

Identification of hearing loss in neonates by otoacoustic emission: A cross-sectional study

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Back group and Objectives: Hearing loss can be classified as sensorineural, conductive, or mixed. As far as neonatal hearing loss are concerned, sensorineural is the most common etiology and in about 50% of cases cause which is genetic and among these 50%, approximately 70% have non-syndromic deafness. Congenital sensorineural hearing loss is one of the most common congenital disorders, having an estimated incidence of 1–3/1000 live births. Hearing screening in newborns is performed through otoacoustic emission (OAE) which is an easy bedside hearing screening test and requires no need of sedation for performing the test. The present study has been undertaken with the aim and objective to determine the prevalence of hearing loss in all neonates and compare it with the prevalence of deafness in high-risk neonates. **Methods:** The present cross-sectional study was conducted in all the neonates in the Department of ENT and Pediatrics, at a Tertiary Care Hospital in western Uttar Pradesh for 2 months from July 15, 2019, to September 14, 2019. All the subjects, after getting the consent from their parents, have undergo hearing screening by OAE test by OAE-Maico, the result of it was either “Pass” or “Refer.” **Results:** The overall prevalence of hearing loss was found to be 13.5% and that in high-risk neonates was 9.2%. Out of the total of 19 neonates who failed hearing screening, 11 of them were low birth weight and eight were with normal birth weight. There were 19 cases of assisted ventilation and pathological jaundice, 20 cases of neonatal intensive care unit stay of more than 2 days and all have shown a statistically significant association with hearing loss. **Interpretation and Conclusion:** The present study has helped us in coming to a conclusion that hearing loss in neonates is Multifactorial and prevalence of hearing loss is more among infants with high-risk history.

KEY WORDS: Congenital hearing loss, high-risk neonates, otoacoustic emissions

INTRODUCTION

Hearing loss is measured in logarithmic decibels and for convenience frequencies between 125 Hz (low pitch sounds)

and 8000 Hz (high pitch sounds) are selected for assessment as these frequencies are mostly used in day to day frequency and hearing loss affecting these frequency will cause most disability and lead to affect our day to day work. According to the cause of hearing loss, it can be classified as sensorineural, conductive or mixed. As far as neonatal hearing loss are concerned, sensorineural is the most common etiology and in about 50% of cases cause is genetic and among these 50%, approximately 70% have non-syndromic deafness. They are mostly related to dysfunction of cochlear hair cell. This is, further, linked to errors in the production of the gap junction protein connexin 26. Rest of the causes of neonatal sensorineural hearing loss includes

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infections during antenatal period, hyperbilirubinemia, and use of ototoxic medications in the antenatal and postnatal period. More than 48 h stay in Neonatal intensive care unit is a well-established risk factor which leads to auditory neuropathy and thereby causes permanent hearing loss in neonates.^[1]

Congenital sensorineural hearing loss is one of the most common congenital disorders, having an estimated incidence of 1–3/1000 live births, which is more than the combined incidence of conditions such as congenital hypothyroidism, phenylketonuria, and other inborn errors of metabolism, for which newborns are routinely screened. The prevalence of significant hearing loss ranges from 1.2/1,000 healthy newborn infants and 2–5% in high-risk newborns.^[2,3]

There is a significant increase in number of people with hearing impairment in the time period between 1985 and 2011 from a total of 42 million to about 360 million, respectively, and in this 7.5 million was constituted by children <5 years of age (the WHO global estimates on prevalence of hearing loss [Internet] Geneva: World Health Organization; 2012).

As per the WHO population based survey, there is a 6.3% prevalence of hearing impairment in India.^[4]

According to the US Joint Committee on Infant Hearing position statement, all the children must be screened for deafness by 1 month, diagnosed within 3 months, and necessary interventions undertaken by as early as 6 months.^[5]

The first 28 days of life are very crucial for the newborn as many early-onset hearing impairment originates during this period and is a cause of prelingual hearing impairment and delayed speech development in later life.

Early detection of congenital hearing loss and development of hearing impairment can be detected easily at this stage by appropriate screening method and appropriate intervention is crucial at this stage for timely development of speech, language, and cognition.

