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Original Article

A Prospective Study on Hearing Assessment of High-risk Neonates in South Tamil Nadu Population

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Abstract

Background: Hearing loss is one of the major abnormalities present at birth. Delayed recognition of hearing impairment has a significant impact on speech development. Universal hearing screening is the ideal strategy. However, in resource-poor country like ours, there should be screening of high-risk neonates at least.

Methods: This is a prospective study done in neonates with risk factors for hearing impairment (*n* = 100). Initial screening was done by otoacoustic emissions (OAE). Hearing impairment was confirmed with automated auditory brainstem response (AABR). If OAE could not be done, neonates were directly subjected to AABR.

Results: One hundred babies were enrolled in the study and 99 neonates were subjected to OAE testing and one baby was directly subjected to AABR; 2 babies who failed in the initial screening by OAE were also subjected to AABR. All the three babies had abnormal AABR.

Conclusion: The incidence of hearing impairment among high-risk neonates in our study is 3.06%. Hearing impairment is not identified in very low birth weight, meningitis, hyperbilirubinemia, and ventilated babies in our study.

Key words: Automated auditory brainstem response, Hearing loss, High-risk neonates, Newborn screening, Otoacoustic emissions

INTRODUCTION

Hearing loss is one of the major abnormalities present at birth. About one in every thousand children is born profoundly deaf and 4 times as many are born with moderate or severe bilateral hearing loss.[1] Infants in neonatal intensive care units (NICUs) are 10–20 times more likely to have significant hearing loss than the healthy population. In India, the incidence of hearing loss is 1 to 6/1000 live births, with an average of 4/1000 live births.[2] The first 3 years of life are most important for language and speech development. Consequently, for many infants and young children, much of the crucial period for language and speech development may be lost if hearing impairment is not diagnosed in infancy.[3]

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In 1993, a consensus statement from the national institute of health recommended universal newborn hearing screening by the age of 3 months and also stated that otoacoustic emissions (OAE) might be the technology used for screening.[4] OAE was first described by Kemp in 1978. The sensitivity of OAE is 80–98% and that of AABR is 84–90%. Both have specificity of >90%.

The early hearing detection and intervention program of the center for disease control recommend the "1-3-6" plan. This means all children should be screened by 1 month, those children who do not pass the screening test must receive diagnostic audiological testing by 3 months, and children with confirmed hearing loss should be enrolled in an appropriate intervention program by 6 months. This screening will lead to early identification of hearing loss and aid in initiating treatment by the age of 6 months.[5]

METHODS

This is a prospective study on hearing assessment of high-risk newborns, conducted in the NICU of the institute

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of child health and research center, Government Rajaji Hospital, Madurai, over a period of 12 months from October 2018 to September 2019. One hundred neonates with risk factors for hearing loss were recruited for this study. Informed consent from parents was recorded, and approval from the Institutional Ethical Committee was obtained. Neonates with the following risk factors were enrolled for the study [Table 1].[3,6,7]

1. Birth weight <1500 g.
2. Apgar scores of 0–3 at 1 min.
3. Hyperbilirubinemia requiring exchange transfusion.
4. Ototoxic medications – Aminoglycosides and loop diuretics used for >5 days.
5. Mechanical ventilation lasting 5 days or longer.
6. Bacterial meningitis.
7. In utero infections by TORCH group of organisms.
8. Craniofacial anomalies, including those with morphological abnormalities of the pinna and ear canal.
9. Family history of permanent childhood sensorineural hearing loss.

Neonates with the above risk factors were subjected to hearing assessment by OAE after 72 h or at the time of discharge. If the neonate passes the first screening, then the hearing is presumed to be normal. If the neonate fails in the first screening, then the second screening by OAE will be done after 1 month. If the second screening is normal, then the hearing is presumed to be normal, and the baby is advised follow-up every 6 months up to 3 years. If the second screening is abnormal, then the baby is subjected to automated auditory brainstem response (AABR). If OAE could not be done due to anatomical defects of the ear, neonates would be subjected directly to AABR. Based on the results of AABR, early intervention is done.

