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Original Research Article

Prospective Observational Assessment of Hearing Impairment in Newborns with Birth Asphyxia Admitted to Neonatal Intensive Care Unit

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Abstract

Aim: To find the prevalence of hearing impairment in inborn neonates with birth asphyxia.

Methods: Prospective Observational study was conducted to assess the prevalence of hearing loss in neonates with birth asphyxia admitted to the Department of Pediatrics, SKMCH, Muzaffarpur, Bihar, India. 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: A total of 100 neonates with birth asphyxia were screened with OAE for hearing impairment included in the study. In our study only 7/72 babies with moderate birth asphyxia had hearing impairment as compared to 4/13 babies with severe birth asphyxia had hearing impairment and the difference was statistically significant (P=0.0002). The statistically significant risk factors for development of hearing impairment in babies with birth asphyxia were - Hypoxic ischemic encephalopathy (P=0.005), and mechanical ventilation (P=0.0003).

Conclusion: The prevalence of hearing impairment among term neonates with birth asphyxia was 11%. Two staged screening with OAE, which is a feasible screening test in resource poor set up, can be used as a screening modality for hearing impairment in babies with birth asphyxia.

Keywords: Birth asphyxia; Term neonates; Hearing impairment; Otoacoustic Emission; Auditory brainstem response.

Introduction

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 Apqar scores, infection, and hyper bilirubinemia, 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% [1,2] 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 [3]. Many factors might play a role in placing these NICU babies at an increased risk of hearing loss, including underlying disease processes as well as the treatment they receive [4,5].

The tests of auditory function recommended for use in newborns are the otoacoustic emmission tests (OAEs) and automated auditory brain stem response (AABR). These two methods provide non-invasive recordings of the physiologic activities of the auditory system and also require minimal patient cooperation. Both technologies are affected by fluids and debris in the auditory canal in the first few days of life. AABR reflects the integrity of the entire auditory pathway, while OAEs will only assess the peripheral auditory system [6]. A sensitivity of 85–100% and specificity of 9195% have been reported for OAEs. The automated auditory brain stem response is recommended for use in NICU graduates who have stayed up to 5 days on admission. Two stage screening tests utilizing TOAE and then AABR have been used in large screening programmes to avoid false failed or passed results.

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 [7]. 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 [8]. Thus, this study aims to find the prevalence of hearing impairment in inborn neonates with birth asphyxia.

Material & Methods:

The present prospective observational study was conducted in the department of Pediatrics, SKMCH, Muzaffarpur, Bihar, India.

Inclusion Criteria:

Term neonates born in SKMCH, Muzaffarpur with birth asphyxia defined as Apgar score of < 7 at 1 minute were included in the study as defined by WHO South East Asia, Neonatal Perinatal Mortality Database working definition of Birth Asphyxia [9].

Exclusion criteria:

Neonate with any congenital anomalies was excluded.

Methodology

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.

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 otorhinolarynogologist. 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 OAEscreening. ABR was carried out using Biologic NatusNavigator 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.

Stimulus parameters

Stimulus: Clicks, (100 micro sec duration)

Intensity: start at 90 dBnHL; reduced until peaks were present. Repetition rate – 11.1/second

Recording parameters

Epoch time- 16ms

Averages- 2000

Acquisition parameters

Gain- 100000

Filter setting- 30Hz to 3000Hz

Recording of waveforms was carried out at different intensities starting at 90dB nHL which was further reduced in 10dB steps until peaks were present. Two replications were obtained at each intensity and peaks I, III, V were marked wherever present. The lowest intensity until which Peak V was resent was found and diagnosis would be made based on the same.

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:

A total of 100 neonates with birth asphyxia were screened with OAE for hearing impairment included in the study. 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., 5 babies had mild grade of hearing loss. Two babies 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 7/72 babies with moderate birth asphyxia had hearing impairment as compared to 4/13 babies with severe birth asphyxia had hearing impairment and the difference was statistically significant (P=0.0002). The statistically significant risk factors for development of hearing impairment in babies with birth asphyxia were - Hypoxic ischemic encephalopathy (P=0.005), 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-10.3, CI-2.81-57.21)

