfusion		0	0	-
Sepsis	Yes		21	21	-
	No		79	79	-
Meningitis	Yes		4	4	-
	No		96	96	-
Mechanical ventilation	Yes		17	17	-
	No		83	83	-
Duration of Mechanical ventilation	< 5 days		20	90.9 n=22	-
	> 5 days		09	40.9 n=22	-

Table 2: Grades of Hearing Loss (N=22)

Classification of hearing loss	Right EAR	Left EAR	Bilateral	Total
Mild	1	2	10	14
Moderate	1	1	2	4
Moderately Severe	1	0	1	02
Severe	1	1	1	03
Total	04	04	14	22

Table 3: Table Comparing Various Risk Factors Associated with Hearing Loss in Birth Asphyxia Babies

Characteristics	Category	Hearing Impairment N=22	Normal Hearing	Total no. of babies with birth Asphyxia N=100	P value
Gender	Male	11	78	81	0.417
	Female	11	66	51	
Birth weight	<2.5 kg	7	40	32	0.917
	>2.5 kg	15	88	87	
MAS	Yes	6	45	43	0.918
	No	16	61	67	
Apgar at 1 minute	4 to 6 (moderate birth asphyxia)	19	87	78	0.0003
	≤ 3 (severe birth asphyxia)	3	10	13	
HIE of any Stage	Yes	12	32	41	0.00817
	No	10	40	67	
HIE	Stage 1	5	8	6	0.0871
	Stage 2	10	21	24	
	Stage 3	7	10	6	
Hyperbilirubinemia requiring Phototherapy	Yes	2	12	19	0.9017
	No	20	95	84	
Sepsis	Yes	3	6	10	0.0518
	No	19	78	91	
Meningitis	Yes	3	0	6	0.251
	No	13	127	79	
Mechanical ventilator	Yes	7	8	18	0.0002

Table 4: Multiple logistic regression analysis of hearing impairments with other variables

Independent variables	Adjusted OR	Std. Err.	Z -value	P -value	95% CI for OR	
					Lower	Upper
Gender	0.72	0.15	- 0.5400	0.425	0.21	2.9
HIE	11.87	09.81	3.200	0.005*	1.89	50.21

Convulsions	0.20	0.11	- 1.200	0.6187	0.21	1.23
Sepsis	0.67	0.41	- 0.2500	0.3167	0.08	2.33
Mechanical ventilation	0.12	2.12	- 0.2100	0.6198	0.06	11.89

Discussion:

It is generally accepted that screening for hearing loss in neonates is crucial, and it has been reported that the use of a universal newborn hearing screening is more valuable than screening just those who have been admitted to a NICU [13]. Recognizing and treating hearing loss in its early phase is of critical value, but the economic aspects of screening should be considered. [11]

Perinatal asphyxia is a condition characterized by an impairment of the exchange of respiratory gases resulting in hypoxemia and hypercarbia, accompanied by metabolic acidosis. The consequences of perinatal asphyxia can range from death to various degrees of neurodevelopment sensory or motor deficits. One of the well-known consequences of birth asphyxia is sensorineural hearing loss. Auditory nucleus (Dorsal cochlear nuclei) in the brainstem is very sensitive to hypoxia and hearing loss in babies with birth asphyxia is due to damage to this brainstem nucleus.[14]

Severe hypoxia will cause irreversible damage to the cochlea including outer hair cells and edema of stria vascular, is which leads to change in the sound waves of mechanical form into electrochemical energy along with damage to the fibers of the auditory nerve, so auditory signals can't be passed on to the brainstem. Joint committee on infant hearing suggests that babies with Apgar score of 0-4 at 1 minute and 0-6 at 5 minutes are at risk of having hearing impairment [15]. In our study, we included babies with both moderate and severe birth asphyxia. Three babies (13.63%) had severe grade of hearing loss. The statistically significant risk factors for development of hearing impairment in babies with birth asphyxia were - Hypoxic ischemic encephalopathy (P=0.00817) and mechanical ventilation (P=0.0003).

In order to determine the relative risk factors associated with hearing loss in neonates we considered only those who had be admitted to the NICU as the incidence of hearing impairment is 24% to 46% in this group. Infants were tested using OAE and ABR, which has been suggested by previous reports to be a successful two step screening protocol for at risk babies. [16, 17]

A Study conducted by Binay C et al who included the babies having Apgar score of 0-4 at 1 minute or 0-6 at 5 min, found no hearing impairment [18]. Nagpoornima et al conducted a study who included babies with severe birth asphyxia requiring ventilation found the prevalence of 1.9% [19].

Majority of the babies in our study i.e., 72.5% (45/62) had stage 2 HIE. When hearing, impairment was compared with different stages of HIE, it was found that babies with stage 3 HIE were more prone to develop hearing impairment as compared to babies with other stages of HIE. This finding suggests that as the severity of hypoxia increases the chances of baby developing the hearing impairment increases. These findings are similar to study conducted by Mishra et al [19]. Neonatal convulsions have been reported to be a risk factor for abnormal hearing [20]. In our study, there was a statistically significant relationship between convulsions and hearing impairment (P=0.0093).

In our study, we found that babies with birth asphyxia who were mechanically ventilated were more prone for development of

hearing impairment as compared to babies who were not mechanically ventilated.

Conclusion:

In conclusion we would like to stress the importance of identifying infants with hearing disorders, administering early treatment, and performing appropriate tests in infants at high risk of hearing impairment. When dealing with these babies' treatments such as unnecessary oxygen or antibiotic therapy should be refused.

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