Table 1: Risk factors

Risk factor	Male	Female	Percentage
Severe birth asphyxia	28	24	52
VLBW	10	10	20
Meningitis	06	04	10
Hyperbilirubinemia	04	04	08
Ototoxic drugs	03	01	04
Ventilated babies	02	01	03
Craniofacial anomaly	02	00	02
TORCH infection	00	01	01

VLBW: Very low birth weight

OBSERVATION, ANALYSIS, AND RESULTS

One hundred babies were enrolled in the study, and 99 neonates were subjected to OAE testing. Sixteen (16.2%) babies failed after the first screening. They include seven babies with birth asphyxia, four babies with very low birth weight, three babies who were treated for meningitis, and two babies for whom exchange transfusion was done for hyperbilirubinemia. One baby with severe birth asphyxia and one baby with hyperbilirubinemia dropped out after the first screening. Twelve out of 14 (85.7%) babies passed the second screening by OAE. Two out of 14 babies (14.3%) failed after the second screening by OAE and were subjected to AABR. One baby was directly subjected to AABR as OAE could not be done due to bilateral atresia of the external auditory canal. Totally three babies were subjected to AABR and all three babies had abnormal AABR [Table 2].

Three (3.06%) babies were diagnosed to have hearing impairment out of 98 high-risk babies (mean = 0.03, S.D = 0.17). To compare the mean of this study with the standard incidence rate, *t*-test has been used. The confidence interval (90%) for the mean is 0.00098–0.05902. The incidence rate is higher in this study as compared to the standard incidence rate but not significant statistically ($P = 0.13$).

Of the 52 babies with birth asphyxia, 45 babies passed the first screening. Two babies had impairment in one ear and five babies had impairment in both ears. One baby with impairment in both ears dropped out. The other six babies were subjected to second screening by OAE after 1 month. Of these six babies, four babies passed the second

Table 2: Results of screening

Risk factor	First screening by OAE		Dropouts	Second Screening by OAE		AABR Done	Abnormal AABR
	Pass	fail		Pass	Fail		
Severe birth asphyxia (52)	45	7	1	4	2	2	2
VLBW (20)	16	4	0	4	0	0	0
Meningitis (10)	7	3	0	3	0	0	0
Hyperbilirubinemia (8)	6	2	1	1	0	0	0
Ototoxic drugs (4)	4	0	0	0	0	0	0
Ventilated babies (3)	3	0	0	0	0	0	0
Craniofacial anomaly (2)	1	0	0	0	0	1	1
TORCH infection (1)	1	0	0	0	0	0	0
Total	83	16	2	12	2	3	3

OAE: Otoacoustic emissions, AABR: Automated auditory brainstem response, VLBW: Very low birth weight

screening and two babies failed the second screening test. These two babies were subjected to AABR.

Of the 20 babies with very low birth weight, 16 babies passed the first screening. Three babies had impairment in one ear and one baby had impairment in both ears. All these four babies were subjected to second screening by OAE after 1 month. All the four babies who failed in the first screening passed when subjected to a second screening by OAE after 1 month and had normal hearing.

Of the ten babies with meningitis, seven babies passed the first screening. Two babies had impairment in one ear, and one baby had impairment in both ears. All these three babies were subjected to second screening by OAE after 1 month. All the three babies who failed in the first screening passed when subjected to second screening by OAE after 1 month.

Of the eight babies for whom exchange transfusion was done for hyperbilirubinemia, six babies passed the first screening. One baby had impairment in one ear and one baby had impairment in both ears. Baby which failed in one ear dropped out. Another baby was subjected to second screening by OAE after 1 month and the baby passed the second screening.

Four babies who received ototoxic drugs were screened and all four babies passed the first screening.

Of the three babies who were ventilated for 5 days, all three babies passed the first screening by OAE.

Two babies had craniofacial malformation. One baby was directly subjected to AABR because OAE could not be done due to bilateral atresia of the auditory canal. The another baby passed the first screening by OAE.

One baby diagnosed with congenital cytomegalovirus (CMV) infection was screened and the baby passed the first screening by OAE.

Two babies who failed in both the screening tests were subjected to AABR and one baby was directly subjected to AABR as OAE could not be done in that baby. AABR was abnormal in all three babies. Of these three babies, two neonates had severe birth asphyxia and one baby had craniofacial malformation. Both the babies have been referred to otorhinolaryngology department for further management [Table 3].