Table 1: Baseline Characteristics of 100 Babies

Characteristic	Category		No. (%)	Mean ± SD
Gender	Male		58	-
	Female		42	-
Birth weight	<2.5 kg		25	2.62 ± 0.38
	>2.5kg		75	
Consanguinity	Consanguineous		44	-
	Non consanguineous		56	-
Mode of delivery	NVD		77	-
	LSCS		16	-
	Instrumental delivery		7	-
Meconium Aspiration Syndrome(MAS)	Yes		33	-
	No		67	-
Apgar at 1 minute	4 to 6 (moderate birth asphyxia)		89	-
	≤ 3 (severe birth asphyxia)		11	
HIE	HIE of any stage	Stage 1	8	-
		Stage 2	39	-
		Stage 3	4	-
		Total	51	-
	No HIE		49	-
Hyper bilirubinemia requiring	Phototherapy		16	-
	Exchange transfusion		0	-
Sepsis	Yes		12	-
	No		88	-
Meningitis	Yes		1	-
	No		99	-
Mechanical ventilation	Yes		15	-
	No		85	-
Duration of Mechanical ventilation	< 5 days		9	-
	> 5 days		2	-

Table 2: Grades of Hearing Loss (N=11)

Classification of hearing loss	Right EAR	Left EAR	Bilateral	Total
Mild	1	1	3	05
Moderate	1	1	1	03
Moderately Severe	0	0	1	01
Severe	1	0	1	02
Total	03	02	06	11

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

Characteristics	Category	Hearing Impairment (N=11)	Total no. of babies with birth Asphyxia (N=85)	p-value
Gender	Male	9	49	0.624
	Female	2	36	
Birth weight	<2.5 kg	3	21	0.618
	>2.5 kg	8	64	
MAS	Yes	1	32	0.50
	No	10	53	
Apgar at 1 minute	4 to 6 (moderate birth asphyxia)	7	72	0.0002
	≤ 3 (severe birth asphyxia)	4	13	
HIE of any Stage	Yes	7	40	0.0368
	No	4	45	
HIE	Stage 1	1	28	0.005
	Stage 2	5	48	
	Stage 3	5	6	
Hyper bilirubinemia requiring Phototherapy	Yes	2	15	0.770
	No	9	70	
Sepsis	Yes	3	10	0.702
	No	8	75	
Meningitis	Yes	1	2	0.109
	No	10	83	
Mechanical ventilator	Yes	4	14	0.0003
	NO	7	71	

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	0.75	0.62	- 0.5200	0.619	0.15	2.52
HIE	10.3	9.02	3.2900	0.005*	2.81	57.21
Convulsions	0.05	0.8	- 2.5100	0.071	0.02	2.83
Sepsis	0.42	0.55	- 0.6600	0.712	0.06	7.61
Mechanical ventilation	0.83	1.11	- 0.1400	0.8870	0.06	11.42

Likelihood chi-square = 24.7500, p = 0.0001*

Discussion:

The prevalence of persistent failed hearing screening at follow up in this study (23% of those who failed on admission) was slightly lower than the 25.6% reported by Min Young et al in Korea [10] while the corresponding figure reported by Akinola et al. [11] was 29.3%. The initial high prevalence is thought to be related to the very early age at the initial screening in a large proportion of the participants during which the presence of amniotic fluid and debris in the middle ear canal may have contributed significantly to the initial failed screening but improved with time as this cleared as is naturally expected.

Recognizing and treating hearing loss in its early phase is of critical value, but the economic aspects of screening should be considered [12]. 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].

With regards to mechanical ventilation for more than five days, the data in the literature point to the procedure as an important cause of deafness. The use of phototherapy has also been studied in the literature and we included it as a variable in this analysis because it is a very common procedure in our unit and it involves a high noise level(mean of 45 dB during the day and 35 dB at night, the maximum limit suggested being 58 dB) [14].

Prevalence also varied depending on the definition of with asphyxia. Most of the studies have included babies with severe birth asphyxia. Laxmi. T et al, who conducted a study in 2014 on babies with birth asphyxia with Apgar score of <6 at 1 minute and 5 minutes found the prevalence to be 60% [15].

Seel et al conducted a study on babies with Apgar score of 0-4 at 1 minute and found the prevalence of hearing impairment to be 13.3% [16]. Gouri et al and Patel. R et al found the prevalence of hearing impairment to be 30% and 35.3% respectively [17-18].

Study by Maqbool M et al. in India, got a similar prevalence of 16% at discharge and 10% at follow up [19] while Hee-Joung [20] in Korea reported 13.5% on discharge. These are much higher than the 3.8% among

NICU graduates with risk factors reported by Kong et al also in Korea though they excluded preterms less than 36 weeks and birthweight less than 2,200 g [21, 22].

Conclusion:

The prevalence of hearing impairment among term neonates with birth asphyxia was 11%. Two staged screening with OAE, which is a feasible screening test in resource poor set up, can be used as a screening modality for hearing impairment in babies with birth asphyxia.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.