At present, hearing screening in newborns is performed through otoacoustic emission (OAE). OAEs are sounds of cochlear origin, which can be recorded by a microphone fitted into the ear canal. They are caused by the motion of the cochlea's sensory hair cells as they energetically respond to auditory stimulation. OAEs provide a simple, efficient, and non-invasive objective indicator of healthy cochlear function. OAEs may be either spontaneous (SOAEs) or induced by acoustic stimulation (EOAEs). OAE is an effective method for neonatal audiological screening both in the general population and in high-risk infants.^[5,6]

OAE is an easy bedside hearing screening test in the newborn with no need of sedation to perform the test. The main prerequisite to perform the test is a silent ambience. so, there should be a silent room near the neonatal intensive care. Other important factor affecting the result by giving false negative results is the accumulation of vernix in the external auditory

meatus,^[7] which can easily be prevented by checking the ear canal with otoscope and cleaning the ear if vernix is present and then perform the test. OAE failure may be higher during the first 24 h of life due to vernix in the ear canal or fluid behind the tympanic membrane. The failure rate is higher with OAEs (7–10%) than AABR (<2–4%) due to the sensitivity of OAEs to outer and middle ear problems.^[8]

Brainstem Evoked response Audiometry (BERA) requires more technical expertise, time consuming, and sedation of the sick newborn which is more often not acceptable for screening procedure and is also expensive.

Risk factors for neonatal hearing screening include: ^[5,6]

1. Family history of permanent hearing loss,
2. Craniofacial abnormalities including those involving the external ear,
3. Congenital infections such as bacterial meningitis, cytomegalovirus, toxoplasmosis, rubella, herpes, and syphilis
4. Physical findings consistent with an underlying syndrome associated with hearing loss
5. Neonatal intensive care unit stay >2 days OR with any of the following regardless of the duration of stay:
 - Extracorporeal membrane oxygenation
 - Assisted ventilation
 - Ototoxic drug use
 - Hyperbilirubinemia requiring exchange transfusion.

Despite these high-risk groups, seldom they show negative result on OAE which implies that not all the high-risk neonates are hearing impaired and cause of hearing impairment is multifactorial. This holds well when the group of neonates without any risk factor gives a negative result on OAE.

Sooner the screening of these neonates is done, better is for the baby and also for their parents so that they can decide their priorities and better utilization of their resources for their child. Seeing on the other side of the problem if these babies are neglected then eventually they are outcaste by the society, and eventually, they become psychological and financial burden on the family. Hence, a timely detection of the problem and appropriate intervention is the solution to this problem.

Some of the treatment and intervention options include:

- Working with a professional (or team) who can help a child and family learn to communicate.
- Getting a hearing device, such as a hearing aid.
- Joining support groups.
- Taking advantage of other resources available to children with a hearing loss and their families.

Newborn hearing screening (UNHS) has been widely adopted throughout North America, Europe and in most other developed regions. However, Indian data among high-risk neonates are limited, and hence, we have taken this study with the aim and objective to determine the prevalence of hearing loss in all neonates and compare it with the prevalence of deafness in high-risk neonates.

MATERIALS AND METHODS

The present cross-sectional study has been conducted in the Department of ENT and Pediatrics, at a tertiary care hospital in western Uttar Pradesh. The study was approved by the Institutional Ethical Committee and the study was funded by Indian Council of Medical Research-Short Term Studentship (ICMR-STs) with Reference ID: 2019-01432.

The study included all the neonates attending department of ENT and Pediatrics during two months from July 15, 2019, to September 14, 2019.

All the neonates attended at our tertiary care hospital that included both outpatient department (OPD) and in patient department (IPD) and fulfilling the selection criteria that were screened for the hearing by OAE after a written consent by their parents.

Selection Criteria

Risk Factors for Neonatal Hearing screening include:

1. Family history of permanent hearing loss,
2. Craniofacial abnormalities including those involving the external ear, congenital infections such as bacterial meningitis, cytomegalovirus, toxoplasmosis, rubella, herpes, and syphilis
3. Physical findings consistent with an underlying syndrome associated with hearing loss
4. Neonatal intensive care unit stay >2 days OR with any of the following regardless of the duration of stay:
 - Extracorporeal membrane oxygenation
 - Assisted ventilation
 - Ototoxic drug use
 - Hyperbilirubinemia requiring exchange transfusion.