Table 3: AABR for failed second screening test

AABR (*n*=3)	Results
Normal hearing	0
Hearing loss in one ear	1
Hearing loss in both ears	2
Total babies with hearing loss	3

AABR: Automated auditory brainstem response

Table 4: Final outcome of babies with risk factors

Risk factor	Total cases	Normal hearing (%)	Hearing impairment (%)
Severe birth asphyxia	51	49 (96.1)	2 (3.9)
VLBW	20	20 (100)	0
Meningitis	10	10 (100)	0
Hyperbilirubinemia	07	07 (100)	0
Ototoxic drugs	04	04 (100)	0
Ventilated babies	03	03 (100)	0
Craniofacial anomaly	02	01 (50)	1 (50)
Stigmata of TORCH	01	01 (100)	0
Total	98	95 (96.94)	3 (3.06)

VLBW: Very low birth weight

Table 5: Final outcome of screened infants

Outcome	Number of cases (%)
Normal hearing	95 (96.94)
Hearing impairment	03 (3.06)

DISCUSSION

Ideally, all newborns should be screened for hearing impairment before discharge from the birth hospital [Table 4]. However, in developing country like ours, with limited resources, this is not always feasible. Hence, newborns with risk factors for hearing loss should at least be screened. OAE is the technology to be used for screening and AABR for confirmation of hearing impairment.

Fifty-two babies with severe birth asphyxia were screened by OAE, and two babies with birth asphyxia had hearing impairment at the end of the second screening which was confirmed with AABR. A study by Nagapoornima *et al.*[6] who screened 51 babies with severe birth asphyxia and identified hearing impairment in 1 baby. Ohl *et al.*[8] screened 12 babies with severe birth asphyxia and identified four babies with hearing impairment which is much higher than our study.

Twenty neonates who were very low birth weight were by screened by OAE. All the babies passed the hearing screening by OAE. A study by Ohl *et al.*[8] also showed that very low birth weight is not a risk factor for hearing impairment as in our study, in which babies with very low birth weight (VLBW) had normal hearing. A study by Finckh-Kramer *et al.*[9] and Hess *et al.*[10] also concluded that VLBW was not a predictor of hearing impairment as in our study.

Ten babies who were treated for meningitis were by screened by OAE. All the babies passed the hearing screening by OAE. Nagapoornima *et al.*[6] screened

14 babies with meningitis, but none had hearing impairment as in our study [Table 5].

Eight babies who underwent exchange transfusion for hyperbilirubinemia were by screened by OAE. Two babies failed the first screening by OAE. One baby dropped out after the first screening. The another baby had impairment in the left ear and passed when subjected to second screening by OAE. Nagapoornima *et al.*[6] screened 38 babies with severe hyperbilirubinemia requiring exchange transfusion, but none had hearing impairment as in our study.

Four babies who received ototoxic drugs for septicemia were screened by OAE and all four babies passed the screening test. Finckh-Kramer *et al.*[9] concluded that aminoglycosides are not an important risk factor. Similar results were obtained by Hess *et al.*[10] and our study also showed aminoglycosides are not a risk factor for hearing impairment.

Three babies who were ventilated for birth asphyxia and sepsis were screened, and all three passed the first screening by OAE. MohdKhairi *et al.*[11] conducted two-stage hearing assessment in 401 at-risk neonates and concluded that mechanical ventilation of more than 5 days was not an independent risk factor for hearing impairment.

Two babies with craniofacial malformation were included in our study. One baby passed the first screening by OAE. Another baby was directly subjected to AABR as the baby had bilateral atresia of the external auditory canal and the baby had abnormal AABR. Nagapoornima *et al.*[6] screened 24 babies with craniofacial malformation, but none had hearing impairment in contrast to our study, in which 1 of the 2 babies with craniofacial malformation had hearing impairment.

One baby was diagnosed with congenital CMV infection and passed the screening by OAE. Nagapoornima *et al.*[6] screened six babies with TORCH infection, but none had hearing impairment as in our study.

Out of 16 babies who failed after the first screening, two dropped out. Of the remaining 14 babies, 12 babies passed when subjected to second screening. Finally, two babies failed after second screening. These two babies along with the baby who had craniofacial malformation were subjected to AABR and all three babies had abnormal AABR.

Hence, in our study of high-risk screening, three babies had hearing impairment (3.06%) out of 98 and it is higher than the incidence of study by Nagapoornima *et al.* who identified 3 out of 279 high-risk babies (1.07%). Ohl *et al.*[8] screened 1461at risk babies among whom 4.55% were diagnosed as deaf which is higher than our study. The incidence is higher in our study probably due to smaller sample size.

CONCLUSION

Overall incidence of hearing impairment among high-risk neonates is 3.06%. About 3.9% of babies with birth asphyxia were diagnosed to have hearing impairment which is quite high and 1 out of 2 (50%) of babies with craniofacial malformation had hearing impairment. Hearing impairment is not identified in VLBW, meningitis, hyperbilirubinemia, and ventilated babies in our study.

Limitations

Risk factors could not be compared as the number in each group showed variation.

All high-risk babies require hearing assessment every 6 months up to 3 years which could not be done in our study.

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