References:

1. Berg AL, Spitzer JB, Towers HM, Bartosiewicz C, Diamond BE. Newborn hearing screening in the NICU: profile of failed auditory brainstem response/passed otoacoustic emission. Pediatrics 2005;116(4): 933-98.
2. Al-Kandari JM, Alshuaib WB. Newborn hearing screening in Kuwait. Electromyogr Clin Neurophysiol 2007; 47(6): 305-13.

3. Zamani A, Daneshjou K, Ameni A and Takand J. Estimating the incidence of neonatal hearing loss in high risk nonates. Acta Medica Iranica 2004; 42 (3): 176-80.
4. Walton JP, Hendricks-Munoz K. Profile and stability of sensorineural hearing loss in persistent pulmonary hypertension of the newborn. J Speech Hear Res 1991; 34: 1362-70.
5. Salamy A, Eldredge L, Tooley WH. Neonatal status and hearing loss in high risk infants. J Pediatr 1989; 114: 847-52.
6. Joint Committee on Infant Hearing. Year 2007 position statement: principles and guidelines for early hearing detection and intervention programs. Pediatrics (2007) 120:898–921. doi: 10.1542/peds.2007-2333
7. Bahl R. Newborn and infant hearing screening.In: Ivo Kocur, editor.Current issues and guiding principles for action. Geneva. WHO Press; 2010.
8. World Health Organization (WHO). Situation review and update on deafness, hearing loss and intervention programs proposed plans of action for prevention and alleviation of hearing impairment in countries of the South East Asia Region. New Delhi WHO Regional Office for South East Asia; 2007.
9. WHO South East Asia Regional Neonatal-Perinatal Database Report 2007-2008. New Delhi, India: World Health Organization Regional Office for South-East Asia (SEARO); 2008.
10. Min-Young K, Sung-Wook J, Lee-Suk K. Changes in the hearing thresholds of infants who failed the newborn hearing screening test and in infants treated in neonatal intensive care unit. Clin Exp Otorhinol. (2012) 5(Suppl.1): S32–6
11. Nelson HD, Bougatsos C, Nygren P. Universal newborn hearing screening: systematic review to update the 2001 US preventive services task force recommendation. Pediatrics (2008) 122:e266–76.
12. Mezzano P, Serra G, Galevo MG; STERN Group. Cost analysis of an Italian neonatal hearing screening programme. J Matern Fetal Neonatal Med 2009; 22(9): 806-11
13. Grill E. Hessel F. Siebert U. Schnell-inderst P. Kunze S. Nickisch A, Wasem J. Comparing the clinical effectiveness of different newborn hearing screening strategies. A decision analysis. BMC Public Health 2005; 5(1): 12.
14. Vincze, J., & Tiszay, G. V. Some Biophysical Modeling of the Human Circulation Apparatus. Journal of Medical Research and Health Sciences, 2020:3(8).
15. American Academy of Pediatrics. Noise: a hazard for the fetus and newborn. Pediatrics 1997; 100: 724-7.
16. Lakshmi T, Zaheera Sultana S, Brid SV. Brainstem Auditory Evoked Potentials in Birth Asphyxia Infants. J of Evolution of Med and Dent Sci. Oct 2014; 3(49):11749-11754.
17. Aseel Al-Meqbel, Hamad Al-Baghli. The prevalence of hearing in high-risk Infants in Kuwait. Aud Vest Res. 2015;24(1):11-16.
18. Gouri ZU, Sharma D, Berwal PK, et al. Hearing impairment and its risk factors by newborn screening in north-western India. Matern Health Neonatol Perinatol. 2015 Jul 6;1:17.
19. Patel R, Goyani R, Patel D. Hearing Impairment and its Correlates among Newborns at Tertiary Care Hospital of Surat. Ntl J of Community Med. Oct – Dec 2015; 6(4):629-632.
20. Maqbool M, Najar BA,Gattoo I, Chowdhary J. Screening for hearing impairment in high risk neonates: a hospital based study. J Clin Diagn Res. (2015) 9:SC18–21.
21. Hee-Joung C, Ki-Won O, Heng-Mi, K. Auditory Brainstem Response (ABR) results in neonatal intensive care unit

graduates. Korean J Paediatr. (2006), 49:1301–7.
22. Kong SH, Kang JH, Hwang KS, Kim JP, Lee HJ, Choi H, et al. Incidence of hearing loss and importance of risk factors in the neonatal intensive care unit. Korean J Pediatr. (2006) 49:845–50.