Inclusion Criterion

All neonates and parents willing to participate and give consent for the screening were included in the study.

Exclusion Criterion

Neonates with any external ear deformities like canal atresia were excluded from the study.

Data Collection Procedure and Instruments Used

All the subjects, after getting the consent from their parents, have undergone hearing screening by OAE test in the Department of ENT by OAE – Maico, the result of it was either “Pass” or “Refer.” All the “Pass” subjects were supposed to have normal hearing and all the “Refer” Cases were asked to come for follow-up at 3 weeks for repeat OAE as they have high chances to develop sensorineural hearing loss and may be considered for evaluation by BERA.

The data so obtained were noted in a preformed format which included the details of the risk factors also. A proper Confidentiality was maintained by writing only the serial number of the neonate in the format.

Plan of Analysis/Statistical Tool

The observation was analyzed with the help of software provided by Epi info 7 from the WHO website. Analysis was done by Chi-square analysis and *P* value was obtained.

OBSERVATIONS AND RESULTS

The overall prevalence of hearing loss after single-stage screening with Otoacoustic Emission (OAE) was found to be 13.5% and that in high-risk neonates was 9.2% [Table 1].

In the study, there was more number of male newborn (91 neonates) as compared to females (49 neonates), but the number of females and males who did not pass the screening for hearing were almost equal. However, statistically the result was not significant. Hence, gender is not a proven risk factor for hearing impairment [Table 2].

Out of the total of 19 neonates who failed hearing screening, 11 of them were low birth weight and eight were with normal birth weight. The result was found to be statistically not significant [Table 3].

Out of a total of 19 neonates who failed the hearing screening, 16 neonates out of 115 belonged to mother of age less than 35 years, whereas three out of six neonates belonged to mother with age 35 years and above [Table 4].

However, the finding was not statistically significant.

In our study, ten neonates out of 19 with hearing loss were born to multigravida mother and when it was statistically compared with the nine neonates with hearing loss in primigravida the statistical test that was found to be not significant [Table 5].

Table 1: Prevalence of hearing loss

Total screened	Pass	Refer	Prevalence
140	121	19	13.5%
Total high-risk screened	Pass	Refer	Prevalence
20	7	13	9.2%

Table 2: Gender distribution

Sex	Pass	Refer	Total
Male	81	10	91
Female	40	9	49
Total	121	19	140

Chi-square=0.9161, Not significant

Table 3: Result of OAE in terms of birth weight

	Pass	Refer	Total
<2.5	74	11	85
≥2.5	47	8	55
Total	121	19	140

Chi-square 0.0003, *P*=0.98. OAE: Otoacoustic emission

In our study, out of 19 neonates with suspected hearing loss, only four were preterm rest 15 neonates were at term delivery. However, the result was statistically not significant. This implies that the causation is multi- factorial [Table 6].

None of the cases were post-dated.

Out of 19 screened cases with suspected hearing loss, 15 neonates delivered through cesarean section in comparison to four normal vaginal delivery. This association was found to be statistically significant [Table 7].

In our short duration study, there were no cases of craniofacial abnormalities, congenital infection, or with history of oto-toxic drugs or family history of permanent hearing loss, this may be due to regular antenatal care being taken at our tertiary care teaching hospital.

However, there were 19 cases of assisted ventilation and pathological jaundice, 20 cases of NICU stay of more than 2 days, and all have shown a statistically significant association with hearing loss [Table 8].

DISCUSSION

Prevalence of Hearing Loss

Studies done by Zamani *et al.*^[9] and Bhat *et al.*^[10] found a 8 % and 7.69% prevalence of sensorineural hearing loss respectively among high-risk neonates, our study has a comparable result of 9.2% among high-risk neonates.

Table 4: Result of OAE in relation to age of mother

Age of mother	Pass	Refer	Total
<35 years	115	16	131
>35 years	6	3	9
Total	121	19	140

Chi-square=1.65, P=0.198. OAE: Otoacoustic emission

Table 5: Result of OAE in comparison with parity

Parity	Pass	Refer	Total
Multigravida	54	10	64
Primigravida	67	9	76
Total	121	19	140

Chi-square=0.1627, P=0.68. OAE: Otoacoustic emission

Table 6: Result of OAE in comparison with the timing of delivery

Timing of delivery	Pass	Refer	Total
Postdated	-	-	-
Full term	111	15	126
Preterm	10	4	14
Total	121	19	140

Chi-square=1.732, P=0.188. OAE: Otoacoustic emission

Our study has got an overall prevalence of 13.5% and 9.2% among high-risk group which is less than the study done by Ahmed *et al.*^[11] who found 13.3% prevalence among full-term neonates with no associated risk factor and 29% among NICU group.

Result of OAE and Gender

In our study, there was no statistically significant difference in the outcome of OAE among male and female neonates. Same result was found by study done by Cavalcante *et al.*

Similar result was also obtained by Zamani *et al.*^[9] and Bhat *et al.*^[10] that they also did not find any significant relationship between hearing loss and gender.

OAE and Birth Weight

Zamani *et al.*^[9] did not find any significant association between birth weight and hearing loss in neonates. Ahmed *et al.*^[11] found a significant association between hearing loss and low birth weight in his study. Our study also did not find a significant association between hearing loss and low birth weight. As per the discrepancies of different studies, a further study of longer duration with larger sample size is required.

OAE and Mothers Age

Our study did not find a statistically significant correlation between hearing loss in neonates and the age of mother. The probable reason of this can be the younger age of marriage in low socioeconomic class and, as our tertiary care center being a charitable hospital is maximally visited by economically deprived class of society.

Gouri *et al.*^[12] also did not find any significant association between age of mother and hearing loss.

Table 7: Result of OAE in comparison with the mode of delivery

Mode of delivery	Pass	Refer	Total
Cesarean section	47	15	62
Normal vaginal delivery	74	4	78
Total	121	19	140

Chi-square=9.14, P=0.0024. OAE: Otoacoustic emission

Table 8: High-risk history and OAE result

High-risk history	Pass	Refer	Inference
Family history of permanent hearing loss	-	-	-
Craniofacial Abnormalities	-	-	-
Congenital Infection TORCHS	-	-	-
History of ototoxic drugs to mother or baby or both	-	-	-
Assisted ventilation	6	13	Significant
Pathologic jaundice	7	12	Significant
Neonatal intensive care unit stay >2 days	7	13	Significant

OAE: Otoacoustic emission

Comparison of Result of OAE and Timing of Pregnancy

Study done by Farid *et al.*^[13] and Pourarian *et al.*^[14] and Smolkin *et al.*^[15] showed a significant association between hearing loss and preterm delivery but our study differs from them and association between the two was not found to be significant.

The possible explanation can be a smaller sample size collected in just 2 months, whereas these studies were performed from data collected for more than a year at least.

Our study is in agreement with study done by Smolkin *et al.*,^[15] who also found a higher rate of hearing loss in neonates delivered by cesarean section and the study attributed the presence of middle ear fluid as the cause of being refer by OAE.

However, on further investigating after few days, it was normal in many subjects.

Ours is a short-term study, and so, further screening after 3 weeks is essential for final decision.

High-Risk History and OAE

Our study is in agreement with the studies done by Zamani *et al.*,^[9] Farid *et al.*,^[13] and Pourarian *et al.*^[14] who found a positive correlation between hearing loss and several high-risk factors such as Assisted ventilation, NICU stay >2 days, and pathological jaundice.

Hence, these are some of the factors which contribute in the causation of hearing loss in neonates and timely screening is a must in these cases so that a timely intervention can be taken for timely speech development. Furthermore, Bhat *et al.*^[10] suggested from their finding that as the number of risk factor increase, chances of hearing impairment also increases.

CONCLUSION

The present study has helped us in coming to a conclusion that hearing loss in neonates is Multifactorial and prevalence of hearing loss is more among infants with high-risk history. A proper implementation of neonatal hearing screening is must in all neonates, especially in high-risk neonates. If we are able to identify such cases at an early age then only a proper rehabilitation program can be implemented and delayed speech development can be prevented.

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